Oracle Database In-Memory

Enabling Real-Time Analytics

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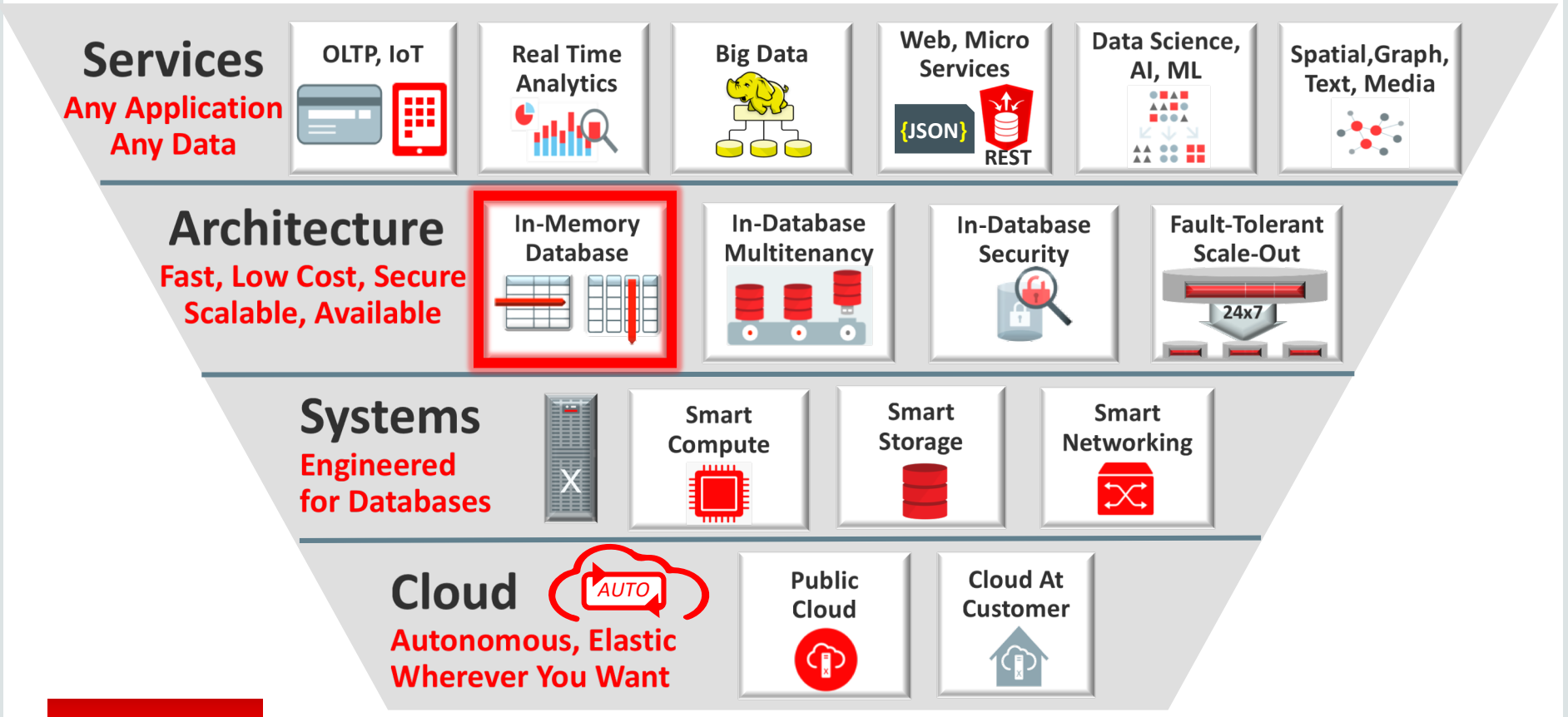
Database Platform of the **Future** – *Complete* and *Integrated*



What is Database In-Memory

Oracle Database In-Memory

Real-Time Analytics

Enable Real-Time Business Decisions

Accelerate Mixed Workload

Run analytics on Operational Systems

Risk-Free

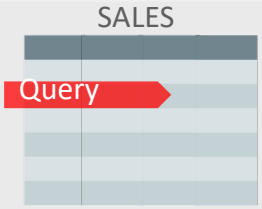
Proven Scale-Out, Availability, Security

Trivial to Implement

No Application Changes
Not Limited by Memory

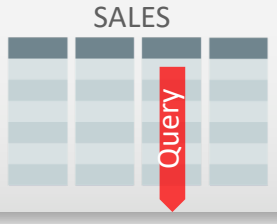
Row Format Databases vs. Column Format Databases

