



ORACLE

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

Berlin, February 2026

Photo by [Sinisa Lekovic](#) on [Unsplash](#)



Oracle

DBAs


run the world







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<https://dohdatabase.com/slides>



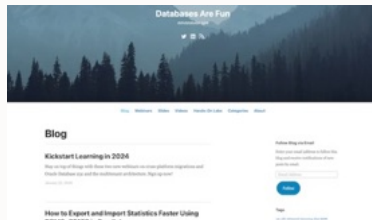


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Web Seminar

Episode 16

(replaces Episode 1 from Feb 2021)

Oracle Database Release and Patching Strategy for 19c and 23c

115 minutes – May 10, 2023

Slides



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

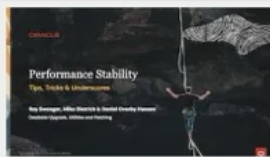
115 minutes – Feb 20, 2021



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



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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

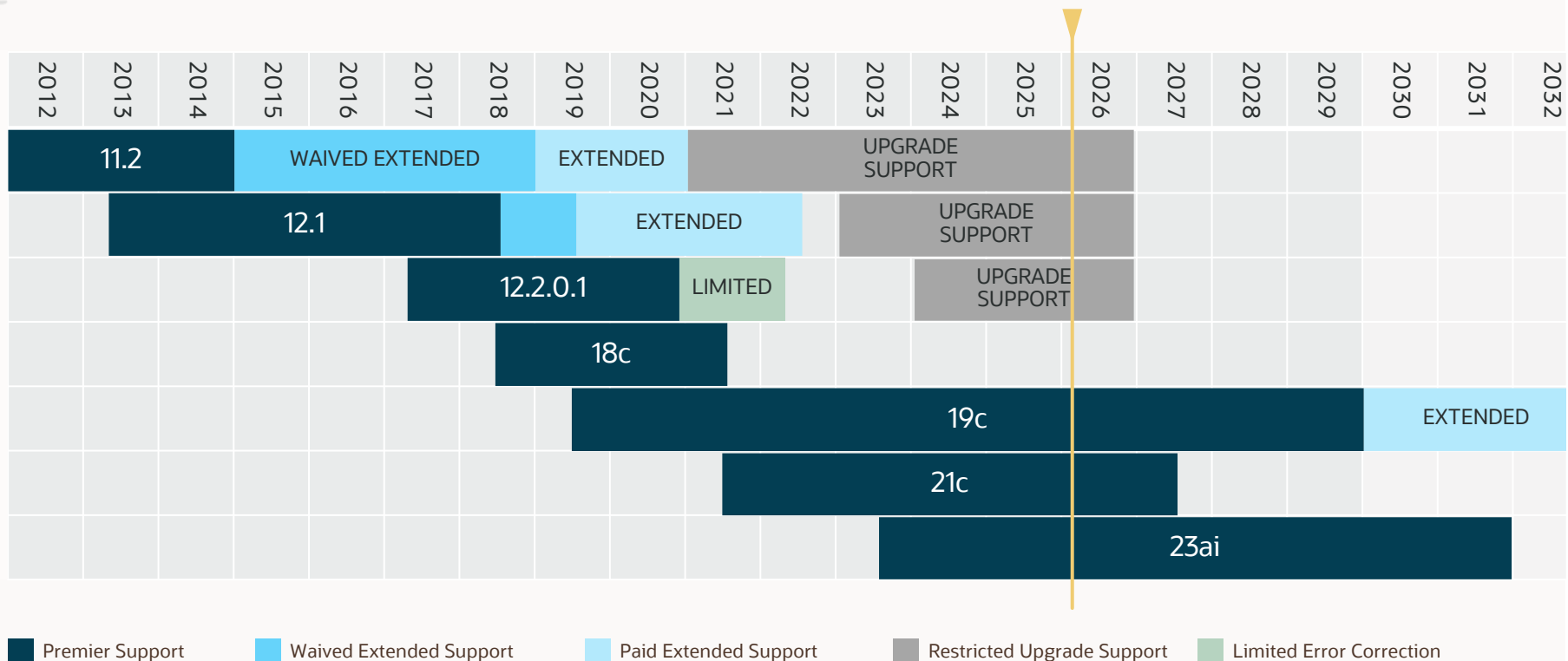
Coffee break



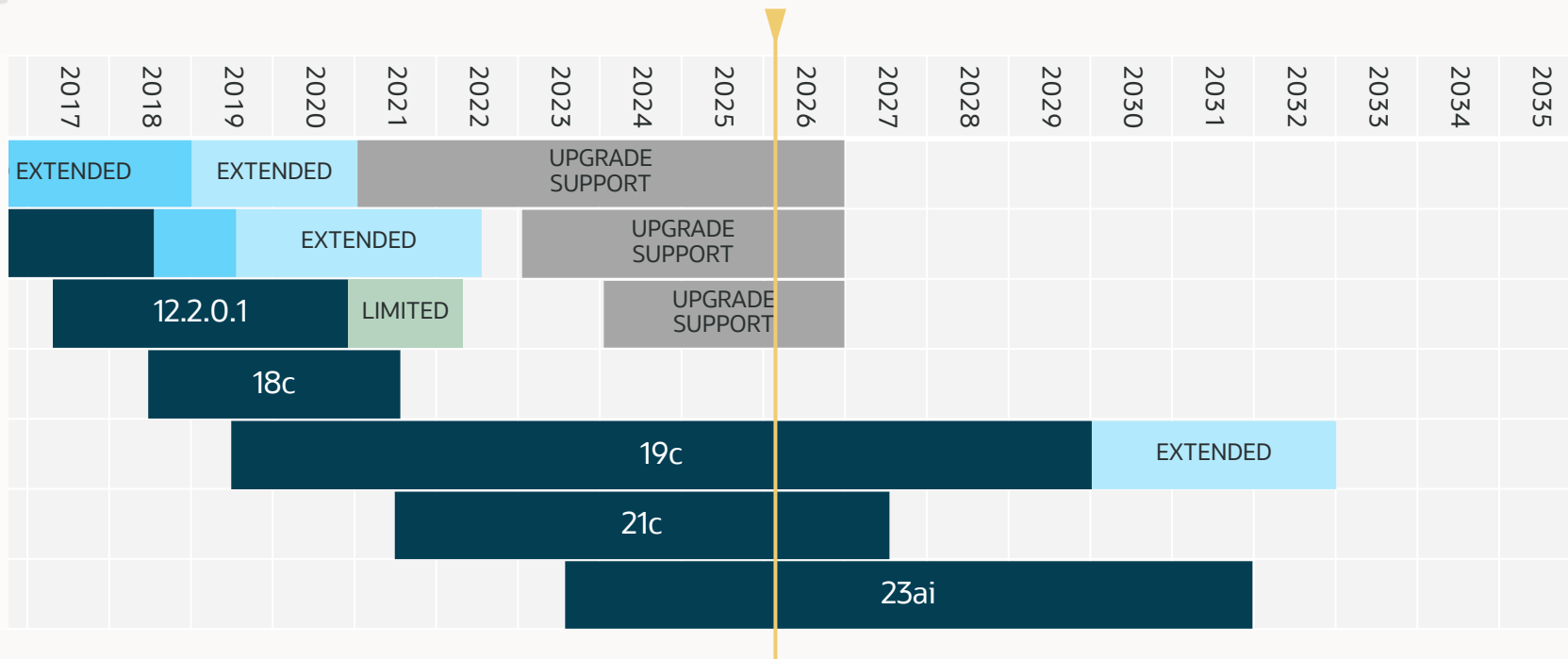
Release Strategy



Lifetime Support Policy



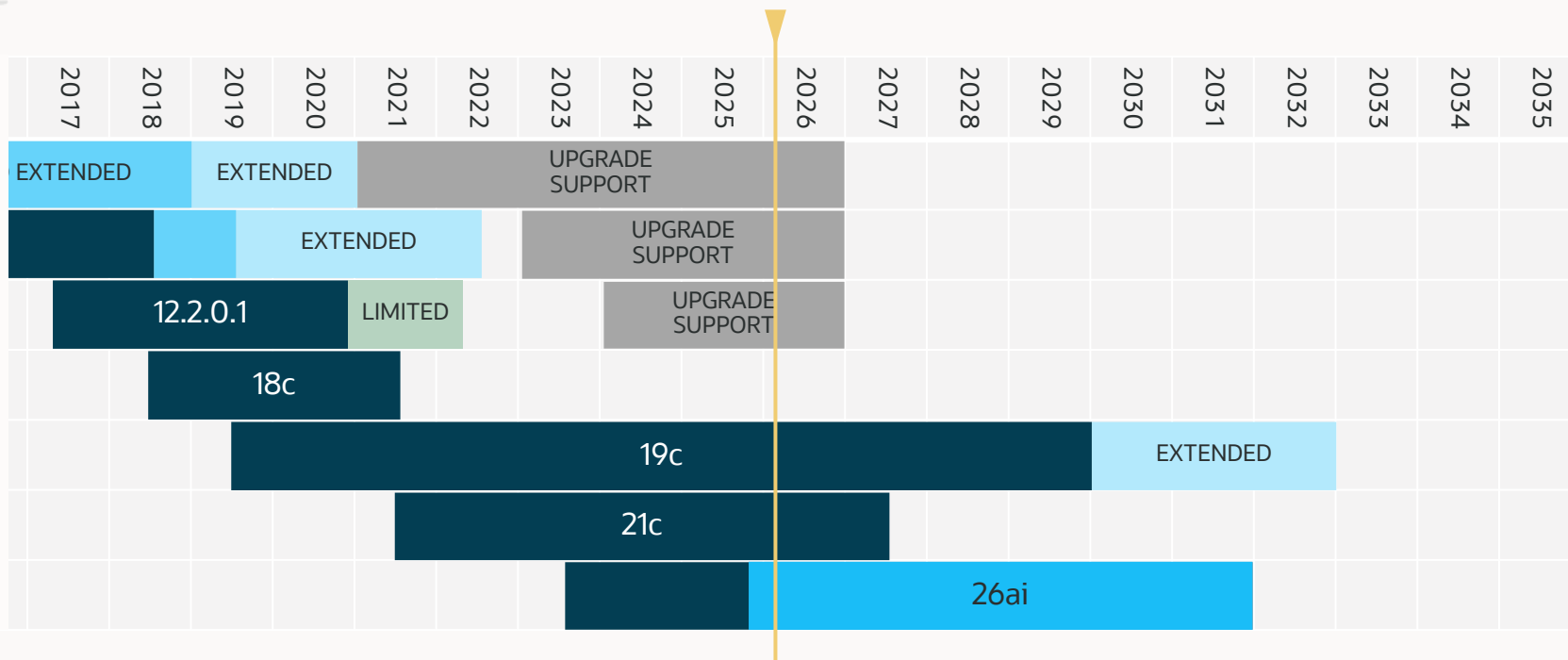
Lifetime Support Policy



Premier Support
 Waived Extended Support
 Paid Extended Support
 Restricted Upgrade Support
 Limited Error Correction



Lifetime Support Policy



■ 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 18c



Oracle Database 19c



Oracle Database 23ai

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



Oracle Database 19c



Oracle Database 23ai

Oracle AI Database 26ai

26^{ai}

When is a database upgrade
required?

Oracle Database 19c ⇒ Oracle Database 23ai ⇒ Oracle AI Database 26ai

UPGRADE

Oracle Database 19c



Oracle AI Database 26ai

UPGRADE

Oracle Database 19c ⇒ Oracle Database 23ai ⇒ 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

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July 2025

Oracle Database 23ai

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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	<i>Not Planned</i>	<i>Not Planned</i>	<i>Not planned</i>	<i>Not planned</i>	<i>Not planned</i>	<i>Not planned</i>	<i>Not planned</i>	<i>Not planned</i>	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	<i>TBA</i>	<i>Not Planned</i>	28-June-2023 Client: May-2021 download	<i>Not Planned</i>	<i>Not Planned</i>	<i>Not Planned</i>	<i>Not Planned</i>	<i>Not Planned</i>			
Oracle Solaris SPARC (64-	<i>TBA</i>	See KR126264	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

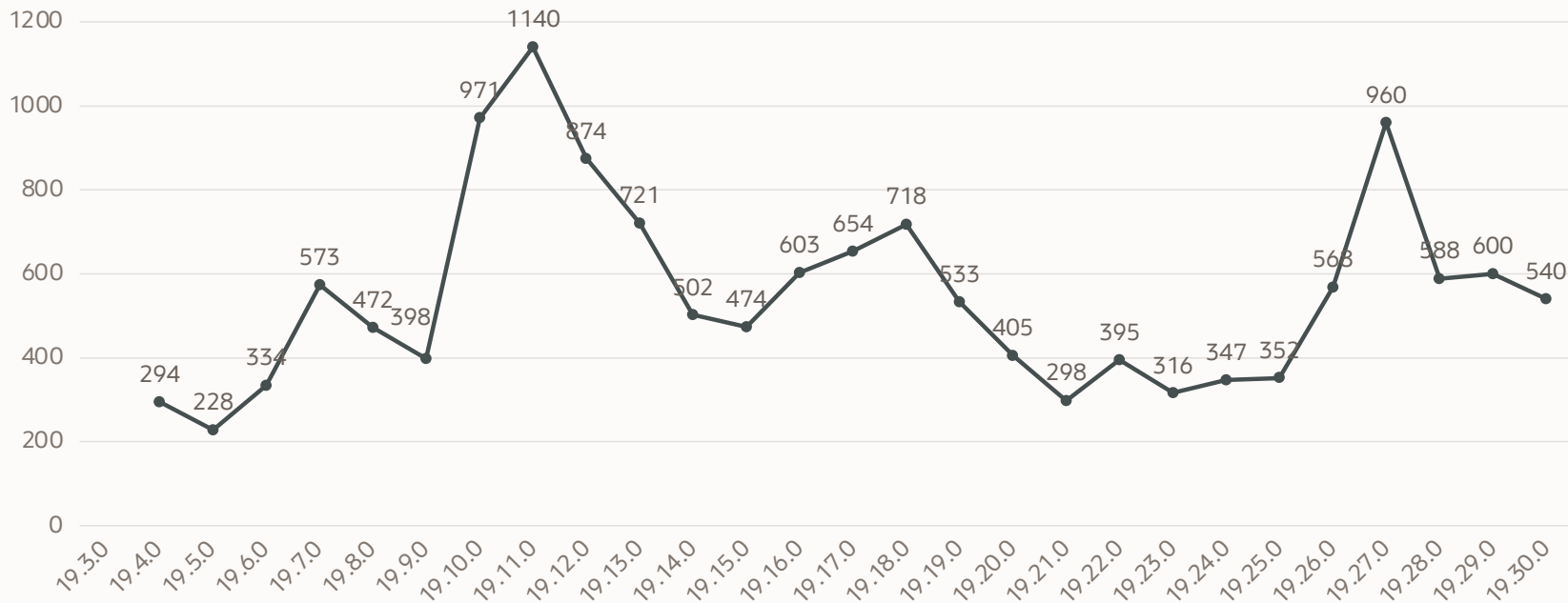


Once per year



Never

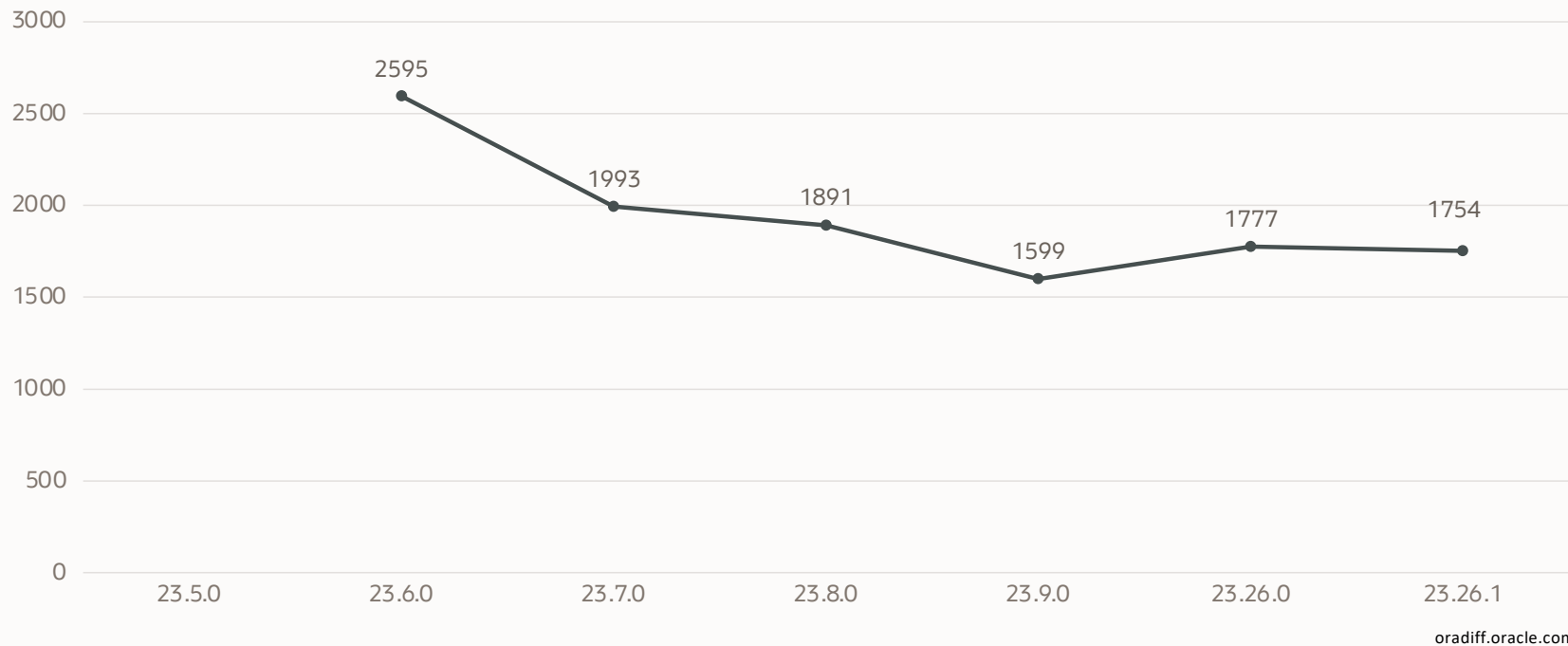
Release Update Contents – Oracle Database 19c



[Database 19 Release Updates and Revisions Bugs Fixed Lists \(Doc ID 2523220.1\)](#)



Release Update Contents – Oracle AI Database 26ai





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

- Almost 15k fixes with 19.30.0
 - More than 750 security fixes
- More than 11k fixes with 23.26.1
 - More than 850 security fixes



Just as easy as patching your smart phone

AutoUpgrade's mission for patching Oracle Database

AutoUpgrade and Patching



Download

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



Install

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



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



Download

- Find the right patch numbers
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Install

