

The Sun Blade™ 100 Workstation Architecture

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Contents

1. Low Cost, Workstation-class Computing	1
The Sun Blade 100 Workstation.....	1
A Solution for Price-sensitive Customers	3
2. The Sun Blade 100 Workstation Architecture	5
Motherboard	5
The UltraSPARC™-IIe Microprocessor	7
Main Memory Subsystem	12
PCI Connectivity	13
On-board Sun™ PGX64 Graphics	14
Enclosure and Internal Options.....	14
Networking and I/O	16
Power and Power Management	19
Specifications	19

3. Flexible Graphics Architecture	21
Sun PGX64 Graphics.....	22
PGX32™ Graphics.....	23
Sun™ Expert3D-Lite Graphics	24
Graphics and the UltraSPARC-IIe Processor.....	28
Performance.....	28
4. Software	29
Solaris™ Operating Environment.....	29
Support for Graphics Accelerators	34
Software Development Support	38
Open Firmware	40
Diagnostics.....	41
References	43

Low-cost, Workstation-class Computing



Escalating processor clock rates, fast network technologies, and accelerated graphics, are driving increased computing performance at a phenomenal rate. While these advances finally enable the powerful applications that users demand, many organizations remain concerned about cost.

With the introduction of the Sun Blade™ 100 workstation, Sun meets a high standard for integrated technology — delivering the workstation-class features that users require at an affordable price. The Sun Blade 100 captures the manufacturing techniques and economies of scale that have propelled the PC industry, and combines them with Sun's traditional workstation strengths. With the Sun Blade 100 workstation, Sun gives its customers all the cost benefits without sacrificing the quality, reliability, functionality and performance that users have come to expect from one of the world's leading workstation vendors.

The Sun Blade 100 Workstation

As first defined by Sun in 1982, *workstation-class features* include the necessary attributes of a powerful computer used for demanding scientific or engineering applications, such as a powerful CPU, large memory capacity, high-performance graphics that support multiple displays, and highly-integrated networking and I/O. Now these qualities are more relevant than ever with organizations asking for increased productivity — and at the same time trying to eliminate the support costs associated with the PC model.

In today's competitive marketplace, organizations increasingly value the creative talent of their employees and recognize that user productivity not only contributes to the bottom line but can be a key differentiator. Workstation functionality is essential for helping creative workers stay efficient, effective and productive in their jobs.

The Sun Blade 100 provides excellent performance for an entry-priced workstation and provides the features required for essential productivity:

- *UltraSPARC™-Ile processor*

All Sun Blade 100 workstation systems are configured with 64-bit UltraSPARC™-Ile processors. Fully binary compatible with existing software, the UltraSPARC-Ile processor provides a low-cost and low-power implementation of the SPARC® Version 9 architecture.

- *Large main memory*

Support for large memories is essential for efficient operation with today's large applications. For this reason, up to 2-GB of error correcting DRAM is supported in each Sun Blade 100 system. Factor-built memory configurations include 128-MB, 256-MB, and 512-MB.

- *Built-in, accelerated 24-bit graphics*

To meet the needs of today's graphically demanding applications, the Sun Blade 100 features built-in, 24-bit, high-resolution graphics with Sun™ PGX64 graphics. Providing 8-MB of SDRAM, Sun PGX64 graphics supports 24-bit resolutions up to 1280 x 1024 and 8-bit resolutions up to 1920 x 1200. All available Sun monitors are supported including Sun's wide-screen 24-inch monitor and 18-inch flat panel.

Standard configurations are also provided with Sun Expert3D-Lite graphics to support accelerated 3D graphics applications.

- *Internal storage and expansion*

All standard Sun Blade 100 configurations include a 15-GB, 7200-rpm hard drive and space is available to support a second 15-GB drive. An internal 48X-speed ATAPI CD-ROM is also provided along with a standard 1.44-MB floppy drive. A 12x DVD-ROM is provided with Sun Expert3D-Lite configurations. A smart card reader is included standard on all systems.

- *PCI expansion options*

Three PCI slots provide access to a variety of Sun and third-party PCI cards. Additional graphics cards, SCSI expansion cards, networking cards, and audio/video input cards are also available. For example, additional PCI-based PGX32™ or Sun Expert3D-Lite graphics boards can be added to the standard configurations to support multiple displays.

- *Integrated I/O Features*

To satisfy the need for connectivity, the Sun Blade 100 workstation provides a wide range of integrated I/O capabilities including USB, and IEEE 1394 (FireWire) support along with traditional serial and parallel ports. Together, these options provide expandability, increased bandwidth, and access to a multitude of third-party products.

- *Advanced networking capabilities*

As with all Sun workstations, the Sun Blade 100 workstation comes standard with a 100-Mbps Fast Ethernet (100BaseT) connection. The interface is autosensing, enabling it to automatically switch down to 10-Mbps operation. Additional PCI-based networking cards and options can be configured as needed.

- *Solaris™ 8 Operating Environment*

Like its predecessors, the Sun Blade 100 comes pre-installed with the 64-bit Solaris™ 8 Operating Environment — the latest version of Sun's benchmark implementation of System V Release 4 (SVR4) of the UNIX® operating system — and enjoys full binary compatibility with other SPARC-based Sun systems.

64-bit applications can support up to four billion times the amount of data of their 32-bit predecessors. Applications like high-resolution graphics, computer-aided design, simulation, scientific data analysis, and multimedia web servers all benefit from 64-bit support.

A Solution for Price-sensitive Customers

Despite its extensive feature set, the Sun Blade 100 workstation was designed to meet the needs of price-sensitive and volume-purchase customers who do not wish to sacrifice performance or the stability the Solaris Operating Environment.

The Sun Blade 100 workstation is ideal for a wide range of disciplines, including:

- Software development (CASE)
- Digital Content Creation (DCC)
- Electronic Design Automation (EDA)
- Financial
- Research and Development
- Telecommunications
- Mechanical CAD

Due to its streamlined design and small size (Figure 1-1), the Sun Blade 100 is also optimal for customers who are space-constrained. Original equipment manufacturers (OEMs) or builders of embedded systems are an ideal match for the Sun Blade 100 workstation.



Figure 1-1 The Sun Blade 100 workstation

The modular design of the Sun Blade 100 system allows incremental additions of memory as well as I/O and networking options. In addition, any application where graphics performance is required or users need the ability to easily increase memory and disk capacity is easily accommodated.

With carefully balanced performance, a full complement of advanced features, maximum upgradability, expandability, and industry leading price/performance, the Sun Blade 100 platform effectively combines next-generation technology and low cost — continuing Sun's commitment to low-cost, high-performance desktop computing.

The Sun Blade 100 Workstation Architecture



The Sun Blade 100 system was designed to provide workstation-class performance, scalability, and flexibility in an entry-level system. To this end, the use of high volume components and application-specific integrated circuits (ASICs) have resulted in a greatly reduced part count, high reliability, and low cost without compromising access to a full complement of expansion options through high-performance, standardized interfaces.

The following pages describe the Sun Blade 100 workstation architecture in detail. The UltraSPARC-IIe processor, memory subsystem, PCI Bus, significant ASICs, and standard peripherals are discussed. Because the Sun Blade 100 workstation supports some very powerful graphics capabilities, a separate discussion of the on-board Sun PGX64 graphics, as well as PGX32, and Sun Expert3D-Lite graphics options is provided in *chapter 3*.

Motherboard

Sun Blade 100 workstations represent a high level of integration and are implemented on a single NLX form factor motherboard. Features integrated into or supported by the motherboard include:

- Socketed UltraSPARC-IIe processor with integral 256-KB level-two cache
- Four unbuffered, standard PC SDRAM DIMM sockets with ECC error correction
- 10BASE-T/100BASE-T Fast Ethernet, self-sensing
- ATA 66 IDE controller for internal hard disks as well as internal CD-ROM or DVD-ROM drives

- Riser card connector to support three full-size, 32-bit, 33-MHz, 5-volt or universal PCI cards; 3.3-volt internal power is supplied
- Four USB ports (two for Sun type-6 USB keyboard and mouse)
- Two IEEE 1394 (FireWire) ports
- One RS232A asynchronous serial port, DB9 connector
- Centronics compatible parallel port interface, IEEE 1284 Bidirectional, DB25 connector
- CD quality audio with line-in, line-out, headphone, and microphone connectors
- On-board ATI XL graphics accelerator, 24-bit support up to 1280 x 1024 resolution, 8-bit support up to 1920 x 1200 resolution, DB15 connector
 - 8 MB SDRAM
 - Supports 17-inch, 19-inch, 21-inch, and 24-inch color CRTs and Sun's 18-inch TFT flat panel display
- Time of day NVRAM for clock and ID functions
- 1-MB Flash memory for boot PROM

Figure 2-1 depicts the high level system design of the Sun Blade 100 system.

