

Maximizing Database Performance

A Practical Approach to Diagnostics and Tuning

Mikael Fries

Director Product Management, Oracle

Sriram Vrinda

Senior Product Manager, Oracle

Christian Bilien

Global head of data infrastructures,
SOCIETE GENERALE



September 18–22, 2016
San Francisco

Accelerate Your
Digital Transformation
in the Cloud

ORACLE

ORACLE
ENTERPRISE MANAGER **13^c**

Safe Harbor Statement

The preceding is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Program Agenda

- 1 Introduction
- 2 Oracle Database Performance Tuning Fundamentals
- 3 Performance Tuning Methodology
- 4 New Features
- 5 Customer Testimonial - SOCIETE GENERALE

Program Agenda

- 1 Introduction
- 2 Oracle Database Performance Tuning Fundamentals
- 3 Performance Tuning Methodology
- 4 New Features
- 5 Customer Testimonial - SOCIETE GENERALE

Top Database Management Challenges

52%

Rapid diagnoses of database performance problems



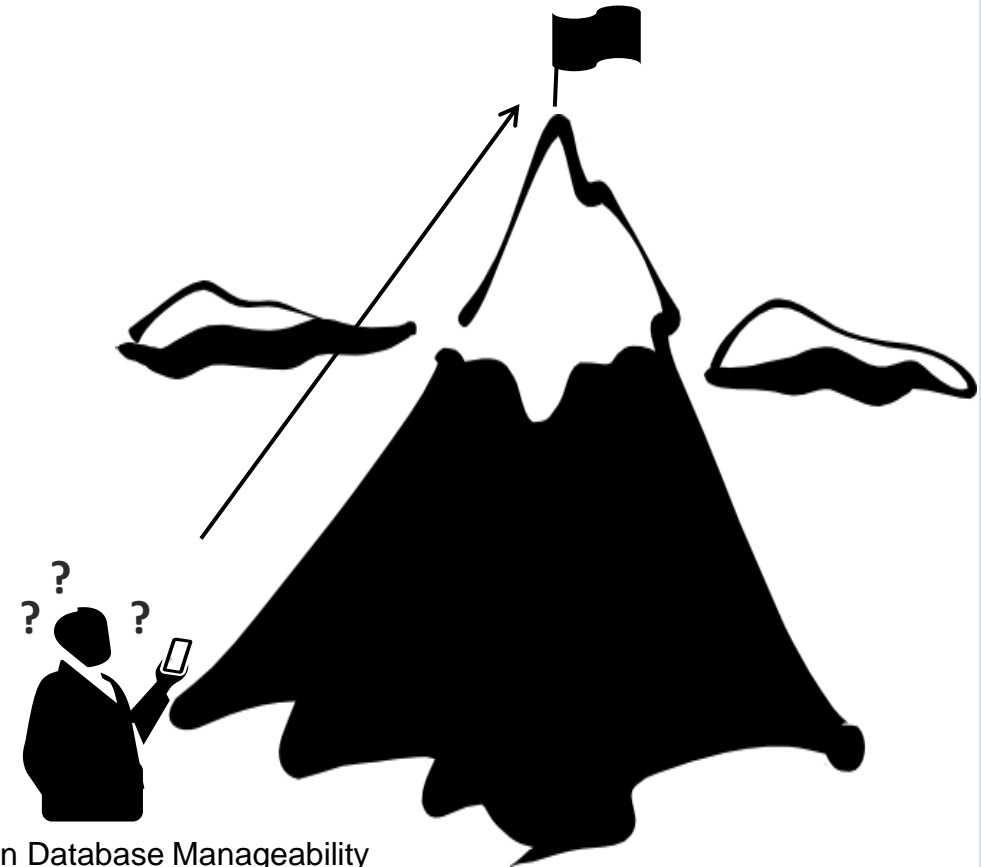
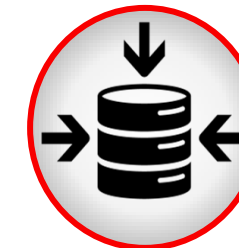
45%

Identifying application (SQL) issues



37%

Validating and applying SQL tuning solutions

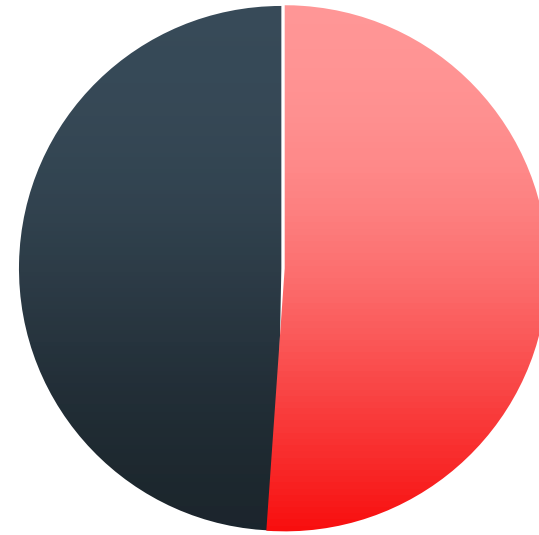


Source: THE RAPIDLY ACCELERATING CLOUD-ENABLED ENTERPRISE: 2015 IOUG Survey On Database Manageability

Change—Avoid or Embrace



90% experienced unplanned downtime resulting from Database changes NOT properly tested



Over **50% of DBAs** avoid making changes to production because of negatively impacting performance

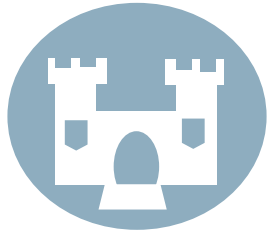
Program Agenda

- 1 Introduction
- 2 **Oracle Database Performance Tuning Fundamentals**
- 3 Performance Tuning Methodology
- 4 New Features
- 5 Customer Testimonial - SOCIETE GENERALE

The Key To Better Diagnostics: Better Performance Metrics

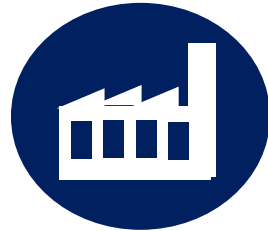
Continious inovation

- Diagnosability has improved over time for the Oracle database as more and better metrics have been introduced



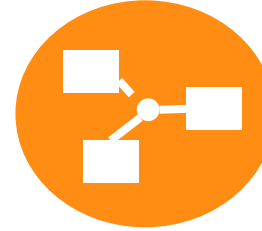
Dark Ages (Oracle DB V5-V7)

Debug Code, Counters/Ratios, BSTAT/ESTAT
Renaissance (v7): Introduction of WAIT events, Moving from Counters to Timers



Modernity (Oracle DB V10)

DB Time Tuning, ASH, AWR, ADDM, EM



Grid Computing (Oracle DB V11)

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



Cloud (Oracle DB V12)

Multitenant-aware, In-memory support, DB Operations Monitoring, EM Express, Performance Hub

