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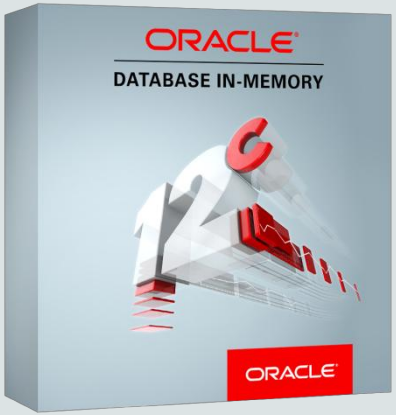
ORACLE DATABASE 12c

Oracle Database In-Memory

The Next Big Thing



Maria Colgan
Master Product Manager

#DBIM12c

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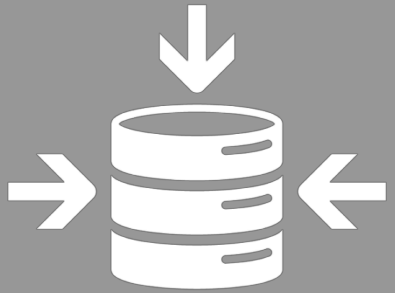
Why is Oracle do this

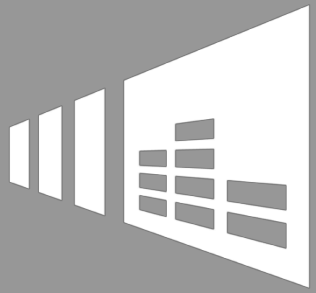
Oracle Database In-Memory Goals

Real Time Analytics

Accelerate Mixed Workload OLTP



No Changes to Applications



Trivial to Implement

What is an analytic query?

What is an analytic query?

- Scans a large amount of data
- Selects a subset of columns from wide tables
- Uses filter predicates in the form of =, >, <, between, in-list
- Uses selective join predicates that reduce the amount of data returned
- Contain complex calculations or aggregations

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

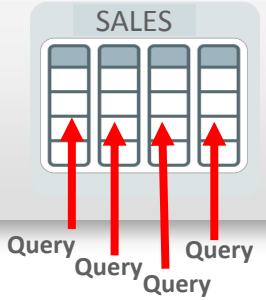
- **Analytics** run faster on column format
  - Example : Report on sales totals by region
  - Fast accessing few columns, many rows

OLTP Example

Row

- Query a single sales order in row format
  - One contiguous row accessed = ***FAST***

