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Oracle Database 12c

The Best Oracle Database 12c Tuning Features for Developers and DBAs

Presented by: Alex Zaballa, Oracle DBA

Alex Zaballa

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ORAWORLD

147 and counting…

http://alexzaballa.blogspot.com/

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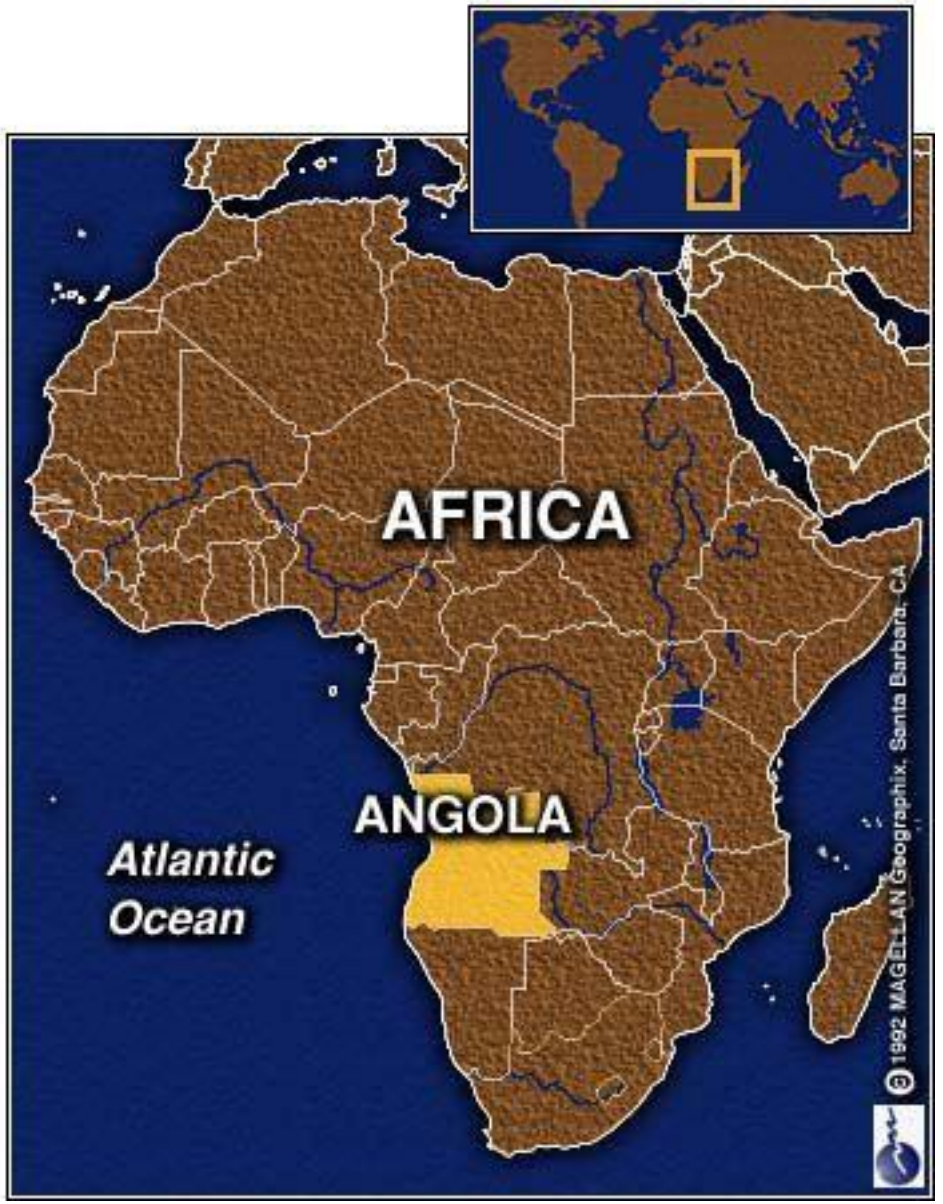
https://www.linkedin.com/in/alexzaballa

GUOB

Worked for **7** years in **Brazil** as a **Developer**

Worked **8** years for the Ministry of Finance
In **Angola** as a **DBA**

March - 2007 until March - 2015



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Oracle Specializations

- Oracle Database
- Oracle Exadata
- Oracle GoldenGate
- Oracle Data Integrator
- Oracle Data Warehouse
- Oracle Real Application Clusters
- Oracle Performance Tuning
- Oracle Database Security

Global systems integrator
focused on the Oracle Database
& Engineered Systems platform

Worldwide leader in Exadata
implementations (600+)

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Oracle Database 12c

The Best Oracle Database 12c Tuning Features for Developers and DBAs

Oracle Official Documentation 12.1.0.2

- http://docs.oracle.com/database/121/NEWFT/chapter12102.htm

Oracle Learning Library (OLL)

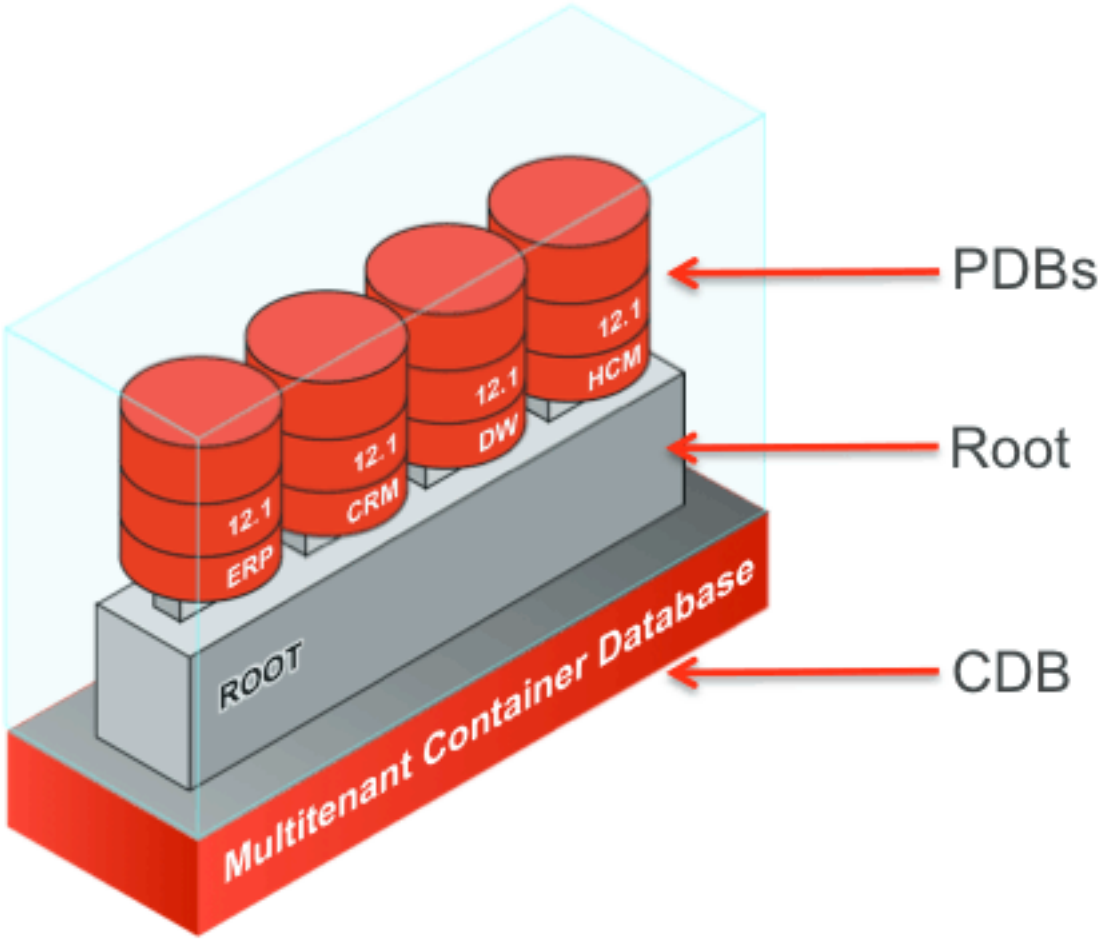
- https://apexapps.oracle.com/pls/apex/f?p=44785:1:0

Articles about 12c

- https://oracle-base.com/articles/12c/articles-12c
- http://www.oraclealchemist.com/news/install-oracle-12c-12-1/
- http://www.profissionaloracle.com.br/

“With more than **500 new features**, Oracle Database **12c** is designed to give Oracle customers exactly what they’ve told us they need for cloud computing, big data, security, and availability.”

Multitenant



Source: Oracle Documentation

Multitenant

Is it a Tuning Feature?

