ORACLE EXADATA STORAGE EXPANSION RACK

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 6.75 TB of Exadata Smart Flash Cache
- Connected directly to Exadata Database Machines X2-2 and X2-8 and SPARC SuperCluster via 40 Gb/second InfiniBand
- Uncompressed I/O bandwidth of up to 97 GB/second per rack
- Hybrid Columnar Compression delivers 10X-15X compression ratios
- Complete redundancy for high availability

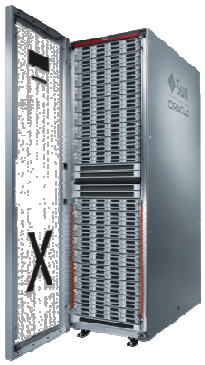
FACTS

- 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.

Extreme Performance and Capacity for Online Transaction Processing, Data Warehousing and Consolidating Mixed Workloads

The Exadata Database Machine and SPARC SuperCluster is an easy to deploy out of the box solution for hosting the Oracle Database. Ready to go day one much of the integration effort, cost and time of database deployment, has been eliminated. Whether its OLTP, DW or mixed workloads, a common deployment creates a tremendous opportunity for consolidation economies of scale in the data center. All this with breakthrough performance. The Exadata Storage Expansion Rack takes this to the next level.



The Exadata Storage Expansion Rack enables you to grow the Exadata storage capacity and bandwidth of any X2-2 and X2-8 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 and archives of Exadata Database Machine data; documents, images, file and XML data, LOBs and other large unstructured data. The expansion rack is extremely simple to configure as there are no LUNs or mount points to configure. Storage is configured and added to a database with a few simple commands, completed in minutes.

The unique technology driving the performance advantages of the Exadata Database Machine and SPARC SuperCluster is the Oracle Exadata Storage Server, and its software. By pushing database processing to the Exadata Storage Servers all the disks can operate in parallel reducing database server CPU consumption while using much less bandwidth to move data between storage and database servers. The Exadata Storage Expansion Rack is composed of standard Exadata Storage Servers

RELATED PRODUCTS AND SERVICES

RELATED PRODUCTS

- Oracle Exadata Database Machine X2-8
- Oracle Exadata Database Machine X2-2
- Oracle Exadata Storage Server X2-2
- 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
- Consulting Services
- Oracle University courses

and InfiniBand switches to seamlessly integrate with your Exadata Database Machine or SPARC SuperCluster. The Exadata Storage Expansion Rack is a high-performance, high-capacity, high-bandwidth, scale-out storage solution delivering up to 288 TB of uncompressed, and mirrored, usable capacity with a corresponding improvement in I/O bandwidth for your Exadata Database Machine deployment.

Oracle has implemented a smart flash cache directly in the Oracle Exadata Storage Server. The Exadata Smart Flash Cache holds frequently accessed data in very fast flash storage while most of the data is kept in very cost effective disk storage. This happens automatically without the user having to take any action. The Oracle Flash Cache is smart because it knows when to avoid trying to cache data that will never be reused or will not fit in the cache. The Oracle Database and Exadata storage 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 moved in and out of flash with a simple command, without the need to move the table to different tablespaces, files or LUNs like you would have to do with traditional storage with flash disks.

The Exadata Smart Flash Cache is also used to reduce the latency of log write I/O eliminating performance bottlenecks that might occur due to database logging. The time to commit user transactions is very sensitive to the latency of log writes. Also, many performance critical database algorithms such as space management and index splits are also very sensitive to log write latency. Today Exadata storage speeds up log writes using the battery backed DRAM cache in the disk controller. Writes to the disk controller cache are normally very fast, but they can become slower during periods of high disk IO. Smart Flash Logging takes advantage of the flash memory in Exadata storage to speed up log writes.

Flash memory has very good average write latency, but it has occasional slow outliers that can be one or two orders of magnitude slower than the average. The idea of the Exadata Smart Logging is to perform redo writes simultaneously to both flash memory and the disk controller cache, and complete the write when the first of the two completes. This literally gives Exadata the best of both worlds. The Smart Flash Logging both improves user transaction response time, and increases overall database throughput for IO intensive workloads by accelerating performance critical database algorithms.

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 enterprises with tremendous cost-savings and performance improvements due to reduced I/O. Typical storage savings can range from 10x to 15x.