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Patch

- Datapatch Sanity Check
- Move instances and files
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- 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
```

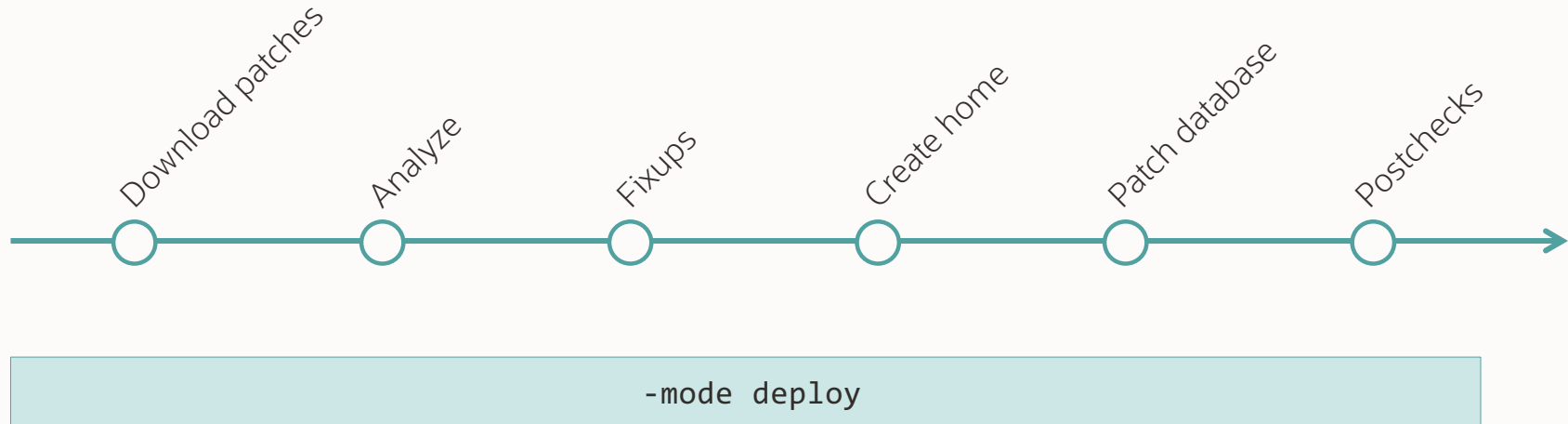
Demo

One-Button Patching

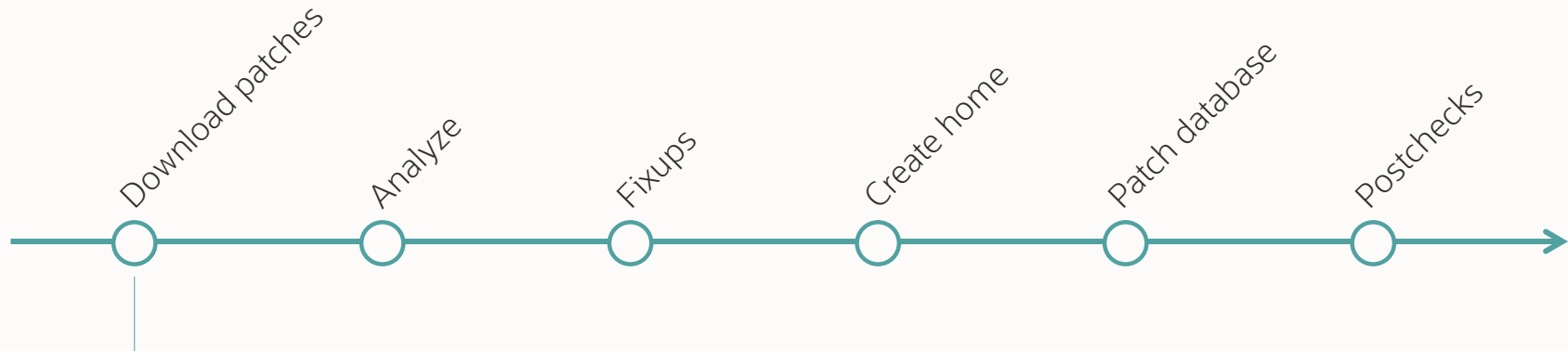
- Download patches
- Install Oracle home
- Patch database

Watch on [YouTube](#)

AutoUpgrade Patching



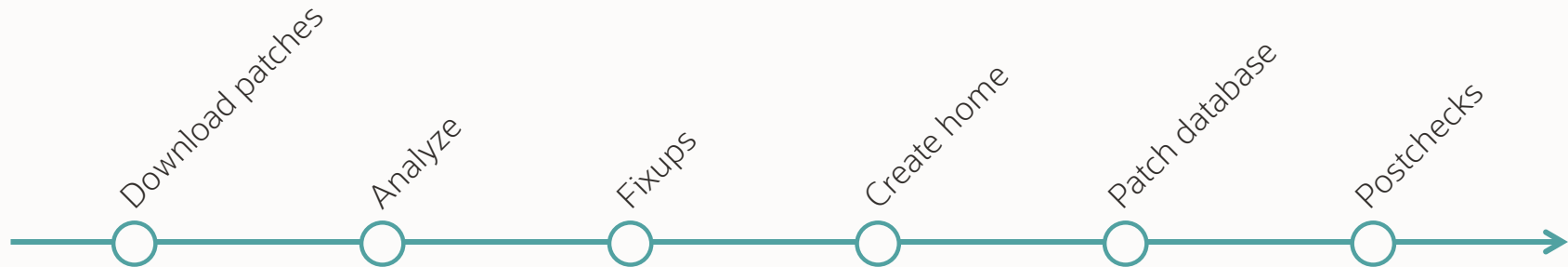
AutoUpgrade Patching



- Finds and downloads patches
- Uses your MOS credentials
- Chooses the right platform
- Stores patches in local repository



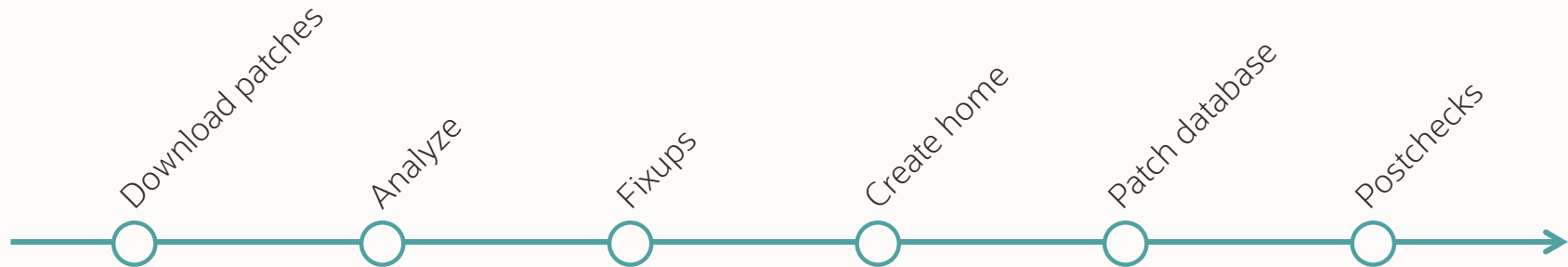
AutoUpgrade Patching



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



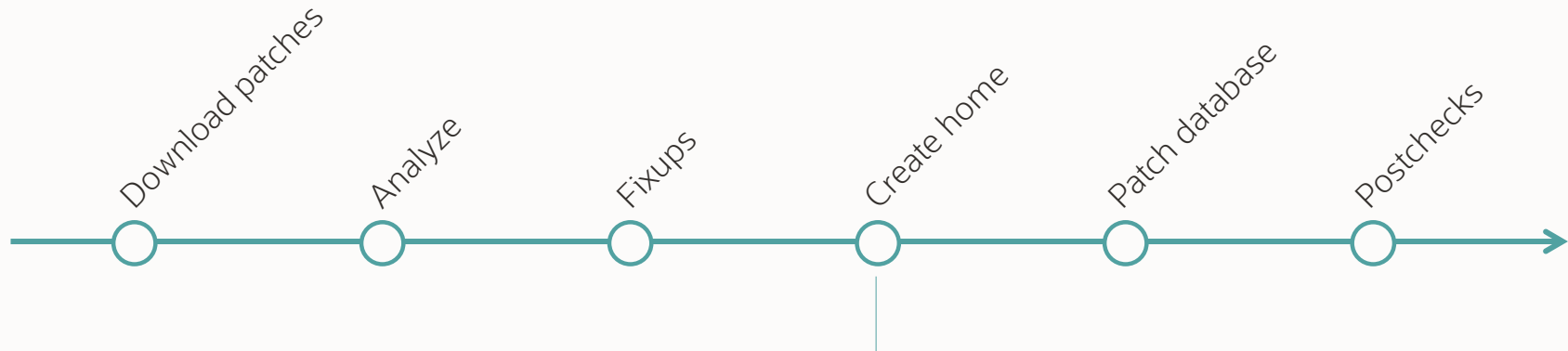
AutoUpgrade Patching



- Gathers dictionary statistics if needed
- Recompiles Oracle-maintained objects if needed
- Executes checks - see Doc ID [2380601.1](#)



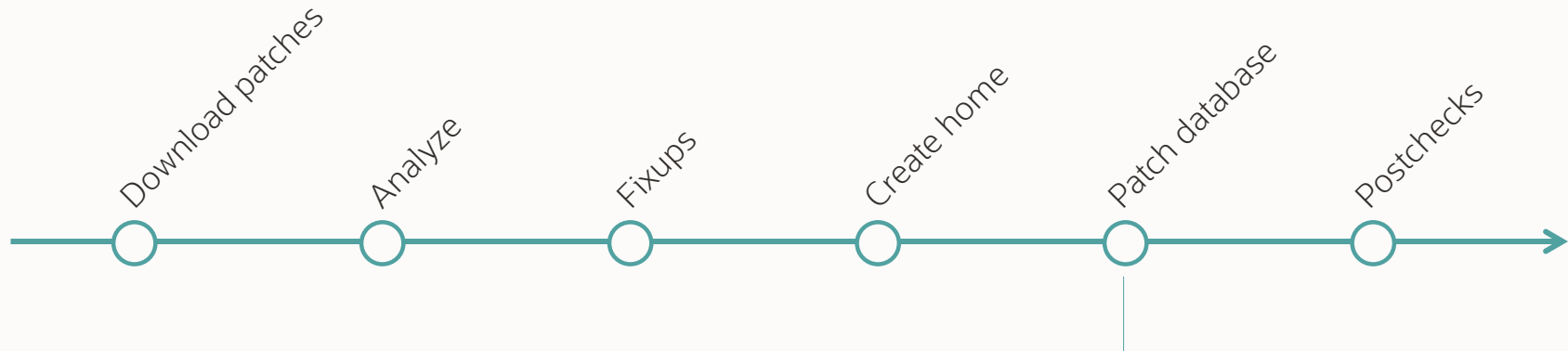
AutoUpgrade Patching



- 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



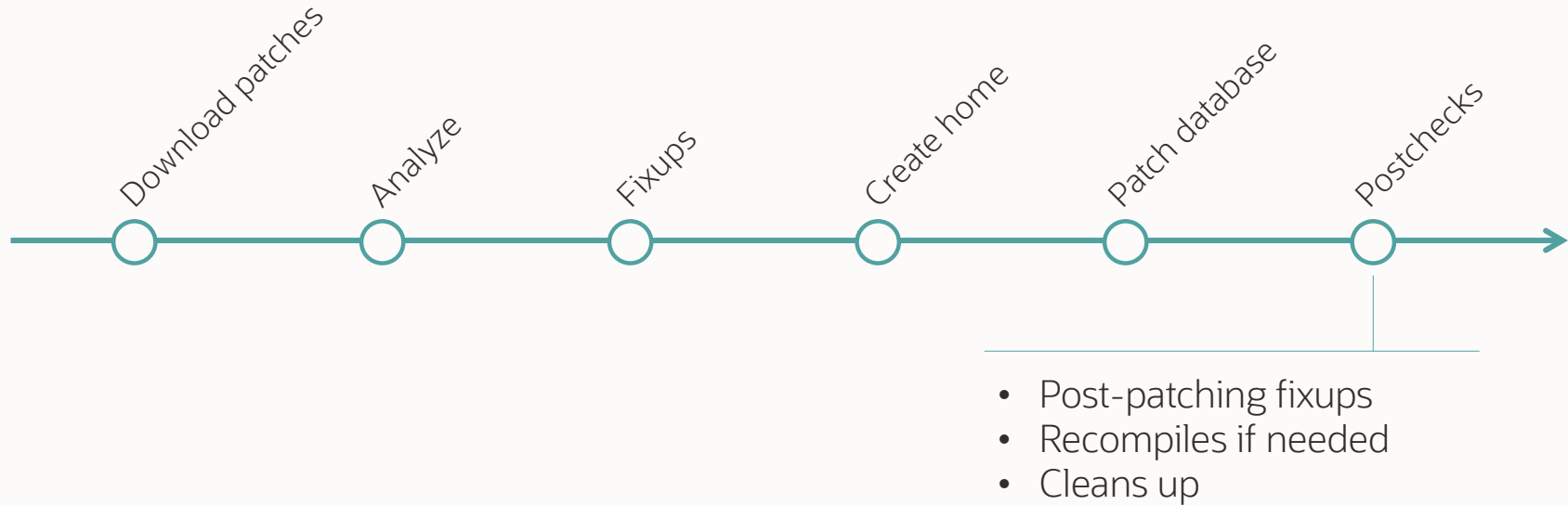
AutoUpgrade Patching



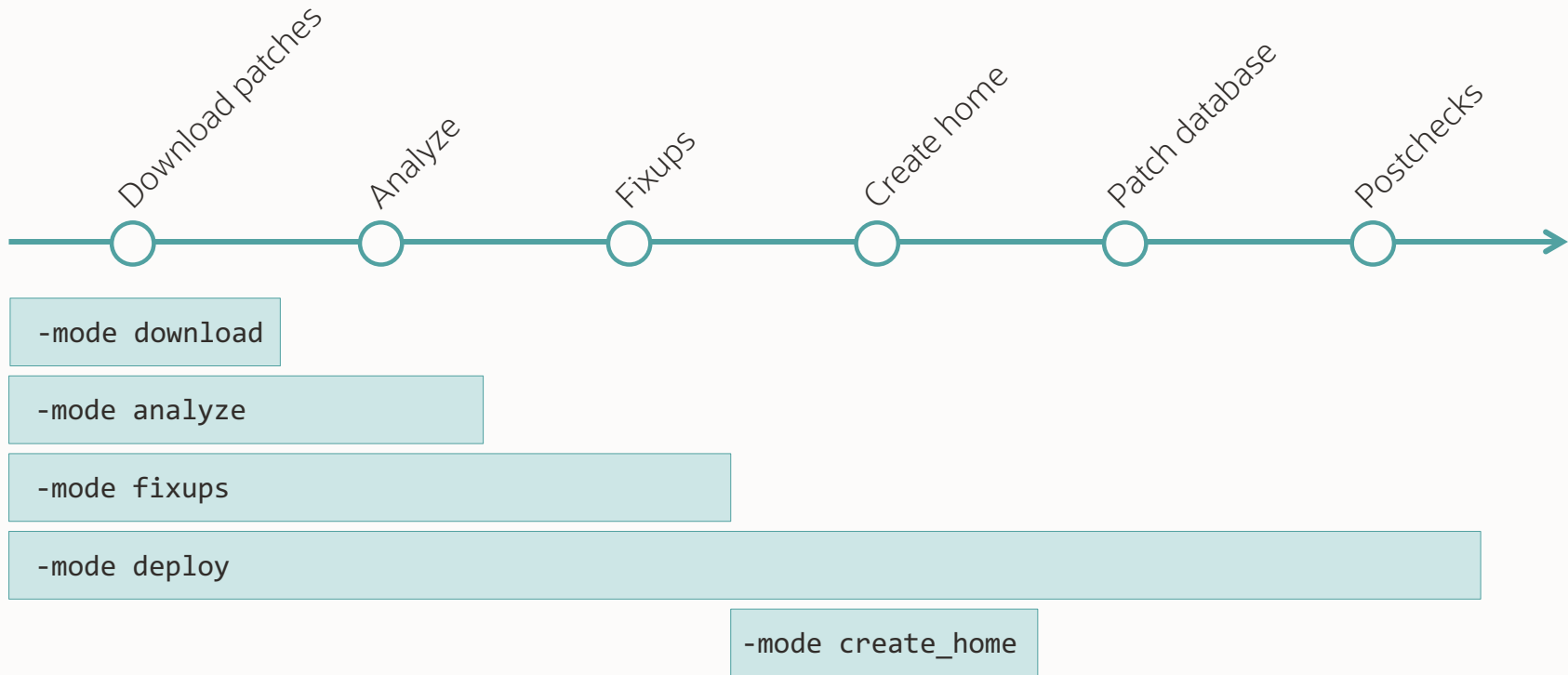
- Moves database instance to new Oracle home
- Moves configuration files
- Executes Datapatch
- Updates system directories (`utlfixdirs.sql`)
- Updates `/etc/oratab`
- Supports read-only Oracle home



AutoUpgrade Patching



Patching Modes





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





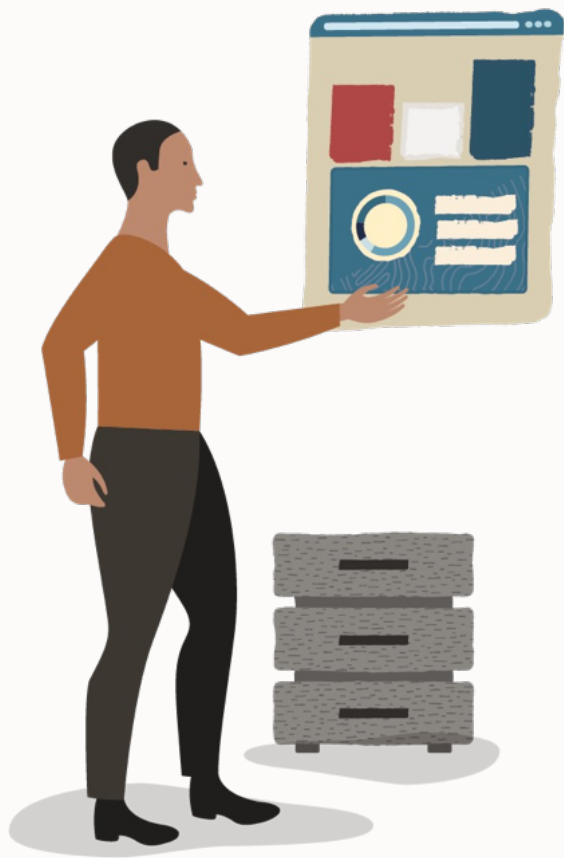
Always download
the latest version of AutoUpgrade

- 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
```

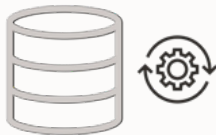




Patching

In-Place Patching

Oracle Home, 19.30.0



```
$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](#))



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

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:
```

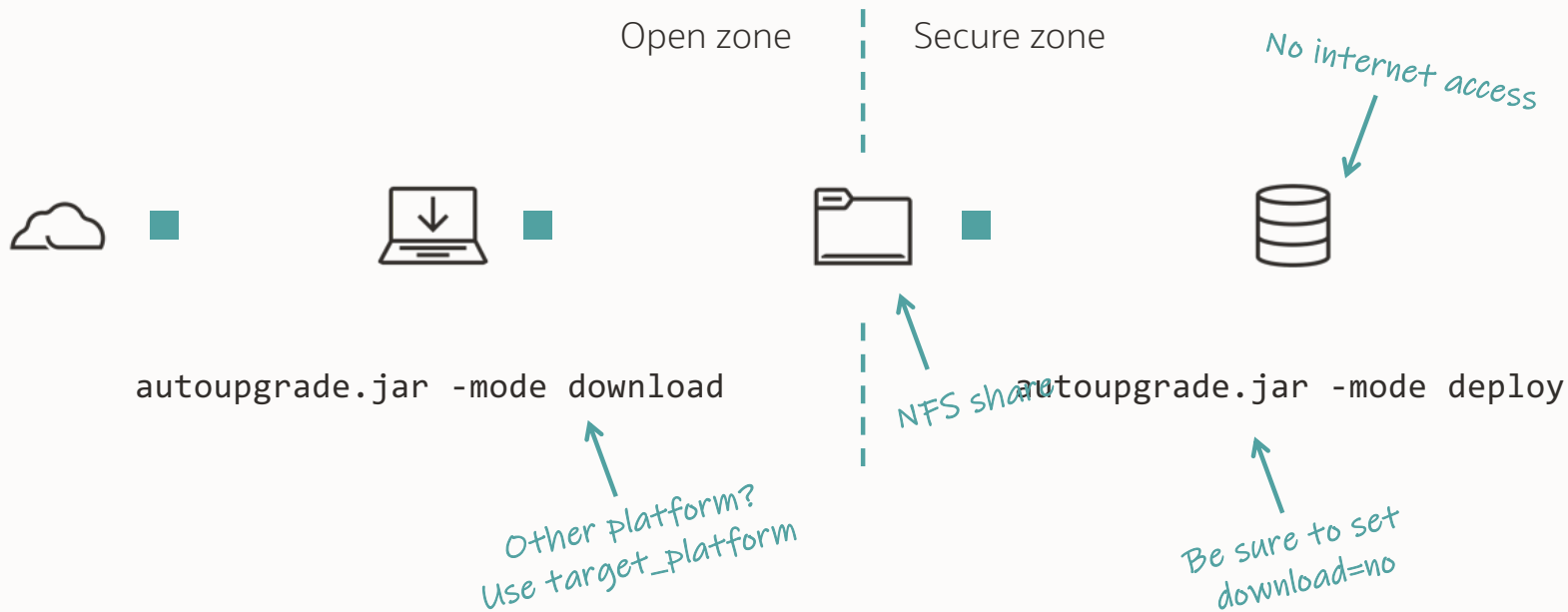
```
Re-enter your secret/Password:
```





Your database host
doesn't have internet access?

Using Download Mode





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

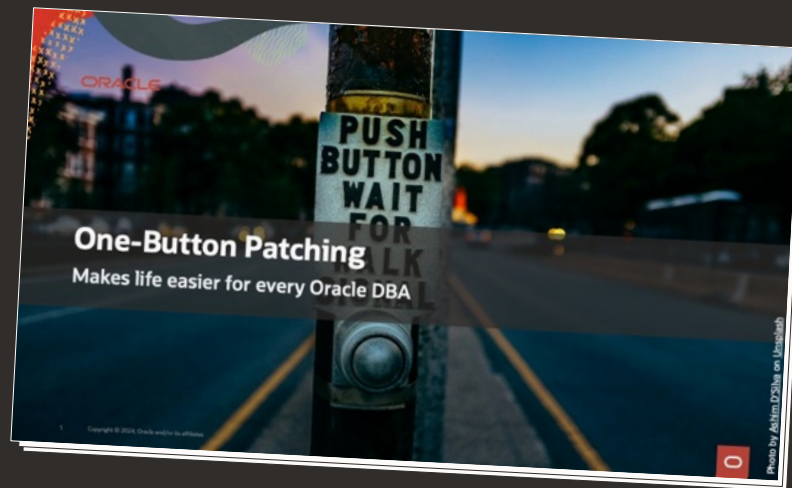
- Cloning Oracle homes
- Gold images

Webinar

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



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:

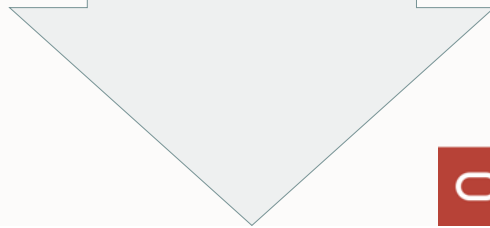
Apply:

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`



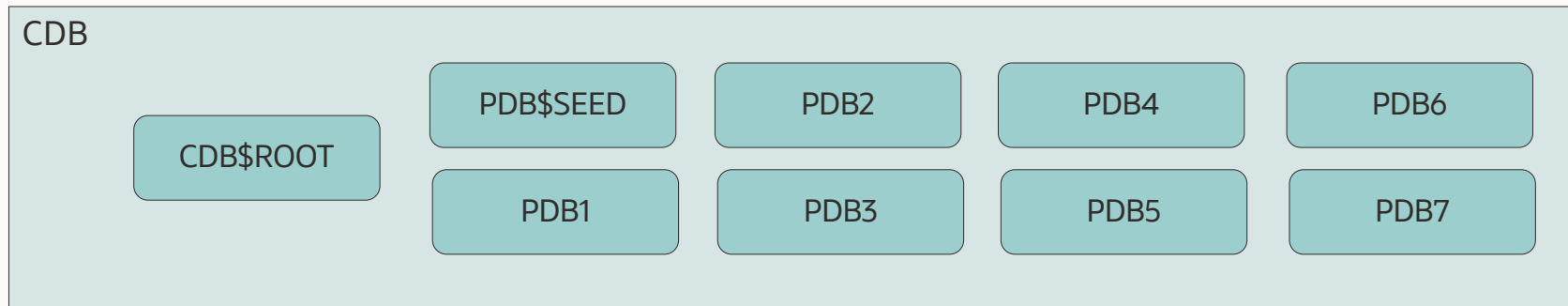
Major retailer in
the US

Saved **20 TB/year** in total:

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



Multitenant



- 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 can now kill blocking sessions

`./datapatch`





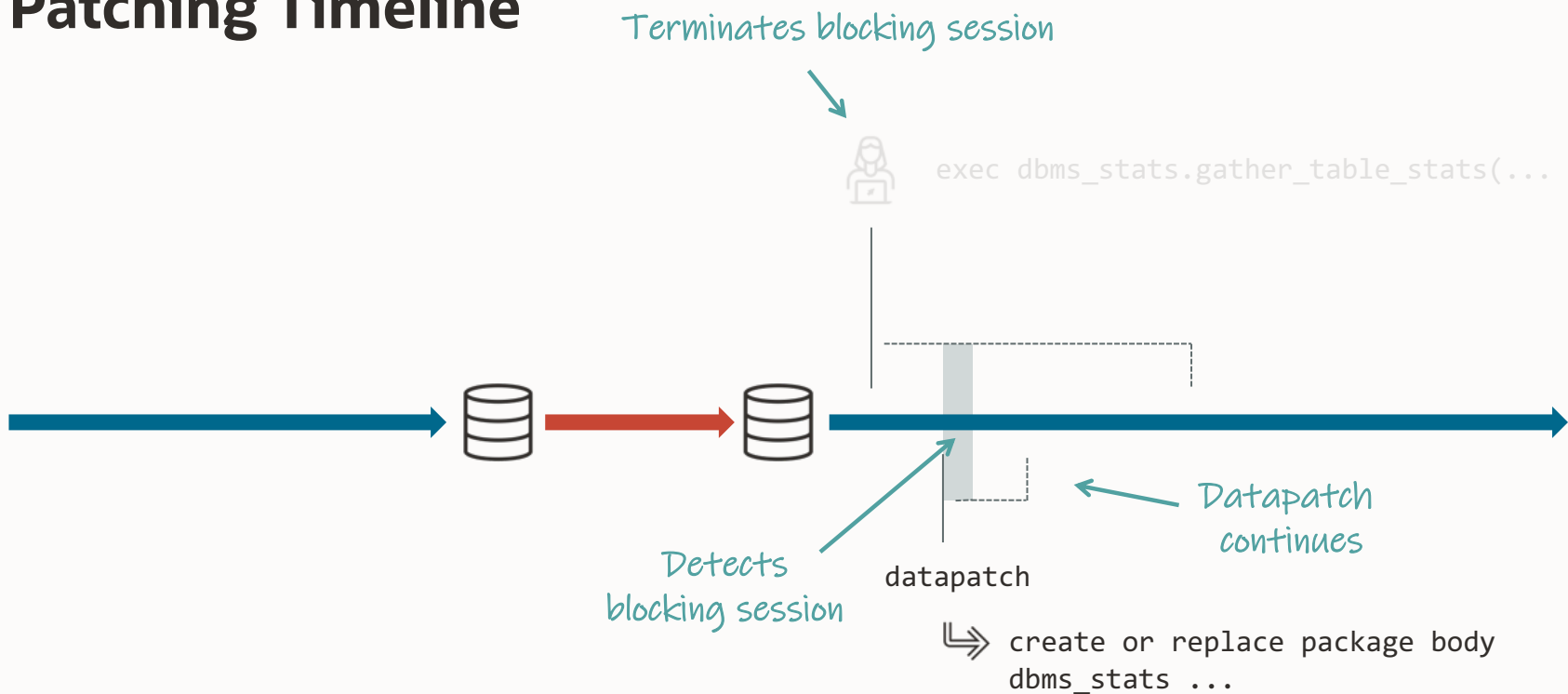
Concurrency Without Kill Switch

- 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>*

-- Enable the automatic kill switch

./datapatch -force_terminate_blocking_sessions true

Patching Timeline



```
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_oracle_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



Kill switch is on by default
in Oracle AI Database 26ai



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

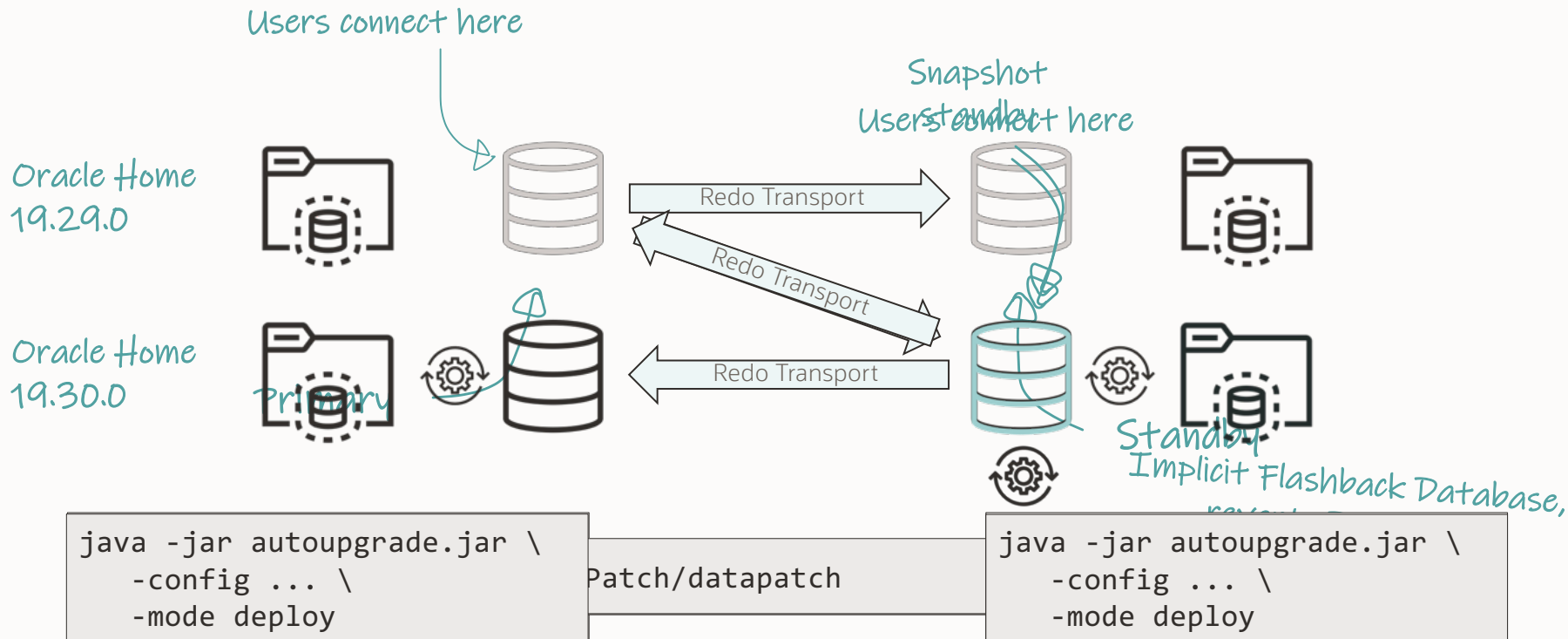
- [KB137118](#)
[Oracle Patch Assurance - Data Guard Standby-First Patch Apply](#)



Safely test and verify patches with Standby-First Patch Apply

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

Standby-First Patching





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



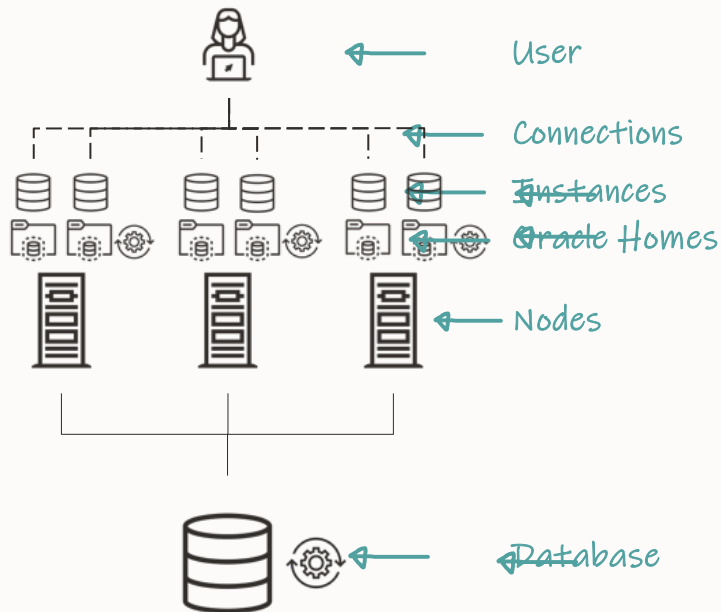
Use AutoUpgrade to patch your standby database

- Check [blog posts](#) for details



Avoid database downtime with RAC Rolling Patch Apply

RAC Rolling Patching



- 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 advise 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
```

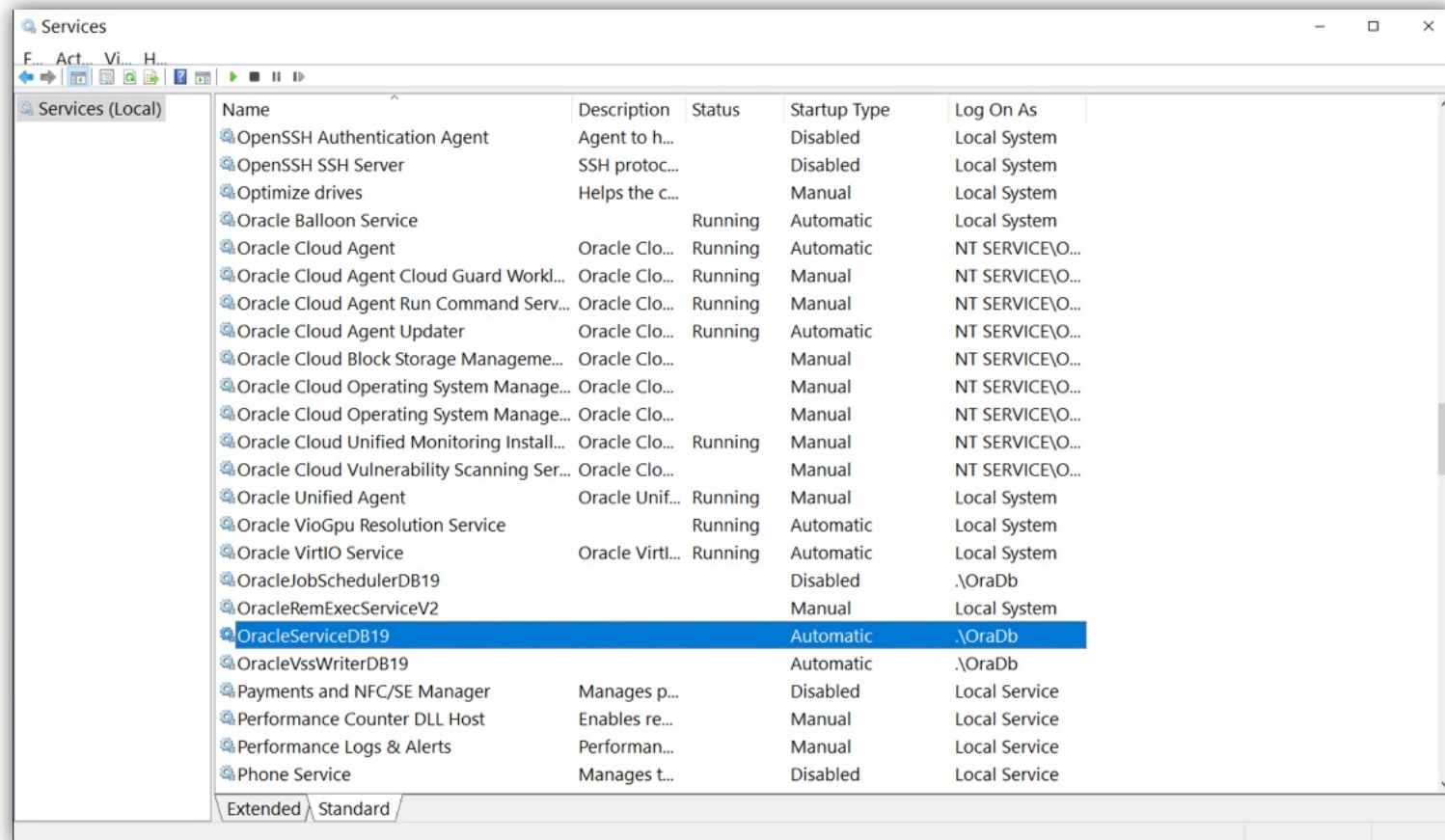
```
upg1.sid=CDB1
```

```
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
```

