

Disruptive New Memory and Cloud Technologies

Juan Loaiza,
Senior Vice President, Oracle

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WORLD

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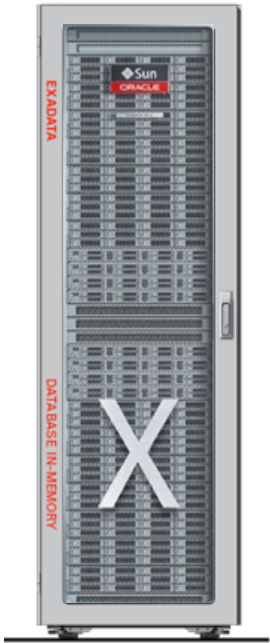


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Exadata Vision

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

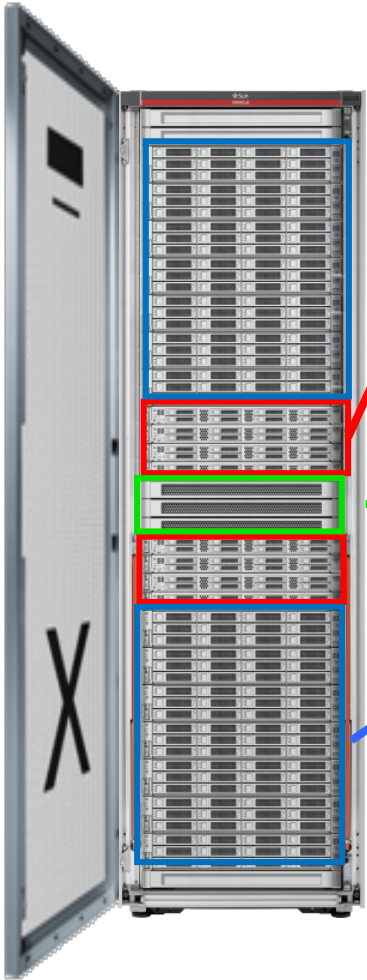
- Oracle SaaS applications run on Exadata
 - Hundreds of Exadata systems deployed globally
- Exadata powers Exadata Express Cloud Service and Exadata Cloud Service
- Autonomous Database and Data Warehouse Cloud will run on Exadata

