Session 1079: Using Real Application Testing to Successfully Migrate to Exadata - Best Practices and Customer Case Studies

Prabhaker Gongloor (GP)
Product Management Director, Database Manageability, Oracle Corporation
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Agenda

• Why migrate/consolidate to Exadata?
• What and how best to consolidate?
• Performance validation using Real Application Testing
• Load testing techniques: Customer examples
• Real-world best practices
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• Why migrate/consolidate to Exadata?
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Why Migrate/Consolidate to Exadata?

• Improve performance and efficiency
  – Optimized configuration for Oracle database applications

• Reduce complexity
  – Less servers running standard configurations

• Lower costs
  – Hardware/Software
  – Maintenance, energy and floorspace

• Better Security
  – Fewer servers to manage

• Migration may also involve consolidation as part of Cloud strategy
  – Drive up utilization rates
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Consolidation Challenges

- Applications have different workload profiles
- Multiple resources need to be analyzed
  - CPU
  - Memory
  - Storage
  - Network
Consolidation Planner

- Leverages resource utilization and configuration data from Enterprise Manager repository
  - CPU, memory, storage, network
  - Over a representative period

- Administrator specifies servers and constraints for workload migration
  - Physical/virtual servers
  - Existing/planned servers
  - Business/technical constraints

- Detailed analysis on different scenarios of consolidated workloads
Consolidation Planning Workflow

1. Collect Data from Source Servers
2. Select Resources to be Analyzed
3. Define Constraints
4. Specify Target Servers
5. Review Consolidation Plan Results

Resource Utilization Data Extracted from Enterprise Manager Metric Tables:
- CPU, Memory, Disk Storage, Disk IO, Network IO

Business Constraints:
- Technical Constraints

Technical Constraints:
- Physical or Virtual Servers
- Existing or Planned Servers

Consolidation Ratio
- Target server utilization
Consolidation Targets Planning - SPECint®

- SPECint® provides benchmark for processing power of different CPUs
- Consolidation Planner provides data for variety of different servers and vendors
  - Intel Xeon
  - Intel Itanium
  - SPARC64
  - SPARC T3
  - AMD Opteron
  - POWER
Consolidation Targets Planning

- Input Performance/Capacity figures for Target Servers
  - CPU (SPECint®_rate_base2006)
  - Memory
  - Disk Storage
  - Disk/Network IO

- Consolidation Targets can be new or existing servers
  - Integrated lookup provides SPECInt® CPU rating for new servers
  - Exadata option for P2P scenarios

- Policies for existing servers – Fewest Servers, Even Distribution

- Specify Maximum Resource Utilization % on Target Servers
Exadata Target Planning
Server Mapping

- Automatic Mapping of Source Servers onto Target Servers
- Manual Mapping can be used if existing servers are part of the consolidation exercise
Reporting

- Consolidation Scenario Report available after running Scenario
- Provides details on:
  - Consolidation ratio
  - Destination server utilization
  - Source to Target server mapping
  - Confidence of meeting requirements based on historical samples
  - Manually mapped consolidation constraint violations
  - Servers that cannot be consolidated (Exceptions)
Consolidation Planner – Key Benefits

• Can identify under-utilized or over-utilized servers
  – Uses Enterprise Manager target performance and configuration data

• Helps administrator determines candidates for consolidation
  – maximizes server density
  – helps maintain performance commitment
  – satisfies business, compliance, and technical constraints

• Works for physical and virtual environments
  – Integrated lookup of SPECint® data
  – Out of the box support for Exadata
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Deployment Challenges

Will performance improve?

What are the risks?

Which apps to consolidate?

How long will it take?

- Deploying application to Exadata involves multiple changes:
  - O/S migrations
  - Storage subsystem changes
  - Database upgrades
  - Single database instance to RAC
- Proper testing required for risk mitigation

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End-to-end testing with real workloads

- SQL Performance Analyzer
  - SQL unit testing for response time
  - Identify and tune regressed SQL
  - Integrated into SQL Tuning Advisor and SQL Plan Baseline

- Database Replay
  - Load, performance testing for throughput
  - Remediate application concurrency problems
  - Integrated with Oracle Application Testing Suite for superior comprehensive testing solution
Response Time Testing with SPA

- SQL unit testing for response time
- Test and measure Exadata impact on response time for real, production SQL statements
- Identify all plan changes and/or regressions
- Eliminate SQL regressions with SQL Tuning Advisor and SQL Plan Baselines
- For data warehouse workloads SPA Exadata simulation helps estimate I/O savings without provisioning Exadata hardware
Throughput Testing using DB Replay

- Database load and performance testing with real production workloads
  - Production workload characteristics such as timing, transaction dependency, think time, etc., fully maintained
- Test and measure transaction throughput improvements
- Identify application scalability and concurrency problems
- Remediate issues pre-production for risk-free migration
- Supports migrations from Oracle 9iR2 and 10gR2
Consolidation Testing with RAT

