

ORACLE EXADATA STORAGE EXPANSION RACK X3-2

FEATURES AND FACTS

FEATURES

- Grow the storage capacity of Oracle Exadata Database Machines and Oracle SPARC SuperCluster
- Includes from 4 to 18 Oracle Exadata Storage Servers
- Mirrored usable capacity of up to 288 TB per rack before compression
- Up to 216 CPU cores dedicated to SQL processing in storage
- Up to 28.8 TB of Exadata Smart Flash Cache
- Connected directly to Exadata Database Machines X3-2 and X3-8 and SPARC SuperCluster via 40 Gb/second InfiniBand
- Uncompressed I/O bandwidth of up to 130 GB/second per rack
- Hybrid Columnar Compression delivers 10X-15X compression ratios
- Complete redundancy for high availability

FACTS

- Engineered scale-out storage architecture pre-configured to easily expand system capacity and performance, online
- Simple upgrade to meet the needs of any size application
- Over 4.5 Petabytes of user data can be stored in a rack using the included Hybrid Columnar Compression
- Scale the configuration by connecting up to 8 Exadata Database Machines and Exadata Storage Expansion Racks by simply connecting via InfiniBand cables. Larger configurations can be built with additional InfiniBand switches

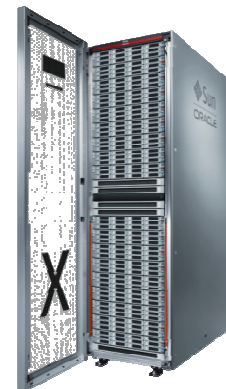
The Oracle Exadata Database Machine and Oracle SPARC SuperCluster delivers extreme performance and scalability for all your database applications including Online Transaction Processing (OLTP), Data Warehousing (DW) and consolidation of mixed workloads. The Oracle Exadata Storage Expansion Rack is engineered to be the simplest, fastest and most robust way to add additional storage capacity to an Exadata Database Machine or SPARC SuperCluster. A natural extension of the Exadata Database Machine, the Exadata Storage Expansion Rack can be used to satisfy the Big Data requirements of the largest mission critical databases.

Engineered System For Fast Deployment of All Your Databases

The Exadata Database Machine and SPARC SuperCluster are easy to deploy systems that include 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 the weeks of effort that is 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. The Exadata Storage Expansion Rack takes this to the next level.

Extreme Performance and Capacity

The Exadata Storage Expansion Rack enables you to grow the Exadata storage capacity and bandwidth of any Exadata Database Machine or SPARC SuperCluster. 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 or SPARC SuperCluster 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.



Extreme Performance by Offloading Data Intensive Processing

As data volumes grow exponentially, conventional storage arrays struggle to efficiently access terabytes of data and push that data through storage networks.

RELATED PRODUCTS AND SERVICES**RELATED PRODUCTS**

- Oracle Exadata Database Machine X3-8
- Oracle Exadata Database Machine X3-2
- Oracle Exadata Storage Server X3-2
- Oracle SPARC SuperCluster
- Oracle Database 11g
- Real Application Clusters
- Partitioning
- 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 Platinum Services
- Consulting Services
- Oracle University courses

The Exadata Database Machine and SPARC SuperCluster not only provide high performance and scalability, they also include 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. Exadata storage offload reduces database server CPU consumption and greatly reduces the amount of data moved between storage and database servers.

Each Exadata Storage Server includes two 6-core Intel® Xeon® processors that are used for database offload. A Full Rack Exadata Storage Expansion Rack has a total of 216 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.