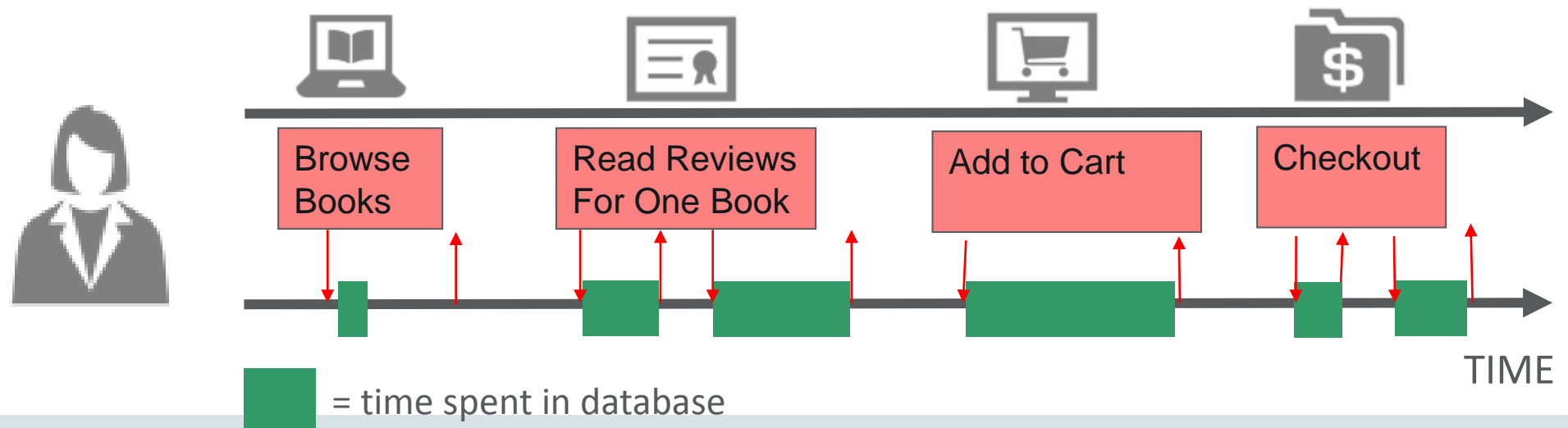
Database Time (DB Time)

- 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

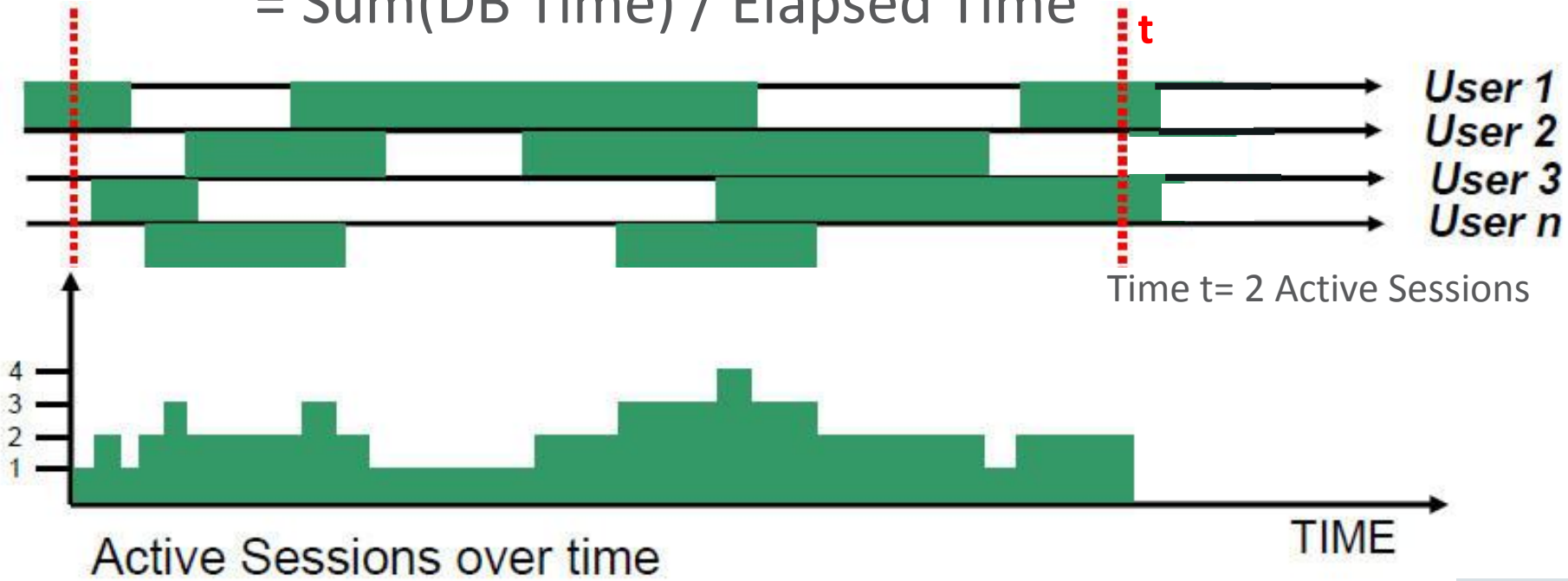
- Active Session = Session currently spending time in a database call
- Database Time (DB Time) = Total time session spent in all database calls
- Average Activity of the Session (% Activity) = The ratio of time active to total wall-clock time



How Does DB Time Work?

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

$$= \text{Sum(DB Time)} / \text{Elapsed Time}$$



What Approach To Use To Identifying Issues?

- Active Sessions by wait class over time
- Colored area = Amount of DB time, More the DB time, More the Problem
 - Focus on the **BIG** problems first!
- **DB time increases as system performance degrades**



Program Agenda

- 1 Introduction
- 2 Oracle Database Performance Tuning Fundamentals
- 3 **Performance Tuning Methodology**
- 4 New Features
- 5 Customer Testimonial - SOCIETE GENERALE

Performance Tuning Methodology –What Approach to Use?



Proactive Performance Management



Reactive Performance Management

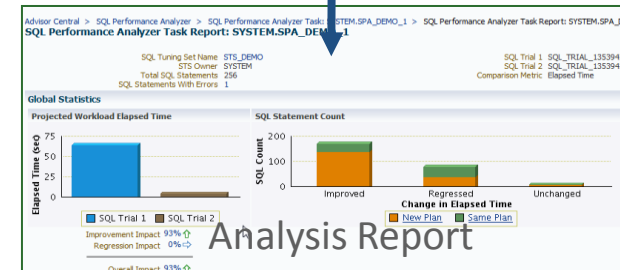
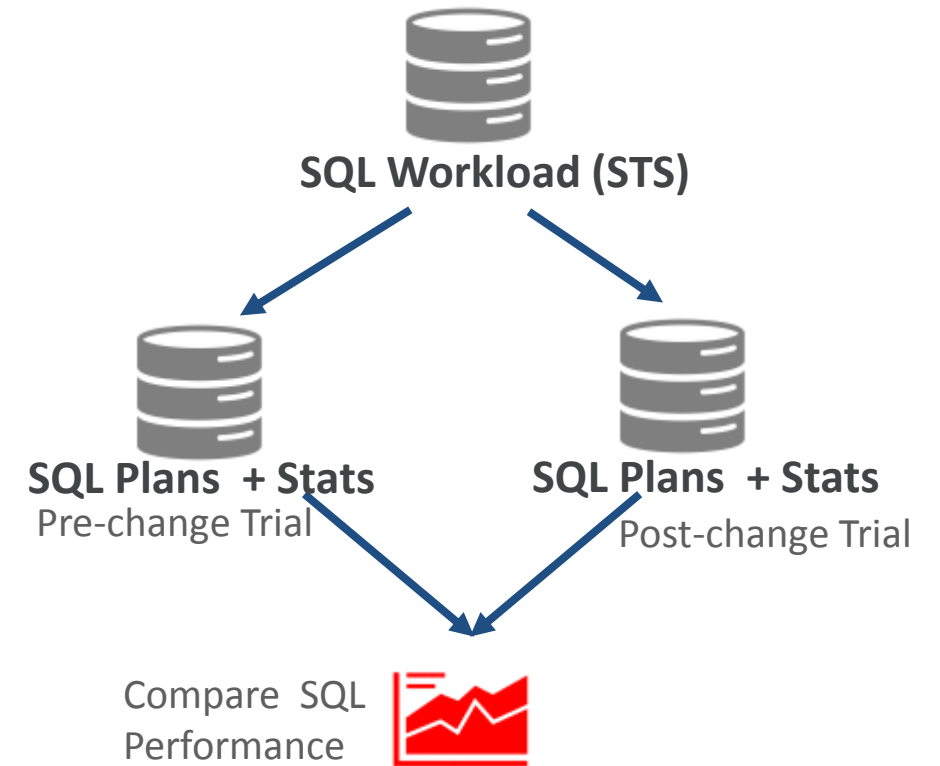
Proactive Performance Management



