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Memory Without Bounds: Policy-Based Automation in In-Memory Column Store Content

Andy Rivenes
Database In-Memory Product Manager
Systems Technology Group
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Database Platform of the **Future** – *Complete and Integrated*

Services

Any Application
Any Data

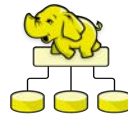
OLTP, IoT



Real Time
Analytics



Big Data



Web, Micro
Services



Data Science,
AI, ML



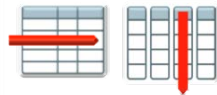
Spatial, Graph,
Text, Media



Architecture

Fast, Low Cost, Secure
Scalable, Available

In-Memory
Database



In-Database
Multitenancy



In-Database
Security



Fault-Tolerant
Scale-Out



Systems

Engineered
for Databases



Smart
Compute



Smart
Storage



Smart
Networking



Cloud

Autonomous, Elastic
Wherever You Want



Public
Cloud



Cloud At
Customer



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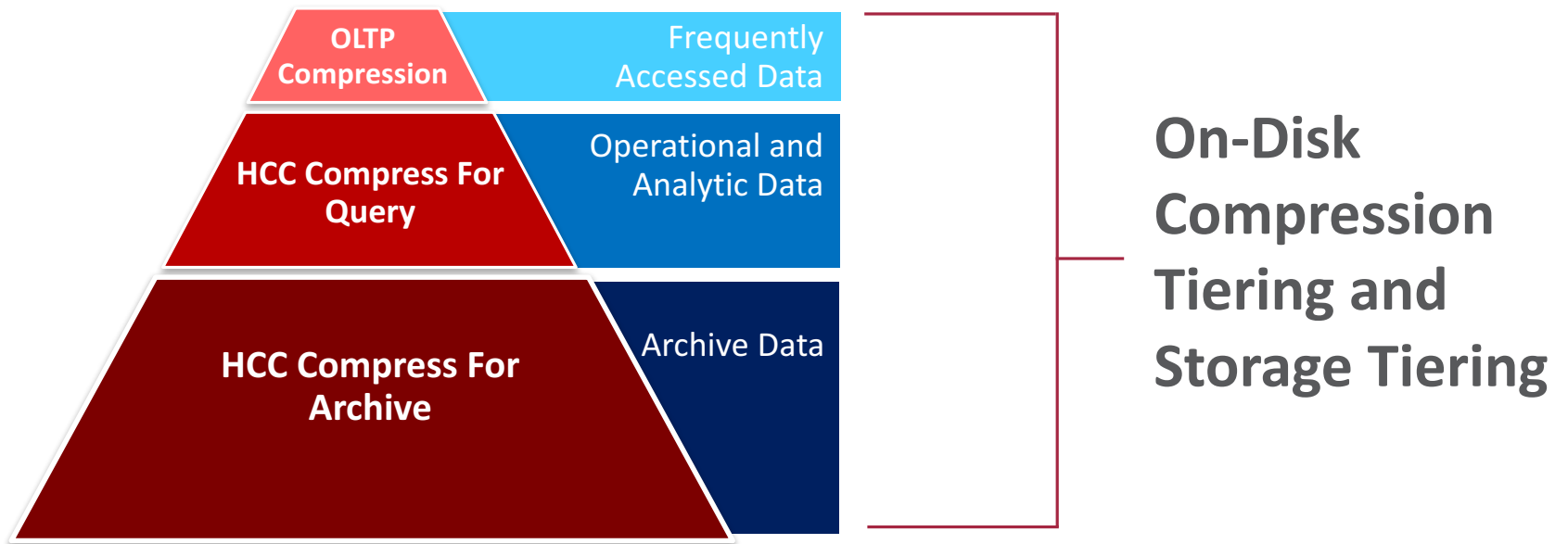
On-Disk Heat Map and Automatic Data Optimization

Automatic Data Optimization

- **Introduced in Oracle Database 12c Release 1 with Heat Map**
 - Part of the Advanced Compression option
- **Declarative User-defined Policies**
 - Customizable with PL/SQL functions
- **Automated Compression Tiering**
- **Automated Storage Tiering**

Heat Map and Automatic Data Optimization

On-Disk ADO



Heat Map

Usage Tracking



- **“Heat Map” Tracking**

- Query and modification times tracked by segment
- Modification times tracked for database blocks
 - Heat map data is collected on a "best effort" basis
 - Heat map data is flushed to disk once per hour

- **Comprehensive**

- Distinguishes index lookups from full table scans
- Automatically excludes maintenance tasks:
 - Stats, DDLs, backups, table redefinitions, etc.

