Disruptive New Memory and Cloud Technologies

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Exadata Vision

Dramatically Better Platform for All Database Workloads

- **Ideal Database Hardware** - Scale-out, database optimized compute, networking, and storage for fastest performance and lowest costs

- **Smart System Software** – specialized algorithms vastly improve all aspects of database processing: OLTP, Analytics, Consolidation

- **Full-Stack Automation** – Automation and optimization of: configuration, updates, performance, resource management

Identical On-Premises and in Cloud
Proven at Thousands of Ultra-Critical Deployments since 2008

- Best for all Workloads
- Petabyte Warehouses
- Online Financial Trading
- Business Applications  
  – SAP, Oracle, Siebel, PSFT, …
- Massive DB Consolidation

4 OF THE TOP 5  
BANKS, TELECOMS, RETAILERS RUN EXADATA
Exadata Powers Oracle Cloud

• Oracle SaaS applications run on Exadata
  • Hundreds of Exadata systems deployed globally
• Exadata powers Exadata Express Cloud Service and Exadata Cloud Service
• Autonomous Database and Data Warehouse Cloud will run on Exadata
Introducing Exadata X7

Continue Tradition of State-of-the-Art Hardware
Exadata X7 Hardware (changes in red)

• Scale-Out 2-Socket Database Servers
  – 20% to 40% faster CPUs – latest 24 core Intel Skylake
  – 150% faster Ethernet – 25 GigE client connectivity
  – 50% more DRAM capacity and throughput

• Ultra-Fast Unified InfiniBand Internal Fabric

• Scale-Out Intelligent 2-Socket Storage Servers
  – Intel 10 core Skylake CPUs offload database processing
  – 25% more disk capacity - 10TB Helium Disk Drives
  – 100% more flash capacity - 6.4 TB Hot swappable NVMe Flash
Exadata X7 Performance Improvements vs X6

- **350 GB/sec** IO Throughput
  - 17% more (vs Exadata X6)
- **5.97 Million** OLTP Read IOPs
  - 50% more IOPs (vs Exadata X6) under 250usec = 3.5M
- **40%** CPU improvement for Analytics
- **20%** CPU improvement for OLTP
  - 40% on X7-8
- Dramatically faster than leading **all-flash** arrays

Huge Capacity per Rack:
- **1.7 PB Disk**
- **720 TB NVMe Flash**
Exadata X7 I/O is Dramatically Faster than All-Flash EMC

One High Capacity Exadata beats the fastest EMC VMAX all-flash array in every performance metric

– 9X more throughput
– 3X more IOPS
– 2X faster latency
Exadata Smart Software

Continue Tradition of Adding Major Differentiators
Exadata Uniquely Accelerates Analytics
Completely Automatic, No Management Required

• Exadata automatically offloads data intensive SQL operations to storage
  – Unique Smart Scan technology offloads SQL processing to storage delivering:
    • Over 350 GB per sec SQL scan throughput while offloading database CPUs
    – Unique algorithms offload Data Mining, Decryption, Aggregation, and Backups to storage

• Exadata automatically reduces I/O
  – Unique Database-aware Flash Caching gives speed of PCI Flash with capacity of disk
  – Unique Storage Indexes eliminates I/O that is not relevant to a particular query

• Exadata uses analytics optimized Columnar format
  – Unique Hybrid Columnar Compression reduces space usage by up to order of magnitude
  – Unique Columnar Flash Cache automatically transforms data to column formats
Exadata Uniquely Delivers **OLTP in Real-Time**
Completely Automatic, No Management Required

- **Exadata automatically eliminates traditional OLTP bottleneck: Random I/O**
  - *Unique* scale-out storage, ultra-fast PCIe Flash, ultra-fast NVMe protocol, ultra-fast InfiniBand, and ultra-fast iDB protocol delivers:
    - Over 5.4 Million DB reads or **writes** per rack; ¼ millisecond latency
  - *Unique* Smart Flash Logging automatically optimizes OLTP logging to flash

- **Exadata automatically eliminates OLTP stalls from failed or sick components**
  - *Unique* detection of server failures without a long timeout avoids system hangs
  - *Unique* sub-second redirection of IOs around sick devices avoid database hangs

- **Exadata automatically eliminates inter-node coordination bottlenecks**
  - *Unique* Direct-to-Wire Protocol gives 3x faster inter-node OLTP messaging
  - *Unique* Smart Fusion Block Transfer eliminates the need to write the log file when moving blocks between nodes
Exadata Uniquely Optimizes **Mixed Workloads**
Completely Automatic, No Management Required