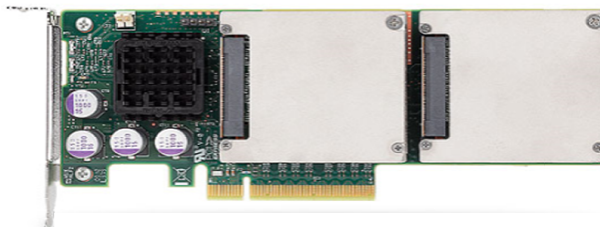
Extreme System Scalability and Growth

Three versions of the Exadata Storage Expansion Rack are available. From the Full Rack configuration with 18 Exadata Storage Servers; to the Half Rack with 9 Exadata Storage Servers; to the Quarter Rack system with 4 Exadata Storage Servers; there is a configuration that fits any application. One version can be upgraded online to another ensuring a smooth upgrade path as processing requirements grow. All three versions of the expansion rack are delivered with the same 600 GB High Performance disks or 3 TB High Capacity disks, and Exadata Smart Flash Cache, available in the Exadata Database Machine. In addition to upgrading from a small to large Exadata Storage Expansion Rack, Oracle continues to use a building-block approach to connect the Exadata Storage Expansion Rack to the Exadata Database Machine and SPARC SuperCluster using the integrated InfiniBand fabric to easily scale the system to any size. Exadata Storage Expansion Full, Half and Quarter Racks can be coupled to Exadata Database Machine Full, Half and Quarter Rack systems in almost any combination. Up to 8 Exadata Database Machine racks and Exadata Storage Expansion Racks can be easily connected via InfiniBand cables. An 8 rack Exadata configuration has a raw disk capacity of up to 5,040 TB and 1,680 CPU cores dedicated to SQL processing. Larger configurations can be built with additional InfiniBand switches.

As new Exadata Storage Expansion Racks are connected to an Exadata Database Machine or SPARC SuperCluster the storage capacity and performance of the system grow. The system can be run in single system image mode or logically partitioned for consolidation of multiple databases. Scaling out is easy with Exadata Database Machine, SPARC SuperCluster and Exadata Storage Expansion Racks. Automatic Storage Management (ASM) dynamically and automatically balances the data across Exadata Storage Servers, online, evenly spreading the I/O load across the racks, fully utilizing all the hardware and easily integrating the expansion rack into the configuration. The I/O Resource Manager can also be used to apportion I/O bandwidth to different databases and users of the system to deliver on business service level targets.

Extreme Performance from Exadata Smart Flash Cache

Exadata systems use the latest PCI flash technology rather than flash disks. PCI flash greatly accelerates 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 Storage Expansion Rack includes 72 PCI flash cards providing 28.8 TB of flash memory.



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 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 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 Exadata Storage Expansion Rack to deliver up to 130 GB per second of I/O bandwidth and up to 1,900,000 random 8K read I/O operations per second (IOPS) to database workloads. This performance is orders of magnitude faster than traditional storage arrays. Exadata Flash IOPS are so high they are typically limited by database server CPU, not IO. This is especially true for the Exadata Storage Expansion Rack.

The Exadata Smart Flash Cache also implements unique algorithms to reduce the latency of log write I/O. 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 to speed up log writes while implementing special algorithms that bypass the latency spikes that are seen in other flash solutions.

Optimizing Storage Use and I/O Through Compression

Compressing data can provide 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. Typical storage savings range from 10x to 15x. 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.

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 Database Machine provides the ability to fully encrypt all database data and run queries against fully encrypted databases with near zero overhead. This is done by moving decryption processing from software into the Exadata Storage Server hardware.

Extreme Backup & Recovery Speed

One example of the Big Data strengths of the Exadata Storage Expansion Rack is when used as a destination for Exadata Database Machine backups. A full database backup can be created at up to 27 TB/hour when backing up uncompressed data that is being written to mirrored disk in an Exadata Storage Expansion Rack. It is capable of backing up hundreds of terabytes per hour when doing incremental database backups and petabytes per hour with incremental backups of Hybrid Columnar Compressed data. A disk backup on an Exadata Storage Expansion Rack is usable directly without loss of performance and without having to do a restore. This is a unique backup capability only available when backing up to an Exadata Storage Expansion Rack. It is by far the fastest and simplest way to backup and recover your Oracle Exadata Database Machine.