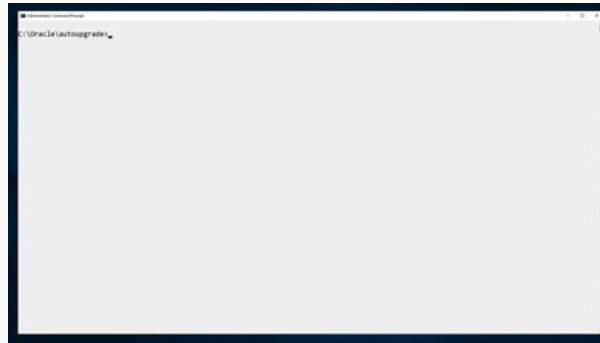
```
C:\> java -jar autoupgrade.jar  
-config patch_on_win.cfg  
-patch  
-loadwincredential "DB19"
```



```
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

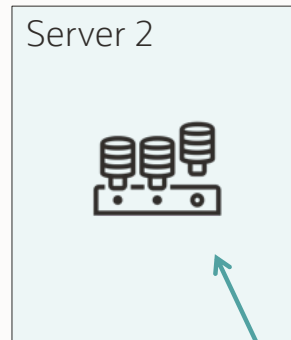
To become a proper PDB, it must be converted

Refreshable Clone PDB

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



Source
non-CDB



Target
CDB

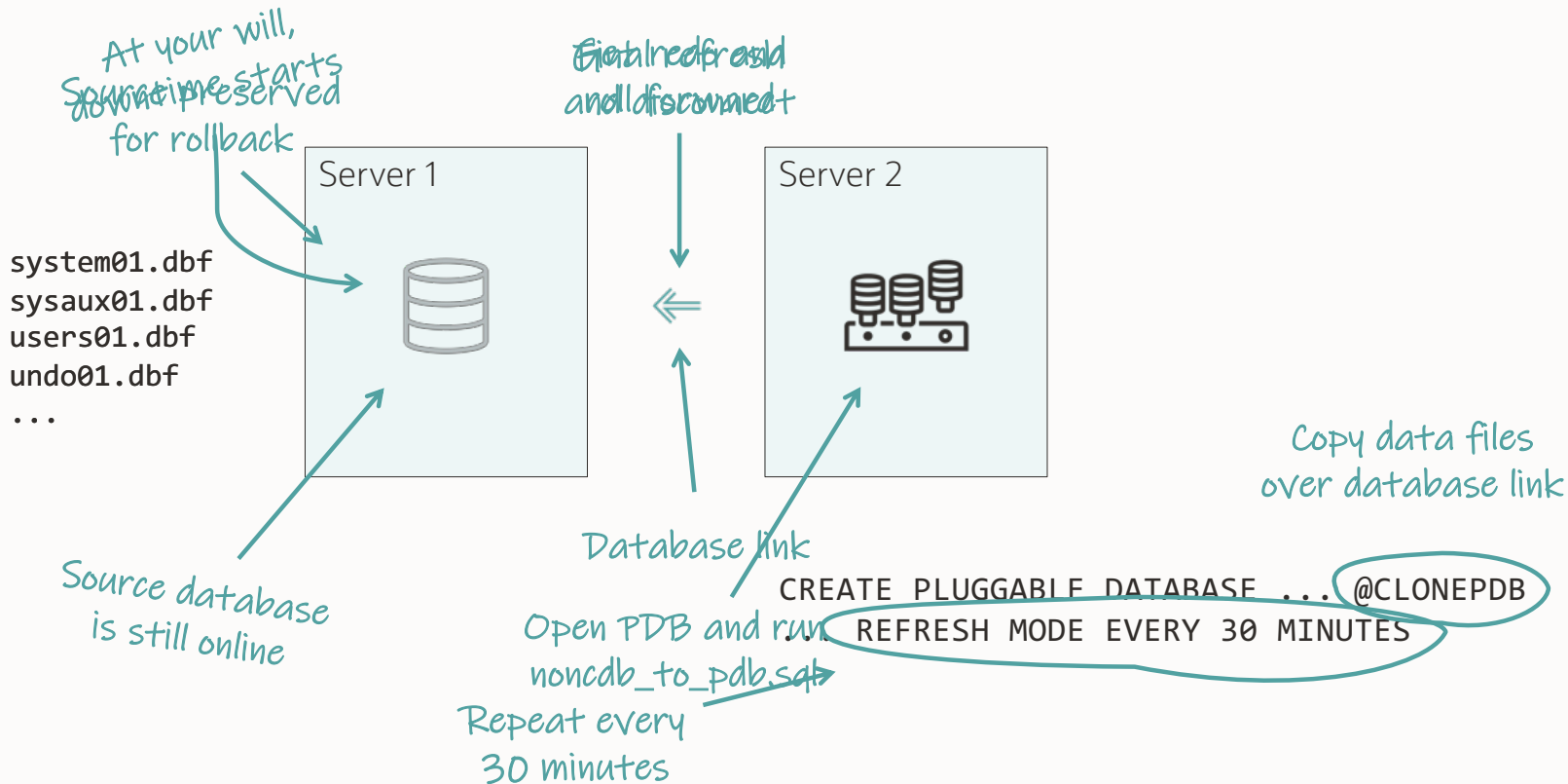
Refreshable Clone PDB

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



← Could be same
server as well

Refreshable Clone



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
```





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.

PDB
is created

2.

Data files
are copied

3.

Redo is
applied

4.

Final refresh

5.

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 Database 19c 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

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks

Move to Oracle Database 23ai with ExaScale

- No ASM, no Oracle Database 19c anymore



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

Customer

Project

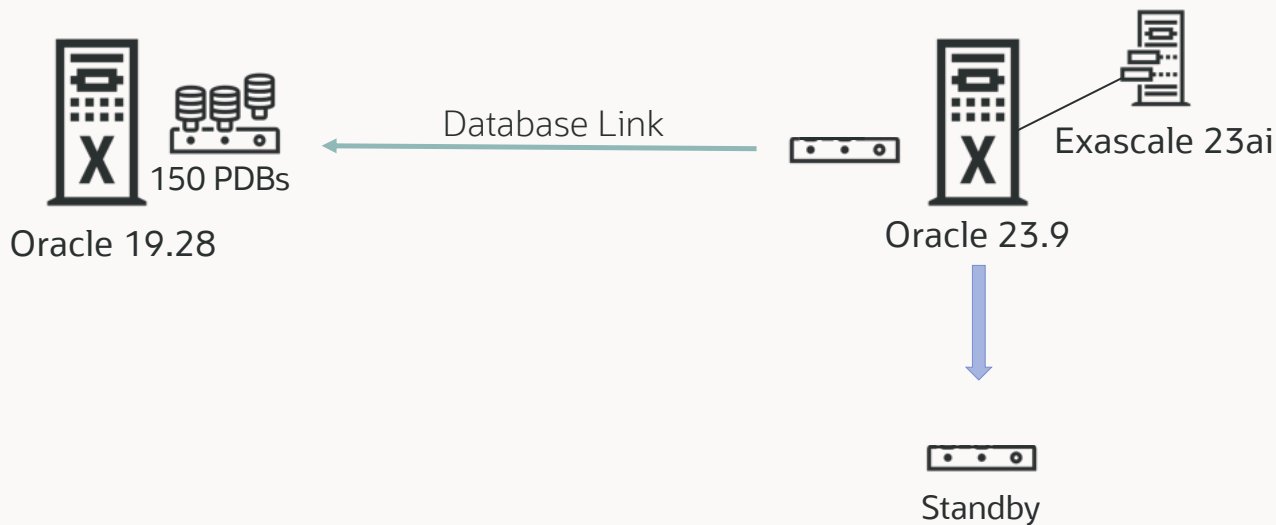
Constraints

Preparation

Upgrade

Success?

Remarks



Customer Case | Techniker Krankenkasse

Customer

Project

Constraints

Preparation

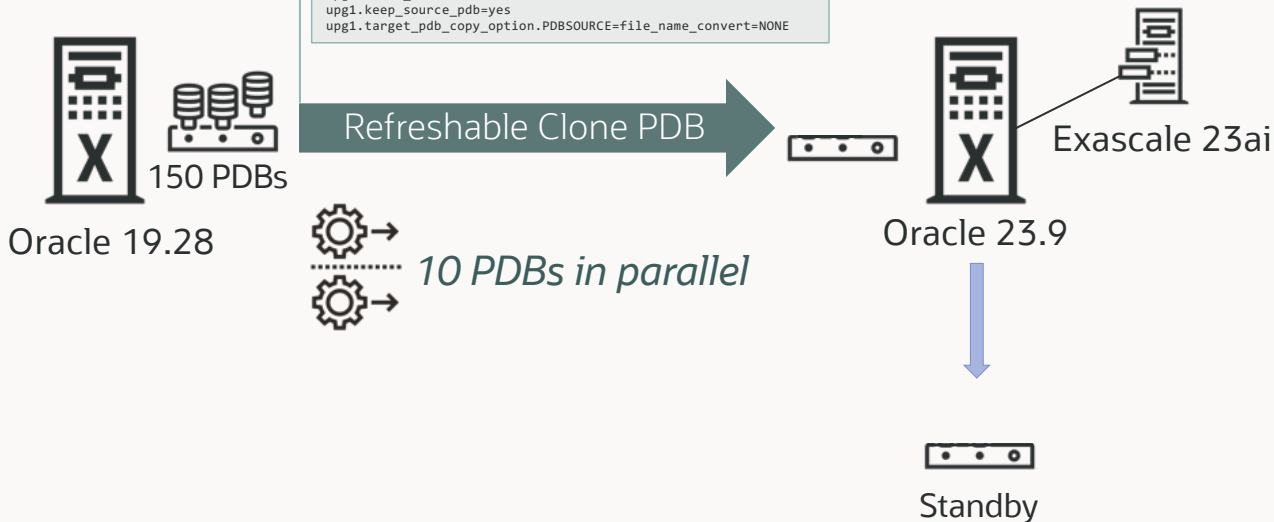
Upgrade

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
```



Customer Case | Techniker Krankenkasse

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks



Oracle 19.28



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

Database Configuration Assistant - Create 'orcl' database - Step 9 of 15

Specify Configuration Options

ORACLE 26ai
AI Database

Memory Sizing **Character sets** Connection mode

The database character set determines how character data is stored in the database.

☒ Use Unicode (AL32UTF8)
Setting character set to Unicode (AL32UTF8) enables you to store multiple language groups.

☐ Use OS character set (WE8MSWIN1252)
Character set is based on the language setting of this operating system.

☐ Choose from the list of character sets

Database character set: AL32UTF8 - Unicode UTF-8 Universal character set

☒ Show recommended character sets only

National character set: AL16UTF16 - Unicode UTF-16 Universal character set

Default language: American

Default territory: United States



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

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
<input type="checkbox"/> Oracle JVM	SYSTEM	<input type="checkbox"/>
<input type="checkbox"/> Oracle Text	SYSAUX	<input type="checkbox"/>
<input type="checkbox"/> Oracle OLAP	SYSAUX	<input type="checkbox"/>
<input type="checkbox"/> Oracle Spatial	SYSAUX	<input type="checkbox"/>
<input type="checkbox"/> Oracle Label Security	SYSTEM	<input type="checkbox"/>
<input type="checkbox"/> Oracle Database Vault	SYSAUX	<input type="checkbox"/>




Create Container Database

1 Character set

2 Components

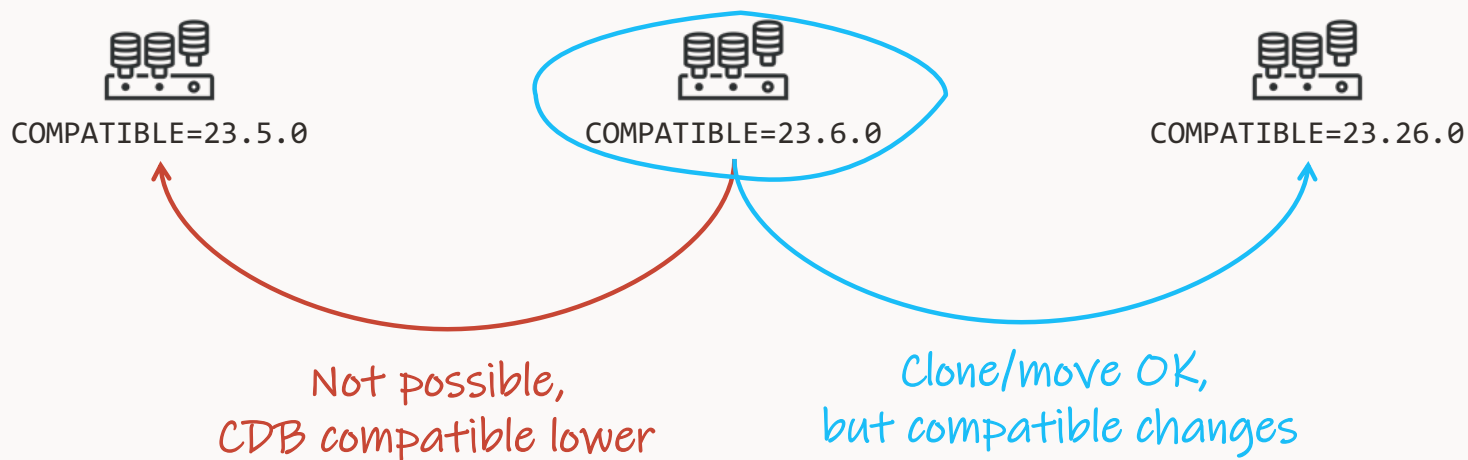
3 COMPATIBLE

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

All initialization parameters			
 Update the initialization parameters only when it is required. Refer to the Oracle documentation to learn more about each initialization parameter and its valid set of values.			
(Storage related parameter(s) value is shown in MB)			<input type="checkbox"/> Show advanced parameters
Name	Value	Include in spfile	Category
undo_tablespace	UNDOTBS1	<input checked="" type="checkbox"/>	Cluster Database
sga_target	19202	<input checked="" type="checkbox"/>	SGA Memory
db_block_size (bytes)	8192	<input checked="" type="checkbox"/>	Cache and I/O
nls_language	AMERICAN	<input checked="" type="checkbox"/>	NLS
control_files	{* {ORACLE_BASE}/oradata/...	<input checked="" type="checkbox"/>	File Configuration
remote_login_passwordfile	EXCLUSIVE	<input checked="" type="checkbox"/>	Security and Auditing
processes	640	<input checked="" type="checkbox"/>	Processes and Sessions
pga_aggregate_target	6401	<input checked="" type="checkbox"/>	Sort, Hash Joins, Bitmap Indexes
nls_territory	AMERICA	<input checked="" type="checkbox"/>	NLS
open_cursors	300	<input checked="" type="checkbox"/>	Cursors and Library Cache
db_domain	livelabs.oraclevcn.com	<input checked="" type="checkbox"/>	Database Identification
compatible	23.6.0	<input checked="" type="checkbox"/>	Miscellaneous
db_name	orcl	<input checked="" type="checkbox"/>	Database Identification
cluster_database	FALSE	<input type="checkbox"/>	Cluster Database
Description:			
compatible: Allows you to use a new release, while at the same time guaranteeing backward compatibility with an earlier release. Range of Values: Default to current release. Default Value: Release dependent			



Compatible



- 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

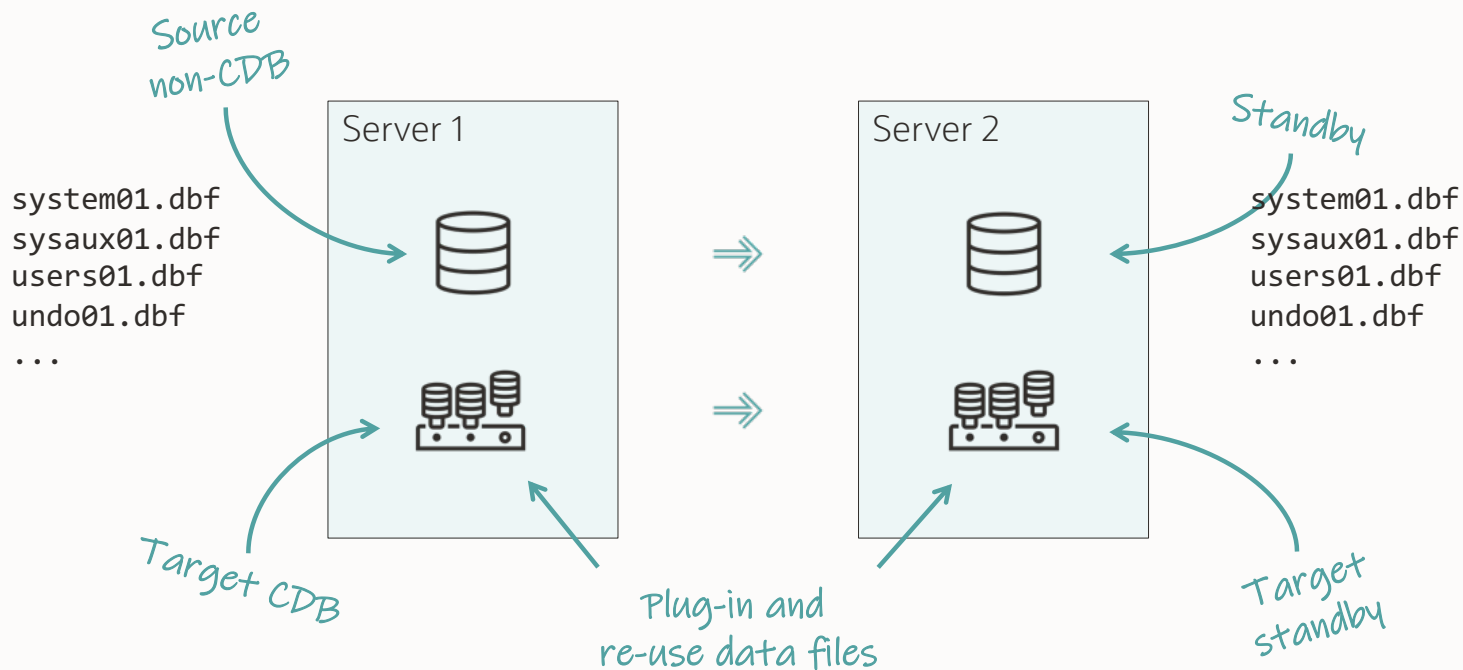
Default

2

Deferred recovery



Enabled Recovery





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 version="1.0" encoding="UTF-8"?>
<PDB>
  <xmlversion>1</xmlversion>
  <pdbname>DB12</pdbname>
  <cid>0</cid>
  <byteorder>1</byteorder>
  <vsns>203424000</vsns>
  <vsns>
    <vsnum>12.2.0.1.0</vsnum>
    <cdbcompt>12.2.0.0.0</cdbcompt>
    <pdbcompt>12.2.0.0.0</pdbcompt>
    <vslibnum>0.0.0.0.24</vslibnum>
    <vsnsql>24</vsnsql>
    <vsnsbv>8.0.0.0.0</vsnsbv>
  </vsns>
  <dbid>1852833295</dbid>
  <ncdb2pdb>1</ncdb2pdb>
  <cdbid>1852833295</cdbid>
  <guid>86D5DC2587337002E0532AB2A8C0A57C</guid>
  <uscnbas>4437941</uscnbas>
  <uscnwrp>0</uscnwrp>
  <undosc>8</undosc>
  <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>
    <bunitsize>8</bunitsize>
    <file>
      <path>/u02/oradata/DB12/system01.dbf</path>
      <afn>1</afn>
      <rfn>1</rfn>
    </file>
  </tablespace>
</PDB>
```


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



Standby



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

NAME

+DATA/DB_BOSTON/DATAFILE/system.269.1103046537

+DATA/DB_BOSTON/DATAFILE/sysaux.270.1103046537

+DATA/DB_BOSTON/DATAFILE/users.273.1103046827

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

NAME

+DATA/DB_CHICAGO/DATAFILE/system.265.1103050007

+DATA/DB_CHICAGO/DATAFILE/sysaux.266.1103050007

+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009

Same file,
but different name

Enabled Recovery | ASM

19c
Non-CDB
Primary



19c
Non-CDB
Standby



The manifest file contains

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

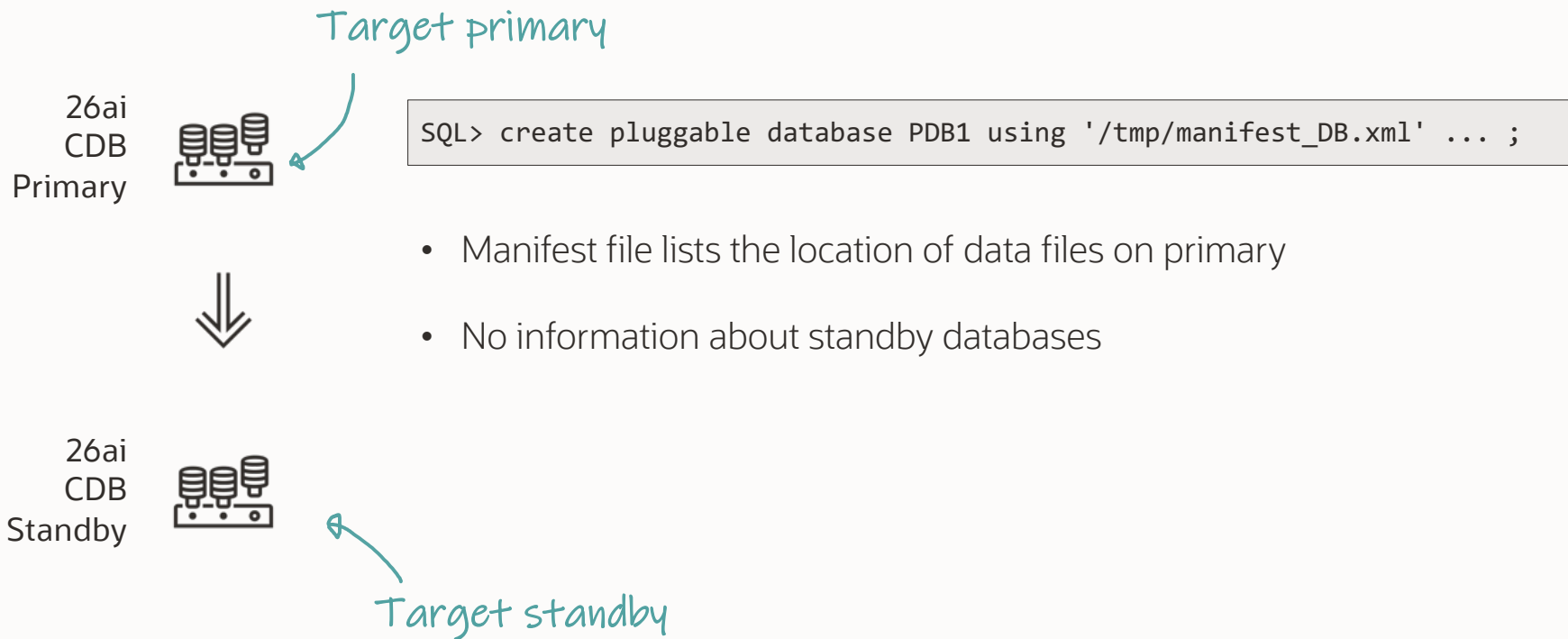
- File path on primary database only

...

```
<?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



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

+DATA/DB_CHICAGO/DATAFILE/users.269.1103050009

26ai
CDB
Standby



Enabled Recovery | ASM

26ai
CDB
Primary



+DATA/DB_BOSTON/DATAFILE/users.273.1103046827



26ai
CDB
Standby



OK, let's check the OMF directory

+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



26ai
CDB
Standby



OK, let's check the OMF directory

+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

Primary



Standby



Looking for file like on primary



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



Follows alias and finds the real file





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

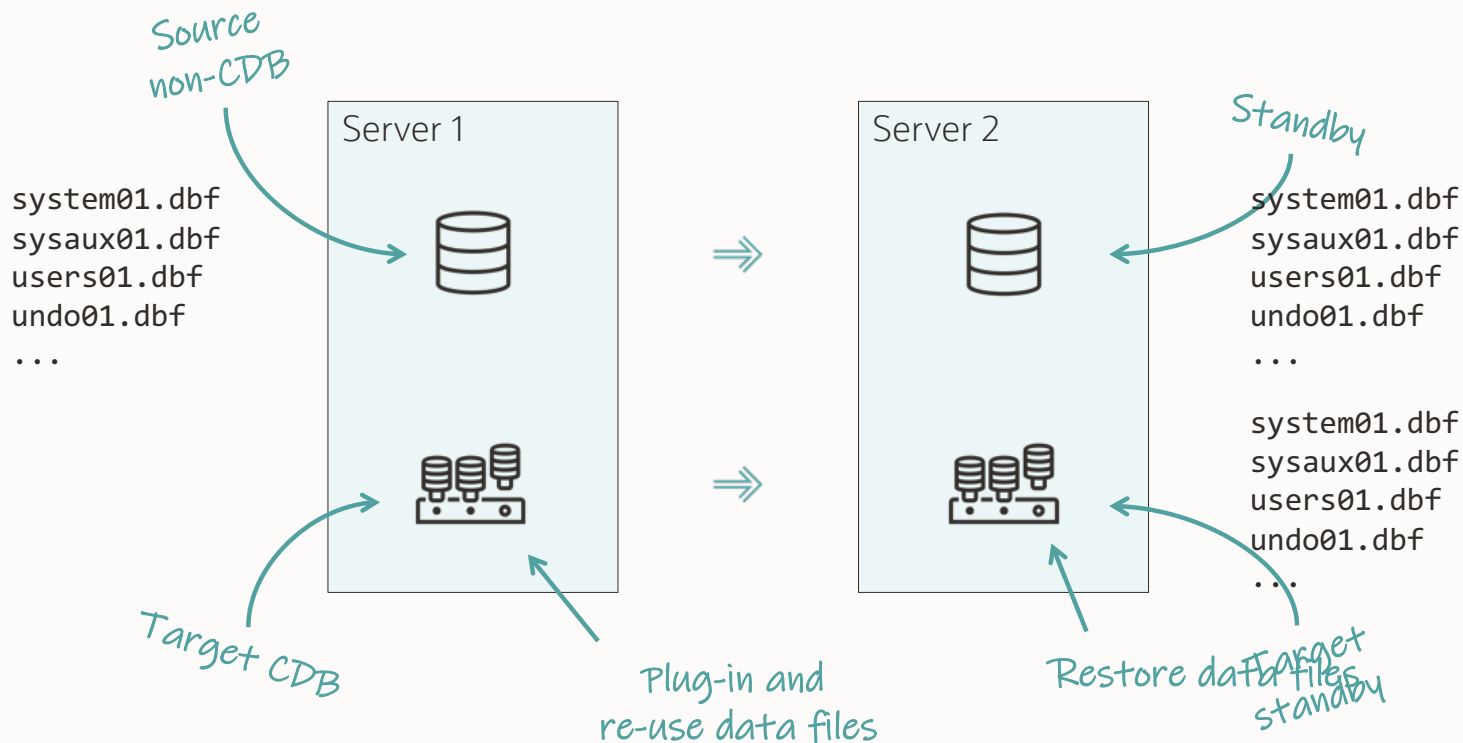
Standby ignores data files

MRP skips redo

PDB protected after restore



Deferred Recovery



Deferred Recovery



Source
Non-CDB



Target
Primary

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



Target
Standby



Deferred Recovery



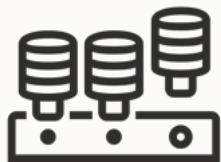
```
SQL> create pluggable database ...  
standbys=none;
```



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$pdb;
```