- **Exadata automatically prioritizes latency sensitive operations**
  - *Unique* prioritization of critical network messages for locks, cache fusion, logging, etc.
  - *Unique* prioritization of OLTP I/O over Analytic or Batch I/O

- **Exadata automatically prioritizes important workloads based on user policies**
  - *Unique* prioritization of CPU and I/O by job, user, service, session, SQL

- **Exadata automatically provides isolation between multiple tenants**
  - *Unique* no-overhead virtual machines
  - *Unique* prioritization by database, or pluggable database

- Many lanes
- Priority Lane
- Reserved Lane
- Separate Road
Exadata Automates and Simplifies Administration
Spend Less by Administering and Managing Less

- All layers in Exadata are pre-configured, pre-tuned, pre-debugged
  - DB, OS, drivers, firmware, network, servers, storage
- Automatic database installation and configuration
  - Input sizing parameters and Exadata will deploy and configure the database
- Automatic periodic full-stack health checks
  - Validates compliance with best practices, software versions, parameter settings, etc
- One Support team expert in and accountable for full stack
  - Oracle performs free full-stack updates and 24/7 monitoring
- One management tool for the entire stack
  - Drill down from DB to storage, and up from storage to DB
Exadata Automates Software Updates at Cloud Scale

- **New** automation updates all Exadata infrastructure software on full fleet
  - 600+ components per full rack
- Updates multiple systems in parallel
- Runs automatically on schedule
  - Online (rolling) or Offline (all in parallel)
- Oracle Cloud updates hundreds of racks in single weekend
The Next Big Thing:

In-Memory Performance in Storage
Latest Flash Creates **Giant Bottleneck** for Shared Storage

Latest NVMe Flash
5.5 GB/sec

SAN Link = 40 Gb/s
5 GB/sec
Less than 1 Flash card

480 Flash Drive EMC Array
38 GB/sec

**But Should Achieve**
5.5GB * 480 Drives = **2,640 GB/sec**

Single Flash Drive is Faster than fast SAN
Exadata **Uniquely Achieves Memory Speed with Shared Flash**

- **Architecturally**, Storage Arrays can share Flash **capacity** but not Flash **performance** due to network bottlenecks
  - Even with next gen scale-out, PCIe networks, or NVMe over fabric
  - Network continues to be a huge bottleneck
- **Must move compute to data** to achieve full Flash potential
  - Requires owning full stack; can’t be solved in storage alone
- **Exadata X7 delivers 350 GB/s Flash bandwidth to any server**
  - Approaches 800 GB/s aggregate DRAM bandwidth of DB servers
Analytics: Exadata Brings In-Memory Analytics to Storage

- With Exadata Flash throughput approaching memory throughput, SQL bottleneck moves from I/O to CPU
- Exadata automatically transforms table data into In-Memory DB columnar formats in Exadata Flash cache
  - Enables fast vector processing for storage server queries
- **Uniquely** optimizes next generation Flash as memory
  - Now works for both **row format OLTP** databases, and Hybrid Columnar Compressed Analytics databases
OLTP: Exadata Brings In-Memory OLTP to Storage

• Exadata Storage Servers add a memory cache in front of Flash memory
  – Similar to current Flash cache in front of disk

• Cache is additive with cache at Database Server
  – Only possible because of tight integration with Database

• 2.5x Lower latency for OLTP IO – 100 usec

• Up to 21 TB of DRAM for OLTP acceleration per rack with Memory Upgrade Kit
  – Compare to 5TB of flash in V2 Exadata
Preview: Non-Volatile Memory Cache in Exadata Storage

- Exadata Storage Servers will add Non-Volatile memory cache in front of Flash memory – Intel 3D X-Point
- **RDMA** bypasses the software stack, giving 20X faster access to remote NVRAM
- NVRAM mirrored across storage servers for fault-tolerance
- NVRAM used as a **cache** effectively increases its capacity by 10x vs using NVRAM directly as expensive storage
  - Cost-effective to run multi-TB databases in memory
- NVRAM shared across servers for lower cost
Exadata Disruptive Cloud Technologies
Best Database Cloud Service - Exadata Cloud Service

• Full Oracle Database with All Advanced Options Included
  – 100% compatible with existing applications that use Oracle Database

