ORACLE EXADATA DATABASE MACHINE X4-2

FEATURES AND FACTS

FEATURES

- Up to 192 CPU cores and 4 TB memory for database processing
- Up to 168 CPU cores dedicated to SQL processing in storage
- From 2 to 8 database servers
- From 3 to 14 Oracle Exadata Storage Servers
- Up to 44.8 TB of Exadata Smart Flash Cache
- 40 Gb/second (QDR) InfiniBand Network
- Uncompressed and mirrored usable capacity of up to 300 TB per rack
- Hybrid Columnar Compression often delivers 10X-15X compression ratios
- Complete redundancy for high availability
- Oracle Linux or Solaris based database servers

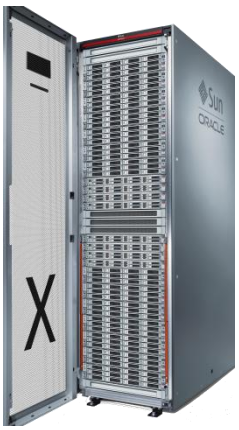
FACTS

- Uncompressed I/O bandwidth of up to 100 GB/second per rack from SQL
- Ability to perform up to 2,660,000 database 8K read I/O operations per second
- Easily upgrade to meet the needs of any size application
- Scale by connecting multiple Exadata Database Machine X4-2 racks or Exadata Storage Expansion Racks. Up to 18 racks can be connected by simply connecting via InfiniBand cables and using internal switches. Larger configurations can be built with external InfiniBand switches
- Pre-configured system optimized for all database applications

The Oracle Exadata Database Machine is engineered to be the highest performing and most available platform for running the Oracle Database. Exadata is a modern architecture featuring scale-out industry-standard database servers, scale-out intelligent storage servers, and an extremely high speed InfiniBand internal fabric that connects all servers and storage. Unique software algorithms in Exadata implement database intelligence in storage, PCI based flash, 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) and consolidation of mixed workloads. Simple and fast to implement, the Exadata Database Machine powers and protects your most important databases and is the ideal foundation for a consolidated database cloud.

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 the Oracle Database. 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 high performance system. Extensive end-to-end testing ensures all components 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. Customer machines are also identical to the machines Oracle Support uses for problem identification and resolution, and the machines Oracle Engineering uses for development and testing of the Oracle Database. Hence, **Exadata is the most thoroughly tested and tuned platform for running the Oracle Database** and is also the **most supportable platform**.

The Oracle Exadata Database Machine runs the standard Oracle Database.

RELATED PRODUCTS AND SERVICES

RELATED PRODUCTS

- Oracle Exadata Database Machine X3-8
- Oracle Exadata Storage Expansion Rack X4-2
- Oracle Exadata Storage Server X4-2
- Oracle SuperCluster
- Oracle Database 11g and 12c
- Real Application Clusters
- Partitioning
- Multitenant
- Advanced Compression
- Advanced Security
- Active Data Guard
- GoldenGate
- Real Application Testing
- OLAP
- Advanced Analytics
- Business Intelligence
- Enterprise Manager
- Oracle Linux
- Oracle Solaris

RELATED SERVICES

The following services are available from Oracle:

- Advanced Customer Services
- Oracle Premier Support for Systems
- Oracle Infrastructure as a Service On-Premise (IaaS)
- Oracle Platinum Services
- Oracle PlatinumPlus Services
- Consulting Services
- Oracle University courses

Therefore, **any application that uses the Oracle Database today can be seamlessly migrated to use the Exadata Database Machine with no changes to the application**.

Unlike competing hardware platforms such as IBM Mainframes, Teradata, or IBM Puredata System for Analytics (Netezza), the Exadata platform does not "lock in" customers. These competing platforms have extensive proprietary software interfaces that make it extremely complex and expensive to migrate applications to a different platform. Because Exadata is based on the industry standard Oracle database, applications can be easily and quickly migrated on or off the Exadata platform.