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



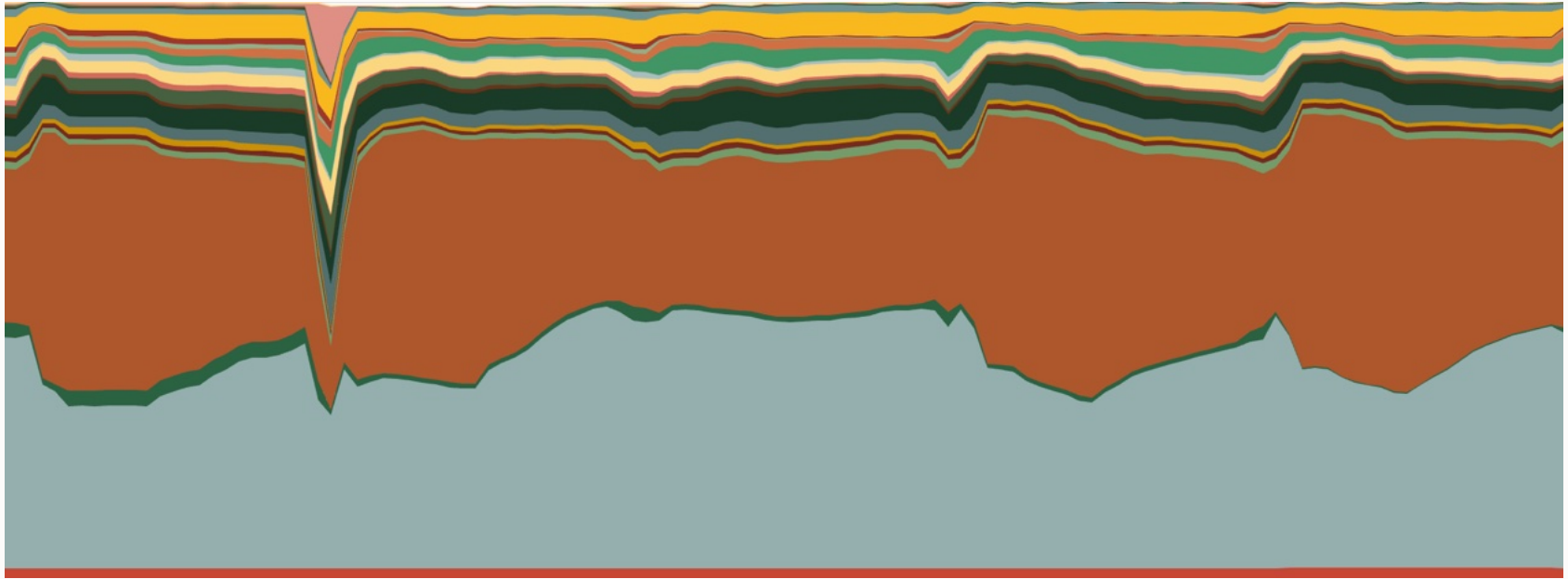
Files



Resource Consolidation

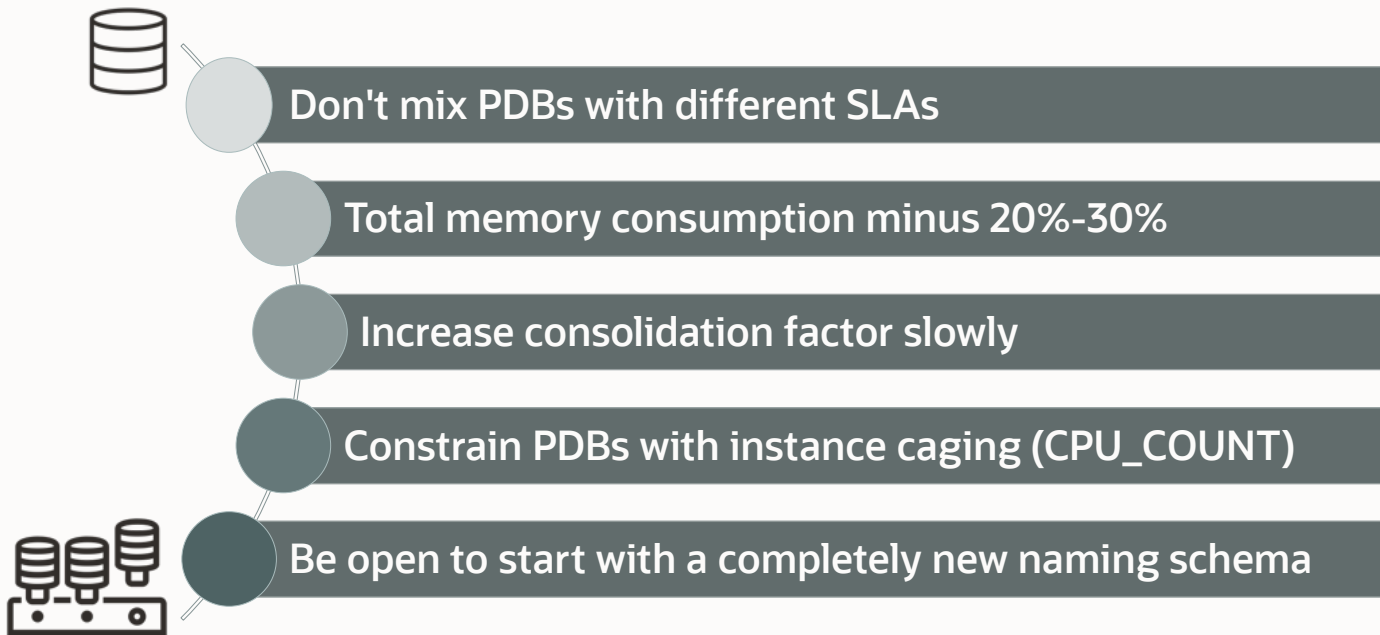


Resource Consolidation



Consolidation Strategies?

There is no "*best*" strategy



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



Virtual Private Database



PDB consolidation

- 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

CPU_COUNT=4

CPU_COUNT=4

CPU_COUNT=4

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

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



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



CPU_MIN_COUNT=1



CPU_MIN_COUNT=1

At peak, may use up to 5 CPUs

4 CPUs are reserved,
3 are free for all

Method 3



8 GB memory



SGA_TARGET=7G



SGA_MIN_SIZE=2G



SGA_MIN_SIZE=1G



SGA_MIN_SIZE=1G

At peak, may use
up to 4G shared memory





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:

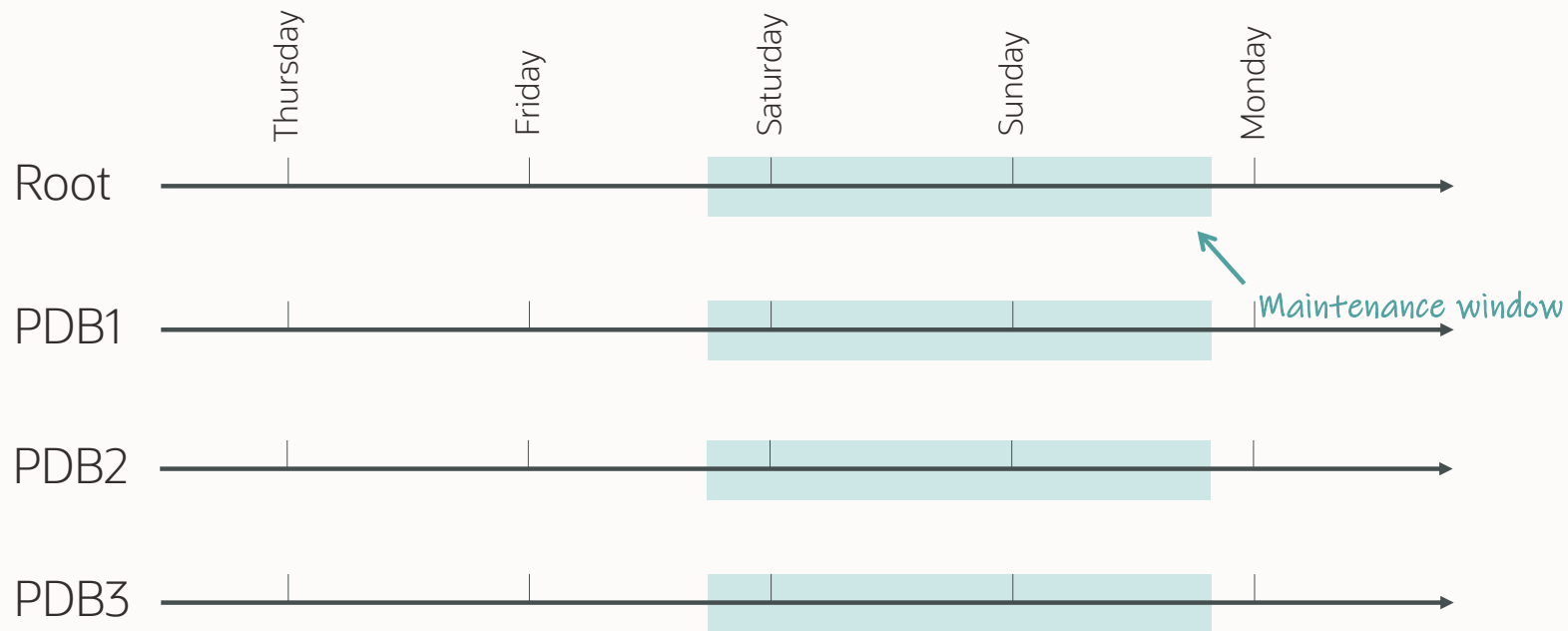
- Controls resource sharing using Linux c-groups
- Check [RESOURCE MANAGER CPU SCOPE](#)
- Exadata Database Machine and Autonomous AI Database



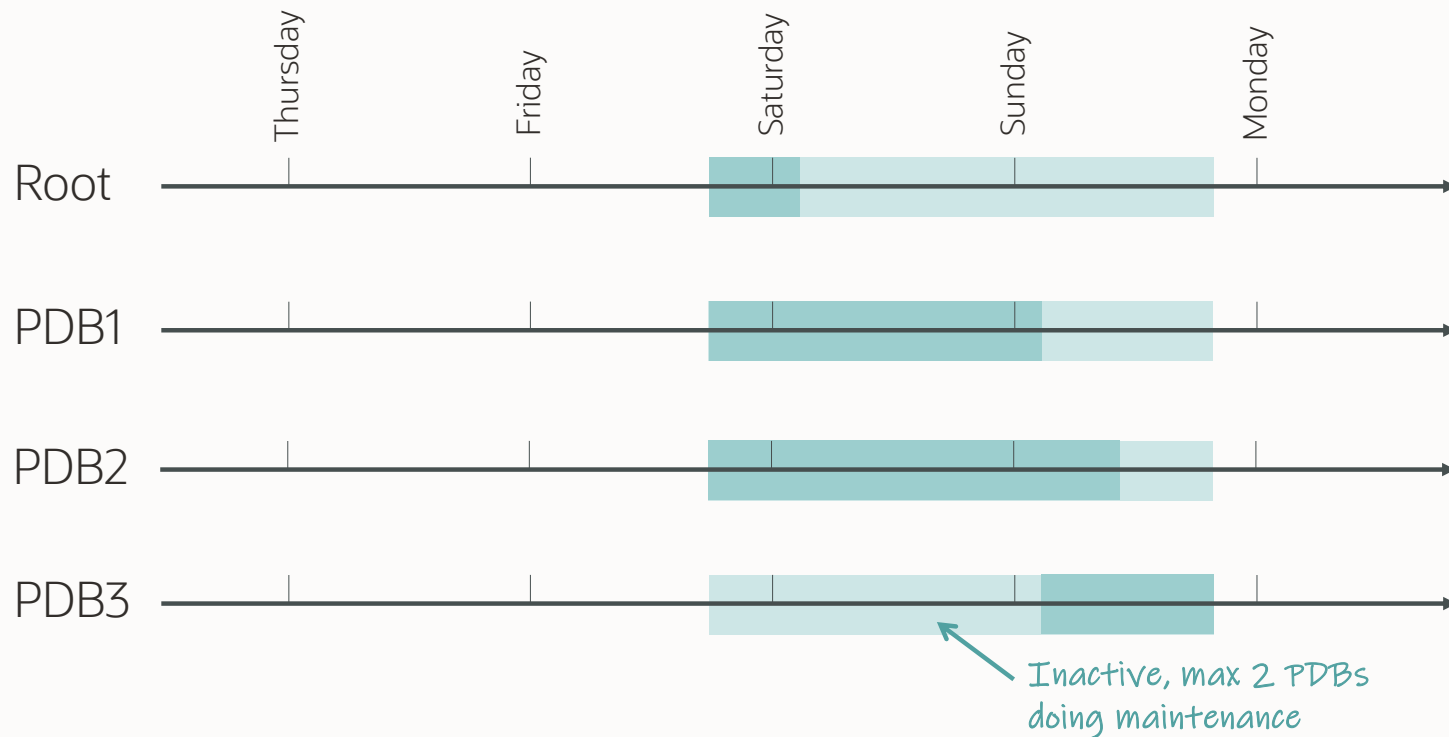


A word about automated maintenance tasks

Automated Maintenance Tasks



Automated Maintenance Tasks

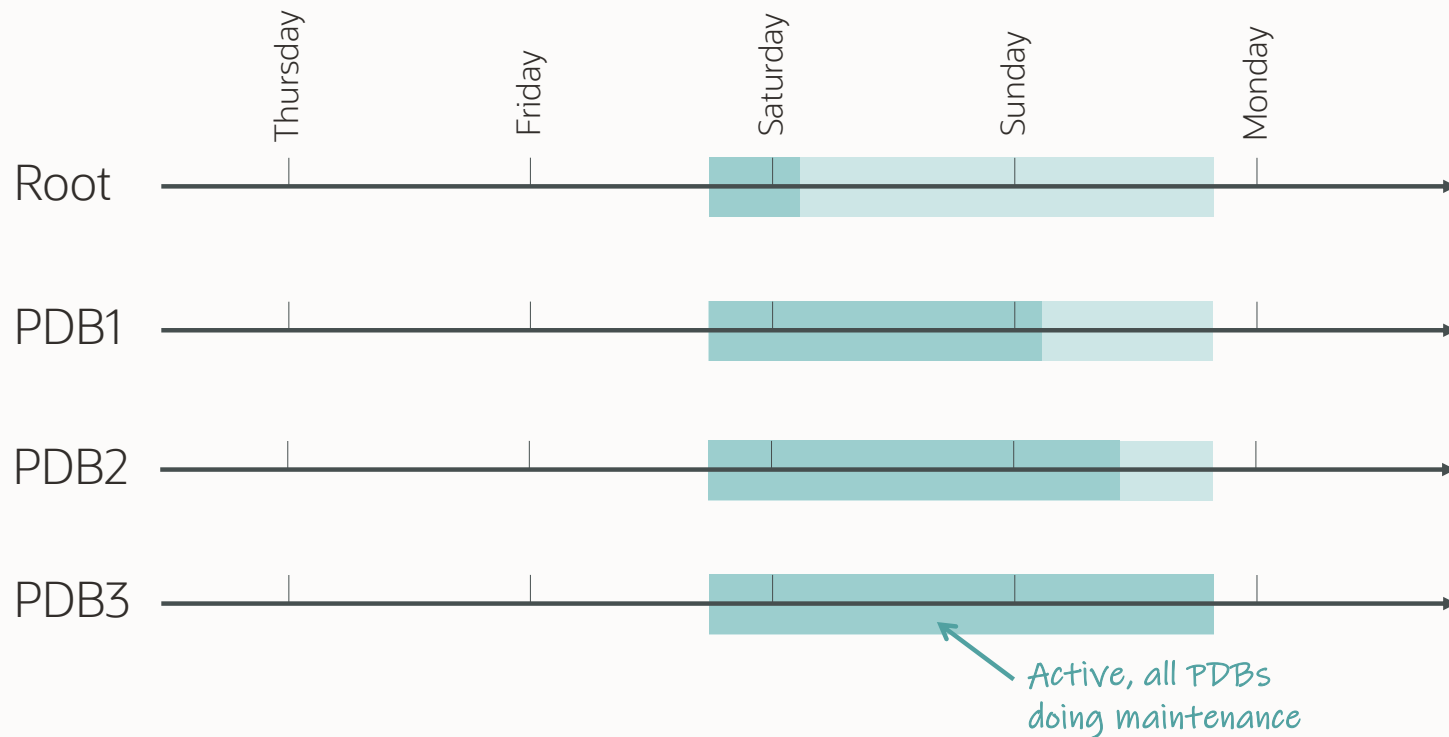


--Change the amount of PDBs that can run maintenance tasks at the same time
--Default value 2

```
alter system set autotask_max_active_pdb=3;
```



Automated Maintenance Tasks

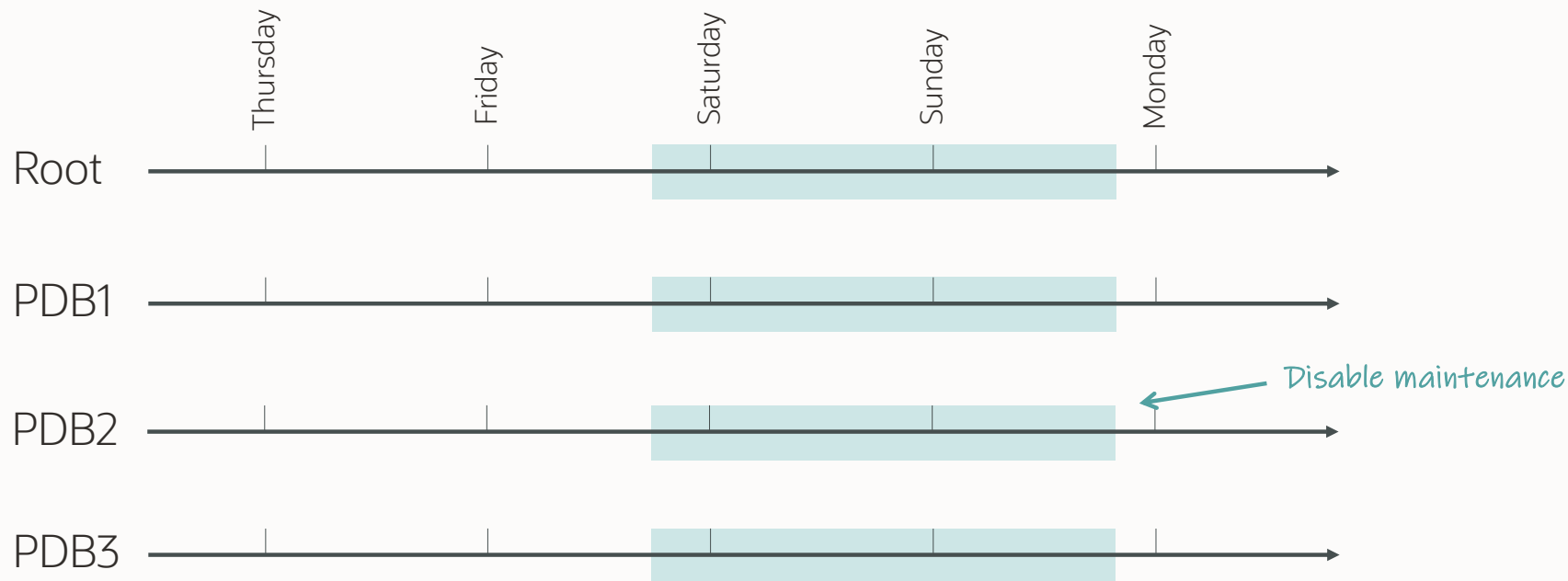


--Selectively disable maintenance tasks in a PDB
--For instance, test databases or databases that are rebuilt frequently

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



Automated Maintenance Tasks



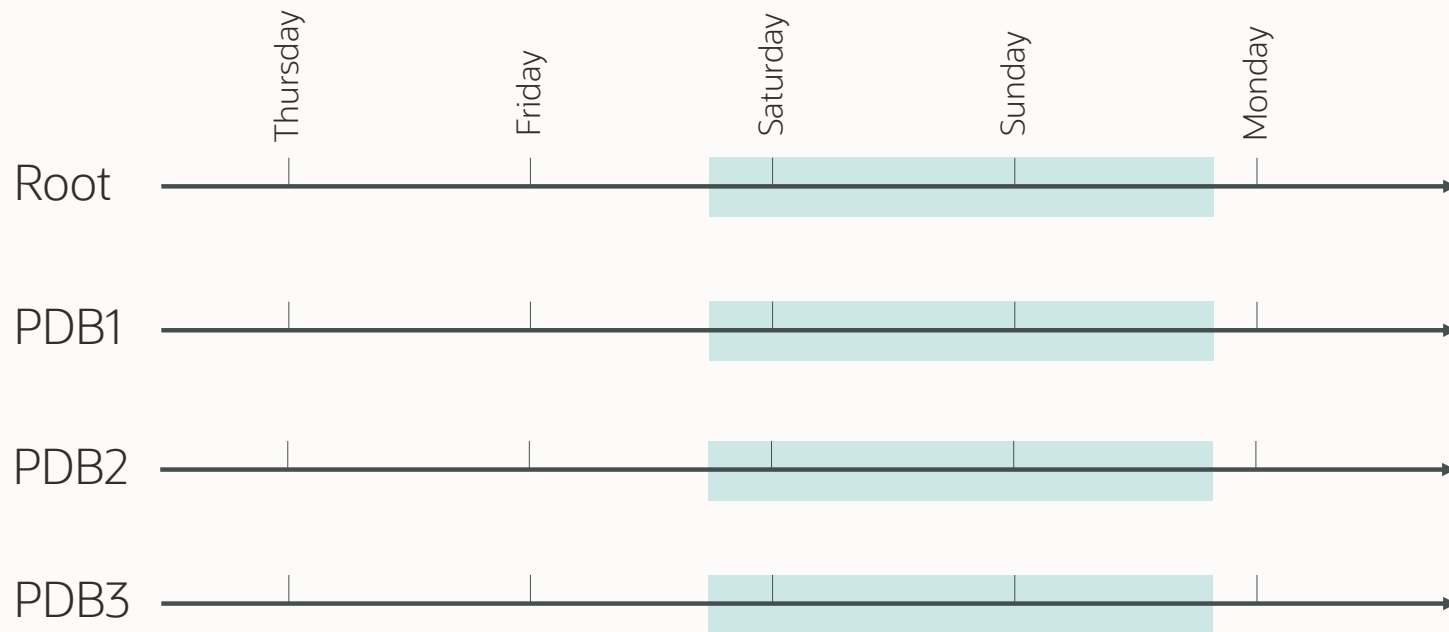


Shift maintenance windows

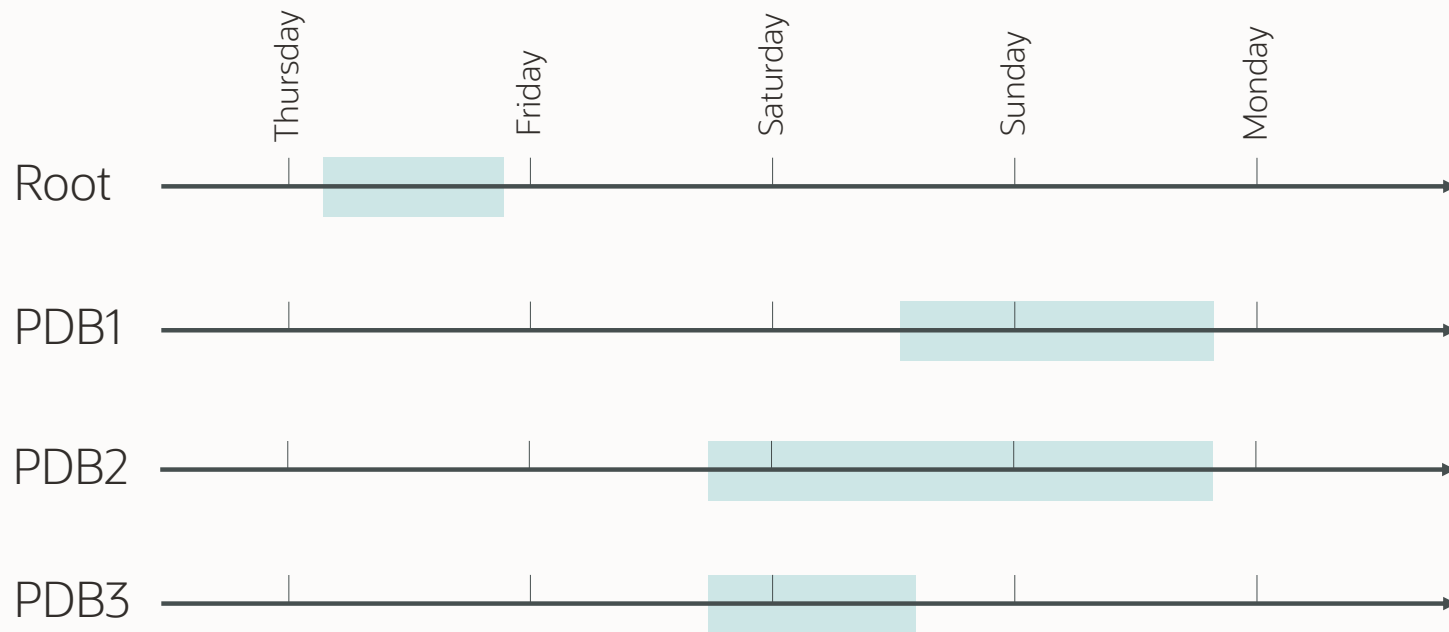
- Optionally, shorten maintenance windows



Automated Maintenance Tasks



Automated Maintenance Tasks





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

The background features a light gray pattern of concentric circles. In the top right corner, there is a blue circle with horizontal stripes and a dark gray circle. In the bottom right corner, there is a red circle with a grid pattern and a green circle. A small red square with a white 'O' logo is located in the bottom right corner.

