

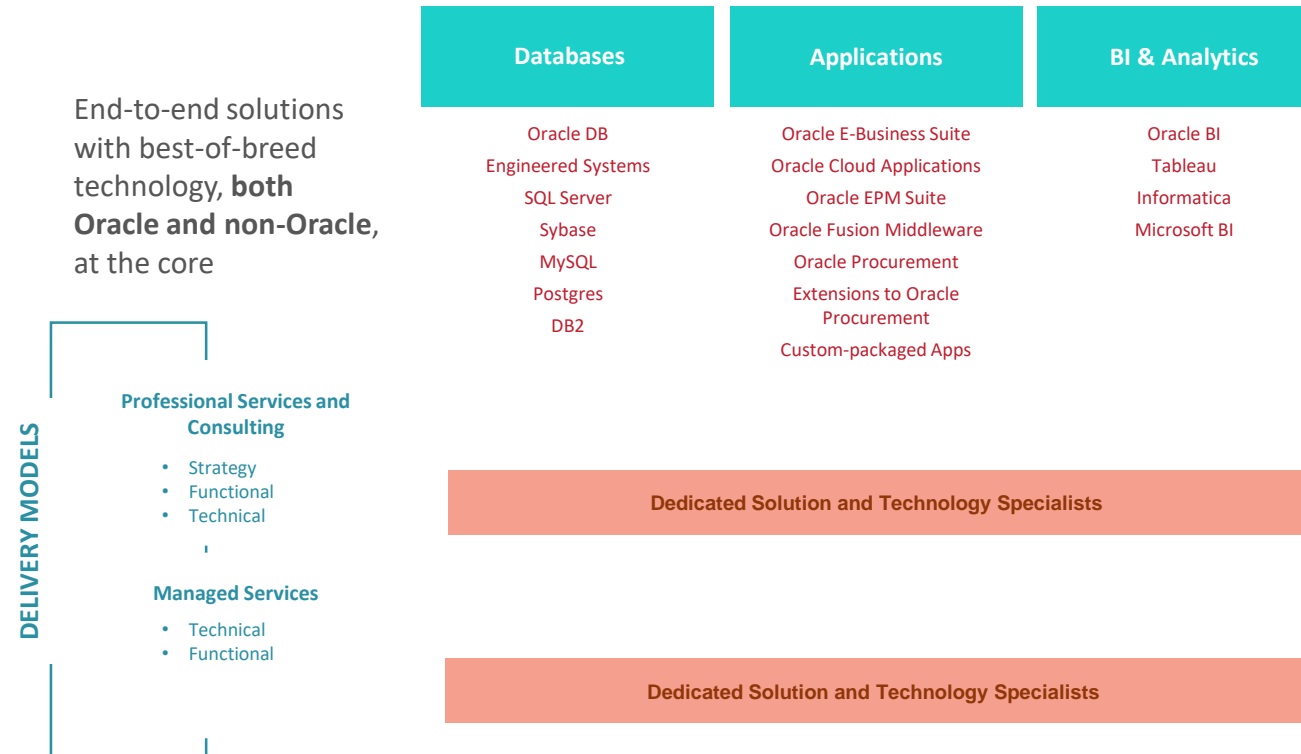


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 @anujmo

DBA 101: Multitenant for beginners

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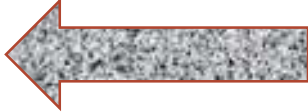
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AGENDA

- Oracle's Previous Releases 
- CDB/PDB Introduction and Concepts
- Shared / Exclusive components
- Accessing CDB's/PDB's
- Backup and Recovery
- Quick overview: migration options to 18c from previous versions.
- PDB - Explanation of Value (EOV)

- 1982: RSI became Oracle Corporation
- 1983: version 3, supported COMMIT and ROLLBACK functionality for transactions. extended platform support to include Unix environments
- 1984: version 4, which supported read-consistency
- 1985: version 5, which supported the client–server
- 1986: Oracle version 5.1 started supporting distributed queries
- 1988: version 6 supported PL/SQL embedded within Oracle Forms v3 (version 6 could not store PL/SQL in the database proper), row-level locking and hot backups

1992: Oracle version 7

- Referential integrity
- Stored procedures
- Triggers.

1997: Oracle version 8

- Object-oriented
- Multimedia applications

1999: Oracle8i

- Internet
- Java virtual machine

2001: Oracle9i

- 400+ New features
- Oracle RAC replace OPS

2003: Oracle Database 10g

- Automatic Storage Management
- Oracle Data Pump
- Virtual Private Database
- Automatic Shared Memory Management
- ADDM and SQL Tuning Advisor
- Automatic Workload Repository
- Automatic Segment Management
- Flashback Table

2007: Oracle Database 11g

- Database Replay
- SQL Performance Analyzer
- Active Data Guard
- Snapshot Standby
- Flashback Data Archives
- Edition-Based Redefinition
- RAC One Node, and Clusterware
- Grid Infrastructure (R2)
- Data Recovery Advisor
- Few years later EXADATA

