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Introduction

In a period of intense competition and emerging technologies, telecommunications companies face the challenge of delivering and supporting a multitude of new voice and data solutions. The integration of wireless, video, multimedia, and messaging solutions—along with skyrocketing growth in user volumes—is forcing the underlying IT infrastructure to expand rapidly to meet application demands. Although many IT managers must quickly and dramatically scale datacenter resources to address this growth trend, they must do so within tight constraints of operating budgets and available floor space.

For this reason, Oracle’s strategy focuses on engineering innovative processors and systems with robust compute, memory, and I/O densities to provide higher levels of throughput—higher by orders of magnitude than existing systems. At the same time, Oracle’s ecocentric design choices drastically change typical assumptions for required power and cooling. In pursuit of these goals, Oracle has introduced a second-generation processor leveraging chip multithreading (CMT)—the UltraSPARC T2 processor with CoolThreads technology—designed to deliver high throughput within a small power envelope. The UltraSPARC T2 processor incorporates up to eight cores and 64 processor threads, delivering breakthrough application throughput—up to twice the throughput of the previous UltraSPARC T1 processor. In addition, the UltraSPARC T2 processor embeds on-chip high-speed networking and improved floating-point capabilities to accelerate packet processing and multimedia processing workloads.

Oracle’s new Sun Netra T5220 servers combine the certified ruggedness and reliability of earlier Sun Netra server designs with the performance and ecoefficiency of UltraSPARC T2 processors. The Sun Netra T5220 systems use a compact 2U-form-factor chassis that features remarkable expansion capabilities for memory, I/O, and storage. The resulting ruggedized server offers a dramatic boost in throughput capacity while lowering operating costs and conserving energy and space—at the same time enhancing availability even within challenging environmental conditions.
Breakthrough Density, Throughput, and Reliability

As next-generation technologies for wireless, video, and messaging emerge, the telecommunications marketplace is becoming increasingly complex and competitive. Network equipment providers (NEPs) and service providers place increasing demands on the IT infrastructure to support expanding voice and data services and escalating transaction volumes. At the same time, many providers are moving toward a consolidated framework to converge telecom, internet, and multimedia services using a single standards-based architecture. These trends of growth and consolidation put additional strain on existing IT infrastructures, which strive to deliver needed service volumes within the constraints of budget and time to market deadlines.

Even as the demand increases for an expanded range of services, economic realities are reshaping the IT infrastructure. Real-estate constraints—along with rapidly rising energy costs—are significant factors that discourage the past practice of adding racks upon racks of servers. The cost and complexity of managing large numbers of systems creates formidable challenges, especially because low utilization levels can sometimes result, lowering the return on investment. Exacting service-level agreements (SLAs) are increasingly common because service availability is often closely tied to economic success. In managing the IT infrastructure, organizations are looking to control capital and operational costs more precisely and are making deployment decisions that take into account overall system lifecycle and total cost of ownership (TCO).

Introducing Oracle’s Sun Netra T5220 Server

To help telecommunications providers address the challenge of scaling throughput while managing TCO and service levels, Oracle offers the Sun Netra T5220 server—a robust carrier-grade system that features the powerful and energy-efficient UltraSPARC T2 processor. This server offers extreme reliability and high throughput, at the same time offering unprecedented processor core, memory, and I/O densities to enable dramatic expansion and configuration flexibility within a small, compact 2U form factor.

CoolThreads chip multithreading (CMT) technology in the UltraSPARC T2 processor helps to deliver high throughput for demanding telecommunications applications while minimizing power consumption. (The section “The Evolution of Throughput Computing” describes the evolution of CMT and explains how CMT improves application throughput while maintaining a low power envelope.) The UltraSPARC T2 processor in the Sun Netra T5220 server is Oracle’s second-generation CMT processor design. It leverages the same CoolThreads technology proven in the Sun Netra T2000 server based on the previous-generation UltraSPARC T1 processor. The UltraSPARC T2 processor in the Sun Netra T5220 server—with up to 8 cores and 64 concurrent processor threads—takes throughput-per-watt to a new level, doubling the throughput of the earlier UltraSPARC T1 processor. It adds on-chip networking and improved floating-point
capabilities to address the demands of intensive packet processing and multimedia processing workloads.

In addition to breakthrough performance and scalability, the Sun Netra T5220 server is certified to meet Network Equipment Building Specification (NEBS) Level 3 requirements for environments that demand continuous availability and simplified management. NEBS Level 3 certification (not merely compliance) indicates that the system has undergone a series of rigorous, independently conducted tests to prove that it can continue to operate under severe environmental conditions.

Numerous architectural features—including key redundant and hot-swappable components—enable the Sun Netra T5220 server to deliver outstanding levels of availability and reliability that contribute to continuous system operation. Redundant hot-swappable DC or AC power supplies and hot-pluggable disk drives, for example, help to enhance system uptime. A built-in service processor with Integrated Lights Out Manager (ILOM) capabilities enables remote monitoring and system management, providing the kind of reliability and serviceability needed by telecommunications companies or military organizations that operate in severe environments.

The Sun Netra T5220 server delivers scalability, energy efficiency, and reliability for a variety of demanding applications:

- Media gateway controllers
- Operations and maintenance for telecommunications networks
- Signaling gateways
- Intelligent networks
- Multimedia Messaging Service (MMS)/Short Message Service (SMS) and unified messaging
- Defense/military/intelligence applications including shipboard command and control, mobile weapons control, and remote intelligence access servers
- Embedded original equipment manufacturer (OEM) applications, such as industrial process control, semiconductor test equipment, and network imaging systems
- Application servers
- Web servers
- Content caching, network proxy servers
- Home/visitor location registries (HLR/VLR)
- Base station controllers (BSCs)
- Content distribution networks
- DNS services
• Firewalls for virtual private network/IP security (VPN/IPSEC)
• IP traffic management systems
• Security systems
• Streaming media systems

Key Features

Key features of the Sun Netra T5220 server include the following:

• Up to 64 simultaneous execution threads using CoolThreads CMT technology with four or eight cores in the UltraSPARC T2 processor

• Telecordia NEBS Level 3 certification for extremely reliable operation in harsh environmental conditions

• Enhanced system uptime with Dry Contact Alarms (DCAs); on-chip reliability, availability, and serviceability (RAS) features; redundant AC or DC power supplies; hot-pluggable disk drives; support for hardware RAID (0 + 1); and redundant hot-swappable fan modules

• Exceptional expandability and I/O performance, featuring four PCI-Express (PCIe) and two PCI-X slots, four onboard 10/100/1,000-Mb/sec Ethernet ports, and 16 Fully Buffered Dual Inline Memory Module (FB-DIMM) memory slots (for a maximum of 64 Gb using 4-Gb FB-DIMMs)

• Large internal storage capacity, with a maximum of four internal, 2.5-inch, 146-Gb, hot-pluggable serial-attached SCSI (SAS) disk drives

• A compact rack-optimized 2U design

• Simplified state-of-the-art remote maintenance with Integrated Lights Out Manager (ILOM)

• Preloaded with the Oracle Solaris operating system to shorten time to deployment

Designed to complement the rest of Oracle’s carrier-grade server family, the Sun Netra T5220 server addresses the dynamic and emerging needs of telecommunications providers:

• **Efficient application scalability.** With support for 64 threads and large memory capacity, Sun Netra T5220 servers integrate 10-Gb Ethernet (10-GbE), I/O, and cryptographic acceleration directly onto the UltraSPARC T2 processor chip. This approach contributes to leading levels of performance and scalability for packet processing and media processing workloads, while maintaining extremely high efficiency.
• **Leading ecoresponsibility.** Sun Netra T5220 servers continue a tradition of ecoresponsibility by offering optimal performance and performance-per-watt across a wide range of workloads. The UltraSPARC T2 processor incorporates unique power management features at both processor core and memory levels. High-efficiency power supplies and an innovative chassis design (with hexagonal suction holes that optimize airflow) help to minimize the need for cooling and lower energy costs.

• **System reliability.** Reliability features help to increase availability, reduce costs, and meet SLA targets, even in harsh operating environments. NEBS Level 3 certification demonstrates that the system has been rigorously tested and can withstand severe operating conditions. With high levels of integration provided by the UltraSPARC T2 processor design, the Sun Netra T5220 server has a relatively small part count and is designed specifically for high RAS levels. Redundant, hot-swappable AC or DC power supplies, fan modules, and disk drives enhance reliability and serviceability. Low power consumption reduces generated heat loads and the possibility of temperature-related problems.

• **Simplified management.** Each Sun Netra T5220 server provides an ILOM service processor. ILOM provides a command-line interface (CLI), a Web-based graphical user interface (GUI), and Intelligent Platform Management Interface (IPMI) functionality to support out-of-band monitoring and administration.

• **Industry-leading tools for virtualization and consolidation.** The Sun Netra T5220 server is ideal for consolidation, providing low-level multithreading support for virtualization at multiple layers of the technology stack. Oracle VM Server for SPARC (previously called Sun Logical Domains) exploits the thread-intensive model of the UltraSPARC T2 processor because they allow multiple instances of Oracle Solaris to run concurrently, while Oracle Solaris Containers provide virtualization within a single Oracle Solaris instance.

• **Zero-cost security.** With electronic intrusion and theft at all-time highs, secure communications and data protection have never been more important. Because each UltraSPARC T2 processor features up to eight integrated cryptographic accelerators, there is no need to transmit plain text on the network or to store plain text in storage systems. Sun Netra T5220 servers can support more cryptographic operations per second than many competitive systems and dedicated cryptographic accelerator cards, with minimal impact to system overhead.

