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# Database Consolidation using Oracle Multitenant

Pini Dibask, Product Manager for Database Solutions

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Quest

# About Me

- Pini Dibask, Product Manager, Database Monitoring Solutions (Quest)
- Based in Israel 
- Oracle DBA since 2006 (started with version 9i)
- Oracle Certified Professional DBA (OCP) 
- Public Speaker: Oracle OpenWorld, IOUG Collaborate, DOAG, OUGN, AOUG
- Blogger: [OracleDBPro.BlogSpot.com](http://OracleDBPro.BlogSpot.com)



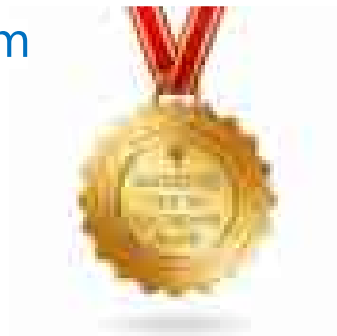
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@pini\_dibask



## About Quest



- Quest is now an independent company again!
- **Simplifies** IT management
- #1 independent software company for Database Tools
- Driven by innovation

*“Spend **less time** on what you **need** to do, and **more time** on what you **want** to do!”*

- Committed to providing great products and superior support

# Agenda

- Introduction to Database Consolidation
- Oracle Multitenant Concepts
- Ensuring QoS in Multitenant Environments
- RAC and Multitenant
- Performance Monitoring for Multitenant Environments

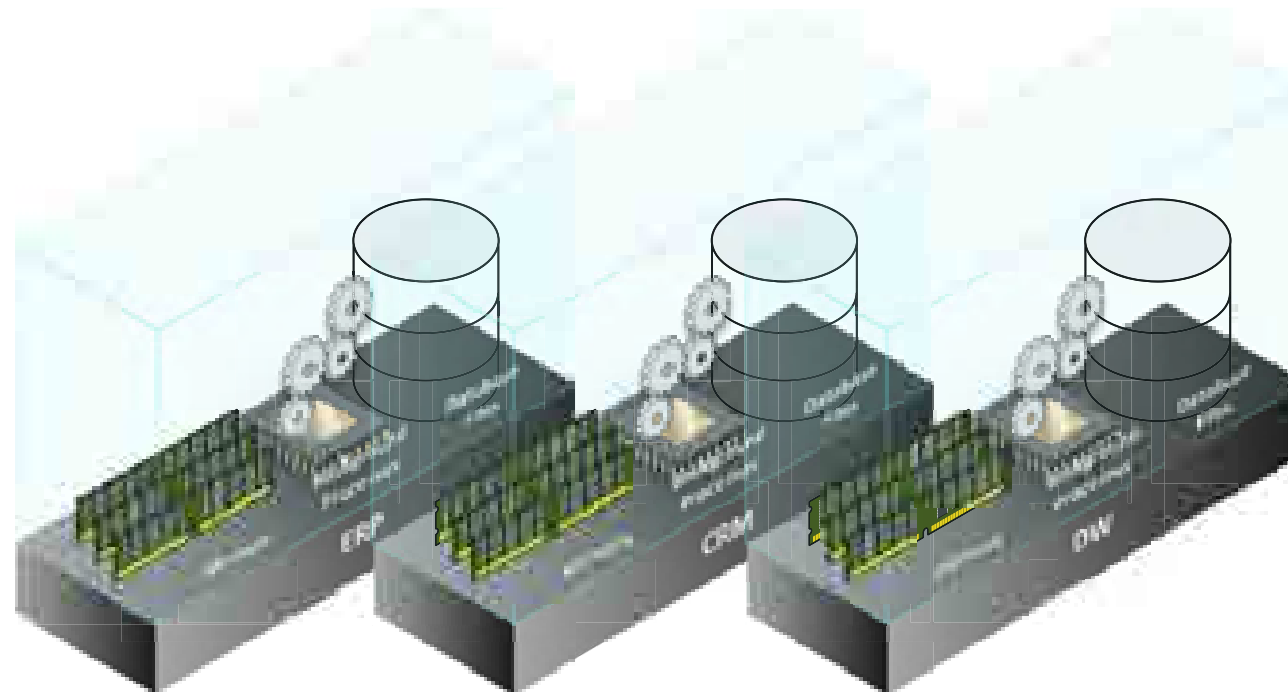
# Introduction to Database Consolidation



