ORACLE EXADATA DATABASE MACHINE X3-2

FEATURES AND FACTS

FEATURES

- Up to 128 CPU cores and 2 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 22.4 TB of Exadata Smart Flash Cache
- 40 Gb/second (QDR) InfiniBand Network
- Uncompressed and mirrored usable capacity of up to 224 TB per rack
- Uncompressed I/O bandwidth of up to 100 GB/second per rack
- Hybrid Columnar Compression delivers 10X-15X compression ratios
- Complete redundancy for high availability
- Oracle Linux or Solaris based database servers

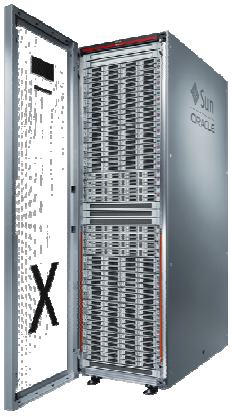
FACTS

- Ability to perform up to 1,500,000 database read I/O operations per second
- Easily upgrade to meet the needs of any size application
- Scale by connecting multiple Exadata Database Machine X3-2 racks or Exadata Storage Expansion Racks. Up to 18 racks can be connected by simply connecting via InfiniBand cables. Larger configurations can be built with additional InfiniBand switches
- Pre-configured system optimized for all database applications

The Oracle Exadata Database Machine is engineered to be the highest performance and most available platform for running the Oracle Database. Built using industry-standard hardware from Sun, and intelligent database and storage software from Oracle, the Exadata Database Machine delivers extreme performance for 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 is ready to tackle your largest and most important database applications — and often run them 10x faster, or more.

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 most supportable platform for running the Oracle Database.

The Oracle Exadata Database Machine runs the standard Oracle Database. 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.

RELATED PRODUCTS AND SERVICES

RELATED PRODUCTS

- Oracle Exadata Database Machine X3-8
- Oracle Exadata Storage Expansion Rack X3-2
- Oracle Exadata Storage Server X3-2
- 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

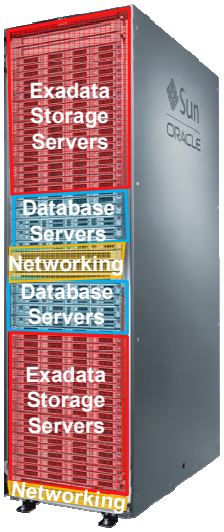
RELATED SERVICES

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

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 running specialized database networking protocols connects all the components inside an Exadata Database Machine. External connectivity to the Exadata Database Machine is provided through standard 1 Gigabit and 10 Gigabit Ethernet.

Four sizes of the Exadata Database Machine X3-2 are available, 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 upgraded to another online ensuring a smooth upgrade path as database requirements grow. All four sizes are available with either 600 GB High Performance disks or 3 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, completed in minutes.

Exadata Database Machines protect your investment by allowing newer generation processors and storage to be deployed seamlessly into existing Exadata Database Machines. Similarly, new software releases are compatible with older Exadata Database Machines. As your database deployments grow, the Exadata system grows as required.

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 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.

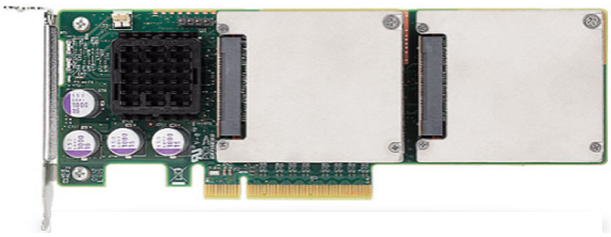
For example, if a query is executed to identify the customers who placed sales orders over $1000 in the month of March, an Exadata system will: offload the scanning of the table to the Exadata storage; filter out all sales orders that are less than $1000; filter out sales orders not in March; and extract 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 includes two 6-core Intel® Xeon® processors that are used for database offload. A full rack Exadata Database Machine has a total of 168 storage processing cores. 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.

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 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 capacity of 1.6 TB of flash memory. A

full rack Exadata Database Machine includes 56 PCI flash cards providing 22.4 TB of flash memory.



Sun Flash Accelerator F40 PCIe Card

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 will never be reused or will not fit in the cache. The Oracle Database and Exadata storage optionally allow the user to provide SQL directives at the database table, index and segment level to ensure that specific data is retained in flash. Tables can be retained in flash without the need to move the table to different tablespaces, files or LUNs like you would have to do with traditional storage and flash disks.

The combination of scale-out storage, InfiniBand networking, database offload, and PCI flash allows a single rack Exadata Database Machine rack to achieve up to 100 GB per second of data scan bandwidth, and up to 1,500,000 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 inside a single rack Exadata system. They are not component level measurements based on low level IO measurement 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 Exadata rack exceeds 1,000,000 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 Exadata Smart Flash Cache also implements algorithms to reduce the latency of log write I/Os. 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 speed up log writes and bypass the latency spikes that can occur in flash solutions. The Exadata Smart Flash Logging algorithms are unique to the Exadata system.