• **Accelerated time to deployment.** Sun Netra T5220 servers running Oracle Solaris 10 provides full binary compatibility with earlier UltraSPARC systems, preserving investments and speeding time to deployment. Oracle’s CoolTools for SPARC help to accelerate application selection, profiling, testing, tuning, debugging, and deployment. Sun Netra T5220 servers come preinstalled with Oracle Solaris 10 to expedite deployment and provide a robust and secure operating environment.
The Evolution of Throughput Computing

Traditional high-frequency, single-threaded processor designs offer little hope for improvement over time in real-world application performance. For many processor designs, ramping up clock rates yields only small gains in performance while consuming significantly more power and generating large heat loads that require extensive cooling. Rising power and cooling requirements translate into escalating energy costs that take an increasingly large bite out of IT operating budgets, which are often already flat or shrinking.

For this reason, Oracle’s Sun servers have been engineered with processors and systems that provide higher throughput—higher by orders of magnitude than for existing systems—at the same time drastically reducing requirements for power and cooling. This focus on throughput computing is a composite strategy targeted at improving the performance of key workloads:

• CMT processor designs (such as the UltraSPARC T2 processor) provide massive thread-level parallelism (TLP) and increase application throughput, at the same time maintaining attractive power and cooling profiles.

• Innovative and secure, Oracle Solaris 10 effectively delivers the resources of CMT processors to applications, facilitating fine-grained system virtualization and high utilization while maintaining binary compatibility for Oracle Solaris applications running on SPARC processor-based platforms.

• Oracle’s compilers, development tools, APIs, and system engineering efforts leverage CMT processor capabilities, resulting in significant application performance gains.

This section describes the limitations of traditional processor designs and how Oracle’s emphasis on CMT can increase real-world application performance while optimizing energy and space efficiency.

Moore’s Law and Diminishing Returns of Traditional Processor Design

An often-quoted tenet of Moore’s Law states that the number of transistors that fit in a square inch of integrated circuitry will double approximately every two years. For more than three decades, the pace of Moore’s Law has held, driving processor performance to new heights. Processor manufactures have long exploited these gains in chip real estate to build increasingly complex processors, with instruction-level parallelism (ILP) as a goal. Today, these traditional processors employ very high frequencies along with a variety of sophisticated tactics to accelerate a single instruction pipeline, including

• Large caches
• Superscalar designs
• Out-of-order execution
• Very high clock rates
• Deep pipelines
• Speculative prefetches

Although these techniques have produced faster processors with impressive-sounding multigigahertz frequencies, they have largely resulted in complex, hot, and power-hungry processors that don’t fit well within the constraints of today’s datacenters. In fact, many workloads are simply unable to take advantage of the hard-won ILP provided by these processors. Applications with high shared memory and data requirements are typically more focused on processing a large number of simultaneous threads (or TLP) rather than running a single thread as quickly as possible, as in ILP-centric workloads.

Making matters worse, the majority of ILP in existing applications has already been extracted, and further gains are likely to be small. With higher clock speeds, each successive processor generation has seemingly demanded more power than the last, and microprocessor frequency scaling has leveled off in the range of 2 to 4 GHz as a result. Deploying pipelined superscalar processors requires more power, which limits the approach because of a fundamental need for processor cooling.

Chip Multiprocessing with Multicore Processors

To address this limitation, some microprocessor engineers have used the transistor budget provided by Moore’s Law to group two or even four conventional processor cores on a single physical die, creating multicore processors (or CMP). The individual processor cores introduced by many CMP designs have no greater performance than previous single-processor chips and in fact have been observed to run single-threaded applications more slowly than single-core processor versions. However, aggregate chip performance increases because multiple programs (or multiple threads) can be accommodated in parallel (or TLP).

Unfortunately, most currently available (or soon-to-be-available) chip multiprocessors simply replicate cores from existing single-threaded processor designs. This approach typically yields only slight improvements in aggregate performance, because it ignores key performance issues such as memory speed and hardware thread context switching. As a result, although these designs provide some additional throughput and scalability, they can still consume considerable power and generate significant heat.

Chip Multithreading with CoolThreads Technology

There is a disparity between processor speeds and memory access rates. Although processor speeds continue to double every two years, memory speeds have typically doubled only every six years. As a result, memory latency now dominates much application performance, erasing even
very impressive gains in clock rates. This growing disconnect is the result of memory suppliers focusing on density and cost rather than speed.

Unfortunately, this relative gap between processor and memory speeds can leave ultrafast processors idle as much as 85 percent of the time, waiting for memory accesses to return required data. Ironically, as traditional processor execution pipelines get faster and more complex, the effect of memory latency grows—fast, expensive processors spend more cycles waiting and doing nothing. Worse still, idle processors continue to draw power and generate heat. It is easy to see that frequency (for example, gigahertz) is truly a misleading indicator of real performance.

First introduced with the UltraSPARC T1 processor, CMT takes advantage of CMP evolution but adds a critical capability—the ability to scale with threads rather than frequency. Unlike traditional single-threaded processors and even most current multicore (or CMP) processors, hardware multithreaded processor cores allow rapid switching between active threads as other threads stall for memory. Figure 2 illustrates the difference between CMP, fine-grained hardware multithreading (FG-MT), and CMT. The key to the CMT approach is that each core is designed to switch between multiple threads on each clock cycle. As a result, the processor’s execution pipeline remains active doing useful work, even as memory operations for stalled threads continue in parallel.

CMT provides value by increasing the execution pipeline’s ability to do useful work on any given clock cycle. Pipeline utilization is greatly enhanced because a number of execution threads now share resources. The negative effects of memory latency are effectively masked because the processor and memory subsystems remain active in parallel to the execution pipeline. Because
individual processor cores implement much simpler pipelines (emphasizing TLP over ILP), they are also substantially cooler and require significantly less electrical energy to operate. This innovative approach results in CoolThreads technology—multiple physical instruction execution pipelines (one for each core), with multiple active thread contexts available per core.

UltraSPARC T2 Processors with CoolThreads Technology

The first processor to implement CoolThreads technology was the UltraSPARC T1 processor, shown on the right in Figure 3. The UltraSPARC T2 processor (see Figure 3, left) is the second processor generation to use CoolThreads technology.

Table 1. A Side by Side Comparison of UltraSPARC T1 and UltraSPARC T2 Features

<table>
<thead>
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<th>FEATURE</th>
<th>ULTRASPARC T1 PROCESSOR</th>
<th>ULTRASPARC T2 PROCESSOR</th>
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<tbody>
<tr>
<td>Year introduced</td>
<td>2005</td>
<td>2007</td>
</tr>
<tr>
<td>Cores per processor</td>
<td>Up to 8</td>
<td>Up to 8</td>
</tr>
<tr>
<td>Threads per core</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Threads per processor</td>
<td>32</td>
<td>64</td>
</tr>
<tr>
<td>Hypervisor</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chip memory characteristics</td>
<td>4 memory controllers,</td>
<td>4 memory controllers,</td>
</tr>
<tr>
<td></td>
<td>4 DIMMs per controller</td>
<td>16 DIMMs per controller</td>
</tr>
<tr>
<td>Caches</td>
<td>16-KB instruction cache,</td>
<td>16-KB instruction cache,</td>
</tr>
<tr>
<td></td>
<td>8-KB data cache,</td>
<td>8-KB data cache,</td>
</tr>
<tr>
<td></td>
<td>3-MB L2 cache (4 banks, 12-way associative)</td>
<td>4-MB L2 cache (8 banks, 16-way associative)</td>
</tr>
<tr>
<td>Technology</td>
<td>90-nm technology</td>
<td>65-nm technology</td>
</tr>
<tr>
<td>Floating-point unit (FPU)</td>
<td>1 FPU per chip</td>
<td>1 FPU per core, 8 FPUs per chip</td>
</tr>
<tr>
<td>Integer resources</td>
<td>Single execution unit</td>
<td>2 integer execution units per core</td>
</tr>
<tr>
<td>Cryptography</td>
<td>Accelerated modular arithmetic operations (RSA), support for</td>
<td>Stream-processing unit per core, support for the 10 most</td>
</tr>
<tr>
<td></td>
<td>2 popular ciphers</td>
<td>popular ciphers</td>
</tr>
<tr>
<td>Additional on-chip resources</td>
<td>None</td>
<td>Dual 10-GbE interfaces, integrated PCIe controller</td>
</tr>
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Taking Chip-Multithreaded Design to the Next Level

The design team for the UltraSPARC T2 processor started with these key goals in mind:

• Increasing computational capabilities to meet growing throughput demands by providing twice the throughput of the UltraSPARC T1 processor

• Supporting larger and more-diverse workloads with greater floating-point performance

• Powering faster networking to serve new network-intensive content

• Providing end-to-end datacenter encryption

• Increasing service levels and reducing downtime

• Improving datacenter capacities while reducing costs

CMT architecture is ultimately very flexible, allowing different modular combinations of processors, cores, and integrated components. The considerations listed above drove an internal engineering effort that compared different approaches with regard to making improvements on the successful UltraSPARC T1 architecture. For example, simply increasing the number of cores would have gained additional throughput but would have resulted in consuming extra die area, leaving no room for integrated components such as floating-point processors.

System on a Chip (SoC) Design

Unlike complex single-threaded processors, CMT processors utilize the available transistor budget to implement multiple hardware multithreaded processor cores on a chip die. In particular, the UltraSPARC T2 processor uses the available transistor budget to implement the industry’s first SoC, including:

• Up to eight cores at 1.2 GHz

• Eight threads per core for a maximum of 64 threads per processor

• On-chip Level-1 and Level-2 caches

• Four memory controllers for on-chip support of as many as 64 FB-DIMMs

• Eight fully pipelined FPUs (1 per core)

• Per-core cryptographic acceleration

• Two on-chip 10-GbE interfaces

• Integrated PCIe interface

The UltraSPARC T2 processor design recognizes that memory latency is truly the bottleneck to improving performance, allowing each core to switch between up to eight threads. By increasing the number of threads supported by each core, the UltraSPARC T2 is able to provide approximately twice the throughput of the UltraSPARC T1 processor. Each UltraSPARC T2
processor provides up to eight cores, with each core able to switch between up to eight threads (64 threads per processor). In addition, each core provides two integer execution units, so that a single UltraSPARC core is capable of executing two threads at a time. Figure 4 provides a simplified high-level illustration of the thread model supported by an eight-core UltraSPARC T2 processor.