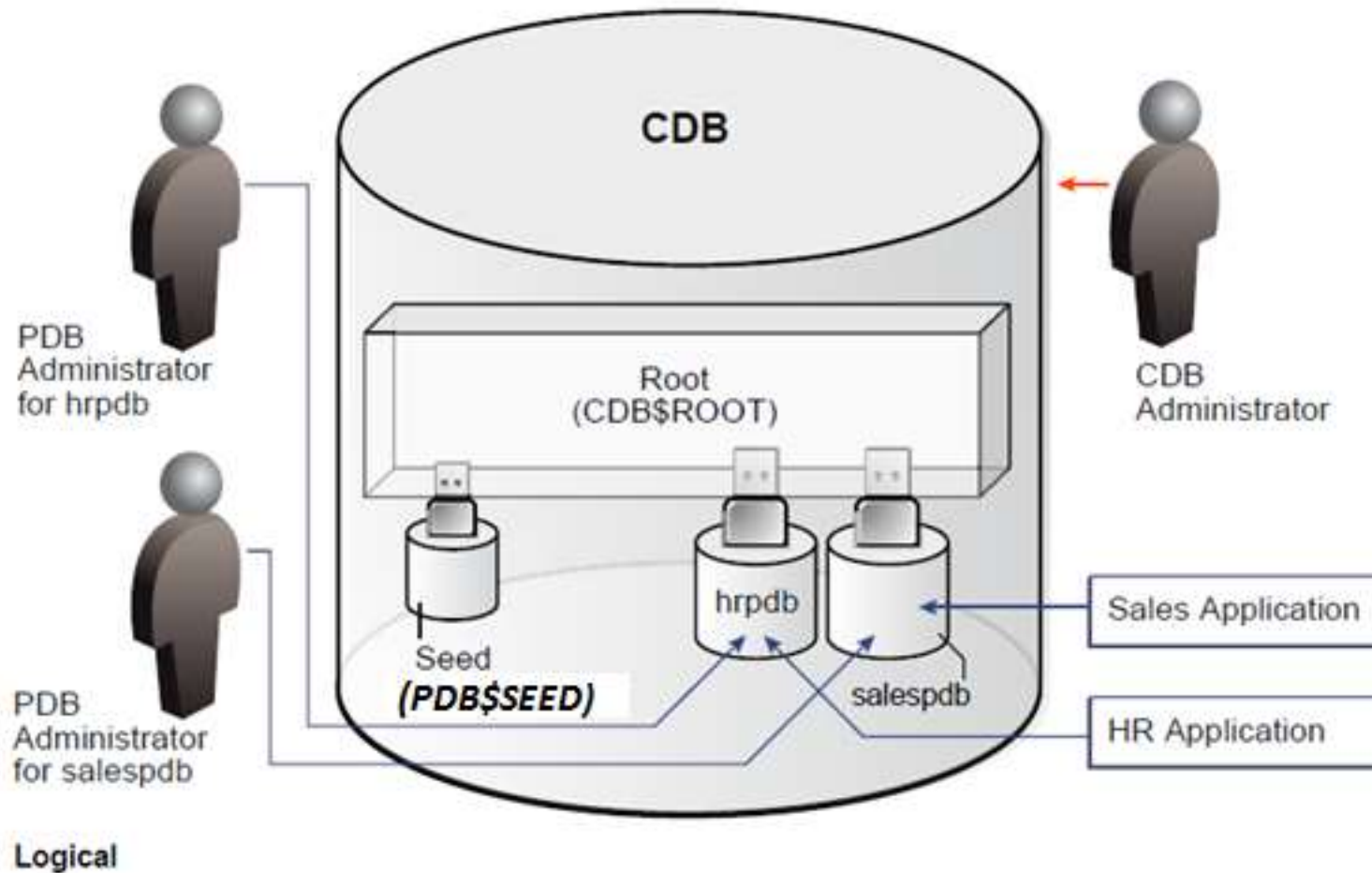
2013: Oracle 12c

- Container / Pluggable databases
- Online Datafile and Partition Movement
- Policy-Based Automatic Redaction
- Flex ASM
- SQL Plan Management enhancements
- Information Lifecycle Management (ILM)
- Automatic Data Optimization (ADO)

AGENDA

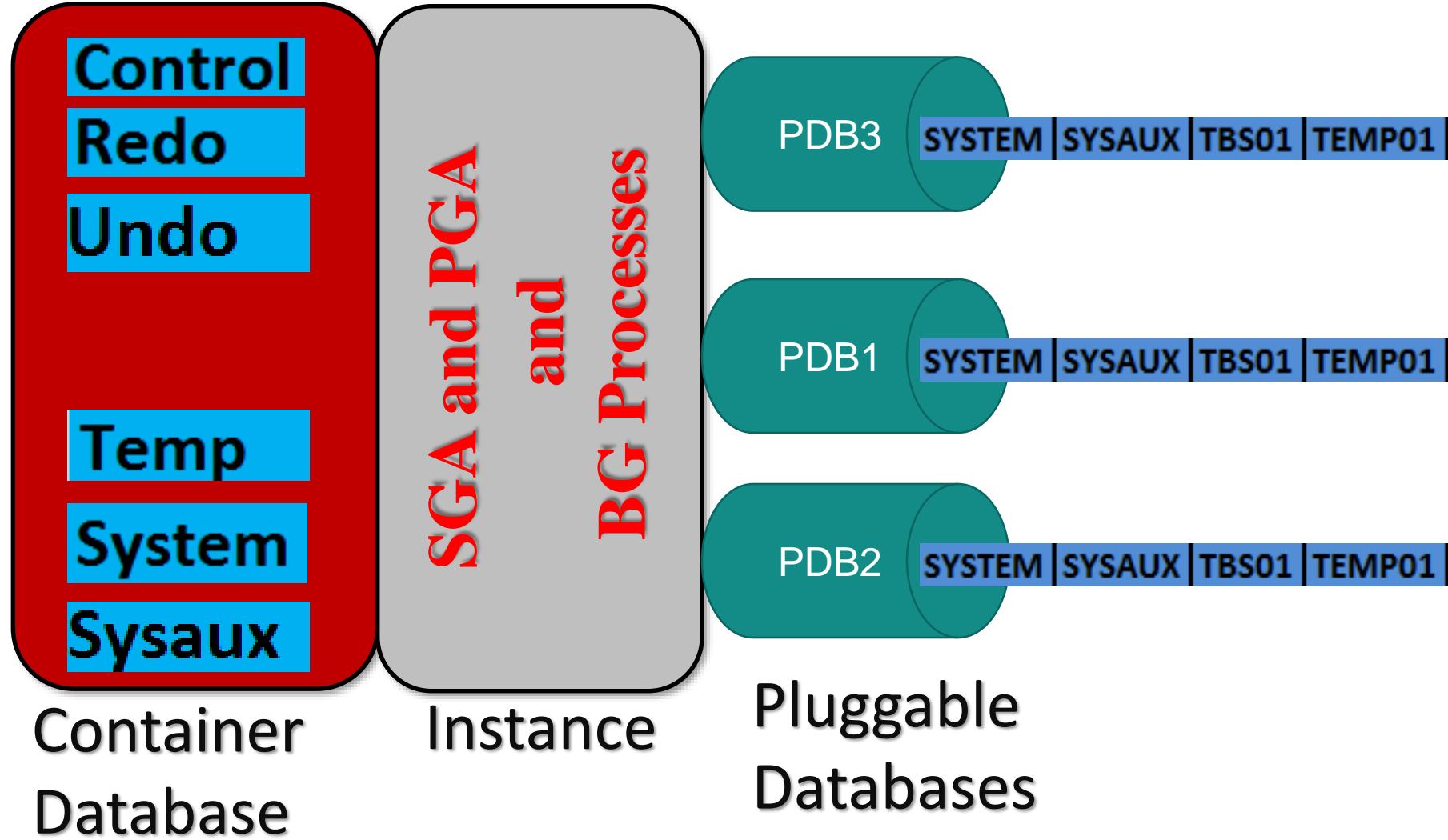
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Understanding in simple words