Column

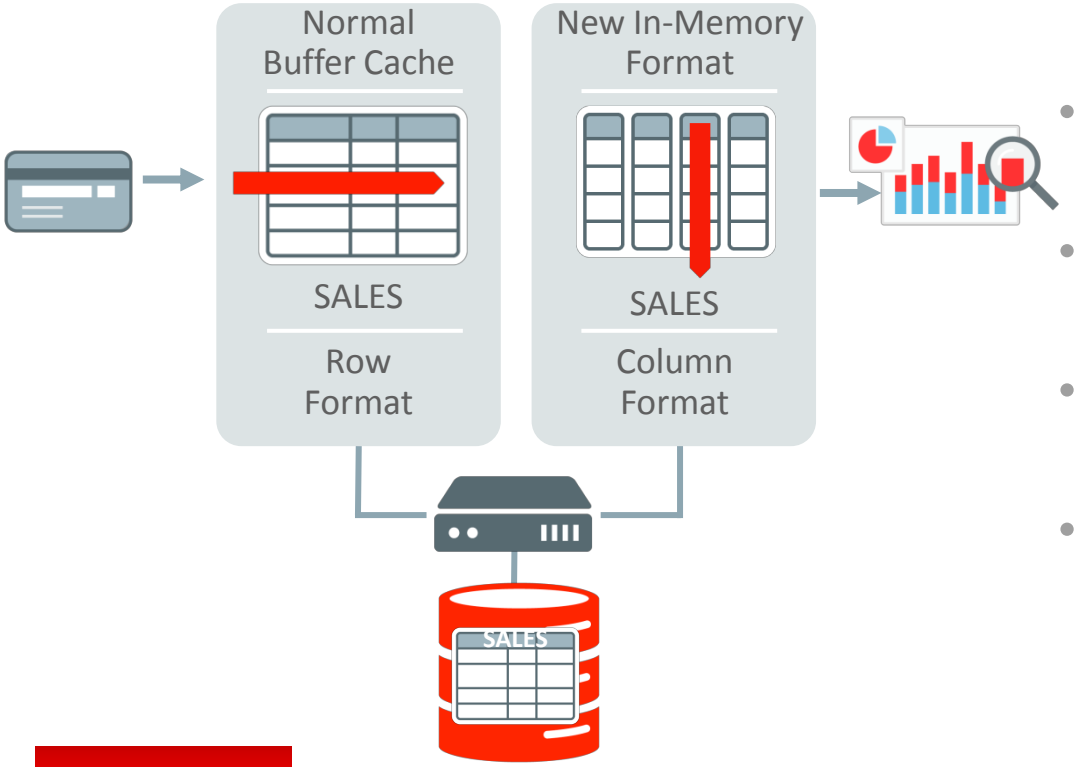


- Query a sales order in Column Format
  - Many column accessed = **S L O W**

Until Now Must Choose One Format and Suffer Tradeoffs

What is it

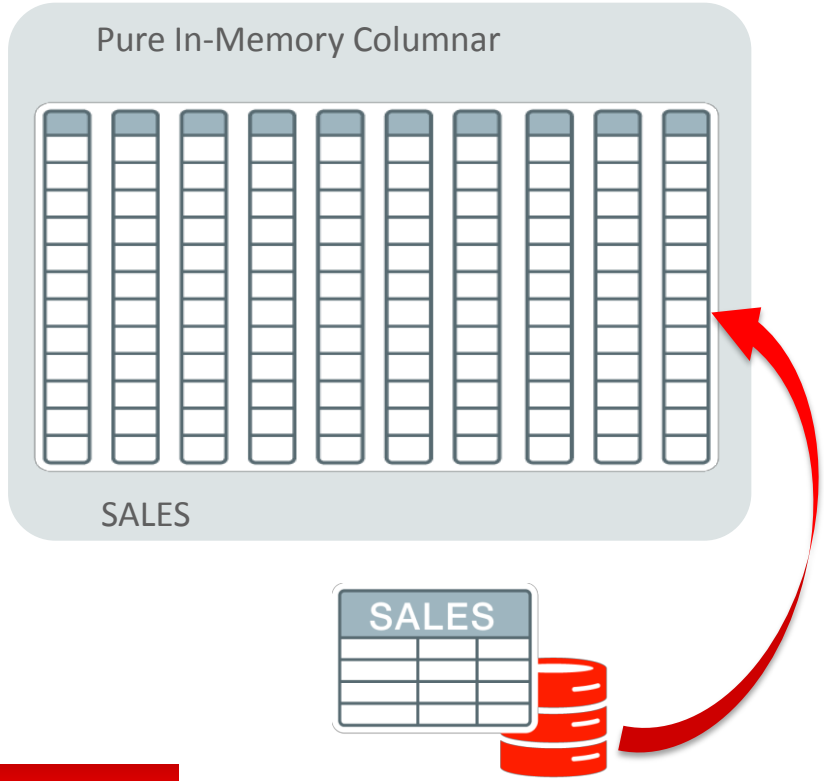
Breakthrough: Dual Format Database



- **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

How Does it work

Oracle In-Memory Columnar Technology

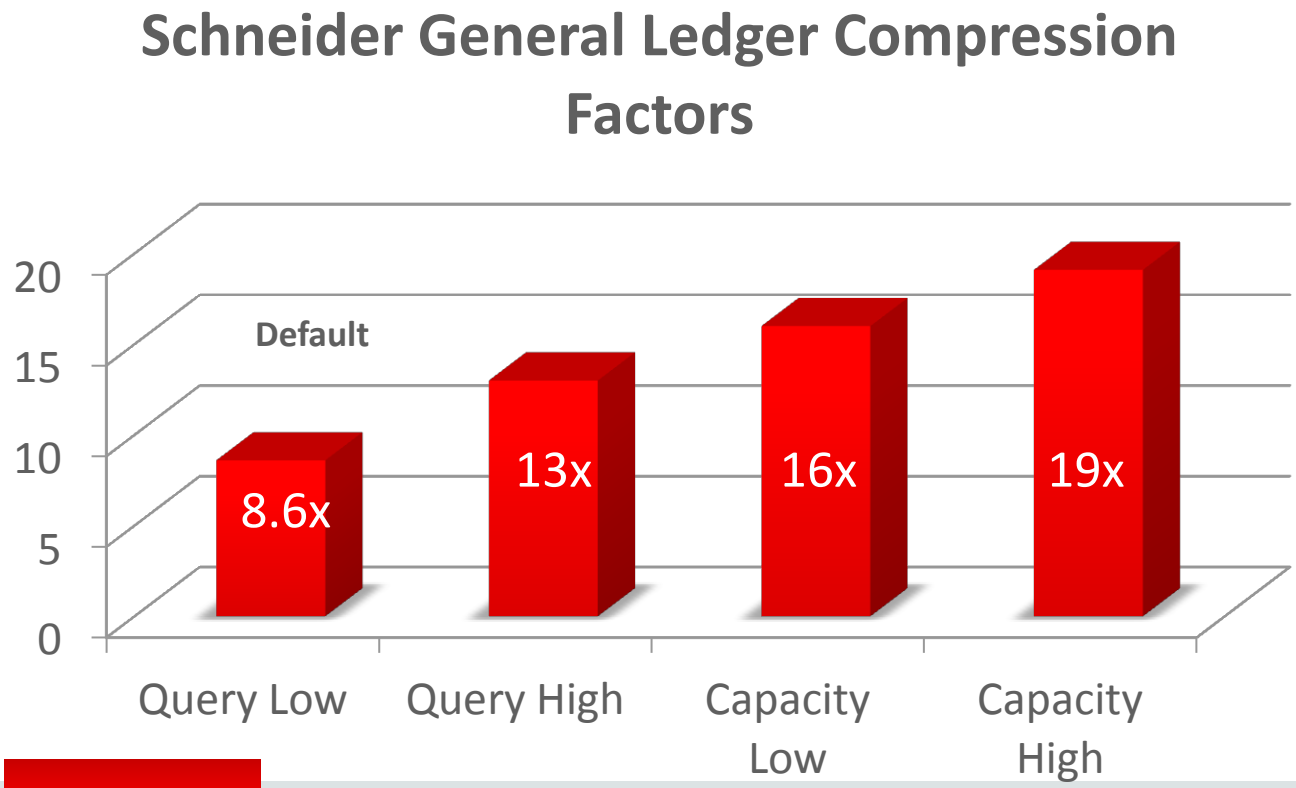


- Pure in-memory column format
  - Not persistent, and no logging
  - Quick to change data: fast OLTP
- Enabled at table or partition
  - Only active data in-memory
- 2x to 20x compression typical
- Available on all hardware platforms

Early User - Schneider Electric

- Global Specialist in Energy Management™
- 25 billion € revenue
- 160,000+ employees in 100+ countries

