



SUN NETRA

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Oracle's Sun Netra 6000 Modular System: Open and Modular NEBS Level 3 Certified Infrastructure

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Introduction

Blade technology is playing an expanding role in telecommunications data centers—both in the core network and in service delivery. Oracle offers the Sun Netra 6000 modular system, which is designed for effective service delivery and for core network applications.

Oracle's carrier-grade Sun Netra 6000 modular system delivers compute performance, scalability, and mission-critical availability, even in harsh conditions. The Sun Netra 6000 modular system supports both SPARC and Intel processor-based blades simultaneously. It is predominantly for DC-powered environments, and an AC-powered version is also available. The AC-powered version is typically used for development or in the lab.

The Sun Netra 6000 modular system is uniquely positioned to support next-generation smartphone applications and services, as well as OSS and BSS applications. Specifically, the Sun Netra 6000 platform offers a stable, long product-life platform, simplifying customer product-life management while also offering cutting edge, high-performance blades to deliver the highest ROI for deployed applications.

This document describes the features and architecture of the Sun Netra 6000 modular system as well as how the system can deliver value to telecommunications companies.

Service Delivery in Telecommunications Environments

Telecommunications IT managers must be able to scale their IT systems to support application rollout very quickly. It is also hard to predict which telecommunications applications will take off. As a result, application infrastructures must be agile to enable fast reallocation of resources. In addition, rapid growth in the data center has made consolidation a popular approach in telecommunications. When IT organizations consolidate underutilized resources into shared pools, key resources can be redeployed as needed for business-critical applications.

A popular strategy for addressing these challenges is to standardize on a blade server architecture, which can accelerate deployments as well as simplify management and maintenance of the equipment. A blades platform enables IT managers to maintain a consistent architecture and yet choose the most suitable compute blades for each application.

The Promise of Blade Architecture for Service Delivery

At its best, modular or blade server architecture blends carrier-grade availability and management features with the scalability and economic advantages of horizontally scalable systems. In general, modular architectures offer considerable promise and can contribute to:

- **Higher compute density**—Blade systems offer more processing power per rack unit than rack mount systems.
- **Increased serviceability, availability, and power efficiency**—Shared common system components, such as power, cooling, and I/O interconnects, make blades power efficient and easier to service and maintain.
- **Reduced complexity**—Modular blade architectures require fewer components and enable cable and component aggregation as well as consolidated management.
- **Faster service expansion and bulk deployment**—Organizations can quickly expand or scale existing services and flexibly preprovision blade chassis and I/O components.
- **Lowered costs**—Modular blade servers can be less expensive to acquire, easier to service, and easier to manage, and they are faster to deploy as well as more power efficient than rackmount systems.

The telecommunications industry has additional needs, such as NEBS Level 3 certification, that bring requirements that include:

- Fire suppression
- Stringent thermal testing
- Vibration and shock testing
- Failover and redundancy

Sun Netra 6000 Modular System

To address the compromises of earlier blade platforms, Oracle started with a design point focused on the needs of the telecommunications applications and services tier. The Sun Netra 6000 modular system is designed to help telecommunications companies quickly add compute or networking capacity without interrupting existing blades in operation. The result is better utilization of equipment, lower capital investment in dedicated equipment, and the flexibility to move equipment to areas of demand. This helps reduce risk and makes it easier to scale rapidly as demand spikes or grows.

A Proven Blade Platform—Adapted for the Telco Data Center

With an innovative and modular approach, as well as a powerful feature set, the Sun Netra 6000 modular system offers considerable advantages for a wide range of applications.

- **Scalable, expandable, and serviceable multitier architecture.** Sun Netra 6000 modular systems let organizations deploy many applications on a single unified modular architecture. These systems support Oracle's volume CPU architectures, including both Intel Xeon processors and SPARC T-Series processors. By offering the latest Intel and SPARC processors, large memory capacity, high I/O bandwidth, and integral storage, these systems support a very broad range of applications.

Oracle's SPARC T4 processor provides approximately five times the single-threaded throughput of the previous generation SPARC T3 processor, enabling telecommunications companies to deliver new kinds of applications with the same Sun Netra 6000 modular system architecture. In addition, the Sun Netra 6000 modular system achieves better power efficiency than rackmount servers by consolidating the power and cooling infrastructure for multiple systems into a highly efficient modular system chassis. The result is a high-performance IT infrastructure that packs more scalable capacity and functionality into a smaller package—in terms of both real estate and power envelope.

- **Innovative chassis design.** The Sun Netra 6000 modular system allows organizations to take full advantage of future technology without “forklift upgrades.” All major components are redundant hot pluggable and hot swappable with no single point of failure, including I/O modules. Compute, I/O, storage, power, cooling, and management modules can all be independently serviced, upgraded, and expanded.
- **Complete separation between CPU, I/O, and storage modules.** The Sun Netra 6000 modular system design avoids compromises because it provides a complete separation between server modules and I/O modules. Through this flexible approach, each server module can be configured with different I/O options depending on the applications hosted. I/O modules are hot pluggable and hot swappable, and organizations can choose from Oracle-branded or third-party adapters for networking, storage, clustering, and other I/O functions. Two types of I/O modules are supported.
 - Up to two industry-standard PCI Express (PCIe) ExpressModules (EMs) can be dedicated to each individual server module.
 - Up to two Network Express Modules (NEMs) provide bulk or consolidated I/O for all of the server modules installed in the system.

- **Standard and expandable storage options.** The Sun Netra 6000 modular system includes a range of flexible and expandable storage options. Server modules contain hot-pluggable and hot-swappable hard disk drives (HDDs).
- **Highly efficient cooling.** Traditional blade platforms have a reputation for being hot and unreliable—a reputation earned by systems with insufficient cooling and chassis airflow. Not only do higher temperatures negatively impact electronic reliability, but hot and inefficient systems also require more data center cooling infrastructure, with its associated footprint and power draw. In response, the Sun Netra 6000 modular system provides optimized cooling and airflow that can lead to reliable system operation and efficient data center cooling. In fact, the Sun Netra 6000 modular system delivers the same cooling and airflow capacity of Oracle's rackmount systems—for both SPARC and x86 server modules—resulting in reliable system operation and less required cooling infrastructure while accommodating the high-performance processors and memory found in equivalent rackmount servers.

Open and Modular System Architecture

The Sun Netra 6000 modular system provides a new approach to modular system architecture. This approach combines careful long-term chassis design with an open and standards-based system architecture.

Server Modules with a Choice of Processor Architectures

The Sun Netra 6000 modular system supports a range of full-performance and full-featured Sun Netra 6000 server modules. Many blade platforms are restrictive in the processor architectures they support, limiting innovation for modular systems and forcing difficult architectural choices for adopters. The Sun Netra 6000 modular system offers a choice of server modules based on SPARC or Intel Xeon processors. In addition, the Sun Netra 6000 family server modules provide large memory capacities, while the individual chassis provide significant power and cooling capacity.

The available Sun Netra 6000 family server modules include:

- Oracle's Netra SPARC T4-1B server module provides eight processor cores using the SPARC T4 processor, which offers approximately five times the single-threaded throughput of the previous generation SPARC T3 processor. The Netra SPARC T4-1B server module now provides both single-threaded and high multithreaded performance to meet a broad range of telecommunication network infrastructure workloads.
- Oracle's Netra Blade X3-2B server module provides two sockets for eight-core CPUs based on the Intel Xeon processor E5-2600 Platform for Intelligent Systems. The specific processor used in this server module is the Intel Xeon processor E5-2658 CPU, a NEBS-friendly 95-watt processor that can endure temporary environmental excursion without frequency throttling or reduction in long-term product reliability. The two processors in the Netra Blade X3-2B server module are interconnected using Intel's QuickPath Interconnect (QPI) technology, and each processor provides 40 PCI Express 2.0 lanes to support high-bandwidth connectivity. Netra Blade X3-2B server modules also support 24 dual inline memory module (DIMM) slots for memory-intensive workloads.

This server module is ideal for the most demanding telecommunication workloads that require a high-performance x86 server¹.

Each of these server modules is described in more detail in the later section titled Server Module Architecture.

High-Bandwidth, Open, and Independent Industry-Standard I/O

The Sun Netra 6000 modular system provides a cable-once architecture with support for true industry-standard I/O. The system utilizes standard PCIe I/O architecture and adapters—the same technology that dominates the rackmount server industry—allowing organizations to select I/O options on a per-blade basis rather than being forced into chassis-wide options. I/O adapters from several vendors are available to work with the Sun Netra 6000 modular system.

Each server module provides significant I/O capacity as well, with considerable bandwidth delivered from server modules to the multiple available I/O expansion modules (a total of up to 282 Gb/sec per supported server module). To enhance availability, server modules have no power supply or fans but rely on redundant, large, and efficient chassis-level power and cooling subsystems. Service providers can deploy individual server modules with their own processor, I/O, and operating system configurations that best serve the requirements of their applications or workloads. Different server modules can be mixed and matched in a single chassis, and they can be deployed and redeployed as needs dictate.

Transparent Chassis Management Infrastructure

Within the Sun Netra 6000 modular system, a chassis monitoring module works with the service processor on each server module to form a complete and transparent management solution. Each server module contains its own directly addressable management service processor that is also accessible through the chassis monitoring module. Each server module incorporates an Oracle Integrated Lights Out Manager (Oracle ILOM), providing support for IPMI, SNMP, CLI (through serial console or SSH), and HTTP(S) management methods. In addition, Oracle Enterprise Manager Ops Center provides discovery, aggregated management, and bulk deployment for multiple systems.

¹ The Sun Netra X6270 M2 server module will be supported as an end-of-life product for some time. For additional information on end-of-life server products, visit <http://www.oracle.com/us/products/servers-storage/servers/previous-products/>.

A Choice of AC or DC Chassis

Telecommunications organizations need a modular chassis that allows them to deploy exactly the amount of processing and types of I/O that they require, while scaling effectively to meet their needs. The Sun Netra 6000 modular system supports flexible configurations and is built from a range of standard hot-pluggable, hot-swappable modules, including:

- Up to 10 Netra SPARC T4-1B or Netra Blade X3-2B server modules, in any combination
- Blade-dedicated PCIe ExpressModules (EM), supporting industry-standard PCIe interfaces
- Network Express Modules (NEMs), providing access to all the server modules in the Sun Netra 6000 chassis
- Integral chassis monitoring module for transparent management access to server modules
- Hot-swappable power supply modules and hot-swappable redundant (N+1) cooling fans

The Sun Netra 6000 modular system is intended for a long life, with a design that assumes ongoing improvements in technology. With common system components and a choice of chassis, carriers can scale capacity with either fine or coarse granularity, as their needs dictate. Essential for telco data center flexibility, the Sun Netra 6000 modular system is offered in a choice of either an AC or DC powered chassis.

Depending on the chassis, integral AC or DC power supplies and cooling fans are provided for all the server and I/O modules. This approach keeps these components off the server modules, making them more efficient and more reliable. Power supplies and fan modules in the chassis are designed for ease of service, hot swappability, and redundancy. The chassis provides power and cooling infrastructure to support current and future CPU, memory, and I/O configurations, helping to ensure that the chassis lifecycle will span generations of upgrades. All modular components, such as the chassis monitoring module, server modules, EMs, and NEMs are hot pluggable. In addition, I/O paths can be configured in a redundant fashion.

Sun Netra 6000 AC Chassis

The Sun Netra 6000 AC chassis (Figure 1) is provided in a 10 rack unit (10U) form factor with up to four chassis supported in a single 42U rack. Two power supplies are provided in the AC chassis, each with two AC input circuits (N+N).



Figure 1. The Sun Netra 6000 AC chassis provides two power supply units (PSUs) and supports up to 10 Sun Netra 6000 server modules in 10U.

Sun Netra 6000 DC Chassis

To accommodate typical DC central-office environments, the Sun Netra 6000 modular system is also provided in a DC chassis. Other than the power supply, the DC-powered chassis offers the same functionality as the AC chassis in terms of supported server modules and I/O modules. As shown in Figure 2, the DC chassis features four power supply units (PSUs) in an N+1 redundancy scheme. Each PSU has two input circuits to support redundant power. A 1U DC power input unit at the top of the chassis accommodates the input power cabling required, taking the rack space required for a single Sun Netra 6000 DC chassis to 11U.



Figure 2. The Sun Netra 6000 DC chassis supports four power supply units (PSUs) and adds a 1U power plenum to accommodate power cabling.

Sun Netra 6000 Modular System Overview

The Sun Netra 6000 modular system brings significant advancements to telecommunications organizations. The Sun Netra 6000 modular system is ideal for delivering maximum price/performance with superior features compared to traditional rackmount servers. Supporting a choice of x86 or SPARC platforms, the Sun Netra 6000 modular system can deliver highly dense configurations in conjunction with other Oracle systems.