Extreme System Scalability and Growth

The Exadata Database Machine uses a **scale-out architecture for both database servers and storage servers**. The Exadata configuration carefully balances CPU, I/O and network throughput to avoid bottlenecks. As an Exadata Database Machine grows, database CPUs, storage, and networking are added in a balanced fashion ensuring scalability 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.

Four sizes of the Exadata Database Machine X4-2 are available, starting from the Eighth Rack system with 2 database servers and 3 Exadata Storage Servers, to the Full Rack system with 8 database servers and 14 Exadata Storage Servers. One size can be expanded to another online ensuring a smooth upgrade path as database requirements grow. All four sizes are available with either 1.2 TB High Performance disks or 4 TB High Capacity disks.

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 Full 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 processors. 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.

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 Exadata 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, LOBs, etc. Available in Full Rack, Half Rack and Quarter Rack sizes, it connects to the Exadata Database Machine using the integrated InfiniBand fabric. The expansion rack is extremely simple to configure as there are no LUNs or mount points to set up. Storage is configured and added to a database online with a few simple commands.

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 previous generation Exadata Database Machines. All currently supported Exadata platforms can be mixed in a single configuration and can run the latest Exadata software.

Extreme Performance by Offloading Data Intensive Processing

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 many CPUs can consume data at many tens to hundreds of gigabytes a second. This is far faster than conventional architectures that use storage arrays can deliver data through their storage heads and the storage network.

The scale-out architecture of the Exadata Database Machine not only provides high performance and scalability, it also includes a unique technology that **offloads data intensive SQL operations into the Oracle Exadata Storage Servers**. By pushing SQL processing to the Exadata Storage Servers, data filtering and processing occurs 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.

Each Exadata Storage Server has two Intel® Xeon® processors that are used for database offload. A full rack Exadata Database Machine has a total of 168 processor cores in the storage servers tha can be used to offload the database servers. The CPUs in Exadata Storage Servers do not replace database CPUs. Instead they accelerate data intensive workloads similar to how graphics cards accelerate image intensive workloads.

Optimizing Storage Use and I/O Through Compression

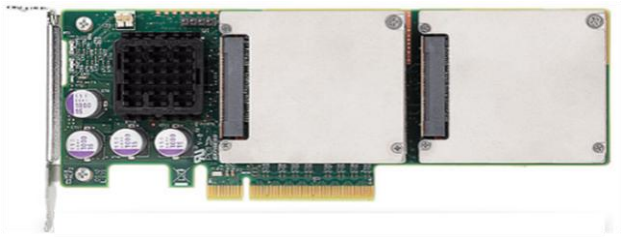
The Exadata Storage Server provides a very advanced compression capability called **Hybrid Columnar Compression (HCC) that provides dramatic reductions in storage for large databases**. Hybrid Columnar Compression enables the highest levels of data compression and provides tremendous cost-savings and performance improvements due to reduced I/O, especially for analytic workloads. Storage savings is data dependent and often ranges from 5x to 20x. Typical storage savings is an industry leading 10x. On conventional systems, enabling high data compression has the drawback of reducing performance. Because the Exadata Database Machine is able to offload decompression overhead into large numbers of processors in Exadata storage, most analytics workloads run faster using Hybrid Columnar Compression than they do without it. Hybrid Columnar Compression delivers the compression and analytic performance benefits of column storage while avoiding the dramatic slowdown that pure columnar stores experience for drilldown operations (single row access).

Two modes of Hybrid Columnar Compression are available. **Query optimized 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 seldom accessed data that is 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.

Extreme Performance from Exadata Smart Flash Cache

Exadata systems use the latest **PCI flash technology** rather than flash disks. PCI flash delivers ultra-high performance by placing flash memory directly on the high speed PCI bus rather than behind slow disk controllers and directors. Each Exadata Storage Server includes 4 PCI flash cards with a total raw capacity of 3.2 TB of flash memory. A full rack Exadata Database Machine X4-2 includes 56 PCI flash cards providing 44.8 TB of raw physical flash memory.



Sun Flash Accelerator F80 PCIe Card

Exadata flash can be used directly as flash disks, but it is almost always configured as a flash cache in front of disk since caching provides flash level performance for much more data than fits directly into flash.