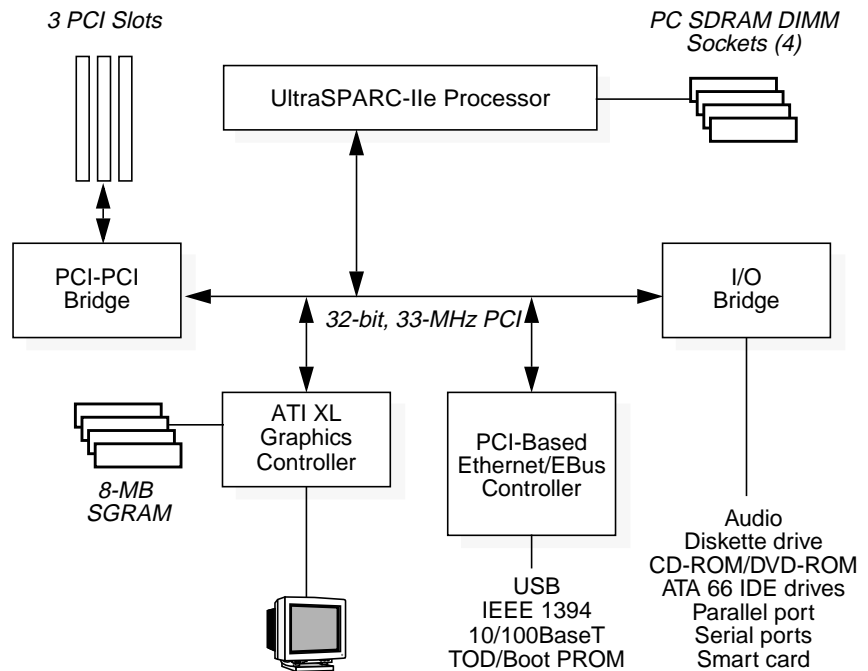


Figure 2-1 Sun Blade 100 system design

The UltraSPARC-IIe Microprocessor

The heart of the Sun Blade 100 platform is the UltraSPARC-IIe microprocessor. Designed for high-performance embedded applications, the processor incorporates on-chip level-two cache along with memory and I/O control to facilitate simple and economical system design. The UltraSPARC-IIe integrates:

- *UltraSPARC-IIe microprocessor* — provides a high-performance, highly-integrated superscalar processor implementing the SPARC-V9 64-bit architecture and VIS™ Instruction Set, running at 500 MHz
- *PCI interface* — supplies a direct interface with a 32-bit PCI version 2.1 compliant bus
- *256K of on-chip level-two cache* — handles instruction and data cache misses efficiently and provides high transfer bandwidth
- *Memory control unit (MCU)* — manages all transactions to the PC SDRAM.

Key Features of the UltraSPARC-IIe Processor

The UltraSPARC-IIe CPU offers the following key features:

- Full 64-bit implementation of the SPARC V9 architecture
- 100% application software binary compatibility with other SPARC processors
- VIS instruction set for accelerated processing of multimedia/graphics or network packet contents
- Four-way superscalar design incorporating six pipes — two integer, two floating-point, one load/store, and one branch
- 64-bit address pointers with transparent 32-bit addressing compatibility
- 16-KB write-through, direct mapped data cache
- Integrated 256-KB level-two cache (unified instruction and data) and controller. Sustained throughput of 1 load per cycle
- Block Load/Store Instructions for increased bandwidth (800 MB/second peak bandwidth)
- Integrated PCI 2.1-compliant controller, 33/66-MHz, 32-bit, 3.3-volt interface
- Integrated PC SDRAM memory interface
- JTAG boundary scan and special performance instrumentation to support product development and testing
- 0.18 micron six-layer metal CMOS process.
- On-chip power management
- 370 pin CPGA packaging

The UltraSPARC-IIe also supports both 2D and 3D graphics as well as image processing, video compression and decompression, and video effects through the sophisticated VIS instruction set. VIS provides high levels of multimedia performance, including real-time H.261 video compression/decompression and MPEG-2 decompression.

UltraSPARC-IIe Processor Functional Units

UltraSPARC-IIe processor features a very high level of integration in a single-chip (Figure 2-2). Its SPARC-V9 compliant implementation consists of a integer execution unit with two ALUs, a floating-point/graphics unit, a memory controller unit, integrated level-two cache, PCI interface module, and instruction and data caches.

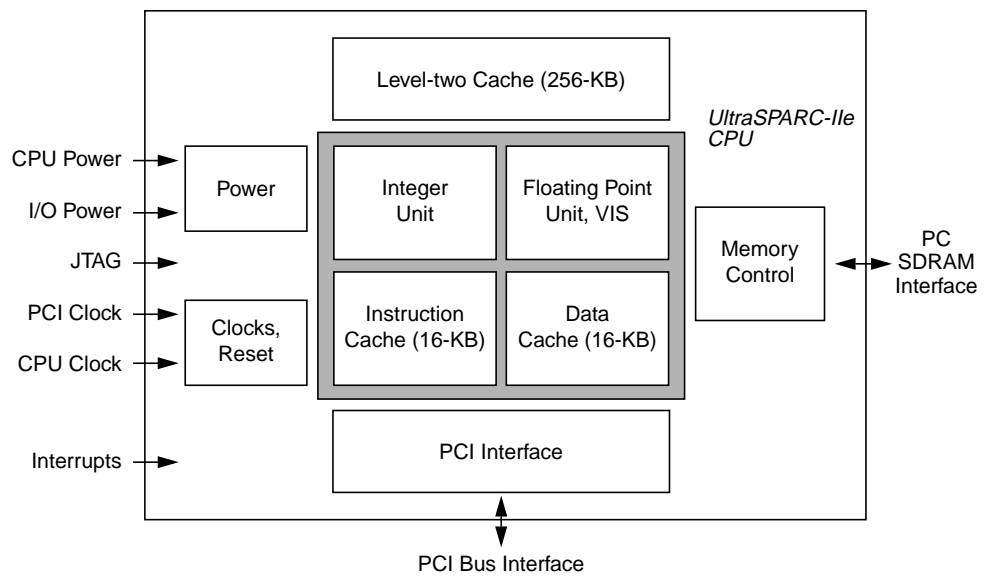


Figure 2-2 UltraSPARC-IIe processor functional block diagram

Integer Execution Unit (IEU)

The integer execution unit (IEU) is designed to maximize performance while maintaining full software compatibility — minimizing architectural changes to host software. The UltraSPARC-IIe IEU incorporates several important features:

- 2 ALUs for arithmetic, logical, and shift operations
- A multi-cycle integer multiplier with early-finish detection
- A multi-cycle integer divider
- 8-window register file
- Result bypassing
- A completion unit that allows a six-stage pipeline with minimal bypasses

Floating-Point Unit (FPU)

The UltraSPARC-IIe processor floating-point unit (FPU) is a pipelined floating-point processor that conforms to SPARC-V9 architecture specifications. Its IEEE-compliant design consists of five separate functional units to support floating-point and multimedia operations. The separation of execution units enables the UltraSPARC-IIe to issue and execute two floating-point instructions per cycle. Source and data results are stored in a 32-entry register file. Most floating-point instructions have a throughput of one cycle, a latency of three cycles, and are fully pipelined. The FPU is able to operate on both single-precision (32-bit), and double-precision (64-bit) numbers (normalized or denormalized) in hardware, and quad-precision (128-bit) operands in software.

The UltraSPARC-IIe processor provides a comprehensive set of instructions for graphics operations that provide fast hardware support for 2D and 3D graphics, image manipulation and compression, and video and audio processing. 16-bit and 32-bit partitioned add, Boolean, and compare functions are provided, as are 8-bit and 16-bit partitioned multiplies. Single-cycle pixel distance, data alignment, packing, and merge operations are all supported.

Integrated Level-two Cache

The UltraSPARC-IIe processor further boosts performance and integration by providing a 256-KB, on-chip level-two SRAM cache. This secondary cache is a unified instruction and data cache that can operate in either four-way associative or direct-mapped mode. Preliminary analysis has shown that in many applications, the on-chip, four-way set associative cache performs as

well, or better, than an external direct-mapped cache over twice its size. An integrated cache control unit interfaces the level-two cache to the CPU, memory, and PCI subsystems, arbitrating their requests for data from the external SDRAM memory.

Memory Controller Unit (MCU)

UltraSPARC-IIe processors also employ an on-chip memory controller unit (MCU). This I/O subsystem handles input and output between local resources, including the processor, main memory, control space, and all external system resources. Specifically, all transactions to the system, such as level-two cache misses, interrupts, snoops, and writebacks are handled by the MCU.

