ORACLE

Oracle Database 19c: Real Application Testing Overview

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TABLE OF CONTENTS

Introduction

The Oracle database is the market-leader and the preferred database for hundreds of thousands of enterprises as well as application developers and database administrators worldwide. Over the years, enterprises have come to rely on the Oracle database to provide unparalleled performance and reliability. Oracle continues to raise the bar with Oracle Database 19c with extensive support for consolidation. Designed for data center environments that are rapidly evolving and changing to keep up with the demands of the business, Oracle Database 19c allows businesses to adopt new technologies quickly while minimizing risk

Real Application Testing

Today, enterprises have to make sizeable investments in hardware and software to roll out infrastructure changes. For example, a data center may have an initiative to move databases to a low cost computing platform, such as Oracle Enterprise Linux. This would, traditionally, require the enterprise to invest in duplicate hardware for the entire application stack, including web server, application server and database, to test their production applications. Organizations therefore find it very expensive to evaluate and implement changes to their data center infrastructure. Additionally, in spite of the extensive testing performed by customers, unexpected problems are frequently encountered when a change is finally made in the production system. This is because test workloads are typically simulated and are not accurate or complete representations of true production workloads. Data center managers are therefore reluctant to adopt new technologies and adapt their businesses to the rapidly changing competitive pressures.

Oracle Database 19c Real Application Testing option addresses these issues head-on with two complementary solutions, SQL Performance Analyzer and Database Replay.

SQL Performance Analyzer

Changes that affect SQL execution plans can severely impact application performance and availability. As a result, DBAs spend enormous amounts of time identifying and fixing SQL statements that have regressed due to the system changes. SQL Performance Analyzer (SPA) can predict and prevent SQL execution performance problems caused by environment changes.

SQL Performance Analyzer provides a granular view of the impact of environment changes on SQL execution plans and statistics by running the SQL statements serially before and after the changes. The SQL Performance Analyzer report that is generated outlines the net benefit on the workload due to the system change as well as the set of regressed SQL statements. For regressed SQL statements, appropriate execution plan details along with recommendations to tune them are provided.

SQL Performance Analyzer is well integrated with existing SQL Tuning Set (STS), SQL Tuning Advisor and SQL Plan Management functionality. SQL Performance Analyzer completely automates and simplifies the manual and time-consuming process of assessing the

impact of change on extremely large SQL workloads (thousands of SQL statements). DBAs can use SQL Tuning Advisor to fix the regressed SQL statements in test environments and generate new plans. These plans are then seeded to SQL Plan Management baselines and exported back into production. Thus, using SQL Performance Analyzer, businesses can validate with a high degree of confidence that a system change to a production environment in fact results in net positive improvement at a significantly lower cost.

Examples of common system changes for which you can use the SQL Performance Analyzer include:

- Database upgrade, patches, initialization parameter changes
- Configuration changes to the operating system, hardware, or database
- Schema changes such as adding new indexes, partitioning or materialized views
- Gathering optimizer statistics.
- SQL tuning actions, for example, creating SQL profiles
- Database consolidation testing using Oracle Pluggable Databases or schema consolidation methods

Using SQL Performance Analyzer involves the following 5 main steps:

1. Capture the SQL workload that you want to analyze with SPA. The Oracle database offers ways to capture SQL workload from several sources, such as cursor cache and Automatic Workload Repository, into a SQL Tuning Set (STS). This would typically be done on a production system and the STS would then be transported to the test system where SPA analysis will take place.
2. Measure the performance of the workload before a change by executing SPA on the STS. Very short running queries are executed multiple times and their statistics are averaged to eliminate variations due to buffer cache state and other noise factors
3. Make the change, such as database upgrade or optimizer statistics refresh.
4. Measure performance of the workload after the change by executing SPA on the STS again, as in step 2.
5. Compare performance of the two executions of the SQL tuning set to identify the SQL statements that have regressed, improved, or were unchanged.

