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x86 SERVERS

Oracle Server X5-4 System Architecture

ORACLE WHITE PAPER | JULY 2016

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Introduction

Oracle Server X5-4, Oracle's new four-socket x86 server, is part of a family of Oracle x86 servers that are purpose-built to be best for running Oracle software. Oracle is introducing NVMe SSDs that accelerate Oracle Database. The new Oracle Server X5-4 system is the ideal platform for virtualization and enterprise applications requiring large amounts of memory and compute power. Each server provides two or four Intel Xeon E7-8895 v3 processors with 18 cores each. With up to 96 DDR3 low-voltage dual inline memory modules (DIMMs), Oracle Server X5-4 supports up to 3 TB of memory.

Product Overview

The Oracle Server X5-4 system's 3U enclosure contains 11 PCIe 3.0 slots (two 16-lane, nine 8-lane), six 2.5-inch drive bays, six USB ports (two front, two rear, and two internal), four on-board Ethernet 10Gbase-T ports (Intel Twinville), and a DVD+/-RW drive. The system supports up to six SAS-3 hard disk drives (HDDs) or solid-state drives (SSDs), allowing for up to 7.2 TB of internal HDD storage or up to 2.4 TB of internal SSD storage. Oracle Server X5-4 can also be configured with up to four NVM Express (NVMe) SSDs from Oracle for a total of 12.8 TB of internal write-optimized, high-endurance PCIe flash.

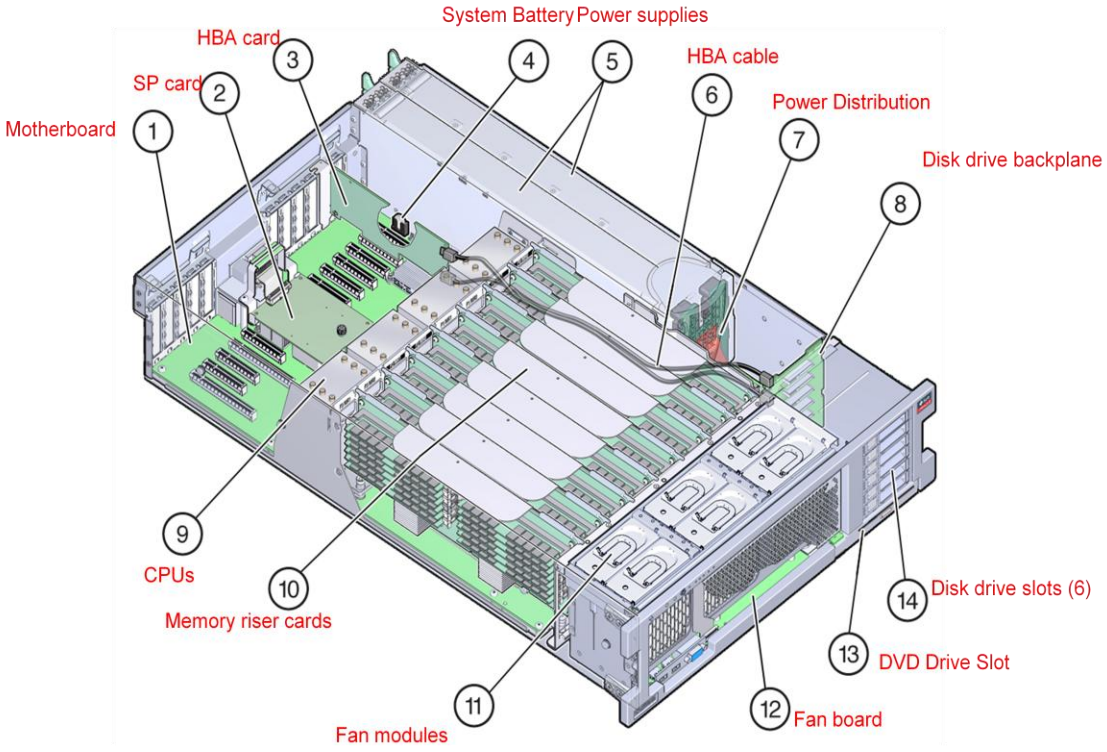

Figure 1. Oracle Server X5-4 components

Each server contains built-in enterprise management tools that reduce operating expenses by finding hardware problems early and making initial setup easy. Oracle Integrated Lights Out Manager (Oracle ILOM) provides remote power control, virtual keyboard, video, mouse (KVM), advanced health monitoring, and remote server configuration. Oracle Server X5-4 is engineered to work best with Oracle's operating systems. Each server can optionally be shipped from the factory with Oracle Linux, Oracle VM, or Oracle Solaris preinstalled.