- Be in charge of your environments
- Use Oracle Enterprise Manager to avoid production issues
 - Understand what you are introducing into production
 - Test changes before they are introduced into production
 - Try out every single change...to ensure it will not have a negative effect

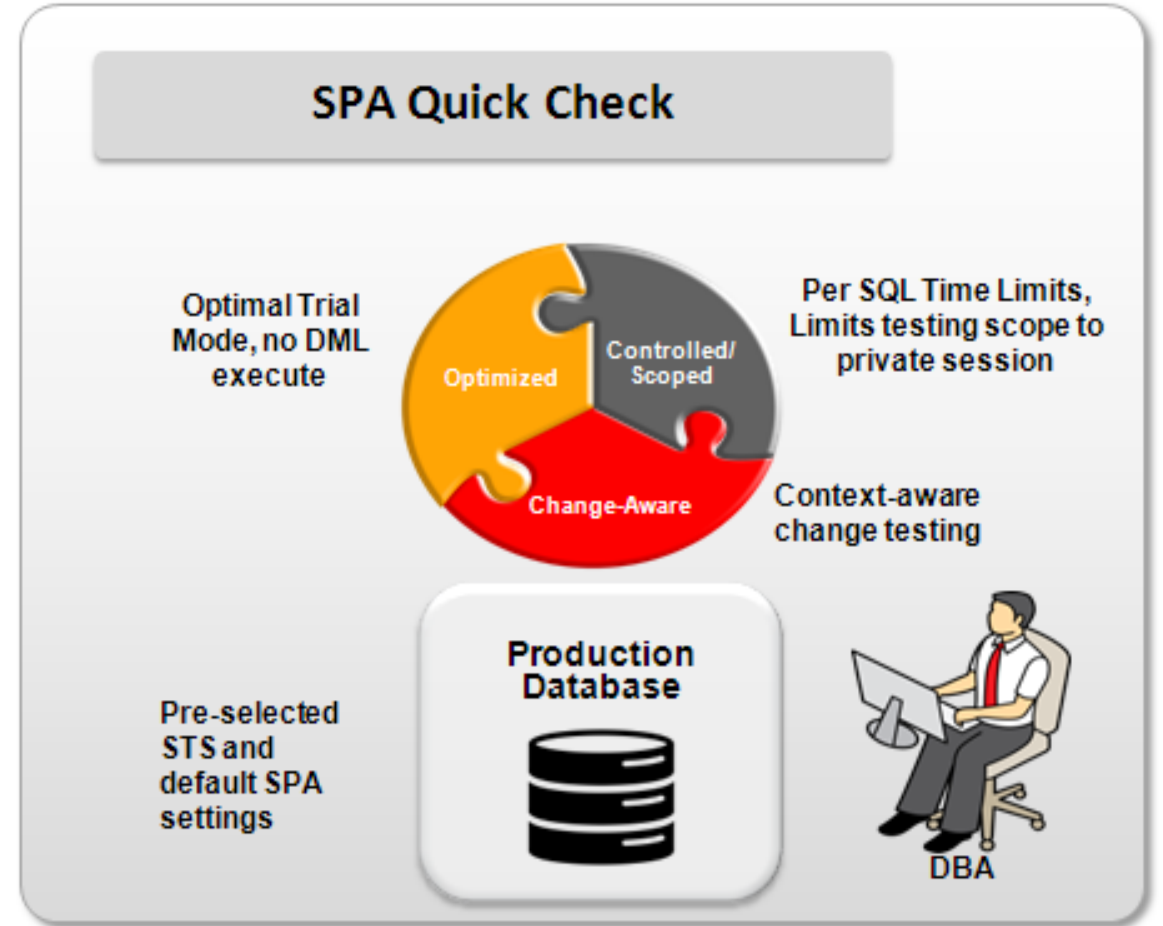
SQL Performance Analyzer (SPA)

- 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



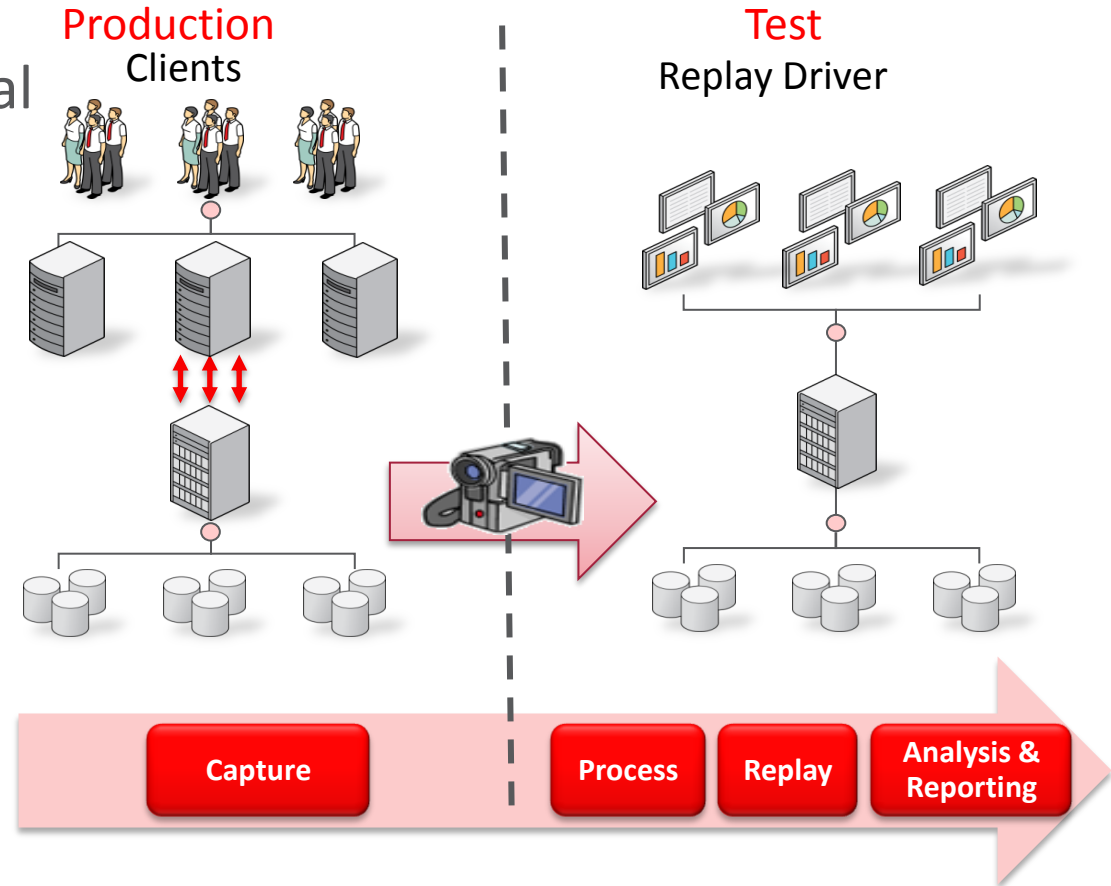
Predict the Impact of Routine System changes in Production SQL workload response time

- **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



Database Replay, Concurrent 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 deployment problems on test system before production
- Perform capacity planning with consolidated replay with Multitenant or schema consolidation



Reactive Performance Management



- Unfortunately we are not always in control
- Use Oracle Enterprise Manager to deal with production issues not introduced in a controlled way