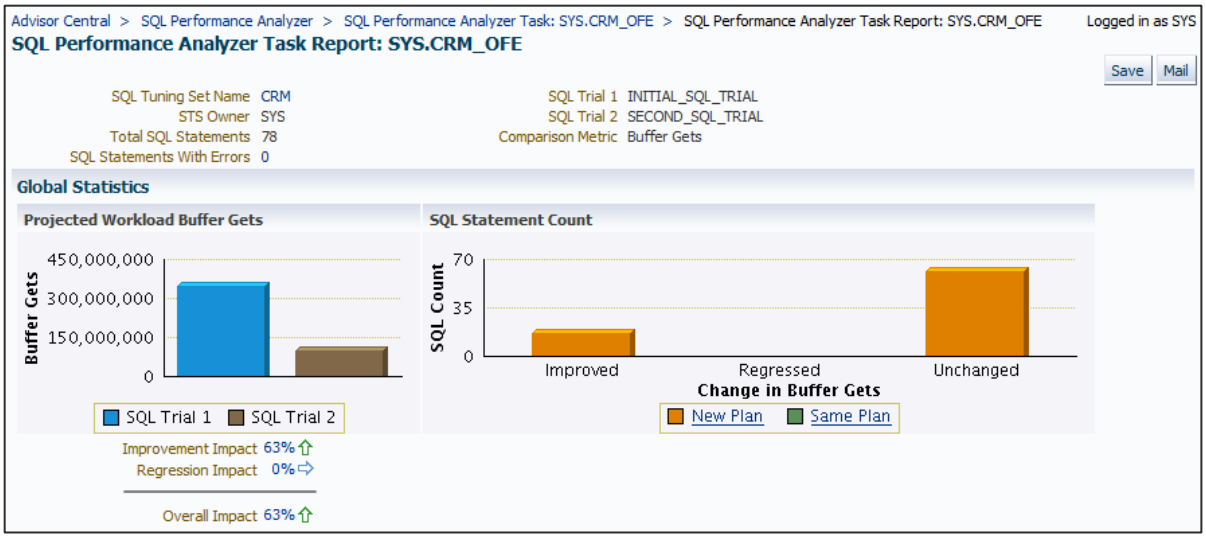

Figure 1. SQL Performance Analyzer report

The SPA comparison report in Figure 1 shows significant performance improvement of overall SQL workload after the proposed system change but with a few execution plan regressions. SQL Performance Analyzer takes into account the number of executions of a SQL

statement when measuring its impact. A SQL statement that completes in seconds but is frequently executed may have a higher impact on the system than a long running statement executed only once. SPA takes these factors into account when predicting overall performance improvements and regressions. If any regressions are encountered, SPA allows the user to fix them using SQL Tuning Advisor or with SQL Plan Baselines, a plan stability feature introduced in Oracle Database 11g.

SPA supports numerous other features that help assess system changes, these are briefly described below:

1. SPA helps estimate the IO reduction that can be accomplished by migrating to Exadata server but without actually requiring you provision the hardware. This can be used to identify potential workloads/systems that are good candidates for Exadata migration.
2. SPA supports comparing the performance of two similar workloads or STSs – this functionality is useful when you have mechanisms such as load testing scripts or Oracle Application Testing Suite that can be used to test system changes. By capturing the workload in to two different STSs (for before and after change runs), one can use SPA to assess the impact of the system change.
3. With Oracle Enterprise Manager Cloud Control 13c, a "one-click" STS transport mechanism can be used to simplify the process of moving STS workloads and tuning artifacts such as SQL Profiles or Plan Baselines between production and test databases.
4. SPA supports testing of databases consolidated through Oracle Pluggable Databases or schema consolidation techniques.

Database Replay

Database Replay provides DBAs and system administrators with the ability to faithfully, accurately and realistically rerun actual production workloads, including online user and batch workloads, in test environments. By capturing the full database workload from production systems, including all concurrency, dependencies and timing, Database Replay enables you to realistically test system changes by essentially recreating production workloads on the test system – something that traditional testing tools that rely on simulation can never duplicate. With Database Replay, DBAs and system administrators can test:

- Database upgrades, patches, parameter, schema changes, etc.
- Configuration changes such as conversion from a single instance to RAC, ASM, etc.
- Storage, network, interconnect changes
- Operating system, hardware migrations, patches, upgrades, parameter changes
- Database consolidation testing projects using Oracle Pluggable Databases and schema consolidation
- Workload scale-up and custom load testing scenarios

Lower test infrastructure cost

DBAs now have a test infrastructure at their disposal to test their changes without the overhead of having to duplicate an entire application infrastructure. Database Replay does not require the set up overhead of having to recreate a middle-tier or a web server tier. Thus, DBAs and system administrators can rapidly test and upgrade data center infrastructure components with the utmost confidence, knowing that the changes have truly been tested and validated using production scenarios.

Faster deployment

Another major advantage of Database Replay is that it does not require the DBA to spend months getting a functional knowledge of the application and developing test scripts. With a few point and clicks, DBAs have a full production workload available at their fingertips to test and rollout any change. This cuts down testing cycles from many months to days or weeks and brings significant cost savings to businesses as a result.