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

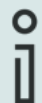
DEMO

Apply Data Pump Bundle Patch



[Watch on YouTube](#)

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



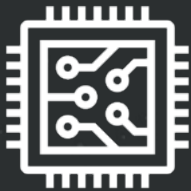
On-prem (x86-64)

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



Control process



Worker processes

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

`select * from t2`

`select * from t3`

`select * from t4`

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](#)



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
Import parallel 1	6h 44m
Total	8h 46m

Export parallel 16	1h 8m
Import parallel 16	1h 23m
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_t1" 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_t1" 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](#)

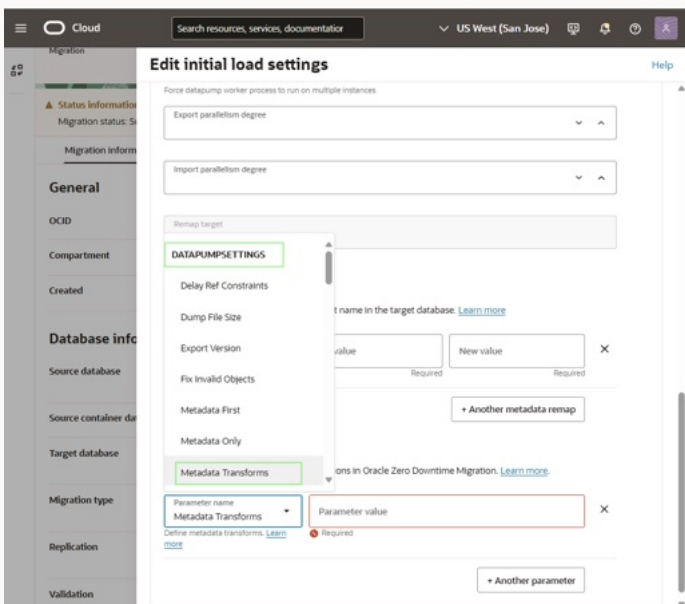


- Data Pump always validates certain constraints:
 - On DEFAULT ON NULL columns
 - Used by a reference partitioned table
 - Used by a reference partitioned child table
 - Table with Primary key OID
 - Used as clustering key on a clustered table



NOVALIDATE Constraints

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



Edit initial load settings

Force datapump worker process to run on multiple instances

Export parallelism degree

Import parallelism degree

Remap target

DATAPUMPSETTINGS

Delay Ref Constraints

Dump File Size

Export Version

Fix Invalid Objects

Metadata First

Metadata Only

Metadata Transforms

Parameter name: Metadata Transforms

Parameter value

Define metadata transforms. [Learn more](#)

+ Another parameter

F.28 DATAPUMPSETTINGS_METADATATRANSFORMS_LIST_ELEMENT_NUMBER

Defines the name, the object type, and the value for the Data Pump METADATA_TRANSFORM property.

To add multiple filters, increment the integer appended to the parameter name, as shown in the examples below.

```
DATAPUMPSETTINGS_METADATATRANSFORMS-1=name:nameValue1st, objectType:objectType, value:valueValue
DATAPUMPSETTINGS_METADATATRANSFORMS-2=name:nameValue2nd, objectType:objectType, value:valueValue
```

Copy

See [Transforms Provided by the METADATA_TRANSFORM Procedure](#) for more information.

Parameter Relationships

The optional DATAPUMPSETTINGS_* parameters let you customize Oracle Data Pump Export and Import jobs.

Property	Description
Syntax	<code>DATAPUMPSETTINGS_METADATATRANSFORMS-list_element_number = name:nameValue, objectType:objectType, value:valueValue</code> Note: See Transforms Provided by the METADATA_TRANSFORM Procedure for more information about the values that can be specified for name.
Default value	There is no default value
Range of values	An entry specifying the name, type, and value is expected, as shown in the examples above.
Required	No
Modifiable on Resume	No

Usage Notes

You can set XMLTYPE_STORAGE_CLAUSE to 'BINARY XML'. DATAPUMPSETTINGS_METADATATRANSFORMS-1=name:XMLTYPE_STORAGE_CLAUSE, value:'BINARY XML'. With this enhancement all XML types can be converted as part of the migration.





Use index size to determine
parallel degree on index creation

Index Creation

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

Before 12.1

Worker 1 CREATE INDEX PARALLEL 16

Really good for few big indexes



Index Creation

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

From 12.1

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

Really good for many small indexes



Index Creation

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

From 26

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

The best of both worlds



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

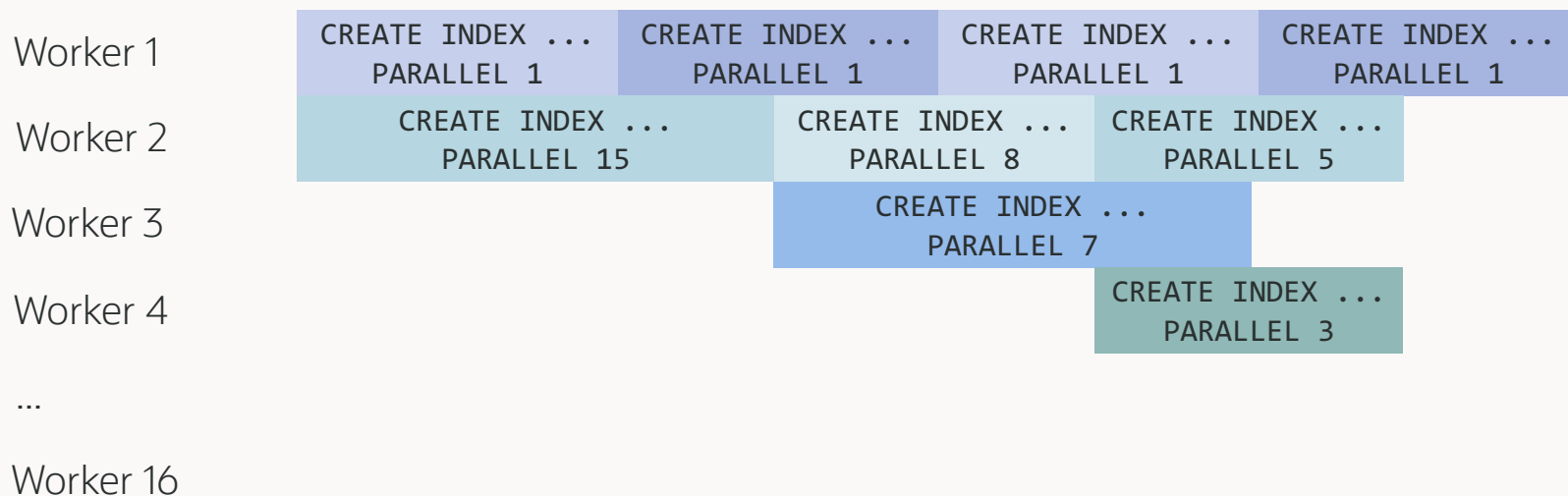
2 Create indexes

- 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`



Importing with former index method

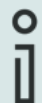
```
10-MAY-25 16:18:55.130: W-12 Processing object type SCHEMA_EXPORT/TABLE/INDEX/INDEX  
10-MAY-25 16:36:46.902: W-30      Completed 480 INDEX objects in 1071 seconds
```

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:



- 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

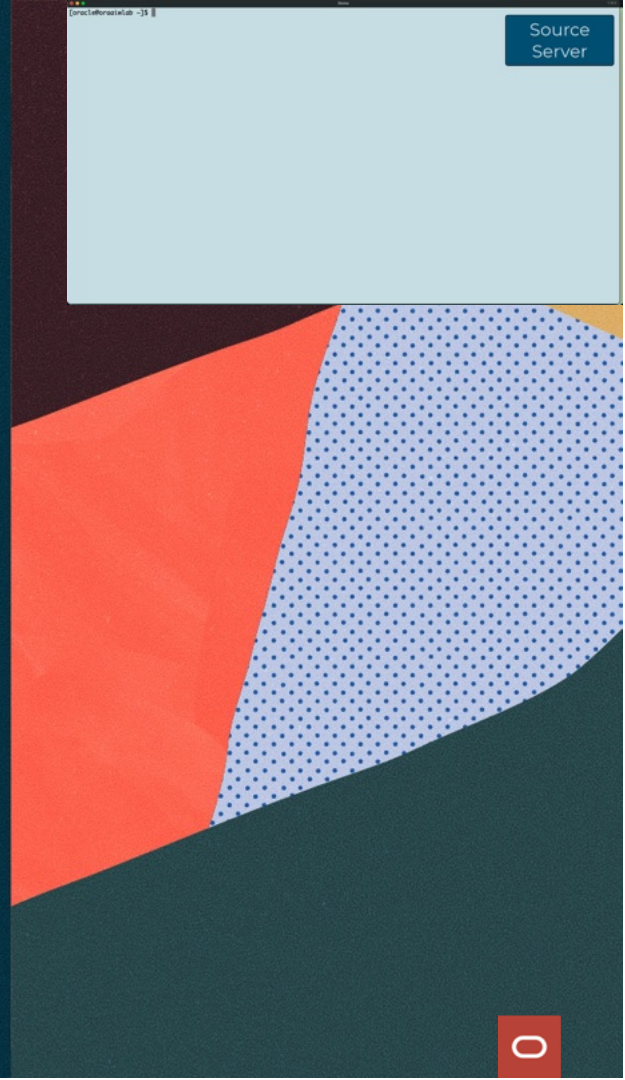
ORA-39405: Oracle Data Pump does not support importing from a source database with TSTZ version 43 into a target database with TSTZ version 42.

DEMO

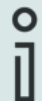
Convert time zone data on import



[Watch on YouTube](#)



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.



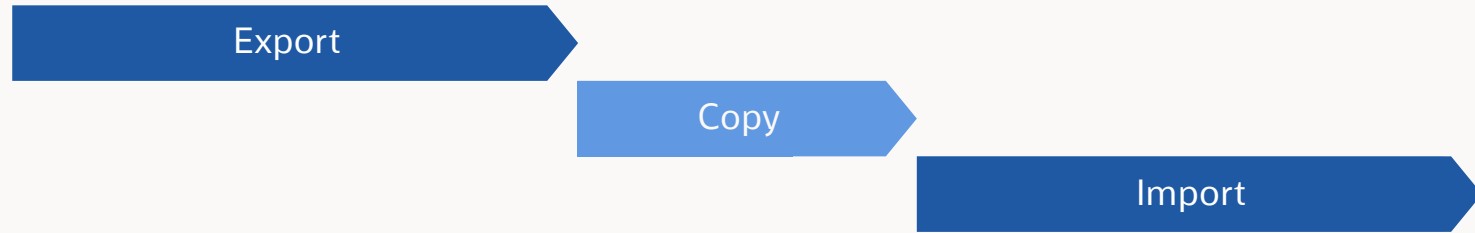


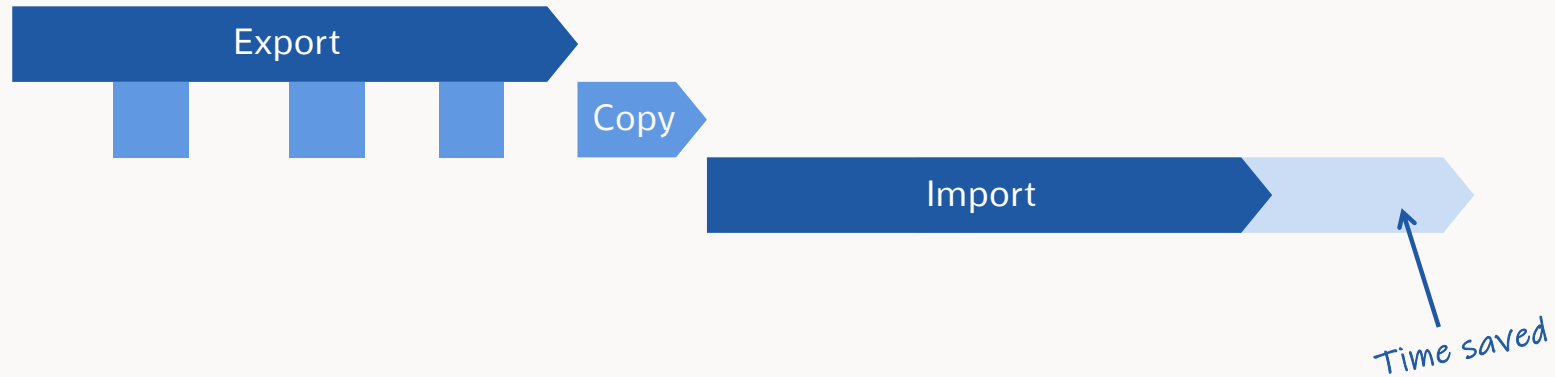
Also available in Oracle Database 19c
via 19.27 Data Pump Bundle Patch



Copy the dump files before the export completes

- Oracle AI Database 26ai





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

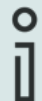


```
end loop;
```

```
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

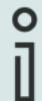
- Oracle AI Database 26ai

```
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

KEYNOTE PRESENTATION

Oracle OpenWorld San Francisco 2017



by LESEN


OO W 2017

ORACLE®



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

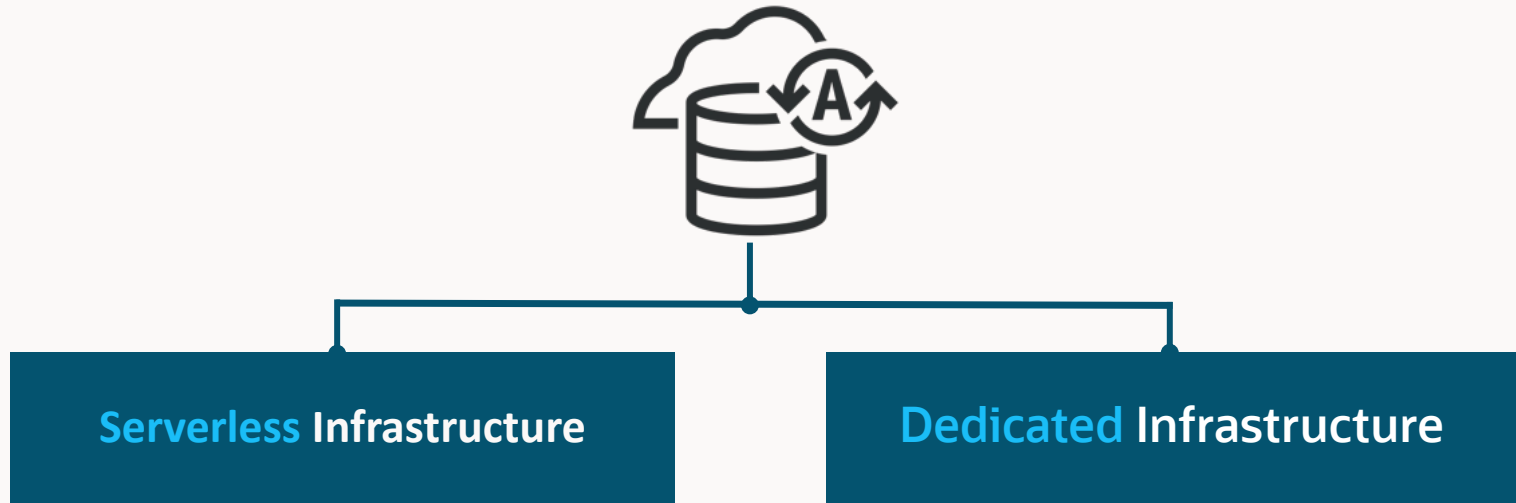


Cloud@Customer

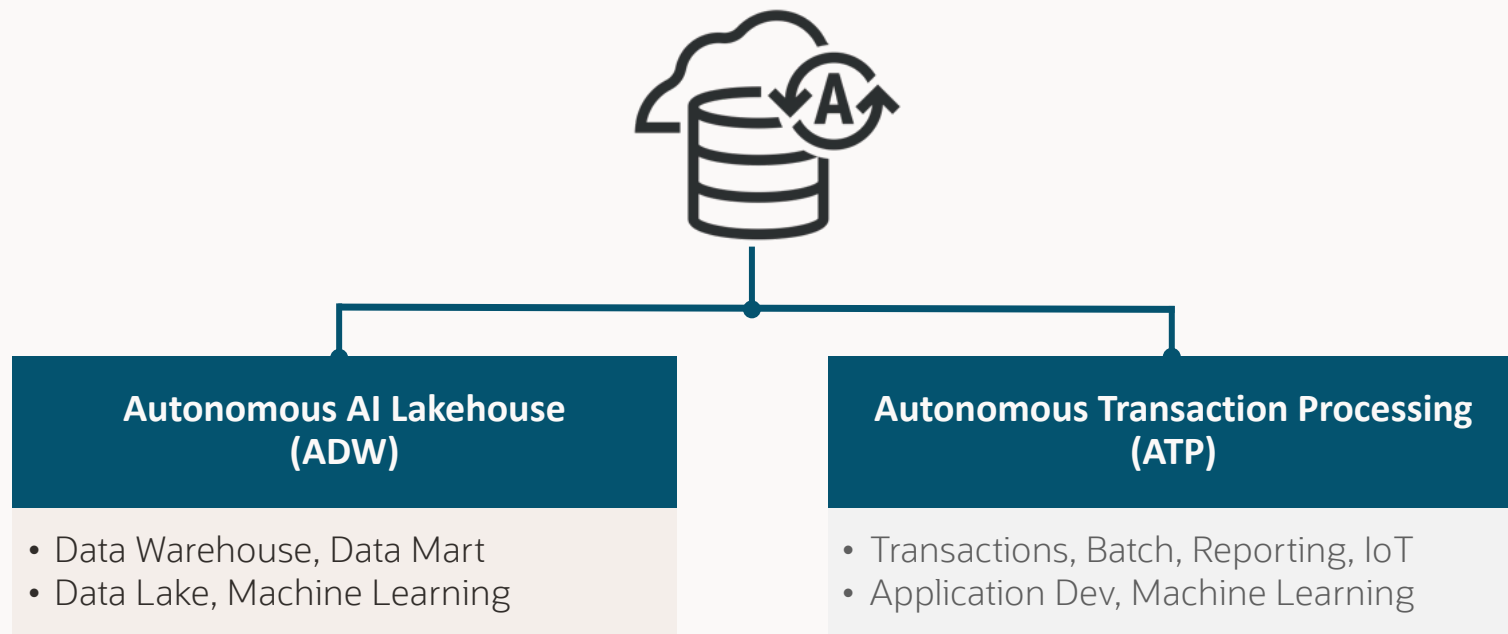
Autonomous AI Database in a VM environment



One Autonomous AI Database – Two Deployment Choices



One Autonomous AI Database – Workload Choices



Migration Planning

No migration without a proper runbook



Photo by bert.b on Unsplash

Estate Modernization

But not every database is a great candidate for ADB



Migration to Autonomous AI Database is always a **logical** migration

- Move the data, 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

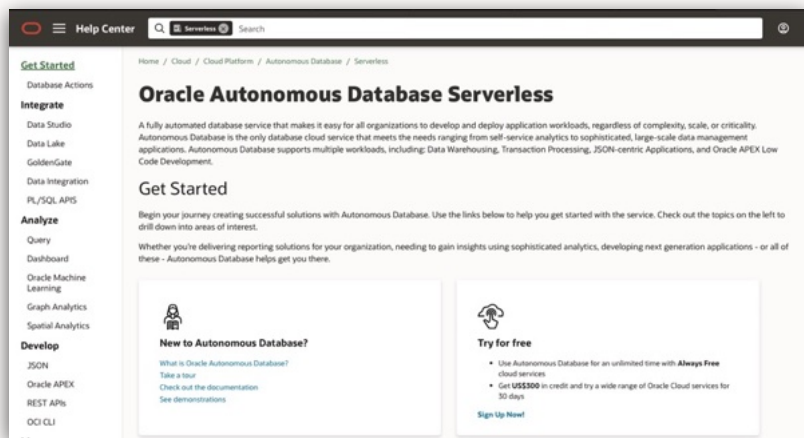


APEX

Execute SQL and PL/SQL
Build Data Models,
generate DDL statements
Monitor and manage the DB



Essentials

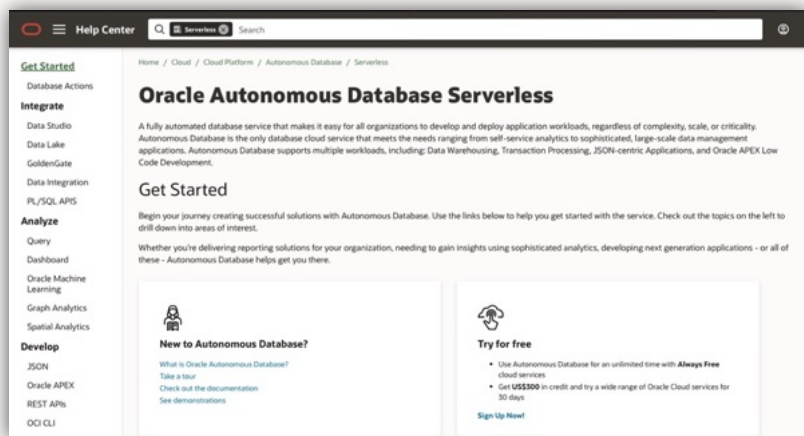


Outside the database,
check [OCI Documentation](#)

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



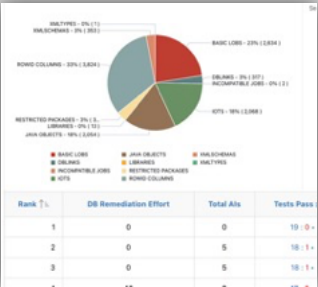
2

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

Oracle Cloud Migration Advisor

mike.dietrich@oracle.com

Home

Guided Mode

Create Project

My Available Projects

Download Collectors

File Exchange with Custom...

REST Services

Help

Oracle Cloud Migration Advisor

Welcome to the Cloud Migration Advisor (CMA)

Oracle Cloud Migration Advisor brings you the expert technical knowledge of Oracle Database upgrade and migration development teams, combined with more than a century of combined real-world experience with customer migrations, to give your customer the **best possible migration advice**.

With **Guided Mode**, CMA will quickly tell you

- Which databases can be **most easily migrated** to Oracle Autonomous Database, or
- What is the **best migration method** to move chosen databases to a desired Oracle Cloud platform?

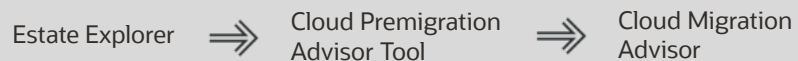
For more options, you can

- Create and configure migration scenarios using **Create Project**, or
- Access your existing migration projects and scenarios with **My Available Projects**.

Now it is time to start - let's move to the Oracle Cloud!

Guided Mode **My Available Projects** **Create New Project**

Getting an Overview



- 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 MOS Note: 2758371.1



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
```



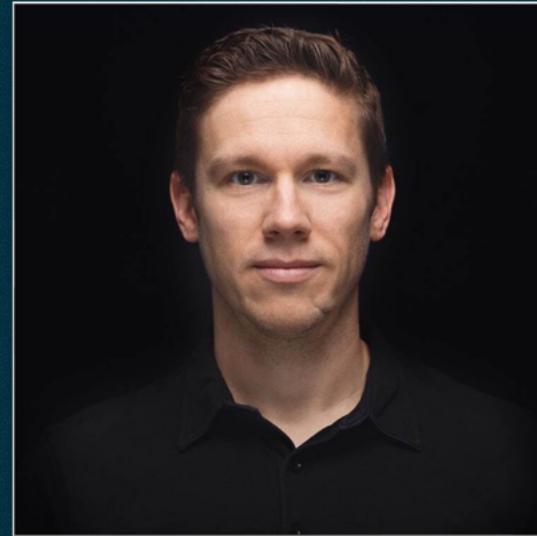


That's a lot of options.
Help me out, please!

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
```

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

- [Premigration Advisor Report Summary](#)
- [Report 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](#)
- [Report Legend](#)

[Expand All](#)[Close All](#)

▼ Premigration Advisor Report Summary

Report Result

Action Required

Number of schemas analyzed:

4

List of schemas analyzed:

EDBUSER_CG_UR_MYAPP

- [Premigration Advisor Check Details List](#)
- [Report Legend](#)

[Expand All](#)[Close All](#)

▼ Premigration Advisor Report Summary

Report Result

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

[Return to Table of Contents](#)

▼ 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:@dbssystemaz: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](#)

[Return to Table of Contents](#)

› **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:	dbssystemaz
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](#)

[Return to Table of Contents](#)

› **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

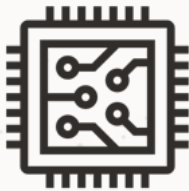




Data Pump Bundle Patch aren't yet applied in ADB Serverless (October 2025)

- 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: $\text{PARALLEL} = \text{ECPU} / 4$, 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

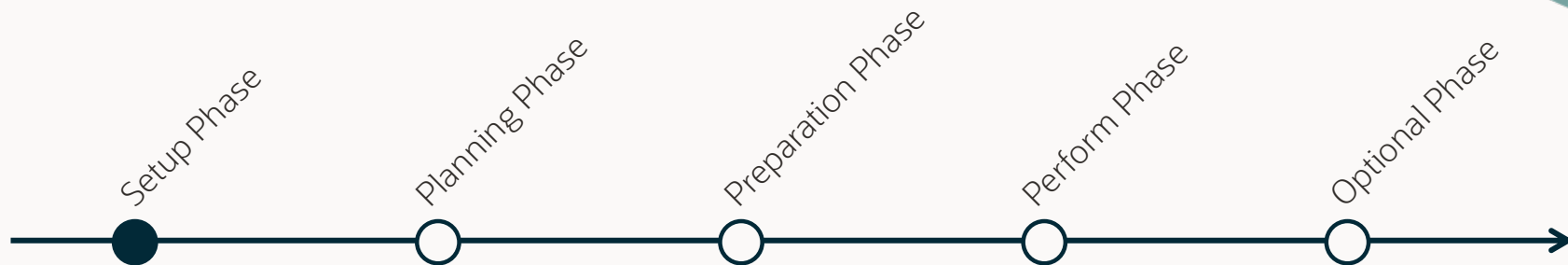
*You need a script book
You need to cast actors
You need a film set
You need ...*

Now you can start filming your scenes

And then there's plenty of work
on editing and cutting the movie



AMA Workflow



- 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:

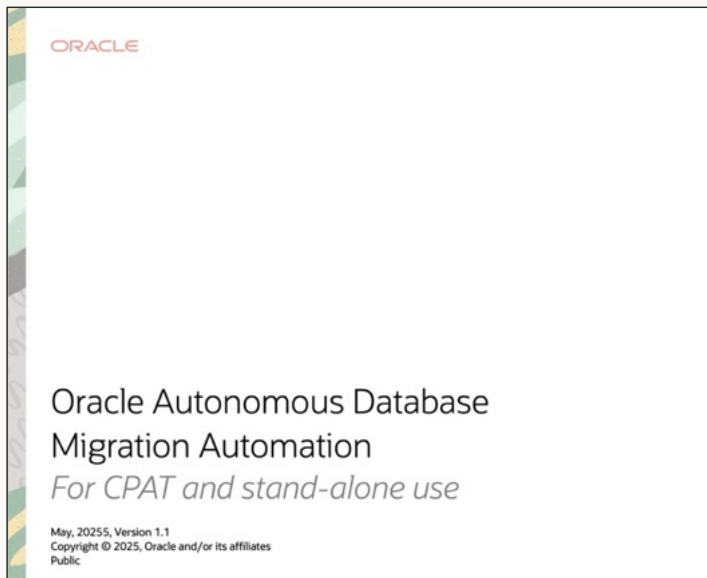
- Connect strings source and target
- Data Pump encryption
- Storage (FSS or Object Store)
- Format: TAB or SCRIPT



Documentation

AMA Documentation is available at request

- Documents the entire flow and all options and parameters

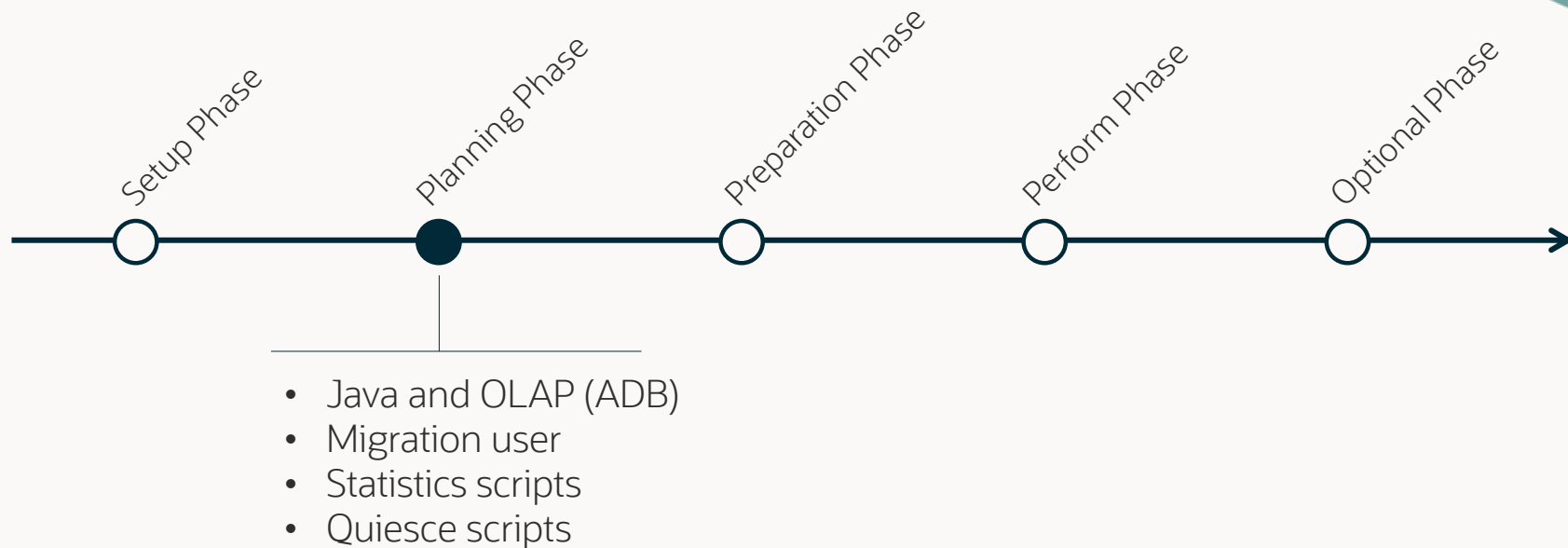


The image shows the table of contents for the Oracle Autonomous Database Migration Automation (CPAT) documentation. The Oracle logo is at the top left. The title "Table of contents" is in red. The table lists the following sections and their page numbers:

Introduction	3
Current Restrictions	3
Workflow	4
Setup	4
Planning Phase	4
Prepare Phase	4
Perform Phase	5
Post Phase	5
Optional Phase	6
How to use AMA	7
Setup and execute AMA	7
How to setup the shared storage	10
Setting up an NFS Share for the migration	10
OCI Console	10
Associate Mount Target	13
Linux	13
Windows	13
Setting up an Object Storage Bucket for the migration	13
Pre-Authenticated URL	14
APPENDIX A - AMA Migration Parameters	16
CONNECT_SRC	16
CONNECT_TGT	16
UID	16
PWD	16
EXCLUDE_USER	16
DP_ENCRYPTION_PWD	16
USE_FSS_CURL	16
DUMP_OUTPUT_PATH	17
ADB Dump File Storage Related Parameters	17
CONTROL_FILE_FORMAT	17
USE_DP_API TRUE	17
CPAT_OUTPUT_DIR	18
APPENDIX B - The AMA Configuration File	19
APPENDIX C - AMA Walkthrough including Output (Linux)	21



AMA Workflow



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-jl0sd1 OUTPUT]$ cat __US3BLDW_MIGRATION_CONTROL_FILE.ct1
```

```
---
```

```
---
```

```
--- 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
```

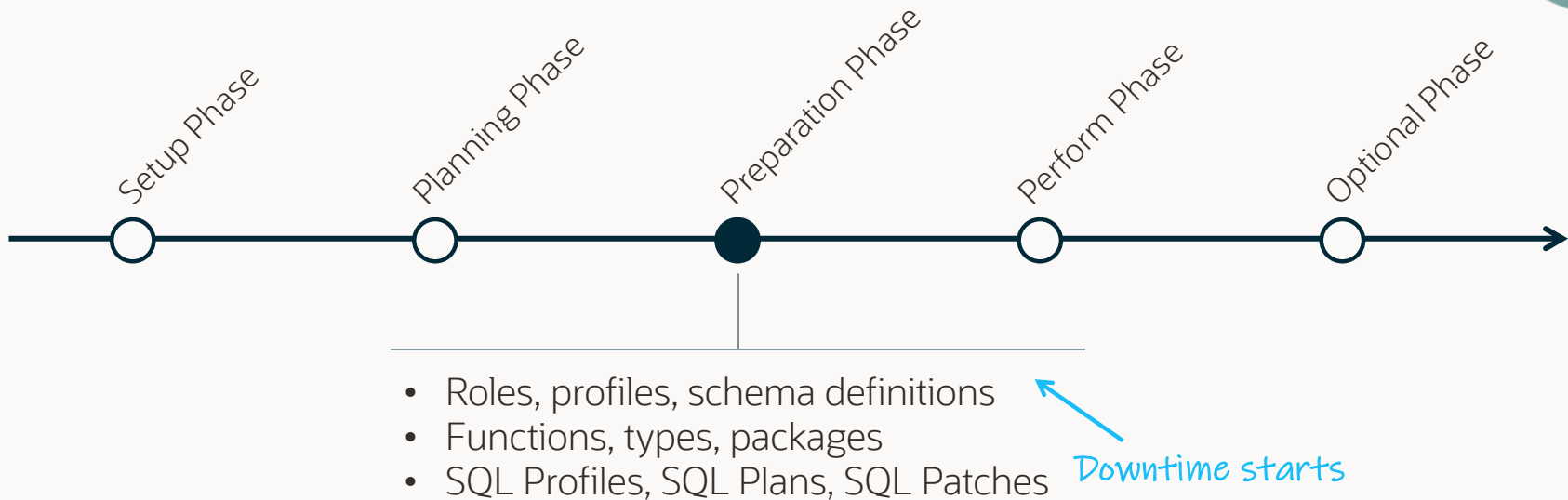
```
PLAN SOURCE 00004 01 00004_US3BLDW_SQL_SET_JOB_QUEUE_PROCESSES.sh
```

```
PLAN SOURCE 00005 01 00005_US3BLDW_SQL_ENABLE_RESTRICTED_SESSION.sh
```

```
---
```



AMA Workflow



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

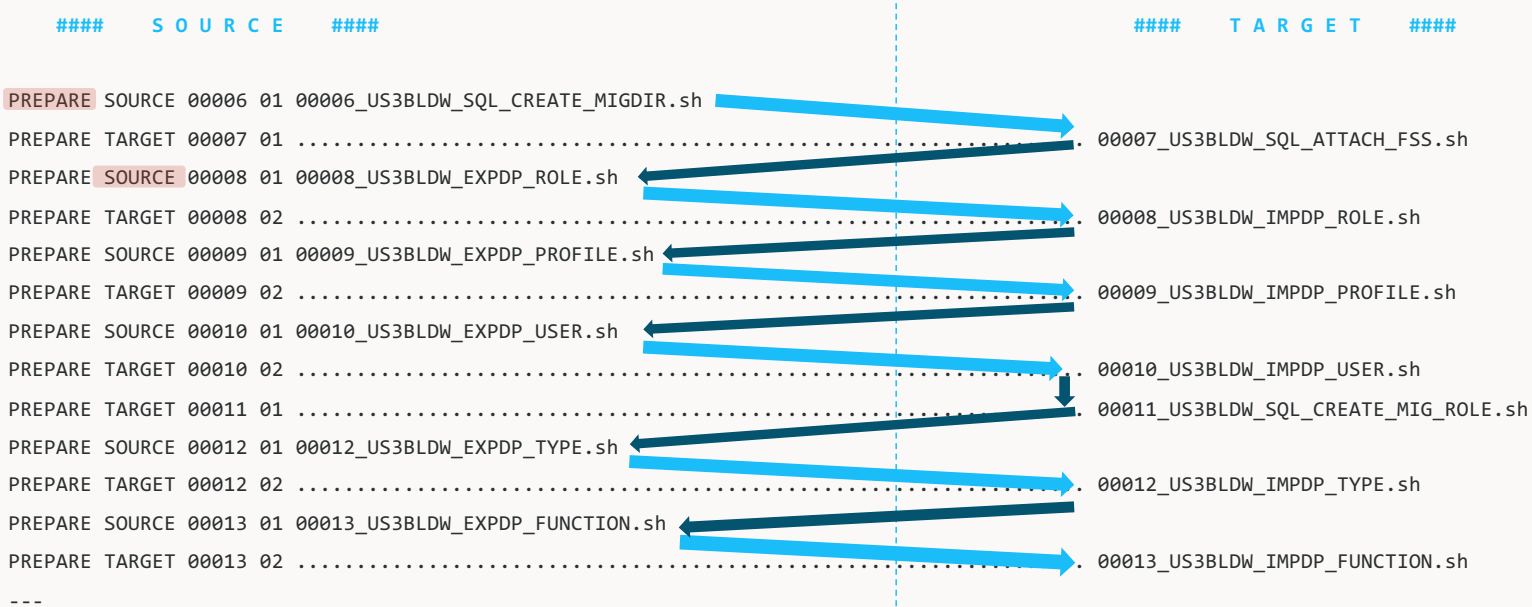
Create SQL Profiles, SQL Plans, SQL Patches



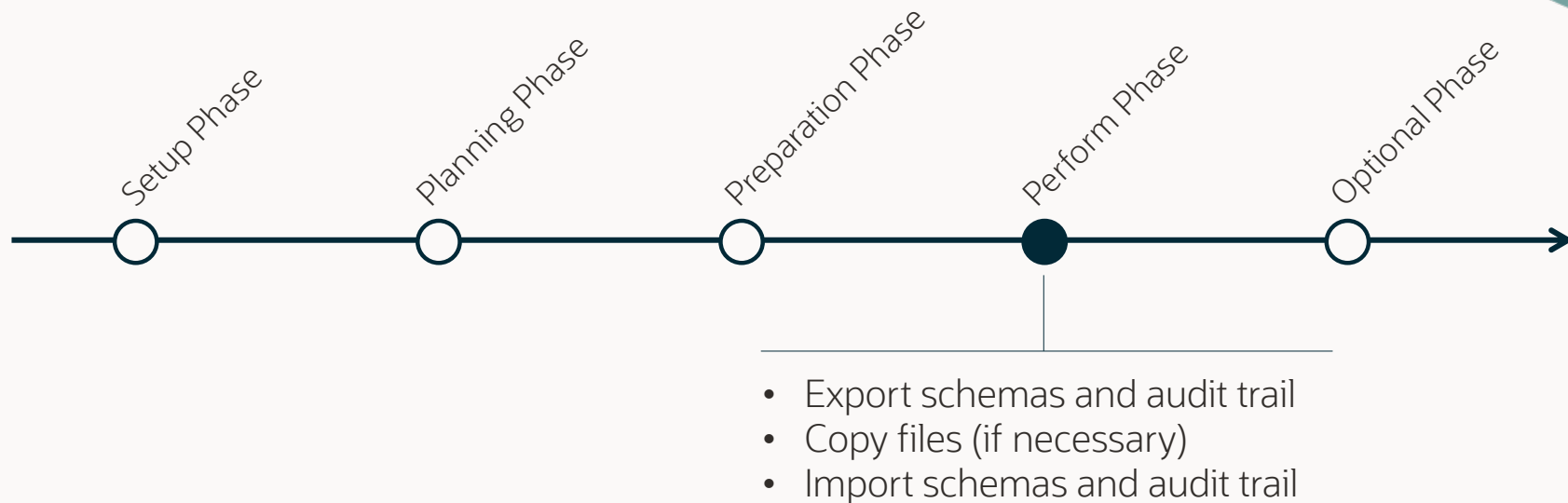
--- PREPARATION PHASE ---

--- 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 ---



AMA Workflow



AMA | Perform Phase

On-Prem - Source

Export all schemas

Export audit trail



Copy files (if necessary)



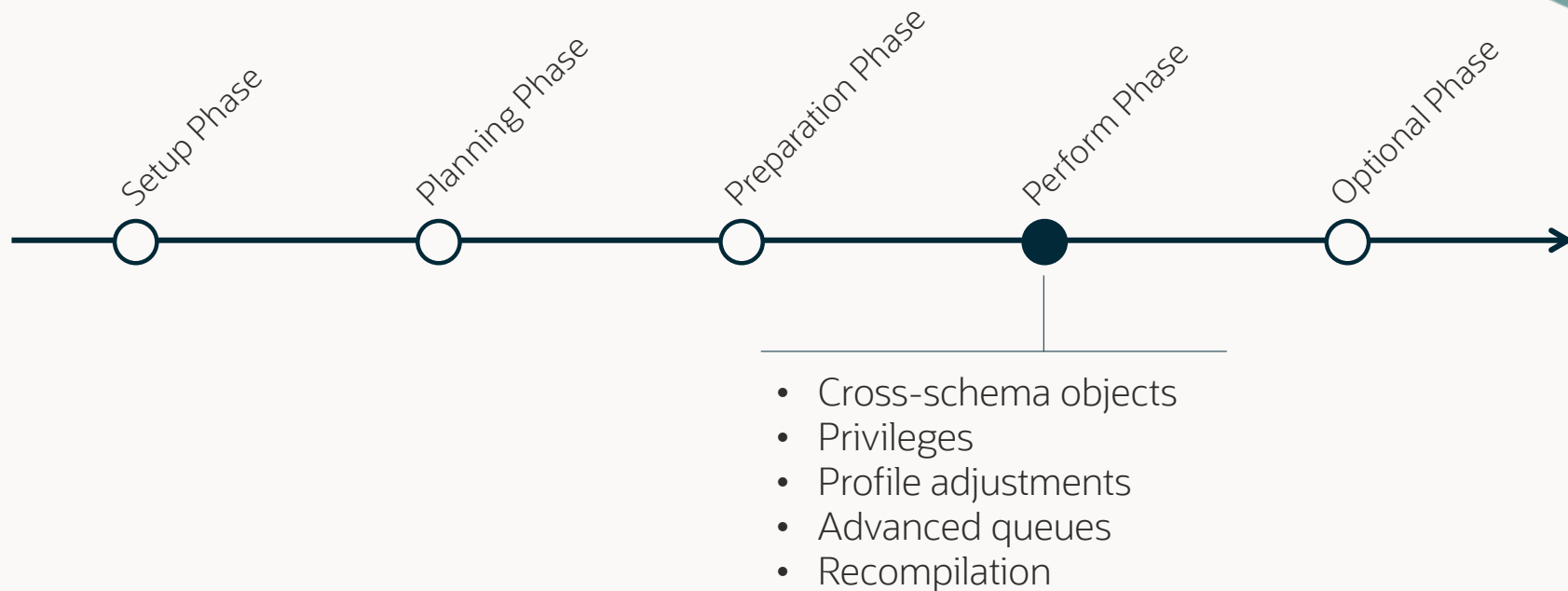
ADB-S - Target

Import all schemas

Import audit trail



AMA Workflow



--- 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

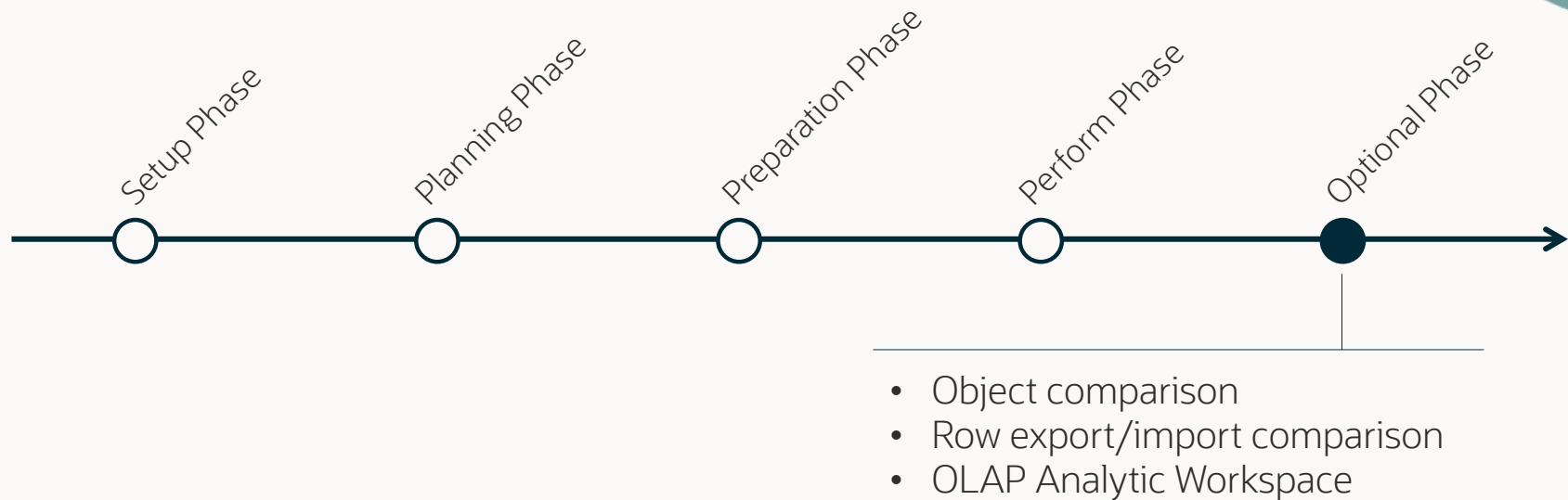
T A R G E T

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





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



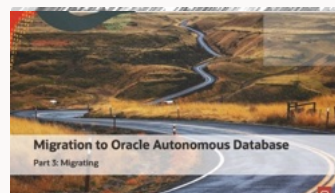
1 PLANNING

Watch [recording](#)
Get [slides](#)



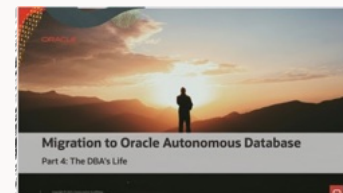
2 PREPARING

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

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

Ladbrokes

 **BETMGM**

sportingbet

CORAL 
GET CLOSER TO THE ACTION

bwin 

EUROBET 

SuperSport

party ker

Foxy BINGO

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



Photo by Mihály Köles on Unsplash

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

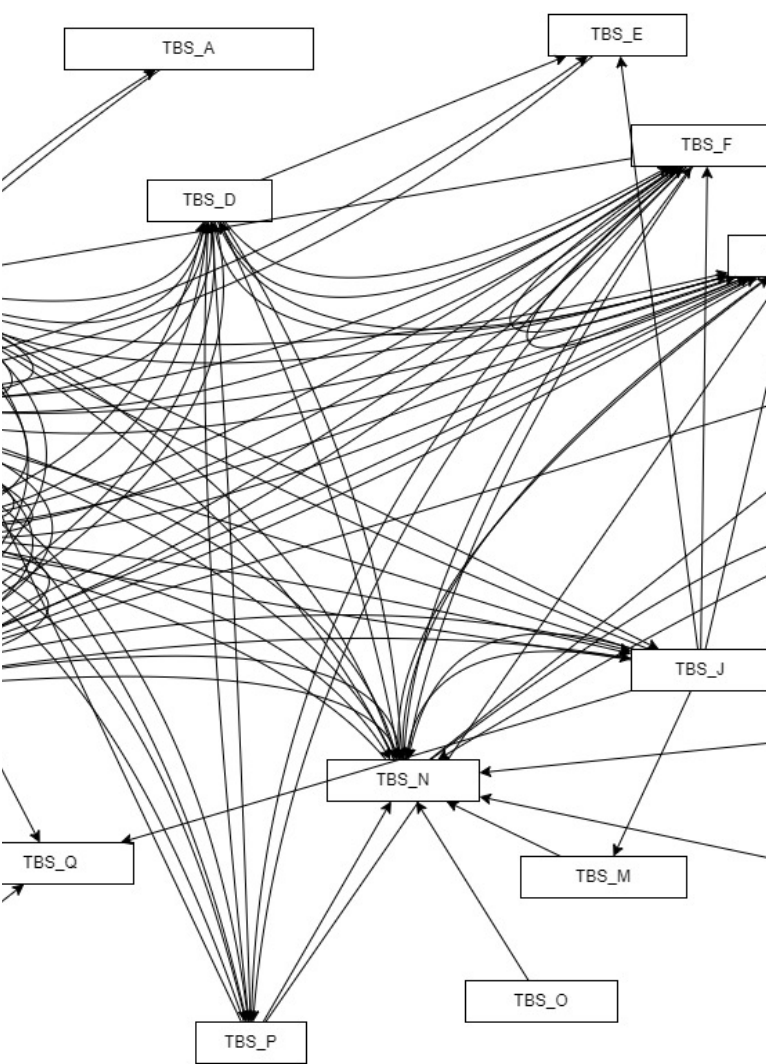


Photo by [Dave Hoefler](#) on [Unsplash](#)

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

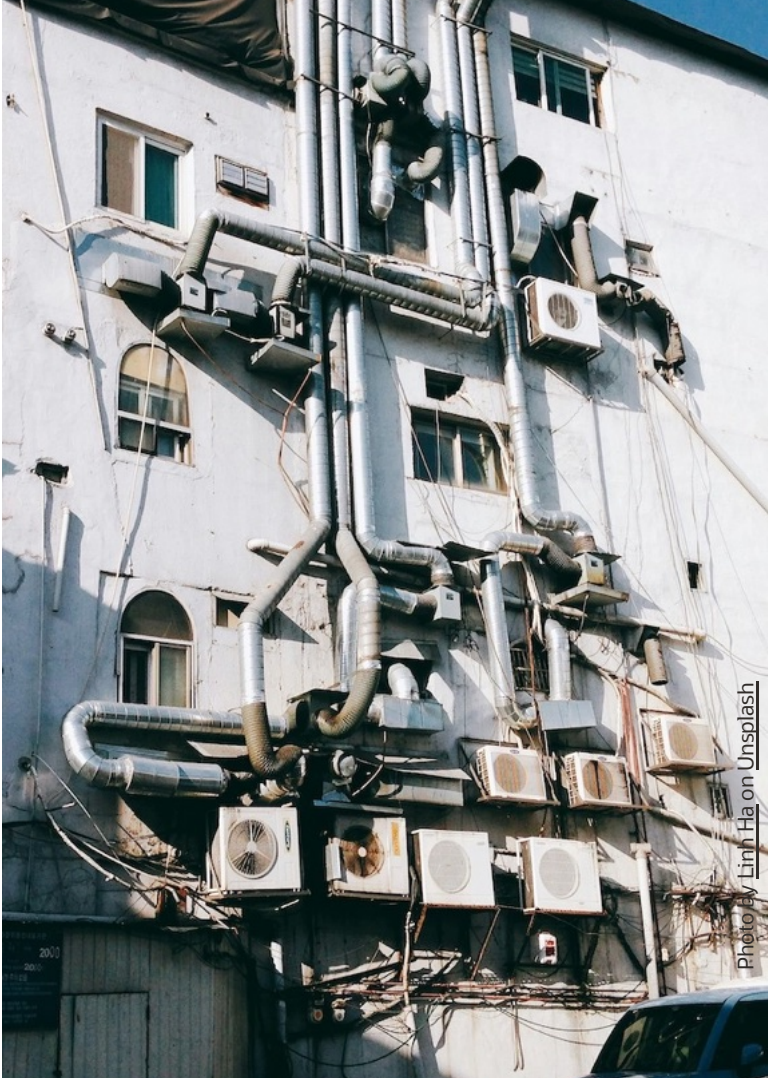


Photo by Linh Ha on Unsplash

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
 - Tablespace read-only
 - Full Transportable Export
- Live migration: 13 hours approved



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

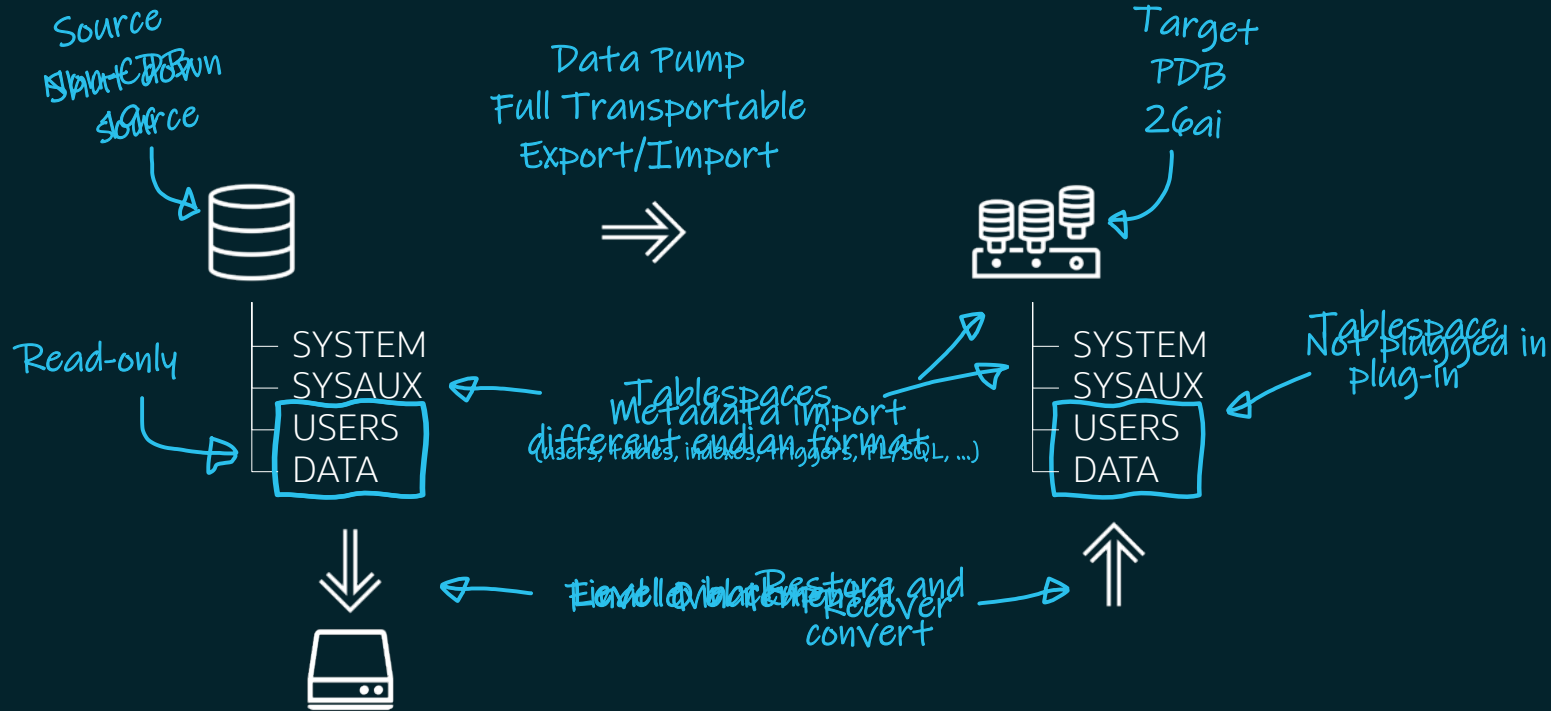
- No section-size backup support
- No standby backup support
- No selective PDB migration support

Migration



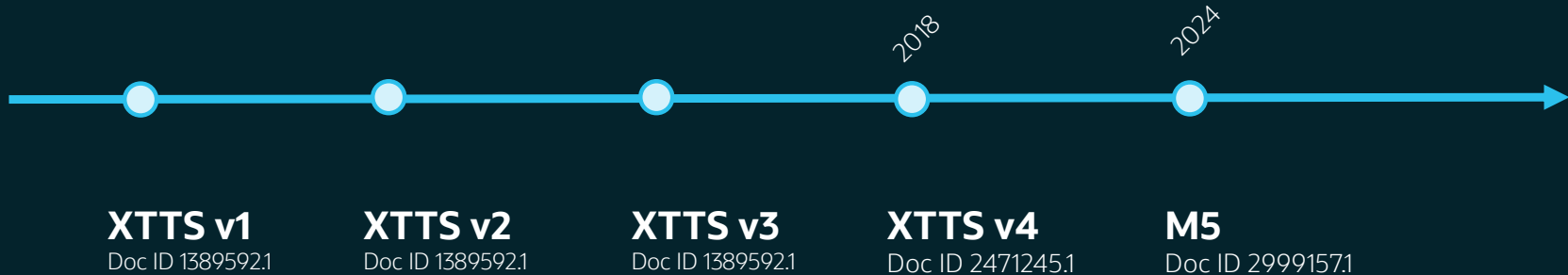
Typically, we use **Full Transportable Export/Import** for large cross-endian migrations

Concept



Scripts for Incremental Backup Automation

Backup / restore / recover



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

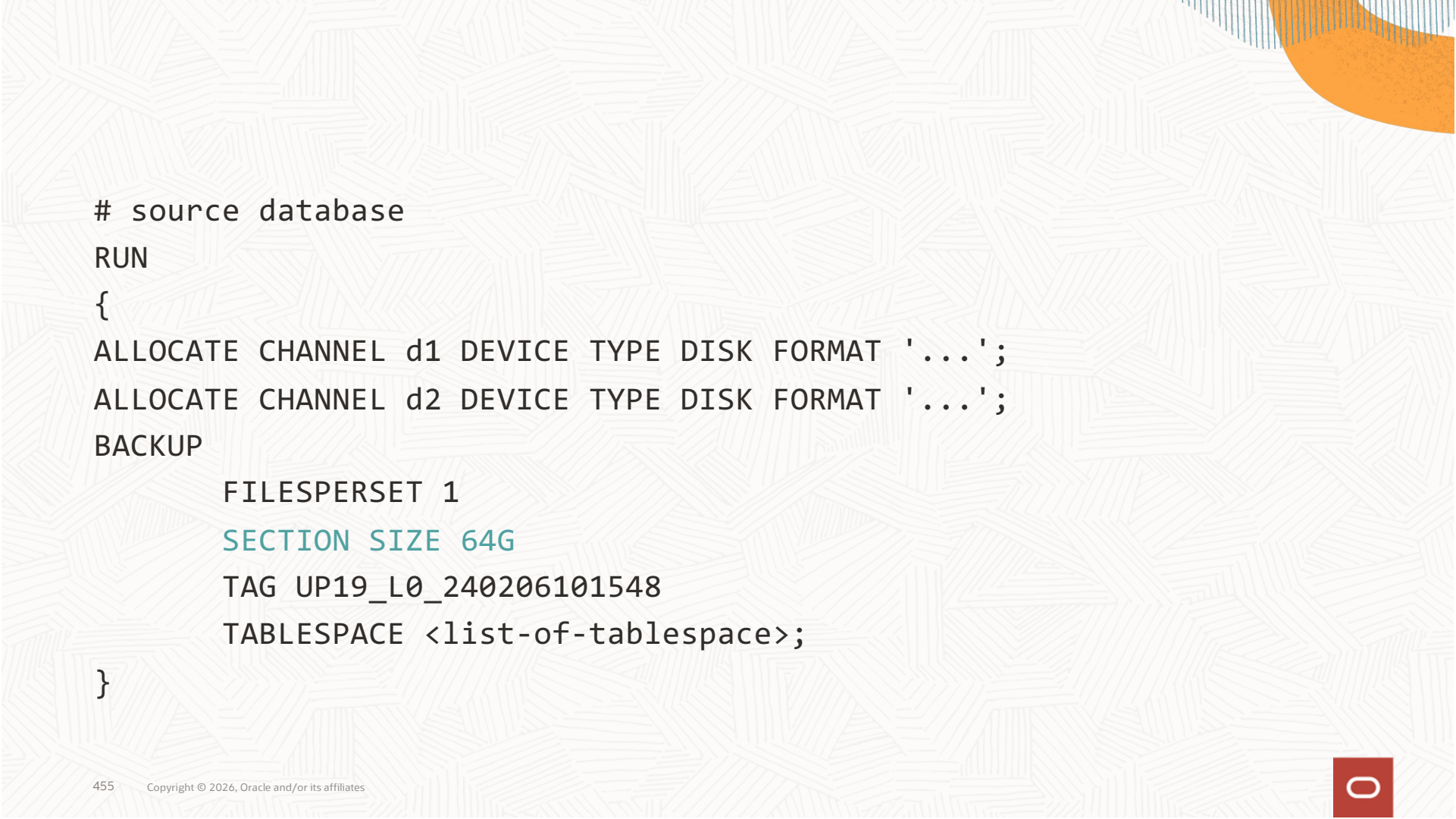


M5 is the **next-generation** cross-platform transportable tablespace procedure

- New RMAN functionality combined with Full Transportable Export/Import
- Doc ID [2999157.1](#)

M5 Migration Script

The new migrations scripts superseding 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](#)

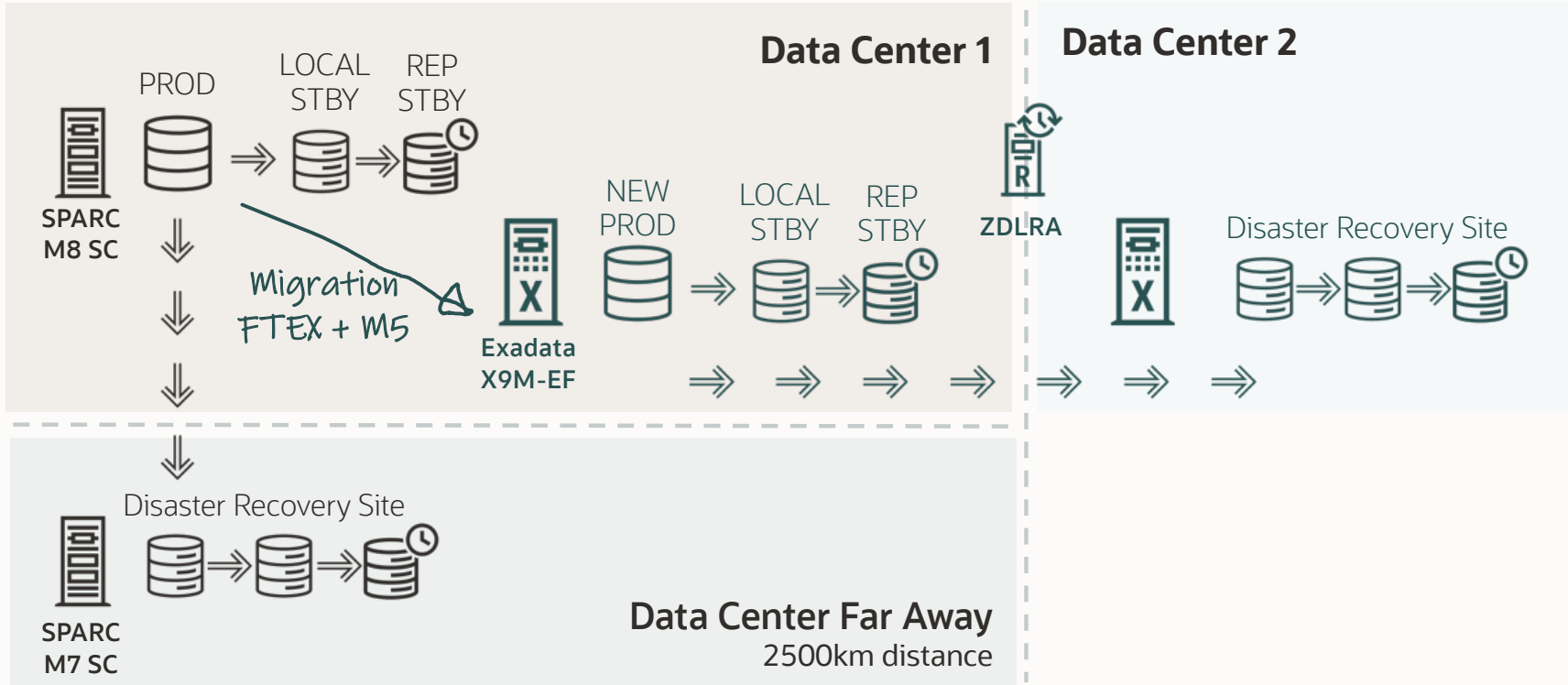


Use Block Change Tracking for faster incremental backups

- 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



- Download M5 script from Doc ID [29991571](#)
- 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



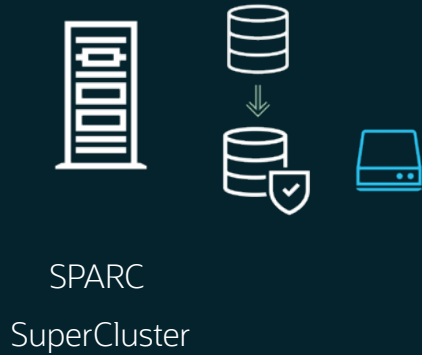
M5 Workflow



- 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



M5 Workflow



- 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



- 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



- 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



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



M5 Workflow



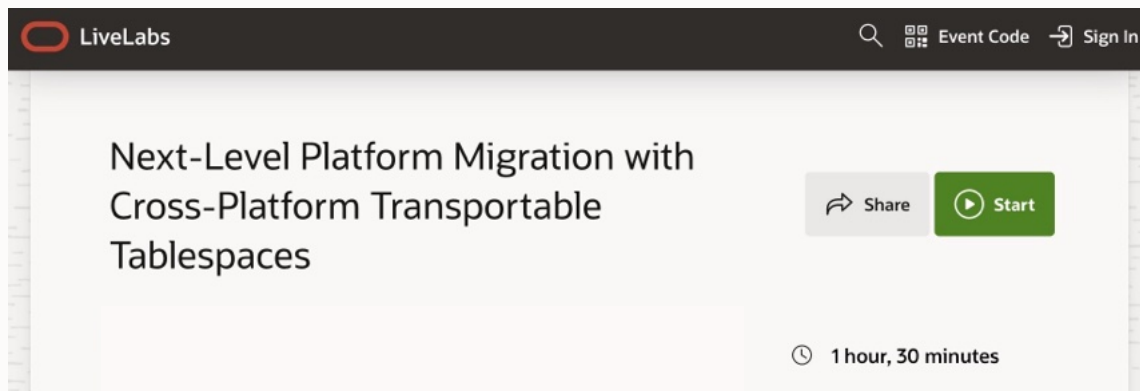
M5 Workflow



- 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?



Oracle LiveLabs – Run the lab just inside your browser!

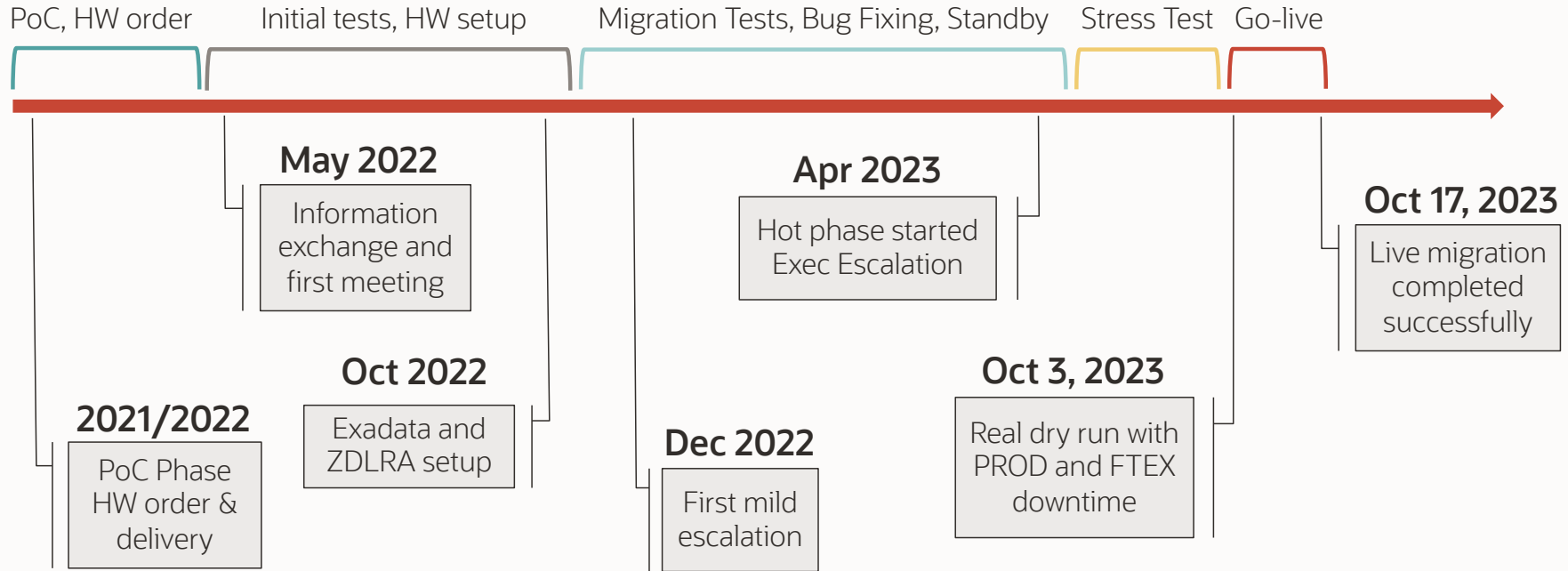


The Project Plan



Timelines and the Run Book

Overall Project Timeline



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

479 Copyright © 2026, Oracle and/or its affiliates

How many people were involved?



6 DBAs



Managers



2 data center
engineers



4 product
engineering



4 DB developer



War Room



2-3 infrastructure



2 monitoring,
communication



4 compliance



2 network



10 testing

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

...



Photo by Justin Chrn on Unsplash

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

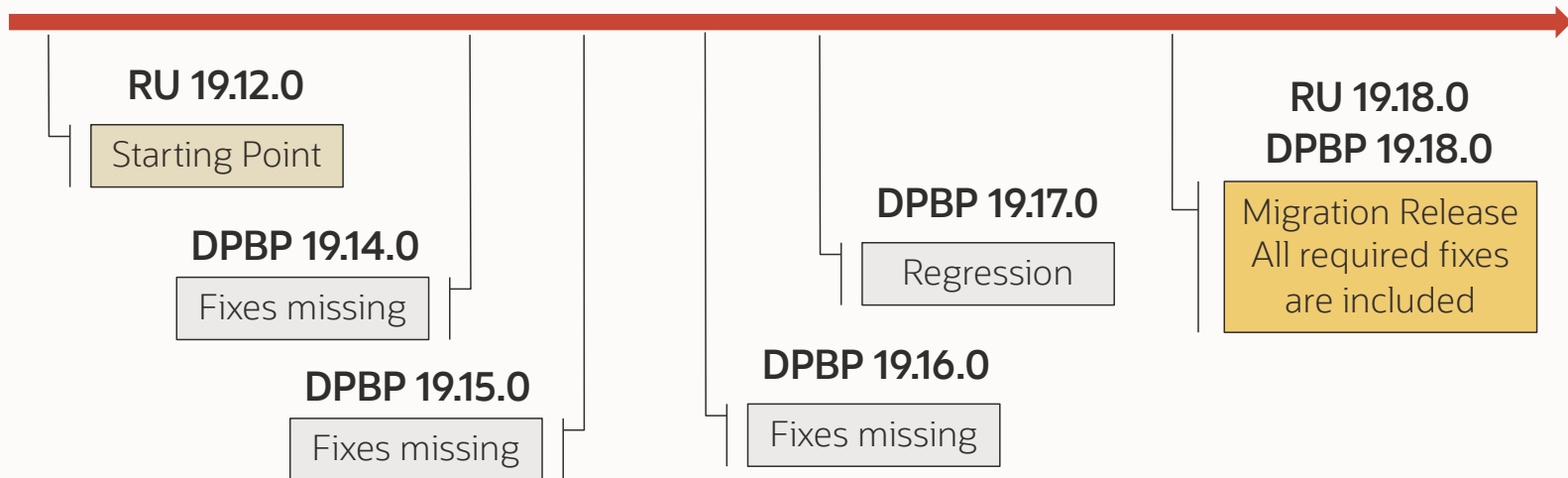
- Data Pump creates the index, and then alters it – here the overflow happened
- Side effect was a misleading error message



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 \(Doc ID 2819284.1\)](#)



Issue 4 | Evolved Object Types

Evolved TYPES 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'));
```

