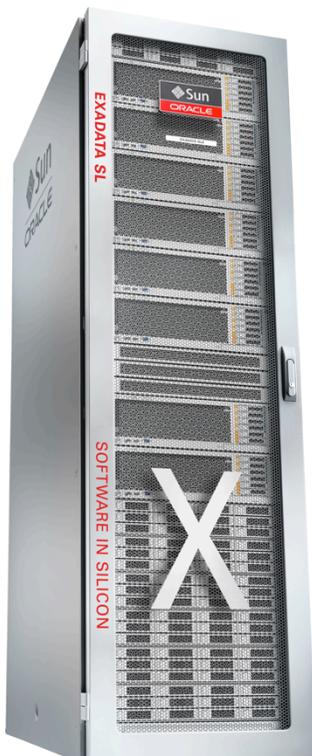


ORACLE EXADATA DATABASE MACHINE SL6

All the Benefits of Exadata Combined with Ultra-Fast SPARC Processors running Linux



The Oracle Exadata Database Machine is engineered to deliver dramatically better performance, cost effectiveness, and availability for Oracle databases. Exadata features a modern cloud-based architecture with scale-out high-performance database servers, scale-out intelligent storage servers with state-of-the-art PCI flash, and an ultra-fast InfiniBand internal fabric that connects all servers and storage. Unique software algorithms in Exadata implement database intelligence in storage, compute, and InfiniBand networking to deliver higher performance and capacity at lower costs than other platforms. Exadata runs all types of database workloads including Online Transaction Processing (OLTP), Data Warehousing (DW), In-Memory Analytics as well as consolidation of mixed workloads. Simple and fast to implement, the Exadata Database Machine powers and protects your most important databases.



Since the 2008 debut of Exadata, Intel x86 processors have powered Exadata database servers. The Exadata Database Machine SL6 is nearly identical to the Intel based Exadata, except it uses Oracle SPARC T7-2 database servers based on the SPARC M7 processor. SPARC M7 is the world's most advanced processor to run Oracle databases, and the first to use a revolutionary technology from Oracle referred to as **Software in Silicon**. Software in Silicon technology is a breakthrough in microprocessor and server design, enabling databases to run faster and with unprecedented security and reliability. Even though the database servers are based on SPARC processors, Exadata SL6 runs the exact same Linux Operating System as x86-based Exadata systems.

Software in Silicon: Breakthrough Performance and Security

Software in Silicon is comprised of three very unique technology offerings: SQL in Silicon, Capacity in Silicon and Security in Silicon.

The SPARC M7 processor incorporates 32 on-chip Data Analytics Accelerator (DAX) engines that are specifically designed to speed up analytic queries. The accelerators offload in-memory query processing and perform real-time data decompression; capabilities that are also referred to as **SQL in Silicon** and **Capacity in Silicon**, respectively. The DAX SQL in Silicon processors accelerate analytic queries by

KEY FEATURES

- Up to 640 CPU cores and 10TB memory per rack for database processing
- Up to 320 CPU cores per rack dedicated to SQL processing in storage
- From 2 to 10 Database Servers per rack
- From 3 to 16 Storage Servers per rack
- Up to 410 TB of flash capacity (raw) per rack
- Up to 1.54 PB of disk capacity (raw) per rack
- Hybrid Columnar Compression often delivers 10X-15X compression ratios
- 40 Gb/second (QDR) InfiniBand Network
- Complete redundancy for high availability

KEY BENEFITS

- Pre-configured, pre-tested system optimized for all database applications
- Uncompressed I/O bandwidth of up to 280 GB/second per full rack equivalent, from SQL
- Ability to perform up to 6.9M 8K database read I/O operations, or 6.3M 8K flash write I/O operations per second per full rack equivalent
- Easily add compute or storage servers to meet the needs of any size application
- Scale by connecting multiple Exadata Database Machine SL6 racks or Exadata Storage Expansion Racks. Up to 18 racks can be connected by simply adding InfiniBand cables and using internal switches. Larger configurations can be built with external InfiniBand switches

independently searching and filtering columns of data while the normal processor cores run other functions. Using Capacity in Silicon processors perform data decompression at full memory speeds, allowing large volumes of data to be kept in compressed format without incurring processing overhead.

The **Security in Silicon** functions of SPARC M7 continuously perform validity checks on every memory reference made by the processor without incurring performance overhead. Security in Silicon helps detect buffer overflow attacks made by malicious software, and enable applications such as the Oracle Database to identify and prevent erroneous memory accesses. The Security in Silicon technologies also encompass the cryptographic instruction accelerators, which are integrated into each processor core of the SPARC M7 processor. These accelerators enable high-speed encryption for more than a dozen industry-standard ciphers.

Engineered System for Fast and Reliable Deployment

The Exadata Database Machine is an easy to deploy system that includes all the hardware needed for running Oracle Databases. The database servers, storage servers and network are pre-configured, pre-tuned and pre-tested by Oracle experts, eliminating weeks or months of effort typically required to deploy a mission critical high performance system. Extensive end-to-end testing ensures all components including database software, OS, firmware, drivers, etc. work seamlessly together and there are no performance bottlenecks or single points of failure that can affect the complete system.

Because all Exadata Database Machines are identically configured, customers benefit from the experience of thousands of other users that have deployed the Exadata Database Machine for their mission critical applications including most of the top Banks, Telecoms, and Retailers in the world. Customer machines are also identical to the machines Oracle Support uses for problem identification and resolution, the machines Oracle Engineering uses for development and testing of Oracle Database, and the machines Oracle uses to implement its own SaaS and PaaS public cloud. Hence, **Exadata is the most thoroughly tested and tuned platform for running Oracle Database, and is also the most supportable platform.**

The Oracle Exadata Database Machine runs the standard Oracle Database. Therefore, **any application that uses the Oracle Database today can be easily and seamlessly migrated to use the Exadata Database Machine with no changes to the application.** Databases can also be easily migrated off of Exadata eliminating any fear of “lock-in”.

Customers thinking of deploying databases on the Public Cloud, now or in the future, can be confident that **Exadata provides 100% compatibility between on-premises and public cloud** enabling easy migration to the public cloud and simple hybrid cloud deployments.

Extreme System Scalability and Growth with Elastic Configurations

The Exadata Database Machine uses a **scale-out architecture for both database servers and storage servers.** As an Exadata Database Machine grows, database CPUs, storage, and networking can be added in a balanced fashion ensuring scalability

RELATED PRODUCTS

- Oracle Database Exadata Cloud Service
- Oracle Database Exadata Cloud Machine
- Oracle Exadata Database Machine X6-2
- Oracle Exadata Database Server X6-2 Plus InfiniBand Infrastructure
- Oracle Exadata Storage Expansion Rack X6-2
- Oracle Exadata Storage Server X6-2 Plus InfiniBand Infrastructure
- Oracle SuperCluster
- Oracle Database 12c
- Real Application Clusters
- Partitioning
- Multitenant
- Database In-Memory
- Advanced Compression
- Advanced Security
- Active Data Guard
- GoldenGate
- Real Application Testing
- OLAP
- Advanced Analytics
- Business Intelligence
- Enterprise Manager
- Oracle Linux

RELATED SERVICES

The following services are available from Oracle:

- Advanced Customer Services
- Oracle Premier Support for Systems
- Oracle Platinum Services
- Consulting Services
- Oracle University courses

“I would recommend Exadata as a platform for performance, reliability and ease of support. Those three things mean very much to me in my daily life.”

*- Richard Ewald
Senior Technical Architect
Sprint*

without bottlenecks.