• On Fastest, Most Available DB Cloud Platform - Exadata
  – Best Quality of Service – no over-provisioning

• All the Benefits of Public Cloud
  – Fast, elastic, web and API-driven provisioning, updates, backup, etc.
  – Oracle experts deploy and manage infrastructure
  – Pay per Use subscription
  – Best elasticity - Online compute bursting

Production since late 2015
Some Customers Cannot Move to Public Cloud

• **Regulatory**
  – Regulatory or corporate policies that require data to be local to territory or corporation

• **Latency**
  – Applications require performance of local LAN

• **Integration**
  – Databases are tightly-coupled with on-premises applications and infrastructure

• **Risk**
  – Not ready to bet the business on public clouds due to quality of service or security concerns
Unique Solution: Exadata Cloud at Customer

- Exadata Cloud Service Delivered in Customer Data Center
  - Same cloud hardware, software, interfaces, APIs, control plane

- Same Pay Per Use Subscription Model as Oracle Cloud
  - Pricing based on enabled cores

- Runs Small to Extremely Large Workloads
  - From 16 cores to hundreds of cores

Production since late 2016
Exadata Cloud at Customer: How it Works

• **Oracle Cloud Operations Team Manages Exadata Infrastructure**
  – Servers, storage, storage software, networking, firmware, hypervisor, etc.

• **Customers Have Full Control of Databases**
  – Oracle Cloud Control Plane simplifies management with Web and REST based DB and OS provisioning, management, and orchestration
    • Updates, backup, resource management, Data Guard, RAC, quotas, etc.

• **Easy Migration of Existing Databases – Simple Copy Across LAN**

• **Maximum Availability Architecture Configurations and Best Practices are Built in**
Cloud, Your Way

**Private Cloud**
Exadata Database Machine

**Cloud at Customer**
Exadata Cloud at Customer

**Public Cloud**
Exadata Cloud Service

- **Customer Data Center**
  - Purchased
  - Customer Managed

- **Customer Data Center**
  - Subscription
  - Oracle Managed

- **Oracle Cloud**
  - Subscription
  - Oracle Managed
Preview: Oracle Autonomous Database on Exadata

• Less Labor, Lower Cost, Fewer Errors, More Secure, More Reliable

  Self-Driving - User defines service levels, database makes them happen
  Self-Tuning - Continuous adaptive performance tuning
  Self-Scaling - Instantly resize without downtime
  Self-Securing - Protection from both external attacks and internal users
  Self-Repairing - Automated protection from all downtime
Ten percent of **Fortune Global 100** companies have already adopted Exadata Cloud

6X faster Adoption than Exadata On-Premises at launch
Conclusion: Exadata Advantages Increase Every Year

Dramatically Better Performance and Cost

Smart Software
- Database Aware Flash Cache
- Storage Indexes
- Columnar Compression
- Smart Scan
- InfiniBand Scale-Out
- IO Priorities
- Data Mining Offload
- Offload Decrypt on Scans
- Network Resource Management
- Multitenant Aware Resource Mgmt
- Prioritized File Recovery
- Unified InfiniBand
- Software-in-Silicon
- Tiered Disk/Flash
- PCIe NVMe Flash
- Unified InfiniBand

Smart Hardware
- Scale-Out Storage
- Scale-Out Servers
- DB Processors in Storage
- Exadata Cloud at Customer
- In-Memory OLTP Acceleration
- In-Memory Columnar in Flash
- Exadata Cloud Service
- Smart Fusion Block Transfer
- In-Memory Fault Tolerance
- Direct-to-wire Protocol
- JSON and XML offload
- Instant failure detection
- Hot Swappable Flash
- 25 GigE Client Network
- 3D V-NAND Flash
- Tiered Disk/Flash
- Software-in-Silicon
- Unified InfiniBand
- Exadata Cloud Service
- Smart Fusion Block Transfer
- In-Memory OLTP Acceleration
- In-Memory Columnar in Flash
- Exadata Cloud Service
- Smart Fusion Block Transfer

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Monday 2 October

CON6672 High Availability and Sharding Deep Dive with Next Generation Oracle Database
11:00am – Moscone West 3006

CON6713 Oracle’s New, Scale Out, OLTP Optimized, In-Memory RDBMS
11:00am – Moscone West 3014

CON6569 GoldenGate: Deep Dive into Automating GoldenGate using the new Microservices
1:15pm – Moscone West 3010