The type is now evolving



--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));
```

Existing data is not updated



--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'));
```

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 exact 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_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 table

Queue
infrastructure

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`



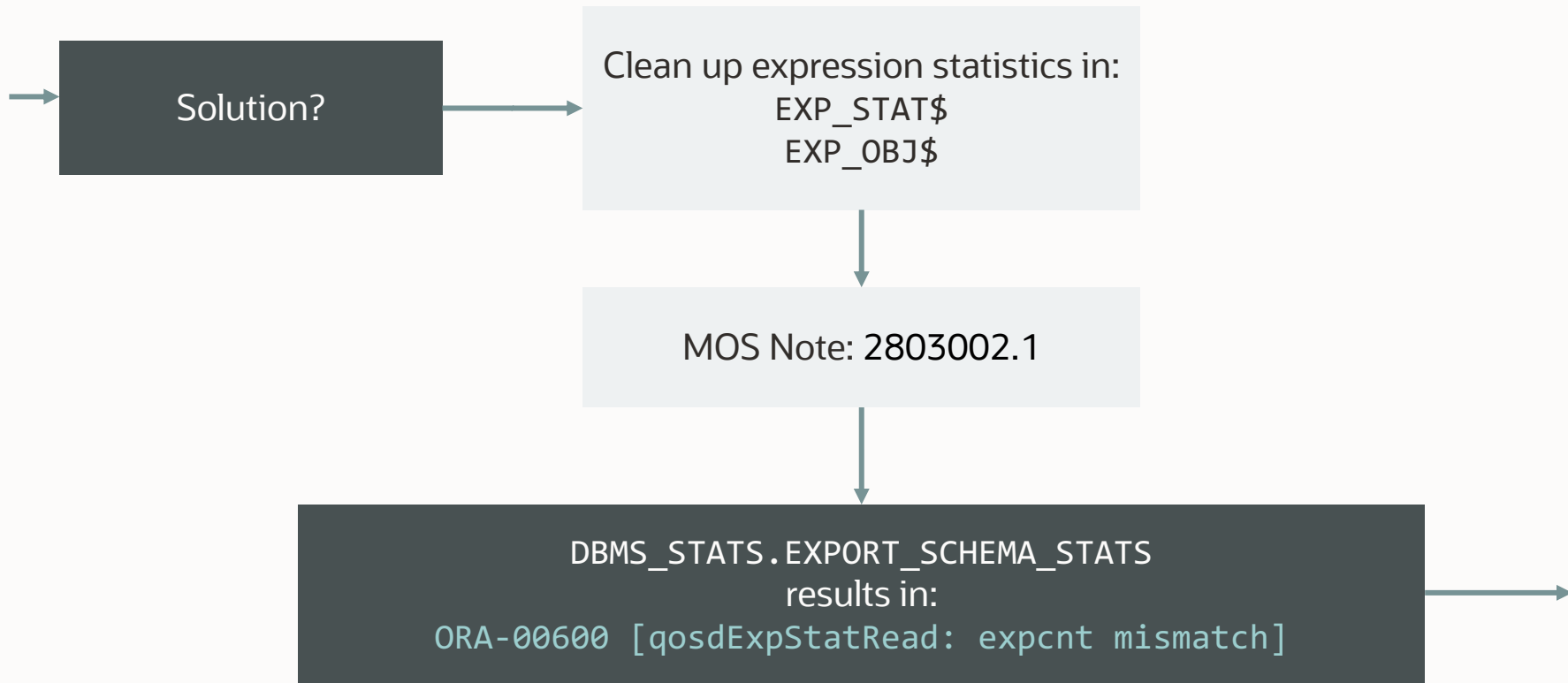
10046 trace reveals long runtime on:
`EXP_STAT$`
`EXP_OBJ$`

Expression Statistics for Auto-Indexing

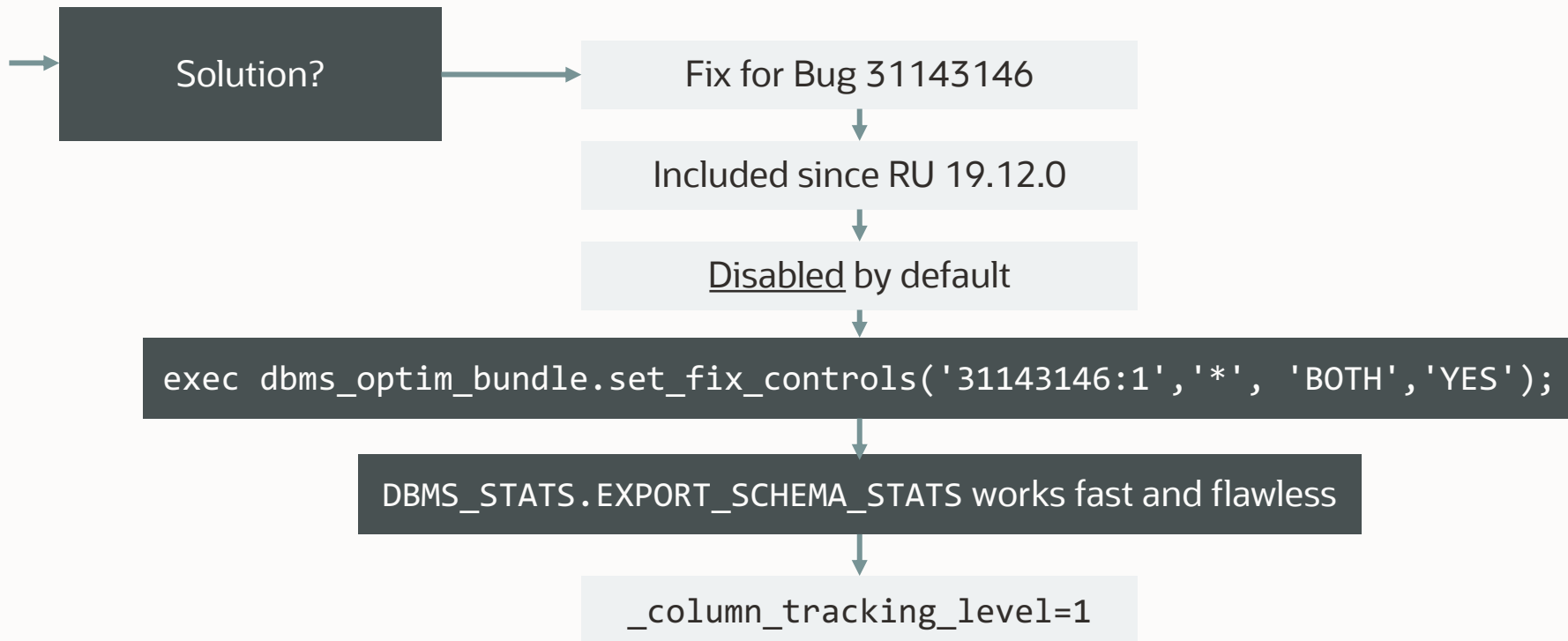
Default: `_column_tracking_level=53;`



Issue 7 | Exporting Statistics



Issue 7 | Exporting Statistics



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



Harvard Business Review

***“AI won’t replace humans -
but humans with AI will
replace humans without AI”***

Karim Lakhani





AI Database



Using AI

Filter



Year ▼

Genre ▼

Nominations

Awards

Question

Message

Motivational movies about athletics

35




Search Type

☒ Text Search ☐ Vector Search

Search

Results

1 - 10 of 10

	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, 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



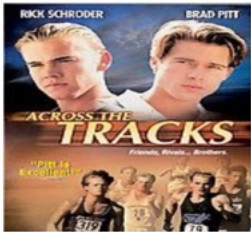



Vector Search

Search

Results

1 - 10 of 10

	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



Filter



Year
2023

Genre
Sport

Nominations

Awards

Question

Message

Motivational movies about athletics

35




Search Type

☐ Text Search ☒ Vector Search

Search

Results

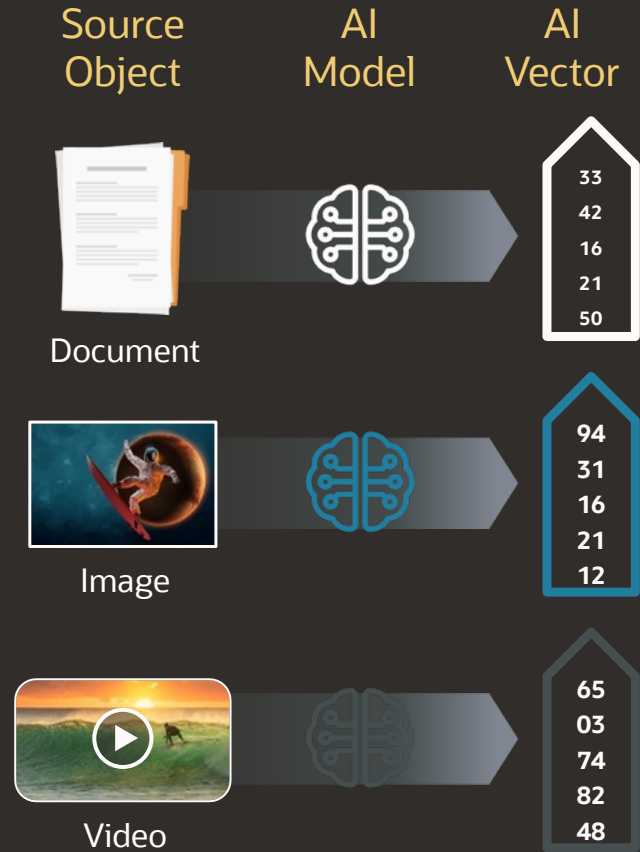
1 - 3 of 3

	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

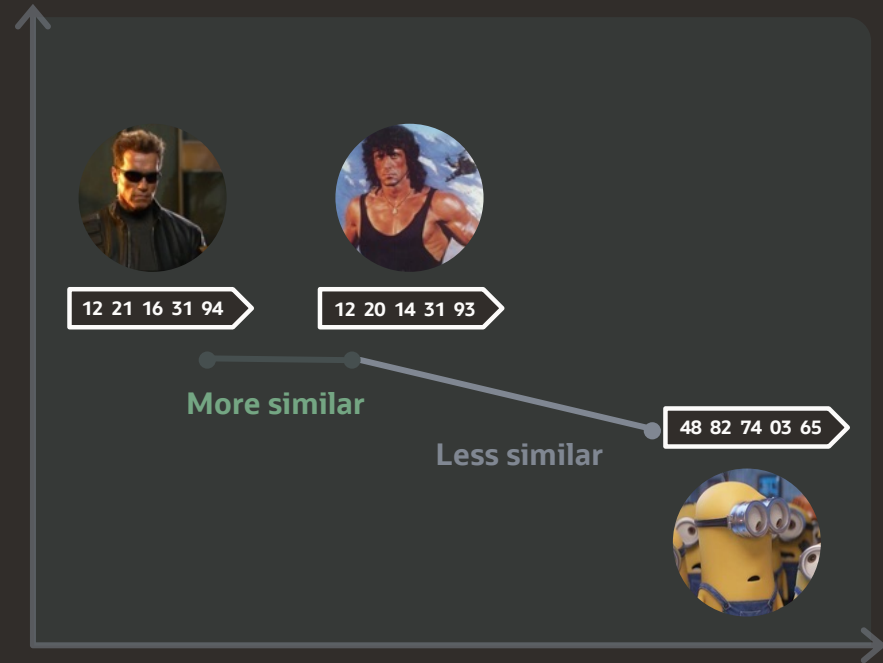
1 - 3 of 3

Key new AI data type: **AI Vector**

Stores semantic content
of a complex object



Oracle AI Database
can **store** AI vectors and
use them to **find**
similar objects



AI needs **business data** to answer your questions

Finding relevant business data requires
searching **private data**
with **traditional data search**
and **AI Vector Search**

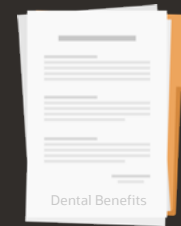


AI Database **unifies** search across traditional data and AI vectors



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

Find semantically similar
benefit documents
that are relevant to the
employee



Bring AI search to
both operational and
analytical systems

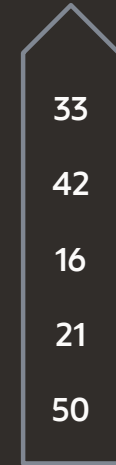
with just **one extra**
line of SQL



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

```
SELECT document
FROM   benefits_documents
WHERE  doc_plan_id IN (SELECT plan_id from emp_plans...)
ORDER BY VECTOR_DISTANCE(:question_vec,
document_vec);
```

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



Vector



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?