- **High Performance**

- Object level at no cost
- Block level << 5% cost

To Enable Heat Map:
heat_map=on (init.ora parameter)

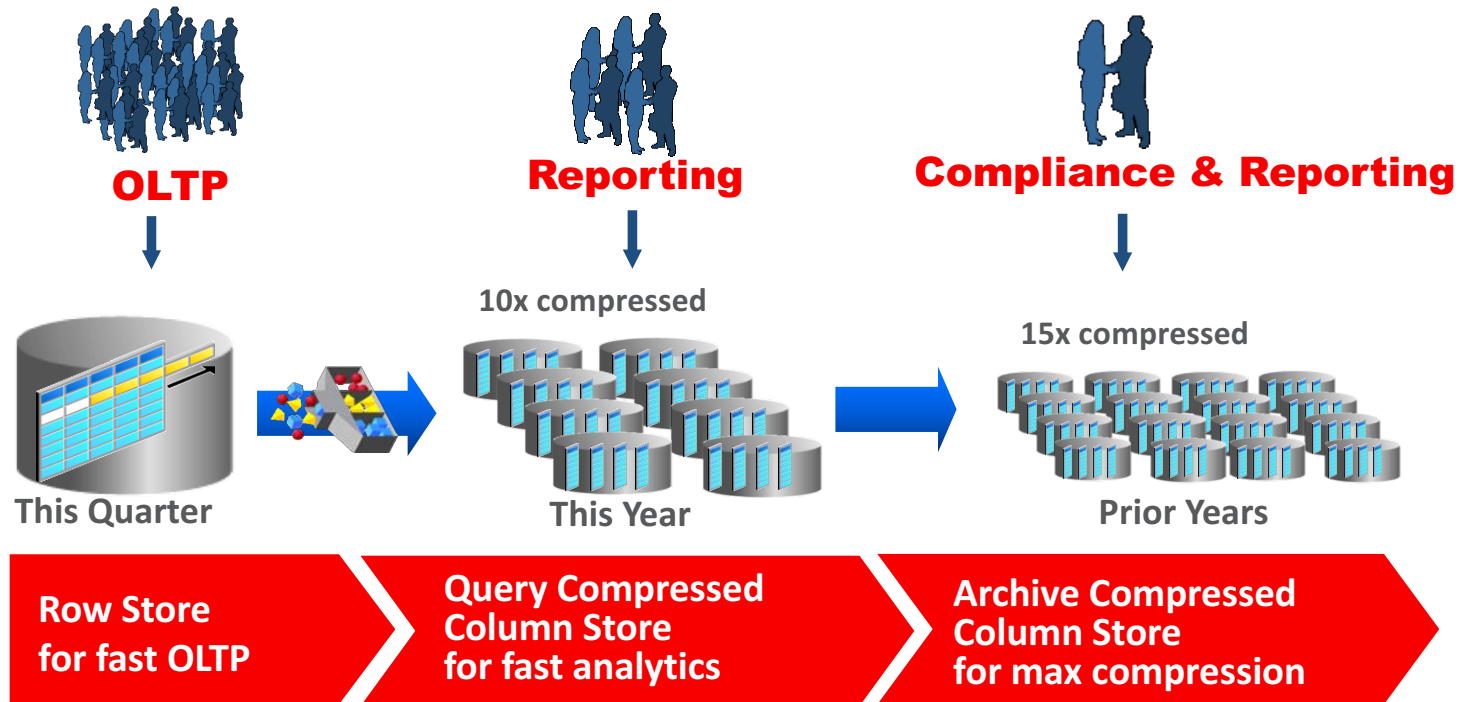
Automatic Data Optimization

Simple Declarative SQL extension

ALTER TABLE sales ILM add policy

<p>Active</p>	<ul style="list-style-type: none"> Advanced Row Compression (2-4x) Affects ONLY candidate rows Cached in DRAM & FLASH 	<p>row store compress advanced row after 2 days of no modification</p>
<p>Frequent Access</p>	<ul style="list-style-type: none"> Warehouse Compression(10x) High Performance Storage 	<p>column store compress for query low after 1 week of no modification</p>
<p>Occasional Access</p>	<ul style="list-style-type: none"> Warehouse Compression(10x) Low Cost Storage 	<p>tier to lowcost tablespace</p>
<p>Dormant</p>	<ul style="list-style-type: none"> Archive Compression(15-50X) Archival Storage 	<p>column store compress for archive high after 6 months of no modification</p>

