Persistent Memory: Revolutionizing the Modern Database

**Gurmeet Goindi**
Master Product Manager

Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Exadata Database Machine

Performance, Availability and Security
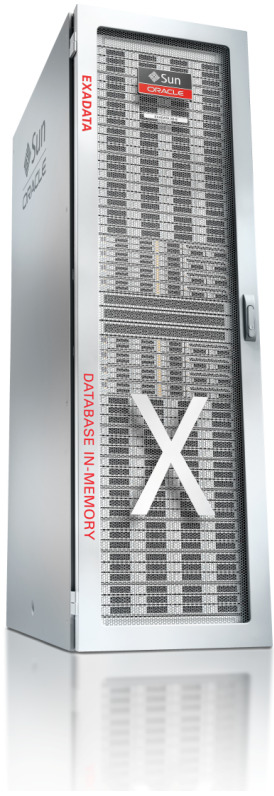
**Best Platform for Oracle Databases on-premises and in the Cloud**

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
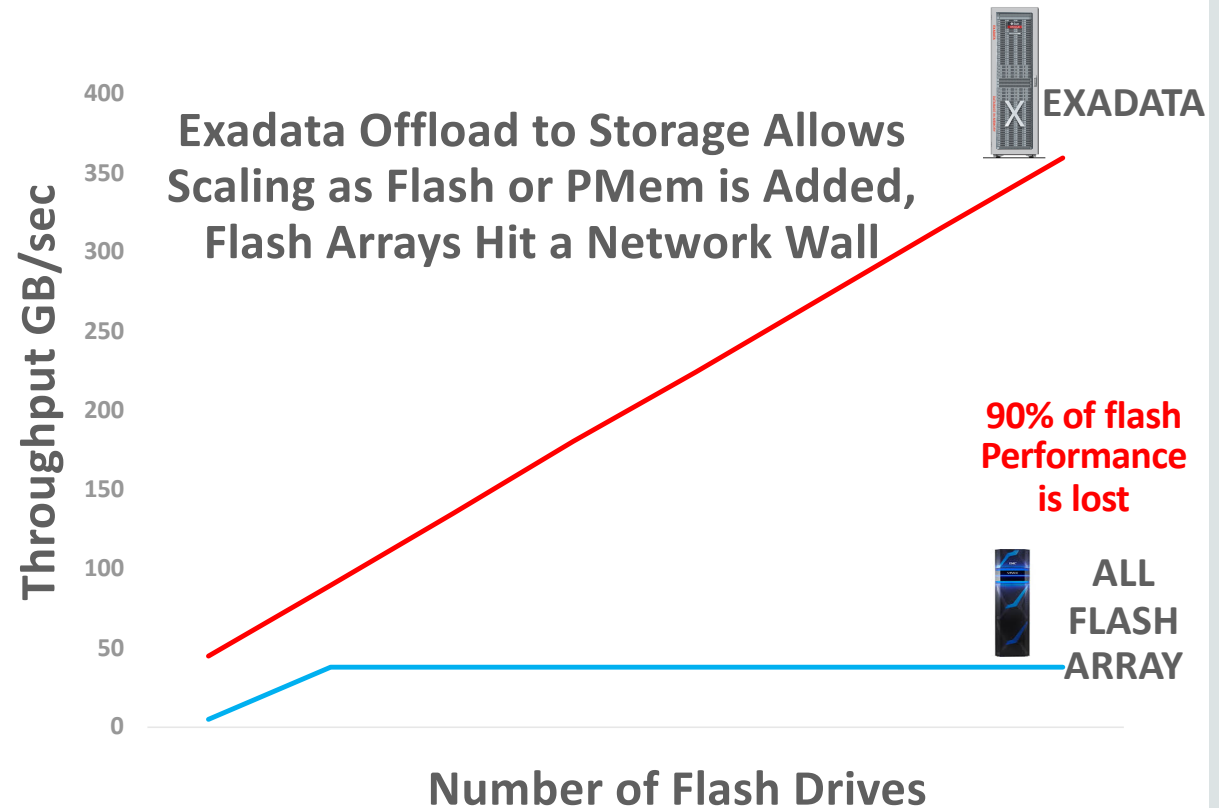 - However must still propagate changes across servers to protect from server failures