Figure 4. A single eight-core UltraSPARC T2 processor can run up to 64 threads, with up to two threads running in each core simultaneously.
UltraSPARC T2 Processor Architecture

The UltraSPARC T2 processor extends Oracle's throughput computing initiative with an elegant and robust architecture that delivers real performance to applications. A high-level block diagram of the UltraSPARC T2 processor is shown in Figure 5.

![UltraSPARC T2 Processor Diagram](image)

Figure 5. The UltraSPARC T2 processor combines eight cores, memory management, cryptographic support, 10-GbE, and PCIe on a single chip.

The eight cores on the UltraSPARC T2 processor are interconnected with a full on-chip nonblocking 8 x 9 crossbar switch. The crossbar connects each core to the eight banks of L2 cache, and to the system interface unit for I/O. The crossbar provides approximately 300 Gb/sec of bandwidth and supports 8-byte writes from a core to a bank and 16-byte reads from a bank to a core. The system interface unit connects networking and I/O directly to memory.
through the individual cache banks. Using FB-DIMM memory supports dedicated northbound and southbound lanes to and from the caches to accelerate performance and reduce latency. This approach provides higher bandwidth than with DDR2 memory, with up to 42.4 Gb/sec of read bandwidth and 21 Gb/sec of write bandwidth.

Each core provides its own fully pipelined floating-point and graphics unit, as well as a stream-processing unit (SPU). The FPUs greatly enhance floating-point performance over that of the UltraSPARC T1, enhancing the performance of multimedia processing including image encoder/decoder (codec) operations. The SPUs provide wire-speed cryptographic acceleration with over 10 popular ciphers supported, including DES, 3DES, AES, RC4, SHA-1, SHA-256, MD5, RSA to 2048 key, ECC, and CRC32. (In contrast, the UltraSPARC T1 processor supports only two ciphers—DES and 3DES.) Embedding hardware cryptographic acceleration for many ciphers in the UltraSPARC T2 processor allows end-to-end encryption with no penalty in either performance or cost.

UltraSPARC T2 Core Architecture and Pipelines

Figure 6 provides a block-level diagram representing a single UltraSPARC core on the UltraSPARC T2 processor.

![Figure 6. A single UltraSPARC core on the UltraSPARC T2 processor](image-url)
Components implemented in each core include

- **Trap logic unit (TLU).** The TLU updates the machine state as well as handling exceptions and interrupts.

- **Instruction fetch unit (IFU).** The IFU includes the 16KB instruction cache (32-byte lines, 8-way set associative) and a 64-entry fully-associative instruction translation lookup buffer (ITLB).

- **Integer execution units (EXUs).** Dual integer EXUs are provided per core with four threads sharing each unit. Eight register windows are provided per thread, with 160 integer register file (IRF) entries per thread.

- **Floating-point/graphics unit.** A floating-point/graphics unit is provided within each core and is shared by all eight threads assigned to the core. Thirty-two floating-point register file entries are provided per thread.

- **Stream-processing unit (SPU).** Each core contains an SPU that provides cryptographic coprocessing.

- **Memory management unit (MMU).** The MMU provides a hardware table walk (HWTW) and supports 8-KB, 64-KB, 4-MB, and 256-MB pages.

An eight-stage integer pipeline and a 12-stage floating-point pipeline are provided by each UltraSPARC processor core (see Figure 7). A new pipeline stage called “pick” has been added to choose two threads (out of the eight possible per core) to execute each cycle.

![Eight-Stage Integer Pipeline](image)

**Figure 7.** An eight-stage integer pipeline and a 12-stage floating-point pipeline are provided by each UltraSPARC processor core.

To illustrate how the dual pipelines function, Figure 8 depicts the integer pipeline with the load-store unit (LSU). The instruction cache is shared by all eight threads within the core. A least-recently-fetched algorithm is used to select the next thread to fetch. Each thread is written into a thread-specific instruction buffer (IB), and each of the eight threads is statically assigned to one of two thread groups within the core.
Figure 8. Threads are interleaved between pipeline stages with very few restrictions (integer pipeline shown; letters depict pipeline stages, and numbers depict different scheduled threads).

The pick stage chooses one thread each cycle within each thread group. Picking within each thread group is independent of the other, and a least-recently-picked algorithm is used to select the next thread to execute. The decode state resolves resource conflicts that are not handled during the pick stage. As shown in Figure 8, threads are interleaved between pipeline stages with very few restrictions. Any thread can be at the fetch or cache stage, before being split into either of the two thread groups. LSUs and FPUs are shared among all eight threads. Only one thread from either thread group can be scheduled on such a shared unit.

Integrated Networking

By providing integrated on-chip networking, the UltraSPARC T2 processor is able to provide better networking performance for applications with intensive packet-processing requirements. All network data is supplied directly from and to main memory. Placing networking so close to memory reduces latency, provides higher memory bandwidth, and eliminates inherent inefficiencies of I/O protocol translation.

The UltraSPARC T2 processor provides two 10-GbE ports with an integrated serializer/deserializer, providing line-rate packet classification at up to 30 million packets/sec (based on Layers 1 through 4 of the protocol stack). Multiple DMA engines (16 transmit and 16 receive DMA channels) match DMAs to individual threads, providing binding flexibility between
ports and threads. Virtualization support includes provisions for eight partitions, and interrupts may be bound to different hardware threads.

**Stream-Processing Unit (SPU)**

The SPU on each UltraSPARC T2 core runs in parallel with the core at the same frequency. The cipher/hash unit provides RC4, DES/3DES, AES-128/192/256, MD5, SHA-1, and SHA-256. The SPU is designed to achieve wire-speed encryption and decryption on both of the processor’s 10-GbE ports.

**Integral PCI-Express (PCIe) Support**

The UltraSPARC T2 processor provides an on-chip PCIe controller that operates at 4 Gb/sec per lane bidirectionally through a point-to-point dual-simplex chip interconnect. An integral IOMMU supports I/O virtualization and process device isolation by using the PCIe BDF number. The total I/O bandwidth is 2.17 Gb/sec, with maximum payload sizes of 128 to 512 bytes. An x8 serializer/deserializer interface is provided for integration with off-chip PCIe switches.

**Power Management**

Beyond efficiency, the UltraSPARC T2 is the first processor to incorporate unique power management features at both the core and memory levels of the processor. These features include reduced instruction rates, parking of idle threads and cores, and the ability to turn off clocks in both cores and memory to reduce power consumption. Substantial innovation is present in the areas of

- Limiting speculation such as conditional branches not taken
- Extensive clock gating in the data path, control blocks, and arrays
- Power throttling that allows extra stall cycles to be injected into the decode stage

**Sun Netra T5220 Servers**

Sun Netra T5220 servers are designed to leverage the considerable resources and power of the UltraSPARC T2 processor. These carrier-grade servers mark a departure from traditional system designs and take advantage of specific UltraSPARC T2 processor features, including 64 threads, large on-chip memory capacities, cryptographic acceleration, integrated on-chip 10-GbE networking and I/O technology, and power management. In a compact, energy-efficient, 2U package, Sun Netra T5220 servers provide high performance within significant power, cooling, and space constraints—at the same time enabling remarkable reliability, density, and expandability.
Sun Netra T5220 Server Architecture

Sun Netra T5220 servers are designed to deliver breakthrough performance while maximizing reliability, minimizing power consumption, and optimizing expandability. This section details physical and architectural aspects of the system.

### TABLE 2. FEATURES OF SUN NETRA T5220 SERVERS

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>SUN NETRA T5220 SERVER</th>
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<tbody>
<tr>
<td>CPU</td>
<td>UltraSPARC T2 processor at 1.2 GHz with 4 or 8 cores</td>
</tr>
<tr>
<td>Threads</td>
<td>Up to 64 threads with 8 cores</td>
</tr>
<tr>
<td>Memory capacity</td>
<td>16 slots with up to 64 GB maximum (using 4-GB FB-DIMMs; can be populated with pairs of 1-GB, 2-GB, or 4-GB FB-DIMMs)</td>
</tr>
<tr>
<td>Internal storage</td>
<td>Up to 4 2.5-inch SAS 146-Gb disk drives without DVD, or up to 2 2.5-inch SAS 146-Gb disk drives with DVD (hardware RAID 0/1), and support 300Gb disk drives (via ATO)</td>
</tr>
<tr>
<td>Removable media</td>
<td>Optional DVD-RW (uses 2 of 4 internal disk slots)</td>
</tr>
<tr>
<td>USB</td>
<td>2 USB 2.0 ports (bootable)</td>
</tr>
<tr>
<td>PCI expansion</td>
<td>2 PCI-X slots:</td>
</tr>
<tr>
<td></td>
<td>1 full-height, full-length, 64-bit at 133MHz</td>
</tr>
<tr>
<td></td>
<td>1 full-height, half-length, 64-bit at 133MHz</td>
</tr>
<tr>
<td></td>
<td>4 PCIe slots:</td>
</tr>
<tr>
<td></td>
<td>1 full-height, full-length x8 PCIe slot (x16 connector)</td>
</tr>
<tr>
<td></td>
<td>1 low-profile x8 PCIe slot (x8 connector)</td>
</tr>
<tr>
<td></td>
<td>2 low-profile x4 PCIe or XAUI combo slots (x8 connector)</td>
</tr>
<tr>
<td>Ethernet</td>
<td>4 onboard GbE ports (10/100/1,000)</td>
</tr>
<tr>
<td></td>
<td>2 10-GbE ports via XAUI combo slots</td>
</tr>
<tr>
<td>Power supplies</td>
<td>2 hot-swappable AC or DC 650-W power supply units (N+1 redundancy)</td>
</tr>
<tr>
<td>Fans</td>
<td>3 fan trays with 2 fans per tray (N+1 redundancy)</td>
</tr>
<tr>
<td>Form factor</td>
<td>2U</td>
</tr>
<tr>
<td>Operating system</td>
<td>Oracle Solaris 10 (preinstalled)</td>
</tr>
<tr>
<td>System management</td>
<td>ILOM, accessible via network or serial management ports</td>
</tr>
<tr>
<td>Telco features</td>
<td>Dry Contact Alarms (DCAs), DB-15 connector</td>
</tr>
<tr>
<td></td>
<td>Watchdog Timer (WDT)</td>
</tr>
<tr>
<td></td>
<td>NEBS Level 3 certified</td>
</tr>
</tbody>
</table>

1Optional XAUI cards in PCI combination slots are available for direct connection to two integrated 10-GbE ports on the UltraSPARC T2 processor.