Flash and RAM memory are central to the architecture of the Exadata Database Machine X3. Prior database systems were disk-centric with flash memory used to

accelerate database execution. The Exadata Database Machine X3 systems are flash-centric, with large RAM memory footprints used to further accelerate workload execution. In order to realize the highest level of performance at the lowest cost, the Exadata X3 system implements a mass memory hierarchy that automatically moves active data into flash memory and the most active data into RAM memory while keeping less active data on low-cost disks.

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 degrade or fail unexpectedly after a few years of usage. The enterprise grade flash chips used in Exadata X3 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 are used in a traditional database server, the data placed on flash is only available on that server since flash cards cannot be shared between servers. This precludes the use of RAC and limits the database deployment to the size of 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 can become crippled without failing when it hangs, experiences intermittent poor performance, or data loss on power cycle, and may not trigger failover or alerts. In addition it will not automatically be protected by high-level mirroring like Exadata. There is no Hybrid Columnar Compression so the expensive flash resource is underutilized and does not provide I/O resource management for prioritizing bandwidth. Third party flash lacks the storage hierarchy and tiering automatically provided in Exadata and is much more complex to administer.

When considering third party flash arrays (storage arrays comprised solely of flash) they have other limitations. Flash arrays will be data bandwidth limited since they have to transfer all the data from SQL queries to the database server as they do not provide offload functionality like Exadata Smart Scans. They require much more administrative overhead than Exadata storage since LUNs, mount points and tablespaces must be created. No special backup procedures are required for Exadata flash while backup and recovery procedures are required for flash arrays. With flash arrays there is no automatic dynamic tiering of the data between disk, flash and memory, as in Exadata. And of critical importance, as data usage patterns change the administrator must monitor and reconfigure the data placed on flash arrays to maintain good performance since the data is statically tied to the flash array; unlike Exadata. None of this extra administrative overhead is required for Exadata.

Optimizing Storage Use and I/O Through Compression

Compressing data provides dramatic reduction in the storage consumed for large databases. The Exadata Storage Server provides a very advanced compression capability called Hybrid Columnar Compression (HCC). Hybrid Columnar Compression enables the highest levels of data compression and provides

tremendous cost-savings and performance improvements due to reduced I/O. Storage savings range from 5x to 20x with typical storage savings of 10x. On conventional systems, enabling high data compression has the drawback of reducing performance. Because the Exadata Database Machine is able to offload compression overhead into large numbers of processors in Exadata storage, most workloads run faster using Hybrid Columnar Compression than they do without it. Hybrid Columnar Compression combines the compression and analytic performance benefits of column storage while avoiding the dramatic slowdown that pure columnar stores experience for drilldown operations.

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 maintaining excellent performance. Archive compression mode provides the highest degree of compression and is targeted at rarely accessed data that is kept online.

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 the most secure database system in the industry.

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.

Database Cloud

The Exadata Database Machine can host many databases, enabling the creation of a Database Cloud or a sophisticated Database-as-a-Service (DBaaS). Consolidated environments inherently have complex workloads mixing sequential and random access patterns. Exadata's industry leading scalability and performance make it an ideal platform for these demanding workloads. Further, Exadata Database Machine implements unique CPU and disk prioritization of workloads at the database, application, user, or even job level to ensure that each of the consolidated databases receives the necessary resources and achieves the target response times.

Comprehensive System Management

Oracle Enterprise Manager Cloud Control 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. In an Oracle Exadata Database Machine, system management is engineered together with hardware and software to provide not just high performance and availability but also ease of management and consolidation.

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 remote fault monitoring and, should an issue occur, provides faster response times and expedited escalation to development. With Platinum Services, 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 500TB 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 be 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 directly improves 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