Issue

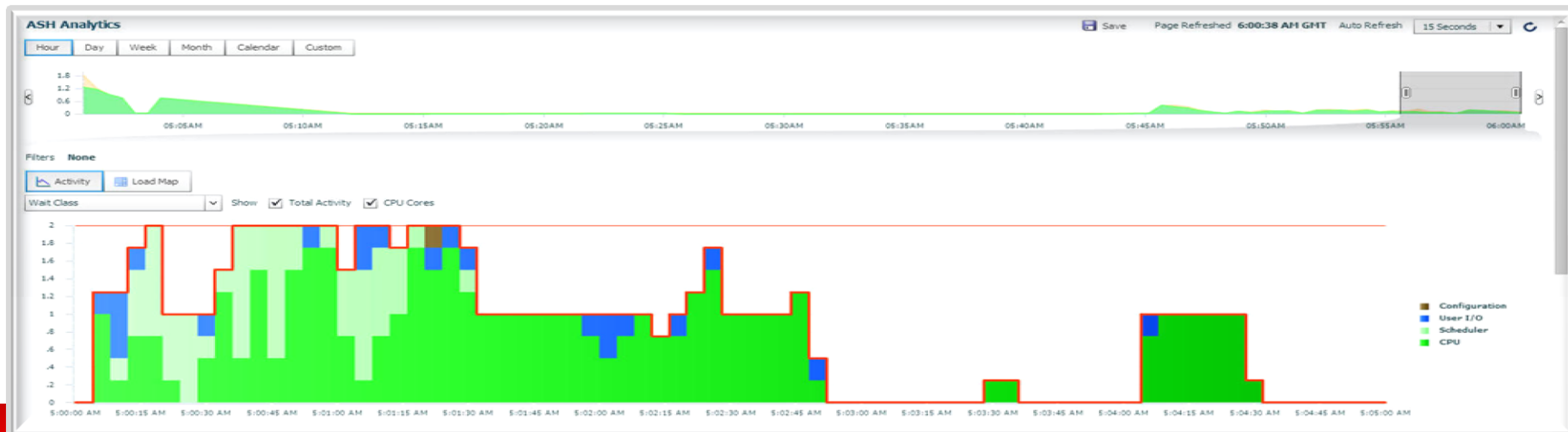
- Analyzing transient performance problems
- Diagnose persistent performance issues
- In-depth SQL performance analysis
- Optimizing top SQL's with sub-optimal plans

EM solution

- **ASH Analytics**
- **ADDM**
- **Real-Time SQL Monitoring**
- **SQL Tuning Advisor**

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

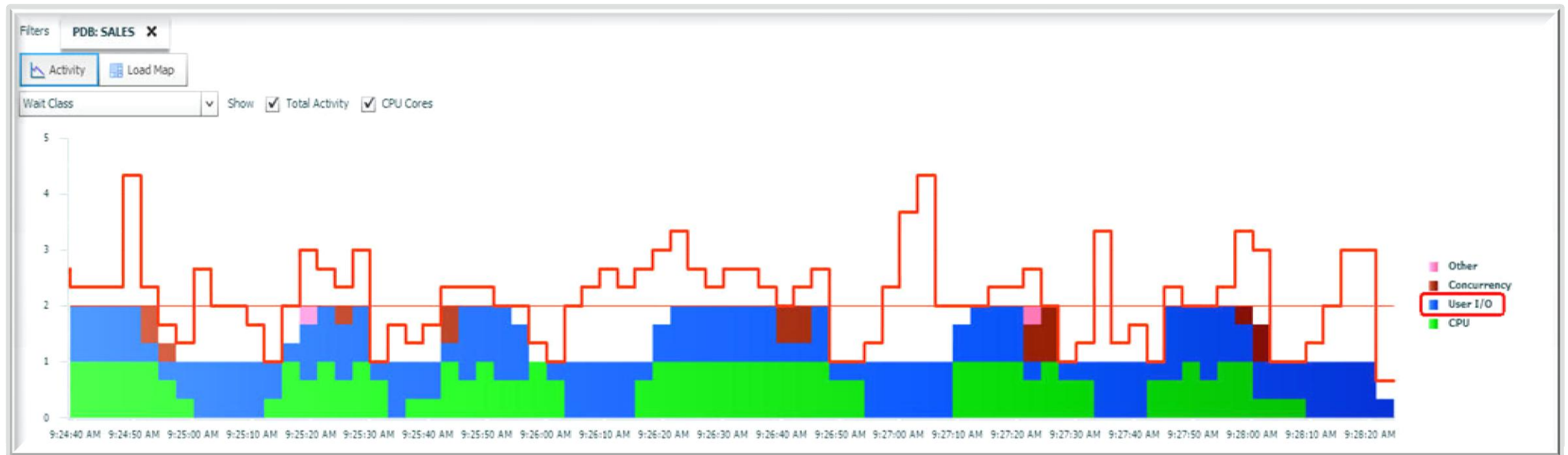


Reactive Performance Management

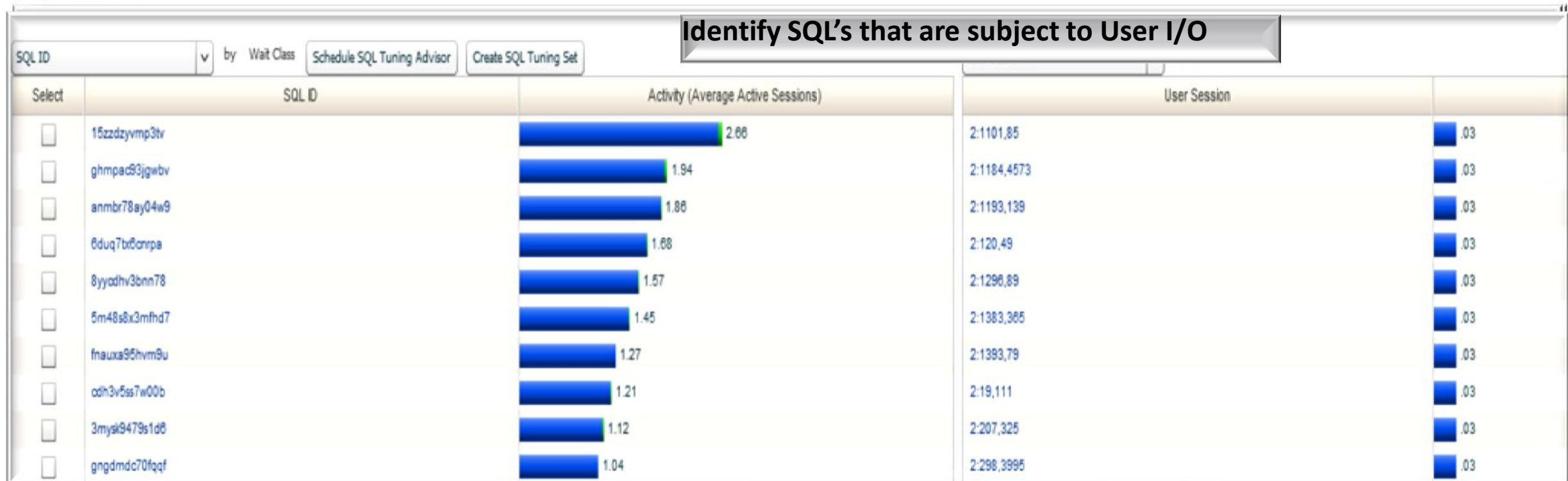
- I am a CDBA and asked to investigate transient performance issues reported by one application owner. I need to diagnose the cause of these issues and address them
- AWR report indicates some unusual issues on the system
 - But I don't get a PDB specific report...
 - What to do next?