Step 1 – Level the playing field with SPA

- Capture STS over important period
- Restore all database
- Export STS to Central SPA System
- Execute SPA Trials
- Compare Performance
- Remediate Regression

Central SPA System
Consolidation Testing with RAT

Step 2 – Database Replay Load testing

1. Capture Workload over important period
2. Restore all databases
3. Move capture files + Preprocess
4. Replay*
5. Analyze performance

*Simultaneously replay on multiple databases
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Load Testing Techniques: Customer Examples

**Technique 1**
- Run replays on multiple databases concurrently on the same Exadata machine
- Customers: U.S based large utility, Boeing (non-Exadata)
- Pros:
  - Tests hardware limits, OS settings
  - Use Instance Caging for QoS
- Cons:
  - Resources not shared at db level but can be reallocated dynamically*

**Technique 2**
- Run multiple concurrent replays on same database
  - Replay enhancement, tentative availability: Jan 2012
  - Useful for disjoint schema level consolidation
- Pros:
  - Tests hardware, OS, DB settings
  - Able to test db level consolidation using schemas, resources shareable
- Cons:
  - Application dependent

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* Resource reallocation capability may vary depending on specific configurations and system constraints.
Load Testing Techniques: Customer Examples

Technique 3

- Increase read-only workload using replay parameter “SCALE_UP_MULTIPLIER”
- Customers: Large on-line auctioneer, Large smart-phone manufacturer
- Pros:
  - Provides good coverage, since most db tend to have 90% read activity
- Cons:
  - Applicable to read-only part of the workload

Technique 4

- Increase effective workload by reducing replay parameters, connect and think time scales
  - Same workload executed in shorter duration
- Customers: Nationwide Insurance, Large EMEA-based bank
- Pros:
  - Good stress test
- Cons:
  - For applications that have lot of latency
### Load Testing Techniques: Customer Examples

#### Technique 5
- Run additional workloads during workload replay to holistically stress test
  - Database is not locked up, so user can run workload/scripts
  - Example: run online-queries or backups
- Customers: Leading business information intelligence provider
- Pros:
  - Helps test custom what-if scenarios
- Cons:
  - None

#### Technique 6
- Use Application Testing Suite to perform scaled-up load testing with different scenarios
- Customers: Possible, no customer yet
- Pros:
  - Helps test what-if scenarios
  - ATS integration with Database Replay allows real workload testing
- Cons:
  - Works well if few scripts/bind variables to be handled
Load Testing Techniques: Customer Examples

Technique 7

- **Oracle Application Replay**
  - Application server tier to disk, production-scale workload testing solution
  - Introduced in Oracle Enterprise Manager Cloud Control 12c
- **Customers:** None, just introduced
- **Pros:**
  - Tests entire stack - app server to disk
  - Zero overhead capture (uses RUEI)
- **Cons:**
  - None
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Real-world Best Practices (1)

1. Always latest apply patches for SPA and Database Replay
   - MOS Note: 560977.1
   - On both capture and replay servers
2. Setup up flash back, guaranteed restore point, make sure database can be restored
3. Before using Database Replay always complete SPA trials & fix any SQL regressions
4. Perform replays or trials for short duration first and then gradually move on to longer duration testing
5. Check Workload Analyzer output during first replay and implement recommendations to improve quality of replay, MOS Note:1268920.1
   - Synchronized/unsynchronized replay, in-flight transactions, unsupported calls, etc.
Real-world Best Practices (2)

6. For Replay analysis, compare Replay to Replay in the same environment & database server. Review divergence information first & then move on to performance analysis.

7. Test one change at a time incrementally to understand causality before production deployment.

8. Make sure to save the AWR exports after capture/replay, use AWR Global reports for RAC (awrg*.sql).

9. If significant in-flight transactions are reported by Workload Analyzer, try re-capturing for longer duration or after database restart.

10. Provide diagnostic information to Support or contact PM team in case of any issues – MOS Note: 1287620.1, 760402.1, 463263.1.

11. For replay performance analysis, focus on DB Time rather than just elapsed time.
Some Caveats and Workarounds

1. If platform changed on Exadata migration, SPA erroneously reports all SQL statements have plan changes, apply patch for Bug 10241091
   - Workaround: Set the following session parameters and re-run before and after change SPA trials
     ```sql
     alter system set "_cursor_plan_hash_version"=2;
     ```

2. Slow preprocessing related object-id replay synchronization, contact Oracle Support, workaround available

3. SPA reports no improvement for a SQL statement (even though it improved by 99%) due to <1% impact on SQL workload impact, Bug 11701577
   - Workaround: Set SPA task parameters as follows:
     ```sql
     exec dbms_sqlpa.set_analysis_default_parameter('WORKLOAD_IMPACT_THRESHOLD',0);
     exec dbms_sqlpa.set_analysis_default_parameter('SQL_IMPACT_THRESHOLD',0);
     ```
Database Replay

A Powerful Oracle Performance and Load Test Tool
First-hand experience by Boeing

Andre Scharkowski

Andre.Scharkowski@Boeing.com
Introduction

• About myself
  • Oracle Database Administration
  • Performance & Scalability Testing

• About the Boeing Company
  • 200+ DBAs
  • Oracle, SQL Server, DB2, Teradata

• About my work group - DCAC/MRM
  • 16 Oracle DBAs
  • Applications for the design, configuration & manufacturing of airplanes
  • 30 production and about 400 non-production databases
Introduction (cont.)