Designed to Meet Today's Security Challenges

According to the Department of Homeland Security, imported software and electronics are often shipped to the United States with purposely embedded malware, spyware, and security-compromising components by unknown foreign parties. There has been concern about supply-chain security, because computers and IT equipment pass through several suppliers before the final product is deployed. A federal report released on the supply chain between the United States and foreign nations speculated the possibility that somewhere along the line someone could compromise a component and design a "back door entry" capability that could enable cyber attacks.

One example of such a cyber attack has been christened "BIOS Plot." An NSA analyst discovered that a nation state had the intention to destroy computers—via the BIOS—used by US financial institutions.

As recently as December 2015, a security breach was discovered at a major US computer networking equipment manufacturer. US officials worried that hackers working for a foreign government were able to spy on the encrypted communications of the US government and private companies for years. It is believed that attackers embedded a "back door" into the source code of the communication protocols of the equipment.

These types of attacks are just a few examples of how hackers are becoming more and more sophisticated at attacking multiple layers in the IT stack. It is no longer good enough just to secure applications and the network perimeter of a data center; the enterprise must apply security in depth across hardware, firmware, and software.

Oracle's Approach to Security

Oracle's philosophy on security in-depth is based on the philosophy that "security needs to be built in and not bolted on." Oracle has a company-wide initiative to incorporate security features across all of its products, starting with the design and manufacturing of its servers, through the operating systems layers, and extending into the database, middleware, and application layers. The Global Product Security group is chartered with the goal of setting, auditing, and enforcing security policies across all Oracle products. It also performs periodic security audits and ensures compliance with the latest threat profiles. This organization also publishes regular security alerts to users of Oracle products. An example alert can be found at:

http://www.oracle.com/technetwork/topics/security/alert-cve-2016-0603-2874360.html

Securing the Foundation—100 Percent In-House Design and Manufacture

The entire x86 server product line is designed 100 percent in-house. No third parties ever touch the motherboard design, ensuring that no components are added to create a “back door entry” into Oracle servers. Additionally Oracle applies strict control over the entire supply chain with all of its servers being manufactured in the United States, thus maximizing supply chain security. This is unique to Oracle.

The firmware installed in Oracle’s x86 servers, such as the BIOS and system management stack, are developed and owned by Oracle with no source code ever released to third parties. The Oracle Integrated Lights Out Manager (Oracle ILOM) system management stack is FIPS 140-2 compliant, ensuring the latest cryptography ciphers are supported. Oracle ILOM also includes other security-related features such as fine-grained access control and logging that enable IT administrators to control and monitor access to the infrastructure. Oracle has incorporated technologies into Oracle ILOM that ensure that illegal firmware updates are prevented.

In addition, Oracle ILOM makes sure that newly unpacked and connected Oracle x86 servers are secure “out of the box,” because only secure protocols such as HTTPS, SNMP, and IPMI are allowed, while untrustworthy connections are rejected. The Oracle ILOM service processor is ubiquitous across all of Oracle’s engineered systems, storage appliances, SPARC servers, and x86 servers—ensuring that common security, reliability, and manageability features are applied across all platforms.

All of these features are embedded within the servers themselves and there are no additional licensing fees to be paid for them.

Best for Oracle Software

Oracle x86 systems are the best x86 platforms for Oracle software. Only Oracle provides customers with an optimized hardware and software stack that comes complete with choice of OS, virtualization software, and cloud management tools—all at no extra charge. Oracle’s optimized hardware and software stack has enabled a 10x performance gain in its engineered systems and delivered world-record benchmark results. Oracle’s comprehensive, open standards–based x86 systems provide the best platform to run Oracle software with enhanced reliability for data center environments.

Organizations are in need of faster transaction times and increased throughput from the database, which in turn stresses I/O, and increases main memory requirements in data centers. Oracle Database is designed to take advantage of hardware features such as high-core-count central processing units (CPUs) and non-uniform memory access (NUMA) memory architectures to enhance system performance.

Benefits include increased transaction throughput and improved application response times, which reduce the overall cost per transaction. Oracle has extended NVMe capabilities into the new Oracle Server X5-4.