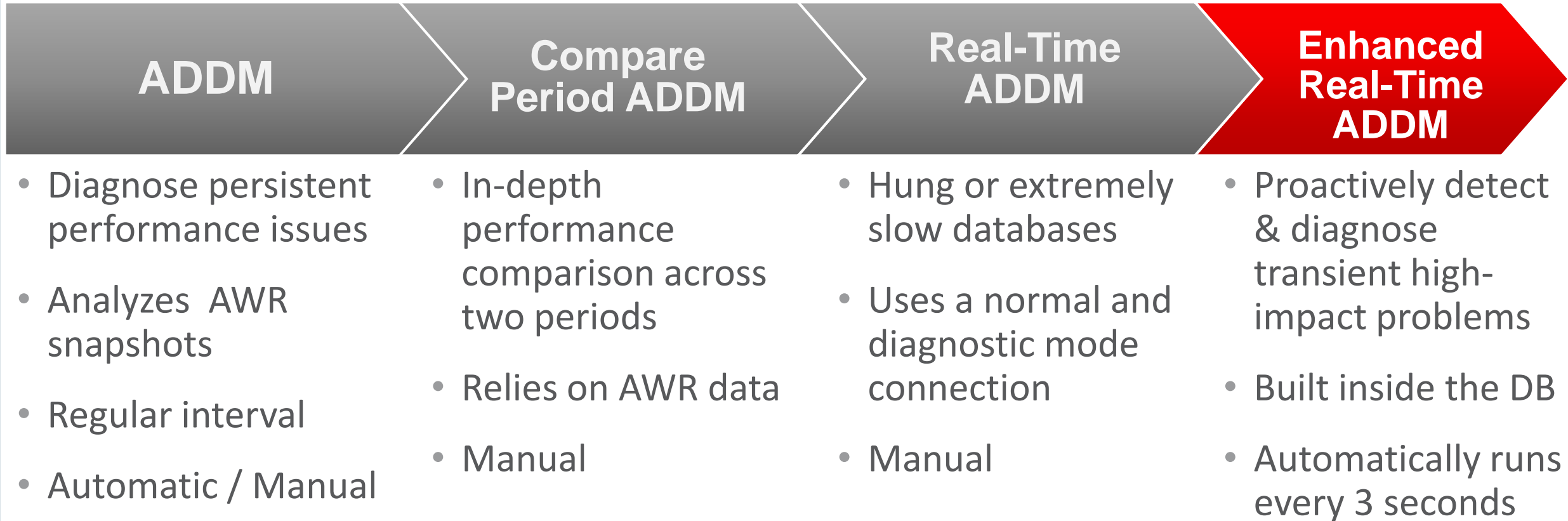
Analyzing transient performance issues using ASH Analytics



ASH Analytics identifies User I/O as the problem



Diagnose Persistent Performance Issues



Reactive Performance Management

- My database is unresponsive and end-users are complaining of performance issues. Should I bounce the database or wait for some time for problem to go away?
- Database Hung state
 - Blocking Sessions
 - Memory allocation issues
 - Library cache issues
 - Unresponsive Storage (ASM)
 - Interconnect problems

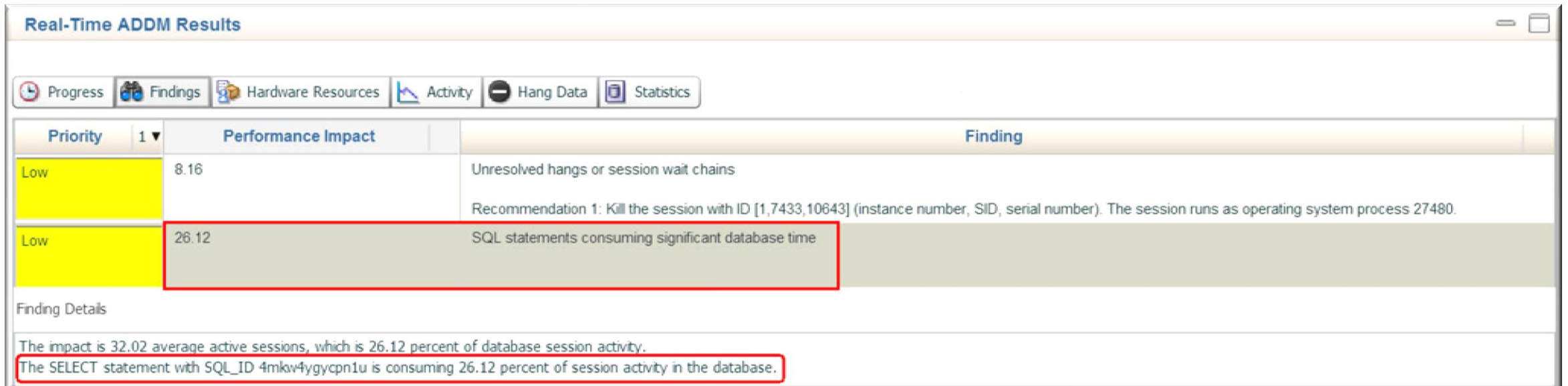


Real-Time ADDM

- Automatic real-time problem detection and analysis
- Database self-monitors for serious performance issues
- Recognize bad performance trends and trigger analysis
 - High CPU, I/O spikes, memory, interconnect, hangs, deadlocks
 - Identify a problem before it threatens application performance
- Short duration (5 min spikes) ADDM analysis
- Reports (analysis and data) stored in AWR for historical analysis
 - ADDM, SQL Monitoring reports

Diagnose Hung Database Issues Using Real-Time ADDM

- Identify the problem area
- Turns out to be a SQL that consumes significant amount of DB Time
- Review SQL Monitor report of the problem SQL for in-depth analysis



The screenshot shows the 'Real-Time ADDM Results' window. It features a navigation bar with tabs for Progress, Findings, Hardware Resources, Activity, Hang Data, and Statistics. Below the navigation bar is a table with three columns: Priority, Performance Impact, and Finding. The table contains two rows. The first row has a priority of 'Low', a performance impact of 8.16, and a finding of 'Unresolved hangs or session wait chains'. The second row has a priority of 'Low', a performance impact of 26.12, and a finding of 'SQL statements consuming significant database time'. This second row is highlighted with a red border. Below the table is a 'Finding Details' section with two paragraphs of text. The second paragraph, 'The SELECT statement with SQL_ID 4mkv4ygyqpn1u is consuming 26.12 percent of session activity in the database.', is also highlighted with a red border.

Priority	Performance Impact	Finding
Low	8.16	Unresolved hangs or session wait chains Recommendation 1: Kill the session with ID [1,7433,10643] (instance number, SID, serial number). The session runs as operating system process 27480.
Low	26.12	SQL statements consuming significant database time

Finding Details

The impact is 32.02 average active sessions, which is 26.12 percent of database session activity.

The SELECT statement with SQL_ID 4mkv4ygyqpn1u is consuming 26.12 percent of session activity in the database.

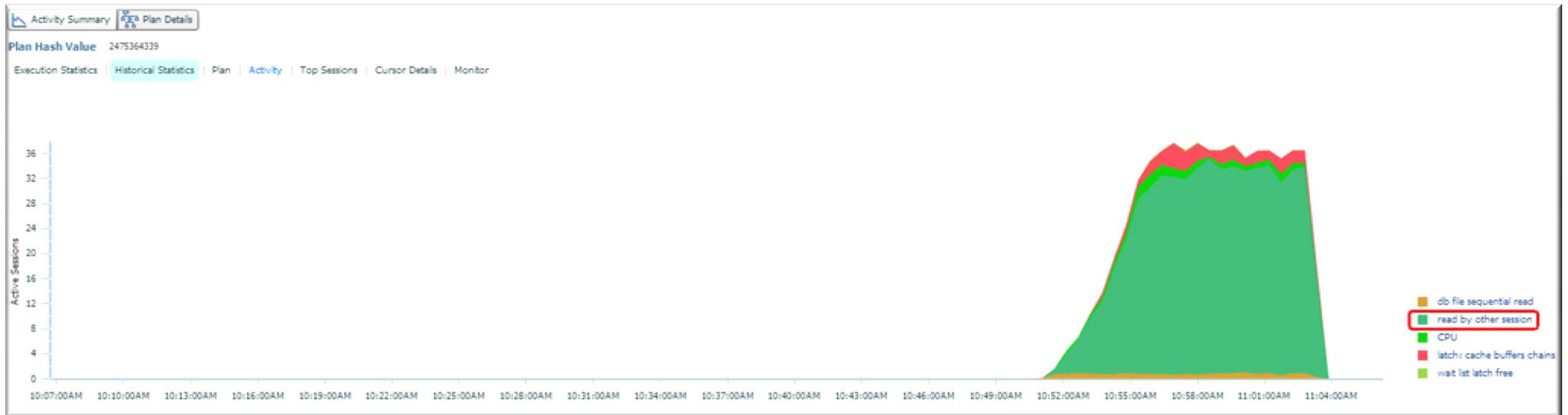
Diagnose SQL Performance using Real-Time SQL Monitoring