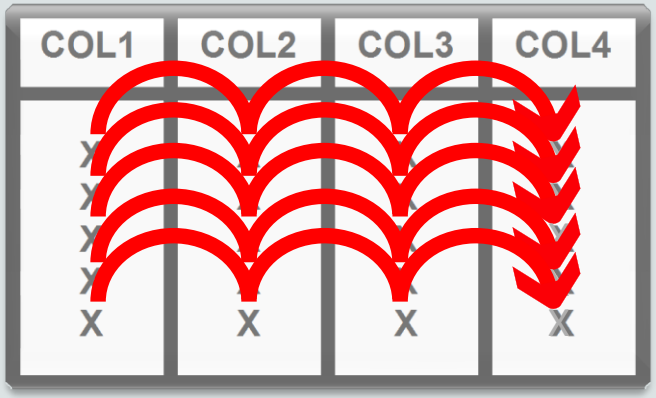
Schneider In-Memory Compression



- Over 2 billion General Ledger Entries
- 900 GB on disk

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

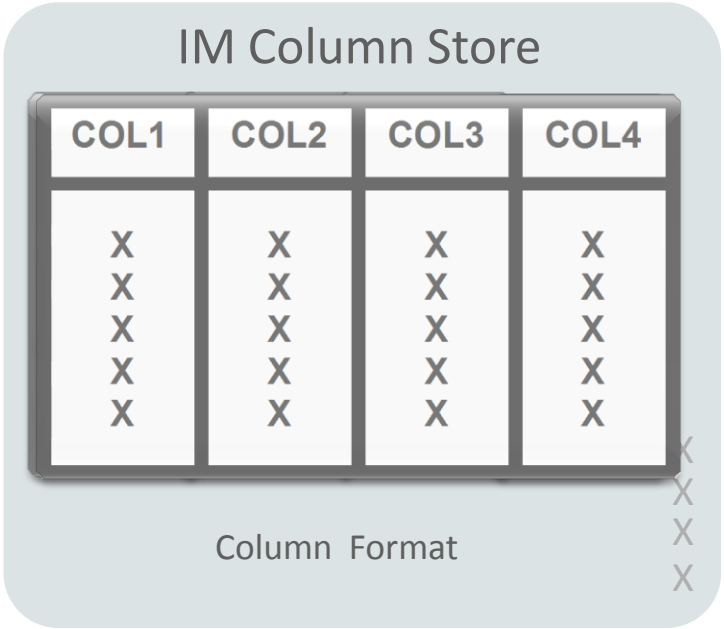
Buffer Cache



Row Format

```
SELECT COL4 FROM MYTABLE;
```

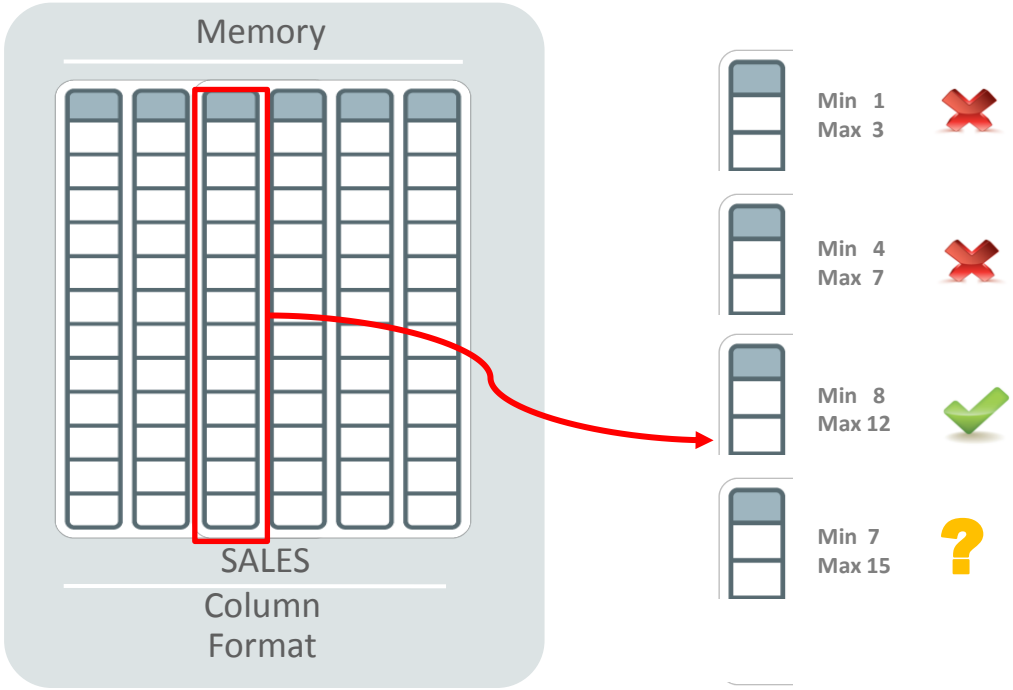
Why is an In-Memory scan faster than the buffer cache?




```
SELECT COL4 FROM MYTABLE;
```

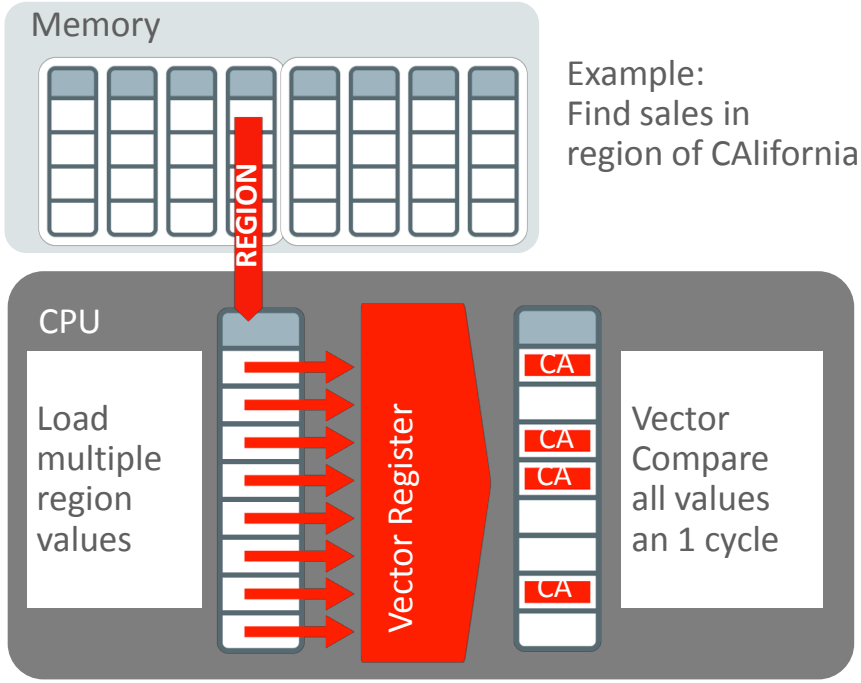
Oracle In-Memory Column Store Storage Index

Example: Find all sales from stores with a store_id of 8



- Each column is the made up of multiple column units
- Min / max value is recorded for each column unit in a storage index
- Storage index provides partition pruning like performance for ALL queries

Orders of Magnitude Faster Analytic Data Scans

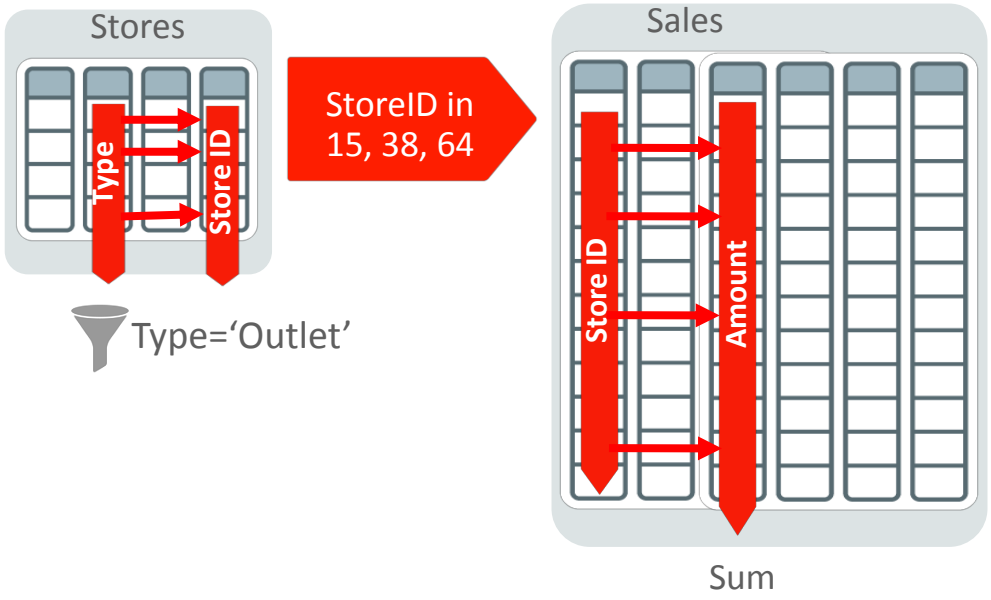


> 100x Faster

- Each CPU core scans local in-memory columns
- Scans use super fast SIMD vector instructions
  - Originally designed for graphics & science
- **Billions of rows/sec** scan rate per CPU core
  - Row format is millions/sec