Database Replay consists of four main steps as illustrated in Figure 2 and described below:

1. Workload capture

   When workload capture is enabled, all external client requests directed to the Oracle Database are tracked and stored in binary files, called capture files, on the database server host file system. Oracle recommends taking a backup of the entire database prior to the workload capture. The user specifies the location of the capture files and the workload capture start and end time. During this process, all information pertaining to external database calls is written to the capture files.

2. Workload processing

   Once the workload has been captured, the information in the capture files has to be processed. This processing transforms the captured data into replay files and creates all necessary metadata needed for replaying the workload. The capture files would typically be copied to another system for processing. This must be done once for every captured workload before they can be replayed. After the captured workload is processed, it can be replayed repeatedly on a replay system. As workload processing can be time consuming and resource intensive, it is generally recommended that this step be performed on the test system where the workload will be replayed.

3. Workload replay

   After the captured workload has been processed, it is now ready for replay. A client program, called Replay Client, then processes the replay files and submits calls to the database with the exact same timing and concurrency as in the capture system. Depending on the captured workload, you may need one or more replay clients to properly replay the workload. A calibration tool is provided to help determine the number of replay clients needed for a workload. It should be noted that since the entire workload is replayed including DML and SQL queries, it is important that the data in the replay system be identical to that in the production system, whose workload was captured, to enable reliable analysis for reporting purposes.

4. Analysis and Reporting

   Extensive reports are provided to enable detailed analysis of the capture and replay. Any errors encountered during replay are reported. Any divergence in rows returned by DML or queries is shown. Basic performance comparisons between capture and replay are provided. For advanced analysis, Replay Compare Period and other AWR reports are available to allow detailed comparison of various statistics between capture and replays.

Both the workload capture and replay process support a filtering capability that is useful for targeting workload of interest, such as by service, action, module to name a few. Oracle Enterprise Manager Cloud Control 13c significantly enhances the value of Real Application Testing by supporting end-to-end Database Replay automation. This simplifies the process of saving and transferring the workload capture and performance data to test system, setting up the test system and replay clients correctly, and orchestrating the entire replay through the Cloud Control interface.

