ORACLE
Data Deep Dive
at AI World

Upgrade, Migration, and Patching to Oracle AI Database 26ai

Masterclass



Oracle

DBAs

run the world



Speakers



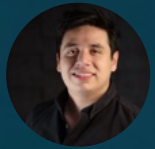
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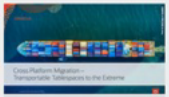
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Virtual Classroom Seminars	Slides
Episode 16 (replaces Episode 1 from Feb 2021) Oracle Database Release and Patching Strategy for 19c and 23c *115 minutes – May 10, 2023*	
Episode 17 From SR to Patch – Insights into the Oracle Database Development process *55 minutes – June 22, 2023*	
Episode 18 Cross Platform Migration – Transportable Tablespaces to the Extreme *145 min – February 22, 2024*	
Episode 19 Move to Oracle Database 23ai – Everything you need to know about Multitenant PART 1 *145 min – May 16, 2024*	
Episode 20 Move to Oracle Database 23ai – Everything you need to know about Multitenant PART 2 *100 min – June 28, 2024*	
Episode 21 One-Button Patching with AutoUpgrade – Easing every DBA's life *55 min – October 24, 2024*	

Recorded Web Seminars

https://MikeDietrichDE.com/videos

More than 45 hours of technical content
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09:00
Welcome
Upgrade to 26ai
Upgrade internals

10:30
Coffee break

11:00
Patching
Hands-on labs

12:15
Lunch

13:00
Hands-on labs
Cool features
Multitenant

14:45
Coffee break

15:15
Data Pump
Q&A

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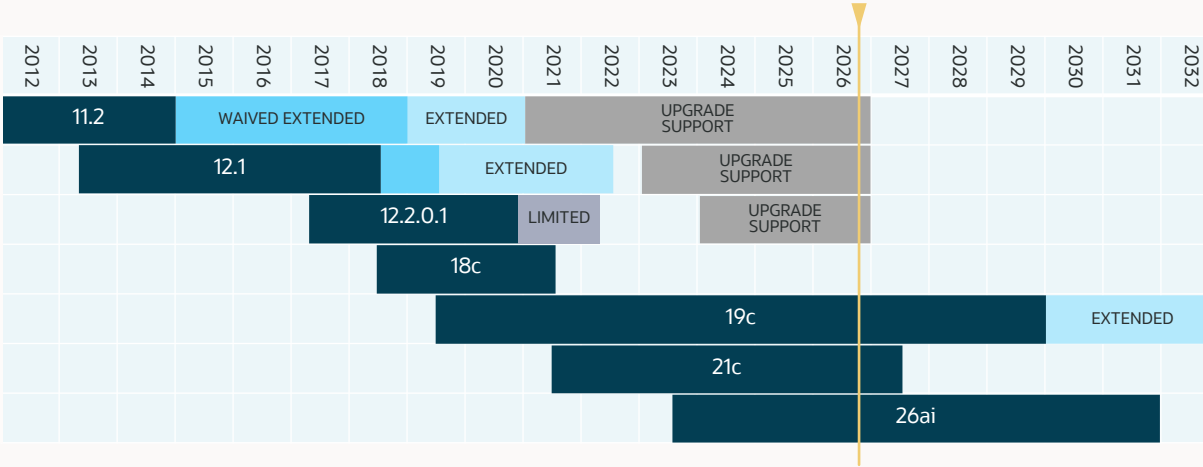




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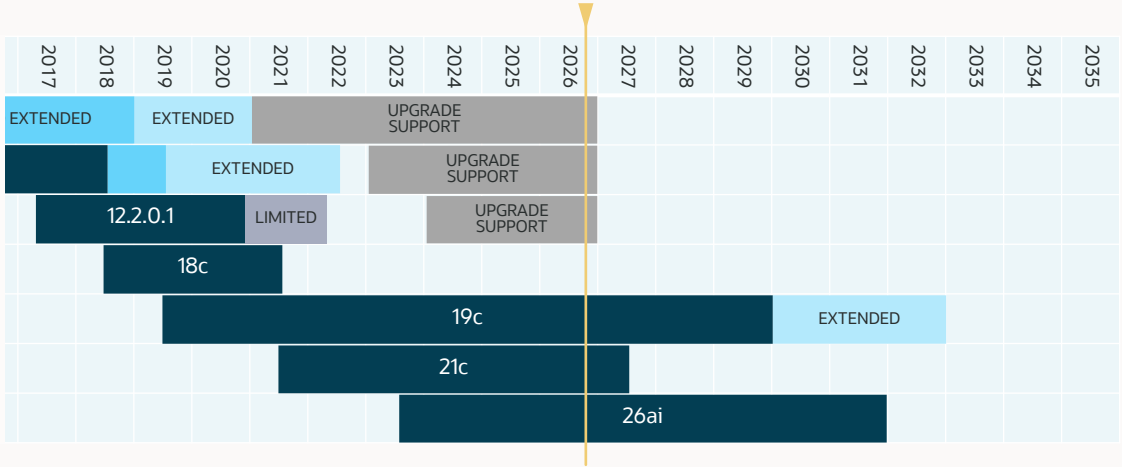
Upgrade to Oracle AI Database 26ai

Lifetime Support Policy



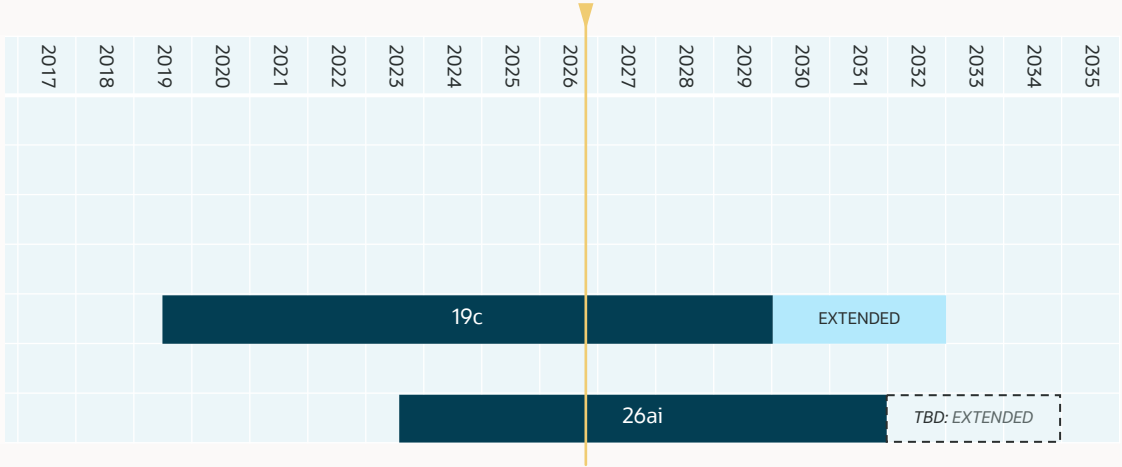
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Lifetime Support Policy



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Lifetime Support Policy



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It is urgent that you upgrade to a Long-Term Support Release

- Oracle Database 19c
- Oracle AI Database 26ai

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Types of Upgrades

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Types of Upgrades



CDB
upgrade



PDB
unplug-plug



Non-CDB
upgrade and convert

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CDB Upgrade



- Upgrades entire CDB including all PDBs
- *Many-as-one* principle
- Less work, more automation
- In-place upgrade, no extra resources needed
- Supports Flashback Database
- Seamless Data Guard + RMAN integration
- At least 30-45 minutes, possibly hours

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CDB Upgrade



- Less control
- Common SLAs needed

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PDB Upgrade



- Upgrades single PDB
- More flexibility
- More control
- Typically 10-30 minutes

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PDB Upgrade



- Additional CDB needed
- Out-of-place upgrade, extra resources needed
- PDB is moved or cloned
- No support for Flashback Database
- Extra work for Data Guard
- Restore between containers requires pre-plugin backups

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Non-CDB to PDB



- Similar to unplug-plug upgrade
- One-time conversion
- Irreversible
- No support for Flashback Database
- Extra work for Data Guard
- Typically 5-10 minutes
- Restore requires pre-plugin backups

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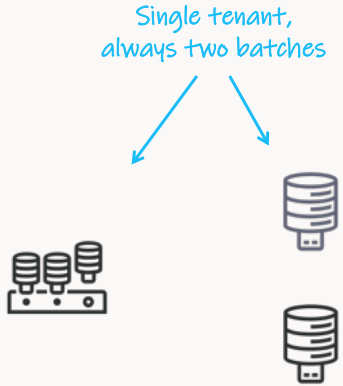


Comparing CDB and PDB upgrades

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Oracle Database 19c



Oracle AI Database 26ai



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Unplug-plug upgrades are faster than upgrading an entire CDB

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Comparing **UPGRADE** types

	CDB upgrade	PDB upgrade	PDB conversion
Time	Longest	Shorter	Very short
Complexity	Easy	Moderate	Moderate
Outage	One big outage	Many smaller outages	Many smaller outages
Rollback	Flashback Database	Other rollback options	Other rollback options
Data Guard + RMAN	Seamless integration	Extra work	Extra work

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Upgrading an entire CDB

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```
global.global_log_dir=/home/oracle/autoupgrade/logs/CDB1
upg1.source_home=/u01/app/oracle/product/19
upg1.target_home=/u01/app/oracle/product/26
upg1.sid=CDB1
```


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```
global.global_log_dir=/home/oracle/autoupgrade/logs/CDB1
upg1.source_home=/u01/app/oracle/product/19
upg1.target_home=/u01/app/oracle/product/26
upg1.sid=CDB1
upg1.timezone_upg=no
```


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```
global.global_log_dir=/home/oracle/autoupgrade/logs/CDB1
upg1.source_home=/u01/app/oracle/product/19
upg1.target_home=/u01/app/oracle/product/26
upg1.sid=CDB1
upg1.timezone_upg=no
upg1.run_dictionary_health=full
```


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```
global.global_log_dir=/home/oracle/autoupgrade/logs/CDB1
upg1.source_home=/u01/app/oracle/product/19
upg1.target_home=/u01/app/oracle/product/26
upg1.sid=CDB1
upg1.timezone_upg=no
upg1.run_dictionary_health=full
upg1.raise_compatible=yes
```


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```
global.global_log_dir=/home/oracle/autoupgrade/logs/CDB1
upg1.source_home=/u01/app/oracle/product/19
upg1.target_home=/u01/app/oracle/product/26
upg1.sid=CDB1
upg1.timezone_upg=no
upg1.run_dictionary_health=full
upg1.raise_compatible=yes
upg1.emcli_path=/u01/app/oracle/oem
upg1.em_target_name=CDB1_myhost.domain.int
```


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```
global.global_log_dir=/home/oracle/autoupgrade/logs/CDB1
upg1.source_home=/u01/app/oracle/product/19
upg1.target_home=/u01/app/oracle/product/26
upg1.sid=CDB1
upg1.timezone_upg=no
upg1.run_dictionary_health=full
upg1.raise_compatible=yes
upg1.emcli_path=/u01/app/oracle/oem
upg1.em_target_name=CDB1_myhost.domain.int
upg1.rman_catalog_connect_string=catalogdb
```


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```
java -jar autoupgrade.jar -config CDB1.cfg -mode analyze
```


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```
java -jar autoupgrade.jar -config CDB1.cfg -mode analyze
```

```
java -jar autoupgrade.jar -config CDB1.cfg -mode deploy
```


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Use AutoUpgrade to download patches and install Oracle home

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Upgrade

- Webinar: Best Practices for Upgrading to Oracle AI Database 26ai
- Blog post: Upgrade to Oracle AI Database 26ai

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Refreshable Clone PDBs

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Non-CDB to PDB conversion is irreversible

What are your rollback options?

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ROLLBACK



Backup / restore

Ensure you have a recent backup and requires time to restore and recover



Copy data files

Requires time and disk space to hold a copy of the data files

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ROLLBACK

Backup / restore

Ensure you have a recent backup and requires time to restore and recover

Copy data files

Requires time and disk space to hold a copy of the data files



Refreshable clone PDB

Requires ~~time and~~ disk space to hold a copy of the data files

Requires Oracle Database 12.2 or newer

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Refreshable Clone PDB



CREATE

Create PDB from non-CDB over a database link



REFRESH

Apply redo from non-CDB to keep PDB up-to-date



OUTAGE

Disconnect users and refresh PDB for the last time

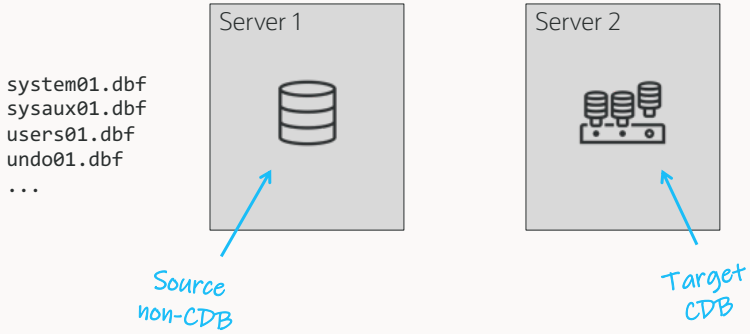


CONVERT

To become a proper PDB, it must be converted

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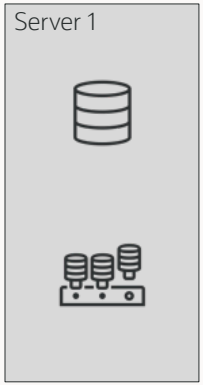
Refreshable Clone PDB



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Refreshable Clone PDB

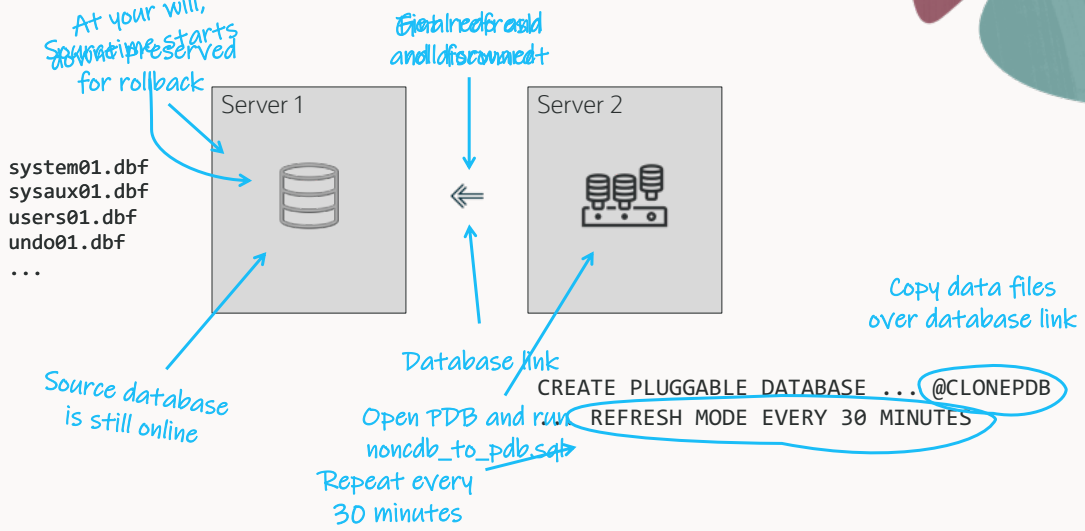
```
system01.dbf
sysaux01.dbf
users01.dbf
undo01.dbf
...
```



Could be same server as well

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Refreshable Clone



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Refreshable Clone PDB

Source non-CDB	Target CDB



```
CREATE USER dblinkuser
       IDENTIFIED BY ... ;

GRANT CREATE SESSION,
      CREATE PLUGGABLE DATABASE,
      SELECT_CATALOG_ROLE TO dblinkuser;

GRANT READ ON sys.enc$ TO dblinkuser;
```

```
CREATE DATABASE LINK CLONEPDB
       CONNECT TO dblinkuser
       IDENTIFIED BY ...
       USING 'noncdb-alias';
```


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Refreshable Clone

Source non-CDB	Target CDB



```
upg1.source_home=/u01/app/oracle/product/dbhome_19_33
upg1.target_home=/u01/app/oracle/product/dbhome_26_4
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=26
upg1.source_dblink.NONCDB1=CLONEPDB
upg1.target_pdb_name.NONCDB1=PDB1
```


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You can drop user and database link after migration

- Config file parameter `drop_dblink`

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Refreshable Clone PDB

Source non-CDB	Target CDB



```
upg1.source_home=/u01/app/oracle/product/dbhome_19_33
upg1.target_home=/u01/app/oracle/product/dbhome_26_4
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=26
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
```


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Refreshable Clone PDB

Source non-CDB	Target CDB



```
upg1.source_home=/u01/app/oracle/product/dbhome_19_33
upg1.target_home=/u01/app/oracle/product/dbhome_26_4
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=26
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
```


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Rename your PDB to avoid name collision

- If CDB is on same host,
  it also registers for the default service

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Refreshable Clone

Source non-CDB	Target CDB



```
upg1.source_home=/u01/app/oracle/product/dbhome_19_33
upg1.target_home=/u01/app/oracle/product/dbhome_26_4
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=26
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
upg1.start_time=19/01/2038 03:14:07
```


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```
--When a job is in REFRESHPDB stage,
--you can force it to start immediately
upg> proceed -job 101
```


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```
--When a job is in REFRESHPDB stage,
--you can force it to start immediately
upg> proceed -job 101

--Or postpone it
upg> proceed -job 101 -newstarttime +2h30m
```


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```
--When a job is in REFRESHPDB stage,
--you can force it to start immediately
upg> proceed -job 101

--Or postpone it
upg> proceed -job 101 -newstarttime +30m

--Or reschedule it
upg> proceed -job 101 -newstarttime 01/11/2026 02:30:00
```


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Refreshable Clone PDB

Source non-CDB	Target CDB



```
upg1.source_home=/u01/app/oracle/product/dbhome_19_33
upg1.target_home=/u01/app/oracle/product/dbhome_26_4
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=26
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
upg1.start_time=19/01/2038 03:14:07
upg1.parallel_pdb_creation_clause=4
```


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Refreshable Clone

1

Run on source

```
autoupgrade.jar ... –mode analyze
autoupgrade.jar ... –mode fixups
```

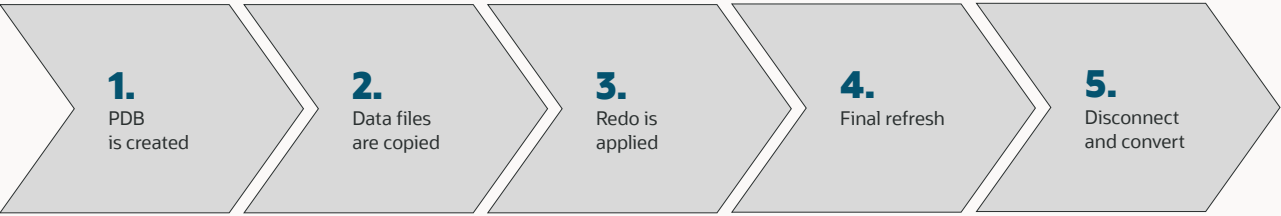
2

Run on target

```
autoupgrade.jar ... –mode deploy
```


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Refreshable Clone PDB




```
autoupgrade.jar ... –mode deploy
```

```
upg1.start_time=19/01/2038 03:14:07

upg> proceed -job n
```


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Works for unplug-plug upgrades as well

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The source non-CDB stays intact to allow rollback

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Techniker Krankenkasse

Move hundreds of Oracle Database19c PDBs to Oracle Database 23ai with ExaScale-only

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Customer Case | Techniker Krankenkasse

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks

Large German Public Health Insurance

- **Founded**: 1884
- **Legal Form**: Public Corporation
- **Headquarters**: Hamburg, Germany
- **Members**: 11.9 million
- **Employees**: aprx. 19,000
- **Customer Service**: 174 service centers
- **Budget 2024**: €62.5 billion

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Customer Case | Techniker Krankenkasse

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks

Move to Oracle Database 23ai with ExaScale

- No ASM, no Oracle Database 19c anymore



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Customer Case | Techniker Krankenkasse

- Customer
- Project
- **Constraints**
- Preparation
- Upgrade
- Success?
- Remarks

`COMPATIBLE=23.0.0`

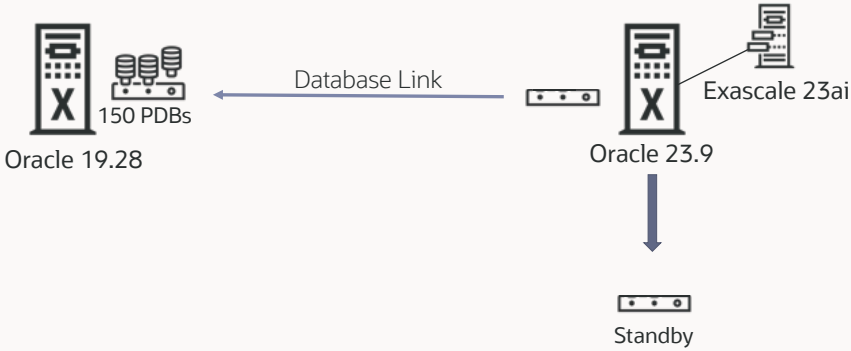
No ASM, no Oracle Database 19c anymore

Data Pump as rollback

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Customer Case | Techniker Krankenkasse

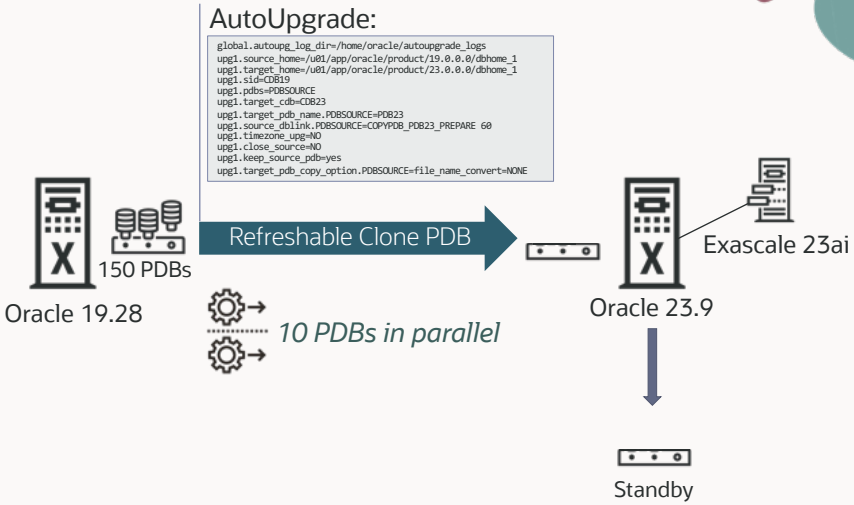
- Customer
- Project
- Constraints
- **Preparation**
- Upgrade
- Success?
- Remarks



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Customer Case | Techniker Krankenkasse

- Customer
- Project
- Constraints
- Preparation
- **Upgrade**
- Success?
- Remarks



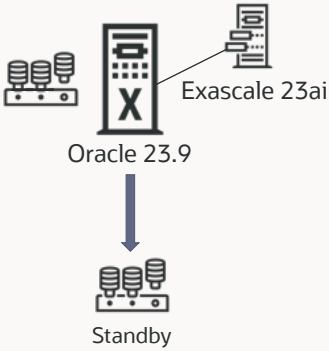
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Customer Case | Techniker Krankenkasse

- Customer
- Project
- Constraints
- Preparation
- **Upgrade**
- Success?
- Remarks



Oracle 19.28



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Customer Case | Techniker Krankenkasse

Customer
Project
Constraints
Preparation
Upgrade
Success?
Remarks

Yes!!

- Migrated 150 PDBs from TEST & DEV within less than 4 weeks
- Migration of all Oracle Database 19c instances completed by end of 2025
- Exascale snapshots are super-fast

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Customer Case | Techniker Krankenkasse

Customer
Project
Constraints
Preparation
Upgrade
Success?
Remarks

Standby building

- There were some issues
- Refreshable Clones don't propagate
- PDB recovery isolation doesn't work as expected

A number of SRs had to be opened for various areas

Optimizer works very well

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In the cloud, upgrading Oracle databases is as easy as pressing a button



The easy approach → Upgrade entire CDB, including all PDBs



The fast approach → Upgrade single PDB

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Refreshable clone works only with deferred recovery on standby database

- You must restore the PDB on standby database after disconnect from non-CDB

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Further Information

Upgrading in the cloud



Blog post:
Upgrade Encrypted PDB in Cloud to Oracle AI Database 26ai

Blog post:
Upgrade Oracle Base Database Service to Oracle AI Database 26ai

Blog post:
Upgrade from 19c to 26ai using AutoUpgrade –ExaDB-D or ExaC@C – Part 1

Blog post:
When A Refreshable Clone Takes Over The Service

Blog post:
Upgrade to Oracle AI Database 26ai

Documentation: Proceed command

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How does a standby database handle a plug-in operation?

- Take care of your Data Guard during migration

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Data Guard



Plug-in on primary propagates to standby database via redo

1 Enabled recovery

2 Deferred recovery

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Enabled Recovery

1

Enabled recovery

```
create pluggable database ... standbys=all
```

Standby records PDB creation

Standby locates data files

MRP applies redo to PDB

PDB is immediately protected

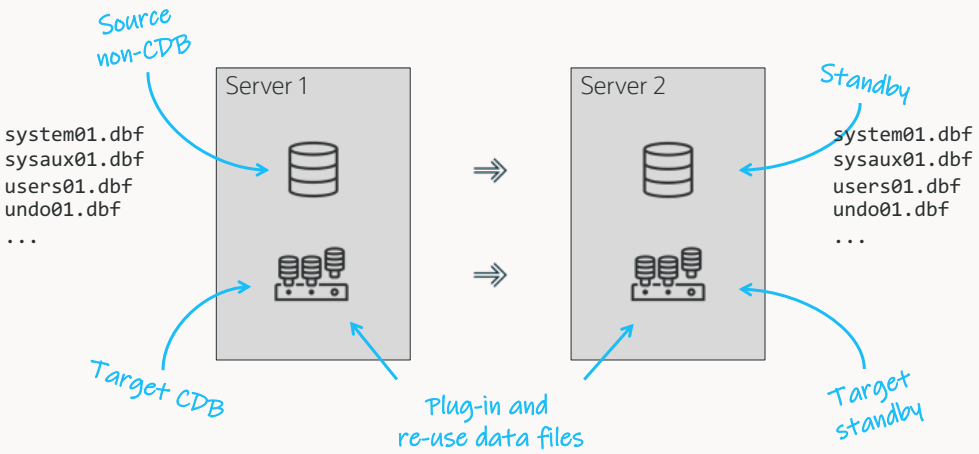
Default

2

Deferred recovery

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Enabled Recovery



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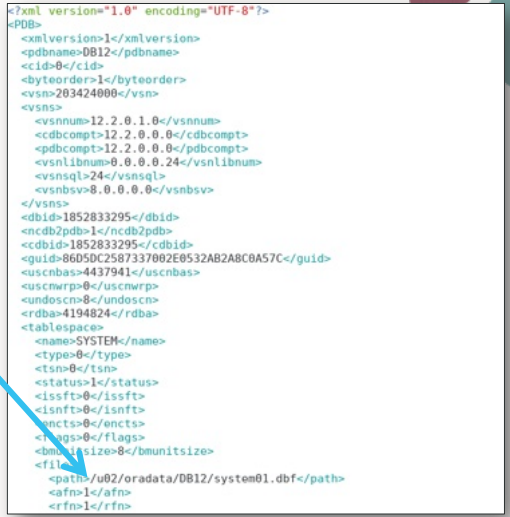


All data files on primary and standby must be at the same SCN

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Enabled Recovery

- The plug-in happens on the primary database
- The plug-in uses the *manifest file*
- The manifest file contains information on data files from the primary database only



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Enabled Recovery

- The plug-in happens on the primary database
- The plug-in uses the *manifest file*
- The manifest file contains information on data files from the primary database only

How does the standby database know which files to plug in?

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Enabled Recovery

How does the standby database know which files to plug in?

1 Regular files

2 OMF in regular file system

3 ASM

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Enabled Recovery

1 Regular files

- Standby search for data files at the same location as the primary
- Override with `DB_FILE_NAME_CONVERT`
- Or, override with `STANDBY_PDB_SOURCE_FILE_DIRECTORY`

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Enabled Recovery

2 OMF in regular file system

- Standby search for data files at the OMF location (`DB_CREATE_FILE_DEST`)
- Move data files from non-CDB location into OMF location
- Or, create soft links in OMF location pointing to data file location

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Enabled Recovery

3 ASM

- Standby search for data files at the OMF location (`DB_CREATE_FILE_DEST`)
- Use ASM aliases to find data files at non-CDB OMF location

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Enabled Recovery | ASM

Primary





Standby