Oracle Server X5-4, NVM Express and Oracle Database Smart Flash Cache

Oracle Database utilizes a feature called Database Smart Flash Cache. This feature is available on Oracle Linux and Oracle Solaris and allows customers to increase the effective size of the Oracle Database buffer cache without adding more main memory to the system. For transaction-based workloads, Oracle Database blocks are normally loaded into a dedicated shared memory area in main memory called the system global area (SGA). Database Smart Flash Cache allows the database buffer cache to be expanded beyond the SGA in main memory to a second level cache on flash memory. The new NVMe flash drives in Oracle Server X5-4 provide a high-bandwidth, low-latency implementation of Database Smart Flash Cache based on PCI Express (PCIe) that vastly improves on-line transaction processing (OLTP) times.

Oracle Server X5-4 introduces a new flash technology called NVM Express that provides a high-bandwidth, low-latency PCIe interface to large amounts of flash within the system. Oracle Database with Database Smart Flash Cache and Oracle Solaris ZFS are specifically engineered to take advantage of this low-latency, high-bandwidth interface to flash in Oracle Server X5-4. Oracle Solaris and Oracle Linux are co-engineered with Oracle Server X5-4 to function in enterprise-class workloads by enabling hot-pluggable capabilities. Traditional SSDs with a SAS/SATA interface are a popular method of adding flash to a server, and these take advantage of legacy storage controller and disk cage infrastructure. NVMe is an entirely new end-to-end design that eliminates the performance bottlenecks that accompany conventional storage interfaces.

Figure 2 illustrates a block diagram of a traditional SAS-3 SSD connected to a server. The server PCIe root complex is connected to a PCIe/SAS controller that translates PCIe to SAS protocol to allow the server to read and write the SAS-3 SSD. As NVMe SSDs already use the PCIe protocol, there is no need for the PCIe/SAS controller translation, as shown in Figure 3.

Oracle-Unique NVMe Design and Database Smart Flash Cache

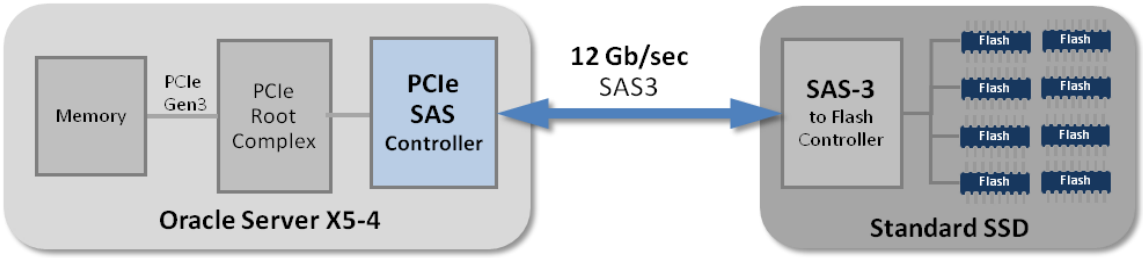

Figure 2. Traditional SAS-3 solid state drive architecture

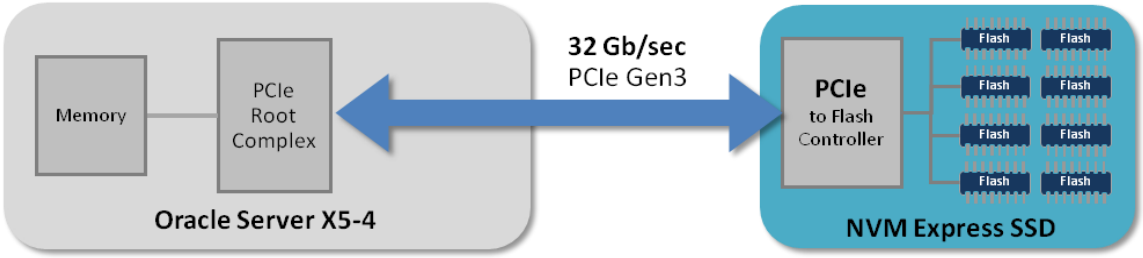

Figure 3. Oracle NVMe solid state drive architecture

Oracle's NVMe SSDs and PCIe cards have a much lower latency and higher bandwidth than standard SAS-3 drives due to the fact that the drive connects directly to four lanes of the PCIe Gen3 with an aggregate bandwidth of 32 Gb/sec as opposed to 12 Gb/sec for a traditional SAS-3 SSD.

