Flashback PDB in Oracle Database

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- Oracle Beta Tester (on site) for Oracle Database 12cR2 (2015)
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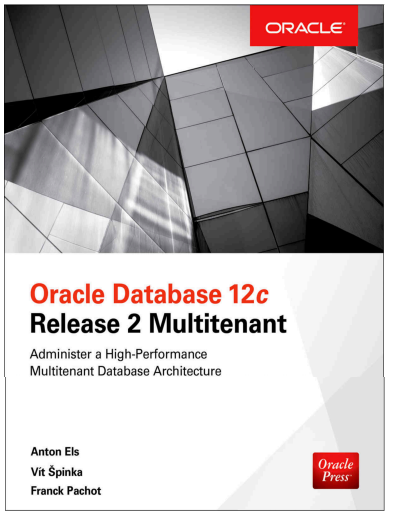
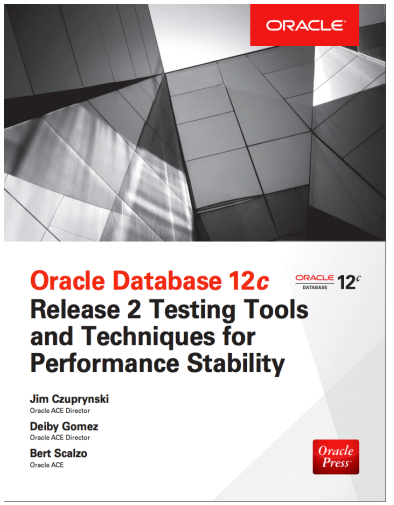


Co-Author



Agenda

- Flashback Database in Oracle Database 10g, 11g
- Flashback Database in Oracle Database 12cR1
- Local and Shared Undo in Oracle Database 12cR2
- Flashback Pluggable Database in Oracle Database >12cR2

Disclaimer

“The postings on this document are my own and don’t necessarily represent my actual employer positions, strategies or opinions. The information here was edited to be useful for general purpose, specific data and identifications were removed to allow reach the generic audience and to be useful for the community.”

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Flashback Technology

Object Level	Scenario Examples	Flashback Technology	Uses	Affects Data
Database	Truncate table; Undesired multitable changes made	Database	Flashback logs	TRUE
Table	Drop table	Drop	Recycle bin	TRUE
	Update with the wrong `WHERE` clause	Table	Undo data	TRUE
	Compare current data with data from the past	Query	Undo data	FALSE
	Compare versions of a row	Version	Undo data	FALSE
Tx	Investigate several historical states of data	Transaction	Undo data	FALSE

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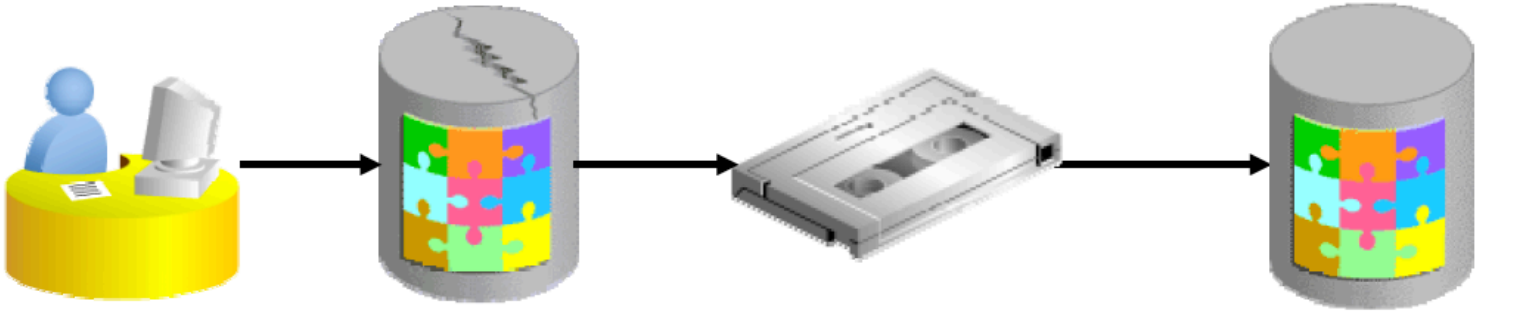
Flashback Database

Rollback all the changes in a Database to a time.