# Database Consolidation - Prior to Oracle 12c

## Server Consolidation

- **Multiple databases** reside on a **single server**



# Database Consolidation - Prior to Oracle 12c (Cont'd)

## Database Consolidation

- **Single database** with **multiple schemas**



# Database Consolidation with Schema Separation - Challenges

- **Name Collisions**

- Same schema name or same public synonym name

- **Security**

- DBA can access data of both applications

- **Upgrades**

- You cannot patch/upgrade only one schema

- **Point-In-Time Recovery**

- Impossible to perform schema level point-in-time recovery

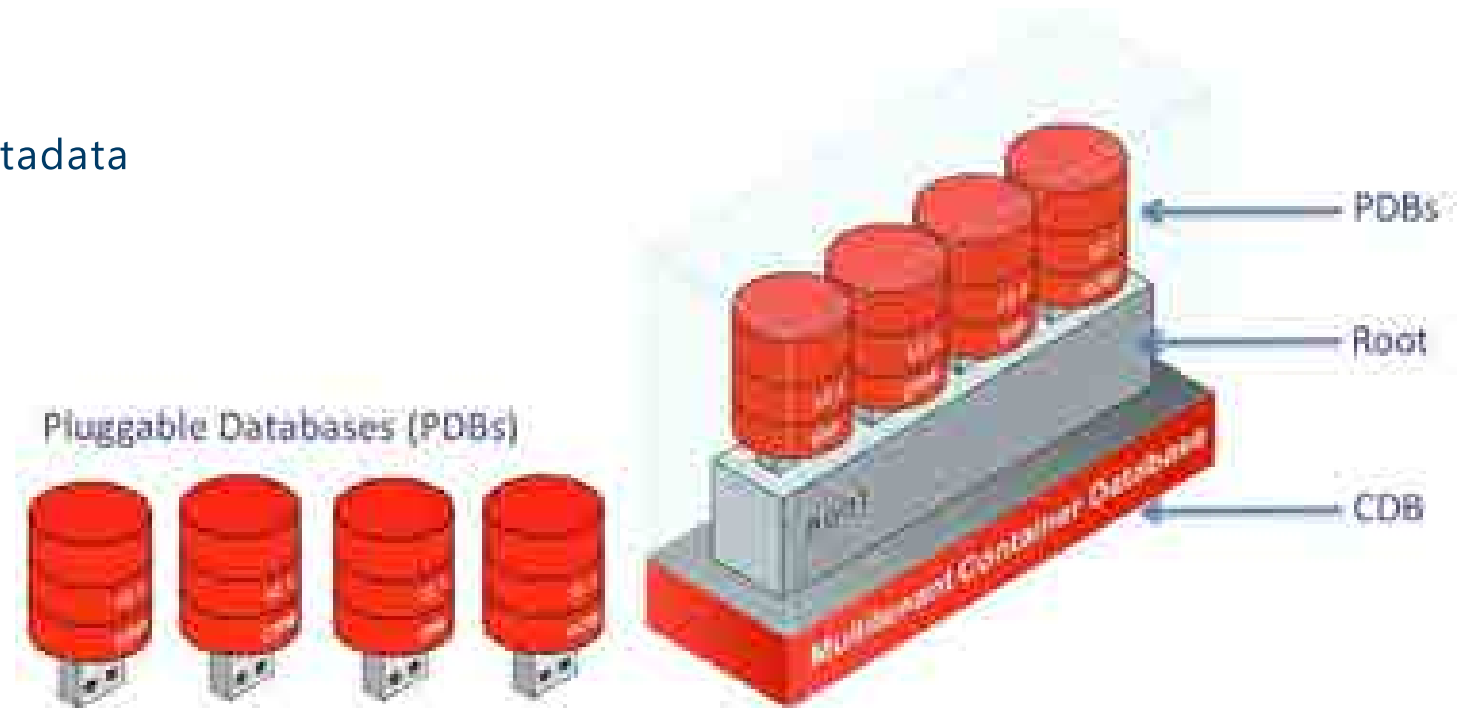


# Multitenant Architecture



# Database to Instance Relationship

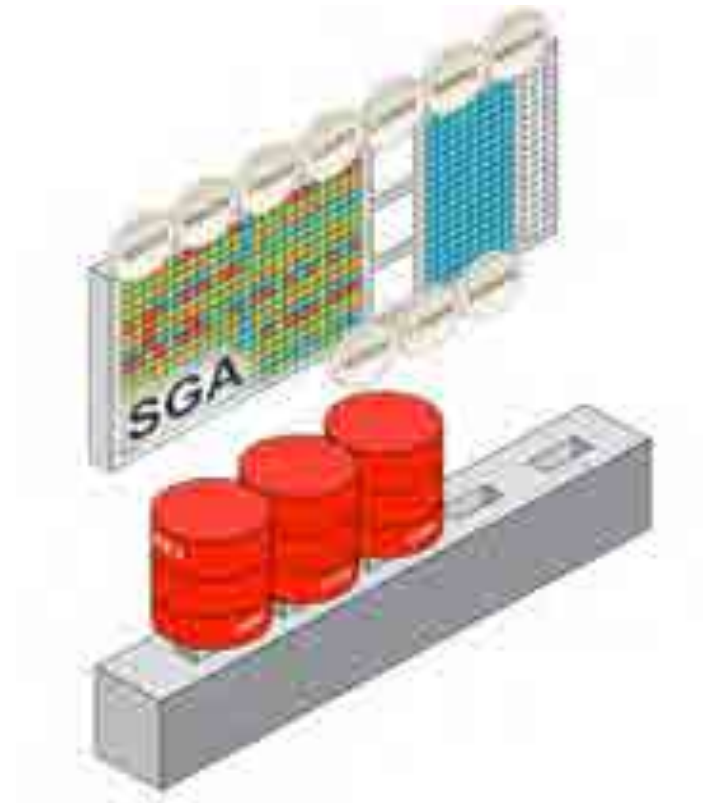
- Pluggable Database
  - Self-contained Oracle database
- Root Container
  - Oracle-supplied metadata



# Oracle 12c – Multitenant Architecture

- **One** SGA
- **One** set of background processes
- **One** root container
- **Multiple** pluggable databases
  - Up to **252** PDBs (12cR1)
  - Up to **4096** PDBs (12cR2)

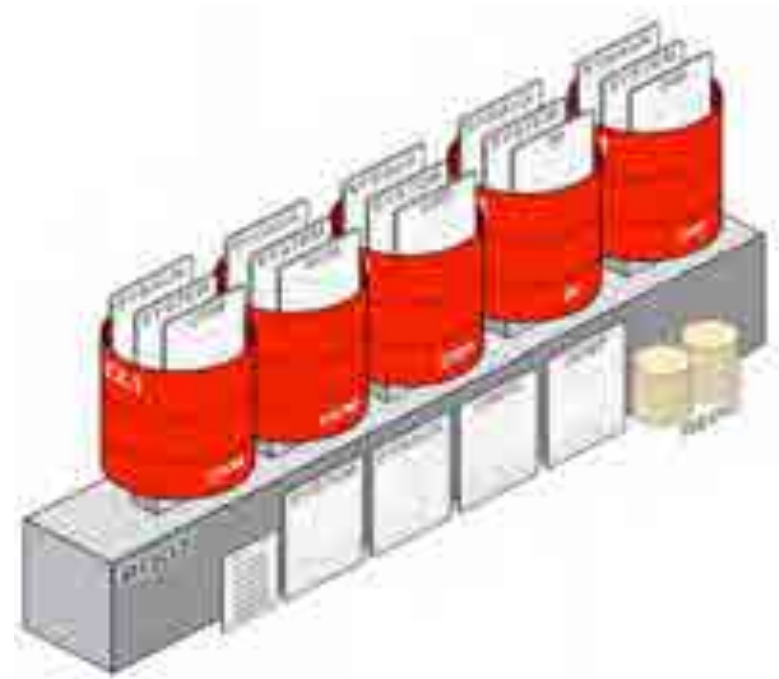
Only on Oracle  
Cloud and  
Oracle Exadata



## Oracle 12c – Multitenant Architecture (Cont'd)

- Pluggable Databases share the following files:
  - Undo Tablespace
  - Redo Logs
  - Control Files
  - (S)Pfile

Local undo  
introduced in  
12cR2



# Multitenant Architecture - Containers

```
SQL> SELECT con_id, NAME, open_mode FROM v$containers;
```

CON_ID	NAME	OPEN_MODE
1	CDB\$ROOT	READ WRITE
2	PDB\$SEED	READ ONLY
3	PDBTEST	READ WRITE
4	PINIDB	READ WRITE

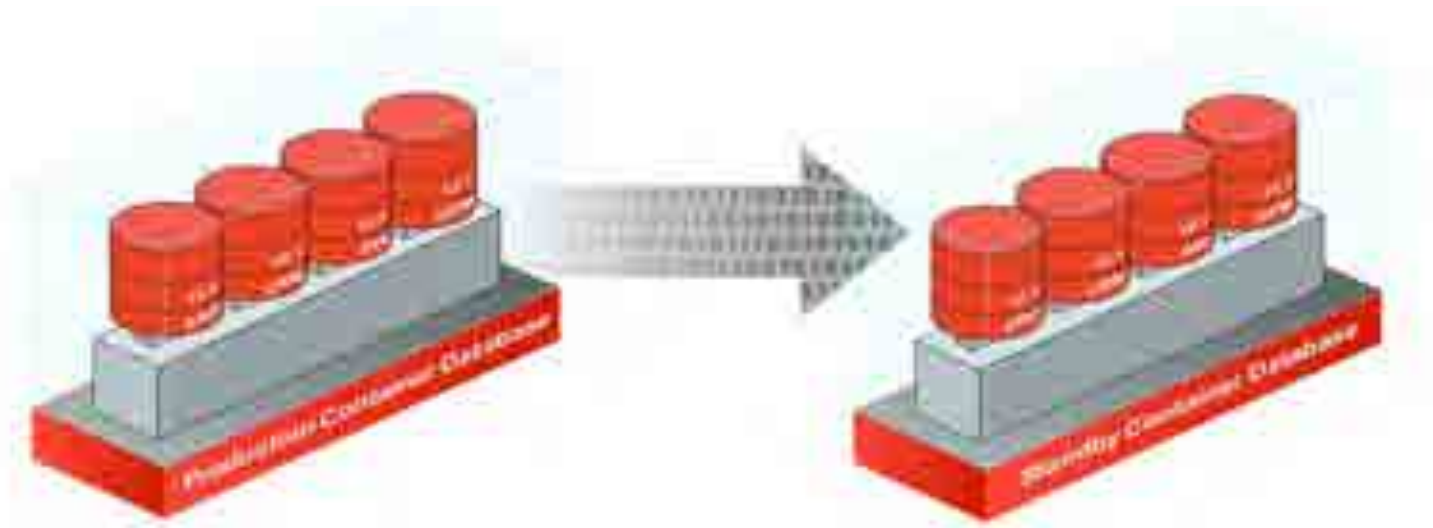
Created by default -  
Used as a template PDB  
for cloning

CON_ID	Description
0	Entire CDB/Non-CDB
1	Root container
2	Seed container
3-4098	User PDBs

# Manage Many as One

## Data Guard

- Data Guard operates at **CDB-Level**
- Maintenance at CDB-Level = **Reduced DBA efforts**



# Multitenant Advantages - Manage Many as One

## RMAN - Granular Backup & Restore Options

- Backup **entire CDB** at once or at **PDB level**

```
RMAN> BACKUP DATABASE;  
RMAN> BACKUP PLUGGABLE DATABASE PDB1, PDB2;
```