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

Database Server



High-Capacity (HC) Storage

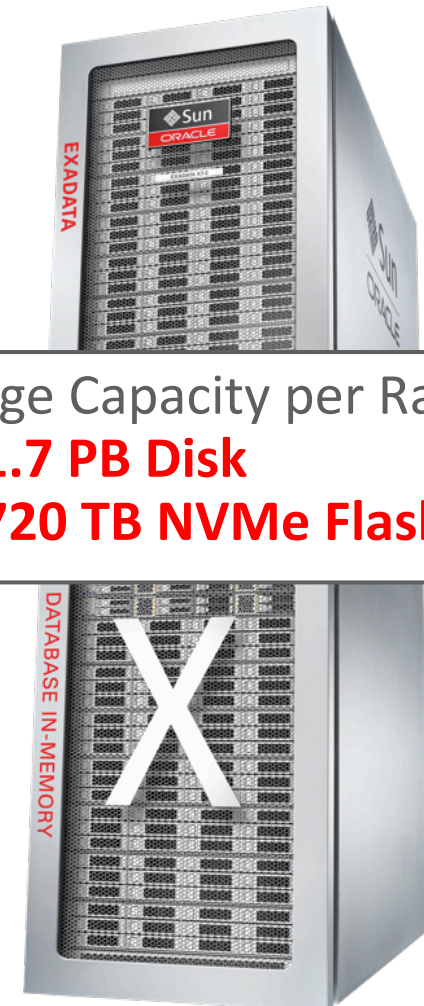


Extreme Flash (EF) Storage



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



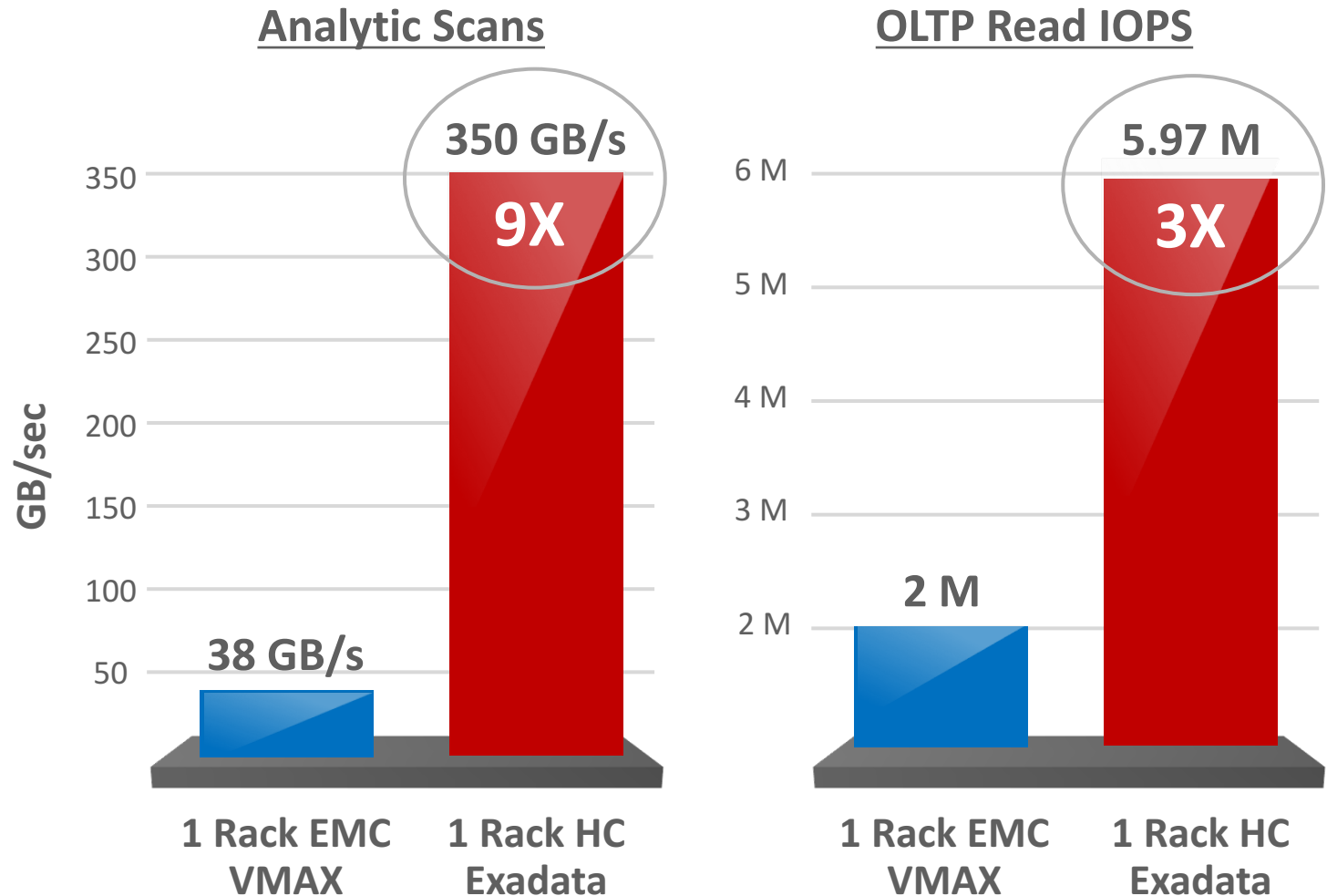
Huge Capacity per Rack:

- **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**



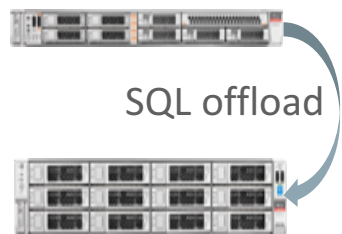
Exadata Smart Software

Continue Tradition of Adding Major Differentiators

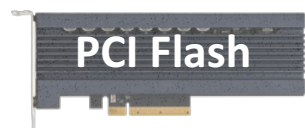


Exadata Uniquely Accelerates **Analytics**

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



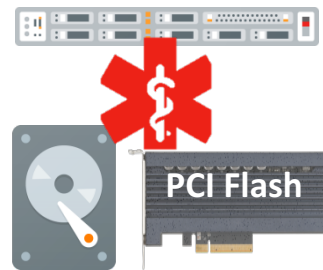
- **Exadata automatically reduces I/O**
 - **Unique** Database-aware Flash Caching gives speed of PCI Flash with capacity of disk
 - **Unique** Storage Indexes eliminates I/O that is not relevant to a particular query