Oracle Server X5-4 can be configured with up to four NVMe small form factor (SFF) SSDs that support up to 12.8 TB of flash storage.

As flash technologies are temperature sensitive, most high-performance flash drives are enabled to throttle down I/O speeds as temperatures rise in order to protect the flash from damage. Oracle's NVMe SSDs, on the other hand, include multiple temperature sensors that are monitored by Oracle Server X5-4's Oracle Integrated Lights Out Manager (Oracle ILOM) service processor (SP) to ensure the drive maintains optimum operating temperature. Oracle ILOM modulates the fan speed to ensure sufficient cooling for maximum system performance at all times. The benefits of this being that the system consistently operates at maximum performance across the full operating temperature range of the server independent of system configuration.

Efficient Computing and Virtualization

With organizations facing growing IT expenses, it is essential to be able to do more with less. Server virtualization is the foundation of private cloud infrastructures and serves as the consolidation mechanism for heterogeneous workloads. Oracle Server X5-4 is the ideal platform for virtualization, providing the ability to get the most out of each server by simultaneously maximizing memory capacity, I/O, and compute density.

The best virtualization platforms allow for high virtual machine (VM) density while providing fast live migration, reliability, and performance. While one important metric for estimating VM density is core density, there are many other factors—such as memory capacity, memory bandwidth, and I/O bandwidth—that are equally important in determining how many VMs can be consolidated onto one server. Enterprise-class VM environments rely heavily on I/O bandwidth and low-latency networks to be able to migrate VMs for load balancing as well as failover scenarios. The I/O slots can be configured with high-bandwidth low-latency fabrics such as InfiniBand. Combined with Oracle Virtual Networking, enterprises get the benefit of high server consolidation ratios as a large number of VMs can be reliably deployed and managed. The cable aggregation advantages of Oracle Virtual Networking, combined with a full suite of tools like Oracle Fabric Manager and Oracle Enterprise Manager 12c, allow customers to benefit from simplifications of managing virtualized infrastructures.

By allowing more VMs per server, organizations can reduce operating expenses by having fewer physical servers in their inventories. This means less patching, less maintenance, less cabling, and easier overall systems management. Oracle Server X5-4 strikes an ideal balance for virtualized environments: its high VM consolidation factor provides simplified infrastructure while at the same time providing a cost-effective means for scaling out.

With over 216 GB/sec of raw I/O bandwidth, combined with the high core and memory density, Oracle Server X5-4 is also an ideal server for consolidating enterprise virtual machines when used with Oracle VM. With an optimal balance among core density, memory footprint, and I/O bandwidth, Oracle Server X5-4 can be easily deployed into existing data centers as the building block of a private cloud or infrastructure-as-a-service (IaaS) implementation. When combined with Oracle Fabric Interconnect and Oracle SDN, Oracle Server X5-4 packs in the most VMs per rack in the industry while enabling fast live migration and cable consolidation. This consolidation can result in 70 percent less I/O complexity and 50 percent cost reduction.

Challenges of Compute Density

Today's IT architects are constantly faced with the challenges of increasing compute density at the expense of serviceability, expandability, and reliability. Oracle Server X5-4 is designed with a holistic approach of engineering hardware and firmware together. This integrated design allows Oracle Server X5-4 to provide a substantial performance improvement over the previous generation while remaining within the same power profile. Specifically, the server design maximizes efficiency, providing the best combination of compute power and density that allows these servers to fit into existing and greenfield data centers.

Rather than optimizing only for compute and memory density, Oracle Server X5-4 allows for the extreme I/O bandwidth and expandability required by enterprise virtualization workloads. This enables customers to consolidate I/O-intensive VMs, such as Oracle Database and applications, without compromising on performance.

Innovative Reliability, Availability, and Serviceability (RAS)

Oracle Server X5-4 is designed completely in house from the ground up and is engineered to be easily serviceable while maximizing reliability. Oracle engineers pay particular attention to the chassis design, which has special features added to improve performance while improving reliability and

serviceability. Oracle engineers have designed a rigorous testing process for all components of the server such as memory DIMMs, hard disk drives, power supplies, and more. These quality assurance tests are supplementary to those conducted by the supplier. All components of the system are required to pass these tests prior to release of the products to market.

