Validate Database Performance Before Committing Updates, Upgrades, and Migrations

Oracle Enterprise Manager Real Application Testing

Alfredo Krieg
Principal Security & Management Specialist

Timothy Mooney
Product Marketing Director

oracle.com/corporate/events/enterprise-manager-webcast-series.html
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Program agenda

1. Enterprise Manager Overview
2. Real Application Testing Concepts
3. Demonstration
4. Business Value
5. Q&A and resources
Database Management Packs

Diagnostics and Tuning

Real Application Testing

Lifecycle Management

Cloud Management

Data Masking and Subsetting
Who am I?

Oracle Enterprise Manager Specialist
North America Technology Division - Sales Engineering
Oracle Security and Systems Management Team

https://alfredokriegdba.com
@alfredokrieg
Oracle Real Application Testing
Available Tools

• Consolidation Workbench
• SQL Performance Analyzer (SPA)
• Database Replay
• SPA Quick Check
Oracle Real Application Testing
How to interact with RAT?

- Oracle command-line API’s
- Oracle Enterprise Manager
  - Quality Management
    - Database Replay
    - SQL Performance Analyzer
Database Consolidation Workbench
Consolidate with confidence

- Consolidate to Oracle private or public cloud or to Exadata
- Accurately estimate required resources for migration
- Use high availability options to minimize downtime, subject to source and destination database platform and version
- Currently supports 2 consolidation scenarios (SI or RAC):
  - Source DB’s to fewer destination databases
  - Source DB’s to fewer servers (same number of DB’s)
Database Consolidation Workbench

Plan

• Gives consolidation advice by identifying candidate databases for the designated consolidation platform using AWR data

• Accurately estimates requirements

Migrate

• Implements consolidation plan by migrating databases to new consolidation platform using EM’s provisioning features

Validate

• Validates consolidation plan with Real Application Testing (SPA) by running test workloads on consolidated databases
Database Consolidation Workbench
Database Selection

![Database consolidation workbench screenshot](https://docs.oracle.com/en/enterprise-manager/cloud-control/enterprise-manager-cloud-control/13.4/emcp/enterprise-manager-consolidation.html#GUID-51363BBB-775F-4379-AD2E-D37D80C3C7EE)

<table>
<thead>
<tr>
<th>Database Name</th>
<th>CPU Capacity (SPEC metric)</th>
<th>CPU Utilization (%)</th>
<th>Memory Capacity (GB)</th>
<th>Memory Utilization (%)</th>
<th>Allocated Storage (GB)</th>
<th>Used Storage (GB)</th>
<th>Estimated Compression Ratio</th>
<th>Estimated Workload Type</th>
<th>I/O Usage (Requests/Second)</th>
<th>I/O Usage (MB/Second)</th>
<th>Database Version</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB12.us.oracle.com</td>
<td>265.0 (Estimated)</td>
<td></td>
<td>214.99</td>
<td></td>
<td>39.23</td>
<td>33.51</td>
<td>Not Available</td>
<td>Insufficient</td>
<td>1633.90</td>
<td>258.00</td>
<td>12.1.0.2.0</td>
<td>Oracle Linux</td>
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<tr>
<td>BB12P.us.oracle.com</td>
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<td>214.99</td>
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<td>5.33</td>
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<td>Insufficient</td>
<td>8.50</td>
<td>0.10</td>
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<td>Oracle Linux</td>
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<td>Insufficient</td>
<td>813.40</td>
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<td>11.2.0.4.0</td>
<td>Oracle Linux</td>
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<tr>
<td>BBPROD12.us.oracle.c</td>
<td>265.0 (Estimated)</td>
<td></td>
<td>214.99</td>
<td></td>
<td>5.20</td>
<td>3.00</td>
<td>Not Available</td>
<td>Insufficient</td>
<td>9.40</td>
<td>0.10</td>
<td>12.1.0.2.0</td>
<td>Oracle Linux</td>
</tr>
<tr>
<td>exadb1</td>
<td>352.0 (Estimated)</td>
<td></td>
<td>503.86</td>
<td></td>
<td>719.41</td>
<td>672.69</td>
<td>Not Available</td>
<td>Insufficient</td>
<td>10980.10</td>
<td>100.30</td>
<td>12.1.0.2.0</td>
<td></td>
</tr>
<tr>
<td>exadb2</td>
<td>352.0 (Estimated)</td>
<td></td>
<td>503.86</td>
<td></td>
<td>201.01</td>
<td>178.89</td>
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<td>Insufficient</td>
<td>7258.30</td>
<td>8279.60</td>
<td>12.1.0.2.0</td>
<td></td>
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</tbody>
</table>
SQL Performance Analyzer (SPA) Overview