The **Exadata Smart Flash Cache** automatically caches frequently accessed data in PCI flash while keeping infrequently accessed data on disk drives. 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 understands when I/Os are run for backup purposes, for table scans, and for storing 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 always retained in flash. Tables can be retained in flash without the need to move the table to different tablespaces, files or LUNs as is often required with traditional storage.

Exadata's Smart Flash Cache is designed to deliver flash-level IO rates, throughput, and response times for data that is many times larger than the physical flash capacity in the machine by automatically moving active data that is experiencing heavy IO activity into flash, while leaving cold data that sees infrequent IO activity 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 10 times smaller than disk capacity. Such high flash cache hit rates mean that Exadata Smart Flash Cache provides an **effective flash capacity** that is often 10 times larger than the physical flash cache. For example, a full rack Exadata Database Machine X4-2 often has an effective flash capacity of 440 TB.

On top of the capacity benefits provided by smart caching, **Exadata Smart Flash Cache Compression** dynamically increases the capacity of the flash cache by transparently compressing user data as it is loaded into the flash cache. This allows much more data to be kept in flash memory, and further decreases the need to access data on disk drives. The compression and decompression operations are completely transparent to the application and database. Exadata Smart Flash Cache Compression leverages hardware acceleration to deliver **zero performance overhead for compression and decompression**, even when running at rates of millions of I/Os per second or 100s of Gigabytes per second.

Flash Cache Compression benefits vary based on the compressibility of the user data. Tables that are uncompressed will see the largest benefits. Indexes will also typically compress very well. Exadata Smart Flash Cache Compression will also

provide significant flash cache space expansion on top of the benefits already provided by Advanced Row and Basic table compression. OLTP applications will often see the overall logical size of the flash cache double even if they use Advanced Row compression. Tables that use Hybrid Columnar Compression or LOB Compression will see minimal additional compression since these are already very highly compressed formats. With Flash Cache Compression turned on, a full rack Exadata Database Machine X4-2 provides up to 88 TB of logical flash cache capacity (before database level compression is factored in).

Flash performance is often limited and bottlenecked by traditional storage architectures. 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. A single full rack Exadata Database Machine X4-2 achieves up to **100 GB per second of data scan bandwidth**, and up to **2.66 Million random 8K read I/O operations per second** (IOPS) when running database workloads. This performance is orders of magnitude faster than traditional database architectures. It is important to note that these are real-world end-to-end performance figures measured running SQL workloads with realistic IO sizes inside a single rack Exadata system. They are not component level measurements based on low level IO tools.

The Exadata Smart Flash cache also caches database block writes. Write caching eliminates disk bottlenecks in large scale OLTP and batch workloads. The flash write capacity of a single full rack Exadata Database Machine X4-2 exceeds **1.96 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.

To further accelerate OLTP workloads, the Exadata Smart Flash Cache also implements a special algorithm to reduce the latency of log write I/Os 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 greatly reduce the latency of log writes and avoid the latency spikes that frequently occur in other flash solutions. The Exadata Smart Flash Logging algorithms are unique to Exadata.

Exadata uses only enterprise grade flash that is designed by the flash manufacturer to have high endurance. Exadata is designed for mission critical workloads and therefore does not use consumer grade flash that can potentially experience performance degradations or fail unexpectedly after a few years of usage. The enterprise grade flash chips used in Exadata X4 have an expected endurance of 10 years or more for typical database workloads.

The automatic data tiering between RAM, flash and disk implemented in Exadata provides tremendous advantages over other flash-based solutions. When third-party flash cards or flash disks are used directly in database servers, the data placed in flash is only available on that server since local flash cannot be shared between

servers. This precludes the use of RAC and limits the database deployment to the size of a single server handicapping performance, scalability, availability, and consolidation of databases. Any component failure, like a flash card, in a single server can lead to a loss of database access. Local flash lacks the intelligent flash caching and Hybrid Columnar Compression provided in Exadata and is much more complex to administer.

