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An Oracle White Paper
May 2010

Oracle's Sun Fire X2270 M2 Server Architecture

ORACLE

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Introduction

The Sun Fire X2270 M2 server provides the most effective path to cloud and technical computing. They bring an enhanced next generation, small form-factor, high performance system to the datacenter. Oracle has built upon the features of the previous generation of Sun Fire X2270 server by introducing the latest Intel Xeon Processor 5600 Series CPUs and enhancing local storage capability significantly through support of both Flash Modules (FMOD's) and Solid State Disks (SSD's), alongside standard higher capacity Hard Disk Drive (HDD) storage. In addition, Integrated Lights Out Management (ILOM) capabilities are included in the platform as standard. These enhancements can help dramatically increase application performance, reduce response times and latency and improve manageability and deployment of new services.

The Sun Fire X2270 M2 is an excellent fit for large horizontal scaled deployments of servers to tackle both multiple instances of single threaded workloads and single highly threaded workloads.

The Sun Fire X2270 M2 finds a natural home in the datacenter, typical deployments will include,

- **Technical Computing**, large numbers of servers are deployed to tackle computationally intensive problems such as Enterprise Risk Management, Financial Trend Analysis with applications such as Oracle Reveleus as well as more traditional Engineering Design Simulation and Modeling computational workloads.

- **Cloud Computing** access and presentation layers requiring scalable, reconfigurable building blocks that can be dedicated and re-purposed easily and remotely without sacrificing performance and capability. Integrated Light Out management (ILOM) service processors and high capacity and performance local storage allow a wide range of Cloud deployments to be satisfied by the Sun Fire X2270 M2.



Figure 1. The Sun Fire X2270 M2 server offers two sockets for Intel Xeon 5600 Series processors in a one rack unit chassis.

Sun Fire X2270 M2 Server

The energy-efficient Sun Fire X2270 M2 server is a one rack unit (1RU), two-socket x86 server designed to offer advanced features and capabilities. It utilizes processor and memory speed grades that are among the fastest available and eliminates I/O bottlenecks through support for SSDs and Flash technology. The Sun Fire X2270 M2 supports operating system and application choices that can easily be managed through their integrated ILOM capabilities, and on a larger scale by the Oracle Ops Centere as well as by third-party systems management tools. This flexibility enables organizations to lower costs and ease manageability. The following technology aspects maximize the value of the Sun Fire X2270 M2 server for Enterprise computing workloads and Cloud infrastructure deployments:

- Intel Xeon Processor 5600 Series CPU's and chipsets
- Standard Integrated Lights Out Manager (ILOM) service processor
- Support for high speed and energy efficient Solid State Disk drives and Oracle's Flash modules
- PCIe 2.0
- Intel 82575EB Gigabit Ethernet controller
- An Energy-efficient 80 W Intel Xeon processor option

The Sun Fire X2270 M2 server demonstrates Oracle's commitment to economy and performance by delivering industry-leading price/performance and performance per watt. In fact, the Sun Fire X2270 M2 server offers up to 50% more compute capability than the previous generation Sun Fire X2270 without significantly increasing energy consumption[1]. Table 1 presents the features of the Sun Fire X2270 M2 server.

[1] Intel Xeon Processor 5600 Series CPU's have up to 6 cores compared to the earlier Intel Xeon Processor 5500 Series CPUs within the same Thermal Design Point (TDP).

TABLE 1. SUN FIRE X2270 M2 SYSTEM CHARACTERISTICS

FEATURE	DESCRIPTION
Enclosure	1U
Processor	1 or 2 Intel Xeon 5600 Series processors[2]
Memory	12 DDR3 DIMM slots (6 per CPU) 4 GB 1,333 MTransfer/sec or 8 GB 1,066 MTransfer/sec ECC Registered DIMMs Up to 96 GB per systems, or up to 48 GB per CPU
Internal storage	As many as four 3.5-inch SATA hard disk drives or SSDs 1TB or 2TB hard disk drives or 32 GB SSD One or two 24 GB Sun Flash Modules No internal DVD/CD-RW support (utilizes USB device or ILOM remote KVMS)
System I/O	2 Gigabit Ethernet ports (one port can be shared with the service processor for side-band management) One RJ45 serial port (shared with the optional service processor) 4 USB 2.0 ports (2 front, 2 rear)
Expansion	One 16-lane PCIe 2.0 slot
Power	Non-redundant, 600 W power supply
Operating systems	Oracle Solaris 10, Oracle Enterprise Linux, Red Hat Enterprise Linux, SuSE Linux Enterprise Server, Microsoft Windows Server, VMware ESX Server
Service Processor	ILOM 3.0 Service processor, standard in all configurations IPMI 2.0-compliant, Web, graphical, and command-line interface SNMP V1, V2c, and V3, and SSH V2 support 1 dedicated 10/100 BASE-T Ethernet port and 1 VGA video port Remote keyboard, video, mouse, and storage (KVMS)

[2] For current information on supported CPU options, please consult the Sun Fire X2270 M2 product web pages at http://www.oracle.com.

