Persistent Memory: Revolutionizing the Modern Database

Gurmeet Goindi
Master Product Manager
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Exadata Database Machine
Performance, Availability and Security

Best Platform for Oracle Databases on-premises and in the Cloud

Enabled by:

- Single-vendor accountability
- Exclusive focus on databases
- Deep h/w and s/w integration
- Revolutionary approach to storage
Persistent Memory Opens up New Opportunities

• **High capacity** makes it possible to run multi-TB databases completely in memory
  – The majority of OLTP databases will fit

• **Speed** of Non-Volatile memory changes dynamics of storage industry
  – However, putting Non-Volatile memory in traditional shared storage loses much of performance gains

• **RDMA** enables order of magnitude lower latency remote access of stored data

• **Instant, Byte Level Persistence** enables new database algorithms for storing data
  – However must still propagate changes across servers to protect from server failures
Shared Storage Has Many Advantages over Local Storage

- Much better **space utilization**
- Much better **security, management, reliability**
- Enables DB **consolidation**, DB **high availability**, RAC **scale-out**
- **Shares storage performance**
  - Aggregate performance of shared storage can be dynamically used by any server that needs it
Flash and PMEM Create **Bottleneck** for Shared Storage Analytics

Flash and Persistent Memory are Faster than fast SAN

- **5.5 GB/sec**
- **5 GB/sec**

<table>
<thead>
<tr>
<th>One NVMe Flash Drive</th>
<th>40Gb SAN Link</th>
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<tbody>
<tr>
<td>Throughput GB/sec</td>
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Exadata Offload to Storage Allows Scaling as Flash or PMem is Added, Flash Arrays Hit a Network Wall

90% of flash Performance is lost

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Exadata – eXtended Memory (XMEM) Support for Analytics

- **Persistent Memory** will provide higher capacity than DRAM, but lower performance
- Oracle Database on Exadata will automatically tier in-memory store for best performance and price
  - Most frequently used columns placed in DRAM
  - Next most frequent in PMEM on DB nodes
  - Next most frequent in Exadata Columnar Flash Cache
  - Least used columns on hard drives for lowest cost
Exadata – Persistent Memory Accelerator for OLTP

- Exadata Storage Servers will add Persistent Memory Accelerator in front of Flash memory
- **RDMA** bypasses the software stack, giving 20X faster access latency to remote Persistent Memory
- Persistent Memory mirrored across storage servers for fault-tolerance
- Persistent Memory used as a shared cache effectively increases its capacity 10x vs using it directly as expensive storage
- Log Writes will use RDMA to achieve super fast commits
Exadata Cloud – Your Way

Exadata Cloud Service

Same Product
Same Price
Oracle Managed
Oracle Owned

Oracle Public Cloud

Cloud at Customer

Exadata Cloud Machine
Exadata Customer Case Studies
Industry Examples of Heavy Ingest Workloads

- Korea's number one mobile operator
- 65 billion transactions per day
- 18TB of data per day
- All data processing occurs on Oracle Database running on Exadata

- One of world's largest law enforcement orgs
- ~3 billion transactions per day
- ~32 billion queries per day
- Database is over 1PB
- Deployed on Oracle Database on Exadata

- World’s largest stock exchange
- ~1000 million database transactions per day
  - 180,000 messages/sec
  - ~15 TB of data per day
- All data captured and processed in an Oracle Database on Exadata
Heavy Transactional Workloads with Oracle Exadata

- Garmin Connect Mobile
  - 4 million active users
  - 6 Billion miles of user activity a day
  - All user data & geospatial data is store in an Oracle Database on Exadata

- Leading electricity and gas providers in Europe
  - Ingests and processes 2.4 Billion smart meter reads a day
  - System runs on Oracle Database on Exadata

- Leading camera and printer manufacture
  - Remote monitoring of over 1 million multifunction printers from 100 countries
  - System runs on Oracle Database on Exadata
Exadata Database Machine
Performance, Availability and Security

Best Platform for Oracle Databases on-premises and in the Cloud

Delivers:

• Memory-Level Performance
• Automatic Data Tiering
• 5 Nines Availability
Exadata Advantages Increase Every Year

Dramatically Better Platform for All Database Workloads

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

Smart Hardware
- Scale-Out Storage
- Scale-Out Servers
- Scale-Out Storage
- DB Processors in Storage
- 3D V-NAND Flash
- Tiered Disk/ Flash
- Software-in-Silicon
- In-Memory Fault Tolerance
- Direct-to-wire Protocol
- JSON and XML offload
- Instant failure detection
- Exadata Cloud Machine
- Exadata Cloud Service
- In-Memory Columnar in Flash
- Smart Fusion Block Transfer

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Integrated Cloud
Applications & Platform Services