```
SQL> select name from v$datafile;

NAME
--------------------------------------------------------
+DATA/DB_BOSTON/DATAFILE/system.269.1103046537
+DATA/DB_BOSTON/DATAFILE/sysaux.270.1103046537
+DATA/DB_BOSTON/DATAFILE/users.273.1103046827
```

```
SQL> select name from v$datafile;

NAME
--------------------------------------------------------
+DATA/DB_CHICAGO/DATAFILE/system.265.1103050007
+DATA/DB_CHICAGO/DATAFILE/sysaux.266.1103050007
+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009
```

Same file,
but different name

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Enabled Recovery | ASM

19c Non-CDB Primary





19c Non-CDB Standby



The manifest file contains

- File path on primary database only
- Not standby database

```
SQL> exec dbms_pdb.describe('/tmp/manifest_DB.xml');
```

```
<?xml version="1.0" encoding="UTF-8"?>
<PDB>
  <xmlversion>1</xmlversion>
  <pdbname>PDB1</pdbname>
  ...
  <guid>DDB49CFEFD8ED4FCE053E801000A078C</guid>
  ...
  <tablespace>
    <name>USERS</name>
    ...
    <file>
       <path>+DATA/DB_BOSTON/DATAFILE/users.273.1103046827</path>
```


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Enabled Recovery | ASM

Target primary

26ai
CDB
Primary



```
SQL> create pluggable database PDB1 using '/tmp/manifest_DB.xml' ... ;
```



- Manifest file lists the location of data files on primary
- No information about standby databases

26ai
CDB
Standby



Target standby

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Enabled Recovery | ASM

26ai
CDB
Primary



+DATA/DB_BOSTON/DATAFILE/users.273.1103046827



Redo record says:
Plug in this data file

No good, data file
has a different name

26ai
CDB
Standby



+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009

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Enabled Recovery | ASM

26ai
CDB
Primary



+DATA/DB_BOSTON/DATAFILE/users.273.1103046827



OK, let's check the OMF directory

26ai
CDB
Standby



+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009

+DATA/CDB1_CHICAGO/<PDB_GUID>/DATAFILE

It's empty

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Could I just move the file in ASM??

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There's no `move` command in ASM.
But you can create *aliases*

- Similar to file system soft links

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```
SQL> alter diskgroup data add alias
     '+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009'
     for
     '+DATA/CDB1_CHICAGO/<PDB_GUID>/DATAFILE/users.269.1103050009':
```


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```
SQL> alter diskgroup data add alias
     '+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009'
     for
     '+DATA/CDB1_CHICAGO/<PDB_GUID>/DATAFILE/users.269.1103050009':
```


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```
SQL> alter diskgroup data add alias
     '+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009'
     for
     '+DATA/CDB1_CHICAGO/<PDB_GUID>/DATAFILE/users.269.1103050009':
```



Standby PDB OMF location

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```
SQL> alter diskgroup data add alias
     '+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009'
     for
     '+DATA/CDB1_CHICAGO/<PDB_GUID>/DATAFILE/users.269.1103050009':
```



Name does not matter.
Standby scans all files in OMF directory

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Data Guard | Re-use Data Files

26ai
CDB
Primary





26ai
CDB
Standby



- Standby database scans its own OMF directory for data files
- Standby ignores file names and look at file headers
- Standby will find aliases and find the real file locations

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Data Guard | Re-use Data Files

Primary





Standby



Looking for file like on primary

```
Recovery scanning directory +DATA/DB_BOSTON/... for any matching files
Deleted Oracle managed file +DATA/DB_BOSTON/...
Successfully added datafile 37 to media recovery
Datafile #37: +DATA/DB_CHICAGO/DATAFILE/users.269.1103050009
```

Follows alias and finds the real file

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What happens with enabled recovery if the standby fails to find the data files?

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Enabled Recovery | Missing Data Files

What if a standby database fails to find data files?

- If Active Data Guard and PDB Recovery Isolation is turned on
  - New feature in Oracle Database 21c
  - Recovery disabled for PDB
  - Recovery proceeds in the entire CDB, except in specific PDB
  - Standby automatically restores data files from primary and re-enables recovery afterward
  - PDB protected after auto-restore

- If not, recovery halts in the **entire** CDB
  - **This is a critical situation**

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What about AutoUpgrade and enabled recovery?

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```
----------------- Continue with the manual steps -----------------
There is a job with manual steps pending.
The checkpoint change number is 2723057 for database DB19.
For the standby database <DB19_AARHUS>, use the checkpoint number <2723057> to
recover the database.

You can find the SCN information in:
/home/oracle/autoupgrade/upgrade26/DB19/101/drain/scn.json
Once these manual steps are completed, you can resume job 101
-------------------------------------------------------------------
```


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Deferred Recovery

1

Enabled recovery

`create pluggable database ... standbys=all`

Standby records PDB creation

Standby locates data files

MRP applies redo to PDB

PDB is immediately protected

2

Deferred recovery

`create pluggable database ... standbys=none`

Standby records PDB creation

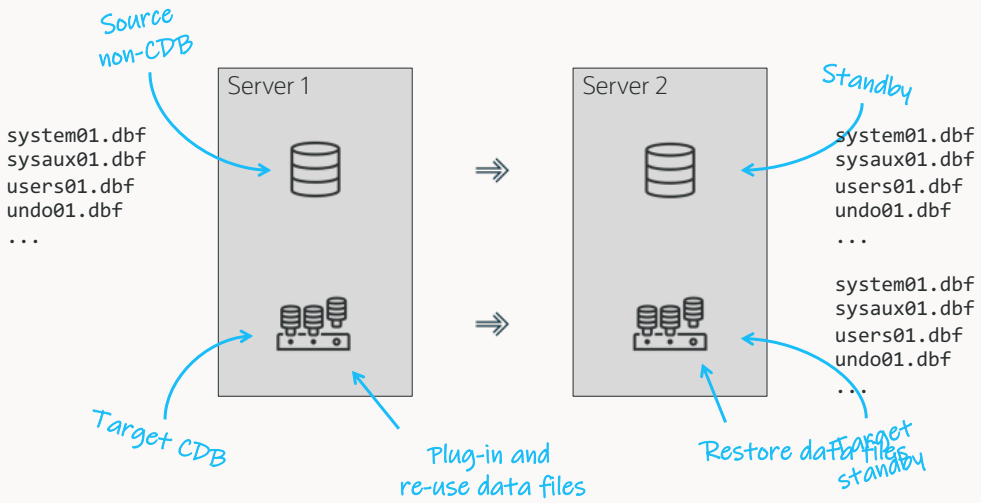
Standby ignores data files

MRP skips redo

PDB protected after restore

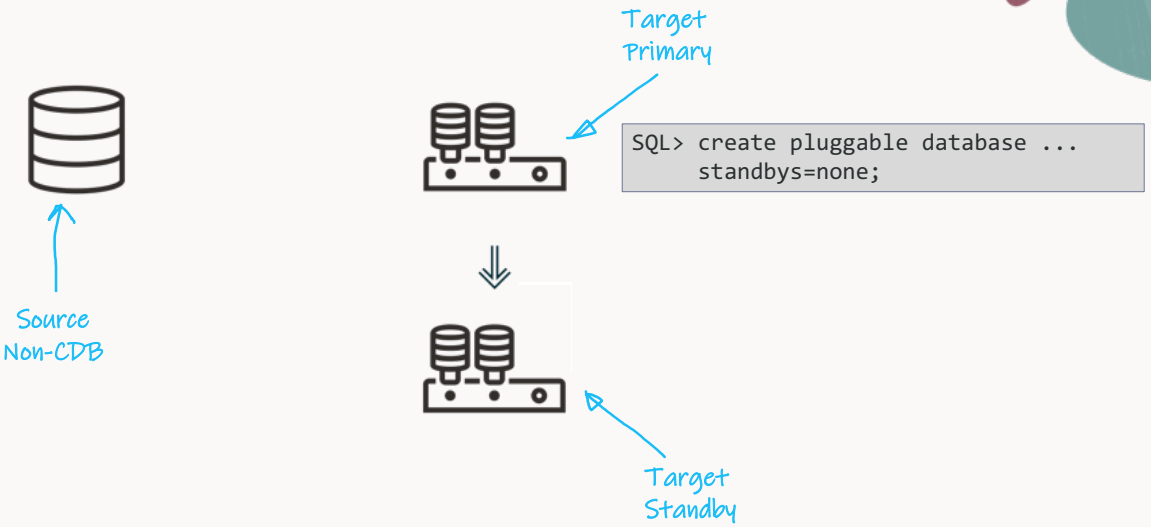
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Deferred Recovery



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Deferred Recovery



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Deferred Recovery



```
SQL> create pluggable database ...
     standbys=none;
```





PDB created
Data files missing

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Deferred Recovery



```
SQL> show pdbs

CON_NAME    OPEN MODE
PDB1        READ WRITE
```

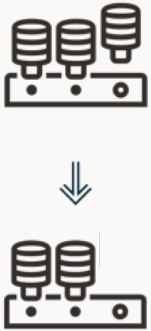


```
SQL> show pdbs

CON_NAME    OPEN MODE
PDB1        MOUNTED
```


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Deferred Recovery

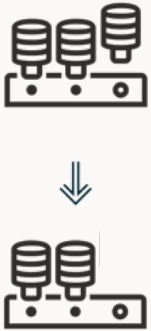


```
SQL> select name, recovery_status
     from v$pdbs;

NAME    RECOVERY_STATUS
PDB1    DISABLED
```


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Deferred Recovery



```
RMAN> restore pluggable database
      ... from service ... ;

SQL> alter pluggable database
     enable recovery;
SQL> alter database datafile
     ... online;
```


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Deferred Recovery



```
RMAN> restore pluggable database
      ... from service ... ;

SQL> alter pluggable database
     enable recovery;
SQL> alter database datafile
     ... online;
```

- Automated process in Oracle Database 21c
- PDB Recovery Isolation
- Requires Active Data Guard

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Further Details

Multitenant Conversion



- Move to Oracle Database 23ai –

  Everything you need to know about Oracle Multitenant – Part 1

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Don't jeopardize your Data Guard

- Test the procedure and verify your environment

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Upgrade to Oracle AI Database

And Become an AI-Enabled DBA

Wednesday, 09:00
HOL6019

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Upgrade Internals



Oracle home

Binaries



Database

Data dictionary

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Binaries and data dictionary release version must match exactly

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Oracle Database 19c



Data dictionary 19c



Oracle AI Database 26ai



Data dictionary 26ai



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Database Upgrade Guide

This Book This Release

Table of Contents

- Oracle Database
  - Preface
  - Introduction
  - Preparing to Upgrade
  - Upgrading to the New Oracle Database 10g Release
  - After Upgrading a Database
  - Compatibility and Interoperability
  - Upgrading Your Applications

3 Upgrading to the New Oracle Database 10*g* Release

This chapter guides you through the process of upgrading a database to the new Oracle Database 10*g* release. This chapter covers the following topics:

- System Considerations and Requirements
- Install the Release 10.2 Oracle Software
- Install the Latest Available Patch Set Release and Any Required Patches

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9. Set the system to spool results to a log file for later verification of success:

```
SQL> SPOOL upgrade.log
```

10. Run `catupgrd.sql`:

```
SQL> @catupgrd.sql
```

The `catupgrd.sql` script determines which upgrade scripts need to be run and then runs each necessary script. You must run the script in the new release 10.2 environment.

The upgrade script creates and alters certain data dictionary tables. It also upgrades or installs the following database components in the new release 10.2 database:

- Oracle Database Catalog Views
- Oracle Database Packages and Types
- JServer JAVA Virtual Machine

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dbua

dbupgrade



catctl



@catupgrd.sql



@@catupstr.sql
@@catalog.sql
@@cdstrt.sql
@@cdfixed.sql
...
@catshutdown.sql

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~~dbua~~

~~dbupgrade~~

```
java -jar autoupgrade.jar -config UPGR26.cfg -mode deploy
```



catctl



@catupgrd.sql



@@catupstr.sql
@@catalog.sql
@@cdstrt.sql
@@cdfixed.sql
...
@catshutdown.sql

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`catupgrd.sql` Overview

Initialize

- i-script / c-script

RDBMS upgrade

- catalog/catproc
- a-script

Components

- javavm,dv,ols,sdo,...

Finalizing

- bootstrap upgrade

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```
$ ll $ORACLE_HOME/rdbms/admin

-rw-r-----. 1 oracle oinstall 46693 Feb 10 2025   a19.sql
-rw-r-----. 1 oracle oinstall 11261 Nov 10 2022   a20.sql
-rw-r-----. 1 oracle oinstall 113582 Jul 4 06:47  a21.sql

-rw-r-----. 1 oracle oinstall 106648 Feb 27 2025  c19.sql
-rw-r-----. 1 oracle oinstall 70597 Oct 18 2024   c20.sql
-rw-r-----. 1 oracle oinstall 406297 Jul 10 06:42 c21.sql

-rw-r-----. 1 oracle oinstall 3933 Jul 20 2020    i19.sql
-rw-r-----. 1 oracle oinstall 3712 Nov 23 2022    i20.sql
-rw-r-----. 1 oracle oinstall 13877 Oct 9 2024    i21.sql
```


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```
$ ll $ORACLE_HOME/rdbms/admin

-rw-r-----. 1 oracle oinstall 46693 Feb 10 2025   a19.sql
-rw-r-----. 1 oracle oinstall 11261 Nov 10 2022   a20.sql
-rw-r-----. 1 oracle oinstall 113582 Jul 4 06:47  a21.sql

-rw-r-----. 1 oracle oinstall 106648 Feb 27 2025  c19.sql
-rw-r-----. 1 oracle oinstall 70597 Oct 18 2024   c20.sql
-rw-r-----. 1 oracle oinstall 406297 Jul 10 06:42 c21.sql

-rw-r-----. 1 oracle oinstall 3933 Jul 20 2020    i19.sql
-rw-r-----. 1 oracle oinstall 3712 Nov 23 2022    i20.sql
-rw-r-----. 1 oracle oinstall 13877 Oct 9 2024    i21.sql
```


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```
$ vi i19.sql

(output truncated)

Rem ============================================================================
Rem Bug 28618619: Add new col to lob$ and lobfrag$, with values
Rem               4000 for enable and 0 for disable storage in row
Rem ============================================================================

alter table lob$ add maxinl number;
update lob$ set maxinl =
               case when bitand(property, 2) != 0 then 4000 else 0 end;
commit;
alter table lob$ modify maxinl not null;

alter table lobfrag$ add maxinl number;
update lobfrag$ set maxinl =
                   case when bitand(fragpro, 2) != 0 then 4000 else 0 end;
commit;
alter table lobfrag$ modify maxinl not null;
```


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Upgrading from Oracle Database 19c to Oracle AI Database 26ai:

- 20,000 `CREATE OR REPLACE`
- 7,000 `CREATE ...`
- 1,500 `ALTER TABLE`
- 300 `ALTER TYPE`
- 7,000 `ALTER SESSION`
- … and a lot more statements

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Parallel Upgrade

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```
$ vi catupgrd.sql
```

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```
Rem
Rem Initial checks and RDBMS upgrade scripts
Rem
@@catupstr.sql

Rem
Rem Execute upgrade and catalog session script
Rem
@@catupses.sql    --CATFILE -SES
@@catalogses.sql  --CATFILE -SESS
@@catalogses.sql  --CATFILE -SESS

Rem
Rem Run catalog with some multiprocess phases
Rem
@@catalog.sql     --CATFILE -X

Rem
Rem Execute catproc session script
Rem
@@catprocses.sql  --CATFILE -SESE -SESS

Rem
Rem Run catproc with some multiprocess phases
Rem
@@catproc.sql     --CATFILE -X
```


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```
Rem
Rem Initial checks and RDBMS upgrade scripts
Rem
@@catupstr.sql

Rem
Rem Execute upgrade and catalog session script
Rem
@@catupses.sql    --CATFILE -SES
@@catalogses.sql  --CATFILE -SESS
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Rem
Rem Run catalog with some multiprocess phases
Rem
@@catalog.sql     --CATFILE -X

Rem
Rem Execute catproc session script
Rem
@@catprocses.sql  --CATFILE -SESE -SESS

Rem
Rem Run catproc with some multiprocess phases
Rem
@@catproc.sql     --CATFILE -X
```


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```
Rem
Rem Initial checks and RDBMS upgrade scripts
Rem
@@catupstr.sql

Rem
Rem Execute upgrade and catalog session script
Rem
@@catupses.sql    --CATFILE -SES
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Rem
@@catalog.sql     --CATFILE -X

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Rem
Rem Run catproc with some multiprocess phases
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@@catproc.sql     --CATFILE -X
```


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Rem
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Rem
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Rem
@@catalog.sql     --CATFILE -X

Rem
Rem Execute catproc session script
Rem
@@catprocses.sql  --CATFILE -SESE -SESS

Rem
Rem Run catproc with some multiprocess phases
Rem
@@catproc.sql     --CATFILE -X
```


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```
--CATCTL -S -D "Catalog Core SQL"    Initial scripts single process
@@cdstrt.sql
@@cdfixed.sql
@@catcdbviews.sql
@@catblock.sql
@@cdcore.sql

--CATCTL -R
--CATCTL -M -D "Catalog Tables and Views"
@@cdplsql.sql
@@cdsqlddl.sql
@@cdmanage.sql
@@cdtxnspc.sql
@@cdenv.sql
@@cdrac.sql
@@cdsec.sql
@@cdobj.sql
@@cdjava.sql
@@cdpart.sql
@@cdrep.sql
@@cdaw.sql
@@cdsummgt.sql
@@cdtools.sql
@@cdexttab.sql
@@cddm.sql
@@cdclst.sql
```


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```
--CATCTL -S -D "Catalog Core SQL"    Initial scripts single process
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@@cdenv.sql
@@cdrac.sql
@@cdsec.sql
@@cdobj.sql
@@cdjava.sql
@@cdpart.sql
@@cdrep.sql
@@cdaw.sql
@@cdsummgt.sql
@@cdtools.sql
@@cdexttab.sql
@@cddm.sql
@@cdclst.sql
```


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@@cdtxnspc.sql
@@cdenv.sql
@@cdrac.sql
@@cdsec.sql
@@cdobj.sql
@@cdjava.sql
@@cdpart.sql
@@cdrep.sql
@@cdaw.sql
@@cdsummgt.sql
@@cdtools.sql
@@cdexttab.sql
@@cddm.sql
@@cdclst.sql
```


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```
$ grep "jloaiza" catalog.sql

Rem     jloaiza    06/20/94 -  fix all_tables
Rem     jloaiza    06/16/94 -  add disable dml locks
Rem     jloaiza    05/23/94 -  add new fixed views
Rem     jloaiza    10/28/92 -  add v$db_object_cache and v$open_cursor
```


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Juan Loaiza
EVP, Database Technologies, Oracle

```
Rem
Rem Run catproc with some multiprocess phases
Rem
@@catproc.sql     --CATFILE -X

--CATCTL -R
--CATCTL -S -D "Final RDBMS scripts"
Rem
Rem Final RDBMS upgrade scripts
Rem
@@catupprc.sql

Rem
Rem Upgrade components with some multiprocess phases
Rem
@@cmpupgrd.sql    --CATFILE -X -SESE

--CATCTL -S -D "Final Upgrade scripts"
Rem
Rem Final upgrade scripts
Rem
@@catupend.sql
```


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```
--CATCTL -M  -D "Upgrading Java and non-Java"
Rem
Rem Java upgrade (JAVAVM, XML, CATJAVA)
Rem
@@cmpupjav.sql

Rem
Rem non-Java dependent upgrades (include XDB and Dependent since all
Rem     single process while Java components being upgraded in other single
Rem     process):
Rem     APS, AMD, OLS, DV, CONTEXT, XDB, OWM, MGW, RAC
Rem
@@cmpupnjv.sql

--CATCTL -R
--CATCTL -S
Rem
Rem Extracted grants/revokes of bootstrap tables for component scripts
Rem These are run serially as to not run into timeout/deadlocking issues
Rem
@@cmpupprv.sql

--CATCTL -R -D "Upgrading XDB"
Rem
Rem Oracle XDB (uses catctl directly)
Rem
--CATCTL -CP XDB -X
```


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```
--CATCTL -M  -D "Upgrading Java and non-Java"
Rem
Rem Java upgrade (JAVAVM, XML, CATJAVA)
Rem
@@cmpupjav.sql

Rem
Rem non-Java dependent upgrades (include XDB and Dependent since all
Rem     single process while Java components being upgraded in other single
Rem     process):
Rem     APS, AMD, OLS, DV, CONTEXT, XDB, OWM, MGW, RAC
Rem
@@cmpupnjv.sql

--CATCTL -R
--CATCTL -S
Rem
Rem Extracted grants/revokes of bootstrap tables for component scripts
Rem These are run serially as to not run into timeout/deadlocking issues
Rem
@@cmpupprv.sql

--CATCTL -R -D "Upgrading XDB"
Rem
Rem Oracle XDB (uses catctl directly)
Rem
--CATCTL -CP XDB -X
```


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```
$ pwd
/u02/app/oracle/autoupgrade/runs/LONGHORN1/LONGHORN1/101/dbupgrade

$ vi autoupgrade*cdbroot.log
```


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```
------------------------------------------------------
Phases [0-106]         Start Time:[2025_08_22 18:00:46]
Container Lists Inclusion:[CDB$ROOT] Exclusion:[NONE]
------------------------------------------------------
***********    Executing Change Scripts    ***********
Serial    Phase #:0    [CDB$ROOT] Files:1    Time: 51s
***************   Catalog Core SQL    ***************
Serial    Phase #:1    [CDB$ROOT] Files:5    Time: 40s
Restart   Phase #:2    [CDB$ROOT] Files:1    Time: 0s
***********   Catalog Tables and Views    ***********
Parallel Phase #:3    [CDB$ROOT] Files:21   Time: 18s
Restart   Phase #:4    [CDB$ROOT] Files:1    Time: 0s
*************   Catalog Final Scripts    ************
Serial    Phase #:5    [CDB$ROOT] Files:7    Time: 12s
*****************   Catproc Start    ****************
Serial    Phase #:6    [CDB$ROOT] Files:1    Time: 9s
******************   Catproc Types    ****************
Serial    Phase #:7    [CDB$ROOT] Files:2    Time: 9s
Restart   Phase #:8    [CDB$ROOT] Files:1    Time: 0s

(output truncated)

***   End PDB Application Upgrade Post-Shutdown   **
Serial    Phase #:104  [CDB$ROOT] Files:2    Time: 101s
Serial    Phase #:105  [CDB$ROOT] Files:1    Time: 0s
Serial    Phase #:106  [CDB$ROOT] Files:1     Time: 24s
Serial    Phase #:106  [CDB$ROOT] Files:1     Time: 24s
```


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```
Phases [0-106]         Start Time:[2025_08_22 18:00:46]
Container Lists Inclusion:[CDB$ROOT] Exclusion:[NONE]
----------------------------------------------------
**********   Executing Change Scripts   **********
Serial   Phase #:0    [CDB$ROOT] Files:1    Time: 51s
***************   Catalog Core SQL   ***************
Serial   Phase #:1    [CDB$ROOT] Files:5    Time: 40s
Restart  Phase #:2    [CDB$ROOT] Files:1    Time: 0s
**********   Catalog Tables and Views   **********
Parallel Phase #:3    [CDB$ROOT] Files:21
Restart  Phase #:4    [CDB$ROOT] Files:1
************   Catalog Final Scripts   ************
Serial   Phase #:5    [CDB$ROOT] Files:7
****************   Catproc Start   ****************
Serial   Phase #:6    [CDB$ROOT] Files:1
*****************   Catproc Types   *****************
Serial   Phase #:7    [CDB$ROOT] Files:2
Restart  Phase #:8    [CDB$ROOT] Files:1

(output truncated)

***   End PDB Application Upgrade Post-Shutd
Serial   Phase #:104  [CDB$ROOT] Files:2
Serial   Phase #:105  [CDB$ROOT] Files:1
Serial   Phase #:106  [CDB$ROOT] Files:1
Serial   Phase #:106  [CDB$ROOT] Files:1    Time: 24s
```

```
--CATCTL -S -D "Catalog Core SQL"    Initial scripts single process
@@cdstrt.sql
@@cdfixed.sql
@@catcdbviews.sql
@@catblock.sql
@@cdcore.sql

--CATCTL -R
--CATCTL -M -D "Catalog Tables and Views"
@@cdplsql.sql
@@cdsqlddl.sql
@@cdmanage.sql
@@cdtxnspc.sql
@@cdenv.sql
@@cdrac.sql
@@cdsec.sql
@@cdobj.sql
@@cdjava.sql
```


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```
Phases [0-106]          Start Time:[2025_08_22 18:00:46]
Container Lists Inclusion:[CDB$ROOT] Exclusion:[NONE]
------------------------------------------------------
**********   Executing Change Scripts   **********
Serial   Phase #:0    [CDB$ROOT] Files:1    Time: 51s
***************   Catalog Core SQL   ***************
Serial   Phase #:1    [CDB$ROOT] Files:5    Time: 40s
Restart  Phase #:2    [CDB$ROOT] Files:1    Time: 0s
**********   Catalog Tables and Views   **********
Parallel Phase #:3    [CDB$ROOT] Files:21
Restart  Phase #:4    [CDB$ROOT] Files:1
************   Catalog Final Scripts   ************
Serial   Phase #:5    [CDB$ROOT] Files:7
****************   Catproc Start   ****************
Serial   Phase #:6    [CDB$ROOT] Files:1
*****************   Catproc Types   *****************
Serial   Phase #:7    [CDB$ROOT] Files:2
Restart  Phase #:8    [CDB$ROOT] Files:1

(output truncated)

***   End PDB Application Upgrade Post-Shutd
Serial   Phase #:104  [CDB$ROOT] Files:2
Serial   Phase #:105  [CDB$ROOT] Files:1
Serial   Phase #:106  [CDB$ROOT] Files:1
Serial   Phase #:106  [CDB$ROOT] Files:1    Time: 24s
```

```
--CATCTL -S -D "Catalog Core SQL"   Initial scripts single process
@@cdstrt.sql
@@cdfixed.sql
@@catcdbviews.sql
@@catblock.sql
@@cdcore.sql

--CATCTL -R
--CATCTL -M -D "Catalog Tables and Views"
@@cdplsql.sql
@@cdsqlddl.sql
@@cdmanage.sql
@@cdtxnspc.sql
@@cdenv.sql
@@cdrac.sql
@@cdsec.sql
@@cdobj.sql
@@cdjava.sql
```


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```
Phases [0-106]          Start Time:[2025_08_22 18:00:46]
Container Lists Inclusion:[CDB$ROOT] Exclusion:[NONE]
------------------------------------------------------
**********   Executing Change Scripts   **********
Serial   Phase #:0    [CDB$ROOT] Files:1     Time: 51s
***************   Catalog Core SQL   ***************
Serial   Phase #:1    [CDB$ROOT] Files:5     Time: 40s
Restart  Phase #:2    [CDB$ROOT] Files:1     Time: 0s
**********   Catalog Tables and Views   **********
Parallel Phase #:3    [CDB$ROOT] Files:21
Restart  Phase #:4    [CDB$ROOT] Files:1
************   Catalog Final Scripts   ************
Serial   Phase #:5    [CDB$ROOT] Files:7
****************   Catproc Start   ****************
Serial   Phase #:6    [CDB$ROOT] Files:1
*****************   Catproc Types   *****************
Serial   Phase #:7    [CDB$ROOT] Files:2
Restart  Phase #:8    [CDB$ROOT] Files:1

(output truncated)

***   End PDB Application Upgrade Post-Shutd
Serial   Phase #:104  [CDB$ROOT] Files:2
Serial   Phase #:105  [CDB$ROOT] Files:1
Serial   Phase #:106  [CDB$ROOT] Files:1
Serial   Phase #:106  [CDB$ROOT] Files:1     Time: 24s
```

```
--CATCTL -S -D "Catalog Core SQL"    Initial scripts single process
@@cdstrt.sql
@@cdfixed.sql
@@catcdbviews.sql
@@catblock.sql
@@cdcore.sql

--CATCTL -R
--CATCTL -M -D "Catalog Tables and Views"
@@cdplsql.sql
@@cdsqlddl.sql
@@cdmanage.sql
@@cdtxnspc.sql
@@cdenv.sql
@@cdrac.sql
@@cdsec.sql
@@cdobj.sql
@@cdjava.sql
```


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For parallel upgrade, AutoUpgrade

- Uses 8 threads for CDB$ROOT
- Uses 2 threads per PDB
- Upgrades CPU_COUNT / 2 PDBs concurrently

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For parallel upgrade, AutoUpgrade

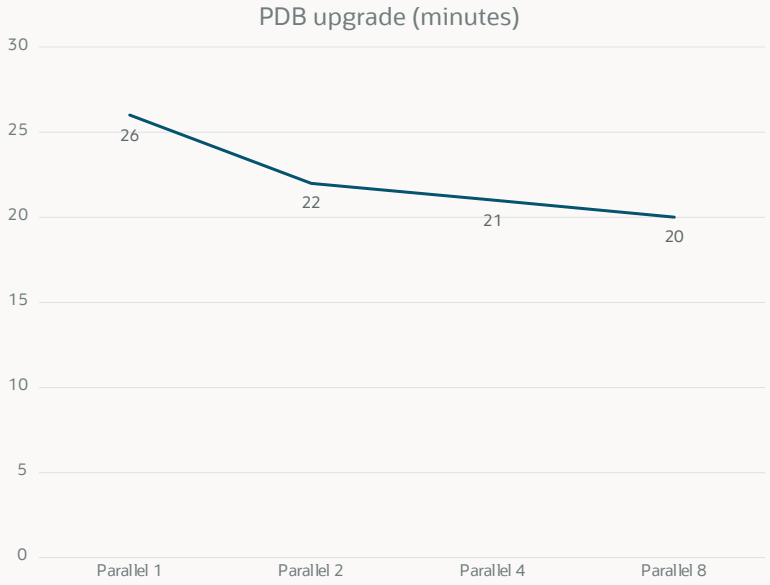
- Uses 8 threads for CDB$ROOT
- Uses 2 threads per PDB
  - Overridable with `upg1.catctl_options=-N <value>`
- Upgrades CPU_COUNT / 2 PDBs concurrently
  - Overridable with `upg1.catctl_options=-n <value>`

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More threads leads to more contention

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Scale by upgrading
more PDBs concurrently

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Upgrade Details

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You must `STARTUP UPGRADE` to upgrade a database

- Enables restricted session

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```
ALTER SYSTEM SET "_SYSTEM_TRIG_ENABLED" = FALSE
                 "_UNDO_AUTOTUNE"       = FALSE
                 AQ_TM_PROCESSES        = 0
                 DB_SECUREFILE          = PERMITTED
                 ENABLE_DDL_LOGGING     = FALSE
                 PLSQL_WARNINGS         = 'DISABLE:ALL'
                 RECYCLEBIN             = OFF
                 RESOURCE_MANAGER_PLAN  = ''
                 UNDO_RETENTION         = 900
```


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```
SQL> startup upgrade
ORACLE instance started.