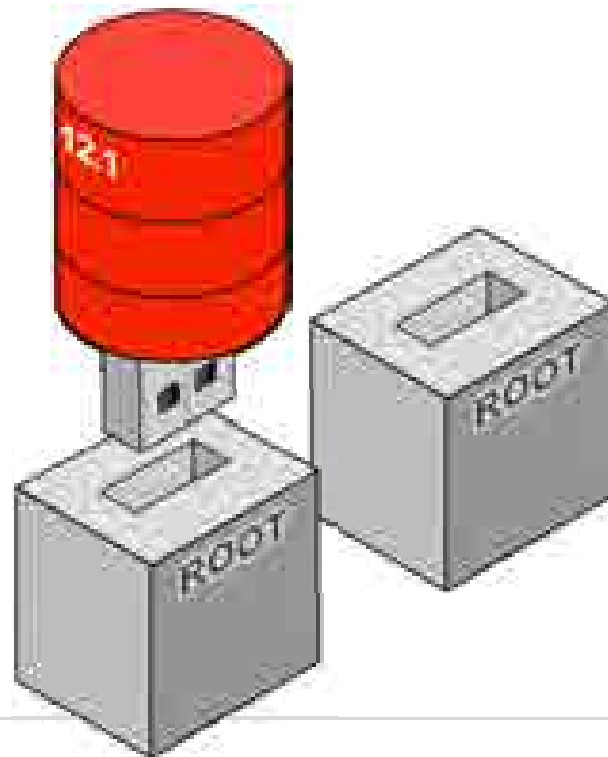
- Recover **entire container** at once or at **PDB level**

```
RMAN> RUN {  
    ALTER PLUGGABLE DATABASE DWH CLOSE;  
    SET UNTIL SCN 194551074;  
    RESTORE PLUGGABLE DATABASE DWH;  
    RECOVER PLUGGABLE DATABASE DWH;  
    ALTER PLUGGABLE DATABASE DWH OPEN RESETLOGS;  
}
```

## Multitenant Advantages - Unplug/Plug

Moving PDB from one container to another is **straightforward**

```
SQL> ALTER PLUGGABLE DATABASE pdbtest UNPLUG INTO '/oravl01/oracle/pdbtest_1.xml';  
Pluggable database altered.  
  
SQL> CREATE PLUGGABLE DATABASE pdbtest USING '/oravl01/oracle/pdbtest_1.xml'  
Pluggable database created.
```



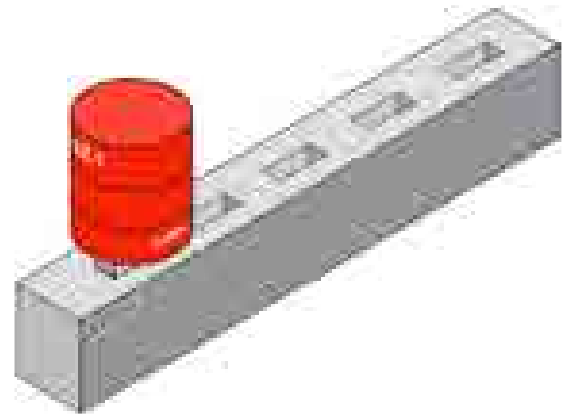


# Multitenant Advantages - Fast Cloning

- Clone PDB from another PDB **within the same CDB**
- Requires source PDB to be **OPEN READ ONLY** (12cR1)

Hot Clones  
are available  
in 12cR2

```
SQL> CREATE PLUGGABLE DATABASE DWH_TEST FROM DWH_PROD;  
Pluggable database created.
```

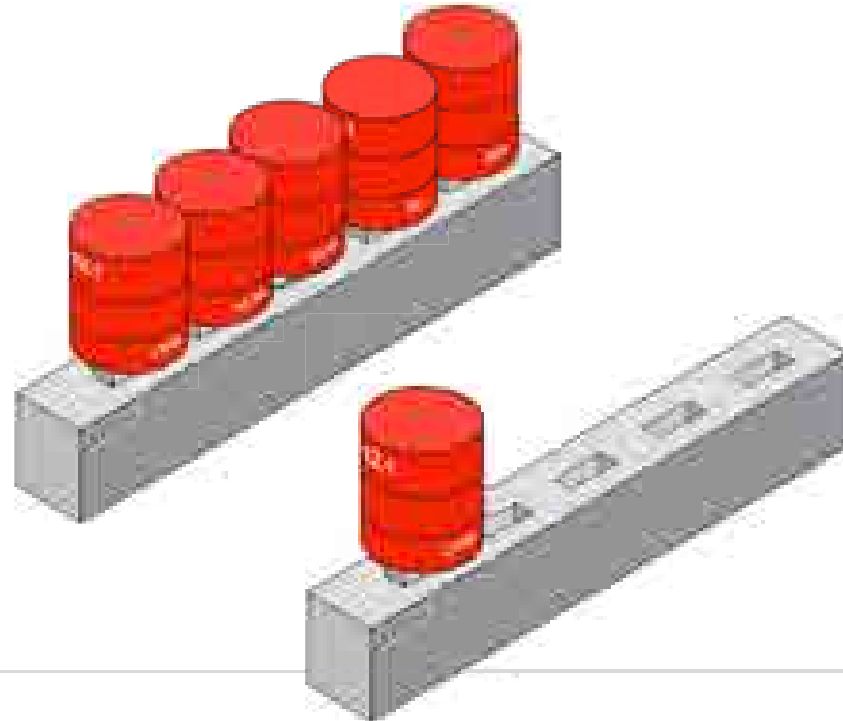


# Multitenant Advantages - Fast Cloning

- Clone PDB from another PDB in **remote CDB**
- Requires source PDB to be **OPEN READ ONLY** (12cR1)

```
SQL> CREATE PLUGGABLE DATABASE ERP FROM ERP@REMOTE_HOST;  
Pluggable database created.
```

Hot Clone is available in 12cR2



## Multitenant Advantages - Easy Replication (12c Release 2)

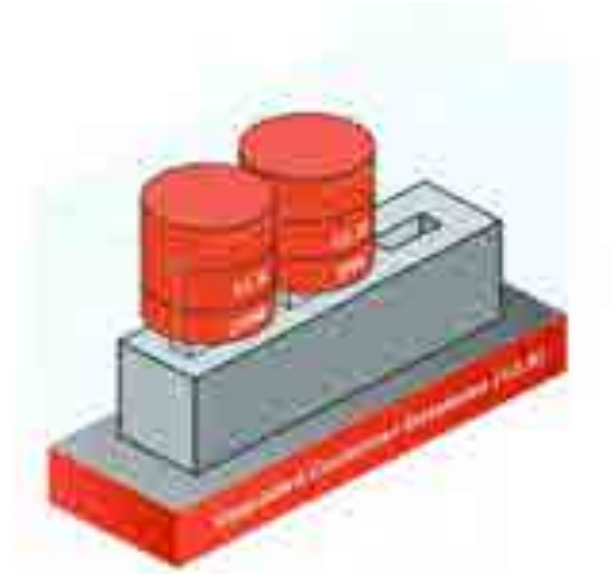
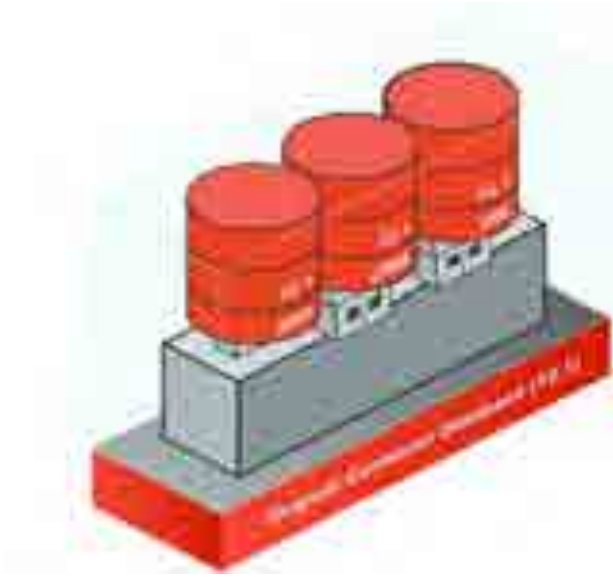
- **Refreshable PDB** – Allows refreshing contents of a cloned PDB
  - **Step 1** – takes a full clone. Doesn't require any downtime due to hot clone feature
  - **Step 2** - refresh by applying redo logs (either on-demand or automatically scheduled)
- Refreshable PDB should be in a read-only mode

```
CREATE PLUGGABLE DATABASE ERP FROM ERP@REMOTE_HOST  
REFRESH MODE EVERY 10 MINUTES;  
Pluggable database created.
```