Rows Stored Contiguously



- **Transactions** run faster on row format
  - Example: Query or Insert a sales order
  - Fast processing few rows, many columns

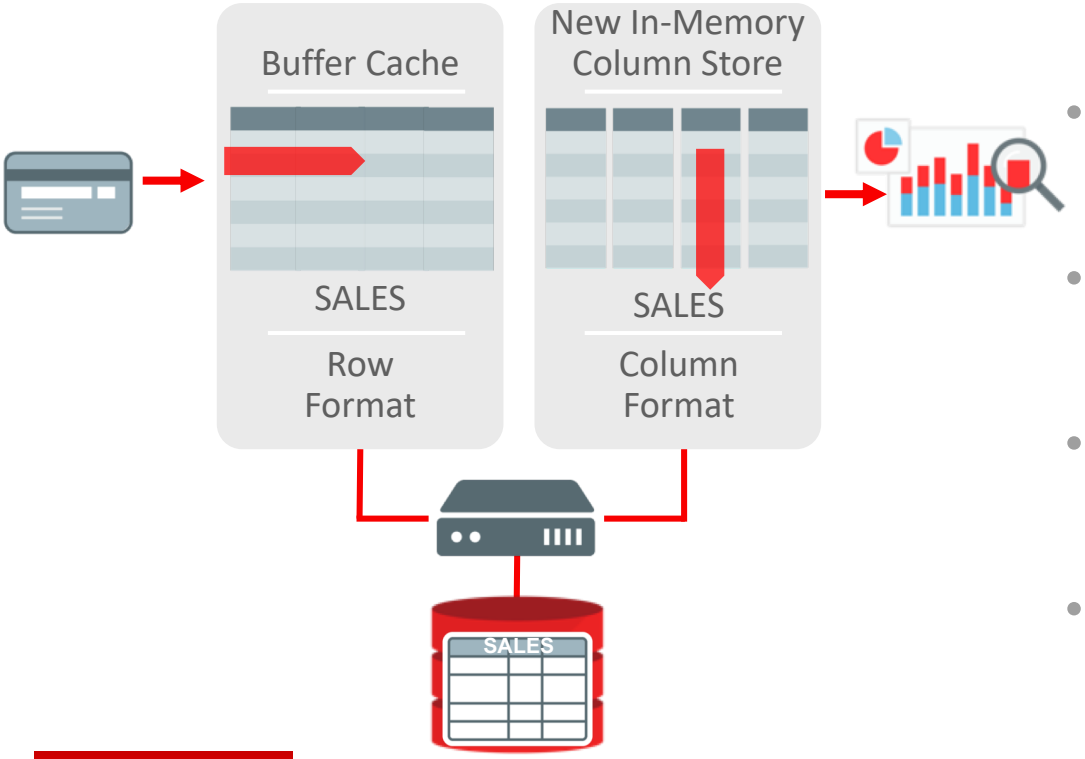
Columns Stored Contiguously



- **Analytics** run faster on column format
  - Example : Report on sales totals by region
  - Fast accessing few columns, many rows

Until Now Must Choose One Format and Suffer Tradeoffs

Breakthrough: Dual Format Database



- **BOTH** row and column formats for same table
- Simultaneously active and transactionally consistent
- Analytics & reporting use new in-memory Column format
- OLTP uses proven row format

The Forrester Wave™: In-Memory Databases, Q1 2017

- Oracle In-Memory Scored Highest of All Databases for Current Offering and Strategy

- For the full report see:

https://reprints.forrester.com/#/assets/2/132/%27RES132143%27/reports

Where Is It Available

Oracle Database

- Database In-Memory is an option for Oracle Database 12c Enterprise Edition
- Database In-Memory is included in the first patchset (12.1.0.2) for 12.1
- Oracle Database 12c Release 2 (12.2)
- Oracle Database 18c is available in the Cloud and on Exadata
- No additional installation steps required

