Oracle Engineered Systems at Thomson Reuters

Engineered Systems – the Foundation of Efficiency

Aaron Pust

April 16th
Engineered Systems Strategy

- Thomson Reuters – use cases in an information company
  - Enterprise Data Warehouse – Customer, product, and usage data analysis
  - Risk & Fraud Warehouses - Product serving up large amounts of information

- Large scale Data Warehousing workloads
  - Large growth of data warehouses and the need to load, analyze, and report on huge data sets quickly
  - Stretched traditional approaches to data warehousing to solve the throughput bottlenecks
  - High costs to deploy and optimize

- Oracle Solution Proposition - Exadata
  - Delivery strategy as a Turnkey solution of balanced configuration with both compute and storage
  - Unique software solution in the storage tier

- Evolution of the Oracle Solution at Thomson Reuters
  - Early Adopter
Enterprise Data Warehouse

Enterprise repository of information on our customer and their interactions with our products. This platform supports the various analytics used by marketing and other business operations.
Enterprise Data Warehouse – Next Generation

- Next Generation of the Enterprise Data Warehouse for Business Systems is Needed
  - Mixed workload, and concurrency requirements severely impacting response times for all users.
  - Current environment unable to support response time requirements of the sales support projects.
  - 3Cs – Concurrency, Consistency, and Cost
    - **Concurrency** – Increase capacity in data size and number of users
    - **Consistency** – Increased and predictable performance
    - **Cost** – Cost effective solution that can scale to meet future needs
- Trials with IBM, Oracle, and Greenplum
  - Replace a traditional warehouse solution using IBM p-series servers and Hitachi SAN storage (P570 12 cores 192GB)
Evolution of the Oracle solution

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Enterprise Data Warehouse Evaluation of Alternatives

- **Test Setup**
  - 43 queries taken from the production system
  - Mix of long, medium, short running Business Objects and Siebel Analytics dashboard queries.
  - Custom developed test driver program used to simulate activity in current environment.
  - 3.2 Terabytes of usage and revenue data, nearly half total size (7.5 billion rows).

- **Test Execution**
  - Baseline Query Execution
  - User Simulation Stress Test
  - Mixed Workload Stress Test

**Baseline Test = All 43 benchmark queries run single file**

<table>
<thead>
<tr>
<th>Example Long Queries</th>
<th>TR</th>
<th>ORACLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO_Q6</td>
<td>15.98</td>
<td>0.38</td>
</tr>
<tr>
<td>BO_Q17</td>
<td>28.31</td>
<td>1.01</td>
</tr>
<tr>
<td>BO_Q2</td>
<td>29.29</td>
<td>0.60</td>
</tr>
<tr>
<td>BO_Q3</td>
<td>37.20</td>
<td>0.87</td>
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<tr>
<td>BO_Q15</td>
<td>77.87</td>
<td>1.72</td>
</tr>
<tr>
<td>BO_Q21</td>
<td>90.16</td>
<td>1.94</td>
</tr>
</tbody>
</table>

- Oracle more than 19x better than current system.
Enterprise Data Warehouse Evaluation of Alternatives

Significant improvement in **Concurrency**, **Consistent** performance in mixed workloads, **Cost effective** choice in an all-in-one model.

- **Long Queries**
  - TR system unable to complete a long query during these 3 hour tests.

- **Medium Queries**
  - Over 5x advantage for Oracle.

- **Business Objects Short Queries**
  - 4x advantage for Oracle over current system.

- **Siebel Analytic Short Queries**
  - Somewhat anomalous data skew in this category, however, still extremely wide gap for Oracle.