- Helps users predict the impact of system changes on SQL workload
- Low overhead capture of SQL workload to SQL Tuning Set (STS) on production system
- Build different SQL trials (experiments) of SQL statements performance by test execution or explain plan
- Integrated with STS, SQL Plan Baselines, & SQL Tuning Advisor to form an end-to-end solution
SQL Performance Analyzer
Available Workflows

SQL Performance Analyzer Home

SQL Performance Analyzer Workflows
Create and execute SQL Performance Analyzer Task experiments of different types using the following links.
- Upgrade from 9i or 10.1
- Upgrade from 10.2 or higher releases
- Parameter Change
- Optimizer Statistics
- Ignore Optimizer Hints
- Exadata Simulation
- Guided Workflow

SQL Performance Analyzer Tasks

<table>
<thead>
<tr>
<th>Select</th>
<th>View Latest Report</th>
<th>Name</th>
<th>Owner</th>
<th>Last Modified</th>
<th>Current Step Name</th>
<th>Type</th>
<th>Last Run Status</th>
<th>SQLs Processed</th>
<th>Steps Completed</th>
<th>Task Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑</td>
<td></td>
<td>TEST_SPA_PRE2</td>
<td>SYSTEM</td>
<td>Jun 15, 2020 10:45:11 AM</td>
<td>COMPARE_1592577911510</td>
<td>Compare</td>
<td>Completed</td>
<td>4 of 4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>☑</td>
<td></td>
<td>TEST_SPA_PRE1</td>
<td>SYSTEM</td>
<td>Jun 18, 2020 4:45:04 PM</td>
<td>COMPARE_1592513104582</td>
<td>Compare</td>
<td>Completed</td>
<td>4 of 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TIP: For an explanation of the icons and symbols used in the following table, see the Icon Key.
SQL Performance Analyzer
Guided Workflow

Hide Overview

- Run Post-Change Trial
- Compare SQL Performance
- Test Complete
- Analysis & Reporting
- Implement Tuning Recommendations
- Run Pre-Change Trial
- Make Change
- Capture SQL Tuning Set
## SQL Performance Analyzer

### Guided Workflow

The following guided workflow contains the sequence of steps necessary to execute a successful two-trial SQL Performance Analyzer test.

**Note:** Be sure that the Trial environment matches the tests you want to conduct.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Executed</th>
<th>Status</th>
<th>Execute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Create SQL Performance Analyzer Task based on SQL Tuning Set</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>2</td>
<td>Create SQL Trial in Initial Environment</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>3</td>
<td>Create SQL Trial in Changed Environment</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>4</td>
<td>Compare Step 2 and Step 3</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>5</td>
<td>View Trial Comparison Report</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

**TIP** For an explanation of the icons and symbols used in the following table, see the Icon Key.
SQL Performance Analyzer
Guided Workflow

Run SQL Trial Comparison

Task Name: SYSTEM.TEST_SPA_PRE2
SQL Tuning Set: SYSTEM.TEST_PSALES_CAPTURE

Trial 1 Name: SQL_TRIAL_1593028541307
Description
SQL Executed: No

Trial 2 Name: SQL_TRIAL_1593028977811
Description
SQL Executed: Yes

Comparison Metrics: Elapsed Time

CPU Time
User I/O Time
Buffer Gets
Physical I/Os
Optimizer Cost
I/O Interconnect Bytes

Compare trials to assess change impact
SQL Performance Analyzer trial comparison allows you to assess the impact on SQL Tuning Set performance of changes made between two trials.

It is important to know the difference between Trial 1 and Trial 2 execution environments in order to properly assign impacts to the changes between trials. Tracking environmental changes between trials is currently a user responsibility.