- CDB is a normal database with additional capability of storing one or more non CDB
- These non CDB's within CDB are called PDB
- PDB's can be plugged and unplugged easily from one container to another container.
In previous example we have two PDBs hrpdb and salespdb
- ***CDB Container database
- ***PDB pluggable database



Option for creating Container Database

Database Configuration Assistant - Application - Step 2 of 5

Creation Mode

Database Operation
Creation Mode
Pre Requisite Checks
Summary
Progress Page

☒ Create a database with default configuration

Global Database Name: ANUJ

Storage Type: File System

Database Files Location: {ORACLE_BASE}/oradata Browse...

Fast Recovery Area: {ORACLE_BASE}/fast_recovery_area Browse...

Administrative Password:

Confirm Password:

☒ Create As Container Database

Pluggable Database Name: anuj_pdb1

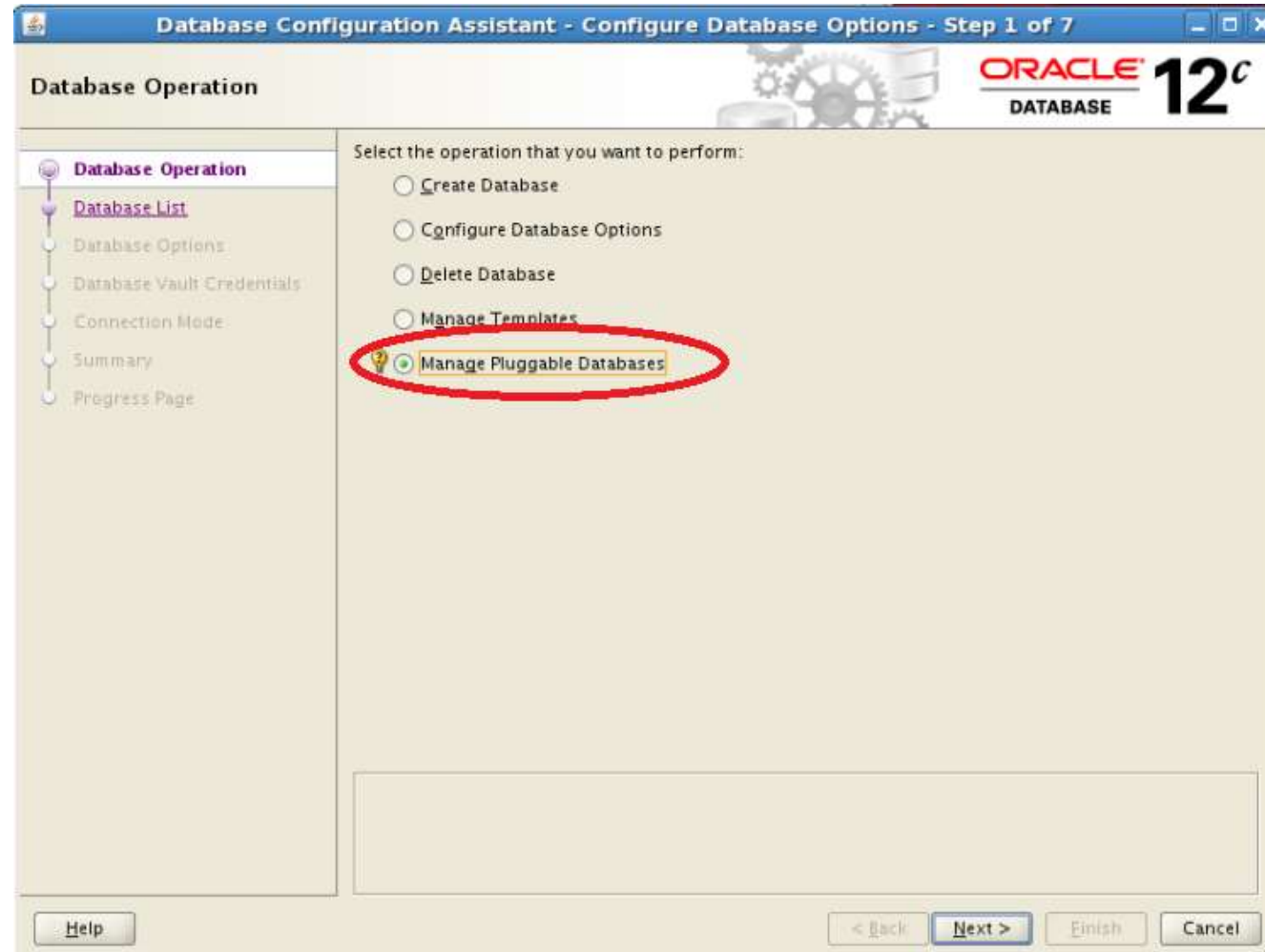
☐ Advanced Mode

Allows customization of storage locations, initialization parameters, management options, database options and different passwords for Administrator user accounts.

Help < Back Next > Finish Cancel

Check this option to create container database. You can give name of PDB in below text box

PDB using DBCA



PDB using DBCA



Ways to deploy a PDB

- From an existing remote PDB
- From PDB\$SEED
- From an existing local PDB
- Unplug from a CDB and plug into another CDB

Ways to deploy a PDB

- **Cloning a remote PDB (Clone anuj@CDB1 as mohan@CDB2)**

- Connect to CDB1 and place Anuj in read only mode

- Connect to CDB2 as sys and run clone command

(if using a common user you need to grant "create pluggable database" container=all)

- `create pluggable database mohan from anuj@CDB2_dbl** admin user sys identified by sys_pwd file_name_convert = ('/u01/pdbs/anuj','/u01/pdbs/mohan');`
- `alter pluggable database Mohan open;`

* Endian format, character set, etc must be compatible between CDBs

** CDB2_dbl is database link used for communication between CDB1 and CDB2

Ways to deploy a PDB

- **Creating an PDB (Anuj) from PDB\$SEED**

- Set db_file_name_convert

```
SQL> alter system set PDB_FILE_NAME_CONVERT ='/u01/datafiles/pdbseed/', '/u01/datafiles/Anuj/'  
scope=both;
```

- Run create pdb command

```
SQL> CREATE PLUGGABLE DATABASE Anuj ADMIN USER PDB_Anj IDENTIFIED BY PDB_Anj default tablespace users  
datafile '/u01/datafiles/Anuj/users_01.dbf' size
```

```
1000M;ROLES=(DBA);
```

Pluggable database created.

- Open PDB in read write mode

```
SQL> alter pluggable database Anuj open;
```

Ways to deploy a PDB

Cloning a PDB (Clone Anuj as Mohan)

Connect to CDB root as sys

Open Anuj in read-only mode and run create pdb

- `alter pluggable database Anuj close;`
- `alter pluggable database Anuj open read only;`