### System-Level Architecture

The motherboard is a 20-layer printed circuit board (PCB) containing the UltraSPARC T2 processor, 16 FB-DIMM sockets for main memory, the ILOM service processor, the disk...
controller, and I/O subsystems. I/O subsystems include USB, optional DVD-RW, quad GbE, and two levels of PLX PCIe branching out into a total of six card sockets for a wide variety of custom or third-party PCI-X and PCIe expansion options. Two PCIe slots are combination PCIe/XAUI slots and can be populated with XAUI cards for direct connection to integrated networking capabilities on the UltraSPARC T2 processor.

![Diagram of Sun Netra T5220 system motherboard design](image)

**Figure 9.** The Sun Netra T5220 system motherboard design is the central component in the UltraSPARC T2 processor.

The motherboard interconnect has been greatly simplified over prior-generation servers. Power is distributed to the motherboard through a pair of metal bus bars connected to a power distribution board (PDB). A single flex-circuit connector routes all critical power control and DVD drive signaling to the PDB. One or two mini-SAS cables connect the motherboard to the disk drive backplane, providing data access to the internal SAS hard drives.

**Memory Subsystem**

In Sun Netra T5220 servers, the UltraSPARC T2 processor’s on-chip memory controllers communicate directly to FB-DIMM memory through high-speed serial links. With a bus clock of 166.67 MHz, the four dual-channel FB-DIMM memory controllers can transfer data at an aggregate rate of 32 giga-transfers per second. Sixteen memory socket locations provide sufficient board space for two rows of FB-DIMMs per channel. FB-DIMM modules must be populated in like pairs—with 1-Gb, 2-Gb, or 4-Gb modules—enabling a maximum capacity of 64 Gb using 4-Gb modules.
I/O Subsystem

The UltraSPARC T2 processor incorporates a single, 8-lane (x8) PCIe port capable of operating at 4 Gb/sec bidirectionally. This port natively interfaces to I/O devices through a series of PLX technology PCIe expander chips, connecting either to PCIe card slots, or to bridge devices that interface with PCIe, such as those listed below:

- **Disk controller.** Disk control is managed by a single LSI Logic SAS1068E controller chip that interfaces to a four-lane (x4) PCIe port.
- **Dual GBE.** Two x4 PCIe ports connect to two Intel Ophir dual GbE chips, providing four 10/100/1,000 Mb/sec Ethernet interfaces on the rear panel.
- **SB and DVD.** One x4 PCIe port connects to a PLX PEX8111 PCI bridge device. A second bridge chip converts the 32-bit 33-MHz PCI bus into multiple USB 2.0 ports. The system’s USB interconnect is driven from those ports. In addition, a bridge chip interfaces one of the USB ports to IDE format, which is used to drive the optional DVD-RW drive.

To minimize cabling and increase reliability, a variety of smaller boards and riser cards are deployed. These infrastructure boards serve various functions:

- **PDBs** distribute system power from the dual power supplies to the motherboard and to the disk backplane (via a connector board).
- **Connector boards** eliminate the need for many discrete cables, providing a direct card plug-in interconnect to distribute control and most data signals to the disk backplane, the fan boards, and the PDB.
- **Fan boards** provide connections for power and control for both the primary and secondary fans in the front of the chassis. No cables are required because every dual fan module plugs directly into one of these PCBs, which in turn plugs into the connector board.
- **PCIe Riser Cards** plug directly into the motherboard, allowing PCIe and PCI-X cards to be installed. Two XAUI riser cards provide slots that access to the on-chip 10-GbE interfaces on the UltraSPARC T2 Processor, or alternatively provide access to PCIe interfaces. Each PCI/XAUI slot can accept either an Oracle proprietary optical/copper XAUI card or a low-profile PCIe card with up to an x8 form factor edge connector (x4 electrically). All PCI cards are installed in a horizontal orientation.
- **A four-disk backplane** mounts to the disk cages in the chassis, delivering disk data through a single, discrete mini-SAS cable from the motherboard.

### Sun Netra T5220 Server Overview and Subsystems

The expandable Sun Netra T5220 server is optimized to deliver high performance and throughput. With considerable expansion capabilities and many high-reliability features, the Sun
Netra T5220 server is an ideal platform for demanding mission-critical and consolidated workloads.

**Enclosure**

The Sun Netra T5220 server features a compact yet expandable 2U rackmount chassis that provides the flexibility to scale processing and I/O needs without wasting valuable datacenter space.

<table>
<thead>
<tr>
<th>TABLE 3. DIMENSIONS AND WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERVER/DIMENSION</td>
</tr>
<tr>
<td>Height</td>
</tr>
<tr>
<td>Width</td>
</tr>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Weight (without PCI cards or rackmounts)</td>
</tr>
</tbody>
</table>

**Major Components**

The Sun Netra T5220 server includes the following major components:

- An UltraSPARC T2 processor running at 1.2 GHz with four or eight cores
- Up to 64 Gb of memory in 16 FB-DIMM slots (populated in pairs of 1-Gb, 2-Gb, or 4-Gb FB-DIMMs)
- Four onboard 10/100/1,000-Mb/sec Ethernet ports
- Two PCI-X slots: one full-height, full-length, 64-bit at 133 MHz and one full-height, half-length, 64-bit at 133 MHz
- Four PCIe slots: one full-height, full-length x8 PCIe slot (x16 connector), one low-profile x8 PCIe slot (x8 connector), and two low-profile x4 PCIe or XAUI combination slots (x8 connector)
- Two USB 2.0 ports on the rear panel
- Either four internal SAS drives or two internal SAS drives if an optional DVD-RW is installed
- Onboard service processor with ILOM
- Two (N+1) hot-pluggable/hot-swappable high-efficiency AC or DC power supplies
- Three fan assemblies (each with two fans for N+1 redundancy), operating under environmental monitoring and control
Front and Rear Perspectives

Figure 10 illustrates the front and back panels of the Sun Netra T5220 server.

External features of the Sun Netra T5220 server include:

- Front and rear system status indicator lights provide “Locator” (white), “Service Required” (amber), and “Activity Status” (green) for the system.
- A hinged access door opens to provide access to the front panel, where hot-swappable SAS disk drives and the optional DVD-RW device are accessible.
- Two USB ports are provided on the rear panel.
- Two hot-pluggable/hot-swappable AC or DC power supply units (PSUs) insert from the rear (rear indicator lights convey the status of each PSU).
- Four autosensing 10/100/1,000Base-T Ethernet ports are available on the rear panel.
- Two 10-GbE ports (that connect directly to the UltraSPARC T2 processor) are available via optional XAUI networking cards.
- Four PCIe card slots are provided, two of which are combination PCIe/XAUI slots for optional XAUI networking cards.
• Two additional PCI-X slots are available to support legacy PCI-X telecommunications cards.

• Two RJ-45 management ports (serial and network) are located on the rear panel for use with the ILOM system controller. The serial port is the default connection to the ILOM controller, and optionally the network port supports a 10/100Base-T connection to the controller.

• One ttya serial port (DB-9) is provided on the rear panel for serial device connection.

• One telco alarm output port (DB-15) on the rear panel is connected to the service processor.

**PCI Expansion**

When the Sun Netra T5220 server is viewed from the rear, the PCI slots are in numeric order from bottom left-to-right numbered from zero to two, and top left-to-right numbered from three to five. The Sun Netra T5220 server has four PCIe card slots (Slots 0, 1, 2, and 5), two of which can support XAUI cards connected to the UltraSPARC T2 10-GbE interfaces (Slots 0 and 1). In addition, two PCI-X slots are available to support legacy PCI-X telecommunications cards (Slots 3 and 4). Slot numbering and type are summarized below.

<table>
<thead>
<tr>
<th>SLOT NUMBER</th>
<th>TYPE</th>
<th>MECHANICAL</th>
<th>ELECTRICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>PCIe or XAUI</td>
<td>x8</td>
<td>x4</td>
</tr>
<tr>
<td>1</td>
<td>PCIe or XAUI</td>
<td>x8</td>
<td>x4</td>
</tr>
<tr>
<td>2</td>
<td>PCIe</td>
<td>x8</td>
<td>x8</td>
</tr>
<tr>
<td>3</td>
<td>PCI-X</td>
<td>133 MHz at 64-bit, full-height, half-length</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PCI-X</td>
<td>133 MHz at 64-bit, full-height, full-length</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PCIe</td>
<td>X16</td>
<td>X8</td>
</tr>
</tbody>
</table>

**PCI-Express Slots**

Operating at 2.5 GHz, PCIe is a next-generation system bus interconnect that replaces the original PCI bus design. It is a high-speed, point-to-point dual simplex chip interconnect.

The Sun Netra T5220 system includes four PCIe slots: one full-height, full-length x8 PCIe slot (x16 connector), one low-profile x8 PCIe slot (x8 connector), and two low-profile x4 PCIe/XAUI combination slots (x8 connector). PCIe riser cards connect the PCI bus between the motherboard and the PCI tray. Optional copper or optical PCI XAUI cards can be used in the two combination slots to enable direct connection of two 10-GbE ports to the UltraSPARC T2 processor's integrated networking capabilities. The on-chip networking capabilities are ideal for applications that feature intensive packet-processing requirements.
PCI-X Expansion Slots

The Sun Netra T5220 server includes two PCI-X expansion slots. The two PCI-X slots are converted from PCIe buses to PCI-X buses through the two Intel 41210 bridge chips on the PCI tray. Both PCIe signals for these slots are 4-lane (x4).