Platform Design Optimization

Organizations with intense computational workloads demand servers that can offer top performance while also providing cost savings, energy efficiency, ease of management, and investment protection.

Maximize Performance in constrained environments

The Sun Fire X2270 M2 server delivers a level of performance that can help organizations save money by tackling complex computing problems with fewer physical platforms. Built with the latest high performance Intel micro-architecture, DDR3 memory, Intel QuickPath technology, and PCIe 2.0 support, the Sun Fire X2270 M2 server provides top entry-class server processing performance in a small physical platform. Through the flexibility to incorporate up to 96 GB of memory, two Oracle Flash modules, SSDs, and as much as twice the storage of similar systems in the same class, the Sun Fire X2270 M2 server also provides organizations with plenty of I/O bandwidth, storage capacity and processor performance.

Optimize Energy Efficiency

By combining Intel Intelligent Power Technology with energy-efficient system design principles, the Sun Fire X2270 M2 server can help organizations save on power and cooling costs. The system lowers energy costs by automatically adjusting processors and memory into the lowest-available power state to handle the current workload. In addition, the compact form factor and high memory and I/O density of this platform help minimize real estate requirements. In fact, the Sun Fire X2270 M2 server provides up to 50% more computing resources than previous generations while maintaining the same footprint, power and cooling requirements.

Integration of Flash based storage media allows further energy savings, improved performance can be obtained within previously established environmental limits on power or cooling capacity.

Simplify System Management

Remote management requires the ability to perform monitoring, control, and administration from a remote location. The integrated ILOM service processor supports remote execution of management functions without any physical contact with the system. Based on industry standards, the ILOM service processor also easily integrates into existing management environments.

The Intel Xeon Processor 5600 Series Advantage

Oracle has worked closely with Intel Corporation to bring to market a broad server family based on the latest Intel Xeon processor technology. In the Sun Fire X2270 M2 servers, system engineering expertise combines with processor design proficiency to emphasize performance,

quality, reliability, and eco-responsibility. Engineers have optimized system performance under Oracle Solaris as well as under other operating environments.

The Sun Fire X2270 M2 server incorporates Intel Xeon Processor 5600 Series processors, which include the revolutionary QuickPath interconnect and the Intel Xeon microarchitecture. Each server incorporates a common motherboard populated with one or two processors, enabling the system to deliver short response times and high throughput for performance-hungry applications. Compatible with a legacy of IA-32 software, these 64-bit processors support a large volume of existing 32-bit applications as well as emerging 64-bit applications.

Intel Core Microarchitecture

With this latest introduction, Intel transitioned to a 32 nm manufacturing process that enabled smaller transistors, enabling this newest processor generation to pack up to six processor cores and cache into a die that consumes the same space and power as the previous generation.

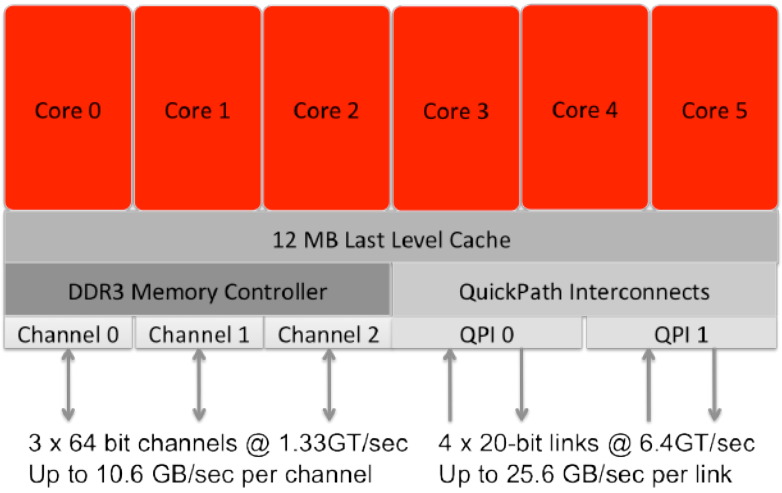


Figure 2. The microarchitecture employed by the Intel Xeon Processor 5600 Series CPU offers significant innovations over previous designs.