The selected comparison metric is used as the basis for comparison, and defaults to execute elapsed time when both trials contain test execution statistics. When execution statistics are not available, a less accurate comparison can be made using optimizer cost.
SQL Performance Analyzer
Guided Workflow

[Diagram of SQL Performance Analyzer interface]

Top 10 SQL Statements Based on Impact on Workload:

<table>
<thead>
<tr>
<th>SQL ID</th>
<th>Net Impact on Workload (%)</th>
<th>Elapsed Time (sec)</th>
<th>Net Impact on SQL (%)</th>
<th>New Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Explore alternate execution plans using SQL Tuning Advisor.
Run SQL Tuning Advisor.
Create SQL tuning set for regressed SQLs.
Create SQL Tuning Set.
Increase your DB Replay confidence by executing SPA first

Execute SPA first to identify regressed SQL’s in the TEST system before attempting a Database Replay
Database 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 on test system before production deployment
- Perform capacity planning with consolidated replay with Multitenant or schema consolidation
Database Replay

Know your application

No detail knowledge is needed but you need to know:

• Distinct workloads to capture
• Peak time
• Optimizer changes during login such as:
  • `alter session set optimizer_mode=FIRST_ROWS_10`
• Workload capture restrictions such as:
  • XA transaction
  • Distributed transaction
  • See 19c Testing Guide ([10.4 Workload Capture Restrictions](#))
• When database backups or batch jobs are executed
• DBMS_SCHEDULER jobs

Capture your workload

SPA

• Capture distinct workloads into separate SQL Tuning Sets
• Capture STS from a time period before cloning the database

Database Replay

• Identify time period/s with critical workload
  • Peak time
  • Batch jobs
  • Time critical activity
• Start capture in a quiet period so it can ramp up
• Make sure you have enough space for capture
Database Replay Guided Workflow
Capture

Database Replay enables you to effectively test system changes in test environments by replaying a full production workload on a test system to determine the overall impact of the change. Database Replay captures your production workload and maintains all its characteristics such as timing and concurrency.

Database Replay workload capture is performed at the database server level and therefore can be used to assess the impact of any change which might affect database performance such as parameter changes, patching, storage migrations and database upgrades.

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Owner</th>
<th>Creation Date</th>
<th>Database Name</th>
<th>Database Version</th>
<th>Concurrent Capture Name</th>
<th>Original Capture Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST_CAPTURE</td>
<td>Completed</td>
<td>SYSMAN</td>
<td>Jun 18, 2020 4:09:23 PM GMT-04:00</td>
<td>SALES</td>
<td>18.3.0.0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Database Replay Guided Workflow

Capture
Database Replay Guided Workflow

Capture
Database Replay
Configure Replay Environment

- Sizing Database servers
  - CPU
  - Memory
  - Storage

- Replay clients
  - Dedicated servers
  - CPU
  - Memory
  - Storage

- Network
  - Production equal

Clone your database

- Does not need to be an exact copy of the database.
- Should be as close as possible to the start capture SCN
  - Certain applications like Siebel is sensitive to an offset in the dataset

Methods to Clone

- RMAN copy.
  - Use point in time recovery until Capture SCN
- Standby Database
  - Can use Snapshot Standby or by breaking the standby database
  - Use recovery until capture SCN
- Data pump
  - Incremental
  - Flashback time
- Test master and Snap clone
Database Replay
Replay Transaction Settings

Do I need to restart the database?
• Inflight sessions are not in general a problem but look out for:
  • Optimizer changes during login
  • Batch Job
  • Long running transaction
  • Maintenance windows interference
• How to avoid it
  • Start capture in a quiet period
  • Use capture subsetting
    • DBMS_WORKLOAD_REPLAY.GENERATE_CAPTURE_SUBSET
      • begin_include_incomplete
      • end_include_incomplete

Synchronization = SCN, TIME?
• TIME
  • default and recommended
  • If low divergence stick to it
  • Also, only option if stress testing with decreased think_time_scale, connect_time_scale

• SCN
  • Use only when high divergence with TIME synchronization
  • Use when transaction dependencies is high
  • Make sure all statements are tuned before replay
  • If regression be aware that the replay will take much longer time
Database Replay
Replay Modes

Replay Query Only mode (TIME Sync mode only)
• Will omit DML, DDL and PL/SQL
• Query regression is no 1 reason for slow replay:
  • No synchronization
  • No locking
  • Highlight slow SQL
  • Can be repeated no needed to restore database
    • Keeps all statistics for easy comparison
• Progress to read/write only when Query Only has:
  • Same or shorter elapsed time
  • Same or shorter DB Time