ORACLE®

Shared Storage Has Many Advantages over Local Storage

Servers

SAN/LAN
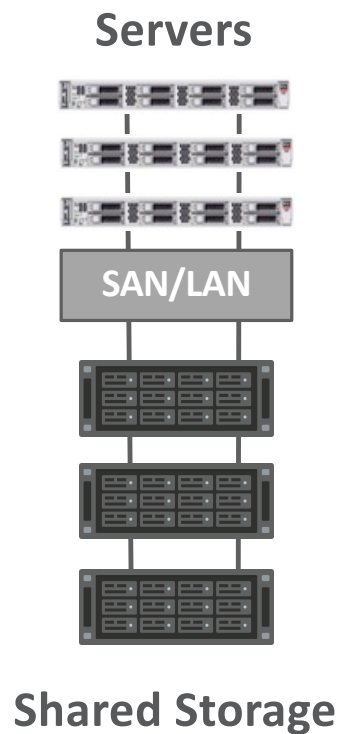
Shared Storage

- Much better **space utilization**

- Much better **security, management, reliability**

- Enables DB **consolidation**, DB **high availability**, RAC **scale-out**

- **Shares storage** <u>performance</u>
  - 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

One NVMe Flash Drive

40Gb SAN Link

Exadata Offload to Storage Allows Scaling as Flash or PMem is Added, Flash Arrays Hit a Network Wall