Hardware Designed for Advanced RAS

Oracle Server X5-4 is designed for maximum uptime with enterprise-grade availability features. All disks are hot swappable and support RAID 0, 1, 5, 6, 10, 50, and 60. The RAID controller has a 1GB write back cache design and uses an energy storage module to save data in flash upon server power failure. This energy storage module resides in a location in the server that guarantees data protection of the write-back cache for all operating conditions of the server. The power supplies and fans are also redundant and hot swappable, ensuring that a failure to any single component does not affect the running system. With two power supplies, the server offers N+N power redundancy.

Fault Management and Diagnostics

Reliability, availability, and serviceability (RAS) are extremely important to customers who demand maximum system availability when running business-critical applications. If a fault occurs in a server, revenue can be lost and extensive time and effort can be spent debugging the problem and waiting on replacement parts and service personnel to replace faulty components.

With higher levels of integration of various subsystems in the server, it is becoming more complex to diagnose faults down to the component level. A key element of serviceability that is taken into consideration in Oracle Server X5-4 is automatic fault diagnosis with accurate identification of faulty components.

Oracle Server X5-4 includes built-in fault management and diagnostic tools that increase system availability and enable faster service response times that increase server uptime. Oracle Server X5-4 includes Oracle ILOM, which performs advanced health monitoring of the server operating environment (power and cooling), CPUs, and memory subsystems. This advanced diagnosis engine is resident in the embedded service processor firmware and constantly monitors the state of these subsystems without interfering with the functionality of the host. Automatic notifications are generated in the event of problems. Building on the fault management infrastructure, Oracle ILOM has the ability to raise automatic service requests (ASRs). This feature enables service requests to be generated automatically and important fields pre-populated for use by Oracle service personnel. The elimination of human intervention in the service request generation process improves accuracy of problem notification to Oracle.

On a typical server, the host operating system and the service processor have mutually exclusive (although sometimes partially overlapping) subsystems to manage. The host operating system has ownership of the CPU, memory, and I/O subsystems while the service processor presides over the fans, power supplies, DIMMs, and other miscellaneous chassis components. For these reasons, data

center managers are often forced to monitor the health of the host operating system and the service processor as if they were separate entities.

Oracle Server X5-4 overcomes the above limitations by enabling a bidirectional communication path, between Oracle ILOM and Oracle Solaris or Oracle Linux, which facilitates exchange of critical health information between the host and the service processor. Having a dedicated interconnect between the host OS and Oracle ILOM allows a holistic and single view of all problems in a system. Data center managers and administrators can depend on this operating system and hardware integration for complete system diagnosis, eliminating the need to connect to multiple management entities.

Oracle Solaris and Oracle Linux include a set of diagnosis engines that process raw error events from the hardware and provide an automated and intelligent method for problem diagnosis and fault isolation. These engines are part of the Fault Management Architecture feature of Oracle Solaris and Oracle Linux and include a set of agents that respond to fault events, such as off-lining a faulty CPU thread or retiring a memory page on a DIMM. These advanced, self-healing features help reduce unplanned downtime by isolating a problem at runtime and keeping applications running.

Running Oracle Linux or Oracle Solaris on Oracle Server X5-4 ensures maximum system availability by providing early warnings of potential failures, fault visibility and dynamic off-lining of faulty hardware. All of these functions are available at no additional cost.

	Oracle x86 with Oracle Solaris or Oracle Linux	Non-Oracle x86 with third-party OS
Diagnosis of correctable and uncorrectable CPU and memory errors on Intel Xeon processor-based servers	✔	✔
Single view of all hardware problems on the server	✔	✖
Identification of faulty components using the same name that is printed on the chassis or motherboard	✔	✖
Fault indicator (LED) turned on for component and server that has a problem	✔	✖
Automatically generated service request for host diagnosed problems	✔	✖
Validated and quality tested for each new hardware model	✔	✖

Table 1: Benefits of Oracle Solaris and Oracle Linux on Oracle Server X5-4

Oracle's x86, Oracle Linux, and Oracle Software—Engineered To Work Together

Oracle invests heavily in engineering and quality assurance for its Oracle Linux operating system. While many customers choose Oracle Linux to support their mission-critical applications, Oracle Linux is also the principle development platform for Oracle's own database, middleware, and application software. More than 175,000 Oracle Linux installations are deployed on both physical and virtual servers.