PCI Controller

The UltraSPARC-IIe processor incorporates an on-chip PCI controller — eliminating the need for external controller chips. Compliant with version 2.1 of the PCI specification, the PCI controller enables the UltraSPARC-IIe to interface directly with the PCI bus. The PCI controller is optimized for 16-, 32-, and 64-byte transfers, and can support up to four PCI bus masters. While the PCI address space is non-cacheable for CPU references, coherent DMA is supported. All reads and writes to memory from PCI are cache coherent, and interrupt handling is synchronized to the completion of all prior DMA writes.

The PCI controller includes support for the following features:

- Single 64-byte DMA read/write buffer, single 64-byte PIO read/write buffer
- 64-bit addressing (dual address cycle) for DMA bypass
- Fast back-to-back cycles as a DMA target
- Industry-standard 3.3-volt signaling

Cache Architecture

The UltraSPARC-IIe processor provides both level-one instruction and data caches in addition to the on-chip level-two cache.

- *Instruction cache*

The instruction cache (I-cache) is a 16-KB two-way set associative cache with 32-byte blocks. The cache is physically indexed and contains physical tags. The set is predicted as part of the next field so that only the index bits of an

address are necessary to address the cache (13 bits which matches the minimum page size). The instruction cache returns up to 4 instructions from an 8 instruction-wide line.

- *Data cache*

The UltraSPARC-IIe processor data cache (D-cache) is a 16-KB direct mapped, software selectable write-through non-allocating cache that is used on load or store accesses from the CPU to cacheable pages of main memory. It is a virtually-indexed and virtually-tagged cache. The D-cache is organized as 512 lines with two 16-byte sub-blocks of data per line. Each line has a cache tag associated with it. On a data cache miss to a cacheable location, 16 bytes of data are written into the cache from main memory.

VIS Instruction Set

The UltraSPARC processor was the first general-purpose processor to fully support advanced multimedia and networking. By introducing a comprehensive set of multimedia instructions, known as the VIS instruction set, the UltraSPARC processor provides enhanced hardware support for 2D and 3D graphics, video and audio processing, and image manipulation.

- *Image data manipulation*

The graphics unit in UltraSPARC-IIe processor relies on the integer registers for *addressing* image data and the floating point registers for *manipulating* image data. This division of duty between the integer and floating point registers enables UltraSPARC-IIe to make use of all available internal registers, maximizing throughput.

The UltraSPARC-IIe CPU also includes a variety of instructions that are essential for advanced image manipulation. For example, the UltraSPARC-IIe processor supports a filtering operation for scaling, rotating, and smoothing images. The filtering operation processes four pixels at a time, giving the UltraSPARC-IIe an order of magnitude performance advantage over other processors.

- *Motion estimation*

By performing motion estimation, the UltraSPARC-IIe processor is able to support motion compensation — a technique used to code real-time video for compression — greatly accelerating multimedia applications. Motion estimation takes advantage of the minimal changes in the position of images from one frame to the next. The processor performs hundreds of

comparisons for a region of the image, searching for a motion value that minimizes the estimation error. The error is calculated by summing the differences for each pixel in the region between a reference frame and a newer frame.

The UltraSPARC-IIe processor minimizes this compute-intensive operation by operating on eight pixels at a time. The motion compensation process for eight pixels requires eight subtractions, eight absolute values, eight additions, a load of eight pixels, an align of eight pixels, and one final addition. The UltraSPARC-IIe CPU performs this complex set of operations for eight pixels in just one clock compared to the minimum of 48 instructions and numerous clocks typically required by other processors. Because motion estimation is the dominant operation for compression, the UltraSPARC-IIe's high throughput for this operation allows it to support compression for desktop video conferencing without the aid of external circuitry.

- *High performance*

Unique block load/store commands in the UltraSPARC-IIe CPU allow the processor to execute 64-byte loads and stores directly into main memory. The block load/store commands avoid “cache pollution” by eliminating data allocation to external cache. With the resulting high copy bandwidth, the UltraSPARC-IIe processor can move images directly from main memory to the screen fast enough to eliminate image flicker.

Although VIS was created to accelerate the manipulation of graphics data, it handles other types of partitioned data just as well. Other uses of VIS include the processing of audio data and encryption/decryption applications.

Main Memory Subsystem

The memory system in the Sun Blade 100 workstation uses four standard PC 133 SDRAM DIMMs — supporting 64 bits of data and 8 bits of ECC error correction. The systems support 128-MB, 256-MB, and 512-MB modules for increased memory capacity. Maximum memory capacity is 2 gigabytes in Sun Blade 100 systems. DIMMs can be added individually and different capacity DIMMs can be combined in a single system.

PCI Connectivity

In addition to its commitment to expand the capacity and performance of all of its systems, Sun is continually looking for ways to increase their openness and standards compliance. Choosing PCI as the system bus for the Sun Blade 100 system leverages the strengths of this industry standard:

- *PCI is an open, architecture-independent bus*
Because PCI is open and shipping in volume, it has been quickly adopted by both consumers and producers of computer hardware. As a result, significant numbers of platform-independent PCI solutions are available for integration in to the Sun Blade 100 workstation.
- *PCI is standardized*
PCI is a standard bus architecture that has been adopted by the volume personal computer industry. Because of its wide acceptance, PCI promises that compliant adapter cards will be available from more sources than ever before.

PCI provides a high-performance bus that is optimized for high-speed data transfers. System-board resident, the PCI bus operates at high speeds and is used as an interconnect between highly integrated components and subsystems, such as peripherals and add-on boards. The processor and main memory communicate with the PCI bus at 33 MHz on Sun Blade 100 systems.

The PCI bus is based on the industry standard PCI specification version 2.1. Unlike most standards, the PCI specification is very broad. It covers everything from multiple form factors and voltages to connector types. Sun has chosen to implement the most common options available on the Sun Blade 100 workstation:

- 33-MHz bus
- 32-bit cards
- 5-volt cards
- 7-inch (short) cards
- 12-inch (long) cards
- PCI Specification 2.1 compliance
- Low power operation, Energy Star compliance (on most configurations)

To sustain the performance level on Sun Blade 100 systems, a PCI-PCI bridge chip connects two logically separate PCI buses. The system's three PCI slots utilize an "external" 32-bit, 33 MHz bus running at 5 volts. A second 32-bit, 33-MHz PCI supports on-board 3.3-volt devices including an I/O bridge, a PCI-based Ethernet/EBus controller, and PCI-based Sun PGX64 graphics.

Sun offers support for a variety of PCI-based adaptor cards, including Ethernet, Fast Ethernet, Gigabit Ethernet, ATM, Token Ring, and FDDI networking cards, as well as video, SCSI, and high-speed serial and parallel interfaces. In addition, Sun is working with a host of third-party partners to develop PCI hardware and software that is certified for operation on Sun Blade 100 systems running the Solaris Operating Environment.

On-board Sun PGX64 Graphics

Sun has long appreciated the importance of graphics performance in the technical workstation market. Today, Sun offers products with some of the best graphics price/performance available anywhere. The Sun Blade 100 workstation continues this trend by providing support for 8-bit/24-bit Sun PGX64 graphics directly on the motherboard. Details of Sun PGX64 graphics along with other PCI graphics options are provided in *chapter 3*.

Enclosure and Internal Options

The Sun Blade 100 workstation enclosure was designed to provide convenience and ease of serviceability. Besides being easy to open and service, all connections are color-coded for quick identification. For physical security, a Kensington security lock can be affixed through an opening in the chassis.

The Sun Blade 100 workstation enclosure accommodates outstanding expansion opportunities (Figure 2-3). In addition to affording room for PCI expansion cards, the enclosure provides:

- Two 3.5-inch front accessible bays for the standard 1.44-MB diskette drive and smart card reader
- One 5.25-inch full-height bay for the standard CD-ROM or DVD-ROM
- Two 3.5-inch bays provide room for internal ATA/66 IDE mass storage devices

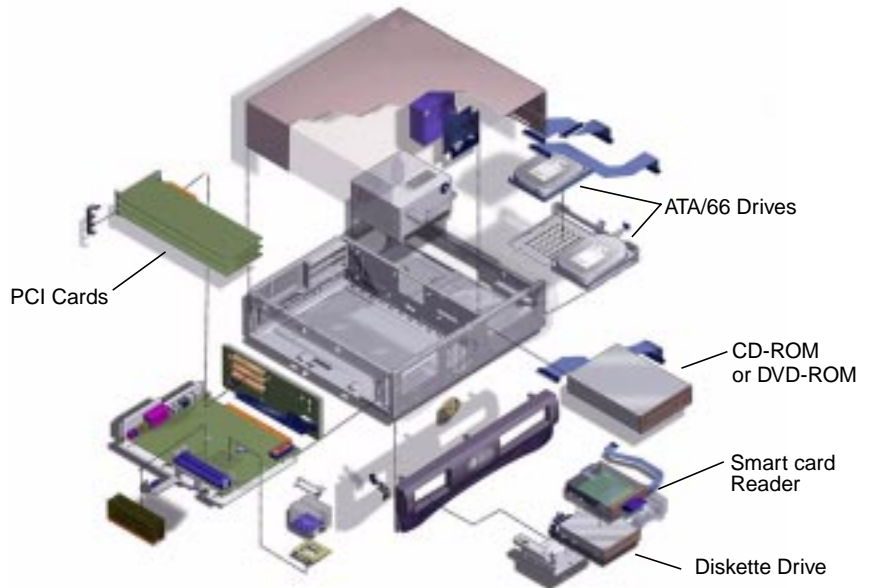


Figure 2-3 The Sun Blade 100 system enclosure

All Sun Blade 100 systems support external disk options and tape library systems via PCI-based SCSI host bus adapters. A number of Sun StorEdge™ mass storage products are supported for high-reliability storage and backup needs.