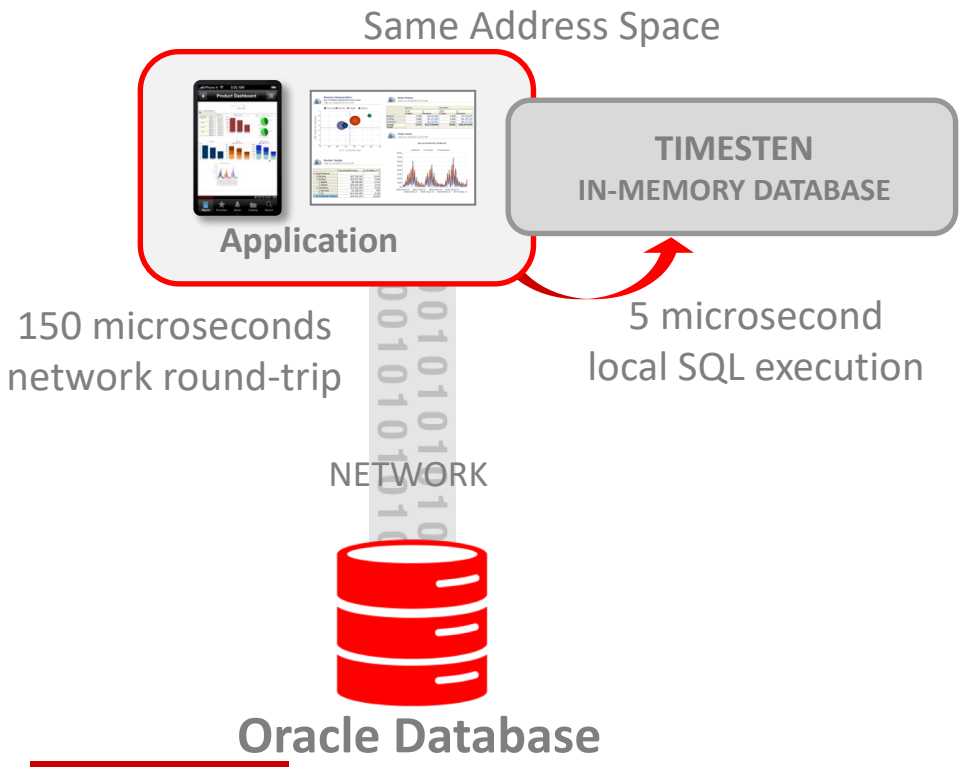
Note: Database In-Memory is **not** enabled by default

Where Is Database In-Memory Available?

- Exadata Express Cloud Service – X1000IM – up to 10GB Column Store
- Database Cloud Service: **Extreme Performance**
- Exadata Cloud Service
- Exadata Cloud at Customer
- On-premises

Isn't it just TimesTen

TimesTen for Latency-Critical OLTP
Complementary In-Memory Technology



- **Latency-Critical OLTP limited by network between application and database**
  - Phone call routing, stock trading
- TimesTen In-Memory Database is light-weight and ultra-fast
  - Runs in application address space: No Network
  - **30x** faster latency-critical OLTP

Why not just ”cache” the table in the row store

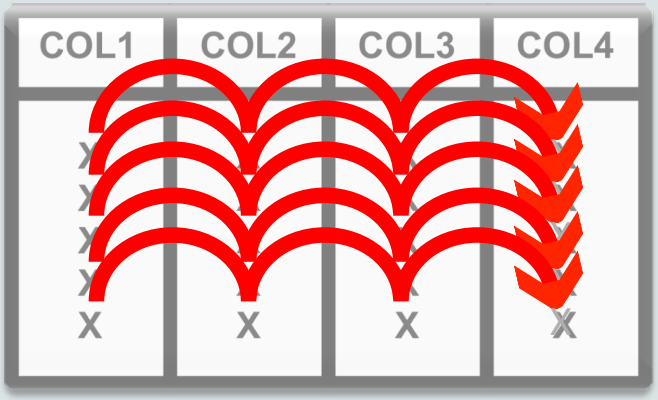
Compare Column-store to Row-store

```
SQL> -- In-Memory Column Store query
SQL>
SQL> select  max(lo_ordtotalprice) most_expensive_order From LINEORDER;

MOST_EXPENSIVE_ORDER
--------------------
            57346348

Elapsed: 00:00:00.01

-------------------------------------------------------------------------------------------------
| Id  | Operation                   | Name      | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT            |           |       |       |  5401 (100)|          |
|   1 |  SORT AGGREGATE             |           |     1 |     6 |            |          |
|   2 |   TABLE ACCESS INMEMORY FULL| LINEORDER |    59M|   343M|  5401   (16)| 00:00:01 |
-------------------------------------------------------------------------------------------------

SQL> -- Buffer Cache query with the column store disabled via NO_INMEMORY hint
SQL>
SQL> select /*+ NO_INMEMORY */ max(lo_ordtotalprice) most_expensive_order From LINEORDER;

MOST_EXPENSIVE_ORDER
--------------------
            57346348

Elapsed: 00:00:08.38

-----------------------------------------------------------------------------------------
| Id  | Operation          | Name      | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT   |           |       |       |   123K(100)|          |
|   1 |  SORT AGGREGATE    |           |     1 |     6 |            |          |
|   2 |   TABLE ACCESS FULL| LINEORDER |    59M|   343M|   123K  (1)| 00:00:05 |
-----------------------------------------------------------------------------------------
```

How does it work

Why is an In-Memory scan faster than the buffer cache?