Total System Global Area 1002435912 bytes
Fixed Size                  8947016 bytes
Variable Size             272629760 bytes
Database Buffers          713031680 bytes
Redo Buffers                7827456 bytes
Database mounted.
Database opened.

SQL> create table t1 (c1 number);

Table created.

SQL> create table t1 (c1 number);

Table created.

SQL> create table t1 (c1 number);

Table created.
```


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A restart is the only way out of *UPGRADE* mode

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Bootstrapping

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```
STARTUP MOUNT

ALTER SESSION SET EVENTS '10046 TRACE NAME CONTEXT FOREVER, LEVEL 12';

ALTER DATABASE OPEN;
```


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```
grep -i "CREATE TABLE" FTEX_ora_328857.trc | cut -c1-100
```


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```
create table bootstrap$ ( line#         number not null,   obj#          number not null,   sql_tex
CREATE TABLE TAB$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT
CREATE TABLE CLU$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT
CREATE TABLE FET$("TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT NULL,"BLOCK#" NUMBER NOT NULL,"LENGTH" NU
CREATE TABLE UET$("SEGFILE#" NUMBER NOT NULL,"SEGBLOCK#" NUMBER NOT NULL,"EXT#" NUMBER NOT NULL,"TS#
CREATE TABLE SEG$("FILE#" NUMBER NOT NULL,"BLOCK#" NUMBER NOT NULL,"TYPE#" NUMBER NOT NULL,"TS#" NUM
CREATE TABLE UNDO$("US#" NUMBER NOT NULL,"NAME" VARCHAR2(30) NOT NULL,"USER#" NUMBER NOT NULL,"FILE#
CREATE TABLE TS$("TS#" NUMBER NOT NULL,"NAME" VARCHAR2(30) NOT NULL,"OWNER#" NUMBER NOT NULL,"ONLINE
CREATE TABLE FILE$("FILE#" NUMBER NOT NULL,"STATUS$" NUMBER NOT NULL,"BLOCKS" NUMBER NOT NULL,"TS#"
CREATE TABLE OBJ$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"OWNER#" NUMBER NOT NULL,"NAME" VARCHAR2(
CREATE TABLE IND$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT
CREATE TABLE ICOL$("OBJ#" NUMBER NOT NULL,"BO#" NUMBER NOT NULL,"COL#" NUMBER NOT NULL,"POS#" NUMBER
CREATE TABLE COL$("OBJ#" NUMBER NOT NULL,"COL#" NUMBER NOT NULL,"SEGCOL#" NUMBER NOT NULL,"SEGCOLLEN
CREATE TABLE USER$("USER#" NUMBER NOT NULL,"NAME" VARCHAR2(128) NOT NULL,"TYPE#" NUMBER NOT NULL,"PA
CREATE TABLE PROXY_DATA$("CLIENT#" NUMBER NOT NULL,"PROXY#" NUMBER NOT NULL,"CREDENTIAL_TYPE#" NUMBE
CREATE TABLE PROXY_ROLE_DATA$("CLIENT#" NUMBER NOT NULL,"PROXY#" NUMBER NOT NULL,"ROLE#" NUMBER NOT
CREATE TABLE CON$("OWNER#" NUMBER NOT NULL,"NAME" VARCHAR2(128) NOT NULL,"CON#" NUMBER NOT NULL,"SPA
CREATE TABLE CDEF$("CON#" NUMBER NOT NULL,"OBJ#" NUMBER NOT NULL,"COLS" NUMBER,"TYPE#" NUMBER NOT NU
CREATE TABLE CCOL$("CON#" NUMBER NOT NULL,"OBJ#" NUMBER NOT NULL,"COL#" NUMBER NOT NULL,"POS#" NUMBE
```


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```
create table bootstrap$ ( line#         number not null,   obj#          number not null,   sql_tex
CREATE TABLE TAB$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT
CREATE TABLE CLU$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT
CREATE TABLE FET$("TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT NULL,"BLOCK#" NUMBER NOT NULL,"LENGTH" NU
CREATE TABLE UET$("SEGFILE#" NUMBER NOT NULL,"SEGBLOCK#" NUMBER NOT NULL,"EXT#" NUMBER NOT NULL,"TS#
CREATE TABLE SEG$("FILE#" NUMBER NOT NULL,"BLOCK#" NUMBER NOT NULL,"TYPE#" NUMBER NOT NULL,"TS#" NUM
CREATE TABLE UNDO$("US#" NUMBER NOT NULL,"NAME" VARCHAR2(30) NOT NULL,"USER#" NUMBER NOT NULL,"FILE#
CREATE TABLE TS$("TS#" NUMBER NOT NULL,"NAME" VARCHAR2(30) NOT NULL,"OWNER#" NUMBER NOT NULL,"ONLINE
CREATE TABLE FILE$("FILE#" NUMBER NOT NULL,"STATUS$" NUMBER NOT NULL,"BLOCKS" NUMBER NOT NULL,"TS#"
CREATE TABLE OBJ$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"OWNER#" NUMBER NOT NULL,"NAME" VARCHAR2(
CREATE TABLE IND$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT
CREATE TABLE ICOL$("OBJ#" NUMBER NOT NULL,"BO#" NUMBER NOT NULL,"COL#" NUMBER NOT NULL,"POS#" NUMBER
CREATE TABLE COL$("OBJ#" NUMBER NOT NULL,"COL#" NUMBER NOT NULL,"SEGCOL#" NUMBER NOT NULL,"SEGCOLLEN
CREATE TABLE USER$("USER#" NUMBER NOT NULL,"NAME" VARCHAR2(128) NOT NULL,"TYPE#" NUMBER NOT NULL,"PA
CREATE TABLE PROXY_DATA$("CLIENT#" NUMBER NOT NULL,"PROXY#" NUMBER NOT NULL,"CREDENTIAL_TYPE#" NUMBE
CREATE TABLE PROXY_ROLE_DATA$("CLIENT#" NUMBER NOT NULL,"PROXY#" NUMBER NOT NULL,"ROLE#" NUMBER NOT
CREATE TABLE CON$("OWNER#" NUMBER NOT NULL,"NAME" VARCHAR2(128) NOT NULL,"CON#" NUMBER NOT NULL,"SPA
CREATE TABLE CDEF$("CON#" NUMBER NOT NULL,"OBJ#" NUMBER NOT NULL,"COLS" NUMBER,"TYPE#" NUMBER NOT NU
CREATE TABLE CCOL$("CON#" NUMBER NOT NULL,"OBJ#" NUMBER NOT NULL,"COL#" NUMBER NOT NULL,"POS#" NUMBE
```


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Bootstrap tables are a core part of the data dictionary

- `OBJECT_ID` below 56

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```
SQL> select obj#, sql_text from bootstrap$ order by 1;

   OBJ# SQL_TEXT
------- --------------------------------------------------------------------------------
      0 CREATE ROLLBACK SEGMENT SYSTEM STORAGE (  INITIAL 112K NEXT 56K MINEXTENTS 1 MAX ...
      2 CREATE CLUSTER C_OBJ#("OBJ#" NUMBER) PCTFREE 5 PCTUSED 40 INITRANS 2 MAXTRANS 25 ...
      3 CREATE INDEX I_OBJ# ON CLUSTER C_OBJ# PCTFREE 10 INITRANS 2 MAXTRANS 255 STORAGE ...
      4 CREATE TABLE TAB$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL ...
      5 CREATE TABLE CLU$("OBJ#" NUMBER NOT NULL,"DATAOBJ#" NUMBER,"TS#" NUMBER NOT NULL ...
      6 CREATE CLUSTER C_TS#("TS#" NUMBER) PCTFREE 10 PCTUSED 40 INITRANS 2 MAXTRANS 255 ...
      7 CREATE INDEX I_TS# ON CLUSTER C_TS# PCTFREE 10 INITRANS 2 MAXTRANS 255 STORAGE ( ...
      8 CREATE CLUSTER C_FILE#_BLOCK#("TS#" NUMBER,"SEGFILE#" NUMBER,"SEGBLOCK#" NUMBER) ...
      9 CREATE INDEX I_FILE#_BLOCK# ON CLUSTER C_FILE#_BLOCK# PCTFREE 10 INITRANS 2 MAXT ...
     10 CREATE CLUSTER C_USER#("USER#" NUMBER) PCTFREE 10 PCTUSED 40 INITRANS 2 MAXTRANS ...
     11 CREATE INDEX I_USER# ON CLUSTER C_USER# PCTFREE 10 INITRANS 2 MAXTRANS 255 STORA ...
     12 CREATE TABLE FET$("TS#" NUMBER NOT NULL,"FILE#" NUMBER NOT NULL,"BLOCK#" NUMBER  ...
     13 CREATE TABLE UET$("SEGFILE#" NUMBER NOT NULL,"SEGBLOCK#" NUMBER NOT NULL,"EXT#"  ...
     14 CREATE TABLE SEG$("FILE#" NUMBER NOT NULL,"BLOCK#" NUMBER NOT NULL,"TYPE#" NUMBE ...
     15 CREATE TABLE UNDO$("US#" NUMBER NOT NULL,"NAME" VARCHAR2(30) NOT NULL,"USER#" NU ...
     16 CREATE TABLE TS$("TS#" NUMBER NOT NULL,"NAME" VARCHAR2(30) NOT NULL,"OWNER#" NUM ...
     17 CREATE TABLE FILE$("FILE#" NUMBER NOT NULL,"STATUS$" NUMBER NOT NULL,"BLOCKS" NU ...
```


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```
CREATE CLUSTER C_OBJ#("OBJ#" NUMBER)
PCTFREE 5 PCTUSED 40 INITRANS 2 MAXTRANS 255
STORAGE (
      INITIAL 136K NEXT 200K
      MINEXTENTS 1 MAXEXTENTS 2147483645
      PCTINCREASE 0
      OBJNO 2
      EXTENTS (FILE 1 BLOCK 144)
      ) SIZE 800
```


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```
SQL> alter table registry$sqlpatch add(DANIEL number);

Table altered.
```


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```
SQL> alter table registry$sqlpatch add(DANIEL number);

Table altered.

SQL> alter table tab$ add(DANIEL number);
alter table tab$ add(DANIEL number)
*
ERROR at line 1:
ORA-00701: object necessary for warmstarting database cannot be altered
```


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```
SQL> startup

ORA-01092: ORACLE instance terminated. Disconnection forced
ORA-00704: bootstrap process failure
ORA-39700: database must be opened with UPGRADE option
Process ID: 22211
Session ID: 1125 Serial number: 3
```


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Diagnosing Upgrades

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```
$ pwd
/u02/app/oracle/autoupgrade/runs/FIREBALL1/FIREBALL1/101

$ ll
total 23936
-rw-r----- 1 oracle oinstall 24279072 Aug 22 13:41 autoupgrade_20250822.log
-rw-r----- 1 oracle oinstall   110170 Aug 22 13:41 autoupgrade_20250822_user.log
-rw-r----- 1 oracle oinstall    20655 Aug 22 13:30 autoupgrade_err.log
drwxr-x--- 2 oracle oinstall    32768 Aug 22 13:04 dbupgrade
drwxr-x--- 2 oracle oinstall     4096 Aug 22 11:33 drain
drwxr-x--- 2 oracle oinstall     4096 Aug 22 13:04 postchecks
drwxr-x--- 2 oracle oinstall    12288 Aug 22 13:30 postfixups
drwxr-x--- 2 oracle oinstall     4096 Aug 22 13:31 postupgrade
drwxr-x--- 2 oracle oinstall     4096 Aug 22 11:29 prechecks
drwxr-x--- 2 oracle oinstall    12288 Aug 22 11:29 prefixups
drwxr-x--- 2 oracle oinstall     4096 Aug 22 11:20 preupgrade
drwxr-x--- 2 oracle oinstall     4096 Aug 22 13:41 sysupdates
drwxr-x--- 2 oracle oinstall     4096 Aug 22 13:04 upgstat
```


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```
$ pwd
/u02/app/oracle/autoupgrade/runs/FIREBALL1/FIREBALL1/101/dbupgrade

$ grep -h "Grand Total" autoupgrade* | sort
Grand Total Time: 1456s
Grand Total Time: 1690s [PDB017]
Grand Total Time: 1691s [PDB007]
Grand Total Time: 1702s [PDB028]
Grand Total Time: 1703s [PDB019]
...
Grand Total Time: 2157s [PDB006]
Grand Total Time: 2161s [PDB008]
Grand Total Time: 2168s [PDB005]
Grand Total Time: 2180s [PDB003]
Grand Total Time: 2182s [PDB029]
```


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```
$ grep -ih "Elapsed" catupgrd*pdb029*.log | sort
...
Elapsed: 00:01:06.01
Elapsed: 00:01:37.71
Elapsed: 00:01:47.52
Elapsed: 00:02:36.98
Elapsed: 00:09:59.70

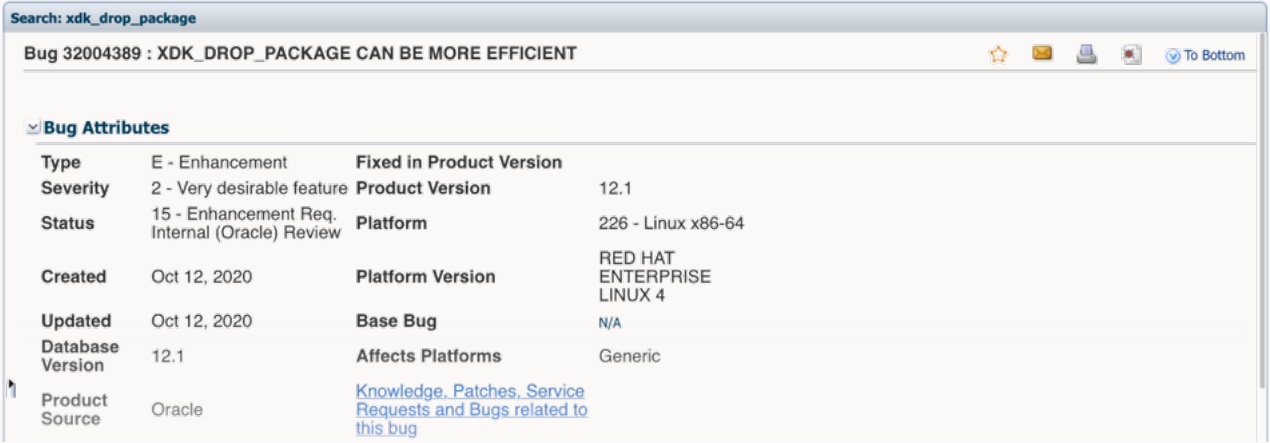
$ grep -i "00:09:59.70" -B5 catupgrd*pdb0290.log
11:32:26 SQL>
11:32:26 SQL> EXECUTE xdk_drop_package;

PL/SQL procedure successfully completed.

Elapsed: 00:09:59.70
```


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You can't use AWR while upgrading

- Or can you?

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```
SQL> select status from v$instance;

STATUS
------------
OPEN MIGRATE
```


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```
SQL> select status from v$instance;

STATUS
------------
OPEN MIGRATE

SQL> exec dbms_workload_repository.create_snapshot();
BEGIN dbms_workload_repository.create_snapshot(); END;

*
ERROR at line 1:
ORA-13516: AWR Operation failed: CATPROC not valid
ORA-06512: at "SYS.DBMS_WORKLOAD_REPOSITORY", line 99
ORA-06512: at "SYS.DBMS_WORKLOAD_REPOSITORY", line 145
ORA-06512: at line 1
Help: https://docs.oracle.com/error-help/db/ora-13516/
```


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```
--After upgrading CDB$ROOT and while PDBs are upgrading,
--you can use AWR in the root container

SQL> alter session set container=CDB$ROOT;

SQL> select status from v$instance;

STATUS
------------
OPEN

SQL> exec dbms_workload_repository.create_snapshot();

PL/SQL procedure successfully completed.
```


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```
$ pwd
/u02/app/oracle/autoupgrade/runs/DB08221/DB08221/101/upgstat

$ ll
total 144
-rw-r----- 1 oracle oinstall 65575 Aug 24 08:20 fullpdbs.txt
-rw-r----- 1 oracle oinstall 49978 Aug 24 08:20 nonpdb_catproc.txt
-rw-r----- 1 oracle oinstall 21428 Aug 24 08:20 nonpdb_upg.txt
```


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```
AUStats Database Upgrade Report

 Database Name  : DB0822
 Instance Name  : DB08221
 Upgrade from   : 19.28.0.0.0 to 23.9.0.25.07
 Snapshots      : 42-62

 Note: This report displays selective data from internal Oracle
 views for database upgrades via AutoUpgrade. For a full Oracle
 statistics report, use AWR (Automatic Workload Repository).

    Begin Snap ID   End Snap ID Elapsed Time
----------------- ------------- ---------------
               42            62 66 mins

Begin Snap ID Begin Time                          Description
------------- ----------------------------------- -----------------------------------
           42 2025-Aug-24 07:13:28 +00:00         PDBS_START

  End Snap ID End Time                            Description
------------- ----------------------------------- -----------------------------------
           62 2025-Aug-24 08:19:41 +00:00         PDBS_END
```


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#4 Top 20 Foreground Events

- Ordered by Total Wait Time, Waits

Event	Waits	Total Wait Time (sec)	Avg Wait (ms)	% DB Time	Wait Class
Disk file operations I/O	20,968,536	7,622.0	0.36	11.0	User I/O
library cache lock	26,145	4,959.8	189.70	7.2	Concurre
latch: shared pool	518,161	2,127.7	4.11	3.1	Concurre
library cache: mutex X	180,079	436.2	2.42	.6	Concurre
cell list of blocks physical r	240,920	338.1	1.40	.5	User I/O
cell single block physical rea	65,887	319.3	4.85	.5	User I/O
latch free	1,457,213	287.4	0.20	.4	Other
cell multiblock physical read	132,588	279.5	2.11	.4	User I/O
library cache: bucket mutex X	37,309	191.3	5.13	.3	Concurre
Free private memory to OS	415,968	114.2	0.27	.2	Other
DBWR range invalidation sync	827	74.0	89.50	.1	Configur
online DDL delay	31	60.0	1935.54	.1	Other
row cache lock	15,504	58.2	3.75	.1	Concurre
Allocate CGA memory from OS	2,589,636	50.0	0.02	.1	Other
cursor: pin S wait on X	4,352	48.5	11.15	.1	Concurre
ASM IO for non-blocking poll	1,269,052	46.2	0.04	.1	User I/O

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#4 Top 20 Foreground Events

- Ordered by Total Wait Time, Waits

Event	Waits	Total Wait Time (sec)	Avg Wait (ms)	% DB Time	Wait Class
Disk file operations I/O	20,968,536	7,622.0	0.36	11.0	User I/O
library cache lock	26,145	4,959.8	189.70	7.2	Concurre
latch: shared pool	518,161	2,127.7	4.11	3.1	Concurre
library cache: mutex X	180,079	436.2	2.42	.6	Concurre
cell list of blocks physical r	240,920	338.1	1.40	.5	User I/O
cell single block physical rea	65,887	319.3	4.85	.5	User I/O
latch free	1,457,213	287.4	0.20	.4	Other
cell multiblock physical read	132,588	279.5	2.11	.4	User I/O
library cache: bucket mutex X	37,309	191.3	5.13	.3	Concurre
Free private memory to OS	415,968	114.2	0.27	.2	Other
DBWR range invalidation sync	827	74.0	89.50	.1	Configur
online DDL delay	31	60.0	1935.54	.1	Other
row cache lock	15,504	58.2	3.75	.1	Concurre
Allocate CGA memory from OS	2,589,636	50.0	0.02	.1	Other
cursor: pin S wait on X	4,352	48.5	11.15	.1	Concurre
ASM IO for non-blocking poll	1,269,052	46.2	0.04	.1	User I/O

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#5. Background Wait Events

Event	Waits	Total Wait Time (s)	Avg Wait Time (ms)
AQPC idle	773	3,987	5,158.37
log file parallel write	2,584,727	123	.05
Streams AQ: load balancer id	316	116	367.73
flashback log file write	118,767	115	.97
db file parallel write	209,083	68	.32
db file async I/O submit	361,607	67	.18
log file sequential read	14,937	28	1.85
latch: shared pool	2,132	21	9.73
oracle thread bootstrap	371	10	27.03
latch free	3,957	9	2.24
ASM file metadata operation	24,151	9	.36
ASM IO for non-blocking poll	189,219	7	.04
latch: MGA shared context la	28	7	265.10
LGWR wait for redo copy	259,860	5	.02
LGWR worker group ordering	8,105	4	.53
resmgr:internal state change	26	3	100.09
KSV master wait	7,368	2	.33
os thread creation	632	2	3.50

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#8 Wait Event Histogram for Top 20 Foreground Events

Event	Foreground Waits	Total Waits	% of Waits <1ms	1 to <32ms	32 to <1024ms	>= 1024ms
Disk file operations I/O	20,968,536	20981704	97.45	2.46	.09	.00
library cache lock	26,145	26211	4.65	61.25	31.08	3.02
latch: shared pool	518,161	520308	70.62	26.97	2.41	.00
library cache: mutex X	180,079	180242	80.36	19.51	.13	.00
cell list of blocks physic	240,920	241951	89.49	10.06	.45	.00
cell single block physical	65,887	65886	60.97	37.49	1.54	.00
latch free	1,457,213	1461626	97.60	2.40	.00	.00
cell multiblock physical r	132,588	133264	84.26	15.20	.54	.00
library cache: bucket mute	37,309	37345	54.06	45.66	.28	.00
Free private memory to OS	415,968	415995	98.17	1.82	.01	.00
DBWR range invalidation sy	827	829	1.45	49.46	49.10	.00
online DDL delay	31	31	3.23	.00	.00	96.77
row cache lock	15,504	15539	42.29	57.30	.40	.01
Allocate CGA memory from O	2,589,636	2611823	100.00	.00	.00	.00
cursor: pin S wait on X	4,352	4553	8.41	87.44	4.13	.02
ASM IO for non-blocking po	1,269,052	1458394	99.90	.10	.00	.00

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```
SQL> select table_name from dba_tables where table_name like 'UPD$%' and owner='SYS';

TABLE_NAME
--------------------------------------------------------------------------------
UPD$_TOP_FG_EVENTS
UPD$_EVENT_HISTOGRAM
UPD$_OSSTAT
UPD$_PARAMETER
UPD$_SESSION_EVENT
UPD$_SESSTAT
UPD$_SESS_TIME_MODEL
UPD$_SNAPSHOT
UPD$_SYSSTAT
UPD$_SYSTEM_EVENT
UPD$_SYS_TIME_MODEL
UPD$_THREAD

12 rows selected.
```


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An upgrade is always resumable and restartable

- All scripts are idempotent, including `catalog.sql` and `catproc.sql`

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```
INSERT INTO sys.registry$upg_resume(version,phaseno,errorcnt,starttime,endtime)
VALUES ('23.0.0.0.0', 57,-1, sysdate, sysdate);

...

UPDATE sys.registry$upg_resume SET endtime=sysdate WHERE phaseno=57;
```


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```
$ java -jar autoupgrade.jar ... -mode deploy

Previous execution found loading latest data
Total jobs recovered: 1
+--------------------------------+
| Starting AutoUpgrade execution |
+--------------------------------+
Type 'help' to list console commands
upg>
```


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```
upg> resume -job 100 -catctl_options=-p 0
```


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Replay Upgrade

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```
--The database automatically starts an upgrade
--when you plug in a lower-release PDB

SQL> alter pluggable database pdb1 open;

Pluggable database altered.