Networking and I/O

In addition to internal expansion options, Sun Blade 100 systems support a full complement of I/O connections through connectors on the back panel (Figure 2-4).

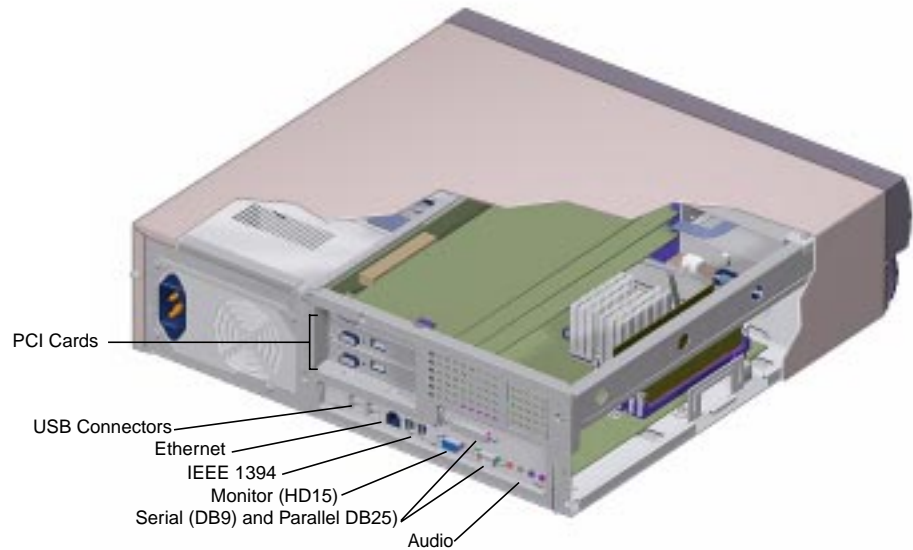


Figure 2-4 In the tradition of earlier Sun workstations, the Sun Blade 100 systems feature strong connectivity options

The standard list of connectors includes:

- Fast Ethernet (100BaseT)
- Serial-port (DB9 connector)
- Centronics-compatible parallel port (DB25 connector)
- USB (four ports, two for keyboard and mouse)
- IEEE 1394 (two ports)
- Audio ports (microphone, headphone, line in/out)
- Monitor port (HD15 connector)

As illustrated, PCI cards mount horizontally with any connectors exposed to the back panel.

Ethernet

To support higher performance networking connectivity, all Sun Blade 100 systems provide 100-Mbps Fast Ethernet technology. Sun's Fast Ethernet interface is backwards compatible with 10-Mbps Ethernet, with the interface able to auto-sense the speed of the network. The Ethernet interface on Sun Blade 100 systems supports access to Category 5 twisted pair through an RJ45 connector.

ATA/66 IDE (Internal)

Sun Blade 100 systems provide internal support for the Advanced Technology Attachment (ATA) Integrated Drive Electronics (IDE) peripheral interface. Running at 66.6 MB/second, the ATA/66 interface, offers equivalent performance at significantly lower cost than comparable SCSI disk drives. Sun Blade 100 systems can support two internal EIDE devices in its two drive bays.

Serial Port

An RS-232 serial port provides a convenient way to connect Sun Blade 100 systems to devices such as modems and terminals. All systems include one asynchronous RS423A port with a DB9 connector.

Parallel Port

The IEEE 1284 bidirectional parallel port can be operated using programmed I/O or DMA. Its interface direction, timing, and protocol is programmable to meet the wide variety of Centronics interfaces that exist on peripheral devices. Access to the parallel port is through a DB25 connector located on the backpanel.

USB

Sun Blade 100 systems provide four USB ports on the back panel for support of both low-speed (1.5-Mbps) and full-speed (12-Mbps) devices. A maximum of 126 USB devices are supported and the bus can be easily extended via self- or bus-powered hubs. USB devices support hot-plug capabilities so device attachment is automatically detected and drivers and software automatically configured.

A variety of USB devices are supported via standard administration utilities such as mass storage devices (i.e. Iomega ZIP drives), USB hubs, and various USB-connected PostScript printers. Vendors providing other third-party USB devices must also supply drivers for the Solaris Operating Environment.

A Sun Type-6 USB keyboard and USB opto-mechanical mouse are standard with each Sun Blade 100 system. Users can choose between the common IBM AT 101-key keyboard or one with a UNIX layout. Both keyboards include keys for controlling audio and for turning the system on and off.

IEEE 1394

IEEE 1394 — also known as FireWire — has emerged as a new standard for medium speed devices such as digital cameras and digital video cam-corders. IEEE 1394 provides an isochronous service which guarantees latency along with providing the needed 400-Mbps bandwidth for transferring large images and other multimedia data. Two IEEE 1394 connectors are provided on the back panel of the Sun Blade 100 workstation.

Audio

On-board audio capabilities help Sun Blade 100 provide high-quality audio utilizing an internally-mounted speaker as well as through external audio connectors.

The audio subsystem employed in Sun Blade 100 systems supports a variety of standard sampling rates, including:

- 16-bit 48-KHz Digital Audio Tape (DAT)
- 16-bit 44.1-KHz CD
- 16-bit 16-KHz medium-quality audio for applications like speech processing
- 8-bit 8-KHz standard telephony

The backpanel provides a variety of audio connectors that connect Sun Blade 100 systems to standard audio equipment such as amplifiers and tape recorders.

Monitors

All Sun Blade 100 systems support a family of Sun monitors, including:

- 17-inch CRT
- 18-inch TFT flat panel
- 19-inch CRT
- 21-inch CRT
- Wide-screen 24-inch CRT

Power and Power Management

Sun Blade 100 workstations come equipped with a 200W, auto-voltage sensing, switched power supply. The power supply provides all the power needed for internal expansion options. The auto-voltage sensing feature allows the power supply to accommodate both U.S. and EMEA power factors without user intervention (known as power factor correction).

Sun has also recognized the need for environmentally-sensitive construction and operation of its systems. Configurations without Sun Expert3D-Lite graphics are compliant with Tier 2, Guideline B of the EPA's Energy Star 3.0 MOU. When the Sun Blade 100 system is in a power managed state, the maximum power consumption will be 30 watts or less.

The Sun Blade 100 system accomplishes Energy Star compliance by dropping its internal operating frequencies. The system remains “network aware” — and able to respond to all types of network requests — even in a power managed state.

Specifications

Factory-built configurations of the Sun Blade 100 workstation meet all relevant domestic and international agency safety, ergonomics, EMI, and environmental requirements:

- *Safety*
UL 1950, CSA C22.2 No. 950, EN 60950, CB Scheme with all Country Deviations including Nordic EMKO-TSE (74-SEC), IEC825-1, 2, and CFR21 part 1040

- *Ergonomics*
EN 29241-3, -7, -8, ISO 9296, EKI 59-98, EKI 60-98, BildscharbV, A15 and A17, ISO 9241-4 and DIN2137
- *RFI/EMC*
FCC Class B, ICES-003 Class B, VCCI Class B, EN55022 Class B, BSMI Class B, EN61000-3-2, EN61000-3-3
- *Immunity*
EN55024

Flexible Graphics Architecture



Sun understands that graphics is rapidly shifting away from being a specialized requirement of technical users and is becoming an essential part of nearly every computing discipline. Sun believes that as this trend continues, the standards for graphics functionality and performance will continue to rise. Sun Blade 100 systems anticipate this trend by providing full featured graphics options at breakthrough prices.

Rather than viewing graphics as an add-on subsystem, Sun engineers have taken a systematic approach that includes graphics as a highly-integrated core element of system architecture. Even earlier generation Ultra systems were designed with a graphics architecture that could not only withstand the rigors of current requirements, but one that could excel and scale for years to come. Today this approach has resulted in several key areas of focus:

- *Performance and functionality*

Sun strives to build superior performance and extensive functionality into its graphics products with more standard functionality in each new generation. Features like 24-bit graphics, video decompression, 3D graphics, and high resolution are a standard part of the system, not expensive options.