Buffer Cache

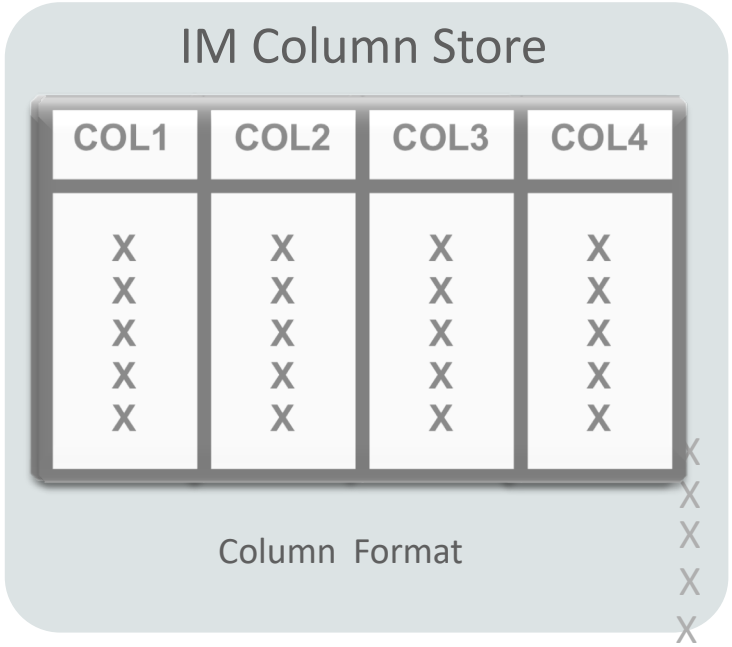


Row Format

```
SELECT COL4 FROM MYTABLE;
```

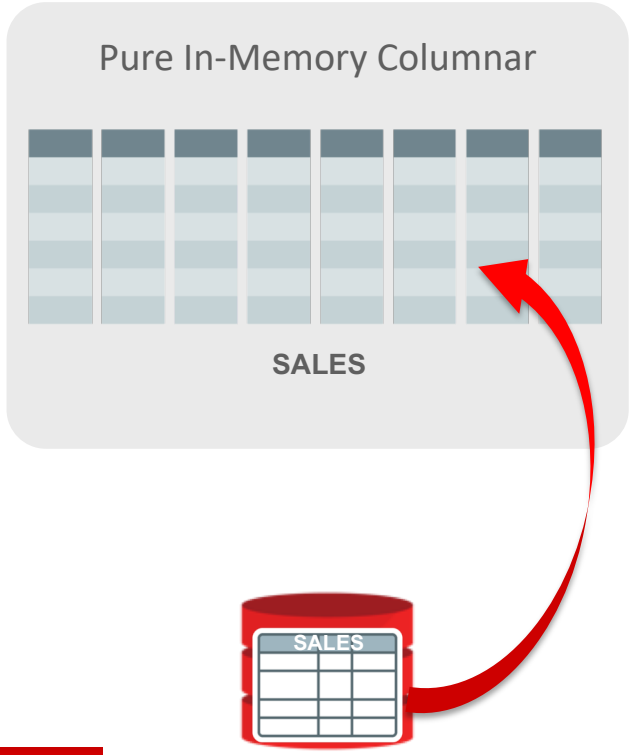
RESULT

Why is an In-Memory scan faster than the buffer cache?