- **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

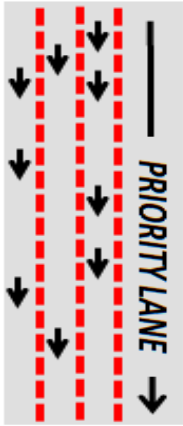
Completely Automatic, No Management Required



- **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**

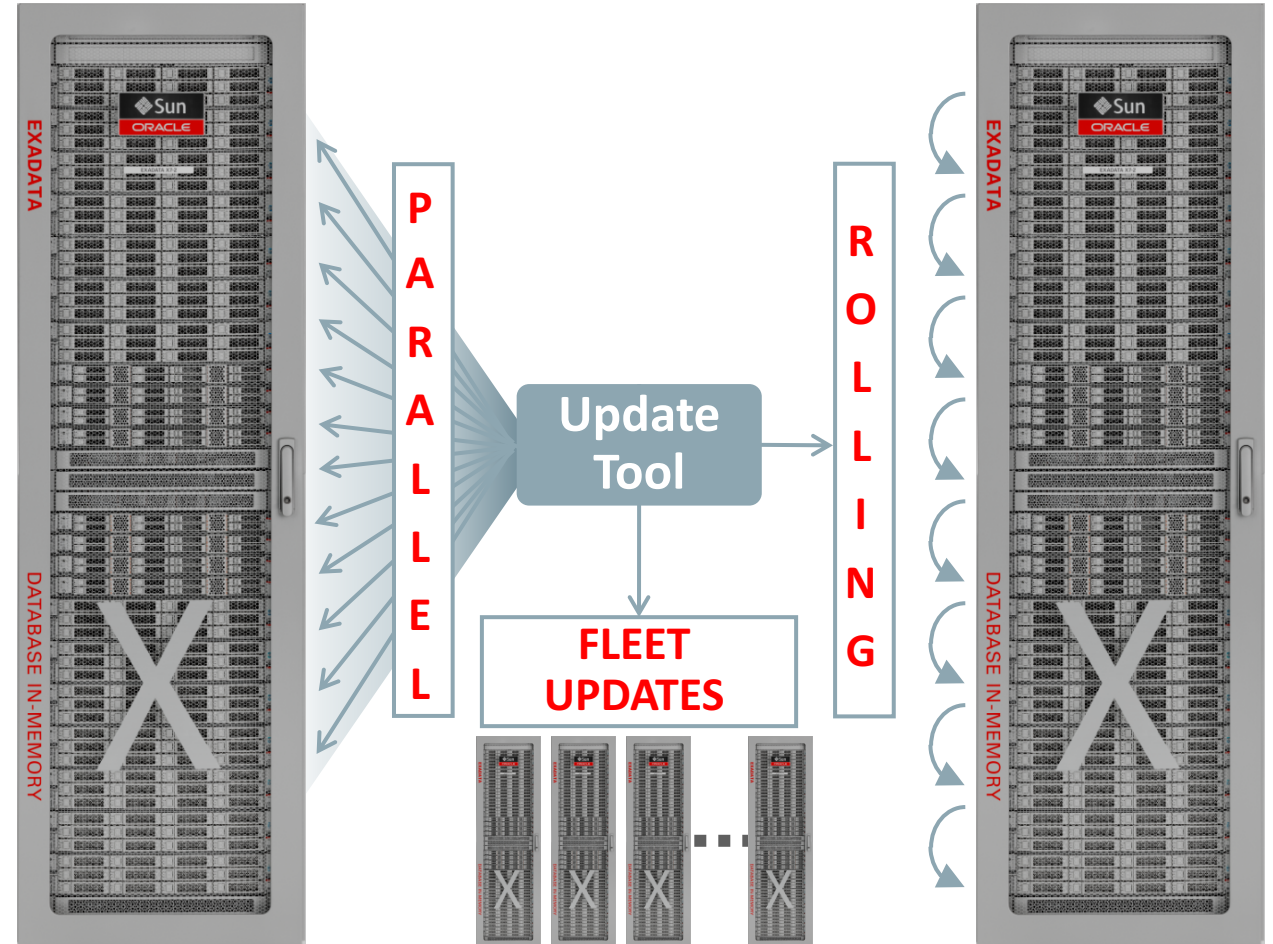
Spend Less by Administering and Managing Less

