An Oracle White Paper
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Oracle's Sun Server X4-8 System Architecture

Introduction

Sun Server X4-8, Oracle's new eight-socket x86 server, is part of a family of Oracle x86 servers that are purpose-built to be best for running Oracle software. The new Sun Server X4-8 is a scale-up server optimized for database and enterprise workloads requiring large amounts of memory and compute power. This white paper describes the architecture of the Sun Server X4-8 system.

Product Overview

Sun Server X4-8 provides up to eight Intel® Xeon® E7-8895 v2 processors, each of which contains 15 cores operating at 2.8 GHz with 37.5 MB L3 Cache. Each CPU module houses one Intel Xeon E7-8895 v2 processor along with 24 DIMM slots. The Intel Xeon E7-8895 v2 processor is capable of functioning in many different modes. Building on Intel's Turbo Boost technology, the Sun Server X4-8 system offers customers the ability to modulate between the number of active cores and the maximum Intel Turbo Boost frequency.

Further, the modular design of the Sun Server X4-8 system and its CPU modules ensures forward compatibility of the system with future Intel CPUs. With up to 192 DDR3 low-voltage dual inline memory modules (DIMMs), Sun Server X4-8 provides up to 6 TB of memory and is ideal for running medium-to-large databases entirely in memory.

The system's industry-leading 5U enclosure contains 16 PCIe 3.0 slots (eight 16-lane slots and eight 8-lane slots), eight 2.5-inch drive bays, and four USB ports (two front and two internal). The system supports up to eight SAS-2 hard disk drives (HDDs) or eight SATA-3 solid-state drives (SSDs), allowing for up to 9.6 TB of internal HDD storage or up to 3.2 TB of internal SSD storage. Sun Server X4-8 can also be configured with up to eight Sun Flash Accelerator F80 PCIe Cards for a total of 6.4 TB of internal write-optimized, high-endurance PCIe flash.

Figure 1. Front chassis view

Figure 2. Rear chassis view

The Sun Server X4-8 system is designed for maximum uptime with enterprise-grade availability features. All disks are hot-swappable and support RAID 0, 1, 6, 10, 50, and 60. The power supplies and fans are also redundant and hot-swappable, ensuring that a failure to any single component will not affect the running system. With four power supplies, the system offers N+N power redundancy.

The dual PCIe card carrier (DPCC) is an electro-mechanical subassembly that enables hot-pluggable I/O support to industry-standard low-profile PCIe cards. Each DPCC has one 8-lane and one 16-lane PCIe Gen 3 slot, along with buttons and indicators that allow users to perform I/O hot-plug functions. A number of I/O option cards are supported that enable Ethernet, Fibre Channel, InfiniBand, SAS, and Flash connectivity to the Sun Server X4-8 system.

Each system includes 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. In addition, Sun Server X4-8 comes with Oracle System Assistant, an embedded wizard-style tool that assists with each step of deploying the system, such as checking for firmware updates from Oracle, updating firmware and drivers, configuring RAID and Oracle ILOM, and streamlining operating system installation.

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.

Oracle Linux

Sun Server X4-8 can be combined with one of Oracle's best-in-class operating systems to provide the most reliable, highest-performing combination for database and enterprise applications. Oracle offers its own enterprise Linux, called Oracle Linux. Oracle Linux has been optimized to run best on Oracle hardware through enhancement at all levels including the kernel, which is known as Oracle's Unbreakable Enterprise Kernel.

Specifically, Oracle Linux has been engineered to scale up for large CPU and memory configurations. Further, Oracle Linux has been designed and extensively tested to handle the large number of processor cores and the memory footprint of Sun Server X4-8. In addition, Oracle Linux has been improved with 10 GbE optimizations and I/O and block layer enhancements that improve application reliability and performance.