Automatic Data Optimization

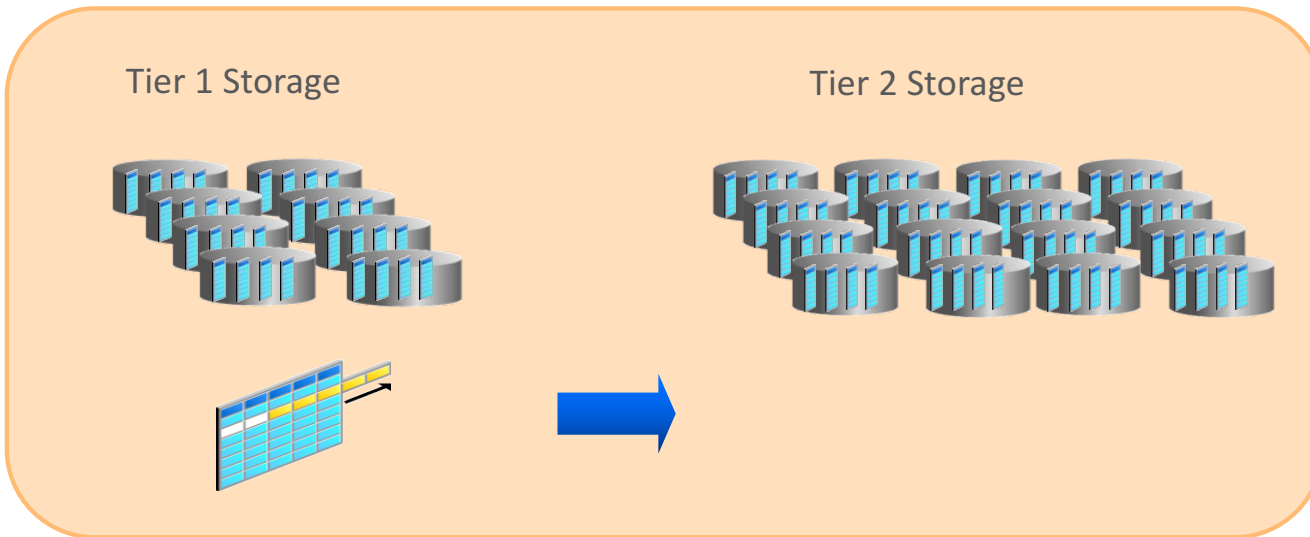


As data cools down, Automatic Data Optimization can automatically convert Advanced Row compressed data to Columnar compressed online

Automatic Data Optimization

Usage Based Storage Tiering

```
DBMS_ILM_ADMIN.CUSTOMIZE_ILM (DBMS_ILM_ADMIN.TBS_PERCENT_USED, 85):  
DBMS_ILM_ADMIN.CUSTOMIZE_ILM (DBMS_ILM_ADMIN.TBS_PERCENT_FREE, 25):
```



As storage pressure increases in Tier 1 storage, segments with tiering policies defined will automatically move to Tier 2 storage

Database In-Memory (DBIM)

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

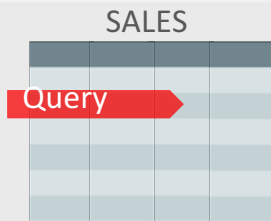
Trivial to Implement



No Application Changes
Not Limited by Memory

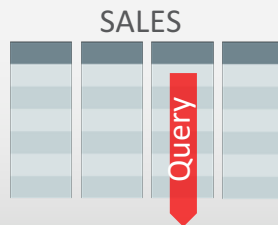
Row Format Databases vs. Column Format Databases