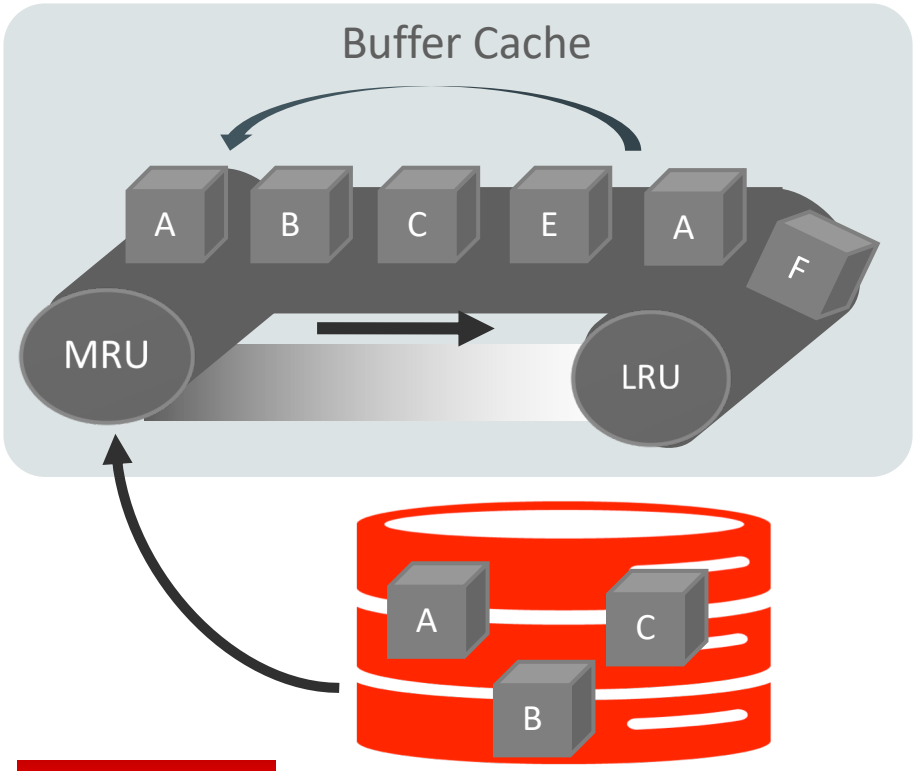

```
SELECT COL4 FROM MYTABLE;
```

Oracle In-Memory Columnar Technology



- Pure in-memory columnar format
  - Not persistent, and no logging
  - Quick to change data: fast OLTP
- Enabled at table or partition
  - Only active data in-memory
- 2x to 20x compression typical
- Available on all hardware platforms

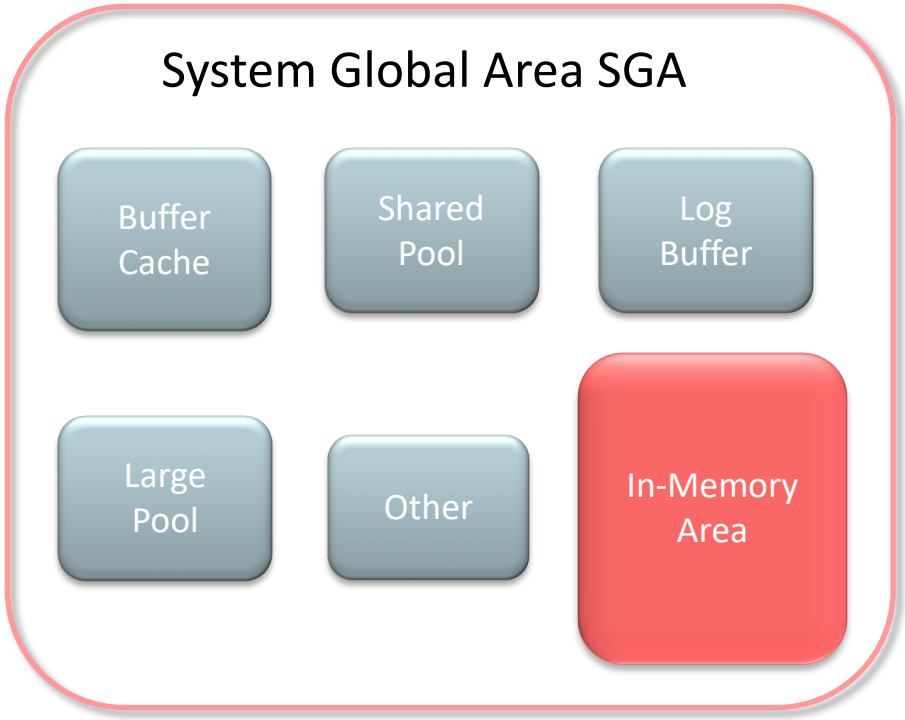
In-Memory A Store – Not A Cache



- What is a cache?
- A pool of memory
- Data automatically brought into memory based on access
- Data automatically aged out
- Good example:

  Oracle Database Buffer Cache

In-Memory Area: Static Area within SGA



- Contains data in the new In-Memory Column Format
- Controlled by INMEMORY_SIZE parameter
  - Minimum size of 100MB
- SGA_TARGET must be large enough to accommodate this area