- `create pluggable database Mohan from Anuj admin user sys identified by sys_pwd file_name_convert = ('/u01/pdbs/anuj','/u01/pdbs/mohan');`

Open the database

- `alter pluggable database mohan open;`

Ways to deploy a PDB

Unplug and plug

Connect to source(CDB1) as sys

Shut down Anuj

- alter pluggable database Anuj close;
- alter pluggable database Anuj unplug into '/u01/datafiles/Anuj/Anuj.xml';
- If you do not want to keep this PDB anymore on Current CDB you can drop it but make a copy of data files before drop.
 - drop pluggable database Anuj

Ways to deploy a PDB

Unplug and plug continue...

Connect to Destination(CDB2) as sys

- `select dbms_pdb.check_plug_compatibility(pdb_descr_file=>'/u01/datafiles/Anuj/Anuj.xml', store_report=>true) from dual;`

Check for errors in pdb_plug_in_violations table


move PDB files and use nocopy

- `create pluggable database Anuj using '/u01/datafiles/Anuj/Anuj.xml' nocopy;`

** Similar to transportable databases

** XML file has PDB metadata

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Common Component in Container Databases (CDB's)

- Background processes –
- Memory areas – buffer cache, log buffer, etc.
- Datafiles (Undo / Redo
- Undo tablespace
- Single ADR location
- PDB's may have their own datafiles

Common vs. Local Concept

- Common vs Local Concept
 - Can be defined on CDB or PDB Level
 - Users → Defined on root or local PDB
 - Roles → Defined on root or local PDB
 - Privileges → Defined on root or local PDB
 - Objects → Defined on root or local PDB

Common and Local Privileges

- A common privilege is privilege granted across all containers
- A privilege granted to a single PDB is a local privilege
- Local users can only utilize privileges locally in the current PDB
- Common users can only utilize privileges locally in the current PDB
- Common users connected to the root container can utilize privileges across container, such as creating a common user

Common and Local Roles

- local user can only create local roles. Local roles can be granted to local or common users. Local roles can be granted to common roles.
- common user can create common roles and/or local roles. Common roles can be granted to local or common users. Common roles can be granted to local roles
 - SQL> create role c##_bill_master CONTAINER=ALL;
 - SQL> create role bill_local CONTAINER=CURRENT;

Grant and Revoke Privileges and Roles

- Grant common privilege by common user
 - SQL> grant prv1 to c##_cm_user CONTAINER=ALL;
- Grant local privilege by common user
 - SQL> grant prv2 to pdb01_user CONTAINER=CURRENT;
- Grant a local privilege by a local user
 - SQL> grant prv2 to pdb01_user;
- Revoke common privilege by common user
 - SQL> revoke prv1 from c##_cm_user CONTAINER=ALL;