NOTA: Flashback Database requires the Database to be in **Archivelog mode**

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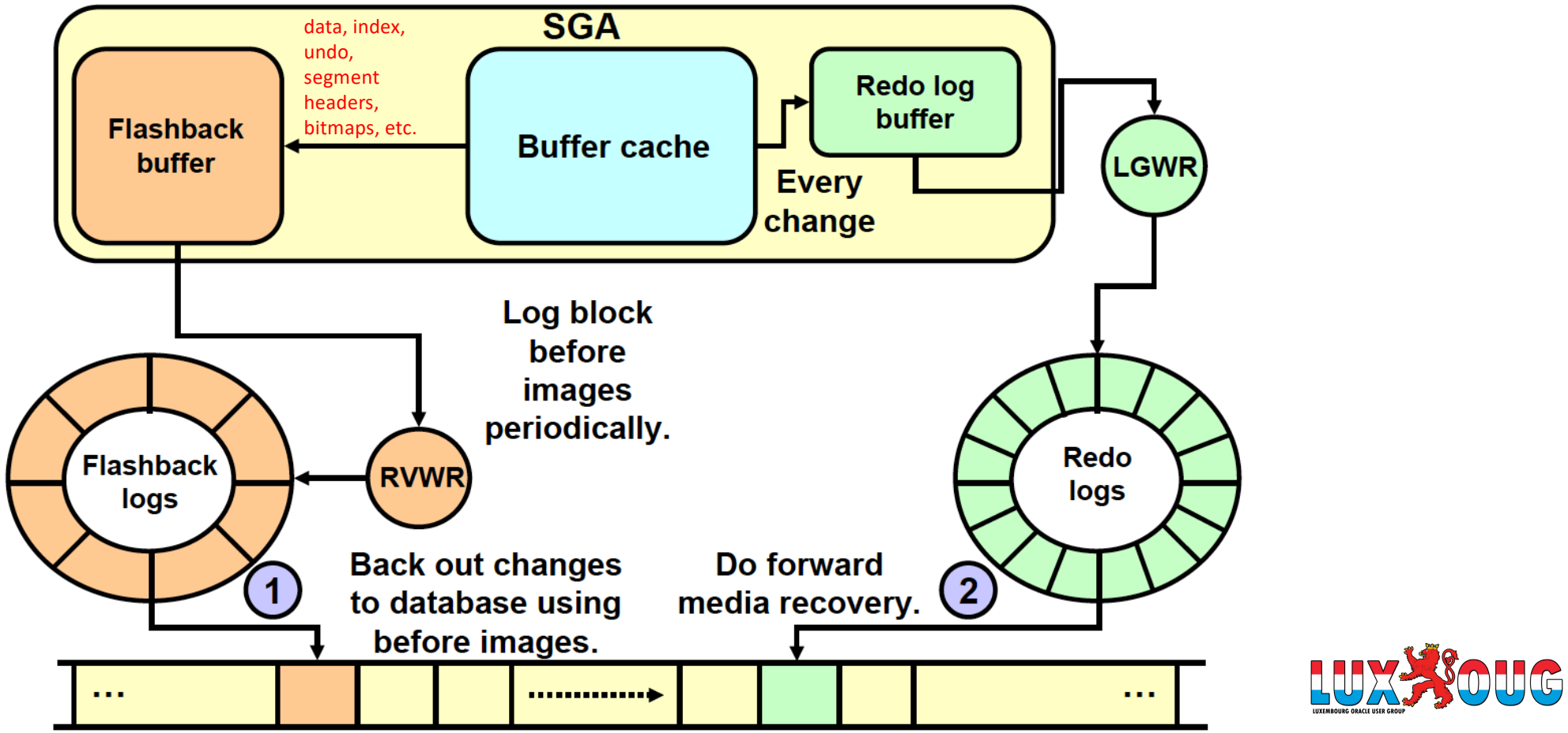
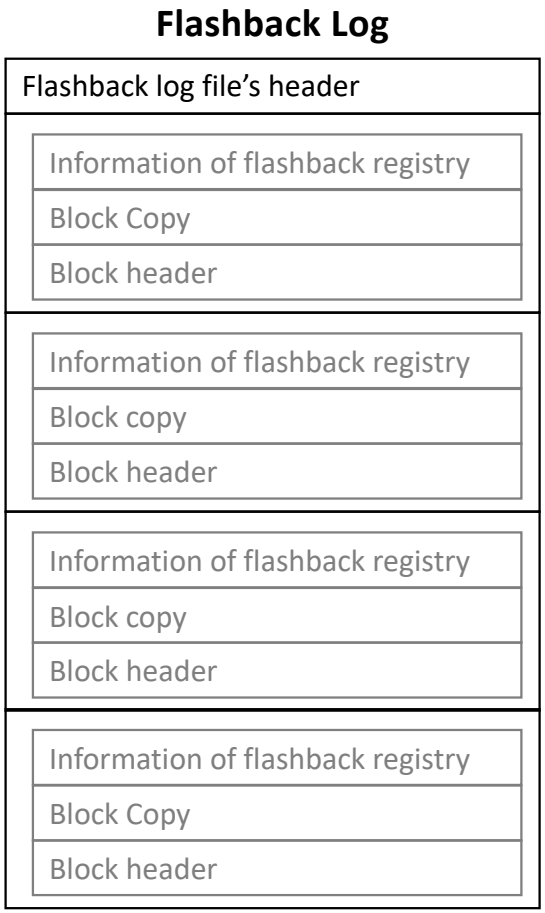
Flashback Database



Flashback Log Structure



File Header: It has general metadata of the flashback log file and its registries.

Information of flashback registry: It has metadata of one specific flashback registry such as the SCN, physical location of the registry in the file, information of the block copy, etc.

Block Copy: It's an exact copy of the data block that was modified.

Block header: Metadata of the data block.

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Flashback Log Registry

```
**** Record at fba: (lno 1 thr 1 seq 1 bno 3328 bof 352) ****
    RECORD HEADER:
      Type: 35 (Block Image - 12.2 compatible)  Size: 32
    RECORD DATA (Block Image - 12.2 compatible):
      file#: 10 rdba: 0x02800084
      Next scn: 0x0000000000000000
      Flag: 0x0
      Block Size: 8192
      Encryption key version: 0
    BLOCK IMAGE:
      buffer rdba: 0x02800084
      scn: 0x1b2b6e seq: 0x01 flg: 0x06 tail: 0x2b6e0601
      frmt: 0x02 chkval: 0x58ea type: 0x06=trans data
```

Information of the Flashback log registry

```
Hex dump of block: st=0, typ_found=1
Dump of memory from 0x00007F722F88BC00 to 0x00007F722F88DC00
7F722F88BC00 0000A206 02800084 001B2B6E 06010000  [........n+......]
...
7F722F88DBF0 012C6702 67640601 7A656D6F 2B6E0601  [.g,...dgomez..n+]
```

Block Copy

```
Block header dump:  0x02800084
 Object id on Block? Y
 seg/obj: 0x132d3  csc:  0x00000000001b2b6c  itc: 2  flg: E  typ: 1 - DATA
     brn: 0  bdba: 0x2800080 ver: 0x01 opc: 0
     inc: 0  exflg: 0
 Itl           Xid                  Uba         Flag  Lck        Scn/Fsc
0x01   0x0005.00d.00000697  0x01000098.0161.31  --U-    1  fsc 0x0000.001b2b6e
0x02   0x0000.000.00000000  0x00000000.0000.00  ----    0  fsc 0x0000.00000000
bdba: 0x02800084
```

Block header

```
data_block_dump,data header at 0x7f722f88bc64
===============
tsiz: 0x1f98
hsiz: 0x14
pbl: 0x7f722f88bc64
     76543210
flag=--------
ntab=1
nrow=1
....
0xe:pti[0]      nrow=1  offs=0
0x12:pri[0]     offs=0x1f8e
block_row_dump:
tab 0, row 0, @0x1f8e
tl: 10 fb: --H-FL-- lb: 0x1  cc: 1
col  0: [ 6]  64 67 6f 6d 65 7a       ← dgomez
end_of_block_dump
```