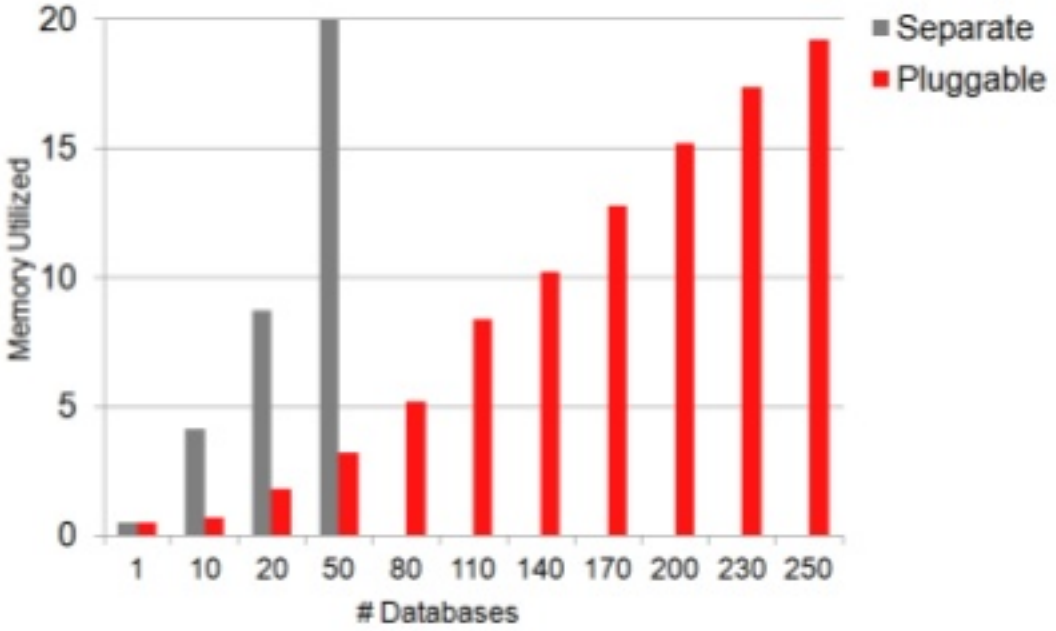
Pluggable vs Separate Databases

Highly Efficient: 6x Less H/W Resource, 5x more Scalable

OLTP benchmark comparison

Only 3GB of memory vs. 20GB memory used for 50 databases

Pluggable databases scaled to over 250 while separate database instances maxed at 50



ORACLE

Source: Oracle Documentation

Multitenant

Non-CDB architecture of Oracle databases is DEPRECATED since Oracle Database 12.1.0.2

By Mike Dietrich-Oracle on Jan 22, 2015

Beginning with Oracle Database 12.1.0.2 a **non-CDB architecture is deprecated**.

8.1.1 Deprecation of Non-CDB Architecture

The non-CDB architecture is deprecated in Oracle Database 12*c*, and may be desupported and unavailable in a later Oracle Database release. Oracle recommends use of the CDB architecture.

Note:

There remain a small number of features that do not work with the CDB architecture (see README, section 2.2.1 "Features Restricted or Not Available for a Multitenant Container Database"). If you need these features, then continue to use the non-CDB architecture until your required feature works with the CDB architecture.

Source: https://blogs.oracle.com/UPGRADE/entry/non_cdb_architecture_of_oracle

Multitenant

What does this mean?

Deprecation first of all **does not mean "desupported"**.

Source: https://blogs.oracle.com/UPGRADE/entry/non_cdb_architecture_of_oracle

Multitenant

Which features are not supported at the moment?

- Database Change Notification
- Continuous Query Notification (CQN)
- Client Side Cache
- Heat Map
- Automatic Data Optimization
- Oracle Streams
- Oracle Fail Safe
- Flashback Pluggable Database (Flashback Database works but will flashback CDB$ROOT including all PDBs)
- DBVERIFY
- Data Recovery Advisor (DRA)
- Flashback Transaction Backout

Source: https://blogs.oracle.com/UPGRADE/entry/non_cdb_architecture_of_oracle

In-Memory

Source: Oracle Documentation

In-Memory

SIMD Vector Processing

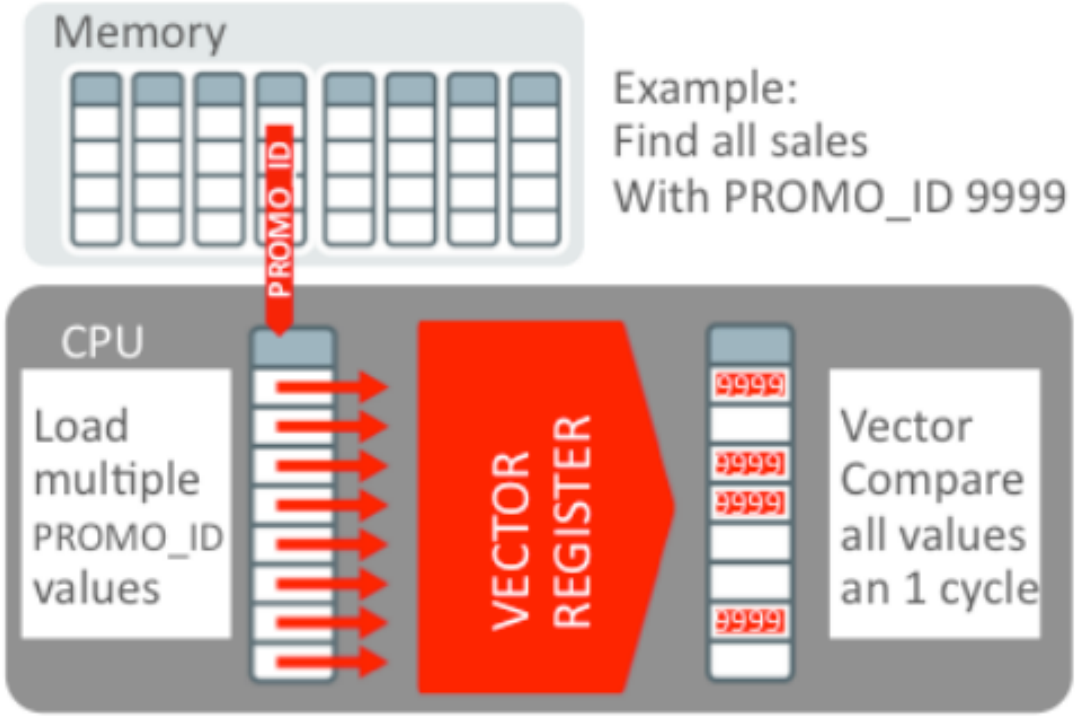


Figure 11. Using SIMD vector processing enables the scanning of billions of rows per second

Source: http://www.oracle.com/technetwork/database/in-memory/overview/twp-oracle-database-in-memory-2245633.html

In-Memory

Is it a Tuning Feature?

"Using Database In-Memory, businesses can **instantaneously** run analytics and reports that previously took **hours** or **days**."

Source: Oracle Documentation

In-Memory

In-Memory Area – a static pool in SGA

In-Memory

```
ALTER SYSTEM SET SGA_TARGET=3G SCOPE=SPFILE;
ALTER SYSTEM SET INMEMORY_SIZE=2G SCOPE=SPFILE;
SHUTDOWN IMMEDIATE;
STARTUP;

ORACLE instance started.

Total System Global Area 3221225472 bytes
Fixed Size                  2929552 bytes
Variable Size             419433584 bytes
Database Buffers          637534208 bytes
Redo Buffers               13844480 bytes
In-Memory Area           2147483648 bytes
Database mounted.
Database opened.
```

Source: OracleBase.com

In-Memory

Alter table hr.EMPLOYEES inmemory;

ALTER TABLE sales MODIFY PARTITION SALES_Q1_1998 NO INMEMORY;

ALTER TABLE sales INMEMORY NO INMEMORY(prod_id);

```
CREATE TABLESPACE tbs_test
  DATAFILE '+DG01 SIZE 100M
  DEFAULT INMEMORY;
```