Create Common User

- Connect to CDB and Create Common User

```
SQL> show con_id
```

```
CON_ID
```

```
-----
```

```
1
```

```
SQL> show con_name
```

```
CON_NAME
```

```
-----
```

```
CDB$ROOT
```

```
SQL> create user C##_main identified by qweasdzc  
container=ALL;
```

```
User created.
```

Grant some role and privilege to common user

```
SQL> grant dba to C##_main container=ALL;
```

Grant succeeded.

```
SQL> grant select any table to C##_main container=ALL;
```

Grant succeeded.

```
select grantee, granted_role from dba_role_privs where grantee ='C##_MAIN';
```

GRANTEE	GRANTED_ROLE
C##_main	DBA
C##_main	DBA

```
select grantee, privilege from dba_sys_privs where grantee ='C##_MAIN';
```

GRANTEE	PRIVILEGE
C##_main	UNLIMITED TABLESPACE
C##_main	SELECT ANY TABLE
C##_main	UNLIMITED TABLESPACE
C##_main	SELECT ANY TABLE

Common User Information

- Connect to PDB using just created common user

```
SQL> show con_name
```

```
CON_NAME
```

```
-----  
ANUJPDB
```

```
SQL> show con_id
```

```
CON_ID
```

```
-----  
3
```

```
SQL> select grantee, granted_role from dba_role_privs where grantee = 'C##_MAIN';
```

```
GRANTEE
```

```
GRANTED_ROLE
```

```
-----  
C##_main
```

```
DBA
```

```
SQL> select grantee, privilege from dba_sys_privs where grantee = 'C##_MAIN';
```

```
GRANTEE
```

```
PRIVILEGE
```

```
-----  
C##_main
```

```
UNLIMITED TABLESPACE
```

```
C##_main
```

```
SELECT ANY TABLE
```

While connected to PDB try to create common user

```
create user C##_main1 identified by qweasdzxc container=ALL;  
create user C##_main1 identified by qweasdzxc container=ALL  
*
```

ERROR at line 1:
ORA-65050: Common DDLs only allowed in CDB\$ROOT

```
create user C##_main1 identified by qweasdzxc  
*
```

ERROR at line 1:
ORA-65094: invalid local user or role name

```
SQL> create user main1 identified by qweasdzxc; /* User local to PDB */
```

User created.

```
SQL> grant dba to main1;
```

Grant succeeded.

```
SQL> grant create any table to main1;
```

Grant succeeded.

Check roles/privileges you just granted

```
SQL> select grantee, privilege from dba_sys_privs where grantee = 'MAIN1';
```

GRANTEE	PRIVILEGE
main1	CREATE ANY TABLE
main1	UNLIMITED TABLESPACE

```
SQL> select grantee, granted_role from dba_role_privs where grantee = 'MAIN1';
```

GRANTEE	GRANTED_ROLE
main1	DBA

Connect to CDB and check privileges of local user we just granted

```
SQL> show con_name
```

```
CON_NAME
```

```
-----
```

```
CDB$ROOT
```

```
SQL> select grantee, privilege from dba_sys_privs where grantee ='MAIN1';
```

```
no rows selected
```

```
SQL> select grantee, granted_role from dba_role_privs where grantee =MAIN1';
```

```
no rows selected
```

Connect PDB again and review

```
SQL> select grantee, granted_role from cdb_role_privs where grantee ='MAIN1';
```

GRANTEE	GRANTED_ROLE

main1	DBA

```
SQL> select grantee, privilege from cdb_sys_privs where grantee ='MAIN1';
```

GRANTEE	PRIVILEGE

main1	CREATE ANY TABLE
main1	UNLIMITED TABLESPACE

- USER_%% Show list of all the Objects owned by the current user in a PDB
- ALL_%% Show list of all the Objects accessible by the current user in a PDB
- DBA_%% Show list of all the Objects in the root or a pluggable database
- CDB_%% Show list of all the Objects in the container database. CDB_%% use new column CON_ID

Creating Objects

- Local object can be created by common and local users
- Common objects can NOT be created by user defined “common users”. To create Common objects you need to use by Oracle supplied common user (sys/system)


DBA_USERS

Name	Null?	Type
USERNAME	NOT NULL	VARCHAR2(128)
USER_ID	NOT NULL	NUMBER
PASSWORD		VARCHAR2(4000)
ACCOUNT_STATUS	NOT NULL	VARCHAR2(32)
LOCK_DATE		DATE
EXPIRY_DATE		DATE
DEFAULT_TABLESPACE	NOT NULL	VARCHAR2(30)
TEMPORARY_TABLESPACE	NOT NULL	VARCHAR2(30)
CREATED	NOT NULL	DATE
PROFILE	NOT NULL	VARCHAR2(128)
INITIAL_RSRC_CONSUMER_GROUP		VARCHAR2(128)
EXTERNAL_NAME		VARCHAR2(4000)
PASSWORD_VERSIONS		VARCHAR2(12)
EDITIONS_ENABLED		VARCHAR2(1)
AUTHENTICATION_TYPE		VARCHAR2(8)
PROXY_ONLY_CONNECT		VARCHAR2(1)
COMMON		VARCHAR2(3)
LAST_LOGIN		TIMESTAMP(9) WITH TIME ZONE

CDB_USERS

Name	Null?	Type
-----	-----	-----
USERNAME	NOT NULL	VARCHAR2(128)
USER_ID	NOT NULL	NUMBER
PASSWORD		VARCHAR2(4000)
ACCOUNT_STATUS	NOT NULL	VARCHAR2(32)
LOCK_DATE		DATE
EXPIRY_DATE		DATE
DEFAULT_TABLESPACE	NOT NULL	VARCHAR2(30)
TEMPORARY_TABLESPACE	NOT NULL	VARCHAR2(30)
CREATED	NOT NULL	DATE
PROFILE	NOT NULL	VARCHAR2(128)
INITIAL_RSRC_CONSUMER_GROUP		VARCHAR2(128)
EXTERNAL_NAME		VARCHAR2(4000)
PASSWORD_VERSIONS		VARCHAR2(12)
EDITIONS_ENABLED		VARCHAR2(1)
AUTHENTICATION_TYPE		VARCHAR2(8)
PROXY_ONLY_CONNECT		VARCHAR2(1)
COMMON		VARCHAR2(3)
LAST_LOGIN		TIMESTAMP(9) WITH TIME ZONE
→ CON_ID		NUMBER