Oracle Database and the In-Memory Option

Oracle Database runs faster and more reliably when running on Oracle hardware. Sun Server X4-8 has been engineered to work best when running Oracle Database, with optimizations to both the hardware and firmware. Specifically, the storage controller, BIOS, and network interface card (NIC) firmware have been optimized for Oracle Database. Oracle has built in hundreds of enhancements including improvements to cache recovery, path failover, device failure detection, I/O handling, SCSI recovery, and disk failure and recovery.

At Oracle OpenWorld 2013 in San Francisco, Oracle announced the upcoming availability of the Oracle Database In-Memory option—a solution for accelerating database-driven business decision-making to real-time speeds. Unlike specialized approaches that are restricted to particular workloads or applications, the unique approach of the Oracle Database In-Memory option leverages a new in-memory column store format to speed up analytic, data warehousing, and reporting workloads, while also accelerating online transaction processing (OLTP) workloads.

Organizations of all sizes running any application can benefit from real-time analytics performance and acceleration for all workloads. Virtually every existing application that runs on top of Oracle Database will run dramatically faster by simply turning on the new Oracle Database In-Memory feature. By supporting up to 6 TB of memory, Sun Server X4-8 is ideal for running more of the database in memory and taking advantage of the new in-memory features of Oracle Database.

Best for Scale-Up Applications

While many organizations rely on scale-out architectures for their web and virtualization tiers, large scale-up architectures remain the optimal choice for organizations that need extreme performance for specific enterprise applications. Because Sun Server X4-8 provides hundreds of threads and industry-leading memory density, it is the ideal x86 platform for scale-up applications that require large amounts of memory and I/O executing on a single-instance operating system.

Extreme CPU Performance

With up to eight Intel Xeon E7-8895 v2 processors, Sun Server X4-8 provides up to a total of 120 cores in a 5U enclosure. In addition to having the highest core count of any Intel processor, each processor contains 37.5 MB of shared L3 cache, which is also the highest for any Intel processor. With integrated PCIe 3.0 and Intel Turbo Boost 2.0 technology, the Intel Xeon E7-8895 v2 processors provide extreme performance and elasticity.

Very Large Memory Footprint

With up to 6 TB of memory, the Sun Server X4-8 system provides an average of over 51 GB of memory per core. This enables applications to have access to a large amount of memory as well as memory bandwidth. The system's large memory footprint and bandwidth are well suited to run memory-intensive applications such as financial trading applications, batch processing workloads, and applications that require large amounts of simulation or computation.

Glueless Architecture

Oracle designed Sun Server X4-8 with a "glueless" architecture in which the number of hops from any processor to any other processor is a maximum of two, as compared to as many as three hops for designs using a "glued" approach. Using a spoke-and-wheel connectivity pattern, the glueless design enables the fastest possible performance for database and enterprise applications, because it minimizes the latency for shared-memory access.

Figure 3. Glueless architecture

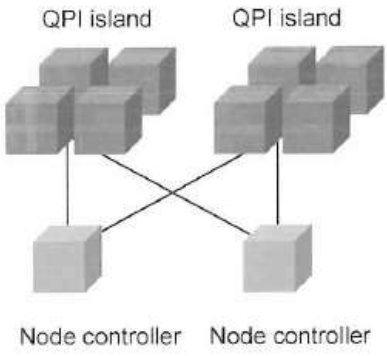

Figure 4. Glued architecture

In addition, a glueless architecture removes the need for a node controller. Eliminating the node controller saves on power and improves reliability. The power savings come from reducing the number of components needed to interconnect the processors. The reliability enhancements are realized by eliminating non-Intel components in the interprocessor communication path.

Node controllers typically need to change from one processor generation to another because of changes to coherency link protocols and other modifications to interprocessor communication. The elimination of the node controller enables Oracle to offer a future-proof chassis that will support three processor releases from Intel.

Elastic Computing with Sun Server X4-8

Sun Server X4-8 offers a new elastic computing capability that dramatically reduces operating expenses. While Intel provides a wide range of processor SKUs, each SKU has historically offered only a fixed combination of core count, operational frequency, and power consumption. Customers have, therefore, been forced to make tradeoffs when they select a particular processor SKU and they've had to base their selection on a particular workload that needs to be known upfront.