System Network Interfaces

The Sun Netra T5220 server features four 10/100/1,000-Mb/sec Ethernet ports (RJ-45) located on the rear panel. Multiple onboard GbE ports promote flexibility as well as network configurations that support interface failover. The ports are numbered in sequence from left to right. Each port autonegotiates its link connection, and LEDs above the port indicate the speed of the established link (green signifies that the link is established at 1,000 Mb/sec). All four ports support 10/100/1,000 Mb/sec; full-and half-duplex operation; IEEE 802.3ab autonegotiation for speed, duplex, and flow control; and PXE boot for network booting.

Internal Storage

The Sun Netra T5220 server supports two storage configurations: one with four internal SAS drives, and another with two internal SAS drives and one internal DVD-RW device. The SAS hard drives are hot-swappable, 146-Gb-capacity, 10,000-RPM, 3-Gb/sec, 2.5-inch hard drives. The Sun Netra T5220 server supports 300-Gb-capacity, 10,000-RPM, 3Gb/sec, 2.5-inch hard drives via ATO. The drives are also 100 percent duty-cycle, small-form-factor drives that are NEBS certified.

The onboard LSI SAS1068E disk controller enables hardware RAID, providing data redundancy and increased performance without additional cost. The controller provides either two-disk RAID 1 volumes (integrated mirroring) or two-, three-, or four-disk RAID 0 volumes (integrated striping).

The optional DVD-RW device (standard with the two-drive configuration and not available with the four-drive configuration) provides the ability to read and write to a removable DVD media access device, enabling users to store data without external storage or hard drive requirements. In addition, the virtual storage feature of the ILOM service processor allows host access to remote CD-ROM ISO images, just as if the CD device were a locally attached USB CD-ROM device, eliminating the cost, complexity, and need for a separate optical disk drive for each individual server.
Power and Thermal

Typical heat dissipation and power consumption metrics for a Sun Netra T5220 server equipped with a 1- to 2-GHz UltraSPARC T2 processor and 4 Gb RAM are as follows:

- AC power: 100 to 240 VAC, 50 to 60 Hz
  - Maximum input current: 6.0 A at 100 to 120 VAC, 3.0 A at 200 to 240 AC
  - Maximum operating input power: 600 watts
  - Maximum heat dissipation: 1,365 BTU/hour
- DC power: 48 VDC or 60 VDC (nominal), 40 VDC to 75 VDC (range)
  - Maximum input current: 12.5 A at 48 VDC, 10 A at 60 VDC

Power Supplies

Engineered for high availability as well as low energy consumption, the Sun Netra T5220 server is equipped with two highly-efficient, redundant, hot-swappable AC or DC power supplies with separate power cords. The power supplies are rated at 650 watts each and can auto-detect between 120/240V and 50/60Hz.

One power supply is sufficient to run a fully populated server. For maximum protection against power supply failures, however, dual power supplies should be installed at all times. In normal operation, the power supplies share the power demands of the system equally.

To further reduce power requirements and to meet NEBS certification, the Sun Netra T5220 server can be run on DC power. Using DC power reduces overall operating costs by lowering energy use, reducing heat, and increasing reliability.

Cooling

Sun Netra T5220 servers feature an innovative chassis design engineered to lessen the need for cooling. The power and cooling efficiency of these systems exceeds that of many competitive carrier-grade systems configured with similar processing, memory, and storage capacities. The effective front-to-back airflow design helps to lower component temperatures, reducing the number of fans needed to cool the system. The chassis design features hex-shaped, honeycombed air inlet holes that enhance airflow and provide EMI shielding.

The chassis is divided into two distinct airflow chambers. One chamber draws airflow for the motherboard (CPUs, RAM) and PCI trays. The other chamber provides airflow for the hard drives, DVD-RW device (if present), and power supplies. The power supply/storage chamber is cooled by individual fans on the back of each power supply. The motherboard/PCI chamber is cooled by a row of fans mounted in front of the server behind the bezel.
Variable-speed fans run under the control of the onboard service processor, which monitors processor temperatures and system ambient air temperature. Based on these readings, the fans operate at the lowest speeds possible to provide sufficient cooling—conserving power usage, prolonging fan life, and reducing acoustical noise.

Fan failures are indicated by an amber “Service Required” LED on the front panel. Fan modules are designed for redundancy—a backup fan enables system continuity in the event of a fan failure.

Rackmounting

The Sun Netra T5220 server ships with a hard rackmount 19-inch 4-post kit. Optional kits are available for 19-inch two-post, 23-inch two-post, and 600 x 600 millimeter hard rackmount, as well as 19-inch 4-post slide rackmount. For example, the following options are available from Oracle to facilitate rack mounting:

- **Rack-Mounting Slide Rail Kit.** This is a four-point mounted slide rail kit (mounting points are located at the rack front and rear).

- **Tool-less Rack Kit.** As the name implies, this rackmounting kit snaps into most third-party racks without requiring any tools.

- **Cable Management Arm.** The Cable Management Arm supports and protects cables as the server slides into and out of the rack.
System Management Technology

As the number of systems grows in any organization, managing the infrastructure throughout its lifecycle becomes increasingly complex. Effective system management requires both integrated hardware that can sense and modify the behavior of key system elements, as well as advanced tools that can automate key administrative tasks.

Oracle Integrated Lights Out Manager

The Oracle Integrated Lights Out Manager service processor, which is provided across many of Oracle’s x64 servers, acts as a system controller, simplifying the remote management and administration of Sun Netra T5220 servers. The service processor is similar in implementation to that used in other Oracle modular and rackmount x64 servers. As a result, these servers integrate easily with existing management infrastructures, including on-site enterprise management frameworks or element managers.

The service processor

- Provides IPMI 2.0–compliant management functions to the server module’s firmware, OS, and applications, and to IPMI-based management tools that access the service processor via the ILOM Ethernet management interface. It provides visibility of environmental sensors, both on the server module and elsewhere in the chassis.

- Manages inventory and environmental controls for the server module, including CPUs, FB-DIMMs, and power supplies, and supplies HTTPS, CLI, or SNMP access to this data.

- Supplies remote textual console interfaces.

- Provides a means to download upgrades to all system firmware.

The Oracle Integrated Lights Out Manager service processor allows the administrator to remotely manage the server independently of the OS running on the platform and without interfering with system processing. Oracle Integrated Lights Out Manager can send e-mail alerts of hardware failures and warnings, as well as other system-related events. The Oracle Integrated Lights Out Manager circuitry runs independently from the server, using server standby power. As a result, Oracle Integrated Lights Out Manager firmware and software continue to function when the server OS goes offline and even when the server is powered off.

Oracle Integrated Lights Out Manager monitors the following Sun Netra T5220 server conditions:

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

**Sun Management Center Software**

Sun Management Center software is an element management system for monitoring and managing Sun environments. Sun Management Center software integrates with the leading enterprise management systems to provide customers with a unified management infrastructure. The base package is free and provides hardware monitoring. Advanced applications (add-ons) extend the monitoring capability of the base package. Sun Management Center software provides

• Agents for managing Oracle Solaris (SPARC and x64/x86 platforms) and Linux OSs
• In-depth hardware and software diagnostics
• Aggregate CPU utilization reporting
• Event and alarm management for thousands of attributes
• Corrective action automation through scripts triggered by alarm thresholds
• Secure management controls for remote dynamic reconfiguration
• The ability to customize modules with a powerful, easy-to-use GUI

**Oracle Enterprise Manager Ops Center**

Oracle Enterprise Manager Ops Center is infrastructure lifecycle management software for deploying, monitoring, patching, and managing large and small installations of Oracle systems. Oracle Enterprise Manager Ops Center takes a step-by-step approach to unraveling the challenges of getting systems operational quickly:

• **Discover.** As systems are added to the management network, administrators can use Oracle Enterprise Manager Ops Center to discover bare metal systems based on a given subnet address or IP range.

• **Group.** Given the number of systems to manage and the constant repurposing of systems, it is critical for IT organizations to find ways to group resources together. Oracle Enterprise Manager Ops Center enables users to logically group systems together and perform actions across a group of systems as easily as performing actions on a single system. Systems can be grouped by function (Web servers versus grid computing), administrative responsibility, or other categorization based on organizational needs.

• **Provision.** Oracle Enterprise Manager Ops Center remotely installs OSs (Oracle Solaris, RedHat, or SuSE Linux) onto selected systems. Administrators can use this functionality to provision OSs onto bare metal systems or reprovision existing systems. As the infrastructure
lifecycle continues, Oracle Enterprise Manager Ops Center can update firmware and provision software packages and patches to selected systems.

- **Monitor.** When systems are up and running, administrators can use Oracle Enterprise Manager Ops Center to monitor system health, helping to ensure that everything is running at the optimal levels. The software provides detailed hardware monitoring for attributes such as fans, temperature, disk, and voltage usage, including bare metal systems. Oracle Enterprise Manager Ops Center also monitors OS attributes such as swap space, CPU, memory, and file systems. Administrators can define specific threshold levels and set preferred notification methods, including e-mail, pager, or Simple Network Management Protocol (SNMP) traps, for each monitored component as business needs demand.

- **Manage.** Businesses require that infrastructure lifecycle management extend beyond just deploying and monitoring systems. Oracle Enterprise Manager Ops Center includes lights-out management capabilities, such as powering systems on and off, and remote serial console access to help IT organizations manage their IT infrastructure from remote locations. Leveraging Oracle Enterprise Manager Ops Center software’s Role-Based Access Control (RBAC) feature, organizations can grant permissions to specific users to perform specific management tasks.