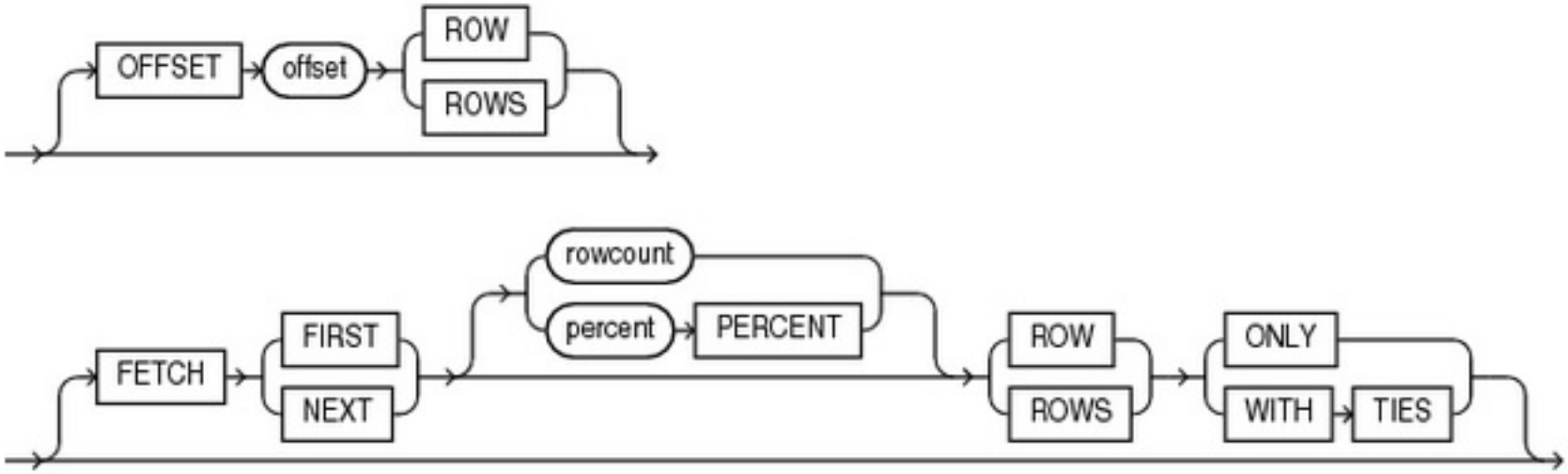
In-Memory

PRIORITY	DESCRIPTION
CRITICAL	Object is populated immediately after the database is opened
HIGH	Object is populated after all `CRITICAL` objects have been populated, if space remains available in the IM column store
MEDIUM	Object is populated after all `CRITICAL` and `HIGH` objects have been populated, and space remains available in the IM column store
LOW	Object is populated after all `CRITICAL`, `HIGH`, and `MEDIUM` objects have been populated, if space remains available in the IM column store
NONE	Objects only populated after they are scanned for the first time (Default), if space is available in the IM column store

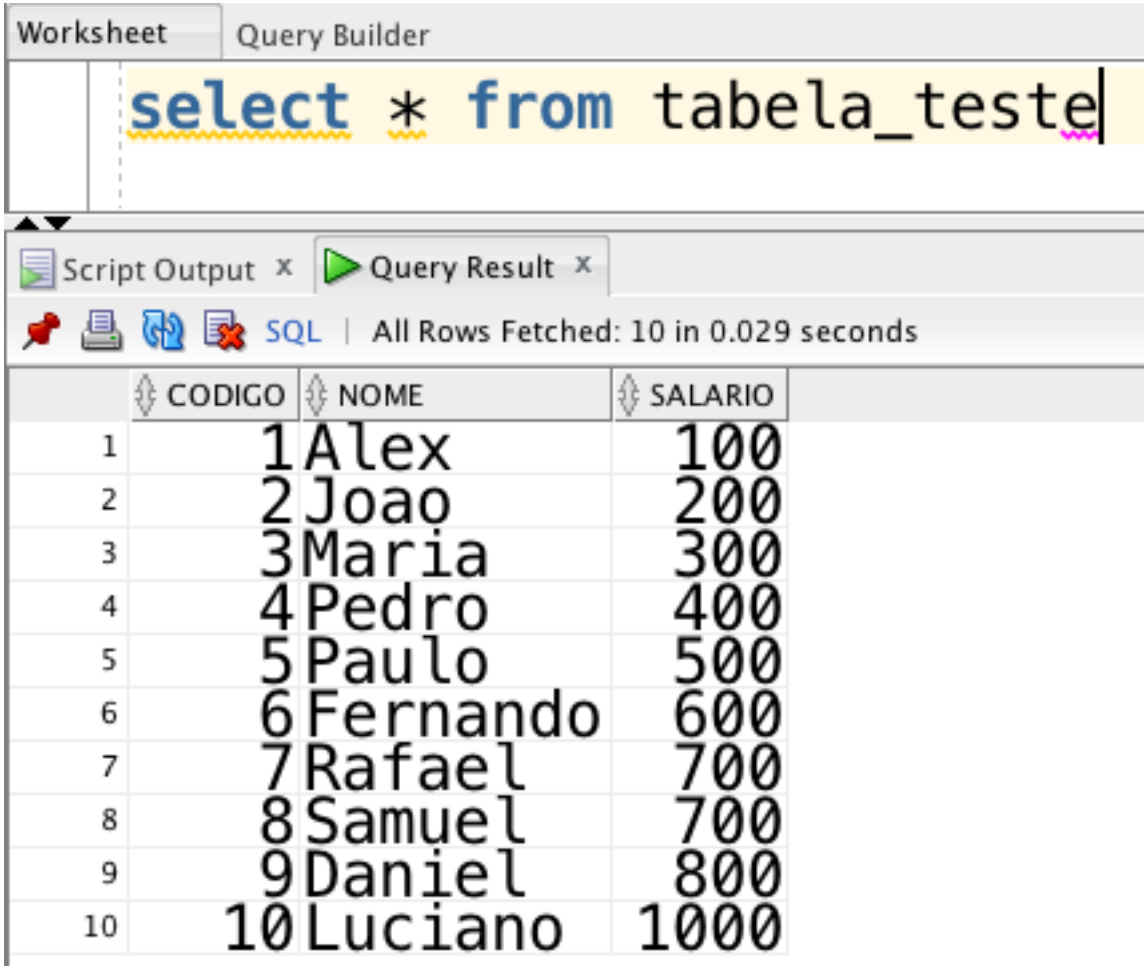
Figure 7. Different priority levels controlled by the `PRIORITY` sub clause of the `INMEMORY` clause

Source: http://www.oracle.com/technetwork/database/in-memory/overview/twp-oracle-database-in-memory-2245633.html

SQL Query Row Limits and Offsets



SQL Query Row Limits and Offsets



	CODIGO	NOME	SALARIO
1	1	Alex	100
2	2	Joao	200
3	3	Maria	300
4	4	Pedro	400
5	5	Paulo	500
6	6	Fernando	600
7	7	Rafael	700
8	8	Samuel	700
9	9	Daniel	800
10	10	Luciano	1000

SQL Query Row Limits and Offsets

Top-N Queries – Pré 12c

```
select * from ( select codigo, nome, salario
                from tabela_teste
                order by salario desc)
where rownum <= 5
```

SQL Query Row Limits and Offsets

```
select codigo, nome, salario
  from tabela_teste
order by salario desc
FETCH FIRST 5 ROWS ONLY
```

CODIGO	NOME	SALARIO
10	Luciano	1000
9	Daniel	800
7	Rafael	700
8	Samuel	700
6	Fernando	600

SQL Query Row Limits and Offsets

```
select codigo, nome, salario
  from tabela_teste
order by salario
FETCH FIRST 30 PERCENT ROWS ONLY
```

CODIGO	NOME	SALARIO
1	Alex	100
2	Joao	200
3	Maria	300

SQL Query Row Limits and Offsets

```
select codigo, nome, salario
  from tabela_teste
order by salario desc
OFFSET 2 ROWS FETCH NEXT 2 ROWS ONLY;
```

CODIGO	NOME	SALARIO
7	Rafael	700
8	Samuel	700

DEMO

Approximate Count Distinct

This function provides an alternative to the COUNT (DISTINCT expr), with **negligible deviation from the exact result**.

```
SQL> SELECT count (distinct manager_id) AS "Gerentes Ativos"
  FROM hr.employees_big;

Gerentes Ativos
---------------
     18

Elapsed: 00:00:03.02
```

Utilizando a função *APPROX_COUNT_DISTINCT*:

```
SQL> SELECT APPROX COUNT DISTINCT(manager_id) AS "Gerentes Ativos"
  FROM hr.employees_big;

Gerentes Ativos
---------------
     18

Elapsed: 00:00:00.62
```

DEMO

PL/SQL From SQL

```
with
     function Is_Number
     (x in varchar2) return varchar2 is
       Plsql_Num_Error exception;
       pragma exception_init(Plsql_Num_Error, -06502);
     begin
       if (To_Number(x) is NOT null) then
         return 'Y';
       else
        return '';
      end if;
    exception
     when Plsql_Num_Error then
       return 'N';
    end Is_Number;
select rownum, x, is_number(x) is_num from t;
```

DEMO

Session Level Sequences

Session level sequences are used to produce unique values in a session. Once the session ends, the sequence is reset.