Replay Read Write mode
Functional Analysis
• Investigate errors, data divergence - Is it small percentage of overall calls?
• Target replay for 80-90% user calls successful
• Is divergence limited to few objects, schemas?
• Can divergence be ignored?
  • Background jobs
  • Belongs to non-critical business flows
• High divergence usually points to test system setup incorrectly (missing objects.)
• Use application metrics for validation
## Database Replay

**Replay Target**

- **Database** Target: upgr.oracle.com
  - Database Version: 19.3.0.0.9
- **Replay Host**: ocsworkshop.oracle.com

### Task List

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Go To Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare Test Database</td>
<td>Set up and prepare a test database environment to be used for replay. Steps include cloning the production database, restoring the database to the point of capture and making any additional changes necessary to the test database environment.</td>
<td></td>
</tr>
<tr>
<td>Set Up Test Database</td>
<td>Clone the production database to a test environment. The test database should be restored to match the capture database at the start of capture. You may make any changes to the test environment as needed.</td>
<td></td>
</tr>
<tr>
<td>Isolate Test Database</td>
<td>Isolate the test system from the production environment prior to the workload replay.</td>
<td></td>
</tr>
<tr>
<td>Prepare for Replay</td>
<td>Prepare (preprocess) the workload capture files for replay and deploy the Replay Clients.</td>
<td></td>
</tr>
<tr>
<td>Preprocess Workload</td>
<td>Preprocess the captured workload. Preprocessing prepares the workload for replay and only needs to be performed once against a specific database version. A workload should be preprocessed using the target test database.</td>
<td></td>
</tr>
<tr>
<td>Deploy Replay Clients</td>
<td>Deploy Replay Clients</td>
<td></td>
</tr>
<tr>
<td>Replay Workload on Test Database</td>
<td>Set up the workload replay on the test database and analyze the results.</td>
<td></td>
</tr>
<tr>
<td>Replay Workload</td>
<td>Replay the preprocessed workload on a test copy of the production database.</td>
<td></td>
</tr>
</tbody>
</table>
Database Replay

---

**Assessing the Replay**

The Elapsed Time Comparison chart shows how much time the replay workload took to accomplish the same amount of work as captured.

When the replay has completed, the Galaxy bar for the replay environment is processed, highlighting the relative amount of work in the replay environment. The Divergence section shows information about both the data and error discrepancies between the replay and capture environments, which can be stored as a measure of the replay quality.
SPA Quick Check

Optimized
• Optimized for use on prod systems
• Optimal Trial or Explain Plan mode
• Disable multi-executions, full DML execute disabled

Controlled
• Per SQL time limits
• Testing scoped to private session
• Associate with Resource Consumer Group

Change Aware
• Context-aware change testing workflows, e.g. -
  • Optimizer gather statistics
  • Init.ora parameter changes

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Demo
**Find → Fix → Validate: Integrated Database Performance Workflow**

**FIND:**
Diagnostics Pack
(ADDM, ASH, AWR, …)

**FIX:**
Tuning Pack
(SQL Tuning Advisor, …)

**VALIDATE:**
Real Application Testing
(SQL Performance Analyzer, …)
When To Validate Performance With Real Application Testing (RAT)

Move workloads to Oracle Cloud safely and quickly
Accurately estimate required Oracle cloud compute size and shape for cloud migration
Ensure database performance on cloud meets SLAs
Use Database Cloud Services to test on-premises DB patching and upgrades

Proactively identify, fix, and validate performance problems before they are deployed on production systems whether on cloud or on-premises

Improve business agility through faster and risk-free new technology adoption (DB 19c upgrades, Sharding, Multitenant, In-memory, etc.)

Consolidation Workbench _DSPA Quick Check  SPA  DB Replay

Cloud Migration/Adoption  Performance Management  Upgrade/New Feature Adoption

224% ROI over 3 years
5.9 months payback period

Source: Forrester Study
Webcasts and Workshops: oracle.com/corporate/events/enterprise-manager-webcast-series.html

Blogs: https://blogs.oracle.com/oem/
Additional Resources

- Enterprise Manager Real Application Testing [Oracle.com](https://oracle.com)
- [Oracle Testing Guide](https://docs.oracle.com) (Docs)
- [Enterprise Manager Groundbreakers Community](https://blogs.oracle.com/oem)
- [Enterprise Manager Cloud Control](https://docs.oracle.com) (Docs)

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