Chassis Front Perspective

The Sun Netra 6000 chassis houses the server modules and I/O modules, connecting the two through a passive midplane. Redundant and hot-swappable power supplies and fan modules are also hosted in the chassis. All slots are externally accessible from either the front or the rear of the chassis for easy upgrade or servicing. Server modules, I/O modules, power supplies, and fan modules all can be added and removed while the chassis and other elements in the enclosure are powered on. This capability yields great real-time expansion opportunity and provides considerable flexibility. The front perspective of the Sun Netra 6000 chassis is shown in Figure 3, with components described in the sections that follow.

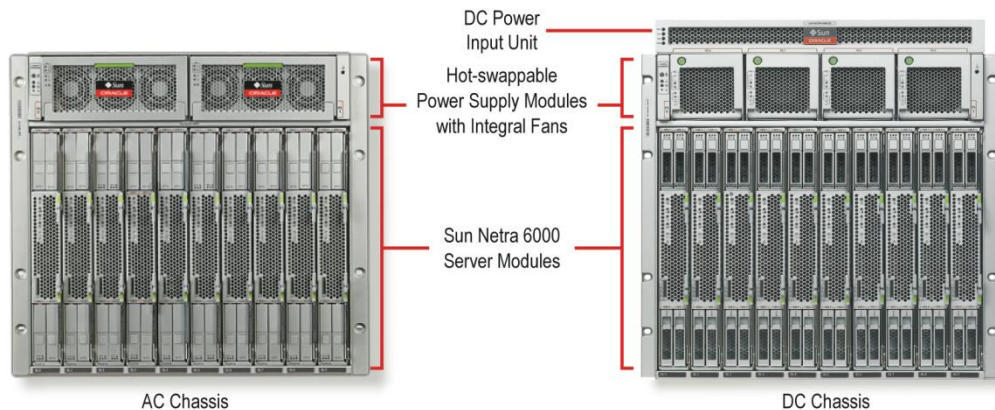


Figure 3. The Sun Netra 6000 AC chassis (left) and DC chassis (right) are shown from the front perspective.

Operator Panel

An operator panel is located near the top of both chassis, providing status on the overall condition of the system. Indicators show whether the chassis is on standby or in operational mode and whether an over-temperature condition is occurring. A push-button indicator acts as a locator button for the chassis in case there is a need to remotely identify a chassis within a rack or in a crowded central office. If any of the components in the chassis present a problem or a failure, the operator panel reflects that issue as well.

Power Supply Modules and Front Fan Modules

Power supply modules load from the front of the chassis. Power supply modules are hot swappable and contain a fan module that helps cool both the power supplies as well as the PCIe EMs in the rear of the enclosure. In case of a power supply failure, the integral fan modules continue to function because they are energized directly from the chassis power grid, independently from the power supply modules that contain them.

The power supply modules provide the total power required by the chassis. In the AC chassis, two power supply modules are provided, and they can be configured redundantly in an N+N configuration, with a single power supply module able to power the entire chassis at full load. In order to provide N+N redundancy, all four power cords must be energized. If both power supply modules are energized, all the systems in the chassis are protected from power supply failure. A power supply

module can fail or be disconnected without affecting the server modules and components running inside the chassis. To further enhance this protection, power grid redundancy for all the systems and components in the chassis can be achieved easily by connecting each of the two power supply modules to different power grids within the data center.

The DC chassis provides four power supply modules in an N+1 redundant configuration. Each module has two input circuits (A+B) to support redundant power. Four supplied power supply modules per system results in eight input power circuits per system. For a more in-depth analysis of day-to-day power consumption of the system, please visit the power calculator located at:

<http://www.oracle.com/us/products/servers-storage/sun-power-calculators/calc/netra-6000-power-calculator-519736.html>

Server Modules

Up to 10 Sun Netra 6000 server modules can be inserted vertically beneath the power supply modules in the front of the Sun Netra 6000 chassis. Depending on the server module, up to four slots for hard disk drives (HDDs) are provided for easy hot swap from the front of the chassis. Indicator LEDs and a high-density I/O port are also provided on the front of the server modules for easy access. A number of connectors are provided through the high-density front panel port of each server module. These ports are broken out using an available server module adaptor “dongle” cable. Depending on the server module, available ports include a VGA HD-15 monitor port, two USB 2.0 ports, and a DB-9 or RJ-45 serial port that connects to the server module and integral service processors.

Chassis Rear Perspective

The rear of the Sun Netra 6000 AC chassis (Figure 4) and DC chassis (Figure 5) provide access to the back side of the passive midplane for I/O modules. N+1 hot-swappable fan modules also are inserted from the rear of the chassis. Slots for PCIe EMs and NEMs are provided. I/O modules are all hot swappable and provide I/O capabilities to server modules.

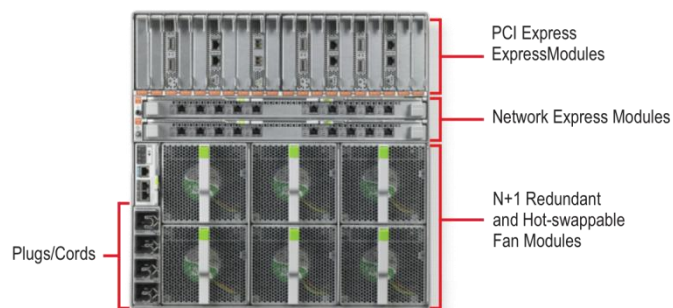


Figure 4. The Sun Netra 6000 AC chassis is shown from the rear perspective.

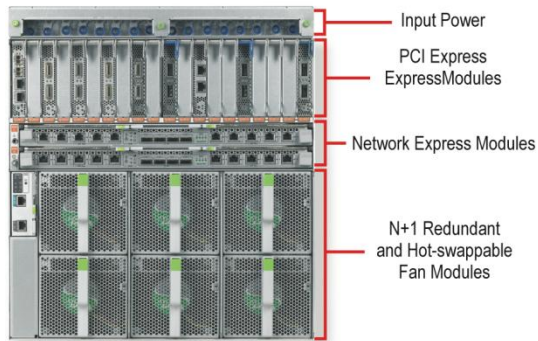


Figure 5. The Sun Netra 6000 DC chassis offers eight input power circuits at the rear of the power plenum.

PCIe ExpressModules (EMs)

Twenty hot-pluggable and hot-swappable PCIe EM slots are accessible at the rear top of each Sun Netra 6000 chassis, and they are dedicated in pairs to corresponding server modules through the passive midplane. EMs offer a variety of choices for communications including SAS, GbE, 10 GbE, Fibre Channel, and Ethernet/Fibre Channel combined. Different EMs can be selected for every server module in order to provide each with the right type of fabric connectivity with a high degree of granularity.

Network Express Modules (NEMs)

Space is provided for up to two NEMs in the rear of the Sun Netra 6000 chassis. NEMs provide the same I/O capabilities across all of the server modules installed in the chassis, simplifying connectivity and also usually offering a low-cost I/O solution since they provide I/O to all the server modules. All the server modules are directly connected to each of the configured NEMs via high-speed point-to-point connections across the passive chassis midplane. More details on available NEMs are provided later in this document.

Chassis Monitoring Module

A chassis monitoring module is located to the left of the NEM slots on the rear left side of the Sun Netra 6000 chassis, providing remote monitoring capability and a central access point to the chassis. The chassis monitoring module includes an integrated network switch that provides LAN access to the chassis monitoring module's Ethernet ports and to the individual server module management ports. Individual server module management is completely transparent and independent from the chassis monitoring module.

Power Supply Inlets

Four power supply inlets (plugs) are available from the rear of the Sun Netra 6000 AC chassis and correspond to the number of power supply cores in the two front-loaded power supply modules. Integral cable holders prevent accidental loss of power from inadvertent cable removal. Each of the cables requires a 200–240 VAC, 20 A circuit, and a minimum of two circuits is required to power each chassis. For full N+N redundancy, four circuits are required. On the DC chassis, each PSU has two

input circuits (A+B) to support redundant power. A total of eight input-power circuits are provided per system. For each circuit, nominal operating voltage range is -48 VDC to -60 VDC. Minimum operational input voltage is -39.5 VDC and maximum is -72 VDC. Maximum DC current for each input circuit is 60 A.

Fans and Airflow

Chassis airflow is entirely front to back and is powered by rear fan modules as well as by the front fan modules mounted in the power supply modules. All rear fan modules are hot swappable and N+1 redundant, with six fan modules provided for each Sun Netra 6000 chassis. Each rear fan module is composed of two redundant in-line fans. The front fan modules pull air in from the front of the chassis and blow it across the power supplies and out through the EM and NEM spaces. The rear fan modules pull air from the front of the chassis and out through the rear. When all the fans in the chassis are running at full speed, the chassis can provide up to 1,000 cubic feet per minute (CFM) of airflow through the chassis.

Passive Midplane

In essence, the passive midplane in the Sun Netra 6000 chassis is a collection of wires and connectors between different modules in the chassis (Figure 6). Since there are no active components, the reliability of these printed circuit boards is extremely high—in the millions of hours or hundreds of years. The passive midplane provides electrical connectivity between the server modules and the I/O modules.

All modules, front and rear, with the exception of the power supplies and the fan modules connect directly to the passive midplane. The power supplies connect to the midplane through a bus bar and to the AC inputs via a cable harness. An adapter is provided for the DC modules. The redundant fan modules plug individually into a set of three fan boards, where fan speed control and other chassis-level functions are implemented. The front fan modules that cool the PCIe EMs each connect to the chassis via blind-mate connections. The main functions of the midplane include:

- Providing a mechanical connection point for all the server modules
- Providing 12 VDC from the power supplies to each customer-replaceable module
- Providing 3.3 VDC power to power the system management bus devices on each module and to power the chassis monitoring module
- Providing a PCIe 2.0 interconnect between the PCIe root complexes on each server module to the EMs and NEMs installed in the chassis
- Connecting the server modules, chassis monitoring modules, and NEMs to the chassis management network

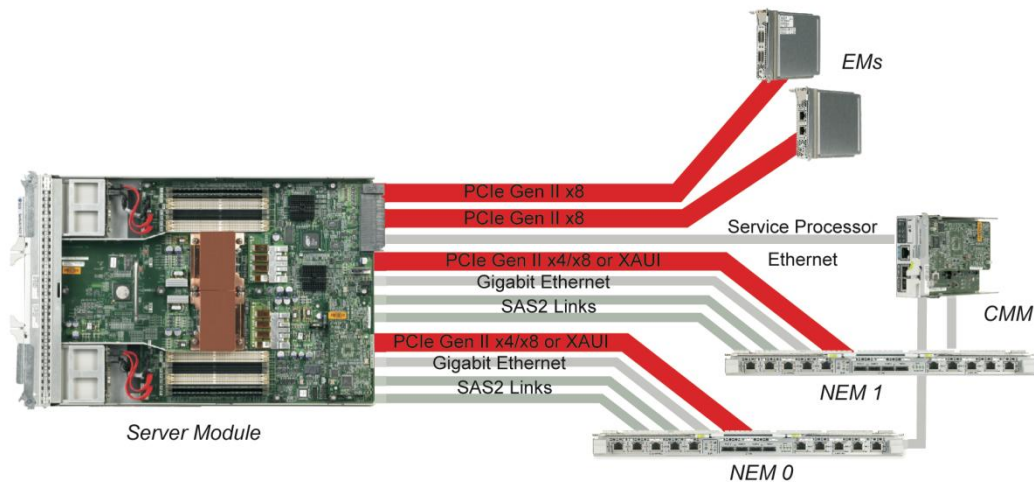


Figure 6. Server modules communicate with PCIe Express Modules and Network Express Modules via high-speed point-to-point links across the passive chassis midplane.

Each server module is energized through the midplane from the redundant chassis power grid. The midplane also provides connectivity to the I2C network in the chassis, letting each server module directly monitor the chassis environment, including fan and power supply status as well as various temperature sensors. A number of I/O links are also routed through the midplane for each server module.

The capabilities and bandwidth of each server module connections typically include:

- Two midplane x8 PCIe 2.0 links connect from each server module to each of the dedicated EMs
- Two midplane x8 PCIe 2.0 links connect from each server module, one to each of the NEMs
- Two GbE links are provided, each connecting to one of the NEMs
- Four x1 Serial Attached SCSI (SAS1 for SPARC) links, with two connecting to each NEM slot through the passive midplane

Server Modules Based on SPARC T-Series and Intel Xeon Processors

The ability to host demanding compute, memory, and I/O-intensive applications is ultimately dependent on the characteristics of the actual server modules. The innovative Sun Netra 6000 chassis allows designers considerable flexibility in terms of delivering powerful server modules for a broad range of applications.

Server modules feature a physically similar front panel design, with support for either two or four disk bays. This consistent design is intentional since any server module can be used in any slot of the chassis, regardless of the internal architecture of the server module. As mentioned, all server modules use the same midplane connectors and have similar I/O characteristics.