Extreme Scalability

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 SAS disks or 3 TB High Capacity SAS 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 configuration has a raw disk capacity of 5,040 TB and 1,840 CPU cores dedicated to SQL processing. Larger configurations can be built with additional InfiniBand switches.

On 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.

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.

Enterprise Ready

Building on the high security capabilities in every Oracle Database, Exadata Database Machine and the Exadata Storage Expansion Rack provide the ability to query fully encrypted databases with near zero overhead at hundreds of gigabytes of user data per second. This is done by moving decryption processing from software into the Exadata Storage Server hardware.

The Exadata Storage Expansion Rack has complete redundancy built in to support the demands of mission critical applications. Each Exadata Storage Expansion Rack has redundant InfiniBand connectivity, redundant Power Distribution Units (PDU),

and the servers all have hot-swappable disks, power supplies and fans for high availability. ASM provides disk mirroring (normal or triple mirrored) to protect against disk failures. Hot swappable components ensure the database can tolerate server and disk drive failure. In addition, data is mirrored across the Exadata Storage Servers to protect against loss of data and safeguard data accessibility.

Oracle Enterprise Manager Cloud Control 12c uses a holistic approach to manage the Exadata product family and provides comprehensive lifecycle management from monitoring to management and ongoing maintenance for the entire engineered system. It provides a unified view of hardware and software where you can view hardware components such as compute nodes, Exadata cells, and InfiniBand switches and see the placement of software running on them along with their resource utilization. DBAs can also drill down from the database to the storage layer of Exadata to identify and diagnose problems such as performance bottlenecks or hardware faults. Lights-out monitoring capability of Enterprise Manager is optimized for Exadata where metrics and thresholds are predefined so that administrators can get timely notifications when issues arise. In addition, hardware and software incidents are automatically detected and service requests logged to reduce problem resolution time. In addition, administrators can use Consolidation Planner in Oracle Enterprise Manager to determine optimal consolidation strategies for different Exadata configurations. In Oracle Exadata Database Machine, management is engineered together with hardware and software to provide not just high performance and availability but also ease of management and consolidation.

Software from Oracle, Hardware from Sun

The Exadata Database Machine, SPARC SuperCluster and Exadata Storage Expansion Rack build upon years of Oracle and Sun jointly solving customers' business and technical challenges. Integrated hardware and software technology, and related hardware support services, are provided in a unified fashion by Oracle. By combining leading, industry-standard servers and storage hardware from Sun with the intelligence built into the Oracle software, the Exadata Database Machine, SPARC SuperCluster and Exadata Storage Expansion Rack delivers the industry's highest levels of performance, scalability, capacity and reliability, and is backed by Oracle Support.

Exadata Storage Expansion Rack Key Capabilities		
Exadata Storage Expansion Full Rack with High Performance SAS Disks	**Exadata Storage Expansion Half Rack with High Performance SAS Disks**	**Exadata Storage Expansion Quarter Rack with High Performance SAS Disks**
Up to 32 GB/second of uncompressed disk bandwidth [1]	Up to 16 GB/second of uncompressed disk bandwidth [1]	Up to 7.2 GB/second of uncompressed disk bandwidth [1]
Up to 97 GB/second of uncompressed Flash Cache data bandwidth [1]	Up to 48.5 GB/second of uncompressed Flash Cache data bandwidth [1]	Up to 21.5 GB/second of uncompressed Flash Cache data bandwidth [1]
Up to 64,000 Database Disk IOPS [2]	Up to 32,000 Database Disk IOPS [2]	Up to 14,400 Database Disk IOPS [2]
Up to 1,900,000 Database Flash IOPS [2]	Up to 950,000 Database Flash IOPS [2]	Up to 425,000 Database Flash IOPS [2]
128 TB of raw disk data capacity [3]	64 TB of raw disk data capacity [3]	28 TB of raw disk data capacity [3]
Up to 58 TB of uncompressed usable capacity [4]	Up to 29 TB of uncompressed usable capacity [4]	Up to 13 TB of uncompressed usable capacity [4]
Up to 27 TB/hour full uncompressed backup to a mirrored destination	Up to 13.5 TB/hour full uncompressed backup to a mirrored destination	Up to 6 TB/hour full uncompressed backup to a mirrored destination
Exadata Storage Expansion Full Rack with High Capacity SAS Disks	**Exadata Storage Expansion Half Rack with High Capacity SAS Disks**	**Exadata Storage Expansion Quarter Rack with High Capacity SAS Disks**
Up to 23 GB/second of uncompressed disk bandwidth [1]	Up to 11.5 GB/second of uncompressed disk bandwidth [1]	Up to 5 GB/second of uncompressed disk bandwidth [1]
Up to 88 GB/second of uncompressed Flash Cache data bandwidth [1]	Up to 44 GB/second of uncompressed Flash Cache data bandwidth [1]	Up to 19 GB/second of uncompressed Flash Cache data bandwidth [1]
Up to 36,000 Database Disk IOPS [2]	Up to 18,000 Database Disk IOPS [2]	Up to 8,000 Database Disk IOPS [2]
Up to 1,900,000 Database Flash IOPS [2]	Up to 950,000 Database Flash IOPS [2]	Up to 425,000 Database Flash IOPS [2]
648 TB of raw disk data capacity [3]	324 TB of raw disk data capacity [3]	144 TB of raw disk data capacity [3]
Up to 288 TB of uncompressed usable capacity [4]	Up to 144 TB of uncompressed usable capacity [4]	Up to 64 TB of uncompressed usable capacity [4]
Up to 27 TB/hour full uncompressed backup to a mirrored destination	Up to 13.5 TB/hour full uncompressed backup to a mirrored destination	Up to 6 TB/hour full uncompressed backup to a mirrored destination