The scale-out architecture accommodates any size workload and allows seamless expansion from small to extremely large configurations while avoiding performance bottlenecks and single points of failure.

A high-bandwidth low-latency 40 Gb/second **InfiniBand network** connects all the components inside an Exadata Database Machine. Specialized database networking protocols run over the InfiniBand network and provide **much lower latency and higher bandwidth** communication than is possible using generic communication protocols. This enables both faster response time for OLTP operations, and higher throughput for analytic workloads. External connectivity to the Exadata Database Machine is provided using standard 10 Gigabit Ethernet.

Exadata Database Machine is the most versatile database platform. The Exadata SL6 Database Machine uses powerful database servers, each with two 32-core SPARC M7 processors and 256 GB of memory (expandable up to 1TB). Exadata also uses scale-out, intelligent storage servers that appear in two configurations – High Capacity (HC) or Extreme Flash (EF). HC Storage Servers have four PCI Flash cards each with 3.2 TB (raw) Exadata Smart Flash Cache and twelve 8 TB 7,200 RPM disks. EF Storage Servers have an all-Flash configuration with eight PCI Flash drives, each with 3.2 TB (raw) storage capacity. The starting configuration of an Exadata Database Machine consists of two database servers and three storage servers, which can be elastically expanded by adding more database and/or storage servers as requirements grow. Elastic configurations provide an extremely flexible and efficient mechanism to expand computing power and/or storage capacity to meet any business need.

In addition to upgrading within a rack, **multiple racks can be connected using the integrated InfiniBand fabric** to form even larger configurations. For example, a system composed of four racks is simply four times as powerful as a single rack system - providing quadruple the I/O throughput, quadruple the storage capacity, and quadruple the processing power. It can be configured as a large single system or logically partitioned for consolidation of multiple databases. Scaling out is easy with Exadata Database Machine. Oracle Real Application Clusters (RAC) can dynamically add more processing power, and Automatic Storage Management (ASM) can dynamically add more storage capacity.

When even larger storage capacity is required, the **Oracle Exadata Storage Expansion Rack** is available. The Exadata Storage Expansion Rack enables you to grow the storage capacity and bandwidth of any Exadata Database Machine. It is designed for database deployments that require very large amounts of data, including historical or archive data, backups, documents, images, XML, JSON and LOBs. The storage expansion rack connects to the Exadata Database Machine using the integrated InfiniBand fabric and is extremely simple to configure, as there are no LUNs or mount points. Storage is configured and added to a database online with a few simple commands. The starting configuration of the Oracle Exadata Storage Expansion Rack consists of four storage servers and can be further expanded by adding additional storage servers.

Exadata Database Machines protect your investment by allowing **newer generation servers and storage to be deployed seamlessly into existing Exadata Database Machines**. Similarly, new software releases are compatible with most previous

generation Exadata Database Machines.

Extreme Flash Storage Server: Record-breaking I/O Performance

Exadata **Extreme Flash (EF) Storage Server**, first introduced with Exadata X5, is the foundation of a database-optimized all-flash Exadata Database Machine. Each EF Storage Server contains eight 3.2 TB state-of-the-art Flash Accelerator F320 PCI flash drives, offering 25.6TB raw flash capacity per EF Storage Server. Exadata SL6 uses state-of-the-art 3D V-NAND flash technology for improved speed, power efficiency, and endurance compared to previous generations of Flash. The enterprise grade flash used in Exadata SL6 have an expected endurance of 8 years or more for typical database workloads. This is very different from consumer grade flash that can potentially experience performance degradations or fail unexpectedly after a few years of usage. In addition, Exadata delivers ultra-high performance by placing the flash devices directly on the high speed PCI bus rather than behind slow disk controllers and directors. Finally, Exadata flash uses the latest NVMe (Non-Volatile Memory Express) flash protocol to achieve extremely low latency and CPU overhead.

Flash performance is often limited and bottlenecked by traditional storage architecture. In contrast, Exadata uses a combination of scale-out storage, InfiniBand networking, database offload, and PCI flash to deliver extremely high performance rates from flash. An elastic configuration of Exadata Database Machine SL6, with 8 database servers and 14 Extreme Flash storage servers, can achieve up to **280 GB per second of analytic scan bandwidth from SQL**, and **0.25 ms Database I/O latency at 2.4 Million Flash IOPS** when running database workloads. In addition this configuration can achieve up to **6.9 Million random 8K database read and 6.3 Million random 8K flash write I/O operations per second (IOPS)**, which is an industry record for database workloads. This performance scales as more racks are added.

This performance is orders of magnitude faster than traditional storage array architectures, and is also much faster than current all-flash storage arrays. It is important to note that these are real-world end-to-end performance figures measured running SQL workloads with realistic I/O sizes inside a single rack Exadata system. They are not component-level measurements based on low-level I/O tools.



Fig 1: Flash Accelerator F320 PCIe Card

“Oracle Exadata enabled seamless and rapid migration of our cloud-based, integrated business applications, required no major modifications, and helped us reduce costs. With Oracle, we dramatically improved our batch processing speed by 241x and overall system performance by 3x, enabling us to improve operating efficiency for our daily, critical tasks and to enhance customer service.”

- Kyoji Kato
Executive Officer and GM
Daiwa House

“Oracle Exadata Database Machine is helping to transform our business. Our SAP environment, one of the world’s largest, can now support twice as much throughput with improved stability.”

- Milt Simonds
Director, Enterprise Platform Delivery
AmerisourceBergen Corporation

High Capacity Storage Server: Tiered Disk and Flash Deliver Cost of Disk with Performance of Flash

The second Exadata storage option is the Exadata X6-2 **High Capacity (HC) Storage Server**. This server includes twelve 8 TB SAS disk drives with 96 TB total raw disk capacity. It also has four Flash Accelerator F320 NVMe PCIe cards with a total raw capacity of 12.8 TB of flash memory. These flash cards are also based on innovative 3D V-NAND technology. Exadata flash in a High Capacity Storage Server can be used directly as flash disks, but is almost always configured as a flash cache (**Exadata Smart Flash Cache**) in front of disk storage since caching provides flash level performance for much more data than fits directly into flash.

Exadata Smart Flash Cache automatically caches frequently accessed data while keeping infrequently accessed data on disk. This provides the performance of flash with the capacity and low cost of disk. The Exadata Smart Flash Cache understands database workloads and knows when to avoid caching data that the database will rarely access or is too big to fit in the cache. For example, Exadata doesn't cache I/Os caused by backups, table scans, or temporary results that will be quickly deleted. In addition to automatic caching, administrators can optionally provide SQL directives to ensure that specific tables, indexes, or partitions are preferentially retained in the flash cache. An elastic configuration of Exadata Database Machine SL6, with 8 database servers and 14 High Capacity storage servers can achieve up to **252 GB per second of analytic scan bandwidth from SQL**, and up to **6.6 Million random 8K read I/O operations per second (IOPS) from SQL**, and **0.25 ms I/O latency at 2 Million flash IOPS** when running database workloads. This performance scales as more racks are added.

Exadata's Smart Flash Cache is designed to deliver flash-level I/O rates and response times for data that is many times larger than the physical flash capacity in the machine by moving active data into flash, while leaving cold data on disk. It is common for hit rates in the Exadata Smart Flash Cache to be over 90%, or even 98% in real-world database workloads even though flash capacity is more than 7 times smaller than disk capacity. Such high flash cache hit rates mean that Exadata Smart Flash Cache provides an **effective flash capacity** that is many times larger than the physical flash. For example, an elastic configuration of Exadata Database Machine SL6 with 8 database servers and 14 High Capacity Storage Servers often has an effective flash capacity equal to the usable disk capacity of 508 TB.