A Choice of Processors and a Choice of Operating Systems

By providing a choice of SPARC T-Series or Intel Xeon processors, the Sun Netra 6000 modular systems can serve a wide range of applications and demands. Organizations are free to choose the platform that best suits their needs or fits in with their existing environments. Server modules of different architectures can also be mixed and matched in a single Sun Netra 6000 chassis.

To help ensure the best application performance, server modules provide substantial computational and memory capacity to support demanding applications. Table 1 lists the capabilities of the server modules including processors, cores, threads, and memory capacity.

TABLE 1. PROCESSOR SUPPORT AND MEMORY CAPACITIES FOR SUN NETRA 6000 SERVER MODULES

SERVER MODULE	PROCESSOR TYPE	NUMBER OF PROCESSORS	PROCESSOR SPEED	MAXIMUM CORES/THREADS PER SERVER MODULE	MEMORY SLOTS
Netra SPARC T5-1B	16-core SPARC T5 processor	1	3.6 GHz	16 cores/128 threads	16 DDR3 DIMM slots
Netra SPARC T4-1B	8-core SPARC T4 processor	1	2.85 GHz	8 cores/64 threads	16 DDR3 DIMM slots
Netra Blade X3-2B	8-core Intel Xeon processor E5-2658 CPUs	2	2.1 GHz	8 cores/16 threads	24 DDR3 DIMM slots

Leading I/O Throughput

Sun Netra 6000 server modules provide extensive I/O capabilities and a wealth of I/O options, allowing modular servers to be used for applications that require significant I/O throughput:

- Up to 282 Gb/sec of I/O throughput is provided per server module², delivered through 32 lanes of PCIe 2.0 I/O, as well as multiple GbE and SAS-2 links. Each server module delivers its I/O to the passive midplane and the I/O devices connected to it in the Sun Netra 6000 chassis.
- The 2.5-inch SAS-2 disk drives are supported on the server modules.
- Two hot-pluggable PCIe EM slots are dedicated to each server module, 20 per Sun Netra 6000 chassis for granular (per blade) I/O configuration.

² Please see Table 2 for more information.

- NEMs provide bulk I/O across multiple server modules and aggregate I/O functions. Up to two NEMs are supported per Sun Netra 6000 chassis. Each NEM slot features a PCIe x8 or high-bandwidth XAUI connection, a GbE connection, and two SAS-2 link connections to each server module.

Table 2 lists the throughput provided through the passive midplane from each of the server modules.

TABLE 2. MIDPLANE THROUGHPUT FOR SUN NETRA 6000 SERVER MODULES

SERVER MODULE	PCI EXPRESS LINKS TO EMS	PCI EXPRESS LINKS TO NEMS	GIGABIT ETHERNET LINKS	OTHER LINKS	TOTAL BANDWIDTH
Netra SPARC T5-1B server module	2 x 8 PCIe 2.0 links @ 64 Gb/sec	2 NEM and 2 XAUI, or 4 NEM links, 4 x PCIe 2.0 links @ 64 Gb/sec	2 @ 1 Gb/sec	4 SAS-2 links @ 6 Gb/sec	282 Gb/sec
Netra SPARC T4-1B server module	2 x 8 PCIe 2.0 links @ 64 Gb/sec	2 NEM and 2 XAUI, or 4 NEM links, 4 x PCIe 2.0 links @ 64 Gb/sec	2 @ 1 Gb/sec	4 SAS-2 links @ 6 Gb/sec	282 Gb/sec
Netra Blade X3-2B server module*	2 x 8 PCIe 2.0 links, @ 64 Gb/sec	2 NEM and 2 XAUI, or 4 NEM links, 2 x 8 PCIe 2.0 links, @ 64 Gb/sec	2 @ 1 Gb/sec	4 SAS-2 links, @ 6 Gb/sec	282 Gb/sec

* Server modules feature RAID expansion module (REM) and fabric expansion modules (FEM)

Enterprise-Class Features

Unlike most traditional blade servers, Sun Netra 6000 server modules provide a host of enterprise features that help ensure greater reliability and availability:

- Each server module supports hot-plug capabilities.
- Disk capacity varies between server modules, but when provided (2- or 4-disk models), disks are hot pluggable and provide the option of RAID controllers³.
- Redundant hot-swap chassis-located fans mean greater reliability through decreased part count and no fans located in the server modules.
- Redundant hot-swap chassis-located power supply modules mean that no power supplies are located in individual server modules.

³ REMs are supported by the Netra SPARC T4-1B and Netra Blade X3-2B server modules only.

Open Transparent Management

The Sun Netra 6000 modular system provides a robust and comprehensive list of management features, including:

- A dedicated Oracle ILOM service processor on each server module for blade-level management granularity
- A chassis monitoring module for direct access to server module management features
- Optional Oracle Enterprise Manager Ops Center (included in x86 server modules) for server module discovery and OS provisioning as well as bulk application-level provisioning

A Choice of Operating Systems and Virtualization Support

In order to provide maximum flexibility and investment protection, the server modules support a choice of operating systems, including:

- Oracle Solaris OS
- Linux operating systems, including Oracle Linux, 64-bit Red Hat, SUSE
- Microsoft Windows
- Virtualization software support includes:
 - Oracle VM
 - VMware

Oracle VM Server for SPARC Support in Netra SPARC T4-1B Server Modules

Supported in all SPARC and Netra SPARC servers that utilize SPARC processors with chip multithreading (CMT) technology, Oracle VM Server for SPARC (formerly Sun Logical Domains) provides a full virtualization layer. Multiple independent virtual machines, each with their own operating system instance, enable virtualized CPU, memory, storage, console, and cryptographic devices. Within the Oracle VM Server for SPARC architecture, a small firmware layer known as the Hypervisor provides a stable, virtualized machine architecture to which an operating system can be written. As such, each logical domain is completely isolated. The maximum number of virtual machines created on a single platform relies upon the capabilities of the underlying hardware architecture and the Hypervisor as opposed to the number of physical hardware devices installed in the system. For example, the Netra SPARC T4-1B server module supports up to 64 logical domains, and each individual logical domain can run a unique instance of the operating system⁴.

⁴ Though technically possible, this practice is not generally recommended.

By taking advantage of Oracle VM Server for SPARC, organizations gain the flexibility to deploy multiple operating systems simultaneously on a single server module. In addition, administrators can exploit virtual device capabilities to transport an entire software stack hosted on a logical domain from one physical machine to another. Logical domains can also host Oracle Solaris Zones, a feature of Oracle Solaris 11, to capture the isolation, flexibility, extensive granularity, and manageability features of both technologies. By deeply integrating logical domains with both the industry-leading CMT capabilities of the SPARC T-Series processors and the Oracle Solaris OS, Oracle VM Server for SPARC technology increases flexibility, isolates workload processing, and improves the potential for maximum server utilization.

Oracle Solaris Support on All Server Modules

Among the available operating systems, Oracle Solaris is ideal for large-scale enterprise deployments. Supported on all the Sun Netra 6000 server modules, Oracle Solaris has certain hardware-specific features that can enhance performance, efficiency, and reliability—with different features affecting different processors, as noted.

Scalability and Support for Oracle SPARC T-Series Processor Technology

The Oracle Solaris OS is specifically designed to deliver on the available capacity of the considerable resources provided by SPARC processor-based systems, such as the Netra SPARC T4-1B server module. In fact, the Oracle Solaris OS provides functionality for optimal utilization, availability, security, and performance of these systems, as follows:

- **CMT awareness**—The Oracle Solaris 10 and Oracle Solaris 11 OS versions are aware of the SPARC T4 and T5 processor hierarchies so that the scheduler can effectively balance the load across all the available pipelines. For instance, even though it exposes every physical processor strand as a logical processor (up to 128 per chip), Oracle Solaris understands the correlation between cores and the threads they support, and it provides a fast and efficient thread implementation that can speed application performance.
- **Fine-granularity manageability**—The Oracle Solaris OS has the ability to dedicate, enable, or disable individual processors and threads. The SPARC T4 and T5 processors support a "critical thread API" that is new in Oracle Solaris 11, enabling the operating system to recognize critical threads and assign them, by themselves, to a single processor core. This allows critical threads to run at the very highest performance levels without competing with other less critical threads, resulting in faster overall performance for threaded applications. Standard Oracle Solaris OS features, such as processor sets, also provide the ability to define a group of logical processors and schedule processes or threads on them.
- **Binding interfaces**—Oracle Solaris allows considerable flexibility in that processes and individual threads can be bound to either a processor or a processor set, if required or desired.
- **Support for virtualized networking and I/O with hardware-accelerated cryptography**—Oracle Solaris contains technology to support and virtualize components and subsystems on the SPARC T4 processors. As a part of a high-performance network architecture, CMT-aware device drivers are provided so that applications running within virtualization frameworks can effectively

share I/O and network devices. Hardware-accelerated cryptography is supported through the Oracle Solaris Cryptographic Framework feature and the in-core hardware accelerators present in all SPARC T4 and T5 processors.

Oracle Solaris Zones for Consolidation, Secure Partitioning, and Virtualization

Oracle Solaris Zones comprises a group of technologies that work together to efficiently manage system resources, virtualize the system, and provide a complete, isolated, and secure runtime environment for applications. Oracle Solaris Zones can be used to partition and allocate the considerable computational resources of the server modules. Oracle Solaris Zones and Oracle Solaris resource management work together with the Oracle Solaris fair-share scheduler on both SPARC-based and x86-based server modules.

- **Oracle Solaris Zones**—Oracle Solaris Zones can be used to create an isolated and secure environment for running applications. A zone is a virtualized operating system environment created within a single instance of Oracle Solaris. It can be used to isolate applications and processes from the rest of the system. This isolation helps enhance security and reliability since processes in one zone are prevented from interfering with processes running in another zone.
- **Resource management**—Resource management tools provided with Oracle Solaris let administrators dedicate resources such as CPU cycles to specific applications. CPUs in a multicore, multiprocessor system—such as those provided by Sun Netra 6000 server modules—can be logically partitioned into processor sets and bound to a resource pool, and can ultimately be assigned to a Oracle Solaris zone. Resource pools provide the capability to separate workloads so that consumption of CPU resources does not overlap. Resource pools also provide a persistent configuration mechanism for processor sets and scheduling class assignment. In addition, the dynamic features of resource pools let administrators adjust system resources in response to changing workload demands.

Oracle Solaris DTrace Facility to Instrument and Tune Live Software Environments

When production systems exhibit nonfatal errors or subpar performance, the sheer complexity of modern distributed software environments can make accurate root-cause diagnosis extremely difficult. Unfortunately, most traditional approaches to solving this problem have proved time-consuming and inadequate, leaving many applications languishing far from their potential performance levels.

The Oracle Solaris DTrace feature is a facility on both SPARC and x86 platforms that provides dynamic instrumentation and tracing for both application and kernel activities—even allowing tracing of application components running in a Java Virtual Machine (JVM)⁵. Oracle Solaris DTrace lets

⁵ The terms "Java Virtual Machine" and "JVM" mean a Virtual Machine for the Java platform.

developers and administrators explore the entire system to understand how it works, track down performance problems across many layers of software, or locate the cause of aberrant behavior. Tracing is accomplished by dynamically modifying the operating system kernel to record additional data at locations of interest. Best of all, although Oracle Solaris DTrace is always available and ready to use, it has no impact on system performance when not in use, making it particularly effective for monitoring and analyzing production systems.

NUMA Optimization in Oracle Solaris

With memory managed by each processor on Oracle's Netra SPARC T4-1B and Netra Blade X3-2B server modules, the implementations represent non-uniform memory access (NUMA) architectures. Namely, the speed with which a processor can access its own local memory is higher than that required to access memory managed by the other processor. Oracle Solaris provides technology that can specifically help applications improve performance on NUMA architectures.

- **Memory placement optimization (MPO)**—The Oracle Solaris 10 and Oracle Solaris 11 OS versions use MPO to improve the placement of memory across the physical memory of a server, resulting in increased performance. Through MPO, the Oracle Solaris OS works to help ensure that memory is as close as possible to the processors that access it, while still maintaining enough balance within the system. As a result, many database and enterprise applications are able to run considerably faster with MPO.
- **Hierarchical lgroup support (HLS)**—HLS improves the MPO feature in Oracle Solaris. HLS helps Oracle Solaris optimize performance for systems with more complex memory latency hierarchies. HLS lets Oracle Solaris distinguish between the degrees of memory remoteness, allocating resources with the lowest possible latency for applications. If local resources are not available by default for a given application, HLS helps Oracle Solaris allocate the nearest remote resources.

Oracle Solaris ZFS File System

The Oracle Solaris ZFS file system offers a dramatic advance in data management, automating and consolidating complicated storage administration concepts and providing unlimited scalability with the world's first 128-bit file system. Oracle Solaris ZFS is based on a transactional object model that removes most of the traditional constraints on I/O issue order, resulting in dramatic performance gains. Oracle Solaris ZFS also provides data integrity, protecting all data with 64-bit checksums that detect and correct silent data corruption.