- *Cost-effective platforms*

At the same time, Sun works to design new graphics systems that are affordable, even in large deployments. At the low end this means designing systems with advanced graphics features that are economical enough to be included as standard equipment on high-performance desktop systems. On higher-end systems this approach implies innovation and a high level of

integration and use of new technologies. With each new generation, Sun continues to drive high-end functionality into continually lower-priced platforms.

- *Software compatibility*
Sun recognizes that the real costs associated with any platform are likely to be software related — the days of releasing accelerators with proprietary graphics languages are long-gone. Any new graphics system Sun designs must be compatible with the large set of existing graphics libraries, and must transparently accelerate software written to existing APIs.

In addition to the standard on-board Sun PGX64 graphics, Sun Blade 100 systems support the addition of multiple additional PCI-based graphics options including the PGX32 and Sun Expert3D-Lite boards. Through the Solaris Operating Environment, Sun Blade 100 systems can display to multiple graphics options simultaneously allowing multi-headed operation. If all three PCI slots are available, a maximum of four displays can be supported on a single Sun Blade 100 system.

Table 3-1 briefly describes each graphics option and indicates the maximum number of each board type supported in the system.

Graphics	Description	Capabilities	Maximum number per system
Sun PGX64	Standard, on-board	2D graphics and imaging	1
PGX32	PCI-based option	2D graphics and imaging	3
Sun Expert3D-Lite	PCI-based option	2D and 3D graphics with hardware texture mapping	2

Table 3-1 Supported graphics options in the Sun Blade 100 workstation

Sun PGX64 Graphics

To take advantage of commercially available, low-cost components, Sun Blade 100 systems utilize on-board, Sun PGX64 graphics featuring the 64-bit ATI Rage XL graphics controller chip and 8 MB of SGRAM. A highly integrated graphics controller, the ATI chip includes 2D and video accelerators,

palette DAC, and a dual-clock synthesizer to provide low-cost, 8-bit and 24-bit color graphics that is accessible via a standard VGA connector (DB15) from the back panel of the motherboard.

The on-board Sun PGX64 graphics provides a host of standard features on the Sun Blade 100 workstation:

- 8-bit and 24-bit color
- Wide range of resolutions, up to 1280 x 1024 (24-bit) and 1920 x 1200 (8-bit)
- 2D and windowing acceleration
- OpenWindows™ and CDE support
- XIL™, XGL™, and X-Windows support along with software pipeline support for OpenGL®, Java 3D™, and the Java™ Advanced Imaging API
- Hardware acceleration, including rectangle fill, line draw, polygon fill, planning/scrolling, bit masking, monochrome expansion, scissoring, and full ROP support
- Packed pixel support for true color
- Large command and display FIFOs (48 and 24 double-words respectively)
- High-performance FIFO management to memory controller
- 8 x 8 x 8 SRC brush support
- Quick setup with alias registers

PGX32 Graphics

The PGX32 graphics framebuffer is ideal as a low-cost addition to Sun Blade 100 systems — providing support for additional displays. Like Sun PGX64 graphics, PGX32 graphics provides economical 8-bit and 24-bit graphics through a standard VGA HD-15 connector (13W3 video adaptor provided). A low-cost, high-volume graphics board, the PGX32 frame buffer provides a host of standard features:

- Low-cost, PCI-based 8-bit and 24-bit color
- 8 MB of video RAM provide support for a wide range of resolutions, up to 1280 x 1024 true color (24-bit) and 1600 x 1280 in pseudo-color (8-bit color)
- 2D windowing acceleration
- OpenWindows and CDE support
- XIL, XGL, OpenGL, Java 3D and Java Advanced Imaging API support along with X Windows support
- An 8-bit overlay plane allows 8-bit windows to be superimposed on 24-bit visuals without damaging underlying visual for seamless window integration and manipulation

- Hardware acceleration, including rectangle fill, line draw, polygon fill, planning/scrolling, bit masking, monochrome expansion, scissoring, and full ROP support
- Packed pixel support for true color

The PCI 33-MHz card format helps ensure high performance and allows for multi-headed display — with up to three PGX32 frame buffers in one system — an important capability for users who need to monitor multiple tasks simultaneously or for special applications. For example, *Xinerama* support in the Solaris 8 Operating Environment allows images and applications to share two or three PGX32 frame buffers for 2D environments.

Sun Expert3D-Lite Graphics

User productivity is often tied to better system interactivity — particularly when operating on complex graphical data. The need for high-end graphics support continues to increase along with the desire to leverage the skills of valuable technical personnel. These key users need to simulate and visualize complex problems and data in order to gain insight and understanding — tasks frequently essential to an organization's core mission or business. Examples of these demanding applications include high-end MCAD/MCAE, seismic data visualization for oil and gas exploration, terrain mapping for GIS, auto-styling applications in mechanical computer-aided design, digital content creation, and medical imaging applications that rely on 3D graphics to analyze patient data.

Sun Expert3D-Lite graphics is based on the high-end Sun Expert3D graphics design — providing slightly lower 3D graphics performance and smaller dedicated texture memory — at a significantly lower cost. Sun Expert3D-Lite graphics performance is similar to that of the Sun Elite3D m3 graphics accelerator except that Sun Expert3D-Lite graphics provides hardware acceleration for texture mapping through 16-MB of dedicated texture memory.

Sun Expert3D-Lite graphics offers high-end 3D graphics performance and functionality including support for accelerated texture mapping with on-board texture memory and state-of-the-art handling of color and gamma correction. The Sun Expert3D-Lite accelerator supports monitor refresh rates up to 112 Hz and provides double-buffered/Z-buffered support for 3D graphics up to resolutions of 1920 x 1080 with support for stereoscopic 3D applications up to 1152 x 900 resolution at 112 Hz.

Sun Expert3D-Lite provides significant features not found in other accelerators:

- *On-board 3D geometry accelerator.* Accelerates 3D geometry up to 4 million triangles per second with up to 3.2 GFLOPS of floating point performance
- *On-board rasterization engine.* Performs triangle setup, texture processing, and all pixel operations in rasterization, with a peak performance of 60 million pixels per second (trilinear) fill rate
- *32 MB of on-board frame buffer memory.* Supports 24-bit 2D and 3D graphics up to 1920 x 1080 and all Sun displays, including the Sun 24-inch monitor. Allows users to display all windows with minimal or no overlapping. High 3D resolution at 1920 x 1080 provides more image detail and higher accuracy.
- *16-MB of on-board dedicated texture memory.* Provides significant texture-mapping acceleration, allowing complex true-color 2D and 3D textures for applications that require texture mapping
- *Supports stereoscopic video graphics at 1152 x 900 resolution at 112 Hz.* Allows display of 3D data in stereoscopic graphics mode at a high resolution providing enhanced realism for immersive applications and environments.
- *Multi-display support.* Allows users to run multiple displays when multiple Sun Expert3D-Lite cards are installed. Applications can span multiple displays for command and control applications, animation, automotive design and analysis, and other demanding applications. Up to two Sun Expert3D-Lite accelerators are supported in each Sun Blade 100 system
- *True-color double- and Z-buffering at up to 1920 x 1080 resolution.* Allows users to employ large-screen super-high-resolution monitors, including Sun's 24-inch HDTV-style monitor to display 2D and 3D graphical data.
- *32-bit Z-buffer at all resolutions.* Provides a high level of three-dimensional accuracy, eliminating anomalies such as the flickering of objects when moving around in a 3D image

Sun Expert3D-Lite graphics is implemented as a full-length PCI graphics card and provides a standard HD-15 interface along with a VESA standard 3-pin mini-DIN stereo connector. Automatic acceleration is provided for Sun 2D and 3D graphics APIs including Xlib, OpenGL, and Java 3D APIs. For example, Sun Expert3D-Lite graphics provides acceleration for the following Sun OpenGL for Solaris™ API operations:

- Points (2D, 3D, wide)
- Vectors (2D and 3D lines and linestrips; wide and stippled)
- Polygons (triangles, triangle strips, quads, quad strips, polygons, and point/line polygon mode)
- Antialiased points, vectors, and polygons
- Image support (multiple formats, zoom, bilinear scaling, color matrix, and color tables)
- Alpha operations
- Scissoring
- Window clipping
- Masking
- Double-buffered overlay
- Fogging (linear, exponential, exponential**2, user-defined)
- Texture mapping (point, bilinear, trilinear, and multiple internal formats)
- Stencil operations
- Dithering
- Rich set of blending operations
- Depth buffering (32 bit, integer and floating point depth formats)
- Hardware Pbuffer operations
- Fast window clears
- Fast window-mode double buffering
- Frame-sequential stereo support
- Texture mapping features:
 - Support for 64 MB of texture memory
 - 2D and 3D nearest/linear/mip-mapped textures
 - 1, 2, 4, or 8 bytes/texel
 - 1, 2, 3, or 4 components/texel
 - Texture scale and bias; texture lookup table
 - Texture environment blending functions
 - Stencil plane support

Sun Expert3D-Lite Architecture

The Sun Expert3D-Lite graphics system shares the architecture of Sun Expert3D graphics (Figure 3-1).