The Exadata Smart Flash cache also caches database block writes using Exadata Write Back Flash Cache technology. Write caching eliminates disk bottlenecks in large scale OLTP and batch workloads. The flash write capacity of an elastic configuration of Exadata Database Machine SL6 with 8 database servers and 14 High Capacity Storage Servers exceeds **5.74 Million 8K write I/Os per second**. The Exadata write cache is transparent, persistent, and fully redundant. The I/O performance of the Exadata Smart Flash Cache is comparable to dozens of enterprise disk arrays with thousands of disk drives.

The automatic data tiering between RAM, flash and disk implemented in Exadata provides tremendous advantages over other flash-based solutions. Many storage vendors have recognized that the architecture of their traditional storage arrays inherently bottlenecks the performance of flash and therefore have developed new flash-only arrays. These flash-only arrays deliver higher performance than traditional

"We chose Oracle Exadata because it offered a complete solution ... we've created daily financial reports 4x faster and liquidity risk reports 7x faster to consistently meet our service-level agreement, improved credit risk management, and reduced our data center footprint."

- Vaibhav Samant
Senior Vice President, IT
HDFC Bank Ltd.

"None of the reports takes more than 10 minutes. It was taking 3-4 hours before, now it completes in 3 minutes. It sounds like unreal but it is real."

- Finance User
Turkcell

"The heart and soul of our stack right now is Oracle Exadata Database Machine. With Oracle Exadata, we've been able to reduce queries from days to minutes, and those that used to take minutes to seconds."

- Chris Wones
Enterprise Architect
dunnhumby

"[With Exadata] We can more quickly process 65 billion daily transactions for data charging, while providing real-time information for customer inquiries, increasing customer satisfaction, and reducing costs."

- Jin Hyung Lee
ICT Team Manager, Networking
Engineering
SK Telecom

arrays but give up the cost advantages of smart tiering of data between disk and flash. Therefore the overall size of data that benefits from flash is limited to the size of expensive flash. These flash arrays also do not benefit from any of Exadata's unique storage optimization technologies. Data deduplication provided by some flash arrays is very effective for VDI (Virtual Desktop Infrastructure) environments but is ineffective for databases.

Exadata not only delivers much more capacity than generic all-flash arrays, it also delivers better performance. Flash-only storage arrays cannot match the throughput of Exadata's integrated and optimized architecture with full InfiniBand based scale-out, fast PCI flash, offload of data intensive operations to storage, and algorithms that are specifically optimized for databases.

Accelerating Database Processing with Smart System Software

As data volumes grow exponentially, conventional storage arrays struggle to quickly transfer data from disk and flash to database servers at a rate that keeps the CPUs busy. Modern servers with dozens of CPU cores can consume data at many tens to hundreds of gigabytes a second. This is far faster than conventional storage arrays can deliver data through their storage controllers and the storage network.

The technology that enables Exadata's unparalleled performance without any of the bottlenecks of traditional storage arrays is **Exadata Storage Server Software**. This software powers the Exadata storage servers, providing a highly efficient database-optimized storage infrastructure. Each Exadata Storage Server has two 10-core x86 processors that are used to offload database processing. A rack of Exadata Database Machine SL6 can have a total of up to 320 processor cores in the storage servers that can be used to offload the database servers. The CPUs in the storage servers do not replace database CPUs. Instead they accelerate data intensive workloads similar to how graphics cards accelerate image intensive workloads.

One of the many unique features of Exadata Storage Server software is **Smart Scan** technology, which **offloads data intensive SQL operations from the database servers directly into the storage servers**. By pushing SQL processing to the storage servers, data filtering and processing occur immediately and in parallel across all storage servers, as data is read from disk and flash. **Only the rows and columns that are directly relevant to a query are sent to the database servers.**

For example, if a query is executed to identify the customers who placed sales orders over \$1000 in the month of March, an Exadata system will offload the scanning of the table to the Exadata storage, filter out all sales orders that are less than \$1000, filter out sales orders not in March, and extract just the relevant customer names. The result is that the data transferred to the database servers is reduced by orders of magnitude. This greatly accelerates query execution, eliminates bottlenecks, and significantly reduces the CPU usage of the database servers.

Storage Index is another powerful capability of Oracle Exadata Storage Server software that helps avoid unnecessary I/O operations and improves overall performance. The storage index, maintained in-memory, tracks summary information for table columns contained in a storage region on that storage server. When a query specifies a WHERE clause, Exadata Storage Server software examines the storage

index using a bloom filter to determine if rows with the specified column value might exist in a region of disk on the storage server. If the column value doesn't exist in the bloom filter, then scan I/O in that region for that query is avoided. Storage Indexes make many SQL operations run dramatically faster because large numbers of I/O operations are automatically replaced by a few in-memory lookups.

Besides the intrinsic capabilities of Exadata Storage Server software, the combination of Oracle Database software, Exadata Storage Server software and Exadata infrastructure enables several additional capabilities that offer unparalleled performance levels for today's complex enterprise databases. For example, **Exafusion Direct-to-Wire Protocol** allows database processes to read and send Oracle Real Application Clusters (Oracle RAC) messages directly over the InfiniBand network, bypassing the OS kernel and networking software overhead. This improves the response time and scalability of Oracle RAC configurations on Oracle Exadata Database Machine.

The **Smart Fusion Block Transfer** capability improves performance of a RAC configuration further by eliminating the impact of redo log write latency, especially when hot blocks need to be transferred between sending and receiving nodes. The block is transferred as soon as the I/O to the redo log is issued at the sending node, without waiting for it to complete. Based on internal tests, it has been observed that Smart Block Transfer increases throughput (about 40% higher) and decreases response times (about 33% less) for communication intensive workloads.

To further accelerate OLTP workloads, the Exadata Smart Flash Cache implements a special algorithm to ensure low latency of database log writes called **Exadata Smart Flash Logging**. The time to commit user transactions or perform critical updates is very sensitive to the latency of log writes. Smart Flash Logging takes advantage of the flash memory in Exadata storage combined with the high speed RAM memory in the Exadata disk controllers to reduce the average latency of log writes and avoid the latency spikes that occur in other flash solutions. The Exadata Smart Flash Logging algorithms are unique to Exadata.

Optimizing Storage Use and I/O Through Compression

The Exadata Storage Server provides a very advanced compression capability called **Hybrid Columnar Compression (HCC) that enables dramatic reductions in storage for large databases**. Hybrid Columnar Compression technology is an innovative method of organizing data within a database table. As the name implies, this technology utilizes a combination of both row and columnar methods for storing data. This hybrid approach achieves the compression benefits of columnar storage, while avoiding the performance shortfalls of a pure columnar format.

With Hybrid Columnar Compression, Exadata enables the highest levels of data compression possible with Oracle databases, and provides tremendous cost-savings and performance improvements due to reduced I/O, especially for analytic workloads. Storage savings is data dependent and often ranges from 5x to 20x. Average storage savings is an industry leading 10x. On conventional systems, enabling high data compression has the drawback of reducing performance by consuming CPU for decompression. Because the Exadata Database Machine is able to offload decompression overhead into large numbers of processors in Exadata storage, and in

"Exadata is the heart of the booking engine, and we cannot operate as a business, we cannot sell tickets without it."

- James Callaghan
Chief Technologist
Westjet

"Exadata delivers an amazing 20x compression for our Data Warehouse."