Generating Primary Keys for a Global Temporary Table would be a field where those kinds of sequences could be used.

Session Level Sequences

```
CREATE SEQUENCE sequence_teste
  START WITH   1
  INCREMENT BY 1
  SESSION
/
```

Session Level Sequences

ALTER SEQUENCE sequence_teste

SESSION;

ALTER SEQUENCE sequence_teste

GLOBAL;

DEMO

Session private statistics for Global Temporary Tables

Pre 12c, statistics gathered for global temporary tables (GTTs) were common to all sessions.

Session private statistics for Global Temporary Tables

On 12c, by default session-private statistics are enabled

```
SELECT DBMS_STATS.get_prefs('GLOBAL_TEMP_TABLE_STATS')
FROM dual;

STATS
--------------------------------------------------------------------------------
SESSION
```

Session private statistics for Global Temporary Tables

How to change?

Behavior pre 12c:

```
BEGIN
  DBMS_STATS.set_global_prefs (
    pname   => 'GLOBAL_TEMP_TABLE_STATS',
    pvalue  => 'SHARED');
END;
/
```

Back to default on 12c:

```
BEGIN
  DBMS_STATS.set_global_prefs (
    pname   => 'GLOBAL_TEMP_TABLE_STATS',
    pvalue  => 'SESSION');
END;
/
```

Session private statistics for Global Temporary Tables

How to change for one table?

```
BEGIN
 dbms_stats.set_table_prefs('SCOTT','GTT_TESTE',
  'GLOBAL_TEMP_TABLE_STATS','SHARED');
END;
```

```
BEGIN
 dbms_stats.set_table_prefs('SCOTT','GTT_TESTE',
  'GLOBAL_TEMP_TABLE_STATS’,’SESSION');
END;
```

DEMO

Temporary Undo

Global Temporary Tables (GTT) hold the data in a temporary tablespace. The data in GTTs are either deleted after commit or kept until the session is connected depending of the definition of the GTT.(ON COMMIT PRESERVE OR DELETE ROWS).

DMLs in a Global Temporary Tables **do not generate REDO, but generate UNDO** and this will result in REDO generating.

Temporary Undo

alter session set temp_undo_enabled=true;

alter system set temp_undo_enabled=true;

**you can change for the session or for the database.

*default true

DEMO

Multiple Indexes on the same set of Columns

Pre 12c:

ORA-01408: such column list already indexed error.

Multiple Indexes on the same set of Columns

Is the ability to create more than one index on the same set of columns in 12c.

**Only one of these indexes can be visible at a time

Multiple Indexes on the same set of Columns

Why would you want to do that?

- Unique versus nonunique
- B-tree versus bitmap
- Different partitioning strategies

DEMO

Limit the PGA

```
SQL> show parameter pga

NAME                                 TYPE        VALUE
------------------------------------ ----------- ------------------------------
pga_aggregate_limit                  big integer 2G
```

Limit the PGA

PGA_AGGREGATE_LIMIT is set to the greater of:

- 2 GB (default value)
- 200% of PGA_AGGREGATE_TARGET
- 3 MB times the PROCESSES parameter

Statistics During Loads

The ability to gather statistics automatically during **bulk loads**:

- CREATE TABLE AS SELECT

- INSERT INTO ... SELECT into an empty table using a **direct path insert**

DEMO

Partial Indexes for Partitioned Table

- You can create local and global indexes on a **subset** of the partitions of a table, enabling more flexibility in index creation.

- This feature is not supported for unique indexes, or for indexes used for enforcing unique constraints.

Partial Indexes for Partitioned Table

```
create table tabela_teste
(
  coluna1 number,
  coluna2 number
)
indexing on
partition by range(coluna1)
(
  partition part1 values less than(100) indexing off,
  partition part2 values less than(200) indexing on,
  partition part3 values less than(300),
  partition part4 values less than(400)
);
Table created.
```

DEMO

Full Database Caching

Can be used to cache the entire database in memory. It should be used when the buffer cache size of the database instance **is greater than the whole database size**.

```
SQL> ALTER DATABASE FORCE FULL DATABASE CACHING;

Database altered.

SQL> SELECT force_full_db_caching FROM v$database;

FOR
---
YES
```

Adaptive Query Optimization

Adaptive Plans

Adaptive Join Method

Adaptive Join Method

Optimizer can change join from Nested Loop to Hash Join and vice versa.

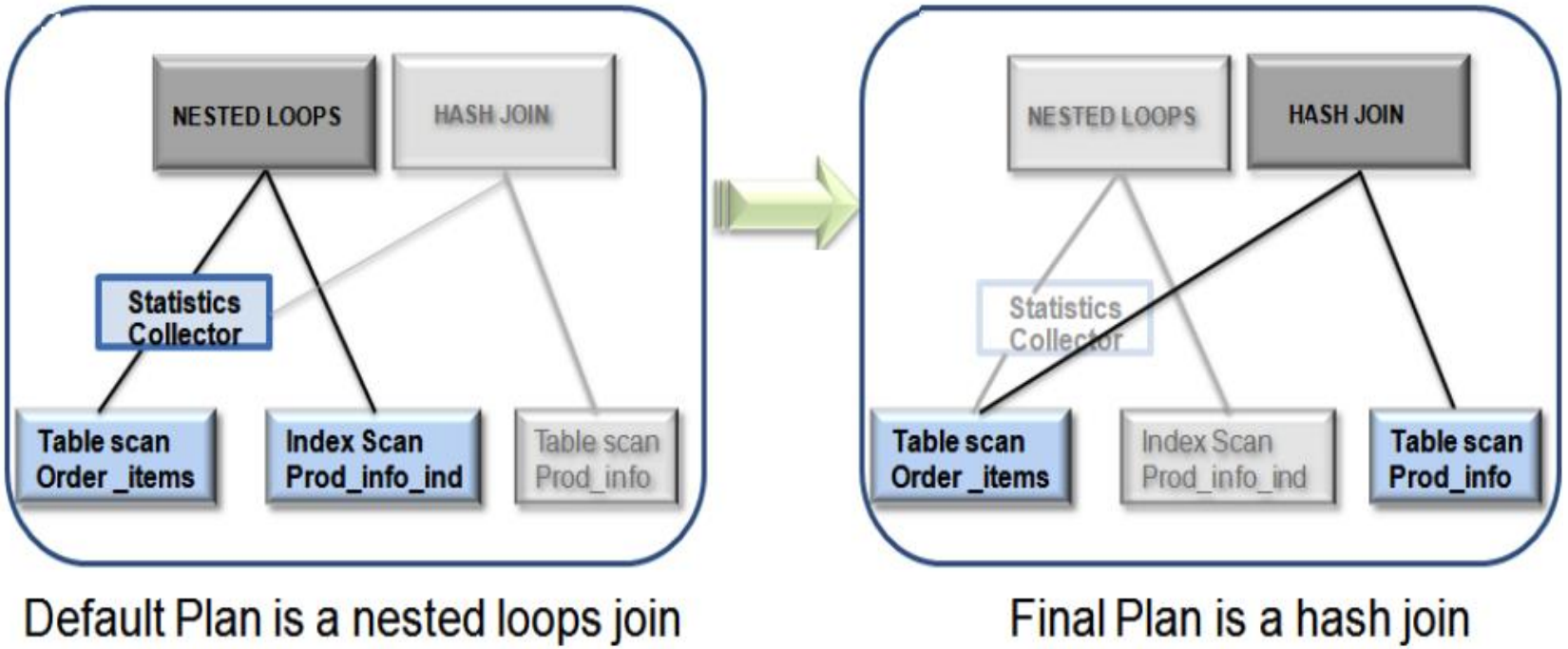
Why?