- **ETL Operations**
  - 5x advantage for Oracle.
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*Source: Oracle*
The Compression Advantage

Exadata V1 – OLTP Compression
- 7 Large Table sample
- 2.5:1 – No Compression
- 5:1 – OLTP

<table>
<thead>
<tr>
<th></th>
<th>Initial Size</th>
<th>V1 - OLTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAW Data Size</td>
<td>4.48 TB</td>
<td>2.96 TB</td>
</tr>
<tr>
<td>Compressed Data Size</td>
<td>1.75 TB (2.5 : 1)</td>
<td>584 GB (5 : 1)</td>
</tr>
<tr>
<td>Index Space*</td>
<td>2.3 TB</td>
<td>148 GB</td>
</tr>
<tr>
<td>Total Used Space</td>
<td>4 TB</td>
<td>732 GB</td>
</tr>
</tbody>
</table>

Exadata V2 – Hybrid Columnar Compression
- 10:1 or Higher with proper sorting

EXADATA v2 Query Performance Test (25 test queries run single file with no indexes)

<table>
<thead>
<tr>
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<th>SECONDS</th>
</tr>
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<tr>
<td>NOCOMPRESS</td>
<td>1500</td>
</tr>
<tr>
<td>OLTP w/SORT</td>
<td>1000</td>
</tr>
<tr>
<td>HYBRID COL</td>
<td>500</td>
</tr>
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OLTP vs. NOCOMPRESS
- Queries faster with compression

Hybrid Columnar vs. NOCOMPRESS
- 14
- 11
- 7
- 18
Backup Strategies

Initial Strategy kept data Backups on Exadata Storage

Production

ASMA Group 1 = HOT
Primary Data & Indexes

ASMA Group 2 = COLD
In-machine Backups
7-day Incremental Backups

Prod Standby , QA, DEV

Active Data Guard

Introduction of Sun ZFS Storage Appliance to enable off machine backups using RMAN

• Enabled expansion on Exadata for Production Workload
• High Speed Interconnect with Dedicated backup appliance
  • 9.8 TB backups in 1 hr 15 min
  • Incremental is 15 min

Sun 7420
2 Trays 2TB drives
Enterprise Data Warehouse Implementation Architecture

EDW STATS

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<table>
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<tr>
<td>Raw Data Size</td>
<td>20 TB</td>
</tr>
<tr>
<td>Compressed Data Size</td>
<td>5 TB (4:1) Max(12:1)</td>
</tr>
<tr>
<td>Index Space</td>
<td>700GB</td>
</tr>
<tr>
<td>ETL Batches</td>
<td>900</td>
</tr>
<tr>
<td>Users</td>
<td>~8000</td>
</tr>
<tr>
<td>Concurrent Sessions</td>
<td>~300</td>
</tr>
<tr>
<td>Tables</td>
<td>~3,500</td>
</tr>
<tr>
<td>Indexes</td>
<td>2,368</td>
</tr>
<tr>
<td>Largest Table</td>
<td>200 GB 20 Billion Rows</td>
</tr>
<tr>
<td>Data Change Rate</td>
<td>500 GB/day</td>
</tr>
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Exalytics
- Warm Standby
- Active Repository
- Standby Repository
- Active Primary

Exadata
- Exadata X2 Full Rack Read/Write
- Active Dataguard

ZFS Storage
- Backup & Recovery
  - Sun 7420 2 Trays 2TB drives

Exadata X2 Full Rack
- Read/Write
- Active Dataguard
- Active read

Sun 7420 2 Trays 2TB drives

Data Change Rate: 500 GB/day
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- **Enterprise Data Warehouse**
- **Exadata Benchmarks**
- **Evaluation for MIS Data Warehouse platform (Oracle Labs)**
- **Exadata POC**
- **Evaluation for Use across Warehouse applications (In-house Labs)**
- **Exalytics POC**
- **Evaluation for MIS BI (In-house Labs)**
- **Oracle Platinum Services**
- **Remote Monitoring & Patching**
- **Oracle EM 12c**
- **ZFS Storage Appliances**
- **Backups for Exadata**
- **Exalytics for BI**

**Timeline**
- 2008: Introduction of Oracle Database Machine Oracle 11.1
- 2009: Initial Rollout on Oracle Exadata V1
- 2010: Enterprise Data Warehouse
- 2011: Exadata X2 Released
- 2012: Exalytics Released
- 2013: Exadata X-2 Implemented
Risk & Fraud – Data Warehouses

Need for a new data warehouse for public information requiring significant performance and scalability

Large amounts of data processed for relationships requiring high performance

- Large data sets to identify connections and recognize relationships between people
- ETL processes to support the creation of data marts for various products in our Risk & Fraud business

- ~400 million people records
- ~4 Billion Public Record documents
- 30-100 million documents loaded daily
Risk & Fraud Warehouses – Evaluating Exadata

