ORACLE

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

Berlin, February 2026

Oracle **DBAs** run the world

Mike Dietrich

Vice President

 mikedietrich

 @mikedietrichde.com

 https://mikedietrichde.com

Daniel Overby Hansen

Distinguished Product Manager

in dohdatabase

@dohdatabase.com

https://dohdatabase.com

Get the Slides

https://dohdatabase.com/slides

Find Slides and Much More on Our Blogs
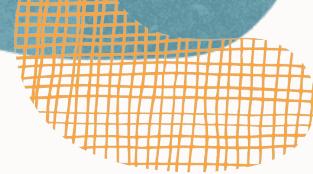
MikeDietrichDE.com

Mike.Dietrich@oracle.com

dohdatabase.com

Daniel.Overby.Hansen@oracle.com

DBArj.com.br

Rodrigo.R.Jorge@oracle.com

AlexZaballa.com

Alex.Zaballa@oracle.com

Web Seminar	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*	
***NEW* Episode 18** Cross Platform Migration – Transportable Tablespaces to the Extreme *145 min – February 22, 2024*	
Episode 2 AutoUpgrade to Oracle Database 19c *115 minutes – Feb 20, 2021*	
Episode 3 Performance Stability, Tips and Tricks and Underscores *120 minutes – Mar 4, 2021*	
Episode 4 Migration to Oracle Multitenant	

Recorded Web Seminars

https://MikeDietrichDE.com/videos

More than 40 hours of technical content, on-demand, anytime, anywhere

Scan me to sign up

Database Patching for DBAs

– Patch smarter, not harder

February 12, 14:00 CET
Sign up

AGENDA

09:30
Welcome
Release Strategy
Patching

11:15
AutoUpgrade
Multitenant

13:30
Data Pump
Autonomous AI Database

15:15
Migrating
"The Beast"

11:00
Coffee break

12:45
Lunch

15:00
Coffee break

Release Strategy

Lifetime Support Policy

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 |

11.2 — Premier Support (2012–2014), WAIVED EXTENDED (2015–2018), EXTENDED (2019–2020), UPGRADE SUPPORT (2021–2025)

12.1 — Premier Support (2013–2017), Waived Extended (2018), EXTENDED (2019–2021), UPGRADE SUPPORT (2022–2025)

12.2.0.1 — Premier Support (2017–2020), LIMITED (2021), UPGRADE SUPPORT (2024–2025)

18c — Premier Support (2018–2020)

19c — Premier Support (2019–2029), EXTENDED (2030–2032)

21c — Premier Support (2020–2024)

23ai — Premier Support (2023–2032)

Legend:
- Premier Support
- Waived Extended Support
- Paid Extended Support
- Restricted Upgrade Support
- Limited Error Correction

Lifetime Support Policy

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

EXTENDED — EXTENDED — UPGRADE SUPPORT

EXTENDED — UPGRADE SUPPORT

12.2.0.1 — LIMITED — UPGRADE SUPPORT

18c

19c — EXTENDED

21c

23ai

Legend:
- ■ Premier Support
- ■ Waived Extended Support
- ■ Paid Extended Support
- ■ Restricted Upgrade Support
- ■ Limited Error Correction

Lifetime Support Policy

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

- EXTENDED / EXTENDED / UPGRADE SUPPORT
- EXTENDED / UPGRADE SUPPORT
- 12.2.0.1 / LIMITED / UPGRADE SUPPORT
- 18c
- 19c / EXTENDED
- 21c
- 26ai

Legend: Premier Support · Waived Extended Support · Paid Extended Support · Restricted Upgrade Support · Limited Error Correction

Do you want to upgrade?

Oracle Database 11.2.0.4
Oracle Database 12.1.0.2
Oracle Database 12.2.0.1
Oracle Database 18c

Oracle Database 11.2.0.4
Oracle Database 12.1.0.2
Oracle Database 12.2.0.1   ⇒   Oracle Database 19c   ⇒   **Oracle Database 23ai**
Oracle Database 18c

Oracle Database 11.2.0.4
Oracle Database 12.1.0.2
Oracle Database 12.2.0.1
Oracle Database 18c

$\Rightarrow$

Oracle Database 19c

$\Rightarrow$

Oracle Database 23ai

Oracle AI Database 26ai

26ᵃⁱ   When is a database upgrade required?

Oracle Database 19c $\Rightarrow$ Oracle Database 23ai $\Rightarrow$ Oracle AI Database 26ai

UPGRADE

Oracle Database 19c $\Rightarrow$ Oracle AI Database 26ai

UPGRADE

Oracle Database 19c $\Rightarrow$ Oracle Database 23ai $\Rightarrow$ Oracle AI Database 26ai

UPDATE

July 2025	Oracle Database 23ai	23.9.0.25.07
October 2025	Oracle AI Database 26ai	23.26.0.0.0
January 2026	Oracle AI Database 26ai	23.26.1.0.0
April 2026	Oracle AI Database 26ai	23.26.2.0.0

July 2025	Oracle Database 23ai	23.9.0.25.07
October 2025	Oracle AI Database 26ai	23.26.0.0.0
January 2026	Oracle AI Database 26ai	23.26.1.0.0
April 2026	Oracle AI Database 26ai	23.26.2.0.0

July 2025	Oracle Database 23ai	23.9.0.25.07
October 2025	Oracle AI Database 26ai	23.26.0.0.0
January 2026	Oracle AI Database 26ai	23.26.1.0.0
April 2026	Oracle AI Database 26ai	23.26.2.0.0

July 2025	Oracle Database 23ai	23.9.0.25.07
October 2025	Oracle AI Database 26ai	23.26.0.0.0
January 2026	Oracle AI Database 26ai	23.26.1.0.0
April 2026	Oracle AI Database 26ai	23.26.2.0.0

July 2025	Oracle Database 23ai	23.9.0.25.07
October 2025	Oracle AI Database 26ai	23.26.0.0.0
January 2026	Oracle AI Database 26ai	23.26.1.0.0
April 2026	Oracle AI Database 26ai	23.26.2.0.0

July 2025	Oracle Database 23ai	23.9.0.25.07
October 2025	Oracle AI Database 26ai	23.26.0.0.0
January 2026	Oracle AI Database 26ai	23.26.1.0.0
April 2026	Oracle AI Database 26ai	23.26.2.0.0

26^{ai}

When will it be available for non-Oracle hardware on-premises?

- See MOS Note: PNEWS1360

On-Premises Server Releases (includes client)

(Download here)

Linux x86	*Not Planned*	*Not Planned*	*Not planned*	*Not planned*	*Not planned*	*Not planned*	*Not planned*	28-Aug-2013
Linux x86-64	January 2026 Release Update (23.26.1) (Instant Client and Full Client are available today)	13-Aug-2021	25-Apr-2019	23-Jul-2018	1-Mar-2017	22-Jul-2014	25-Jun-2013	27-Aug-2013
Linux on Arm	*TBA*	*Not Planned*	28-June-2023 Client: May-2021 download	*Not Planned*	*Not Planned*	*Not Planned*	*Not Planned*	*Not Planned*
Oracle Solaris SPARC (64-	*TBA*	*See KB126264*	26-Apr-2019	30-Jul-2018	1-Mar-2017	22-Jul-2014	25-Jun-2013	29-Aug-2013

Patching

Question

How often do you patch your Oracle environments?

☐ Every quarter

☐ Twice per year

☐ Once per year

☐ Never

Release Update Contents – Oracle Database 19c

Release Update Contents – Oracle AI Database 26ai
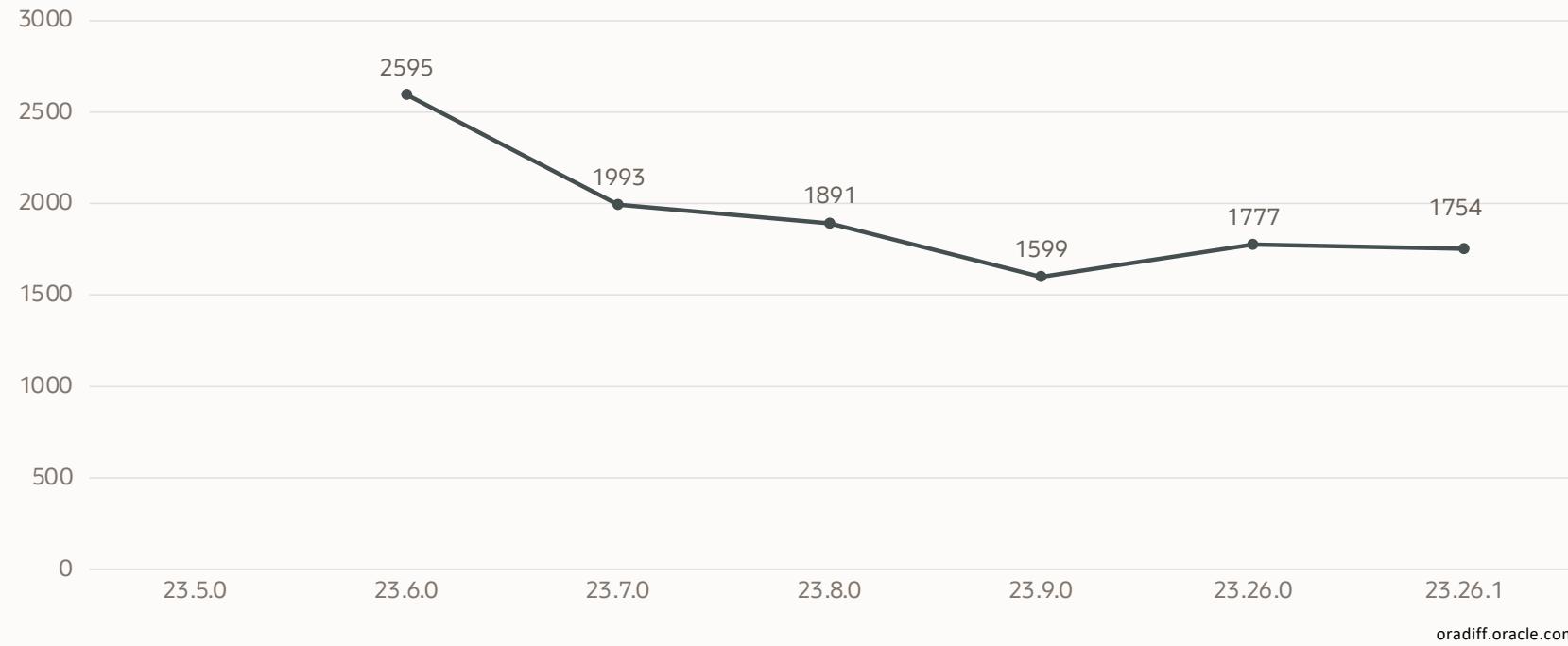
oradiff.oracle.com

FIX numbers

If you don't apply a recent Release Update, you will miss thousands of fixes

- More than 14k fixes with 19.29.0
  - More than 750 security fixes
- Almost 10k fixes with 23.26.0
  - More than 850 security fixes

Just as easy as patching your smart phone

AutoUpgrade's mission for patching Oracle Database

AutoUpgrade and Patching

1
Download

- Find the right patch numbers
- For the right platform
- Get latest OPatch

2
Install

- Install brand-new Oracle home
- Update OPatch
- Apply all patches

3
Patch

- Datapatch Sanity Check
- Move instances and files
- Datapatch
- Recompilation
- Post-tasks

```
$ cat just_patch.cfg

patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
```

AutoUpgrade and Patching

1 Download

- Find the right patch numbers
- For the right platform
- Get latest OPatch

2 Install

- Install brand-new Oracle home
- Update OPatch
- Apply all patches

3 Patch

- Datapatch Sanity Check
- Move instances and files
- Datapatch
- Recompilation
- Post-tasks

```
$ cat do_it_all.cfg

global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RU,OPATCH,OJVM,DPBP
```

```
$ cat do_it_all.cfg

global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RU,OPATCH,OJVM,DPBP

$ java -jar autoupgrade.jar -config do_it_all.cfg –patch -mode deploy
```

Demo

One-Button Patching

- Download patches
- Install Oracle home
- Patch database

Watch on YouTube

AutoUpgrade Patching

Download patches   Analyze   Fixups   Create home   Patch database   Postchecks
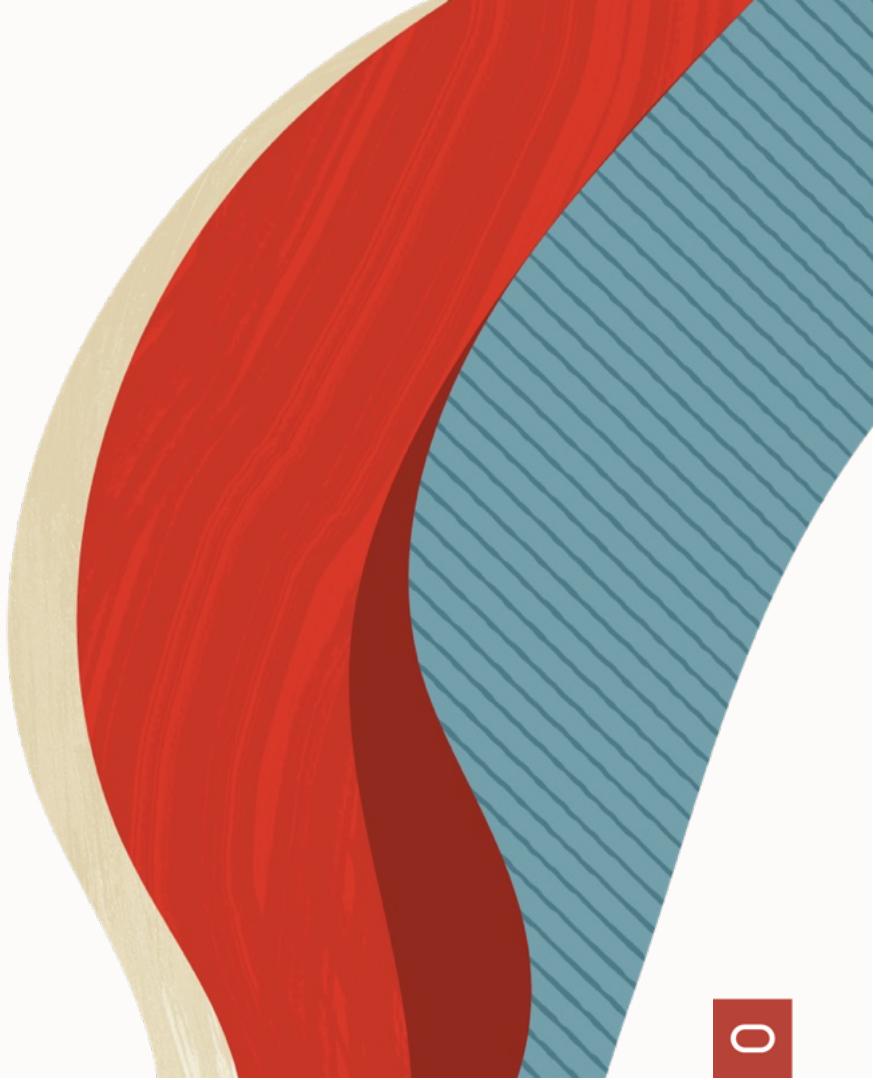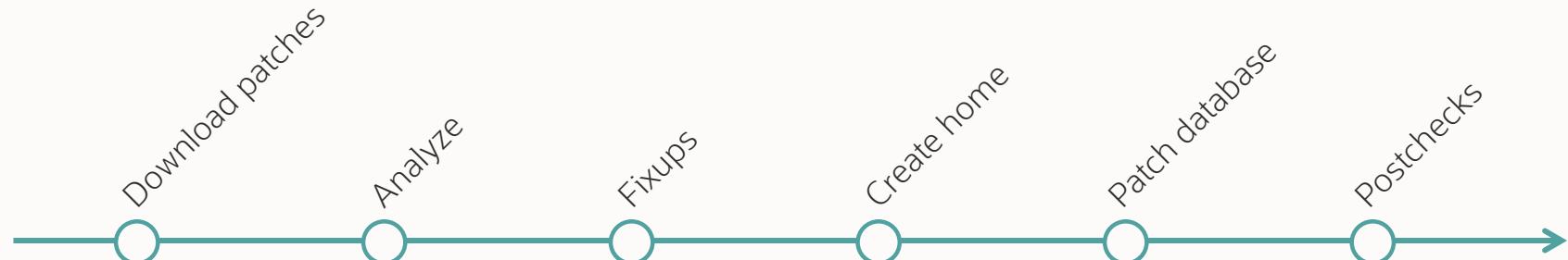
`-mode deploy`

AutoUpgrade Patching

Download patches — Analyze — Fixups — Create home — Patch database — Postchecks
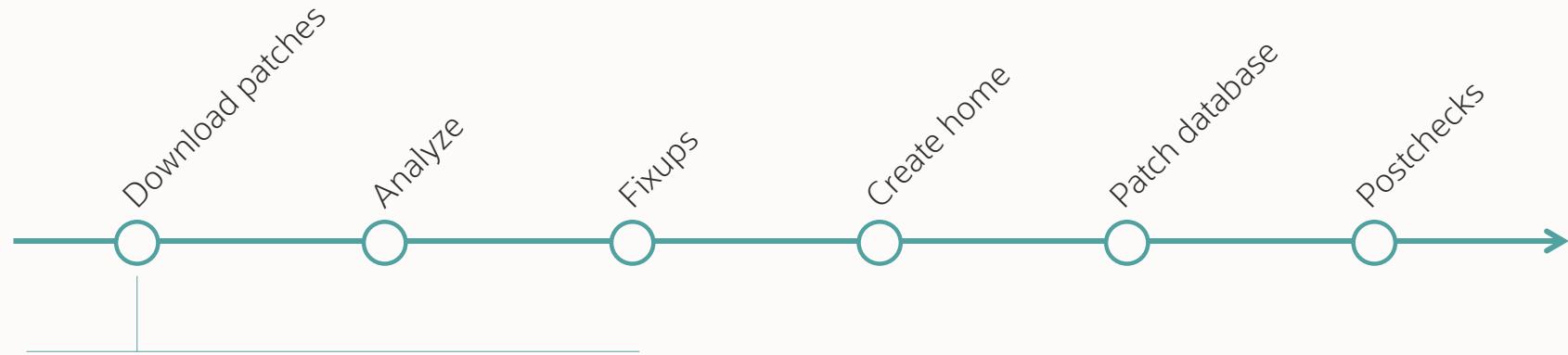
- Finds and downloads patches
- Uses your MOS credentials
- Chooses the right platform
- Stores patches in local repository

AutoUpgrade Patching

Download patches

Analyze

Fixups

Create home

Patch database

Postchecks
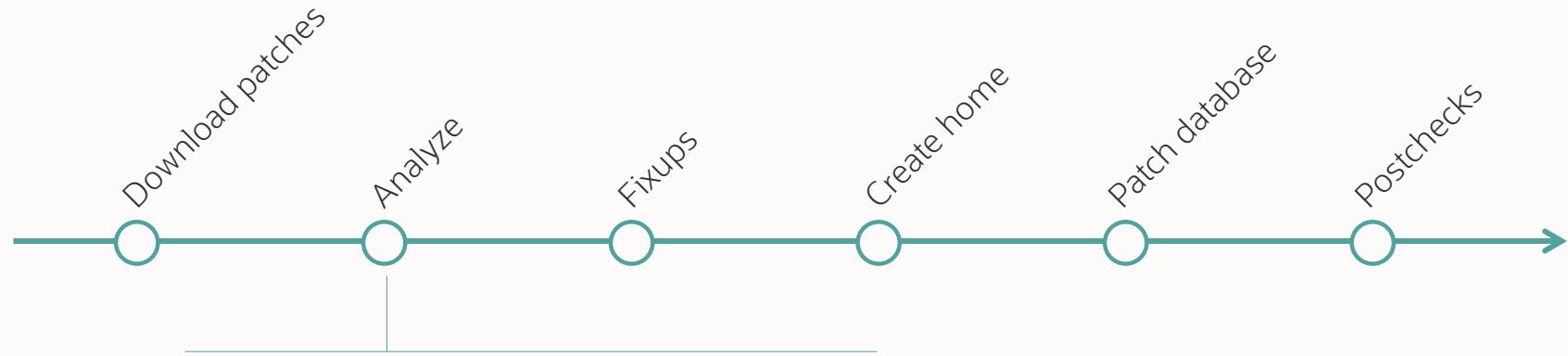
- Analyzes database for patch readiness
- Datapatch Sanity Checks
- Lightweight
- Non-intrusive
- Recommended, not required

AutoUpgrade Patching

Download patches — Analyze — Fixups — Create home — Patch database — Postchecks
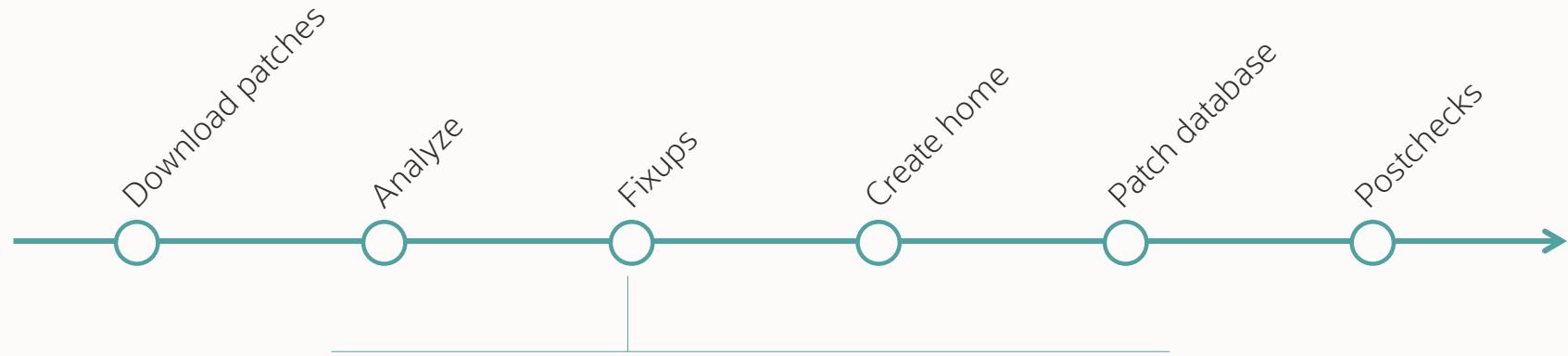
- Gathers dictionary statistics if needed
- Recompiles Oracle-maintained objects if needed
- Executes checks - see Doc ID 2380601.1

AutoUpgrade Patching

Download patches Analyze Fixups Create home Patch database Postchecks
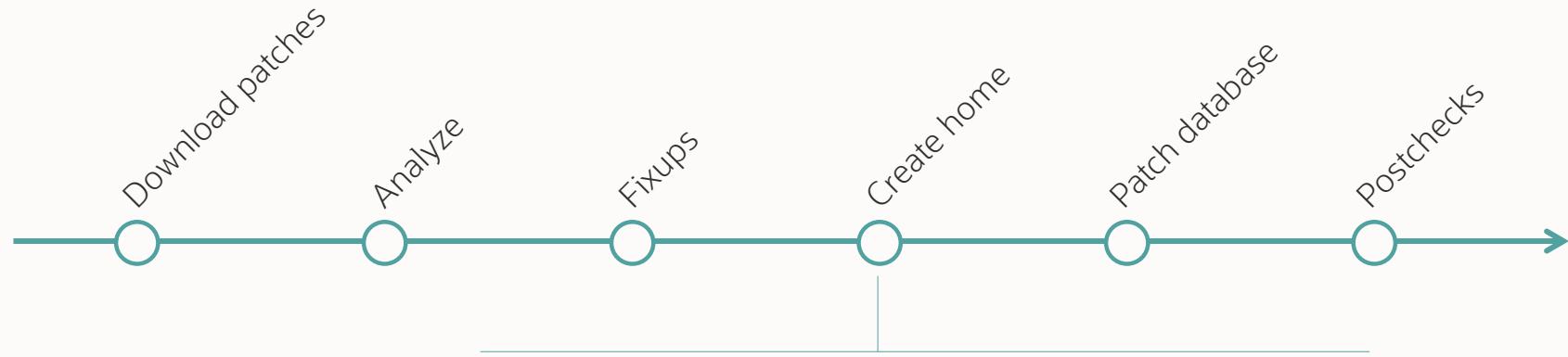
- Out-of-place patching
- Creates a brand-new Oracle home
- Uses *runInstaller settings* and binary options from source Oracle home
- Execute `root.sh` via sudo

AutoUpgrade Patching

Download patches   Analyze   Fixups   Create home   Patch database   Postchecks
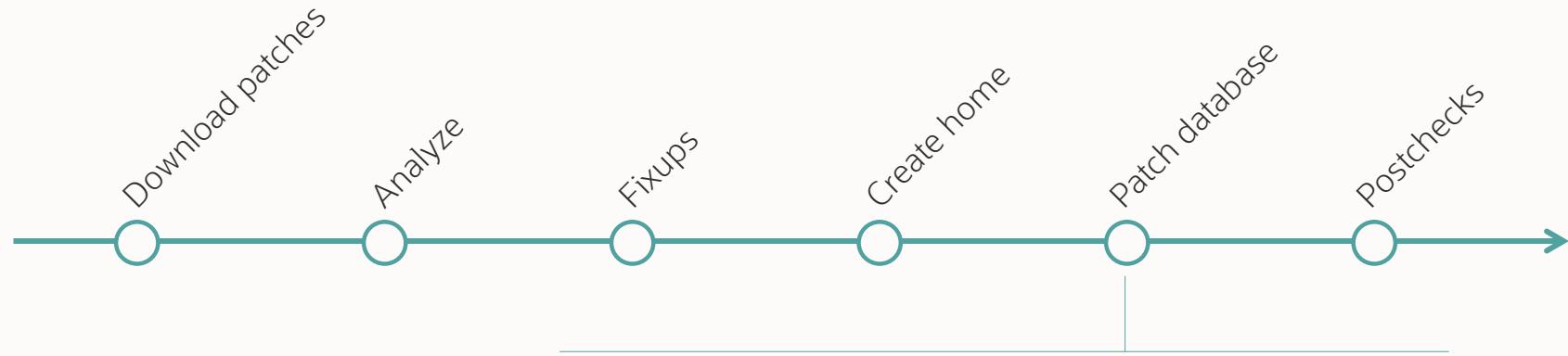
- Moves database instance to new Oracle home
- Moves configuration files
- Executes Datapatch
- Updates system directories (`utlfixdirs.sql`)
- Updates `/etc/oratab`
- Supports read-only Oracle home

AutoUpgrade Patching

Download patches — Analyze — Fixups — Create home — Patch database — Postchecks
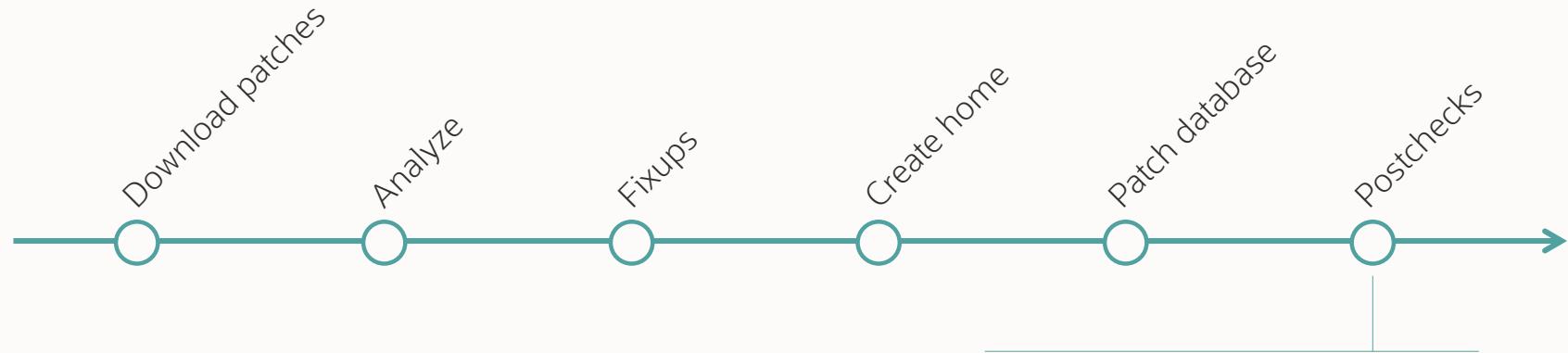
- Post-patching fixups
- Recompiles if needed
- Cleans up

Patching Modes

Download patches — Analyze — Fixups — Create home — Patch database — Postchecks

`-mode download`

`-mode analyze`

`-mode fixups`

`-mode deploy`

`-mode create_home`
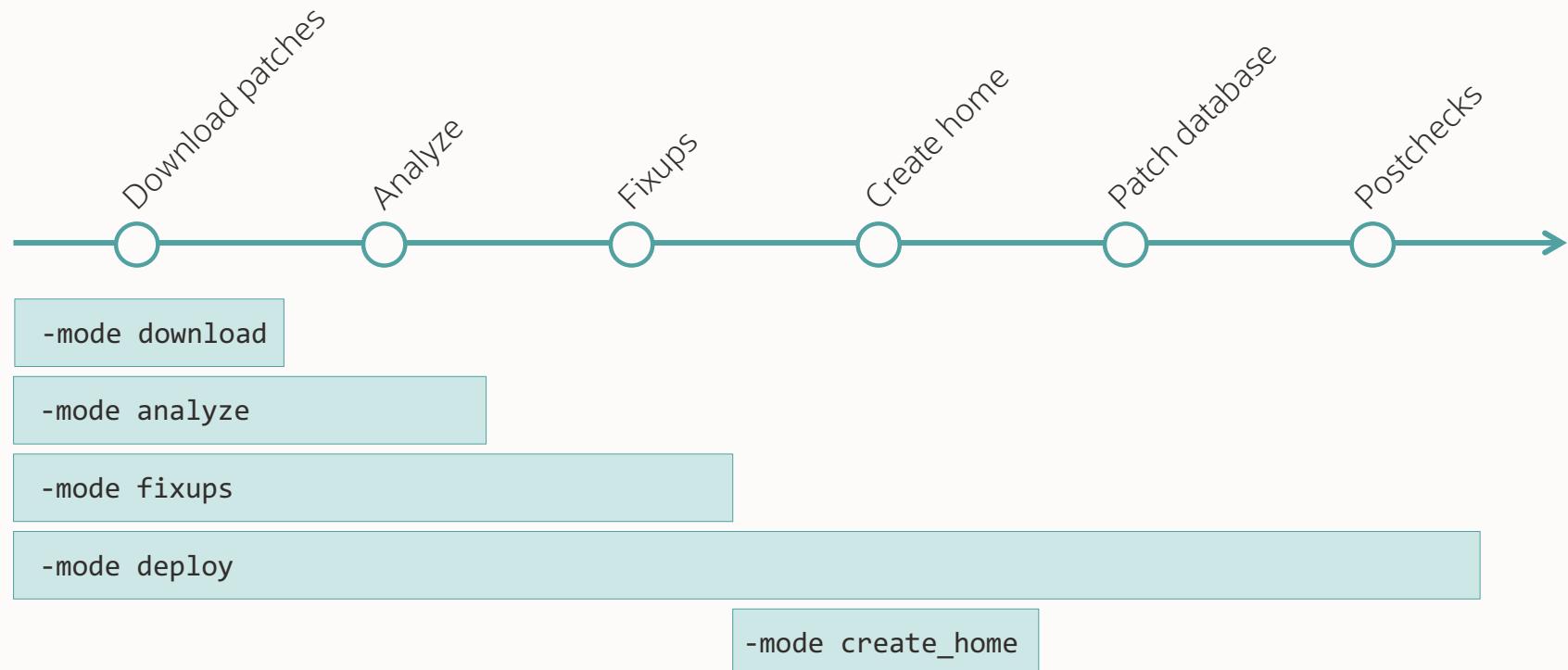
Requirements

Current Requirements

Single instance

Oracle Database 19c

Current Requirements

Single instance

Oracle Database 19c or newer

Current Requirements

All databases, including RAC and Data Guard

Oracle Database 19c or newer

Always download
the latest version of AutoUpgrade

- My Oracle Support KB123450

```
--Download the latest version of AutoUpgrade directly from oracle.com
--No authentication needed
```

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

# Patching

In-Place Patching

Oracle Home, 19.39.0

$ORACLE_HOME/OPatch/opatch rollback -id ...

Out-of-Place Patching

Oracle Home, 19.29.0

```
SQL> SHUTDOWN IMMEDIATE
```

```
[oracle]$ $ORACLE_HOME/OPatch/datapatch
```

New Oracle Home
Oracle Home, 19.30.0
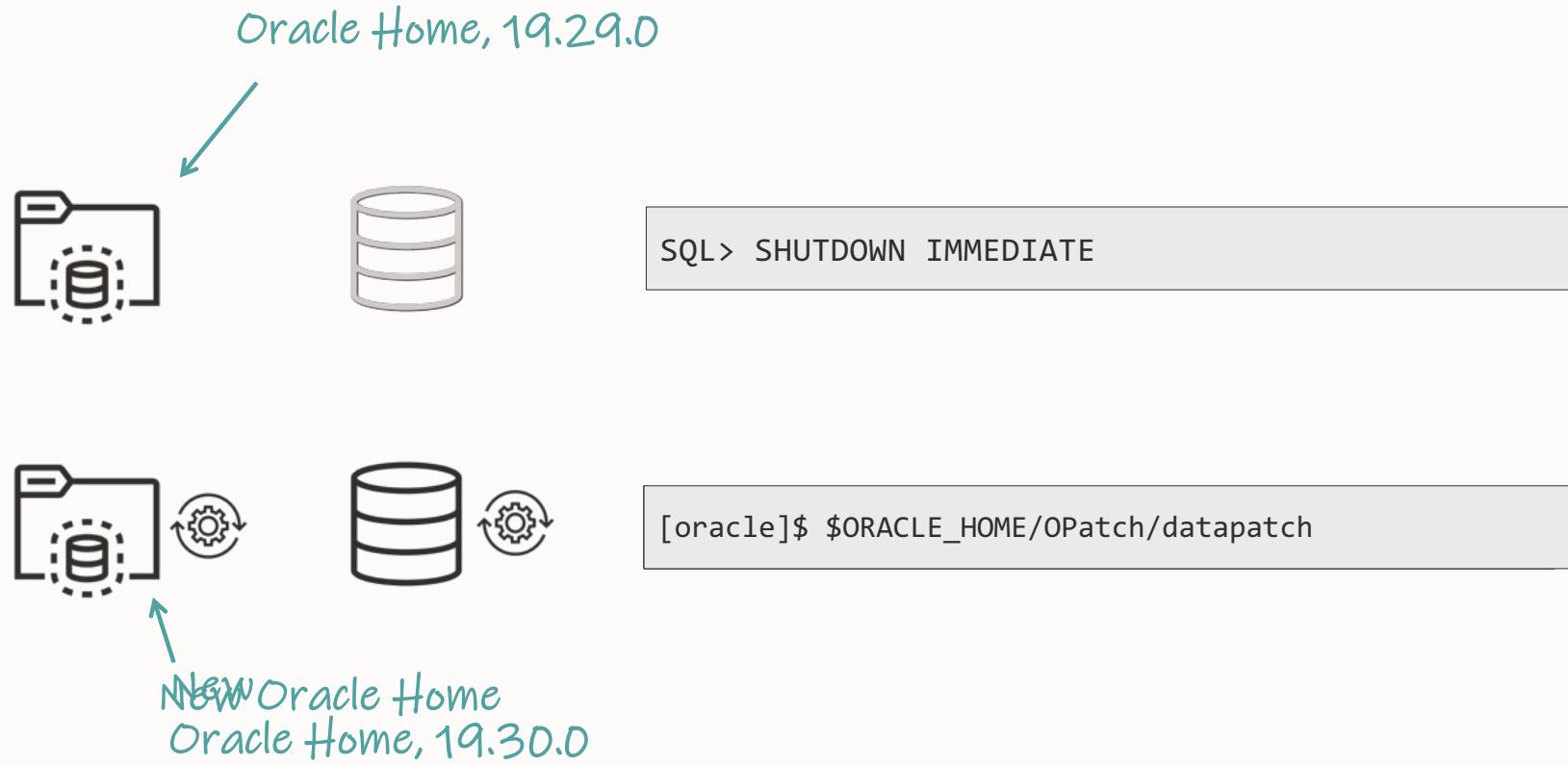
Tim Hall ∞ 👶 +∞ ⌨️
@oraclebase

When patching your production Oracle GI/DB installations, which method do you use?