Block Dump

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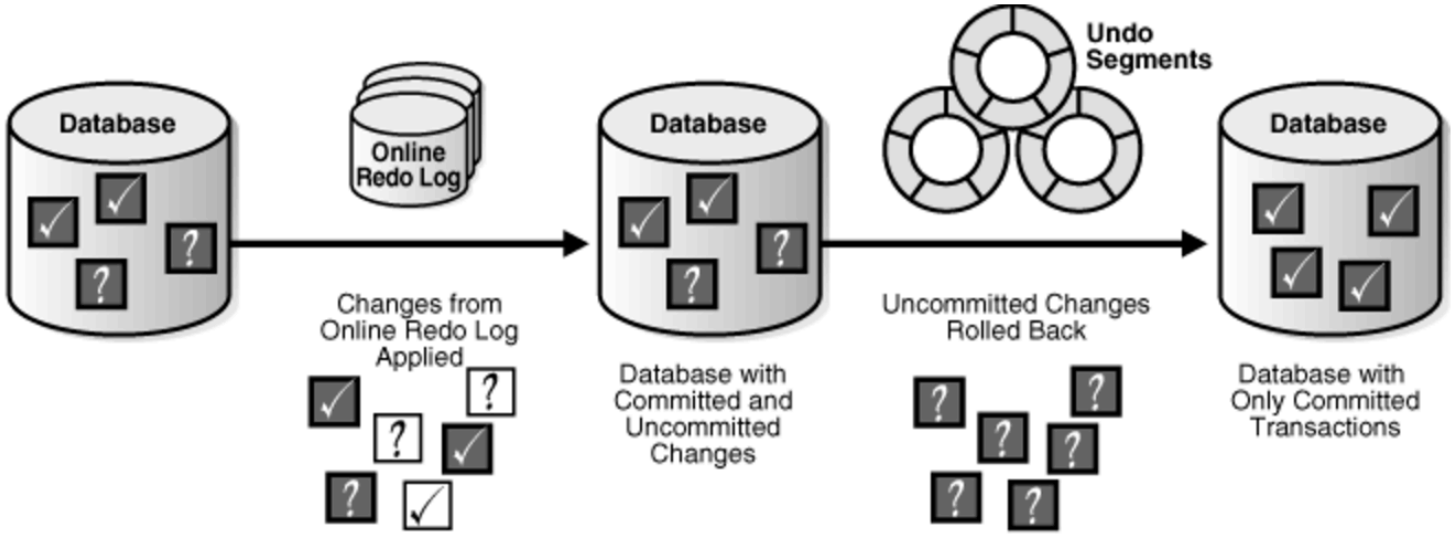
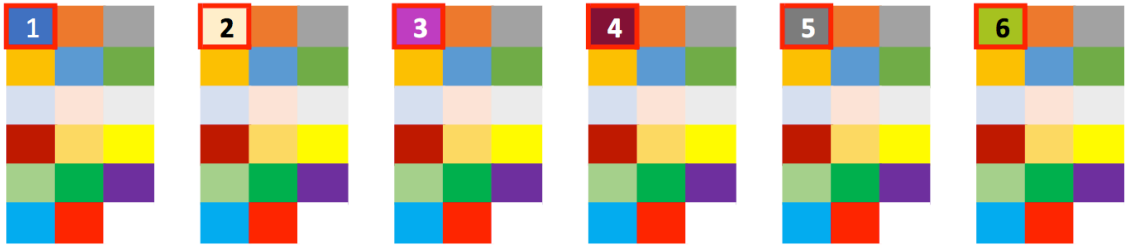
Instance Recovery Phases

- **“Rolling forward” Phase**: It applies redo information, this information not only re-creates (Rolling forward) the changes in the datafiles, but also in the undo datafiles. When this phase is completed, the datafiles are exactly in the same state (commited operations and non-commited operations) than the Database at the flashback target time.

- **“Rolling back” Phase:** It uses the undo data to ”undo” all the operations that were not commited at the time of the flashback target time. Once this phase is completed, the Database will be in a “consistent” state.





SCN 100
File 3 Block 5

SCN 101
File 3 Block 5

SCN 102
File 3 Block 5

SCN 103
File 3 Block 5

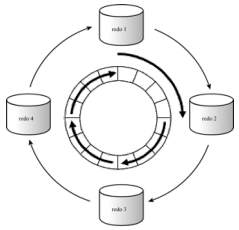
SCN 104
File 3 Block 5

SCN 105
File 3 Block 5

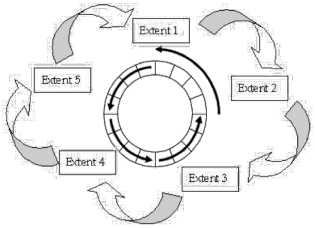
Flashback Log #1 - SCN 101	Flashback Log #2 - SCN 104
2	5