Oracle and Intel worked jointly to define a new processor SKU, the Xeon E7-8895 v2 processor, that has unique characteristics and effectively combines the capabilities of three different Xeon processor SKUs into a single processor SKU. This processor SKU is the only one offered on Sun Server X4-8.

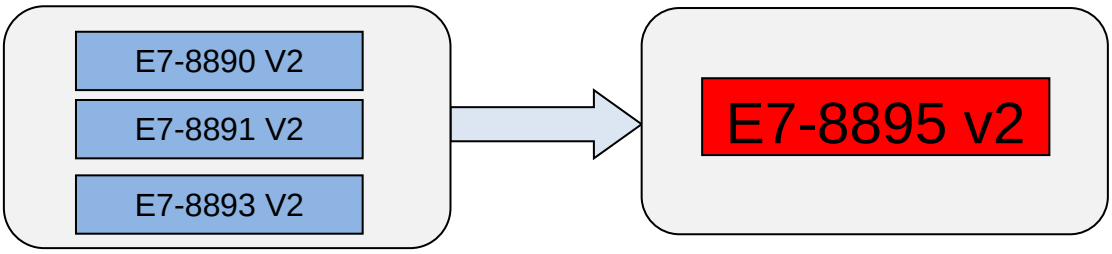

Figure 5. Elastic computing with a single processor SKU

The Xeon E7-8895 v2 processor has been designed to span the performance characteristics of the three processor SKUs shown in the box on the left side of Figure 5. Oracle system design engineers worked closely with the operating system development teams to achieve the ability to transform the core count and operating frequency of the Xeon E7-8895 v2 processor to vary with time without the need for a system level reboot. This simplifies the process of determining system configuration, streamlines the purchasing process, and decreases the system management overhead through dynamic repurposing of common assets. In addition, power consumption is reduced by maximizing CPU utilization.

Along with the new processor SKU, enhancements have been made to the system BIOS, Oracle Solaris, and Oracle Linux, which allow the processors in the system to dynamically clock up to faster speeds as cores are disabled and to reach higher maximum turbo frequencies for the remaining active cores.

Building on Intel's Turbo Boost technology, Oracle's Sun Server X4-4 and Sun Server X4-8 systems offer 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, all while staying within the same power profile.

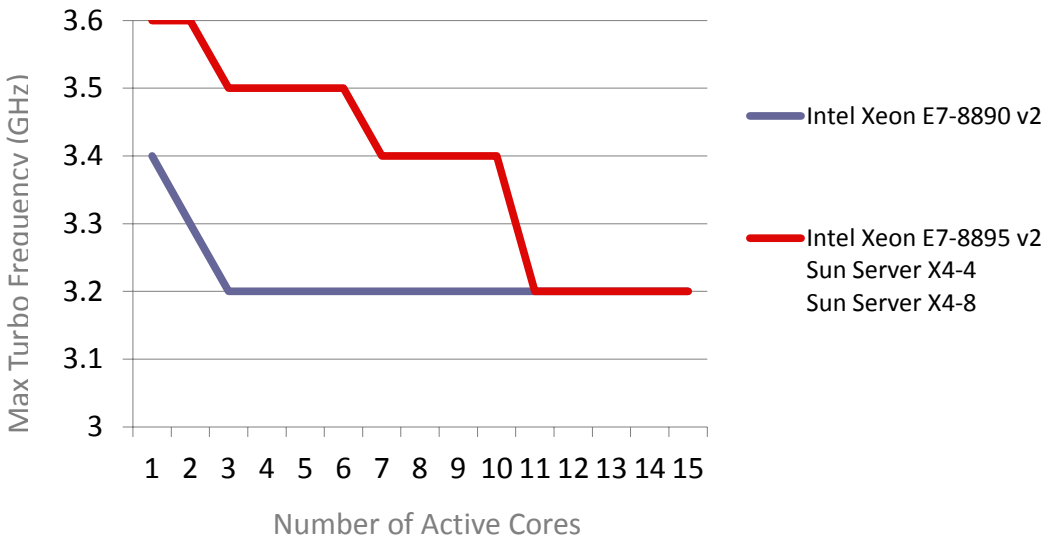

Figure 6. Comparison of Intel Xeon E7-8895 v2 processor to Intel Xeon E7-8890 v2 processor