In-Place = Current ORACLE_HOME
Out-Of-Place = New ORACLE_HOME

If you don't look after have production kit, then don't answer.

| In-Place | 55.4% |
| Out-Of-Place | 44.6% |

AutoUpgrade patches out-of-place

Which patches should you install?

```
global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RECOMMENDED
```

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

OJVM is embedded in Release Updates

- No separate download
- Complete RAC Rolling patching support

You can also add MRPs

- Get patch number from Primary Note for Database Quarterly Release Updates (KB106822)

Primary Note for Database Quarterly Release Updates

KB106822

Last Updated

Dec 17, 2025

Service

Dec 17, 2025

Service

Gen 2 Exadata Cloud at Gen 2 Exadata Cloud at Customer, Generation 1 - Exadata Cloud at Customer (First Generation Cloud Machine), Oracle Cloud Infrastructure - Exadata Cloud Service, Oracle Database - Enterprise Edition, Oracle Database - Standard Edition

★★☆☆☆   1.7

Authoring Instructions

This is a crossover article and must be edited only in Legacy MOS for Document ID : 888.1. Any changes made here will be lost in the next update.

Applies To

All Users

Summary

The purpose of this document is to list Database patches for both proactive and reactive maintenance.

This was MOS Document ID: 888.1 in Legacy MOS. Post migration, we will be moving to KB888 (Date TBA)

Solution

1.0 Overview

2.0 Oracle Recommendation

3.0 Latest Release Updates

- 3.1 Oracle Database Long Term Releases
  - 3.1.1 Database 19c

```
$ cat DB19.cfg

global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RECOMMENDED,38716952
```

```
$ cat DB19.cfg

global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RECOMMENDED,38716952
patch1.patch=RECOMMENDED,MRP
```

You can also add specific one-off fixes

- Oracle Database 19c and Oracle AI Database 26ai
  Important Recommended One-off Patches (KB188772)

Account ▼   Daniel Overby Hansen

Oracle Database 19c and Oracle AI Database 26ai Important Recommended One-off Patches

KB188772

Last Updated
Yesterday 11:23 PM

Service
Oracle Database - Enterprise Edition

★★☆☆☆ 1.9

Authoring Instructions

MOS Document ID : 555.1. Any changes made here will be lost in the next update.

Applies To

All Users

Summary

This document has MOS Document ID set in Legacy Mode.

Solution

NOTE: This document will be updated once a week on Tuesdays at 9AM EST if any new patch is identified.

Through our review of service requests, we often find that issues encountered are the result of customers being on an older Release Update (RU) or Monthly Recommended Patch (MRP). Many issues will have been fixed in the latest updates, which we always recommend.

As noted in the RU-specific tables below, fixes for known issues are targeted for inclusion in the next available MRP and RU. You can always find the latest RUs, MRPs, other patches, lists of fixed bugs and known issues in KB106822 Identifying and installing the latest updates (patches) helps ensure you are using the most current content for security, functional, regression and bug fixes, as well as minor enhancements and any emergency one-offs.

Note:
Oracle encourages customers to install the latest MRP whenever possible. MRPs deliver the safest, fully-tested path to receive the fixes in this document. Refer to FAQ2283 for further details.

In addition to the relevant patches listed below, you should apply patches based on the specific RU after reviewing the following My Oracle Support knowledge documents:

```
$ cat DB19.cfg

global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RECOMMENDED,37690446,34672698,34774667,29213893
```

```
$ cat DB19.cfg

global.keystore=/home/oracle/autoupgrade-patching/keystore
patch1.source_home=/u01/app/oracle/product/19/dbhome_19_29_0
patch1.target_home=/u01/app/oracle/product/19/dbhome_19_30_0
patch1.sid=DB19
patch1.folder=/home/oracle/autoupgrade-patching/patch
patch1.patch=RECOMMENDED,OCW
```

Demo

Applying recommended patches

- Specifying patches
- Patch database

Watch on YouTube
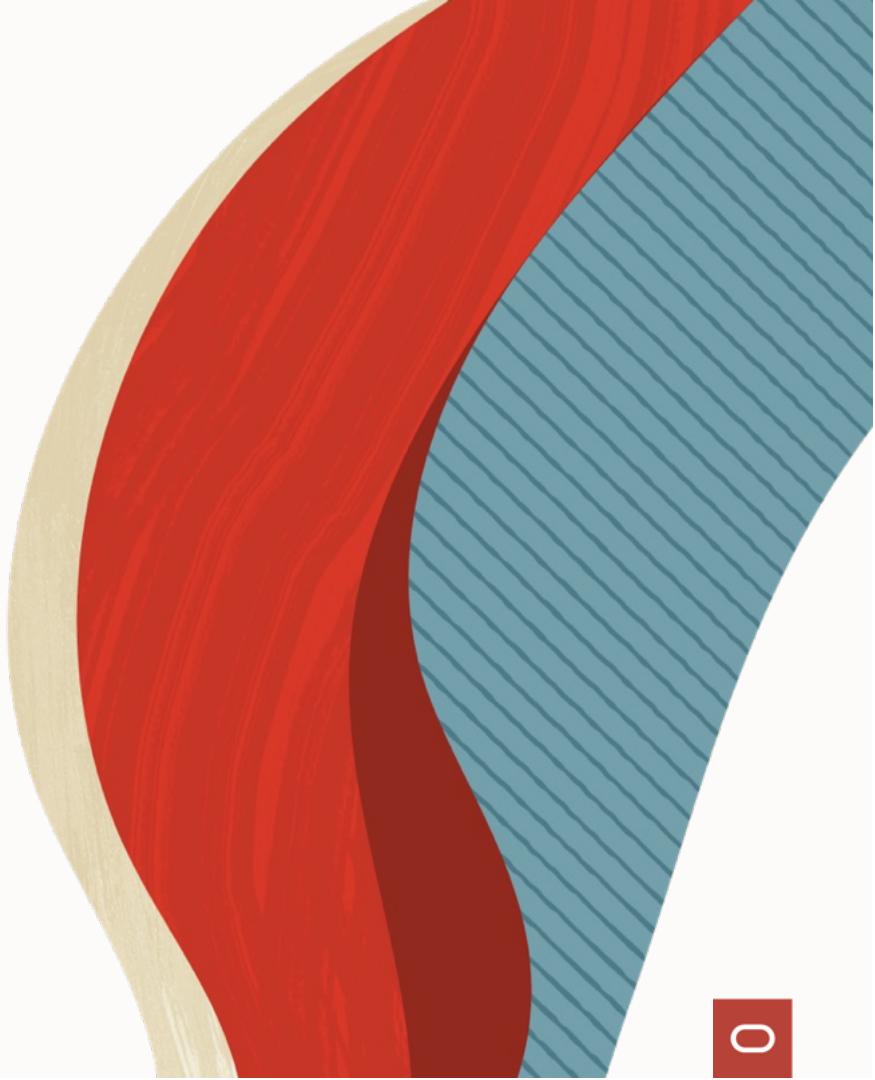
How to download patches

Network Connectivity

The download stage requires:

1. Internet access

2. My Oracle Support credentials

Internet Access

AutoUpgrade connects to:

- `https://updates.oracle.com`
- `https://login-ext.identity.oraclecloud.com`
- `https://aru-akam.oracle.com`

URLs are part of a CDN, so expect changing IP addresses
- Use DNS names instead of IP addresses in your firewall

For connections via proxy use environment variables
- `https_proxy`

MOS Credentials

You must have:

- A valid My Oracle Support credential
- Connected to a Customer Support Identifier (CSI)
- Privilege to download patches using that CSI

Failure to meet the requirements:

- `*Connection Failed - You entered an incorrect user name or password.*`

MOS Credentials

For *download patches* privilege contact an MOS administrator in your organization.

- In *User Details*
- Select the appropriate *Support Identifier*
- Set the *Patches* drop-down to *Download*

Keystore

AutoUpgrade stores MOS credentials in a keystore

- Config file parameter: `global.keystore`

- Governs directory of AutoUpgrade keystore

- Password protected software keystore

- Optionally, an auto-open keystore

- No additional license needed

```
$ java -jar autoupgrade.jar ... -patch -load_password
```

```
$ java -jar autoupgrade.jar ... -patch -load_password

...


MOS> add -user <MOS username>
Enter your secret/Password:
Re-enter your secret/Password:
```

Your database host
doesn't have internet access?

Using Download Mode

Open zone | Secure zone

No internet access

autoupgrade.jar -mode download

NFS share

autoupgrade.jar -mode deploy

Other platform?
Use target_platform

Be sure to set
download=no
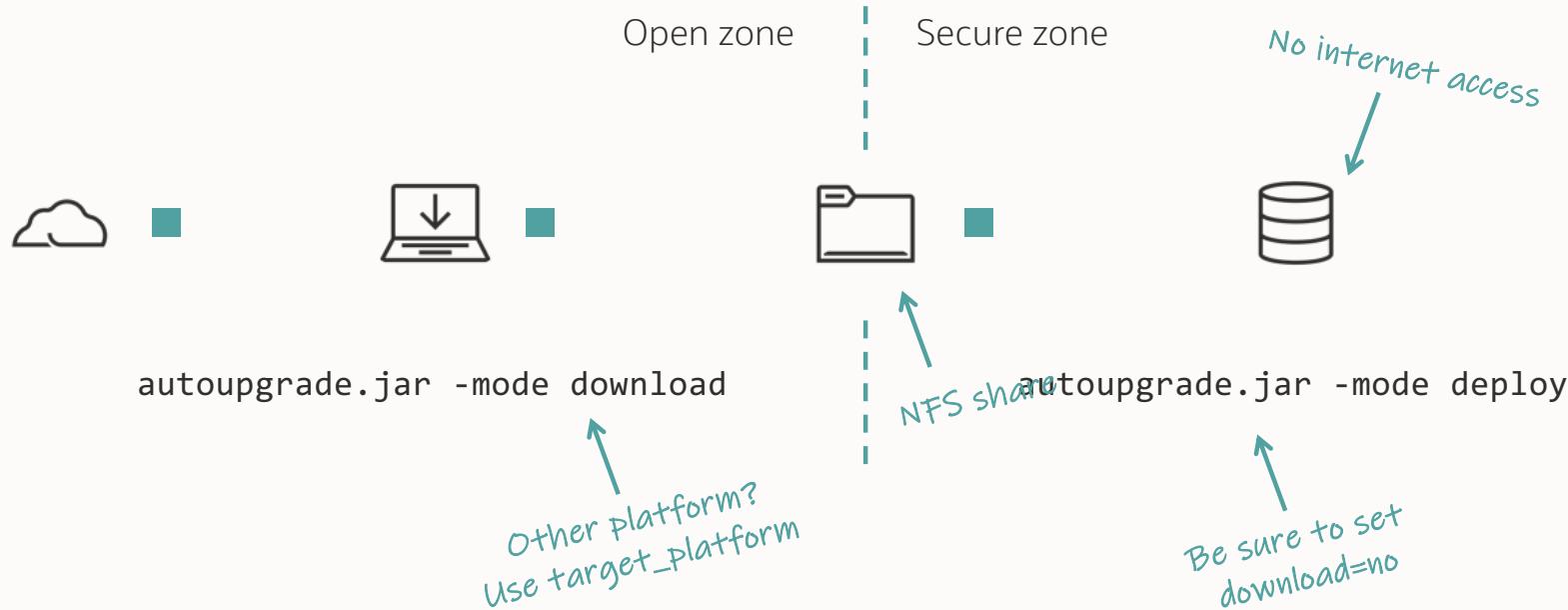
You can download patches manually
and place them in the *patch* folder

- Use a shared folder accessible to all hosts

In The Plans

We're working to support

- Cloning Oracle homes

- Gold images

One-Button Patching

Makes life easier for every Oracle DBA
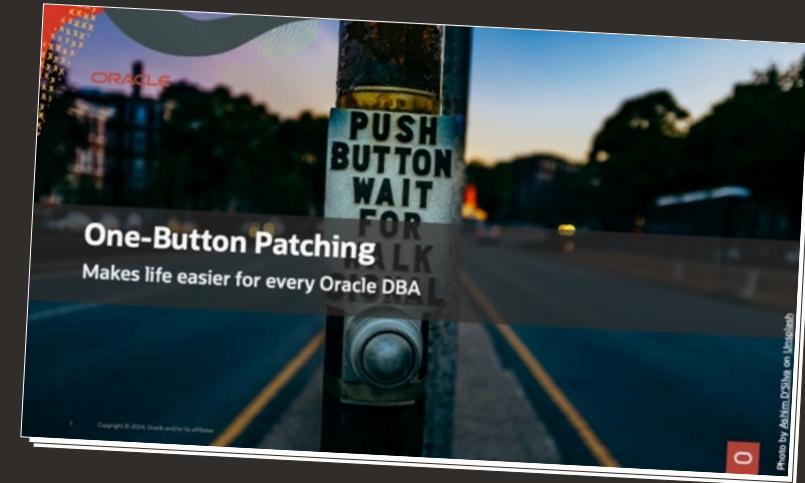
Recording on YouTube
Get the slides

Hands-on Lab

Patch Me If You Can

It's better to fail in our lab, than in production

Access lab on Oracle Live Labs

Datapatch

What is Datapatch?

$ORACLE_HOME/OPatch/datapatch

⤷ $ORACLE_HOME/sqlpatch/sqlpatch

⤷ $ORACLE_HOME/sqlpatch/sqlpatch.pl

```
use strict;
use Getopt::Long;

use sqlpatch.pm
```

Datapatch uses `OPatch` to determine patches installed in Oracle home

- From within the database via **DBMS_QOPATCH**

ORA-20001: Latest xml inventory is not loaded into table

```
--Avoid the use of Queryable Inventory by using OPatch directly
--Safe for single instance databases. In RAC, it's vital you ensure
--all nodes are patched and the inventories on each node is similar.

./datapatch -noqi

./datapatch -local_inventory
```

Patch Apply Sequence

`datapatch` $\Rightarrow$

1   Java patches

2   Release Update

3   One-off patches

Datapatch | Patch Rollback and Apply Queue

Binary Registry after opatch:

Patch 444 – Java Patch
Patch 555 – Release Update
Patch 666 – One-off Patch

Oracle Home

SQL Registry before datapatch:

Patch 111 – Java Patch
Patch 222 – Release Update
Patch 333 – One-off Patch

Database

`$ ./datapatch`

datapatch queue

Rollback:

Apply:

Rollback:

Cumulative: Patch 222 to 555 – Release Update

Apply:

Datapatch uses
`REGISTRY$SQLPATCH_RU_INFO` to
control the patching operations

Rollback Scripts

Apply/rollback scripts

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

Rollback scripts (zipped as BLOB):

One-off patches:
```
SELECT  PATCH_DIRECTORY
FROM    REGISTRY$SQLPATCH
```

Release Updates:
```
SELECT  PATCH_DIRECTORY
FROM    REGISTRY$SQLPATCH_RU_INFO
```

```
  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.
```

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

   ...          ...

  4098          953
```

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

`./datapatch -purge_old_metadata`

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 annualy*

Multitenant

CDB

| CDB$ROOT | PDB$SEED | PDB2 | PDB4 | PDB6 |
| | PDB1 | PDB3 | PDB5 | PDB7 |
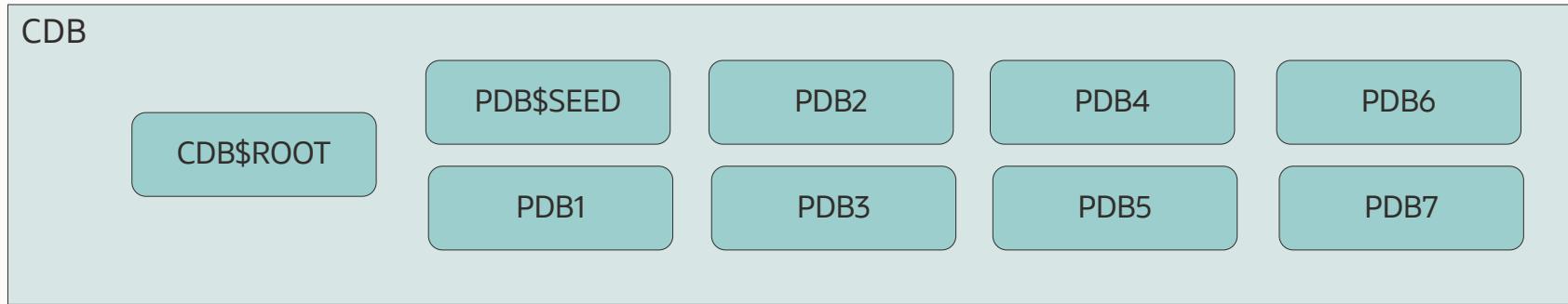
- Datapatch starts with CDB$ROOT

- Datapatch sorts PDBs by *priority* and *con_id*
  - Set priority using `ALTER PLUGGABLE DATABASE ... PRIORITY`

- Datapatch determines parallel degree based on `CPU_COUNT`

Datapatch patches *PDB$SEED* automatically

- New PDBs are ready to go
- No need to execute Datapatch on new PDBs
- Always set: `_exclude_seed_cdb_view=FALSE`

⚠️

Datapatch only patches open PDBs

- `READ WRITE`, `READ ONLY`, or `UPGRADE`

Unpatched PDBs will open in **RESTRICTED** mode

- Applies to failed or incomplete Datapatch runs
- Reported as plug-in violation

```
--Prevent PDBs from opening in restricted mode after a failed/incomplete
--Datapatch run. Quickly resolve the patching issue and re-run Datapatch.
--Use with caution.

alter system set "_pdb_datapatch_violation_restricted"=false;
```

Datapatch now kills blocking sessions

Patching Timeline

exec dbms_stats.gather_table_stats(...

Concurrency

datapatch

↳ create or replace package body
dbms_stats ...

Patching Timeline

Terminates blocking session

exec dbms_stats.gather_table_stats(...

datapatch

Detects
blocking session

Datapatch
continues

create or replace package body
dbms_stats ...
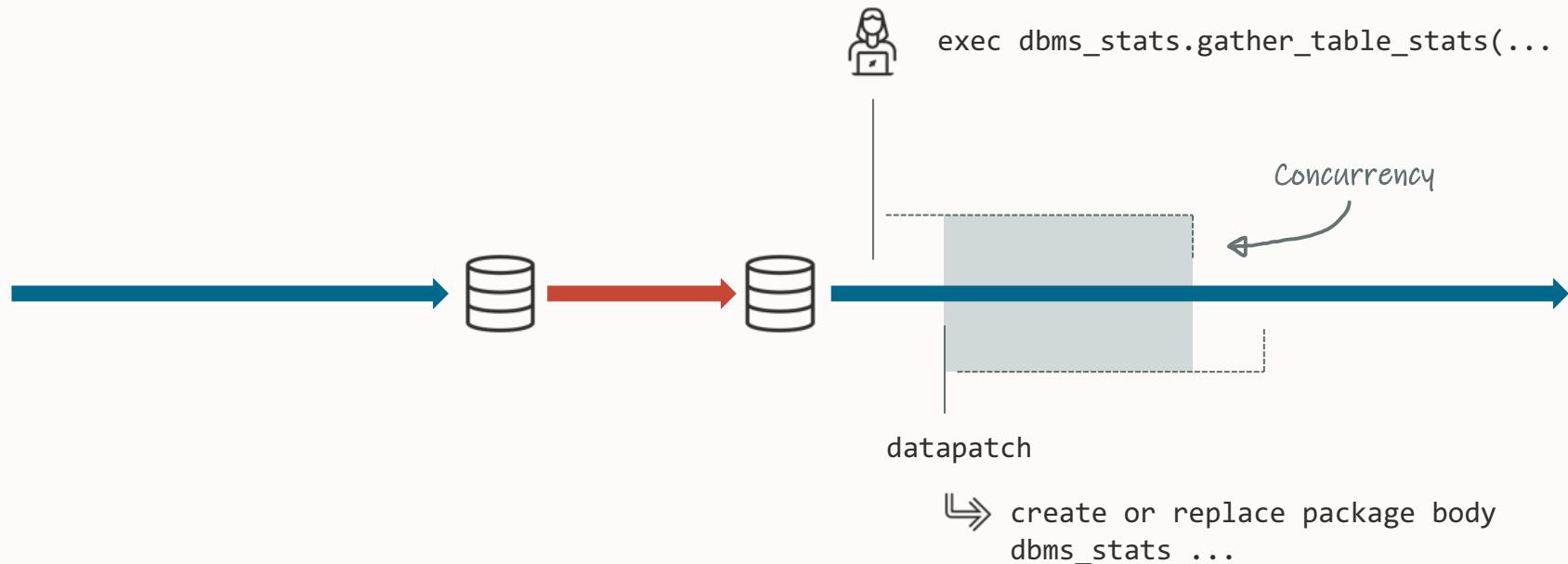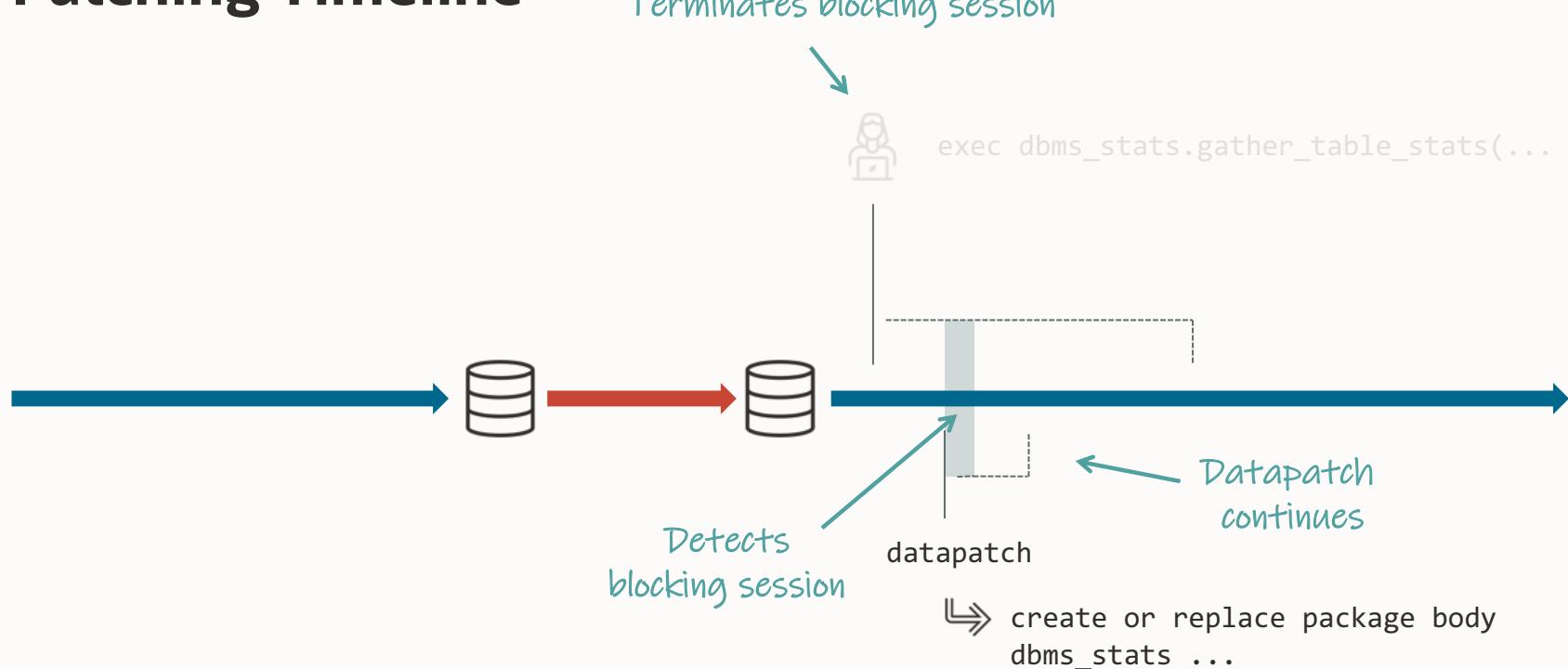
```
SQL> exec dbms_stats.gather_table_stats(..

ERROR at line 1:
ORA-03113: end-of-file on communication channel
Process ID: 94
Session ID: 424 Serial number: 30685
Help: https://docs.oracle.com/error-help/db/ora-03113/
```

```
$ cd u01/app/oracle/diag/rdbms/cdb26/CDB26/trace

$ grep -i "Kill Final Blocker" *
CDB26_ora_50498.trc: Attempting to Kill Final Blocker blkr_sid:
424 blkr_ser: 30685 session_SO: 0xa19df200 sess_ser: 30685
```

Datapatch kills first blocker within two minutes; kills subsequent blockers immediately

Default in Oracle AI Database 26ai
and Oracle Database 19c (19.30)

```
-- Disable the automatic kill switch

./datapatch -force_terminate_blocking_sessions false
```

Concurrency Without Kill Switch

- Datapatch waits 15 min to acquire a lock
  - On timeout, `ORA-04021 timeout occurred while waiting to lock object`

- Optionally, [find blocking session](#) and kill it

- Increase timeout using **-ddl_lock_timeout** *<time-in-seconds>*

Datapatch Kill Switch

- Blog post: A kill-switch terminates blocking sessions during patching

Advanced Patching

Reduce downtime to the time it takes to perform a switchover

- KB137118
  Oracle Patch Assurance - Data Guard Standby-First Patch Apply

Safely test and verify patches with Standby-First Patch Apply

- [KB137118
Oracle Patch Assurance - Data Guard Standby-First Patch Apply](#)

Standby-First Patching

Users connect here

Snapshot standby
Users connect here

Oracle Home
19.29.0

Redo Transport

Redo Transport

Oracle Home
19.30.0

Primary

Redo Transport

Standby

Implicit Flashback Database, revert...

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

Patch/datapatch

```
java -jar autoupgrade.jar \
   -config ... \
   -mode deploy
```
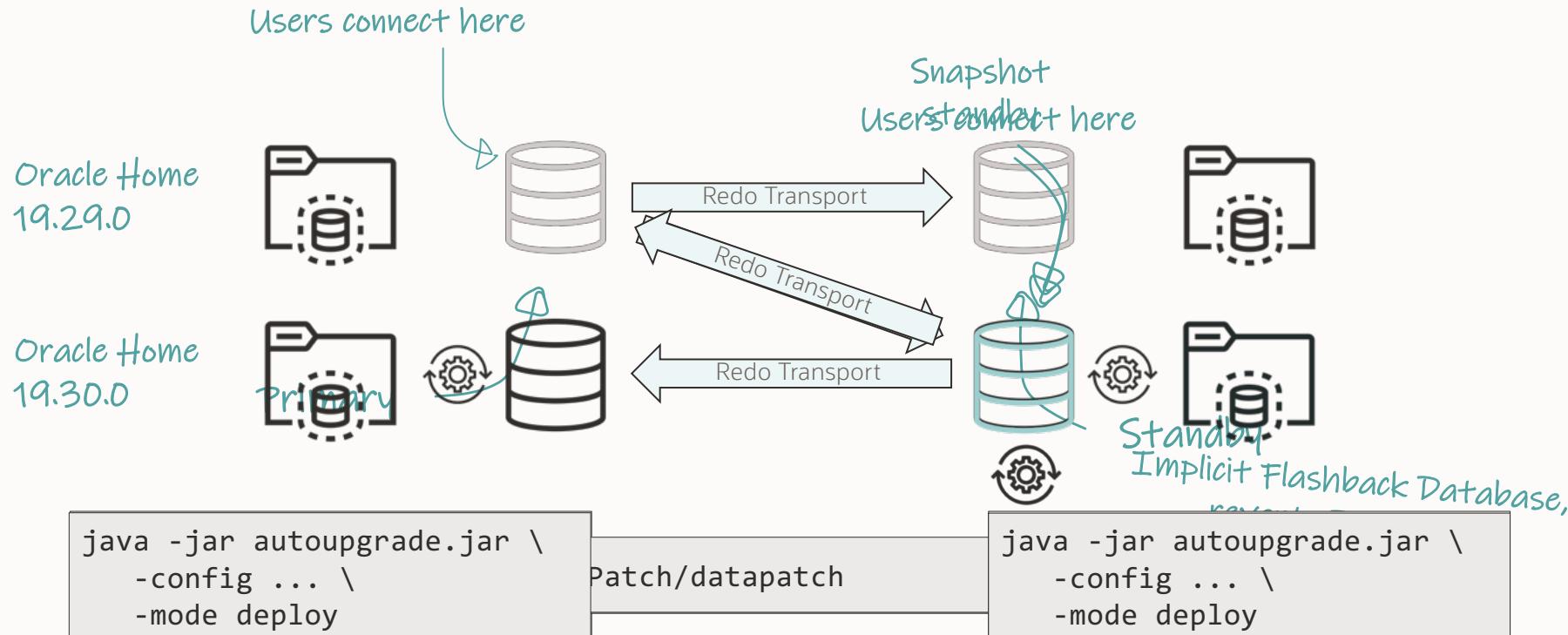
Patch must Standby-First installable

- Release Updates (RU) are always standby-first installable
- Always check the patches' readme

Execute Datapatch on the primary database

- Only execute Datapatch when all homes are on the new patch

Use AutoUpgrade to patch your standby database

- Check blog posts for details

Avoid database downtime with
RAC Rolling Patch Apply

RAC Rolling Patching

User

Connections

Instances

Oracle Homes

Nodes

Database
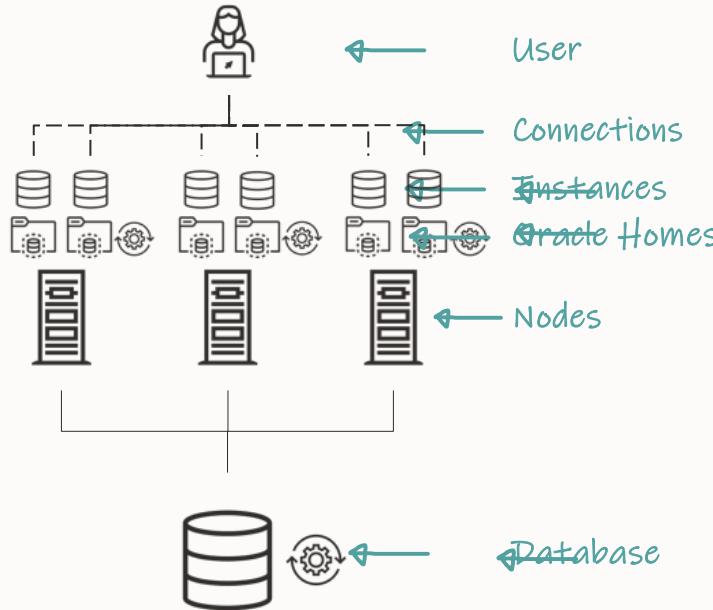
- New Oracle Home
- Patch Oracle Home
- Move to new Oracle Home
- Execute Datapatch

Keep GI and DB patch levels in sync

- This is what we test and run in our Cloud

GI and DB Patch Levels

Method	Status	Example
In sync	Recommended, best practice	GI 19.30 + DB 19.30
Within two Release Updates	Supported, good practice	GI 19.30 + DB 19.28 GI 19.28 + DB 19.30
Within three or more Release Updates	Supported, not recommended	GI 19.30 + DB 19.27 GI 19.27 + DB 19.30
Different releases	Supported, use only for upgrades	GI 26.1 + DB 19.30

Complete a rolling patching operation always as quickly as possible

- FAQ7365
  RAC: Frequently Asked Questions

Unusual combinations are supported, but we strongly advice against it

- Node 1 with GI 19.30.0, node 2 with GI 19.29.0
- Patching node 1 on Monday, node 2 on Tuesday ...
- Mix of GI and DB versions on various nodes

Release updates are **always**:

Standby-First installable

RAC Rolling installable

Key Learnings

1   Patch your Oracle Database regularly

2   Patch out-of-place

3   Use AutoUpgrade Patching

Break

We start again at 11:15

AutoUpgrade

Overview and new features

AutoUpgrade is the only supported tool to upgrade your Oracle Database

- DBUA is desupported

```
$ java -jar autoupgrade.jar -version

build.version 26.1.260109
build.date 2026/01/09 12:19:19 -0500
build.supported_target_versions 12.2,18,19,21,23
build.type production
build.MOS_NOTE 2485457.1
build.MOS_LINK https://support.oracle.com/.../?id=2485457.1
```

```
--Download the latest version of AutoUpgrade directly from oracle.com
--No authentication needed
```

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

New Features

```
--Upgrade RMAN catalog after upgrade
--https://dohdatabase.com/autoupgrade-new-features-upgrade-rman-catalog-schema


$ cat CDB1.cfg

upg1.source_home=/u01/app/oracle/product/19/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/26/dbhome_26_1
upg1.sid=CDB1
upg1.rman_catalog_connect_string=catalogdb
```

--Update OEM configuration after upgrade
--https://dohdatabase.com/autoupgrade-new-features-update-enterprise-manager-configuration

```
$ cat CDB1.cfg

upg1.source_home=/u01/app/oracle/product/19/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/26/dbhome_26_1
upg1.sid=CDB1
upg1.upg1.emcli_path=/u01/app/oracle/oem
upg1.em_target_name=ORCL_myhost.domain.int
```

Upgrading and patching on Windows

```
$ cat patch_on_win.cfg

global.keystore=c:\oracle\autoupgrade\keystore
patch1.source_home=c:\oracle\product\dbhome_19_29_0
patch1.target_home=c:\oracle\product\dbhome_19_30_0
patch1.sid=DB19
patch1.folder=c:\oracle\patches
patch1.patch=RECOMMENDED
patch1.wincredential=c:\oracle\autoupgrade\credential
```

```
C:\> java -jar autoupgrade.jar
      -config patch_on_win.cfg
      –patch
      -loadwincredential "DB19"
```

```
C:\> java -jar autoupgrade.jar
    -config patch_on_win.cfg
    –patch
    -loadwincredential "patch1"



C:\> java -jar autoupgrade.jar
    -config patch_on_win.cfg
    –patch
    -mode deploy
```

Windows