Flashback Database to SCN 103

Using Flashback Logs



With commited and non Commited operations



Only commited operations

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```
flashback pluggable database NuvolaPDB1 to timestamp to_timestamp('11-28-2016 04:52:41','mm-dd-yyyy hh24:mi:ss')
2016-11-28T05:34:12.987810+00:00
Flashback Restore Start
Restore Flashback Pluggable Database NUVOLAPDB1 (3) until change 1761131
Flashback Restore Complete
Flashback Media Recovery Start
2016-11-28T05:34:13.464044+00:00
Serial Media Recovery started
2016-11-28T05:34:13.737489+00:00
Recovery of Online Redo Log: Thread 1 Group 1 Seq 65 Reading mem 0
  Mem# 0: /u02/app/oracle/oradata/NuvolaCG/NUVOLACG/onlinelog/o1_mf_1_d3dns1nq_.log
  Mem# 1: /u03/app/oracle/fast_recovery_area/NUVOLACG/onlinelog/o1_mf_1_d3dns4lx_.log
2016-11-28T05:34:13.918613+00:00
Incomplete Recovery applied until change 1761251 time 11/28/2016 04:53:01
Flashback Media Recovery Complete
Flashback Pluggable Database NUVOLAPDB1 (3) recovered until change 1761251, at 11/28/2016 04:53:01
Completed: flashback pluggable database NuvolaPDB1 to timestamp to_timestamp('11-28-2016 04:52:41','mm-dd-yyyy
hh24:mi:ss')
2016-11-28T05:48:24.552867+00:00
alter pluggable database NuvolaPDB1 open resetlogs
2016-11-28T05:48:24.901340+00:00
Online datafile 26
Online datafile 7
Online datafile 6
NUVOLAPDB1(3):Autotune of undo retention is turned on.
NUVOLAPDB1(3):Endian type of dictionary set to little
2016-11-28T05:48:25.719949+00:00
NUVOLAPDB1(3):[14115] Successfully onlined Undo Tablespace 3.
NUVOLAPDB1(3):Undo initialization finished serial:0 start:706407862 end:706407965 diff:103 ms (0.1 seconds)
NUVOLAPDB1(3):Database Characterset for NUVOLAPDB1 is US7ASCII
NUVOLAPDB1(3):JIT: pid 14115 requesting stop
2016-11-28T05:48:27.075724+00:00
NUVOLAPDB1(3):Autotune of undo retention is turned on.
2016-11-28T05:48:27.350412+00:00
NUVOLAPDB1(3):Endian type of dictionary set to little
NUVOLAPDB1(3):[14115] Successfully onlined Undo Tablespace 3.
NUVOLAPDB1(3):Undo initialization finished serial:0 start:706409707 end:706409798 diff:91 ms (0.1 seconds)
```

Rolling Forward

Rolling Back

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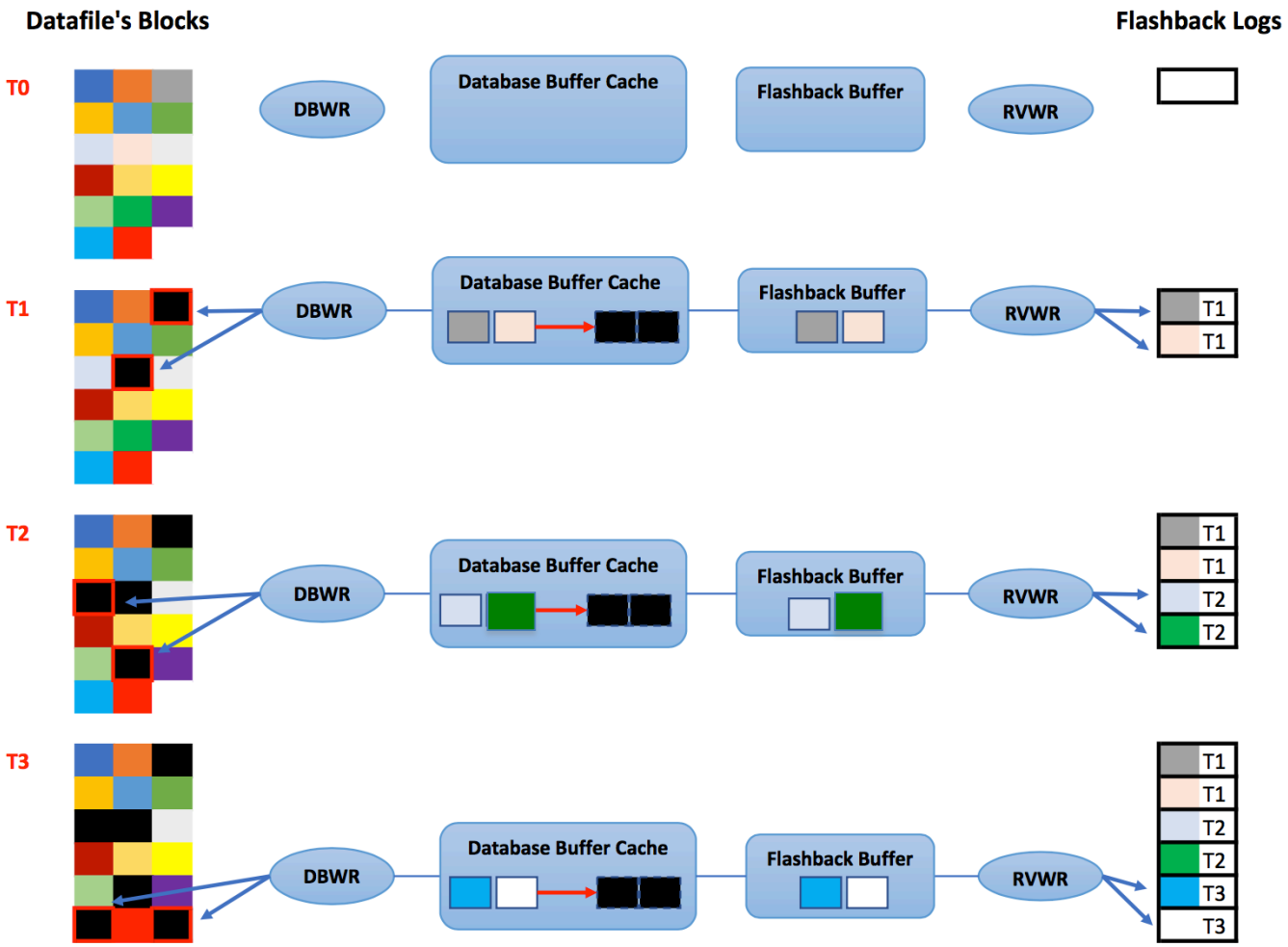

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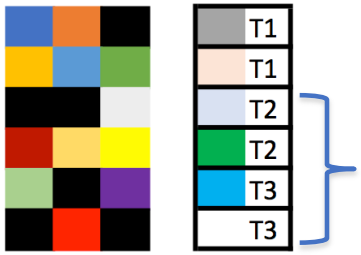
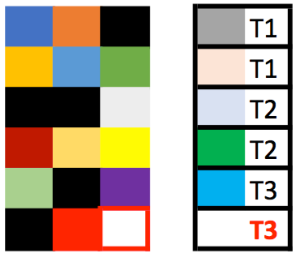
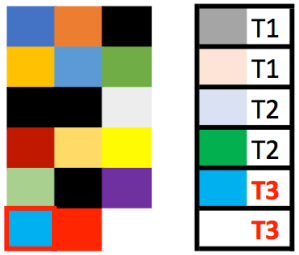
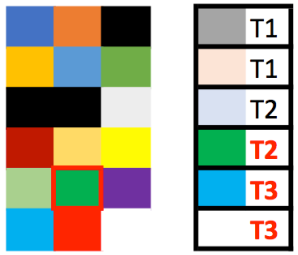
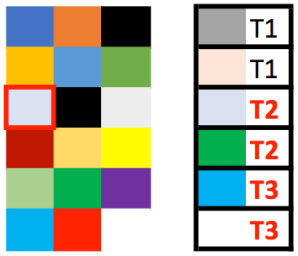
Flashback Database a **T1**

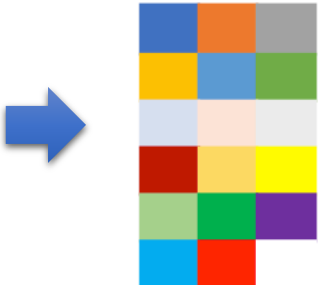


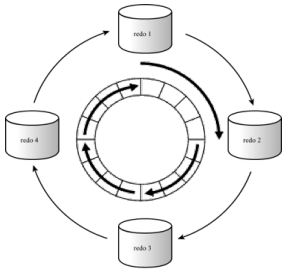


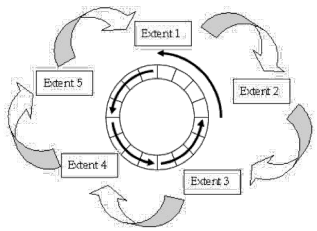












Target Time

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Parameters and Views

```
v$flashback_database_log;   - General Information of Flashback Data
v$flashback_database_stat;  - Stats of Flashback Usage
v$session_longops where opname like 'Flashback%'; - Monitoring
```

DB_FLASHBACK_RETENTION_TARGET: Time that Oracle will try to keep the data in Flashback Logs. Value in minutes.

DB_RECOVERY_FILE_DEST_SIZE: Espace Used to store recovery files and also the flashback Logs. Ensure that there is enough free space to store flashback Logs for manintenance window.