# Multitenant Advantages - Manage Many as One

## Upgrades

- Upgrade or apply a patch **at CDB-Level**  
[https://blogs.oracle.com/UPGRADE/entry/upgrade\\_pdb\\_everything\\_at\\_once1](https://blogs.oracle.com/UPGRADE/entry/upgrade_pdb_everything_at_once1)
- **Unplug/plug** PDB into another container database  
[https://blogs.oracle.com/UPGRADE/entry/upgrade\\_pdb\\_one\\_at\\_a](https://blogs.oracle.com/UPGRADE/entry/upgrade_pdb_one_at_a)



## CDB Level vs. PDB-Level

### CDB-Level

- Oracle Software
- SGA & Background Processes
- RMAN Scheduled Backups
- Data Guard
- Some Parameters  
(*IsPDB\_Modifiable= 'FALSE'*)
- Control Files, Redo
- (S)Pfile, Password File

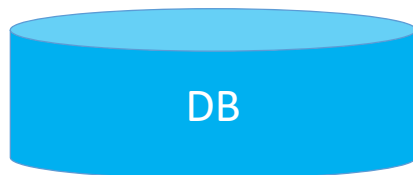
### PDB-Level

- FLUSH SHARED\_POOL
- FLUSH BUFFER\_CACHE
- Point In-Time Recovery
- RMAN Ad hoc Backups
- Some Parameters  
(*IsPDB\_Modifiable= 'TRUE'*)
- Undo Tablespace (**12cR2**)
- Character Set (**12cR2**)
- Flashback Database (**12cR2**)

# Oracle 12c – Deployment Options

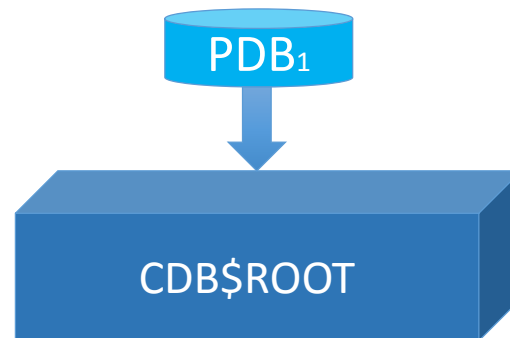
## Non-CDB

- Same as before 12c



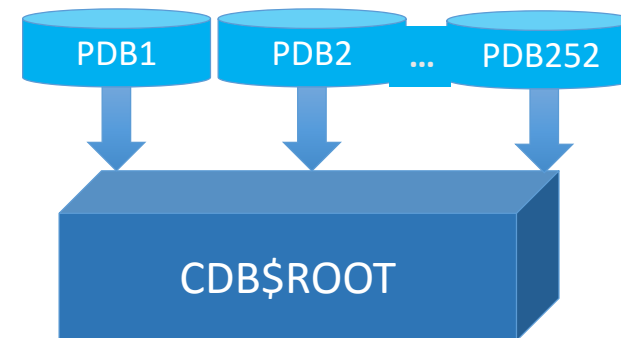
## Single Tenant

- No additional license
- Available in SE/SE1/SE2
- One active PDB



## Multitenant

- Option on top of Enterprise Edition
- Supports up to 4096 active PDBs



## Oracle 12c – Deployment Options (Cont'd)

### Why use Single Tenant instead of Non-CDB?

- Unplug/Plug
- Fast Cloning
- **but most importantly ...**

### Deprecation of Non-CDB Architecture

The non-CDB architecture was deprecated in Oracle Database 12c. It can be desupported and unavailable in a release after Oracle Database 12c Release 2.

Oracle recommends use of the CDB architecture.

*(source: Oracle 12c Release 2 Documentation)*

# Oracle 12c – DBCA

Non-CDB



Single Tenant / Multitenant





# Ensuring High Level of QoS with Multitenant Environments



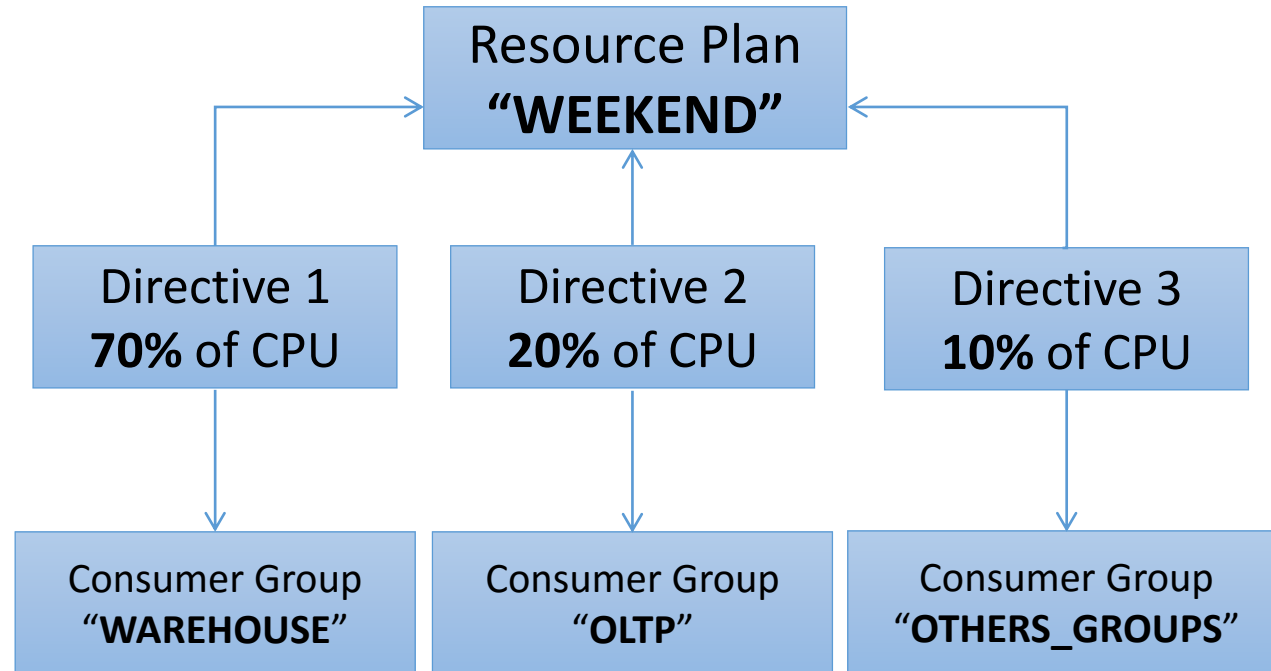
# QoS Challenges – Multitenant Environments

- **PDB-Level** QoS challenge
  - Allocation of resources among competing sessions
  - Example: One session consumes too many resources
- **CDB-Level** QoS challenge
  - Allocation of resources among competing PDBs
  - Example: One PDB consumes too many resources

# Oracle Resource Manager - The Basics (Pre 12c)

## Resource Manager Elements

- Resource Plan
- Resource Plan Directive
- Consumer Group



# The Solution - Oracle Resource Manager

- **PDB-Level** Resource Plan
  - Specifies how resources are allocated to consumer groups
  - Prioritize resources between competing sessions
- **CDB-Level** Resource Plan
  - Specifies how resources are allocated to PDBs
  - Prioritize resources between competing PDBs

# Oracle Resource Manager - 12c Multitenant

## CDB Resource Plan Directive

- CPU Shares
- CPU Utilization Limit
- Parallel Servers Limit

Example:

Pluggable Database	CPU Shares	Guaranteed CPU	CPU Limit	Parallel Servers Limit
OLTP	3	$3/4 = 75\%$	100%	100%
DWH	1	$1/4 = 25\%$	60%	100%

# Oracle Resource Manager - 12c Multitenant

- Obtain information about default CDB resource plan

```
SQL> SELECT plan_id,  
           plan,  
           comments,  
           mandatory  
FROM dba_cdb_rsrc_plans  
WHERE plan = 'DEFAULT_CDB_PLAN';
```