- **Hybrid user interface.** Oracle Enterprise Manager Ops Center offers users a hybrid user interface (UI), accessible from the Web, that integrates both the GUI and CLI into one console. With this hybrid UI, operations performed in the GUI are simultaneously reflected in the CLI, and vice versa.

**RAS Features**

Customer data and applications comprise critical business assets. Enterprise computing technologies strive to furnish a high degree of data protection (reliability), to provide virtually continuous application access (availability), and to incorporate procedures and components that help to resolve problems with minimal business impact (serviceability). Commonly referred to as RAS, these capabilities are a standard part of Oracle’s mission-critical computing solutions.

The Sun Netra T5220 servers are engineered for hardware failure prevention, near-continuous operation, fast recovery, and easy serviceability. RAS features for these systems include

- **Reduced component count.** Integration of key functionality into the UltraSPARC T2 processor means fewer components and reduced incidence of component failures to increase overall availability.

- **Hot-swappable redundant components.** Mirrored disks, redundant fan modules, and redundant power supply units can be quickly and easily changed out, increasing system uptime.

- **Accessible components for improved serviceability.** Front-accessible, hot-swappable disk drives can be replaced quickly. The optional DVD-RW drive can also be removed without
opening the top cover of the chassis. Fan modules and power supply units can be replaced without completely removing a system from the rack.

- **Indicator LEDs on the back of the chassis.** Easily visible LEDs allow problems to be identified and isolated easily. Diagnostic LEDs are also included on the motherboard.

- **Integrated out-of-band management.** Standard on the Sun Netra T5220 servers at no additional charge, ILOM provides powerful tools for remote system management, simplifying administrative tasks, reducing on-site personnel needed, and lowering the cost of operations.

- **NEBS Level 3 certification.** Telecordia NEBS Level 3 certification demonstrates that the system meets stringent requirements for extremely reliable operation, even in harsh environmental conditions.

**Enterprise-Class Software Support**

The UltraSPARC T2 processor technology is mature and well tested, and Sun Netra T5220 servers share binary compatibility with earlier SPARC systems—they come preloaded with the solid and secure foundation of Oracle Solaris 10. Moreover, Oracle Solaris 10 includes a variety of sophisticated tools that let organizations easily consolidate and manage workloads while taking advantage of processor technology innovation.

**Scalability and Support for CoolThreads Technology**

Oracle Solaris 10 is specifically designed to deliver advanced capabilities of UltraSPARC T2 processor–based systems. In fact, Oracle Solaris 10 provides key functionality for virtualization, optimal utilization, high availability, unparalleled security, and extreme performance for both vertically and horizontally scaled environments.

One significant advantage of a system based on the UltraSPARC T2 processor is that it appears as a familiar symmetric multiprocessing (SMP) system to Oracle Solaris and applications. In addition, Oracle Solaris 10 incorporates features that help to improve application performance on CMT architectures:

- **CMT awareness.** Oracle Solaris 10 is aware of the UltraSPARC T2 processor hierarchy so that the scheduler can effectively balance the load across all the available pipelines. Even though it exposes the UltraSPARC T2 processor as 64 logical processors, Oracle Solaris understands the correlation between cores and threads they support.

- **Fine-grained manageability.** Oracle Solaris 10 has the ability to enable or disable individual processors. In the case of the UltraSPARC T2 processor, this ability extends to enabling or disabling individual cores and threads (logical processors). In addition, standard Oracle Solaris features such as processor sets provide the ability to define a group of logical processors and schedule processes or threads on them.
• **Support for virtualized networking and I/O, and accelerated cryptography.** Oracle Solaris contains technology to support and virtualize components and subsystems on the UltraSPARC T2 processor, including support for the on-chip 10-GbE ports and the on-chip PCIe interface. Accelerated cryptography is supported through the Oracle Solaris cryptographic framework.

**End-to-End Virtualization Technology**

Virtualization technology is increasingly popular as organizations strive to consolidate disparate workloads onto fewer but more-powerful systems to improve utilization. Sun Netra T5220 servers are specifically designed for virtualization, providing very fine-grained division of multiple resources—from processing to virtualized networking and I/O. Most importantly, Oracle’s virtualization technology is provided as a part of the system.

**A Multithreaded Hypervisor**

Like the UltraSPARC T1 processor, the UltraSPARC T2 processor provides a multithreaded hypervisor—a small firmware layer that provides a stable virtual machine architecture that is tightly integrated with the processor. Multithreading is crucial, because the hypervisor interacts directly with the underlying chip-multithreaded UltraSPARC T2 processor. This architecture is able to context-switch between multiple threads in a single core, a task that can require additional software and considerable overhead in competing architectures that do not interface with the hardware directly.

![Diagram](image.png)

**Figure 12.** Oracle provides parallelization and virtualization at every level of the technology stack.
Corresponding layers of virtualization technology are built on top of the hypervisor, as shown in Figure 12. The strength of Oracle’s approach is that all of the layers of the architecture are fully multithreaded, from the processor up through applications that use the fully threaded Java application model. Far from new technology, Oracle Solaris has provided multithreading support since 1992. This experience has helped to inform technology decisions at other levels, ultimately resulting in a system that parallelizes and virtualizes at every level. In addition to the processor and hypervisor, Oracle provides fully multithreaded networking and the revolutionary, fully multithreaded Oracle Solaris Zetabyte File System (ZFS). Using Oracle Solaris ZFS, Oracle VM Server for SPARC, Oracle Solaris Containers, and multithreaded applications can receive exactly the resources that they need.

**Oracle VM Server for SPARC**

Supported in all Oracle servers using CMT technology, Oracle VM Server for SPARC provides full virtual machines that can run an independent OS instance—each containing virtualized CPU, memory, storage, console, and cryptographic devices. Within the Oracle VM Server for SPARC architecture, each instance of Oracle Solaris 10 is written to the hypervisor, which provides a stable, idealized, and virtualizable representation of the underlying server hardware to the OS in each domain. Each domain is completely isolated, and the maximum number of virtual machines created on a single platform relies upon the capabilities of the hypervisor rather than on the number of physical hardware devices installed in the system. For example, the Sun Netra T5220 server with a single UltraSPARC T2 processor supports up to 32 domains, and each individual domain can run a unique OS instance.

By taking advantage of domains, organizations gain the flexibility to deploy multiple OS instances simultaneously on a single platform. In addition, administrators can leverage virtual device capabilities to transport an entire software stack hosted on a domain from one physical machine to another. Domains can also host Oracle Solaris Containers to capture the isolation, flexibility, and manageability features of both technologies. Tightly integrating domains with both the UltraSPARC T2 processor and Oracle Solaris 10 increases flexibility, isolates workload processing, and improves the potential for maximum server utilization.

To support virtualized networking, Oracle VM Server for SPARC implements a virtual Layer 2 switch, to which guest domains (guest OSs) can be connected. Each guest domain can be connected to multiple vSwitches, and multiple guest domains can also be connected to the same vSwitch. vSwitches can either be associated with a real physical network port, or they may exist without an associated port, in which case the vSwitch provides only communications between domains in the same server (interdomain networking), thus saving valuable network resources.
Oracle Solaris Containers

Providing virtualization at the OS level, Oracle Solaris Containers consist of a group of technologies that work together to efficiently manage system resources, virtualize the environment, and provide a complete, isolated, and secure runtime environment for applications.

Oracle Solaris Containers create an isolated and secure environment for running applications in a virtualized OS environment created within a single instance of Oracle Solaris. Oracle Solaris Containers can be used to isolate applications and processes from the rest of the system. This isolation helps enhance security and reliability because processes in one zone are prevented from interfering with processes running in another zone.

Resource management tools provided with Oracle Solaris help allocate resources such as CPUs to specific applications. CPUs in a multiprocessor system (or threads in the UltraSPARC T2 processor) can be logically partitioned into processor sets and bound to a resource pool, which in turn can be assigned to an Oracle Solaris Container. Resource pools provide the capability to separate workloads so that consumption of CPU resources does not overlap. They also provide a persistent configuration mechanism for processor sets and scheduling class assignment. In addition, the dynamic features of resource pools enable administrators to adjust system resources in response to changing workload demands.

Fault Management and Predictive Self-Healing

Oracle Solaris 10 introduced a new architecture for building and deploying systems and services capable of fault management and predictive self-healing. Oracle Solaris Predictive Self Healing is an innovative capability in Oracle Solaris 10 that automatically diagnoses, isolates, and recovers from many hardware and application faults. As a result, business-critical applications and essential system services can continue uninterrupted in the event of software failures, major hardware component failures, and even software misconfiguration problems.

- **Oracle Solaris fault manager.** Oracle Solaris fault manager collects data relating to hardware and software errors. This facility automatically and silently detects and diagnoses the underlying problem, with an extensible set of agents that automatically respond by taking the faulty component offline. Easy-to-understand diagnostic messages link to articles in Oracle’s knowledge base to guide administrators through corrective tasks that require human intervention. The open design of Oracle Solaris fault manager also permits administrators and field personnel to observe the activities of the diagnostic system. With Oracle Solaris fault manager, the overall time from a fault condition, to automated diagnosis, to any necessary intervention is greatly reduced, increasing application uptime.

- **Oracle Solaris service manager.** Oracle Solaris service manager creates a standardized control mechanism for application services by turning them into first-class objects that administrators can observe and manage in a uniform way. These services can then be automatically restarted if they are accidentally terminated by an administrator, if they are
aborted as the result of a software programming error, or if they are interrupted by an underlying hardware problem. In addition, Oracle Solaris service manager reduces system boot time by as much as 75 percent by starting services in parallel according to their dependencies. An “undo” feature helps safeguard against human errors by permitting easy change rollback. Oracle Solaris service manager is also simple to deploy; developers can convert most existing applications to take full advantage of Oracle Solaris service manager features by adding a simple XML file to each application.

Oracle Solaris Predictive Self-Healing and Oracle Solaris fault management provide the following specific capabilities on Sun Netra T5220 servers:

- **CPU Offlining** takes a core offline that has been deemed faulty. Offlined CPUs are stored in the resource cache and stay offline on reboot unless the processor has been replaced, in which case the CPU is cleared from the resource cache.