Joining and Combining Data Also Dramatically Faster

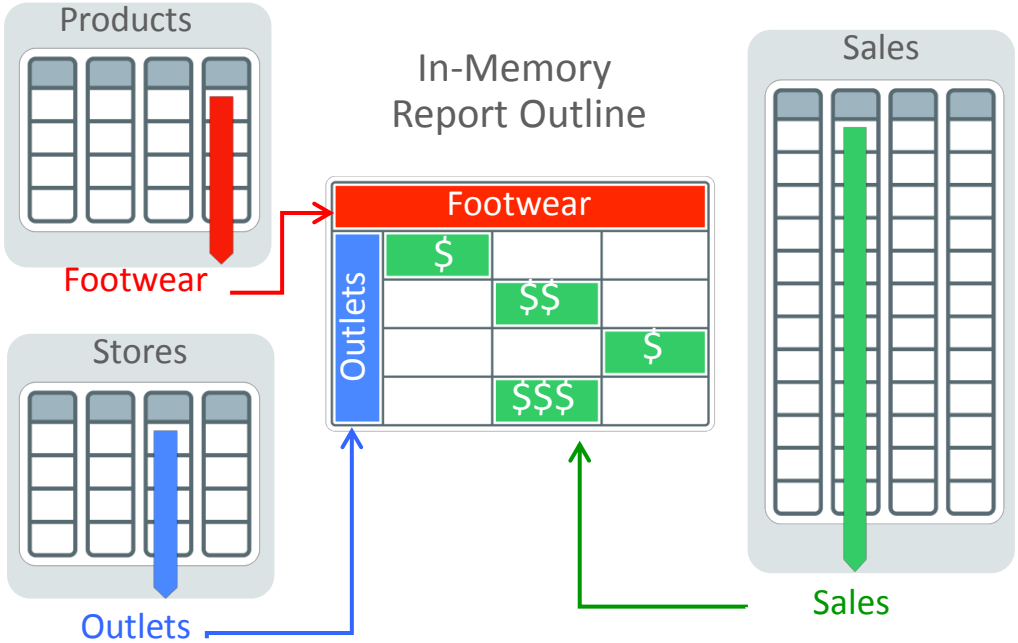
Example: Find total sales in outlet stores



- Converts joins of data in multiple tables into fast column scans
- Joins tables **10x** faster

Generates Reports Instantly

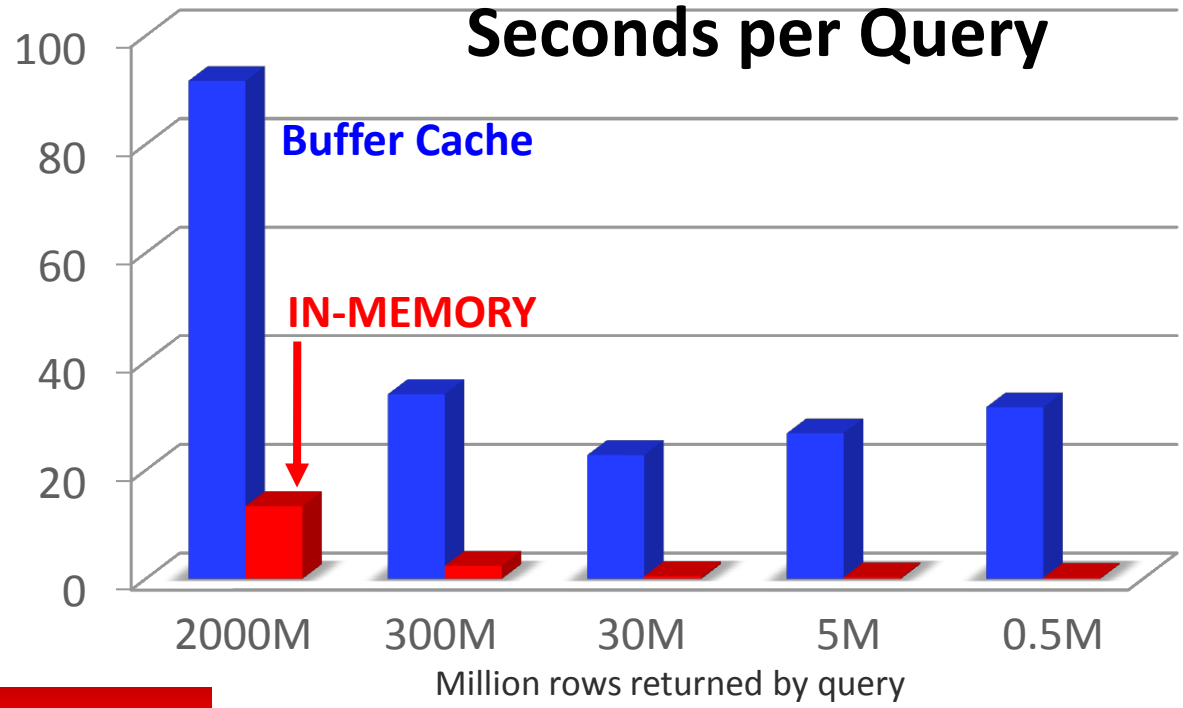
Example: Report sales of footwear in outlet stores



- Dynamically creates in-memory report outline
- Then report outline filled-in during fast fact scan
- Reports run much faster
  - Without predefined cubes
- Also offloads report filtering to Exadata Storage servers