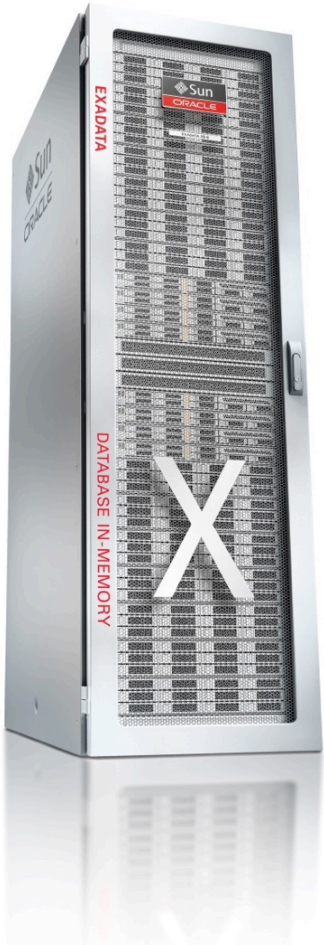


- **All layers in Exadata are pre-configured, pre-tuned, pre-debugged**
 - DB, OS, drivers, firmware, network, servers, storage
- **Automatic database installation and configuration**
 - Input sizing parameters and Exadata will deploy and configure the database
- **Automatic periodic full-stack health 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:

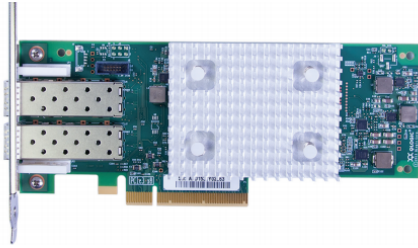
In-Memory Performance in Storage

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

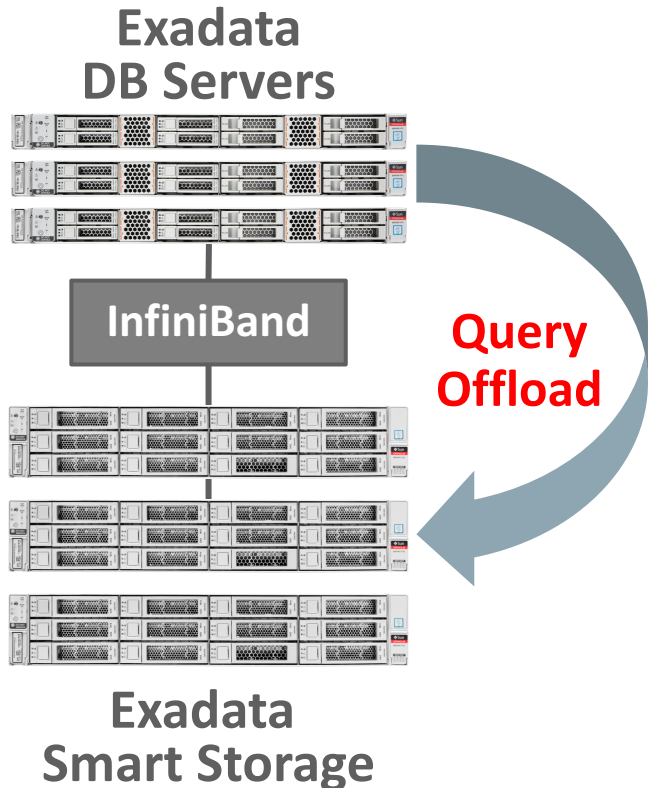
38 GB/sec



But Should Achieve
 $5.5\text{GB} * 480 \text{ Drives} = \mathbf{2,640 \text{ GB/sec}}$