Oracle Linux receives more than 128,000 hours of database and application testing each day, which makes Oracle software more reliable. Even before formal evaluation occurs, Oracle Linux is the base platform on which developers prove functionality, quality, and software viability. In addition, Oracle Linux includes Oracle's Unbreakable Enterprise Kernel, a feature that is specifically optimized for the best performance of Oracle software. Oracle engineers extensively test the Unbreakable Enterprise Kernel across Oracle's database, middleware, and application tiers on Oracle's x86 servers and engineered systems to ensure optimum functionality. This extensive testing ensures that the combination of Oracle Server X5-4 with Oracle Linux provides an extremely reliable, robust, and high-performance server for database and enterprise applications.

To streamline the installation of Oracle Linux and Oracle Solaris, Oracle provides Oracle System Assistant, an embedded wizard-style tool that assists with each step of deploying the server. In addition to installing the operating system, Oracle System Assistant updates firmware, drivers, and configures RAID and Oracle ILOM—all of which improves the efficiency of server deployment.

Oracle VM

Oracle offers an enterprise-grade hypervisor and virtualization platform called Oracle VM. Oracle VM Server has been optimized to run best on Oracle hardware through enhancements at the kernel level. Specifically, Oracle VM has been engineered to work well with large CPU and memory configurations and has been designed to handle the large number of processor cores and the memory footprint of Oracle Server X5-4. In addition, Oracle VM and Oracle Linux have been engineered with 10 gigabit Ethernet (GbE) optimizations, InfiniBand improvements, and I/O and block-layer enhancements to both flash and magnetic media that improve application performance and reliability.

Oracle VM Server is also best-tested with Oracle x86 servers. Forming the basis of Oracle's public cloud, which is called Oracle Public Cloud, Oracle VM and Oracle x86 servers are subjected to daily stress testing in production as the infrastructure building blocks that enable 5.5 million cloud users.

Oracle Server X5-4 systems can be provisioned quickly with Oracle software using Oracle VM Templates. Oracle VM Templates provides an innovative approach for deploying a fully configured software stack by offering preinstalled and preconfigured software images. Using Oracle VM Templates eliminates installation and configuration costs and reduces ongoing maintenance costs, helping organizations achieve faster time to market and lower cost of operations. Oracle VM Templates for many key Oracle products is available for download, including Oracle Linux, Oracle Solaris, Oracle Database, Oracle Fusion Middleware, and many more.

Extreme Memory Density

With up to 3 TB of memory per server, Oracle Server X5-4 provides an average of over 40 GB of memory per core. As database and enterprise applications are beginning to require 32 GB or 64 GB of RAM per VM, larger memory capacity is becoming critical. Because of the higher ratio of memory to cores, the Oracle Server X5-4 system allows for optimal consolidation of larger VMs that require more memory.

Calculated at the rack level, Oracle Server X5-4 systems allow for extreme memory density with 42 TB of memory, assuming fourteen systems in a standard 42U rack.

Higher Memory Bandwidth

With over 45 percent more memory bandwidth per socket than Intel's E5-4600 v2 family of processors, the Intel E7-8800 v3 processors offer the best performance for memory-intensive workloads running in virtualized environments. Higher memory bandwidth means that applications start and run more quickly, and databases and other enterprise applications are less likely to have memory bottlenecks.

Maximized I/O

Oracle Server X5-4 is architected to support the growing I/O workloads of virtualized environments and enterprise applications. Each server packs in nine 8-lane PCIe Gen3 slots, two 16-lane PCIe Gen3 slots, and four 10GBase-T Ethernet ports. PCIe slots can be configured with 16 Gb Fibre Channel, QDR dual-port InfiniBand (active-active), and copper or fiber 10 GbE, providing extreme I/O capacity and flexibility.

In addition, Oracle Server X5-4 and Intel Xeon E7-8895 v3 processors are designed with full mesh connectivity between processors. It is never more than one hop between any processor to another, minimizing I/O latency for maximum I/O performance.

Software Defined Networking

When combined with Oracle Virtual Networking, Oracle Server X5-4 is able to offer integrated virtualization of compute and networking resources by extending the virtualization boundary to include I/O. Providing a converged infrastructure whereby network and storage traffic can share and load-balance across the same infrastructure, the Oracle Virtual Network family of products allows for lower overhead and faster live migration when used to build private clouds.

