Tips for Maximizing DB Performance
Theory and Practice

Mughees A. Minhas
Vice President, Product Management
Oracle
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Program Agenda

1. Introduction
2. Oracle Database Performance Tuning Fundamentals
3. Performance Tuning Methodology
4. New Features
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Top Challenges: **Database Management**

- **52%** Rapid diagnoses of database performance problems
- **45%** Identifying application (SQL) issues
- **37%** Validating and applying SQL tuning solutions

**Key Takeaway: Improve & Ensure Higher Quality of Service**

Source: THE RAPIDLY ACCELERATING CLOUD-ENABLED ENTERPRISE: 2015 IOUG Survey On Database Manageability
Debug Code, Counters/Ratios, BSTAT/ESTAT
Renaissance (v7): Introduction of WAIT events, Moving from Counters to Timers

DB Time Tuning, ASH, AWR, ADDM, EM

ASH Analytics, RAC Aware ADDM, Real-Time ADDM, Real-Time SQL Monitoring, Active Reports, SQL Performance Analyzer, Exadata support

Multitenant-aware, In-memory support, DB Operations Monitoring, EM Express, Performance Hub
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Database Time (DB Time)

- Total time in database calls by foreground sessions
- Includes CPU time, IO time and non-idle wait time
- DB Time <> response time
- New metric for Oracle performance analysis

*Database time is total time spent by user processes either actively working or actively waiting in a database call.*
**Fundamental Concepts**

**Active Session** =
Session currently spending time in a database call

**Database Time (DB Time)** =
Total time session spent in all database calls

**Average Activity of the Session (% Activity)** =
The ratio of time active to total wall-clock time

\[
\text{Average Activity of the Session} = \frac{\text{Active Session}}{\text{Database Time}}
\]

= time spent in database
Multiple Sessions

• DB Time = Sum of DB Time Over All Sessions
• Avg. Active Sessions = Sum of Avg. Activity Over All Sessions

\[ \text{Avg. Active Sessions} = \frac{\text{Sum}(\text{DB Time})}{\text{Elapsed Time}} \]

At time \( t \) we have 2 active sessions

\( t \) = time spent in database
Visualizing DB Time

![Diagram showing active sessions over time for different users from t0 to t1.](image-url)
Quiz

An AWR report of snapshots taken between 15 minutes shows DB Time greater than 15 minutes. How is this possible?

• DB Time is the time spent in the database: Includes CPU time, IO time and non-idle wait time

• You have more than one session contributing to the "time" of the database.

• If you have 2 cpus, you have 2 cpu seconds per every 'real second’

• How can you have 30 minutes of enqueue wait in 15 minutes?

• Easy - 30 sessions waited one minute apiece, or two sessions waited 15 minutes or ......
Where to find DB time: EM Performance page

- Active Sessions by wait class over time
- Colored area = Amount of DB time, More the DB time, More the Problem
- DB time increases as system load increases, DB time increases as system performance degrades.
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Performance Tuning Methodology

Proactive Performance Management

Reactive Performance Management
Proactive Performance Management: SPA Quick Check

• Helps users predict the impact of routine system changes on production SQL workload
• Low overhead capture of SQL workload to SQL Tuning Set (STS)
• Build different SQL trials (experiments) of SQL statements performance by test execution or explain plan
• Day to day use cases integrated with SPA Quick Check, SQL Plan Baselines, & SQL Tuning Advisor to form an end-to-end solution
Proactive Performance Management
Predict the impact of routine system changes on SQL workload response time

- 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, such as,
    - Optimizer gather statistics
    - Init.ora parameter changes
Proactive Performance Management

Predict the impact of system changes on SQL workload response time
Performance Tuning Methodology

Reactive Performance Management

• Analyzing transient performance problems
  – ASH Analytics

• Diagnose persistent performance issues
  – ADDM

• In-depth SQL performance analysis
  – Real-Time SQL Monitoring

• Optimizing top SQL’s with sub-optimal plans
  – SQL Tuning Advisor
Reactive Performance Management

Identify performance issues using ASH Analytics

- Graphical ASH report for advanced analysis
- Provides visual filtering for recursive drill-downs
- Select any time period for analysis
- Analyze performance across many dimensions
Reactive Performance Management

• I am a CDBA and asked to investigate transient performance issues reported by one application owner. I need to diagnose the cause of these issues and address them.

• AWR report indicates some unusual issues on the system
  – But I don’t get a PDB specific report...
  – What to do next?
Reactive Performance Management

Analyzing transient performance problems using ASH Analytics
ASH Analytics identifies User I/O as the problem

Identify SQL’s that are subject to User I/O
Which Database Performance Diagnostics Tool to Use?