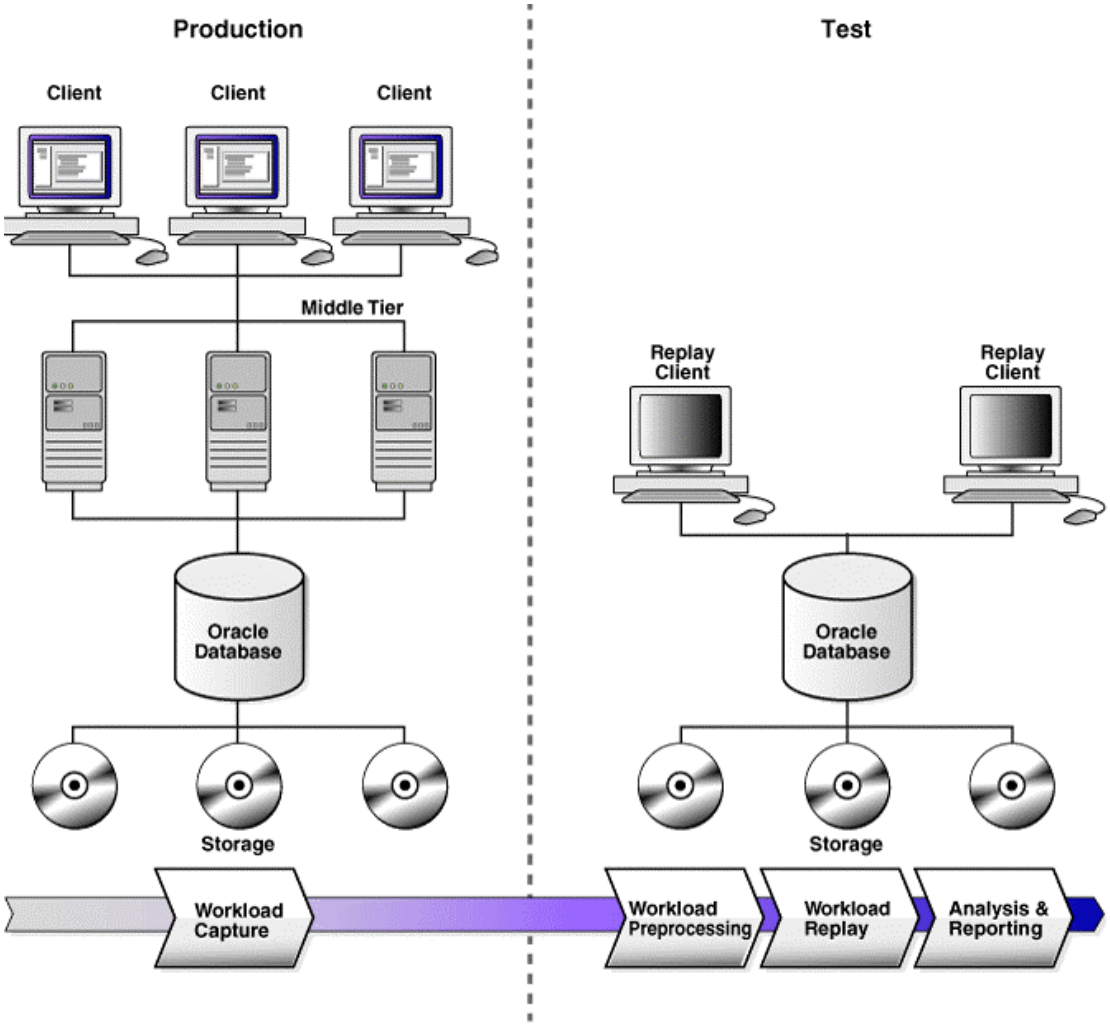

Figure 2. Database Replay Workflow

Consolidate Database Replay

New in Oracle Database 12c, Database Replay supports simultaneous execution of multiple database captures on a single consolidated database. The consolidated database can be a container database with Oracle Pluggable Databases or a traditional database consolidated using schema consolidation methods. Replaying multiple workloads against a consolidated database gives assurance that the target platform can support the workload. Database Replay supports captures from all supported versions of the Oracle Database. Database Replay can be executed on Oracle Database 11 and above. Consolidated Database Replay can be executed on Oracle Database 11.2.0.2 and above. The captures for Database Replay are platform agnostic and can be replayed on any supported operating system.

In addition, Consolidated Database Replay supports scheduling of the individual replays enabling investigations of various workload scenarios.

Figure 3 shows the result of a Consolidated Replay of two workloads.