Real world experience has shown that server local flash cards and flash disks can become crippled without completely failing leading to database hangs, poor performance, or even corruptions. Flash products have been seen to intermittently hang, exhibit periodic poor performance, or lose data during power cycles, and these failures often do not trigger errors or alerts that would cause the flash product to be taken offline. Worse, these issues can cause hangs inside the Operating System causing full node hangs or crashes. Exadata software automatically detects and bypasses poorly performing or crippled flash. When an unusual condition is detected, Exadata will automatically route I/O operations to alternate storage servers.

Many storage vendors have recognized that the architecture of their traditional storage arrays inherently bottleneck the performance of flash and therefore have developed new flash-only arrays. These flash-only arrays deliver higher performance than traditional 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. Exadata smart flash caching often provides flash level performance for data that is 10 times larger than physical flash since it automatically keeps active data that is experiencing heavy IO activity in flash while leaving cold data that sees infrequent IO activity on low-cost disk. Database and Flash Cache Compression further extend the capacity of Exadata flash. Third party flash arrays will also not benefit from Exadata Hybrid Columnar Compression.

Exadata not only delivers much more capacity than flash-only 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 database.

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 near zero overhead at hundreds of gigabytes of user data per second.

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**.

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

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 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. 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 to transparently maintain a real-time copy of the database at a remote site to provide full protection against primary database failures and site disasters.

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. Mission Critical availability is not restricted to OLTP workloads; it also applies to warehousing and analytics workloads.

Comprehensive System Management

Oracle Enterprise Manager 12c uses a holistic approach to manage the Exadata Database Machine and provides comprehensive lifecycle management from monitoring to management and ongoing maintenance for the entire system. It provides **a unified view of all the hardware and software components** such as database servers, Exadata storage, and InfiniBand switches and allows monitoring the operations running on them and their resource utilization. DBAs can drill down from database monitoring screens to the storage layer of the Exadata Database Machine to quickly determine the root cause of application level performance bottlenecks. Lights-out monitoring within Enterprise Manager is optimized for the Exadata Database Machine with predefined metrics and thresholds so that administrators receive timely notifications when issues arise. In addition, hardware incidents are automatically detected and service requests logged to reduce problem resolution time. Administrators can use Consolidation Planner in Oracle Enterprise Manager to determine optimal consolidation strategies for different Exadata Database Machine configurations and the **Cloud Management Pack** to manage

Database as a Service deployments.

Ideal Platform for Database as a Service Private or Public Cloud

The Exadata Database Machine can host many databases, enabling Database Consolidation or a sophisticated Database as a Service (DBaaS) 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 platform for multi-database workloads.

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.

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.

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** which is available exclusively for Oracle's Engineered Systems. Platinum Services provides fault monitoring, faster response times, and expedited escalation to development. With Platinum Services, fault monitoring, software maintenance, and patching is performed remotely by Oracle engineers. 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 free of charge to

Exadata customers.

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 single 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 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 10X compared to a traditional system.

Exadata provides a huge RAM, flash and disk footprint for large data sets. Raw storage on an Exadata full rack exceeds 670 TB and Hybrid Columnar Compression often expands storage and memory capacity 10X. By intelligently moving active data across storage 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.

Exadata Business Benefits

Beyond the operational benefits of extreme performance, availability, and security at low cost, 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 enhances 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. Given what can be achieved with Exadata, it is no surprise it is the new global standard for running the Oracle Database.