- Jonathan Walsh
Head of BI & DW
Morrisons, Plc.

In addition there is reduced I/O because of the high compression achieved, most analytic workloads run faster using Hybrid Columnar Compression than they do without it. Hybrid Columnar Compression delivers the compression and analytic performance benefits of columnar storage while avoiding the dramatic slowdown that columnar-only data stores experience for drilldown operations that often involve single row access.

Two modes of Hybrid Columnar Compression are available. **Warehouse compression** mode is suitable for read intensive workloads such as Data Warehouses and provides large storage savings while providing enhanced analytic performance. **Archive compression** mode provides the highest degree of compression and is targeted at data that is seldom accessed but still must be kept online.

On OLTP systems, Hybrid Columnar Compression can be used to compress older, less active data while newer, more active and update intensive data can be compressed using Advanced Row Compression. Oracle Database 12c provides the ability to change the type of compression used by individual table partitions online (even if there are global indexes on the table), to ensure seamless tiering across different compression types as data ages and becomes less active.

For data analytics which benefits from pure columnar access, Exadata Smart Flash Cache implements a unique algorithm to accelerate reporting and analytical queries called **Exadata Columnar Flash Cache**. Columnar Flash Caching implements a dual format architecture in Exadata flash by automatically transforming frequently scanned Hybrid Columnar Compressed data into a pure columnar format as it is loaded into the flash cache. Smart scans on pure columnar data in flash run faster because they read only the selected columns, reducing flash I/Os and storage server CPU consumption. This accelerates reporting and analytic queries while maintaining excellent performance for OLTP style single row lookups.

Fault Tolerant and Fastest Database In-Memory Machine

Exadata is the ideal platform for running Oracle Database In-Memory. Oracle Database In-Memory on Exadata does not require all data to reside in memory. Data can be stored across multiple tiers of storage, with the hottest data in memory providing extremely high query performance, active data on flash providing very high I/O throughput, and less active or older data on disk at a very low cost. **A single query can access data from all three tiers: memory, flash and disk, completely transparently.** This allows Exadata to run faster, support higher capacities and deliver lower costs than competing products.

In-memory databases leverage vector instructions built into processors to process large amounts of data using relatively few instructions. But vector processing instructions in general purpose processors such as x86 processors were designed for graphic operations, not for database processing. SPARC M7 with its unique **SQL in Silicon** technology has specialized Database Accelerators (DAX) that are engineered for in-memory database processing. The 32 DAX engines on each M7 chip are like 32 additional processor cores that accelerate analytic scanning and filtering of in-memory data for free.

Though most in-memory databases leverage dictionary based logical compression, they are not able to leverage bit level compression as decompressing bit-compressed data in software can drastically slow down database processing. With **Capacity in**

Silicon technology the SPARC M7 processor overcomes this conventional decompression challenge by implementing decompression algorithms directly in the microprocessor. This effectively doubles the in-memory database capacity without incurring any performance penalty.

Exadata implements **Oracle Database In-Memory fault tolerance**. In-memory fault tolerance is unique to Oracle Engineered Systems. On a generic cluster configuration, when a server node fails, the in-memory data on that node is lost, and it takes many minutes to repopulate the in-memory data on a surviving node. During this time analytic queries will run orders of magnitude slower. This means generic platforms will fail to meet business SLAs. However, on Exadata, in-memory fault-tolerance can eliminate this slowdown by duplicating any subset of the in-memory data store across the clustered database servers. If a database server fails, queries will transparently access the duplicate copy of data on a surviving database server and processing will continue without interruption.

Enterprise-Class Security with Extreme Performance

Exadata Database Machine is the world's most secure database machine. Building on the high security capabilities in the Oracle Database, **Exadata moves decryption processing from database server software into the Exadata Storage Server hardware**. Exadata storage leverages hardware decryption and compression together to provide the highest performance secure databases. **Encryption occurs after the data is compressed so that the cost of decryption is decreased by the degree of compression**. By leveraging both technologies, Exadata is able to query fully encrypted and compressed databases with minimal overhead at hundreds of gigabytes of user data per second. **Security in Silicon** further provides the capability of detecting and preventing invalid operations to application data, through hardware monitoring of software access to memory. This can stop malware from exploiting software vulnerabilities, such as buffer overflows. The hardware approach of Security in Silicon is much faster than traditional software-based detection tools.

The Exadata system is designed and delivered as an integrated whole, and not a collection of components. In traditional database deployments, the customer takes on all the integration tasks for the system – including the task of ensuring the security of each individual software and hardware component, and ensuring that security is maintained across the full product stack. **Oracle delivers full stack security in the Exadata Database Machine**. Additionally, Exadata systems use minimal Linux distributions to ensure that just the RPMs needed to run Oracle Database are installed and enabled. With this approach, system security is stronger than default installations and common security vulnerabilities are avoided.

Exadata security has been probed and evaluated by hundreds of leading banks, telcoms, and government organizations worldwide. The security findings of all these evaluations have been incorporated into the Exadata standard configuration, making it a highly secure database platform.

Mission Critical High Availability

The Exadata Database Machine is engineered to provide the highest levels of availability. **All types of failures are protected against** including simple failures such

"I don't get the calls in the middle of the night anymore that we have a system down. Exadata is taken as always being available."

- James Callaghan
Chief Technologist
Westjet

as disk, server, or network, as well as complex site failures and human errors. Each Exadata Database Machine has **completely redundant hardware**, including redundant InfiniBand networking, redundant Power Distribution Units (PDU), redundant power supplies, and redundant database and storage servers. Oracle RAC protects against database server failure. Oracle ASM provides data mirroring to protect against disk or storage server failures. Oracle RMAN provides extremely fast and efficient backups to disk or tape. Oracle's Flashback technology allows backing out user errors at the database, table or even row level. Using Oracle Data Guard, a second Exadata Database Machine can be configured in a Maximum Availability Architecture (MAA) configuration to transparently maintain a real-time copy of the database at a remote site and provide full protection against primary database failures and site disasters.

Exadata in an MAA configuration is recognized by the analyst firm IDC as a system that **delivers at least 5-nines availability** and is categorized in the IDC AL4 fault-tolerant market segment, along with HP Integrity NonStop and IBM z Systems¹.

The Exadata principle of deep hardware and software integration is also evident in the many ways Exadata uniquely assures high availability across several different failure conditions. One such capability is **Instant Detection of Compute and Storage Server Failures**. On non-Exadata platforms, detecting a server failure requires waiting for a long timeout, leading to extended application brownouts. Exadata leverages InfiniBand integration to very quickly determine that the suspect server is not reachable through any network path and can immediately initiate eviction of the failed server from the cluster. This entire operation can be completed in less than 2 seconds, leading to virtual elimination of application brownout conditions.

Disk and flash devices occasionally exhibit very long latency IO operations due to internal recovery of failed sectors, internal firmware reboots, or wear leveling. These long IO operations can cause stalls in mission critical OLTP databases. With Exadata **I/O Latency Capping**, Oracle Exadata Storage Server software automatically redirects read I/O operations to an ASM-mirrored copy of the data when the latency of a read I/O is much longer than expected. Similarly, it automatically redirects high latency write I/O operations to a healthy flash device, eliminating write outliers. If disks do fail, ASM performs a rebalance operation for the data that was resident on the disk. Exadata Storage Server software takes rebalance one step further by preserving the flash cache population and storage indexes when moving data between storage servers to maintain consistent application performance. On rare occasions when there are outliers within the networking subsystem, Exadata redirects the I/O issued by the database server to another storage server.