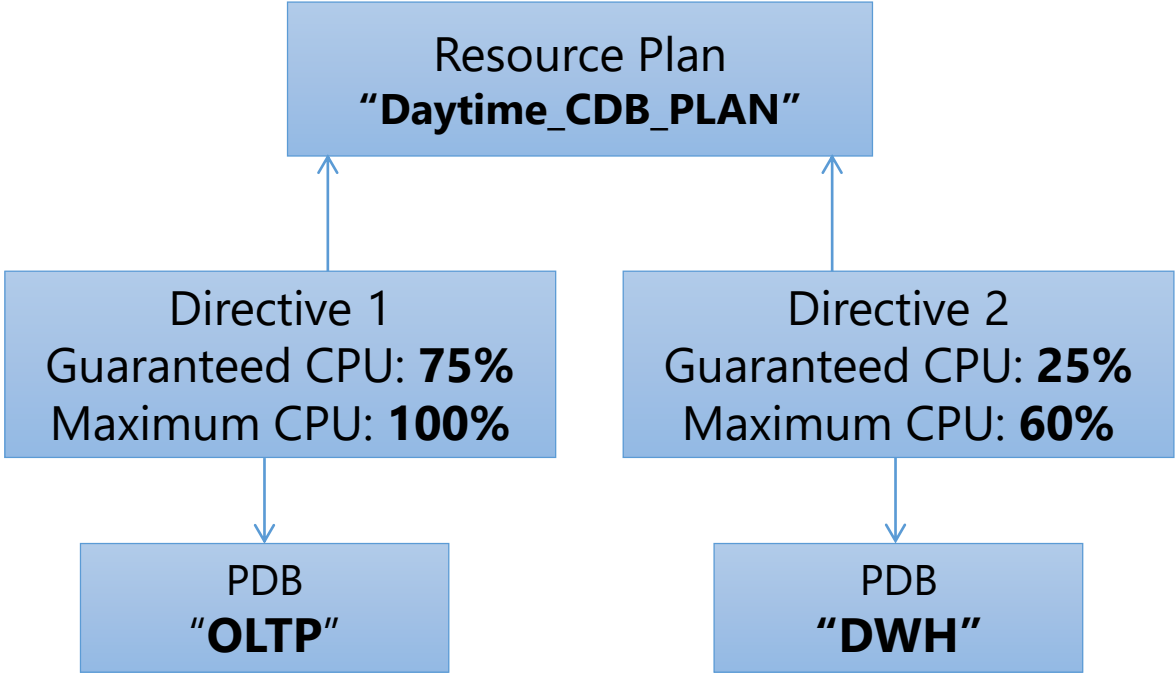
PLAN ID	PLAN	COMMENTS	MANDATORY
17349	DEFAULT_CDB_PLAN	Default CDB plan	YES

- Obtain information about default PDB directive

```
SQL> SELECT SHARES, UTILIZATION_LIMIT, PARALLEL_SERVER_LIMIT  
FROM DBA_CDB_RSRC_PLAN_DIRECTIVES  
WHERE PLAN = 'DEFAULT_CDB_PLAN'  
AND PLUGGABLE_DATABASE = 'ORACLEDEFAULT_PDB_DIRECTIVE';
```

SHARES	UTILIZATION_LIMIT	PARALLEL_SERVER_LIMIT
1	100	100

# Example of CDB-Level Resource Plan



Pluggable Database	CPU Shares	Guaranteed CPU	CPU Limit	Parallel Servers Limit
OLTP	3	3/4 = 75%	100%	100%
DWH	1	1/4 = 25%	60%	100%

# Creating CDB Resource Plan

```

DECLARE
  daytime_plan VARCHAR2(30) := 'DAYTIME_CDB_PLAN';
BEGIN
  DBMS_RESOURCE_MANAGER.clear_pending_area;
  DBMS_RESOURCE_MANAGER.create_pending_area;

  DBMS_RESOURCE_MANAGER.create_cdb_plan(
    plan      => daytime_plan,
    comment   => 'A daytime CDB resource plan');

  DBMS_RESOURCE_MANAGER.create_cdb_plan_directive(
    plan                => daytime_plan,
    pluggable_database  => 'OLTP',
    shares              => 3,
    utilization_limit   => 100,
    parallel_server_limit => 100);

  DBMS_RESOURCE_MANAGER.create_cdb_plan_directive(
    plan                => daytime_plan,
    pluggable_database  => 'DWH',
    shares              => 1,
    utilization_limit   => 60,
    parallel_server_limit => 100);

  DBMS_RESOURCE_MANAGER.validate_pending_area;
  DBMS_RESOURCE_MANAGER.submit_pending_area;

END;
/

```

Pluggable Database	CPU Shares	Guaranteed CPU	CPU Limit
OLTP	3	3/4 = 75%	100%
DWH	1	1/4 = 25%	60%



## Creating CDB Resource Plan (Cont'd)

```
SQL> SELECT plan_id,  
           plan,  
           comments,  
           mandatory  
FROM dba_cdb_resource_plans  
WHERE plan = 'DAYTIME_CDB_PLAN'
```

PLAN_ID	PLAN	COMMENTS	MANDATORY
183675	DAYTIME_CDB_PLAN	A daytime CDB resource plan	NO

```
SQL> SELECT pluggable_database,  
           shares,  
           utilization_limit,  
           parallel_server_limit  
FROM dba_cdb_resource_plan_directives  
WHERE plan = 'DAYTIME_CDB_PLAN' AND DIRECTIVE_TYPE = 'PDB';
```

PLUGGABLE_DATABASE	SHARES	UTILIZATION_LIMIT	PARALLEL_SERVER_LIMIT
CLTP	3	100	100
DWH	1	60	100

## Enabling/Disabling CDB Resource Plan

- Manually enabling resource plan

```
SQL> ALTER SYSTEM SET RESOURCE_MANAGER_PLAN = 'DAYTIME_CDB_PLAN';
System altered.

SQL> SHOW PARAMETER RESOURCE_MANAGER_PLAN
NAME                                TYPE                                VALUE
-----                                -                                -
resource_manager_plan                string                              DAYTIME_CDB_PLAN
```

- Manually disabling resource plan

```
SQL> ALTER SYSTEM SET RESOURCE_MANAGER_PLAN = '';
System altered.

SQL> SHOW PARAMETER RESOURCE_MANAGER_PLAN
NAME                                TYPE                                VALUE
-----                                -                                -
resource_manager_plan                string
```

## Enabling/Disabling CDB Resource Plan (Cont'd)

### Automatically Enable/Disable CDB Resource Plan

```
BEGIN
DBMS_SCHEDULER.CREATE_WINDOW (
  window_name      => 'DAYTIME_WINDOW',
  resource_plan    => 'DAYTIME_CDB_PLAN',
  start_date       => '15-JUL-23 9.00.00AM US/Pacific',
  repeat_interval  => 'FREQUENTLY',
  duration         => interval '10' HOUR,
  comments         => 'Daytime window for CDB Resource Plan');
END;
/

SQL> SELECT START_DATE,
           REPEAT_INTERVAL,
           DURATION,
           ENABLED,
           ACTIVE
        FROM cdb_scheduler_windows
        WHERE window_name = 'DAYTIME_WINDOW';
```

START_DATE	REPEAT_INTERVAL	DURATION	ENABLED	ACTIVE
15-JUL-23 09:00:00:00 AM US/PACIFIC	FREQ=DAILY	+000 10:00:00	TRUE	FALSE

# PDB Level Memory Resource Management

- Not available in 12c Release 1
- 12c Release 2 - Memory parameters can be set at PDB level
  - SGA\_TARGET
  - DB\_CACHE\_SIZE
  - DB\_SHARED\_POOL\_SIZE
  - PGA\_AGGREGATE\_LIMIT
  - PGA\_AGGREGATE\_TARGET
  - SGA\_MIN\_SIZE

A thought bubble graphic with an orange-to-brown gradient, containing the text "New in 12c Release 2". It is connected to the "SGA\_MIN\_SIZE" parameter in the list above by three small circles of the same color.