Exadata Database Machine X4-2 Key Capacity and Performance Metrics								
Metric	**Full Rack**		**Half Rack**		**Quarter Rack**		**Eighth Rack**	
Maximum SQL flash bandwidth [2]	100 GB/s		50 GB/s		21.5 GB/s		10.7 GB/s	
Maximum SQL flash read IOPS [3]	2,660,000		1,330,000		570,000		285,000	
Maximum SQL flash write IOPS [4]	1,960,000		980,000		420,000		210,000	
Flash data capacity (raw) [5]	44.8 TB		22.4 TB		9.6 TB		4.8 TB	
Effective Flash cache capacity [7]	Up to 448 TB		Up to 224 TB		Up to 96 TB		Up to 48 TB	
	HC[1] Disks	**HP[1] Disks**	**HC[1] Disks**	**HP[1] Disks**	**HC[1] Disks**	**HP[1] Disks**	**HC[1] Disks**	**HP[1] Disks**
Maximum SQL disk bandwidth [2]	20 GB/s	24 GB/s	10 GB/s	12 GB/s	4.5 GB/s	5.2 GB/s	2.25 GB/s	2.6 GB/s
Maximum SQL disk IOPS [3]	32,000	50,000	16,000	25,000	7,000	10,800	3,500	5,400
Disk data capacity (raw) [5]	672 TB	200 TB	336 TB	100 TB	144 TB	43.2 TB	72 TB	21.6 TB
Disk data capacity (usable) [6]	300 TB	90 TB	150 TB	45 TB	63 TB	19 TB	30 TB	9 TB
Maximum data load rate [8]	20 TB/hour		10 TB/hour		5 TB/hour		2.5 TB/hour	

Actual system performance varies by application.

[1] HP = High Performance; HC = High Capacity

[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 IO requests running SQL. Note that the IO size greatly affects Flash IOPS. Others quote IOPS based on smaller IOs and are not relevant for databases.

[4] Based on 8K IO 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. Usable capacity is measured using normal powers of 2 space terminology with 1 TB = 1024 * 1024 * 1024 * 1024 bytes.

[6] Actual space available for a database after mirroring (ASM normal redundancy) while also providing adequate space (one disk on Quarter and Half Racks and two disks on a Full Rack) to reestablish the mirroring protection after a disk failure in the normal redundancy case.

[7] Effective Flash Capacity is larger than the physical flash capacity and takes into account the high flash hit ratios due to Exadata's intelligent flash caching algorithms, and the size of the underlying disk storage. It is the size of the data files that can often be stored in Exadata and be accessed at the speed of flash memory.

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

Exadata Database Machine X4-2 Support Services

- Hardware Warranty: 1 year with a 4 hour 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 and Solaris 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 Infrastructure as a Service On-Premise (IaaS)
- Oracle Platinum Services
- Oracle PlatinumPlus 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)

<table>
<tr><th colspan="4">Exadata Database Machine X4-2 Hardware</th></tr>
<tr><th>Full Rack</th><th>Half Rack</th><th>Quarter Rack</th><th>Eighth Rack</th></tr>
<tr><td>8 x Database Servers, each with:</td><td>4 x Database Servers, each with:</td><td>2 x Database Servers, each with:</td><td>2 x Database Servers, each with:</td></tr>
<tr><td colspan="4">• 2 x Twelve-Core Intel® Xeon® E5-2697 v2 Processors (2.7 GHz)
• 256GB Memory (expandable to 512GB)
• Disk Controller HBA with 512MB Battery Backed Write Cache
• 4 x 600 GB 10,000 RPM Disks
• 2 x QDR (40Gb/s) InfiniBand Ports
• 4 x 1/10 Gb Ethernet Ports (copper)
• 2 x 10 Gb Ethernet Ports (optical)
• 1 x ILOM Ethernet Port
• 2 x Redundant Hot-Swappable Power Supplies</td></tr>
<tr><td>192 CPU cores and up to 4TB memory for database processing (24 CPU cores and up to 512 GB memory per Database Server)</td><td>96 CPU cores and up to 2 TB memory for database processing (24 CPU cores and up to 512 GB memory per Database Server)</td><td>48 CPU cores and up to 1TB memory for database processing (24 CPU cores and up to 512 GB memory per Database Server)</td><td>24 CPU cores and up to 1 TB memory for database processing (12 CPU cores per Database Server are enabled with up to 512 GB memory per Database Server)</td></tr>
<tr><td>14 x Exadata Storage Servers X4-2:
• 168 CPU cores for SQL processing
• 56 PCI flash cards with 44.8 TB (raw) Exadata Smart Flash Cache
• 168 x 1.2 TB 10,000 RPM High Performance disks
or 168 x 4 TB 7,200 RPM High Capacity disks</td><td>7 x Exadata Storage Servers X4-2:
• 84 CPU cores for SQL processing
• 28 PCI flash cards with 22.4 TB (raw) Exadata Smart Flash Cache
• 84 x 1.2 TB 10,000 RPM High Performance disks
or 84 x 4 TB 7,200 RPM High Capacity disks</td><td>3 x Exadata Storage Servers X4-2:
• 36 CPU cores for SQL processing
• 12 PCI flash cards with 9.6 TB (raw) Exadata Smart Flash Cache
• 36 x 1.2 TB 10,000 RPM High Performance disks
or 36 x 4 TB 7,200 RPM High Capacity disks</td><td>3 x Exadata Storage Servers X4-2:
• 36 CPU cores for SQL processing (18 cores enabled)
• 6 PCI flash cards with 4.8 TB (raw) Exadata Smart Flash Cache (6 more flash cards reserved for use on upgrade to quarter rack)
• 18 x 1.2 TB 10,000 RPM High Performance disks
or 18 x 4 TB 7,200 RPM High Capacity disks
(18 more reserved for use on upgrade to quarter rack)</td></tr>
<tr><td colspan="4">2 x 36 port QDR (40 Gb/sec) InfiniBand Switches</td></tr>
<tr><td colspan="4">Additional Hardware Components:
• 42U Rack
• Ethernet switch for administrative connectivity to servers in the Database Machine
• 2 x Redundant Power Distributions Units (PDUs)</td></tr>
<tr><td colspan="4">Included Spare Parts Kit Contains:
• 1 x 1.2 TB High Performance disk or 1 x 4 TB High Capacity disk
• 1 x 800 GB PCI flash card</td></tr>
</table>