Optimizer mistakes

- Estimated Rows and Actual rows are different

Before 12c requires DBA/Developer intervention

Adaptive Join Method



Default Plan is a nested loops join

Final Plan is a hash join

Source: Oracle Documentation

Adaptive Join Method

Parameters that control Adaptive Plans:

Name	Type	Value
optimizer_adaptive_features	boolean	TRUE
optimizer_adaptive_reporting_only	boolean	FALSE
optimizer_features_enable	string	12.1.0.1

Explain Plan command shows the default plan

```
SQL> explain plan for
  2  select /*+ gather_plan_statistics*/ p.product_name
  3  from order_items2 o, product_information p
  4  where o.unit_price = 15
  5    and o.quantity > 1
  6    and p.product_id = o.product_id;

Explained.

SQL>
SQL> select * from table(dbms_xplan.display());

PLAN_TABLE_OUTPUT
--------------------------------------------------------------------------------
Plan hash value: 983807676

--------------------------------------------------------------------------------
| Id  | Operation                    | Name
--------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |
|   1 |  NESTED LOOPS                |
|   2 |   NESTED LOOPS               |
|*  3 |    TABLE ACCESS FULL         | ORDER_ITEMS2
|*  4 |    INDEX UNIQUE SCAN         | PRODUCT_INFORMATION_PK
|   5 |   TABLE ACCESS BY INDEX ROWID| PRODUCT_INFORMATION
--------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   3 - filter("O"."UNIT_PRICE"=15 AND "O"."QUANTITY">1)
```

Source: Oracle Documentation

DBMS_XPLAN.DISPLAY_CURSOR shows the final plan

```
SQL> select * from table(dbms_xplan.display_cursor());

PLAN_TABLE_OUTPUT
------------------------------------------------------------------------------------
SQL_ID  d3mzkmzxn264d, child number 0
-------------------------------------
select /*+ gather_plan_statistics */ p.product_name from order_items2
o, product_information p where o.unit_price = 15   and o.quantity > 1
and p.product_id = o.product_id

Plan hash value: 2886494722

-------------------------------------------------------------------------------------
| Id  | Operation          | Name                | Rows  | Bytes | Cost (%CPU)|
-------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT   |                     |       |       |     7 (100)|
|*  1 |  HASH JOIN         |                     |     4 |   128 |     7   (0)|
|*  2 |   TABLE ACCESS FULL| ORDER_ITEMS2        |     4 |    48 |     3   (0)|
|   3 |   TABLE ACCESS FULL| PRODUCT_INFORMATION |     1 |    20 |     1   (0)|
-------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("P"."PRODUCT_ID"="O"."PRODUCT_ID")
   2 - filter(("O"."UNIT_PRICE"=15 AND "O"."QUANTITY">1))
```