A Secure and Robust Enterprise-Class Environment

The Oracle Solaris binary compatibility guarantee helps ensure that existing applications continue to run unchanged, protecting investments. Certified multilevel security protects Oracle Solaris environments from intrusion. Oracle's comprehensive fault management architecture means that elements such as the Oracle Solaris Predictive Self Healing feature can communicate directly with the hardware to help reduce both planned and unplanned downtime.

Server Module Architecture

The Sun Netra 6000 modular system provides high performance, capacity, and massive levels of I/O through full-featured interfaces that use the latest technology and make the most of innovative chassis design. The architecture of the Netra SPARC T5-1B, Netra SPARC T4-1B and Netra Blade X3-2B server modules are described in this section, while PCIe ExpressModules (EMs), Network Express Modules (NEMs) and the chassis monitoring module are described later in this document.

Oracle's Netra SPARC T5-1B Server Module Overview

The Netra SPARC T5-1B server module is a single-socket 3.6 GHz SPARC T5 processor-based blade module with 16 cores and 218 threads. The SPARC T5 processor delivers 1.2 times the single-thread performance of the previous generation SPARC T4 processor while maintaining industry-leading multithreaded performance. The Netra SPARC T5-1B server contains 16 DIMM slots to support up to 256 GB of memory using DDR3 DIMMs, providing significant memory bandwidth for single-threaded and multithreaded workloads.

The motherboard design for the Netra SPARC T5-1B server module is shown in Figure 7

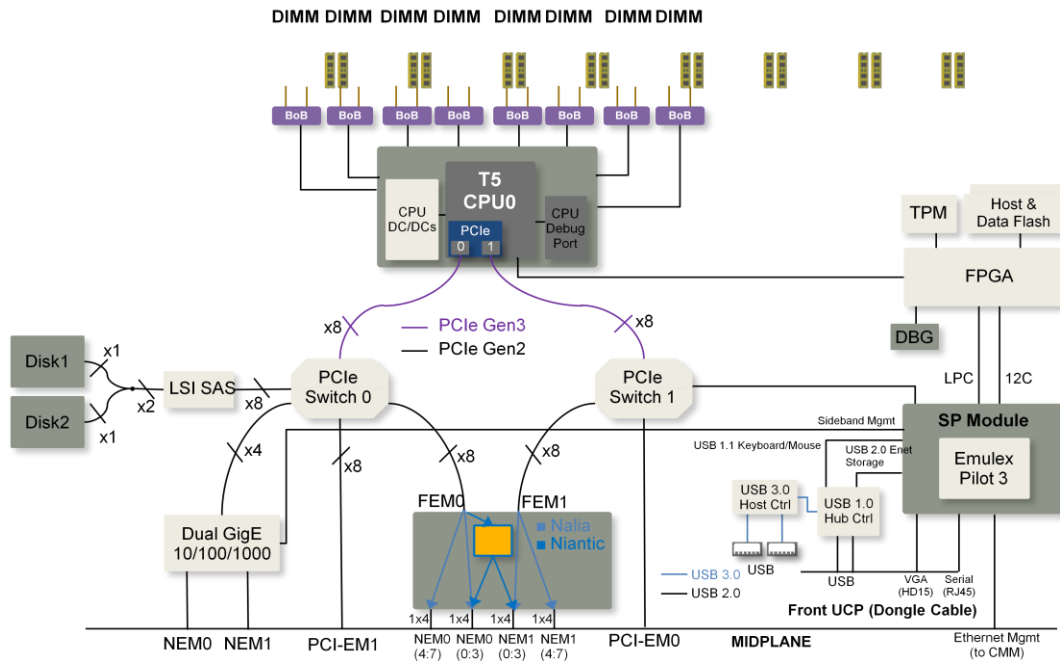


Figure 7. Oracle's Netra SPARC T5-1B server module motherboard design.

Oracle's Netra SPARC T5-1B server module features a compact blade server, giving organizations the flexibility to scale their processing and I/O by simply adding the Netra SPARC T5-1B to an existing Sun Netra 6000 chassis (Table 3).

SERVER DIMENSION U.S./INTERNATIONAL
Height: 12.9 inches (blade)/327.2 millimeters
Width: 1.8 inches/44.5 millimeters
Depth: 20.1 inches/511.7 millimeters
Weight (with 4 disks, full memory): 16.4 pounds/7.4 kilograms

The SPARC T5 systems have been designed specifically for the most demanding data-intensive and enterprise workloads that require the very highest levels of performance, reliability, scalability, and security. SPARC T5 builds on the momentum begun with SPARC T4 by increasing SPARC's already record-setting single-thread performance, while simultaneously doubling the number of compute cores. These extraordinary engineering improvements deliver a 2.3 times increase in throughput performance.

The SPARC T5 processor:

- Sixteen S3cores, 128 threads, 3.6GHz
- Private 128k L2 cache
- Shared 8 MB L3 cache
- On-chip PCIe 3.0*
- 28 nm process technology

The SPARC T5 processor was designed from the ground up with security as a focus and has cryptographic instruction accelerators integrated directly into each processor core. Crypto instruction accelerators enable high-speed encryption for more than a dozen industry-standard ciphers including DES, 3DES, AES, SSL, and RSA. By integrating encryption capabilities directly inside the instruction pipeline, the SPARC T5 processor eliminates the performance and cost barriers typically associated with secure computing.

The SPARC T5 processor uses a robust out-of-order, dual-issue processor core that is heavily threaded among eight strands. Additionally, each core has a 16-stage integer pipeline to achieve high operating frequencies, advanced branch prediction to mitigate the effect of a deep pipeline, and dynamic allocation of processor resources to threads. The SPARC T5 processor includes 16 of these cores, a private 128 KB L2 cache per core, a shared 8 MB L3 cache with full crossbar, four dual-channel memory control units, two PCI Express 3.0 interfaces, and seven inter-CPU coherency links—which, when combined with a new high-performance directory-based protocol, enables SPARC T5 systems to scale to eight sockets without any additional silicon. The SPARC T5 processor also includes advanced power management features such dynamic voltage and frequency scaling (DVFS), per core pair cycle skip, link scaling, and memory control unit low power states which means that power consumption will scale well with work load.

* Cards that are categorized as PCIe 3.0 are qualified to run with the Netra SPARC T5-1B; however, due to midplane restriction, will only run at 2.0 speeds. Between switch and CPU, the blade runs at

PCIe 3.0. Due to midplane connector capabilities, the speed from switch to the EM/NEM is limited to PCIe 2.0 speed.

Front and Rear Perspectives for Netra SPARC T5-1B Server Module

External features of the Netra SPARC T5-1B include the following:

- System and component status indicator lights that provide locator (white), service required (amber), and activity status (green) for the system (on the front)
- Hot-pluggable SAS-2 disk drives accessible through the front panel of the system
- Two external USB 2.0 ports accessible via dongle
- A VGA video port
- Two management ports for use with Oracle ILOM 3.0 system controller; RJ-45 serial management port provides default connection to the Oracle ILOM 3.0 controller (network management port supports an optional RJ-45 10/100Base-T connection to the Oracle ILOM 3.0 system controller)

Figure 8 shows the front and rear view of the Netra SPARC T5-1B server module. Figure 9 highlights where some of the features mentioned above can be found on the Netra SPARC T5-1B server module.

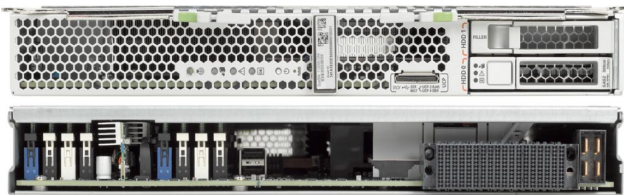


Figure 8. The front and back panels of the Netra SPARC T5-1B server module.

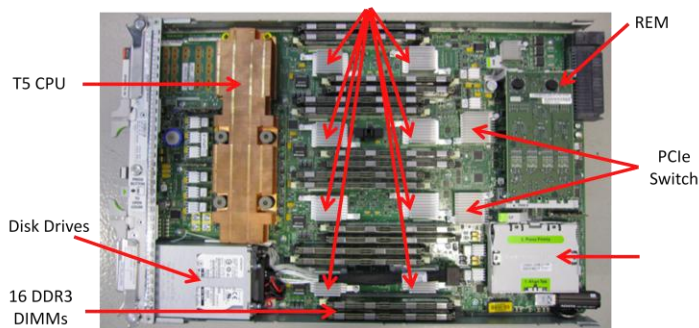


Figure 9. Component locations on the Netra SPARC T5-1B server module.

Designed for Reliability, Availability, and Serviceability

Netra SPARC T5-1B server modules help organizations maximize the uptime of network services. The inclusion of redundant components and features that automate data integrity, fault isolation, and error correction improve the robustness of these SPARC processor-based servers. Online maintenance capabilities and simplified maintenance procedures help enterprises avoid the need for planned

outages. Extensive fault management and self-healing capabilities reduce unplanned outages and recovery time.

The massively threaded, multisolet, system-on-a-chip (SoC) design of SPARC T-Series processors directly contributes to the low component count of the Netra SPARC T4-1B server modules. SPARC T-Series processors combine advanced server functions on the processor die itself, including two eight-lane PCIe Generation 2 interfaces for low-latency data transfer, two 10 GbE ports, a stream processing unit (SPU) on each core for wire speed cryptography, and a fully pipelined floating point unit with a Fused Mul/Add (FMADD) instruction (Figure 10). The SPARC T-Series processors also have multisolet capabilities, cache coherency links, and the ability to handle FB-DIMM single-link failover.

SPARC T5 Processor Architecture

The SPARC T5 processor further extends Oracle's multicore/multithreaded initiative with an elegant and robust architecture that delivers real performance to applications. Figure 10 provides a block-level diagram of the SPARC T5 processor.

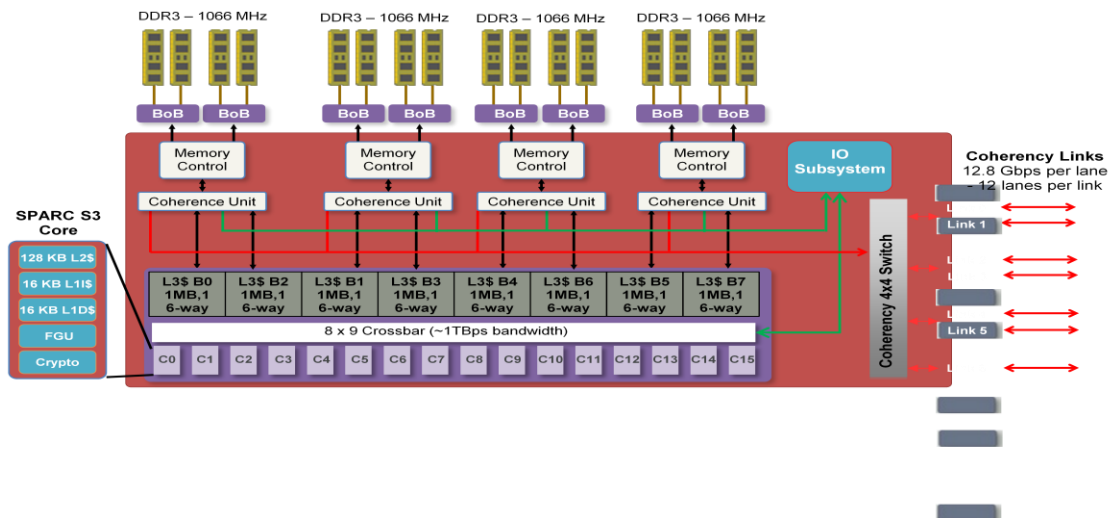


Figure 10. The SoC design of the multiprocessing SPARC T-Series processors incorporates massive compute power, I/O, network, and cryptographic capabilities onto a single die (SPARC T5 processor design shown here).

The SoC design of the SPARC T-Series processors reduces the need for additional ASICs to connect onboard components. As a result, Netra SPARC T5-1B server modules simply contain fewer parts and pins that can fail compared to many traditional servers with multiple single-threaded dual-core or quad-core processors.

Improving Availability: Redundancy, Serviceability, and Self-Diagnosis

Minimizing the need for system interruptions in order to correct error conditions improves the availability of a system and the hosted IT service. Netra SPARC T5-1B server modules provide many design features to help enable completion of maintenance procedures without having an impact on continuous system operation.

Redundant Hot-Swap Components and RAID Capabilities

Oracle's Netra SPARC T5-1B server modules are built to achieve high levels of uptime and fast recovery from failures. Hot-swappable and hot-pluggable chassis-mounted hard drives, fan units, and power supplies also help improve serviceability and availability. For systems configured with redundant components, administrators can use software commands to remove and replace disks, power supplies, and fan units while the system continues to operate.