- The *bus interface ASIC* provides the host bus (64-bit/32-bit PCI) interface for the card, supporting up to 64 MB of local request memory — referred to as direct burst memory. Sun Expert3D-Lite graphics features 8 MB of direct burst memory.

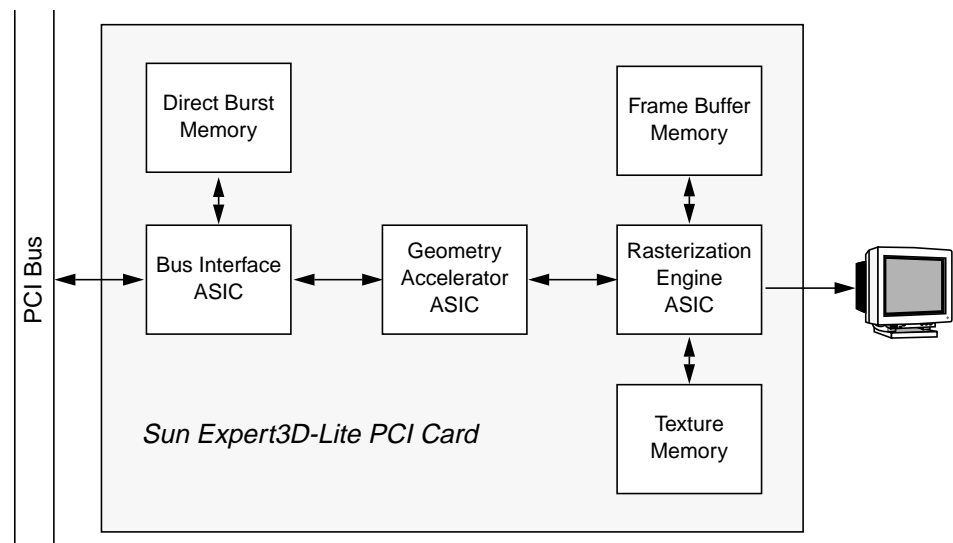


Figure 3-1 The Sun Expert3D-Lite board high-level architecture

- The *geometry accelerator ASIC* performs transformations, clipping, and lighting
- The *rasterization engine ASIC* performs 2D and 3D rasterization, 2D and 3D texturing, pixel transfers, imaging, and fragment processing.
- The *texture memory* is 16 MB of SDRAM
- 32 MB of *frame buffer memory* is provided. The frame buffer memory is integrated with the rasterization engine and uses a high-resolution DAC to provide 10-bit RGB analog video output at dot rates up to 350 MHz.

Graphics and the UltraSPARC-IIe Microprocessor

Throughout the design of the Sun Blade 100 workstation, computational power was applied where it could best benefit graphics. In particular, the UltraSPARC-IIe processor and its VIS instruction set contribute greatly to graphics performance. As a result, much of the image processing in Sun Blade 100 systems can be handled by the CPU, an approach with many advantages:

- *Better performance in memory-intensive tasks*
When processing is done in the CPU, images can be held in system memory. Because many image processing algorithms operate on neighboring pixels, the system cache and MMU can help to dramatically speed these functions.
- *Scalable performance*
By giving image processing operations to the CPU, scalability can be achieved by adding faster or larger numbers of processors to the system. Many image processing functions can also benefit from parallel execution on multiprocessor machines.
- *Faster rendering*
Most image processing is performed in a pipelined fashion with the results of one operation serving as the input image for another, with only the final image being displayed to the screen. With Sun's UltraSPARC-IIe based graphics systems, these intermediate images can be written to fast system memory. When the final image is ready, it can be cropped, panned, zoomed, and copied to the screen via a fast block copy.
- *Exploitation of the UltraSPARC VIS Instruction Set*
The UltraSPARC VIS Instruction Set allows the CPU to directly access and operate on image (pixel) data with a high degree of parallelism. Other instructions are also available to format and move data at a high rate of speed. Still others can aid with volume rendering and video compression and decompression.

Performance

Sun's graphics systems have proven to be very effective at providing real-world performance in a wide range of applications that include windowing, 2D and 3D graphics, imaging and graphically intensive visualization. See Sun's Web page (<http://www.sun.com>) for additional details, including the results of key graphics benchmarks.

Solaris Operating Environment

All Sun Blade 100 workstations come ready to use with the 64-bit Solaris 8 Operating Environment (release 10/00 or later) pre-installed. The Solaris 8 Operating Environment provides the enhanced level of functionality expected of a Sun workstation, including a proven, scalable 64-bit kernel, standards-based networking, and Java technology support. These technologies provide the foundation for building and deploying enterprise-class systems for multi-vendor, multi-client workgroup environments, as well as highly available data center environments. The strengths of the Solaris Operating Environment lie in its enterprise-class reliability, scalability, and performance.

The 64-bit Solaris 8 Operating Environment provides enhancements in overall performance, scalability, reliability, availability, security, and ease-of-use while maintaining backward compatibility for all existing 32-bit Solaris Operating Environment applications and commands. The Solaris 8 Operating Environment continues the tradition of providing exceptional functionality and performance by delivering the following major enhancements:

- *Mainframe-class reliability, availability, and serviceability* for systems of all sizes
- *Higher performance*, the complete 64-bit computing environment provides greater capacity, precision, and performance
- *Enhanced scalability* with a 64-bit kernel that enables access to more system resources and the ability to consolidate applications onto a single server
- *Greater ease-of-use*, including Web-based installation, text and voice notes, and a graphical process manager

- *Comprehensive global support*, including support for the Euro currency symbol, complex text formats for Arabic, Thai, and Hebrew languages, and support for the development of multilingual applications
- *Software investment protection* with complete binary compatibility that allows today's 32-bit Solaris Operating Environment applications to continue to run on the Solaris 8 Operating Environment without modification or recompilation.
- *Extended security features* through authentication, data integrity, data privacy, and single sign-on capabilities so that tampering, snooping, and eavesdropping do not compromise data or associated transactions
- *32-bit and 64-bit development environment*, helping developers to generate a single set of source code that runs on both operating modes

Designed to deliver the power, flexibility, availability, and compatibility to support enterprise-wide computing, the Solaris 8 Operating Environment combines four key computing elements — operating system, networking, window system, and user environment — into a stable, high-quality foundation that helps enable the development, delivery, and management of a wide range of computing solutions.

Operating System

Based on UNIX System V Version 4 (SVR4), the Solaris 8 Operating Environment provides a rich applications development environment, and fully supports multithreaded applications as well as symmetric multiprocessing (SMP) on multiprocessor machines. The Solaris Operating Environment enables maximum portability across platforms by conforming to several important standards including SPARC ABI, CDE-compliant Motif, X11R6, POSIX 1003.1b and 1003.2, NIS, WebNFS™ software, HTTP, XML, IIOP, UNIX 95 and UNIX98 branding, X/Open (XPG4 base functionality), EnergyStar, Kodak Color Management System, and ISO 9660.

Networking

Sun's Open Network Computing (ONC+™) provides transparent access to information and services distributed throughout the environment. Solaris also defines a standard interface to ONC+ for alternative networking technologies (DCE and NetWare) helping to smooth integration with enterprise computing environments. Networking products such as LDAP, DHCP, NIS+, NFS™, and

RPC/XDR are supported for remote execution and data exchange. Transport layer independence provides support for a variety of network transport protocols such as TCP/IP (Figure 4-1).

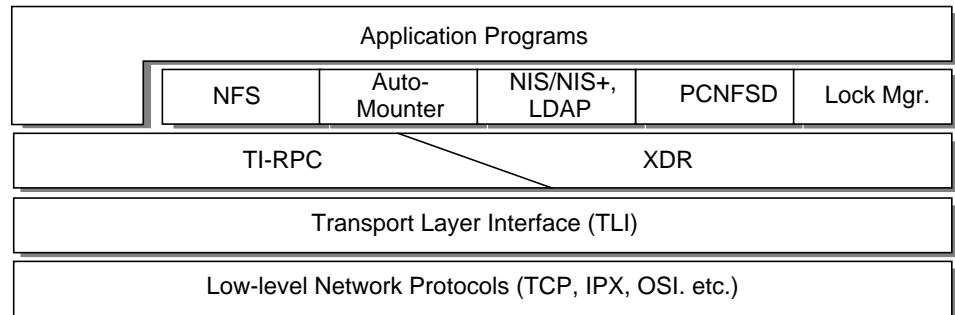


Figure 4-1 The Solaris Operating Environment supports a family of advanced networking protocols and services

Windowing Systems

The Solaris Operating Environment X11-based window server, user interface, and ToolTalk™ messaging services are engineered to exploit the Solaris Operating Environment distributed client-server computing model. To provide a consistent look and feel across all major UNIX platforms, Sun includes the Common Desktop Environment (CDE) with every copy of Solaris Operating Environment. Users and developers have the choice of continuing to use the Motif-based industry standard CDE, or the new GNOME environment. The CDE environment includes graphics, imaging, audio and video services, and Display PostScript to facilitate the development and delivery of multimedia applications for communication and collaboration across the enterprise.