New in 12c  
Release 2

# PDB Level I/O Resource Management

- Not available in 12c Release 1
- 12c Release 2 Introduced the following new parameters:
  - **MAX\_IOPS** - limits number of I/O operations per second
  - **MAX\_MBPS** - limits megabytes for I/O operations per second
  - Default : **0** (no limit)
- If Oracle waits due to I/O limit “**resmgr: I/O rate limit**” wait event will appear
- Cannot be set in a Non CDB

# How Many Resources Actually Being Used by PDBs?

- **Option #1** - DBA\_HIST\_RSRC\_PDB\_METRIC
  - Displays historical resource manager metrics by PDB

```
SQL> SELECT MAX(IOPS),  
           MAX(IOMBPS),  
           MAX (SGA_BYTES)/1024/1024 MAX_SGA_MB,  
           MAX (PGA_BYTES)/1024/1024 MAX_PGA_MB  
FROM DBA_HIST_RSRC_PDB_METRIC  
WHERE CON_ID = 3
```

MAX(IOPS)	MAX(IOMBPS)	MAX_SGA_MB	MAX_PGA_MB
70.42610093	19.146117287	761.419693	56.08001532

- **Option #2** - AWR\_ROOT\_RSRC\_PDB\_METRIC (underlying AWR table)
- **Option #3** - AWR Reports

# Maintenance Tasks in Oracle Multitenant

- **ENABLE\_AUTOMATIC\_MAINTENANCE\_PDB** parameter
  - Can be used to enable/disable running of maintenance tasks
  - Default: true
  - Can be set at either CDB or PDB levels
- **AUTOTASK\_MAX\_ACTIVE\_PDBS** parameter
  - Maximum number of PDBs that can schedule maintenance tasks concurrently
  - Default: 2 (two PDBs and the CDB root can run tasks at the same time)
  - Can be set at CDB level only
- Both parameters introduced in 12c Release 2

# RAC & Multitenant





# Why RAC & Multitenant?

- Single Instance & Multitenant **challenges**
  - Not Scalable = Limited Consolidation Solution
  - Instance Down → Downtime for all PDBs
- RAC makes Multitenant **better**
  - **Scalable** = True consolidation solution
  - **Available** = Instance Down → PDBs continue running on other nodes

# RAC & Multitenant

- Multitenant **fully** supports RAC
- PDBs can be opened on **specific** instances

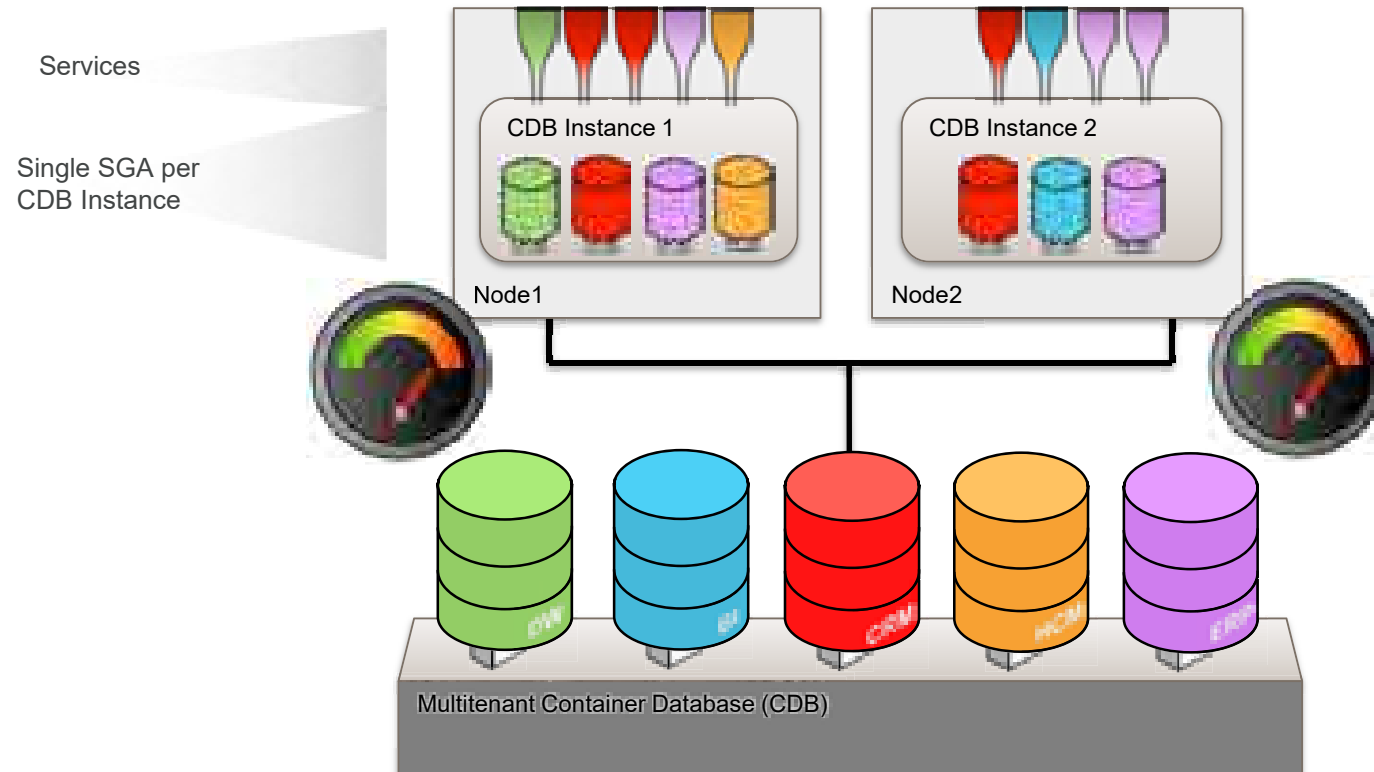
```
SQL> SELECT inst_id, name, open_mode FROM gv$pdbs ORDER BY 1 DESC;
```

INST_ID	NAME	OPEN_MODE
2	PDBTEST	READ WRITE
1	PDBTEST	MOUNTED
1	PDB\$SEED	READ ONLY
2	PDB\$SEED	READ ONLY
1	POGPDN	READ WRITE
2	POGPDN	READ WRITE

6 rows selected.