The built-in RAID capabilities of the Netra SPARC T5-1B server modules provide data redundancy and increased performance at no additional cost. These servers support onboard hardware RAID 0/1 to enable striping or mirroring of data across any two internal drives. In addition, Netra SPARC T5-1B server modules running Oracle Solaris can take advantage of software RAID capabilities. For example, Oracle Solaris ZFS can be used for internal or external storage devices, providing flexibility and redundancy beyond the chassis.

Oracle's Netra SPARC T4-1B Server Module Overview

The Netra SPARC T4-1B server module is a single-socket 2.85 GHz SPARC T4 processor-based blade module with eight cores and 64 threads. The SPARC T4 processor delivers five times the single-thread performance of the previous generation SPARC T3 processor while maintaining industry-leading multithreaded performance. The Netra SPARC T4-1B server module contains 16 DIMM slots to support up to 256 GB of memory using DDR3 DIMMs, providing significant memory bandwidth for single-threaded and multithreaded workloads.

The motherboard design for the Netra SPARC T4-1B server module is shown in Figure 7.

- Two dedicated x8 PCIe ExpressModule slots
- Two x8 PCIe slots for use by optional fabric expansion modules (use with appropriate Network Expansion Modules)
- Two USB 2.0 ports (two external via dongle)
- Up to two available disk drive slots supporting commodity SAS-2 disk drives
- Oracle ILOM 3.0 system controller

Front and Rear Perspectives for Netra SPARC T4-1B Server Module

External features of the Netra SPARC T4-1B include the following:

- System and component status indicator lights that provide locator (white), service required (amber), and activity status (green) for the system (on the front)
- Hot-pluggable SAS-2 disk drives accessible through the front panel of the system
- Two external USB 2.0 ports accessible via dongle
- A VGA video port
- Two management ports for use with the Oracle ILOM 3.0 system controller; RJ-45 serial management port provides default connection to the Oracle ILOM 3.0 controller (network management port supports an optional RJ-45 10/100Base-T connection to the Oracle ILOM 3.0 system controller)

Figure 8 shows the front and rear view of the Netra SPARC T4-1B server module. Figure 9 highlights where some of the features mentioned above can be found on the Netra SPARC T4-1B server module.

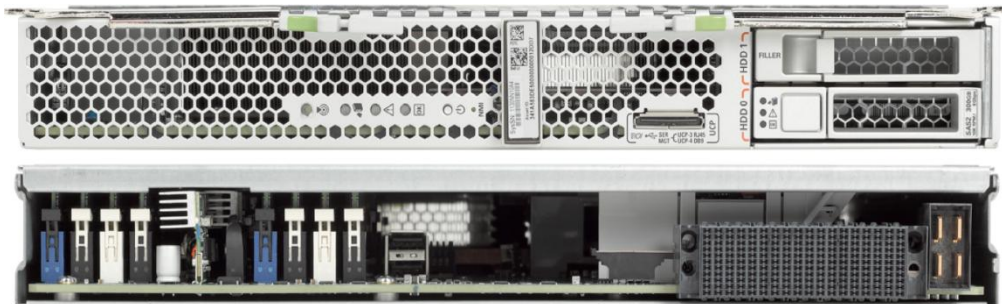


Figure 8. The front and back panels of the Netra SPARC T4-1B server module.

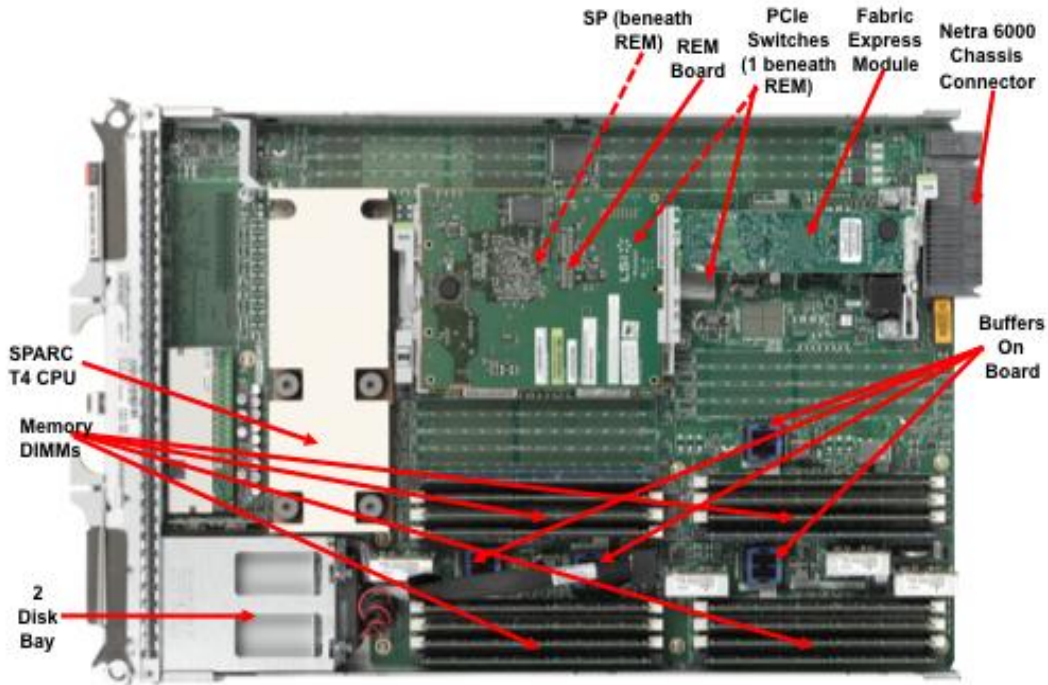


Figure 9. Component locations on the Netra SPARC T4-1B server module.

Designed for Reliability, Availability, and Serviceability

Netra SPARC T4-1B server modules help organizations maximize the uptime of network services. The inclusion of redundant components and features that automate data integrity, fault isolation, and error correction improve the robustness of these SPARC processor-based servers. Online maintenance capabilities and simplified maintenance procedures help enterprises avoid the need for planned outages. Extensive fault management and self-healing capabilities reduce unplanned outages and recovery time.

The massively threaded, multsocket, system-on-a-chip (SoC) design of SPARC T-Series processors directly contributes to the low component count of the Netra SPARC T4-1B servers. SPARC T-Series processors combine advanced server functions on the processor die itself, including two eight-lane PCIe Generation 2 interfaces for low-latency data transfer, two 10 GbE ports, a stream processing unit (SPU) on each core for wire speed cryptography, and a fully pipelined floating point unit with a Fused Mul/Add (FMADD) instruction (Figure 10). The SPARC T-Series processors also have multsocket capabilities, cache coherency links, and the ability to handle FB-DIMM single-link failover.

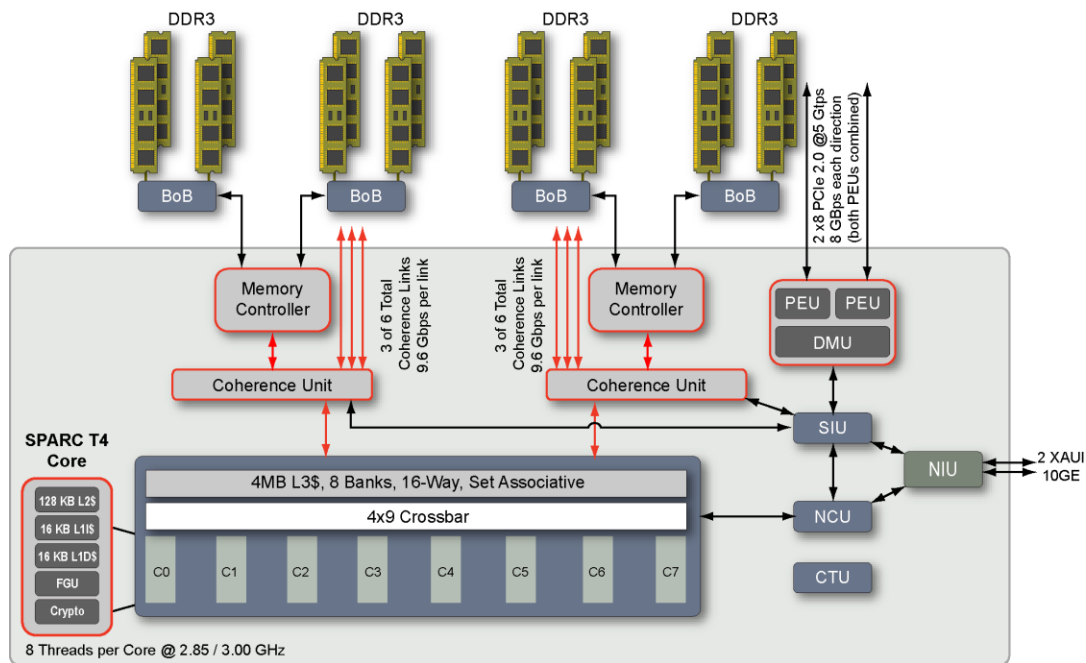


Figure 10. The SoC design of the multiprocessing SPARC T-Series processors incorporates massive compute power, I/O, network, and cryptographic capabilities onto a single die (SPARC T4 processor design shown here).

The SoC design of the SPARC T-Series processors reduces the need for additional ASICs to connect onboard components. As a result, Netra SPARC T4-1B server modules simply contain fewer parts and pins that can fail compared to many traditional servers with multiple single-threaded dual-core or quad-core processors.

Improving Availability: Redundancy, Serviceability, and Self-Diagnosis

Minimizing the need for system interruptions in order to correct error conditions improves the availability of a system and the hosted IT service. Netra SPARC T4-1B servers provide many design features to help enable completion of maintenance procedures without having an impact on continuous system operation.

Redundant Hot-Swap Components and RAID Capabilities

Oracle's Netra SPARC T4-1B server modules are built to achieve high levels of uptime and fast recovery from failures. Hot-swappable and hot-pluggable chassis-mounted hard drives, fan units, and power supplies also help improve serviceability and availability. For systems configured with redundant components, administrators can use software commands to remove and replace disks, power supplies, and fan units while the system continues to operate.

The built-in RAID capabilities of the Netra SPARC T4-1B server modules provide data redundancy and increased performance at no additional cost. These server modules support onboard hardware RAID 0/1 to enable striping or mirroring of data across any two internal drives. In addition, Netra SPARC T4-1B server modules running Oracle Solaris can take advantage of software RAID capabilities. For example, Oracle Solaris ZFS can be used for internal or external storage devices, providing flexibility and redundancy beyond the chassis.

Netra Blade X3-2B Server Module

The Netra Blade X3-2B server module improves on previous-generation Sun Netra X6270 M2 server modules by offering support for two eight-core Intel Xeon processor E5-2658 CPUs. In addition to the increased number of cores offered by these latest CPUs, this server module supports 24 DIMM sockets using low-voltage DDR3 DIMMs to accommodate memory-intensive applications. Up to four hard disk drives (HDDs) can be accommodated through front accessible SAS-2-based bays in the front panel. Fabric expansion modules and RAID expansion modules are also supported, allowing for flexible storage and I/O connectivity options.

The Netra Blade X3-2B server module builds on the success of previous-generation Sun Netra 6000 server modules by offering a number of enhancements, including:

- Support for Intel Xeon processor E5-2658 CPUs with eight cores
- SAS Gen-2 signaling capabilities throughout

A top-view of the Netra Blade X3-2B server module is shown in Figure 11.

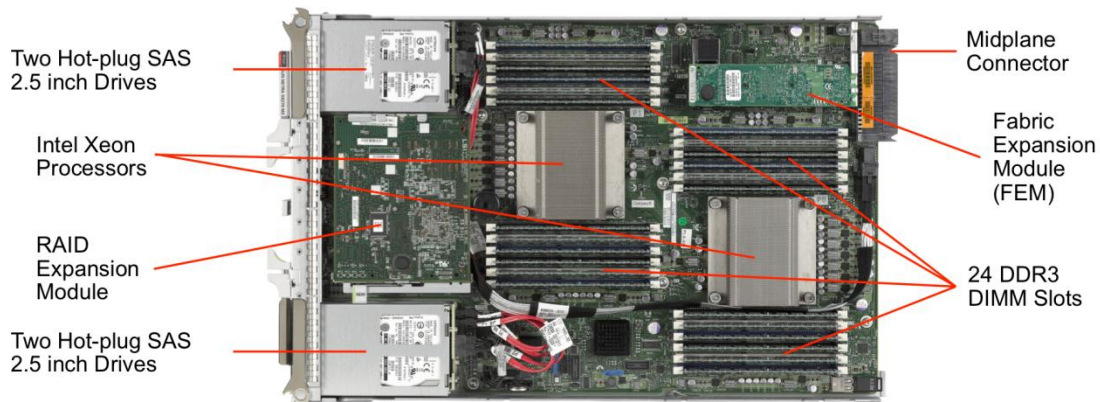


Figure 11. The Netra Blade X3-2B server provides two sockets for eight-core Intel Xeon processor E5-2600 series CPUs.