CDE has been extended to include a variety of tools to simplify the management of applications and the desktop environment—a front panel to launch applications with a single click; a workspace manager to create multiple virtual desktops, including support for multiple monitors; a style manager to personalize the use of colors, backdrops, mouse and keyboard behavior, and startup characteristics. Other tools include text and icon editors, an image viewer, process and system management controls, workgroup calendaring, file and print manager, web-browser, performance meter, and MIME-compatible electronic mail. Solaris Operating Environment CDE features drag-and-drop and cut-and-paste across OpenWindows and Motif applications.

The Solaris 8 Operating Environment supports numerous graphics and windowing APIs such as Xlib, Display Postscript™, Java 2D™, Java 3D, and OpenGL to assist in the development of applications (Figure 4-2). In addition, the Solaris 8 Operating Environment includes Xlib, Java 3D, and OpenGL 64-bit ready, high-performance graphic APIs.

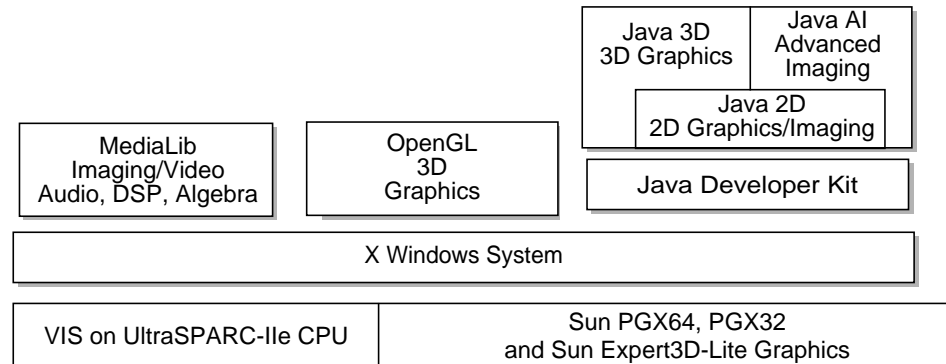


Figure 4-2 Solaris Operating Environment foundation graphics libraries and layered interfaces from Sun and other vendors

Installation

The 64-bit Solaris 8 Operating Environment comes pre-installed and ready to use on all Sun Blade 100 workstations. For re-installations or operating system upgrades Sun offers additional choices including Solaris JumpStart™ and Solaris Web Start with either remote or local CD installation.

Installation of the Solaris Operating Environment can be fully automated using the Solaris JumpStart software technology. When the system is first powered on, Solaris JumpStart software locates the install information over the network or from a local CD drive. The software installation is driven by profiles customized by the system administrator, or from a default installation profile, called the SmartStart™ profile. The SmartStart profile intelligently determines the best installation based on heuristics such as the amount of installed memory and available disk capacity.

Solaris Web Start software eliminates the UNIX system administration chores normally associated with software deployment through a flexible software management console that can be run from any desktop in an organization's network. An easy to use tool for software deployment and management,

Solaris Web Start software is a Java technology-based utility that simplifies and accelerates the installation of the operating system and associated software. A browser interface provides a familiar way to deploy and manage software resources in the workgroup and even across the Web. Customization and configuration options provide the flexibility needed for even the most unusual configurations, and by leveraging Sun's Solaris JumpStart technology, Solaris Web Start software provides the advanced replicated installation and remote software deployment features demanded by enterprise administrators:

- One-button and custom deployment options simplify installation and configuration.
- Java technology-based management console looks like a set of web pages.
- Support for a variety of media, including CD-ROMs and the Web, enhances distribution options.
- Extensive context-sensitive and on-line documentation delivers help and support when needed.
- File system tools streamline the software installation process.
- Replicated installation “profiles” ease the enterprise administration burden.
- Remote option directs deployment from any desktop to any host.
- A Software Developers Kit (SDK) extends the benefits of Solaris Web Start to all developers of Solaris applications.

Additional Pre-installed Software

In addition to the standard Solaris 8 Operating Environment, the Sun Blade 100 comes pre-installed with a variety of helpful applications, including:

- StarOffice™ 5.2
- Java 2 SDK
- Java 3D and Sun OpenGL for Solaris/SPARC
- Netscape Navigator
- Caldera Graphics CameleoLIGHT
- Apache Web Server
- Adobe Acrobat Reader
- SunForum™ and ShowMe™ TV

Dozens of freeware packages are also provided on an “as-is” basis.

Support for Graphics Accelerators

Sun Blade 100 systems support all of Sun's Solaris 8 Operating Environment graphics APIs, including the OpenGL, Java 3D, and Java Advanced Imaging libraries, Display PostScript, and the OpenWindows (X11-compliant) window system. Industry-standard X-extension libraries, such as Xlib and PEXlib, are also available and are accelerated via the Sun foundation graphics libraries.

As both imaging and geometry devices, the graphics products available for Sun Blade 100 systems accelerate many of the APIs mentioned above. The following sections briefly describe the foundation graphics interfaces and the functions accelerated by the on-board Sun PGX64, PGX32, and Sun Expert3D-Lite graphics subsystems.

OpenGL

The OpenGL graphics application programming interface is an industry-standard, vendor-neutral software interface which operates independently of operating and window system platforms. Based upon its proprietary predecessor, GL, OpenGL is an applications programming interface that provides 2D and 3D graphics functions, including modeling, transformations, color, lighting, and smooth shading, as well as advanced features such as texture mapping, NURBS, fog, alpha blending, and motion blur. The OpenGL API works in both immediate and non-editable display-list graphics modes.

The OpenGL library is targeted at developers creating interactive 3D applications for the enterprise, the intranet, and the Internet. These developers are generally affiliated with technical markets or in research facilities. Potential users include those in computer-aided design and manufacturing, global information systems, simulation, industrial design and modeling, entertainment, biochemistry, and petroleum exploration.

Sun OpenGL for Solaris provides a complete solution for developing and deploying interactive 3D applications across Sun workstations. It enables mainstream, industry-leading 3D graphics and visualization applications to be deployed on Sun Blade 100 systems at a compelling price/performance ratio.

The widespread multivendor availability of OpenGL libraries ensures source code portability of 3D graphics clients. OpenGL 1.2.1 for Solaris is a compliant implementation of OpenGL 1.2 from the OpenGL Architecture Review Board

and is, therefore, source code compatible with other compliant OpenGL applications. Most existing OpenGL applications will only need to be recompiled in order to run under OpenGL 1.2.1 for Solaris.

OpenGL 1.2.1 for Solaris provides an implementation of OpenGL that incorporates hardware acceleration when used in conjunction with Sun Expert3D-Lite, graphics. Accelerated features include:

- Transformations - 2D (3x2) and 3D (4x4)
- Geometry Attributes - color, line type, fill pattern and textures, etc.
- Lighting and Shading - flat and Gouraud as well as up to 32 light sources (positional, directional, spot, and ambient)
- Non-Uniform Rational B-Splines (NURBS)
- Transparency - screen-door and alpha blended transparency
- Anti-Aliasing
- Depth Cueing - linear and scaled
- Texture Mapping - 2D texturing of 3D surfaces (accelerated using VIS)

In addition, several OpenGL 1.2 extensions are supported, including:

- Texture level of detail control
- BGRA and packed pixel formats
- Texture specular color
- Texture edge clamping
- New interface imaging and 3D texturing

Finally, additional Sun-specific extensions are also provided in OpenGL 1.2.1 for Solaris, including:

- *Global Alpha Extension.* Allows applications to specify an alpha component that can be applied globally to all primitives (useful for cases in which many vertices share the same alpha value, because the application does not have to send an alpha component for each vertex)
- *Vertex Extension.* Allows applications to specify all vertex data (color, normal, coordinates, and so on) in a single function call (saves function calls overhead)
- *Triangle List Primitive.* Allows multiple triangle strips or fans to be specified within a single `glBegin-glEnd` pair (for improved performance)

Fully integrated with the Solaris 8 Operating Environment, OpenGL 1.2.1 allows developers to take advantage of its advanced features, including multithreading and full support for 64-bit computing. OpenGL 1.2.1 also includes new imaging extensions to allow developers access to both graphics

and imaging functionality within the same application and other enhancements to support increased performance and functionality. Solaris OpenGL can run with Common Desktop Environments (CDE) or OpenWindows environments. A defined common extension to the X Window System allows OpenGL client to run across distributed heterogeneous networks.