Real-Time Analytics

Scanning and filtering data more efficiently

Columnar Format

Access only the columns you need

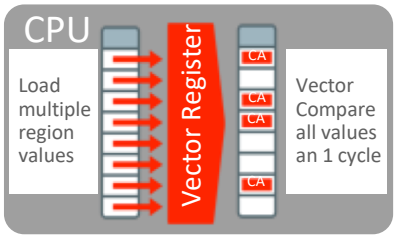
Compression

Scan & filter data in compressed format

Storage Indexes

Prune out any unnecessary data from the column

SIMD Vector Processing



Process multiple column values in a single CPU instruction

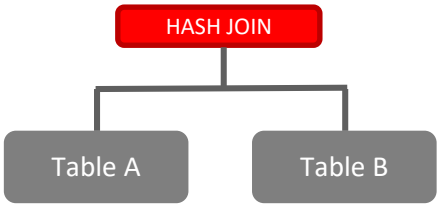
Real-time Analytics

Improves all aspects of analytic queries

Data Scans

- Speed of memory
- Scan and Filter only the needed Columns
- Vector Instructions

Joins



- Convert Star Joins into 10X Faster Column Scans
- Search large table for values that match small table

In-Memory Aggregation

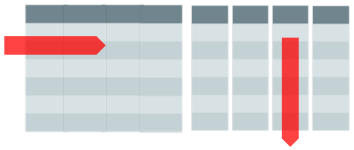
- Create In-Memory Report Outline that is Populated during Fast Scan
- Runs Reports Instantly

Improvements in 12.2 for Database In-Memory

Real-Time Analytics

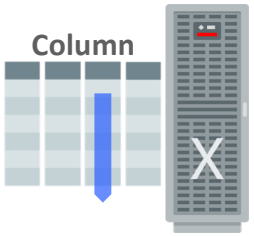
- **2X** Faster Joins
- **5X** Faster Expressions

Mixed Workload



- Active Data Guard Support

Massive Capacity



- In-Memory on Exadata Flash

Multi-model

- Native support for JSON Data type

Automation

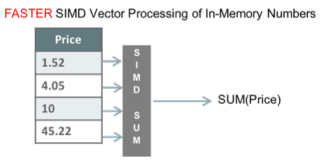
- Dynamic Data Movement Between Storage & Memory
- IM FastStart
- IM Column Store Re-sizing