Elapsed: 00:14:01.95
```


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```
SQL> select property_name, property_value
     from   database_properties
     where  property_name like '%OPEN%';

PROPERTY_NAME          PROPERTY_VALUE
---------------------- --------------------
CONVERT_NONCDB_ON_OPEN true
UPGRADE_PDB_ON_OPEN    true
```


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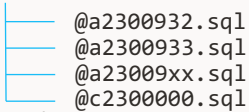
Classic Upgrade

Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
...
Phase *nnn*

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Classic Upgrade

Phase 1
Phase 2
Phase 3
Phase 4
Phase 5



Phase 6
Phase 7
Phase 8
...
Phase *nnn*

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Classic Upgrade

@a2300932.sql

```
VARIABLE initfile VARCHAR2(32)
COLUMN :initfile NEW_VALUE init_file NOPRINT;

Rem ================================================================
Rem SQLJTYPE
Rem ================================================================

BEGIN
  IF sys.dbms_registry.is_loaded('JAVAVM',sys.dbms_registry.release_version) = 1 THEN
     :initfile := 'initsjty.sql';
  ELSE
     :initfile := 'nothing.sql';
  END IF;
END;
/
SELECT :initfile FROM DUAL;
@@&init_file
```


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Classic Upgrade

```
@@&init_file
```

```
.
.
[more PL/SQL code]
.
.
CREATE TABLE SYS.T1 ...
CREATE INDEX SYS.T1I1 ...
.
.
[more PL/SQL code]
.
.
```


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Comparison

Classic

Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
...
Phase *nnn*

Replay

```
DROP INDEX SYSTEM.IDX$FLOW ...
CREATE OR REPLACE ...
ALTER TYPE ...
CREATE FUNCTION ...
CREATE TABLE SYS.T1 ...
CREATE INDEX SYS.T1I1 ...
DROP INDEX MDSYS.IDX$IK ...
DROP TABLE MDSYS.TBL$TT ...
CREATE OR REPLACE ...
ALTER TYPE ...
GRANT SELECT ON ...
CREATE VIEW ...
```


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```
select sqlstmt from pdb_sync$;


ALTER SESSION SET "_oracle_script_counter"=7
alter pluggable database application app$cdb$pdbonly$ncdbtopdb begin install '1.0.upgmode'
alter session set "_enable_view_pdb"=false
alter session set NLS_LENGTH_SEMANTICS=BYTE
INSERT INTO sys.utl_recomp_skip_list select obj# from obj$ where BITAND(flags, 4194304)=0 ...
create or replace view sys.cdb$common_root_objects sharing=object as
select u.name owner, o.name object_name, o.type# object_type, o.namespace nsp,
       o.subname object_subname, o.signature object_sig,
       decode(bitand(o.flags, (65536+131072+4294967296)),
       4294967296+65536, 'EDL', 131072, 'DL', 'MDL') sharing
  from sys.obj$ o, sys.user$ u
 where o.owner#=u.user# and bitand(o.flags, (65536+131072+4294967296)) <> 0
   and bitand(o.flags,0)=0


(output truncated)
```


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Classic

- Triggered by AutoUpgrade
- Runs `catalog.sql` / `catproc.sql`
- Many `CREATE OR REPLACE` statements for objects that didn't change
- Customizable
- Used by AutoUpgrade

Replay

- Triggered by `OPEN` command
- Runs only captured statements
- Only statements that actually do some change
- Automated

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Classic

```
Stages
   SETUP                <1 min
   PREUPGRADE           <1 min
   PRECHECKS            <1 min
   PREFIXUPS            <1 min
   DRAIN                <1 min
   DBUPGRADE            19 min
   DISPATCH             <1 min
   UNPLUGWORK           <1 min
   POSTCHECKS           <1 min
   POSTFIXUPS           10 min
   POSTUPGRADE          <1 min
   SYSUPDATES           <1 min
```

Replay

```
Stages
   SETUP                <1 min
   PREUPGRADE           <1 min
   PRECHECKS            <1 min
   PREFIXUPS            <1 min
   DRAIN                <1 min
   DBUPGRADE            17 min
   DISPATCH             <1 min
   UNPLUGWORK           <1 min
   POSTCHECKS           <1 min
   POSTFIXUPS           10 min
   POSTUPGRADE          <1 min
   SYSUPDATES           <1 min
```


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Replay upgrade doesn't handle pre- and post-upgrade tasks

- You must run these manually
- Or use *Replay Upgrade* through AutoUpgrade

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Replay upgrade doesn't write proper logfiles

- Logs into the **DIAG** destination only in case of error

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```
SQL> alter pluggable database pdb1 open;
alter pluggable database pdb1 open
*
ERROR at line 1:
ORA-60510: encountered an error during Replay Upgrade
```


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If Replay Upgrade fails

- Check for errors:
  - `SELECT * FROM dba_replay_upgrade_errors`
  - `SELECT * FROM dba_app_errors`
  - `SELECT * FROM dba_applications WHERE app_name='APP$CDB$CATALOG';`
  - Check alert log
  - Trace files

- Revert to classic upgrade
  - Use AutoUpgrade (`upg1.replay=no`)

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```
--To disable replay upgrade
ALTER DATABASE UPGRADE SYNC OFF;

--Or
ALTER DATABASE PROPERTY SET UPGRADE_PDB_ON_OPEN='false';

--To disable convert on open
ALTER DATABASE PROPERTY SET CONVERT_NONCDB_ON_OPEN='false';
```


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Replay upgrade
is neither resumable nor restartable

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Downgrade

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A downgraded data dictionary is *different*, but fully compatible

- A downgraded database is not identical to the pre-upgraded database

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```
SQL> select count(*) from dba_tables where owner='SYS';

COUNT_BEFORE
------------
        1549


 COUNT_AFTER
------------
        1805
```

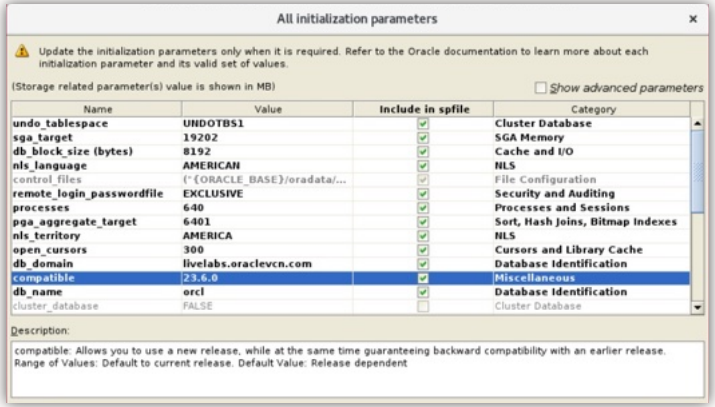

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Don't change `COMPATIBLE` if you want the option of downgrading

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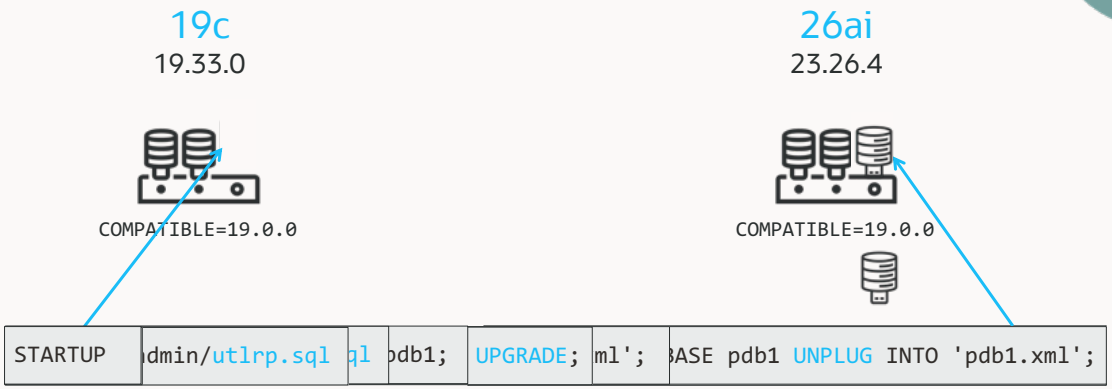


You can downgrade days, months, or even years after upgrading

- No data loss

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Downgrade



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Downgrade

1

Actions in 26ai Oracle home

- Apply latest Release Update
- Open in downgrade mode
- Execute `catdwgrd.sql`
  - Rolls back one-off patches
  - Prepares for old release

2

Actions in 19c Oracle home

- Apply latest Release Update
- Open in upgrade mode
- Execute `catrelod.sql`
  - Invalidates all PL/SQL
  - Executes catalog/catproc
  - Reloads all components
  - Gather stats on bootstrap tables
- Open in normal mode
- Recompile all PL/SQL
- Gather dictionary/fixed objects stats

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```
$ grep -i "truncate *table" catdwgrd0.log
...
11:56:38 SQL> truncate table wri$_optstat_tab_model;
11:56:38   3          execute immediate 'truncate table hcs_av_fact_column$';
11:56:38 SQL> Rem truncate table to store service conflicts stats persistently
11:56:38 SQL> truncate table svcobj_conflict$;
11:56:38 SQL> truncate table data_guard_site$;
11:56:38 SQL> truncate table dgpdb_site$;
11:56:39   4          execute immediate 'truncate table hcs_tbl$';
11:56:39 SQL> truncate table rsrc_cnt_history$;
```


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```
$ grep -i "truncate *table" catdwgrd0.log
...
11:56:38 SQL> truncate table wri$_optstat_tab_model;
11:56:38   3          execute immediate 'truncate table hcs_av_fact_column$';
11:56:38 SQL> Rem truncate table to store service conflicts stats persistently
11:56:38 SQL> truncate table svcobj_conflict$;
11:56:38 SQL> truncate table data_guard_site$;
11:56:38 SQL> truncate table dgpdb_site$;
11:56:39   4          execute immediate 'truncate table hcs_tbl$';
11:56:39 SQL> truncate table rsrc_cnt_history$;
```

```
$ grep -i "truncate *table" catdwgrd0.log | wc -l
311
```


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```
SQL> desc pdb_sync$

 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 SCNWRP                                    NOT NULL NUMBER
 SCNBAS                                    NOT NULL NUMBER
 CTIME                                     NOT NULL DATE
 SQLSTMT                                            VARCHAR2(4000)
 NAME                                      NOT NULL VARCHAR2(128)
 AUXNAME1                                           VARCHAR2(128)
 AUXNAME2                                           VARCHAR2(128)
 OPCODE                                    NOT NULL NUMBER
 FLAGS                                              NUMBER
 LONGSQLTXT                                         CLOB
 REPLAY#                                   NOT NULL NUMBER
 CREATION#                                          NUMBER
 SPARE3                                             VARCHAR2(128)
 SPARE4                                             VARCHAR2(128)
 SPARE5                                             VARCHAR2(4000)
 SPARE6                                             NUMBER
 SPARE7                                             NUMBER
 SPARE8                                             NUMBER
 SQLID                                              VARCHAR2(13)
 APPID#                                             NUMBER
 VER#                                               NUMBER
 PATCH#                                             NUMBER
 APP_STATUS                                         NUMBER
 SESSSERIAL#                                        NUMBER
```

```
SQL> desc pdb_sync$

 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 SCNWRP                                    NOT NULL NUMBER
 SCNBAS                                    NOT NULL NUMBER
 CTIME                                     NOT NULL DATE
 SQLSTMT                                            VARCHAR2(4000)
 NAME                                      NOT NULL VARCHAR2(128)
 AUXNAME1                                           VARCHAR2(128)
 AUXNAME2                                           VARCHAR2(128)
 OPCODE                                    NOT NULL NUMBER
 FLAGS                                              NUMBER
 LONGSQLTXT                                         CLOB
 REPLAY#                                   NOT NULL NUMBER
 CREATION#                                          NUMBER
 SPARE3                                             VARCHAR2(128)
 SPARE4                                             VARCHAR2(128)
 SPARE5                                             VARCHAR2(4000)
 SPARE6                                             NUMBER
 SPARE7                                             NUMBER
 SPARE8                                             NUMBER
 SQLID                                              VARCHAR2(13)
 APPID#                                             NUMBER
 VER#                                               NUMBER
 PATCH#                                             NUMBER
 APP_STATUS                                         NUMBER
 SESSSERIAL#                                        NUMBER
 OWNER                                              VARCHAR2(128)
 OBJNAME                                            VARCHAR2(128)
 EDNAME                                             VARCHAR2(128)
 NAMESPACE                                          NUMBER
 SIGNATURE                                          RAW(16 BYTE)
 MODULE                                             VARCHAR2(64)
 ACTION                                             VARCHAR2(64)
```


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```
SQL> desc REGISTRY$LOG
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 CID                                                VARCHAR2(30)
 NAMESPACE                                          VARCHAR2(30)
 OPERATION                                 NOT NULL NUMBER
 OPTIME                                             TIMESTAMP(6)
 ERRMSG                                             VARCHAR2(1000)
```

```
SQL> desc REGISTRY$LOG
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 CID                                                VARCHAR2(30)
 NAMESPACE                                          VARCHAR2(30)
 OPERATION                                 NOT NULL NUMBER
 OPTIME                                             TIMESTAMP(6) WITH TIME ZONE
 ERRMSG                                             VARCHAR2(1000)
```


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Downgrade, Guidelines

- Generally, dropping is avoided
- Some types of statistics are marked `STALE`
- Complete rebuild of certain components, such as Data Pump

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Final Pointers

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Can you make upgrades run faster?

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Things that

Matter a lot

- Number of components
- Dictionary size
- Dictionary complexity
- Some feature/version combinations

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Things that

Matter a lot

- Number of components
- Dictionary size
- Dictionary complexity
- Some feature/version combinations

Matter a little

- CPU speed
- I/O capabilities
- Memory
- SGA/PGA

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Things that

Matter a lot

- Number of components
- Dictionary size
- Dictionary complexity
- Some feature/version combinations

Matter a little

- CPU speed
- I/O capabilities
- Memory
- SGA/PGA

Don't matter

(usually)

- Physical size
- Amount of user data

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Unplug-plug upgrades are faster than upgrading an entire CDB

- Consider your rollback options
- Use refreshable clone PDBs

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Key Learnings



1. Use AutoUpgrade
2. Scale by upgrading more PDBs in parallel
3. Remove unused components

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BREAK

We start again at 11:00

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Patching



How often do you apply patches?

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Critical Patch Updates

Critical Patch Updates provide security patches for supported Oracle on-premises products. A Critical Patch Update is a collection of patches for multiple security vulnerabilities. These patches address vulnerabilities in Oracle code and in third party components included in Oracle products. These patches are usually cumulative. They are available to customers with valid support contracts. Critical Patch Updates are released on the third Tuesday of January, April, July, and October. The next four dates are:

- 19 January 2027
- 20 April 2027
- 20 July 2027
- 19 October 2027

A pre-release announcement will be published on the Thursday preceding each Critical Patch Update release.

The Critical Patch Updates released since 2021 are listed in the following table. Critical Patch Updates released before 2021 are available here.

Critical Patch Update	Latest Version/Date
Critical Patch Update - October 2026	Rev 1, 20 October 2026
Critical Patch Update - July 2026	Rev 7, 20 August 2026
Critical Patch Update - April 2026	Rev 2, 24 April 2026

Critical Patch Updates

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Critical Patch Update - July 2026	Rev 7, 20 August 2026
Critical Patch Update - April 2026	Rev 2, 24 April 2026

Oracle Critical Patch Update Advisory - October 2026

Description

A Critical Patch Update is a collection of patches for multiple security vulnerabilities. These patches address vulnerabilities in Oracle code and in third party components included in Oracle products. These patches are usually cumulative, but each advisory describes only the security patches added since the previous Critical Patch Update Advisory. Thus, prior Critical Patch Update advisories should be reviewed for information regarding earlier published security patches. Refer to Critical Patch Updates, Critical Security Patch Updates, Security Alerts and Bulletins for information about Oracle Security advisories.

Oracle continues to periodically receive reports of attempts to maliciously exploit vulnerabilities for which Oracle has already released security patches. In some instances, it has been reported that attackers have been successful because targeted customers had failed to apply available Oracle patches. Oracle therefore strongly recommends that customers remain on actively-supported versions and apply security patches without delay.

This Critical Patch Update contains 1295 new security patches across the product families listed below. Please note that a My Oracle Support (MOS) note summarizing the content of this Critical Patch Update and other Oracle Software Security Assurance activities is located at October 2026 Critical Patch Update: Executive Summary and Analysis.

Affected Products and Patch Information

Security vulnerabilities addressed by this Critical Patch Update affect the products listed below.

Please click on the links in the Patch Availability Document column below to access the documentation for patch availability information and installation instructions.

Oracle Communications Network Analytics Data Director, versions 25.1.200, 25.2.100, 25.2.200	Oracle Communications Network Analytics Da Director
Oracle Communications Operations Monitor, versions 6.0, 6.1	Oracle Communications Operations Monitor
Oracle Communications Policy Management, versions 15.0.0.0.0, 15.1.0.0.0	Oracle Communications Policy Management
Oracle Communications Service Catalog and Design, versions 8.0-8.3	Oracle Communications Service Catalog and D
Oracle Communications Unified Assurance, versions 6.1.1-7.0.0	Oracle Communications Unified Assurance
Oracle Communications Unified Inventory Management, versions 7.5.0, 7.5.1, 7.6.0, 7.7.0, 7.8.0, 8.0.1	Oracle Communications Unified Inventory Management
Oracle Data Integrator, versions 12.2.1.4.0, 14.1.2.0.0	Fusion Middleware
Oracle Database Server, versions 19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	Database
Oracle Demand Planning, versions 12.1, 12.2	Oracle Supply Chain Products
Oracle E-Business Suite, versions 12.2.3-12.2.15	Oracle E-Business Suite
Oracle Enterprise Manager Base Platform, versions 13.5, 24.1	Oracle Enterprise Manager
Oracle Enterprise Manager for Oracle Database, versions 13.5, 24.1	Oracle Enterprise Manager
Oracle Enterprise Manager for Siebel, versions 13.5, 24.1	Oracle Enterprise Manager
Oracle Enterprise Manager for Virtualization, version 13.5	Oracle Enterprise Manager
Oracle Essbase, version 21.8.3.0.0	Database
Oracle Financial Services Analytical Applications Infrastructure, versions 8.0.7.9, 8.0.8.7, 8.1.2.5, 8.1.2.6	Oracle Financial Services Analytical Applicatio Infrastructure

Oracle Critical Patch Update Advisory - October 2026

CVE ID	Component	Package and/ or Privilege Required	Protocol	Remote Exploit without Auth.?	CVSS VERSION 3.1 RISK (see Risk Matrix Definitions)									Supported Versions Affected	Notes
					Base Score	Attack Vector	Attack Complex	Privs Req'd	User Interact	Scope	Confid-entiality	Inte-grity	Avail-ability		
CVE-2026-75803	RDBMS (OpenSSL)	None	TLS	Yes	9.8	Network	Low	None	None	Un-changed	High	High	High	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91563	Oracle OLAP	DBMS_AW	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91499	RDBMS	DBMS_VECTOR	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	23.4.0-23.26.3	
CVE-2026-93569	RDBMS (Micronaut)	None	HTTP	Yes	8.2	Network	Low	None	None	Un-changed	Low	High	None	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91503	VPD	Create Table	Oracle Net	No	8.1	Network	Low	Low	None	Un-changed	High	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91568	RDBMS	Create Session	Oracle Net	No	7.7	Network	Low	Low	None	Changed	High	None	None	23.4.0-23.26.3	
CVE-2026-101512	RDBMS	None	HTTP	No	6.5	Network	Low	Low	None	Un-changed	High	None	None	23.4.0-23.26.3	
CVE-2026-91479	RDBMS	None	UDP	Yes	6.5	Adjacent Network	Low	None	None	Un-changed	None	None	High	23.4.0-23.26.3	
CVE-2026-91615	Java VM	None	SOCKS5	No	6.3	Network	High	Low	None	Changed	None	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	

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Oracle Critical Patch Update Advisory - October 2026

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CVE-2026-91499	RDBMS	DBMS_VECTOR	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	23.4.0-23.26.3	
CVE-2026-93569	RDBMS (Micronaut)	None	HTTP	Yes	8.2	Network	Low	None	None	Un-changed	Low	High	None	19.3-19.32, 23.4.0-23.26.3	
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CVE-2026-101512	RDBMS	None	HTTP	No	6.5	Network	Low	Low	None	Un-changed	High	None	None	23.4.0-23.26.3	
CVE-2026-91479	RDBMS	None	UDP	Yes	6.5	Adjacent Network	Low	None	None	Un-changed	None	None	High	23.4.0-23.26.3	
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Oracle Critical Patch Update Advisory - October 2026

CVE ID	Component	Package and/ or Privilege Required	Protocol	Remote Exploit without Auth.?	CVSS VERSION 3.1 RISK (see Risk Matrix Definitions)									Supported Versions Affected	Notes
					Base Score	Attack Vector	Attack Complex	Privs Req'd	User Interact	Scope	Confid-entiality	Inte-grity	Avail-ability		
CVE-2026-75803	RDBMS (OpenSSL)	None	TLS	Yes	9.8	Network	Low	None	None	Un-changed	High	High	High	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91563	Oracle OLAP	DBMS_AW	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91499	RDBMS	DBMS_VECTOR	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	23.4.0-23.26.3	
CVE-2026-93569	RDBMS (Micronaut)	None	HTTP	Yes	8.2	Network	Low	None	None	Un-changed	Low	High	None	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91503	VPD	Create Table	Oracle Net	No	8.1	Network	Low	Low	None	Un-changed	High	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91568	RDBMS	Create Session	Oracle Net	No	7.7	Network	Low	Low	None	Changed	High	None	None	23.4.0-23.26.3	
CVE-2026-101512	RDBMS	None	HTTP	No	6.5	Network	Low	Low	None	Un-changed	High	None	None	23.4.0-23.26.3	
CVE-2026-91479	RDBMS	None	UDP	Yes	6.5	Adjacent Network	Low	None	None	Un-changed	None	None	High	23.4.0-23.26.3	
CVE-2026-91615	Java VM	None	SOCKS5	No	6.3	Network	High	Low	None	Changed	None	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	

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Security Updates

Accelerating Vulnerability Detection and Response at Oracle

April 29, 2026 | 3 minute read



Integrated Cyber Center (ICC)

The latest generation of AI is transforming how software vulnerabilities are identified and fixed, increasing the speed and scale of discovery and remediation.

At Oracle, we have long applied AI across our cloud and software environments to support security testing, vulnerability detection, and code analysis. These capabilities run on Oracle Cloud Infrastructure (OCI), leveraging OCI AI services, infrastructure, and development platforms to operate continuously at scale.

Oracle has access to leading frontier AI models, including Anthropic's Claude Mythos Preview and OpenAI's most capable models through Trusted Access for Cyber, and we are extending our capabilities with these models to improve how quickly and effectively vulnerabilities are identified. Combined with our AI-enabled security operations, these capabilities are applied across Oracle-developed software and services, Oracle Health, and the open-source components we build and use in our products.

The result is stronger code, earlier identification of risk and mitigations, and better protection for Oracle and our

Security Updates

Accelerating Vulnerability Detection and Response at Oracle

April 29, 2026 | 3 [illegible] read

Oracle has access to leading frontier AI models, including Anthropic's Claude Mythos Preview and OpenAI's most capable models through Trusted Access for Cyber, and we are extending our capabilities with these models to improve how quickly and effectively vulnerabilities are identified. Combined with our AI-enabled security operations, these capabilities are applied across Oracle-developed software and services, Oracle Health, and the open-source components we build and use in our products.

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The result is stronger code, earlier identification of risk and mitigations, and better protection for Oracle and our



The security practices of yesterday are not sufficient today anymore

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You must patch your database
with the most recent Release Update

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Release Updates are the primary vehicle for delivering security patches

- Plus bug fixes, regression fixes and more

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Quarterly Release Updates

	2024				2025				2026				2027		
	January	April	July	October	January	April	July	October	January	April	July	October	January	April	July
19c	19.22.0	19.23.0	19.24.0	19.25.0	19.26.0	19.27.0	19.28.0	19.29.0	19.30.0	19.31.0	19.32.0	19.33.0	19.34.0	19.35.0	19.36.0
21c	21.13.0	21.14.0	21.15.0	21.16.0	21.17.0	21.18.0	21.19.0	21.20.0	21.21.0	21.22.0	21.23.0	21.24.0	21.25.0	21.26.0	21.27.0
23ai			23.5.0	23.6.0	23.7.0	23.8.0	23.9.0	23.26.0	23.26.1	23.26.2	23.26.3	23.26.4	23.27.1	23.27.2	23.27.3

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Link

Security Updates

Update: Monthly Critical Security Patch Updates (CSPUs)

Oracle releases security patches on the **third Tuesday of each month**, alternating between **Critical Security Patch Updates (CSPUs)** and **Critical Patch Updates (CPUs)**. The upcoming release schedule for late 2026 is:

- **October 20, 2026**: Quarterly **CPU**
- **November 17, 2026**: Monthly **CSPU**
- **December 15, 2026**: Monthly **CSPU**
- **January 19, 2027**: Quarterly **CPU**

CSPUs are smaller, monthly releases targeting critical vulnerabilities, while **CPUs** are quarterly releases that are cumulative and include all prior CSPU fixes.

ncing the start date and cadence for

s provide targeted fixes for critical
ithout waiting for the next quarterly



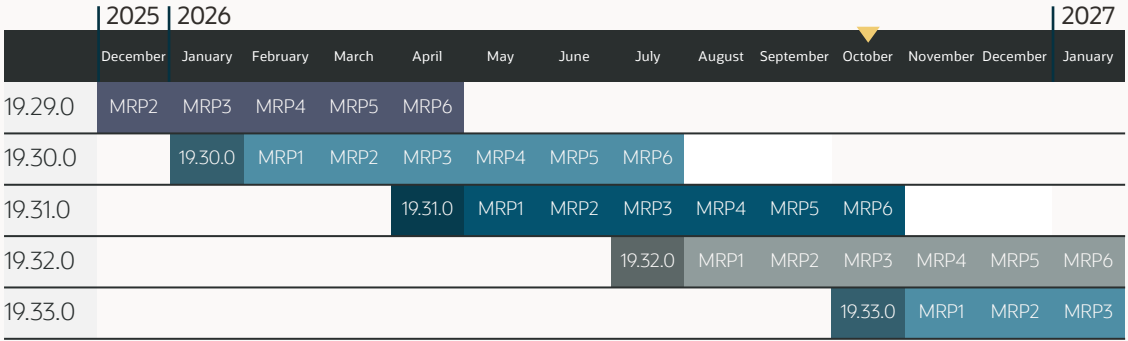
You should patch monthly

- Are you ready for it?

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Monthly Recommended Patches

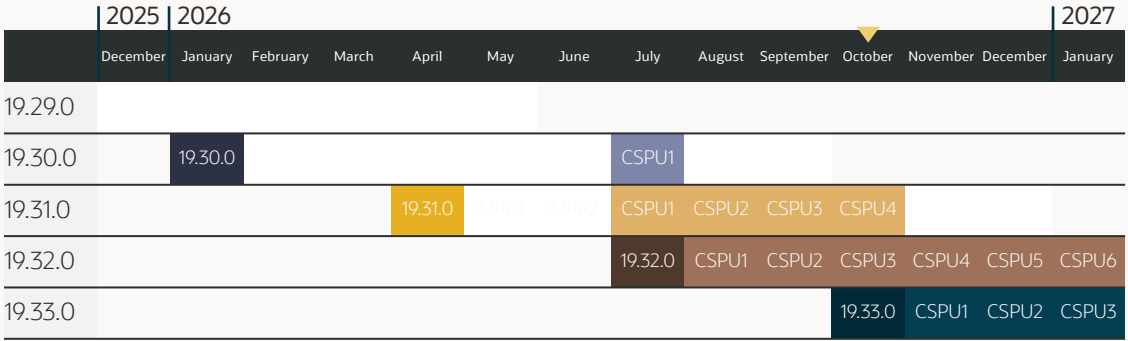
Linux only for Oracle Database 19c and Oracle AI Database 26ai



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Critical Security Patch Updates

On all platforms **except** Linux for 19c and 26ai



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Content

MRP – Monthly Recommended Patch

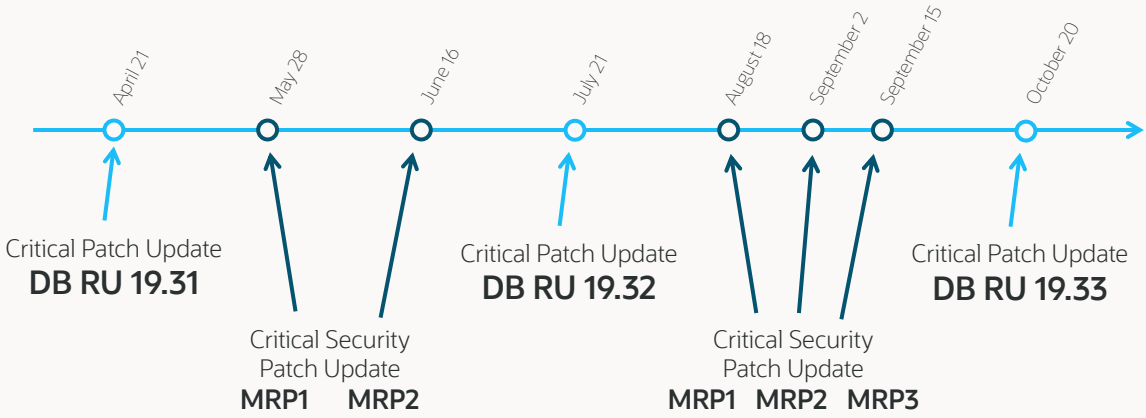
- KB188772
  - Critical fixes
  - Regression fixes
  - 3rd party tools security fixes
- Security fixes

CSPU – Critical Security Patch Update

- Critical fixes
- Security fixes

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Patching Best Practices



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Patching

Oracle AI Database

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1

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2

INSTALL

3

PATCH

4

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Downloading patches *still* the old way?