```
--AutoUpgrade deletes the credential file after use for security reasons
--For automation it is desirable to keep the credential file
```

patch1.delete_credential_file=false

AutoUpgrade fully supports upgrading Oracle RAC Database on Windows

Refreshable Clone PDBs

Non-CDB to PDB conversion is irreversible

What are your rollback options?

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

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

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

Refreshable Clone PDB

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

Server 1

Server 2

Source
non-CDB

Target
CDB

Refreshable Clone PDB

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

Server 1

Could be same
server as well

Refreshable Clone

At your will,
Source time starts
down and preserved
for rollback

Final refresh
and disconnect

Server 1

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

Source database
is still online

Database link

Open PDB and run
noncdb_to_pdb.sql

Repeat every
30 minutes

Server 2

Copy data files
over database link

```
CREATE PLUGGABLE DATABASE ... @CLONEPDB
... REFRESH MODE EVERY 30 MINUTES
```

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';
```

Refreshable Clone

Source non-CDB	Target CDB


```
upg1.source_home=/u01/app/oracle/product/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/dbhome_26_1
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=23
upg1.source_dblink.NONCDB1=CLONEPDB
upg1.target_pdb_name.NONCDB1=PDB1
```

You can drop user and database link after migration

- Config file parameter `drop_dblink`

Refreshable Clone PDB

Source non-CDB	Target CDB


```
upg1.source_home=/u01/app/oracle/product/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/dbhome_26_1
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=23
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
```

Refreshable Clone PDB

Source non-CDB	Target CDB


```
upg1.source_home=/u01/app/oracle/product/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/dbhome_26_1
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=23
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
```

i

Rename your PDB to avoid name collision

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

Refreshable Clone

Source non-CDB	Target CDB


```
upg1.source_home=/u01/app/oracle/product/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/dbhome_26_1
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=23
upg1.source_dblink.NONCDB1=CLONEPDB 300
upg1.target_pdb_name.NONCDB1=PDB1
upg1.start_time=19/01/2038 03:14:07
```

Refreshable Clone PDB

Source non-CDB	Target CDB


```
upg1.source_home=/u01/app/oracle/product/dbhome_19_30
upg1.target_home=/u01/app/oracle/product/dbhome_26_1
upg1.sid=NONCDB1
upg1.target_cdb=CDB1
upg1.target_version=23
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
```

Refreshable Clone

1

Run on source

```
autoupgrade.jar ... –mode analyze

autoupgrade.jar ... –mode fixups
```

2

Run on target

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

Refreshable Clone PDB

1.	2.	3.	4.	5.
PDB is created	Data files are copied	Redo is applied	Final refresh	Disconnect and convert

`autoupgrade.jar ... –mode deploy`

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

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

```
--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
```

```
--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 07/02/2026 02:30:00
```

Works for unplug-plug upgrades as well

The source non-CDB stays intact
to allow rollback

Techniker Krankenkasse

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

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

Customer Case | Techniker Krankenkasse

Move to Oracle Database 23ai with ExaScale

- No ASM, no Oracle Database 19c anymore

150 PDBs

Refreshable Clone PDB

Exascale 23ai

Oracle 19.28

Oracle 23.9

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

Customer Case | Techniker Krankenkasse

150 PDBs

Database Link

Exascale 23ai

Oracle 19.28

Oracle 23.9

Standby

Customer Case | Techniker Krankenkasse

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks

AutoUpgrade:

```
global.autoupg_log_dir=/home/oracle/autoupgrade_logs
upg1.source_home=/u01/app/oracle/product/19.0.0.0/dbhome_1
upg1.target_home=/u01/app/oracle/product/23.0.0.0/dbhome_1
upg1.sid=CDB19
upg1.pdbs=PDBSOURCE
upg1.target_cdb=CDB23
upg1.target_pdb_name.PDBSOURCE=PDB23
upg1.source_dblink.PDBSOURCE=COPYPDB_PDB23_PREPARE 60
upg1.timezone_upg=NO
upg1.close_source=NO
upg1.keep_source_pdb=yes
upg1.target_pdb_copy_option.PDBSOURCE=file_name_convert=NONE
```

Refreshable Clone PDB

150 PDBs

Oracle 19.28

10 PDBs in parallel

Exascale 23ai

Oracle 23.9

Standby

Customer Case | Techniker Krankenkasse

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks

Oracle 19.28

Exascale 23ai

Oracle 23.9

Standby

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

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

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

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](#)

Refreshable clone works only with deferred recovery on standby database

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

Multitenant

Create Container Database

1 Character set

2 Components

3 `COMPATIBLE`

Create Container Database

1 Character set
- Always choose AL32UTF8
- Allows PDBs with any character set

2 Components
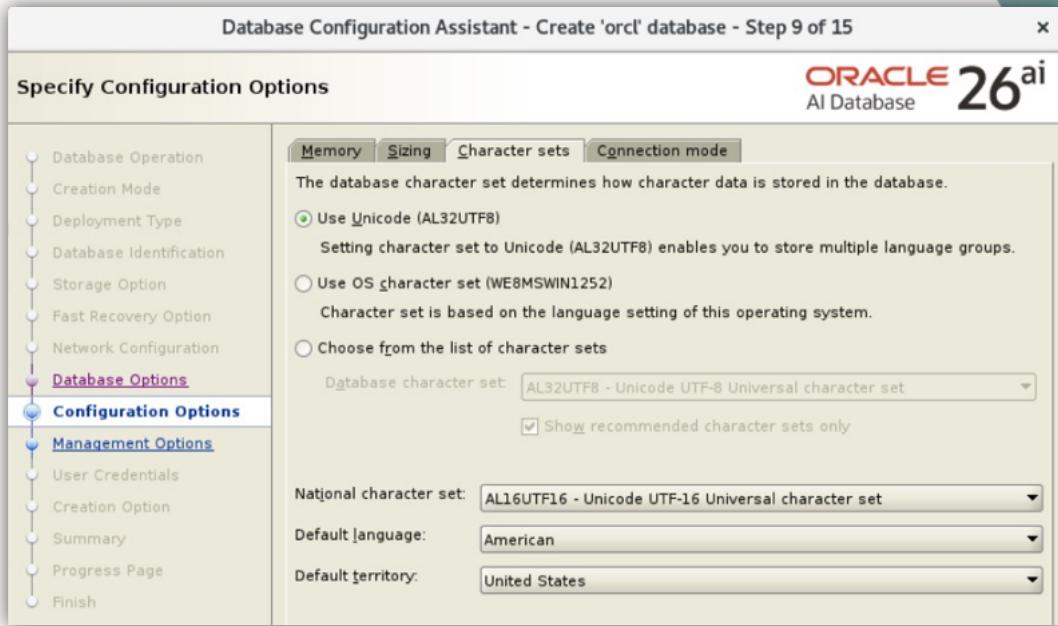
3 COMPATIBLE

Create Container Database

1 Character set

2 Components

- Install as many as you need
- No more than that

3 COMPATIBLE

Database Configuration Assistant - Create 'orcl' database - Step 8 of 15 ✕

Select Database Options

ORACLE **26**^ai
AI Database

Database components

- Database Operation
- Creation Mode
- Deployment Type
- Database Identification
- Storage Option
- Fast Recovery Option
- Network Configuration
- **Database Options**
- Configuration Options
- Management Options
- User Credentials
- Creation Option
- Summary
- Progress Page
- Finish

Select the standard database components you want to configure for use in your database. Oracle recommends that you always install these components in your database. Deselecting these components may cause you to no longer be able to choose some components on the subsequent page.

Select Component	Tablespace	Include in PDBs
☐ Oracle JVM	SYSTEM ▼	☐
☐ Oracle Text	SYSAUX ▼	☐
☐ Oracle OLAP	SYSAUX ▼	☐
☐ Oracle Spatial	SYSAUX ▼	☐
☐ Oracle Label Security	SYSTEM ▼	☐
☐ Oracle Database Vault	SYSAUX ▼	☐

Create Container Database

1 Character set

2 Components

3 `COMPATIBLE`

- Keep at `23.6.0` to benefit from AI Vector Search features
- Unless you want the option of downgrade

Compatible

COMPATIBLE=23.5.0　　　　COMPATIBLE=23.6.0　　　　COMPATIBLE=23.26.0

Not possible,
CDB compatible lower

Clone/move OK,
but compatible changes

```
-- You can now update the COMPATIBLE parameter without a restart
-- Works within a release, e.g., from 23.6.0 to 23.26.0
-- Cross-release changes, e.g., 19.0.0 to 23.6.0, still requires a restart

alter database set downgrade compatibility to '23.26.0';
```

Further Information

Container Database

YouTube:
[Create CDB in Oracle AI Database](#)

Blog post:
[How I Think You Should Create Your Container Databases](#)

[COMPATIBLE Parameter - Documentation](#)

Blog post:
[Online COMPATIBLE raise starting with 23.9](#)

```
SQL> select con$name, comp_id, status from cdb_registry;

CON$NAME  COMP_ID    STATUS
--------  ---------  -----------
CDB$ROOT  CATALOG    VALID
CDB$ROOT  CATPROC    VALID
CDB$ROOT  XDB        VALID
RED       CATALOG    VALID
RED       CATPROC    VALID
RED       XDB        VALID
```

No information on
PDB$SEED

```
alter system set "_exclude_seed_cdb_view"=false;
```

```
alter system set "_exclude_seed_cdb_view"=false;

SQL> select con$name, comp_id, status from cdb_registry;

CON$NAME  COMP_ID    STATUS
--------  --------   -----------
CDB$ROOT  CATALOG    VALID
CDB$ROOT  CATPROC    VALID
CDB$ROOT  XDB        VALID
PDB$SEED  CATALOG    VALID
PDB$SEED  CATPROC    VALID
PDB$SEED  XDB        VALID
RED       CATALOG    VALID
RED       CATPROC    VALID
RED       XDB        VALID
```

How does a standby database handles a plug-in operation

- Take care of your Data Guard during migration

Data Guard

*Plug-in on primary propagates
to standby database via redo*

1 Enabled recovery

2 Deferred recovery

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

Enabled Recovery

Source
non-CDB

Standby

Server 1

Server 2

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

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

Target CDB

Plug-in and
re-use data files

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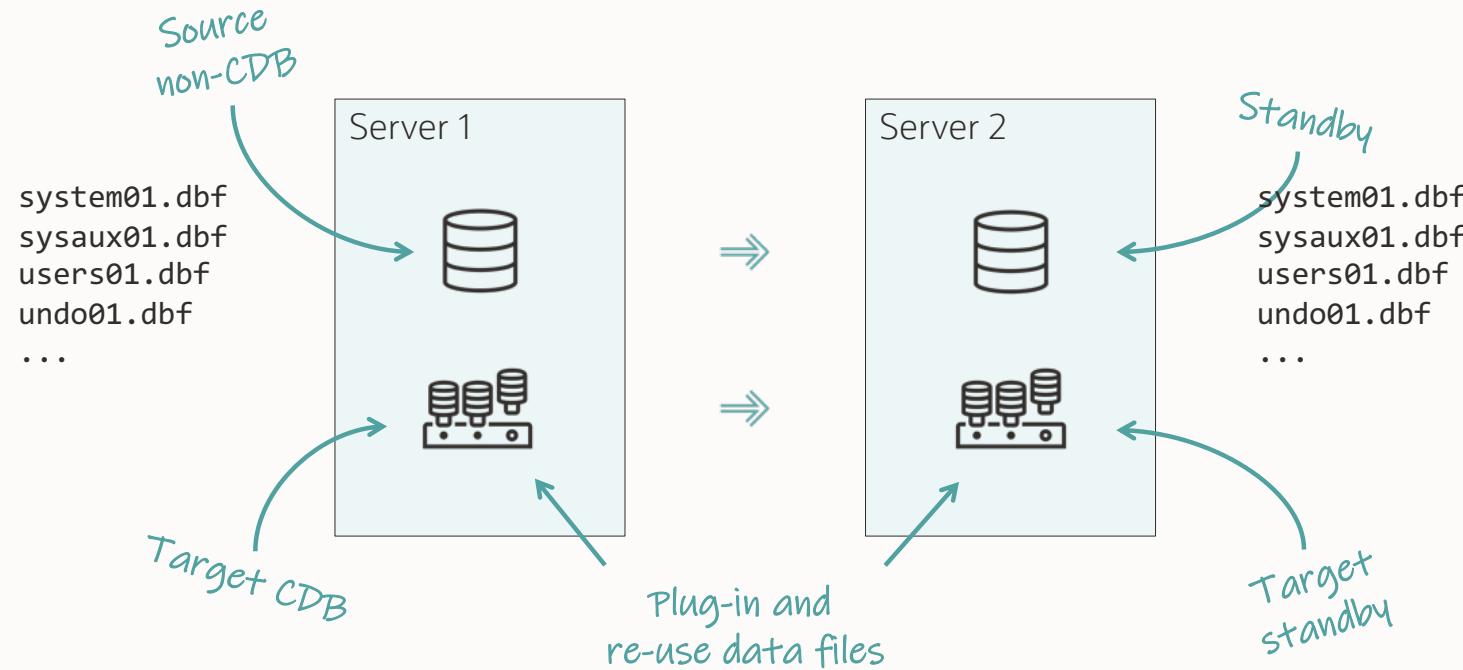
All data files on primary and standby must be at the same SCN

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

```xml
<?xml version="1.0" encoding="UTF-8"?>
<PDB>
  <xmlversion>1</xmlversion>
  <pdbname>DB12</pdbname>
  <cid>0</cid>
  <byteorder>1</byteorder>
  <vsn>203424000</vsn>
  <vsns>
    <vsnnum>12.2.0.1.0</vsnnum>
    <cdbcompt>12.2.0.0.0</cdbcompt>
    <pdbcompt>12.2.0.0.0</pdbcompt>
    <vsnlibnum>0.0.0.0.24</vsnlibnum>
    <vsnsql>24</vsnsql>
    <vsnbsv>8.0.0.0.0</vsnbsv>
  </vsns>
  <dbid>1852833295</dbid>
  <ncdb2pdb>1</ncdb2pdb>
  <cdbid>1852833295</cdbid>
  <guid>86D5DC2587337002E0532AB2A8C0A57C</guid>
  <uscnbas>4437941</uscnbas>
  <uscnwrp>0</uscnwrp>
  <undoscn>8</undoscn>
  <rdba>4194824</rdba>
  <tablespace>
    <name>SYSTEM</name>
    <type>0</type>
    <tsn>0</tsn>
    <status>1</status>
    <issft>0</issft>
    <isnft>0</isnft>
    <encts>0</encts>
    <flags>0</flags>
    <bmunitsize>8</bmunitsize>
    <file>
      <path>/u02/oradata/DB12/system01.dbf</path>
      <afn>1</afn>
      <rfn>1</rfn>
```

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?

Enabled Recovery

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

1 Regular files

2 OMF in regular file system

3 ASM

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`

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

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

Enabled Recovery | ASM

Primary

```
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
```

Standby

```
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
```
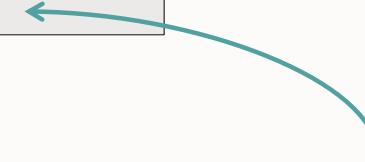
Same file,
but different name

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
<?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>
```

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
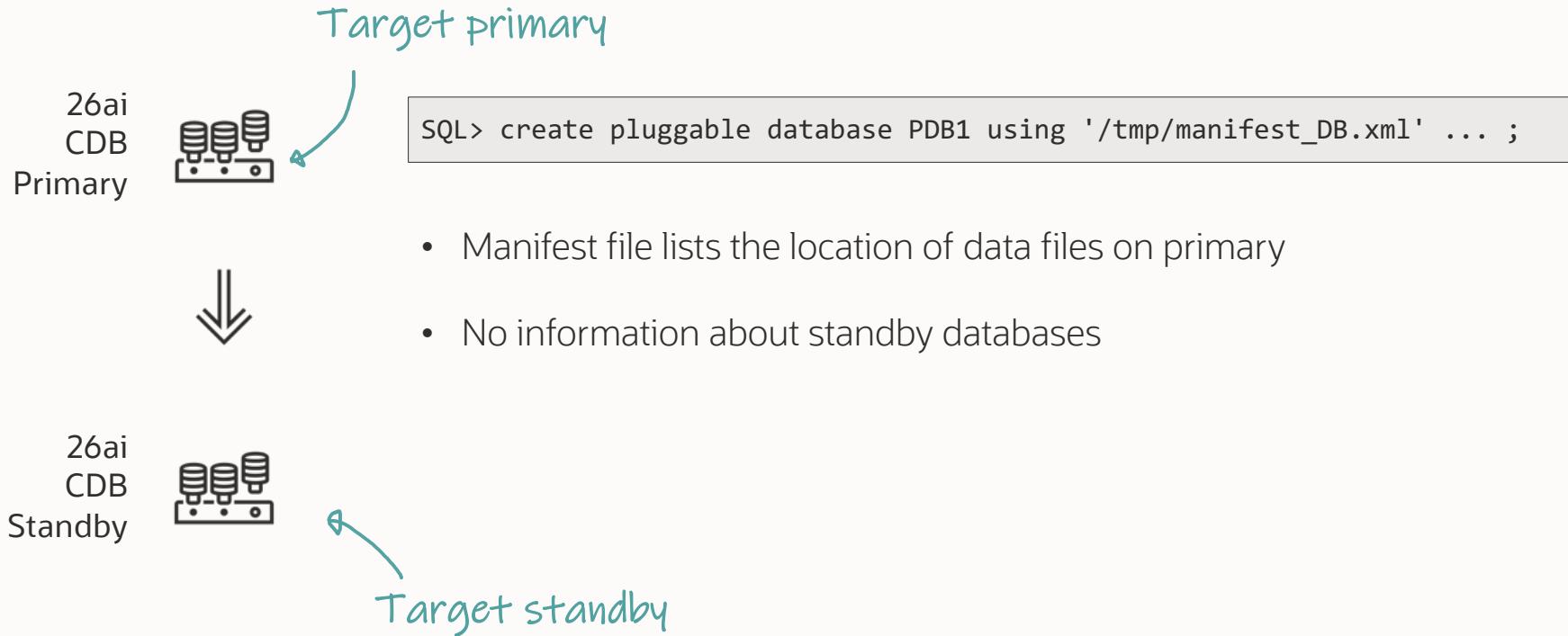
Enabled Recovery | ASM

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

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

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

I'll just move the file in ASM

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

- Similar to file system soft links

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

Non-CDB standby data file

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

```
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

```
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

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

Data Guard | Re-use Data Files

Looking for file like on primary

Primary

Standby

```
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

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

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**

? What about AutoUpgrade
and enabled recovery?

Enabled Recovery | AutoUpgrade

AutoUpgrade does not support plugging in with enabled recovery

- Enabled recovery requires work on both primary and standby hosts

- You must execute commands at specific times

- It's complicated - but we're working on it

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

Deferred Recovery

Source non-CDB

Server 1

Server 2

Standby

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

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

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

Target CDB

Plug-in and re-use data files

Restore data files

Target standby

Deferred Recovery

Target
Primary

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

Source
Non-CDB

Target
Standby
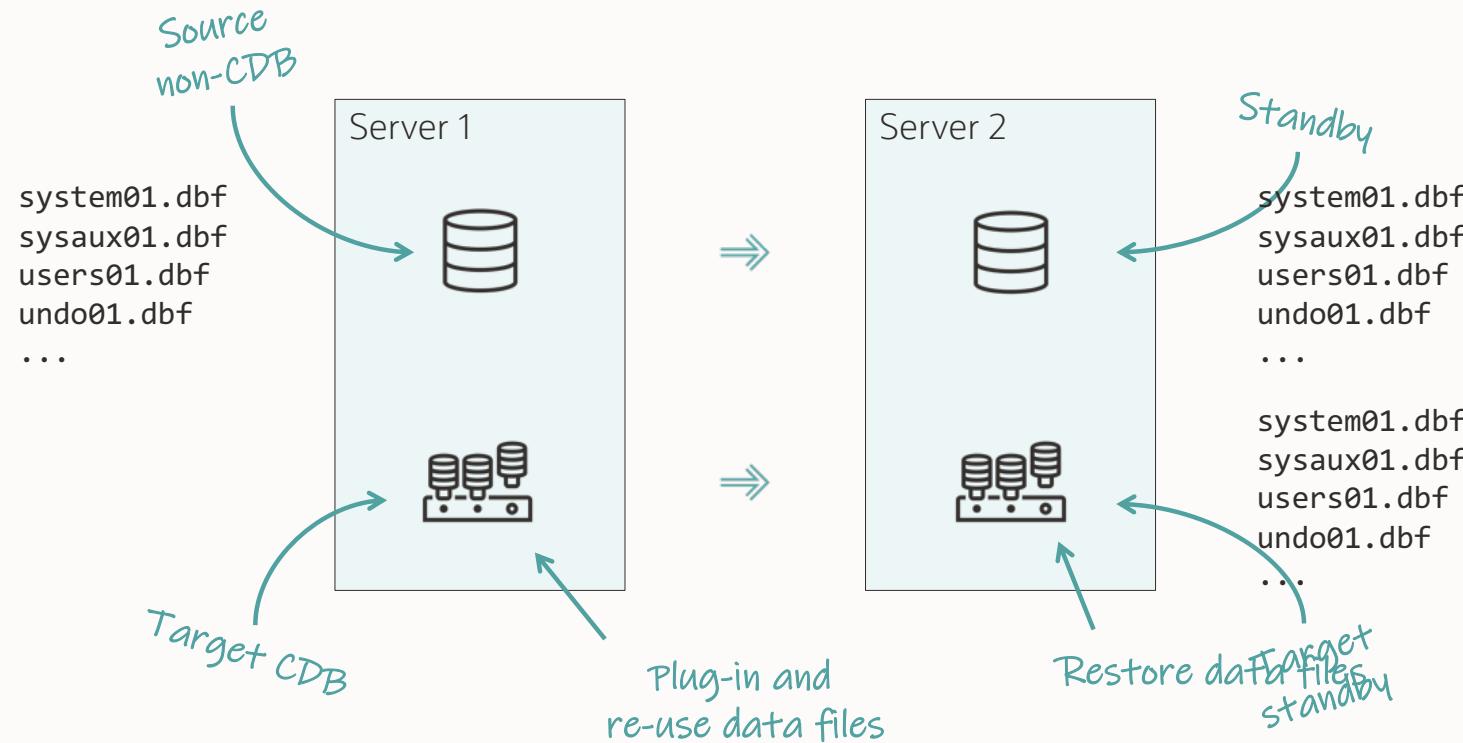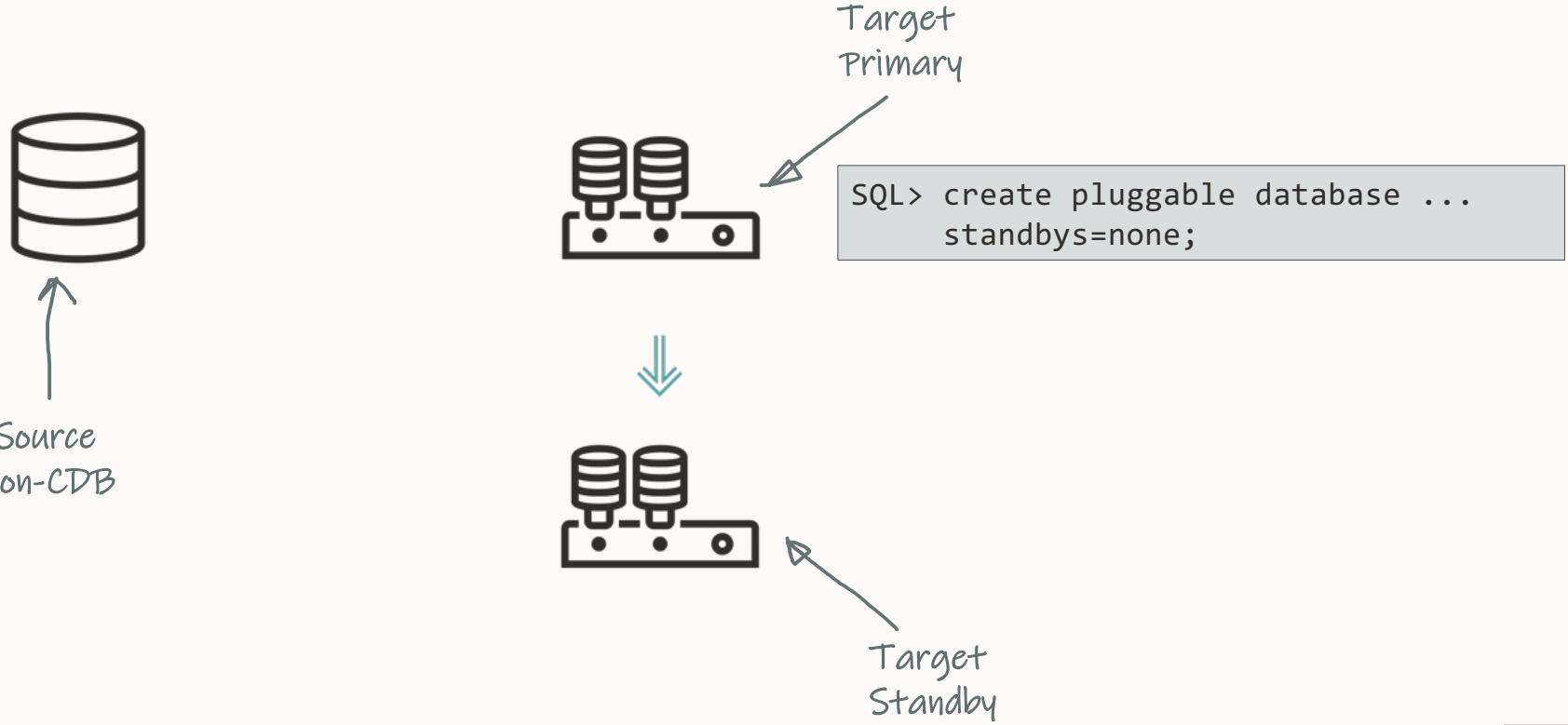
Deferred Recovery

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

PDB created
Data files missing

Deferred Recovery


```
SQL> show pdbs

CON_NAME      OPEN MODE
PDB1          READ WRITE
```



```
SQL> show pdbs

CON_NAME      OPEN MODE
PDB1          MOUNTED
```

Deferred Recovery
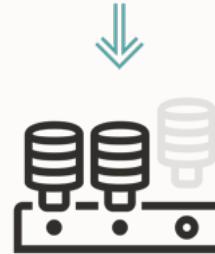

```
SQL> select name, recovery_status
     from v$pdbs;


NAME     RECOVERY_STATUS
PDB1     DISABLED
```