Actual system performance varies by application.

[1] Bandwidth is peak physical scan bandwidth achieved running SQL, assuming no data compression. Effective data bandwidth is higher when compression is used.

[2] Based on read IO requests of size 8K running SQL. Note that the IO size greatly affects Flash IOPS. Others quote IOPS based on 2K, 4K or smaller IOs and are not relevant for databases. Exadata Flash read IOPS are so high they are typically limited by database server CPU, not IO. This is especially true for the Storage Expansion Racks.

[3] For raw capacity, 1 GB = 1 billion bytes. Capacity calculated using normal space terminology of 1 TB = 1024 * 1024 * 1024 * 1024 bytes. Actual formatted capacity is less.

[4] 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 Hardware		
Exadata Storage Expansion Full Rack	**Exadata Storage Expansion Half Rack**	**Exadata Storage Expansion Quarter Rack**
18 x Exadata Storage Servers X2-2 with 12 x 600 GB 15,000 RPM High Performance SAS disks or 12 x 3 TB 7,200 RPM High Capacity SAS disks Includes: • 216 CPU cores for SQL processing • 6.75 TB Exadata Smart Flash Cache	9 x Exadata Storage Servers X2-2 with 12 x 600 GB 15,000 RPM High Performance SAS disks or 12 x 3 TB 7,200 RPM High Capacity SAS disks Includes: • 108 CPU cores for SQL processing • 3.4 TB Exadata Smart Flash Cache	4 x Exadata Storage Servers X2-2 with 12 x 600 GB 15,000 RPM High Performance SAS disks or 12 x 3 TB 7,200 RPM High Capacity SAS disks Includes: • 48 CPU cores for SQL processing • 1.5 TB Exadata Smart Flash Cache
3 x 36 port QDR (40 Gb/sec) InfiniBand Switches	3 x 36 port QDR (40 Gb/sec) InfiniBand Switches	2 x 36 port QDR (40 Gb/sec) InfiniBand Switches
Additional Hardware Components Included: • Ethernet switch for administration of the Storage Expansion Rack • Keyboard, Video or Visual Display Unit, Mouse (KVM) hardware for local administration • 2 x Redundant Power Distributions Units (PDUs) • 42U rack packaging Spares Kit Included: • 2 x 600 GB High Performance SAS disks or 2 x 3 TB High Capacity SAS disks • 2 x 96 GB Exadata Smart Flash Cache cards • InfiniBand cables	Additional Hardware Components Included: • Ethernet switch for administration of the Storage Expansion Rack • Keyboard, Video or Visual Display Unit, Mouse (KVM) hardware for local administration • 2 x Redundant Power Distributions Units (PDUs) • 42U rack packaging Spares Kit Included: • 1 x 600 GB High Performance SAS disk or 1 x 3 TB High Capacity SAS disk • 1 x 96 GB Exadata Smart Flash Cache card • InfiniBand cables	Additional Hardware Components Included: • Ethernet switch for administration of the Storage Expansion Rack • Keyboard, Video or Visual Display Unit, Mouse (KVM) hardware for local administration • 2 x Redundant Power Distributions Units (PDUs) • 42U rack packaging Spares Kit Included: • 1 x 600 GB High Performance SAS disk or 1 x 3 TB High Capacity SAS disk • 1 x 96 GB Exadata Smart Flash Cache card • InfiniBand cables