Intel Xeon Processor E5-2658 CPU from the Intel Xeon Processor E5-2600 Product Family

With Intel's latest introduction, the Intel Xeon processor E5-2600 series, Intel continued with a 32 nm manufacturing process, but increased the core computing power from six processor cores to eight processor cores and also increased cache in the die. The Netra Blade X3-2B server module is based on the Intel Xeon processor E5-2658 CPU, which is part of the Intel Xeon processor E5-2600 product family. The Intel Xeon processor E5-2658 CPU is an eight-core 95-watt processor that operates at 2.1 GHz and is specially designed for NEBS environments. It can endure temporary environmental excursion without frequency throttling or reduction in long-term product reliability, making it a good fit for telecommunications applications.

A new Intel Core microarchitecture is used throughout the Intel Xeon processor E5-2600 product family. The microarchitecture is extremely modular, enabling a range of implementations to meet a variety of application needs and price points. It provides up to 20 MB of shared L3 cache and integrated PCIe 3.0 support. Also, it utilizes Intel Turbo Boost Technology and Intel Hyper-Threading Technology and is equipped with a four-channel DDR3 memory controller—each channel controls up to three DIMMs. Two bidirectional QuickPath Interconnects are also provided for high-speed CPU-CPU and CPU-I/O subsystem communications.

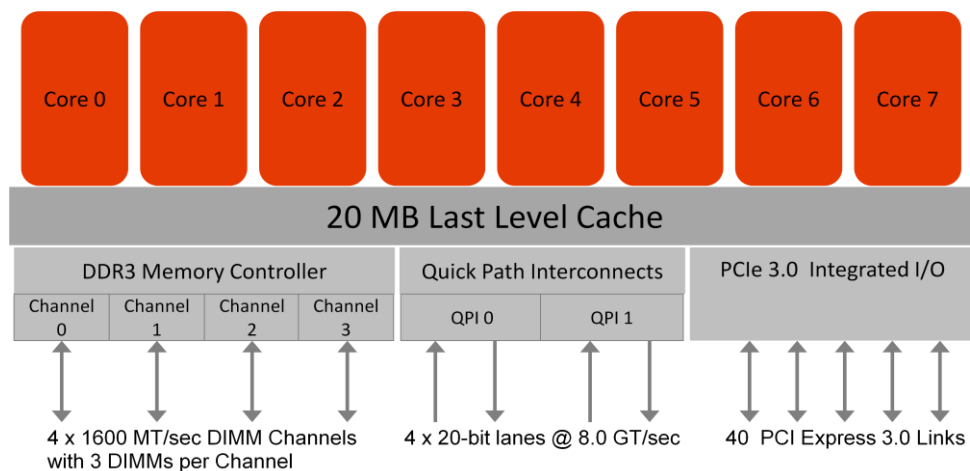


Figure 12. The Intel Xeon processor E5-2600 product family offers up to eight cores, an integrated memory controller, two bidirectional QuickPath Interconnects, and an integrated PCIe controller.

- Intel QuickPath technology**—This technology provides a high-speed, point-to-point interconnect between processors and I/O. The Intel QuickPath Interconnect (QPI) links processors in a design that provides both high-bandwidth and low-latency. Because it is a point-to-point interconnect, processors do not contend for a single bus when accessing memory and I/O, and do not compete for bus bandwidth, enhancing scalability. Each QPI port includes two unidirectional links that support from 6.4 GT/sec up to 8.0 GT/sec per link, offering up to 16 GB/sec bandwidth in each direction for a total bandwidth of 32 GB/sec—significantly higher than previous bus designs.

- **Multiple processor cores**—The Intel Xeon processor E5-2600 product family microarchitecture offers four cores, six cores, or eight cores per die.
- **Integrated DDR3 memory controller**—The integrated memory controller provides four 1,600 MT/sec channels and each channel supports up to three DIMMs. The processor design creates a NUMA-style memory architecture since each processor in multisocket systems can access local memory (connected to the local memory controller) as well as remote memory that is connected to another processor.
- **Integrated I/O controller**—In previous generation Intel platforms, PCIe I/O was handled by a separate I/O hub controller. In the new Intel Xeon processor E5-2600 product family, the processors have PCIe integrated on the processor die, reducing I/O latency. The processor also supports the new PCIe 3.0 specification that greatly improves the PCIe bandwidth.
- **Advanced cache model**—The Intel Xeon processor E5-2600 product family offers a 20 MB Last Level cache that is shared by the processor cores.
- **Virtualization enhancements**—Embedded virtualization technologies provide hardware-based assistance for I/O device virtualization, improved virtualization efficiency, enhanced connectivity, and improved security within a virtualized server.
- **Intel HyperThreading Technology**—This technology provides two virtual threads per core, increasing performance for highly threaded applications.
- **Intel Turbo Boost Technology**—For both multithreaded and single-threaded workloads, this technology increases performance by taking advantage of processor and system power as well as thermal headroom. The Turbo Boost feature can opportunistically increase performance up to nine speed bins per core (900 MHz) above typical performance levels where thermal headroom exists. Intel Turbo Boost Technology and Hyper-Threading Technology capabilities vary according to specific processor models.
- **Intel Intelligent Power Technology**—When a processor workload decreases, unneeded components—cores, cache, and memory—are put into sleep mode to reduce power consumption.

Server Module Architecture

As shown in Figure 13, the Netra Blade X3-2B server supports two Intel Xeon processor E5-2658 CPUs interconnected to each other using Intel's QuickPath Interconnect (QPI) technology. Each Intel Xeon processor E5-2658 CPU has an integrated memory controller with four DDR3 channels and up to three DIMMs per channel. Each processor also provides 40 PCI Express 2.0 lanes that connect to the FEM socket that delivers up to two PCI Express 2.0 x8 interfaces or XAUI connections to the chassis midplane for NEM connections. Two additional PCI Express 2.0 x8 interfaces are delivered to the passive midplane for EM connections.

An x4 PCI Express 2.0 connection interfaces to the optional RAID expansion module, which provides SAS-2 links to the midplane, and hosts the internal HDDs. The Intel C602J I/O controller hub provides SATA and USB connectivity as well as an interface to the ASPEED service processor. The Intel Xeon processor E5-2658 CPUs also interface directly with an Intel I350 Gigabit Ethernet

controller (formerly known as Powerville) to provide two Gigabit Ethernet interfaces to the passive midplane. An internal USB connector is also provided by the Intel C602J.

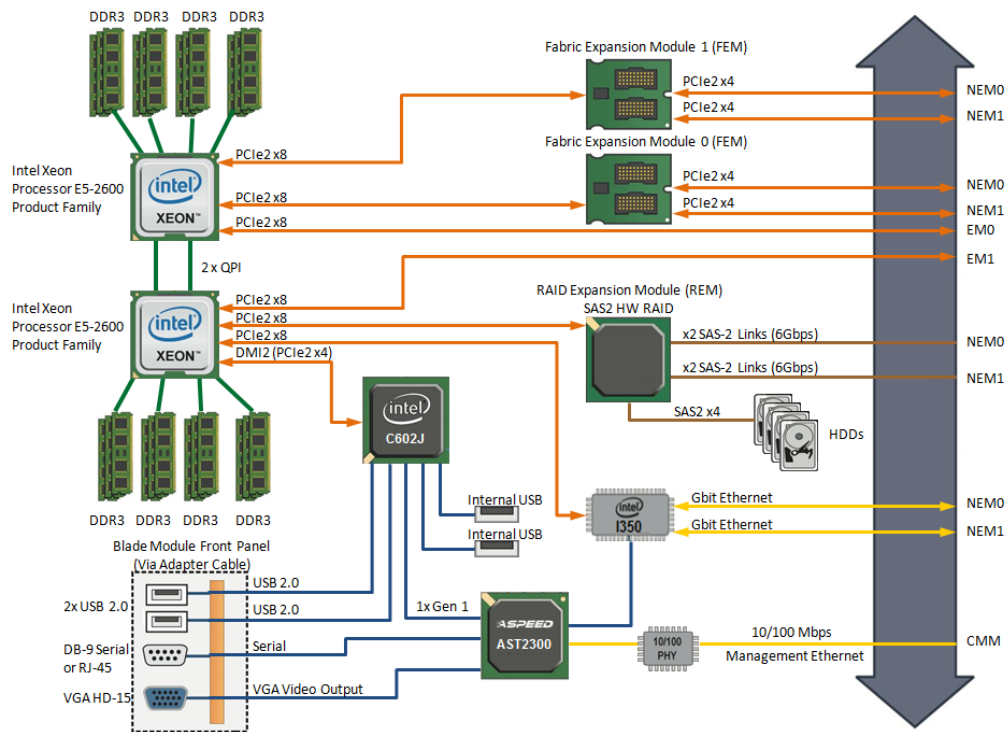


Figure 13. The Netra Blade X3-2B server module introduces support for Intel Xeon processor E5-2600 series CPUs and SAS-2 storage devices.

I/O Expansion, Networking, Storage, and Management

Investments need to be protected, especially as systems are repurposed, expanded, and altered to meet dynamic demands. Modular systems can play a key role, allowing organizations to derive maximum benefit from their infrastructure, even as their needs change. More importantly, modular systems must avoid arbitrary limitations that restrict choice in I/O, networking, or management. The Sun Netra 6000 modular system in particular is designed to work with open and multivendor industry standards without dictating components, topologies, or management scenarios.

PCIe Express Modules (EMs)

Industry-standard I/O, long a staple of rackmount and vertically scalable servers, has been elusive in blade platforms. Unfortunately, the lack of industry-standard I/O has meant that customers often paid more for fewer options and were ultimately limited by a single vendor's innovation. Unlike many traditional blade platforms, the Sun Netra 6000 modular system utilizes PCIe Express Modules (EMs), which are a PCI SIG industry-standard form factor. This approach allows for a wealth of expansion

module options from multiple expansion module vendors, and it avoids a single-vendor lock on innovation.

The passive midplane implements connectivity between the EMs and the server modules, and it physically assigns pairs of EMs to individual server modules. As shown in Figure 14, EMs 0 and 1 (from right to left) are connected to server module 0. EMs 2 and 3 are connected to server module 1. EMs 4 and 5 are connected to server module 3 and so on. Each EM is supplied with an x8 PCIe 2.0 link back to its associated server module, providing up to 64 Gb/s of I/O throughput. EMs are hot pluggable according to the standard defined by the PCI SIG, and they are fully customer replaceable without opening either the chassis or removing the server module.

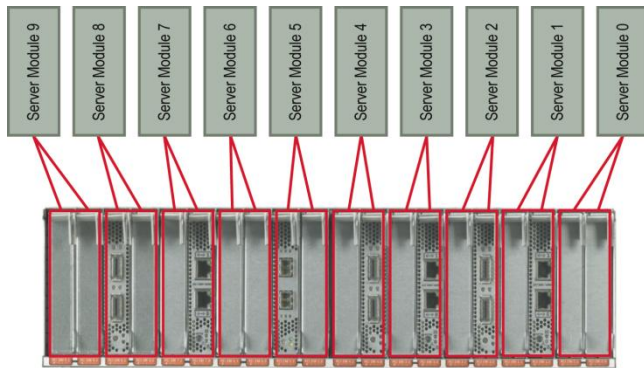


Figure 14. A pair of 8-lane (x8) PCIe slots allow up to two PCIe ExpressModules per server module in the Sun Netra 6000 chassis.

With the industry-standard PCIe EM form factor, EMs are available for multiple types of connectivity, including:

- Gigabit and 10 GbE (quad-port [copper] and dual-port 10 GbE SFP+)
- Fibre Channel (combination dual port 8 Gb/sec Fibre Channel and dual port 1 Gb/sec Ethernet)
- SAS (eight-port)

Network Express Modules (NEMs)

Providing a wide array of I/O access to individual server modules has always been challenging. Many blade platforms are often restrictive in their available options, and many of the options dictate topology and management choices. As a result, data center managers have often found these restrictive blade server platforms difficult to integrate into their existing networks, or were resistant to admitting new switch hardware into their chosen network fabrics.

The Sun Netra 6000 modular system addresses this problem through a specific Network Express Module (NEM) form factor that provides configurable network I/O for all of the server modules in the system. Connecting to all the installed server modules through the passive midplane, NEMs represent a space-efficient mechanism for deploying high-density configurable I/O and provide bulk and consolidated I/O options for the entire chassis.

A selection of NEMs are available for configuration with the Sun Netra 6000 modular systems, providing pass-through access to the GbE interfaces located on the server modules as well as other I/O protocol capabilities.