Deferred Recovery
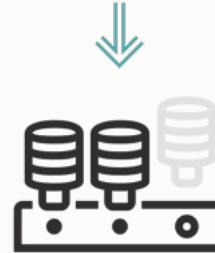

```
RMAN> restore pluggable database
        ... from service ... ;

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

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

Further Details

Webinar:

Move to Oracle Database 23ai –
Everything you need to know about Oracle Multitenant – Part 1

Don't jeopardize your Data Guard

- Test the procedure and verify your environment

Operations

Share resources between PDBs

Resource Consolidation

Non-CDB database

Memory

Background processes

Files

Resource Consolidation
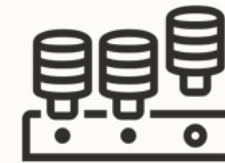
Resource Consolidation
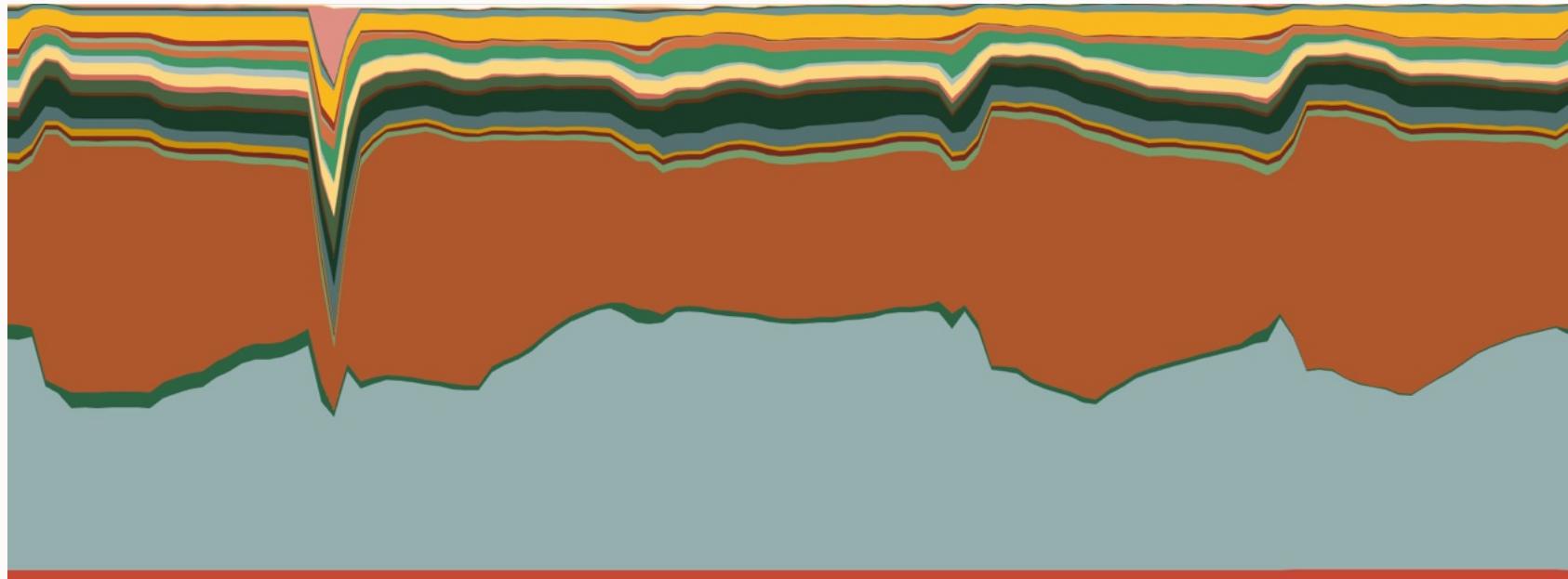
Consolidation Strategies?

There is no "*best*" strategy

- Don't mix PDBs with different SLAs
- Total memory consumption minus 20%-30%
- Increase consolidation factor slowly
- Constrain PDBs with instance caging (CPU_COUNT)
- Be open to start with a completely new naming schema
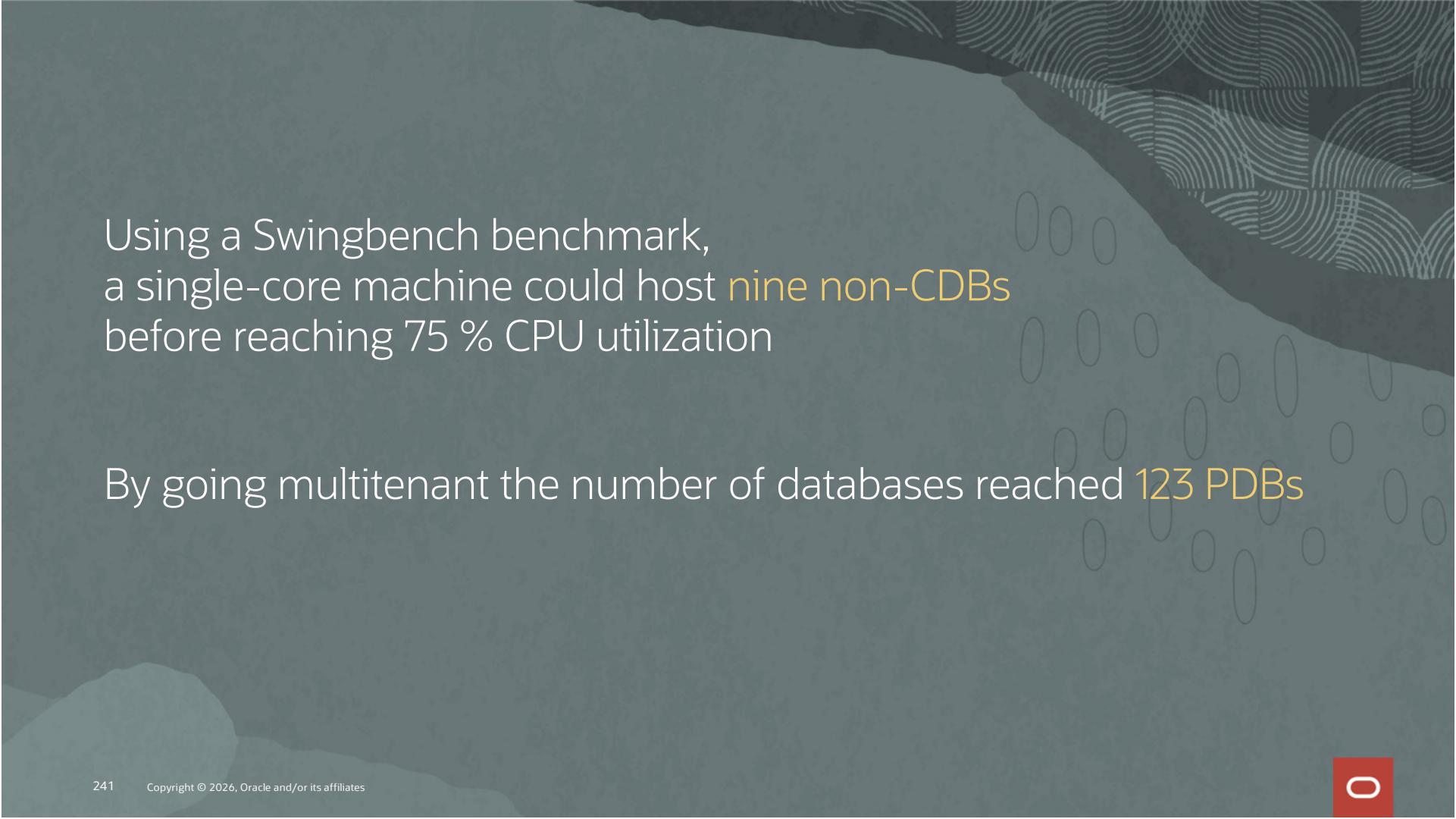
Using a Swingbench benchmark,
a single-core machine could host nine non-CDBs
before reaching 75 % CPU utilization

By going multitenant the number of databases reached 123 PDBs

A US Health Care provider managed to

- Reduce the number of database instances by 7x

- Reduce the number of physical servers by 50 %

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

Consolidation

Schema consolidation

$\Rightarrow$
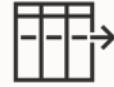
PDB consolidation

Virtual Private Database

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

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.

Avoid *noisy neighbors*

- Allow sharing resources
  but everyone must get a fair share

Method 1

Instance caging

- Most simple

- Define `CPU_COUNT` for each PDB

- Hard limit

Method 1

8 CPUs

CPU_COUNT=3

CPU_COUNT=2

CPU_COUNT=2
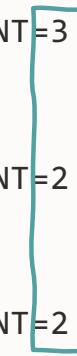
All non-CDBs share 7 CPU

Method 1

8 CPUs

CPU_COUNT=7 ← CDB never uses more than 7 CPUs, despite sum of PDBs
At peak, use more resources, but never deplete the CDB

CPU_COUNT=4

CPU_COUNT=4   PDBs might fight over CPUs, but each process gets a fair share

CPU_COUNT=4
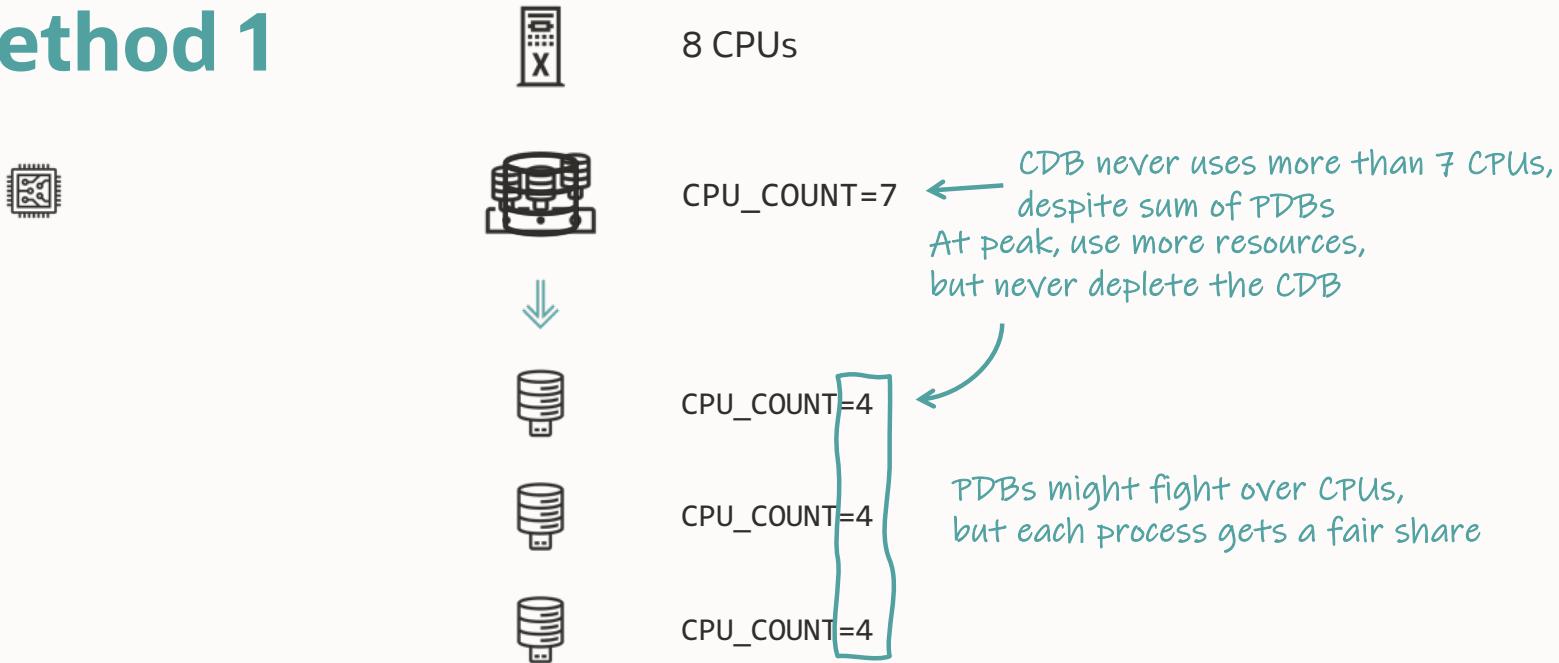
Method 2

Memory allocation

- Simple

- Define `SGA_TARGET` for each PDB

- Hard limit

Method 2

8 GB memory

SGA_TARGET=7G

⇓

SGA_TARGET=4G

SGA_TARGET=4G

SGA_TARGET=4G

PDB may never use more than 4G of shared memory

If all PDBs are active,
cache management comes into play
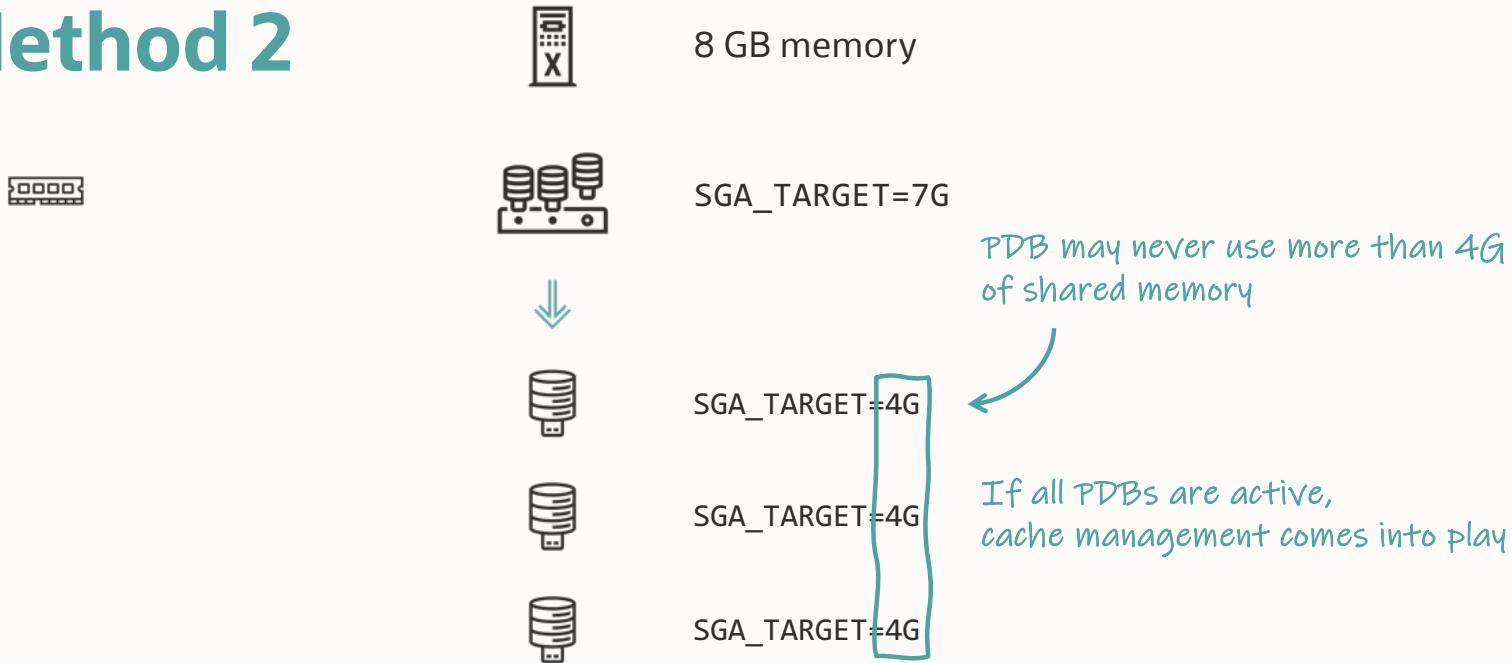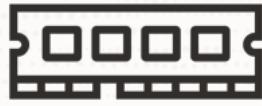
Requires use of
Automatic Shared Memory Management

- Both in CDB and PDB

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

- Use **SHARED_POOL_SIZE** and **DB_CACHE_SIZE**

You can combine method 1 and 2

- Instance caging and memory allocation

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

Method 3

8 CPUs

CPU_COUNT=7

⇓

CPU_MIN_COUNT=2   At peak, may use up to 5 CPUs

CPU_MIN_COUNT=1   4 CPUs are reserved,
3 are free for all

CPU_MIN_COUNT=1

Method 3

8 GB memory

SGA_TARGET=7G

SGA_MIN_SIZE=2G

SGA_MIN_SIZE=1G

At peak, may use
up to 4G shared memory

SGA_MIN_SIZE=1G
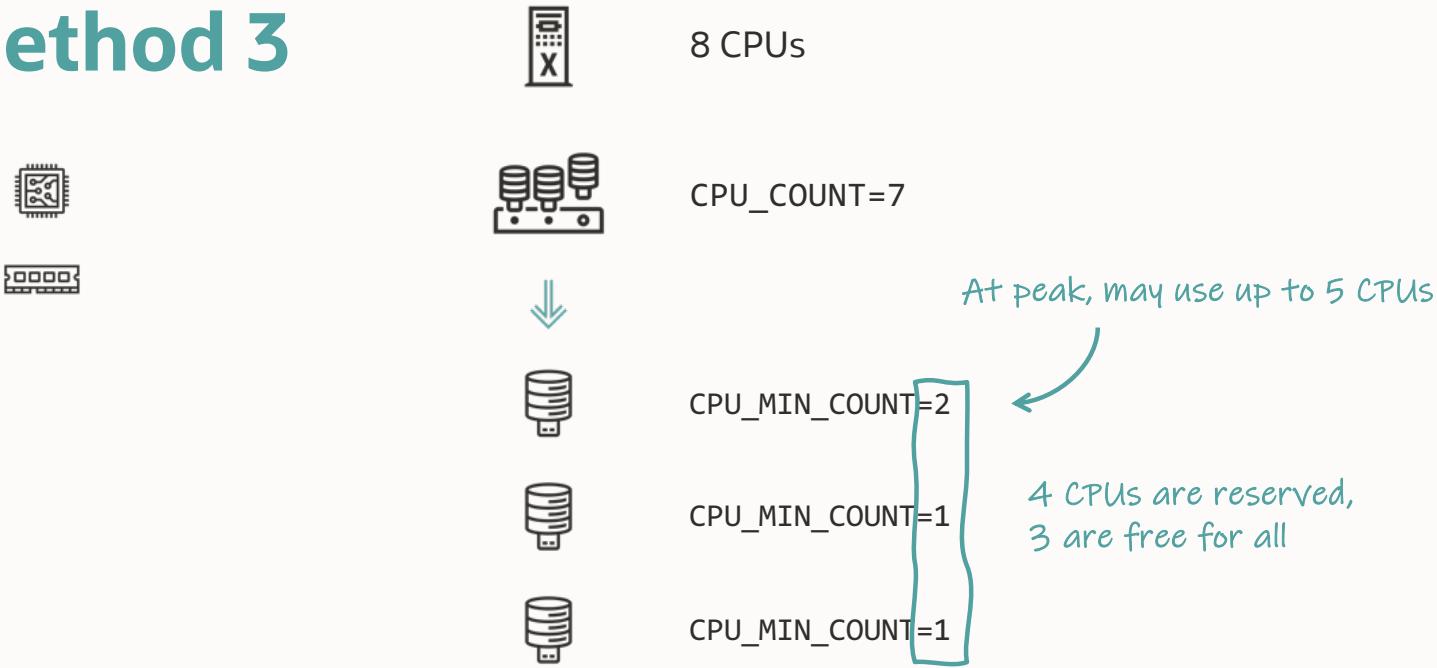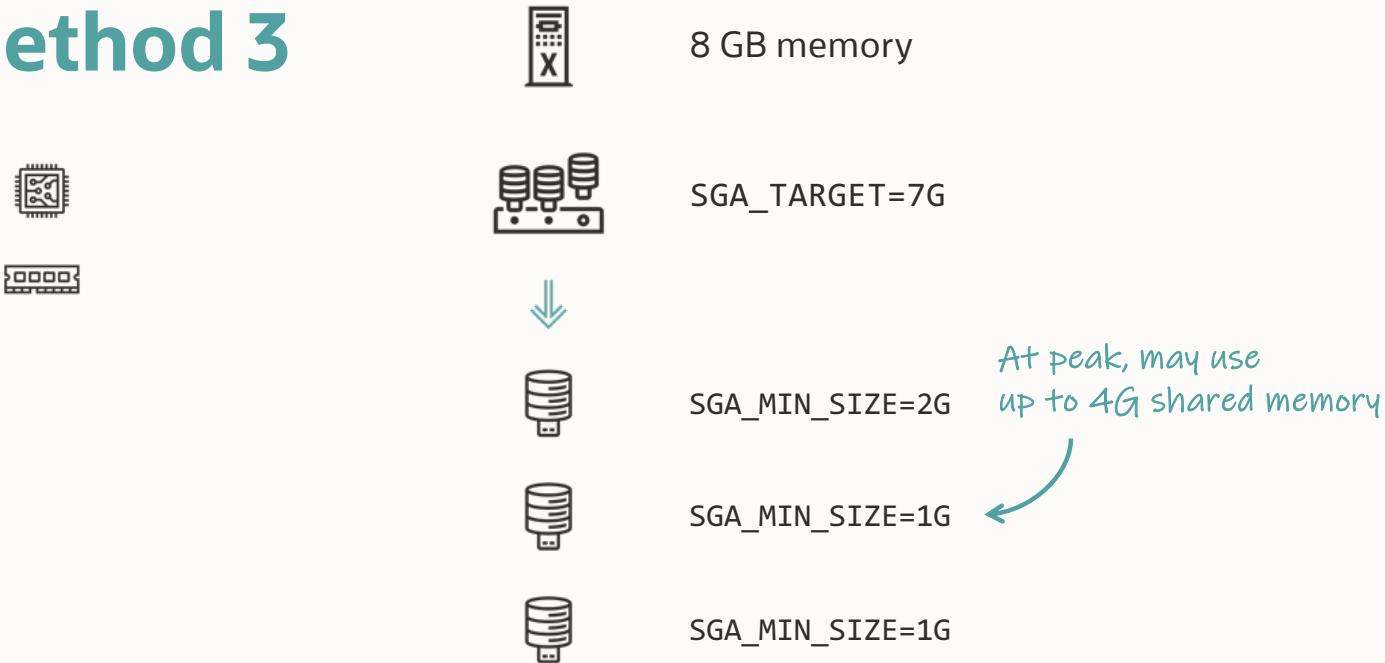
Requires Resource Manager at root level

```
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;
```

Method 4

Advanced Resource Manager

- Requires additional configuration, but much greater control

- Use directives instead of shares

You can still control resources inside a PDB with Resource Manager

What about I/O?

- Exadata I/O Resource Management
- Or, `MAX_MBPS` and `MAX_IOPS`

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

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

New In 26ai

A word about
automated maintenance tasks

Automated Maintenance Tasks

Copyright © 2026, Oracle and/or its affiliates

Automated Maintenance Tasks

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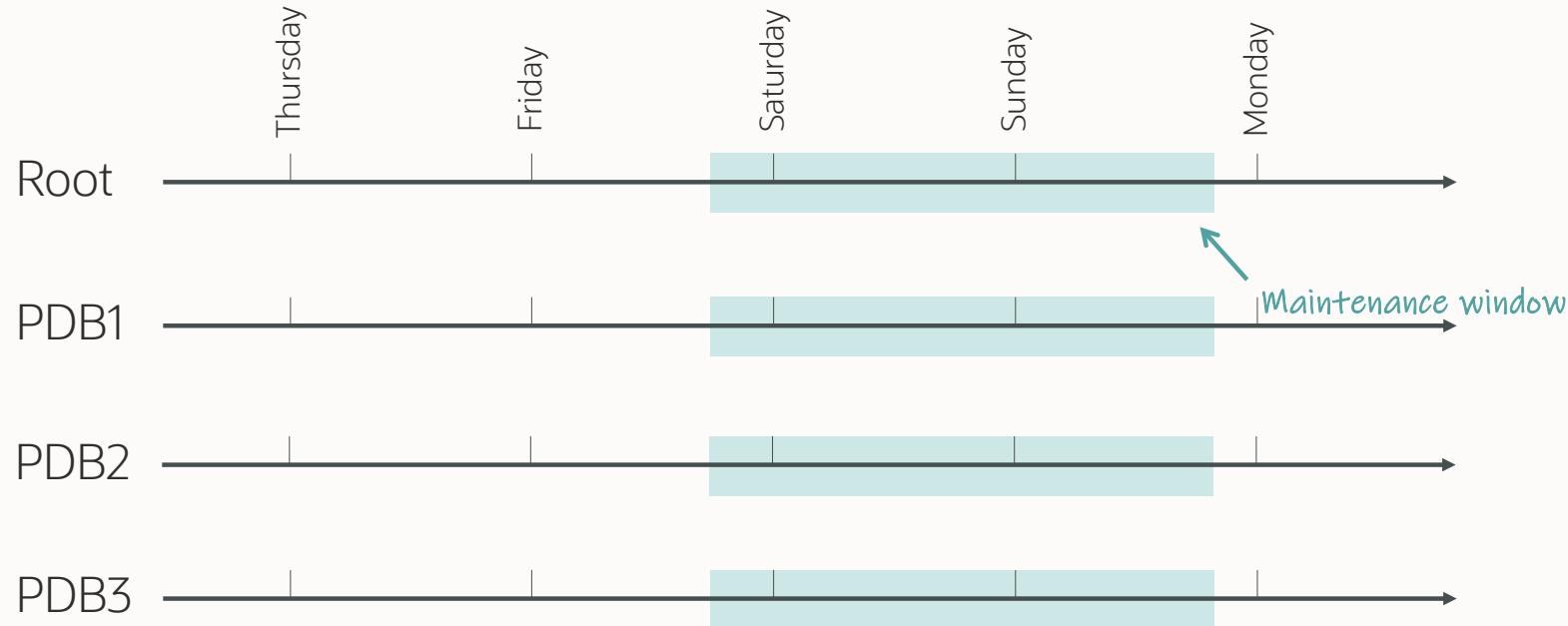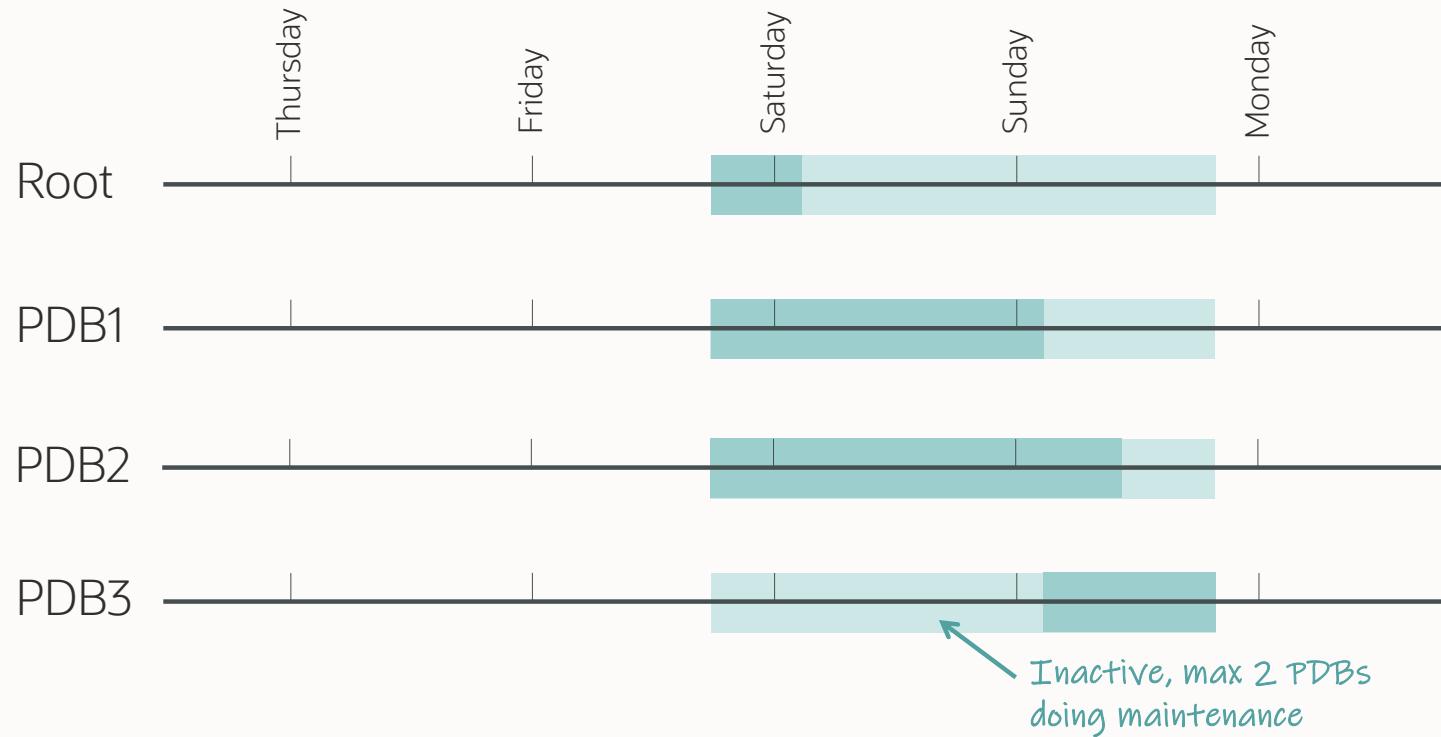
```
--Change the amount of PDBs that can run maintenance tasks at the same time
--Default value 2

alter system set autotask_max_active_pdbs=3;
```

Automated Maintenance Tasks

Active, all PDBs
doing maintenance
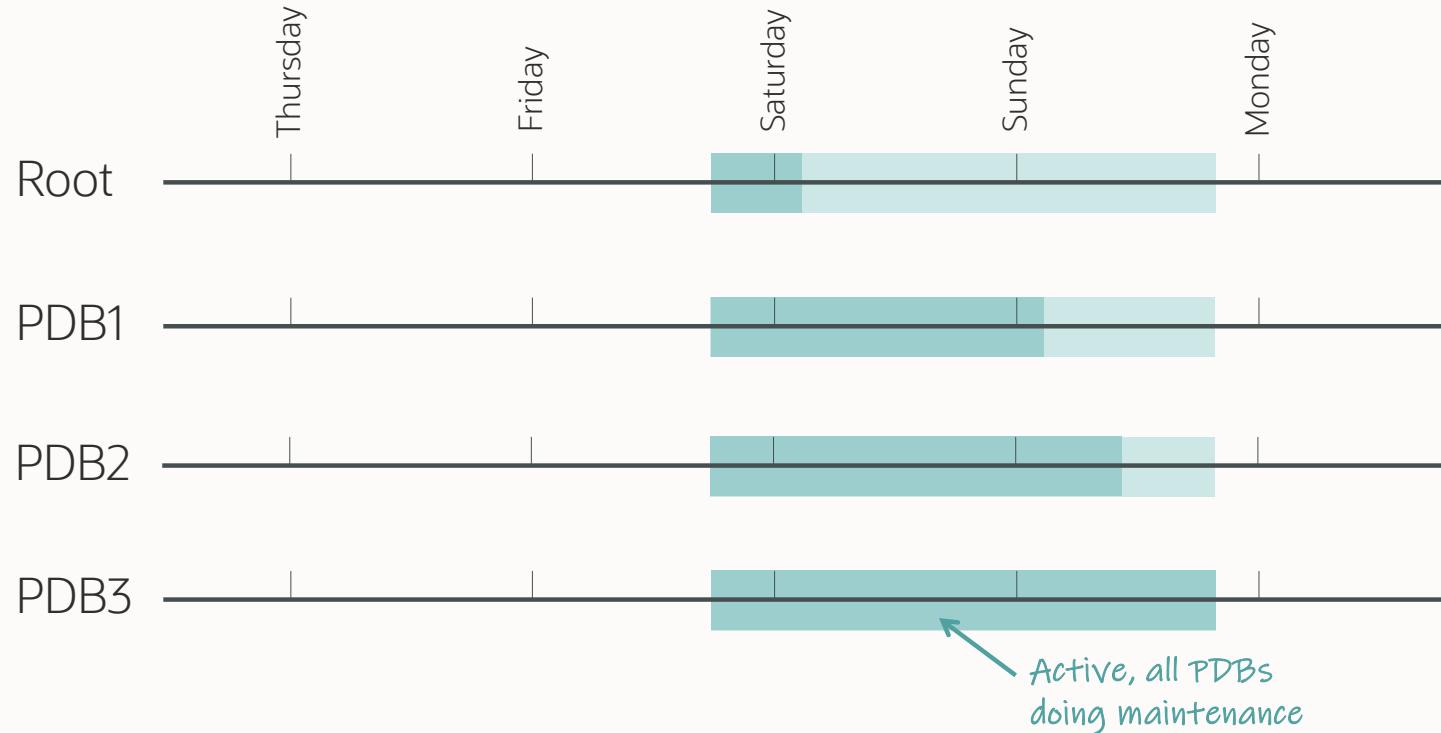
--Selectively disable maintenance tasks in a PDB
--For instance, test databases or databases that are rebuilt frequently

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

Automated Maintenance Tasks

Copyright © 2026, Oracle and/or its affiliates
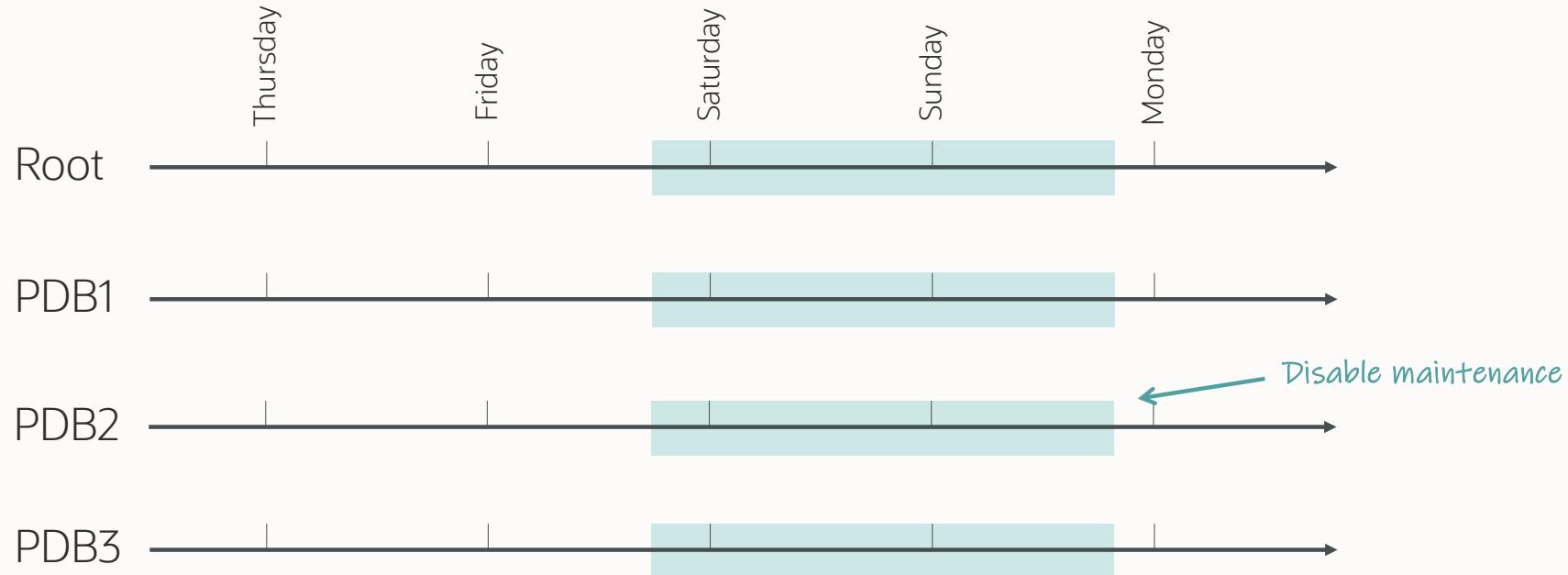
Shift maintenance windows

- Optionally, shorten maintenance windows

Automated Maintenance Tasks

Automated Maintenance Tasks
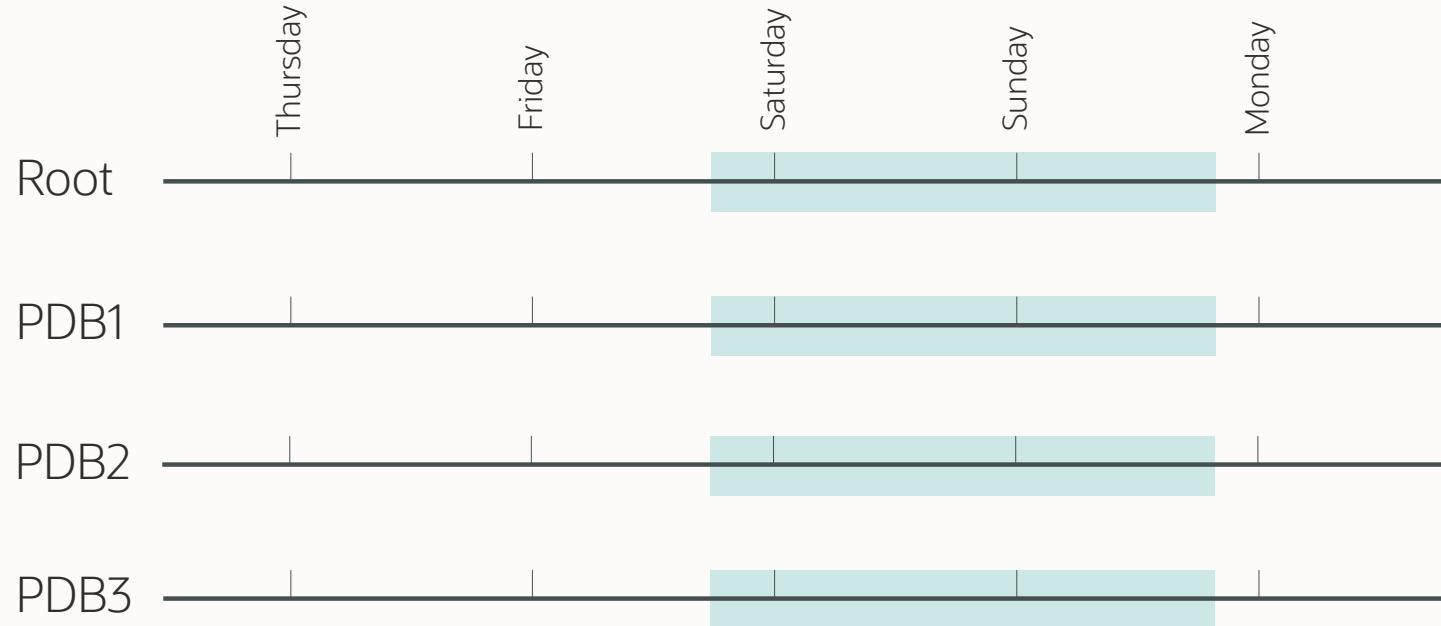
Copyright © 2026, Oracle and/or its affiliates
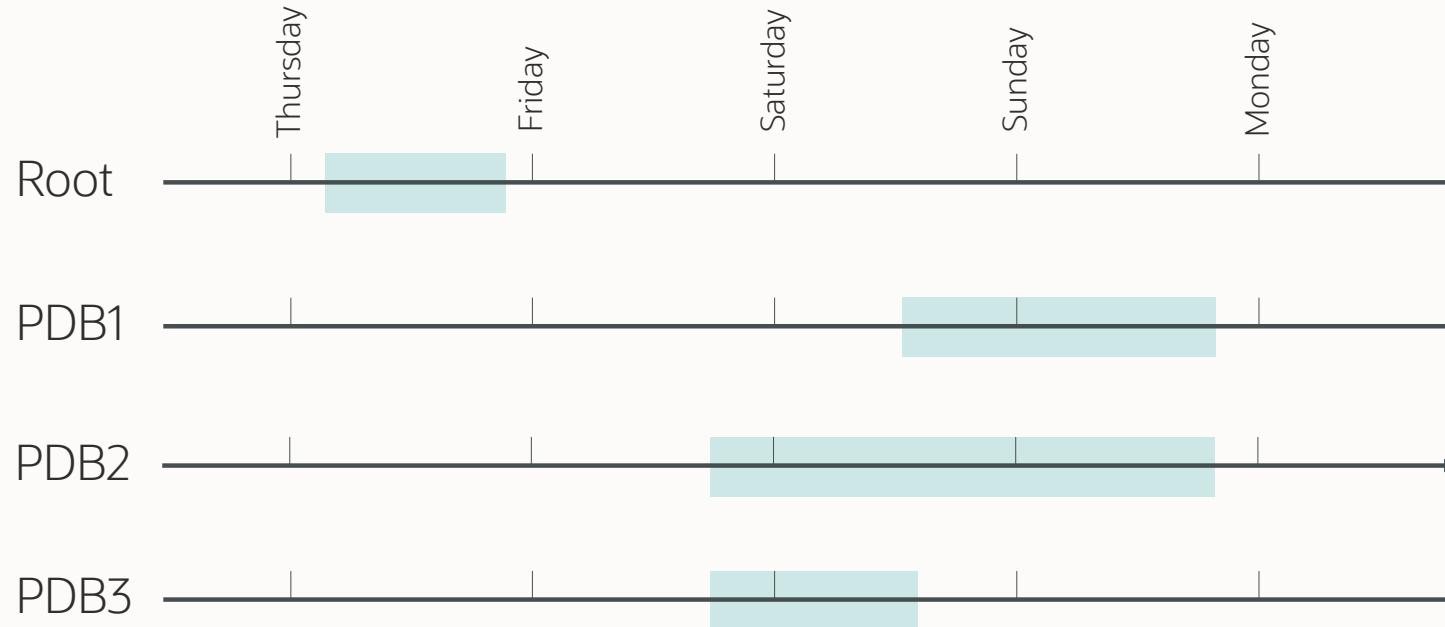
Selectively disable individual maintenance tasks using `DBMS_AUTO_TASK_ADMIN`

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

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

Lunch Break

We start again at 13:30

Data Pump Top Tips

Supercharge data loading/unloading

Always use the Data Pump Bundle Patch

More than 230 functional
and performance fixes
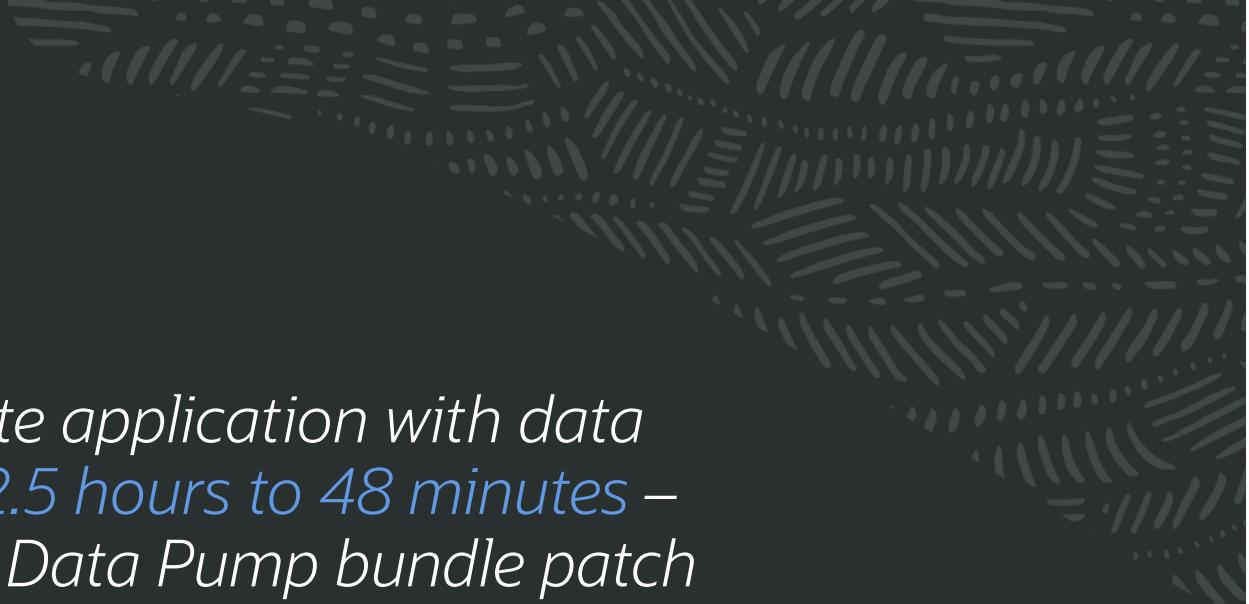
Importing a complete application with data drops from almost 2.5 hours to 48 minutes – by just applying the Data Pump bundle patch

A global provider of financial services

Apply the Data Pump Bundle Patch
without downtime

DEMO

Apply Data Pump Bundle Patch

▶️ <u>Watch on YouTube</u>

Data Pump Bundle Patch

- [Data Pump Recommended Proactive Patches For 19.10 and Above (Doc ID 2819284.1)](#)

- 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`

Use parallel and multiple dump files

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


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

Oracle Cloud Infrastructure

Number of ECPUs / 4

Number of OCPUs

On-prem (x86-64)

2 x physical cores

On-prem (other)

Depends
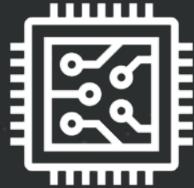
Use at least 32 ECPUs when importing into Autonomous AI Database

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

Parallel Architecture

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

Parallel Architecture
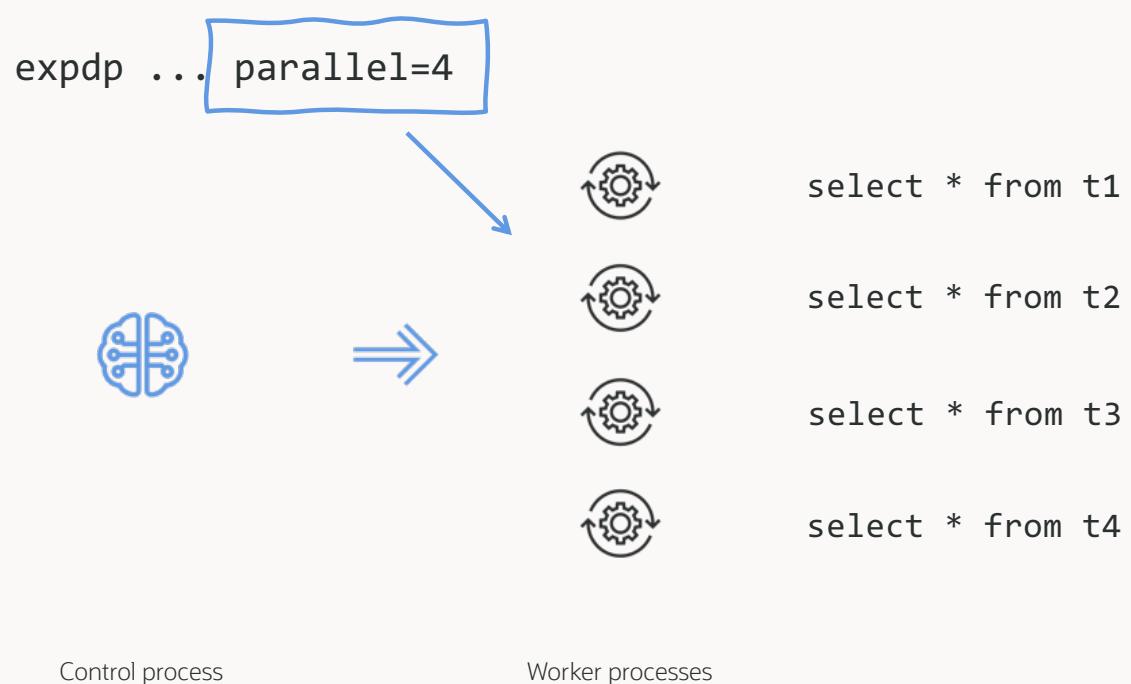
```
expdp ... parallel=4
```

select * from t1

select * from t2

select * from t3

select * from t4

Control process

Worker processes

Parallel Architecture

`expdp ... parallel=4`

select /*+ parallel(2) */ * from t1

select * from t2

select * from t3

select * from t4

Control process

Worker processes

Worker 4 goes idle

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

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