Oracle Fabric Interconnect, part of the Oracle Virtual Networking family, uses InfiniBand as the fabric, reducing cabling and driving 64 Gb/sec of throughput to each I/O slot of the Oracle Server X5-4 system. Once cabled, an organization's private cloud infrastructure can be fully managed and repartitioned through the software-defined networking (SDN) features of Oracle Virtual Networking. Specifically, virtual network interface cards (vNICs) and virtual host bus adapters (vHBAs) are presented to the operating system and can be provisioned and migrated simply—without moving physical cards or cables.

Oracle Virtual Networking is implemented using InfiniBand, which allows live migrations to take place over a single wider, lower latency transport. This translates into live migrations that are nearly 19 times faster compared to live migrations done with traditional Ethernet. Further, Oracle Virtual Networking is

able to provide a granular quality of service that guarantees the required network and storage throughput to a given VM.

Elastic Computing with Oracle Server X5-4

Oracle and Intel have jointly engineered a unique processor SKU, the Intel Xeon E7-8895 v3 processor. This processor has the highest operating frequency of 2.6 GHz of any 18 core E7-88xx v3 SKU stack. Building on the elastic computing feature, first released by Oracle and Intel as part of the E7-88xx v2 release, the E7-8895 v3 has enhanced elastic features.

Elastic computing allows users to configure each processor socket of the server from one through eighteen cores, thereby enabling customers the ability to modulate between the number of active cores and the maximum Turbo Boost frequency. Organizations can choose to run with fewer cores at a higher frequency or more cores at a lower frequency. The desired core setting can be selected at the BIOS menu where it is statically configured, and the system needs to be re-booted to change this setting. For higher levels of dynamic core count control, Oracle Solaris and Oracle Linux have the ability to choose the desired core count at run time. This enables users to switch dynamically between different operating points of the system without rebooting the system. This feature is especially useful when workloads need to switch to batch mode of operation (low core count, high frequency) from high through put mode (high core count) while retaining the data in-memory.

System Design

The Oracle Server X5-4 hardware design has been engineered from the ground up to be best for running Oracle software. It is designed to maximize the number of DIMM slots per processor socket, while at the same time providing the lowest possible latencies between components. Oracle Server X5-4 can be built into either a two-socket or four-socket configuration, with each socket attached to up to twenty four DIMMs.