Source: Oracle Documentation

DEMO

Real-Time SQL Monitoring

- Sql Monitoring requires both Diagnostics and Tuning Pack licenses

Real-Time SQL Monitoring

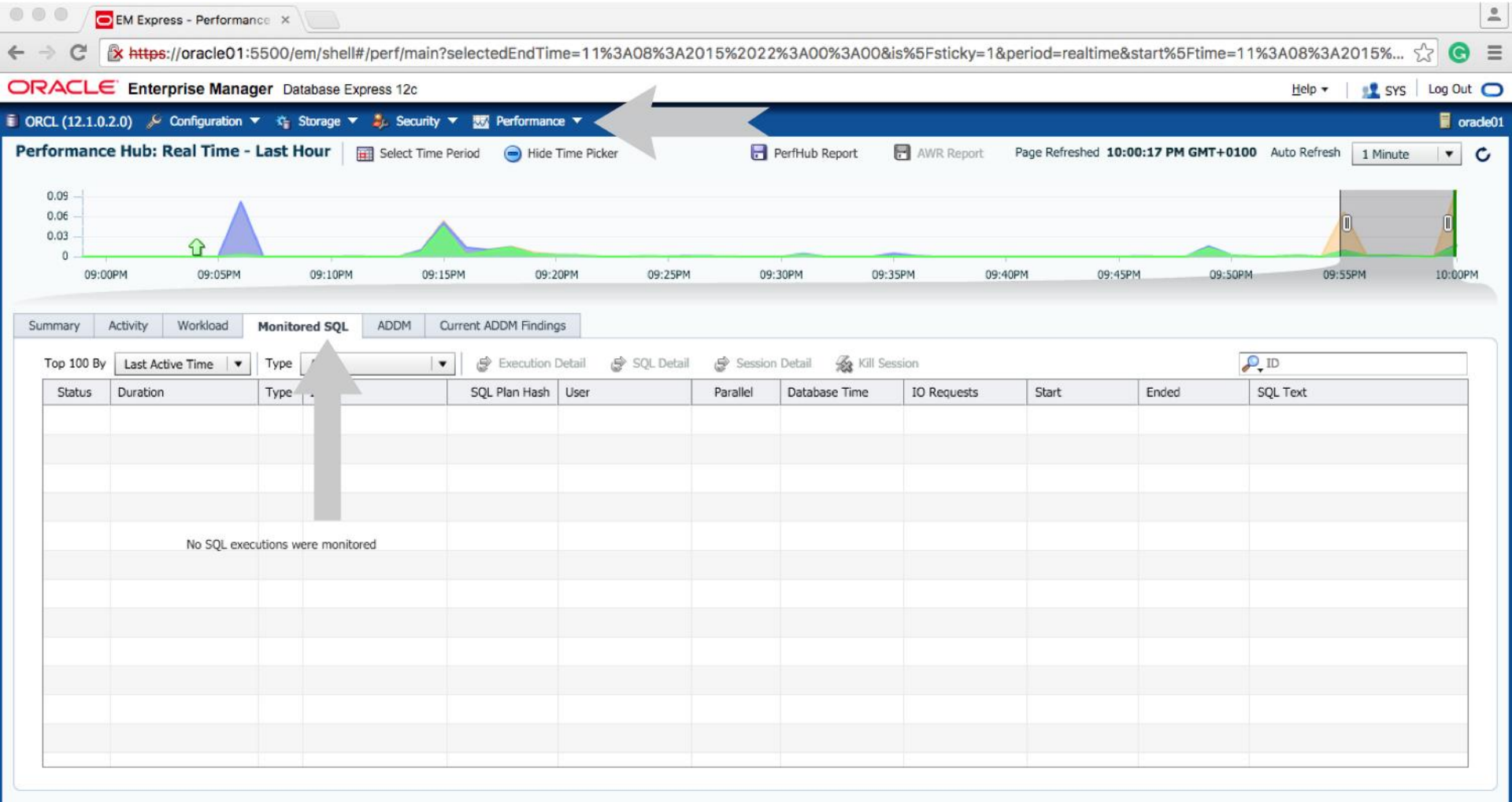
- MONITOR Hint

  SELECT /*+ MONITOR */

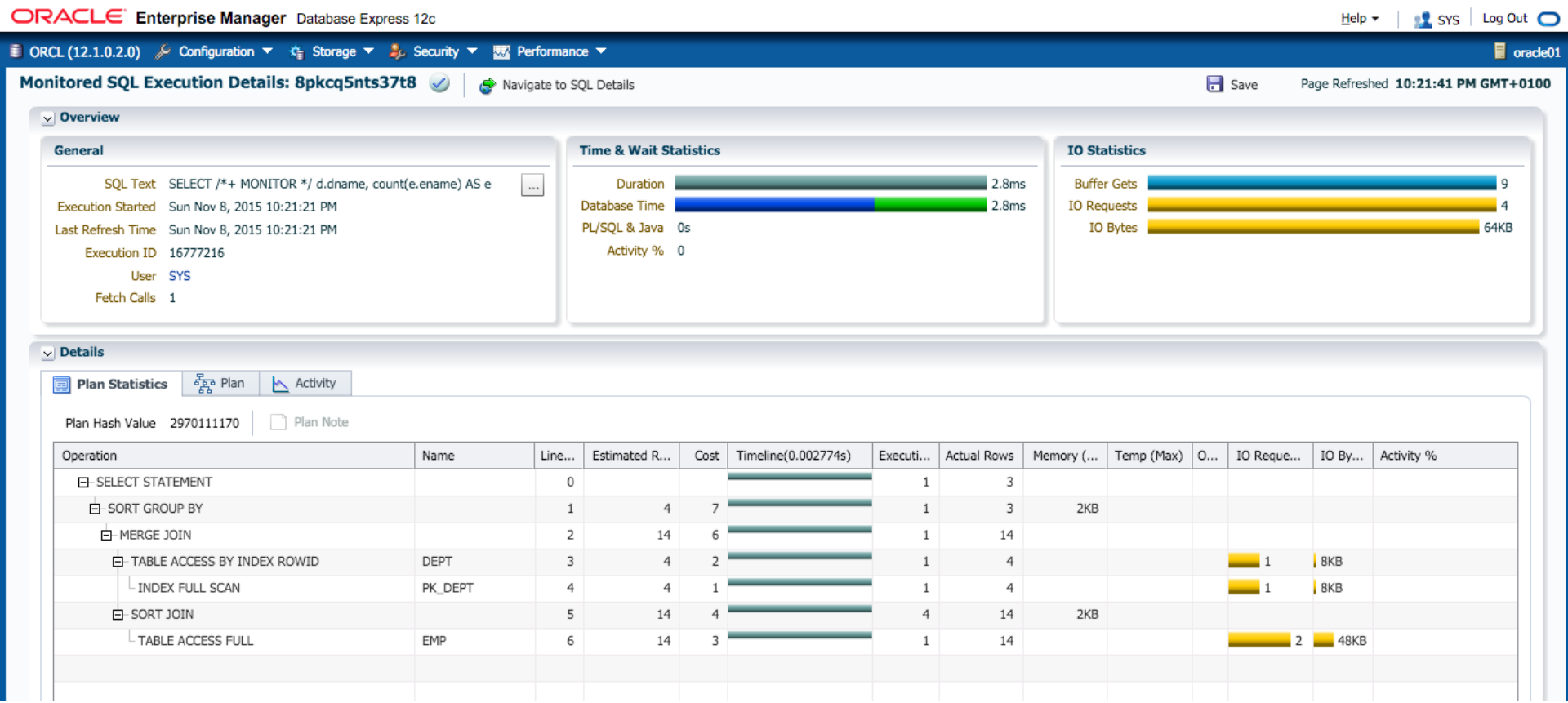
- All parallel statements

- After 5 seconds of CPU/IO time spent for serial queries

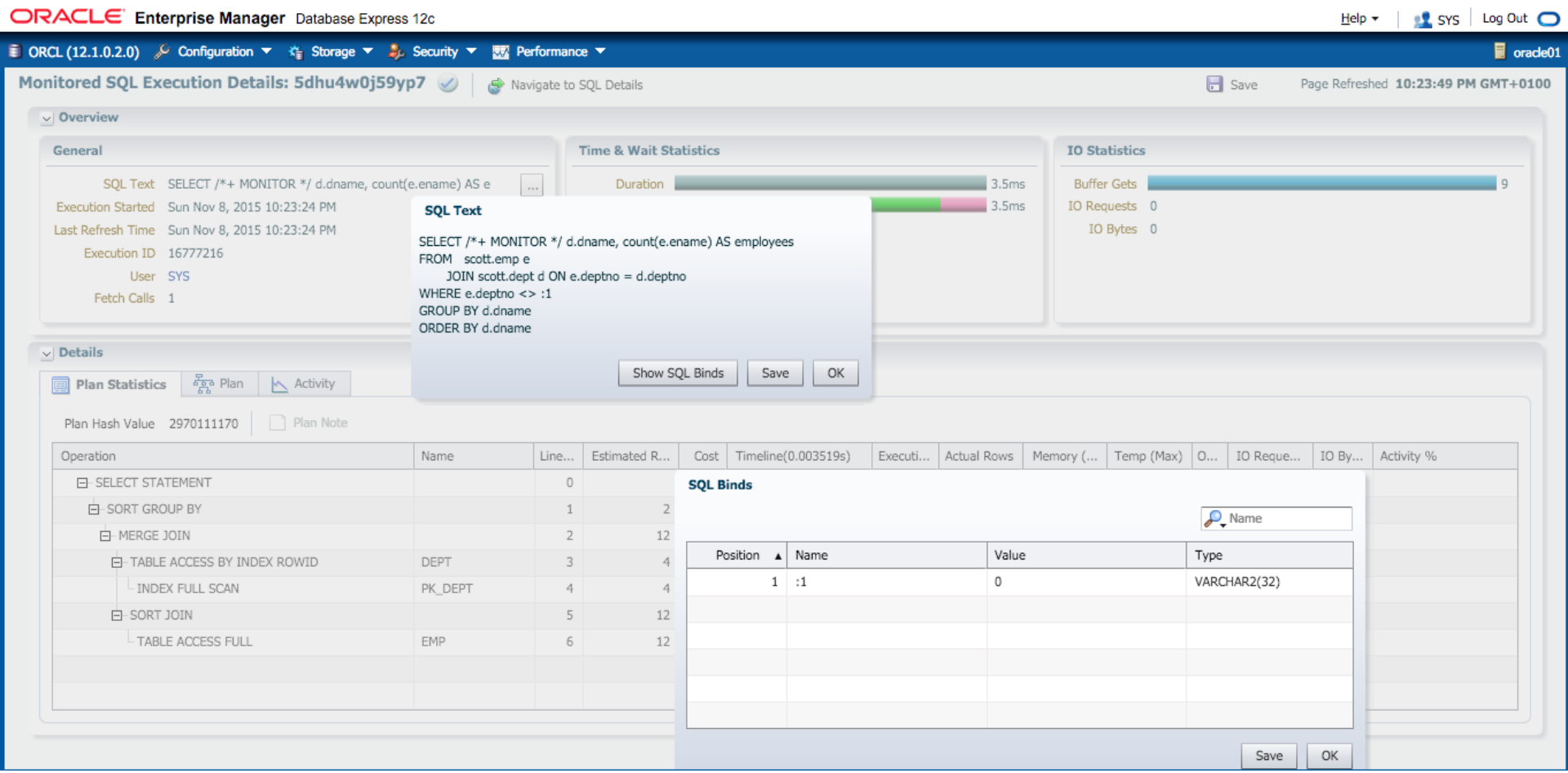
Real-Time SQL Monitoring



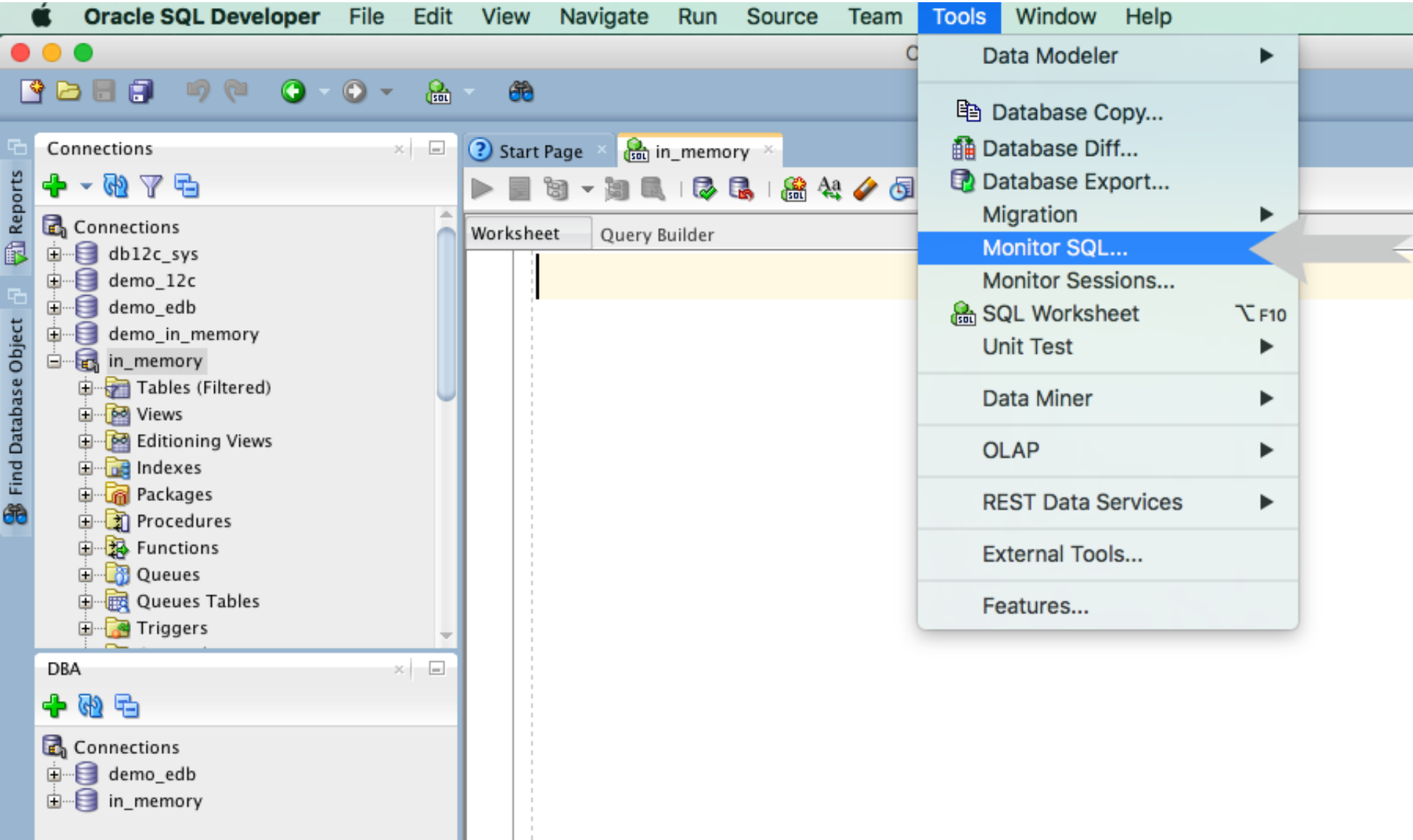
Real-Time SQL Monitoring



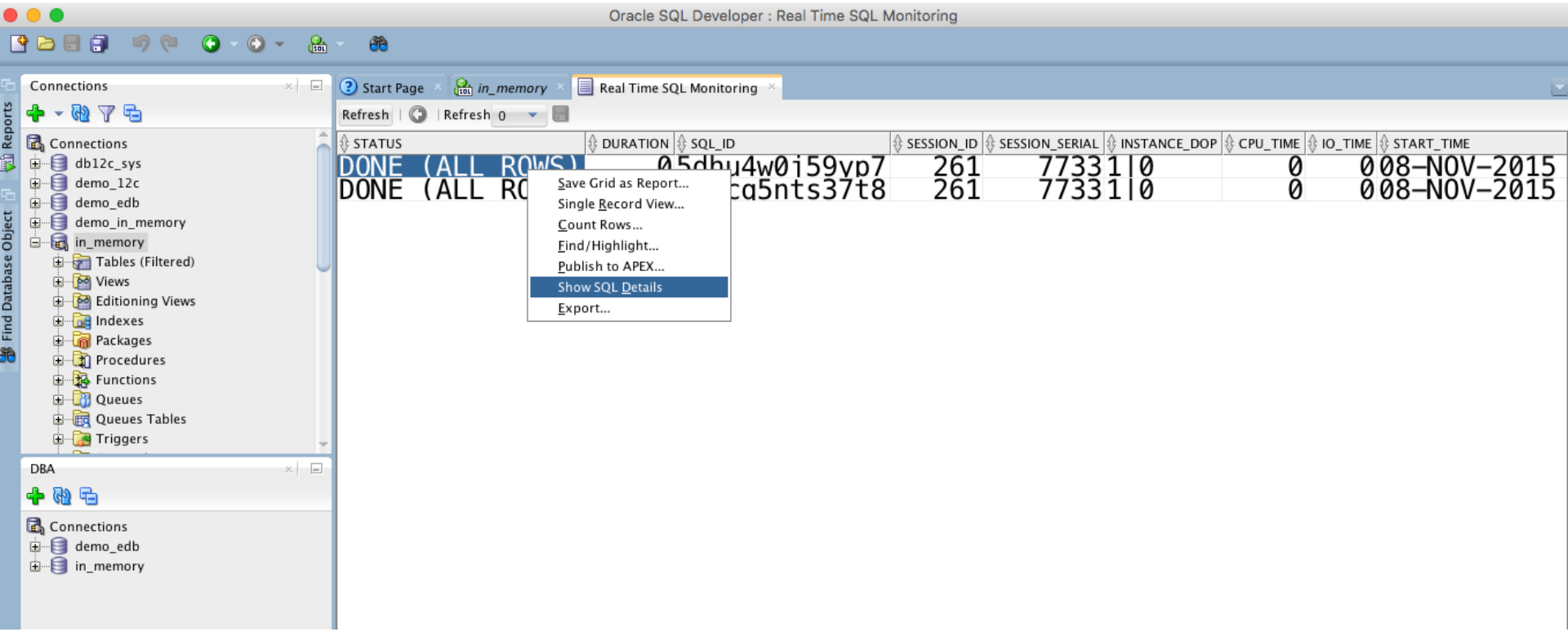
Real-Time SQL Monitoring



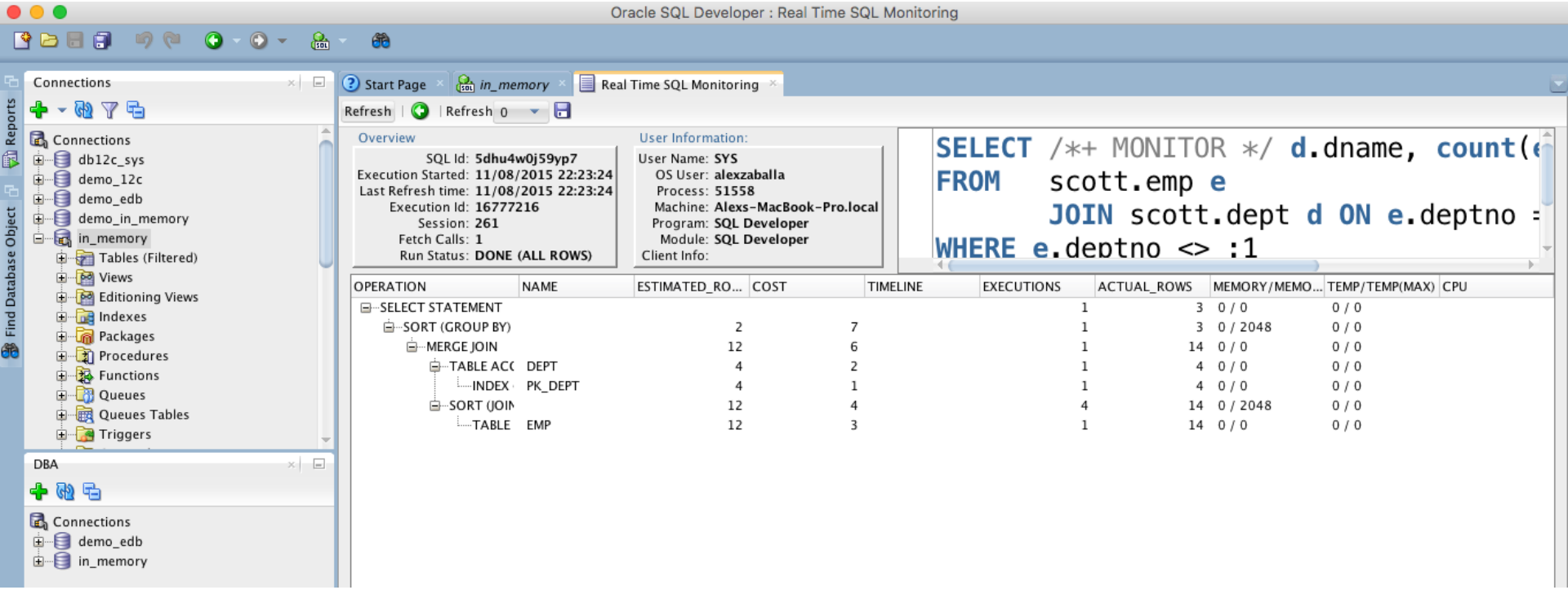
Real-Time SQL Monitoring



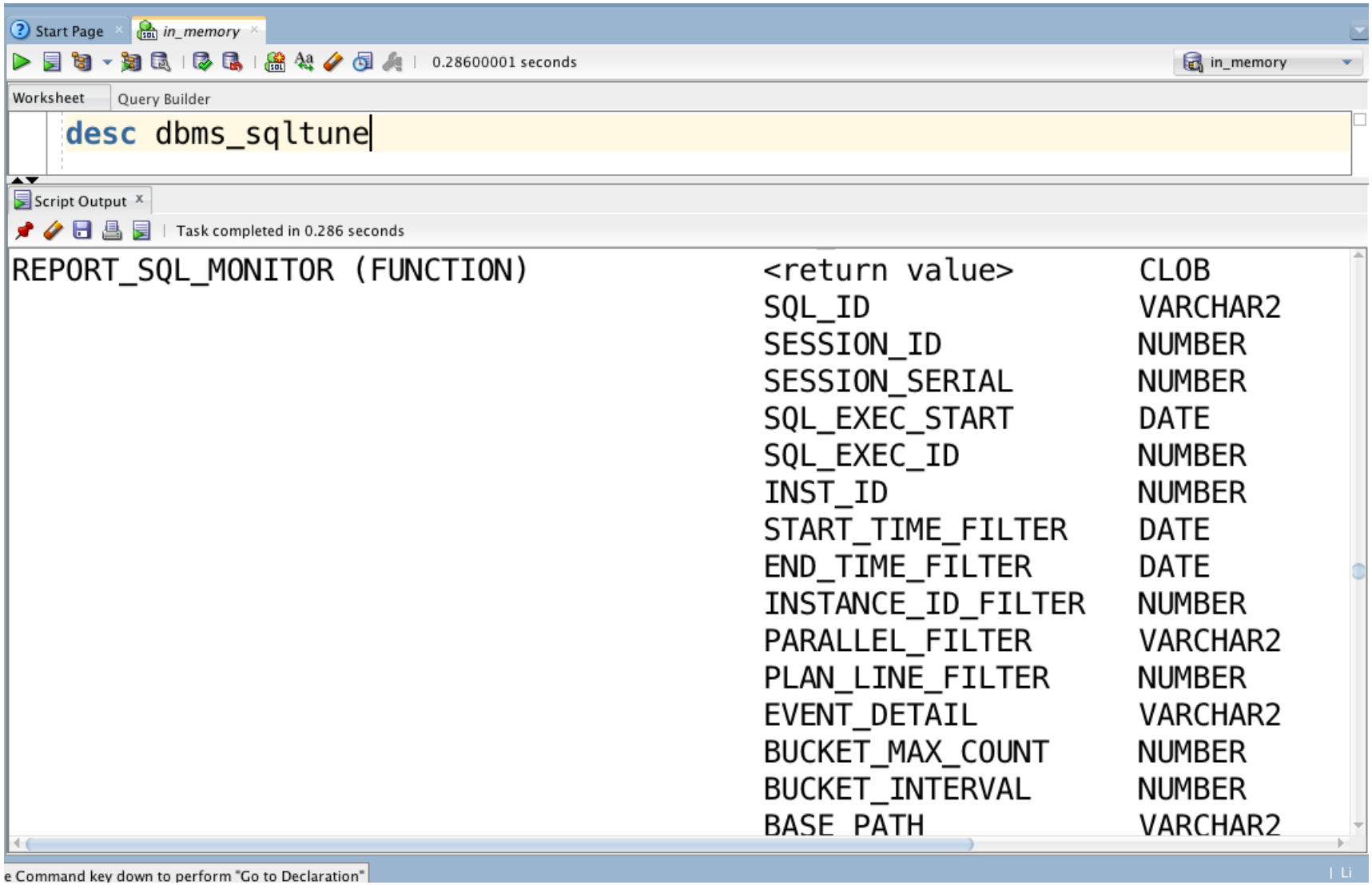
Real-Time SQL Monitoring



Real-Time SQL Monitoring



Real-Time SQL Monitoring



Real-Time SQL Monitoring

```
SPOOL /tmp/report_sql_monitor.htm

SELECT DBMS_SQLTUNE.report_sql_monitor(
  sql_id       => '5dhu4w0j59yp7',
  type         => 'HTML',
  report_level => 'ALL') AS report
FROM dual;

SPOOL OFF
```

Real-Time SQL Monitoring

SQL Monitoring Report

SQL Text

SELECT /*+ MONITOR */ d.dname, count(e.ename) AS employees FROM scott.emp e JOIN scott.dept d ON e.deptno = d.deptno WHERE e.deptno <> :1 GROUP BY d.dname ORDER BY d.dname

Global Information: DONE (ALL ROWS)

Instance ID : 1
Session : SYS (261:7733)
SQL ID : 5dhu4w0j59yp7
SQL Execution ID : 16777216
Execution Started : 11/08/2015 22:23:24
First Refresh Time : 11/08/2015 22:23:24
Last Refresh Time : 11/08/2015 22:23:24
Duration : .003519s
Module/Action : SQL Developer/-
Service : SYS$USERS
Program : SQL Developer