```
-- 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
```

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

- Requires Advanced Security Option

```
-- Protect your dump files from alteration by using encryption
-- Creating an encrypted dump file requires Advanced Security Option

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

```
-- Protect your dump files from alteration by using encryption
-- Creating an encrypted dump file requires Advanced Security Option

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

DEMO

Encrypted exports

▶ [Watch on YouTube](https://youtube.com)

Transportable jobs can use parallel
in Oracle Database 21c

```
-- 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
expdp ... tablespace=<list> parallel=16


impdp ... parallel=16
```

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**

Speed up imports by using NOVALIDATE constraints

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.

Most constraints are VALIDATED

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

```
--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;
```

Recursive full table scan

Recursive full table scan

Recursive full table scan

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


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

```
--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

```
--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

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
```

Real-World Example, Importing 180G Schema

Starting point   44m 50s

Adding Data Pump Bundle Patch   36m 53s

Using NOVALIDATE constraints   7m 25s

NOVALIDATE constraints prevent
the optimizer from certain query rewrites

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!

```
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;
```

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

Also available in
Oracle Autonomous AI Database 19c

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

DATAPUMPSETTINGS_METADATATRANSFORMS-1=name:CONSTR_NOVALIDATE,value:1

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

NOVALIDATE Constraints

- Available in Database Migration Service (DMS)

- In the OCI console, Advanced parameters> DATAPUMPSETTINGS: [Metadata Transforms](#)

Use index size to determine parallel degree on index creation

Index Creation

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

Really good for few big indexes

Before 12.1

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

Index Creation

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

From 12.1

Really good for many small indexes

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

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`

How Data Pump Create Indexes

1   Calculate the optimal parallel degree

2   Create indexes

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`

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

Explained.
```

```
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
```

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)

How Data Pump Create Indexes

`impdp ...` `parallel=16`

Worker 1

| CREATE INDEX ... PARALLEL 1 | CREATE INDEX ... PARALLEL 1 | CREATE INDEX ... PARALLEL 1 | CREATE INDEX ... PARALLEL 1 |

Worker 2

| CREATE INDEX ... PARALLEL 15 | CREATE INDEX ... PARALLEL 8 | CREATE INDEX ... PARALLEL 5 |

Worker 3

| CREATE INDEX ... PARALLEL 7 |

Worker 4

| CREATE INDEX ... PARALLEL 3 |

...

Worker 16
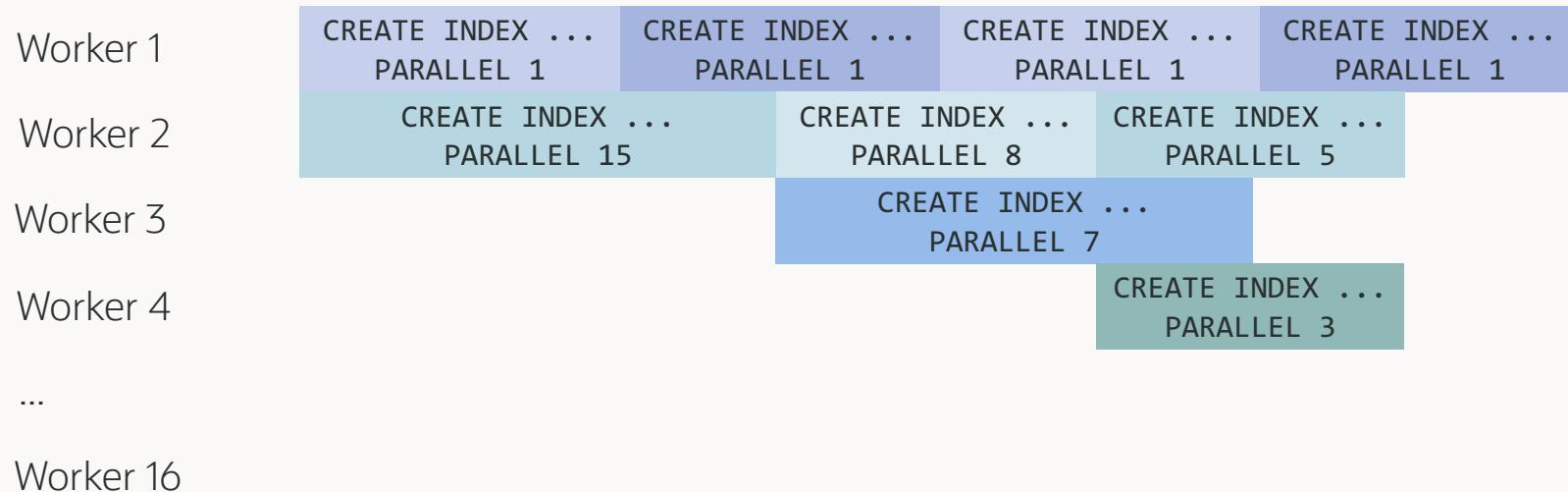
Importing with former index method

```
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
```

Index Creation

Requires:

i

- Oracle AI Database 26ai

- Oracle Database 23.8 plus Data Pump Bundle Patch

- Oracle Database 19.26 plus Data Pump Bundle Patch

Also available in Oracle Database 19c via 19.26 Data Pump Bundle Patch

Convert time zone data on import

Time Zone File Version Check

Source
Version 43

Target
Version 42

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

```
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.
```

DEMO

Convert time zone data on import

▶ Watch on YouTube

Source Server

Time Zone Data Convert

- 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.

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

Copy the dump files before the export completes

- Oracle AI Database 26ai

Export

Copy

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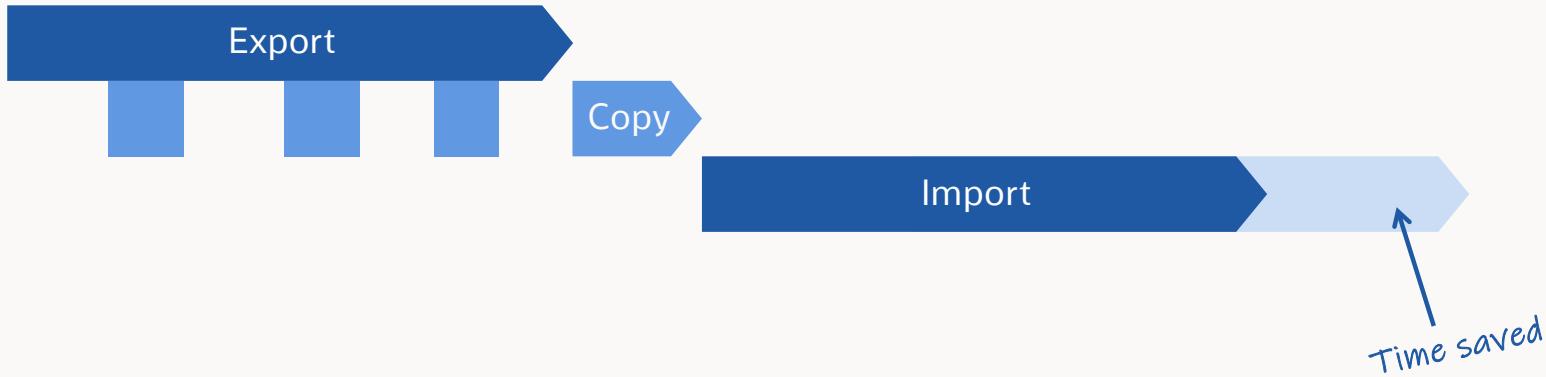
```
dbms_datapump.get_status(l_handle, l_stsmask, NULL, l_job_state, l_status);
```

```
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;
```

```
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;
```

Copy Dump Files

- Blog post: [Copy Data Pump Files Before the End of the Export](#)

Use diagnostics views to assist in troubleshooting

- Oracle AI Database 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
```

Diagnostic Views

- New views available in Oracle AI Database 26ai:

  - `v$datapump_process_info`
  - `v$datapump_sessionwait_info`
  - `v$datapump_processwait_info`

Key Learnings

1   Use Data Pump Bundle Patch

2   Use NOVALIDATE constraints

3   Create indexes faster

Autonomous AI Database

A migration approach

What's the story?

Flashback to October 2017

The idea?

A mostly self-managed database environment, taking care on many tasks

Will the DBA's be fired?

https://www.complexsql.com/oracle-18c-impact-on-dbas/

"It's that sort of attitude that has turned some DBAs into inflexible dinosaurs. You've got to evolve or die, people!"

—

Tim Hall

https://oracle-base.com/blog/2017/10/02/oracle-autonomous-database-and-the-death-of-the-dba/

Autonomous AI Database – Where?

Public cloud

Autonomous AI Database

Cloud@Customer

Autonomous AI Database in a VM environment

One Autonomous AI Database – Two Deployment Choices

Serverless Infrastructure

Dedicated Infrastructure
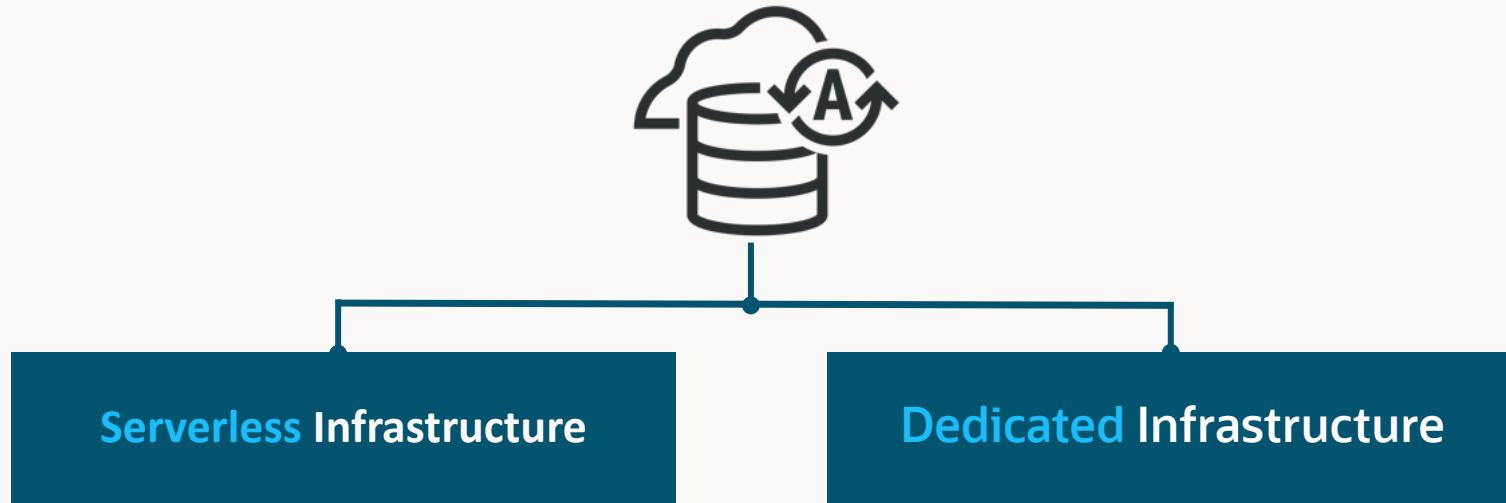
One Autonomous AI Database – Workload Choices

Autonomous AI Lakehouse (ADW)	**Autonomous Transaction Processing (ATP)**
• Data Warehouse, Data Mart • Data Lake, Machine Learning	• Transactions, Batch, Reporting, IoT • Application Dev, Machine Learning
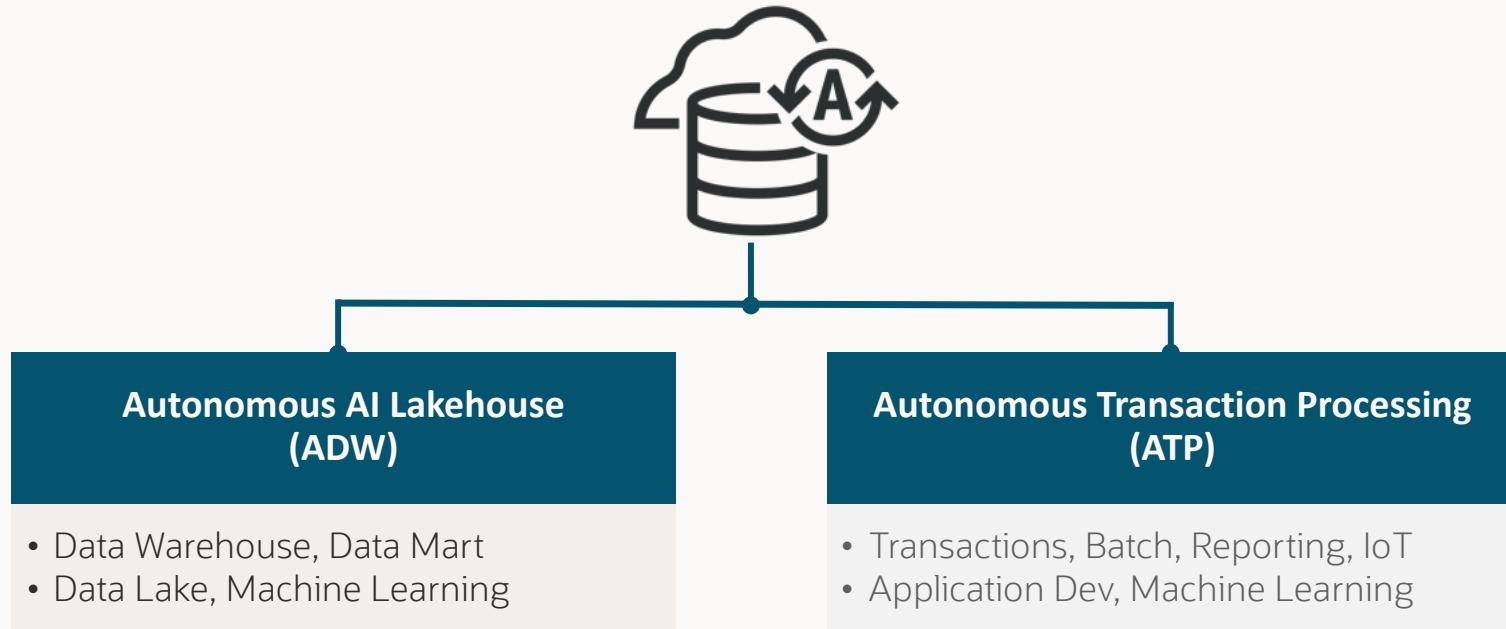
Migration Planning

No migration without a proper runbook

Estate Modernization

But not every database is a great candidate for ADB

Migration to Autonomous AI Database is always a logical migration

- <u>Move the data</u>, not the database

Tools out-of-the-box

SQL Developer Web

Web-based Function rich,
low code development env

No client software needed

Oracle REST Data Services

Ability to REST enable a
schema and autogenerate
REST endpoints for tables,
views, and procedures

APEX

Execute SQL and PL/SQL

Build Data Models,
generate DDL statements

Monitor and manage the DB

Essentials

Outside the database,
check OCI Documentation

Example: Deploy, start, stop, scale

Essentials
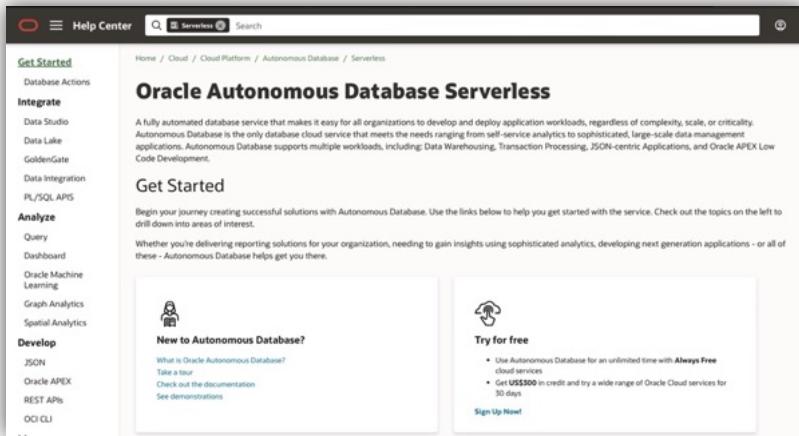
Inside the database,
check Database Documentation

Example: Schema, capabilities, connecting
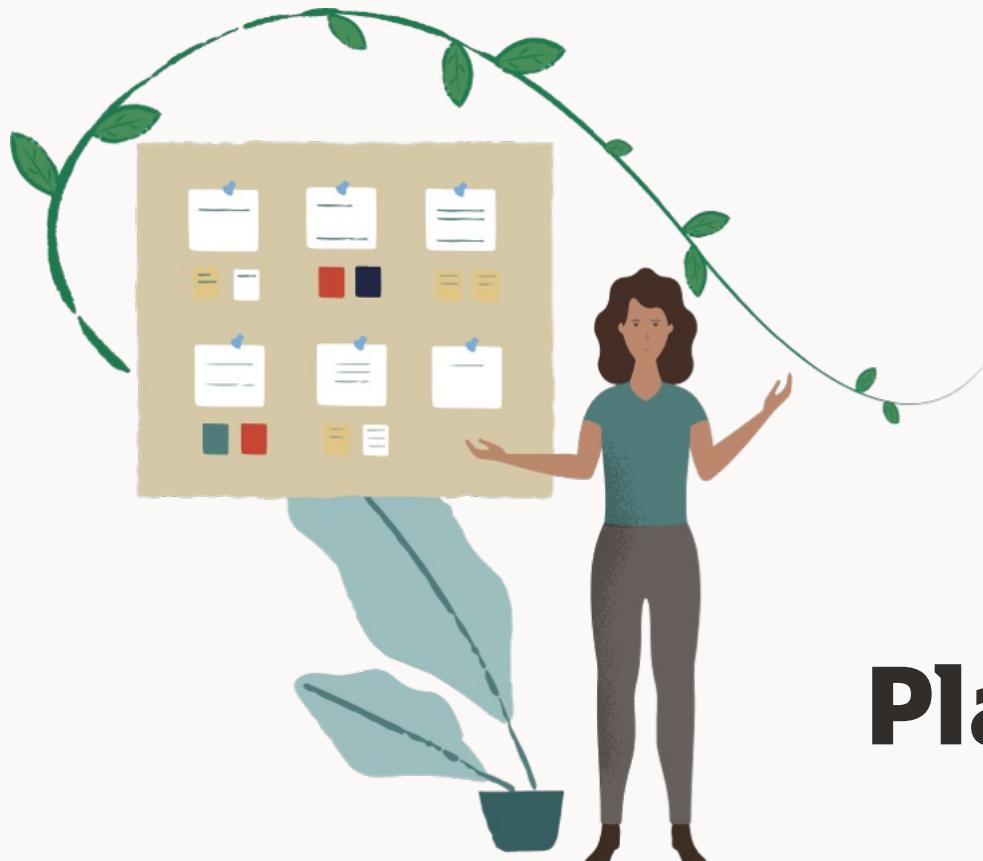
Planning

How do we migrate our 500 databases to Oracle Autonomous AI Database?

- And which ones are good candidates?

Getting an Overview

1

Estate Explorer

⟹

2

Cloud Premigration
Advisor Tool

⟹

3

Cloud Migration
Advisor

Getting an Overview

1

Estate Explorer

2

Cloud Premigration
Advisor Tool

3

Cloud Migration
Advisor

Getting an Overview

1

Estate Explorer

⇒

2

Cloud Premigration
Advisor Tool

⇒

3
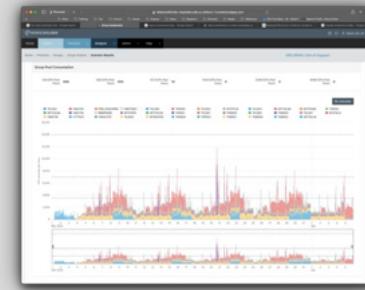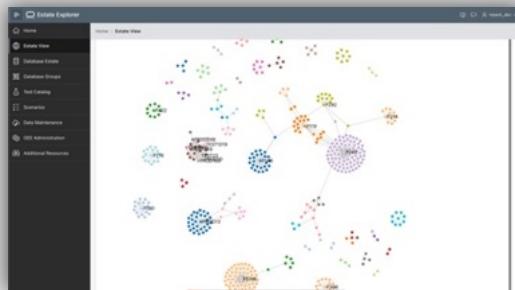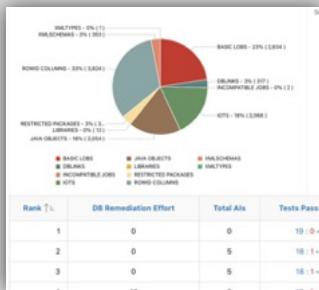
Cloud Migration
Advisor

Analyze 1000's of databases in
just a few hours

Provide a detailed TCO to
compare on-premises and cloud

View innovative visualizations
and detailed reports

Optimize your Autonomous AI
Databases using Elastic Pools

Getting an Overview

1

Estate Explorer

2

Cloud Premigration
Advisor Tool

3

Cloud Migration
Advisor

Getting an Overview

1

Estate Explorer

2

Cloud Premigration Advisor Tool

3
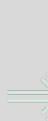
Cloud Migration Advisor

> **˅ Premigration Advisor Check Details List**
>
> **Source Database**
>
> Expand All   Close All
>
> **˅ Action Required (2 checks)**
>
> **˅ OGG Minimal Supplemental Logging Not Enabled**
>
> **Description:**   Minimal supplemental logging is not enabled on the Database.
>
> **Action:**   Make sure minimal supplemental logging data is enabled by using executing the SQL command ALTER DATABASE ADD SUPPLEMENTAL LOG DATA; This command can be done while the database is online and no restart is required.
>
> More Details
>
> **› Relevant Objects (1 relevant object)**
>
> **› OGG Replication Not Enabled**
>
> **› Review Required (1 check)**

Getting an Overview

1

Estate Explorer

2

Cloud Premigration
Advisor Tool

3

Cloud Migration
Advisor

Getting an Overview

1

Estate Explorer

⟹

2

Cloud Premigration
Advisor Tool

⟹

3

Cloud Migration
Advisor

Getting an Overview

Estate Explorer ⟹ Cloud Premigration Advisor Tool ⟹ Cloud Migration Advisor

- OCI Database Migration Service

- Zero Downtime Migration

- Autonomous Migration Automation

- Data Pump

- GoldenGate

- O2O / OOO

Cloud
Premigration
Advisor
Tool

Evaluate an Oracle AI Database for compatibility with Oracle Autonomous AI Database

- Use Cloud Premigration Advisor Tool (CPAT)

Overview

Connects ⇒ Checks ⇒ Reports ⇒ Fixes (optional)

Download CPAT from <u>MOS Note: 2758371.1</u>

Patch 32613591: Cloud Premigration Advisor Tool (CPAT) for version 11.2.0.4 and Higher

Last Updated 11-Feb-2025 17:31 (12 days ago)

Product Oracle Database Upgrade Assistant

Release Oracle 11.2.0.4.8

Platform Generic Platform

Size 8.6 MB

Download Access Software

Classification General

Patch Tag

Release Oracle 11.2.0.4.8

Platform Generic Platform

Language American English

Bugs Resolved by This Patch
List of bugs fixed is not available. Consult the Readme.

View Related Knowledge to this Patch

Read Me   Download   Add to Plan

Analyze with OPatch...

All-time Downloads 50   View Trends

Discuss this patch in the community

```
# One or more report formats separated by spaces
# json html text


./premigration.sh \
    --connectstring jdbc:oracle:thin:@<host>:<port>/<service> \
    --username CPAT_CHECK           \
    --pdbname PDB_COMPLEX           \
    --schemas appuser,reportuser    \
    --outdir /home/oracle/cpat-db   \
    --targetcloud atps              \
     --migrationmethod goldengate    \
    --reportformat html
```

That's a lot of options.
Help me out, please!

CPAT COMPOSER

https://macsdata.com/oracle/cpat-composer

- Free to use

- Available online

- Not an official Oracle tool

- Created by Marcus Doeringer
  Migration Specialist @Oracle

CLOUD PREMIGRATION ADVISOR TOOL (CPAT) COMPOSER

Version: 25.2.0 (Default)   Template: SA: Recommended Settings

Reset   Search   About   Valid

Input Form

★ Recommended   🏷 Default

💻 Operating System

Select the operating system to run CPAT

Linux
Use for Linux operating system

Windows
Use for Windows operating system

⇄ CPAT Mode

Select the mode you want to run CPAT

🔍 **Source Analysis**
Run CPAT on the source database for analysis

◎ **Target Properties**
Generate a properties file from the target database

</> Output

★ Set Recommended   👁 Use Placeholder

✅ Status Info

All required options set

★ Recommended Options have been applied

★ **Recommended Options**

Analysis Mode: SCHEMA   File Prefix

>_ Command   📄 Parameter File

Command Line

```
./premigration.sh --connectstring 'jdbc:oracle:thin:@myhost:1521:ORCL' --
username sys --targetcloud ATPS --migrationmethod DATAPUMP --reportformat HTML
JSON TEXT --full --zip
```

ORACLE

Sat Feb 22 20:59:55 UTC 2025

Cloud Premigration Advisor Tool (CPAT) Report

CPAT Version: 25.2.1-1
Version Date: Feb 17, 2025
Days Since Last CPAT Update: 38 days

Table of Contents

Expand All   Close All

˅ Premigration Advisor Report Summary

Report Result	Action Required
Number of schemas analyzed:	4
List of schemas analyzed:	[PDBUSER, CO, HR, MYAPP]

Expand All   Close All

Premigration Advisor Report Summary

Report Result	Action Required
Number of schemas analyzed:	4
List of schemas analyzed:	[PDBUSER, CO, HR, MYAPP]

Report Results Overview

Source Database		Target Database		Migration Method		Additional Tasks	
Action Required	2	Action Required	10	Action Required	1	Action Required	0
Review Required	1	Review Required	7	Review Required	2	Review Required	0
Review Suggested	2	Review Suggested	4	Review Suggested	1	Review Suggested	4
Passed	16	Passed	17	Passed	4	Passed	16

Report Details

Report Details

CPAT Application Version:	25.2.1-1
Report Generated On:	Sat Feb 22 20:59:44 UTC 2025
Analysis Property File:	premigration_advisor_analysis.properties
Analysis Mode:	FULL
Target Cloud Type:	ALL
Migration Method(s):	[DATAPUMP, DATAPUMP_DBLINK, GOLDENGATE]
Command Line Options:	--connectstring jdbc:oracle:thin:@dbsystemaz:1521/pdb_complex.sub07021512520.upgradeteam.oraclevcn.com --targetcloud ALL --username SYS --sysdba --analysisprops premigration_advisor_analysis.properties --outdir /home/oracle/cpat_22_feb_2025 --logginglevel FINE --migrationmethod ALL --reportformat JSON HTML TEXT --resultlevel R0 --zip --gatherdetails ALL

More Details

Report Analysis Notes

More Details

> ## Report Analysis Notes

> ## Source Database Details

> ## Source Database Version Information

> ## Source Database Patch Information

> ## Source Database Redo Information

> ## Source Database Supplemental Information

> ## Source Database Schema Summary Information

∨ ## Premigration Advisor Check Details List

Source Database

Source Database Details

Source Cloud Vendor:	Oracle Cloud Infrastructure (Database)
Source Database Host Name:	dbsystemaz
Source Oracle SID:	ORCL
Source Database Created Date:	Fri Jan 24 22:23:51 UTC 2025
Source Database DBID:	1719058167
Source Database Unique Name:	ORCL_5tr_iad
Source Instance Name:	ORCL
Source Database Name:	ORCL
Source Database Username:	SYS
Source Database Port String:	x86_64/Linux 2.4.xx
Source Database Platform ID:	13
Source Database Container Name:	PDB_COMPLEX
Source DB Block Size in KB:	8
Source DB Combined Size of DATA, TEMP, LOG, and CONTROL File Usage in GB:	5.044
Source DB Size of DATA File Usage in GB:	1.856
Source DB Size of TEMP File Usage in GB:	0.17

> More Details

› **Report Analysis Notes**

› **Source Database Details**

› **Source Database Version Information**

› **Source Database Patch Information**

› **Source Database Redo Information**

› **Source Database Supplemental Information**

› **Source Database Schema Summary Information**

⌄ **Premigration Advisor Check Details List**

Source Database

Action Required (2 checks)

OGG Minimal Supplemental Logging Not Enabled

Description: Minimal supplemental logging is not enabled on the Database.

Action: Make sure minimal supplemental logging data is enabled by using executing the SQL command ALTER DATABASE ADD SUPPLEMENTAL LOG DATA; This command can be done while the database is online and no restart is required.

More Details

> Relevant Objects (1 relevant object)

OGG Replication Not Enabled

Description: ENABLE_GOLDENGATE_REPLICATION init.ora parameter is not set.

Action: Make sure ENABLE_GOLDENGATE_REPLICATION is set to TRUE by using executing the SQL command: ALTER SYSTEM SET ENABLE_GOLDENGATE_REPLICATION=TRUE SCOPE=BOTH; This command can be done while the database is online and no restart is required.

More Details

> Relevant Objects (1 relevant object)

The documentation has additional information on each CPAT check

Utilities Guide, Oracle AI Database 26ai

```
--Generates fixup scripts whenever possible
--Stores the scripts on disk for review


./premigration.sh ... --genfixups
```

You can run CPAT on any live database.
It is completely non-intrusive.

CPAT integration

Generate CPAT report

ZERO DOWNTIME MIGRATION
Run as part of its migration assessment

OCI DATABASE MIGRATION SERVICE
Run as part of its migration assessment

ENTERPRISE MANAGER MIGRATION WORKBENCH
Run as part of its migration assessment

SQL DEVELOPER / SQLcl
Through the MIGRATEADVISOR command

Data Pump

The simple approach

Data Pump Bundle Patch aren't yet applied in ADB Serverless (October 2025)

- You may request one-off fixes via an SR
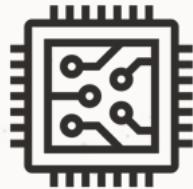
Allocate a sufficient number of ECPUs

- 32 should be the minimum when you import

Export: PARALLEL 2x of physical cores

Import: `PARALLEL=ECPU/4`, or higher

- Scale up to the maximum for migrations

Most simple method: Data Pump

Datapump with Files

Datapump with DB Links

Automation

How AMA scripts ease migrations

What is AMA?

Autonomous AI Database Migration Automation (AMA)

- Simple migration solution for ADB Serverless
- Script based
- Single configuration file
- Migrates in phases
- Can act fully automated

- Not a new product, just a solution to ease migrations

An ADB-S migration is a bit like making a movie

You won't start with filming right away

You need a script book
You need to cast actors
You need a film set
You need ...