CON6661 Oracle Exadata: Disruptive New Memory and Cloud Technologies
2:15pm – Moscone West 3014

CON6667 Recovery Manager (RMAN) Tips and Tricks for On-Premises and Cloud Databases
3:15pm – Moscone West 3006

CON6663 Oracle Exadata Technical Deep Dive: Architecture and Internals
3:15pm – Moscone West 3014

CON6583 Memory Without Bounds-Policy Based Automation of In-Memory Column Store Content
3:15pm – Moscone West 3010

CON6581 Database Consolidation: Resource Management Best Practices
4:45pm – Moscone West 3010

CON6678 Zero Data Loss Recovery Appliance: The World’s Best Database Protection
4:45pm – Moscone West 3006

CON6665 Deploying Oracle Databases in the Cloud with Exadata: Strategies, Best Practices
5:45pm – Moscone West 3006

Tuesday 3 October

CON6666 Oracle Database Exadata Cloud Service: Technical Deep Dive
11:30am – Moscone West 3006

CON6584 Oracle Database In-Memory Deep Dive: Past, Present and Future
11:30am – Moscone West 3014

CON6662 Revolutionize Analytics with Oracle Database In-Memory
12:45pm – Moscone West 3014

CON6668 Oracle Database Exadata Cloud at Customer: Technical Deep Dive
3:45pm – Moscone West 3006

CON6894 Accelerate Cloud Onboarding Using Oracle GoldenGate Cloud Service
3:45pm – Moscone West 3024

CON6745 Implement a Business Continuity Solution for Your Open Cloud Infrastructure
3:45pm – Marriott Marquis Yerba Buena 13

CON6716 Accelerate OLTP Performance with an Application-Tier In-Memory Database
4:45pm – Moscone West 3008

CON6570 GoldenGate: Maximize Availability for Oracle GoldenGate Microservices
4:45pm – Moscone West 3014

CON6674 Maximum Availability Architecture Best Practices: Oracle Database 12c Rel. 2
5:45pm – Moscone West 3006

Wednesday 4 October

CON6715 Oracle TimeTen in the Cloud
11:00am – Moscone West 3004

CON6775 Maximum Availability Architecture Best Practices and Techniques for Oracle Cloud
11:00am – Moscone West 3006

CON6680 Exadata: Achieving Memory Level Performance: Secrets Beyond Shared Flash Storage
12:00pm – Moscone West 3008

CON6577 Get the Best Out of Oracle Compression
12:00pm – Moscone West 3008

CON6568 GoldenGate: Best Practices & Deep Dive on GoldenGate 12.3 Microservices at Cloud
12:00pm – Moscone West 3003

CON6589 Quick Start Your Oracle Database In-Memory Deployment – Step-By-Step Guide
1:00pm – Moscone West 3004

CON6679 Zero Data Loss Recovery Appliance: Deep Dive and Best Practices from Development
1:00pm – Moscone West 3006

CON6673 Oracle Sharding: Linear Scalability, Extreme Availability and Geo-distribution
2:00pm – Moscone West 3006

CON8173 Preview of Oracle Autonomous Database
3:30pm – Moscone West 3014

CON6664 Oracle Exadata: Maximum Availability Best Practices and New Recommendations
3:30pm – Moscone West 3008

CON6590 Oracle Sharding: Linear Scalability, Extreme Availability and Geo-distribution
3:30pm – Moscone West 3004

CON5966 Orchestrating and Automating Business Continuity with Engineered Systems
4:30pm – Marriott Marquis Yerba Buena 11

CON6671 Oracle Exadata Security Best Practices
5:30pm – Moscone West 3008

CON6676 Oracle Active Data Guard: New Features in the Next Generation Oracle Database
5:30pm – Moscone West 3

Demos: Monday 10:15a-6:00p - Tuesday 11:00a-5:15p - Wednesday 10:15a-4:30p
Learn More
oracle.com/exadata
Exadata Cloud at Customer: Modernize Your Data Center

- Exadata delivers latest cloud technologies to your data center
- End-to-End REST API driven provisioning and management
  - Database, Compute Infrastructure and Storage are all REST enabled
- Upcoming Software Defined Network simplifies hybrid data centers
  - Seamlessly extend your network from on-premises to Oracle Public Cloud
- Out-of-the-box Enterprise Class Security
  - Data is always encrypted, kept up to date with latest security updates