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Tools to manage CDBs and PDBs

Your favorite SQL *Plus

12c EM gives dropdown option to select PDB

Sql developer

Any third party software you prefer

- Toad
- Dbartisan

Connecting CDB and PDB

- [oracle@test121 ~]\$ export ORACLE_SID=AnujC
[oracle@test121 ~]\$ sqlplus / as sysdba

```
SQL> select name,open_mode from v$database;
```

NAME	OPEN_MODE
ANUJC	READ WRITE

```
SQL> show con_id
```

CON_ID
1

```
SQL> show user  
USER is "SYS"
```

Connecting CDB and PDB continued...

- `select pdb_id,pdb_name from cdb_pdb;`

PDB_ID	PDB_NAME
2	PDB\$SEED
3	ANUJPDB
4	ANUJP02

There are many ways you can access PDBs

- Using tns

```
sqlplus C##_MAIN/qweasdzxc@ANUJPDB /* Tnsnames.ora */
```

```
SQL> select NAME, OPEN_MODE, CON_ID from V$PDBS;
```

NAME	OPEN_MODE	CON_ID
ANUJP DB	READ WRITE	3

Connecting CDB and PDB continued...

- Connect using service name
 - `Sqlplus C##_MAIN/qweasdzxc@anuj-w530:1521/ANUJPDB /* Service Name */`
- Connect using Local/TWO_TASK
 - `set LOCAL=ANUJPDB /* on windows */`
 - `set TWO_TASK=ANUJPDB /* on unix */`
 - `sqlplus C##_MAIN/qweasdzxc`
- How to check which PDB you are connected
 - `Show CON_ID`
 - `Show CON_NAME`
 - `Using SYS_CONTEXT`
`select sys_context('userenv','CON_ID') from dual;`

CDB Startup stages

- CDB Startup stages
 - ❖ Shutdown
 - Instance and database both down
 - ❖ Nomount
 - Instance is started. V\$ views are accessible
 - ❖ Mount
 - CDB control file is opened
 - Root is mounted
 - PDBs are also in mount stage
 - ❖ Open
 - CDB is open for read /write
 - PDBs will be still in mount stage by default

PDBs Startup

PDBs Startup

- When you open your CDB , that will bring your PDBs to mount stage. At this stage you can use below options to open your PDBs
 - Connect to CDB
 - `Alter pluggable database pdb_name open;`
 - `Alter pluggable database all open ; /* open all PDBs */`
 - `Select name,open_mode from v$pdb;`

Shutting CDBs and PDBs

- Shutting CDBs and PDBs
 - To shutdown CDBs you use “shutdown *****” commands
 - Shutdown immediate
 - Shutdown transactional
 - Shutdown abort
 - Their possible states are MOUNT/OPEN/CLOSE


Closing PDBs

- Closing PDBs
 - Connect to CDB
 - Alter pluggable database all except pdb_name close/open;
 - Alter pluggable database pdb_name close immediate;
 - Connect to PDB
 - Username/password@PDB as sysdba
 - Shutdown immediate
 - OR
 - Alter pluggable database close
 - Connect to CDB and check
 - Select name,open_mode from v\$pdb;

Open restrict

- You can Open your PDBs in restricted /read only and read write based on your requirement
 - Alter pluggable database open restricted
 - Alter pluggable database open read only
 - Alter pluggable database open

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Backups

- RMAN Backup Levels
 - CDB Level backup: All CDB datafiles, PDBs datafiles and controlfile and spfile if control file autobackup is defined
 - PDB backup: All PDBs datafiles and controlfile and spfile if control file autobackup is defined
 - Tablespace level backup, so you can backup individual tablespace of any pdb
 - Datafile level backups

Backup...

- You can connect to CDB/PDB to perform backup
- sysdba or sysbackup privilege required to run backup
 - RMAN> BACKUP DATABASE;
 - BACKUP PLUGGABLE DATABASE pdb1prd, pdb2prd;
 - BACKUP TABLESPACE pdb1prd :tbs2;
 - BACKUP PLUGGABLE DATABASE "CDB\$ROOT";

Recovery options

Media recovery : File loss or damage

- CDB level –Entire CDB
- PDB level – Entire PDB
- Tablespace level: same as for non-CDB.Any tablespace of CDB or PDB
- Datafile level recovery option
- Data block level recovery
- TSPITR for root tablespaces ONLY except SYSTEM, UNDO, SYSAUX

- Flashback database
 - CDB level
 - PDB level
- Block recovery: Same as Oracle 11g

*** Instance recovery is not possible on PDB level

Recovery Commands

Loss of system datafile from PDB

- In order to recover from loss of PDB's system datafile we need to take CDB on mount stage(No CDB/PDB available to users)
- RMAN> startup mount; (cdb mounted)
- RMAN> restore tablespace pdb1prd :system;
- RMAN> recover tablespace pdb1prd :system;
- RMAN> alter database open; (cdb open)
- RMAN> alter pluggable database all open;