Schneider Speedup Across 1545 Queries

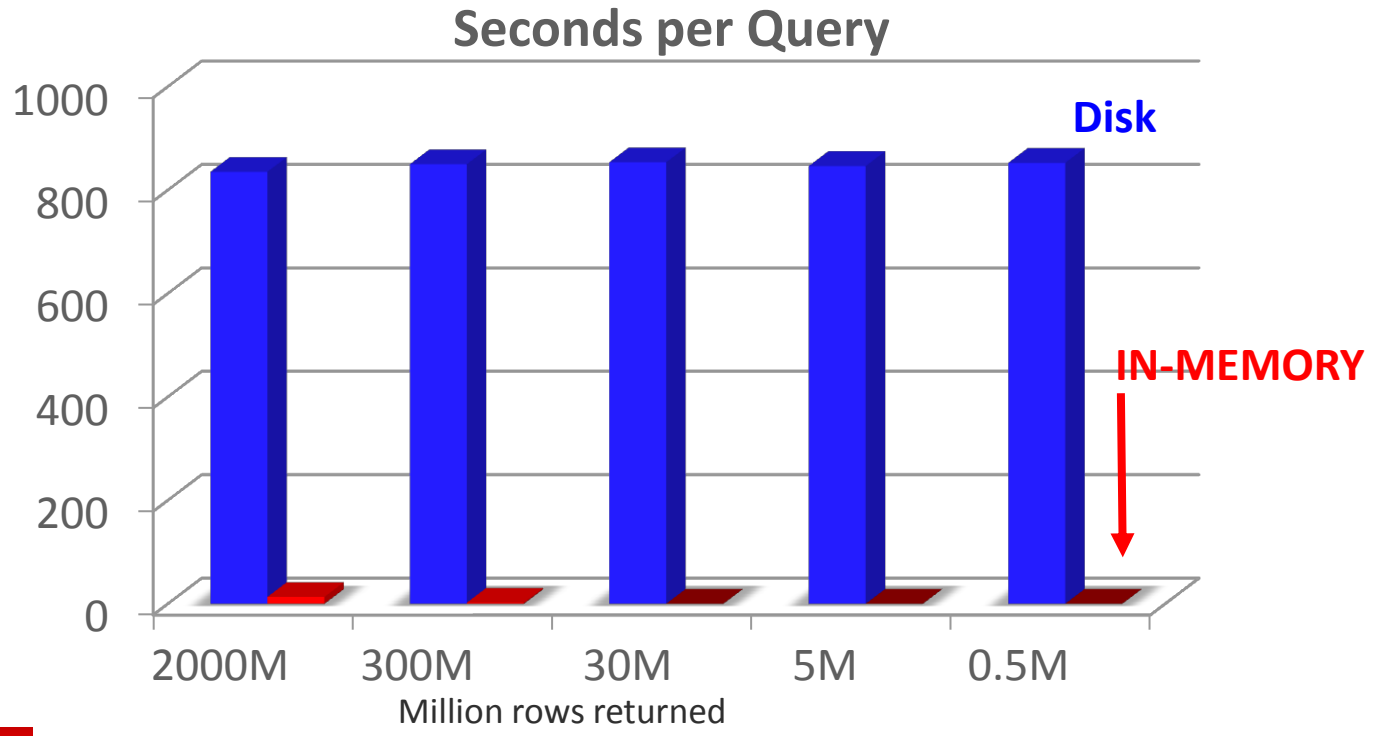
7x to 128x faster



- 2 billion General Ledger Entries
- 1545 queries
  - Currently take 34 hours to complete
  - Combination of filter queries, aggregations and summations