The New Intel Core microarchitecture is extremely modular, enabling a range of implementations to meet a variety of application needs and price points. The Sun Fire X2270 M2 servers are available with processors from the "Standard" and "Low Power" processor classes. Processors in these servers feature four or six cores, 12 MB of shared L3 cache, and Turbo Boost and HT capabilities.

For more information on the latest Intel Xeon Processor 5600 Series CPUs, please visit the Intel website at http://www.intel.com.

Intel Xeon Processor 5500 Platform

The Sun Fire X2270 M2 server supports one or two Intel Xeon processors interconnected with each other and the Intel 5500 I/O Hub (IOH) using Intel QuickPath technology interconnects. The IOH interfaces with an Intel 82801JR I/O Controller Hub (ICH10R), providing expandability and high-I/O throughput. Each platform is designed to match processor performance with memory capacity, I/O expandability, and interconnect bandwidth.

Sun Fire X2270 M2 Server Architecture

The Sun Fire X2270 M2 server is based on a highly integrated system architecture that emphasizes performance, memory bandwidth, and I/O capabilities. The sections that follow detail the physical and architectural aspects of this system.

Motherboard

As shown in Figure 3, the Sun Fire X2270 M2 server motherboard includes two interconnected Intel Xeon processors and the Intel 5500 chipset with QPI technology. The Intel Xeon 5600 Series processors each have one integrated memory controller with three DDR3 channels and one or two DIMMs per channel. The Intel 5500 chipset provides 24 PCIe 2.0 lanes, 16 of which are used for the single PCIe expansion slot. Four PCIe 2.0 lanes connect the Intel 5500 chipset to the Intel 82575EB Gigabit Ethernet controller.

The Intel 82801JR I/O Controller Hub provides PCI, SATA, and USB connectivity. Six SATA device ports are provided by the I/O Controller Hub, four ports are utilized by the drive slots, supporting both internal SATA hard disk drives (HDDs) and/or SSDs. The two remaining SATA ports are connected to the two Sun Flash Module slots. An optional ILOM service processor daughtercard completes the architecture.

The motherboard of the Sun Fire X2270 M2 server supports the following system architecture features:

- Integrated memory controller on each CPU, offering three 64-bit channels that each support two DIMMs and deliver up to 1.33 GT/sec or 10.6 GB/sec of bandwidth
- Intel QuickConnect Architecture, providing 6.4 GT/sec links, delivering up to 25 GB/sec of total bandwidth
- High-speed PCIe 2.0 slot for high-performance I/O expansion
- Two Gigabit Ethernet ports with RJ45 connectors to provide fast network connectivity (one port can be utilized for side-band management)
- A six-channel SATA II disk controller, supporting two Oracle Flash modules and as many as four SATA HHDs or SSDs

- ILOM service processor daughter-card with an ASPEED AST2100 integrated communications processor providing system management and video capabilities