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The easiest way you can download patches and install them is by using AutoUpgrade

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```
-- Always use the latest version of AutoUpgrade
-- Available via direct download from oracle.com or KB123450

wget https://download.oracle.com/otn-pub/otn_software/autoupgrade.jar
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore
global.download_folder=/home/oracle/autoupgrade/patches
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore
global.download_folder=/home/oracle/autoupgrade/patches

patch1.target_version=19
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore
global.download_folder=/home/oracle/autoupgrade/patches

patch1.target_version=19
patch1.patch=RECOMMENDED
```


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Recommended Patches

```
patch1.patch=RECOMMENDED
```

OPATCH	The latest OPatch
RU	The latest Release Update
OJVM	OJVM bundle matching Release Update
DPBP	Data Pump bundle patch matching RU
AU	Latest version of AutoUpgrade
MRP/CSPU	Latest available MRP/CSPU for this RU

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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore
global.download_folder=/home/oracle/autoupgrade/patches

patch1.target_version=19
patch1.patch=RECOMMENDED,JDK
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore
global.download_folder=/home/oracle/autoupgrade/patches

patch1.target_version=19
patch1.patch=RECOMMENDED,JDK,38238416
```


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```
-- Start AutoUpgrade in download mode to get the patches specified in the
config file

java -jar autoupgrade.jar -config get.cfg -patch -mode download
```


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What else?

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```
patch1.target_version=19
patch1.patch=AHF,CVU,SQLCL,DBSAT,CPAT
```


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```
patch1.target_version=19
patch1.patch=AHF,CVU,SQLCL,DBSAT,CPAT

patch2.patch=EXAQFSDP:19,EXAPATCHMGR
patch2.target_version=19
patch2.platform=LINUX.X64
```


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```
patch1.target_version=19
patch1.patch=AHF,CVU,SQLCL,DBSAT,CPAT

patch2.patch=EXAQFSDP:19,EXAPATCHMGR
patch2.target_version=19
patch2.platform=LINUX.X64

patch3.patch=OEM:24.1
patch3.target_version=19
```


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COMING SOON

```
patch1.target_version=19
patch1.patch=AHF,CVU,SQLCL,DBSAT,CPAT,ORDS

patch2.patch=EXAQFSDP:19,EXAPATCHMGR
patch2.target_version=19
patch2.platform=LINUX.X64

patch3.patch=OEM:24.1
patch3.target_version=19

patch4.patch=APEX,APEXPATCH:26.1
```

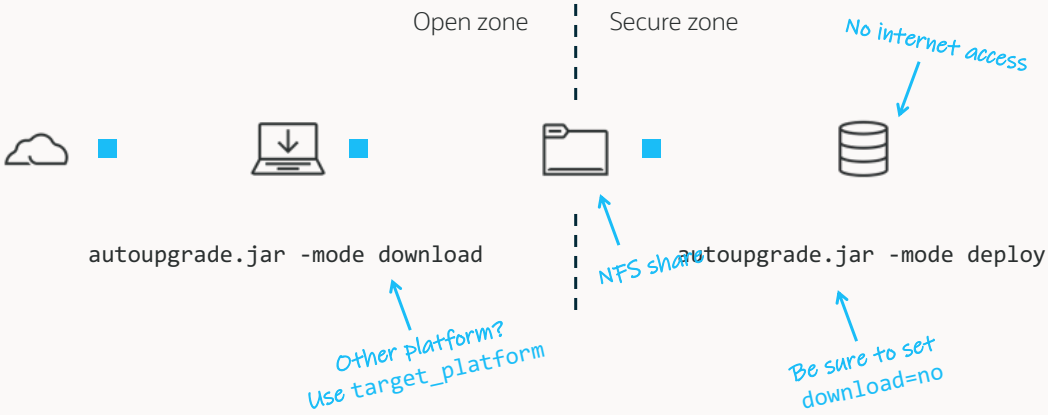

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Your database host doesn't have internet access?

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Using Download Mode



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Using Proxy to Download Patches

```
$ export https_proxy='https://proxy.example.com:8080'

$ java -jar autoupgrade.jar ... -mode download
```


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Always patch Out-of-Place

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```
cat install19.cfg

   global.global_log_dir=/home/oracle/autoupgrade-patching/log
   global.download_folder=/home/oracle/autoupgrade/patches
   patch1.source_home=/u01/app/oracle/product/dbhome_19_32
   patch1.target_home=/u01/app/oracle/product/dbhome_19_33
   patch1.patch=RECOMMENDED
```

Settings

Patches

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```
cat install19.cfg

   global.global_log_dir=/home/oracle/autoupgrade-patching/log
   global.download_folder=/home/oracle/autoupgrade/patches
   patch1.source_home=/u01/app/oracle/product/dbhome_19_32
   patch1.target_home=/u01/app/oracle/product/dbhome_19_33
   patch1.patch=RECOMMENDED
```

```
java -jar autoupgrade.jar -config install19.cfg -patch -mode create_home
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore

patch1.sid=CDB19
patch1.source_home=/u01/app/oracle/product/dbhome_19_32
patch1.target_home=/u01/app/oracle/product/dbhome_19_33
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log
global.keystore=/home/oracle/autoupgrade-patching/keystore

patch1.sid=CDB19
patch1.source_home=/u01/app/oracle/product/dbhome_19_32
patch1.target_home=/u01/app/oracle/product/dbhome_19_33
```

```
java -jar autoupgrade.jar -config CDB19.cfg -mode deploy
```


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Patching Data Guard

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Reduce downtime to the time it takes to perform a switchover

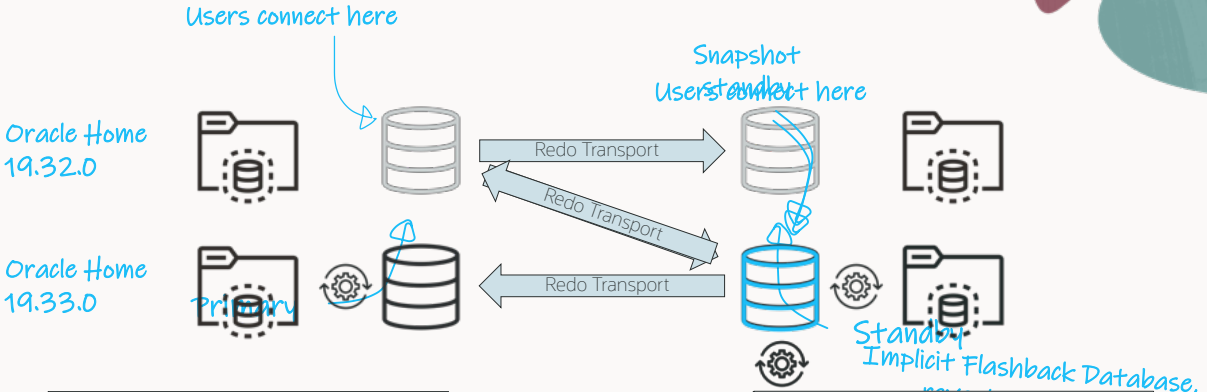
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Safely test and verify patches with Standby-First Patch Apply

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Standby-First Patching




```
java -jar autoupgrade.jar \
   -config ... \
   -mode deploy
```

```
over to PROD2;
```

```
java -jar autoupgrade.jar \
   -config ... \
   -mode upgrade
```


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Patch must Standby-First installable

- Check the patch readme

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1

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Don't forget the clients

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Security Bug Fixes in Clients

CPU	Clients Affected
Oct 2026	Client-only, SQLcl
Jul 2026	Client-only, JDBC
Apr 2026	Client-only
Jan 2026	Client-only, SQLcl
Oct 2025	Client-only, SQLcl
Jul 2025	Client-only, JDBC
Apr 2025	Client-only, SQLcl
Jan 2025	
Oct 2024	Client-only
Jul 2024	Client-only

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Oracle Critical Patch Update Advisory - October 2026

Description

A Critical Patch Update is a collection of patches for multiple security vulnerabilities. These patches address vulnerabilities in Oracle code and in third party components included in Oracle products. These patches are usually cumulative, but each advisory describes only the security patches added since the previous Critical Patch Update Advisory. Thus, prior Critical Patch Update advisories should be reviewed for information regarding earlier published security patches. Refer to Critical Patch Updates, Critical Security Patch Updates, Security Alerts and Bulletins for information about Oracle Security advisories.

Oracle continues to periodically receive reports of attempts to maliciously exploit vulnerabilities for which Oracle has already released security patches. In some instances, it has been reported that attackers have been successful because targeted customers had failed to apply available Oracle patches. Oracle therefore strongly recommends that customers remain on actively-supported versions and apply security patches without delay.

This Critical Patch Update contains 1295 new security patches across the product families listed below. Please note that a My Oracle Support (MOS) note summarizing the content of this Critical Patch Update and other Oracle Software Security Assurance activities is located at October 2026 Critical Patch Update: Executive Summary and Analysis.

Affected Products and Patch Information

Security vulnerabilities addressed by this Critical Patch Update affect the products listed below.

Please click on the links in the Patch Availability Document column below to access the documentation for patch availability information and installation instructions.

Oracle Database Server Risk Matrix

for Oracle Database Products. 4 of these vulnerabilities may be remotely exploitable without authentication, i.e., may be exploited over a network without requiring user credentials.

2 of these patches are applicable to client-only installations, i.e., installations that do not have the Oracle Database Server installed. The English text form of this Risk Matrix can be found here.

CVE ID	Component	Package and/or Privilege Required	Protocol	Remote Exploit without Auth.?	CVSS VERSION 3.1 RISK (see Risk Matrix Definitions)									Supported Versions Affected	Notes
					Base Score	Attack Vector	Attack Complex	Privs Req'd	User Interact	Scope	Confid-entiality	Inte-grity	Avail-ability		
CVE-2026-75803	RDBMS (OpenSSL)	None	TLS	Yes	9.8	Network	Low	None	None	Un-changed	High	High	High	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91563	Oracle OLAP	DBMS_AW	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91499	RDBMS	DBMS_VECTOR	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	23.4.0-23.26.3	
CVE-2026-93569	RDBMS (Micronaut)	None	HTTP	Yes	8.2	Network	Low	None	None	Un-changed	Low	High	None	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91503	VPD	Create Table	Oracle Net	No	8.1	Network	Low	Low	None	Un-changed	High	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91568	RDBMS	Create Session	Oracle Net	No	7.7	Network	Low	Low	None	Changed	High	None	None	23.4.0-23.26.3	
CVE-2026-101512	RDBMS	None	HTTP	No	6.5	Network	Low	Low	None	Un-changed	High	None	None	23.4.0-23.26.3	
CVE-2026-91479	RDBMS	None	UDP	Yes	6.5	Adjacent Network	Low	None	None	Un-changed	None	None	High	23.4.0-23.26.3	
CVE-2026-91615	Java VM	None	SOCKS5	No	6.3	Network	High	Low	None	Changed	None	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-59889	RDBMS (jackson-databind)	None	None	No	6.2	Local	Low	None	None	Un-changed	None	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	

Oracle Database Server Risk Matrix

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					Base Score	Attack Vector	Attack Complex	Privs Req'd	User Interact	Scope	Confid-entiality	Inte-grity	Avail-ability		
CVE-2026-75803	RDBMS (OpenSSL)	None	TLS	Yes	9.8	Network	Low	None	None	Un-changed	High	High	High	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91563	Oracle OLAP	DBMS_AW	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91499	RDBMS	DBMS_VECTOR	Oracle Net	No	8.8	Network	Low	Low	None	Un-changed	High	High	High	23.4.0-23.26.3	
CVE-2026-93569	RDBMS (Micronaut)	None	HTTP	Yes	8.2	Network	Low	None	None	Un-changed	Low	High	None	19.3-19.32, 23.4.0-23.26.3	
CVE-2026-91503	VPD	Create Table	Oracle Net	No	8.1	Network	Low	Low	None	Un-changed	High	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-91568	RDBMS	Create Session	Oracle Net	No	7.7	Network	Low	Low	None	Changed	High	None	None	23.4.0-23.26.3	
CVE-2026-101512	RDBMS	None	HTTP	No	6.5	Network	Low	Low	None	Un-changed	High	None	None	23.4.0-23.26.3	
CVE-2026-91479	RDBMS	None	UDP	Yes	6.5	Adjacent Network	Low	None	None	Un-changed	None	None	High	23.4.0-23.26.3	
CVE-2026-91615	Java VM	None	SOCKSS	No	6.3	Network	High	Low	None	Changed	None	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	
CVE-2026-59889	RDBMS (jackson-databind)	None	None	No	6.2	Local	Low	None	None	Un-changed	None	High	None	19.3-19.32, 21.3-21.23, 23.4.0-23.26.3	



Every quarter, you should evaluate the need for client patching

- Establish a structured process

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Create a process for patching your clients

- Automation is key
- Also useful for upgrading clients

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Database clients are generally very stable

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If possible, Oracle recommends upgrading clients to the latest 26ai driver

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Client / Server Interoperability

Client Version	Server Version						
	26ai	21c	19c	18c	12.2.0	12.1.0	11.2.0
26ai[#11]	Yes	Yes	Yes	No	No	No	No
21c	Yes	Yes	Yes	Was	Was	Yes[#12]	No
19c	Yes	Yes	Yes	Was	Was	Yes[#12]	Yes[#9]
18c	No	Was	Was	Was	Was	Was	Was[#9]
12.2.0	No	Was	Was	Was	Was	Was	Was
12.1.0	No	Yes[#12]	Yes[#12]	Was	Was	Yes[#12]	Yes[#12]
11.2.0	No	No	Yes[#9]	Was[#9]	Was	Yes[#12]	Yes[#9]

MOS Note: KB141043 - Client / Server Interoperability Support Matrix

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If you must use a 19c driver, update to the latest version

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To maintain plan stability certain optimizer fixes are installed but disabled

- Automatic Fix Control Persistence

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```
int optimGenerateCost(char *sql) {
   n = getBaseSost(sql);
   n = n * 2;
   n = n + 10;
   n = n / 3;
   n = n - 5;
   return n;
}
```


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```
int optimGenerateCost(char *sql) {
   n = getBaseSost(sql);
   n = n * 2;

   if (fixEnabled(32854286)) {
      // fixed code
      n = n + 8;
   } else {
      // original code
      n = n + 10;
   }

   n = n / 3;
   n = n - 5;
   return n;
}
```


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```
int optimGenerateCost(char *sql) {
   n = getBaseSost(sql);
   n = n * 2;

   if (fixEnabled(32854286)) {
      // fixed code
      n = n + 8;
   } else {
      // original code
      n = n + 10;
   }

   n = n / 3;
   n = n - 5;
   return n;
}
```


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```
int optimGenerateCost(char *sql) {
   n = getBaseSost(sql);
   n = n * 2;

   if (fixEnabled(32854286)) {
      // fixed code
      n = n + 8;
   } else {
      // original code
      n = n + 10;
   }

   n = n / 3;
   n = n - 5;
   return n;
}
```


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```
int optimGenerateCost(char *sql) {
   n = getBaseSost(sql);
   n = n * 2;

   if (fixEnabled(32854286)) {
      // fixed code
      n = n + 8;
   } else {
      // original code
      n = n + 10;
   }

   n = n / 3;
   n = n - 5;
   return n;
}
```


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The fix is installed, but disabled

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```
-- Selectively enable a specific optimizer fix

exec dbms_optim_bundle.set_fix_controls(
   fix_control_string         => '32854286',
   scope                      => 'BOTH',
   current_setting_precedence => 'YES'
);
```


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```
-- List all optimizer fixes

set serveroutput on;
exec dbms_optim_bundle.getBugsforBundle;
```


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Home
Parameters
Users, Roles, etc
Privileges
Included Fixes
List of Fixes
Total Fixes
Search Fixes
List of CVEs
CPU Explore
Fix Control
Oracle Database Ho...
Objects
Fixed Objects
Audit
System

Version Selector

Source Release: 19c
Source Patch Level: 19.3.0 (Base Release)
Target Release: 19c
Target Patch Level: 19.30.0
List Mode

V_$SYSTEM_FIX_CONTROL

Added | Removed | Modified

Go | Actions

BUGNO	VALUE	SQL_FEATURE	DESCRIPTION	OPTIMIZER_FEATURE_ENABLE	EVENT	IS_DEFAULT
9876287	0	QKSFM_PQ_9876287	Fix perf slowdown due to wait event PXNSQ:PQLOADINFOQUERY		0	1
10123661	0	QKSFM_CURSOR_SHARING_10123661	Enable cursor sharing for AS OF queries		0	1
17295505	0	QKSFM_OBJ_EXT_17295505	allow stateful-access to image operator for ODCI table function		0	1
18101156	0	QKSFM_PARTITION_18101156	no RowCR for global index access on partitioned table		0	1

BUGNO	VALUE	SQL_FEATURE	DESCRIPTION	OPTIMIZER_FEATURE_ENABLE	EVENT	IS_DEFAULT
			table			
29487407	0	QKSFM_SQL_CODE_GENERATOR_29487407	Streamline traversal of CAST_PSR operator		0	1
29499077	0	QKSFM_CBO_29499077	correct sel for LIKE preds with char binds holding numeric data		0	1
29590666	0	QKSFM_ALL_29590666	Do not perform xmlexists(fn:not) rewrite		0	1
29651517	0	QKSFM_COMPILATION_29651517	do not mark load into CDT as multi-start with result cache		0	1
29653132	0	QKSFM_ALL_29653132	Force the usage of BLOB in XMLAGG and XMLELEMENT		0	1
29657973	0	QKSFM_ACCESS_PATH_29657973	for update: force VC base column into row vector for top qbc onl		0	1
29687220	0	QKSFM_CBO_29687220	improve costing for indexes with empty statistics.		0	1
29696242	0	QKSFM_ACCESS_PATH_29696242	use only the best auto index for access path analysis		0	1
29712727	0	QKSFM_DYNAMIC_SAMPLING_29712727	analysis of skipped non-empty table partitions		0	1

1 - 50 of 306

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The Release Update should fix it. Why does it still fail?

- Check for a matching fix control

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Should You Enable Optimizer Fixes?

PATCHING 

Selective enable optimizer fixes
Enable all, if you can properly test

NEW DATABASE 

Enable all optimizer fixes
Perform testing

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```
-- Enable all optimizer fixes

exec dbms_optim_bundle.enable_optim_fixes('ON','BOTH', 'YES');
```


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Until at least Oracle AI Database 23.26.3 optimizer fixes are ON by default

- This is different from Oracle Database 19c where they are OFF by default mostly

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Further Information

Optimizer Fixes



- Managing "installed but disabled" bug fixes in Database Release Updates using DBMS_OPTIM_BUNDLE (KB148297)
- ORAdiff - Fix Control
- Blog post: Should you enable _fix_controls with DBMS_OPTIM_BUNDLE?

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Purge old rollback scripts from the data dictionary

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Rollback Scripts



Apply/rollback scripts

```
$ORACLE_HOME/sqlpatch/.../nnn_apply.sql
$ORACLE_HOME/sqlpatch/.../nnn_rollback.sql
```



Rollback scripts:

```
INSERT INTO REGISTRY$SQLPATCH
VALUES ... ;

INSERT INTO REGISTRY$SQLPATCH_RU_INFO
VALUES ... ;
```


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```
 PATCH_ID   RU_VERSION      RU_BUILD_TS          LOB_SIZE_MB
----------- --------------- -------------------- -----------
   29517242 19.3.0.0.0      04/10/2019 12:27:20            4
   30125133 19.5.0.0.0      09/09/2019 18:05:49           18
   30557433 19.6.0.0.0      12/17/2019 15:50:04           24
   30869156 19.7.0.0.0      04/04/2020 03:50:18           30
   31281355 19.8.0.0.0      07/03/2020 03:15:01           37
   31771877 19.9.0.0.0      09/30/2020 18:32:49           43
   32218454 19.10.0.0.0     01/08/2021 18:50:17           51
   32545013 19.11.0.0.0     04/13/2021 00:40:09           59
   32904851 19.12.0.0.0     07/16/2021 14:18:10           67
   33192793 19.13.0.0.0     10/04/2021 16:50:50           75
   33515361 19.14.0.0.0     12/25/2021 12:21:23           83
   34133642 19.16.0.0.0     07/03/2022 02:22:23           99
   34419443 19.17.0.0.0     09/24/2022 22:40:51          108
   34765931 19.18.0.0.0     01/11/2023 17:17:38          116
   35643107 19.21.0.0.0     09/30/2023 15:19:51          141

15 rows selected.
```


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```
CON_ID LOB_SIZE_MB
------ -----------
     1         953
     2         953
     3         953

   ...         ...

  4098         953
```


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```
--Available since 19.28.0. Purges no longer needed zip files.
--Run in off-peak period after patching