- **Memory Page Retirement** retires pages of memory that have been marked as faulty. Pages are stored in the resource cache and stay retired on reboot unless the offending FB-DIMM has been replaced, in which case affected pages are cleared from the resource cache.

- **I/O Retirement** logs errors and faults.

- **fnlog** logs faults detected by the system.

**Oracle Solaris CoolTools for SPARC: Performance and Rapid Time to Market**

No matter how compelling new hardware or OS platforms may be, organizations must be assured that the costs and risks of adoption are in line with the rewards. In particular, organizations want to be able to continue to leverage the considerable advantages of popular commercial and open source software. Developers want to use familiar compilers and basic development tools. Administrators can little afford time spent on getting applications to run optimally in a new environment. Oracle’s Cool Tools Program is designed specifically to take the cost and risk out of moving Web tier environments to new platforms. Each Sun Netra T5220 server includes CoolTools for SPARC architecture platforms.

**Application Selection**

Application selection helps to identify applications that stand to benefit from CoolThreads technology. The CoolThreads Selection Tool (coolst) helps to determine application suitability for both UltraSPARC T1 and UltraSPARC T2 architectures, reducing the risk of investment decisions. The tool measures application floating-point content along with the number of lightweight processes (threads) to determine potential parallelism.
Development

Developers need to be able to build, test, and evaluate applications, producing the most effective code while advancing their productivity with chosen tools. Tools for development on Sun Netra T5220 servers include

• **GCC for SPARC System.** Specifically tuned and optimized for SPARC systems, GCC for Sparc System complements the popular GCC compiler suite, delivering up to three times the performance of compiled applications with even greater levels of reliability. At the same time, GCC for Sparc System is 100 percent compatible with GCC, supporting all ABIs, language extensions, and flags.

• **Oracle Solaris Studio 12.** Oracle Solaris Studio 12 provides developers with the latest record-setting, high-performance, optimizing C, C++, and FORTRAN compilers for Oracle Solaris on SPARC and x86/x64 platforms. Command-line tools and a NetBeans-based integrated development environment (IDE) are provided for application performance analysis and debugging of mixed source language applications. In addition to providing multiplatform support, Sun Studio 12 compilers are compatible with GCC, Visual C++, C99, OpenMP, and FORTRAN 2003.

• **Binary Improvement Tool (BIT) and Simple Performance Optimization Tool (SPOT).** Used for code coverage analysis, BIT provides instruction and call count data at runtime, helping to significantly improve developer productivity and application performance. BIT does not require source code and works with both executables and libraries. SPOT also helps deliver improved developer productivity by automating the gathering and reporting of code data.

In addition, developers may take advantage of numerous third-party and Oracle APIs to address application requirements, simplify common programming tasks, and enhance platform independence. Libraries of typical media processing operations, for example, are available on multiple platforms, including those designed to deliver optimal performance on UltraSPARC processor–based platforms. The mediaLib library is a low-level performance library for multimedia applications—functions in mediaLib are accelerated with VIS technology on UltraSPARC-based systems. (These same functions are also supported—although without VIS acceleration—on other SPARC-based and x86-based systems running Oracle Solaris.) Media codec functions are also available in libraries such as CodecLib for Oracle Solaris and in Java Advanced Imaging APIs, and they perform well on the UltraSPARC T2 processor because of its robust floating-point and throughput processing capabilities.

Tuning and Debugging

Administrators and developers alike need to monitor, analyze, and tune applications under real-world conditions. The following tools aid with tuning and debugging:
• **Corestat.** Corestat provides an online monitoring tool for core utilization of the UltraSPARC T2 processor, providing a more accurate measure of processor and system utilization than tools that only measure the utilization of individual threads. Implemented as a Perl script, corestat aggregates instructions executed by all the threads on a single core, revealing the cycles per instruction of key workloads and indicating where more tuning is needed.

• **Automatic Tuning and Trouble-Shooting System (ATS).** In the interest of automating application tuning, ATS automatically reoptimizes and recompiles binaries with no need for source code. ATS identifies the inadequate optimization and then automatically rebuilds the application with the correct options for optimization. ATS is a plug-in for GCC for SPARC System and Oracle Solaris Studio.

**Deployment**

Cool Tools deployment elements provide applications that are already optimized for CoolThreads technology, and save critical time in configuring systems for performance and consolidation. Deployment elements include

• **Cool Tuner.** Cool Tuner provides an on-site “virtual” tuning expert, delivering system performance improvements by automatically applying current best practices including both patching and tuning. Depending on administrator experience, Cool Tuner can save hours to weeks of effort tuning Sun Fire or Sun Netra servers based on CoolThreads technology.

• **Cool Stack.** Cool Stack represents a collection of the most commonly used free and open source applications, preoptimized for Sun Fire and Sun Netra servers based on CoolThreads technology that run Oracle Solaris. Including such popular applications as Apache, Perl, PHP, Squid, Tomcat, and MySQL, these applications have been recompiled with Sun Studio 12 compilers to deliver a 30 to 200 percent performance improvement over standard binaries compiled with GCC. Cool Stack applications also bring performance benefits to any SPARC processor–based system.

• **Consolidation tool for Sun Fire servers.** Powerful Oracle Solaris Containers offer myriad consolidation possibilities and the Consolidation Tool for Sun Fire Servers speeds their deployment. With a wizard-based GUI, this tool simplifies and automates the installation of consolidated applications, enabling even novice administrators to create a fully virtualized and consolidated environment using Oracle Solaris Containers. The result is fast and high-quality consolidated deployments using Sun Fire and Sun Netra servers.

**Java Platform, Enterprise Edition (Java EE)**

The software industry has traditionally offered point products that solve specific parts of a problem, leaving it to customers to integrate those products into a solution that can support their business applications. Organizations don’t purchase their OSs by assembling core components
such as drivers, schedulers, command, and administration utilities, and it doesn’t make sense for them to assemble and integrate traditional middleware this way either.

Using world-class software, Oracle redefines the software system from the OS up through the J2EE specification layer. Customers can write their business applications to Java software standards, leveraging Java EE network services, and Oracle delivers the end-to-end solution to run them.

Oracle offers the following products built to optimize Java EE environments:

- **Sun Java System Access Manager.** Open, standards-based access control; single sign-on; and federation services that help control costs and minimize the security risks of conducting business more openly.

- **Oracle Communications Enterprise Mobility Server.** A robust, commercial J2EE 4-compliant application server that makes building robust, scalable enterprise applications easier than ever, and is the perfect platform for implementing SOA and Web 2.0 applications.

- **Oracle Directory Server Enterprise Edition.** A secure, highly available, scalable, and easy-to-manage directory infrastructure that effectively manages identities in dynamic environments.

- **Java Studio Creator.** Rapid visual Web application and portlet development.

- **Java Studio Enterprise.** An award-winning IDE for enterprise architects and developers.

- **Oracle Communications Messaging Exchange Server.** A leading business integration messaging server designed to deliver the exceptional scalability, reliability, and advanced security features necessary for large-scale enterprise deployments.

- **Oracle Solaris Cluster.** A multisystem, multisite disaster recovery solution that manages the availability of applications services and data across local, regional, and vastly dispersed data centers.

- **Oracle Solaris Studio.** A high-performance compiler that optimizes C, C++, and Fortran for Oracle Solaris on SPARC, and both Oracle Solaris and Linux on x86 platforms.

- **Oracle iPlanet Web Server.** A leading enterprise Web server, engineered to meet the stringent requirements of organizations that use Web technologies as a competitive advantage.

- **Oracle iPlanet Web Proxy Server.** A powerful system for caching and filtering Web content, boosting network performance, and reducing user wait times.

**Unified Network Platform**

Many components must come together in a holistic solution in order to address the landscape of challenges confronting the creation of an effective fourth-generation (4G) network infrastructure. Oracle offers an easy-to-use, high-performance, affordable solution to address 4G
network computational challenges using standards-based, commercial off-the-shelf technologies. The unified network platform is a fully integrated and tested environment—OS, virtualization, RAS features, management, and other core services—enabling developers to create network code immediately without the need to build an embedded system from the ground up.

Based on industry standards, the unified network platform can evolve along with market economics, enable colocation of third-party applications and services, and speed application development. The unified network platform also provides carriers with the ability to utilize a single platform for control and data plane functions, improve packet processing rates, and lower the cost structure for initial subscriber offerings. The technology required to accomplish these goals includes contemporary multicore, multithreaded processors available in Advanced Telecommunications Computing Architecture (ATCA) and rack server form factors, virtualization technology, fast-path packet processing software, innovative 10-GbE technology, robust systems management, and high availability (HA) middleware. Specifically, the unified network platform includes the following elements:

- **UltraSPARC T1 or T2 processors.** Volume market, open specification processors from Oracle with up to eight cores and 64 threads.

- **Oracle's 10-GbE networking technology.** A network interface integrated into the UltraSPARC T2 processor that provides the critical bandwidth and granular resource allocation required for high-speed data plane IP packet processing.

- **Cryptographic units.** A security coprocessor embedded within each UltraSPARC T2 processor core for fast, efficient network traffic encryption.

- **Sun Netra Data Plane Suite.** A high-level language development and lightweight runtime environment that enables the rapid creation and high-speed execution of data plane packet processing applications.

- **Oracle VM Server for SPARC.** An OS-independent, virtualized computing environment for Sun UltraSPARC T1 and UltraSPARC T2 processors that enables systems to host control and data plane applications and other third-party software on a single platform while maintaining isolation.

In addition, Sun Netra system management tools provide detailed alarm and fault diagnostic capabilities across multiple blade servers from Oracle and third-party suppliers. The Sun Netra High Availability Suite supports Service Availability Forum (SAF)–compliant, carrier-grade high availability.