Because of its industry leading availability, the Exadata Database Machine has been deployed by leading companies for their most critical applications including interbank fund transfers, online securities trading, real-time call tracking, and web-based retailing. Exadata's Mission Critical availability capabilities are not restricted to OLTP workloads; they also apply to warehousing and analytics.

Ideal Platform for Database as a Service

The Exadata Database Machine can host many databases, enabling massive database

¹ Worldwide Fault-Tolerant Servers Market Shares, 2014: *Vendors Are Hearing the Customer — More Bold Moves Needed to Grow the Segment*, IDC, Peter Rutten, Lloyd Cohen, October 2015

“By consolidating 350 database servers and storage systems onto Oracle Exadata, we gained a high-performance, reliable, and scalable mobile billing platform, enabling us to calculate billings data 10x faster, and halve maintenance costs.”

- Tomoki Shimamura
Senior Manager Billing Systems Group
NTT DoCoMo, Inc.

“By integrating 20 legacy database servers for our investment trust sales system into four Oracle Exadata Database Machines, we can provide information to customers 136x faster, enhance our competitive advantage, and support transaction growth for the next 10 years at lower costs.”

- Tomoshiro Takemoto
Senior Managing Director
Cloud Computing Service Division
Nomura Research Institute Ltd.

consolidation or a sophisticated Database as a Service private cloud. Multi-database environments inherently have diverse, complex, and unpredictable workloads mixing OLTP, analytics, and batch operations with sequential and random access patterns. Exadata’s ability to **run any type or mix of database workloads with industry leading scalability and performance** makes it an ideal consolidation platform – whether for multi-database workloads, or for pluggable databases with Oracle Multitenant in Oracle Database 12c.

Multi-database environments create an inherent risk that one database will consume too many resources and therefore impact the quality of service of other databases. The Exadata Database Machine provides unique **end-to-end prioritization** from the application to database CPUs, network, and storage. Priorities and resource limits can be specified at the physical database, pluggable database, connection, application, user, or even job level to ensure that each of the consolidated databases or SQL operations receives the necessary resources and achieves the target response times.

Exadata implements unique **database and I/O resource management**. Fine-grained priorities specified for operations at the database level are automatically communicated to Exadata Storage Servers and applied to each I/O operation to ensure that prioritization of database operations applies to both CPU operations and I/O operations. The same resource management principles can also be applied when multiple databases are deployed on one Exadata rack, as is typical in a consolidated private cloud.

Exadata also implements unique **database network resource management** to ensure that network intensive workloads such as reporting, batch, and backups don’t stall response time sensitive interactive workloads. Latency sensitive network operations such as RAC Cache Fusion communication and log file writes are automatically moved to the head of the message queue in server and storage network cards as well as InfiniBand network switches, bypassing any non-latency sensitive messages. Latency critical messages even jump ahead of non-latency critical messages that have already been partially sent across the network, ensuring low response times even in the presence of large network DMA (Direct Memory Access) operations.

Fast Deployment of Development and Test Databases with Exadata Snapshots

Space-efficient database snapshots can be quickly created for test and development purposes directly on Exadata. Exadata database snapshots are integrated with Oracle Multitenant to provide an extremely simple interface for creating new pluggable database (PDB) snapshots.

Snapshots start with a shared read-only copy of the production database (or PDB) that has been cleansed of sensitive information. A hierarchy of read-write snapshots can be created from this shared copy. As changes are made, each snapshot writes the changed blocks to a sparse disk group. Since multiple users can create independent snapshots from the same base database copy, multiple test and development environments can share space while maintaining independent databases for each task.

All Exadata specific features such as Smart Scan, resource management and Smart Flash Cache work seamlessly on database instances created via Exadata snapshots, hence providing an exact test and development environment while using a fraction of

valuable storage resources. Backups of snapshots on Exadata are also space efficient as only the changed information is backed up.

Comprehensive System Management

Oracle Enterprise Manager uses a holistic approach to manage the Exadata Database Machine and provides comprehensive capabilities from monitoring and reporting to active lifecycle management. It enables:

- **Unified Monitoring:** The latest version of Enterprise Manager, Oracle Enterprise Manager 13c, supports a single pane of glass view of all the hardware and software components such as database servers, storage servers, InfiniBand switches, and monitors the operations running on them and their resource utilization. DBAs can drill down from database monitoring screens to the Exadata storage layer to quickly determine root causes of any performance bottlenecks.
- **Lights-out monitoring** within Enterprise Manager is optimized for Exadata with predefined metrics and thresholds so that administrators receive timely notifications when issues arise, and manage those exceptions. In addition, hardware incidents are automatically detected and service requests logged to reduce problem resolution time.
- The **Exachk** tool, which is integrated with Enterprise Manager's powerful compliance framework, provides functionality for system administrators to automate the assessment of Engineered Systems for known configuration problems and best practices. Administrators can leverage the Consistency Check functionality to check for deviations in configuration across the racks or among the database servers of a rack.
- Exadata's built in Management Server (MS) processes constantly monitor the health of hardware and software components, and send alerts to both administrators and Oracle support when faulty components are detected.

"With Oracle Platinum Services, we achieved a 40% increase in operational efficiency - virtually eliminating the need for dedicated resources to perform updates, monitor systems, and resolve incidents."

- Roland Schiller
Architect

Highest Level of Service

Oracle offers a complete set of support services for the Exadata family of products including: 24x7 hardware service, system monitoring, software installation and configuration among other standard and custom offerings.

Of particular value is **Oracle Platinum Services** that is available exclusively for Oracle's Engineered Systems. Platinum Services provides fault monitoring, faster response times, and expedited escalation to development. With Platinum Services, Oracle support engineers perform software maintenance and patching remotely. Platinum Services provides a higher level of support than has ever been available before for all software and hardware within an Engineered System including the Oracle Database. Platinum Services is provided at no extra charge to Exadata customers.

"We've seen system performance increase 4x and the total cost of storage ownership fall by 30%, even as our data volumes have surged."

- Holger Haun
Managing Director
IDS GmbH – Analysis and Reporting
Service

IT Agility

Exadata is a complete system for running databases including storage, servers, and internal networks. Management of a traditional database system is typically spread across the management teams of each of the components such as the database team, the storage team, and the system administration team. In contrast, an **Exadata system is typically managed by a unified Database Machine Administration team.**

Database Machine Administrators have full control of all resources in the Exadata Database Machine including storage resources. New database deployments and configuration changes can be implemented by the Database Machine Administrators

“On an annual basis Exadata provides at least half a million dollars in savings in operating costs.”

- James Callaghan
Chief Technologist
Westjet

without coordination across different component management teams that are often overloaded and have differing priorities. Database Machine Administrators can focus on application and business specific enhancements rather than coordinating across component teams, or tuning and triaging of low level configuration issues.

Dramatically Lower Costs

Because of the extreme performance, high storage capacity, and unique compression capabilities delivered by the Exadata Database Machine, workloads that would require very large traditional hardware systems can be run on much smaller Exadata systems. The hardware needed for an application deployed on an Exadata system is often reduced 2-4X compared to a traditional system.

Exadata provides a huge RAM, flash, and disk footprint for large data sets. Raw disk storage on an Exadata full rack can exceed 1.5 Petabytes while raw flash storage can be up to 409.6 TB. In addition, Hybrid Columnar Compression often expands storage and memory capacity 10X. By intelligently moving active data across disk, flash, and memory tiers, Exadata simultaneously delivers the highest performance and the lowest cost.