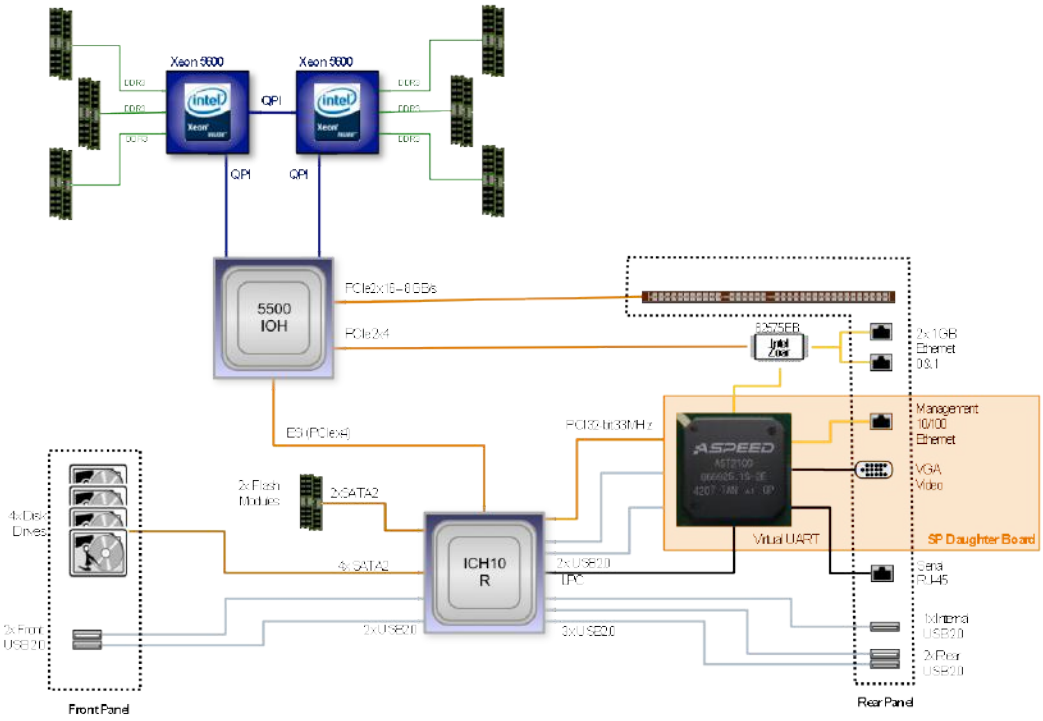


Figure 3. The Sun Fire X2270 M2 server architecture emphasizes performance, memory bandwidth, and I/O capabilities.

Memory Architecture

The memory architecture of the Sun Fire X2270 M2 server contributes to the platform's high performance. Each CPU includes a high-bandwidth, integrated DDR3 memory controller that reduces access latency. As many as six extended ECC memory modules per CPU are supported. Memory slots can be populated with the following DIMM types:

- 4 GB DDR3, 1,333 MT/sec
- 8 GB DDR3, 1,066 MT/sec

Memory DIMM population rules and best practices can help organizations create configurations with the best-possible performance.

- Because each processor contains a separate memory controller, a DIMM slot is accessible only when the corresponding processor slot is populated.

- For each memory channel, populate the DIMM slots that are the farthest from the CPU first. For example, populate D5, D3, and D1 first and then D4, D2, and D0 second. (DIMM numbering starts with D0 in the position closest to the processor and increases with proximity to the end of the memory bank.)
- Populate single-rank (SR) or dual-rank (DR) DIMMs in sets of three for each CPU, one per memory channel.
- The best performance is achieved through preservation of symmetry—for example, installing three DIMMs of the same kind, one per memory channel, and ensuring that both CPUs are utilizing the same DIMMs sizes populated in the same manner.
- DIMMs for the Sun Fire X2270 M2 server are available in two speeds: 1,066 MT/sec and 1,333 MT/sec. Although mixing DIMM types within a configuration is supported, the system operates all memory at the speed of the slowest DIMM.

PCI Express Expansion

High-bandwidth I/O access and flexible expansion are critical for meeting evolving business and application requirements. The Sun Fire X2270 M2 server provides one internal 16-lane, low-profile, PCIe slot with support for PCIe 2.0 technology. Adapter cards insert into a 90-degree-angle PCIe riser slot that provides x16 mechanical and electrical support. PCIe 2.0 doubles the interconnect bit rate, increasing the aggregated bidirectional bandwidth of a 16-lane link to approximately 16 GB/sec. Populating this slot with an optional InfiniBand, Fibre Channel, 10 Gigabit Ethernet, or other high-speed adapter card provides high-bandwidth connectivity to additional network or storage devices.

Onboard Interfaces

The Sun Fire X2270 M2 server provides integrated Gigabit Ethernet, serial, and USB ports. The Sun Fire X2270 M2 server provides two USB 2.0 ports on the front panel of the system. The front and rear panels of the Sun Fire X2270 M2 server are shown in Figure 4. Note that in the absence of the optional ILOM service processor, the VGA port and network management (Net Mgt) connectors do not appear on the rear interface of the Sun Fire X2270 M2 server.