Fetch Calls : 1

Buffer Gets	Database Time	Wait Activity
9	0s	

Binds

Name	Position	Type	Value
:1	1	VARCHAR2(32)	0

SQL Plan Monitoring Details (Plan Hash Value=2970111170)

Id	Operation	Name	Estimated Rows	Cost	Active Period (.003519s)	Execs	Rows	Memory (Max)	Temp (Max)	IO Requests	CPU Activity	Wait Activity
0	SELECT STATEMENT					1	3					
1	SORT GROUP BY		2	7		1	3	2.0KB				
2	MERGE JOIN		12	6		1	14					
3	TABLE ACCESS BY INDEX ROWID	DEPT	4	2		1	4					
4	INDEX FULL SCAN	PK_DEPT	4	1		1	4					
5	SORT JOIN		12	4		4	14	2.0KB				
6	TABLE ACCESS FULL	EMP	12	3		1	14					

SQL> SPOOL OFF

DEMO

Oracle Database 12.2

Oracle Announces Beta Availability of Oracle Database 12c Release 2 - Oct 26, 2015

- PLUGGABLE DATABASES
  From 252 to 4096

- HOT CLONING
  Don’t need to put the source in read-only for cloning

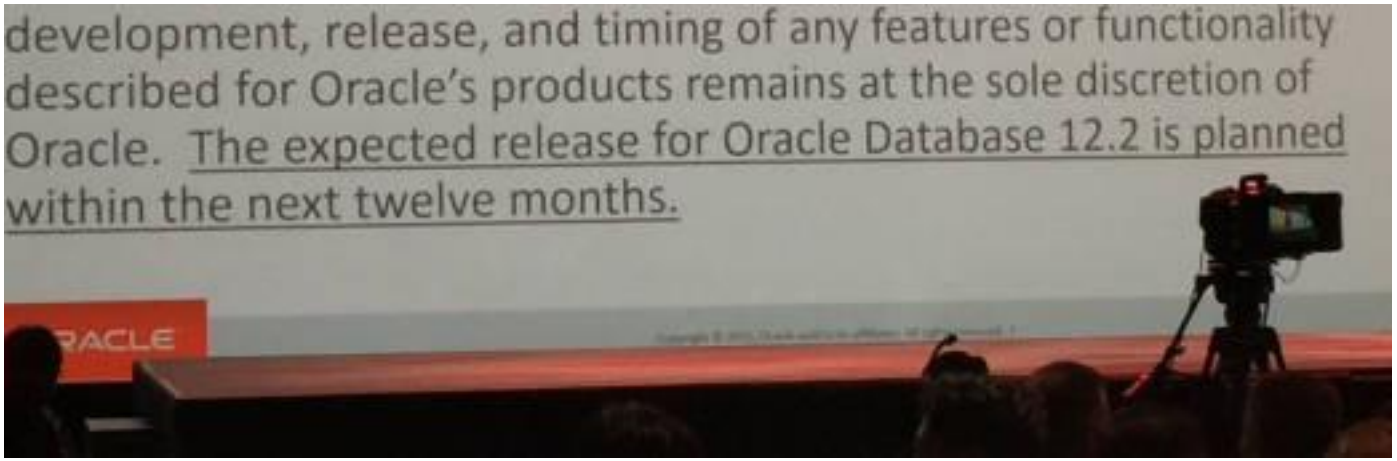
- SHARDING
  It’s like partitioning in a shared nothing database
  The data is split into multiple databases

- In-Memory
  In-Memory column Store on Active Data Guard
  Heat Map

- APPLICATION CONTAINER
  Pluggable Databases will share application objects

- More isolation, resource manager will limit the memory in addition to CPU and I/O.
- AWR will work on Active Data Guard Database: you can tune your reporting database

Availability of Oracle Database 12.2



Source: https://blogs.oracle.com/UPGRADE/entry/oracle_database_12_2_just

Oracle Database Release Status
MOS Note:742060.1

Release	Patching Ends	Notes and Exceptions*
12.1.0.2	**31-Jul-2021**	Extended Support begins 1-Aug-2018
12.1.0.1	**31-Aug-2016**	