More information about OpenGL 1.2.1 can be found at:
<http://www.sun.com/software/graphics/OpenGL/>.

Java 3D Application Programming Interface

The Java 3D API is used for writing stand-alone three-dimensional graphics applications or Web-based 3D applets. The Java 3D API gives developers high level constructs for creating and manipulating 3D geometry and tools for constructing the structures used in rendering that geometry. With Java 3D constructs, application developers can describe very large virtual worlds, which, in turn, are efficiently rendered by Java 3D API implementations.

The Java 3D API specification is the result of a joint collaboration between Silicon Graphics, Inc., Intel Corporation, Apple Computer, Inc., and Sun Microsystems, Inc. All had advanced, retained mode APIs under active internal development, and were looking at developing a single, compatible, cross-platform API based on Java technology.

The Java 3D API draws its ideas from the considerable expertise of the participating companies, from existing graphics APIs, and from new technologies. Java 3D API's low-level graphics constructs synthesize the best ideas found in low-level APIs such as Direct3D, OpenGL, XGL, and QuickDraw3D. Similarly, Java 3D API's higher-level constructs leverage the best ideas found in several modern scene graph-based systems. Java 3D API also introduces some concepts not commonly considered part of the graphics environment, such as 3D spatial sound to provide a more immersive experience for the user.

Java 3D API provides a host of capabilities that yield a high degree of interactivity while preserving true platform independence, including:

- High-performance
- Rich set of 3D features
- High-level, object-oriented paradigm
- Wide variety of file formats, including vendor-specific CAD formats, interchange formats, VRML 1.0, and VRML 2.0

- New 3D view model, enabling images to be rendered on a wide variety of display devices
- High-performance vector math library for advanced object classes
- Rendering models and modes
- Sound and MIDI support
- Geometry compression, enabling geometry to be represented in an order of magnitude less space than most traditional 3D representations, with very little loss in object quality

Java Advanced Imaging API

Image processing techniques are used for manipulating and displaying images. Examples of image-processing techniques range from simple operations such as contrast enhancement, cropping, and scaling to more complex operations such as advanced geometric warping and frequency domain processing.

These techniques are used in a variety of applications including:

- Astronomy
- Medical Imaging
- Geospatial Data Processing
- Defense and Intelligence
- Photography
- E-Commerce and Retail

The Java Advanced Imaging API broadens the reach of the Java platform to allow sophisticated, high performance image processing functionality to be incorporated into Java applets and applications. Going beyond the functionality of traditional imaging APIs, the Java Advanced Imaging API provides a high-performance, platform-independent and extensible image processing framework.

For more information see <http://java.sun.com/products/java-media/jai/>.

Software Development Support

Sun provides a range of powerful software development tools to help developers author successful applications.

Forte™ Products

Successful application development requires that programmers have high performance compilers and tools. The Sun Forte family of products (formerly known as Sun WorkShop™) includes highly optimizing, automatically parallelizing compilers; libraries of highly optimized routines; and tools to help analyze and tune code for additional runtime performance.

Forte features include:

- Integrated programming environment
- Motif user interface, providing a standard look and feel
- Tight, editor-centric tool integration
- Hyperlinks, enabling easy tool navigation
- Multiprocessing, multithreaded development tools
- Distributed and parallel make utilities
- Incremental linker, for faster builds
- Fix and Continue, enabling defects to be found and fixed quickly
- AppGuru, enabling very fast application development for C++
- New version of Rogue Wave Tools.h++ 7.0 class library
- Quick and easy GUI development
- Motif, Windows, and Java GUI Builder, for cross-platform development
- GUI capture and testing, providing reverse engineering capabilities
- Three dimensional data visualizer, speeding debugging of complex arrays
- WorkSets and PickLists, facilitating quick access to work sessions
- Forte TeamWare, for source code and configuration management
- Extensive on-line manuals and help system

Versions of Forte are available that support the Fortran, C, C++, and Java programming languages). Of particular interest to developers is the ability of Forte to perform several advanced optimizations that can speed applications performance:

- *Instruction scheduling*, to arrange the order in which instructions are executed and make optimal use of available machine resources.
- *Profile feedback*, to obtain frequency information about a program. The program is executed and the frequency information is applied to optimizations such as code motion and inlining.
- *Loop parallelization*, to rearrange loop code so that multiple processors may be work in parallel to complete the loop.
- *Cache blocking*, to rearrange loop code to make maximum use of the processor cache.
- *Loop inversion*, to reverse the order of nested loops to gain the advantages of improved loop parallelization or better cache blocking.

To take advantage of innovative UltraSPARC-IIe processor features, Sun Forte compilers support both traditional and hybrid versions of the SPARC Version 9 architecture. Full 64-bit computing is available with SPARC V9 support. A hybrid version, called V8+, precludes the use of all V9 64-bit addressing instructions, ensuring 32-bit compatibility with existing versions of the Solaris Operating Environment and with other existing applications, while still allowing access to most of the UltraSPARC-IIe's advanced capabilities, including the VIS instruction set.

Java Application Development

A discussion of software development would not be complete without mentioning Java technology. Taking the industry by storm, the Java programming language delivers true platform-independent software development for a large number of applications. Software developers have instantly recognized the potential of Java applications, with thousands of firms currently developing, or planning to develop Java technology based products. Sun, the original developer of the Java programming language offers software developers a unique opportunity with a comprehensive product line designed to streamline development.

The object-oriented Java platform delivers the benefits of reusable code, reduced cost of ownership, and broad integration, with the complex, heavyweight object housekeeping process required by other object-oriented development models. Sun's family of Java APIs and development products, including Forte™ for Java™, the Java 2 SDK, and Java Studio, empower developers to create an entire new class of applications that truly enable network-based computing. Sun Blade 100 workstations are ideal platforms for these tools, permitting the development of both client and server components of Java technology solutions. Products can then be easily deployed to more powerful Sun Java Web Server technology

The Java 2 Software Development Kit comes with the Solaris 8 Operating Environment. The Java 2 SDK provides both essential development tools required for creating Java applications and a high-performance, scalable runtime environment that reliably delivers the faster execution of Java applications. Designed to deliver superior performance and scalability across the enterprise, applications developers recognize that the runtime system in Java 2 for Solaris sets a new standard for Java technology performance and reliability.

Open Firmware

The Sun Blade 100 workstation supports the use of a standardized PROM-resident monitor program that is written in a special threaded-interpretive language. Called Open Firmware, this monitor is conformant to the IEEE 1275-1994 standard, also known as Standard for Boot (Initialization Configuration) Firmware. Open Firmware can be brought up during the power-on process if a problem is encountered, or by executing a system *shutdown* followed by a level-0 *init(1M)*.

Once the Open Firmware monitor has control, a variety of diagnostics are available for key subsystems and peripherals:

- Video graphics
- Ethernet interface and AUI
- Internal and external disk drives
- Tape, diskette, and CD-ROM drives
- Serial ports
- Keyboard
- Memory

The Open Firmware monitor also provides tools to allow the continuous monitoring of the network and selective probing of devices on the SCSI bus.

Boot-time behavior and some diagnostics in Sun Blade 100 systems are controlled through 1 MB of flash PROM. The use of flash PROMs permits the reprogramming of specific code blocks to implement updates and enhancements without requiring physical access to the PROMs. Reprogramming may be done from a CD-ROM located in the system or remotely by a system administrator over a local area network.

Diagnostics

The Sun Blade 100 platform has been designed for easy diagnosis and problem repair. Supporting this are several PROM-resident and UNIX- based diagnostic programs that can be applied by end-users and service personnel.

Power-On Self-Test (POST)

Under user control, a power-on self-test (POST) can be automatically executed to test the system board, on-board I/O devices, and memory system each time power is applied to the system. While not intended to be a comprehensive diagnostic, POST can quickly establish that no severe problems exist with the system, and communicates that through a set of light-emitting diodes (LEDs) on the keyboard. POST tests may be monitored via a serial-port connection to another desktop system or dumb terminal.

SunVTS™ Software

The *SunVTS* system exerciser is a graphically-oriented UNIX application that permits the continuous exercising of system resources and internal and external peripheral equipment. Used to determine if the system is functioning properly, *SunVTS* software incorporates a multi-functional stress test of the system through operating system level calls, and allows the addition of new tests as they become available.

References



Sun Microsystems Computer Company posts product information in the form of data sheets, specifications, and white papers on its Internet World Wide Web Home page at: *<http://www.sun.com>*.



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