./datapatch -purge_old_metadata
```


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Major retailer in the US

Saved 20 TB/year in total:

- *5000 DBs*
- 5 PDBs (3 PDBs + Root + Seed)
- *200 Mb in each per patch*
- *4 patches annually*

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Datapatch Purge

- Removes the rollback scripts for all patches
  (except the currently applied)
- Doesn't prevent rolling back the currently applied patches
- Doesn't remove the patching history, just the rollback scripts

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Patch Faster, Disrupt Less

Oracle Database Patching for Today's Threats

Monday, 16:00
HOL6024

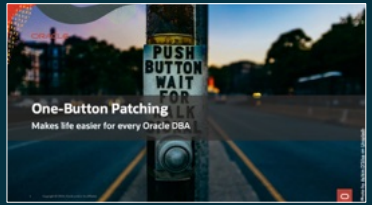
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Webinar

One-Button Patching

Makes life easier for every Oracle DBA

Recording on YouTube
Get the slides



Patch smarter, not harder

Makes life easier for every Oracle DBA

Recording on YouTube
Get the slides



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Key Learnings



1. Apply the Release Update
2. Apply the most recent MRP / CSPU
3. Use AutoUpgrade

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Hands-On Lab

Requirements for running a Hands-on-Lab

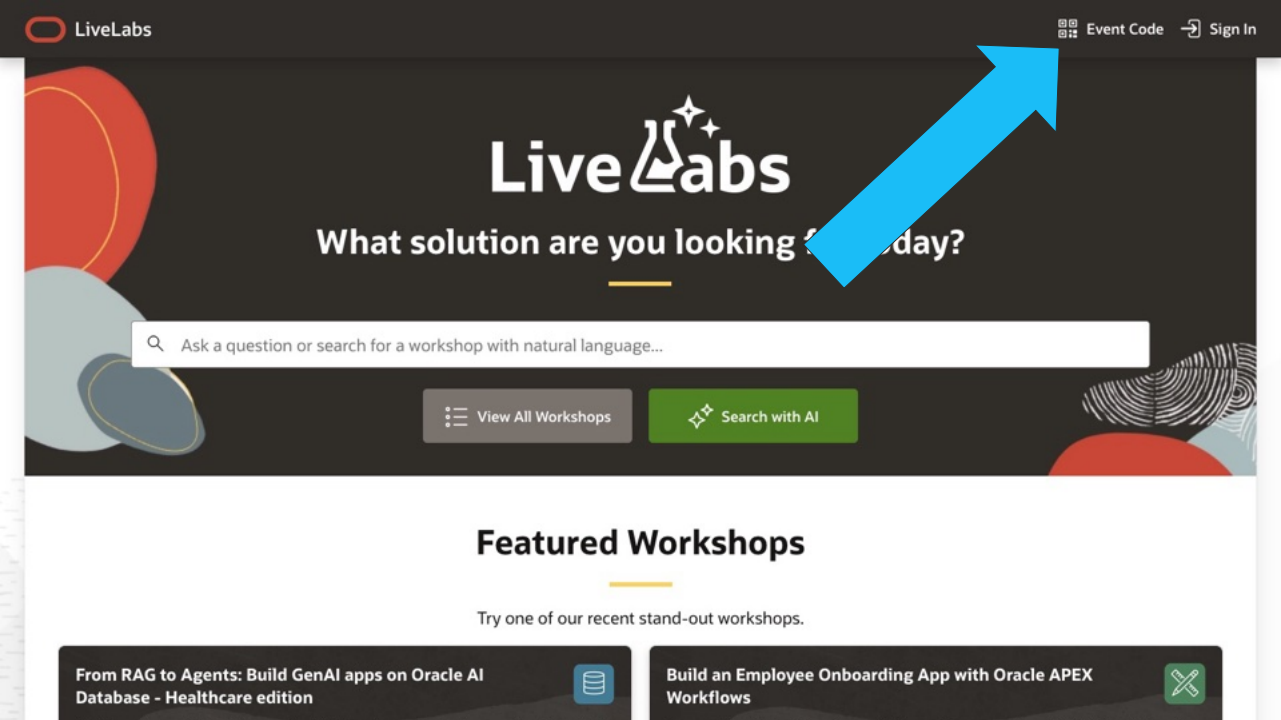


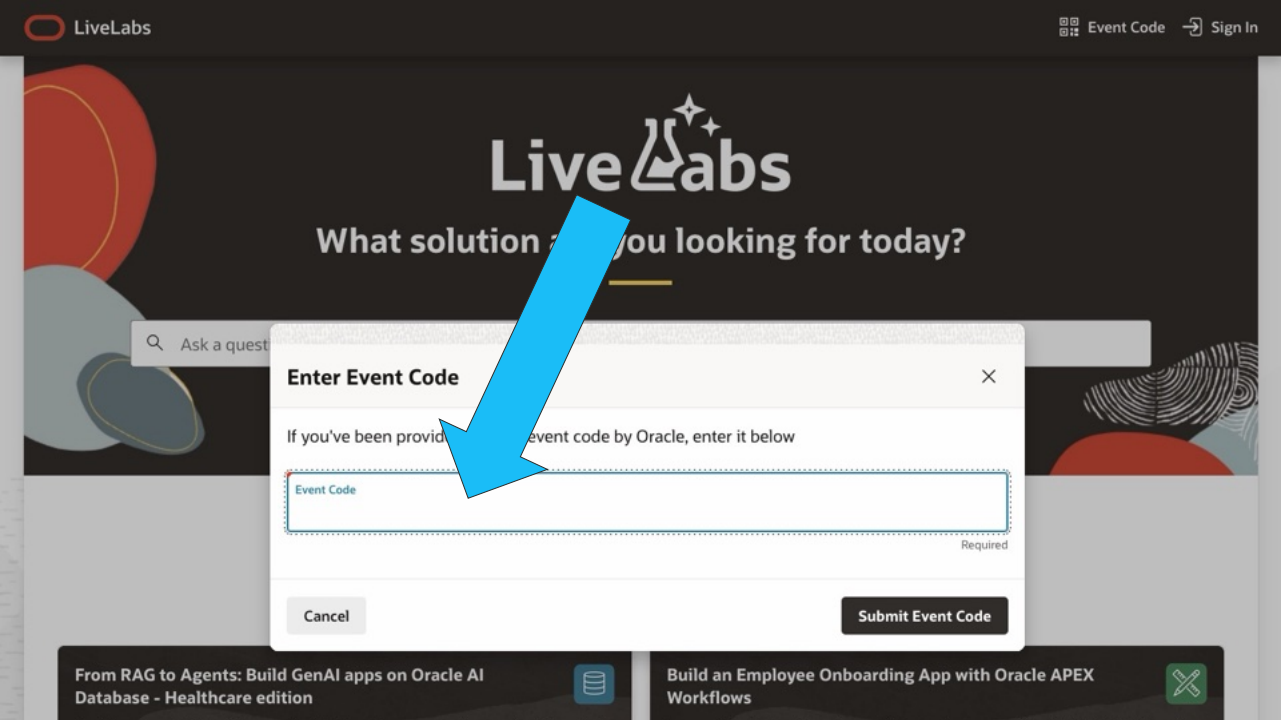
Laptop



Oracle Account

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LiveLabs
Event Code
Sign In
LiveLabs
What solution are you looking
day?
Ask a question or search for a workshop with natural language...
View All Workshops
Search with AI
Featured Workshops
Try one of our recent stand-out workshops.
From RAG to Agents: Build GenAI apps on Oracle AI Database - Healthcare edition
Build an Employee Onboarding App with Oracle APEX Workflows


LiveLabs
Event Code
Sign In
LiveLabs
What solution
you looking for today?
Ask a quest
Enter Event Code
If you've been provid
event code by Oracle, enter it below
Event Code
Required
Cancel
Submit Event Code
From RAG to Agents: Build GenAI apps on Oracle AI Database - Healthcare edition
Build an Employee Onboarding App with Oracle APEX Workflows

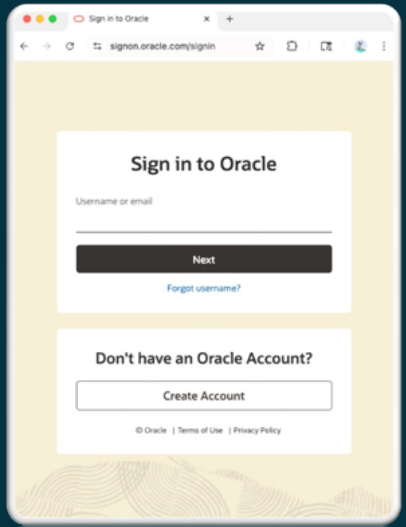
Let's get started

livelabs.oracle.com/ai-world26/HOL6019

- Open a web browser
- Navigate to the provided URL
- Login with your Oracle SSO account

PLEASE NOTE:

This is NOT your Oracle Cloud Infrastructure account

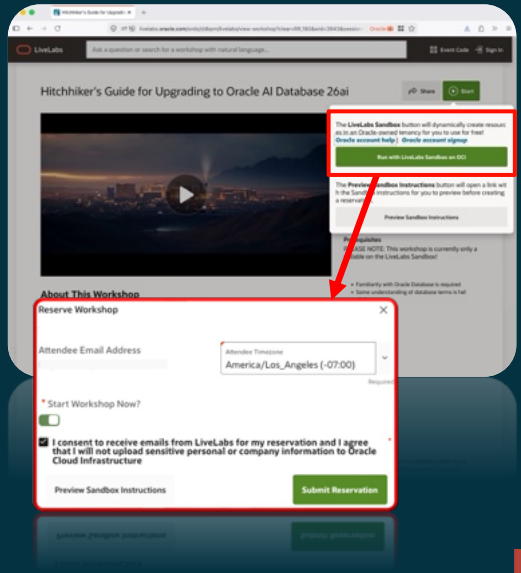


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Let's get started

livelabs.oracle.com/ai-world26/HOL6019

1. Click the **Start** button Click **Run on LiveLabs Sandbox**
2. Toggle the **Start Workshop Now** radio button
3. Check the consent box
4. Click **Submit Reservation**



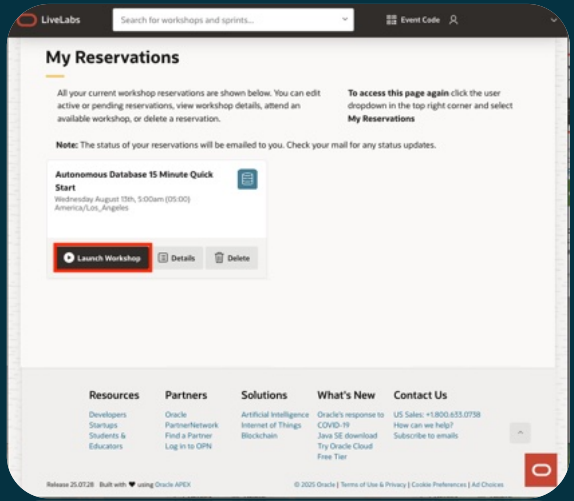
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Let’s get started

livelabs.oracle.com/ai-world26/HOL6019

Click **Launch Workshop** once available

Please note:
The environments are available within a couple of minutes. Refresh the page.



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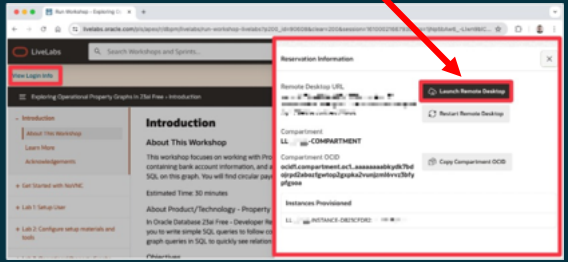
Refresh the page a few times
until a lab environment is assigned

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Let's get started

livelabs.oracle.com/ai-world26/HOL6019

1. Click **View Login Info**
2. Click **Launch Remote Desktop** to proceed to your workshop environment



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HTTPS-Only Mode Alert

Secure Site Not Available

You've enabled HTTPS-Only Mode for enhanced security, and a HTTPS version of **168.138.107.232:6080** is not available.

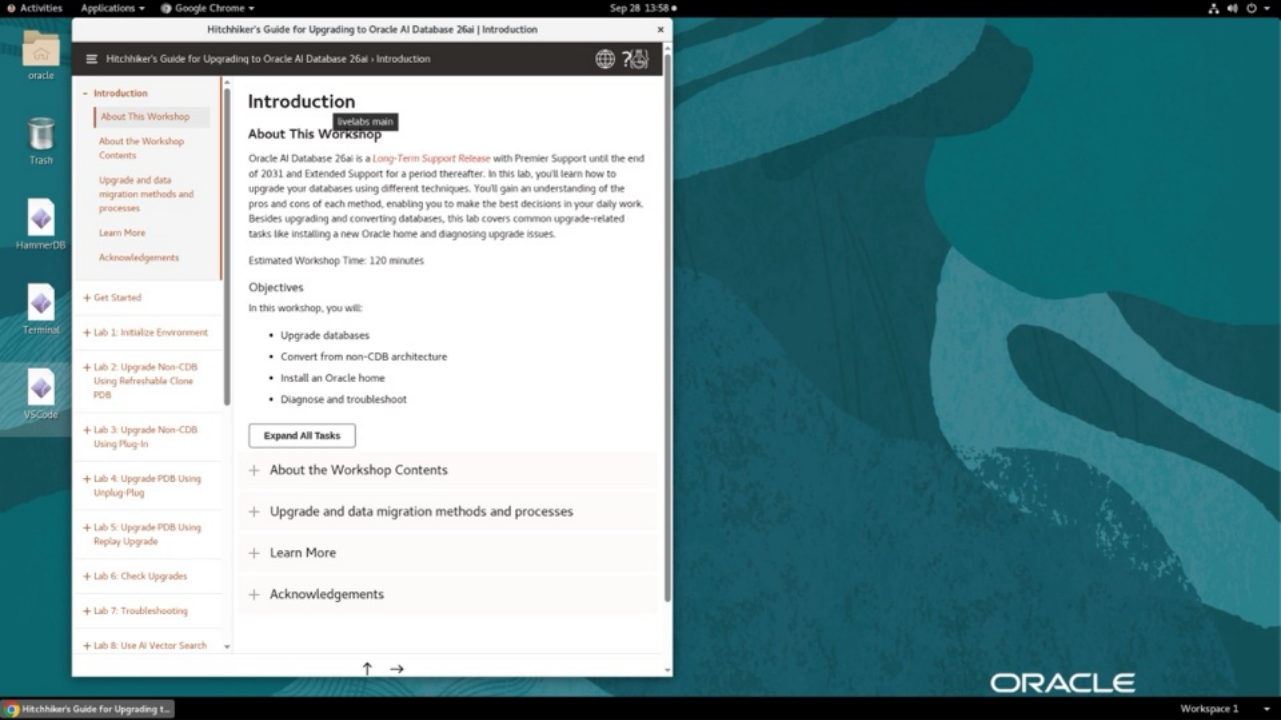
Learn More...

What could be causing this?

- Most likely, the website simply does not support HTTPS.
- It's also possible that an attacker is involved. If you decide to visit the website, you should not enter any sensitive information like passwords, emails, or credit card details.

If you continue, HTTPS-Only Mode will be turned off temporarily for this site.

Continue to HTTP Site | Go Back

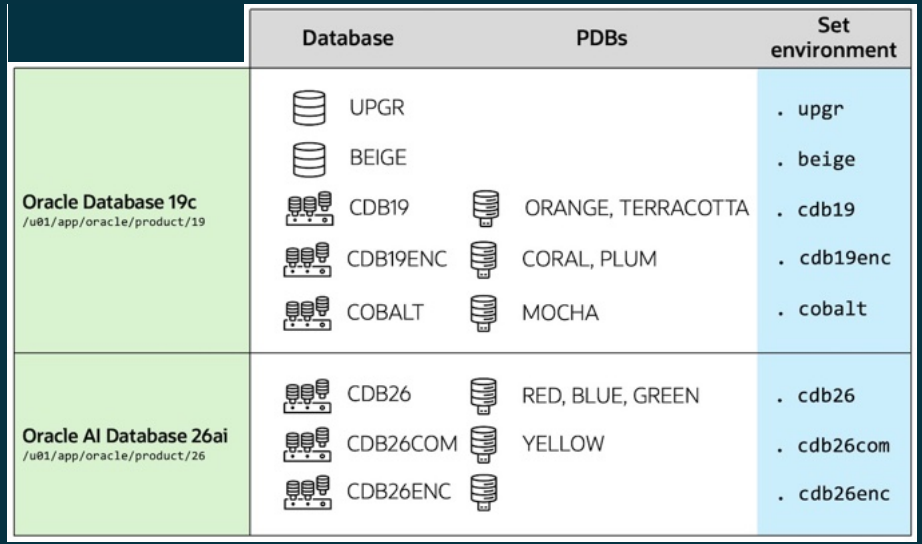

Activities
Applications
Google Chrome
Sep 28 13:58
Hitchhiker's Guide for Upgrading to Oracle AI Database 26ai | Introduction
Hitchhiker's Guide for Upgradinq to Oracle AI Database 26ai › Introduction
livelabs main
Introduction
About This Workshop
About the Workshop Contents
Upgrade and data migration methods and processes
Learn More
Acknowledgements
Get Started
Lab 1: Initialize Environment
Lab 2: Upgrade Non-CDB Using Refreshable Clone PDB
Lab 3: Upgrade Non-CDB Using Plug-In
Lab 4: Upgrade PDB Using Unplug-Plug
Lab 5: Upgrade PDB Using Replay Upgrade
Lab 6: Check Upgrades
Lab 7: Troubleshooting
Lab 8: Use AI Vector Search
Introduction
About This Workshop
Oracle AI Database 26ai is a Long-Term Support Release with Premier Support until the end of 2031 and Extended Support for a period thereafter. In this lab, you'll learn how to upgrade your databases using different techniques. You'll gain an understanding of the pros and cons of each method, enabling you to make the best decisions in your daily work. Besides upgrading and converting databases, this lab covers common upgrade-related tasks like installing a new Oracle home and diagnosing upgrade issues.
Estimated Workshop Time: 120 minutes
Objectives
In this workshop, you will:
Upgrade databases
Convert from non-CDB architecture
Install an Oracle home
Diagnose and troubleshoot
Expand All Tasks
About the Workshop Contents
Upgrade and data migration methods and processes
Learn More
Acknowledgements
oracle
Trash
HammerDB
Terminal
VSCode
Hitchhiker's Guide for Upgrading t...
Workspace 1



You can copy/paste from the instructions

- SHIFT + CTRL + C
- SHIFT + CTRL + V

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Lab Overview

- Upgrade encrypted PDB using Refreshable Clone PDB
- Downgrade PDB

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livelabs.oracle.com / 09836-PBZI-NLUP

- OPTIONAL Lab C: Upgrade Encrypted PDB Using Refreshable Clone
- At Task 6, action 6, go to next lab
- OPTIONAL Lab D: Downgrade PDB
- At Task 3, action 3, go to lunch
- After lunch, complete lab C and D

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LUNCH

We start again at 13:15

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Cool Features for DBAs


IT'S MONDAY MORNING
Photo by Simon Infanger on Unsplash

```
$ sqlplus daniel@mydb1

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Oct 9 12:26:32 2026
Version 19.31.0.0.0

Copyright (c) 1982, 2026, Oracle.  All rights reserved.

ERROR:
ORA-12154: TNS:could not resolve the connect identifier specified
```


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Which tnsnames.ora?

- Current directory
- `TNS_ADMIN` environment variable
- `$ORACLE_HOME/network/admin`
- `$ORACLE_BASE_HOME/network/admin`
- `TNS_ADMIN` registry key (Windows)
- `/etc`

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```
$ sqlplus daniel/password@mydb1

SQL*Plus: Release 23.26.3.0.0 - Production on Fri Oct 9 12:26:51 2026
Version 23.26.3.0.0

Copyright (c) 1982, 2026, Oracle.  All rights reserved.

ERROR:
ORA-12154: Cannot connect to database. Cannot find alias mydb1 in
/u01/app/oracle/product/26/network/admin/tnsnames.ora.
Help: https://docs.oracle.com/error-help/db/ora-12154/
```


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New In 26ai

```
SQL> show conn nets
Local Net Naming configuration file:
/u01/app/oracle/product/26/network/admin/tnsnames.ora
HR
MYDB2
SALES
```


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New In 26ai

```
SQL> show conn nets
Local Net Naming configuration file:
/u01/app/oracle/product/26/network/admin/tnsnames.ora
HR
MYDB2
SALES

SQL> show conn nets SALES
Local Net Naming configuration file:
/u01/app/oracle/product/26/network/admin/tnsnames.ora
SALES = (DESCRIPTION = (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)
(PORT = 1521)) (CONNECT_DATA = (SERVICE_NAME = sales)))
```


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New In 26ai

```
SQL> ping SALES
Local Net Naming configuration file:
/u01/app/oracle/product/26/network/admin/tnsnames.ora
Attempting to contact: (DESCRIPTION = (ADDRESS = (PROTOCOL = TCP)
(HOST = localhost)(PORT = 1521)) (CONNECT_DATA = (SERVICE_NAME = sales)))
Ok (1.815 msec)
```


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New In 26ai

```
SQL> select sysdate from dual;

SQL> select sysdate;
```


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New In 26ai

```
SELECT TRUNC(created) AS created_day,
       object_type,
       COUNT(*) AS object_count
FROM   dba_objects
WHERE  created >= TRUNC(SYSDATE) - 30
GROUP BY TRUNC(created), object_type;
```



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New In 26ai

```
SELECT TRUNC(created) AS created_day,
       object_type,
       COUNT(*) AS object_count
FROM   dba_objects
WHERE  created >= TRUNC(SYSDATE) - 30
GROUP BY 1,2;
```


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New In 26ai

```
SELECT TRUNC(created) AS created_day,
       object_type,
       COUNT(*) AS object_count
FROM   dba_objects
WHERE  created >= TRUNC(SYSDATE) - 30
GROUP BY ALL;
```


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New In 26ai

```
alter session set group_by_position_enabled=true;

SELECT TRUNC(created) AS created_day,
       object_type,
       COUNT(*) AS object_count
FROM   dba_objects
WHERE  created >= TRUNC(SYSDATE) - 30
GROUP BY ALL;
```


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Photo by jimmylloyd laumain on Unsplash



Generate a report on differences between two Release Update

- oradiff.oracle.com

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DEMO

ORAdiff demo



Watch on YouTube

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Recompile Oracle Maintained objects

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```
@?/rdbms/admin/utlrp
```


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```
SQL> select owner, count(*)
     from dba_objects
     where status != 'VALID'
     group by owner;
```


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```
SQL> select owner, count(*)
     from dba_objects
     where status != 'VALID'
     group by owner;

OWNER                COUNT(*)
-------------------- ----------
SYS                          24
OLD_APP                    4887
DANIEL                    76980
DANIEL1                   76980
DANIEL2                   76980
```


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```
-- Recompile just Oracle Maintained objects

@?/rdbms/admin/utlprpom <parallel-degree>
```

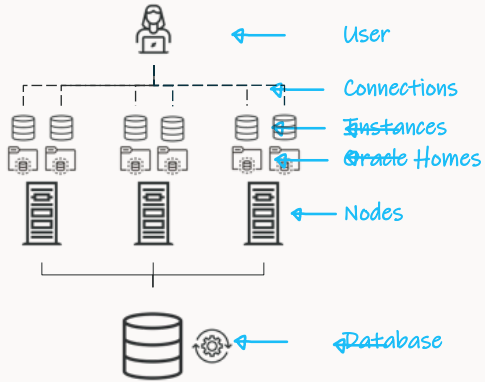

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RAC rolling patching with full control

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RAC Rolling Patching



- New DB home

```
autoupgrade.jar ... -mode create_home
```

- Move to new home

```
autoupgrade.jar ... -mode deploy
```


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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log

patch1.sid=CDB191
patch1.source_home=/u01/app/oracle/product/dbhome_19_32
patch1.target_home=/u01/app/oracle/product/dbhome_19_33
patch1.rac_rolling=auto
```



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AutoUpgrade stops the service using the default drain timeout

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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log

patch1.sid=CDB191
patch1.source_home=/u01/app/oracle/product/dbhome_19_32
patch1.target_home=/u01/app/oracle/product/dbhome_19_33
patch1.rac_rolling=auto
patch1.drain_timeout=300
```


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But my application doesn't drain ...

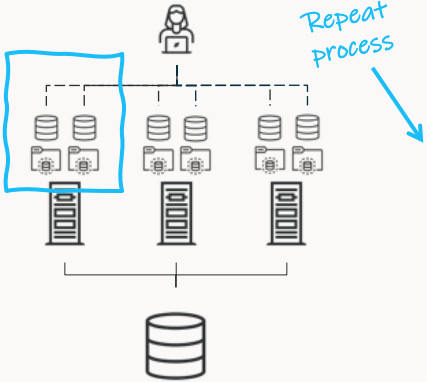
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```
global.global_log_dir=/home/oracle/autoupgrade-patching/log

patch1.sid=CDB191
patch1.source_home=/u01/app/oracle/product/dbhome_19_32
patch1.target_home=/u01/app/oracle/product/dbhome_19_33
patch1.rac_rolling=auto
patch1.drain_timeout=WAIT
```


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Controlling the Draining




```
autoupgrade.jar ... -mode deploy
```

```
srvctl relocate service \
   -stopoption TRANSACTIONAL \
   -drain_timeout 2592000 ...
```

```
upg> proceed -job 101
```

```
srvctl stop instance \
   -stopoption IMMEDIATE \
   -drain_timeout 0 ...
```


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drain_timeout

patch1.drain_timeout = WAIT

```
srvctl relocate service
-oldinst node1
-stopoption TRANSACTIONAL
-drain_timeout 2592000
-wait yes
-verbose

> proceed –job 101

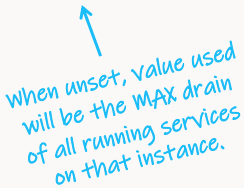
srvctl stop instance
-instance node1
-stopoption IMMEDIATE
-drain_timeout 0
-failover
-verbose
-force
```

patch1.drain_timeout = 120

```
srvctl stop instance
-instance node1
-stopoption IMMEDIATE
-drain_timeout 120
-failover
-verbose
-force
```

patch1.drain_timeout *(unset)*

```
srvctl stop instance
-instance node1
-stopoption IMMEDIATE
-failover
-verbose
-force
```



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Patching

- Webinar: Database Patching for DBAs – Patch smarter, not harder
- Blog post: The Easiest Way to Download 19.27 Release Update
- Blog post: Downloading and using Gold Image with AutoUpgrade
- Blog post: RAC Rolling mode in AutoUpgrade
- Blog post: How to patch Oracle Database using controlled RAC Rolling with AutoUpgrade
- Blog post: Announcing Oracle Update Advisor
- Hands-on lab: Patch Me If You Can

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DEMO

Regressing statement
Fix using SQL Plan Management



Watch on YouTube

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What Happened?

- A statement regressed
- DBA executes `DBMS_SPM.ADD_VERIFIED_SQL_PLAN_BASELINE`
- It finds all previous executions of statement
  - Cursor cache, AWR, SQL tuning set, Automatic SQL Tuning Set
- Use SQL Plan Management Evolve Advisor to find best-performing plan
- Create SQL plan baseline with best-performing plan as *accepted* plan
- Next execution of statement uses the accepted plan

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Let's automate it

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Automatic SQL Plan Management







- User executes SQL
- Optimizer chooses a different execution plan
- Executes with new plan

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Automatic SQL Plan Management







- Background job (30 min)
- Finds resource-intensive SQLs
- Evaluate execution statistics against previous executions

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Automatic SQL Plan Management







- Creates a plan baseline with the best plan
- Next execution uses an accepted plan

- Oracle Database 19c Enterprise Edition, RU 19.22
- Exadata and Autonomous AI Database

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Real-Time SQL Plan Management







- User executes SQL
- Optimizer chooses a different execution plan
- Executes with new plan

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Real-Time SQL Plan Management







- Compares execution statistics with history
- Comparison is performed in the user foreground session

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Real-Time SQL Plan Management







- Creates a plan baseline with the best plan
- Next execution uses an accepted plan

- Oracle AI Database 26ai Enterprise Edition
- Autonomous AI Database 19c

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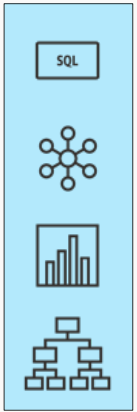


Automatically populate SQL Tuning Set

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SQL Tuning Set | Definition

SQL Tuning Set



SQL statement

Context

Statistics

Plans

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```
--Capture directly from cursor cache at regular intervals
exec DBMS_SQLSET.CAPTURE_CURSOR_CACHE ( ... );

--One time sample from cursor cache
exec DBMS_SQLSET.SELECT_CURSOR_CACHE ( ... );
```


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```
--Capture directly from cursor cache at regular intervals
exec DBMS_SQLSET.CAPTURE_CURSOR_CACHE ( ... );

--One time sample from cursor cache
exec DBMS_SQLSET.SELECT_CURSOR_CACHE ( ... );

--Capture from AWR
SQL> exec DBMS_SQLSET.SELECT_WORKLOAD_REPOSITORY ( ... );
```


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```
SQL> select name, statement_count from dba_sqlset;

NAME                           STATEMENT_COUNT
_____________________________ _________________
SALES_APP_WORKLOAD                        2343
```


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```
BEGIN
      DBMS_AUTO_TASK_ADMIN.ENABLE(
            CLIENT_NAME => 'Auto STS Capture Task',
            OPERATION => NULL,
            WINDOW_NAME => NULL);
END;
/
```


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```
SQL> select name, statement_count from dba_sqlset;

NAME                           STATEMENT_COUNT
------------------------------ ---------------
SALES_APP_WORKLOAD                        2343
SYS_AUTO_STS                              6426
```


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Automatic SQL Tuning Set

- Used for years in Autonomous AI Database
- Stores information in SYSAUX
- Advised to be on 19.25 or newer

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```
SQL> select view_name from dba_views where view_name like
'DBA%SQLSET%';

VIEW_NAME

_____________________________
DBA_SQLSET
DBA_SQLSET_REFERENCES
DBA_SQLSET_STATEMENTS
DBA_SQLSET_BINDS
DBA_SQLSET_PLANS
```


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Gather at least a full month of workload data

- Assist in testing your database
- Useful in solving post-migration performance problems

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```
-- If you have many bind variables in your queries, increase
-- the number of binds to capture from 400 (default) to 3999 (max)

alter system set "_cursor_bind_capture_area_size"=3999;
```


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Automatically recover from certain ORA-00600 errors

- Automatic Error Mitigation

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```
SQL> select ... from ...
ERROR at line 1:
ORA-00600: internal error code, arguments: [...]
```


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New In 26ai

```
SQL> select ... from ...
ERROR at line 1:
ORA-00600: internal error code, arguments: [...]

SQL> alter session set sql_error_mitigation = 'on';

SQL> select ... from ...
n rows returned
```


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Generate SQL diagnostic report

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```
DECLARE
      my_report CLOB;
BEGIN
      my_report := DBMS_SQLDIAG.REPORT_SQL(
            sql       => '6ah8zgpch6ksu',
            directory => 'DATA_PUMP_DIR',
            level     => 'ALL');
END;
/
```


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Collapse All

SQL Report SQLID: 6ah8zgpch6ksu Report Date: 11-OCT-26 05:36

Warning: SQL Not found in memory

PLANS

- Last Execution Plan
- Current Plans Summary
- Historical Plans Summary
- All Execution Plans
- Historical Execution Plans
- Plan Control Objects (Parameters)
- Plan Control Objects (Baselines/Profiles)
- Plan Control Objects (DBA SQLSET STATEMENTS)
- Monitored Executions
- Reoptimization Hints

GLOBAL

- SQL Text
- SQL History
- Parameters(Non-Default Values)
- Instance Parameters
- Observations
- DBMS STATS Table Preferences
- Historical SQL Stats - DELTA
- Historical SQL Stats - TOTAL

CURSOR SHARING AND BINDS

- Peeked vs Monitored Bind Values - In Memory
- Peeked vs Captured Bind Values - In Memory
- Peeked vs Captured Bind Values - AWR

TABLES

- Table Summary
- Table Columns
- Table Partitions
- Table Constraints
- Table Modifications
- Table Extensions
- Tables Statistics Versions
- Gather Table Stats Details

INDEXES

- Index Summary
- Index Columns
- Index Partitions
- Indexes Statistics Versions

ACTIVE SESSION HISTORY(ASH)

- ASH by Plan (in Memory)
- ASH by Plan Line (in Memory)
- ASH by Plan
- ASH by Plan Line
- Index Contention

Further Information

SQL Tuning Set

- Blog post: Oracle SQL Tuning Sets (STS) – The foundation for SQL Tuning
- Blog post: What is the automatic SQL tuning set?
- Blog post: Using the Automatic SQL Tuning Set in Oracle Database 19c
- MOS note: Automatic SQL Tuning Sets (ASTS) 19c RU 19.7 Onwards (KB119960)

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Schema level grants

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New In 26ai

```
SQL> grant select any table on schema appuser to reportuser;
```


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```
grant select any table on schema appuser to reportuser;

create table appuser.newtab1 ( .... );
```



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Changing passwords gracefully

- Gradual Password Rollover

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```
SQL> CREATE PROFILE app_profile LIMIT
       PASSWORD_ROLLOVER_TIME 1;

SQL> CREATE USER app_user
       ...
       PROFILE app_profile;
```


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DEMO

Change password
Use rollover period



Watch on YouTube

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What Happened?