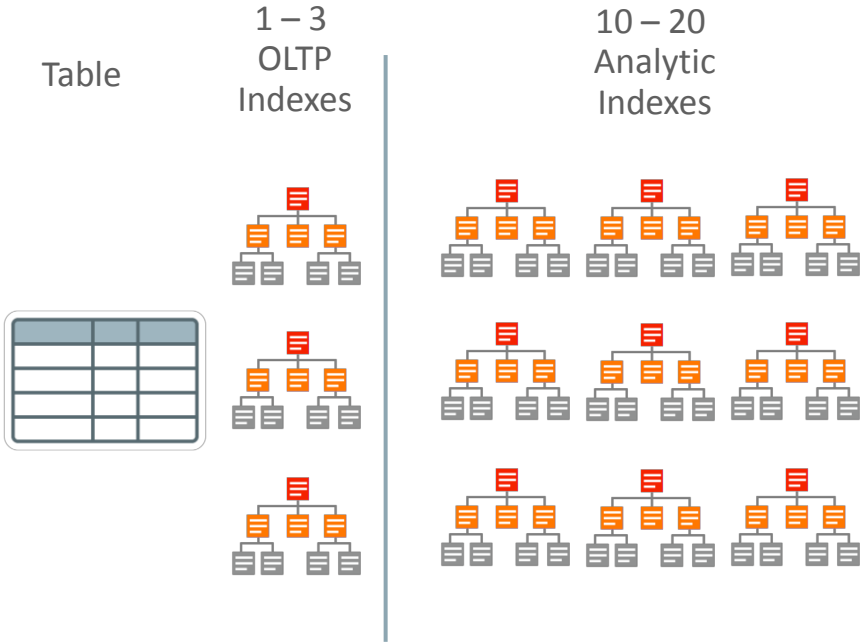
Schneider Speedup vs. Disk

From 62x to 3259x faster



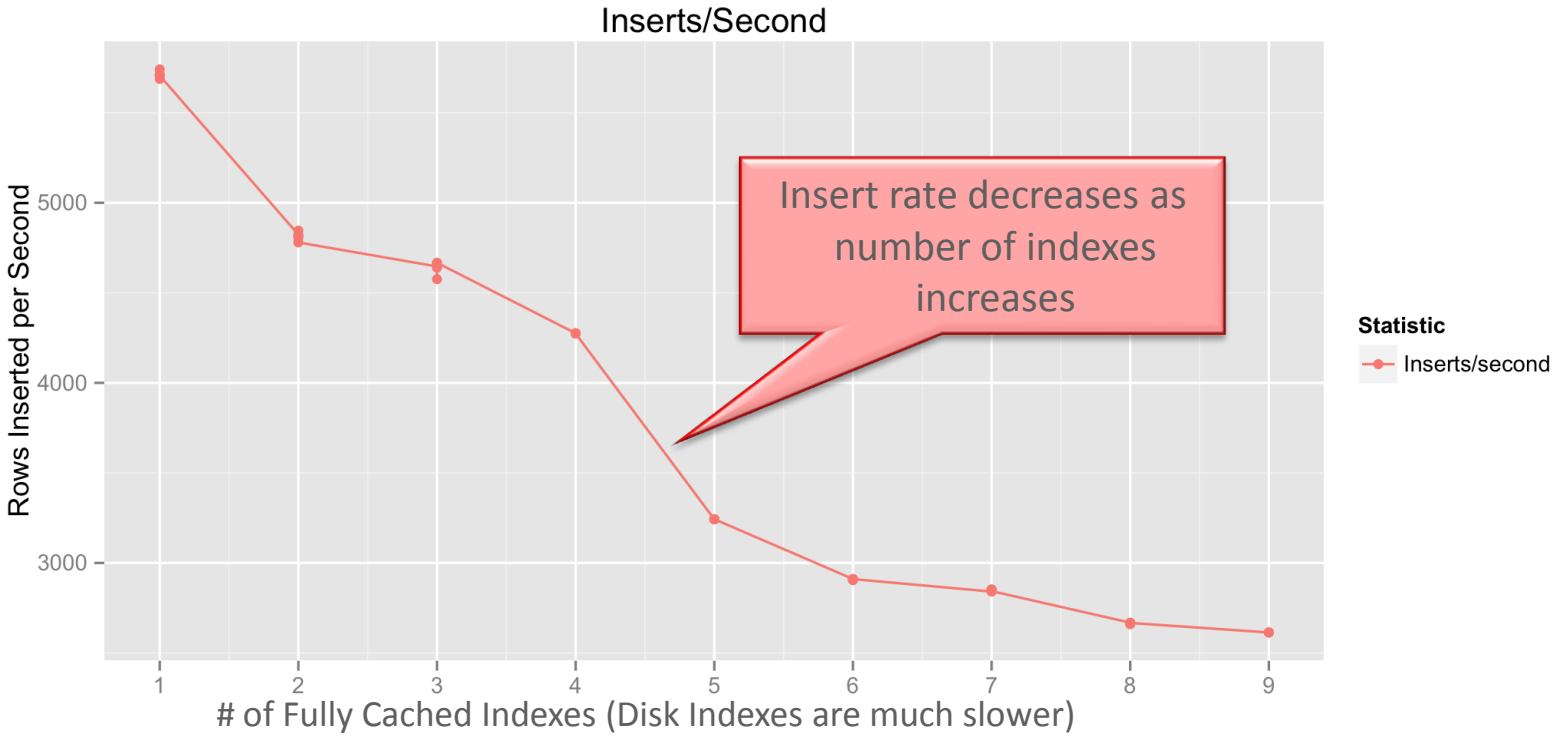
How does it impact OLTP environments

Complex OLTP is Slowed by Analytic Indexes

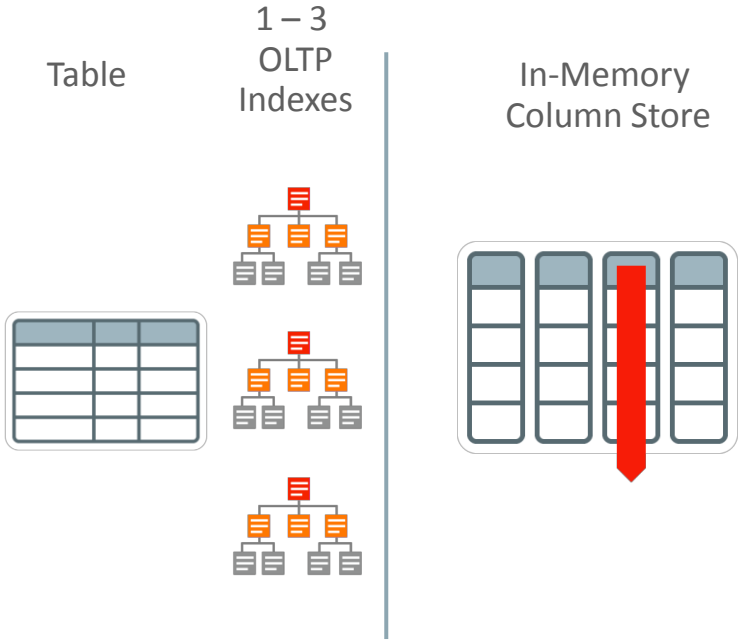


- Most Indexes in complex OLTP (e.g. ERP) databases are only used for analytic queries
- Inserting one row into a table requires updating 10-20 analytic indexes: Slow!
- Indexes only speed up predictable queries & reports

OLTP is Slowed Down by Analytic Indexes



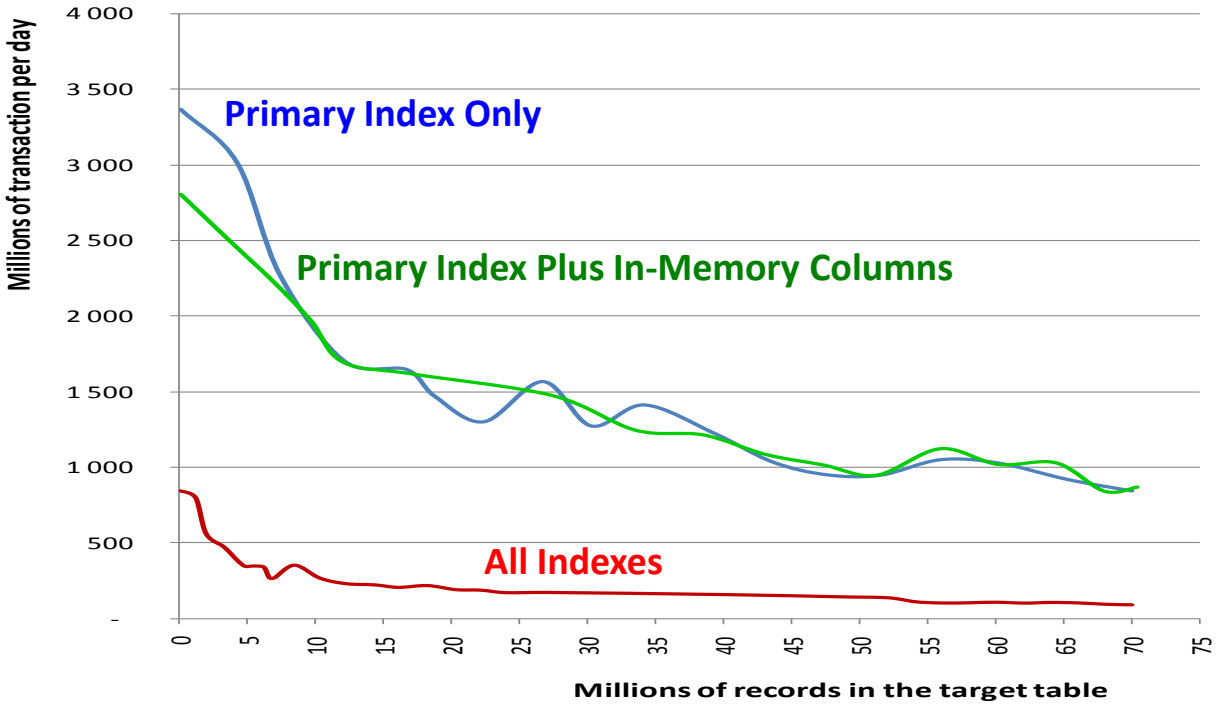
Column Store Replaces Analytic Indexes



- Fast analytics on <u>any</u> columns
  - Better for unpredictable analytics
  - Less tuning & administration
- Column Store not persistent so update cost is much lower
  - OLTP & batch run faster

