Oracle Server X6-2 System Architecture

ORACLE WHITE PAPER | DECEMBER 2016

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Introduction

Oracle Server X6-2 is the newest addition to Oracle's family of x86 servers that are purpose-built to be the most secure, reliable, and highest performance 2-socket servers for running Oracle software. The new Oracle Server X6-2 1U system is the optimal platform for running enterprise applications in virtualized environments and Oracle Database in a clustered configuration with Oracle Real Application Clusters (Oracle RAC) and other clustered database solutions.

Product Overview

Oracle Server X6-2 supports up to two Intel® Xeon® E5-2600 v4 processors; each has up to 22 cores and up to 55 MB L3 cache. With 24 DDR4-2400 dual inline memory module (DIMM) slots, the server provides up to 1.5 TB of main memory. Memory bandwidth increases to 2400 MT/sec per channel compared to 2133 MT/sec in the previous generation.

In addition, Oracle Server X6-2 has four PCIe Gen3 slots (two 16-lane and two 8-lane slots), four 10GBase-T ports, six USB ports, and eight 2.5-inch drive bays providing 9.6 TB of hard disk drive (HDD) storage or 3.2 TB of solid-state drive (SSD) storage. Oracle Server X6-2 can also be configured with up to four NVM Express (NVMe) drives from Oracle for a total of 12.8 TB of high-performance, high-endurance PCIe flash. An optional DVD drive is supported to allow local access for operating system installation.

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 cyberattacks.

One example of such a cyberattack 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 Server X6-2 systems are ideal x86 platforms for running 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 has delivered world-record benchmark results. Oracle's comprehensive, open standards–based x86 systems provide the best platform on which to run Oracle software with enhanced reliability for data center environments.

In today's connected world, vast amounts of unstructured data flow into an enterprise, creating an immediate business need to extract query-able structured datagrams from this slew of information. Online transaction processing (OLTP) is a technology that historically has been used for traditional enterprise applications such as enterprise resource planning (ERP) and human capital management (HCM). Now OLTP is in a unique position to accelerate business intelligence and analytics. As such, this places greater demands on the database, I/O, and 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), non-uniform memory access (NUMA) memory architectures, and tiered storage of data that enhance system performance.

Benefits include increased transaction throughput and improved application response times, which reduce the overall cost per transaction.

Oracle Server X6-2, NVM Express, and Database Smart Flash Cache

Oracle Database incorporates a feature called Database Smart Flash Cache. Oracle Linux and Oracle Solaris have the ability to automatically detect the location and size of flash in a server 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.

Oracle Server X6-2 supports NVMe SSDs that provide a high-bandwidth, low-latency PCI Express (PCIe) interface to large amounts of flash within the system. Oracle Database with Database Smart Flash Cache is specifically engineered to take advantage of these NVMe devices when configured into Oracle Server X6-2. Further, the NVMe device drivers in Oracle Solaris and Oracle Linux are coengineered with Oracle Server X6-2 to enable hot-plug capabilities that decrease downtime of the server.

When using the Database Smart Flash Cache feature of Oracle Database 12*c* in combination with the NVMe SSDs, Oracle Server X6-2 accelerates access to shared storage by keeping recently accessed data in direct-attached flash drives. This reduces the frequency of data access from slower network-attached storage (NAS) or storage-attached networks (SAN).

Traditional SSDs with a SAS/SATA interface are a popular method of adding flash to a server, and these devices take advantage of legacy storage controllers and disk cage infrastructure. NVMe eliminates the performance bottlenecks of using conventional storage interfaces. NVMe flash drives in Oracle Server X6-2 provide a high-bandwidth, low-latency flash implementation that vastly improves OLTP transaction times.

Oracle-Unique NVMe Design and Database Smart Flash Cache

Figure 1 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 the PCIe protocol to the SAS protocol to allow the server to read and write the SAS-3 SSD. Because NVMe SSDs already use the PCIe protocol, there is no need for the PCIe-to-SAS controller translation, as shown in Figure 2.