- Allows a user to have two passwords for a limited period
- Minimum one hour (1/24), maximum 60 days
- Identify sessions using old password in the audit trail

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```
SQL> SELECT authentication_type
     FROM   unified_audit_trail
     WHERE  action_name='LOGON' AND dbusername='APP_USER';

AUTHENTICATION_TYPE
--------------------------------------------------------------------------------
... (LOGON_INFO=((VERIFIER=12C-NEW) ... ))
... (LOGON_INFO=((VERIFIER=12C-OLD) ... ))
```


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I need to check something.
Please grant dba?
Photo by Blackcreek Corporate on Unsplash

```
SQL> grant dba to daniel;
```


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~~SQL> grant dba to daniel;~~

```
SQL> grant db_developer_role to daniel;
```


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DB_DEVELOPER_ROLE

- Combines
  - `CONNECT` and `RESSOURCE`
  - Additional privileges to create additional objects
  - Execute on developer related packages

- Think about *least-privilege* principle

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```
SQL> ALTER SYSTEM SET MAX_IDLE_BLOCKER_TIME = 5;
```


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Blocking Sessions

- Time an idle session is allowed to block other sessions
- Terminates blocking session on timeout
- Also applies if `SESSIONS` or `PROCESSES` are close to their limit

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New In 26ai

```
SQL> ALTER SESSION SET TXN_PRIORITY = LOW;
```


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Transaction Priority

New In 26ai

- Three levels: High, Medium, Low
- By default, everyone goes in High
- Automatically cancels a blocking transaction
  - Optionally, you can just track the block instead of rolling back
- Customizable wait period
  - `PRIORITY_TXNS_HIGH_WAIT_TARGET`, `PRIORITY_TXNS_MEDIUM_WAIT_TARGET`

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THE REST OF THE DAY

Photo by Wonderlane on Unsplash

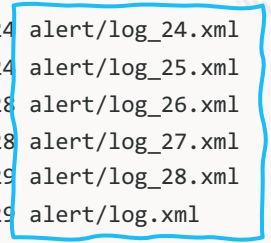


Alert log management

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New In 26ai

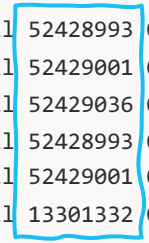
```
ls -l alert/log*
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:24 alert/log_24.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:24 alert/log_25.xml
-rw-r-----. 1 oracle oinstall 52429036 Oct 11 10:28 alert/log_26.xml
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:28 alert/log_27.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:29 alert/log_28.xml
-rw-r-----. 1 oracle oinstall 13301332 Oct 11 10:29 alert/log.xml
```



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New In 26ai

```
ls -l alert/log*
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:24 alert/log_24.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:24 alert/log_25.xml
-rw-r-----. 1 oracle oinstall 52429036 Oct 11 10:28 alert/log_26.xml
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:28 alert/log_27.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:29 alert/log_28.xml
-rw-r-----. 1 oracle oinstall 13301332 Oct 11 10:29 alert/log.xml
```



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New In 26ai

```
ls -l alert/log*
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:24 alert/log_24.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:24 alert/log_25.xml
-rw-r-----. 1 oracle oinstall 52429036 Oct 11 10:28 alert/log_26.xml
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:28 alert/log_27.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:29 alert/log_28.xml
-rw-r-----. 1 oracle oinstall 13301332 Oct 11 10:29 alert/log.xml

ls -l trace/alert*
-rw-r-----. 1 oracle oinstall 2193649 Oct 11 10:24 trace/alert_CDB26_24.log
-rw-r-----. 1 oracle oinstall 2193558 Oct 11 10:24 trace/alert_CDB26_25.log
-rw-r-----. 1 oracle oinstall 2193824 Oct 11 10:28 trace/alert_CDB26_26.log
-rw-r-----. 1 oracle oinstall 2193616 Oct 11 10:28 trace/alert_CDB26_27.log
-rw-r-----. 1 oracle oinstall 2193756 Oct 11 10:29 trace/alert_CDB26_28.log
-rw-r-----. 1 oracle oinstall  789764 Oct 11 10:29 trace/alert_CDB26.log
```


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New In 26ai

```
ls -l alert/log*
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:24 alert/log_24.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:24 alert/log_25.xml
-rw-r-----. 1 oracle oinstall 52429036 Oct 11 10:28 alert/log_26.xml
-rw-r-----. 1 oracle oinstall 52428993 Oct 11 10:28 alert/log_27.xml
-rw-r-----. 1 oracle oinstall 52429001 Oct 11 10:29 alert/log_28.xml
-rw-r-----. 1 oracle oinstall 13301332 Oct 11 10:29 alert/log.xml
```

Smaller segments

```
ls -l trace/alert*
-rw-r-----. 1 oracle oinstall 2193649 Oct 11 10:24 trace/alert_CDB26_24.log
-rw-r-----. 1 oracle oinstall 2193558 Oct 11 10:24 trace/alert_CDB26_25.log
-rw-r-----. 1 oracle oinstall 2193824 Oct 11 10:28 trace/alert_CDB26_26.log
-rw-r-----. 1 oracle oinstall 2193616 Oct 11 10:28 trace/alert_CDB26_27.log
-rw-r-----. 1 oracle oinstall 2193756 Oct 11 10:29 trace/alert_CDB26_28.log
-rw-r-----. 1 oracle oinstall  789764 Oct 11 10:29 trace/alert_CDB26.log
```


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Alert Log Management

New In 26ai

- The segment size is fixed
- The database keeps 1000M of XML alert log
- Text alert log retention based on XML alert log

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New In 26ai

```
SQL> ALTER SYSTEM SET ALERT_LOG_MAX_SIZE = 2500M
```


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```
SQL> ALTER SYSTEM SET ALERT_LOG_MAX_SIZE = 2500M
     COMMENT="20261011: Set to corporate standard";
```


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New In 26ai

$ cat trace/attention_CDB26.log

```
{
  "ERROR"        : "USER (ospid: 15262_15279): terminating the instance due to ORA error 472",
  "URGENCY"      : "IMMEDIATE",
  "INFO"         : "Additional Information Not Available",
  "CAUSE"        : "The specified error is deemed fatal by the Oracle instance and all instance
                    processes have been terminated and the shared memory has been removed.",
  "ACTION"       : "Investigate the additional information recorded in the alert log. Rectify any
                    system, configuration or environment related issues. In RAC configuration,
                    CRS will restart the instance, else manually re-establish ...",
  "CLASS"        : "ORACLE INSTANCE / CDB ADMINISTRATOR / AL-1003",
  "TIME"         : "2026-09-29T08:59:43.163+00:00"
},
```


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Reclaiming space

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New In 26ai

```
SQL> exec dbms_space.shrink_tablespace('USERS');
```


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Tablespace Shrink

New In 26ai

- Works online or offline
- Keeps indexes usable, if possible
- Pay attention to cursor invalidation

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A few more from the goodie bag

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New In 26ai

```
SQL> ALTER SYSTEM SET DB_FLASHBACK_LOG_DEST_SIZE=50G;
SQL> ALTER SYSTEM SET DB_FLASHBACK_LOG_DEST='/u02/flashback';
```


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New In 26ai

```
SQL> ALTER SESSION SET SQL_HISTORY_ENABLED = TRUE;

SQL> SELECT * FROM V$SQL_HISTORY;
```


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```
*
ERROR at line 1:
ORA-04068: existing state of packages has been discarded
ORA-04061: existing state of package body "APPUSER.MYPKG1" has been invalidated
ORA-04065: not executed, altered or dropped package body "APPUSER.MYPKG1"
Help: https://docs.oracle.com/error-help/db/ora-04068/
```


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New In 26ai

```
SQL> CREATE OR REPLACE PACKAGE APPUSER.MYPKG1 RESETTABLE AS ... ;

SQL> CREATE OR REPLACE PACKAGE BODY APPUSER.MYPKG1 RESETTABLE AS ... ;
```


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New In 26ai

```
SQL> select waiting_session, event, dp_state_in_wait
     from   v$datapump_sessionwait_info;

WAITING_SESSION EVENT                                      DP_STATE_IN_WAIT
--------------- ------------------------------------------ ----------------
10              direct path sync                           WAITING
77              log buffer space                           WAITING
191             log buffer space                           WAITING
428             enq: TT - contention                       WAITING
```


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New In 26ai

```
SQL> drop table t1;

ERROR at line 1:
ORA-00942: table or view does not exist
```


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New In 26ai

```
SQL> drop table t1;

ERROR at line 1:
ORA-00942: table or view does not exist
```

```
SQL> drop table if exists t1 ... ;

Table dropped
```


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New In 26ai

```
SQL> create table t1 ( ... );

ERROR at line 1:
ORA-00955: name is already used by an existing object
```


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New In 26ai

```
SQL> create table t1 ( ... );

ERROR at line 1:
ORA-00955: name is already used by an existing object
```

```
SQL> create table if not exists t1 (c1 number);

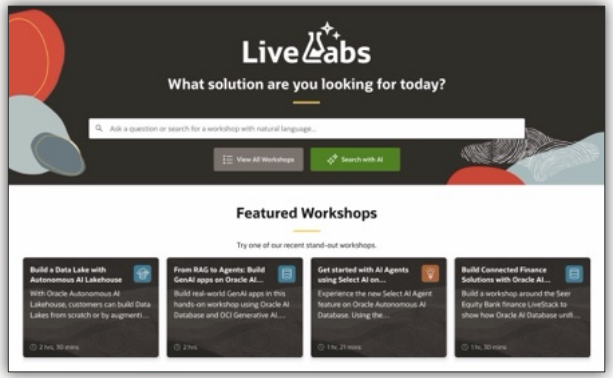
Table created
```


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DON'T TEST IN PRODUCTION

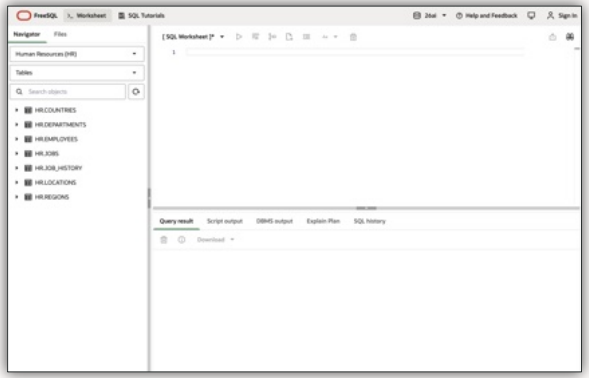
Photo by Dave Hoefler on Unsplash



LiveLabs

- Guided exercises
- Nothing to install
- Runs in browser
- 100 % free

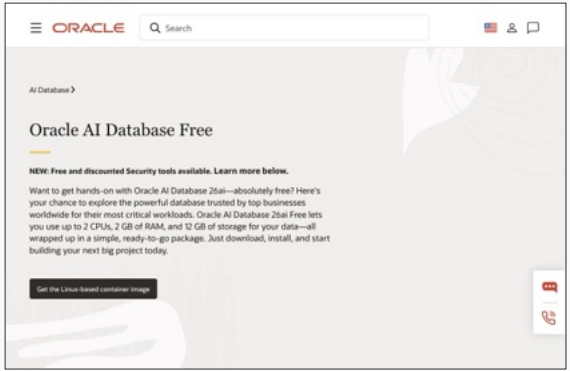
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FreeSQL

- Explore SQL
- Tutorials
- Experiment
- 100 % free

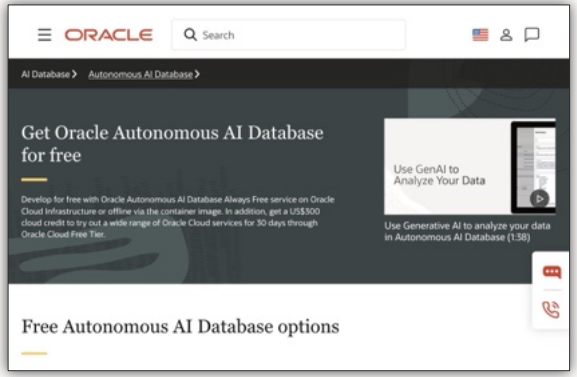
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Oracle AI Database Free

- Complete database
- Explore
- Build
- 100 % free

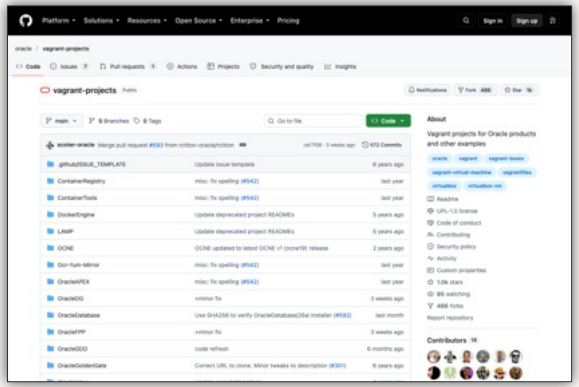
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Always Free Autonomous AI Database

- Fully managed database
- Explore and build
- Cloud or container
- 100 % free

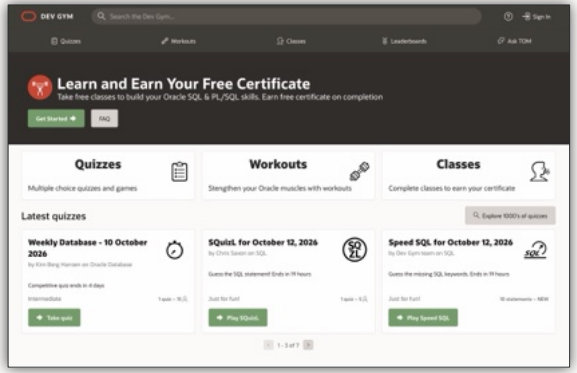
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VMs and containers

- Container or full VM
- Preconfigured
- Repeatable local labs
- 100 % free

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Dev Gym

- Sharpen skill
- Quizzes and workouts
- Guided classes
- 100 % free

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You won't become an expert by listening to me

You become an expert by trying yourself

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Multitenant Operations



Connecting to a PDB

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```
--A common user may switch into a different container, including root

alter session set container=pdb1;
```


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```
create pluggable database blue ...
```

```
lsnrctl status

...

Service "blue" has 1 instance(s).
  Instance "CDB23", status READY, has 1 handler(s) for this service...
```


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```
sqlplus <user>@<hostname>/blue
```

```
<alias_name>=(DESCRIPTION=
   (ADDRESS=
      (PROTOCOL=TCP)(HOST=<hostname>)(PORT=1521)
   )
   (CONNECT_DATA=
      (SERVER=DEDICATED)
      (SERVICE_NAME=blue)
   )
)
```


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Keep PDB names unique on entire host - preferably in your entire environment

- Avoid service name collision

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MAA guidelines recommend creating your own service

- Avoid the default service

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```
--For single instance databases
alter session set container=blue;
exec dbms_service.create_service('SALES', 'SALES');
exec dbms_service.start_service('SALES', NULL);
```


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```
--For single instance databases
alter session set container=blue;
exec dbms_service.create_service('SALES', 'SALES');
exec dbms_service.start_service('SALES', NULL);

--For single instance databases (Oracle Restart) or RAC databases
srvctl add service -d $ORACLE_UNQNAME -service SALES –pdb blue
srvctl start service -d $ORACLE_UNQNAME -service SALES
```


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```
sqlplus <user>@<hostname>/sales
```

```
<alias_name>=(DESCRIPTION=
   (ADDRESS=
      (PROTOCOL=TCP)(HOST=<hostname>)(PORT=1521)
   )
   (CONNECT_DATA=
      (SERVER=DEDICATED)
      (SERVICE_NAME=sales)
   )
)
```


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```
select pdb, name from gv$services order by name;

PDB        NAME
---------- ------------------------------
BLUE       blue
BLUE       SALES
```


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What about ORACLE_PDB_SID?

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```
$ export ORACLE_SID=CDB26
$ export ORACLE_PDB_SID=BLUE
$ sqlplus / as sysdba

SQL*Plus: Release 23.26.3.0.0 - Production on Wed Oct 14 07:26:11 2026
Version 23.26.3.0.0

Copyright (c) 1982, 2026, Oracle.  All rights reserved.

Connected to:
Oracle AI Database 26ai Enterprise Edition Release 23.26.3.0.0 - Production
Version 23.26.3.0.0

SQL> show con_name
CON_NAME
------------------------------
BLUE
```


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This is only documented for use with Oracle E-Business Suite

- Not documented for use elsewhere

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Using `ORACLE_PDB_SID`

- Doesn't work on Windows

- Produces no error when
  - PDB is not started
  - PDB does not exist
  - You mistype the PDB name
  - Database is not started in normal mode

  You end up in root instead - silently

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Using ORACLE_PDB_SID

- MOS note: Performing bequeath direct connections to PDB as SYS and SYSTEM (KB122887)

- Blog post: Pitfalls: Connect to a PDB directly with ORACLE_PDB_SID

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What about TWO_TASK?

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TWO_TASK is just a *shortcut* to a TNS alias

- Does not add any value when connecting to a PDB

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```
--TWO_TASK can hold a TNS alias.
--Use TNS connection, instead of a bequeath connection
export TWO_TASK=my_alias
sqlplus system

--It's basically the same as using @ to connect over TNS
sqlplus system@my_alias
```


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Migrating your *non-CDB scripts*

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```
$ cat /etc/crontab

00 * * * * oracle important.sh
```


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```
$ cat /etc/crontab

00 * * * * oracle important.sh

$ cat important.sh

export ORACLE_SID=NONCDB1
sqlplus / <<EOF
   exec shop.orders.process;
   exec shop.sales.calculate;
   exec shop.shipping.track;
EOF
```


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You must modify
your scripts and procedures

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```
$ cat /etc/crontab

00 * * * * oracle important.sh

$ cat important.sh

export ORACLE_SID=CDB1
sqlplus / <<EOF
   alter session set container=blue;
   exec shop.orders.process;
   exec shop.sales.calculate;
   exec shop.shipping.track;
EOF
```

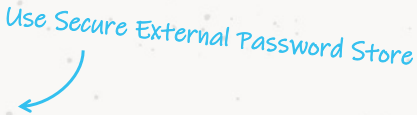

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```
$ cat /etc/crontab

00 * * * * oracle important.sh

$ cat important.sh

sqlplus /@blue <<EOF
   exec shop.orders.process;
   exec shop.sales.calculate;
   exec shop.shipping.track;
EOF
```



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Scripts

- *Many-as-one* principle
- `catcon.pl`
- `DBMS_SCHEDULER`
- Enterprise Manager

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Execute scripts in PDBs using `catcon.pl`

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```
$ cat important.sql

exec shop.orders.process;
exec shop.sales.calculate;
exec shop.shipping.track;
```


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```
$ cat important.sql

exec shop.orders.process;
exec shop.sales.calculate;
exec shop.shipping.track;

$ cd $ORACLE_HOME/rdbms/admin
$ perl catcon.pl -b important -c blue important.sql
```


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```
$ perl catcon.pl \
          -u appuser/apppwd
          -b important
          -c blue,red,green,yellow,purple,orange
          -n 3
          -e -l /tmp/important_log
          important.sql
```


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```
--Use command line help to see all options

perl catcon.pl -help
```


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Word of caution about `_oracle_script`

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```
$ cd $ORACLE_HOME/rdbms/admin
$ grep -i "_oracle_script" * | wc -l

188
```


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_oracle_script

- Default value is **FALSE**
- Undocumented
- Used internally by Oracle
- "_ORACLE_SCRIPT"=TRUE PARAMETER Should not be Invoked by Users (KB141068)

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```
conn appuser/apppwd

create table appuser.t1 (c1 number);
alter session set "_oracle_script"=true;
create table appuser.t2 (c1 number);
```


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```
conn appuser/apppwd

create table appuser.t1 (c1 number);
alter session set "_oracle_script"=true;
create table appuser.t2 (c1 number);

select object_name, oracle_maintained from user_objects;

OBJECT_NAME ORACLE_MAINTAINED
----------- -----------------
T1          N
T2          Y
```


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Do not use `_oracle_script` to customize *PDB$SEED*

- Implement changes in *afterburner* script

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Do not change `_oracle_script`
except under guidance of Oracle Support

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Auto-starting PDBs

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```
--A pluggable database does not start together with the CDB
--You must instruct the CDB to start it
--by saving state when the PDB is open

create pluggable database blue ... ;
alter pluggable database blue open;
alter pluggable database blue save state;
```


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```
--The view contains the list of PDBs with a saved state
--Any PDB not in this view will not auto-start

select con_name, state, restricted from dba_pdb_saved_states;

CON_NAME   STATE RESTRICTED
---------- ----- ----------
BLUE       OPEN  NO
```


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Use Oracle Clusterware to start PDBs in Oracle Restart and Oracle RAC

- Discard saved state and rely on Oracle Clusterware

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```
--If a service depends on a PDB, Clusterware starts the PDB for you
--regardless of the saved state

srvctl add service ... -pdbs BLUE
```

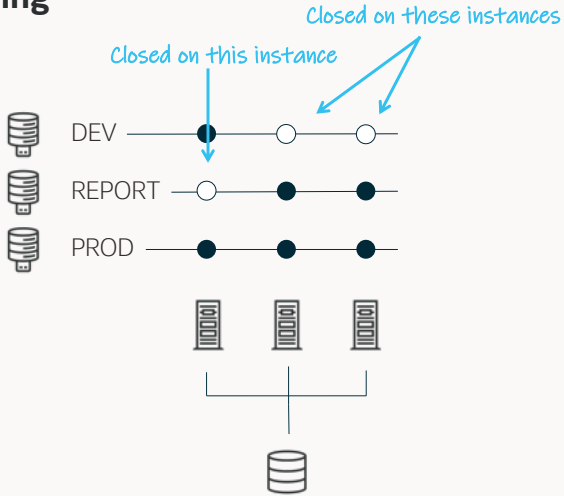

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PDB Subsetting increase flexibility and allow you to use resources wisely

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PDB Subsetting



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```
--By default, a service opens on all instances
--The service brings up the PDB on CDB restart
srvctl add service ... -pdb PROD

--Restrict a service to start on select instances only
srvctl add service ... -pdb REPORT -preferred inst2,inst3
srvctl add service ... -pdb DEV -preferred inst1
```

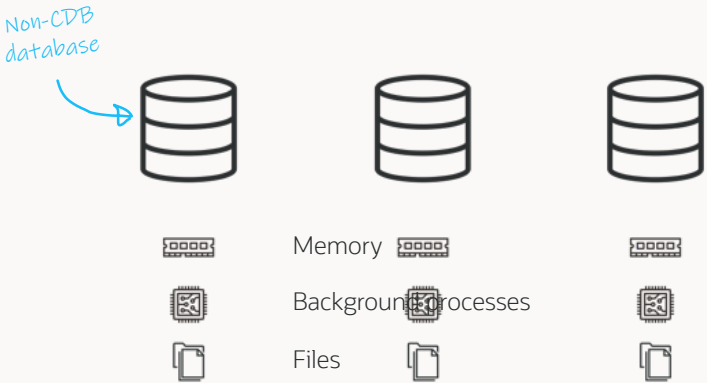

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Share resources between PDBs

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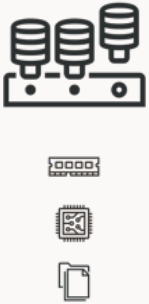
Resource Consolidation



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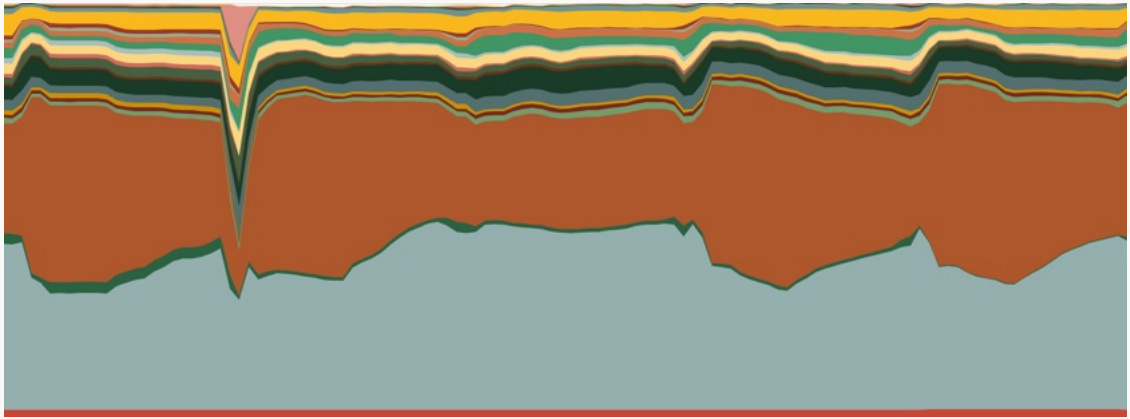
Resource Consolidation





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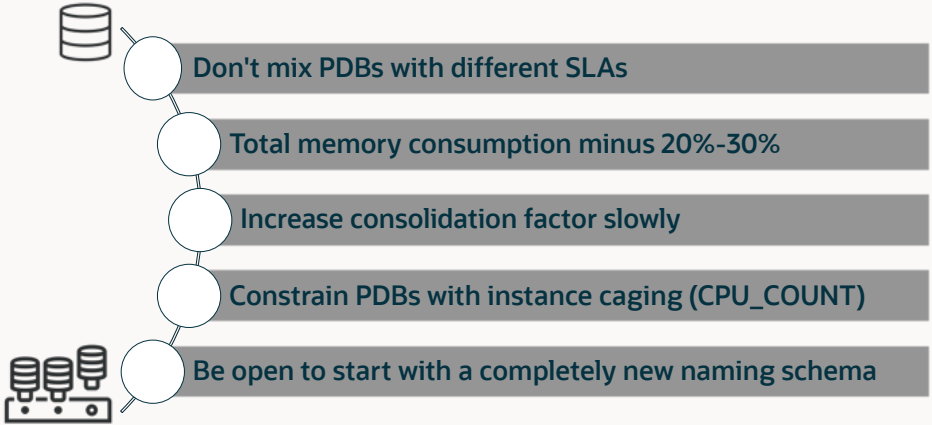
Resource Consolidation



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Consolidation Strategies?

There is no "*best*" strategy



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Using a Swingbench benchmark,
a single-core machine could host nine non-CDBs
before reaching 75 % CPU utilization

By going multitenant the number of databases reached 123 PDBs

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A US Health Care provider managed to

- Reduce the number of database instances by 7x
- Reduce the number of physical servers by 50%

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You can run multiple CDBs on the same host and out of the same Oracle home

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Consolidation



Schema consolidation



Virtual Private Database





PDB consolidation

- Less complexity
- Better isolation
- Operational benefits
- Easier cloning

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A global provider of financial services states

The multitenant architecture gives us complete client separation out of the box, without having to maintain a Virtual Private Database setup.

We went away from Virtual Private Database and consolidated our different clients in individual PDBs.

This reduced the complexity of our database implementation and made operations much easier.