- **Automatic Workload Repository – AWR Reports**
  - Reports about performance and workload data from AWR

- **Active Session History – ASH**
  - Gathers fine-grain data about every active database session every second

- **Automatic Database Diagnostics Monitor - ADDM**
  - Data Analysis and Problem Identification
  - Findings and Advise on how best to resolve bottlenecks

- **Real-time SQL and Database Operations Monitoring**
  - Provides in-depth diagnostics about SQL execution at row source level

**Database Performance Hub** provides holistic performance management
Holistic Performance Management

- Single view of DB performance
  - ADDM, SQL Tuning, Real-Time SQL Monitoring, ASH Analytics
- Switch between ASH analytics, workload view, ADDM findings and SQL monitoring seamlessly
- Supports both real-time & historical mode
- Historical view of SQL Monitoring reports
Performance Hub Report

- New interactive report for analyzing AWR data
- Performance Hub report generated from SQL*Plus
  - `@$ORACLE_HOME/rdbms/admin/perfhubrpt.sql` OR calling `dbms_perf.report_perfhub(....)` function
  - Single view of DB performance
  - ADDM, SQL Tuning, Real-Time SQL Monitoring, ASH Analytics

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AWR and Multitenant: Background and Challenges

- Single AWR repository per database
  - For non-CDB resides in SYSAUX
  - For CDB resides in Root’s SYSAUX (12.1)

- AWR does not have notion of AWR data for a PDB (no Top N per PDB)

- Partial AWR statistics
  - Missing Time-Wait model, metrics statistics per PDB
  - No breakdown per PDB level at root

- AWR data not transportable along with PDB
AWR Enhancements for Multitenant

• **CDB Level Snapshot Support**
  - Same functionality as in Oracle Database 12.1
    - CDB snapshots will be taken at the Root and stored at the Root’s SYSAUX
    - Same default settings – automatic snapshots at every hour, retention period of 8 days
    - Automatic snapshots ON by default
  - Enhanced content
    - More PDB-specific stats are collected and exposed via `v$con_sysstats`, `v$con_sysmetric`, `v$con_sys_time_model`

• **PDB Level Snapshot Support**
  - Per PDB AWR with autonomous retention and snapshot settings
  - Performance data for PDB stored in local SYSAUX
    - Snapshots contains data from PDB level `v$` views
  - Both manual and automatic snapshots supported
    - Automatic snapshots disabled by default, enable selectively
AWR Support for Remote Snapshots and ADG

• Problem
  – AWR snapshots cannot be taken in a read-only standby environment
  – Performance monitoring and analysis is limited to basic STATSPACK functionality

• Solution
  – In Oracle Database 12.2, AWR framework enhanced to support capture of remote snapshots from any generic database including Active Data Guard (ADG) databases.
    • A target catalog database collects snapshots from the remote databases (sources)
    • Snapshots can be collected automatically or manually
    • AWR tables on the catalog database accumulate snapshot data from all sources via database links
    • Source databases must be registered on the catalog via new DBMS_WORKLOAD_REPOSITORY.REGISTER_REMOTE_DATABASE API
AWR Unified Manageability Framework topology

Source databases

Remote database could be a Primary and its ADG or any other generic database

Active Data Guard

Remote AWR Data Store

Catalog of registered remote databases
Remote Snapshot Configuration for ADG Database

3. Define the source databases

4. Define the target database

5. Create the topology

6. Register the source databases

7. Register the source databases for AWR service
SQL Tuning Advisor Support for Active Data Guard

• Problem
  – ADG databases are widely used to offload reporting or ad hoc query-only jobs from primary
  – Reporting workload profile is different from primary and often requires tuning

• Solution
  • Oracle Database 12.2 introduces the ability to tune SQLs workloads running on ADG database
  • All SQL Tuning Advisor tasks issued at the standby
    – Create tuning task, execute tuning task and implement SQL Profile recommendations can be run on standby
    – Test execution (heavy lifting) happens on standby, only minimal write related activity on primary
  • The required data for the above tasks are fetched from primary over a database link from standby
  • Task details and tuning results are stored at primary and the essential data required to construct the report is accessed remotely from primary
  • The report is constructed locally at the standby, with no CPU overhead in primary
SQL Tuning Advisor Support for Active Data Guard

- All changes are done on primary and propagated from primary to standby by redo apply
- Support for PDB level tuning
- The tuning task is executed at the standby, with no CPU overhead in primary
SQL Tuning Advisor Support for Active Data Guard

1b. Write data about the task

1a. `create_tuning_task`: create a tuning task
SQL Tuning Advisor Support for Active Data Guard

2a. `execute_tuning_task`: Fetch data from primary to execute a task

2b. *Execute tuning analysis process*

2c. *Write tuning results to disk*
SQL Tuning Advisor Support for Active Data Guard

**Primary**

3c. Write accepted profile results to disk

**Standby**

3a. `report_tuning_task`: Fetch data from primary to produce and create a tuning report

3b. **Execute**: `accept_sql_profile`

3d. Accepted profile available via redo apply
Performance Tuning Methodology: Summary

Proactive Performance Management

- SQL Performance Analyzer Quick Check

Reactive Performance Management

- ASH Analytics
- ADDM
- Real-Time ADDM
- Real-Time SQL Monitoring
- SQL Tuning Advisor
- Performance Hub for holistic management
Integrated Cloud
Applications & Platform Services