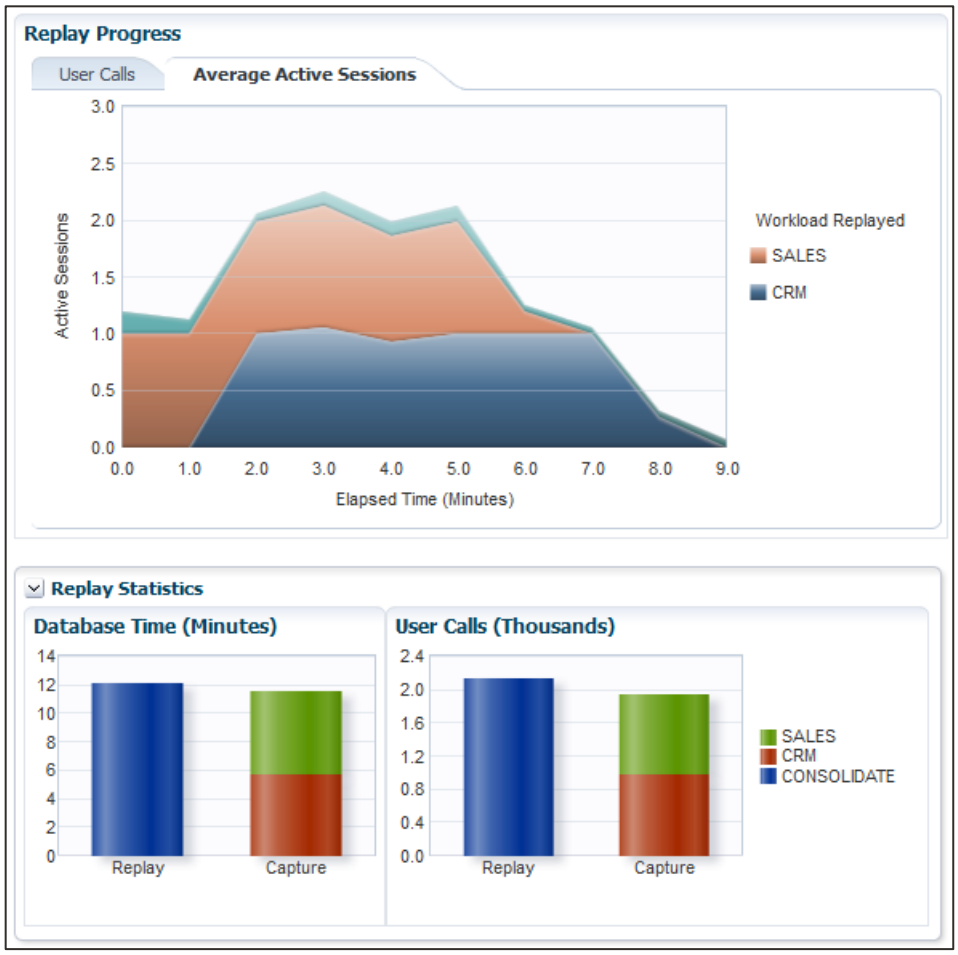

Figure 3. Consolidated Replay of Two Workloads

Database Replay Workload Scale-up

Database Replay also supports creation of a new workloads based on existing captured workloads. The new workloads can be used for capacity planning and validation of various what-if workload scenarios. Three techniques that can be used with Database Replay to validate consolidation include Workload Folding, Time Shifting and Schema Remapping.

The first of these techniques is Workload Folding. Workload subsetting can be used to compose new workloads. Existing captures can be divided into two or more smaller workloads by slicing an existing captured workload into subsets by specifying a point in time within the captured duration. Then you can increase the workload by folding the workload along this specified point-in-time. This is done by submitting simultaneous replays of the subset workloads on the target database. This effectively increases the workload without the need to use scripting or supplying binds. This technique is suitable for applications where individual transactions are mostly independent of each other.

Another scale-up technique is Time Shifting. You can schedule multiple database replays so that their peak database utilizations are aligned. This allows you to see if your target consolidated system can handle the maximum production workload from your current production systems.

Database Replay also supports testing with schema duplication. You can duplicate your target schema and run multiple replays of the same workload. Before running these multiple replays, you remap users so that each replay goes against its separate schema, avoiding workload collisions. Schema duplication allows you to test multiple scales of the current workload,

maintaining the exact workload profile and concurrency. This is useful in scenarios such as schema as a service (SaaS) or where each line of business has its own schema.

Which testing solution

Choosing the right testing solution helps DBAs absorb and manage change efficiently.

SPA helps DBAs improve SQL response time. SPA is the SQL unit test to validate that all of your individual SQL statements are performing optimally and should be used first in almost every testing environment.

Database Replay is designed to test and improve overall system performance. After SPA has validated the individual SQL performance, Database Replay should be used to ensure performance under full system load.

Consolidated Database Replay provides the ability to assure desired database performance for database consolidation projects, whether consolidating onto an Oracle Exadata machine, Oracle Database Appliance, Oracle Pluggable Databases or other consolidated infrastructure. Database Workload Scale-up and custom workload creation functionality enables you to future-proof your environment by making it possible to test the system under various what-if workload scenarios.

Real Application Testing makes it easy for database administrators to manage and execute changes that are critical to the business and do it all at lower

Conclusion

Change is relentless in today's rapidly evolving IT environments. But it doesn't have to be difficult for data center managers and administrators. Thanks to the Real Application Testing capabilities in Oracle Database 18c, database administrators can adapt to changes easily while eliminating any undesired side effects. Numerous customers have already deployed Real Application Testing and benefited from greatly reduced cost and effort in testing target environments with enormous reductions in unplanned downtime. A Forrester research study determined that customers who have deployed Real Application Testing have a 224% risk adjusted ROI over a three-year time frame with a payback period of 5.9 months.

Real Application Testing helps organizations lower their testing costs by giving DBAs and system administrators an easy-to-deploy solution for testing and rolling out data center changes with reduced hardware and software investments.

"The use of Orcle Real Application Testing helped CSX streamline theupgrade process and allowed it to complete the database upgrade in less than half the time requied for the company's previous database upgrade that involved a database footprint that was 30% smaller. Providing critical insight, Oracle Real Application Testing enabled CSX to fully assess the impact of infrastructure changes and finetune queries in a test environment before deploying the change in production."

- http://www.dbta.com/Editorial/News-Flashes/Enterprise-Manager-and-Real-Application-Testing-Help-CSX-Corporation-Upgrade-Databases-Twice-as-Fast-95199.aspx

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