Now you can start filming your scenes
And then there's plenty of work
on editing and cutting the movie

AMA Workflow

Setup Phase   Planning Phase   Preparation Phase   Perform Phase   Optional Phase

- Examination of source database (CPAT)
- Create migration directories
- Configure AMA parameter file

```
--Create migration directories
--Copy parameter file into INPUT
--Edit parameter file and make adjust with your values

mkdir -p /home/oracle/CPAT_MIG_SCRIPTS/INPUT
mkdir -p /home/oracle/CPAT_MIG_SCRIPTS/OUTPUT


cp CPAT_MIGRATION_PARAMETERS.txt /home/oracle/CPAT_MIG_SCRIPTS/INPUT


vi /home/oracle/CPAT_MIG_SCRIPTS/INPUT/CPAT_MIGRATION_PARAMETERS.txt
```

Parameter File

Adjust:

- Connect strings source and target
- Data Pump encryption
- Storage (FSS or Object Store)
- Format: `TAB` or `SCRIPT`

Documentation

AMA Documentation is available at request

- Documents the entire flow and all options and parameters

Oracle Autonomous Database Migration Automation
For CPAT and stand-alone use

May, 20255, Version 1.1
Copyright © 2025, Oracle and/or its affiliates
Public

AMA Workflow

Setup Phase • Planning Phase • Preparation Phase • Perform Phase • Optional Phase

- Java and OLAP (ADB)
- Migration user
- Statistics scripts
- Quiesce scripts
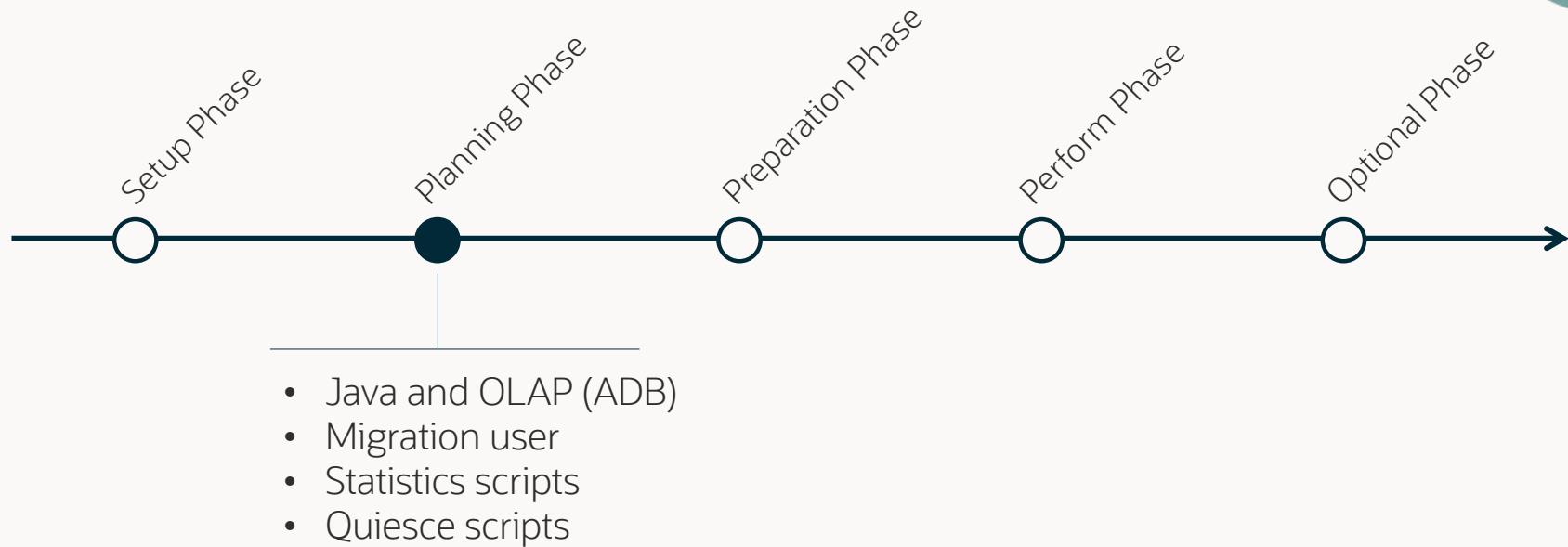
AMA | Planning Phase

On-Prem - Source

Gather stats for `SYS` / `SYSTEM`

Create Migration user

Enable restricted session

Set `JOB_QUEUE_PROCESSES=0`

ADB-S - Target

Enable OLAP / JAVA in ADB-S

```
[oracle@ephx31vm1-jlosd1 OUTPUT]$ cat __US3BLDW_MIGRATION_CONTROL_FILE.ctl


---
---
--- PLAN PHASE ---
--- All steps in this phase affect the source database ---
--- * You can collect the statistics or create the migration user in advance  ---
--- * Get familiar with the restricted session privilege and how to prepare it  ---
--- * shortly before the migration starts make sure no unwanted user is connected  ---
---   to the source database, turn on restricted session and disable the scheduler ---
---
---


    ####   S O U R C E   ####                                                    ####   T A R G E T   ####

PLAN TARGET 00001 01 .........................................................................  00001_US3BLDW_SQL_ENABLE_OLAP_JAVA.sh
PLAN SOURCE 00002 01 00002_US3BLDW_SQL_OPTIONAL_SOURCE_STATS.sh
PLAN SOURCE 00003 01 00003_US3BLDW_SQL_CREATE_MIG_USER_SRC.sh
PLAN SOURCE 00004 01 00004_US3BLDW_SQL_SET_JOB_QUEUE_PROCESSES.sh
PLAN SOURCE 00005 01 00005_US3BLDW_SQL_ENABLE_RESTRICTED_SESSION.sh
---
```

AMA Workflow

Setup Phase — Planning Phase — Preparation Phase — Perform Phase — Optional Phase

- Roles, profiles, schema definitions
- Functions, types, packages
- SQL Profiles, SQL Plans, SQL Patches

Downtime starts
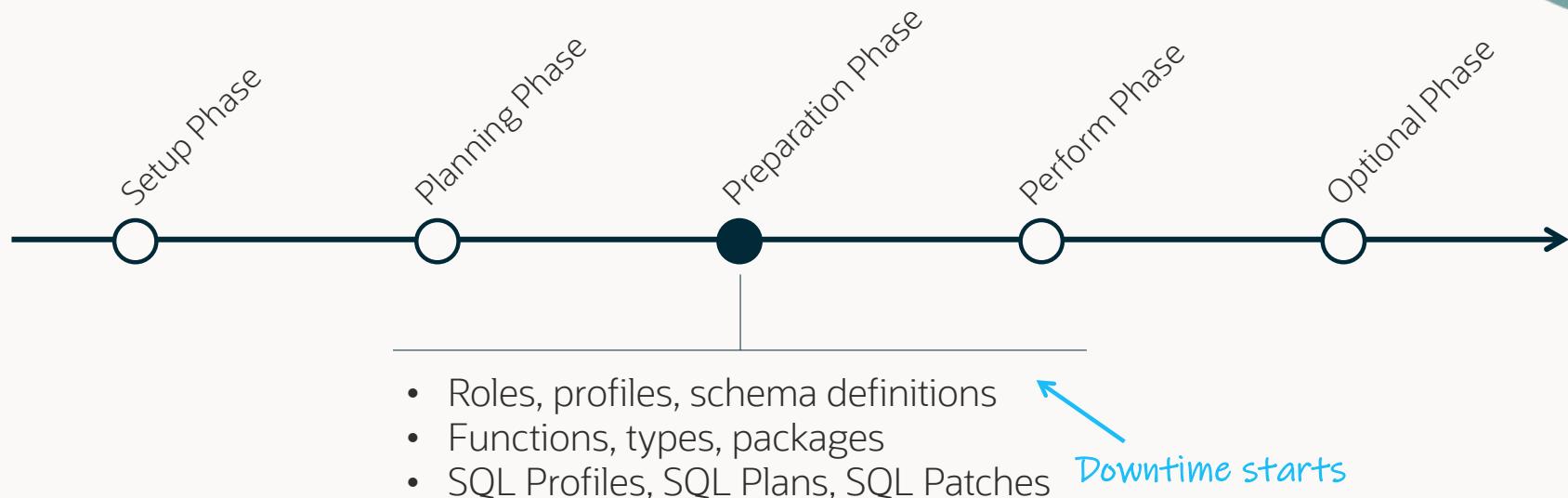
AMA | Preparation Phase

On-Prem - Source

Collect allowed ROLES

Collect PROFILES

Export schema definition

Export FUNCTIONS, TYPES, PACKAGES

Collect SQL Profiles, SQL Plans, SQL Patches

ADB-S - Target

Create ROLES

Create PROFILES

Create storage credential (NFS, Object Store)

Import schema definition

Import FUNCTIONS, TYPES, PACKAGES

Granting migration privileges

Alter user profiles

Create SQL Profiles, SQL Plans, SQL Patches

```
---

--- PREPARATION PHASE ---

--- All steps in this phase will prepare the source and target database ---

--- The scripts depend on each other, so execute in this phase one script after the other ---

---

---


    ####    S O U R C E    ####                                    ####    T A R G E T    ####


PREPARE SOURCE 00006 01 00006_US3BLDW_SQL_CREATE_MIGDIR.sh

PREPARE TARGET 00007 01 .................................................. 00007_US3BLDW_SQL_ATTACH_FSS.sh

PREPARE SOURCE 00008 01 00008_US3BLDW_EXPDP_ROLE.sh

PREPARE TARGET 00008 02 .................................................. 00008_US3BLDW_IMPDP_ROLE.sh

PREPARE SOURCE 00009 01 00009_US3BLDW_EXPDP_PROFILE.sh

PREPARE TARGET 00009 02 .................................................. 00009_US3BLDW_IMPDP_PROFILE.sh

PREPARE SOURCE 00010 01 00010_US3BLDW_EXPDP_USER.sh

PREPARE TARGET 00010 02 .................................................. 00010_US3BLDW_IMPDP_USER.sh

PREPARE TARGET 00011 01 .................................................. 00011_US3BLDW_SQL_CREATE_MIG_ROLE.sh

PREPARE SOURCE 00012 01 00012_US3BLDW_EXPDP_TYPE.sh

PREPARE TARGET 00012 02 .................................................. 00012_US3BLDW_IMPDP_TYPE.sh

PREPARE SOURCE 00013 01 00013_US3BLDW_EXPDP_FUNCTION.sh

PREPARE TARGET 00013 02 .................................................. 00013_US3BLDW_IMPDP_FUNCTION.sh

---
```

AMA Workflow

Setup Phase — Planning Phase — Preparation Phase — **Perform Phase** — Optional Phase

- Export schemas and audit trail
- Copy files (if necessary)
- Import schemas and audit trail

AMA | Perform Phase

On-Prem - Source

Export all schemas

Export audit trail

Copy files (if necessary)

ADB-S - Target

Import all schemas

Import audit trail

AMA Workflow

Setup Phase

Planning Phase

Preparation Phase

Perform Phase

Optional Phase

- Cross-schema objects
- Privileges
- Profile adjustments
- Advanced queues
- Recompilation
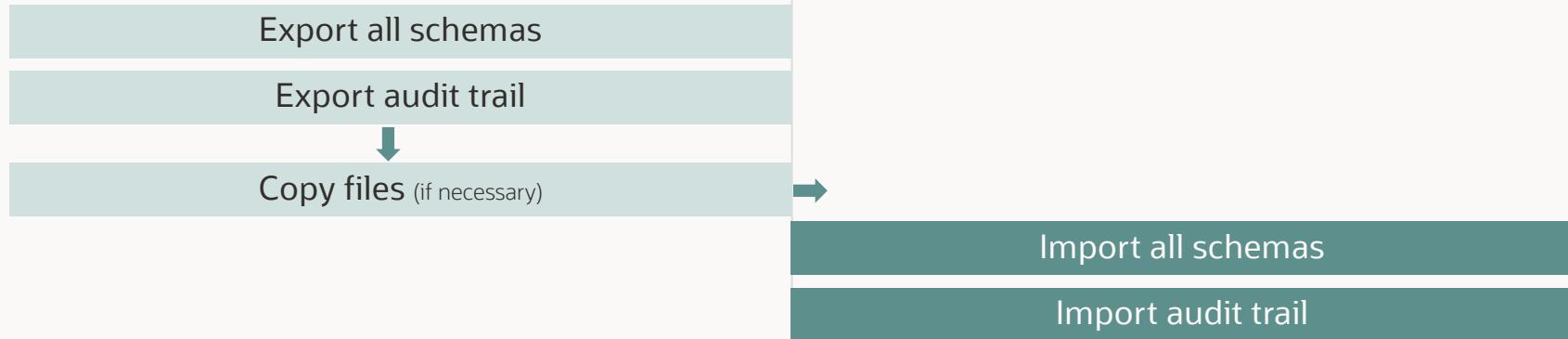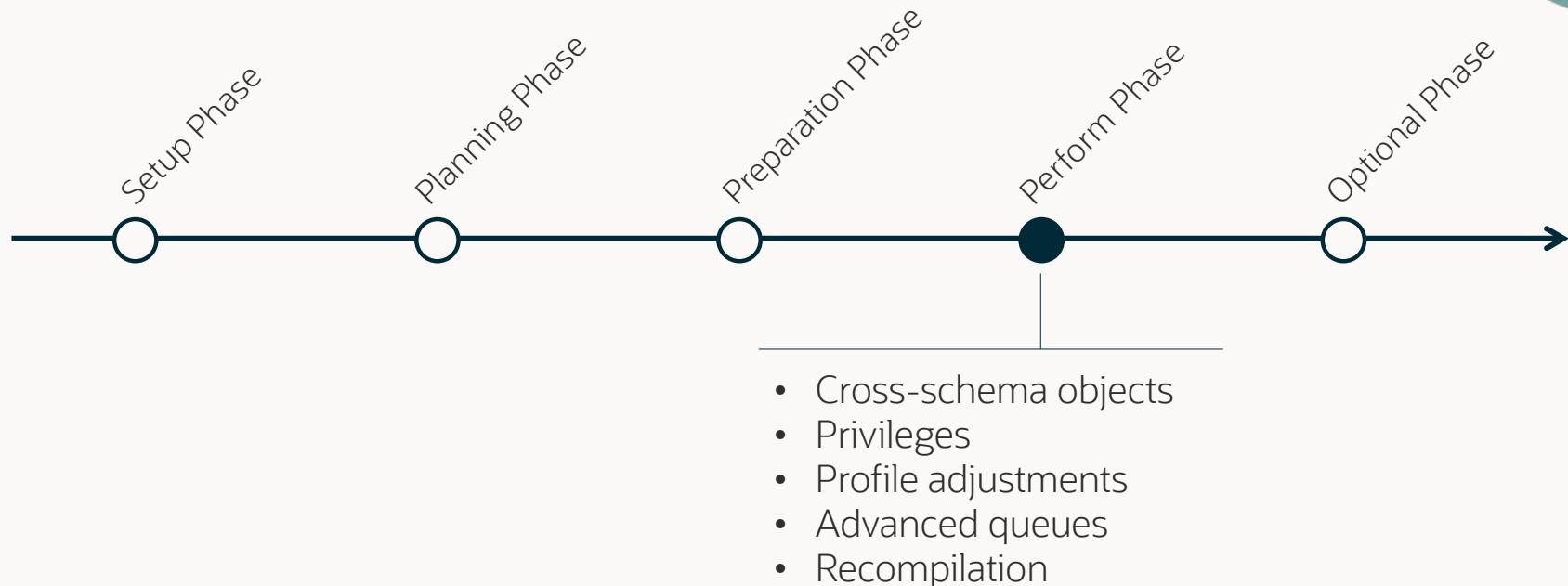
```
---

--- PERFORM PHASE ---

--- Commonly in this phase nothing depends on each other (except you for example have objects that depend on objects stored in other schema) ---

--- So export jobs can be started in parallel and imports once the export finished ---

---

---


    ####   S O U R C E   ####                                      ####   T A R G E T   ####


PERFORM SOURCE 00014 01 00014_US3BLDW_EXPDP_AUDIT_TRAILS.sh

PERFORM TARGET 00014 02 ........................................................................ 00014_US3BLDW_IMPDP_AUDIT_TRAILS.sh

PERFORM SOURCE 00015 01 00015_US3BLDW_SQL_GEN_SQL_PROFILE_STAGE_TAB.sh

PERFORM SOURCE 00015 02 00015_US3BLDW_EXPDP_SQL_PROFILES.sh

PERFORM TARGET 00015 03 ........................................................................ 00015_US3BLDW_IMPDP_SQL_PROFILES.sh

PERFORM TARGET 00015 04 ........................................................................ 00015_US3BLDW_SQL_APPL_SQL_PROFILE_STAGE_TAB.sh

PERFORM SOURCE 00016 01 00016_US3BLDW_SQL_GEN_SQL_PATCHES_STAGE_TAB.sh

PERFORM SOURCE 00016 02 00016_US3BLDW_EXPDP_SQL_PATCHES.sh

PERFORM TARGET 00016 03 ........................................................................ 00016_US3BLDW_IMPDP_SQL_PATCHES.sh

PERFORM TARGET 00016 04 ........................................................................ 00016_US3BLDW_SQL_APPL_SQL_PATCHES_STAGE_TAB.sh

PERFORM SOURCE 00017 01 00017_US3BLDW_EXPDP_SCHEMA_FUSION.sh

PERFORM TARGET 00017 02 ........................................................................ 00017_US3BLDW_IMPDP_SCHEMA_FUSION.sh

PERFORM SOURCE 00018 01 00018_US3BLDW_EXPDP_SCHEMA_FUSION_OCSERVER11G.sh

PERFORM TARGET 00018 02 ........................................................................ 00018_US3BLDW_IMPDP_SCHEMA_FUSION_OCSERVER11G.sh

...
```

AMA | Perform Phase

On-Prem - Source

ADB-S - Target

FOREIGN KEYS cross-schemas
INDEXES cross-schemas
FUNCTIONAL INDEXES enableing
REVOKE transition privileges
GRANT privs SYS, SYSTEM, CTXSYS, objects
Restore final profiles
Set tablespace quotas

Export network ACLs

Import network ACLS
Enable Advanced Queues
Recompilation

```
---
--- POST PHASE ---
--- Here execute again all scripts one after the other as they might have dependencies again ---
---
---


    ####    S O U R C E    ####                                    ####    T A R G E T    ####


POST TARGET 00082 01 .............................................................. 00082_US3BLDW_SQL_REMOVE_MIG_ROLE.sh
POST TARGET 00083 01 .............................................................. 00083_US3BLDW_SQL_SYS_PRIVS.sh
POST TARGET 00084 01 .............................................................. 00084_US3BLDW_SQL_CTXSYS_PRIVS.sh
POST TARGET 00085 01 .............................................................. 00085_US3BLDW_SQL_DATAMINING_PRIVS.sh
POST TARGET 00086 01 .............................................................. 00086_US3BLDW_SQL_OBJECT_PRIVS.sh
POST TARGET 00087 01 .............................................................. 00087_US3BLDW_SQL_ROLE_PRIVS.sh
POST TARGET 00088 01 .............................................................. 00088_US3BLDW_SQL_TBS_QUOTES.sh
POST TARGET 00089 01 .............................................................. 00089_US3BLDW_SQL_DETACH_FSS.sh
POST SOURCE 00090 01 00090_US3BLDW_EXPDP_NETWORK_ACL.sh
POST TARGET 00090 02 .............................................................. 00090_US3BLDW_IMPDP_NETWORK_ACL.sh
POST TARGET 00091 01 .............................................................. 00091_US3BLDW_SQL_SET_AQ_STATUS.sh
POST TARGET 00092 01 .............................................................. 00092_US3BLDW_SQL_RECOMPILE.sh
---
---
--- END OF MIGRATION ---
```

AMA Workflow

Setup Phase

Planning Phase

Preparation Phase

Perform Phase

Optional Phase

- Object comparison
- Row export/import comparison
- OLAP Analytic Workspace

Done!!

AMA can run a migration fully automated and completely unattended

Works with Windows as source database

Database links, external tables, APEX applications

- Work-in-progress

Key Learnings

1 Find the right candidates for ADB

2 Follow our migration approach

3 Ask us about your ADB migration project

Virtual Classroom Seminar Series #22 – #25

1 PLANNING

Watch recording
Get slides

2 PREPARING

Watch recording
Get slides
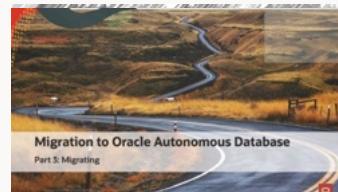
3 MIGRATING

Watch recording
Get slides

4 OPERATING

Wach recording
Get slides

Try it out, please!!

- We are looking for reference customers
- Get in touch with us when you tested it

Break

We start again at 15:15

Cross-Platform Migrations

Pushing the limits

The Beast

Photo by jean wimmerlin on Unsplash

Introduction

Who is who?

ANDREAS GROETZ

Oracle DBA Tech Lead
Entain Services Austria GmbH

Entain is one of the world's largest sports betting and gaming groups. Leveraging the power of the Entain Platform, they bring moments of excitement into their customers lives through more than 30 iconic brands such as bwin, Coral, Ladbrokes and many more.

Entain operates on over 140 licenses across 40+ territories and employs over 29,000 talented workforce. Entain is listed on the London Stock Exchange and is a constituent of the FTSE 100 Index.

Σntain

Challenges

What is special, what makes it so complex?

Migration Challenges

SPARC SuperCluster

ZDLRA

Exadata X9M Extreme Flash

Migration Challenges

180TB
size

SPARC SuperCluster

ZDLRA

→

Exadata X9M Extreme Flash

Migration Challenges

15TB
redo/day

SPARC SuperCluster

ZDLRA

Exadata X9M Extreme Flash

Migration Challenges

SPARC SuperCluster

ZDLRA

⟹
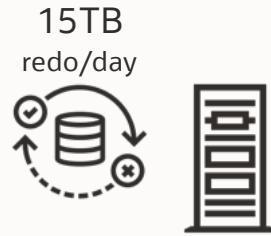
Exadata X9M Extreme Flash

5 Physical Standby DBs
Local, and in different region, 2500km away

Constraints

Limiting factors, and other things to know

Up to 15TB redo/day is beyond what Oracle GoldenGate will be able to synch

The system is highly active 24 x 7 x 365

Photo by Mihály Köles on Unsplash

Very large database, very constrained downtime

- 180+ TB database size
- 5-6 TB growth/month
- Every minute of downtime costs $$$
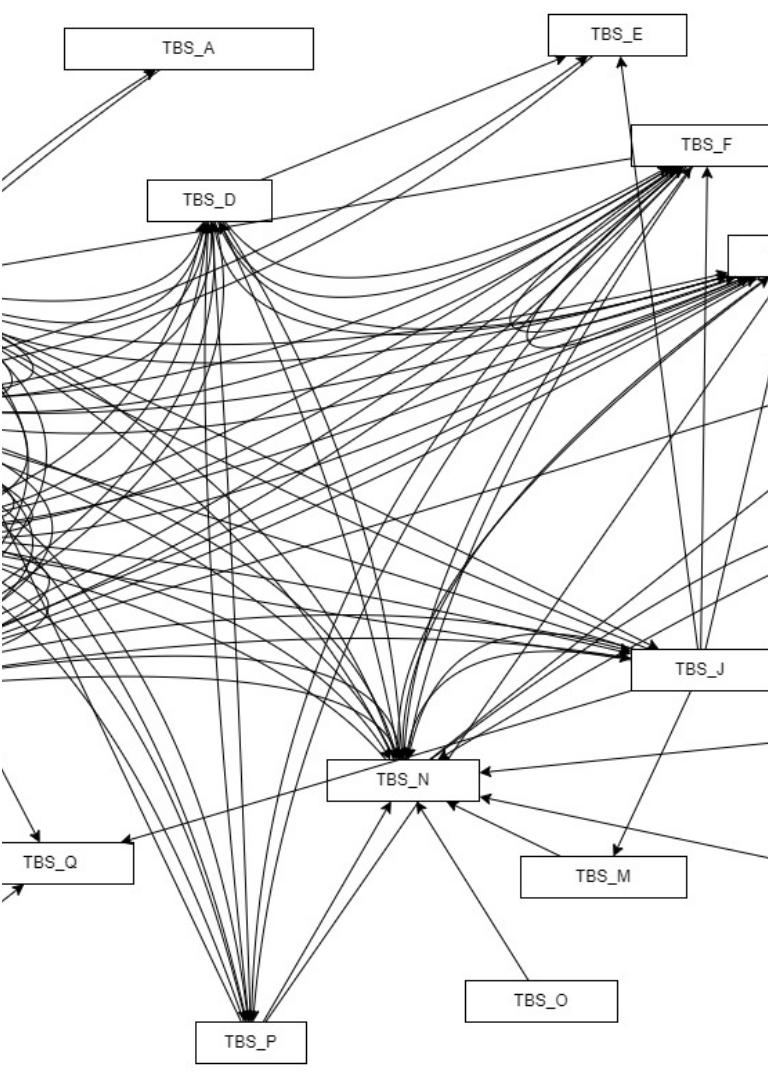
Migrating tablespaces upfront or separately definitely not an option

- Way too many cross-dependencies
- Tablespaces aren't isolated
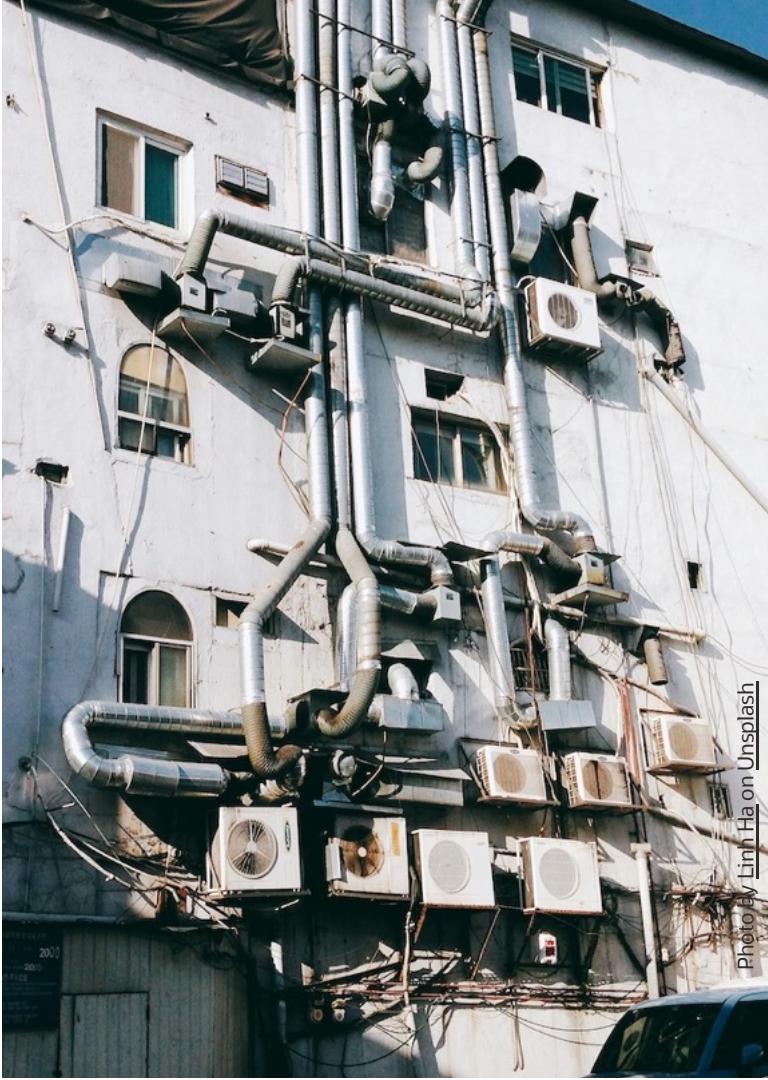
Every complex Oracle data type you can imagine is used

- XML binary types
- Nested partitioned tables
- Evolved object types

Photo by Masaaki Komori on Unsplash

Tight downtime window

- Dry run: 2 hours outage approved
  - Tablespaces read-only
  - Full Transportable Export

- Live migration: 13 hours approved

The available Oracle V4 PERL migration scripts would have been worked technically, but ...

- No section-size backup support
- No standby backup support
- No selective PDB migration support

Photo by Morganel Le Breton on Unsplash

Migration

Typically, we use Full Transportable Export/ Import for large cross-endian migrations

Concept

Source

~~Start Clone~~
~~Shutdown~~
Source

Data Pump
Full Transportable
Export/Import

Target
PDB
26ai

⇒

Read-only

— SYSTEM
— SYSAUX
— USERS
— DATA

— SYSTEM
— SYSAUX
— USERS
— DATA

Tablespaces
~~Metadata import~~
different endian format
(users, tables, indexes, triggers, PL/SQL, ...)

~~Tablespace~~
Not plugged in
plug-in

~~Fiall over backup~~ ~~Restore and~~
~~recover~~
convert
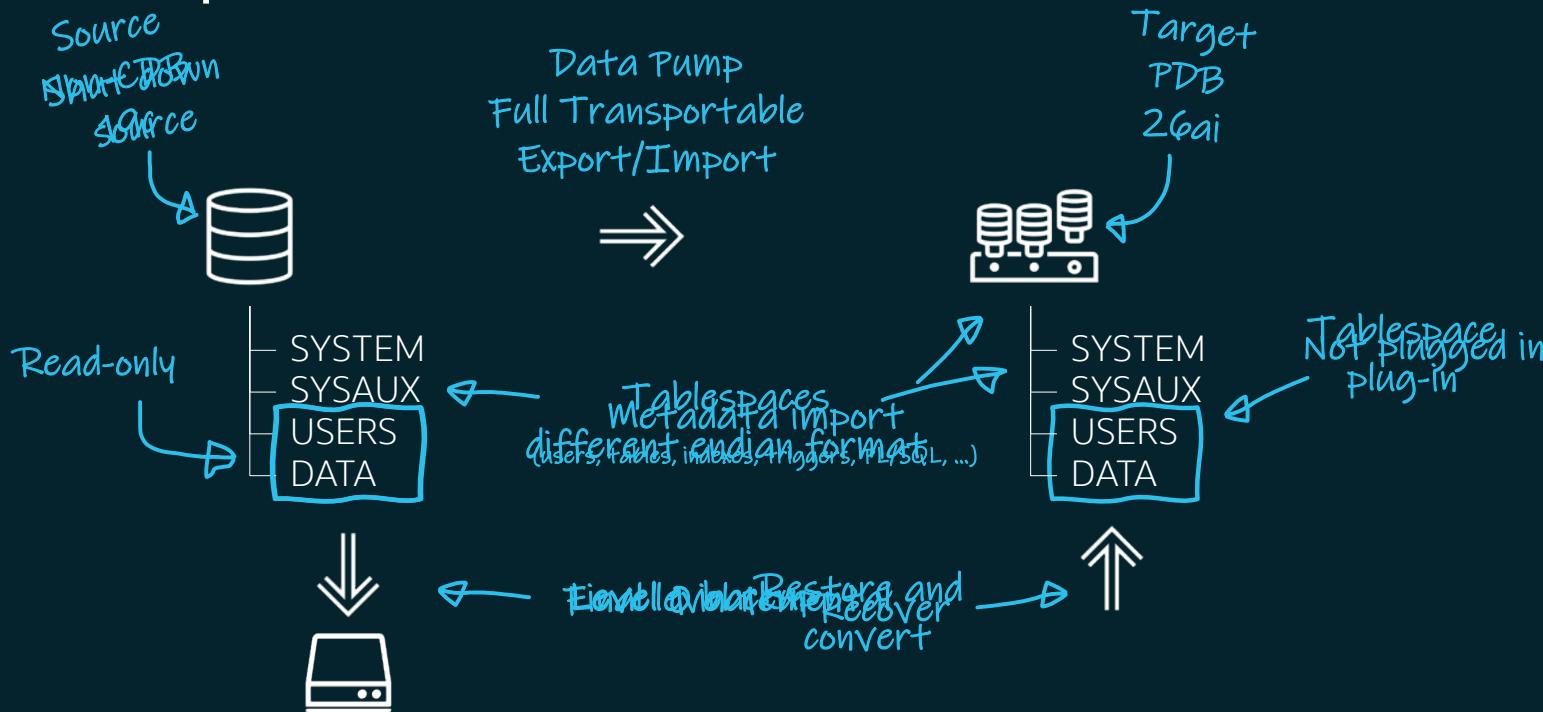
Scripts for Incremental Backup Automation

Backup / restore / recover

2018

2024

XTTS v1
Doc ID 1389592.1

XTTS v2
Doc ID 1389592.1

XTTS v3
Doc ID 1389592.1

XTTS v4
Doc ID 2471245.1

M5
Doc ID 2999157.1

- No multisection backups
- No encrypted tablespaces
- Inefficient parallelism
- Incomplete multitenant support

M5 is the next-generation cross-platform transportable tablespace procedure

- New RMAN functionality combined with Full Transportable Export/Import
- Doc ID 2999157.1

M5 Migration Script

The new migrations scripts superseeding the V4 PERL scripts

```
# source database
RUN
{
ALLOCATE CHANNEL d1 DEVICE TYPE DISK FORMAT '...';
ALLOCATE CHANNEL d2 DEVICE TYPE DISK FORMAT '...';
BACKUP
        FILESPERSET 1
        SECTION SIZE 64G
        TAG UP19_L0_240206101548
        TABLESPACE <list-of-tablespace>;

}
```

```
# source database
RUN
{
ALLOCATE CHANNEL d1 DEVICE TYPE DISK FORMAT '...';
ALLOCATE CHANNEL d2 DEVICE TYPE DISK FORMAT '...';
BACKUP
      FILESPERSET 1
      SECTION SIZE 64G
      TAG UP19_L0_240206101548
      TABLESPACE <list-of-tablespace>;
}
```

```
# target database
RUN
{
ALLOCATE CHANNEL DISK1 DEVICE TYPE DISK FORMAT '...';
ALLOCATE CHANNEL DISK2 DEVICE TYPE DISK FORMAT '...';
RESTORE ALL FOREIGN DATAFILES TO NEW FROM BACKUPSET
'<backup-set-1>',
'<backup-set-2>',
...
'<backup-set-n>'
};
```

Benefits

M5 procedure supports:

- Encrypted tablespaces

- Multisection backups

- Migrating multiple databases into the same CDB simultaneously

- Compressed backup sets

- Better parallelism

Requirements

- Source and target database must

  - be 19.18.0 or higher

  - use Data Pump Bundle Patch

Always use the latest version of M5 script

- Download from Doc ID [2999157.1](2999157.1)