- The SQL ran for a period of 5 minutes and created the spike



Diagnose SQL Performance using SQL Details Active Report

- Multiple sessions trying to read the same block over and over



Diagnose Hung Database Issues Using Real-Time ADDM

- Refer back to Real-Time ADDM to nail this down as login storm issue, understand more about this query

The screenshot displays the Oracle Real-Time ADDM Results window. The window title is "Real-Time ADDM Results". It features a navigation bar with tabs for Progress, Findings, Hardware Resources, Activity, Hang Data, and Statistics. Below the navigation bar, there are three sub-tabs: Database Data, Instance Data, and Host Data. The Database Data section shows the following information:

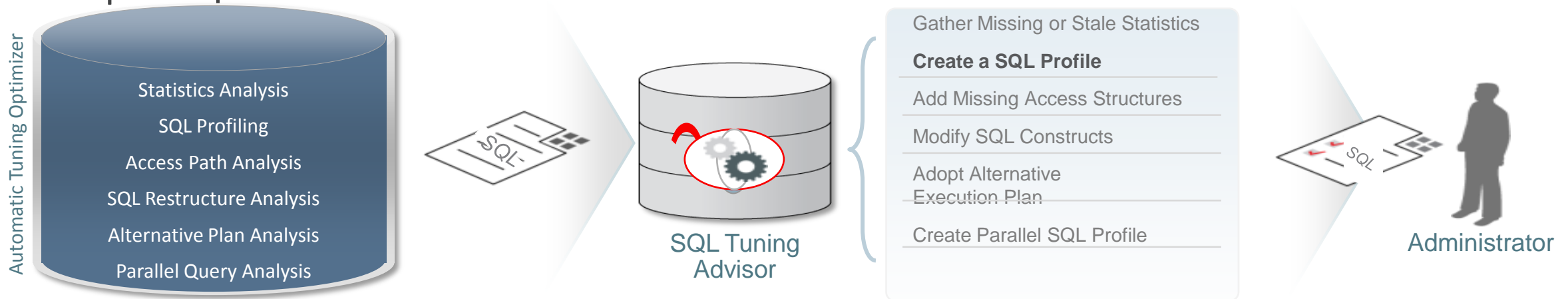
DBID:	676852158	Name:	
Log Mode:	ARCHIVELOG	Open Mode:	READ WRITE
Role:	PRIMARY	Force Log:	YES
Platform:	Solaris[tm] OE (64-bit)	Flashback On:	NO
Unique Name:		Version:	11.2.0.4.0

Below the Database Data section is the System Metrics section, which contains a table with the following data:

Name	Unit	Average	Min	Max
Network Traffic Volume Per Sec	Bytes Per Second	5853223.848	5365976.57	6608742.419
User Commits Per Sec	Commits Per Second	1056.243	931.68	1236.021
Physical Write Total Bytes Per Sec	Bytes Per Second	35644302.092	27501154.843	49818947.817
Physical Read Total Bytes Per Sec	Bytes Per Second	352614414.737	242086086.557	473959349.098
Average Synchronous Single-Block Read Latency	Milliseconds	1.353	1.195	1.51
Logons Per Sec	Logons Per Second	9.942	4.91	25.708

How To Go About Tuning the Sub-optimal SQL?

- Gives recommendations on various problems found during analysis phase
- Uses the same CBO but has more time budget for comprehensive analysis
- Identifies alternate execution plans using real time and historical performance data
- Recommends SQL profile to compensate for incorrect statistics and transparently improve performance



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



Hybrid Cloud Management

- Enterprise Manager supports both traditional on-premise and cloud deployments
- Same software on-premise as in the cloud, same solution for management!
- Same methodology for Performance Management



On Premises



Oracle Cloud

ORACLE
ENTERPRISE MANAGER **13^c**

Enterprise Manager manages both On Premises and Cloud

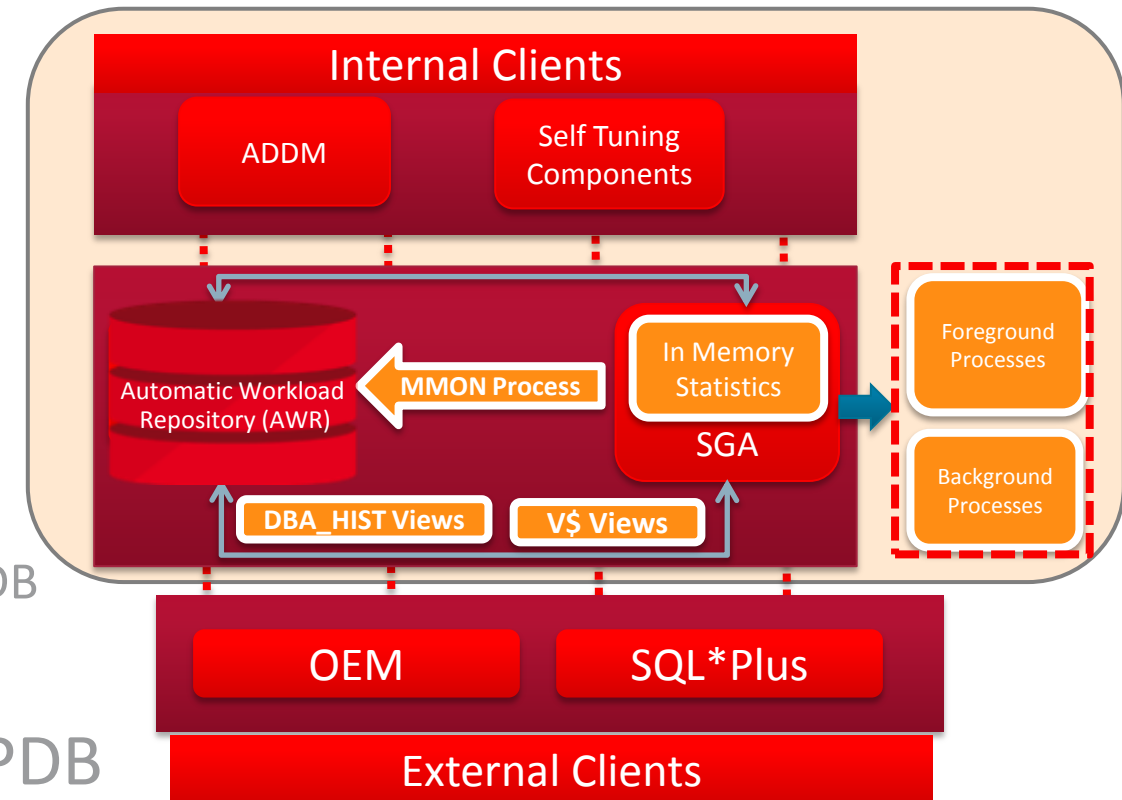
Program Agenda

- 1 Introduction
- 2 Oracle Database Performance Tuning Fundamentals
- 3 Performance Tuning Methodology
- 4 **New Features**
- 5 Customer Testimonial - SOCIETE GENERALE