Exadata Storage Expansion Rack 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: 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 Exadata Start-Up Pack • System Upgrade Support Services including hardware installation and software configuration • Oracle Auto Service Request (ASR)

Exadata Storage Expansion Rack Connectivity and Upgrades		
Connection to Exadata Database Machine X2-2 and X2-8 Racks	**Exadata Storage Expansion Half Rack to Full Rack Upgrade**	**Exadata Storage Expansion Quarter Rack to Half Rack Upgrade**
Connect any combination of Exadata Database Machine or SPARC SuperCluster Full or Half Racks to Exadata Storage Expansion Full or Half Racks via included InfiniBand fabric Connect a maximum of 1 Exadata Storage Expansion Quarter Rack to any multi-rack Exadata Database Machine configuration, of Half or Full Racks, via included InfiniBand fabric Other configuration considerations: • 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	Upgradability: Field upgrade from Half Rack to Full Rack Additional Hardware Components Included With The Upgrade: • 9 x Exadata Storage Servers X2-2 with 12 x 600 GB 15,000 RPM High Performance SAS disks or 12 x 3 TB 7,200 RPM High Capacity SAS 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: • 5 x Exadata Storage Servers X2-2 with 12 x 600 GB 15,000 RPM High Performance SAS disks or 12 x 3 TB 7,200 RPM High Capacity SAS 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
Upgrade Support Services: • Hardware installation and software configuration	Upgrade Support Services: • Hardware installation and software configuration	Upgrade Support Services: • Hardware installation and software configuration

Exadata Storage Expansion Rack Environmental Specifications		
Exadata Storage Expansion Full Rack	**Exadata Storage Expansion Half Rack**	**Exadata Storage Expansion Quarter Rack**
• Height: 42U, 78.66" - 1998 mm • Width: 23.62" – 600 mm • Depth: 47.24" – 1200 mm	• Height: 42U, 78.66" - 1998 mm • Width: 23.62" – 600 mm • Depth: 47.24" – 1200 mm	• Height: 42U, 78.66" - 1998 mm • Width: 23.62" – 600 mm • Depth: 47.24" – 1200 mm
Weight: 2,023 lbs. (917.6 kg)	Weight: 1,275 lbs. (578.3 kg)	Weight: 875 lbs. (396.8 kg)
Power • Maximum power usage: 12.6 kW (12.9 kVA) • Typical power usage (varies by application load): 8.8 kW (9.0 kVA)	Power • Maximum power usage: 6.9 kW (7.1 kVA) • Typical power usage (varies by application load): 4.8 kW (5.0 kVA)	Power • Maximum power usage: 3.4 kW (3.5 kVA) • Typical power usage (varies by application load): 2.4 kW (2.5 kVA)
Cooling • At maximum usage: 43,000 BTU/hour (45,400 kJ/hour) • At typical usage: 30,100 BTU/hour (31,800 kJ/hour)	Cooling • At maximum usage: 23,600 BTU/ hour (24,900 kJ/ hour) • At typical usage: 16,500 BTU/ hour (17,400 kJ/ hour)	Cooling • At maximum usage: 11,600 BTU/ hour (12,250 kJ/ hour) • At typical usage: 8,100 BTU/ hour (8,600 kJ/ hour)
Airflow • At maximum usage: 1,980 CFM • At typical usage: 1,390 CFM • Airflow must be front-to-back	Airflow • At maximum usage: 1,090 CFM • At typical usage: 760 CFM • Airflow must be front-to-back	Airflow • At maximum usage: 530 CFM • At typical usage: 375 CFM • Airflow must be front-to-back
Acoustic noise: 8.3 B operating	Acoustic noise: 8.2 B operating	Acoustic noise: 8.1 B operating
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 [1] • 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 [1] • 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] 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	
• 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 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	
• Oracle Embedded Integrated Lights Out Manager (ILOM) • Oracle Enterprise Manager Grid Control • Oracle Quality of Service Management (requires Oracle Database 11.2.0.2)	

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

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