```
Target FRA = Current FRA + DB_FLASHBACK_RETENTION_TARGET x 60 x Peak Redo Rate (MB/sec)
```

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Flashback Database – Usage

- It was introduced in Oracle 10.1
- All the blocks are registered in Flashback Logs (data, index, undo, segment headers, bitmaps, etc.)
- Flashback recovery to earlier SCN is frecuently used for:
  - Testing
  - User Errors
- Recovery through resetlogs
- Activate a Physical Standby Database (10g)
- Creation of Snapshot Standby (11g)
- To convert a Logical Standby to a Physical Standby
- Configuring Fast Start Failover
- Testing Upgrades with Snapshost Standby
- Reinstate a physical standby database destroyed by Failover

Flashback Database - Limitations

- It does not fix physical corruptions
- It does not restore deleted datafiles
- It’s not used to undo a “shrink datafile” operation
- It’s not used to Rollback the Database to a time before a recreation of restauration of the controlfile.
- It does not restore operations done with “NOLOGGING”

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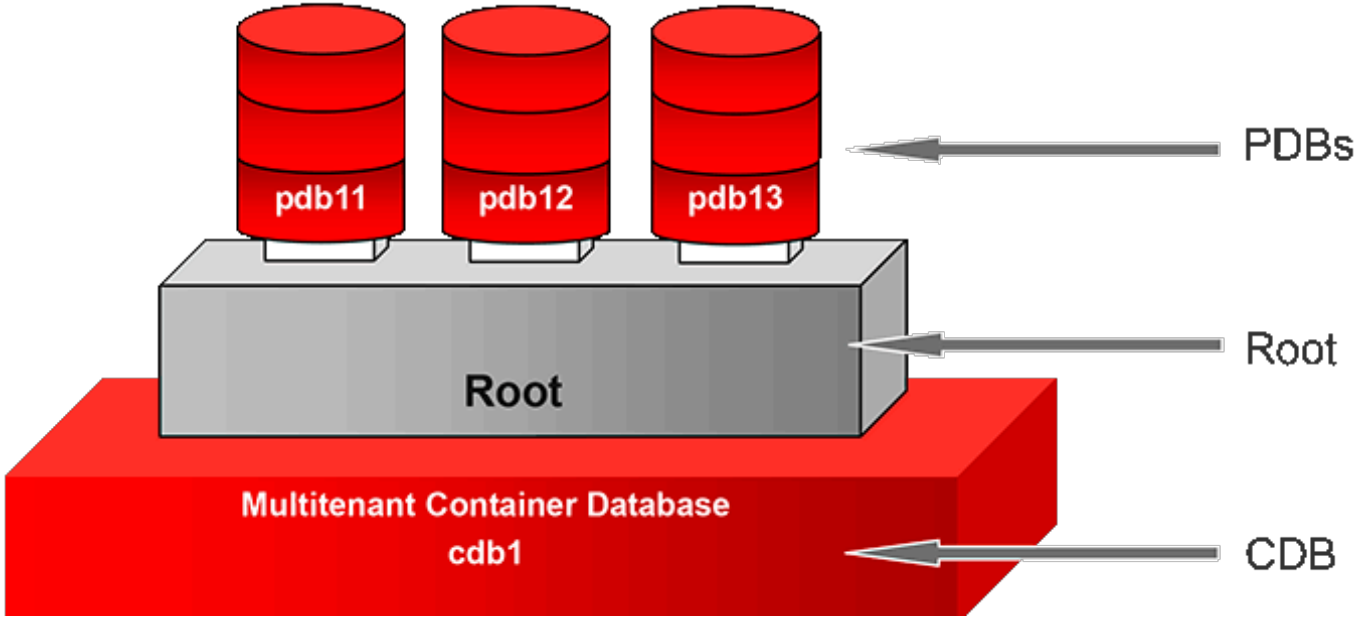
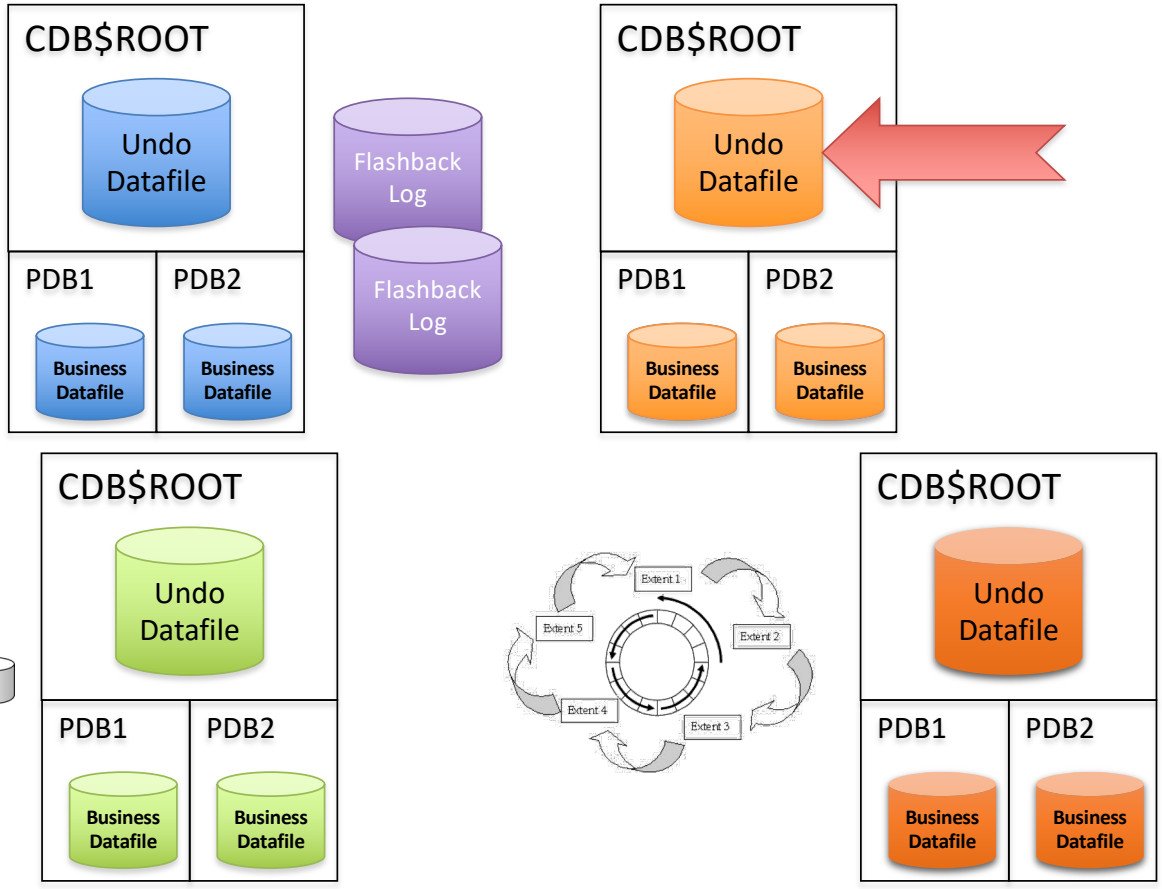