Single Flash Drive is Faster than fast SAN

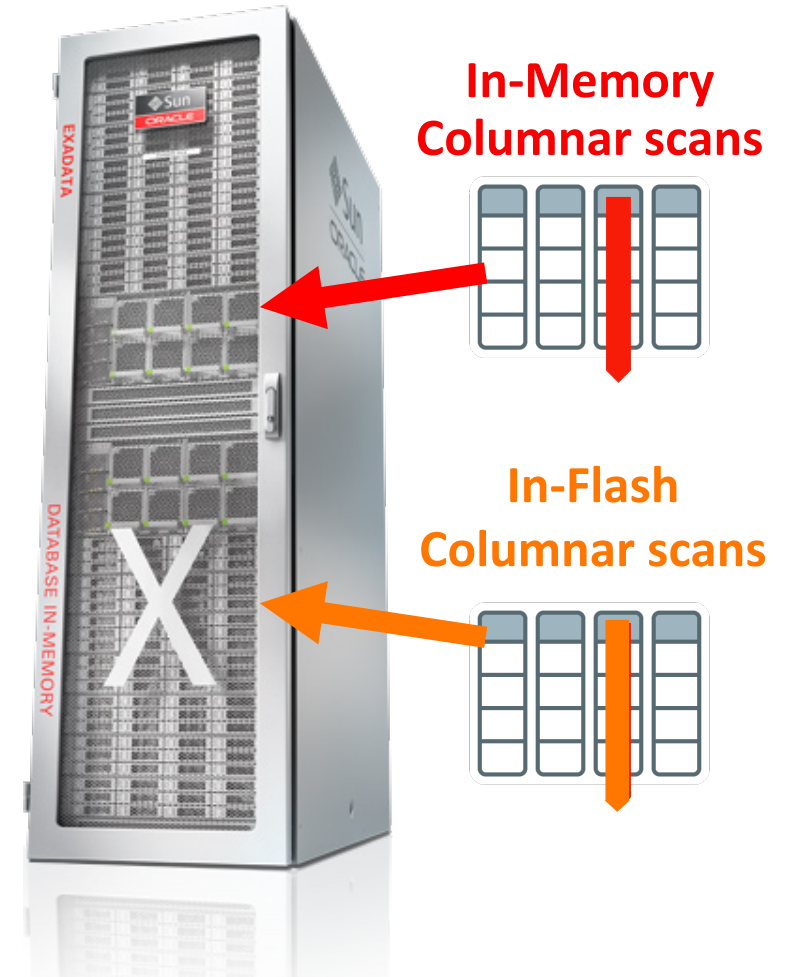
Exadata **Uniquely** Achieves **Memory Speed with Shared Flash**



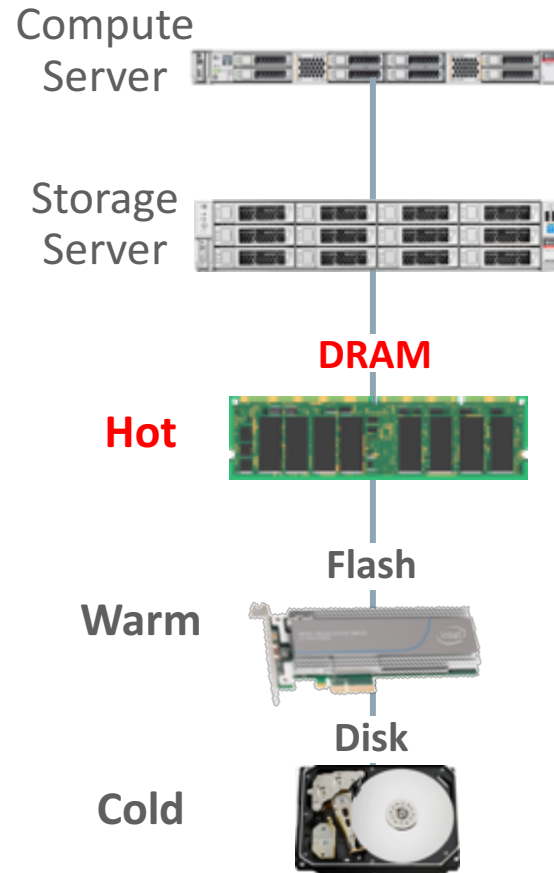
- Architecturally, Storage Arrays can share Flash capacity but not Flash performance due to network bottlenecks
 - Even with next gen scale-out, PCIe networks, or NVMe over fabric
 - Network continues to be a huge bottleneck
- Must move compute to data to achieve full Flash potential
 - Requires owning 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