Exadata Database Machine X4-2 Upgrades			
Multi-Rack Connection	**Half Rack to Full Rack Upgrade**	**Quarter Rack to Half Rack Upgrade**	**Eighth Rack to Quarter Rack Upgrade**
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, or X4 generation hardware.	Upgradability: Field upgrade from Half Rack to Full Rack Additional Hardware Components Included With The Upgrade: • 4 x Database Servers • 7 x Exadata Storage Servers X4-2 with 12 x 1.2TB 10,000 RPM High Performance disks or 12 x 4 TB 7,200 RPM High Capacity disks • InfiniBand and Ethernet cables to connect all the components	Upgradability: Field upgrade from Quarter Rack to Half Rack Additional Hardware Components Included With The Upgrade: • 2 x Database Servers • 4 x Exadata Storage Servers X4-2 with 12 x 1.2TB 10,000 RPM High Performance disks or 12 x 4 TB 7,200 RPM High Capacity disks • InfiniBand and Ethernet cables to connect all the components	Upgradability: Field upgrade from Eighth Rack to Quarter Rack Additional Hardware Components Present In The Eighth Rack Are Enabled With The Upgrade: • Twelve additional cores of the Intel® Xeon® E5-2697 v2 Processors (2.7 GHz), in each Database Server, are enabled • Six disks and two Flash Cache cards, in each Exadata Storage Server, are enabled
Upgrade Support Services: • Hardware installation and software configuration			
Optional Customer Supplied Ethernet Switch Installation in Exadata Database Machine X4-2			
Each Exadata Database Machine X4-2 rack has 2U available at the top of the rack which 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.			