Flashback Database 12cR1

- Only at CDB level
  - Flashback Database impacts all the Pluggable Databases in the same CDB. It's necessary to close all the PDBs and to mount the CDB. All the PDBs will be restored to the flashback target time.



Flashback Database 12cR1



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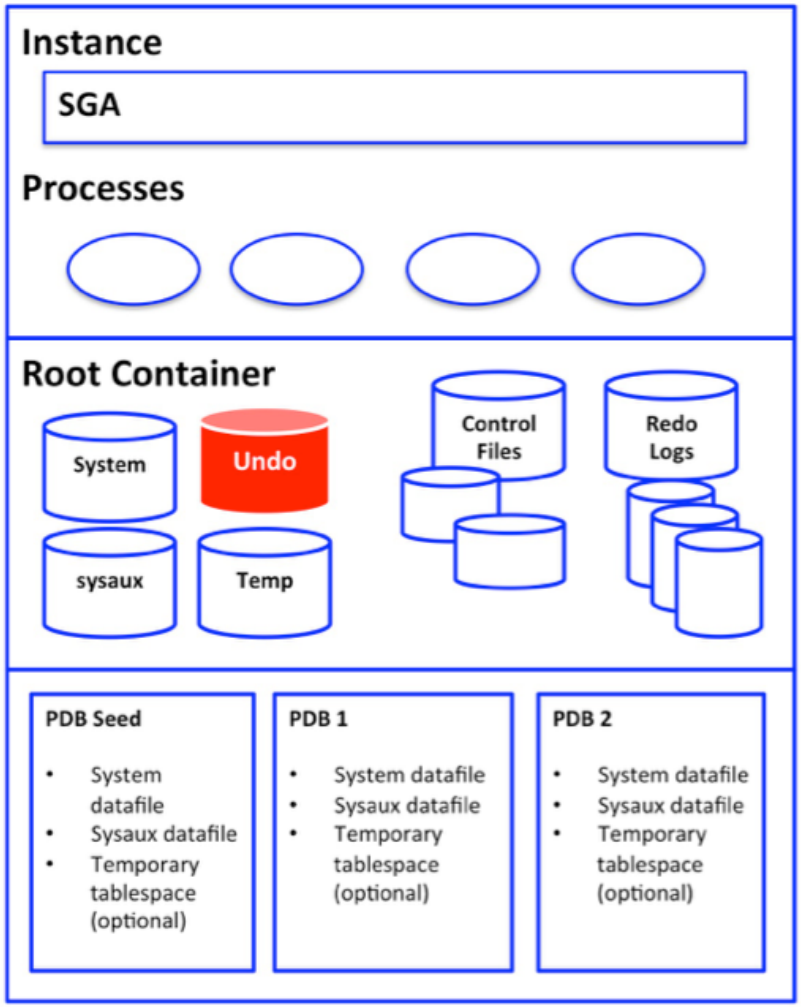
Shared Undo

- The way of usage of Undo tablespace in >12cR1 is called now “Shared Undo”



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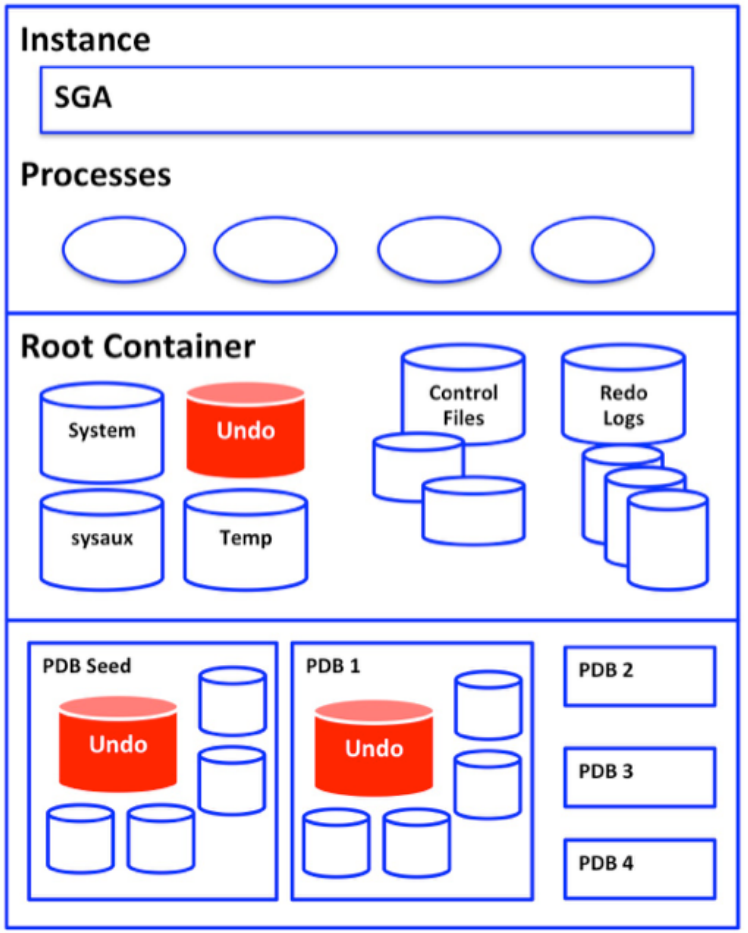
Local Undo *(Starting in 12cR2)*

- Each PDB can have its own Undo Tablespace
- To configure “Local Undo” an instance reboot is needed.
- The PDB$SEED can have a custom tablespace Undo for the new PDBs creation.
- by default an Undo tablespace called “UNDO_1” will be created at the time the PDB is open for the first time.
- It is possible to change from “Local Undo” to “Shared Undo” and viceversa, at anytime, a reboot is required.
- Oracle Public Cloud uses by default “Local Undo”.



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Configuring Local Undo

Shtudown the instance:

```
SQL> shutdown immediate;
SQL> startup upgrade;
SQL> show con_name

CON_NAME
------------------------------
CDB$ROOT
```

Change the Undo mode to “Local Undo”:

```
SQL> alter database local undo on;
```

Reboot the instance:

```
SQL> shutdown immediate;
SQL> startup;
```

Verify that the Local Undo is now used:

```
SQL> SELECT PROPERTY_NAME, PROPERTY_VALUE FROM DATABASE_PROPERTIES WHERE  PROPERTY_NAME
= 'LOCAL_UNDO_ENABLED'

PROPERTY_NAME      PROPERTY_VALUE
-------------------- ---------------
LOCAL_UNDO_ENABLED   TRUE
```

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Configuring Shared Undo

Shutdown the instance:

```
SQL> shutdown immediate;
SQL> startup upgrade;
SQL> show con_name

CON_NAME
------------------------------
CDB$ROOT
```

Change the Undo mode to “Shared Undo”:

```
SQL> alter database local undo off;
```

Reboot the instance:

```
SQL> shutdown immediate;
SQL> startup;
```

Verify that the new Undo mode is now used:

```
SQL> SELECT PROPERTY_NAME, PROPERTY_VALUE FROM DATABASE_PROPERTIES WHERE  PROPERTY_NAME
= 'LOCAL_UNDO_ENABLED'

PROPERTY_NAME      PROPERTY_VALUE
-------------------- ---------------
LOCAL_UNDO_ENABLED   FALSE
```

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Flashback Pluggable Database

Using Local Undo

If you have "Local Undo" in place, it's possible to use Flashback at PDB level normally. The operation will be performed without impacting the others PDBs in the same CDB. This is like if you were performing Flashback in versions 10g or 11g, but in this case is a Pluggable Database.

Using Shared Undo

If you have "Shared Undo" in place, you will need an auxiliary instance in order to perform Flashback in the Pluggable Database. A directory is requested to restore all the required tablespaces to complete the flashback operation, this is similar to the feature "Recover a table from RMAN Backup".

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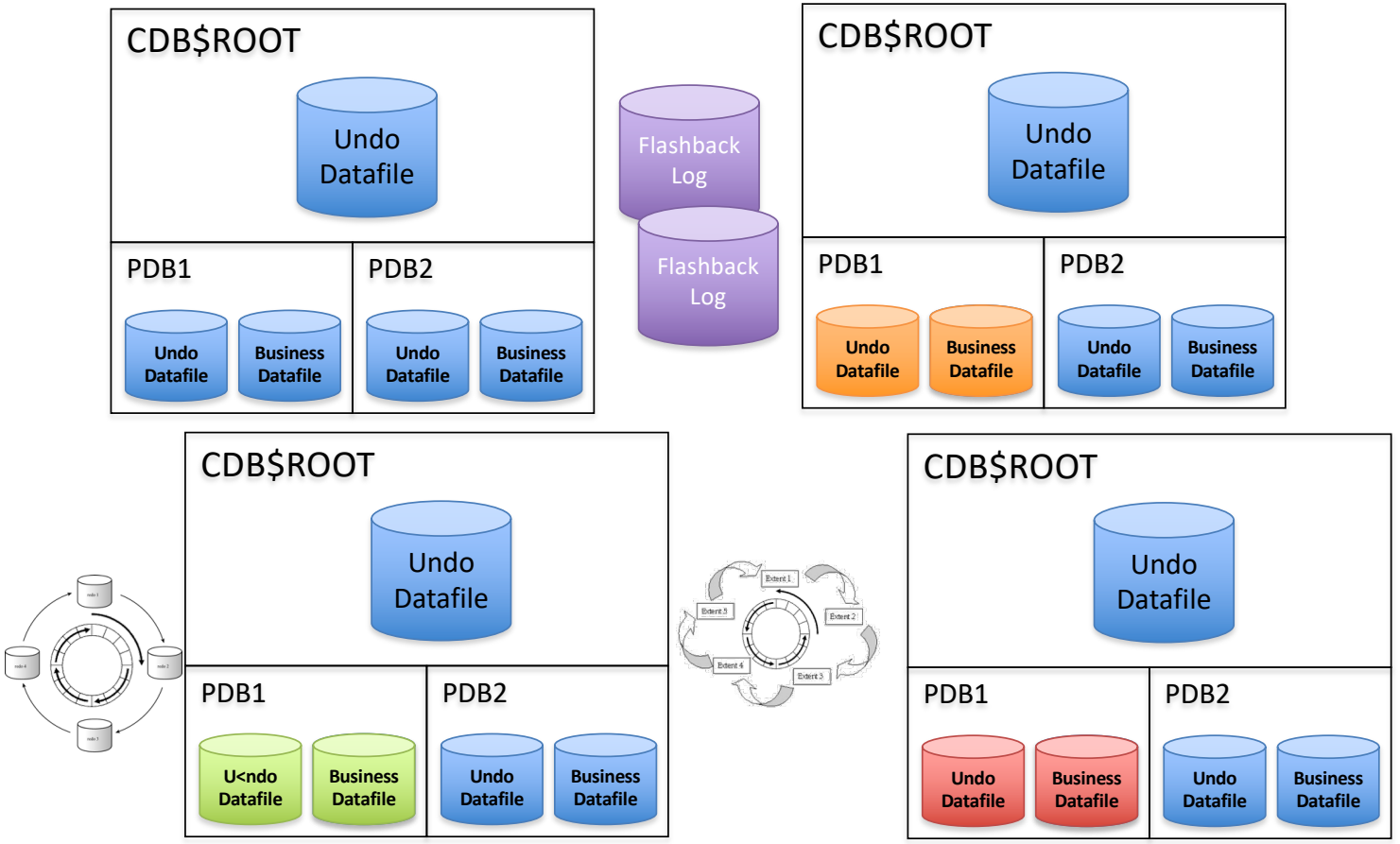
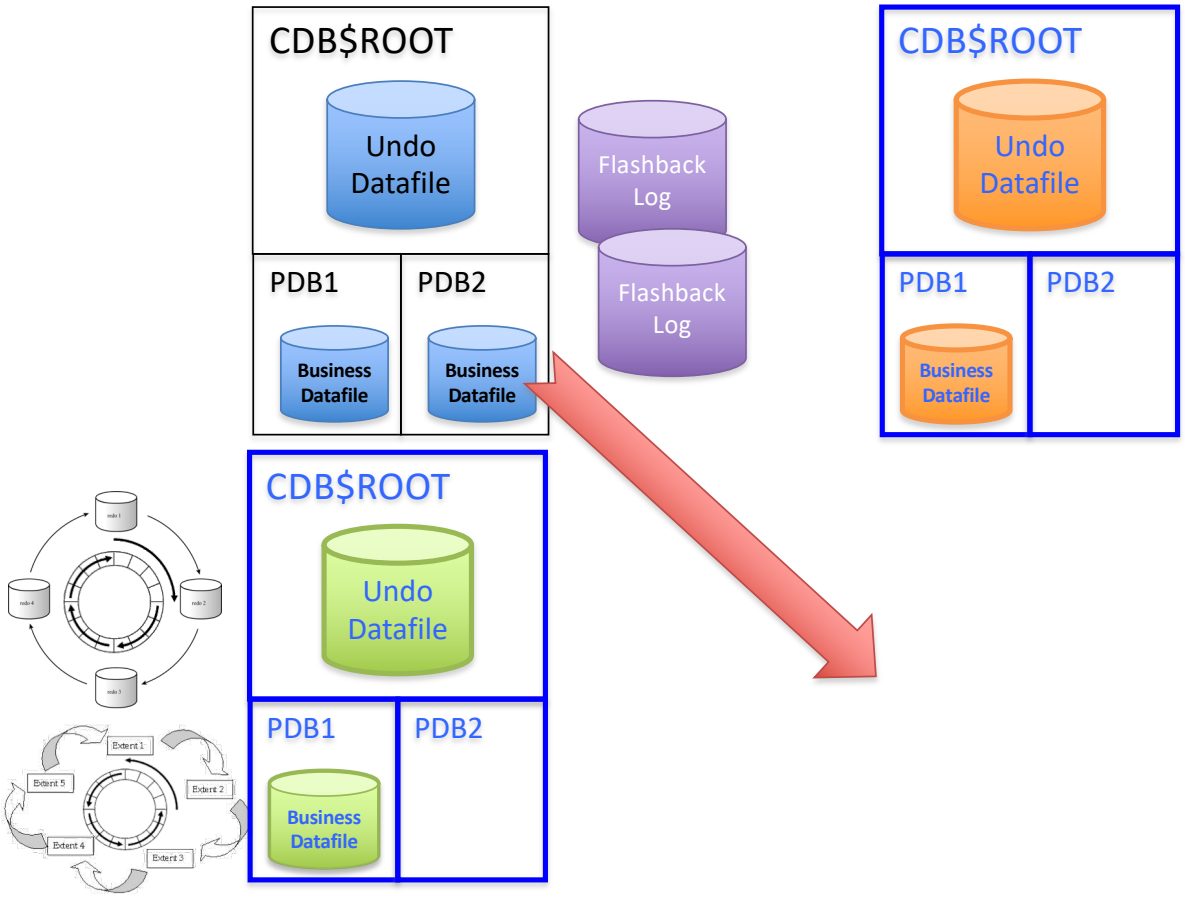
Flashback Database 12cR2 – Local Undo



Flashback Database 12cR2 – Shared Undo



Step 1: To Enable Flashback

1. Connect to CDB$ROOT