Rows Stored
Contiguously



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

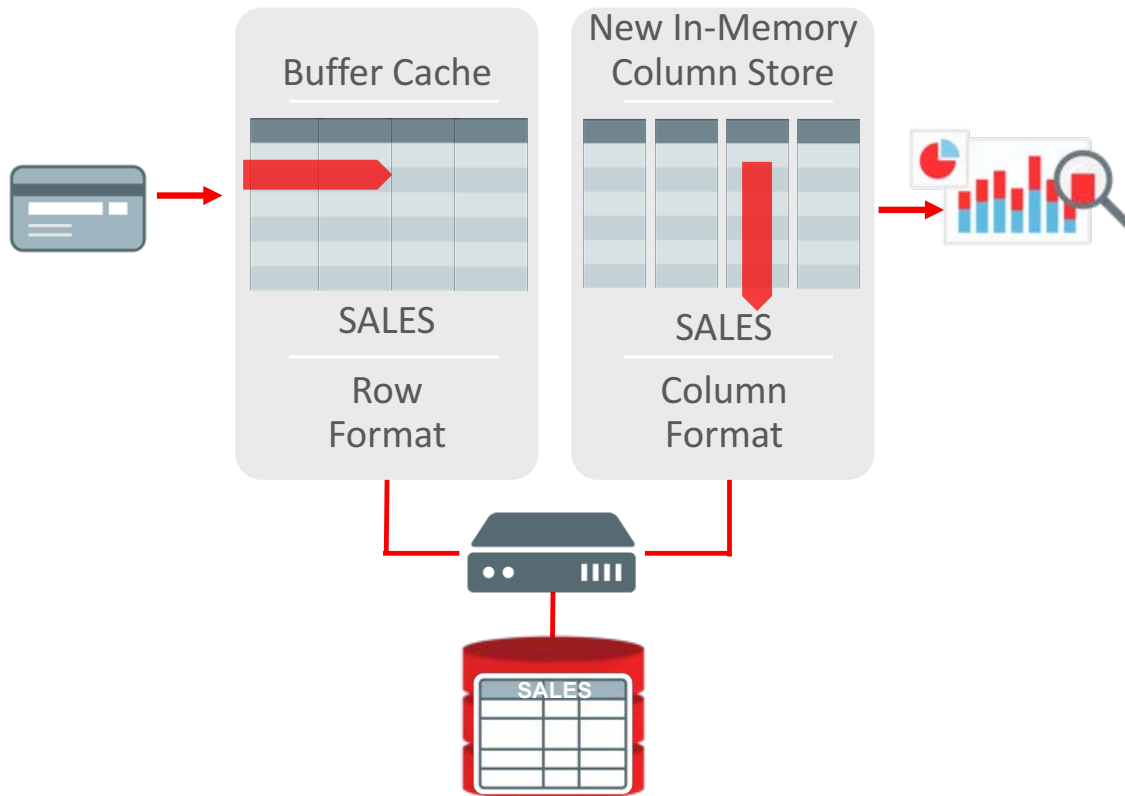
Columns Stored
Contiguously



- **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

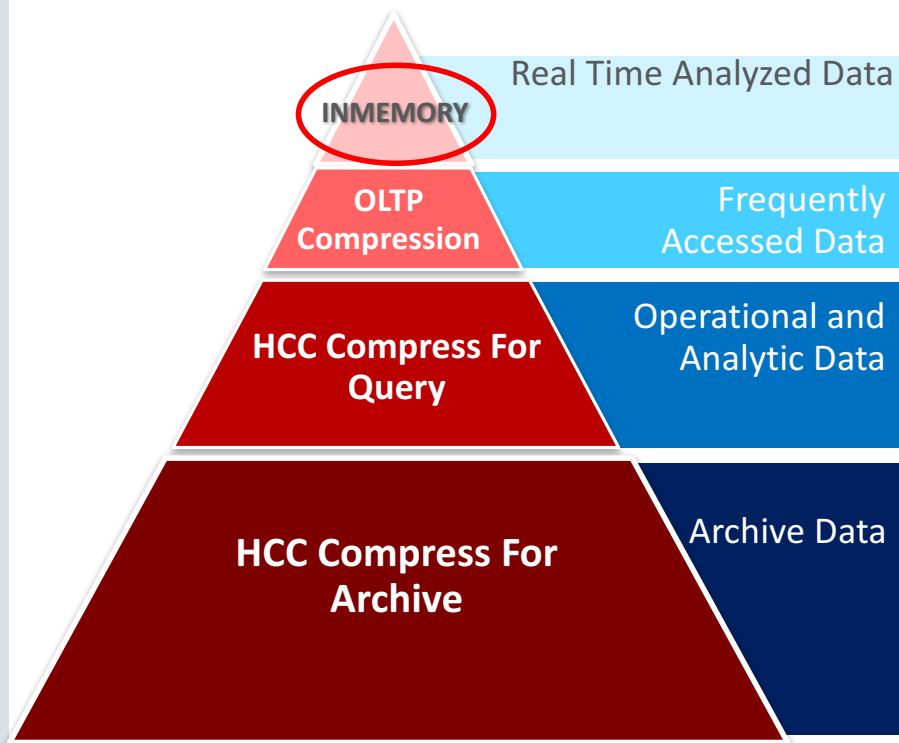


- **BOTH** row and column formats for same table
- Simultaneously active and transactionally consistent
- Analytics & reporting use new in-memory Column format
- OLTP uses proven row format

In-Memory Heat Map and ADO (12.2)

Heat Map and Automatic Data Optimization

Database In-Memory ADO



- **Without ADO:** The in-memory column store can contain a subset of database tables and even a subset of the partitions for a given table. The user must choose the subset (the in-memory advisor can help with this)
- **With ADO:** IM column store is **managed automatically** as a new data tier
 - Policy Mode** - Supports user-defined policies to:
 - Populate objects
 - Compress objects to a higher level
 - Evict objects

Automatic Data Optimization with Database In-Memory Implementation (Available in 12.2)

- **All In-Memory ADO Features Require init Parameter:**
 - `inmemory_size > 0`
- **To Enable Policy Mode:**
 - Requires heat map feature – `heat_map=on` (init.ora parameter)

Automatic Data Optimization with Database In-Memory

dbms_ Packages

- **No Changes to the Existing Packages**
- **ADO Specific Packages**
 - dbms_ilm
 - Used for ADO task management
 - dbms_ilm_admin
 - Administrative functions to manage the heat map and ILM tasks/attributes

In-Memory and Heat Map

Automatic Data Optimization with Database In-Memory Heat Map

- **Heat Map APIs are Unchanged**

- dbms_heat_map

- Used to complement the heat map views
- Displays detailed heat map data at the tablespace, segment, object, extent and block levels