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Avoid *noisy neighbors*

- Allow sharing resources
  but everyone must get a fair share

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Method 1



Instance caging

- Most simple
- Define `CPU_COUNT` for each PDB
- Hard limit

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Method 1





8 CPUs



CPU_COUNT=3



CPU_COUNT=2



CPU_COUNT=2

All non-CDBs
share 7 CPU

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Method 1





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Method 2



Memory allocation

- Simple
- Define `SGA_TARGET` for each PDB
- Hard limit

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Method 2





PDB may never use more than 4G of shared memory

If all PDBs are active, cache management comes into play

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Requires use of Automatic Shared Memory Management

- Both in CDB and PDB

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Optionally, allocate minimum shared pool and buffer cache for a PDB

- Use `SHARED_POOL_SIZE` and `DB_CACHE_SIZE`

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You can combine method 1 and 2

- Instance caging and memory allocation

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Method 3

Simple Resource Manager



- Elaborate, yet simple to implement
- Enable CDB resource manager
- Allocate minimum shares instead of hard limits
- For advanced use cases

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Method 3



8 CPUs

CPU_COUNT=7

At peak, may use up to 5 CPUs

CPU_MIN_COUNT=2

CPU_MIN_COUNT=1

CPU_MIN_COUNT=1

4 CPUs are reserved,
3 are free for all

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Method 3





8 GB memory

SGA_TARGET=7G

SGA_MIN_SIZE=2G

SGA_MIN_SIZE=1G

SGA_MIN_SIZE=1G

At peak, may use
up to 4G shared memory

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Requires Resource Manager at root level

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```
alter session set container=cdb$root;

-- Create an empty resource manager plan with no directives
exec dbms_resource_manager.clear_pending_area;
exec dbms_resource_manager.create_pending_area;
exec dbms_resource_manager.create_cdb_plan('CDB_PLAN');
exec dbms_resource_manager.validate_pending_area;
exec dbms_resource_manager.submit_pending_area;

-- Make plan active in root to enable CDB resource manager
alter system set resource_manager_plan=CDB_PLAN;
```


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Method 4

Advanced Resource Manager



- Requires additional configuration, but much greater control
- Use directives instead of shares

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You can still control resources inside a PDB with Resource Manager

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What about I/O?

- Exadata I/O Resource Management

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```
-- Limit IOPS and throughput from a single PDB
-- Not supported on Exadata
ALTER SYSTEM SET MAX_MBPS = 200;
ALTER SYSTEM SET MAX_IOPS = 5000;

-- From 26.3 you can limit the amount of redo generated by a PDB
ALTER SYSTEM SET REDO_GENERATION_KBPS_MAX = 102400;
```


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You can run multiple CDBs on the same host and out of the same Oracle home

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Inter-instance Resource Management

Shares resources like with non-CDBs:

- `CPU_COUNT`
- `SGA_MAX_SIZE`

Inter-instance CPU resource manager:

- Controls resource sharing using Linux c-groups
- Check `RESOURCE_MANAGER_CPU_SCOPE`
- Exadata Database Machine and Autonomous AI Database



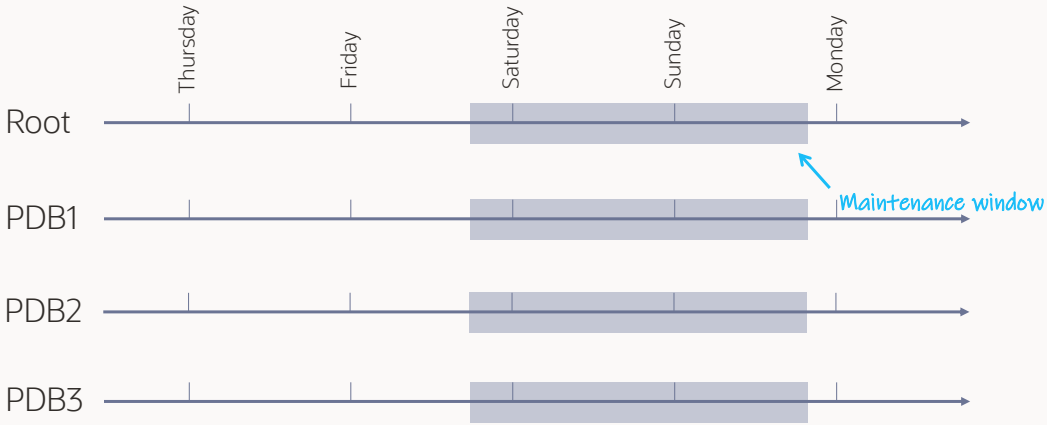
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A word about automated maintenance tasks

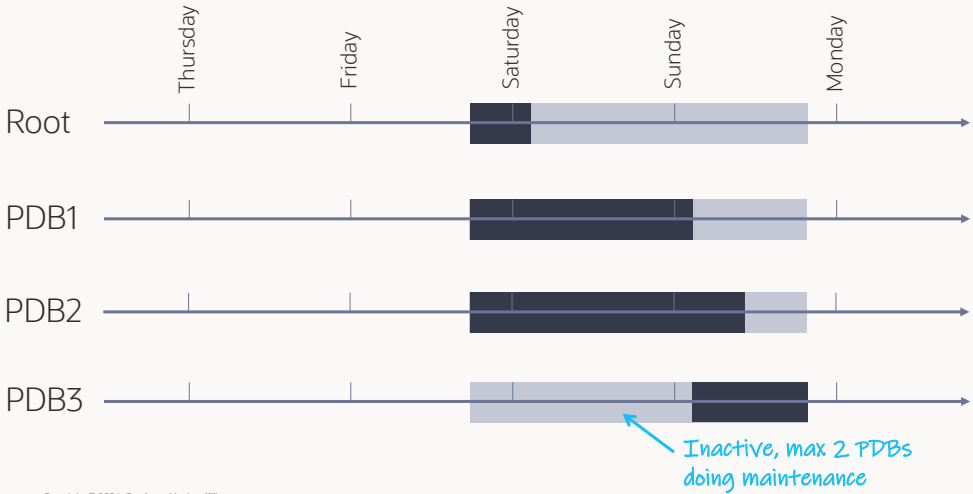
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Automated Maintenance Tasks



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Automated Maintenance Tasks



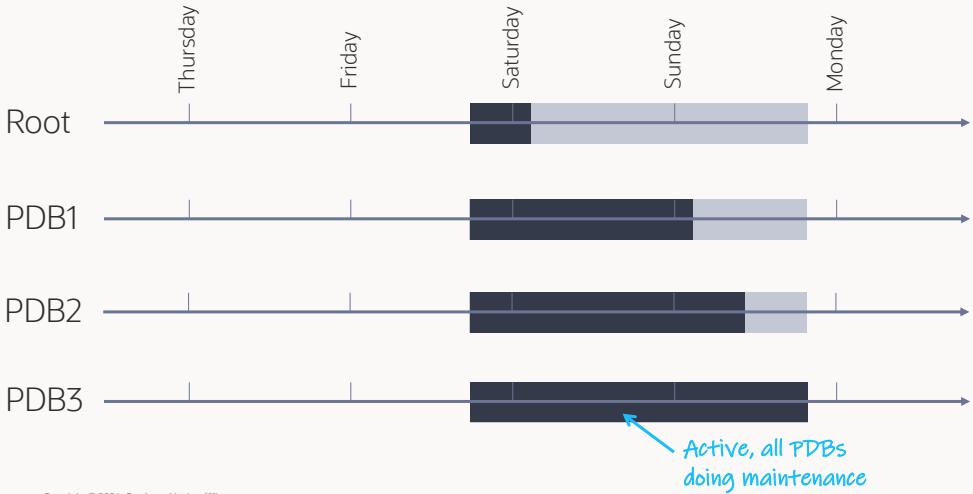
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```
--Change the amount of PDBs that can run maintenance tasks at the same time
--Default value 2

alter system set autotask_max_active_pdbs=3;
```


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Automated Maintenance Tasks



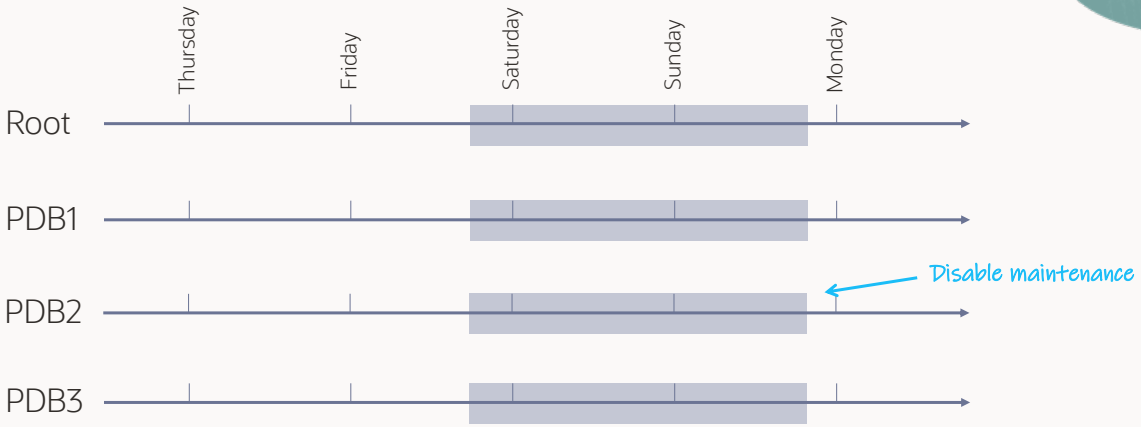
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```
--Selectively disable maintenance tasks in a PDB
--For instance, test databases or databases that are rebuilt frequently

alter session set container=PDB2;
alter system set enable_automatic_maintenance_pdb=false;
```


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Automated Maintenance Tasks



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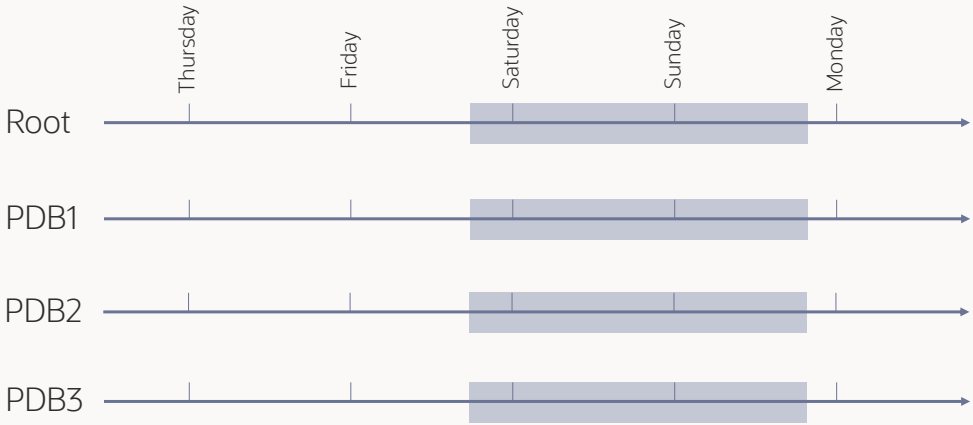


Shift maintenance windows

- Optionally, shorten maintenance windows

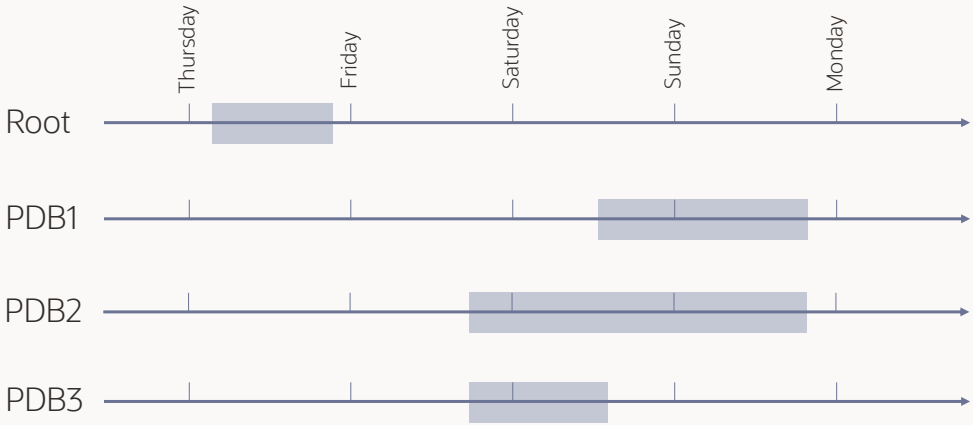
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Automated Maintenance Tasks



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Automated Maintenance Tasks



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Selectively disable individual maintenance tasks using `DBMS_AUTO_TASK_ADMIN`

- Does a test database need Automatic Segment Advisor?
- Or Evolve Advisor?

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Resource Manager prevents maintenance tasks from *stealing* resources from users

- Consumer group `ORA$AUTOTASK`

Key Learnings



1. Get started with Multitenant
2. Understand plug-in on standby databases
3. Finetune your container database

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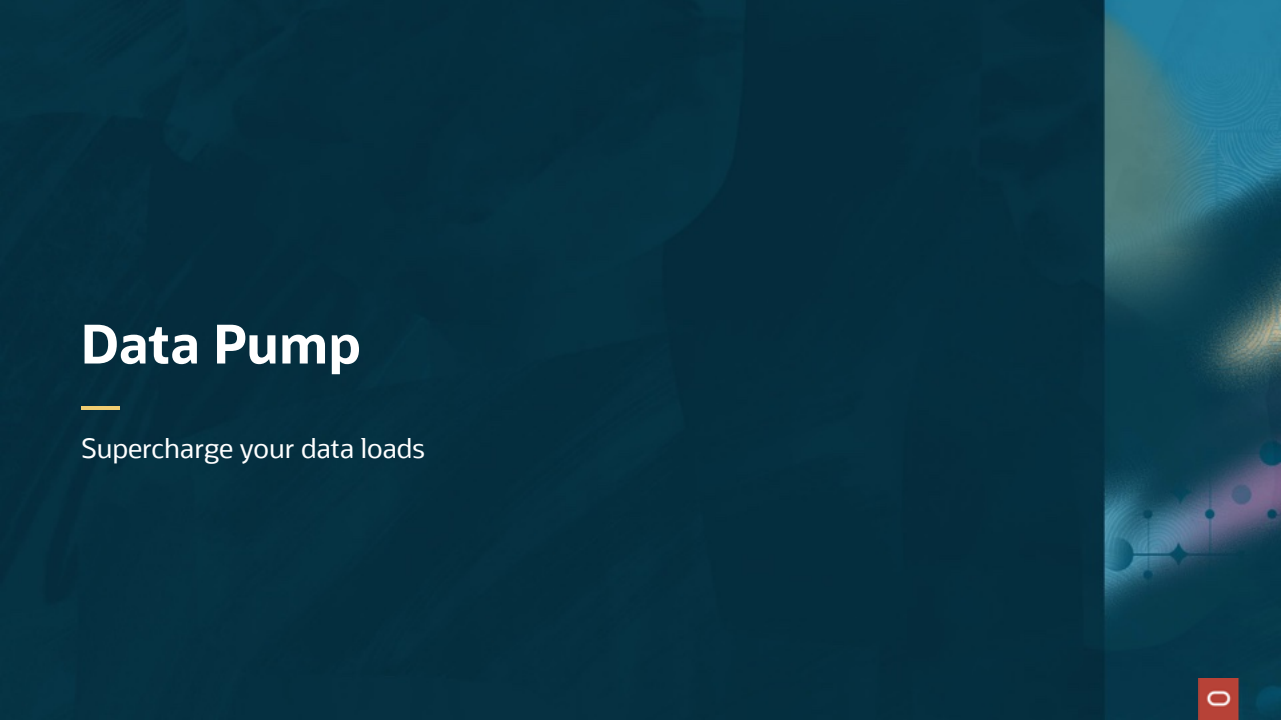
BREAK

We start again at 15:15

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Data Pump

Supercharge your data loads





Always use the Data Pump Bundle Patch

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More than 230 functional and performance fixes

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Importing a complete application with data drops from almost 2.5 hours to 48 minutes – by just applying the Data Pump bundle patch

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Apply the Data Pump Bundle Patch without downtime

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DEMO

Apply Data Pump Bundle Patch



Watch on YouTube

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Further Information

Data Pump Bundle Patch



- (KB107134)
  Data Pump Recommended Proactive Patches For 19.10 and Above

- The patch is not RAC rolling installable
  - The patch is non-binary online installable
  - Apply while the database instance is running
  - Don't use Data Pump or `DBMS_METADATA`

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Ensure dictionary and fixed objects statistics are accurate

- Before export
- Before import
- Immediately after import

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```
begin
   --dbms_stats.gather_dictionary_stats;
   dbms_stats.gather_schema_stats('SYS');
   dbms_stats.gather_schema_stats('SYSTEM');
   dbms_stats.gather_fixed_objects_stats;
end;
/
```


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```
begin
   --dbms_stats.gather_dictionary_stats;
   dbms_stats.gather_schema_stats('SYS');
   dbms_stats.gather_schema_stats('SYSTEM');
   dbms_stats.gather_fixed_objects_stats;
end;
/
```

"After gathering dictionary stats, our Data Pump export went from 46 to 8 minutes"

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Use PARALLEL and multiple dump files

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```
--Apply parallelism by simply specifying a degree
expdp ... parallel=8


--Use different parallel degree on import
impdp ... parallel=32
```


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Oracle Cloud Infrastructure

Number of ECPUs / 4

Number of OCPUs



On-prem (x86-64)

2 x physical cores



On-prem (other)

Depends

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Use at least 32 ECPUs when importing into Autonomous AI Database

- Use the elasticity in Autonomous AI Database and scale even higher

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Parallel Architecture

```
expdp ... parallel=4
```


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Parallel Architecture



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Parallel Architecture

```
expdp ... parallel=4
```







```
select /*+ parallel(2) */ * from t1
select * from t2
select * from t3
select * from t4
```

Worker 4 goes idle

Control process

Worker processes

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```
--Use %L to allow multiple dump files
expdp ... parallel=8 dumpfile=exp%L.dmp
```


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```
--Split dump files into minor files for easier transport
expdp ... parallel=8 dumpfile=exp%L.dmp filesize=10000M
```


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New In 26ai

```
-- After export, store a checksum in the dump file.
-- Detects in-flight corruption or alteration.
-- Specify other algorithms using checksum_algorithm parameter.

expdp ... checksum=yes

impdp ... verify_checksum=yes
          verify_only=yes
```


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For best protection against dump file tampering, use encrypted dump files

- Requires Advanced Security Option

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```
-- Protect your dump files from alteration by using encryption
-- Creating an encrypted dump file requires a license for ASO

expdp ... encryption=all encryption_algorithm=AES256
```


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```
-- Protect your dump files from alteration by using encryption
-- Creating an encrypted dump file requires a license for ASO

expdp ... encryption=all encryption_algorithm=AES256
```


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DEMO

Encrypted exports



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Transportable jobs can use parallel metadata from Oracle Database 21c

- But you need to specify **PARALLEL**

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```
-- Any transportable jobs can now run in parallel
-- Parallel unload/load of metadata provide a significant
-- performance boost

expdp ... full=y transportable=always parallel=16

impdp ... parallel=16
```


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Parallel Transportable Benchmark

Oracle E-Business Suite database

600.000+ objects

Export parallel 1	2h 2m	Export parallel 16	1h 8m
Import parallel 1	6h 44m	Import parallel 16	1h 23m
Total	**8h 46m**	**Total**	**2h 31m**

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Speed up imports by using NOVALIDATE constraints

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A Constraint Can Be

VALIDATED

All data in the table obeys the constraint.
The database guarantees that data is good.

NOT VALIDATED

All data in the table may obey the constraint.
The database does not know if data is good.

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Most constraints are VALIDATED

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On import, Data Pump creates constraints in the same state as in the source

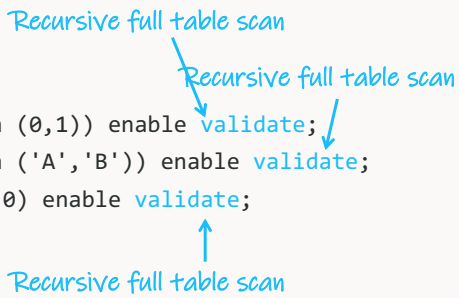
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```
--Example of which commands Data Pump import might execute as part of an import

create table sales ( .... );

insert into sales as select ... ;

alter table sales add constraint c_sales_1 check (c1 in (0,1)) enable validate;
alter table sales add constraint c_sales_2 check (c2 in ('A','B')) enable validate;
alter table sales add constraint c_sales_3 check (c3 > 0) enable validate;
```



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```
-- Add constraints with NOVALIDATE keyword regardless of state in source database
-- Significantly speeds up add constraints for larger tables

impdp ... transform=constraint_novalidate:y
```


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```
--Transforming constraints to NOVALIDATE to speed up import

alter table sales add constraint c_sales_1 check (c1 in (0,1)) enable novalidate;
alter table sales add constraint c_sales_2 check (c2 in ('A','B')) enable novalidate;
alter table sales add constraint c_sales_3 check (c3 > 0) enable novalidate;
```



No full table scan

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```
--Transforming constraints to NOVALIDATE to speed up import

alter table sales add constraint c_sales_1 check (c1 in (0,1)) enable novalidate;
alter table sales add constraint c_sales_2 check (c2 in ('A','B')) enable novalidate;
alter table sales add constraint c_sales_3 check (c3 > 0) enable novalidate;
```



Database validates new rows

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Benchmark, 1 billion rows

Importing VALIDATE constraints

```
10-AUG-24 00:32:28.716: W-1 Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
10-AUG-24 00:36:42.762: W-1 . . imported "FUSION"."hwr_topic_tl" 151.2 GB 1044625000 rows in 254 seconds using external_table
10-AUG-24 00:45:41.226: W-1 Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/CONSTRAINT
10-AUG-24 00:55:35.787: W-1      Completed 7 CONSTRAINT objects in 594 seconds
```

Importing NOVALIDATE constraints

```
10-AUG-24 00:14:56.050: W-1 Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
10-AUG-24 00:19:10.311: W-1 . . imported "FUSION"."hwr_topic_tl" 151.2 GB 1044625000 rows in 254 seconds using external_table
10-AUG-24 00:29:20.841: W-1 Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/CONSTRAINT
10-AUG-24 00:29:21.101: W-1      Completed 7 CONSTRAINT objects in 1 seconds
```


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Real-World Example, Importing 180G Schema

Starting point	44m 50s
Adding Data Pump Bundle Patch	36m 53s
Using NOVALIDATE constraints	7m 25s

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NOVALIDATE constraints prevent the optimizer from certain query rewrites

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Validate constraints after import, or even after go-live

- Still requires a full scan of the table
- But can use parallel query
- And no table lock!

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```
alter table sales add constraint c_sales_1 check (c1 in (0,1)) enable novalidate;

-----------------------
------- GO LIVE -------
-----------------------

-- Validate constraints
-- Optionally, use parallel query

alter session force parallel query;
alter table sales modify constraint c_sales_1 enable validate;
```


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Also available in Oracle Database 19c via 19.27 Data Pump Bundle Patch

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Also available in Oracle Autonomous AI Database 19c

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```
--Add the following to your ZDM response file to set the parameter during
--ADB migrations using ZDM

DATAPUMPSETTINGS_METADATATRANSFORMS-1=name:CONSTRAINT_NOVALIDATE,value:1
```


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Further Information

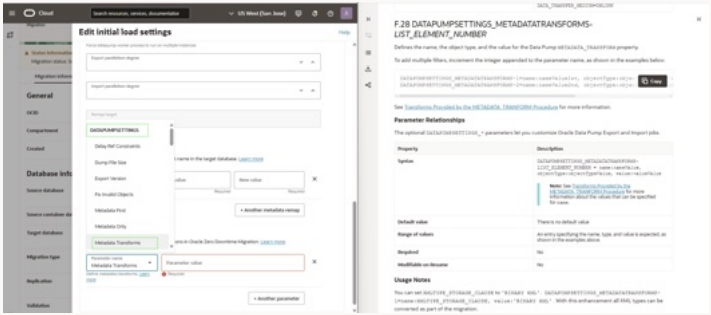
NOVALIDATE Constraints

- 19.26 and earlier also requires patch 37280692
- Allow optimizer to perform query rewrites even with NOVALIDATE constraints using QUERY_REWRITE_INTEGRITY
- Data Pump always validates certain constraints:
  - On DEFAULT ON NULL columns
  - Used by a reference partitioned table
  - Used by a reference partitioned child table
  - Table with Primary key OID
  - Used as clustering key on a clustered table

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NOVALIDATE Constraints

- Available in Database Migration Service (DMS)
- In the OCI console, Advanced parameters> DATAPUMPSETTINGS: [Metadata Transforms]



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Use index size to determine parallel degree on index creation

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Index Creation

```
impdp ... parallel=16
```

Really good for few big indexes

Before 12.1

Worker 1 `CREATE INDEX .... PARALLEL 16`

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Index Creation

```
impdp ... parallel=16
```

From 12.1



Worker 1	`CREATE INDEX .... PARALLEL 1`
Worker 2	`CREATE INDEX .... PARALLEL 1`
...	`CREATE INDEX .... PARALLEL 1`
Worker 16	`CREATE INDEX .... PARALLEL 1`

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Index Creation

```
impdp ... parallel=16
```

From 26

The best of both worlds



Worker 1	`CREATE INDEX .... PARALLEL 1`
Worker 2	`CREATE INDEX .... PARALLEL 8`
Worker 3	`CREATE INDEX .... PARALLEL 4`
Worker 4	`CREATE INDEX .... PARALLEL 3`

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How Data Pump Create Indexes

1. Calculate the optimal parallel degree
2. Create indexes

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How Data Pump Create Indexes

1 Calculate the optimal parallel degree

- Always parallel 1 when a table is less than 150 MB
- Customizable via `INDEX_THRESHOLD`
- Get optimal parallel degree using `EXPLAIN PLAN`

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```
SQL> explain plan for create index i1 on t1(c1) parallel;

Explained.
```


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```
SQL> explain plan for create index i1 on t1(c1) parallel;

Explained.

SQL> select * from table(dbms_xplan.display(format => 'ALL'));

...

Note
-----
   - automatic DOP: Computed Degree of Parallelism is 4 because of degree limit
   - estimated index size: 655K bytes
```


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How Data Pump Create Indexes

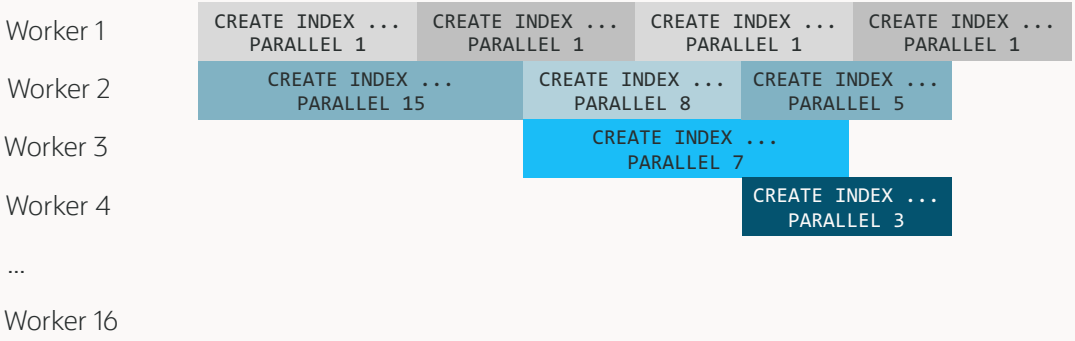
2 Create indexes

- One worker creates small indexes (parallel 1) in large batches
- The next worker starts with the biggest index (measured by optimal parallel degree)

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How Data Pump Create Indexes

```
impdp ... parallel=16
```



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Importing with former index method

```
10-MAY-25 16:18:55.130: W-12 Processing object type SCHEMA_EXPORT/TABLE/INDEX/INDEX
10-MAY-25 16:36:46.902: W-30      Completed 480 INDEX objects in 1071 seconds
```

Importing with new index method

```
10-MAY-25 16:47:50.267: W-4 Processing object type SCHEMA_EXPORT/TABLE/INDEX/INDEX
10-MAY-25 16:59:17.006: W-3      Completed 480 INDEX objects in 686 seconds
```


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Best results with Release Update 23.26.4 and Data Pump Bundle Patch

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Also available in Oracle Database 19c via 19.32 Data Pump Bundle Patch

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Further Information

Index Creation

- Requires:
  - Oracle AI Database 23.26.4 plus Data Pump Bundle Patch
  - Oracle AI Database 23.26.x plus Data Pump Bundle Patch + fix for 38975945
  - Oracle Database 19.32 plus Data Pump Bundle Patch
  - Oracle Database 19.31 plus Data Pump Bundle Patch + fix for 38975945

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Convert time zone data on import

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Time Zone File Version Check







Source
Version 43

Target
Version 42

```
create table t1 (
   ...
   c1 timestamp with timezone
   ...
)
```


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```
Import: Release 19.0.0.0.0 - Production on Sun Sep 30 06:17:06 2025
Version 19.27.0.0.0

ORA-39002: invalid operation
ORA-39405: Oracle Data Pump does not support importing from a source database
with TSTZ version 43 into a target database with TSTZ version 42.
```


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DEMO

Convert time zone data on import



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```
INSERT /*+ APPEND ENABLE_PARALLEL_DML ... */ INTO RELATIONAL( .... )
  SELECT ORA_DST_CONVERT("C1")
   FROM "TESTUSER"."ET$01145D870001" KU$
```


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Further Information

Time Zone Data Conversion



- If needed, Data Pump converts TIMESTAMP WITH TIMEZONE to the target time zone file version
- This works if the target time zone file is higher or lower than the source
- Expect a small overhead for the conversion
- Requires 19.27 including Data Pump Bundle Patch

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Also available in Oracle Database 19c via 19.27 Data Pump Bundle Patch

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Copy the dump files before the export completes

- Oracle AI Database 26ai

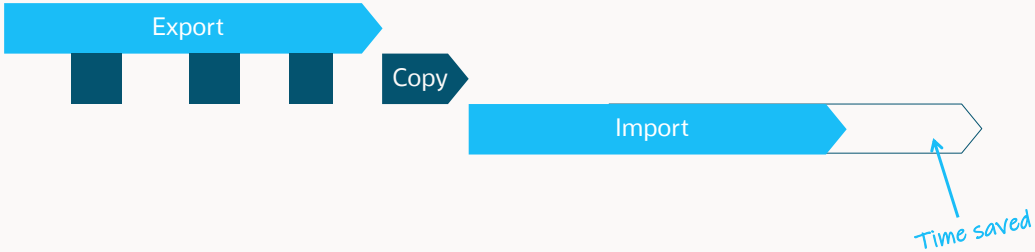
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Copy Dump Files



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Copy Dump Files



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```
dbms_datapump.get_status(l_handle, l_stsmask, NULL, l_job_state, l_status);
```


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```
dbms_datapump.get_status(l_handle, l_stsmask, NULL, l_job_state, l_status);

for i in l_status.job_status.files.first..l_status.job_status.files.last() loop




end loop;
```


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```
dbms_datapump.get_status(l_handle, l_stsmask, NULL, l_job_state, l_status);

for i in l_status.job_status.files.first..l_status.job_status.files.last() loop

   l_dump_file := l_status.job_status.files(i);

   if (l_dump_file.file_bytes_written = l_dump_file.file_size) then
      dbms_output.put_line('DONE: ' || l_dump_file.file_name);
   end if;

end loop;
```


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Further Information

Copy Dump Files



- Blog post:
  Copy Data Pump Files Before the End of the Export

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Use diagnostics views to assist in troubleshooting

- Oracle AI Database 26ai

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```
SQL> select waiting_session, event, dp_state_in_wait
     from   v$datapump_sessionwait_info;

WAITING_SESSION EVENT                                      DP_STATE_IN_WAIT
--------------- ---------------------------------------- ----------------
10              direct path sync                         WAITING
77              log buffer space                         WAITING
191             log buffer space                         WAITING
428             enq: TT - contention                     WAITING
```


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Further Information

Diagnostic Views

- New views available in Oracle AI Database 26ai:
  - `v$datapump_process_info`
  - `v$datapump_sessionwait_info`
  - `v$datapump_processwait_info`

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Key Learnings



1. Use Data Pump Bundle Patch
2. Use NOVALIDATE constraints
3. Create indexes faster

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Q&A

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