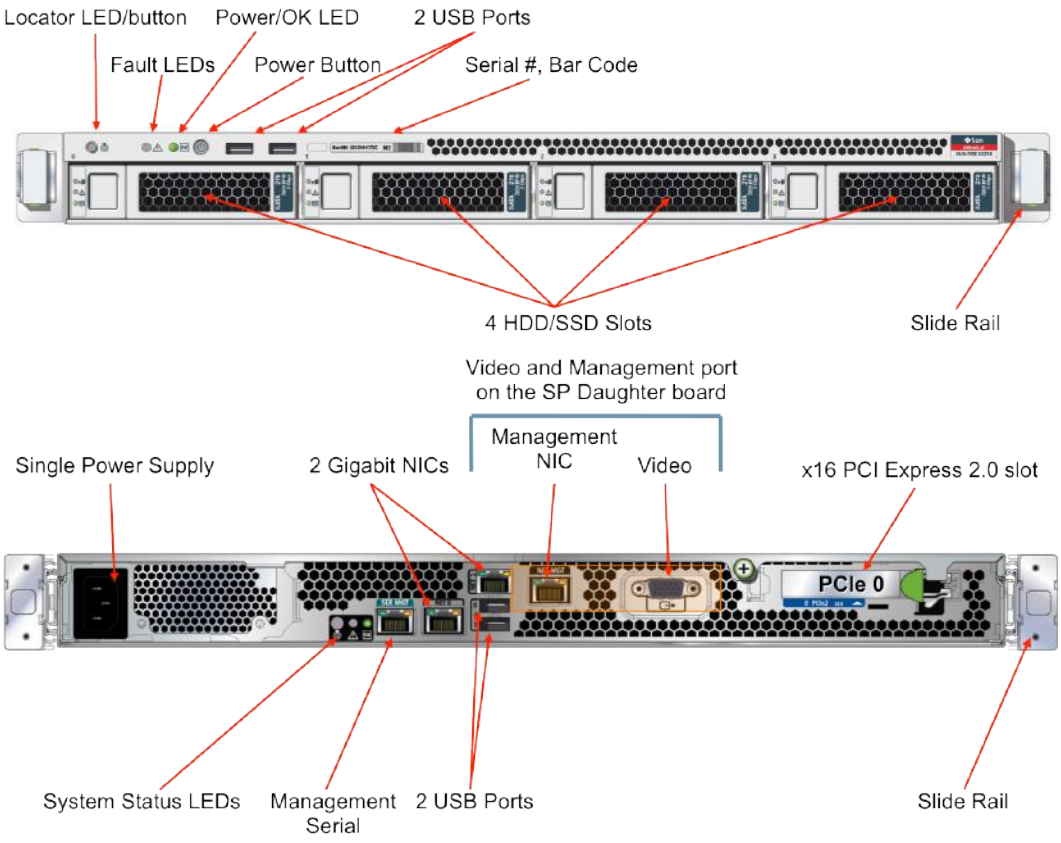


Figure 4. As shown on the front and rear panels, the Sun Fire X2270 M2 server features integrated Gigabit Ethernet, serial, and USB ports.

Internal Storage

The internal storage options for the Sun Fire X2270 M2 server help organizations increase data throughput for I/O-sensitive applications. The Sun Fire X2270 M2 server supports the following internal storage options:

- SATA 3.5-inch 1,000 GB or 2,000 GB HDDs
- SATA 2.5-inch 32 GB SSDs in a 3.5-inch carrier with a bracket adapter
- Internal 24 GB Oracle Flash Modules installed on the motherboard

Disk Drives, in innovative, cooling optimized carrier brackets, insert into a modular disk tray and cable-free disk backplane, increasing reliability and serviceability. The carrier includes an ejection handle that simplifies drive removal. Drive status lights indicate "Ready to remove," "Fault," and "Status."

Using the four internal hot-swappable drive bays, the Sun Fire X2270 M2 server can support up to 8 TB of local conventional disk storage, in addition to up to 48GB or extremely high performance Flash storage on Oracle Flash modules. The RAID controller embedded in the Intel I/O Controller Hub supports RAID 0, 1, 5, or 10 in Windows Server 2008 operating environments and requires Intel Matrix Storage Technology.

For more information on the capabilities and benefits of SSDs and Oracle's Flash modules for the Sun Fire X2270 M2 server, see the "Flash Technology" section.

Power and Cooling

Built to support energy efficiency, the power and cooling subsystem of the Sun Fire X2270 M2 server helps maintain cost-effective datacenter operation. The chassis of the Sun Fire X2270 M2 server is cooled with front-to-back airflow. A sensor within the service processor modulates fan speed. In the absence of the ILOM service processor daughtercard, the BIOS performs this function. The service processor reads the fan speeds and turns the fan fault LED on if the RPM falls under a specific threshold. The Sun Fire X2270 M2 server provides a single 600 W power supply. To assist with proactive maintenance, the system actively monitors the power supply.