11.2.0.4	**31-Dec-2020**	Extended Support fees waived until May 31, 2017. An ES service contract is required starting 1-Jun-2017.
11.2.0.3	**27-Aug-2015**	
11.2.0.2	**31-Oct-2013**	End date extended beyond normal.
11.2.0.1	**13-Sep-2011**	Patch end date for Exadata is 30-Apr-2012
11.1.0.7	**31-Aug-2015**[7]	**HP-UX Itanium - Patching ends Dec 2015.** Beginning Sep 1, 2015 Sev 1 fixes only (no PSU or CPU will be produced). **Extended Support** required starting 1-Sep-2012
11.1.0.6	**18-Sep-2009**	
10.2.0.5	**31-Jul-2015**[7]	**All platforms - standard Extended Support ended 31-Jul-2013.** After that, Limited Extended Support is available from Aug 2013 through July 2015, Sev 1 fixes only (no PSU or SPU will be produced). See Oracle Software Technical Support Policies. **HP-UX, Linux, and Windows Itanium - patching ends Dec 2015.** Beginning Aug 1, 2013, Sev 1 fixes only (no PSU or CPU will be produced).

SQLcl

Oracle SQL Developer 4.1 EA2 (4.1.0.18.37)

March 9, 2015

Thank you for accepting the OTN License Agreement; you may now download this software.

- Bugs Fixed
- Release Notes
- New Features
- Documentation

SQL Developer requires JDK 8	Java 8 Download Page
Platform	
Windows 32/64-bit - Installation Notes	**Download** 307 M
Mac OS X - Installation Notes	**Download** 307 M
Linux RPM - Installation Notes	**Download** 301 M
Other Platforms - Installation Notes	**Download** 307 M

Command Line - SQLcl ***Update Apr 16, 2015***	
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Getting Started Video	

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Thank You