Mission Critical High Availability

The Exadata Storage Expansion Rack 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 Storage Expansion Rack has completely redundant hardware including redundant InfiniBand networking, redundant Power Distribution Units (PDU), redundant power supplies 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 maintain a real-time copy of the database at a remote site to provide full protection against site failures and disasters.

Because of its industry leading availability, the Exadata Database Machine and the Exadata Storage Expansion Rack have 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.

Exadata Storage Expansion Rack X3-2 Key Capabilities						
	Full Rack		Half Rack		Quarter Rack	
	HP ¹ Disks	HC ¹ Disks	HP Disks	HC Disks	HP Disks	HC Disks
Maximum disk bandwidth ²	32 GB/s	23 GB/s	16 GB/s	11.5 GB/s	7.2 GB/s	5 GB/s
Maximum disk IOPS ³	64,000	36,000	32,000	18,000	14,400	8,000
Disk data capacity (raw) ⁵	128 TB	648 TB	64 TB	324 TB	28 TB	144 TB
Disk data capacity (usable) ⁶	58 TB	288 TB	29 TB	144 TB	13 TB	64 TB
Maximum flash bandwidth ²	130 GB/s	121 GB/s	65 GB/s	60.5 GB/s	29 GB/s	27 GB/s
Maximum flash read IOPS ³	1,900,000		950,000		425,000	
Maximum flash write IOPS ⁴	1,350,000		675,000		300,000	
Flash data capacity (raw) ⁵	28.8 TB		14.4 TB		6.4 TB	
Maximum full backup rate	27 TB/hour		13.5 TB/hour		6 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. Exadata Flash IOPS are so high they are typically limited by database server CPU, not IO. This is especially true for the Storage Expansion Racks.						
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.						

Exadata Storage Expansion Rack X3-2 Hardware		
Full Rack	Half Rack	Quarter Rack
18 x Exadata Storage Servers X3-2: <ul style="list-style-type: none">• 216 CPU cores for SQL processing• 72 PCI flash cards with 28.8 TB Exadata Smart Flash Cache• 216 x 600 GB 15,000 RPM High Performance disks or 216 x 3 TB 7,200 RPM High Capacity disks	9 x Exadata Storage Servers X3-2: <ul style="list-style-type: none">• 108 CPU cores for SQL processing• 36 PCI flash cards with 14.4 TB Exadata Smart Flash Cache• 108 x 600 GB 15,000 RPM High Performance disks or 108 x 3 TB 7,200 RPM High Capacity disks	4 x Exadata Storage Servers X3-2: <ul style="list-style-type: none">• 48 CPU cores for SQL processing• 16 PCI flash cards with 6.4 TB Exadata Smart Flash Cache• 48 x 600 GB 15,000 RPM High Performance disks or 48 x 3 TB 7,200 RPM High Capacity disks
3 x 36 port QDR (40 Gb/sec) InfiniBand Switches		2 x 36 port QDR (40 Gb/sec) InfiniBand Switches
Spares Kit Included: <ul style="list-style-type: none">• 2 x 600 GB High Performance disks or 2 x 3 TB High Capacity disks• 2 x 400 GB Exadata Smart Flash Cache cards• InfiniBand cables	Spares Kit Included: <ul style="list-style-type: none">• 1 x 600 GB High Performance disk or 1 x 3 TB High Capacity disk• 1 x 400 GB Exadata Smart Flash Cache cardInfiniBand cables	
Additional Hardware Components Included: <ul style="list-style-type: none">• Ethernet switch for administration of the Storage Expansion Rack• 2 x Redundant Power Distributions Units (PDUs)• 42U rack packaging		