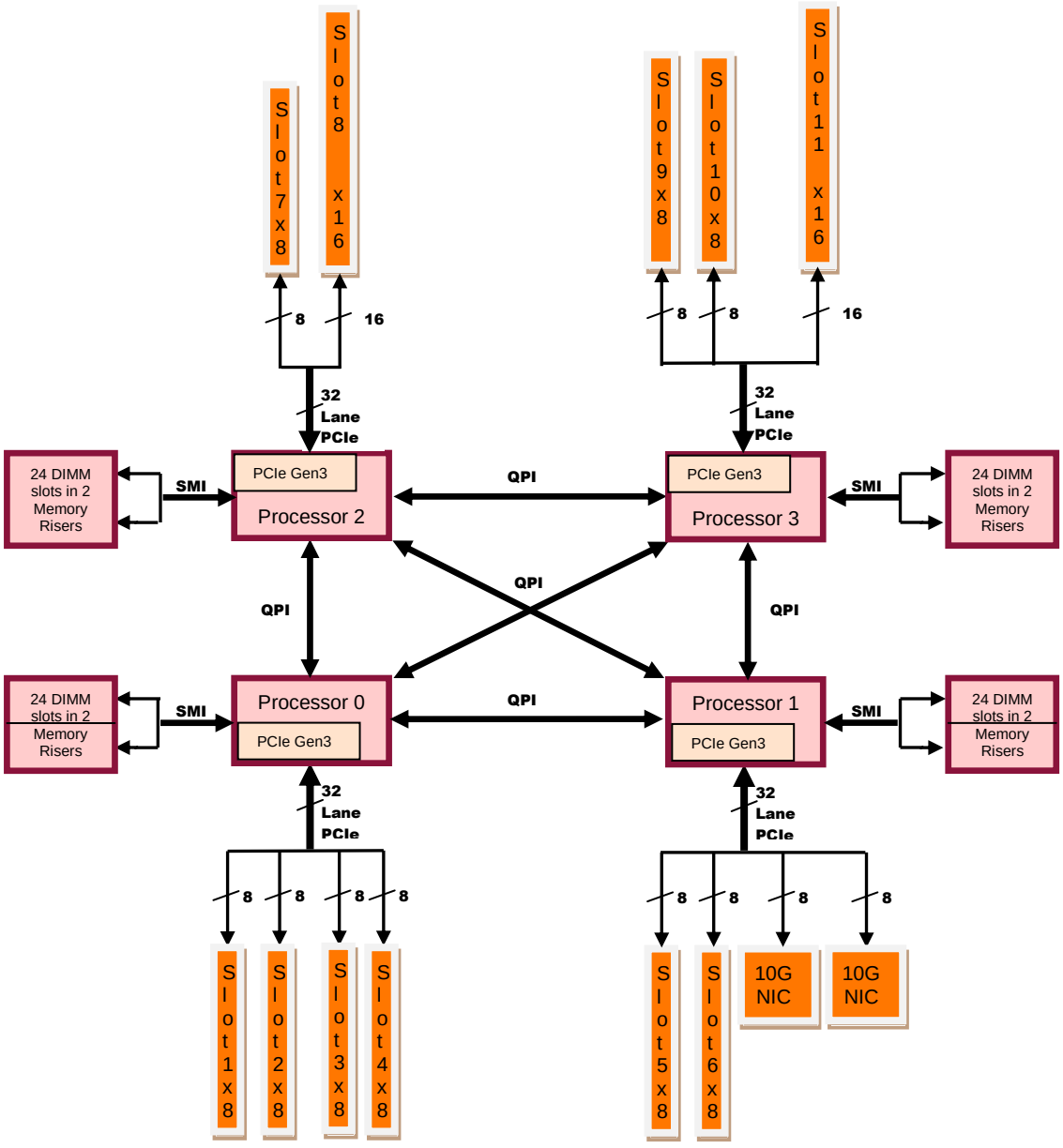

Figure 4. Oracle Server X5-4 system design

The block diagram in Figure 4 shows the direct Intel QuickPath Interconnect (QPI) connections between each processor (P1–P4), such that there is no more than one hop between each. This allows for the lowest possible latency for a given processor to access memory or I/O that is attached to a different processor.

Each processor has a total of four scalable memory interconnect–2 (SMI-2) links that connect to two memory risers. Each memory riser has 12 DIMM slots for a total of 24 DIMM slots per processor. Memory is accessed through a buffer-on-board resident on the memory riser card.

I/O connections are distributed across the four processors. PCIe slots 1–4 are connected to processor 0, with slot 2 being designated for the storage controller HBA. PCIe slots 5 and 6 are connected to processor 1, as well as to the four onboard 10GBase-T Ethernet NICs. In a four-socket configuration only, PCIe slots 7 and 8 are connected to processor 2, and PCIe slots 9–11 are connected to processor 3. PCIe slot 1 will house the NVMe switch card when the system is configured with this option. In a two-socket configuration, PCIe slots 7–11 cannot be used.

Single Pane of Glass Management

Oracle Enterprise Manager 12c is a suite of systems management tools that provides a “single pane of glass” management solution for the entire Oracle stack. This solution enables organizations to manage their Oracle Server X5-4 systems from the hardware layer all the way up to the databases and applications running on them.

Oracle Enterprise Manager Ops Center 12c, part of the Oracle Enterprise Manager family, is an enterprise management tool that allows IT staff to manage all aspects of their servers. In addition to providing detailed hardware monitoring and reporting for hardware problems, Oracle Enterprise Manager Ops Center can provision a bare-metal system with an operating system and also configure virtualization.

Oracle Enterprise Manager Cloud Control 12c, also part of the Oracle Enterprise Manager family, can be used to implement private clouds on Oracle Server X5-4 servers. Oracle Enterprise Manager Cloud Control provides a complete cloud lifecycle management solution enabling organizations to quickly set up, manage, and support enterprise clouds and traditional Oracle IT environments from applications to disk.

Conclusion

Oracle continues to deliver products that simplify IT and reduce operating expenses. Oracle Server X5-4 is designed, optimized and pre-tested for specific Oracle software workloads. The Elastic Computing capability of Oracle Server X5-4 and Intel Xeon E7-8895 v3 processor was co-designed with Intel and provides immediate business value for Oracle customers. Oracle is also uniquely positioned to provide the full solution with Oracle operating systems and database, with features like NVMe SSDs. In addition, Oracle’s x86 servers are the most reliable, highest performing x86 servers on the market, driving simplification through innovation.

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Integrated Cloud Applications & Platform Services

Oracle Server X5-4 System Architecture
July 2016, Version 1.0
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