```
SQL> show con_name

CON_NAME
------------------------------
CDB$ROOT
```

2. Enable Flashback

```
SQL> alter database flashback;
```

Flashback cannot be enabled in one specific PDB:

```
SQL> alter session set container=NuvolaPDB1;

SQL> alter database flashback on;
alter database flashback on
*
ERROR at line 1:
ORA-03001: unimplemented feature
```

NOTA: Flashback Database requires the Database in **Archivelog mode**

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Step 2: Create restore points

1. SCN `dbms_flashback.get_system_change_number`
2. Date `mm-dd-yyyy hh24:mi:ss`
3. Restore Point:

```
SQL> create restore point T3;
```

4. Guaranteed restore point:

```
SQL> create restore point T3 guarantee flashback database;
```

1. Clean restore point:

```
SQL> alter pluggable database NuvolaPDB1 close;

SQL> alter session set container=NuvolaPDB1;

SQL> create clean restore point CleanPoint;

Restore point created.
```

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Step 3: Flashback Pluggable Database

1. Connect to CDB$ROOT

   The database must be in ARCHIVELOG mode.

1. Be sure that the PDB is closed (All the others PDBs in the CDB can be open in read-write, those PDBs will not be impacted.)

```
ALTER PLUGGABLE DATABASE pdb1 CLOSE;
```

2. **-- Flashback PDB –**
   It depends. If we use (Local | Shared) Undo.

1. Open the PDB with Resetlogs:

```
ALTER PLUGGABLE DATABASE pdb1 OPEN RESETLOGS;
```

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Example with Local Undo

```
SQL> alter pluggable database NuvolaPDB1 close;

Pluggable database altered.

    SQL> flashback pluggable database NuvolaPDB1 to restore point T3;

    Flashback complete.

     SQL> flashback pluggable database NuvolaPDB1 to timestamp
    to_timestamp('11-28-2016 04:52:41','mm-dd-yyyy hh24:mi:ss');

    Fashback complete.

    SQL> flashback pluggable database NuvolaPDB1 to scn 1760506;

    Flashback complete.


SQL> alter pluggable database NuvolaPDB1 open resetlogs;

Pluggable database altered.
```

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Example with Shared Undo

```
SQL> alter pluggable database NuvolaPDB1 close;

Pluggable database altered.


RMAN> flashback pluggable database NuvolaPDB1 to scn 1768131 auxiliary destination
'/u01/auxiliary/';

Starting flashback at 28-NOV-16
using target database control file instead of recovery catalog
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=370 device type=DISK

using channel ORA_DISK_1
RMAN-05026: warning: presuming following set of tablespaces applies to specified point-in-time

List of tablespaces expected to have UNDO segments
Tablespace SYSTEM
Tablespace UNDOTBS1

Creating automatic instance, with SID='vkin'
...
...
...


SQL> alter pluggable database NuvolaPDB1 open resetlogs;

Pluggable database altered.
```

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