This single processor SKU can adapt to the requirements of different workloads based on its runtime configuration. For example, the processor can be configured for transaction processing at a higher speed for one hour and then be switched to higher core counts for the next hour for higher throughput computing.

System Design

Sun Server X4-8 is a fully modular system, engineered to be easily serviceable. The eight sockets are connected through a passive midplane that maximizes availability and allows for maximum intersocket bandwidth. Sun Server X4-8 can be configured in either a four-socket or eight-socket configuration, with each socket attached to up to 24 DIMMs.

Each CPU module (CMOD) contains a single Intel Xeon E7-8895 v2 processor and 24 DIMM slots. The processor in each CMOD connects to a total of four memory buffers with six DIMM slots attached to each buffer. The CMODs are located just behind the front fans and are front-panel-accessible by removing the fans.

In the rear of the chassis is a single system module (SMOD) that houses the peripheral control hub functions, the Oracle ILOM service processor, and a PCIe slot for RAID storage HBA connectivity to drive bays. The SMOD also provides connectivity with one VGA, one management, one serial, two USB 2.0, and two GbE ports in the rear of the chassis. Also in the rear are eight hot-swap-capable disk drive bays.

The dual PCIe card carriers (DPCCs) that hold standard low-profile PCIe cards are rear-accessible and, when inserted, sit directly behind a CMOD such that each of the eight CMODs corresponds to one of the eight DPCC modules, respectively.

Cooling for Sun Server X4-8 is front to back using eight variable speed, dual counter rotating fan assemblies mounted in the front of the system.

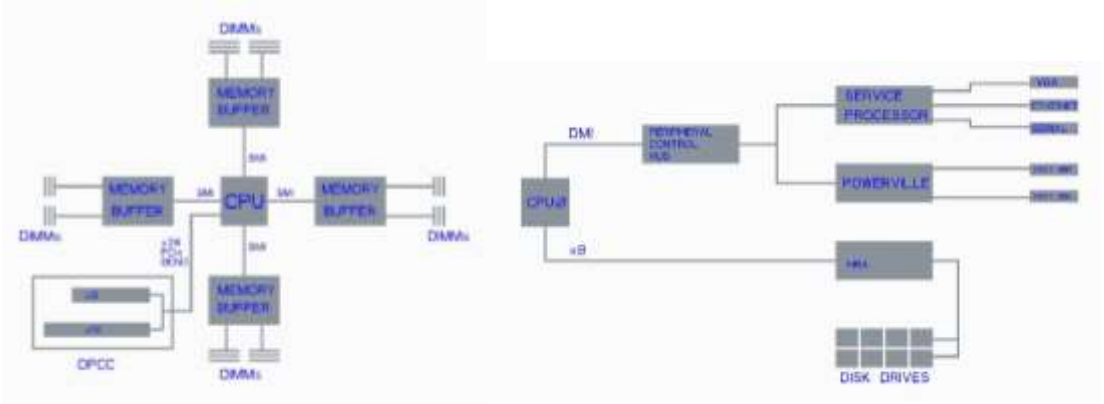

Figure 7. Sun Server X4-8 System Block Diagram

Figure 7 shows the system block diagram and the connections between each CPU to the DIMMs through a memory buffer. Each CPU is connected in a glueless design such that there are never more than two hops between each processor, which allows for the lowest possible latency for a given processor to access memory or I/O that is attached to a different processor.