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 X3-2 Key Capabilities

Metric	Full Rack		Half Rack		Quarter Rack		Eighth Rack	
	HP[1] Disks	HC[1] Disks	HP Disks	HC Disks	HP Disks	HC Disks	HP Disks	HC Disks
Maximum disk bandwidth [2]	25 GB/s	18 GB/s	12.5 GB/s	9 GB/s	5.4 GB/s	4 GB/s	2.7 GB/s	2 GB/s
Maximum disk IOPS [3]	50,000	28,000	25,000	14,000	10,800	6,000	5,400	3,000
Disk data capacity (raw) [5]	100 TB	504 TB	50 TB	252 TB	21.6 TB	108 TB	10.8 TB	54 TB
Disk data capacity (usable) [6]	45 TB	224 TB	22.5 TB	112 TB	9.5 TB	48 TB	4.5 TB	23 TB
Maximum flash bandwidth [2]	100 GB/s	93 GB/s	50 GB/s	46.5 GB/s	21.5 GB/s	20 GB/s	10.7 GB/s	10 GB/s
Maximum flash read IOPS [3]	1,500,000		750,000		375,000		187,000	
Maximum flash write IOPS [4]	1,000,000		500,000		250,000		125,000	
Flash data capacity (raw) [5]	22.4 TB		11.2 TB		4.8 TB		2.4 TB	
Maximum data load rate [7]	16 TB/hour		8 TB/hour		4 TB/hour		2 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 data compression. Effective user data bandwidth is higher when 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 2K or 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. Database writes will usually issue multiple storage IOs to maintain redundancy.

[5] Raw capacity is measured in standard disk drive terminology with 1 GB = 1 billion bytes. Capacity is measured using normal powers of 2 space terminology with 1 TB = 1024 * 1024 * 1024 * 1024 bytes. Actual formatted capacity is less.

[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.

[7] 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 X3-2 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 X3-2 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 Eight-Core Intel® Xeon® E5-2690 Processors (2.9 GHz)
• 256GB Memory
• Disk Controller HBA with 512MB Battery Backed Write Cache
• 4 x 300 GB 10,000 RPM Disks
• 2 x QDR (40Gb/s) 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>128 CPU cores and 2 TB memory for database processing (16 CPU cores and 256 GB memory per Database Server)</td><td>64 CPU cores and 1 TB memory for database processing (16 CPU cores and 256 GB memory per Database Server)</td><td>32 CPU cores and 512 GB memory for database processing (16 CPU cores and 256 GB memory per Database Server)</td><td>16 CPU cores and 512 GB memory for database processing (8 CPU cores per Database Server are enabled with 256 GB memory per Database Server)</td></tr>
<tr><td>14 x Exadata Storage Servers X3-2:
• 168 CPU cores for SQL processing
• 56 PCI flash cards with 22.4 TB Exadata Smart Flash Cache
• 168 x 600 GB 15,000 RPM High Performance disks or 168 x 3 TB 7,200 RPM High Capacity disks</td><td>7 x Exadata Storage Servers X3-2:
• 84 CPU cores for SQL processing
• 28 PCI flash cards with 11.2 TB Exadata Smart Flash Cache
• 84 x 600 GB 15,000 RPM High Performance disks or 84 x 3 TB 7,200 RPM High Capacity disks</td><td>3 x Exadata Storage Servers X3-2:
• 36 CPU cores for SQL processing
• 12 PCI flash cards with 4.8 TB Exadata Smart Flash Cache
• 36 x 600 GB 15,000 RPM High Performance disks or 36 x 3 TB 7,200 RPM High Capacity disks</td><td>3 x Exadata Storage Servers X3-2:
• 36 CPU cores for SQL processing (18 cores enabled)
• 12 PCI flash cards (6 cards enabled) with 2.4 TB Exadata Smart Flash Cache
• 18 x 600 GB 15,000 RPM High Performance disks or 18 x 3 TB 7,200 RPM High Capacity disks (6 disks per storage server enabled)</td></tr>
<tr><td colspan="2">3 x 36 port QDR (40 Gb/sec) InfiniBand Switches</td><td colspan="2">2 x 36 port QDR (40 Gb/sec) InfiniBand Switches</td></tr>
<tr><td>Spares Kit Included:
• 2 x 600 GB High Performance disks or 2 x 3 TB High Capacity disk
• 2 x 400 GB Exadata Smart Flash Cache cards
• InfiniBand cables</td><td colspan="3">Spares Kit Included:
• 1 x 600 GB High Performance disks or 1 x 3 TB High Capacity disk
• 1 x 400 GB Exadata Smart Flash Cache cards
• InfiniBand cables</td></tr>
<tr><td colspan="4">Additional Hardware Components Included:
• Ethernet switch for administration of the Database Machine
• 2 x Redundant Power Distributions Units (PDUs)
• 42U rack packaging</td></tr>
</table>