- **Dynamic Performance Views**

- we added frequency tracking for Database In-Memory

- v\$heat_map_segment

- N_SEGMENT_WRITE
- N_FULL_SCAN
- N_LOOKUP_SCAN

Automatic Data Optimization with Database In-Memory

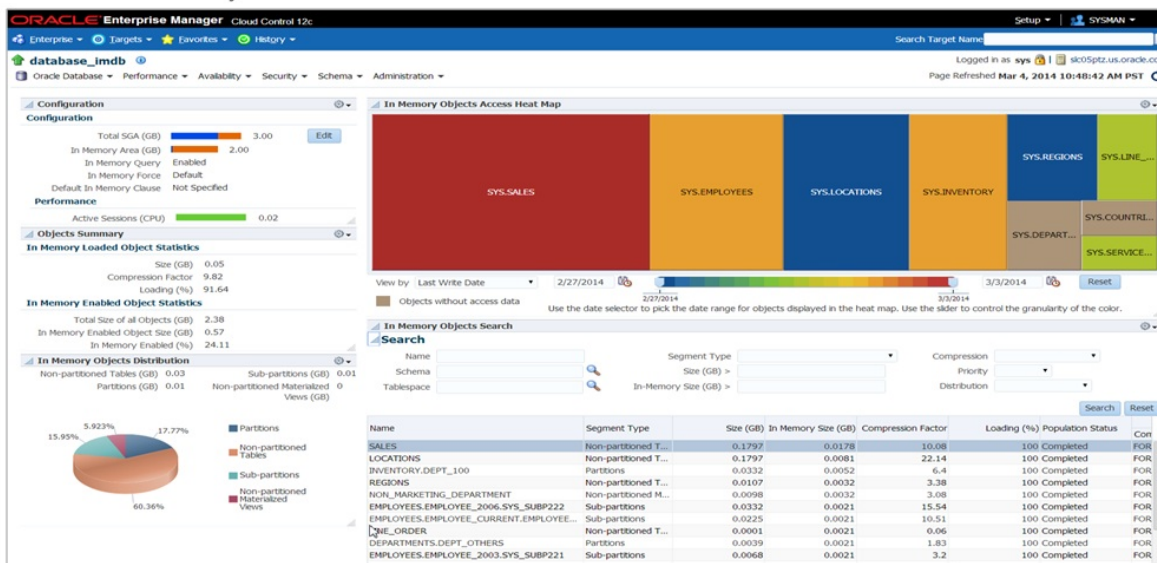
Heat Map Views (all_, user_, dba_)

- **Static Data Dictionary Views (no changes from 12.1)**

- dba_heat_map_seg_histogram
- dba_heat_map_segment
- dba_heatmap_top_objects
- dba_heatmap_top_tablespaces

Oracle Enterprise Manager: In-Memory Central

In-Memory Central



- OEM supports Database In-Memory
- In-Memory Central page gives a dashboard look to the IM column store
- Provides list of objects populated in the IM column store

In-Memory and ADO Policies

Automatic Data Optimization with Database In-Memory

ADO IM Policies

- **Policy Criteria**

- SET INMEMORY

Enables an object for in-memory

- MODIFY INMEMORY

Changes compression level to a higher level

- NO INMEMORY

Removes, or evicts, an object from the IM column store

Automatic Data Optimization with Database In-Memory

ADO IM Policies

- **Successful policy completion results in policy being disabled** (i.e. segment level policy)
- **Policies are inherited from the tablespace or table**
- **Policies run automatically in the maintenance window**
 - Possible to run policies manually – `dbms_ilm.execute_ilm` procedure

Automatic Data Optimization with Database In-Memory

ADO IM Policy Examples

- **Examples**

- ALTER TABLE sales ILM ADD POLICY **SET INMEMORY** AFTER 10 DAYS OF CREATION;
- ALTER TABLE sales ILM ADD POLICY **MODIFY INMEMORY** MEMCOMPRESS FOR CAPACITY HIGH AFTER 30 DAYS OF NO MODIFICATION;
- ALTER TABLE sales ILM ADD POLICY **NO INMEMORY** SEGMENT AFTER 90 DAYS OF NO ACCESS;