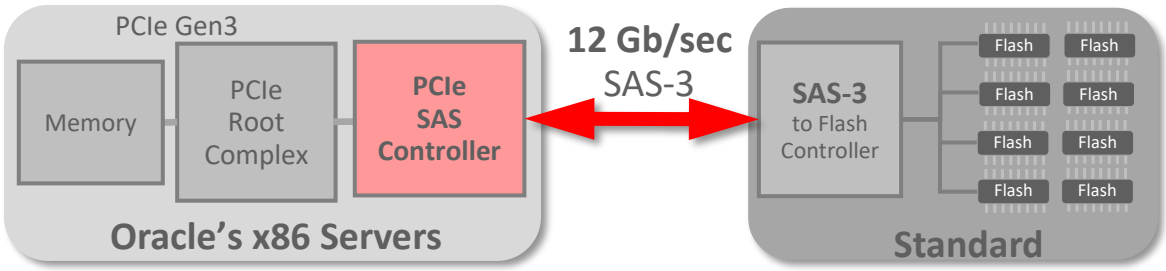

Figure 1. Traditional SAS-3 solid-state drive architecture

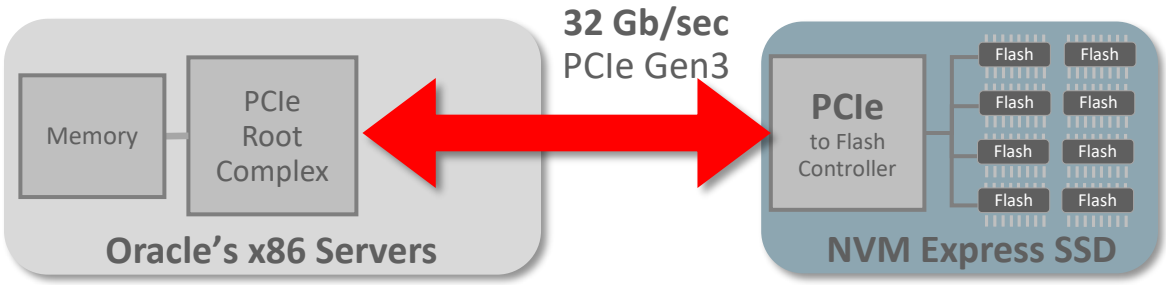

Figure 2. Oracle's NVMe solid-state drive architecture

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

Oracle Server X6-2 can be configured with up to four 3.2 TB NVMe small form factor (SFF) SSDs each.

Because flash technologies are temperature sensitive, most high-performance flash drives will throttle down their 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 the server's Oracle ILOM service processor (SP) to ensure the drives maintain optimum operating temperature. Oracle ILOM modulates the fan speed to ensure sufficient cooling for maximum system performance at all times. The benefits of this are that the server consistently operates at maximum performance across its full operating temperature range while simultaneously maximizing drive endurance.

Agility, Performance, and Reliability with Oracle Real Application Clusters

Designed as an optimal server for running Oracle Database in a clustered configuration, Oracle Server X6-2 can be combined with Oracle Real Application Clusters (Oracle RAC) to achieve high availability, performance, and agility.

Oracle RAC provides a unique technology for scaling out and executing database transactions in a cluster of servers. Traditionally, when database servers run out of capacity, they are replaced with new, larger, more expensive servers. However, for databases using Oracle RAC, there are alternatives for increasing capacity. Oracle Server X6-2 packs up to 44 CPU cores and 1.5 TB of memory into a compact 1U form factor and provides a high-performance, resilient, and scalable building block for the cluster. Adding additional servers to the pool allows the load on the system to be balanced across all servers, hence improving the overall performance.

The firmware for the SAS controller, NVMe drives, and network interface cards (NICs) is optimized to ensure maximum performance and reliability. A reliable and low-latency network is crucial in an Oracle RAC environment

because different servers share common data. The NIC firmware of Oracle Server X6-2 has been optimized to minimize the processing overhead of keep-alive messages between nodes in a cluster, further improving system performance and uptime.

The reliability of Oracle Server X6-2 is fundamental to a robust Oracle RAC configuration. For example, if one node of a two-node Oracle RAC configuration goes down, there is a loss of redundancy in the cluster that compromises availability and impacts overall performance. Oracle Server X6-2 provides the highest level of reliability in the market and is an excellent choice for two-node Oracle RAC configurations. Advanced fault management capabilities built into Oracle ILOM work in conjunction with Oracle Linux and the embedded hardware features to identify component-level issues and move faulty subsystems offline. Oracle is committed to making R&D investments for maximizing the reliability of this stack (Oracle Database on Oracle Linux on Oracle x86 servers) because all of Oracle's engineered systems and Oracle Public Cloud are built on this exact stack. Successful implementation of these capabilities enables Oracle to provide far superior and differentiated service-level agreements to its cloud and engineered systems customers. Therefore, customers who deploy this stack of Oracle Database on Oracle Linux on Oracle Server X6-2 benefit directly from the investments made by Oracle in these technologies.

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 X6-2 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 actually 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 because 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 such as Oracle Fabric Manager and Oracle Enterprise Manager 12*c*, allow customers to benefit from simplifications for 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 X6-2 strikes an ideal balance for virtualized environments: its high VM consolidation factor provides a simplified infrastructure while at the same time providing a cost-effective means for scaling out.

With up to 106 Gb/sec of raw I/O bandwidth, combined with the high core and memory density, Oracle Server X6-2 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 X6-2 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 X6-2 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 a 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 X6-2 is designed with a holistic approach of engineering hardware and firmware together. This integrated design allows Oracle Server X6-2 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, which allows this server to fit into existing and Greenfield data centers.