- Database sizes & load
  - From 100s MB to 3TB
  - 20K sessions 15K active

- Architecture and equipment
  - Oracle 11.2.0.2 on AIX 6.1, IBM pSeries (Power 6)
  - RAC and HACMP / BCV

- Oracle features in use
  - RAC, DataGuard, EBR (Edition-Based Redefinition)
  - DB-links, Materialized Views
  - Triggers, PL/SQL, Synonyms, Complex Views & Grants,
  - EM-grid, OCM, rman
  - Partitioning, some Parallel Query
Why is Database Replay such a big deal?

- Tool is able to reproduce true production load in all its variety and complexity
- DBA has ability to test database changes without having to involve other, non-DBA groups
- Test tool of choice for Oracle patches, Oracle upgrades, parameter changes, architecture and hardware changes
- Tool has the potential of saving large amounts of resources normally spent on test script development
- Tool can be used to generate a background database load that can supplement load generated by traditional test tools (save licenses)
- Tool can reduce the size and complexity of test environments -- no need for application servers, web servers, client machines
Deployment status of Database Replay at Boeing

- Performed about 50 production captures and over 100 replays
- Replays helped validate 10.2.0.4 → 11.2.0.1 upgrade
- Using the tool to validate new EMC V-Max tiered storage
- Plan on making Database Replay part of regular test cycle
  - issue: few outages → many types of changes happen at once
- Plan on working with Oracle to improve the product
  - timeout feature
  - explore Oracle’s Application Testing Suite (ATS)
  - make use of Workload Analyzer
**Workload Profile**

**Average Active Sessions**

<table>
<thead>
<tr>
<th>Active Sessions</th>
<th>0.0</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 18, 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comparison**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Capture</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Time (hh:mm:ss)</td>
<td>05:45:07</td>
<td>04:59:39</td>
<td>86.83</td>
</tr>
<tr>
<td>Average Active Sessions</td>
<td>3.08</td>
<td>2.67</td>
<td>86.83</td>
</tr>
<tr>
<td>Transactions</td>
<td>199,009</td>
<td>198,200</td>
<td>99.59</td>
</tr>
<tr>
<td>Session Logins</td>
<td>21,512</td>
<td>21,328</td>
<td>99.14</td>
</tr>
<tr>
<td>Application Errors</td>
<td>N/A</td>
<td>126</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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Active Session View in OEM during Replay

Start of replay

Contention
### Elapsed Time Comparison

<table>
<thead>
<tr>
<th>Time Duration</th>
<th>Capture</th>
<th>Replay</th>
<th>Percentage of Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (hh:mm:ss)</td>
<td>16:04:28</td>
<td>16:16:59</td>
<td><strong>101.30</strong></td>
</tr>
<tr>
<td>Database Time (hh:mm:ss)</td>
<td>95:08:18</td>
<td>121:48:40</td>
<td><strong>128.04</strong></td>
</tr>
<tr>
<td>Average Active Sessions</td>
<td>5.82</td>
<td>7.48</td>
<td><strong>126.40</strong></td>
</tr>
<tr>
<td>User Calls</td>
<td>279,816,273</td>
<td>280,117,260</td>
<td><strong>100.11</strong></td>
</tr>
</tbody>
</table>

### Detailed Comparison

<table>
<thead>
<tr>
<th>Category</th>
<th>Capture</th>
<th>Replay</th>
<th>Percentage of Capture</th>
</tr>
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### Error Divergence

<table>
<thead>
<tr>
<th>Type of Error</th>
<th>Number of Calls</th>
<th>Percentage of Total Calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session Failures Seen During Replay</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Errors No Longer Seen During Replay</td>
<td>26379</td>
<td>0.01</td>
</tr>
<tr>
<td>Errors Mutated During Replay</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>New Errors Seen During Replay</td>
<td>37289</td>
<td>0.01</td>
</tr>
</tbody>
</table>

### Data Divergence

<table>
<thead>
<tr>
<th>Type of Divergence</th>
<th>Number of Calls</th>
<th>Percentage of Total Calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMLs with Different Number of Rows Modified</td>
<td>287264</td>
<td>0.10</td>
</tr>
<tr>
<td>SELECTs with Different Number of Rows Fetched</td>
<td>485426</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Conclusion

- Exciting performance and load test tool
  - true production load at very low overhead
  - rapid testing possible
  - simple setup
  - resource savings (HW, scripting)
Acknowledgement

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The DCAC/MRM DBA team at Boeing
Hardware and Software
Engineered to Work Together