Exadata Database Machine X4-2 Environmental Specifications				
	Full Rack	**Half Rack**	**Quarter Rack**	**Eighth Rack**
Height Width Depth	78.66" - 1998 mm 23.62" – 600 mm 47.24" – 1200 mm			
Weight	1880 lbs (852.8 kgs)	1158 lbs (525.3 kgs)	806 lbs (365.6 kgs)	806 lbs (365.6 kgs)
Acoustic noise (operating)	9.3 B	8.9 B	8.5 B	8.5 B
Environmentals With High Capacity Disk				
Maximum power usage Typical power usage [1]	11.2 kW (11.4 kVA) 7.9 kW (8.1 kVA)	6.2 kW (6.3 kVA) 4.3 kW (4.4 kVA)	3.1 kW (3.2 kVA) 2.2 kW (2.3 kVA)	2.8 kW (2.9 kVA) 2.0 kW (2.1 kVA)
Cooling at maximum usage Cooling at typical usage	38,300 BTU/hour 40,400 kJ/hour) 27,000 BTU/hour 28,500 kJ/hour)	21,200 BTU/hour 22,400 kJ/hour) 14,700 BTU/hour 15,500 kJ/hour)	10,600 BTU/hour 11,200 kJ/hour) 7,500 BTU/hour 7,900 kJ/hour)	9,500 BTU/hour 10,000 kJ/hour) 6,600 BTU/hour 7,000 kJ/hour)
Airflow at maximum usage [2] Airflow at typical usage [2]	1,780 CFM 1,250 CFM	980 CFM 680 CFM	490 CFM 350 CFM	440 CFM 310 CFM
Environmentals With High Performance Disk				
Maximum power usage Typical power usage [1]	12.1 kW (12.4 kVA) 8.5 kW (8.7 kVA)	6.6 kW (6.8 kVA) 4.7 kW (4.8 kVA)	3.3 kW (3.4 kVA) 2.4 kW (2.5 kVA)	3.0 kW (3.1 kVA) 2.1 kW (2.2 kVA)
Cooling at maximum usage Cooling at typical usage	41,300 BTU/hour (43,600 kJ/hour) 29,000 BTU/hour (30,600 kJ/hour)	22,500 BTU/ hour (23,750 kJ/ hour) 16,000 BTU/ hour (16,900 kJ/ hour)	11,300 BTU/ hour (11,900 kJ/ hour) 8,200 BTU/ hour (8,700 kJ/ hour)	10,200 BTU/ hour (10,700 kJ/ hour) 7,100 BTU/ hour (7,500 kJ/ hour)
Airflow at maximum usage [2] Airflow at typical usage [2]	1,900 CFM 1,350 CFM	1,050 CFM 750 CFM	520 CFM 365 CFM	470 CFM 325 CFM

Operating temperature/humidity: 5 ºC to 32 ºC (41 ºF to 89.6 ºF), 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

Regulations [3]

- 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 [3]

- 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 [3]

- 2006/95/EC Low Voltage Directive, 2004/108/EC EMC Directive, 2011/65/EU RoHS Directive, 2012/19/EU WEEE Directive

[1] Typical power usage varies by application load.

[2] Airflow must be front-to-back.

[3] All 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.

Oracle Database Software (sold separately)	
For database servers	Oracle Database 11g Release 2 Enterprise Edition and Oracle Database 12c Enterprise Edition Oracle Real Application Clusters, Oracle Partitioning, Oracle Multitenant and other Oracle Database options are available 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 5 Update 9 with the Unbreakable Enterprise Kernel 2; or Solaris 11 Update 1: selectable at install time 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)
Exadata Storage Software Features (Partial List)	
• Smart Scan Technology • Smart Flash Cache • Smart Flash Logging • Flash Cache Compression • IO and Network Resource Management • Storage Index • Hybrid Columnar Compression • Smart Scans of Data Mining model scorin	
High-Availability Features	
• Redundant power supplies for all servers • Redundant InfiniBand switches • Redundant Power Distribution Units • Oracle Automatic Storage Management: All database files mirrored; disk failures do not interrupt query processing • Oracle Real Application Clusters: database server failures are tolerated • Oracle Exadata Storage Server Software: storage server failures are tolerated • Backup is performed using Oracle Recovery Manager • Point in time restores are performed using Oracle Flashback Technologies • Oracle Data Guard for protection against disasters	
Manageability Features	
• Oracle Embedded Integrated Lights Out Manager (ILOM) • Oracle Enterprise Manager 12c	

Contact Us

For more information about the Oracle Database Machine, please visit oracle.com or call +1.800.ORACLE1 to speak to an Oracle representative.

Oracle is committed to developing practices and products that help protect the environment

ORACLE