System Management Controller

The Sun Fire X2270 M2 server offers an integrated ILOM service processor, enabling remote management of activities that do not require physically touching the system. Industry standards are embraced throughout, enabling these systems to easily integrate into existing environments. The ILOM service processor is a standard component of the Sun Fire X2270 M2 server, helping organization further lower the cost of projects requiring full featured servers without the need to subsequently purchase additional features or hardware to enable remote management. More information about the service processor can be found in the "System Management" section.

Flash Technology

Modern servers are driving throughput levels that rapidly outpace the capabilities of typical storage solutions. Although many servers can achieve processing capabilities in excess of one million I/O operations per second (IOPS), today's fastest HDDs are capable of only about 300 IOPS to 400 IOPS. To match throughput more closely to server performance and meet the challenging demands of data-intensive applications, many datacenters implement large pools of high-speed disk drives. In some cases, a large buffer of expensive DRAM is also deployed, so that the application's working set can be stored in memory to reduce latency.

Flash technology provides a more economical alternative that can dramatically enhance application I/O performance while also operating with significantly better energy efficiency than

conventional rotational HDDs. The Sun Fire X2270 M2 server supports flash technology in the form of SDDs and internal Oracle flash modules.

Solid-State Drives

Recent advances in the quality of flash technology have made SSDs an effective and reliable solution for enterprise storage. Flash technology contains no moving parts, avoiding the seek times and rotational latencies inherent with traditional HDD technology. Because SSDs offer low latency and are significantly less expensive than DRAM storage, they balance cost and performance in a manner that can provide tremendous value for I/O-intensive workloads. SSDs utilize a disk drive form factor (see Figure 5) and are directly supported by the drive bays of the Sun Fire X2270 M2 server. The operating system and BIOS for the Sun Fire X2270 M2 server view the SSDs as standard SATA drives.



Figure 5. Sun Fire X2270 M2 solid-state drives—shown in the sample drive above—are effective and reliable solutions for enterprise storage.

Oracle's Flash Modules

Oracle's Flash module is a storage innovation that combines NAND flash components and a flash memory controller (FMC) to provide an industry-standard SATA device in a compact, highly efficient form factor. The Sun Fire X2270 M2 server supports installation of one or two 24 GB flash modules to deliver a high-capacity and high-performance storage option for I/O-sensitive applications. As with SSDs, Oracle's Flash modules are viewed by the operating system and BIOS as standard SATA disk drives. Table 5 presents the characteristics of Oracle's flash modules, and Figure 6 shows the key components on the front and back of Oracle's flash modules.

TABLE 5. SUN FLASH MODULE CHARACTERISTICS

FEATURE	DESCRIPTION
Capacity	24 GB
Buffer cache	64 MB
Form factor	JEDEC MO-285A, 3 Gb SATA II/SAS I
Reliability	7 × 24 × 3 years (100% write duty cycle)
Peak performance	Random write: 20,000 IOPS



Figure 6. As shown here, Oracle's flash modules combine NAND flash components and a flash memory controller.

Oracle Solaris Zettabyte File System (ZFS)

Taking best advantage of the performance and cost characteristics of flash technology requires an enabling technology that can transparently combine the strengths of HDDs, SSDs, and Oracle's flash modules. Oracle Solaris ZFS can harness these technologies within hybrid storage pools to create a solution that offers a balance between the speed of flash technology and the economy of HDDs. A hybrid storage pool automatically places data on the most-appropriate storage media to optimize performance and manage costs. In fact, Oracle Solaris ZFS can transparently cache data on SSDs without any need to modify applications.

System Management

A horizontally scaled multi-server architecture can provide the best-possible performance for many types of workloads, including the access layer of Cloud deployments and technical computing architectures. This requires provisioning, monitoring, and managing of, often, very large numbers of servers. Remote server monitoring, system management, and task automation capabilities can help ease the administrative burden. To address this need, the Sun Fire X2270 M2 server provides a full complement of advanced system management features through inclusion of an ILOM service processor.[3] The Sun Fire X2270 M2 server also supports open standards to simplify integration with Oracle and third-party enterprise management software tools.

[3] In Sun Fire X2270 M2 servers include the ILOM service processor in default configurations, however if not installed or removed, control over the platform fans and LEDs is still available via the capabilities of the platform BIOS.