Improvements in 18c for Database In-Memory

Further Performance Gains

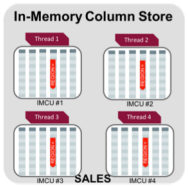
2X Query Performance Gains

Optimized Arithmetic



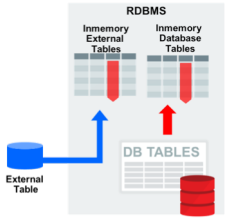
In-Memory Optimized Arithmetic

Dynamic Scans



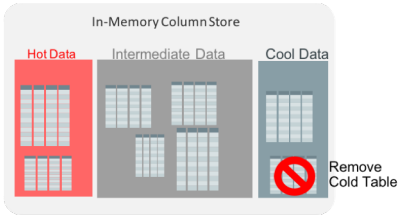
In-Memory Dynamic Scans

External Tables



In-Memory External Tables

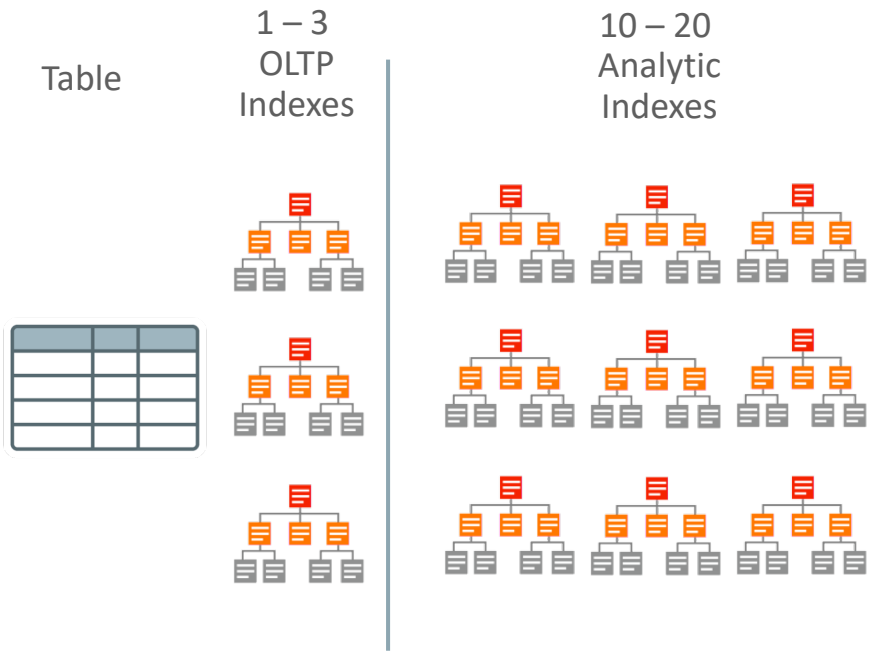
Automatic In-Memory



Automatic Data Movement Between Storage & Memory

How does it impact OLTP environments

Complex OLTP is Slowed by Analytic Indexes



- Most Indexes in complex OLTP (e.g. ERP) databases are only used for analytic queries
- Inserting one row into a table requires updating 10-20 analytic indexes: Slow!
- Indexes only speed up predictable queries & reports

Database In-Memory Accelerates Mixed Workloads

- Complex OLTP is Slowed by Analytic Indexes

- Inserting one row into a table requires updating 10-20 analytic indexes: Slow!

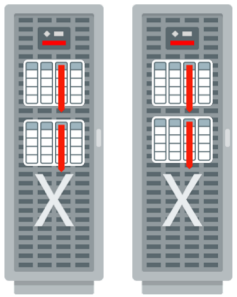
- Column Store Replaces Analytic Indexes

- Fast analytics on any columns
- Not persistent so update cost is much lower

Database In-Memory and other Oracle Database features

Database In-Memory: Scales to Any Size

Scale-Out

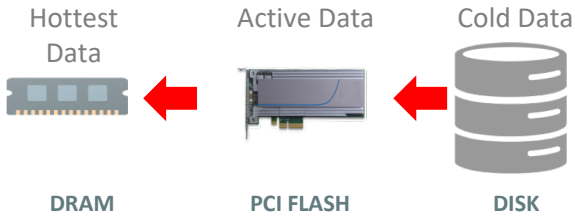


- Scale-Out Across Servers to Grow Memory and CPUs
- In-Memory Queries Parallelized Across Servers

Scale-Up

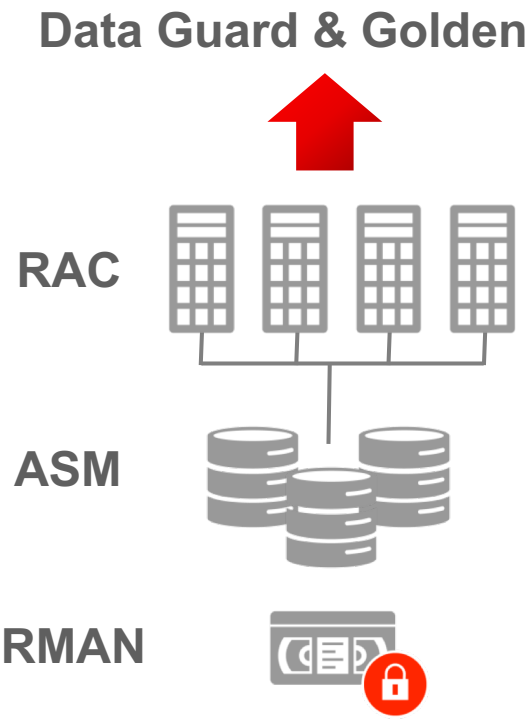
- Scale-Up on large SMPs
  - NUMA Optimized

Combine with Flash and Disk



- Easily place data on most cost effective tier
- Simultaneously Achieve:
  - Speed of DRAM
  - I/Os of Flash
  - Cost of Disk

Database In-Memory: Industrial Strength Availability



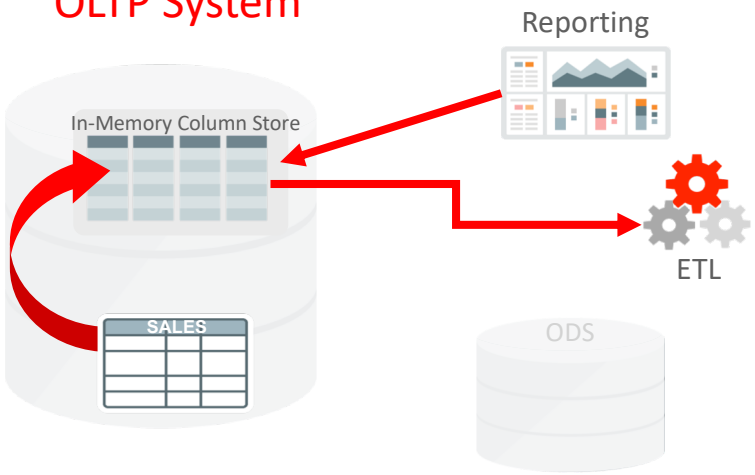
- Pure In-Memory format does not change Oracle's storage format, logging, backup, recovery, etc.
- All Oracle's proven availability technologies work transparently
- Protection from all failures
  - Node, site, corruption, human error, etc.