Automatic Data Optimization with Database In-Memory

ADO IM Policy Examples

- **Run the Policy Manually:**

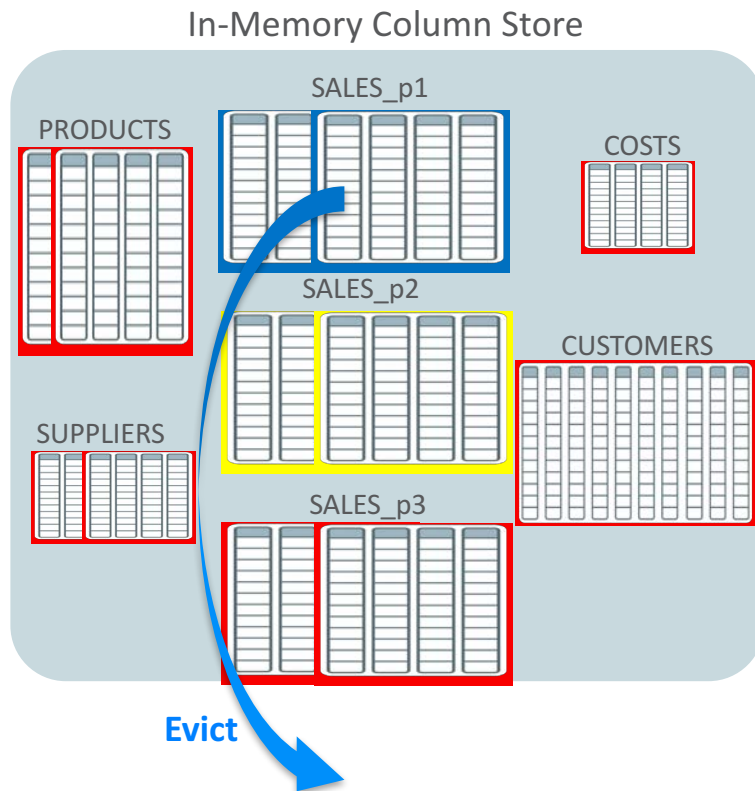
```
declare
  v_executionid number;
begin
  dbms_ilm.execute_ilm (
    owner=>'SSB',
    object_name=>'LINEORDER',
    execution_mode=>dbms_ilm.ilm_execution_offline,
    task_id=>v_executionid);
end;
/
```

Automatic Data Optimization with Database In-Memory

Policy Mode Example – NO INMEMORY

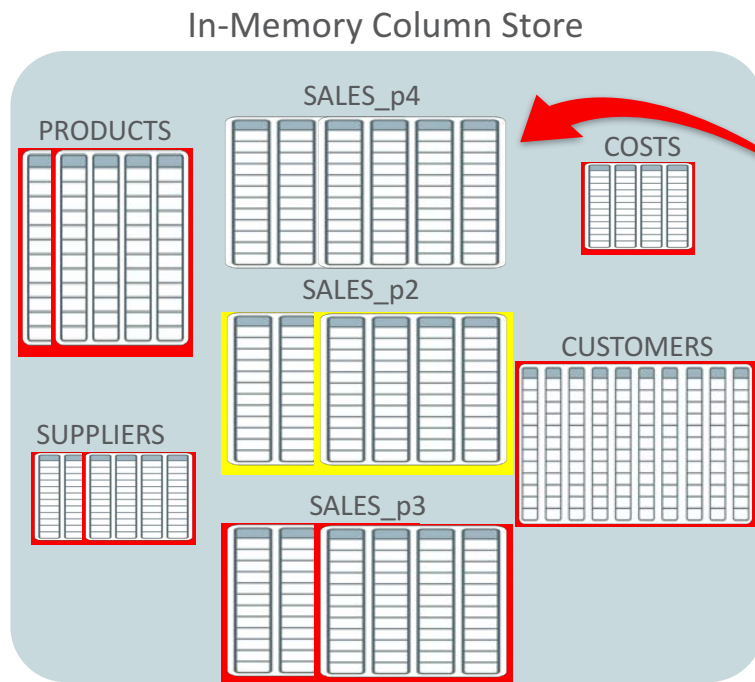
alter table sales ilm add policy **no inmemory** segment after 90 days of no access;

- "Cold" partitions are evicted based on no access
- Removes unused partitions
- Frees room in the IM column store



Automatic Data Optimization with Database In-Memory

Policy Mode Example – SET INMEMORY



alter table sales ilm add policy set inmemory after 10 days of creation;

- Delayed population example
- Table is eligible to be populated 10 days after creation
- Can be used to delay population of initially volatile segments

Futures

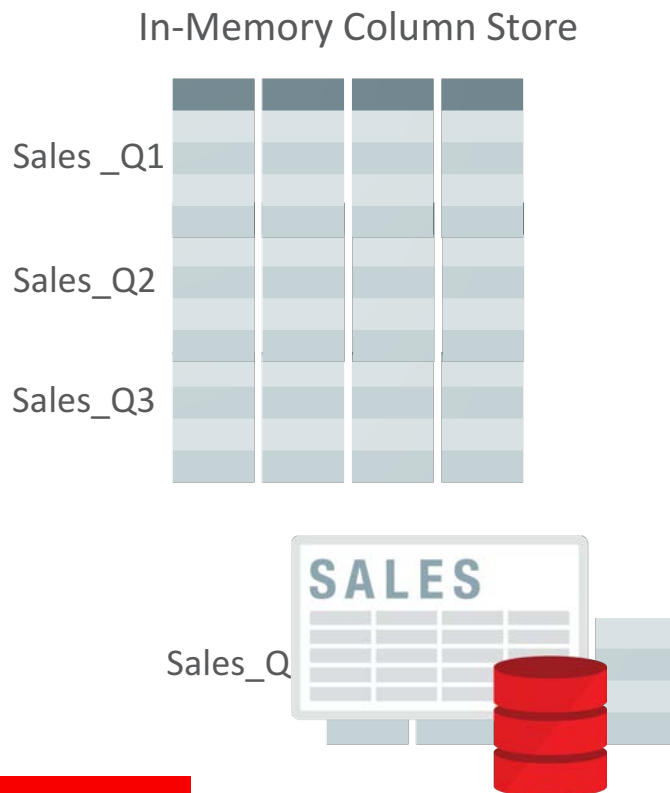
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Automatic In-Memory