Exadata has the unique ability to consolidate many databases supporting multiple workloads in a single cloud platform. High-end OLTP, analytics, batch, reporting, and backups can all run simultaneously within and across databases with extreme performance. **The extreme performance and capacity of Exadata enables very large numbers of databases and workloads to be consolidated on Exadata.** Consolidating databases on Exadata reduces system hardware cost, software cost, and greatly reduces ongoing operations cost.

The uniformity of Exadata Database Machine configurations results in large cost savings. **Exadata standardizes not just technologies, but also integration, testing, hardening, tuning, and support.** Customers deploy Exadata systems much faster and with a lot less labor than traditional systems. Low level tuning, integration, and maintenance is reduced or eliminated. Because all Exadata users run a configuration that is identical to thousands of other users, and is identical to Oracle’s internal configurations, it is far less likely that issues will be encountered, and issue resolution is quicker and simpler reducing both operations cost and downtime cost.

Capacity-on-Demand Software Licensing

An SL6 database server has industry leading compute capacity with two 32-core SPARC M7 processors (64 cores in total). The Capacity-on-Demand feature allows a number of cores per database server to be turned off during the hardware installation, leaving at least 14 cores per server enabled. As your workload grows and more cores are needed, Capacity-on-Demand can be used to re-enable cores and license software 2 cores at a time. This pay-as-you-grow approach to software licensing is another way in which Exadata helps to align costs with business growth. The SPARC M7 Database Acceleration (DAX) engines are always enabled and incur no software charges.

Exadata Business Benefits

Beyond the operational benefits of extreme performance, availability, and security, and deployment flexibilities across on-premises and Cloud, Exadata also directly benefits

the business.

Exadata accelerates time to market for new business applications since the time needed for system configuration, tuning, and testing is largely eliminated. Deployment times are reduced from months to days, and the risk of unexpected system level issues after go-live is greatly reduced. When a new application is deployed, it is common for unanticipated application usage patterns to create performance issues. Exadata's huge I/O, network, and compute throughput can absorb spikes created by unanticipated workloads without slowing response times of mission critical workloads. Overall Exadata speeds application deployment and reduces risk, allowing businesses to innovate faster.

Exadata's extreme performance and large memory and flash capacity enhance employee productivity and customer satisfaction by greatly improving user response times. **Users spend more time doing useful work, and less time waiting** for the system to respond.

Exadata's extreme performance does not just improve business efficiency, it also **enables business users to make smarter decisions, discover growth opportunities, and reduce costs**. Users can analyze data in real-time, explore different possibilities, and perform rapid iteration to find better solutions. Exadata enables:

- Real-time business data analysis
- Faster financial closes
- Better planning and budgeting
- More effective and faster projections

Conclusion

Exadata delivers a fully integrated database platform with the latest hardware technologies and **unique** software to deliver extreme performance, availability, and security. This coupled with cost savings, ease of management, and enhanced supportability result in greater business agility and efficiency. The Exadata SL6 features industry leading SPARC M7 processors with unique Software in Silicon capabilities making SL6 the fastest and most secure Exadata Database Machine ever.

EXADATA SERVER HARDWARE¹

Server Type	CPU	Memory	Disk	Flash	Network
Database Server	2x 32-core SPARC M7 processors	256 GB (default) to 1 TB(max)	6x 600 GB 10,000 RPM disks (Hot-Swappable) – Expandable to 8	None	3x 1/10 Gb copper Ethernet ports (client) 1x 1/10 Gb copper Ethernet port (mgmt) 2x 10 Gb optical Ethernet ports (client) 4x QDR (40 Gb) InfiniBand ports 1x ILOM Ethernet port
Storage Server HC	2x 10-core Xeon E5-2630 v4 processors	128 GB	12x 8 TB 7,200 RPM disks	4x 3.2 TB NVMe PCIe 3.0 flash cards	2x QDR (40 Gb) InfiniBand ports 1x ILOM Ethernet port
Storage Server EF		128 GB	None	8x 3.2 TB NVMe PCIe 3.0 flash drives	

¹ All servers include redundant hot swappable fans and power supplies

EXADATA TYPICAL RACK CONFIGURATIONS²

Rack Size	Database Servers and Cores	Storage Servers and Cores	HC Storage Capacity (raw)		EF Storage Capacity (raw)
Eighth Rack ³	2x servers, 64 cores	3x servers, 30 cores for SQL offload	144 TB disk, 19.2 TB flash	or	38.4 TB flash
Quarter Rack	2x servers, 128 cores	3x servers, 60 cores for SQL offload	288 TB disk, 38.4 TB flash		76.8 TB flash

² Each rack is 42 RU (Rack Units) in height, has 2x redundant Power Distribution Units (PDUs), 2x 36-port QDR (40 Gb/s) InfiniBand switches and 1x 48-port Cisco Ethernet switch for administration. Included Spare Parts Kit Contains:

- 1 x 3.2 TB NVMe PCI Flash card and 1 x 8 TB High Capacity disk, or
- 1 x 3.2 TB NVMe PCI flash drive

³ Eighth Rack is the minimum Exadata configuration. Eighth Rack compute servers have half the cores enabled. Eighth Rack EF storage servers have half the cores and flash drives enabled. Eighth Rack HC storage servers have half the cores enabled and half the disks and flash cards removed.

EXADATA ELASTIC CONFIGURATIONS⁴

Rack Size	Database Servers and Cores	Storage Servers and Cores	HC Storage Capacity (raw)		EF Storage Capacity (raw)
Base Rack (Quarter Rack)	2x servers, 128 cores	3x servers, 60 cores for SQL offload	288 TB disk, 38.4 TB flash	or	76.8 TB flash
+ Database Servers	Up to 10 servers ⁵ , 640 cores max per rack	n/a	n/a		n/a
+ Storage Servers	n/a	Up to 16x servers ⁵ , 320 cores max per rack	1,536 TB disk, 204.8 TB flash max per rack		409.6 TB flash max per rack

⁴ A full rack elastic configuration cannot exceed 18 servers and 39 RU (Rack Units). Database Servers = 3 RU, Storage Servers = 2 RU

⁵ Maximum number of database servers allowed in an elastic configuration is 10. Maximum number of storage servers allowed in an elastic configuration is 16.

OTHER ELASTIC EXPANSION OPTIONS

Multi-Rack Connection	Connect any combination of up to 18 Exadata Database Machine racks or Exadata Storage Expansion Racks via the InfiniBand fabric. Larger configurations can be built with external InfiniBand switches. Connected racks can be any combination of V2, X2, X3, X4, X5 or X6 hardware.
Eighth Rack to Quarter Rack Upgrade	Upgradability: Field upgrade from Eighth Rack to Quarter Rack. Expand just compute or just storage or both. Additional Hardware Components are enabled/installed with the Upgrade: <ul style="list-style-type: none"> • For each Database Server: Thirty two additional cores are enabled, • For each EF Storage Server: Ten additional cores and four PCI Flash drives are enabled • For each HC Storage Server: Ten additional cores are enabled, six disks and two PCI Flash Cache cards are installed.