Use Block Change Tracking for faster incremental backups

- Check the License Guide for details

Migration Plan

M5 Workflow

Configure	Level 0	Level 1	Outage	Final Backup	Final restore	Export Import

SPARC
SuperCluster

Local standby

ZDLRA

Exadata
X9M Extreme Flash

M5 Workflow

Configure → Level 0 → Level 1 → Outage → Final Backup → Final restore → Import
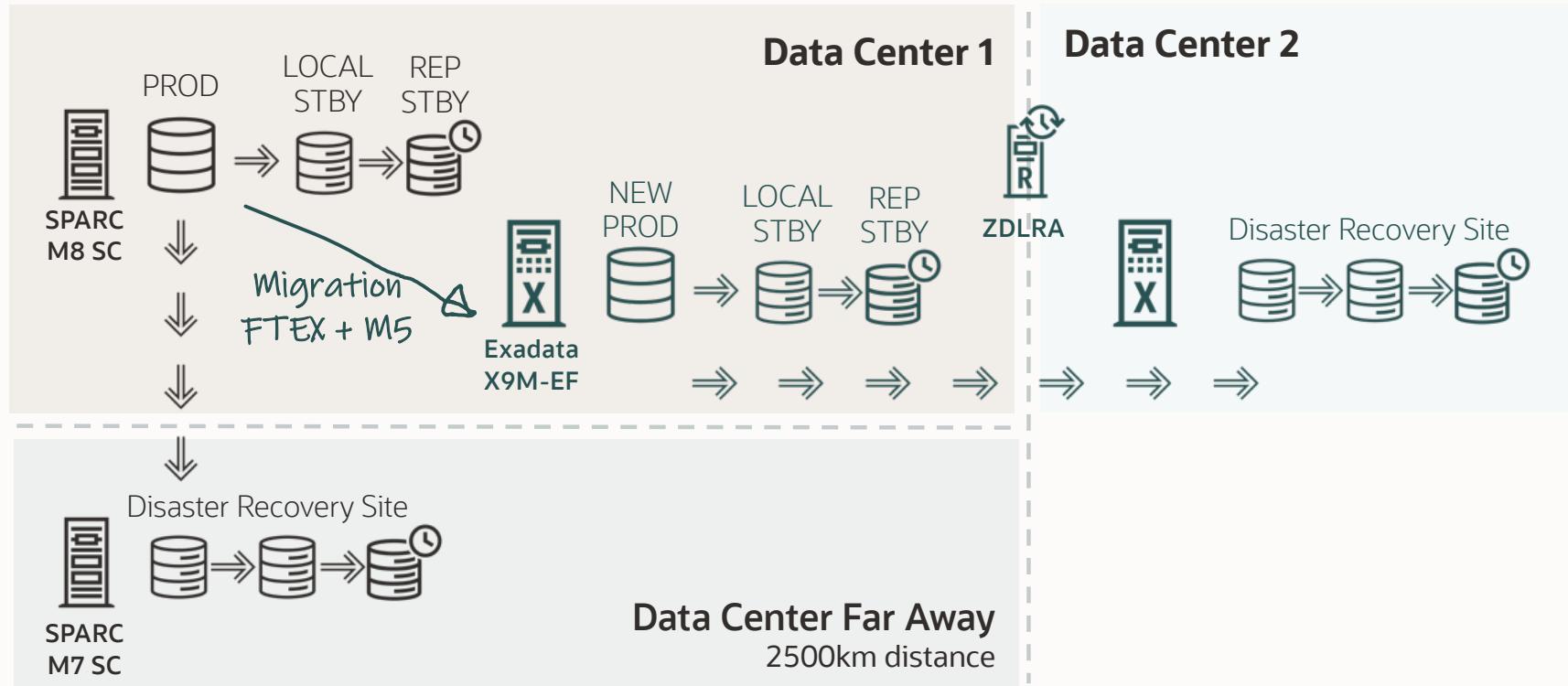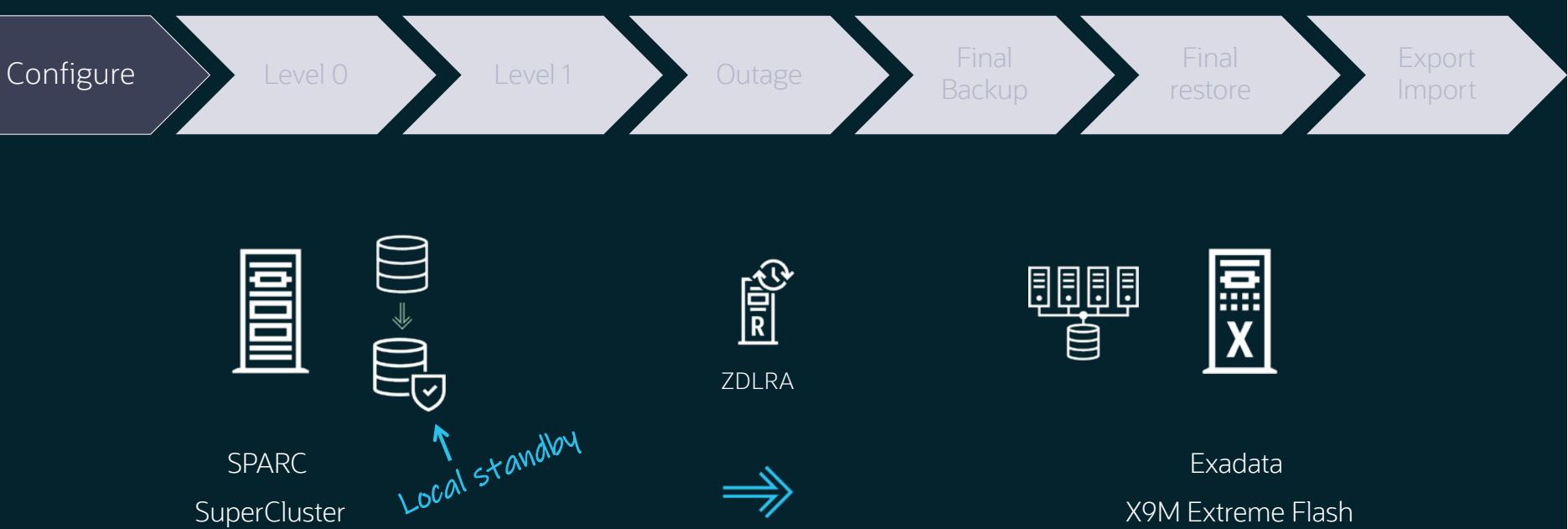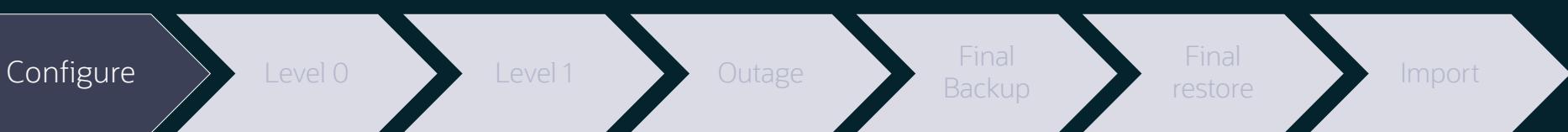
- Download M5 script from Doc ID 2999157.1

- Configure shared NFS
- Edit `dbmig_ts_list.txt`
- Edit `dbmig_driver.properties`

- Create new, empty target database

M5 Workflow

| Configure | Level 0 | Level 1 | Outage | Final Backup | Final restore | Export Import |

SPARC
SuperCluster

ZDLRA

Exadata
X9M Extreme Flash

M5 Workflow

Configure → **Level 0** → Level 1 → Outage → Final Backup → Final restore → Import
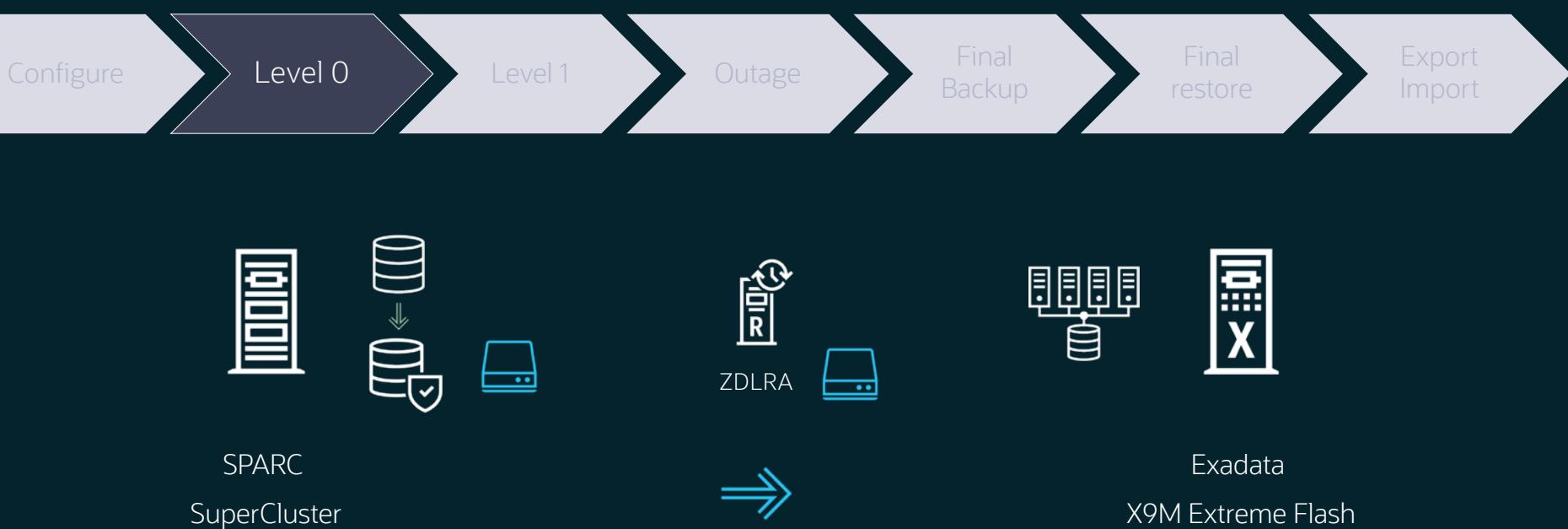
- Start initial level 0 backup
  - Use driver script `dbmig_driver_m5.sh` `L0`

- Driver script creates a restore script
  - Restore using `restore_L0_<source_sid>_<timestamp>.cmd`
- Check logs

M5 Workflow

| Configure | Level 0 | **Level 1** | Outage | Final Backup | Final restore | Export Import |

SPARC
SuperCluster

ZDLRA

Exadata
X9M Extreme Flash

M5 Workflow

| Configure | Level 0 | Level 1 | Outage | Final Backup | Final restore | Import |
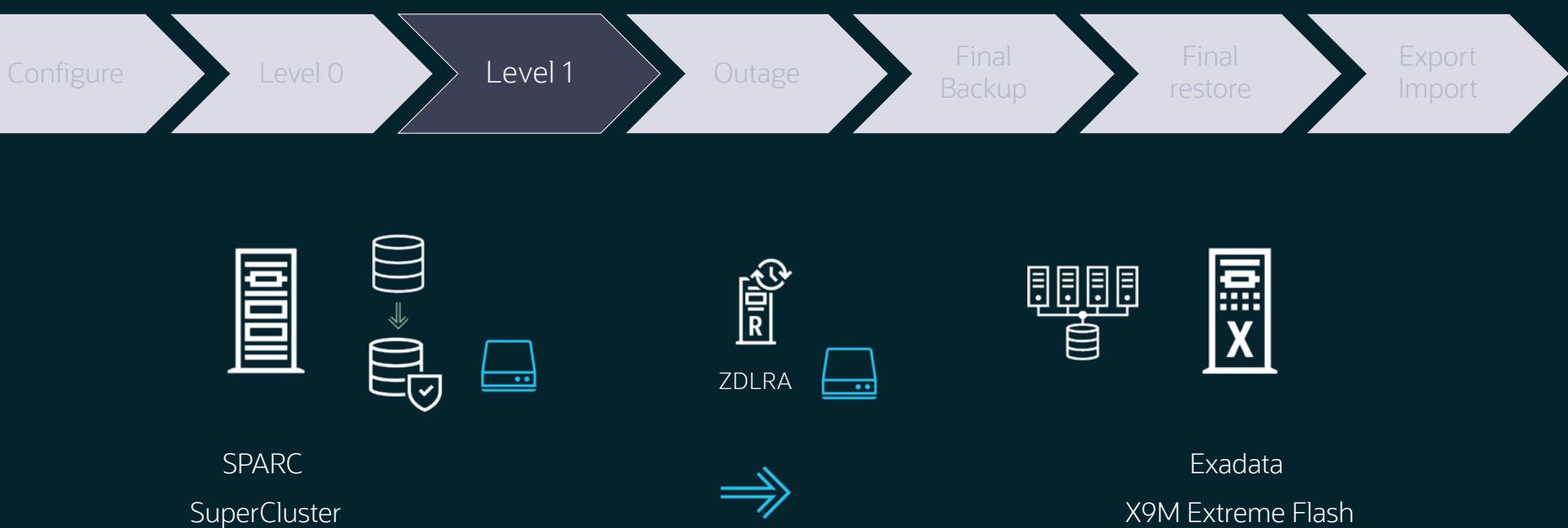
- Start level 1 incremental backup
  - Use driver script `dbmig_driver_m5.sh` `L1`

- Driver script creates a restore script
  - Restore using `restore_L1_<source_sid>_<timestamp>.cmd`
- Check logs

- Repeat as often as desired

M5 Workflow

| Configure | Level 0 | Level 1 | Outage | Final Backup | Final restore | Export Import |

SPARC

SuperCluster

ZDLRA

Exadata

X9M Extreme Flash

M5 Workflow

Configure → Level 0 → Level 1 → **Outage** → Final Backup → Final restore → Import
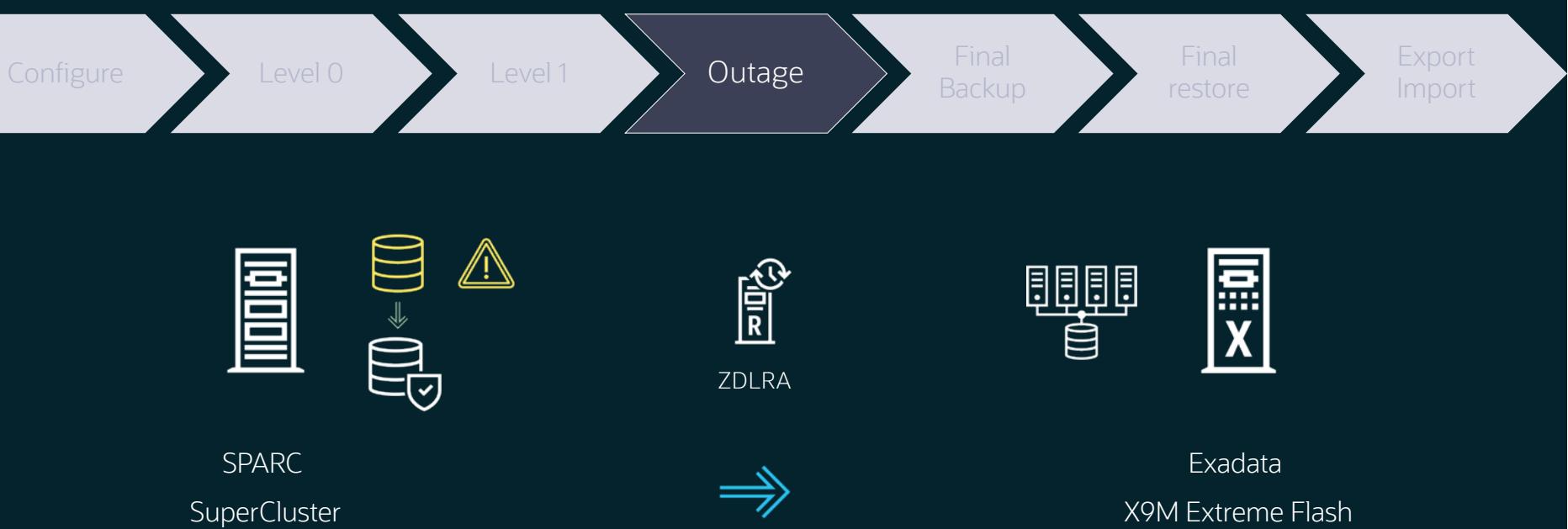
- Maintenance window begins
- Read-only sessions can still use the database

M5 Workflow

Configure	Level 0	Level 1	Outage	Final Backup	Final restore	Export Import

SPARC

SuperCluster

ZDLRA

Exadata

X9M Extreme Flash

M5 Workflow

Configure	Level 0	Level 1	Outage	Final Backup	Final restore	Import
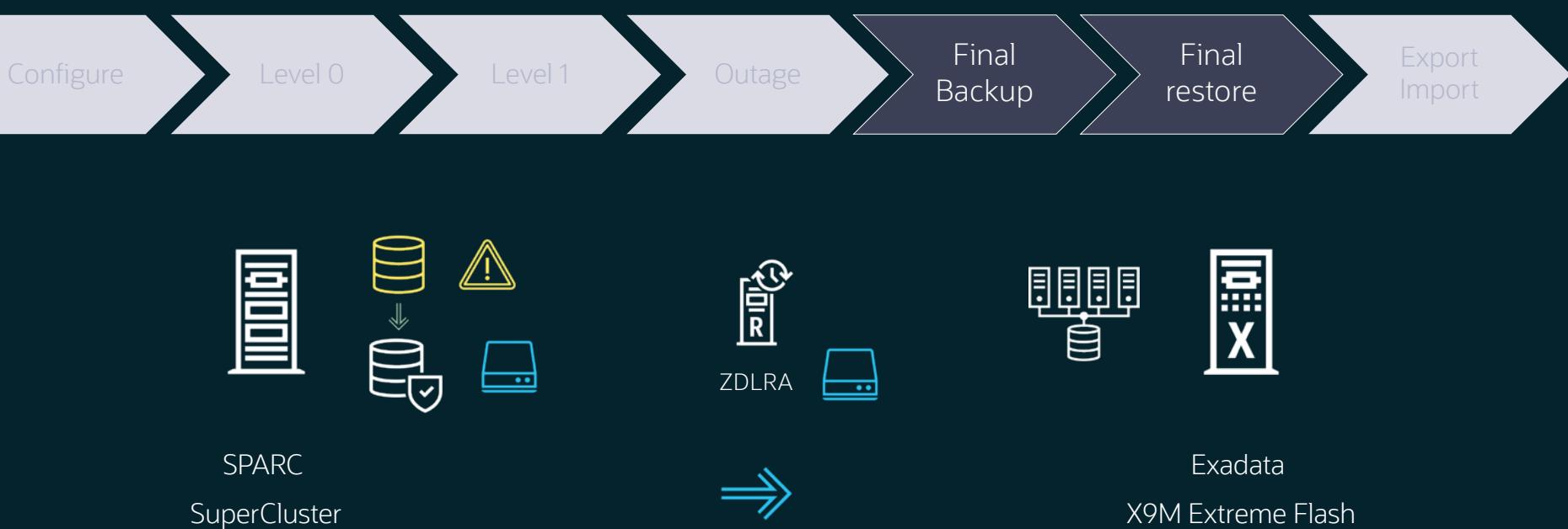
- Start final level 1 incremental backup
  - Use driver script `dbmig_driver_m5.sh` `L1F`

  - Sets tablespaces read-only
  - Performs level 1 incremental backup
  - Starts Data Pump full transportable export

- Optionally, shuts down source database

M5 Workflow

Configure	Level 0	Level 1	Outage	Final Backup	Final restore	Import

- Driver script created a restore script
  - Restore using `restore_L1F_<source_sid>_<timestamp>.cmd`
- Check logs

M5 Workflow

Configure	Level 0	Level 1	Outage	Final Backup	Final restore	Export Import

SPARC

SuperCluster

ZDLRA

Exadata

X9M Extreme Flash

M5 Workflow

Configure	Level 0	Level 1	Outage	Final Backup	Final restore	Import

- Copy Data Pump dump file to *DATA_PUMP_DIR*

- Use import driver script in test mode
  - Start `impdp.sh` *<dump_file>* *<restore_log>* `test`
- Check generated parameter file
  - Use `impdp.sh` *<dump_file>* *<restore_log>* `run`

- Check Data Pump log file

Wanna try it out?
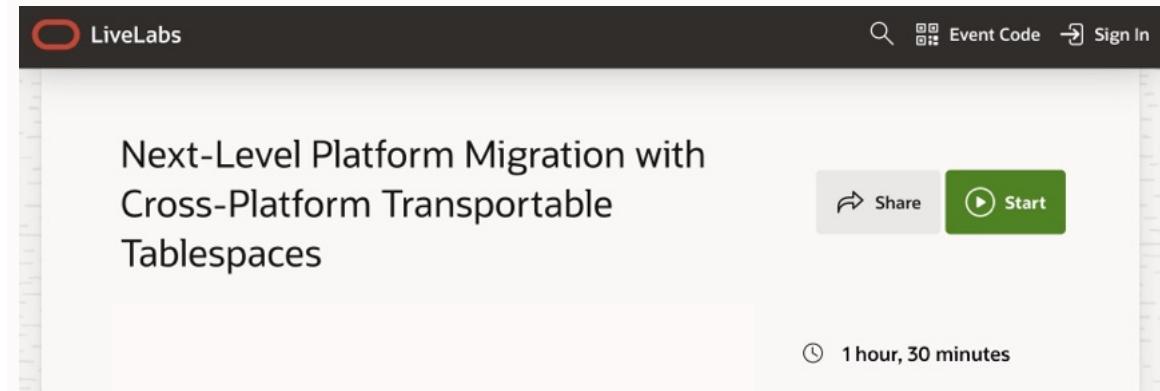
SCAN ME

LiveLabs

Next-Level Platform Migration with Cross-Platform Transportable Tablespaces

Share · Start

1 hour, 30 minutes

Oracle LiveLabs – Run the lab just inside your browser!

The Project Plan

Timelines and the Run Book

Overall Project Timeline

PoC, HW order   Initial tests, HW setup   Migration Tests, Bug Fixing, Standby   Stress Test   Go-live

May 2022

Information exchange and first meeting

Apr 2023

Hot phase started Exec Escalation

Oct 17, 2023

Live migration completed successfully

Oct 2022

Exadata and ZDLRA setup

2021/2022

PoC Phase HW order & delivery

Dec 2022

First mild escalation

Oct 3, 2023

Real dry run with PROD and FTEX downtime

Key to Success: Runbook

Complex projects absolutely require a detailed runbook

ID	Task	Status	Responsible Primary Person	Responsible Secondary Person	Predecessor	Start Time (CEST)	Duration (hh:mm)	End Time (CEST)	Start Time (IST)	End Time (IST)	Actual Start Time (CEST)	Actual Duration	Actual End Time (CEST)	Comments - Blocker

- This run book covered over 200 individual tasks

Timeline Live Migration

Task	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00

How many people were involved?

6 DBAs

4 DB developer

2-3 infrastructure

2 network

10 testing

War Room

Managers

2 data center engineers

2 monitoring, communication

4 product engineering

4 compliance

Migration Issues

Some of them...

Where we started ...

PoC first FTEX export:

```
01-OCT-21 05:32:36.275: Job "SYSTEM"."SYS_EXPORT_FULL_01" successfully completed at
Fri Oct 1 05:32:36 2021 elapsed 0 04:25:22
```

PoC first FTEX import:

```
05-OCT-21 01:48:59.534: Job "SYSTEM"."SYS_IMPORT_FULL_01" completed with 103000
error(s) at Tue Oct 5 01:48:59 2021 elapsed 3 18:34:09
```

The way forward ...

80 SRs opened and solved in various areas

Migration
ZDLRA
Standby
Infrastructure

18 one-off patches

5 merges

Daily calls with Oracle, countless evening / night / weekend hours

Many areas required special attention....

Optimizer Statistics

Scheduler jobs

Resource Manager

Cross Schema objects

AQ

Evolved Types/partitioned nested tables

Binary XML

Standby DBs

...

Issue 1 | Long Running Metadata Import

Fix applied to remedy export errors

- `BUG 34201281 - MERGE ON DATABASE RU 19.12.0.0.0 OF 33963454 34052641`

Result:

- Now Full Transportable import alone took over 6 days (!!)

```
08-JUN-22 16:21:17.887: W-1 Processing object type DATABASE_EXPORT/.../PROCACT_INSTANCE
14-JUN-22 18:56:58.813: W-1       Completed 108 PROCACT_INSTANCE objects in 527737 seconds
…
14-JUN-22 19:15:50.016: Job "SYSTEM"."SYS_IMPORT_TRANSPORTABLE_01" completed with 316 error(s)
                              at Tue Jun 14 19:15:49 2022 elapsed 6 06:45:38
```

Issue 1 | Long Running Meta Import

Long running action identified via tracing:

```
UPDATE "POSTMAN"."T_MAIL_LOG"
       SET "C_CVAR"=SYS_REMAP_XMLTYPE("C_CVAR")
```

- 300+ million rows

Issue in internal package DBMS_CSX_INT

- Fast merge of XMLTYPE is not happening as expected
  - *Reason:* Incorrect internal check query
- Tokens between source and target are not identical
  - *Reason:* Different Endianness

Issue 1 | Long Running Meta Import

Solution:

- Use workaround from MOS Note: 2309649.1 in UPGRADE mode
    - MOS Note: 2309649.1 - How to Migrate Large Amount of Binary XML Data between Databases

```
25-JUL-22 12:28:40.813: Job "SYSTEM"."SYS_IMPORT_TRANSPORTABLE_01" completed
with 317 error(s) at Mon Jul 25 12:28:40 2022 elapsed 0 04:33:03
```

Issue 2 | Metadata API and Nested Tables

Full transportable import errors out for a nested partitioned table

```
PLS-00172: string literal too long
ORA-39151: Table "DBA_XY"."X_GAMES" exists.
          All dependent metadata and data will be skipped due to table_exists_action
```

Root cause was a string overflow in the Metadata API

- Data Pump creates the index, and then alters it – here the overflow happened
- Side effect was a misleading error message

Issue 3 | Data Pump Bundle Patch

Many of the TTS and Metadata fixes got included into Data Pump Bundle

- Data Pump Recommended Proactive Patches For 19.10 and Above (Doc ID 2819284.1)

RU 19.12.0

| Starting Point |

DPBP 19.14.0

| Fixes missing |

DPBP 19.15.0

| Fixes missing |

DPBP 19.16.0

| Fixes missing |

DPBP 19.17.0

| Regression |

RU 19.18.0
DPBP 19.18.0

| Migration Release
All required fixes
are included |
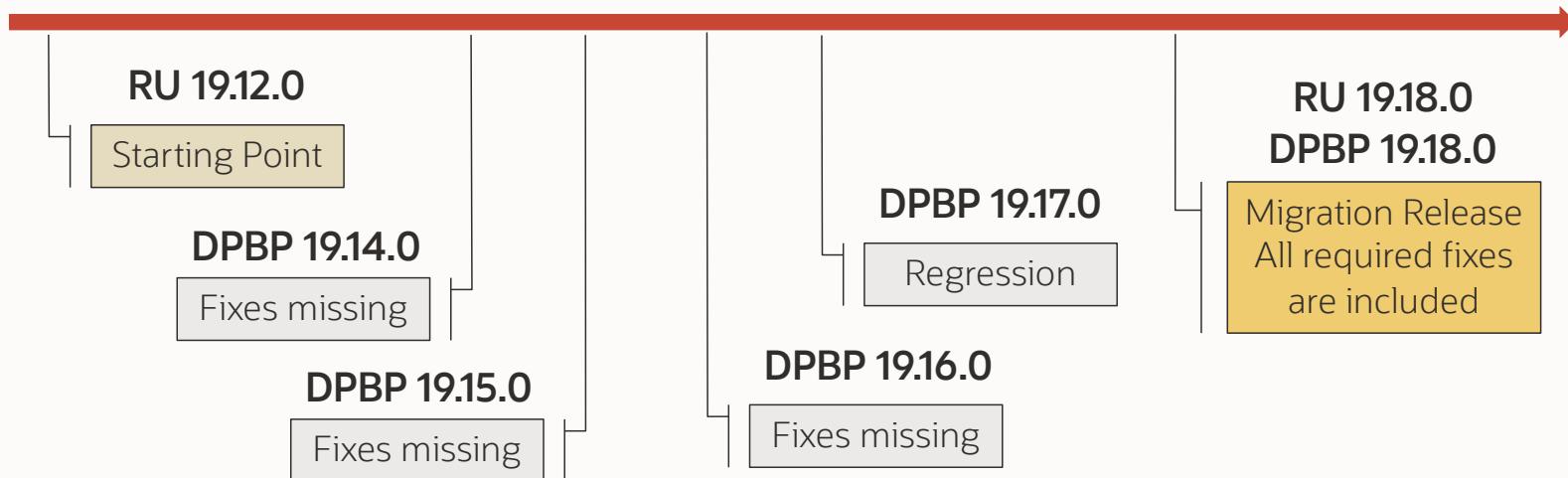
Issue 4 | Evolved Object Types

Evolved `TYPE`s can lead to Data Pump errors during transportable import:

```
ORA-39083: Object type TABLE:"APPUSER"."CARS" failed to create with error:
ORA-39218: type check on object type "APPUSER"."CAR_TYPE" failed
ORA-39216: object type "APPUSER"."CAR_TYPE" hashcode or version number mismatch
```

Further Information:

- Blog Post: Understand why Data Pump errors with evolved types
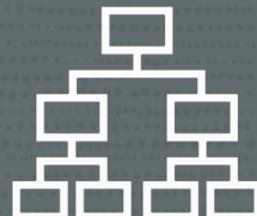
Using evolved types in table definitions

```
--Create a new type. The type is now version 1
--Use the type in a table
CREATE TYPE CAR_INFO_TYPE IS OBJECT (model VARCHAR2(40));
CREATE TABLE CARS (id number, car_info car_info_type);
INSERT INTO CARS VALUES (1, car_info_type('Volvo V90'));


--Make a change to the type. The type is now version 2
ALTER TYPE CAR_INFO_TYPE ADD ATTRIBUTE horsepower NUMBER CASCADE NOT INCLUDING TABLE DATA;
INSERT INTO CARS VALUES (2, car_info_type('BMW 530i', 250));


--Make another change to the type. The type is now version 3
ALTER TYPE CAR_INFO_TYPE ADD ATTRIBUTE color VARCHAR2(20) CASCADE NOT INCLUDING TABLE DATA;
INSERT INTO CARS VALUES (3, car_info_type('Hyundai Sonata', 160, 'Black'));
```

The type is now evolving

Existing data is not updated

Evolved Types

```
SELECT * FROM CARS
```

⇓

CARS	
1	car_info_type v1: Volvo V90
2	car_info_type v2: BMW 530i, 250
3	car_info_type v3: Hyundai Sonata, 160, Black

→

DICTIONARY	
car_info_type v1	model
car_info_type v2	model, horsepower
car_info_type v3	model, horsepower, color

Data Pump recreates types during
Full Transportable Export/Import

Evolved Types

- To avoid data corruption,
  Data Pump must recreate the <u>exact</u> same type evolution in target database

- Due to implementation restrictions,
  it is not always possible to recreate the exact same type evolution

- In such situations, to avoid corruption,
  Data Pump reports `ORA-39218` or `ORA-39216` on import

Evolved Types | Possible Solutions

1   Conventional Data Pump export

2   Manually recreate type in target database with matching evolution

3   Recreate type without evolution before export

Blog post with details

Issue 5 | Advanced Queueing

Source database

Queue table

<queue_table_name>
AQ$_<queue_table_name>_E
AQ$_<queue_table_name>_I
AQ$_<queue_table_name>_T
AQ$_<queue_table_name>_F
AQ$_<queue_table_name>_C
AQ$_<queue_table_name>_D
AQ$_<queue_table_name>_G
AQ$_<queue_table_name>_H
AQ$_<queue_table_name>_L
AQ$_<queue_table_name>_P
AQ$_<queue_table_name>_S
AQ$_<queue_table_name>_V

Queue infrastructure

$\Rightarrow$

Target database

<queue_table_name>
AQ$_<queue_table_name>_E
AQ$_<queue_table_name>_I
AQ$_<queue_table_name>_T
AQ$_<queue_table_name>_F
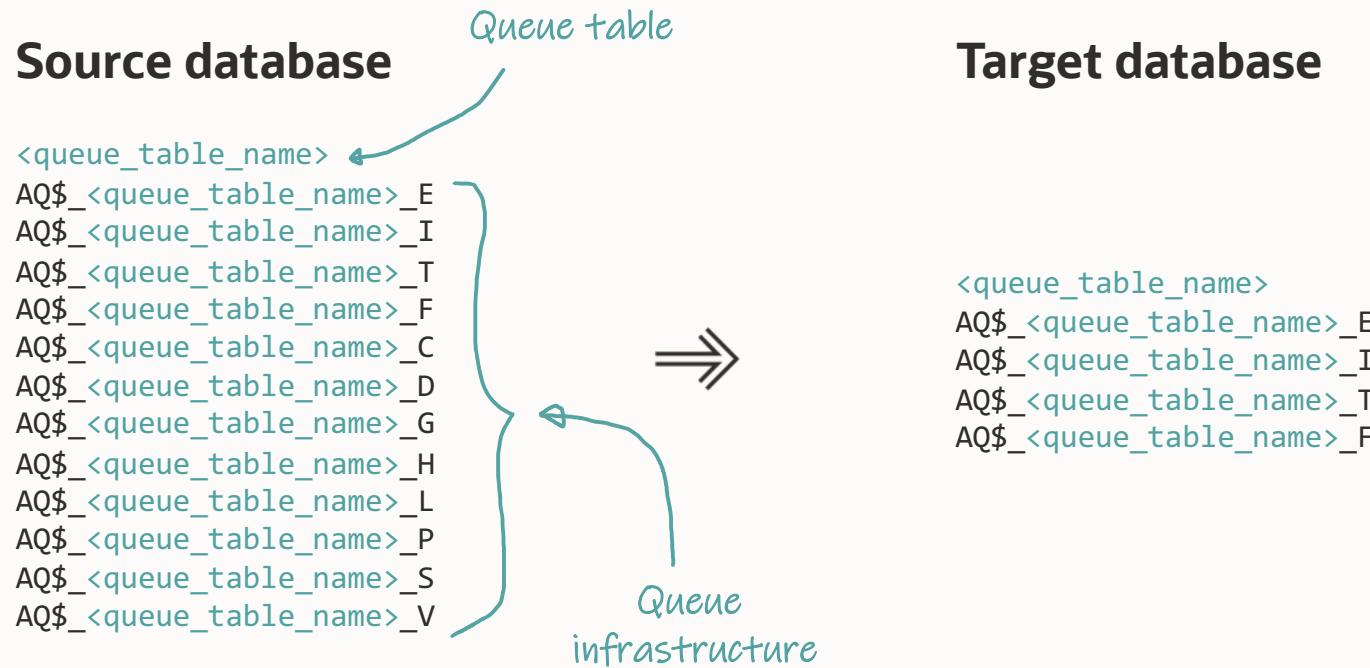
Issue 5 | Advanced Queueing

Queue tables and underlying objects may change during import

- `COMPATIBLE` **during creation** of queue tables matters
- `COMPATIBLE` **during import** matters as well
- MOS Note: 2291530.1 - Understanding How AQ Objects Are Exported And Imported
- Blog post: Changing data types in queue tables during import

Options:

- Recreate the queue tables with "old" `COMPATIBLE` setting
- Benefit from new `COMPATIBLE` setting and test the application

Take into account when comparing source and target databases' object count

- Understanding How Advanced Queueing (AQ) Objects Are Exported And Imported (Doc ID 2291530.1)

Data Pump does not start queues

- Manually start queues after migration
- Use `DBMS_AQADM.START_QUEUE`

Issue 6 | Default Tablespaces

Due to a security fix export wants to write into the user's default tablespace

- Bug 27692190
- But default tablespaces are read-only while full transportable export runs

Workaround:

- Change default tablespace for all users to SYSTEM
- Full Transportable Export
- Full Transportable Import
- Revert default tablespaces back to original in target (and source)

Issue 7 | Exporting Statistics

Exporting statistics is slow using
`DBMS_STATS.EXPORT_SCHEMA_STATS`

8h

10046 trace reveals long runtime on:
EXP_STAT$
EXP_OBJ$

Expression Statistics for Auto-Indexing

Default: `_column_tracking_level`=53;

Issue 7 | **Exporting Statistics**

Solution? → Clean up expression statistics in:
EXP_STAT$
EXP_OBJ$

↓

MOS Note: 2803002.1

↓

DBMS_STATS.EXPORT_SCHEMA_STATS
results in:
ORA-00600 [qosdExpStatRead: expcnt mismatch]

Issue 7 | Exporting Statistics

Solution?