Rather than optimizing only for compute and memory density, like many commodity two-socket servers, Oracle Server X6-2 allows for the extreme I/O bandwidth and expandability required for enterprise virtualization workloads. This enables customers to consolidate I/O-intensive VMs, such as those running Oracle Database and applications, without compromising performance.

Innovative Reliability, Availability, and Serviceability (RAS)

Oracle Server X6-2 is designed completely in-house from the ground up and is engineered to be easily serviceable while maximizing reliability. Oracle engineers paid particular attention to the chassis design, which has special features to improve performance while also 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 so on. These quality assurance tests are supplementary to those conducted by the component suppliers. All components of the system have to pass these tests prior to release of the product to market.

Hardware Designed for Advanced RAS

Oracle Server X6-2 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 1 GB write-back cache design and uses an energy storage module to save data in flash upon a 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.

The chassis and motherboard are designed to eliminate as many cables as possible; for example, the power supplies mate directly to connectors on the motherboard, eliminating a power distribution cable and a single point of failure. The fans also mount directly to the motherboard, eliminating cables, and hence improving reliability. All disks are front accessible and hot swappable including the NVMe SFF drives.

Fault Management and Diagnostics

RAS is 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 at an estimated industry average rate of USD 7,900 per/minute along with extensive time and effort spent on recovery activities.

With higher levels of integration among 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 X6-2 is automatic fault diagnosis with accurate identification of faulty components.

Oracle Server X6-2 includes built-in fault management and diagnostic tools that increase system availability and enable faster service response times that increase server uptime. Oracle Server X6-2 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 to be prepopulated for use by Oracle service personnel. The elimination of human intervention in the service request generation process improves the 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 that they 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 X6-2 overcomes the above limitations by enabling a bidirectional communication path between Oracle ILOM and Oracle Solaris or Oracle Linux that 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 X6-2 ensures maximum system availability by providing early warnings of potential failures, fault visibility, and dynamic off-lining of faulty hardware. Analysis has shown that running Oracle Database on Oracle Linux on Oracle x86 servers provides customers with over 30 percent higher uptime than running Oracle Database on a third-party stack of Linux and x86 servers.

All of the functions mentioned above are available at no additional cost.

TABLE 1: BENEFITS OF ORACLE SOLARIS AND ORACLE LINUX ON ORACLE SERVER X6-2

	Oracle x86 Server with Oracle Solaris or Oracle Linux	Non-Oracle x86 Server 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	✓	✗

Oracle's x86 Servers, 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 globally, proving the popularity of this operating system.

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 X6-2 with Oracle Linux provides an extremely reliable, robust, and high-performance server for database and enterprise applications.

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 Oracle Server X6-2 servers 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, a feature of Oracle Enterprise Manager 12*c*, can be used to implement a private cloud on Oracle Server X6-2. Oracle Enterprise Manager Cloud Control provides a complete cloud lifecycle management solution enabling users to quickly set up, manage, and support enterprise clouds and traditional Oracle IT environments from applications to disk.

Conclusion

Because business success often depends closely on enterprise applications, IT departments strive to provide an optimal software and hardware infrastructure—one that delivers responsive performance, scalable capacity, and "always-on" availability. Oracle Server X6-2 is designed to simplify field installation, reduce cabling, minimize power consumption, maximize system uptime, and improve compute density, making it an ideal choice for system deployment.

Oracle Server X6-2 is also the best two-socket server for running Oracle Database in a clustered configuration and for high-density virtualization environments that require an optimal balance among core density, memory footprint, and I/O bandwidth.

The key new features incorporated in Oracle Server X6-2—such as the high-bandwidth, low-latency NVMe flash drives; SAS-3 SSDs; and DDR4 memory—significantly improve the performance over the previous generation. Combining these features with built-in, proactive fault detection and advanced diagnostics ensures Oracle Server X6-2 provides extreme reliability for enterprise workloads.

Oracle's x86 systems serve as a key building block for Oracle's engineered systems, such as Oracle Exadata, which have achieved a 10x performance gain through integration and optimization. These optimizations have been incorporated into the design of Oracle Server X6-2 further improving its performance and reliability—making it an ideal choice for enterprises that value the quality, system availability, and server efficiency that result in reduced total cost of ownership.

In addition Oracle Server X6-2 is a strategic building block for Oracle Public Cloud. This server's advanced security, reliability, and performance ensure that Oracle delivers an outstanding customer experience for software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS).

More information about Oracle Server X6-2 can be found at: http://www.oracle.com/goto/X6-2 or an Oracle representative can be reached at +1.800.ORACLE1.

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December 2016