Schneider Update Transactions Speedup

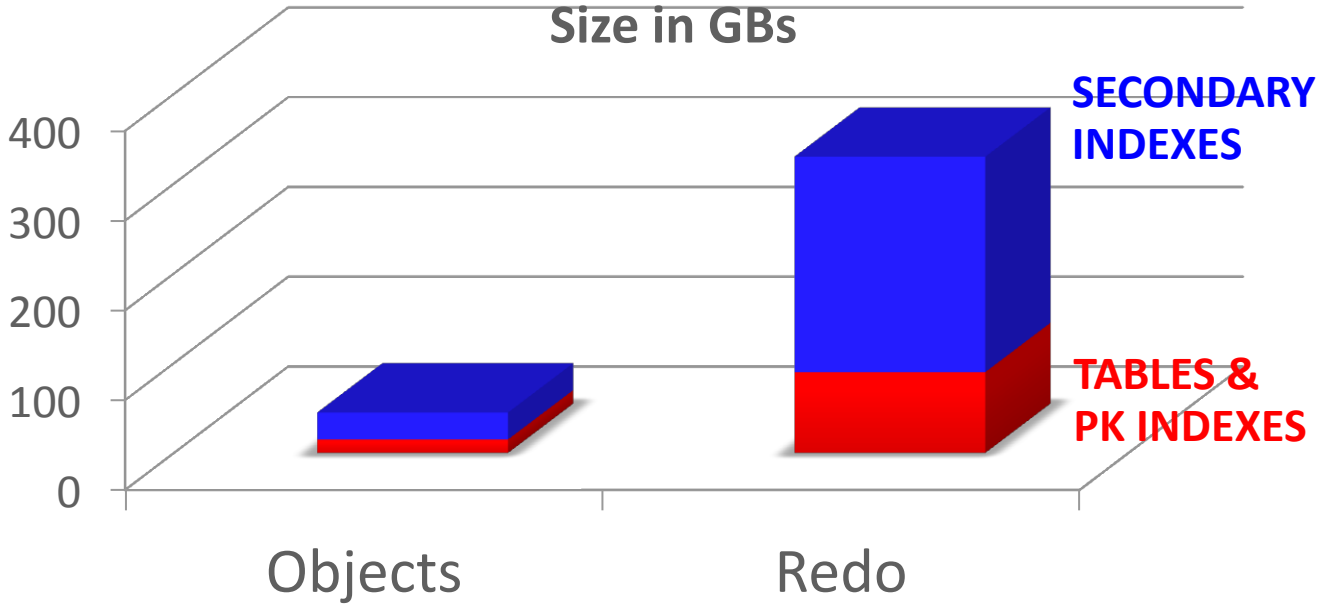
From 5x to 9x faster



- Data – Sales Accounts
- Main table has
  1 Primary Key +
  21 secondary indexes
- Test - 303 million transactions
  - Currently takes 21 hours

Schneider Storage Reduction

Over 70% reduction in storage usage due to analytic index removal

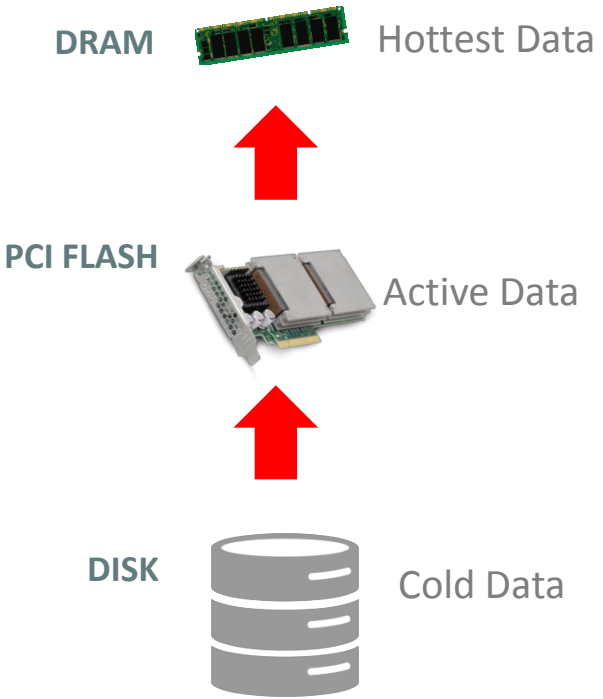


How can I scale this solution

Scale-Out In-Memory Database to Any Size

- Scale-Out across servers to grow memory and CPUs
- In-Memory **queries parallelized** across servers to access local column data
- **Direct-to-wire** InfiniBand protocol speeds messaging on Engineered Systems

In-Memory Speed + Capacity of Low Cost Disk



- Size not limited by memory
- Data transparently accessed across tiers
- Each tier has specialized algorithms & compression
- Simultaneously Achieve:
  - **Speed** of DRAM
  - **I/Os** of Flash
  - **Cost** of Disk