AWR and Multitenant: Background and Challenges

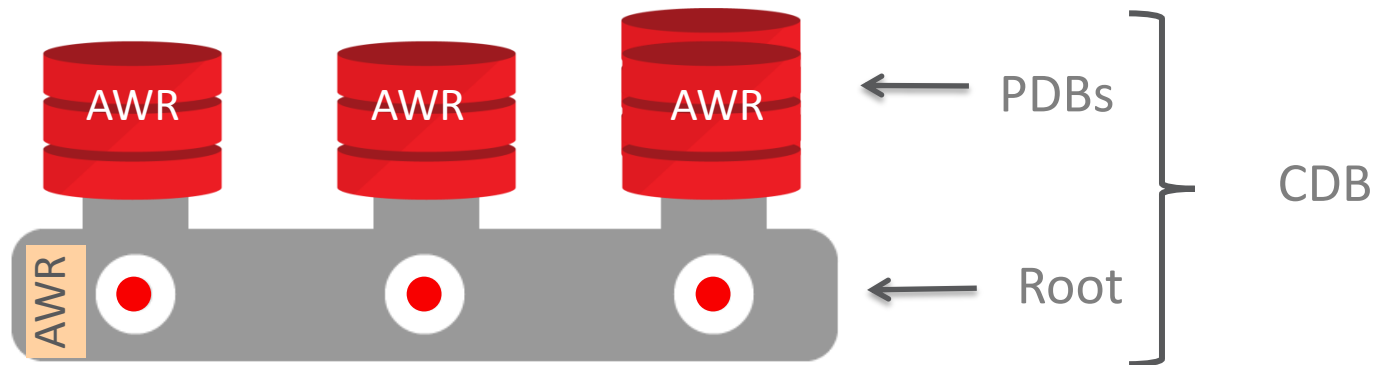
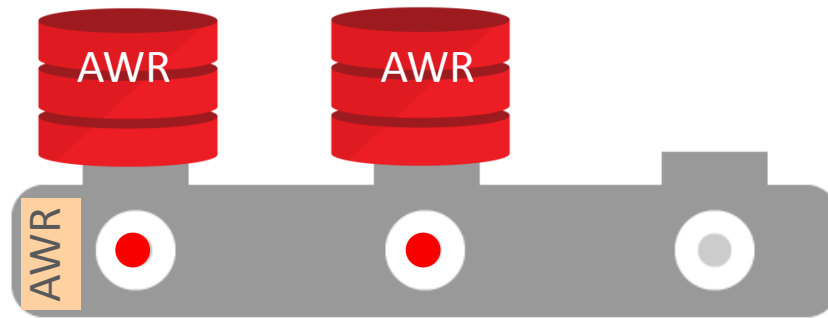
- Single AWR repository per database
 - For non-CDB resides in SYSAUX
 - For CDB resides in Root's SYSAUX (12.1)
- AWR does not have notion of AWR data for a PDB (no Top N per PDB)
- Partial AWR statistics
 - Missing Time-Wait model, sysmetrics statistics per PDB
 - No break down per PDB level at root
- AWR data not transportable along with PDB

AWR Architecture (pre-DB12.2)



AWR for Multitenant (CDB/PDB)

Per -PDB AWR Support



Multitenant Container Database

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

DEMO

AWR for CDB & PDB

Performance Tuning Methodology: Summary

Proactive Performance Management



- SQL Performance Analyzer Quick Check
- SQL Performance Analyzer
- DB Replay

Reactive Performance Management



- ASH Analytics
- ADDM
- Real- Time ADDM
- Real-Time SQL Monitoring
- SQL Tuning Advisor
- Performance Hub for holistic management

Program Agenda

- 1 Introduction
- 2 Oracle Database Performance Tuning Fundamentals
- 3 Performance Tuning Methodology
- 4 New Features
- 5 **Customer Testimonial - SOCIETE GENERALE**



'SOMETHING' is SLOW!

Christian Bilien
Global head of data infrastructures,
SOCIETE GENERALE

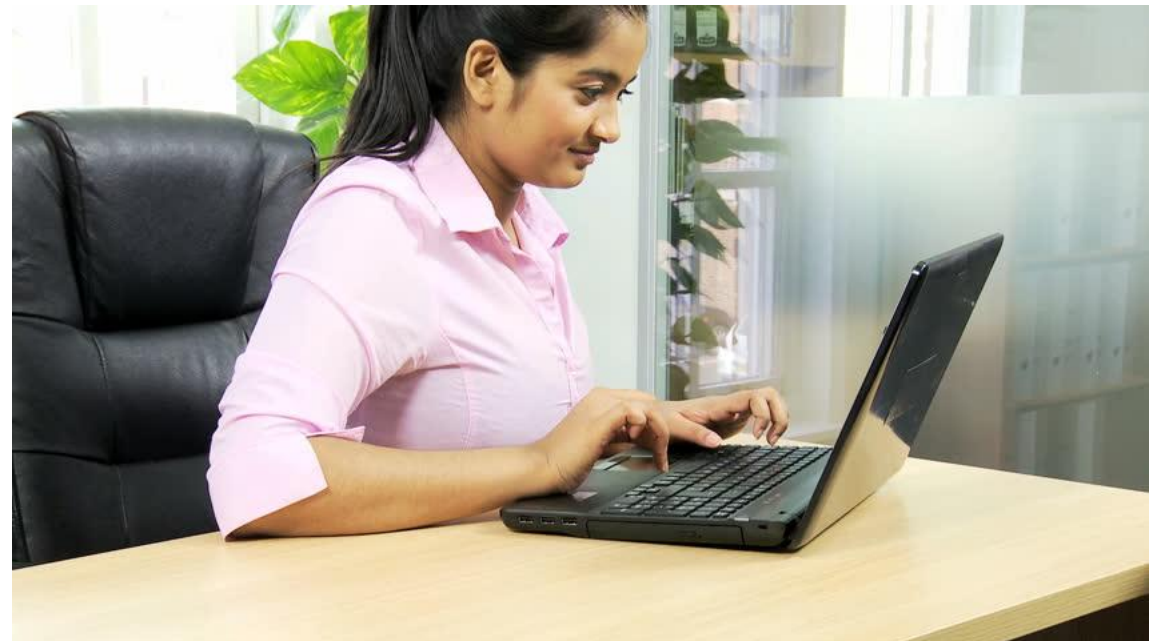


Meet Our Young Graduates



Justin, NYC

Schooled on Docker, Python, MySql, OpenStack
Fundamentals for Oracle Administrators



Ashwini, Bangalore

Schooled on Kubernetes, PostGreSQL, Node.js
Oracle Administration workshop I and II
Performance Tuning DBA

Meet Our 2005 Cryogenized DBA



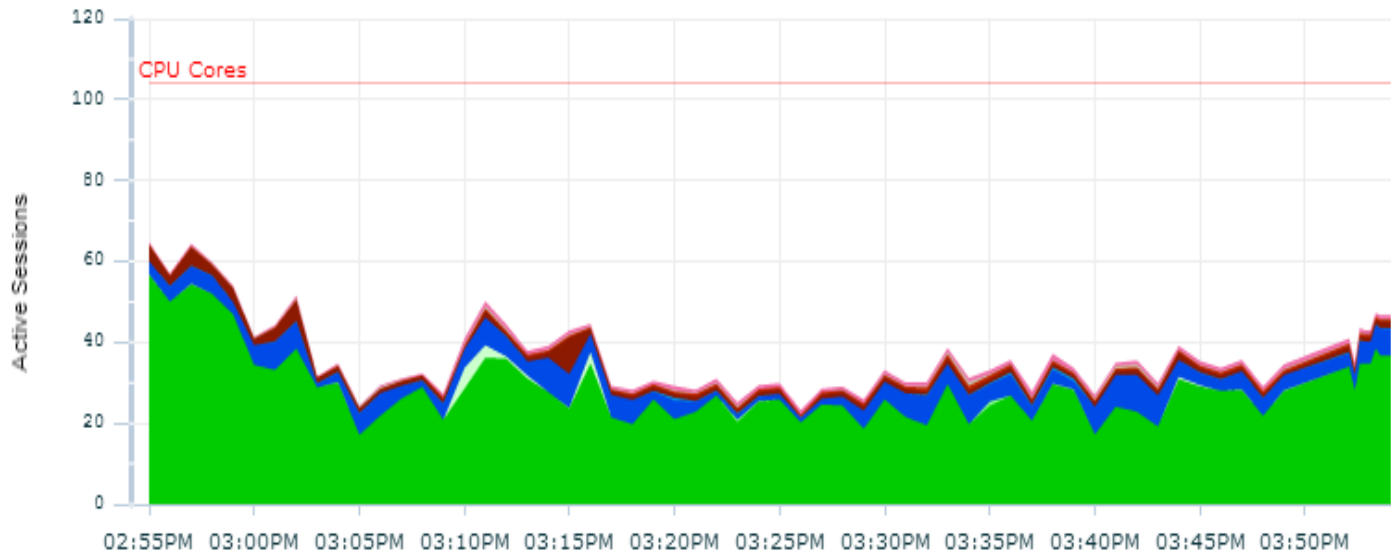
Cuthbert

European country
(still part of the EU)