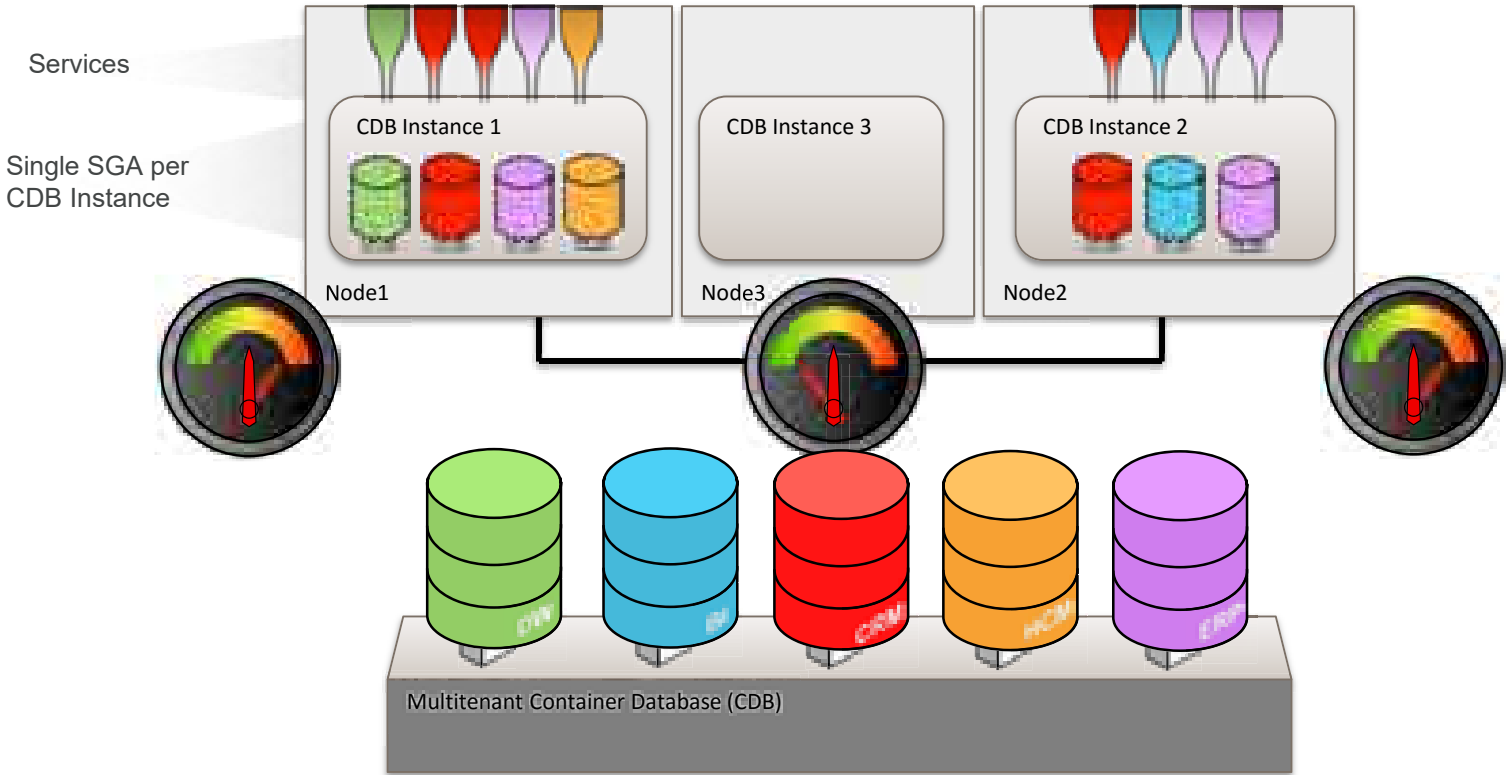
# RAC & Multitenant

PDBs workload **distributed** across RAC instances



# RAC & Multitenant

PDBs workload **distributed** across RAC instances



## RAC & Multitenant

```
SQL> CREATE PLUGGABLE DATABASE pdbtest FROM prod;
Pluggable database created.
```

```
SQL> SELECT inst_id, con_id, open_mode
FROM gv$pdbs
WHERE name = 'PDBTEST'
```

INST_ID	CON_ID	OPEN_MODE
2	4	MOUNTED
1	4	MOUNTED

```
/orav101/12.1.0.1/grid/bin > ./srvctl add service -s svc_pdbtest
-db 0121RAC -pdb PDBTEST -preferred 0121RAC2 -available 0121RAC1
```

Preferred Instance

Available Instance

# RAC & Multitenant

```
SQL> SELECT inst_id, con_id, open_mode
FROM gv$pdbs
WHERE name = 'PDBTEST'
```

INST_ID	CON_ID	OPEN_MODE
1	4	MOUNTED
2	4	MOUNTED

```
/oravl01/12.1.0.1/grid/bin > srvctl start service -s svc_pdbtest -db O121RAC
```

```
SQL> SELECT inst_id, con_id, open_mode
FROM gv$pdbs
WHERE name = 'PDBTEST'
```

INST_ID	CON_ID	OPEN_MODE
1	4	MOUNTED
2	4	READ WRITE

← PDB opened only in Preferred instance

```
SQL> SHUTDOWN IMMEDIATE)
ORACLE instance shut down.
```

← Shutting down the preferred instance

```
SQL> SELECT inst_id, con_id, open_mode
FROM gv$pdbs
WHERE name = 'PDBTEST'
```

INST_ID	CON_ID	OPEN_MODE
1	4	READ WRITE

← PDB automatically starts in the other instance

# Performance Monitoring for Multitenant Environments



# Multitenant & AWR – Oracle 12c Release 1

- Snapshots taken **only** at **CDB-Level**
- AWR data reside in **cdb\$root container**





## Multitenant & AWR – Oracle 12c Release 1 (Cont'd)

```
SQL> show con_name

CON_NAME
-----
CDB$ROOT

SQL> select count(*) from WRH$_WAITSTAT;

COUNT(*)
-----
      10944

SQL> alter session set container=pdbtest;
Session altered.

SQL> show con_name

CON_NAME
-----
PDBTEST

SQL> select count(*) from WRH$_WAITSTAT;

COUNT(*)
-----
         0
```

## Multitenant & AWR – Oracle 12c Release 1 (Cont'd)

- AWR reports are available **only** at **CDB level**
- AWR Management Operations **only** at **CDB level**
  - AWR data retention
  - Snapshot schedule
  - Taking manual snapshots
  - Purging snapshot data
- Unplugged PDB **does not** contain AWR information

# Multitenant & AWR – Oracle 12c Release 1 (Cont'd)

## SQL ordered by Elapsed Time

- Response reported for PL/SQL code includes the resources used by all DDL statements called by the code.
- % Total DB Time is the Elapsed Time of the SQL statement divided into the Total Database Time multiplied by 100.
- % Total - Elapsed Time as a percentage of Total DB Time.
- % CPU - CPU Time as a percentage of Elapsed Time.
- % IO - User I/O Time as a percentage of Elapsed Time.
- Captured SQL account for 75.0% of Total DB Time (at 100).
- Captured PL/SQL account for 3.0% of Total DB Time (at 100).



Elapsed Time (s)	Executions	Elapsed Time per Exec (s)	% Total	% CPU	% IO	SQL ID	SQL Module	Plan Name	SQL Text
127.13	1	127.13	87.86	99.99	1.00	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select COUNTRY from SALES_TERR...
13.56	1	13.56	7.24	6.22	95.78	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select count(*) from SALES_ORG...
5.54	0		2.97	83.41	13.78	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	DECODE(dept_marketed_repository...
0.88	1	0.88	0.33	83.10	17.18	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select table_name from dba_tab...
0.74	1	0.74	0.28	84.57	9.54	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select table_name from dba_tab...
0.68	124	0.00	0.03	100.21	0.00	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select dept, typeid, class, m...
0.66	41	0.00	0.03	100.00	0.00	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select emp, emp1, emp1, emp...
0.60	125	0.00	0.02	99.67	0.00	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	SELECT JOB, LAST_DATE, TIME_DA...
0.60	70	0.00	0.02	100.19	0.00	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select fn_conned_by_name...
0.60	86	0.00	0.02	100.10	0.00	13666666666666666666	sqlplsql@ms008 (TMS V1-V3)	TEST	select user, password, date...

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## Multitenant & AWR – Oracle 12c Release 2

- Snapshots can be taken either at **CDB** or **PDB level**
- Snapshot data reside in SYSAUX tablespace of each PDB
- It is possible to create a report at PDB-level AWR report
- AWR management operations at either **CDB** or **PDB level**
- New Parameter: AWR\_PDB\_AUTOFLUSH\_ENABLED
  - Specifies whether to enable automatic AWR snapshots for PDBs
  - Default : **false** (automatic AWR snapshots are disabled for PDBs)
  - Can be set at CDB or PDB level

# Multitenant & AWR – Oracle 12c Release 2 (Cont'd)

## WORKLOAD REPOSITORY PDB report (PDB snapshots)

DB Name	DB Id	Unique Name	Role	Edition	Release	RAC	COB
ORA122	631936275	ora122	PRIMARY	EE	12.2.0.1.0	NO	YES

Instance	Inst Num	Startup Time
ora122	1	06-Mar-17 18:03

Container DB Id	Container Name	Open Time
631936275	TEST1	06-Mar-17 18:05



Host Name	Platform	CPUs	Cores	Sockets	Memory (GB)
tn-arhb541.prod.quest.com	Linux x86_64-b2	4	4	1	3.74