EXADATA

90% of flash Performance is lost

ALL FLASH ARRAY

Throughput GB/sec

400
350
300
250
200
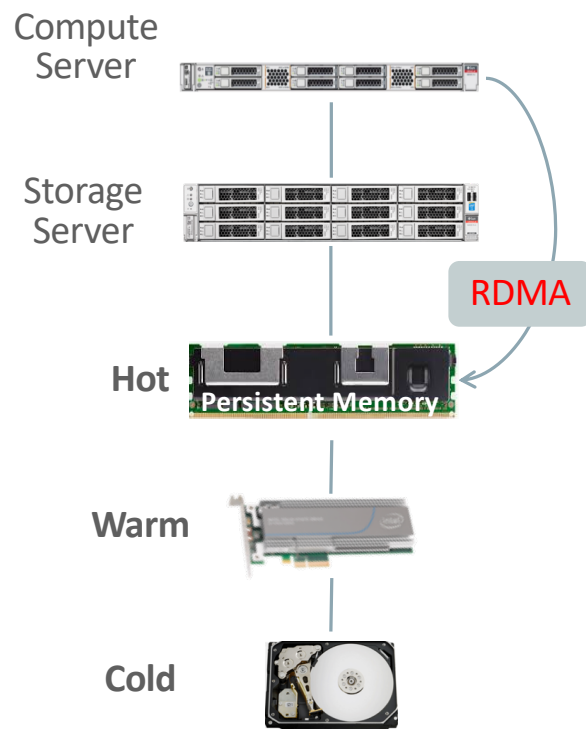150
100
50
0

Number of Flash Drives

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

In-Memory Columnar scans

Persistent Memory

DRAM

In-Flash Columnar scans
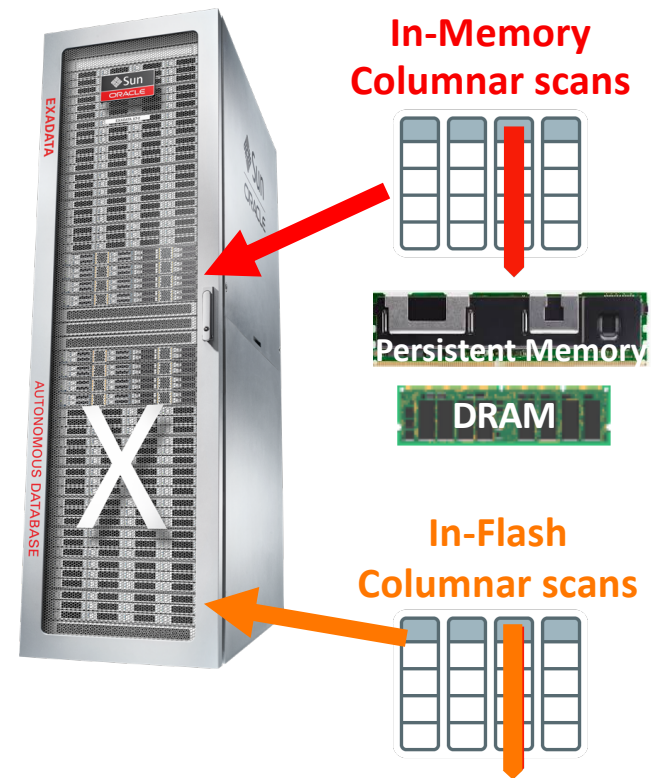
Exadata – Persistent Memory Accelerator for OLTP

Compute Server

Storage Server

RDMA

Hot
Persistent Memory

Warm

Cold

- 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

ORACLE®

8

Exadata Cloud – Your Way

**Exadata Cloud
Service**

**Exadata Cloud
Machine**

Same Product

Same Price

Oracle Managed

Oracle Owned

Oracle Public Cloud

Cloud at Customer

Exadata Customer Case Studies

Industry Examples of Heavy Ingest Workloads

SK telecom

- 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

U.S. Department of Homeland Security

- 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

NYSE

- 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

- 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

## RWE
The energy to lead

- 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

Canon

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

ORACLE®

Exadata Database Machine

Performance, Availability and Security
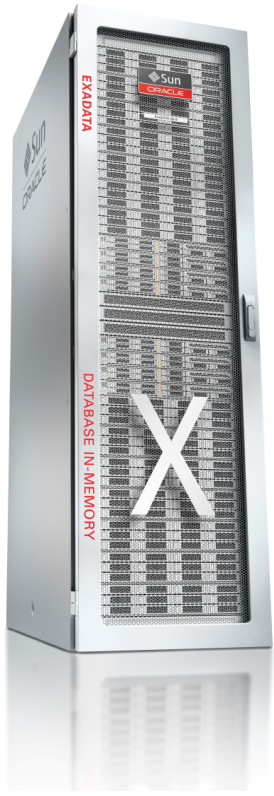
Best Platform for Oracle Databases on-premises and in the Cloud

Delivers:

- Memory-Level Performance

- Automatic Data Tiering

- 5 Nines Availability

ORACLE®

Exadata Advantages Increase Every Year

**Dramatically Better Platform
for All Database Workloads**

- Exadata Cloud Machine
- Exadata Cloud Service
- In-Memory Columnar in Flash
- Smart Fusion Block Transfer
- In-Memory Fault Tolerance
- Direct-to-wire Protocol
- JSON and XML offload
- Instant failure detection
- Network Resource Management
- Multitenant Aware Resource Mgmt
- Prioritized File Recovery
- 3D V-NAND Flash
- IO Priorities
- Data Mining Offload
- Offload Decrypt on Scans
- Software-in-Silicon
- Tiered Disk/ Flash
- Database Aware Flash Cache
- Storage Indexes
- Columnar Compression
- PCIe NVMe Flash
- Smart Scan
- InfiniBand Scale-Out
- Unified InfiniBand
- DB Processors in Storage
- Scale-Out Storage
- Scale-Out Servers

Smart Software

Smart Hardware

ORACLE®

Integrated Cloud

Applications & Platform Services