Scale-Up for Maximum In-Memory Performance

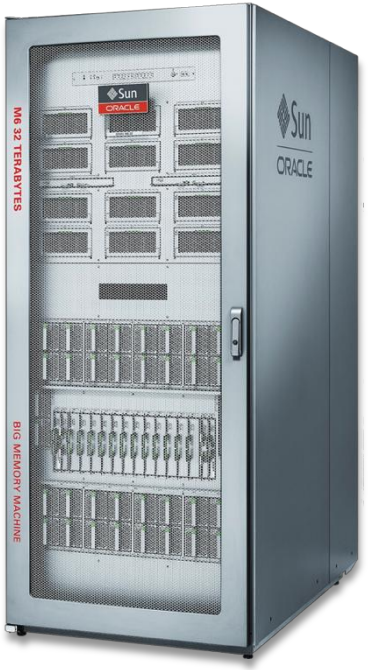
M6-32

Big Memory Machine

32 TB DRAM

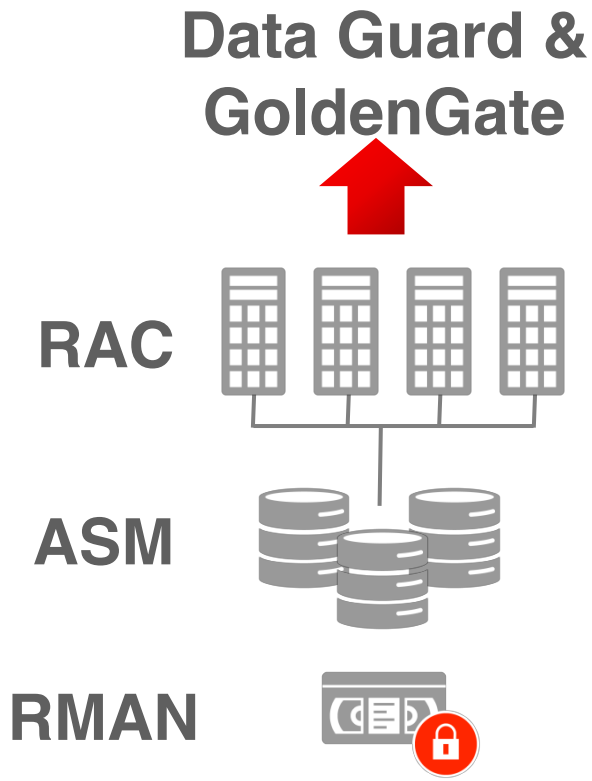
32 Socket

3 Terabyte/sec Bandwidth



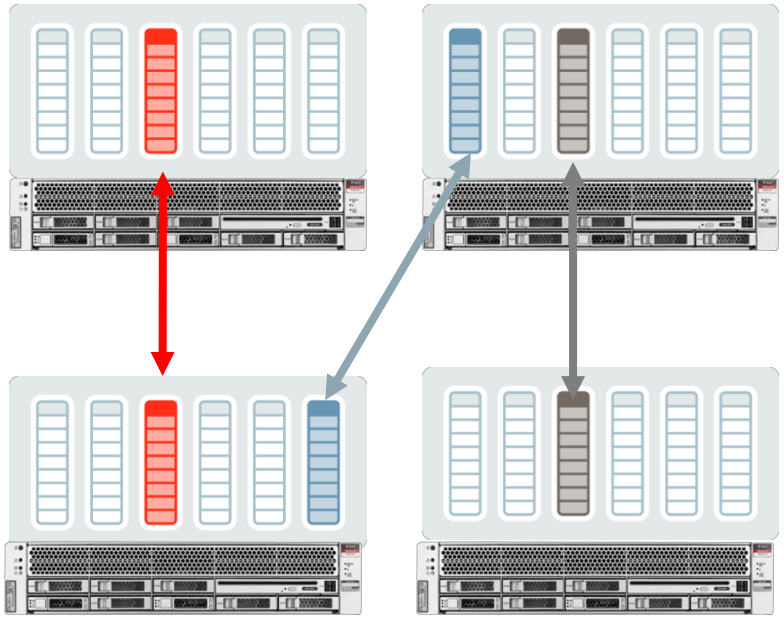
- Scale-Up on large SMPs
  - Algorithms NUMA optimized
- SMP scaling removes overhead of distributing queries across servers
- Memory interconnect far faster than any network

Oracle 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.

Oracle Database In-Memory: Unique Fault Tolerance



Only Available on Engineered Systems

- Similar to storage mirroring
- Duplicate in-memory columns on another node
  - Enabled per table/partition
    - E.g. only recent data
  - Application transparent
- Downtime eliminated by using duplicate after failure

How easy is it to get started

Oracle In-Memory: Simple to Implement

1. Configure Memory Capacity
   - `inmemory_size = XXX GB`

2. Configure tables or partitions to be in memory
   - `alter table | partition … inmemory;`

3. Later drop analytic indexes to speed up OLTP

"In terms of how easy the in-memory option was to use, it was actually almost boring. It just worked – just turn it on, select the tables, nothing else to do."

– Mark Rittman
Chief Technical Officer
Rittman Mead

Oracle In-Memory Requires Zero Application Changes

Full Functionality	- **ZERO restrictions** on SQL
Easy to Implement	- No migration of data
Fully Compatible	- All existing applications run unchanged
Fully Multitenant	- Oracle In-Memory is Cloud Ready

Uniquely Achieves All In-Memory Benefits With No Application Changes

NETSUITE

"Oracle Database In-Memory made our slowest financial queries faster out-of-the box; then we dropped indexes and things just got faster."

– Evan Goldberg
Co-Founder, Chairman, CTO
NetSuite Inc.

"We see clear benefit from the Oracle In Memory for our users. Our existing applications were transparently able to take advantage of them and no application code changes were required"

– Scott VanValkenburgh, SAS

Oracle Applications In-Memory Examples

Oracle Application Module	Improvement	Elapsed Time
ORACLE E-BUSINESS SUITE *In-Memory Cost Management*	1003x Faster	58 hours to 3.5 mins
ORACLE PEOPLESOFT In-Memory - *Financial Analyzer*	1,354x Faster	4.3 hours to 11 seconds
ORACLE JD EDWARDS *In-Memory Sales Order Analysis*	1,762x Faster	22.5 minutes to < 1 sec
ORACLE FUSION APPLICATIONS *Subledger Period Close Exceptions*	200x Faster	600 seconds to 3 secs
ORACLE SIEBEL *Call Center Ad-hoc query pattern*	1247x Faster	129 seconds to < 1 secs

What’s the catch

Getting The Most From In-Memory

Understand Where it Helps

- Fast cars speed up travel, not meetings
- In-Memory speeds up analytic data access, not:
  - Network round trips, logon/logoff
  - Parsing, PL/SQL, complex functions
  - Data processing (as opposed to access)
    - Complex joins or aggregations where not much data is filtered before processing
  - Load and select once – Staging tables, ETL, temp tables

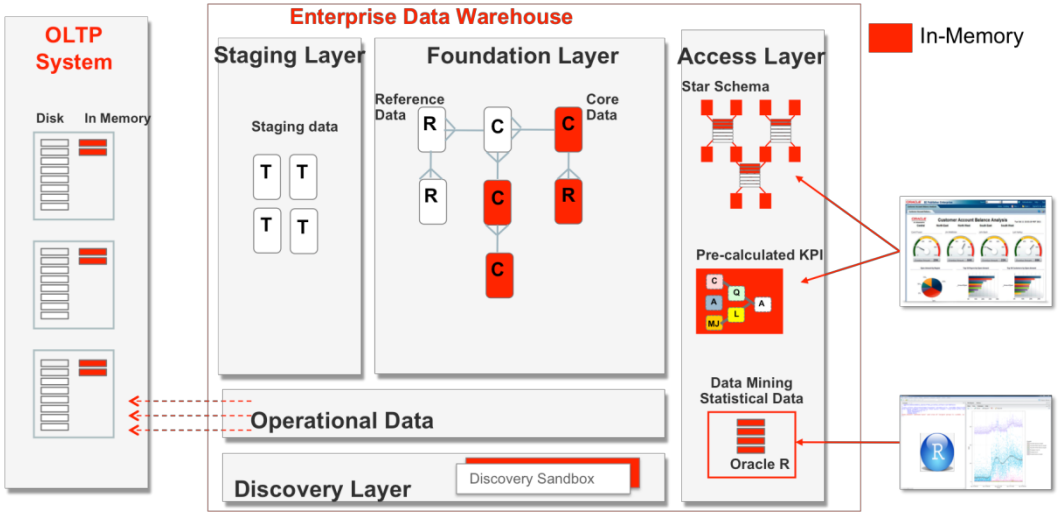
Know your bottleneck!

Getting The Most From In-Memory

The Driver Matters

- Avoid stop and go traffic
  - Process data in sets of rows in the Database
  - Not one row at a time in the application
- Plan ahead, take shortest route
  - Help the optimizer help you: Gather representative set of statistics using DBMS_STATS
- Use all your cylinders
  - Enable parallel execution
  - In-Memory removes storage bottlenecks allowing more parallelism

In-Memory Use Cases



OLTP

- Real-time reporting directly on OLTP source data
- Removes need for separate ODS
- Speeds data extraction

Data Warehouse

- Staging/ETL/Temp not a candidate
  - Write once, read once
- All or a subset of Foundation Layer
  - For time sensitive analytics
- Potential to replace Access Layer

Where can I get more information

Additional Resources

Join the Conversation

- https://twitter.com/db_inmemory
- https://blogs.oracle.com/in-memory/
- https://www.facebook.com/OracleDatabase
- http://www.oracle.com/goto/dbim.html

Related Database In-Memory Free Webcasts

- Oracle Database In-Memory meets Data Warehousing

Related White Papers

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

Related Videos

- In-Memory YouTube Channel
- Database Industry Experts Discuss Oracle Database In-Memory (11:10)
- Software on Silicon

Any Additional Questions

- Oracle Database In-Memory Blog
- My email: maria.colgan@oracle.com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