Greater Automation and Reduced Administration

NEW IN
18^c



- In-memory candidate tables and partitions are **automatically** ranked using Heat Map statistics
- Cold in-memory data automatically evicted enabling Hot data to be populated into memory



Automatic In-Memory


- Enabled with an initialization parameter - **inmemory_auto_level**
- Only objects enabled for INMEMORY with a PRIORITY of NONE are considered
- Automatic In-Memory only operates when there is memory "pressure"
 - An object has failed to populate due to lack of space in the IM column store
 - Least used objects will be evicted to make room
 - Objects will be populated on next access
- Heat Map is used to determine activity
- Priority other than NONE and/or an ADO policy exempts the object

More Information







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Oracle Database In-Memory Schedule for Oracle Open World

Date	Title	Location	Speaker
Mon Oct 2 nd 15:15- 16:00	Memory Without Bounds: Policy Based Automation in In-Memory Column Store Content (CON6583)	Moscone West Room 3010	Andy Rivenes - Product Manager, Oracle
Tues Oct 3 rd 11:30-12:15	Oracle Database In-Memory Deep Dive: Past, Present, and Future (CON6584)	Moscone West Room 3014	Tirthankar Lahiri - Vice President, Oracle
Tues Oct 3 rd 12:45- 13:30	Revolutionize Analytics with Oracle Database In-Memory (CON6682)	Moscone West Room 3014	Juan Loaiza - Sr. Vice President, Oracle
Wed Oct 4 th 13:00-13:45	Quick Start Your Database In-Memory Deployment: Step-by-Step Guide (CON6589)	Moscone West Room 3004	Raj Rathee - Sr. Director, Oracle
Wed Oct 4 th 15:30-16:15	Oracle Database In-Memory: Oracle Experts Answer Your Questions (CON6590)	Moscone West Room 3004	Raj Rathee and Panel of Experts
Mon Oct 2 nd (14:00-15:00) Tues Oct 3 rd (11:30-12:30) Wed Oct 4 th (13:15-14:15)	Oracle Database In-Memory Hands-On Lab (HOL 7584) 	Hilton San Francisco Union Square – Plaza Room A	Andy Rivenes - Product Manager, Oracle

Oracle Database In-Memory Schedule for Oracle Open World Customer/Partner Sessions

	Date	Title	Location	Speaker
	Sun Oct 1 st 9:45- 10:30	Best Practices for Getting Started with Oracle Database In-Memory 12c (SUN4939)	Moscone South Room 160	Xinghua Wei, Woqutech
	Sun Oct 1 st 10:45- 11:30	Uncompromising SaaS on Oracle Cloud, Powered by In-Memory and Multitenant (SUN3527)	Moscone South Room 156	Silviu Lupsa, Tangoe
	Sun Oct 1 st 11:45-12:30	Oracle Database In-Memory: Adventures with SwingBench TPC-DS (SUN5644)	Moscone South Room 153	Jim Czuprynski, Vion Corporation
	Sun Oct 1 st 15:45- 16:40	The Best Oracle Database 12c and 12cR2 Tuning Features (CON5680)	Moscone South Room 153	Rich Niemiec, Viscosity North America
	Mon Oct 2 nd 11:00-11:45	Improving Performance with Oracle Database 12c In-Memory Option (CON4349)	Moscone West Room 3022	Sergiy Smyrnov & Fong Zhuang, Walgreens
	Wed Oct 4 th 14:00-14:45	Oracle In-Memory Applications for Reduced Latency in Maintenance Processes (CON1967)	Moscone West Room 3008	Thorsten Pensky, Lufthansa Systems

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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