I/O connections are distributed across the eight processors. Because each CMOD has a corresponding DPCC that holds the PCIe slots, each processor is directly connected to one 16-lane and one 8-lane PCIe slot. In addition, processor 0 (CPU0) interfaces with the eight disk slots in the SMOD.

Engineered for Upgradeability

The eight-socket chassis that holds the components for the Sun Server X4-8 system is designed to remain unchanged for three generations of eight-socket servers from Oracle. When Intel releases updated Intel Xeon processors in the future, the CMODs and SMOD are the only components that will need to be upgraded.

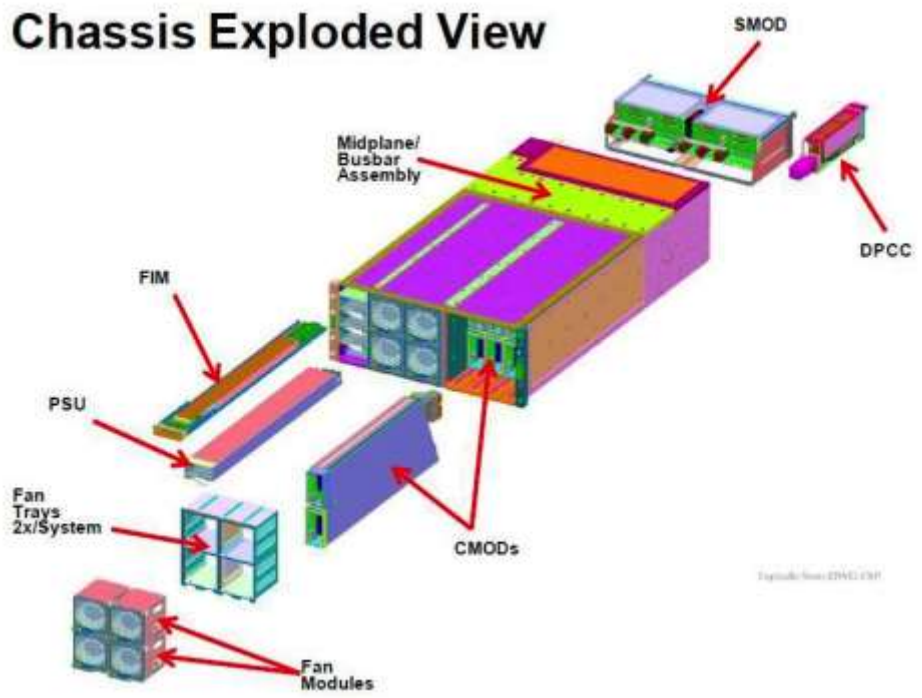

Figure 8. Chassis exploded view

For organizations, this means that a fork-lift upgrade is not necessary in order to take advantage of the latest processors. In fact, the chassis can remain in the rack with cables connected because the CMODs are front-accessible and removable. In addition, the SMOD can also be upgraded without removing or disconnecting the chassis.

Single Pane of Glass Management

Oracle Enterprise Manager 12*c* is a suite of systems management tools that provides a single-pane-of-glass management solution for the entire Oracle stack. This enables organizations to manage their Sun Server X4-8 systems from the hardware layer all the way up to the database and applications running on them.

Oracle Enterprise Manager Ops Center 12*c*, 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 12*c*, also part of the Oracle Enterprise Manager family, can be used to implement a private cloud on Sun Server X4-8 systems. Oracle Enterprise Manager Cloud Control provides a complete cloud lifecycle management solution enabling customers 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. Sun Server X4-8 is designed, optimized and pre-tested for specific Oracle software workloads. The new Elastic Computing capability on Sun Server X4-8 was co-designed with Intel and provides immediate business value for Oracle customers. Oracle is uniquely positioned to provide the full solution for elastic computing with the ability to co-engineer the system design with Oracle operating systems and database. In addition, Oracle's x86 servers are the most reliable, highest performing x86 servers on the market, driving simplification through innovation.

More information about Oracle's x86 systems can be found at oracle.com. Or, an Oracle representative can be reached at +1.800.ORACLE1.

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