Fix for Bug 31143146

Included since RU 19.12.0

<u>Disabled</u> by default

```
exec dbms_optim_bundle.set_fix_controls('31143146:1','*', 'BOTH','YES');
```

DBMS_STATS.EXPORT_SCHEMA_STATS works fast and flawless

_column_tracking_level=1
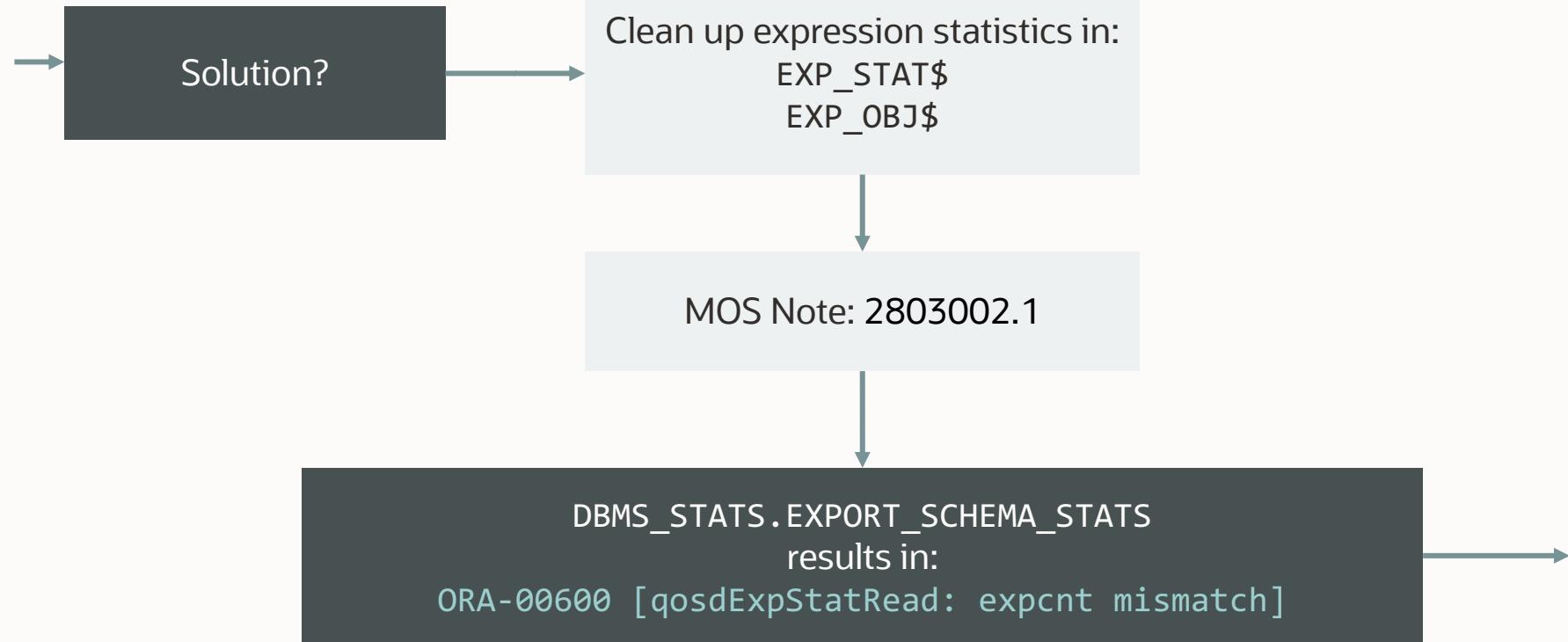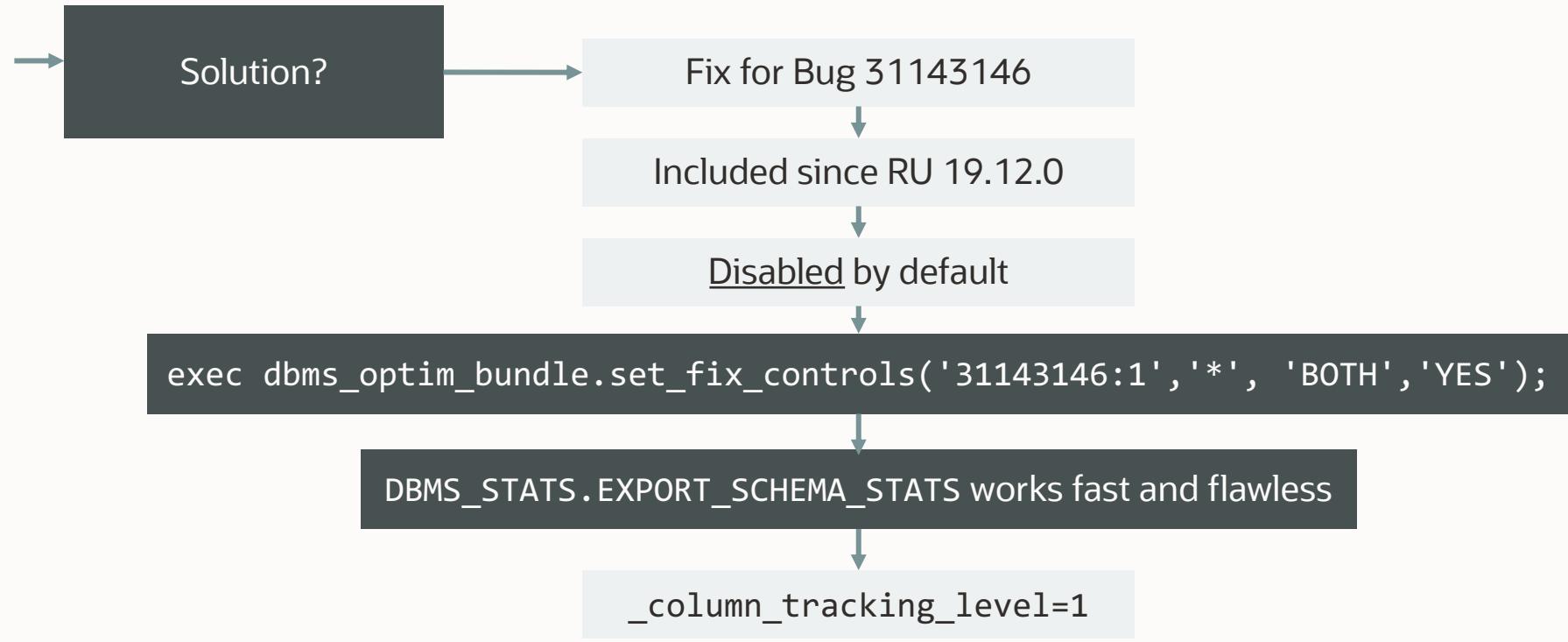
Issue 8 | Auditing

Tablespaces containing auditing tables can't be set read-only

Data Pump always unloads the audit records into the dump file
- Huge audit trail will lead to a huge dump file and longer outage

Options:
- Export audit records, and eventually import them afterwards
- Archive audit records, purge the audit trail

Key Learnings

1   Practice, practice, practice

2   Create a detailed runbook

3   Work together

AI changes everything

"AI won't replace humans - but humans with AI will replace humans without AI"

Karim Lakhani

Filter

| Year ▼ | Genre ▼ | Nominations | Awards |

Question

Message

Motivational movies about athletics

35

Search Type

⦿ **Text Search** ○ Vector Search

Search

Results

	Title	Awards	Year	Nominations	Genre
	Goodbye Columbus	NONE	1969	Academy Award for Best Writing,Adapted Screenplay	Romance,Comedy,Family
	The Formula	NONE	2002	NONE	Unknown
	Batman Returns	NONE	1992	Academy Award for Best Makeup and Hairstyling,Academy Award for Best Visual Effects,MTV Movie Award for Best Villain	Film-Noir,Action,Family,Fantasy

Why *Batman Returns*?

"Motivational Movies about Athletics"

NJQ15253, Batman Returns, 1992, https://upload.wikimedia.org/wikipedia/en/8/83/Batman_returns_poster2.jpg, 'Film-Noir, Action, Family, Fantasy', 'Academy Award for Best Makeup and Hairstyling, Academy Award for Best Visual Effects, MTV Movie Award for Best Villain', , Batman Returns is a 1992 American superhero film directed by Tim Burton and produced by Denise Di Novi and Burton, based on the DC Comics character Batman. The sequel to the 1989 film Batman , it is the second installment of Warner Bros. initial Batman film series, and stars Michael Keaton as Bruce Wayne / Batman, alongside Danny DeVito, Michelle Pfeiffer, Christopher Walken, Michael Gough, Pat Hingle and Michael Murphy. In Batman Returns , Batman faces the Penguin, who plots to kill all of Gotham City's firstborn sons, while dealing with Catwoman, who seeks vengeance against Max Shreck, a corrupt tycoon who allies with the Penguin to bring Gotham City under his control. Burton originally did not want to direct another Batman film. Warner Bros. developed a script with Sam Hamm which had the Penguin and Catwoman going after hidden treasure. Burton agreed to return after they granted him more creative control and replaced Hamm with Daniel Waters. Wesley Strick was later chosen to do an uncredited rewrite shortly before filming. This included normalizing dialogue, fleshing out the Penguin's motivations and master plan, and removing scenes due to budget concerns. Strick continued working as the on-set writer through filming. Annette Bening was originally cast as Catwoman, but became pregnant and was replaced with Pfeiffer. Batman Returns was released on June 19, 1992. It grossed $266.8 million worldwide on a total budget of $80 million and received positive reviews. Critics praised its action sequences, performances, Danny Elfman's score, effects and villains, although its dark tone and high level of violence for a PG-13 film, was criticized. The film was nominated for two Academy Awards: Best Visual Effects and Best Makeup, as well as two BAFTA awards. A stand- alone sequel, Batman Forever , was released in 1995, with Val Kilmer replacing Keaton as Batman. An alternate comic book continuation, which ignores the events of the subsequent films, will be published by DC Comics starting in July 2021. Keaton is also set to reprise the role of Batman in the DC Extended Universe beginning with The Flash (2022).

Filter

Year	Genre	Nominations	Awards

Question

Message

Motivational movies about athletics

35

Search Type

○ Text Search   ● **Vector Search**

Search

Results

	Title	Awards	Year	Nominations	Genre
	The Do-Deca-Pentathlon	NONE	2012	NONE	Comedy
	Champions	NONE	2023	NONE	Comedy,Sport
	Across the Tracks	NONE	1991	NONE	Drama,Action
	Hustle	NONE	2022	NONE	Sport
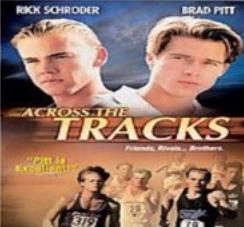
Results
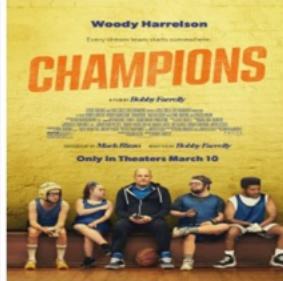
	Title	Awards	Year	Nominations	Genre
	Champions	NONE	2023	NONE	Comedy,Sport
	Sweetwater	NONE	2023	NONE	Biography,Sport
	80 for Brady	NONE	2023	NONE	Sport,Comedy

Oracle AI Database can store AI vectors and use them to find similar objects
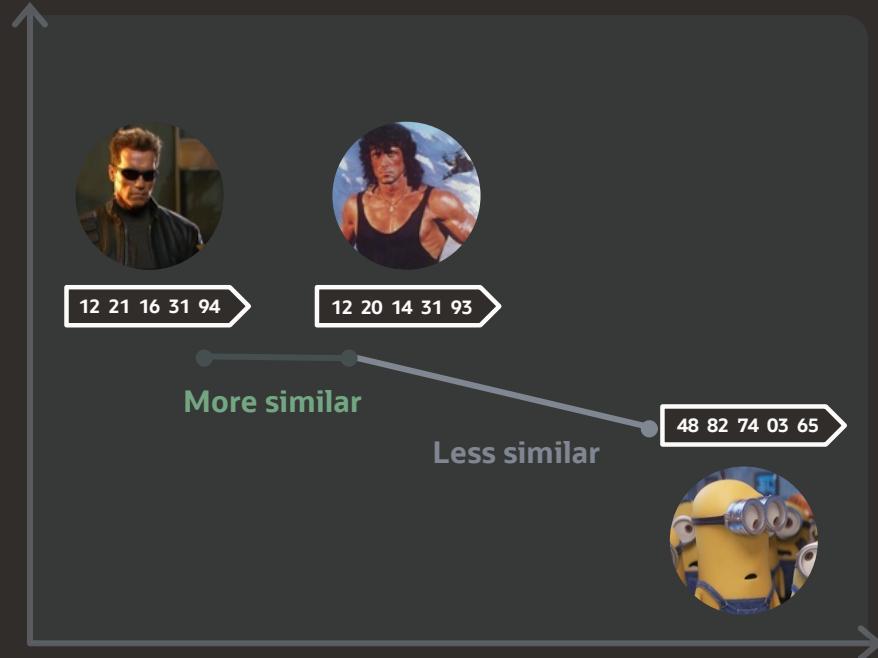
12 21 16 31 94

12 20 14 31 93

More similar

48 82 74 03 65

Less similar

Unify AI Vector Search with all types of data, not just relational

33
42
16
21
50

Vector

+

XML

{JSON}

Spatial

Graph

Relational

Text
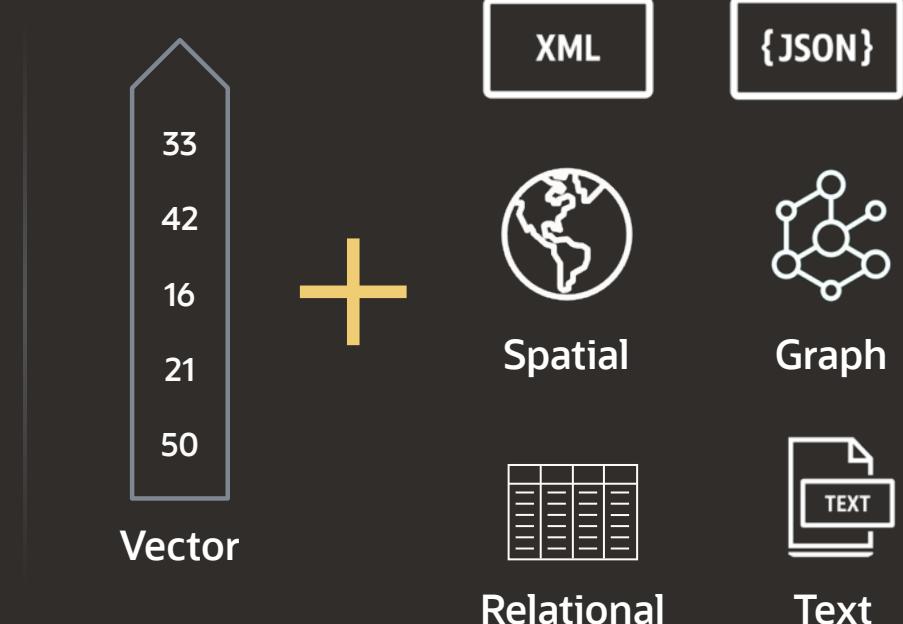
Easily pass results of search to LLM to answer the question

Does my dental plan cover braces for my 19-year-old?

AI Vector Search

[1,4,8]

Dental Benefits

LLM

Yes, your "Dental Plus" plan covers braces for your children until they are 21 years old.

Retrieval Augmented Generation

Vector Database

- New data type: `VECTOR`

- A vector is
  *a numerical representation of data
  that captures key features and relationships of the data*

Vector Database


```
CREATE TABLE movies (
    id           NUMBER,
    description CLOB,
    photo        BLOB,
    my_vector    VECTOR(768, FLOAT32));
```

It's just an array ...

| 50 | 21 | 16 | 42 | 33 |

The dimension is "how many numbers"

Vector Database
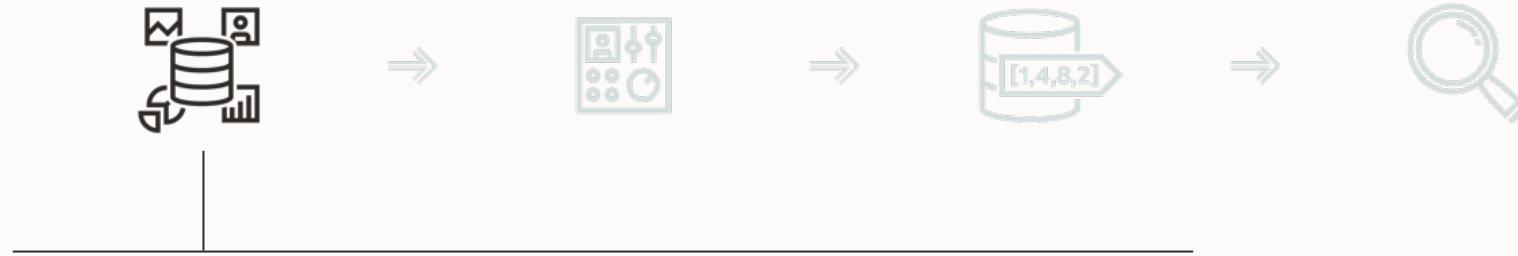
- Your data is already in the database

- How do you perform a semantic search instead of a literal search?

Comparing numbers is trivial

`100 > 50 = true`

How to compare complex data types?

How to search for search complex data types?

Vector Database

- Search vector data using vector indexes

- Calculate the vector distance

2   6   2   3

Type of movie

2 6 2 3

Mood

2 6 2 3 ⟷ 3 1 2 8
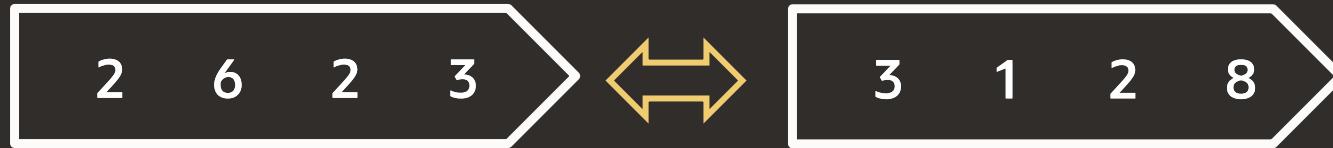
Distance (Euclidean Squared)
$= (3-2)^2+(1-6)^2+(2-2)^2+(8-3)^2$

Vector Database


```
SELECT    ...
FROM      movies
ORDER BY vector_distance(movie1, movie2, EUCLIDEAN_SQUARED);
```

d_1

Comedy

The Mask

Ace Ventura

Shrek

Monty Python

Action

Predator

Rambo

Delta Force

James Bond

Band of Brothers

Sci-Fi

Star Wars

Star Trek

Starship Troopers

d_2

Comedy

The Mask

Ace Ventura

Shrek

Monty Python

Action

Predator

Rambo   Terminator   Delta Force

James Bond

Band of Brothers

Sci-Fi

Star Wars   Star Trek

Starship Troopers

d_1

d_2
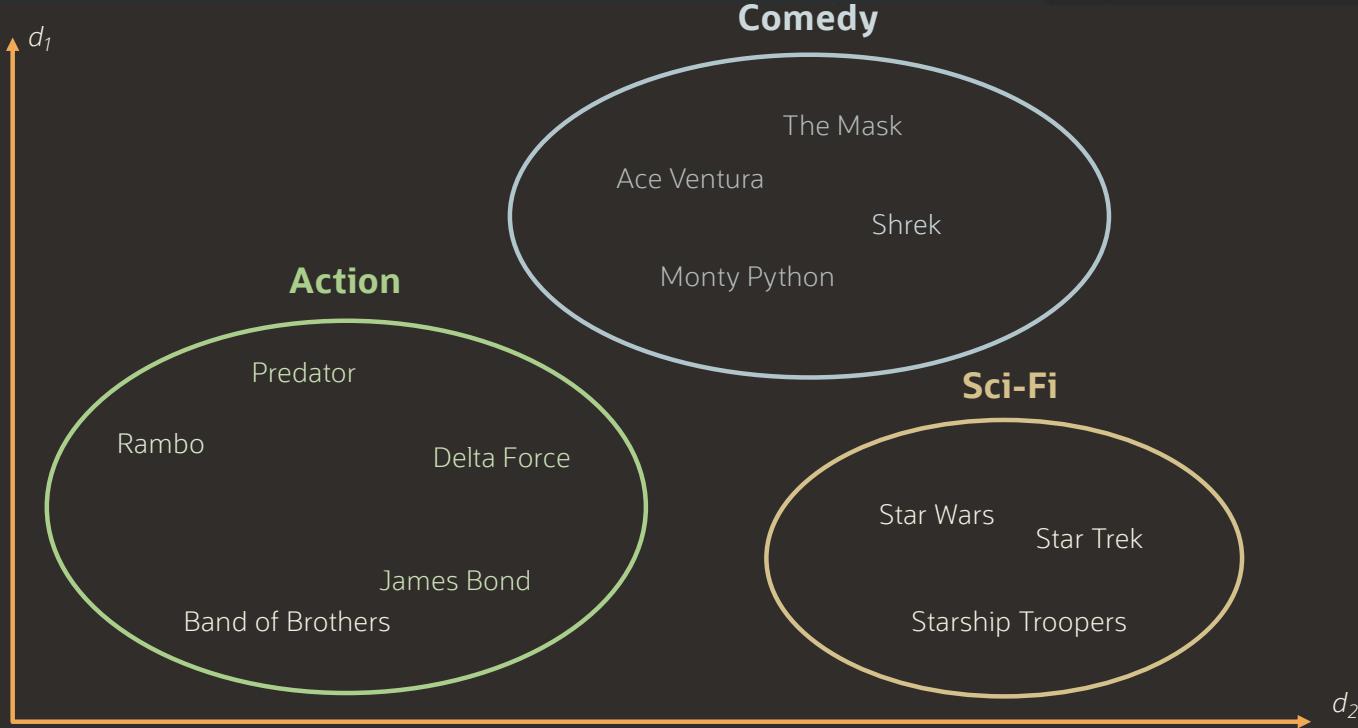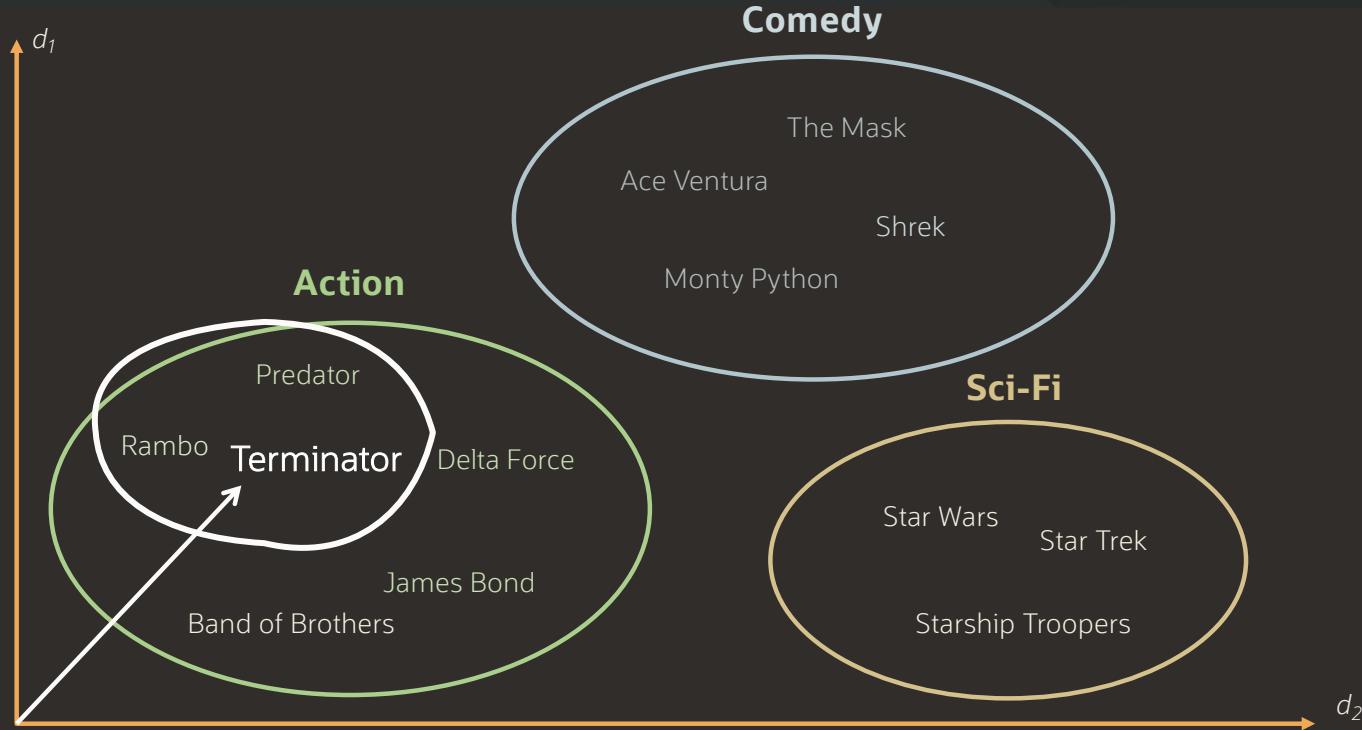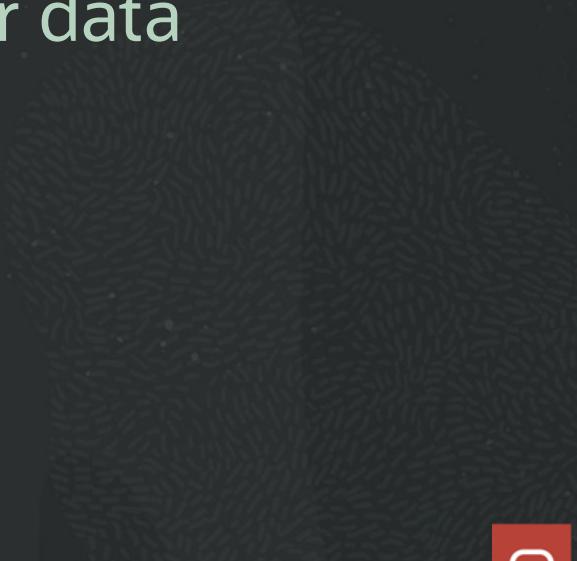
How do you convert your data into vectors?

Vector Database

- Embedding models transform your data into a vector

10,000 GPU ?

```
DBMS_DATA_MINING.import_onnx_model(
    model_name => 'All-MiniLM-L6-v2',
    model_data => 'All-MiniLM-L6-v2.onnx'
    ...
);
```

```
INSERT INTO movies
VALUES (:id,
        :description,
        :photo,
        VECTOR_EMBEDDING(All-MiniLM-L6-v2, :description));
```

Vector Database
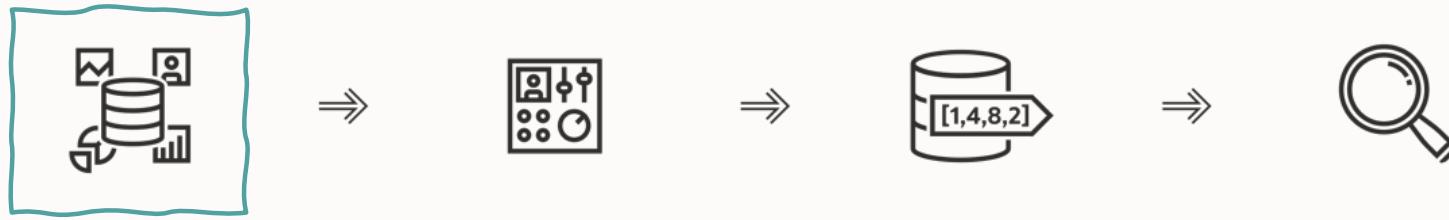
# Vector Database
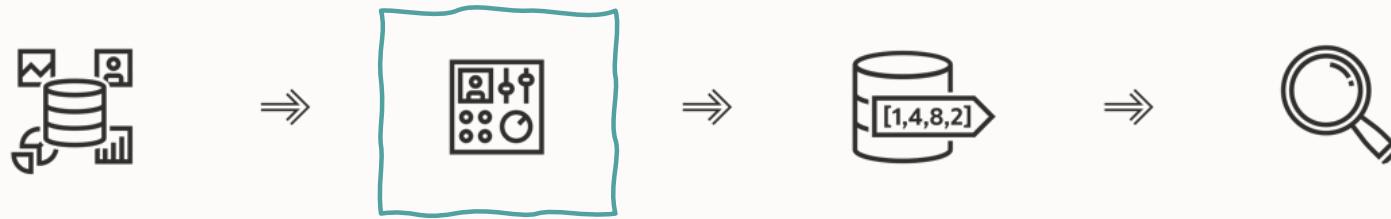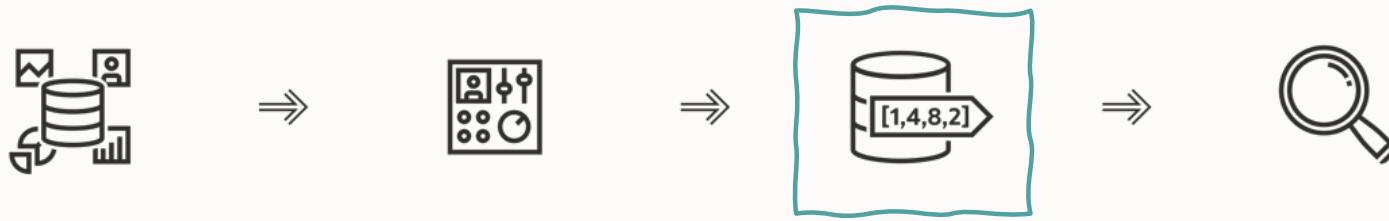
Vector Database

Vector Database

Included in <u>any</u> edition of Oracle AI Database 26ai

- No extra license required

Oracle AI Database 26ai Annotations

Annotations add intended usage to schema elements such as tables, views, columns
User-friendly display names, identify sensitive data, etc.

```
CREATE TABLE Emp(
    Id NUMBER(5),
    Nm VARCHAR2(255)
    Salary NUMBER
    )
```

User friendly column display name

Indicate a sensitive column

Title to display for this table
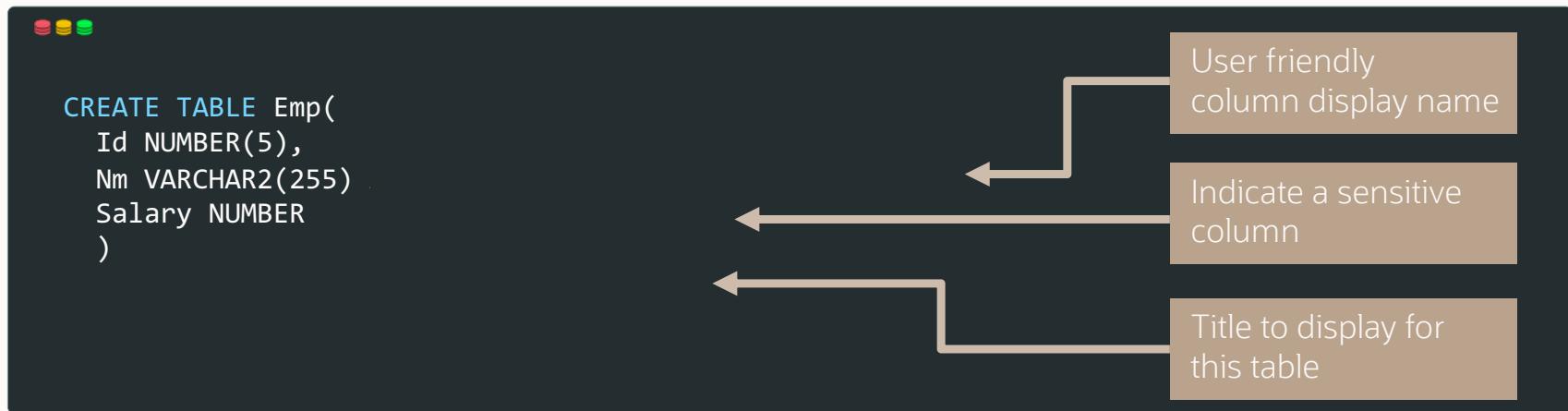
Annotations can be used by low code frameworks to generate user interfaces

AI Database

Using AI

Architecting Agentic AI into the database

> Select AI Agent
> Private Agent Factory
> SQLcl MCP Server

EXTENSIONS

Search Extensions in Marketplace

INSTALLED 5

Cline 504ms
Autonomous coding agent right in your IDE, capable of crea...
Cline

GitHub Copilot Chat 404ms
AI chat features powered by Copilot
GitHub

Oracle Code Assist
Oracle Code Assist
Oracle

Oracle SQL Developer Extension for VSCode 91ms
End-to-end development tools for your SQL and PL/SQL ap...
Oracle Corporation

GitHub Copilot
Your AI pair programmer
GitHub

RECOMMENDED 3

SQLTools 6M ⭐ 3.5
Connecting users to many of the most commonly used data...
Matheus Teixeira
Install

Vim 8.3M ⭐ 4
Vim emulation for Visual Studio Code
vscodevim
Install

MCP SERVERS

MCP Servers

Browse and install Model Context Protocol (MCP)

Untitled-1

CHAT

1 *Generate code (⌘I), or select a language (⌘K M). Start typing to dismiss or don't show this again.*

Build with Agent

AI responses may be inaccurate.

Generate Agent Instructions to onboard AI onto your codebase.

Untitled-1

Describe what to build next

Agent ⌄   GPT-5 mini ⌄

Ln 1, Col 1   Spaces: 4   UTF-8   LF   {} PL/SQL   (Dedicated) ADB26ai

Oracle

DBAs

run the world

YouTube | Oracle Database Upgrades and Migrations

https://www.youtube.com/@upgradenow
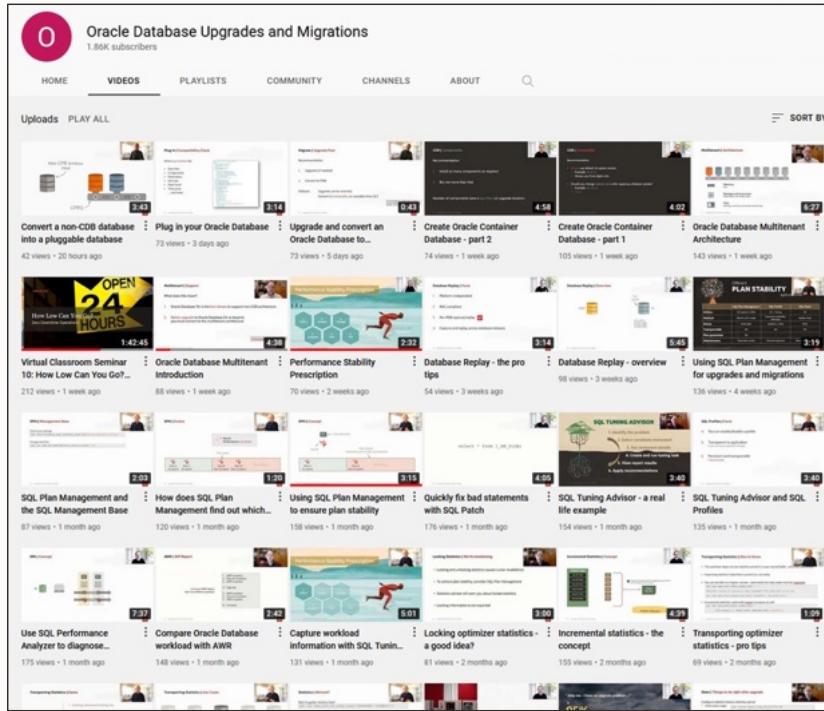
- 300+ videos

- New videos every week

- No marketing

- No buzzword

- All tech

SCAN ME

Thank You