Recovery Commands

Loss of non system datafile of PDB or CDB

- We do not need to take PDB/CDB offline (CDB/PDB available to users except offline tablespace)
- SQL> connect system/12cmanager@ pdb1prd
- SQL> alter tablespace tbs01 offline immediate;
- RMAN> restore tablespace pdb1prd :tbs01;
- RMAN> recover tablespace pdb1prd : tbs01;
- SQL> alter tablespace tbs01 online

Enable Flashback

- Database must be in archivelog mode
- Set Init Parameters
 - db_recovery_file_dest_size=xxgb
 - db_recovery_file_dest=recovery file location
- Enable on sqlplus
 - `sql> alter system set db_flashback_retention_target=1440 scope=both;`
 - `sql> alter database flashback on;`

Flashback database

- Create Restore points

- `sql> create restore point before_upgrade;`
- `sql>create restore point before_upgrade guarantee flashback database;`

- Find out SCN you want to flashback or restore points

- `sql> select name, scn, time, database_incarnation#, guarantee_flashback_database,storage_size from v$restore_point;`
OR
- `rman> list restore point all;`

Flashback database

- sql>startup mount
- flashback database to scn 1809;
- OR
- Rman> flashback database to restore point 'before_upgrade';
- rman> alter database open read only;
- Validate recovered information

- rman> shutdown immediate
- rman> startup mount
- flashback database to scn 1809;
- OR
- flashback database to restore point 'before_upgrade';

- rman> alter database open resetlogs;
- rman> alter pluggable database all open;

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Migration to 18c : Methods

- Expdp / Impdp
- Use of some sort of replication tool
 - E.g. GoldenGate , transient logical standby
- Upgrade a pre-18c database to 18c (non cdb)
 - Plug-in the non-CDB into a CDB

Migration to 18c : Features

- Helpful features :
 - parallel processing to regular upgrades
 - Manual / dbua generates automatic fixups before upgrade
 - dbua can use existing rman backups for fall back strategy
 - you can create restore points and do a flashback database
 - datapump full transportable (combination of datapump and transportable tablespace)

Upgrade paths

Source /Lower Version	Intermediate Version	Final Version
12.2.0.1,	None Required	18c
12.1.0.1, 12.1.0.2	None Required	18c
11.2.0.3, 11.2.0.4	None Required	18c
11.2.0.2 or 11.1.0.7	11g release 2	18c
10.2.0.2, 10.2.0.3, 10.2.0.4,10.2.0.5 or 10.1.0.5	11.2. or 12.1	18c
9.2.0.8	11.2.0.3 or 11.2.0.4.	18c

Multitenant Features :SGA PGA & I/O for PDBs

DB_CACHE_SIZE Sets the minimum, guaranteed buffer cache space for the PDB with **DB_CACHE_SIZE** defined on CDB level

SGA_TARGET Sets the maximum SGA size for the PDB with **SGA_TARGET** in the CDB root

SGA_MIN_SIZE Sets the minimum SGA size for the PDB.

PGA_AGGREGATE_LIMIT Sets the maximum PGA size for the PDB.

PGA_AGGREGATE_TARGET Sets the target aggregate PGA size for the PDB.

Multitenant Features :SGA PGA & I/O for PDBs

MAX_IOPS - number of I/O operations for each second
MAX_MBPS - megabytes I/O operations for each second.

Set at PDB Level - Scope will be individual PDB

Set at CDB Level - Scope will be all PDB's in container

If it is defined at PDB Level then it takes precedence over the settings in the CDB root

This is not in
Exadata

Multitenant Features: Lockdown Profiles

12.2

PDB Lockdown Profiles are new method of restricting/allowing certain access within a role or profile.

You need **CREATE LOCKDOWN PROFILE** system privilege

```
CREATE LOCKDOWN PROFILE hr_prof;
```

```
alter LOCKDOWN PROFILE hr_prof ENABLE STATEMENT = ('alter SYSTEM') clause = ('flush shared_pool');
```

```
alter LOCKDOWN PROFILE hr_prof DISABLE STATEMENT = ('alter SYSTEM');
```

```
alter LOCKDOWN PROFILE hr_prof DISABLE FEATURE = ('XDB_PROTOCOLS');
```


Grant hr_prof to PDB users

Disabled alter system but allowed flush



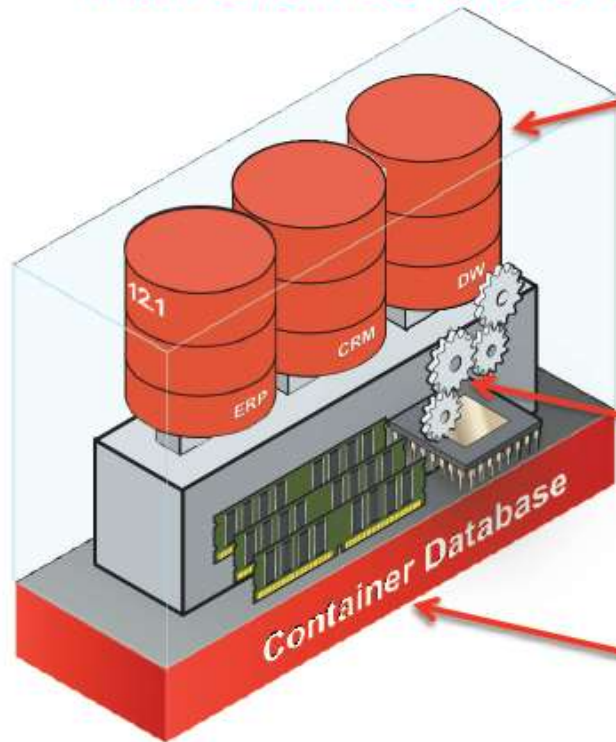
[More Reading](#)

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- Backup and Recovery
- Quick overview: migration options to 18c from previous versions.
- PDB - Explanation of Value (EOV) 