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OPEN
WORLD**

**Hilton
HOLs**

Marriott Marquis
State of the Art Cloud
Platform, JavaOne, Code

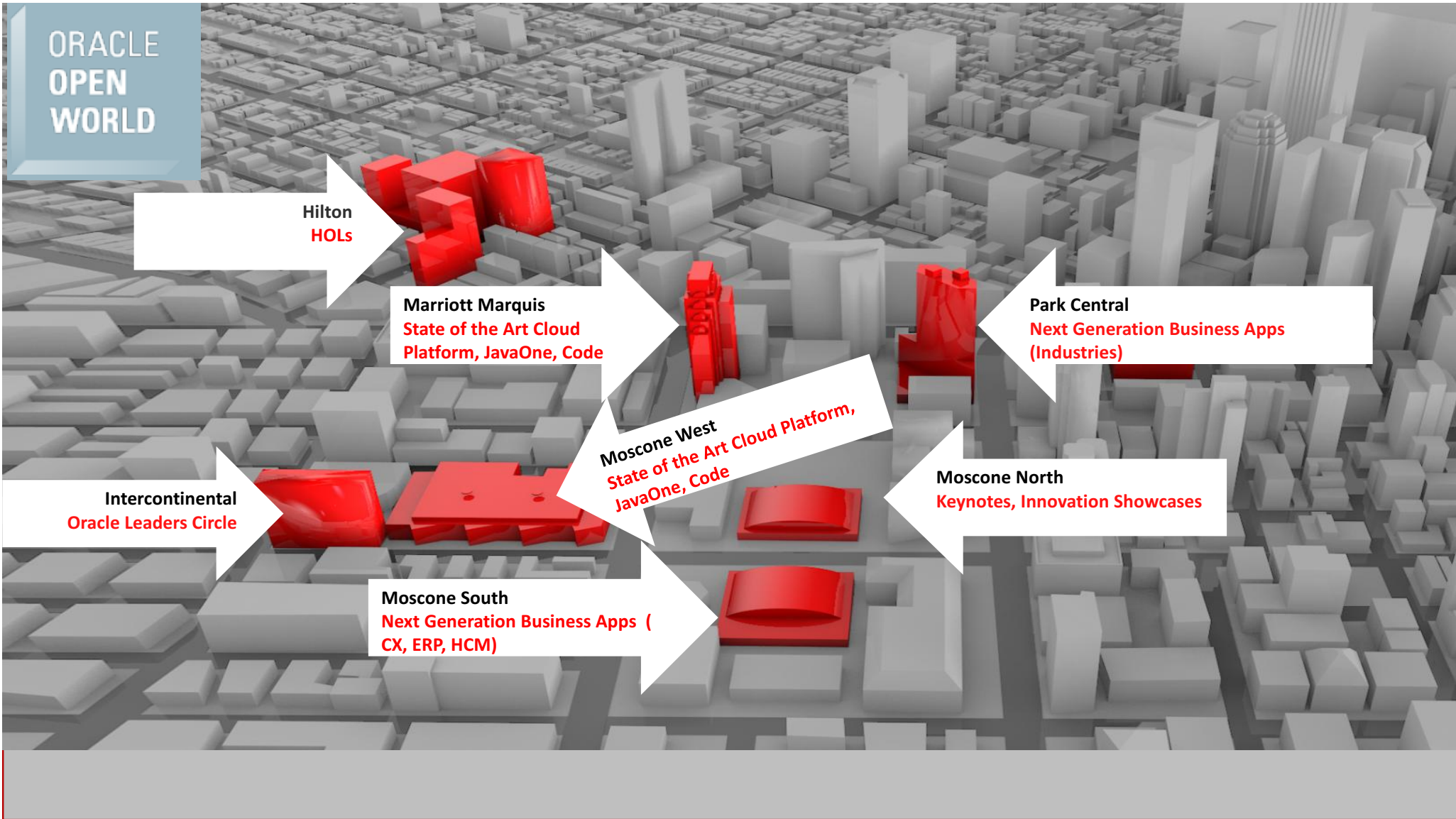
Park Central
Next Generation Business Apps
(Industries)

Intercontinental
Oracle Leaders Circle

Moscone West
State of the Art Cloud Platform,
JavaOne, Code

Moscone North
Keynotes, Innovation Showcases

Moscone South
Next Generation Business Apps (
CX, ERP, HCM)



Additional Resources



Join the Conversation

-  <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 In-Memory Aggregation Paper
- Oracle Database In-Memory Implementation and Usage White 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
 - Industry Experts Share Perspectives
oracle.com/us/corporate/events/dbim/index.html
- YouTube - Juan Loaiza: Software in Silicon




Additional Questions

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

Additional Resources



Join the Conversation

-  https://twitter.com/aco_gregg
-  <https://blogs.oracle.com/DBStorage/>
-  <http://www.oracle.com/database/advanced-compression/index.html>

Advanced Compression Case Studies

- [Goodman Fielder \(SAP user\)](#)
- [Suguna Foods \(EBS user\)](#)

Related White Papers

- [Oracle Advanced Compression White Paper](#)
- [Advanced Compression Helps Fortune 500 Company](#)
- [Automating Compression Tiering and Storage Tiering](#)
- [Oracle E-Business Suite with Advanced Compression](#)

Additional Information

- [Oracle Index Compression](#)
- [Database Storage Optimization \(Oracle.com page\)](#)
- [Advanced Compression Savings Tool](#)
- [Compression Advisor Information](#)

Any Additional Questions

- [Oracle Storage Optimization Blog](#)

Integrated Cloud

Applications & Platform Services

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