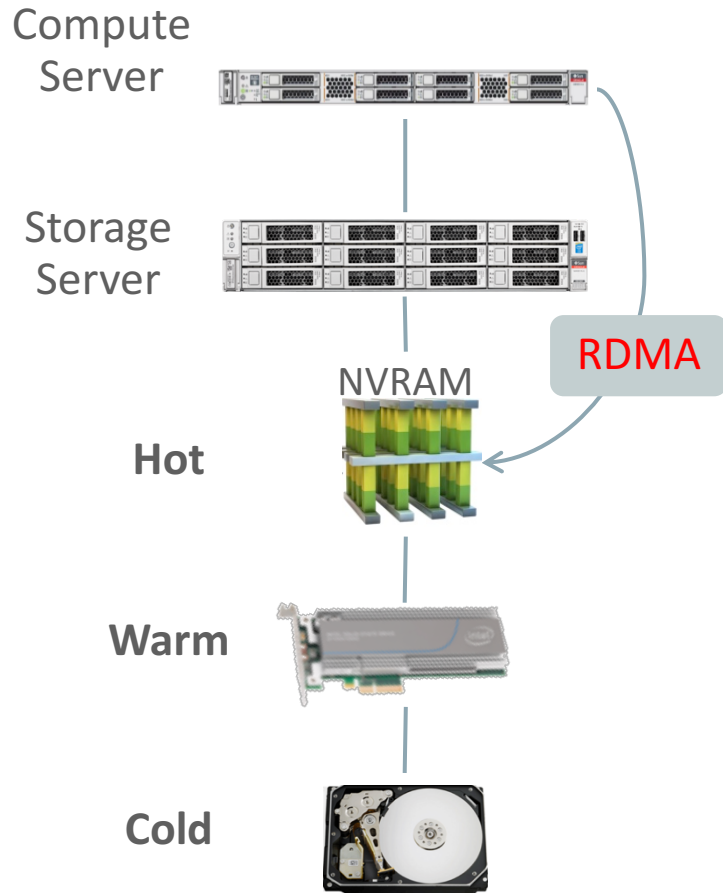


OLTP: Exadata Brings In-Memory OLTP to Storage



- 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



Customer Data Center

Purchased

Customer Managed

Cloud at Customer

Exadata Cloud at Customer



Customer Data Center

Subscription

Oracle Managed

Public Cloud

Exadata Cloud Service



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

- Smart Scan
- InfiniBand Scale-Out
- Database Aware Flash Cache
- Storage Indexes
- Columnar Compression
- IO Priorities
- Data Mining Offload
- Offload Decrypt on Scans

Smart Hardware

- Scale-Out Servers
- Scale-Out Storage
- DB Processors in Storage
- Unified InfiniBand
- Network Resource Management
- Multitenant Aware Resource Mgmt
- Prioritized File Recovery
- Tiered Disk/ Flash
- PCIe NVMe Flash

- In-Memory Fault Tolerance
- Direct-to-wire Protocol
- JSON and XML offload
- Instant failure detection
- Software-in-Silicon
- 3D V-NAND Flash

- Exadata Cloud at Customer
- In-Memory OLTP Acceleration
- In-Memory Columnar in Flash
- Exadata Cloud Service
- Smart Fusion Block Transfer
- Hot Swappable Flash
- 25 GigE Client Network

Oracle Database Development: High Availability, Exadata, and Cloud Services

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

CON6682 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

CON6675 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 3006

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



ORACLE®

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