Exadata Storage Expansion Rack X3-2 Connectivity and Upgrades		
Connection to Exadata Database Machine	Half Rack to Full Rack Upgrade	Quarter Rack to Half Rack Upgrade
<p>Connect any combination of Exadata Database Machine X3-2 or Exadata Storage Expansion Racks via the included InfiniBand fabric with at most 1 Quarter Rack in the configuration</p> <p>Connect a maximum of 2 Quarter Rack Exadata systems via included InfiniBand fabric</p> <p>Other configuration considerations:</p> <ul style="list-style-type: none"> Up to 8 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 	<p>Upgradability: Field upgrade from Half Rack to Full Rack</p> <p>Additional Hardware Components Included With The Upgrade:</p> <ul style="list-style-type: none"> 9 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 	<p>Upgradability: Field upgrade from Quarter Rack to Half Rack</p> <p>Additional Hardware Components Included With The Upgrade:</p> <ul style="list-style-type: none"> 5 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
<p>Upgrade Support Services:</p> <ul style="list-style-type: none"> Hardware installation and software configuration 		

Exadata Storage Expansion Rack X3-2 Support Services
<ul style="list-style-type: none"> 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: 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 Platinum Services Oracle Exadata Start-Up Pack System Upgrade Support Services including hardware installation and software configuration Oracle Auto Service Request (ASR)

Exadata Storage Expansion Rack X3-2 Environmental Specifications			
	Full Rack	Half Rack	Quarter Rack
Height	78.66" - 1998 mm		
Width	23.62" – 600 mm		
Depth	47.24" – 1200 mm		
Weight	Weight: 1,824 lbs. (827.4 kg)	Weight: 1,138 lbs. (516.2 kg)	Weight: 771 lbs. (349.7 kg)
Acoustic noise (operating)	8.2 B	7.9 B	7.6 B
Environmentals With High Performance Disk			
Maximum power usage	10.0 kW (10.2 kVA)	5.6 kW (5.7 kVA)	2.8 kW (2.9 kVA)
Typical power usage ¹	7.0 kW (7.1 kVA)	4.0 kW (4.1 kVA)	1.9 kW (2.0 kVA)
Cooling at maximum usage	34,100 BTU/hour (36,000 kJ/hour)	19,100 BTU/ hour (20,150 kJ/ hour)	9,500 BTU/ hour (10,000 kJ/ hour)
Cooling at typical usage	23,900 BTU/hour (25,200 kJ/hour)	13,650 BTU/ hour (14,400 kJ/ hour)	6,700 BTU/ hour (7,000 kJ/ hour)
Airflow at maximum usage ²	1,600 CFM	900 CFM	440 CFM
Airflow at typical usage ²	1,100 CFM	650 CFM	310 CFM
Environmentals With High Capacity Disk			
Maximum power usage	8.7 kW (8.9 kVA)	5.0 kW (5.1 kVA)	2.5 kW (2.6 kVA)
Typical power usage ¹	6.1 kW (6.2 kVA)	3.5 kW (3.6 kV)	1.8 kW (1.9 kVA)
Cooling at maximum usage	29,700 BTU/hour 31,300 kJ/hour)	17,100 BTU/hour (18,000 kJ/hour)	8,500 BTU/hour 9,000 kJ/hour)
Cooling at typical usage	20,800 BTU/hour 21,950 kJ/hour)	11,950 BTU/hour 12,600 kJ/hour)	6,150 BTU/hour 6,500 kJ/hour)
Airflow at maximum usage ²	1,375 CFM	790 CFM	400 CFM
Airflow at typical usage ²	960 CFM	550 CFM	285 CFM
Operating temperature/humidity: 5 °C to 32 °C (41 °F to 89.6 °F), 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 (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 storage servers	Oracle Exadata Storage Server Software Licenses are transferable from one system to another.
Exadata Storage Server Software Features	
<ul style="list-style-type: none"> • 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	
<ul style="list-style-type: none"> • Redundant power supplies and fans 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 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 	
Manageability Features	
<ul style="list-style-type: none"> • Oracle Embedded Integrated Lights Out Manager (ILOM) • Oracle Enterprise Manager Cloud Control 12c Oracle Quality of Service Management 	

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.



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