Furthermore, Oracle’s strict adherence to industry standards and published open interfaces eliminates the vendor lock-in that NEPs often experience with proprietary technologies. The technology within the unified network platform includes OpenSPARC technology, published open interfaces for Oracle VM Server for SPARC virtualization technology, ANSI C as the basis
for the common control and data plane development environment, and OpenSolaris, as well as carrier-grade Linux options for the control plane environment.

Consolidated Control and Data Plane Applications Using Domains

While Oracle’s Sun servers (such as the Sun Netra T5220 server) can execute a single OS hosting a single application with extreme scalability, domain technology and many physical threads in the unified network platform enable the simultaneous execution of multiple OSs and applications. Consolidation via Oracle VM Server for SPARC and UltraSPARC T2 processors is a new approach to horizontal scaling that is sound in terms of availability, isolation, and ease of deployment. Oracle VM Server for SPARC allows an organization to deploy a single Sun Netra T5220 server to execute control plane applications on Oracle Solaris and data plane applications on NDPS simultaneously in complete isolation (see Figure 14).
Figure 14. Using logical domain technology, a single server with an UltraSPARC T2 processor can simultaneously host data plane applications and control plane applications—while maintaining complete processing isolation.

As a general-purpose and open platform, Sun Netra T5220 servers can seamlessly host a heterogeneous mix of independent Oracle Solaris, NDPS, and Linux environments. Oracle VM Server for SPARC uses a lightweight hypervisor firmware layer to virtualize machine hardware, decoupling the link between the OS and the hardware. The number of virtual machines that can be created thus depends on the capabilities of the hypervisor as opposed to the number of physical hardware devices installed in the system. Within platforms using UltraSPARC T2 processors, a total of 64 logical domains can be established. Each logical domain is a full virtual machine that runs an independent OS instance or runtime environment and contains virtualized CPU, memory, storage, console, and cryptographic devices.

Oracle VM Server for SPARC isolates resources and faults between individual domains. Direct SPARC hardware integration and tight hypervisor firmware code ensure maximum stability and fault resilience. Within each platform virtualized by Oracle VM Server for SPARC, a service domain shares device access to other logical domains in the form of virtual devices. A service domain provides specific virtualized services, including virtual disk, network, and console services to guest domains using a logical domain channel for communication. Many logical domains can share the same physical device, but only the service domain accesses the physical device driver. By buffering device control, the service domain can actually change the underlying device or device driver while the logical domain continues to execute. The ability to dynamically
adjust compute resources between domains provides enterprises with the freedom to scale control plane and data plane workloads independently.

Using the unified network platform, organizations can leverage Oracle VM Server for SPARC and NDPS to consolidate control and data plane applications onto a single server, reducing capital and operational expenses and improving first subscriber costs. As a result, markets that were previously considered too small can be pursued and addressed more cost-effectively.

**Sun Netra Data Plane Suite**

The Sun Netra Data Plane Suite is a high-performance packet processing engine that allows providers to quickly and cost-effectively develop and deploy data plane applications—enabling the aggregation, transport, and routing of voice, video, and data in converged networks. Within Sun Netra Data Plane Suite, high-level language tools produce explicitly parallelized ANSI C code, speeding application development and providing a degree of portability that enhances vendor and platform independence. In addition, a lightweight runtime environment included with Sun Netra Data Plane Suite exploits the UltraSPARC T2 processor architecture to deliver line rate packet processing speeds for data plane applications.

Sun Netra Data Plane Suite combines with UltraSPARC T2 processor technology and Oracle VM Server for SPARC to provision the unified network platform and enable consolidation of control plane and data plane applications. In this way, network processing elements can leverage general-purpose volume market hardware—like the Sun Netra T5220 server—to change the economics of control and data plane solutions for telecommunications.

**Standards-Based Data Plane Application Development**

Sun Netra Data Plane Suite provides developers with standards-based software tools for rapid creation of data plane applications. In addition, the Sun Netra Data Plane Suite -optimized runtime environment exploits multithreaded partitioning firmware for high-speed code execution on UltraSPARC T1 or UltraSPARC T2 multithreaded processors. The following features of the scalable NDPS software framework enable fast path network processing:

- Event-driven scheduling with run-to-completion states
- Explicit parallelization
- Static memory allocation
- Code generation based on hardware description and mapping
- Efficient communication pipes between pipeline states

Using the Sun Netra Data Plane Suite compiler enables programmers to develop scalable, high-performance C applications for embedded multiprocessor target architectures. A system-level
view of the application and the following features contribute to the ability of the Sun Netra Data Plane Suite compiler to deliver superior code validation and optimization:

- Inclusion of characteristics of the targeted hardware and software system architecture through execution of a user-supplied architecture specification
- Simultaneous examination of multiple sets of source files along with the relationships to the target architecture
- Recognition of APIs used in the application code and software generation based on the system-level context

These features help to improve the reliability and performance of resulting applications and systems.

To further simplify and accelerate the creation of packet-processing applications, Sun Netra Data Plane Suite includes a library of reference applications that can be reused and integrated into full-scale network elements. For example, Sun Netra Data Plane Suite includes RLP, IP forwarding (ipfw), User Datagram Protocol (UDP), and packet classification (PacketClassifier) reference applications. New libraries can also be added over time, based on the work of a community of application developers and Oracle’s development efforts. Sun Netra Data Plane Suite can help to shorten development time from years to months without compromising performance.

A Lightweight Runtime Environment on General-Purpose Platforms

Applications can achieve excellent performance by leveraging the high-performance, lightweight Sun Netra Data Plane Suite runtime environment and exploiting the virtually unmatched thread density and SoC design of UltraSPARC T2 processors. The Sun Netra Data Plane Suite lightweight runtime environment executes directly on UltraSPARC T2 processor threads, enabling packet processing throughput at 10-Gb line rates and beyond. Avoiding the performance limitations of general-purpose OSs, the lightweight runtime environment has no scheduler or interrupt handler and performs no context switching. Every thread runs to completion without time slicing, making parallel execution extremely scalable and enabling line rate performance and linear scaling. By utilizing the Sun Netra Data Plane Suite lightweight runtime environment on servers with UltraSPARC T2 processors, organizations gain the ability to implement data plane packet processing on a platform with an economic cost structure that enables deployment throughout the network.

Profiling and Redistribution of Data Plane Processing

In many cases, applications are initially coded and debugged on a general-purpose OS. After profiling the software on the OS, forwarding code is moved to Sun Netra Data Plane Suite. The resulting code represents embedded packet processing code, and as such it is beneficial to optimize it to the best of the hardware threads’ capabilities. The Sun Netra Data Plane Suite multithreaded profiling capabilities can optimize assignment of threads by determining the
number of threads, number of receive DMA channels to utilize, and depth of the packet processing pipeline.

In addition to standard optimizations, the Sun Netra Data Plane Suite profiler enables the collection of critical data during execution. With the ability to profile CPU utilization, instruction counts, I/O wait times, data cache misses, secondary cache misses, memory queue, memory cycles, and more, the profiler guides and simplifies performance tuning efforts. The profiler also makes use of the special counters and resources available in the hardware to collect critical information. In fact, profiler API calls can be inserted at desired places to start collecting or updating profiling data.

Tailoring the Sun Netra Data Plane Suite lightweight runtime environment for specific workloads and utilizing interprocess communications between different control and data plane processes can reduce overall network traffic and lead to greater performance. As a result, organizations can leverage off-the-shelf OSs on Oracle platforms for provisioning, control plane, and exception processing, and only a small amount of code moves to a dedicated packet-processing domain within the same or a separate server.

Advanced Functions

The advantages of using a unified network platform for next-generation telecommunication networks continue to unfold. Deep packet inspection becomes increasingly important within today’s networks to effectively execute security, intrusion detection, and billing applications. The massive threading and large memory footprint of the UltraSPARC T2 processor combine with integrated packet classification capabilities to provide scalability and to address deep packet inspection applications.

Effective networks also require Quality of Service (QoS) features to prioritize ingress traffic and mitigate the effects of network congestion. The differentiated services (DiffServ) data path in the unified network platform includes the classifier, meter, marking, and policing components. Using a pipeline model, each component performs a specific task and propagates the result to the next element. The technology within the unified network platform provides hardware-based scheduling and QoS functions as well as software-based QoS mechanisms within Oracle Solaris and Sun Netra Data Plane Suite. The enormous memory size of the UltraSPARC T2 processor buffers operations, enabling the Oracle system architecture to effectively combine the coarse nonblocking characteristics of hardware execution with scalable, fine-grained per-subscriber QoS functions implemented in software.

As another example, the unified network platform can be used to create a software-defined router. Oracle platforms with UltraSPARC T2 processors provide highly scalable performance for packet routing. In addition, Sun Netra Data Plane Suite offers providers the flexibility to implement software capabilities that uniquely match application processing characteristics, thereby accelerating performance. By replacing legacy routers that use proprietary hardware with
Oracle’s Sun Netra servers or blades, the UltraSPARC T2 processor, and NDPS-developed software, organizations can lower costs, gain flexibility, and tailor processing to achieve exceptional packet processing throughput.

Conclusion

Oracle’s Sun Netra T5220 servers offer incredible reliability and system density—with robust compute, memory, networking, storage, and I/O capabilities in a small, compact 2U form factor. Leveraging UltraSPARC T2 processor technology and engineering expertise in chassis and systems design, these platforms deliver new levels of performance—and new levels of performance-per-watt—in a rackmountable, NEBS-certified system. Deploying these servers can create a more agile and reliable infrastructure that scales easily to deliver new, integrated multimedia application services within a small footprint, while at the same time delivering needed mission-critical service levels.

Sun Netra T5220 servers provide expandable, high-capacity resources for demanding Web infrastructure, database, and server consolidation and virtualization initiatives. These carrier-grade systems are ideal for installations where reliability, performance, density, and energy conservation are paramount. Given the high throughput capabilities and energy efficiency of these servers, IT departments can easily consolidate workloads and improve utilization, while at the same time preserving investments in applications.