Exadata Database Machine X3-2 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 Exadata Database Machine X3-2 or Exadata Storage Expansion Racks via the included InfiniBand fabric with at most 1 Quarter or Eighth Rack in the configuration Connect a maximum of 2 Exadata Quarter or Eighth Racks systems via included InfiniBand fabric Other configuration considerations: • Up to 18 racks can be connected without requiring additional InfiniBand switches • InfiniBand cables to connect 3 racks are included in the rack Spares Kit • Additional optical InfiniBand cables required when connecting 4 or more racks	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 X3-2 with 12 x 600 GB 15,000 RPM High Performance disks or 12 x 3 TB 7,200 RPM High Capacity disks • InfiniBand and Ethernet cables to connect all the components • Upgrade to Full Rack Spares Kit	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 X3-2 with 12 x 600 GB 15,000 RPM High Performance disks or 12 x 3 TB 7,200 RPM High Capacity disks • 1 x 36 port QDR (40 Gb/sec) InfiniBand switch • InfiniBand and Ethernet cables to connect all the components • Upgrade to Half Rack Spares Kit	Upgradability: Field upgrade from Eighth Rack to Quarter Rack Additional Hardware Components Present In The Eighth Rack Are Enabled With The Upgrade: • Eight additional cores of the Intel® Xeon® E5-2690 Processors (2.9 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 X3-2			
Each Exadata Database Machine X3-2 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 some other rack. Some restrictions apply.			

Exadata Database Machine X3-2 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	1,921 lbs. (871.4 kg)	1,199 lbs. (543.9 kg)	813 lbs. (368.8 kg)	813 lbs. (368.8 kg)
Acoustic noise (operating)	8.7 B	8.4 B	8.1 B	8.1 B
Environmentals With High Performance Disk				
Maximum power usage Typical power usage [1]	11.9 kW (12.1 kVA) 8.4 kW (8.6 kVA)	6.5 kW (6.6 kVA) 4.6 kW (4.7 kVA)	3.2 kW (3.3 kVA) 2.3 kW (2.4 kVA)	2.9 kW (3.0 kVA) 2.0 kW (2.1 kVA)
Cooling at maximum usage Cooling at typical usage	40,600 BTU/hour (42,800 kJ/hour) 28,700 BTU/hour (30,300 kJ/hour)	22,200 BTU/ hour (23,400 kJ/ hour) 15,700 BTU/ hour (16,600 kJ/ hour)	10,900 BTU/ hour (11,500 kJ/ hour) 7,850 BTU/ hour (8,300 kJ/ hour)	9,900 BTU/ hour (10,500 kJ/ hour) 6,800 BTU/ hour (7,200 kJ/ hour)
Airflow at maximum usage [2] Airflow at typical usage [2]	1,900 CFM 1,350 CFM	1,050 CFM 750 CFM	500 CFM 375 CFM	460 CFM 325 CFM
Environmentals With High Capacity Disk				
Maximum power usage Typical power usage [1]	10.9 kW (11.1 kVA) 7.6 kW (7.8 kVA)	6.0 kW (6.1 kVA) 4.2 kW (4.3 kVA)	3.0 kW (3.1 kVA) 2.1 kW (2.2 kVA)	2.7 kW (2.8 kVA) 1.9 kW (2.0 kVA)
Cooling at maximum usage Cooling at typical usage	37,200 BTU/hour 39,250 kJ/hour) 26,000 BTU/hour 27,400 kJ/hour)	20,500 BTU/hour 21,600 kJ/hour) 14,300 BTU/hour 15,100 kJ/hour)	10,200 BTU/hour 10,800 kJ/hour) 7,200 BTU/hour 7,600 kJ/hour)	9,200 BTU/hour 9,700 kJ/hour) 6,500 BTU/hour 6,850 kJ/hour)
Airflow at maximum usage [2] Airflow at typical usage [2]	1,700 CFM 1,200 CFM	950 CFM 670 CFM	470 CFM 330 CFM	425 CFM 300 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 60950-1 2nd Ed, EN60950-1:2006 2nd Ed, CB Scheme with all country differences
- RFI/EMI: FCC CFR 47 Part 15 Subpart B Class A, EN 55022:2006+A1:2007 Class A, EN 61000-3-11:2000, EN 61000-3-12:2005, ETSI EN 300 386 V1.4.1 (2008)
- Immunity: EN 55024:1998+A1:2001:+A2:2003

Certifications [3]

- Safety: UL/cUL, CE, BSMI, GOST R, S-Mark, CSA C22.2 No. 60950-1-07 2nd Ed, CCC
- EMC: CE, FCC, VCCI, ICES, KCC, GOST R, BSMI Class A, AS/NZ 3548, CCC
- Other: Complies with WEEE Directive (2002/96/EC) and RoHS Directive 2011/65/EU (2002/95/EC)

[1] Typical power usage varies by application load.

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

[3] 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, and other Oracle Database options See the release specific documentation for feature support.
For storage servers	Oracle Exadata Storage Server Software Licenses are transferable from one system to another.
Oracle Software (included)	
For database servers	Oracle Linux 5 Update 8 with the Unbreakable Enterprise Kernel or Red Hat Compatible Kernel; or Solaris 11: 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	
• Smart Scan Technology • Smart Flash Cache • Smart Flash Logging • IO Resource Manager • Storage Index Technology • Hybrid Columnar Compression • Smart Scans of Data Mining model scoring	
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 Cloud Control 12c	

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