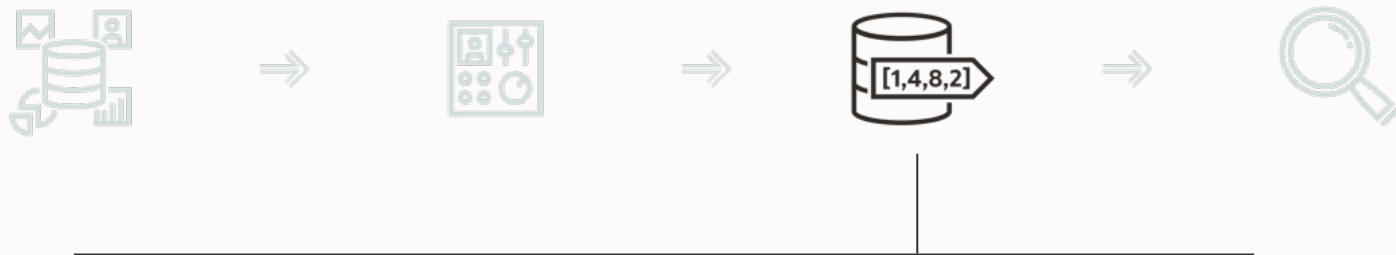
AI Vector Search



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

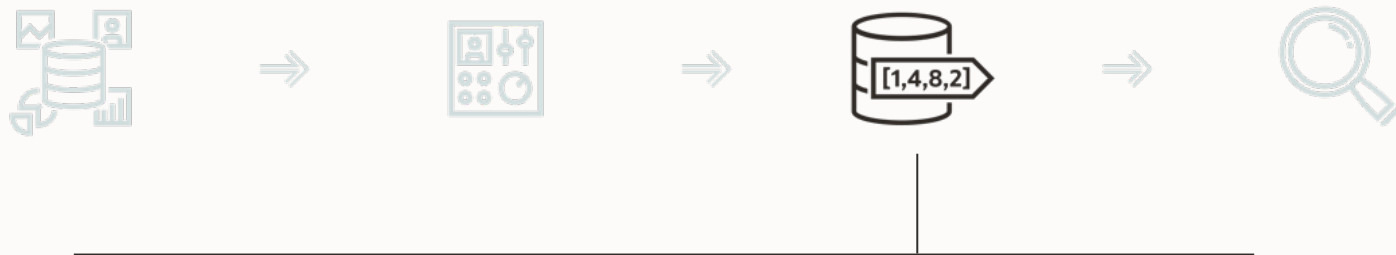
**Retrieval
Augmented
Generation**

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 ...



↑
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

$100 > 50 = \text{true}$

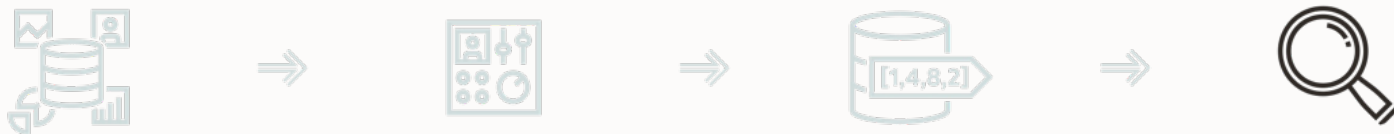
How to compare complex data types?



How to search for search complex data types?



Vector Database



-
- Search vector data using vector indexes
 - Calculate the vector distance



Type of movie



Genre



Mood



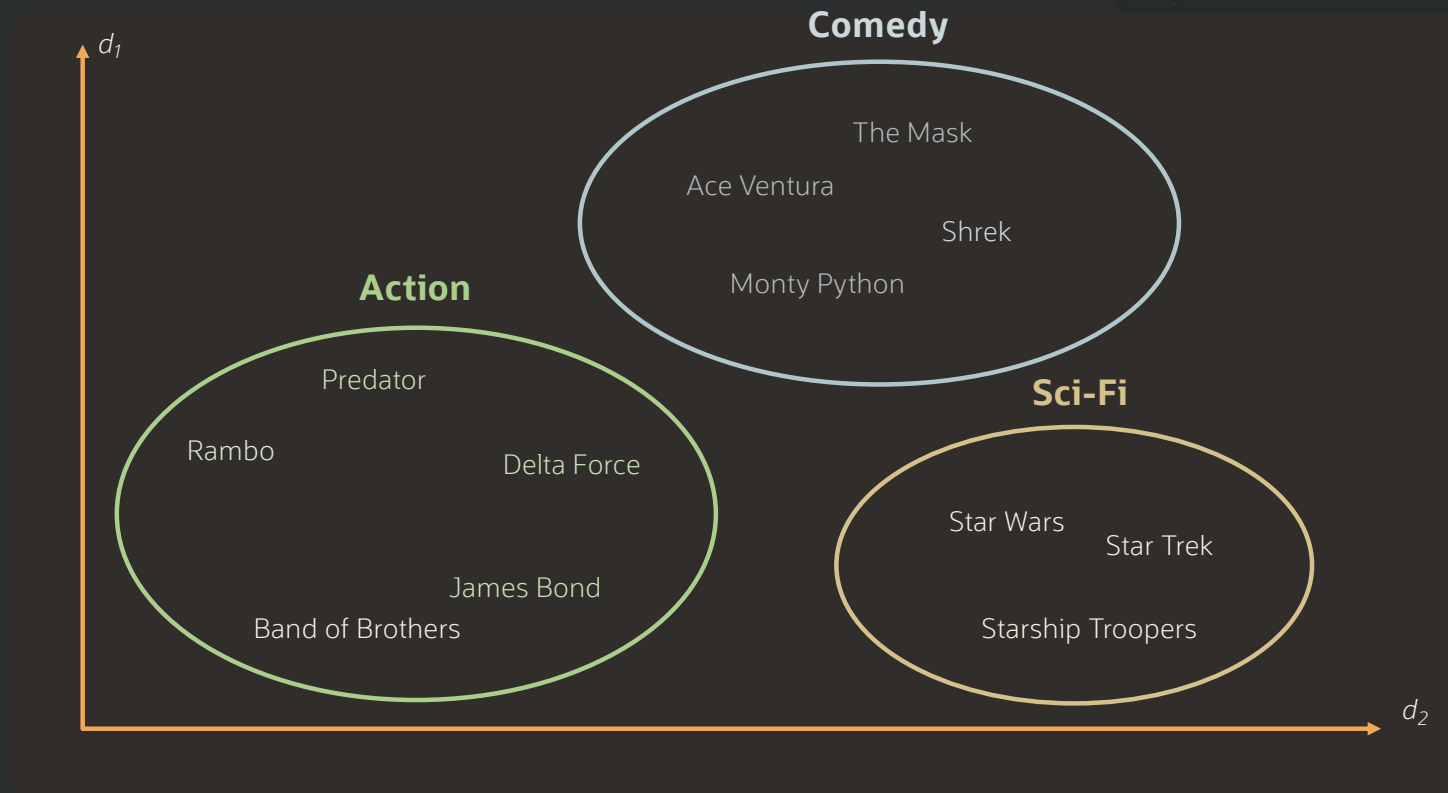
$$\begin{aligned} &\text{Distance (Euclidean Squared)} \\ &= (3-2)^2 + (1-6)^2 + (2-2)^2 + (8-3)^2 \end{aligned}$$

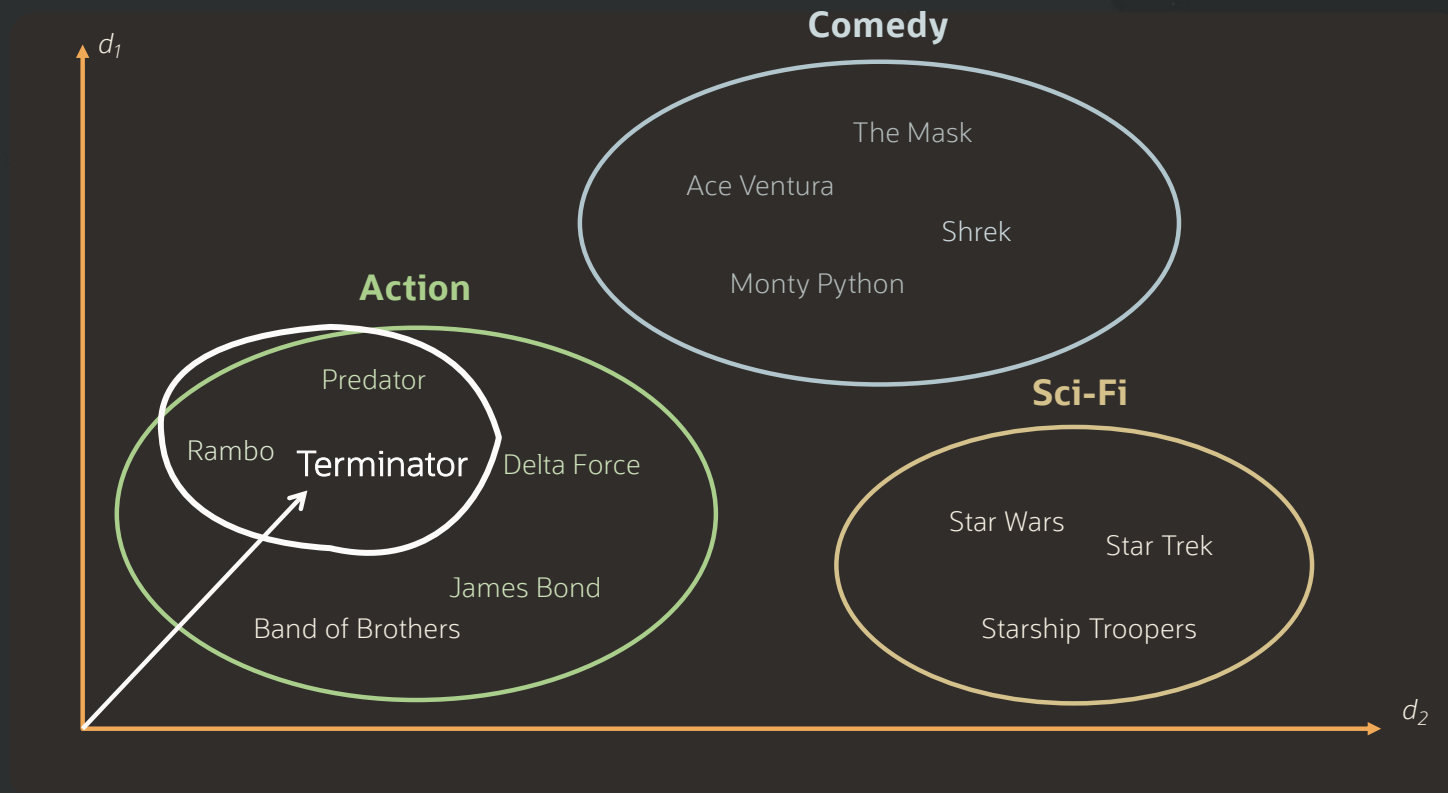
Vector Database



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

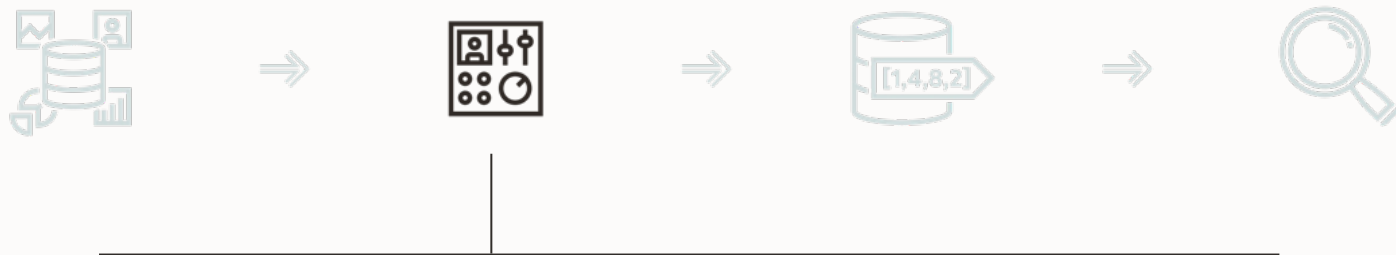




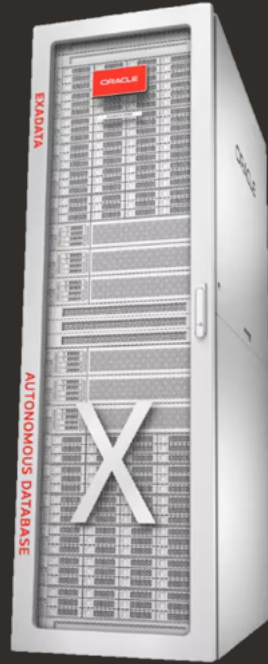


How do you convert your data
into vectors?

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'  
    ...  
);
```





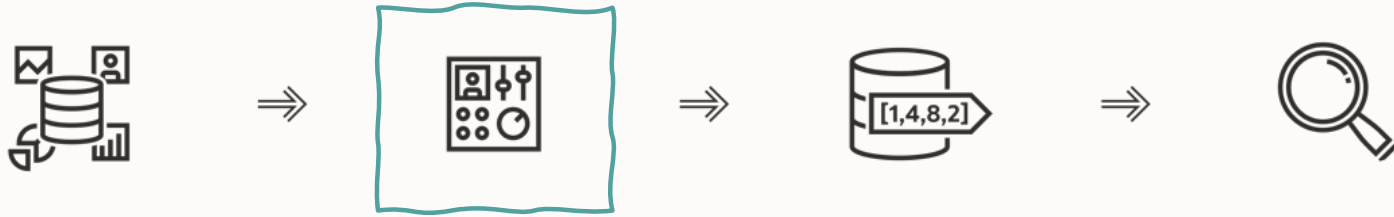
```
INSERT INTO movies
VALUES (:id,
        :description,
        :photo,
        VECTOR_EMBEDDING(All-MiniLM-L6-v2, :description));
```



Vector Database



Vector Database

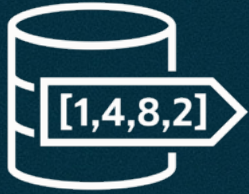


Vector Database



Vector Database



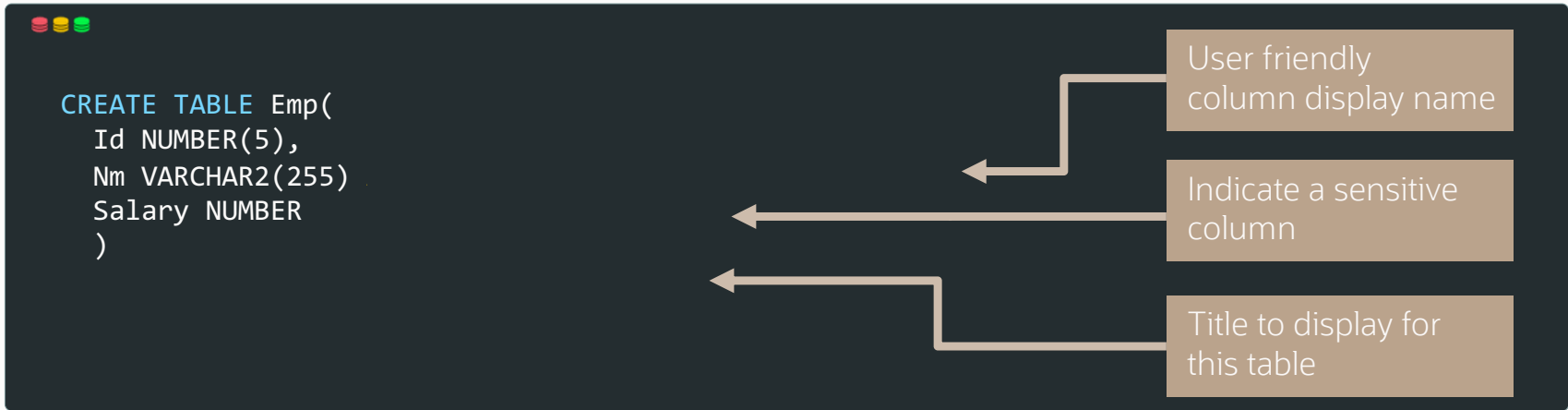


Included in any edition
of Oracle AI Database 26ai

- 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.



Annotations can be used by low code frameworks to **generate** user interfaces



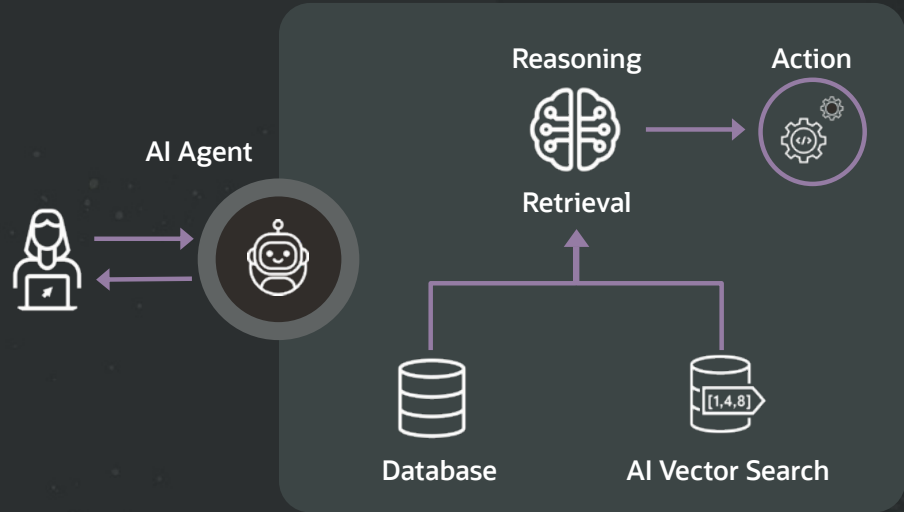
AI Database



Using AI

Architecting **Agentic AI** into the database

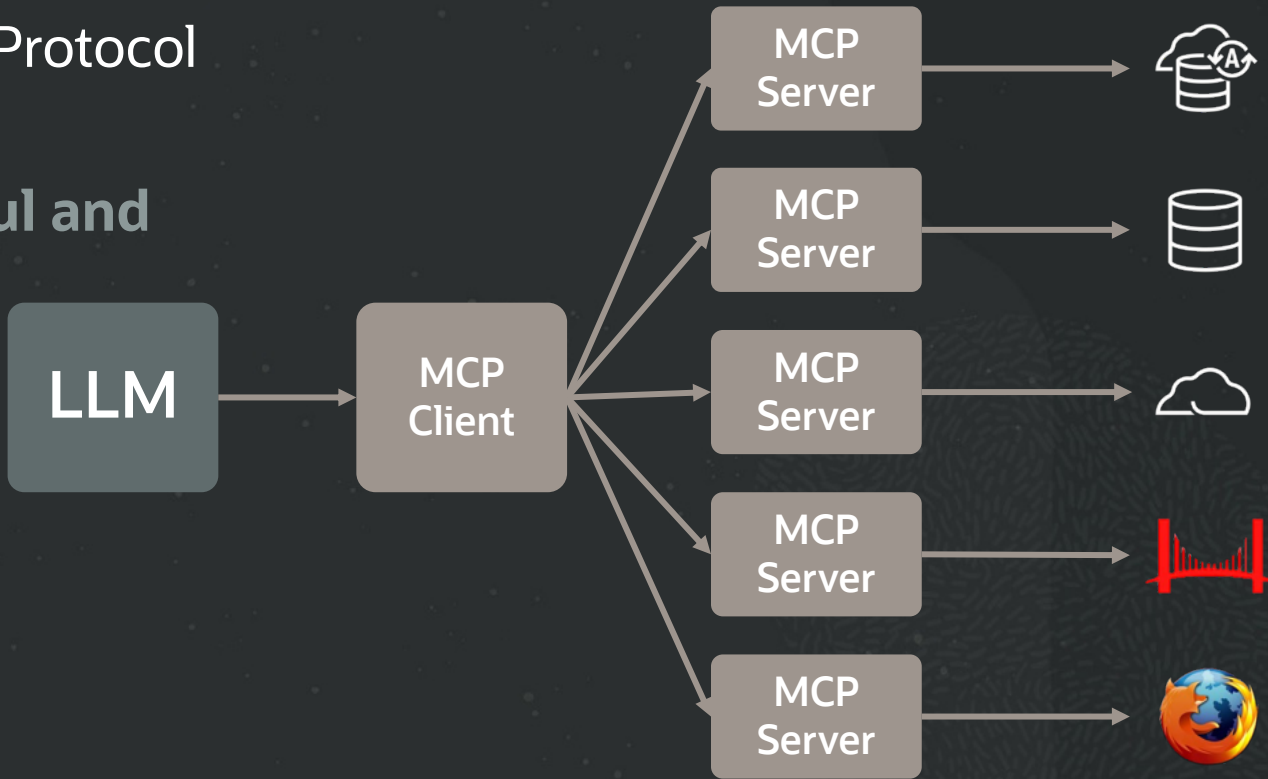
- Select AI Agent
- Private Agent Factory
- SQLcl MCP Server



MCP Server

Model Context Protocol

Enable powerful and
simplistic AI



EXTENSIONS

Search Extensions in Marketplace

INSTALLED

Cline

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

504ms

GitHub Copilot Chat

AI chat features powered by Copilot

404ms

Oracle Code Assist

Oracle Code Assist

Oracle

Oracle SQL Developer Extension for VSCode

End-to-end development tools for your SQL and PL/SQL ap...

91ms

GitHub Copilot

Your AI pair programmer

RECOMMENDED

SQLTools

Connecting users to many of the most commonly used data...

6M 3.5

Vim

Vim emulation for Visual Studio Code

8.3M 4

MCP SERVERS

MCP Servers

Browse and install Model Context Protocol (MCP)

Untitled-1

1

`Generate code (M), or select a language (M M). Start typing to dismiss or don't show this again.`

CHAT

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

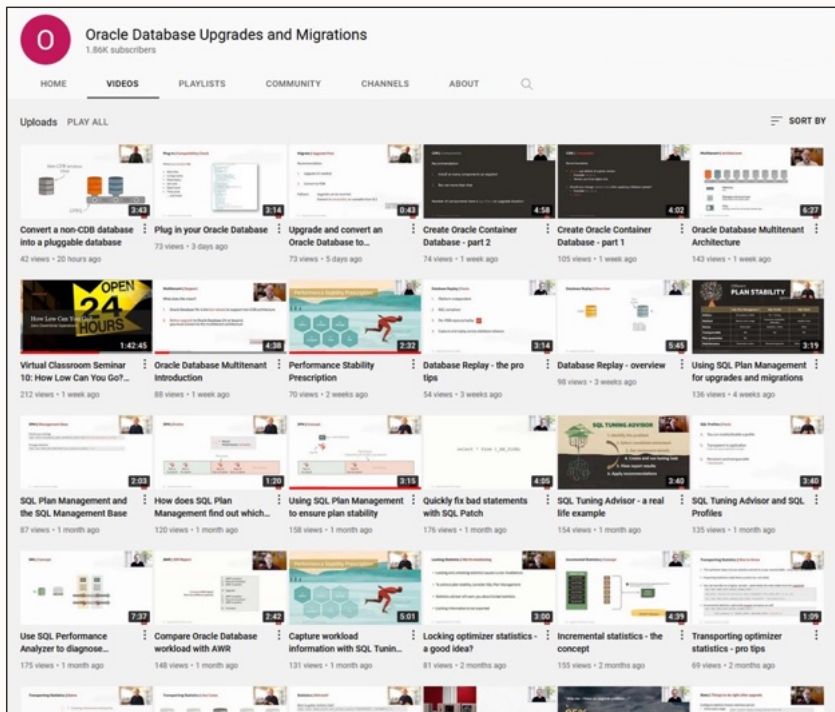
Oracle

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



Thank You