Fabric Expansion Modules (FEMs)

Fabric expansion modules are offered to provide access to interfaces on Sun Netra 6000 server modules. In some cases, these FEMs simply convey access to interfaces that reside either on the processors or the server modules themselves. FEMs can also provide access to additional functionality such as alternative I/O via 10 GbE networking complementing NEM functionality and connectivity. Through the flexibility of FEMs, different network and I/O fabric interfaces can be exposed to the passive midplane, and on to available NEMs.

NEMs available as of this writing for the Sun Netra 6000 chassis are described in the sections that follow, along with FEMs required for specific server modules.

Two NEMs are provided for the Sun Netra 6000 chassis, offering pass-through access to GbE and 10 GbE interfaces on the various server modules. As of this writing, available Sun Netra 6000 NEMs include:

- Sun Netra 6000 GbE 10-port pass-through NEM
- Sun Netra 6000 Virtualized 40 GbE NEM
- Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE

To access advanced networking functionality, some NEMs require that fabric expansion modules be installed in the server modules. Part numbers for FEMs for connecting the various server modules to the Sun Netra 6000 NEMs are listed in Table 4.

TABLE 4: FABRIC EXPANSION MODULE REQUIREMENTS

SERVER MODULE	SUN NETRA 6000 ETHERNET SWITCHED NEM 24P 10GE	SUN NETRA 6000 VIRTUALIZED 40 GBE NEM
Netra SPARC T5-1B server module	X4871A-Z	7100633
Netra SPARC T4-1B server module	X4871A-Z	7100633
Netra Blade X3-2B server module	X4871A-Z	7100633

Sun Netra 6000 GbE 10-Port Pass-Through NEM

For applications that don't require 10 GbE networking, the Sun Netra 6000 GbE 10-port pass-through NEM offers an effective solution. A single Sun Netra 6000 GbE 10-port pass-through NEM (Figure 15) provides 10 GbE pass-through ports that provide access to one of two GbE interfaces on all

server modules. The second interface on each server module can be accessed by adding a second NEM to the chassis.



Figure 15. The Sun Netra 6000 GbE 10-port pass-through NEM provides ten GbE pass-through ports.

Sun Netra 6000 Virtualized 40 GbE NEM

The Sun Netra 6000 Virtualized 40 GbE NEM delivers virtualized 40 GbE or 10 GbE access with near-zero management. Designed to seamlessly integrate into the Sun Netra 6000 chassis, Oracle's Sun Netra 6000 Virtualized 40 GbE Network Express Module is the industry's first fully virtualized 40 GbE network aggregation for all 10 server modules (blades) in the Sun Netra 6000 chassis. It is an ideal network interface for connecting multiple virtualized blades that require scalable I/O throughput for workloads such as Web servers, application servers, and database servers.

The Sun Netra 6000 Virtualized 40 GbE NEM is a multifunction PCIe 2.0 connectivity module that combines virtualized 40 GbE or 10 GbE network connectivity, support for SAS-2 storage connectivity to storage modules in a single chassis, and 1 GbE pass-through. This NEM is a unique platform for simplifying data center networks without adding the extra cost of switches to manage. It utilizes an Oracle-designed 40 GbE NIC ASIC that virtualizes the 40 GbE or 2x10 GbE network connectivity across 10 server modules in the Sun Netra 6000 chassis, thus simplifying the networks by reducing cables by 10:1—and without adding the extra switching layer. Figure 16 illustrates the hardware architecture of the NEM.

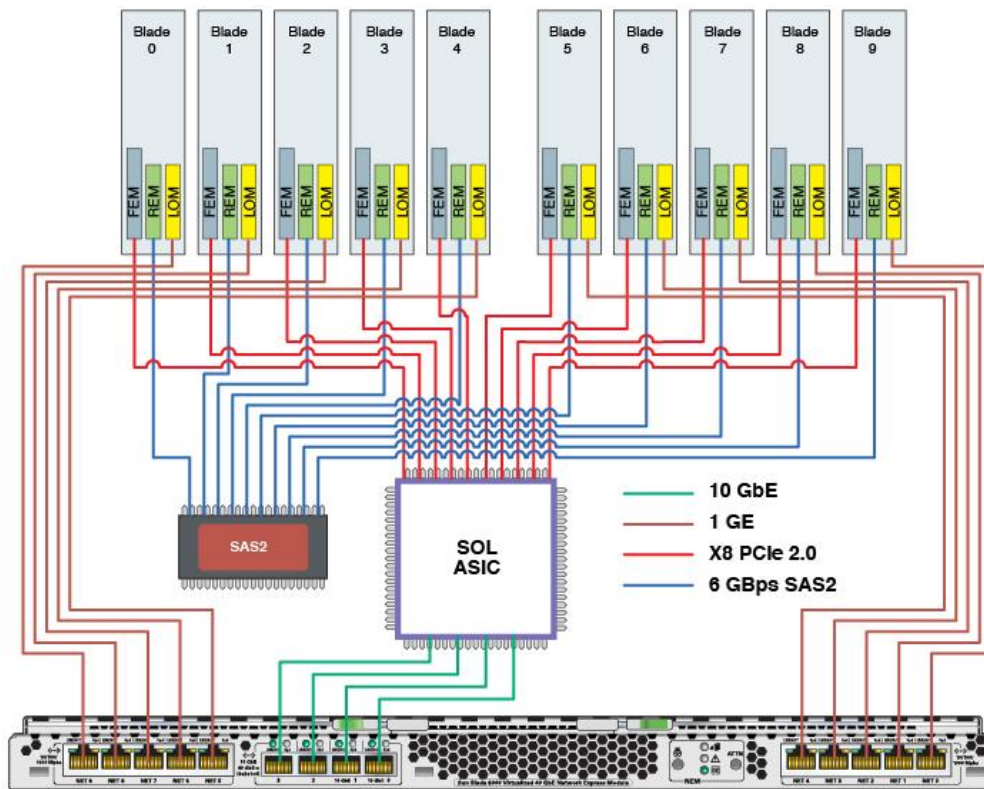


Figure 16. The Sun Netra 6000 Virtualized 40 GbE NEM provides aggregation and optional redundancy at the chassis level.

The Sun Netra 6000 Virtualized 40 GbE NEM offers configurable options, making it ideally suited for different types of workloads ranging from applications just needing high intra-blade communications to those needing higher virtualized bandwidth. Examples of some of these workloads include those that move smaller amounts of data and require high-speed network for lower latency, such as Web servers and application servers, as well as workloads that move a lot of data intermittently, such as enterprise applications and databases. By default, the blades share the available bandwidth in equal amount and are in privacy mode so that unicast traffic from one blade is not seen by other blades. More deterministic bandwidth can be configured for any or all blades in increments of one percent of the total bandwidth. Ingress filtering and VLANs supported by the NEM provide security options for both the unicast and broadcast traffic from the blades.

The Sun Netra 6000 Virtualized 40 GbE NEM supports connection to external devices either through small form-factor pluggable (SFP)+ ports, or 10/100/1000 twisted-pair Ethernet (TPE) ports. Up to 2 SFP+ ports can be used as 2x10 GbE. A 40 GbE link is provided when 4 SFP+ ports are used (with QSFP to 4 SFP+ splitter cables).

The Sun Netra 6000 Virtualized 40 GbE NEM form factor provides a method of deploying bulk remote I/O that allows tool-less installation/removal and packs more performance and functionality in a smaller space, while delivering higher network throughput. It makes efficient use of data center real estate by reducing the number of cables.

This NEM is easy to install and manage. The flexible architecture of the Sun Netra 6000 modular system is based entirely on the hot-pluggable components for I/O, processing, system management, and chassis infrastructure. All critical components, including the NEM modules, are hot swappable and redundant, providing enterprise-class reliability, availability, and serviceability (RAS) features. The Sun Netra 6000 Virtualized 40 GbE NEM helps to boost data center efficiency and uptime and lower total cost of ownership (TCO).

Pass-through PCIe 2.0 Fabric Expansion Module (Marketing Part # 7100633) is required on the server blade for its connectivity to the SFP+ ports on the NEM.

Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE

Beyond providing aggregation of 10 GbE, the Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE offers an active non-blocking, low-latency 10 GbE switch compatible with the Sun Netra 6000 chassis. Based on a 24-port 10 GbE switch chip, the NEM operates as a Layer 2/Layer 3 edge switch, allowing dense non-blocking 10 GbE fabrics to be constructed in combination with suitable rack and larger switches. Providing a full switch within a standard single-height NEM form factor allows for considerable consolidation and savings. A block-level diagram of the NEM aligned with a photo of the back panel is provided in Figure 17.

The switch is designed to support Sun Netra 6000 family server modules via 10 GbE connections that attach through the Sun Dual 10 GbE PCIe 2.0 Fabric Expansion Module.

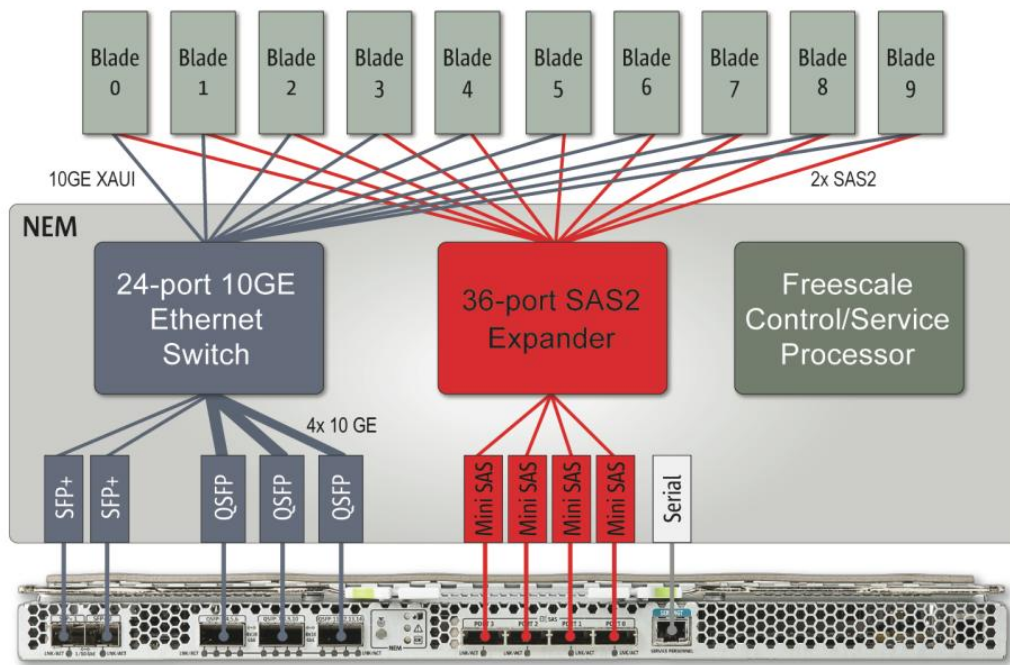


Figure 17. The Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE provides a 24-port 10 GbE switch for non-blocking 10 Gb access to each server module.

Each Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE delivers a 10 GbE connection to each server module installed in the chassis. Redundant 10 GbE connections to each server module can be provided by installing two NEMs into the Sun Netra 6000 chassis.

In order to offer non-blocking throughput, each NEM exposes a total of 14 external 10 GbE connections through the back panel:

- Two SFP+ connectors
- Three 4x QSFP (quad SFP) connectors

In addition to switch consolidation offered by the NEM, the 4x QSFP connectors also provide for considerable cable consolidation when connecting to a compatible rack or enterprise switch. An integrated 36-port SAS-2 expander provides two SAS-2 connections to each slot in the chassis. (External SAS ports are not currently supported as of this writing.)

Consistent with Oracle's modular design principals, the NEM is easy to manage and offers standard interfaces and network protocols, including:

- Unified chassis management
- A Web browser interface and a standard command-line interface (Oracle ILOM shell)
- Multiple user privileges
- Single sign-on
- Oracle ILOM support via the chassis monitoring module
- Environmental monitoring
- An industry-standard compatible L2/L3 network stack
- CLI and command set

Several server modules utilize the Sun Dual 10 GbE PCIe 2.0 Fabric Expansion Module to connect to the NEM. The FEM provides dual 10 GbE interfaces to the server module and is pictured in Figure 18.



Figure 18. The Sun Dual 10 GbE PCIe 2.0 FEM provides two 10 GbE interfaces.

Extending 10 GbE Server Networks Beyond a Single Sun Netra 6000 Chassis

The Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE provides 10 GbE connectivity within a single chassis of server modules but can be further linked to other Sun Netra 6000 chassis to significantly increase the size of the server module deployment. Multiple chassis of Sun Netra 6000 Ethernet Switched NEM 24p 10 GbE-equipped server modules can be interconnected using only a few QSFP-to-QSFP cables to provide high-bandwidth, low-latency, high-node count configurations of servers. To extend even further, to very large node counts, many 10 GbE-equipped chassis of server modules can be connected together using the Sun Network 10 GbE Switch 72p top-of-rack 1U switch. This is a 72-port, low-latency, cut-through 10 GbE switch equipped with 16 QSFP port and 8 SFP+ switch ports. Some simple example network configurations are illustrated in Figure 19.