When To Use Database In-Memory

What is an analytic query?

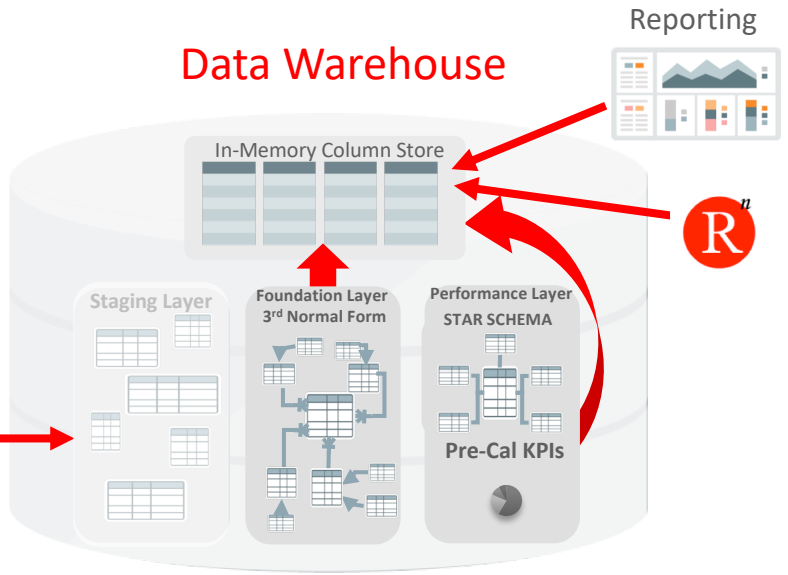
Where to use In-Memory

OLTP System



- Enables real-time reporting directly on OLTP data
- Speeds data extraction part of ETL process
- Removes need for separate ODS

Data Warehouse



- Star-schema and pre-calculated KPIs
  - Improves performance of dash-boards
- All or a subset of Foundation Layer
  - For time-sensitive analytics on 3rd normal form
- Staging/ETL/Temp not good candidates
  - Write once, read once

How are customers using Database In-Memory

Database In-Memory Customers

AT&T WiFi – Data Warehouse

- Business Objects reports 100X faster
- ETL processes improved by 50% faster
- No changes to SAP Business Objects reports

Villeroy & Boch – SAP BW

- SAP BW COPA queries 30 – 33X faster
- SAP Transaction list queries 4 – 4,800X faster
- Avoided expensive & risky upgrade to S4/Hana

BOSCH – SAP CRM

- Dropped all custom indexes
- Analytic queries 2-20X faster, DML 2-3X faster
- No changes to application required

Die Mobiliar – Mixed Workload

- Analytic queries 50-200X faster
- Database size reduced considerably
- Phase out of Netezza and mainframe systems

Database In-Memory Customers

Mankind Pharma – Mixed Workload

- Analytical reports 11x faster
- Dropping indexes improved OLTP
- 90% reduction in database size

Shanghai Customs – Mixed Workload

- Processes Clearance 43x Faster
- Improves Declaration-Services Efficiency
- Reduced Costs

- **LION** – SAP ERP

- Analytic queries 4X faster
- Transactions 2X faster
- Analytic queries now possible on 100s of Millions of Point-of-Sales Transactions

Lufthansa – Reporting Application

- Analytic queries up to 100x faster
- Improved data ingest performance
- Reduction in database size

Where can I get more information

Additional Resources

Join the Conversation

- https://twitter.com/db_inmemory
- https://twitter.com/TheInMemoryGuy
- https://blogs.oracle.com/In-Memory/
- https://www.facebook.com/OracleDatabase
- http://www.oracle.com/goto/dbim.html

White Papers (otn.com)

- Oracle Database In-Memory White Paper
- Oracle Database Implementation and Usage White Paper
- Oracle Database In-Memory Aggregation Paper
- When to use Oracle Database In-Memory
- Oracle Database In-Memory Advisor

Videos

- Oracle Database In-Memory YouTube Channel
- oracle.com
  Powering the Real-Time Enterprise
  oracle.com/us/corporate/events/dbim/index.html
- YouTube - Juan Loaiza: DBIM: What's new in 12.2

Additional Questions

- In-Memory blog: blogs.oracle.com/In-Memory
- My email: andy.rivenes@oracle.com

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