Integrated Lights Out Manager Service Processor

Lights-out management features provided by the ILOM service processor can help organizations simplify system management tasks. The ILOM service processor is a customer-replaceable-unit (CRU) daughter-card. Powered by an ASPEED AST2100 integrated communications processor, the service processor runs independently of the host platform, executing a robust, security-hardened operating system.

Capabilities of the Oracle ILOM service processor include the following:

- Full local and remote keyboard, video, mouse, and storage (RKVMS) access via redirection over dedicated or shared network connections, eliminating the need for KVM switches.
- Monitoring and reporting of environmental, power, hardware, BIOS, and operating system events.
- Remote power control, diagnostics, media attachment, and flash upgrades of the system BIOS and service processor software
- System configuration information retrieval
- User-configurable serial console access through a physical port or redirected through the management network
- Java-enabled remote console access across a secure Web connection
- Multi-level role-based access with support for RADIUS, LDAP, and Microsoft Active Directory Service lookup of authentication data
- Simple Network Management Protocol (SNMP) V1, V2c, and V3 support

For system management operations, the AST2100 uses the following connections:

- Two USB ports for virtual devices (both ports are routed directly on the motherboard between the AST2100 and the ICH10R)
- One RJ45 RS-232 serial interface for console redirection
- Two RJ45 10/100 MB/sec Ethernet network interfaces for IP-based management connections (one for dedicated out-of-band management and one shared host port for side-band management)
- One HD-15 SVGA video port for local video output

Management functions provided by the service processor are implemented by ILOM 3.0 system, management software. This provides an Intelligent Platform Management Interface (IPMI 2.0) Baseboard Management Controller; platform control agents; diagnostics software; and remote KVMS drivers. Many other Oracle servers incorporate this same firmware, providing organizations with a single, consistent, and standards-based management interface.

Secure access to the service processor and associated ILOM software functions takes several possible forms:

- Intuitive browser-based user interface (BUI) over SSL
- Distributed Management Task Force (DMTF) command-line interface (CLI) over Secure Shell (SSH)
- Redirection of the platform console, keyboard, mouse, and video to the ILOM remote console
- SNMP v3 interfaces, providing easy integration with Oracle Enterprise manager Ops Center hird-party applications from companies such as HP and IBM
- IPMI 2.0 command interface, for remote management using IPMI-based tools such as IPMItool

Operating System Support

Support for a variety of 32- and 64-bit operating systems can help protect investments in server hardware. The Sun Fire X2270 M2 server supports multiple operating systems, enabling organizations to deploy a choice of application environments without having to shift hardware platforms when software requirements change. This added flexibility can reduce cost and complexity and help organizations increase return on investment while lowering risk.

Table 8, below, lists the supported Operating Systems for the Sun Fire X2270 M2 server at release. Up-to-date operating system support information for the Sun Fire X2270 server can be found in the most up to date Product Notes available for the Sun Fire X2270 M2 server.

Supported operating systems include

- Oracle Solaris 10
- Oracle Enterprise Linux
- Oracle VM
- Red Hat linux
- SuSE Linux
- Windows Server
- VMWare ESX/ESXi

Summary

Organizations looking for the most effective path to deploying their Cloud and technical computing infrastructures have an ideal platform in the Sun Fire X2270 M2 server. Computing

systems must deliver exceptional throughput and flexibility. At the same time, keeping costs low remains a priority. With hundreds of servers deployed, system management and energy costs also become key factors in achieving a low total cost of ownership.

Oracle's Sun Fire X2270 M2 server, featuring powerful Intel Xeon 5600 Series processors, the new Intel Core microarchitecture, and innovative flash memory storage options, offers flexible, high-performance computing at an entry-level price. Providing sophisticated functionality in an easy-to-cool compact design, the Sun Fire X2270 M2 server is ideal for rack-dense system environments. In fact, the Sun Fire X2270 M2 server delivers excellent price/performance and performance per watt and offers exceptional memory and internal storage capacity. With a choice of operating systems and scalable system management tools, the Sun Fire X2270 M2 server is a powerful and manageable server that is ideal for compute-intensive Web and scientific applications. Built on more than 25 years of system design expertise and excellence, Oracle's Sun Fire X2270 M2 server demonstrates system innovation that maximizes the economies of computing with breakaway efficiency and intelligent scale.





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Oracles Sun Fire X2270 M2 Server Architecture
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