EXADATA SL6 CAPACITY AND PERFORMANCE METRICS: INDIVIDUAL SERVERS

Server Type	Maximum SQL Flash Bandwidth ²	Maximum SQL Read IOPS ³	Maximum SQL Write IOPS ⁴	PCI Flash Capacity (raw) ⁵	Disk Data Capacity(raw)
Database Server	NA	1,050,000	1,015,000	NA	2.4 TB
Storage Server HC ¹	18 GB/s	475,000	410,000	12.8 TB	96 TB
Storage Server EF ¹	20 GB/s	495,000	450,000	25.6 TB	N/A

EXADATA SL6 TYPICAL RACK CONFIGURATIONS: FLASH METRICS (HC & EF)

Flash Metrics		Maximum SQL Flash Bandwidth	Maximum SQL Flash Read IOPS	Maximum SQL Flash Write IOPS	PCI Flash Capacity (raw)
Full Rack Equivalent*	HC	252 GB/s	6,650,000	5,740,000	179.2 TB
	EF	280 GB/s	6,930,000	6,300,000	358.4 TB
Half Rack	HC	126 GB/s	3,325,000	2,870,000	89.6 TB
	EF	140 GB/s	3,465,000	3,150,000	179.2 TB
Quarter Rack	HC	54 GB/s	1,425,000	1,230,000	38.4 TB
	EF	60 GB/s	1,485,000	1,350,000	76.8 TB
Eighth Rack	HC	70 GB/s	712,500	615,000	19.2 TB
	EF	30 GB/s	742,500	675,000	38.4 TB

EXADATA SL6 TYPICAL RACK CONFIGURATIONS: DISK METRICS (HC)

Disk Metrics	Maximum SQL Disk Bandwidth	Maximum SQL Disk IOPS	Data Capacity (raw)
Full Rack Equivalent*	25 GB/s	36,000	1,344 TB
Half Rack	12.5 GB/s	18,000	672 TB
Quarter Rack	5.4 GB/s	7,800	288 TB
Eighth Rack	2.7 GB/s	3,900	144 TB

EXADATA SL6 TYPICAL RACK CONFIGURATIONS: COMBINED METRICS (HC & EF)

Combined Metrics		Data Capacity (Usable) – Normal Redundancy ⁶	Data Capacity (Usable) – High Redundancy ⁶	Maximum Data Load Rate ⁷
Full Rack	HC	508 TB	399 TB	21 TB/hour
	EF	130 TB	102 TB	21 TB/hour
Half Rack	HC	254 TB	199 TB	11 TB/hour
	EF	65 TB	51 TB	11 TB/hour
Quarter Rack	HC	109 TB	85 TB	5 TB/hour
	EF	28 TB	22 TB	5 TB/hour
Eighth Rack	HC	54 TB	43 TB	2.5 TB/hour
	EF	14 TB	11 TB	3 TB/hour

¹HC = High Capacity EF = Extreme Flash. Actual system performance varies by application.

² Bandwidth is peak physical scan bandwidth achieved running SQL, assuming no database compression. Effective user data bandwidth is higher when database compression is used.

³ Based on 8K I/O requests running SQL. Note that the I/O size greatly affects Flash IOPS. Other products quote IOPS based on smaller IOs that are not relevant for databases.

⁴ Based on 8K I/O requests running SQL. Flash write I/Os measured at the storage servers after ASM mirroring, which usually issues multiple storage IOs to maintain redundancy.

⁵ Raw capacity is measured in standard disk drive terminology with 1 GB = 1 billion bytes.

⁶ Usable capacity is measured using normal powers of 2 space terminology with 1 TB = 1024 * 1024 * 1024 * 1024 bytes. It is the actual space available to create a database after taking into account space needed for ASM redundancy, recovering from a drive failure, DBFS disk group, and OS images and binaries.

⁷ Load rates are typically limited by database server CPU, not IO. Rates vary based on load method, indexes, data types, compression, and partitioning.

⁸ Full Rack equivalent represents a configuration with 8 SL6 Database Servers and 14 Storage Servers

EXADATA DATABASE MACHINE SL6 COMPONENT ENVIRONMENTAL SPECIFICATIONS

Metric	SL6 Database Server Plus InfiniBand Infrastructure	X6-2 High Capacity Storage Server Plus InfiniBand Infrastructure	X6-2 Extreme Flash Storage Server Plus InfiniBand Infrastructure
Height	5.1 in. (127.8 mm)	3.5 in. (87.6 mm)	
Width	17.2 in. (436.5 mm)	17.5 in. (445.0 mm)	
Depth	29.0 in. (737.0 mm)	29.0 in. (737.0 mm)	
Acoustic noise (operating)	8.0 B	7.8 B	7.8 B
Weight	80.0 lbs (36.3 kgs)	73.0 lbs (33.1 kgs)	62.0 lbs (28.1 kgs)
Maximum power usage	1.8 kW (1.8 kVA)	0.588 kW (0.600 kVA)	0.547 kW (0.558 kVA)
Typical power usage ¹	1.3 kW (1.3 kVA)	0.412 kW (0.420 kVA)	0.383 kW (0.391 kVA)
Cooling at maximum usage	6,142 BTU/hour (6,480 kJ/hour)	2,006 BTU/hour (2,117 kJ/hour)	1,866 BTU/hour (1,969 kJ/hour)
Cooling at typical usage	4,299 BTU/hour (4,536 kJ/hour)	1,404 BTU/hour (1,482 kJ/hour)	1,307 BTU/hour (1,378 kJ/hour)
Airflow at maximum usage ²	284 CFM	93 CFM	86 CFM
Airflow at typical usage ²	199 CFM	65 CFM	60 CFM

Operating temperature/humidity: 5 °C to 32 °C (41 °F to 89.6 °F), as measured by an industry grade temperature measurement device directed at the front bezel of the servers, 10% to 90% relative humidity, non-condensing

Altitude Operating: Up to 3,048 m, max. ambient temperature is de-rated by 1° C per 300 m above 900 m

¹ Typical power usage varies by application load

² Airflow must be front-to-back.

EXADATA DATABASE MACHINE SL6 ENVIRONMENTAL SPECIFICATIONS

Metric	Half Rack	Quarter Rack	Eighth Rack
Height		• 78.66" - 1998 mm	
Width		• 23.62" - 600 mm	
Depth		• 47.24" - 1200 mm	
Acoustic noise (operating)	8.6 B	8.4 B	8.4 B

Environmentals With High Capacity Disks

Weight	1353.5 lbs (613.9 kg)	910.5 lb (413.0 kg)	880.3 lbs (399.3 kg)
Maximum power usage	12.2 kW (12.5 kVA)	6.3 kW (6.4 kVA)	5.1 kW (5.2 kVA)
Typical power usage ¹	8.6 kW (8.7 kVA)	4.4 kW (4.5 kVA)	3.6 kW (3.6 kVA)
Cooling at maximum usage	41,734 BTU/hour 44,029 kJ/hour	21,243 BTU/hour 22,603 kJ/hour	17,403 BTU/hour 18,360 kJ/hour
Cooling at typical usage	29,214 BTU/hour 30,820 kJ/hour	14,997 BTU/hour 15,822 kJ/hour	12,182 BTU/hour 12,852 kJ/hour
Airflow at maximum usage ²	1932 CFM	992 CFM	806 CFM
Airflow at typical usage ²	1352 CFM	694 CFM	564 CFM

Environmentals With Extreme Flash Drives

Weight	1276.5 lbs (590.0 kg)	877.5 lbs (398.0 kg)	877.5 lbs (398.0 kg)
Maximum power usage	11.9 kW (12.2 kVA)	6.2 kW (6.3 kVA)	5.0 kW (5.1 kVA)
Typical power usage ¹	8.4 kW (8.5 kVA)	4.3 kW (4.3 kVA)	3.5 kW (3.6 kVA)
Cooling at maximum usage	40,755 BTU/hour 42,996 kJ/hour	21,005 BTU/hour 22,160 kJ/hour	17,149 BTU/hour 18,092 kJ/hour
Cooling at typical usage	28,528 BTU/hour 30,097kJ/hour	14,704 BTU/hour 15,512 kJ/hour	12,004 BTU/hour 12,664 kJ/hour
Airflow at maximum usage ²	1887 CFM	972 CFM	794 CFM
Airflow at typical usage ²	1321 CFM	681 CFM	556 CFM

Operating temperature/humidity: 5 °C to 32 °C (41 °F to 89.6 °F), as measured by an industry grade temperature measurement device directed at the front bezel of the servers 10% to 90% relative humidity, non-condensing

Altitude Operating: Up to 3,048 m, max. ambient temperature is de-rated by 1° C per 300 m above 900 m

¹ Typical power usage varies by application load.