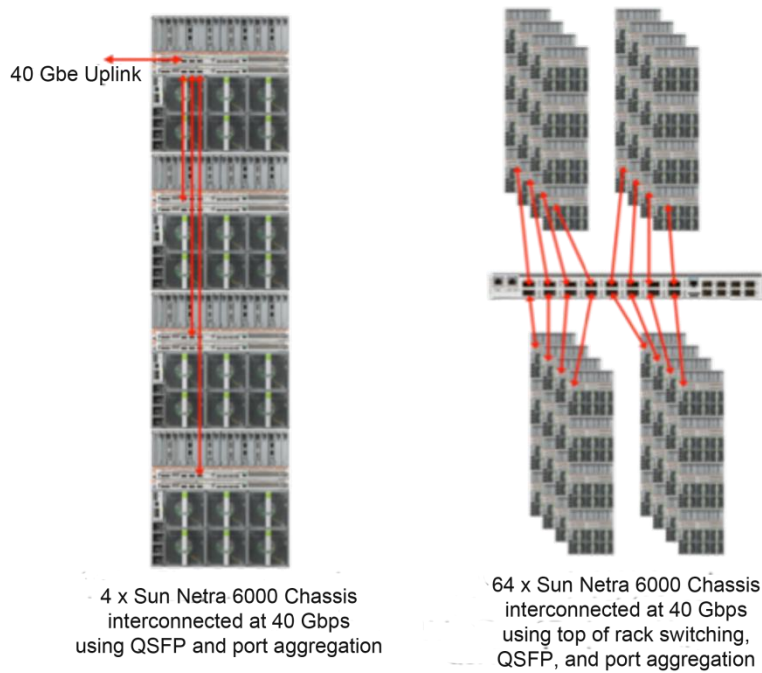


Figure 19. A rack full of Sun Netra 6000 chassis using the 24p NEM switch interconnected using a single QSFP uplink to one NEM and utilizing a 72p switch to connect 16 racks of servers from 24p NEMs to a single 72p switch. Further bandwidth improvement could be achieved through port aggregation configurations.

In-Chassis Storage and Storage Expansion

A number of storage expansion options are available for server modules. Individual server modules have their own internal expansion options, including hard disk drives (HDDs). Supported storage options for the various server modules are shown in Table 5.

TABLE 5: SUPPORTED IN-CHASSIS STORAGE

SERVER MODULE	ARCHITECTURE	SAS HDDS
Netra SPARC T5-1B server module	SPARC T5	2
Netra SPARC T4-1B server module	SPARC T4	2
Netra Blade X3-2B server module	Intel Xeon processor E5-2658	4

Server Module Hard Disk Drives (HDDs)

A choice of (optional) hot-swappable 2.5-inch SAS hard disk drives is supported with all supported server modules in the Sun Netra 6000 modular system. Serial Attached SCSI (SAS) drives provide high performance and high density. These drives provide carrier-grade reliability with up to 1.6 million hours mean time between failures (MTBF).

Transparent and Open Chassis and System Management

Management in blade platforms has typically either been lacking, or administrators have been forced into adopting a unique blade- or platform-specific management infrastructure. To address this issue, the Sun Netra 6000 modular system provides a wide range of flexible management options.

Chassis Monitoring Module

The chassis monitoring module is the primary point of management for all shared chassis components and functions, providing a set of management interfaces. Each server module contains its own service processor, giving it similar remote management capabilities to other Oracle servers. Through their respective lights out management (LOM) service processors, individual server modules provide IPMI, HTTPs, CLI (SSH), SNMP, and file transfer interfaces that are directly accessible from the Ethernet management port on the chassis monitoring module. Each server module is assigned an IP address (either manually or via DHCP) that is used for the management network.

Chassis Monitoring Module Network Functionality

A single chassis monitoring module is provided with each Sun Netra 6000 modular system, and it is configured with an individual IP address assigned either statically or dynamically via DHCP. The chassis monitoring module provides complete monitoring and management functionality for the chassis (or shelf) while providing access to server module management functions. In addition, the chassis monitoring module supports HTTP and CLI “pass-through” interfaces that provide transparent access to each server module. The chassis monitoring module also provides access to each server module via a single serial port through which any of the various LOM interfaces can be configured. The chassis monitoring module’s management functions include:

- Implementation of an IPMI satellite controller, making the chassis environmental sensors visible to the server module’s BMC functions
- Direct environmental and inventory management via CLI and IPMI interfaces
- Chassis monitoring module, Oracle ILOM, and NEM firmware management
- Pass-through management of blades using IPMI, SNMP, and HTTP links along with command line interface (CLI) SSH contexts

The management network internal to the chassis monitoring module joins the local management processor on each server module to the external management network through the passive midplane.

Chassis Monitoring Module Architecture

A portion of the chassis monitoring module functions as an unmanaged switch dedicated exclusively to remote management network traffic, letting administrators access the remote management functions of the server modules. The switch in the chassis monitoring module provides a single network interface to each of the server modules and to each of the NEMs, as well as to the service processor located on the chassis monitoring module itself. Figure 20 provides an illustration and a block-level diagram of the Sun Netra 6000 chassis monitoring module.

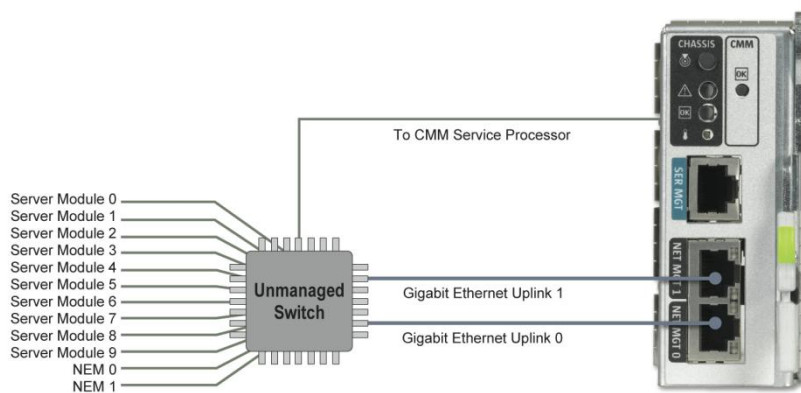


Figure 20. The chassis monitoring module provides a management network that connects to each server module, the two NEMs, and the chassis monitoring module itself.

The chassis monitoring module's functionality provides various management functions, including power control of the chassis as well as hot-plug operations of infrastructure components, such as power supply modules, fan modules, server modules, and NEMs. The chassis monitoring module acts as a conduit to server module LOM configuration, allowing settings, such as network addresses and administrative users, to be configured or viewed.

Integrated Lights Out Management for Simplified Remote Serviceability

A delay in error notification lengthens the time required to resume operations. In addition, cumbersome system maintenance tasks can prolong system downtime and introduce new system configuration issues. Oracle ILOM 3.0 software and an embedded service processor on Netra SPARC T5-1B, T4-1B server modules and Netra Blade X3-2B server modules help ease remote system management, simplify administration, and speed maintenance tasks.

The service processor runs independently of the server, using the server's standby power. Therefore, Oracle ILOM firmware and software continue to function when the server operating system goes offline or when the server is powered off.

Oracle Integrated Lights Out Manager monitors the following the server module conditions:

- CPU temperature conditions
- Hard drive status
- Enclosure thermal conditions
- Fan speed and status
- Power supply status
- Voltage conditions
- Oracle Solaris watchdog, boot timeouts, and automatic server restart events

Oracle Integrated Lights Out Manager enables administrators to monitor and control Sun Netra 6000 server modules over a dedicated Ethernet connection and supports Secure Shell (SSH), Web, and Integrated Platform Management Interface (IPMI) access. Oracle Integrated Lights Out Manager functionality can also be accessed through a dedicated serial port for connection to a terminal or a terminal server. The Oracle ILOM command-line and browser-based interfaces simplify remote administration of geographically distributed or physically inaccessible machines. In addition, Oracle Integrated Lights Out Manager provides remote execution of diagnostics that generally require physical proximity to the server serial port. Oracle Integrated Lights Out Manager can also be configured to distribute e-mail alerts about hardware failures and warnings as well as other events related to the server.

Oracle Integrated Lights Out Manager (Oracle ILOM) System Controller

Provided with all of Oracle's x86 servers and SPARC processor-based blades, the Oracle ILOM service processor acts as a system controller, facilitating remote management and administration. The service processor is full featured and is similar in implementation to that used in other Oracle modular and

rackmount x86 servers. As a result, Sun Netra 6000 server modules integrate easily with existing management infrastructures.

The Netra SPARC T4-1B server module and Netra Blade X3-2B server modules both provide remote keyboard/video/mouse/storage (RKVMS) functionality with the integrated Oracle ILOM service processor. With this capability, system administrators can manage the server modules with full remote graphical management capabilities, including full remote media. This innovation greatly simplifies the management tasks of software updates and patches. Best of all, administrators can now manage Oracle x86 and CMT blade servers in a fully consistent manner.

Oracle Enterprise Manager Ops Center

Beyond local and remote management capabilities, data center infrastructure needs to be agile and flexible, allowing not only fast deployment, but also streamlined redeployment of resources as required. Oracle Enterprise Manager Ops Center technology provides an IT infrastructure management platform for integrating and automating management of thousands of heterogeneous systems. To improve lifecycle and change management, Oracle Enterprise Manager Ops Center supports the management of applications and the servers on which they run, including the Sun Netra 6000 modular system.

Oracle Enterprise Manager Ops Center simplifies infrastructure lifecycle management by letting administrators perform standardized actions across logical groups of systems. Administrators can automatically discover and group bare-metal systems, performing actions on the entire group as easily as operating on a single system. Oracle Enterprise Manager Ops Center also enables remote installation and updates for firmware and operating systems.

It includes support for:

- Oracle Solaris 10 and 11 on x86 platforms
- Oracle Linux
- Oracle Solaris 8, 9, 10, and 11 on SPARC systems
- Red Hat and SUSE Linux distributions

In addition, the software provides considerable lights-out monitoring of both hardware and software, including fans, temperature, disk, and voltage levels—as well as swap space, CPU utilization, memory capacity, and file systems. Role-based access control lets IT staff grant specific management permissions to specific users. A convenient hybrid user interface integrates both a command-line interface (CLI) and an easy-to-use graphical user interface (GUI), providing remote access to manage systems from virtually anywhere.

Oracle Enterprise Manager Ops Center provides advanced management and monitoring features to the Sun Netra 6000 modular systems. The remote management interface discovers and presents the server modules in the chassis as if they were individual servers. In this fashion, the server modules appear in exactly the same way as individual rackmount servers, making the same operations, detailed inventory, and status pages available to administrators. The server modules are discovered and organized into

logical groups for easy identification of individual modules, and the system chassis and racks that contain them. Organizing servers into groups also allows features such as OS deployment across multiple server modules. At the same time, individual server modules can also be managed independently from the rest of the chassis. This flexibility allows for management of server modules that might have different requirements than the other modules deployed in the same chassis.

Some of the functions available through Oracle Enterprise Manager Ops Center software include operating system provisioning, firmware updates (for both the BIOS and Oracle ILOM service processor firmware), and health monitoring. In addition, Oracle Enterprise Manager Ops Center includes a framework allowing administrators to easily access inventory information, simplifying the task of running jobs on multiple servers with server grouping functionality.

Conclusion

Oracle's innovative technology and open-systems approach make modular systems attractive for telecommunications providers. From consolidating infrastructure through virtualization to deploying dynamic carrier-grade applications for next-generation mobile phones, Oracle's Sun Netra 6000 modular system provides the promised advantages of modular architecture while retaining essential flexibility for how technology is deployed and managed—all with NEBS Level 3 certification.

Oracle's standard and open-systems-based approach yields choice and avoids compromise—providing a platform that benefits from widespread industry innovation. With chassis designed for investment protection into the future, organizations can literally cable once and change their deployment options as required—mixing and matching server modules as desired. A choice of Oracle x86 and SPARC processor-based server modules and support for a range of operating systems makes it easy to select the right platform for Oracle and non-Oracle carrier-grade applications. Industry-standard I/O and multiple storage options provide flexibility and leading throughput for individual server modules. Transparent networking and management means that the Sun Netra 6000 modular system fits easily into existing network and management infrastructure.

The Sun Netra 6000 modular systems from Oracle get blade architecture right.

References

To learn more about all of Oracle's Sun Netra carrier-grade systems, please visit:

<http://www.oracle.com/goto/netra>.



Oracle's Sun Netra 6000 Modular Systems
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Hardware and Software, Engineered to Work Together