20 years of Oracle training,
too long to describe

Visualization and Methodology are Powerful Instruments

- Lower the barrier to entry
- Increase productivity
- Enable faster troubleshooting



```
select      A.sample15M,
            CASE instance_number      WHEN 1 THEN 'INSTANCE1'
                                      WHEN 2 THEN 'INSTANCE2'
            END Appli,
            nvl(A.wait_class,'CPU') wait_class,
            CASE instance_number      WHEN 1 THEN
nvl(A.AAS,0)      END aas_waits_i2r,
            CASE instance_number      WHEN 2 THEN
nvl(A.AAS,0)      END aas_waits_tps
from (
            select to_char( trunc(sample_time,'hh24') +
            (trunc(to_char(sample_time,'mi')/60)*60)/24/60, 'YYYY/MM/DD
            HH24:MI') sample15M,
                   instance_number,
                   nvl(wait_class,'CPU') wait_class ,
                   round(count(*)*10/60/60,1)  AAS
```

```
dba_hist_active_sess_history
CAST(sample_time as date) >= (sysdate - 7)
CAST(sample_time as date) <= (sysdate )
dbid = (select dbid from v$database)
nvl(wait_class,'CPU') != 'Idle'
by to_char( trunc(sample_time,'hh24') +
ar(sample_time,'mi')/60)*60)/24/60, 'YYYY/MM/DD
instance_number, nvl(wait_class,'CPU')

distinct to_char( trunc(sysdate,'hh24')
char(sysdate,'mi')/60)*60)/24/60, 'YYYY/MM/DD
mple15M
dba_objects
rownum <= 4*24*(1)
```

```
where A.sample15M = B.sample15M(+)
order by 1, 2, decode(nvl(wait_class,'CPU') , 'CPU',1,'User
I/O',2,'System I/O',3,'Concurrency',4)
```


Methodology

- Identify the session(s) servicing the user/task with the problem
- Check wait interface for these sessions
 - 100% stuck waiting for something
 - 100% busy working and burning CPU
 - Somewhere in between
- Which V\$SESSTAT counters have gone up
- Drill down (SQL, DB events)
- 95% of the time apply a quick fix (aka profile)

If all this fails or doesn't give enough evidence, **take a screwdriver and open up Oracle from outside** – using stack traces, truss, DTrace etc.



Do you even
[Agile | DevOps | Cloud | Docker | you name it]
bruh?

We're just going to put all
the power into the hands
of developers and we
won't need operations
people, especially DBAs,
any more

The DevOps movement
is, intentionally, about
getting rid of the DBA

Database Tuning Is Not Only SQL tuning

ORACLE Enterprise Manager 10g
Grid Control

Home | **Targets** | Deployments | Alerts | Compliance | Jobs | Reports

Hosts | Databases | Middleware | Web Applications | Services | Systems | Groups | All Targets

Setup | Preferences | Help | Logout
Logged in As SYSTEM

Active Sessions Working: CPU + CPU Wait

Drag the shaded box to change the time period for the detail section below.

View Data | Real Time: 15 Second Refresh

Waiting: Application

to change the time period for the detail section below.

View Data | Real Time: 15 Second Refresh

Detail for Selected 5 Minute Interval

Start Time Jan 13, 2012 9:59:09 AM

Top Working SQL

Actions: Schedule SQL Tuning Advisor

Select All | Select None

Select	Activity (%)	SQL ID	SQL Type
<input type="checkbox"/>	16.05	94fzm3jx1c1yp	PL/SQL EXECUTE
<input type="checkbox"/>	15.40	ddthrb7j9a63f	SELECT
<input type="checkbox"/>	11.50	95adfchfv58a5	UPDATE
<input type="checkbox"/>	10.63	3575p6hzg9gat	PL/SQL EXECUTE
<input type="checkbox"/>	9.98	axabnfyfp4r3p	SELECT
<input type="checkbox"/>	4.99	f8ybh6brs1uq2	SELECT
<input type="checkbox"/>	4.12	dsv6nf68zgkuc	INSERT

Top Working Sessions

View: Top Sessions

Activity (%)	Session ID	User Name	Program
44.93	31	HR	sqlplus@dbhost (TNS V1-V3)
37.57	32	HR	sqlplus@dbhost (TNS V1-V3)
4.17	34	SYS	oracle@dbhost (M000)
1.19	127	SYS	JDBC Thin Client
.80	8	SYS	oracle@dbhost (LG01)
.40	6	SYS	oracle@dbhost (LGWR)
.40	9	SYS	oracle@dbhost (LG02)

Waiting: Application

Application

Activity (%)	SQL ID	SQL Type
No activity of the relevant type occurred in the chosen interval.		

Total Sample Count: 0

Waiting: Application

Application

Activity (%)	Session ID	User Name	Program
No activity of the relevant type occurred in the chosen interval.			

Total Sample Count: 0

Monitoring Links


Top SQL data from ASH can be found on the Top Activity page.

- Hang Analysis
- Instance Locks
- Instance Activity
- Baseline Normalized Metrics
- Search Sessions
- Search SQL
- Snapshots
- SQL Tuning Sets






Home | Targets | Deployments | Alerts | Compliance | Jobs | Reports | Setup | Preferences | Help | Logout

Oracle and/or its affiliates. All rights reserved.
Other names may be trademarks of their respective owners.
About Oracle Enterprise Manager

Performance AaS For Developers

Database Instance: prod.kismno03-d1.oracleads.com > [Monitored SQL Executions](#) > **Monitored SQL Execution Details**  Logged in As SYS [View Report](#)











Overview

SQL ID: adf8bp06v2bub  Execution Started: Thu Nov 19 2009 07:59:18 PM Last Refresh Time: Thu Nov 19 2009 07:59:30 PM Execution ID: 16777780 Session: 134 Fetch Calls: 1	Time Duration:  13.0s Database Time:  12.9s PL/SQL & Java: 0.0s	IO & Wait Statistics IO Count:  26K Buffer Gets:  26K Wait Activity %: 0
---	---	--

Details

[Plan Statistics](#) [Activity](#)

Plan Hash Value: 2452208151

Operation	Name	Estimate...	Cost	Timeline(13s)	Exec...	Actual ...	Memor...	Temp (...)	CPU Activity %	Wait Activity %
SELECT STATEMENT			4860		1	1				
HASH UNIQUE		1	4860		1	1	355K			
HASH JOIN		1502K	4767		1	1498K	1317K			
VIEW	index\$join\$_001	5355	23		1	5355				
HASH JOIN					1	5355	1373K			
BITMAP CONVERSION TO ROWIDS		5355	1		1	5355				
BITMAP INDEX FULL SCAN	LU_ITEM_274_PG_ID				1	1				
BITMAP CONVERSION TO ROWIDS		5355	21		1	5355				
BITMAP INDEX FULL SCAN	LU_ITEM_274_ITM_ID				1	5355				
TABLE ACCESS FULL	FACT_PO_OUT_ITM_ID	1502K	4734		1	1502K				



DEMO

Perfhub on Exadata

ORACLE[®]

Copyright © 2016, Oracle and/or its affiliates. All rights reserved. | Oracle Confidential – Internal/Restricted/Highly Restricted

Keep Learning with Oracle University

ORACLE®

UNIVERSITY

Classroom Training

Learning Subscription

Live Virtual Class

Training On Demand



Cloud

Technology

Applications

Industries



education.oracle.com

ORACLE®