² Airflow must be front-to-back.

EXADATA DATABASE MACHINE SL6 REGULATIONS AND CERTIFICATIONS

Regulations ¹	Safety:	UL/CSA 60950-1, EN 60950-1, IEC 60950-1 CB Scheme with all country differences
	RFI/EMI:	EN55022, EN61000-3-11, EN61000-3-12
	Immunity:	EN 55024
	Emissions and Immunity:	EN300 386
Certifications ¹	North America (NRTL), European Union (EU), International CB Scheme, BSMI (Taiwan), C-Tick (Australia), CCC (PRC), MSIP (Korea), CU EAC (Customs Union), VCCI (Japan)	
European Union Directives ¹	2006/95/EC Low Voltage Directive, 2004/108/EC EMC Directive, 2011/65/EU RoHS Directive, 2012/19/EU WEEE Directive	

¹All standards and certifications referenced are to the latest official version at the time the data sheet was written. Other country regulations/certifications may apply. In some cases, as applicable, regulatory and certification compliance were obtained at the component level.

EXADATA DATABASE MACHINE SL6 SUPPORT SERVICES

- *Hardware Warranty: 1 year with a 4 hr web/phone response during normal business hours (Mon-Fri 8AM-5PM), with 2 business day on-site response/Parts Exchange*
 - *Oracle Premier Support for Systems includes Oracle Linux support and 24x7 with 2 hour on-site hardware service response (subject to proximity to service center)*
 - *Oracle Premier Support for Operating Systems*
 - *Oracle Customer Data and Device Retention*
 - *System Installation Services*
 - *Software Configuration Services*
 - *Oracle Platinum Services*
 - *Business Critical Service for Systems*
 - *Oracle Exadata Start-Up Pack*
 - *System Upgrade Support Services including hardware installation and software configuration*
 - *Oracle Auto Service Request (ASR)*
-

OPTIONAL CUSTOMER SUPPLIED ETHERNET SWITCH INSTALLATION IN EXADATA DATABASE MACHINE SL6

- *Each Exadata Database Machine SL6 rack has 2U available at the top of the rack that can be used by customers to optionally install their own client network Ethernet switches in the Exadata rack instead of in a separate rack. Some space, power, and cooling restrictions apply.*
-

KEY FEATURES & FUNCTIONALITY

Exadata and Database Software Features - Analytics

- *SQL in Silicon*
 - *Capacity in Silicon*
 - *Automatically Parallelize and Offload Data Scans to storage*
 - *Filter Rows in Storage based on 'where' clause*
 - *Filter Rows in Storage based on columns selected*
 - *JSON and XML Offload*
 - *Filter rows in Storage based on Join with other Table*
 - *Hybrid Columnar Compression*
 - *Storage Index data skipping*
 - *I/O Resource Management by User, Query, Service, DB, etc.*
 - *Automatic Transformation to Columnar Format in Flash Cache*
 - *Smart Flash Caching for Table Scans*
 - *Offload Index Fast Full Scans*
 - *Offloads Scans on Encrypted Data, with FIPS compliance*
 - *Storage offload for LOBs and CLOBs*
 - *Storage offload for min/max operations*
 - *Data Mining Offload*
 - *All Ports Active InfiniBand Messaging*
 - *Reverse Offload to DB servers if Storage CPUs are Busy*
 - *Automatic Data Compression in Flash Cache*
 - *Offload JSON and XML analytic queries*
-

Exadata and Database Software Features - OLTP

- *Database Aware PCI Flash*
 - *Exadata Smart Flash Caching*
 - *Exadata Smart Flash Logging*
 - *Write-back Flash Cache*
 - *I/O Prioritization by DB, User, or workload to ensure QOS*
 - *Exafusion Direct-to-Wire Protocol*
 - *Network Resource Management*
 - *Exachk full-stack validation*
 - *Full-stack security scanning*
 - *NVMe flash interface for lowest latency IO*
 - *Database scoped security*
 - *Cell-to-Cell Rebalance preserving Flash Cache*
 - *Secure disk and flash erase*
 - *Oracle VM with SRIOV*
 - *InfiniBand Partitioning*
 - *Instant data file creation*
 - *Active Bonding of InfiniBand*
 - *Smart Fusion Block Transfer*
 - *Automatic VLAN creation*
 - *Set Minimum or Maximum Flash Cache Size per Database*
-

Exadata and Database Software Features - High Availability

- *Instant Detection of Node or Cell Failure*
 - *In-Memory Fault Tolerance*
 - *Sub-second Failover of I/O on stuck disk or flash*
 - *Offload backups to storage servers*
 - *Exadata Data Validation (H.A.R.D.)*
 - *Prioritize rebalance of critical files*
 - *Automatic Hard Disk scrub and repair*
 - *Power cycle failed drives to Eliminate false drive failures*
 - *Avoid reading Predictive failed disks*
 - *Cell software transparent restart*
 - *Flash and disk life cycle management alert*
 - *Confinement of temporarily poor performing drives*
 - *Prevent shutdown if mirror server is down*
 - *Detection and disabling of unreliable network links*
 - *Preserve Storage Index on Rebalance*
 - *Automatic disk scrub and repair*
-

Manageability Features

- *Oracle Embedded Integrated Lights Out Manager (ILOM)*
 - *Oracle Enterprise Manager Exadata Plug-in*
 - *Active AWR includes storage stats for end to end monitoring*
 - *IPv6 Support for Ethernet Connections*
 - *Capacity on Demand*
 - *Trusted Partitions for Oracle Virtual Machine*
 - *Automated VLAN Creation*
 - *Oracle Exadata Deployment Assistant*
 - *Separate Management Switch and Connectivity*
 - *Exacl command line management from remote servers*
 - *Cellcli command line management of Storage Servers*
 - *DCLI distributed command line automation tool*
-

Oracle Database Software (available separately):

For database servers: Oracle Database 12c Enterprise Edition. Oracle Database Options such as Oracle Real Application Clusters, Oracle Partitioning, Oracle Multitenant, Oracle Active Data Guard. See the release specific documentation for feature support.

For storage servers: Oracle Exadata Storage Server Software. Licenses are transferable from one system to another, or to a new system

Oracle Software (included):

For database servers: Oracle Linux 6 Update 7 with the Unbreakable Enterprise Kernel 2. Zero-loss Zero-copy Datagram Protocol (ZDP) InfiniBand protocol used to communicate between the Exadata Storage Servers and the Oracle Database which is based on the Reliable Datagram Sockets (RDS) OpenFabrics Enterprise Distribution (OFED)



CONTACT US

For more information about Oracle Exadata, visit oracle.com/exadata or call +1.800.ORACLE1 to speak to an Oracle representative.

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Integrated Cloud Applications & Platform Services

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