• Testing focused to determine if Exadata could support the growing requirements of the Master Record Database (MRD).
  – Ability to cost effectively double the current size
    • Existing system was memory and CPU constrained
      – IBM P-series P570 16 cores/CPU and 768GB memory
  – Support 3x the number of concurrent Connections
    • Needs to support more entity resolution processes
  – Able to balance multiple data warehouse activities without impeding performance
    • Must be able to keep up with the loads and monthly updates
  – Future plans for expansion will significantly increase the number of documents to be processed
    • Acquisition of new content
    • More Historical records for individuals
    • Addition of deceased people
Risk & Fraud Warehouses – Evaluating Exadata

- Exadata was 2-12x faster than production MRD
- Performance degradation on Exadata was minimal as we scaled up to 3x concurrent connections
- Logical IO per second with Exadata is ~16% of the amount on MRD
Risk & Fraud Warehouses – Evaluating Exadata

- Exadata continually outperformed existing MRD in our tests
  - 2-12x faster “out of the box” with minimal tuning on Exadata
  - Redeploying on Exadata will immediately increase processing capacity of the publishing pathway
  - Proved that increasing the size and connections to MRD on Exadata while simulating other ETL activities still was faster than current systems
  - Removing existing Materialized Views solution enabling faster updating
    - Indexes were able to fit into the cell flash cache and exceed performance goals

- Exadata workload management facilities allowed for a much more balanced system behavior
  - Allows for resources to be utilized for other ETL activities
Risk & Fraud Warehouses
Implementation Architecture

People Warehouse and MRD Production Environment
- Exadata V2 Full Rack
  - Active Dataguard

Backup & Recovery
- Sun 7420
  - 8 Trays 2TB drives

Company Warehouse Production Environment
- Exadata V2 Quarter Rack
  - Read/Write
  - Active Dataguard
- Exadata V2 Quarter Rack
  - Active read

Backup & Recovery
- Sun 7420
  - 8 Trays 2TB drives
## Risk & Fraud Warehouse Statistics

<table>
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<th>People Warehouse STATS</th>
<th>Company Warehouse STATS</th>
<th>MRD STATS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Size</td>
<td>19TB</td>
<td>Data Size</td>
</tr>
<tr>
<td>Index Space</td>
<td>112 GB</td>
<td>Index Space</td>
</tr>
<tr>
<td>ETL Batches</td>
<td>13</td>
<td>ETL Batches</td>
</tr>
<tr>
<td>Concurrent Connections</td>
<td>104</td>
<td>Concurrent Connections</td>
</tr>
<tr>
<td>Tables</td>
<td>4,188</td>
<td>Tables</td>
</tr>
<tr>
<td>Indexes</td>
<td>98</td>
<td>Indexes</td>
</tr>
</tbody>
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### High Data Guard Traffic
- Average around 8-10TB of archive log generation per day for People Warehouse
  - Peak was 17TB
- Backup Timings RMAN to ZFS Storage Appliance
  - People Warehouse – 13 hours for Full Backup
  - Company Warehouse – 6 hours for Full Backup
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- Oracle Platinum Services
  - Remote Monitoring & Patching
- Oracle EM 12c

2013
- Exalytics
  - POC
  - Evaluation for Use across Warehouse applications (In-house Labs)
Conclusions

• Exadata Appliance Model
  – Secret Sauce – the storage layer
    • Smart Scans to reduce data sent back to the Database
    • Smart Flash Cache to increase scan bandwidth
    • I/O Resource Manager to prioritize I/O and enable predictable performance
    • Hybrid Columnar Compression
    • 40Gb InfiniBand networking
  – Still requires effort
    • Initial stabilization was a hurdle with many patches and configuration changes
    • Application changes can enable greater performance
      – Significantly decrease materialized views and indexes
      – Compression gains by changing load methodology
    • DBA resource efforts moved away from performance tuning to administration
    • Support Model is cross discipline
    • Patching dependencies across all tiers (Hardware, OS, DB, Storage)
  – Growth Increments are restricted in the model
  – Data Center Space and Cooling
    • Engineered Systems need to be close by each other
Thank you

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