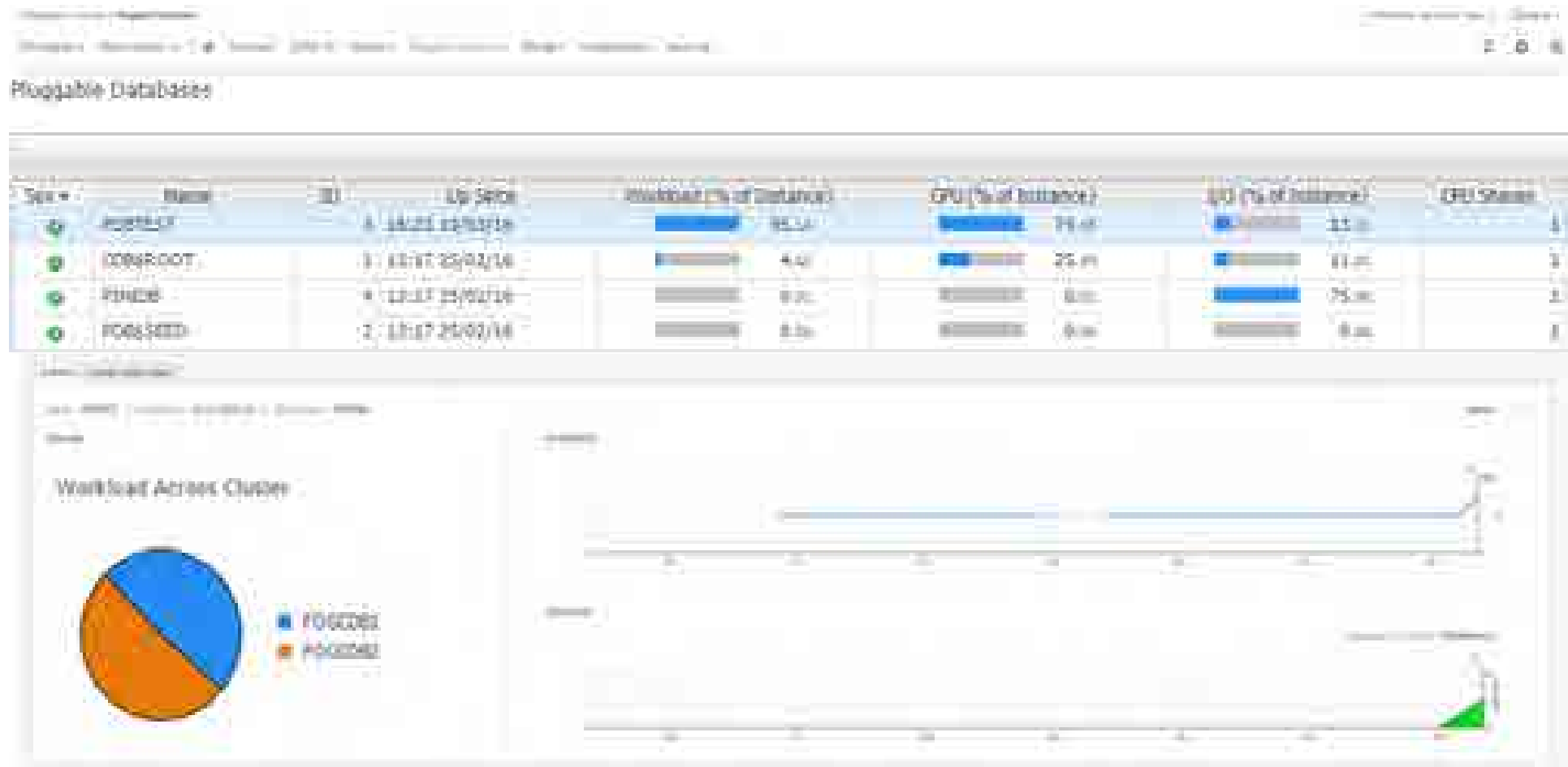
	Snap Id	Snap Time	Sessions	Custom/Sessions
Begin Snap	1	06-Mar-17 21:20:00	0	3.0
End Snap	2	06-Mar-17 21:20:10	0	7.0
Elapsed		0.16 (mins)		
DB Time		0.06 (mins)		

# Workload Analysis using OEM ASH Analytics



Only with Enterprise Edition + Diagnostics Pack

# Workload Analysis using Foglight for Oracle

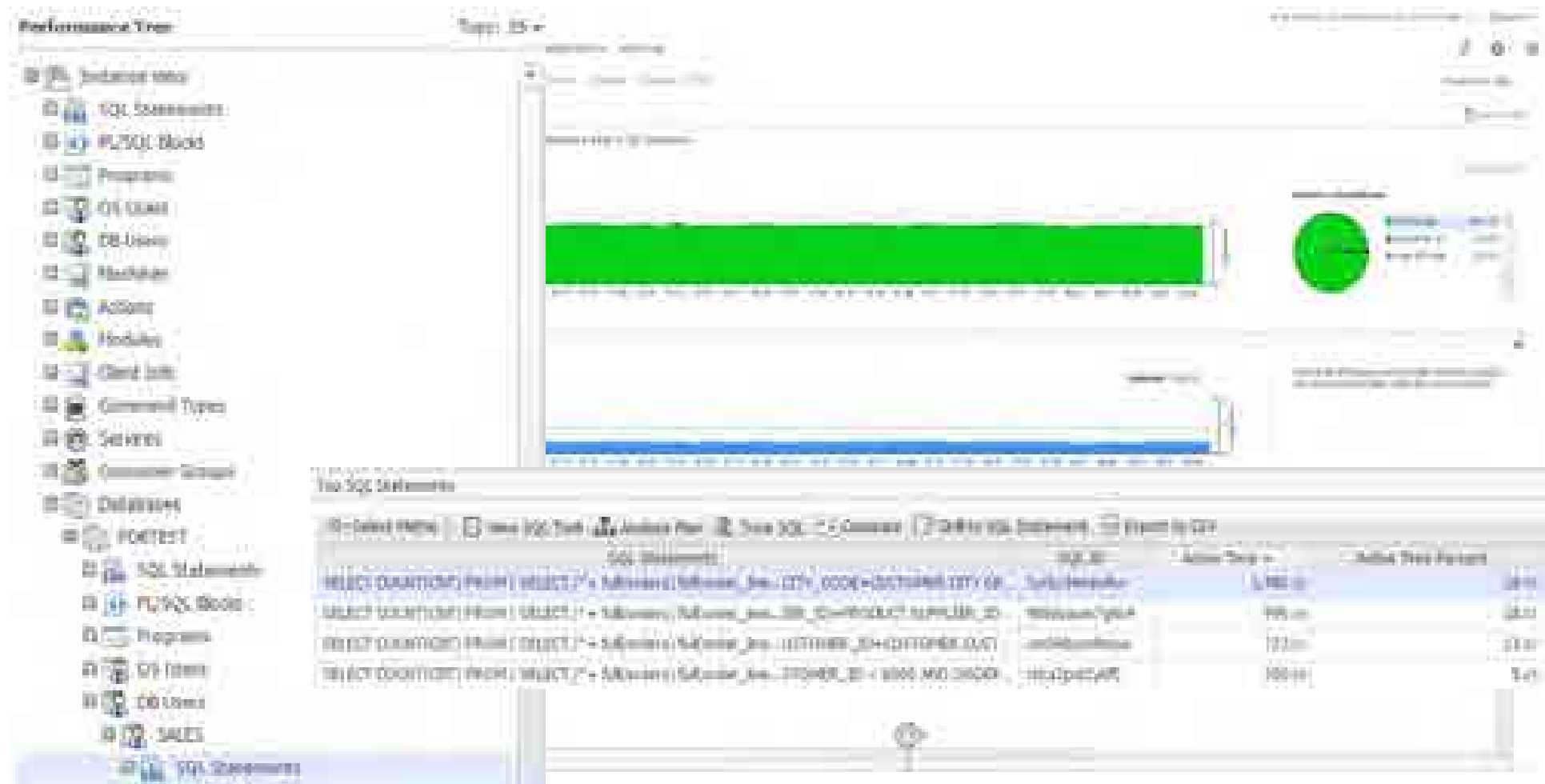


# Workload Analysis using Foglight for Oracle





# Workload Analysis using Foglight for Oracle



# References

- Introduction to the Multitenant: Architecture (Documentation)

<http://docs.oracle.com/database/122/CNCPT/introduction-to-the-multitenant-architecture.htm#CNCPT89234>

- Oracle Multitenant (White Paper)

<http://www.oracle.com/technetwork/database/multitenant-wp-12c-1949736.pdf>

- Oracle Multitenant: New Features in Oracle Database 12c Release 12 (White Paper)

<http://www.oracle.com/technetwork/database/multitenant/overview/multitenant-wp-12c-2078248.pdf>

- Mike Dietrich Blog

<https://blogs.oracle.com/UPGRADE/>

*Note: All diagrams and illustrations are used by permission of Oracle*

# Q&A





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**Registration Required:**

**<http://ora.cl/pO1yL>**

(that's a little p, big O, one, little y, big L)

Thank You!