Oracle Multitenant

New architecture for consolidating databases and simplifying operations



Self-contained PDB for each application

- Applications run unchanged
- Rapid provisioning (via clones)
- Portability (via pluggability)

Shared memory and background processes

- More applications per server

Common operations performed at CDB level

- Manage many as one (upgrade, HA, backup)
- Granular control when appropriate

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Key Benefits

Benefit	Capability Enabled
Minimize CapEx	<ul style="list-style-type: none">• More applications per server
Minimize OpEx	<ul style="list-style-type: none">• Manage many as one• Standardized procedures & service levels• Cloning for development / testing
Maximize Agility	<ul style="list-style-type: none">• Rapid provisioning• Portability through “pluggability”• Scalability with RAC
Ease of Adoption	<ul style="list-style-type: none">• Applications run unchanged

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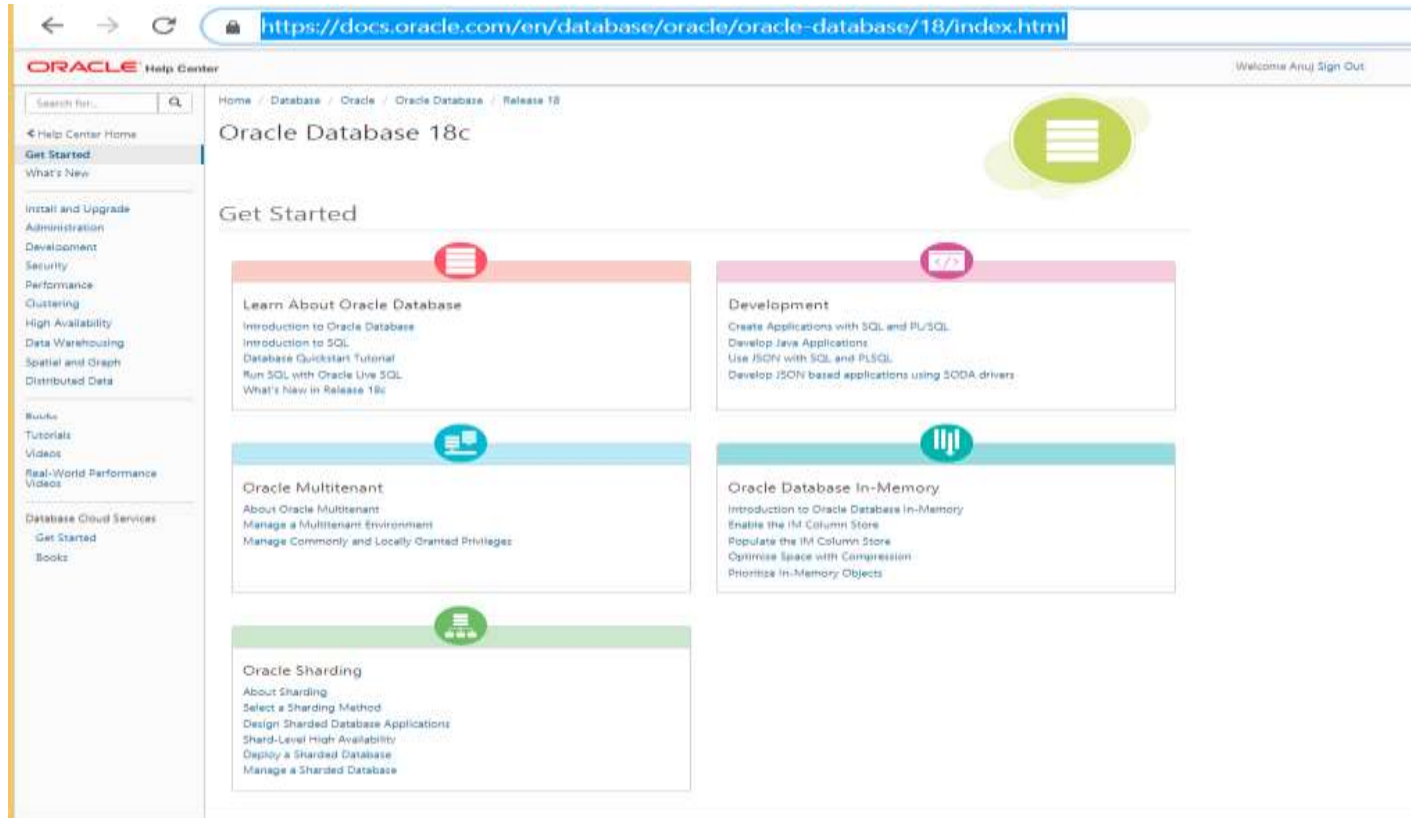
Summary and Conclusions

- There is no application change required for using PDBs
- Cloning is very easy . Perfect for creating test/development system quickly
- If file system supports copy-on-change then clones can be done in sub seconds
- PDBs need to be opened explicitly
- One physical database with multiple PDBs - Less DBA Effort to manage
- One set of memory / processes - Less usage means you can deploy more applications per physical server
- Adding more PDB only requires space
- Upgrade to CDB and plug in PDBs - PDBs are upgraded
- Cloning to remote servers
- Enhanced Resource manager
- No change required in Scripts and applications
- More than One PDB inside a CDB is Extra cost

Explore Oracle Database 18c Learning Resources

Oracle Database 18c Learning Library:

<https://docs.oracle.com/en/database/oracle/oracledatabase/18/index.html>



Thank you ...

- Twitter → @Anujmo
- Blog → <http://www.oracle-12c.com/>
- LinkedIn Page for SIG → www.linkedin.com/groups?gid=4847720
- If you have further questions or need database assistance, Send me email amohan@dataintensity.com