ORACLE

How Low Can You Go?

Zero Downtime Operations

Photo by the blowup on Unsplash

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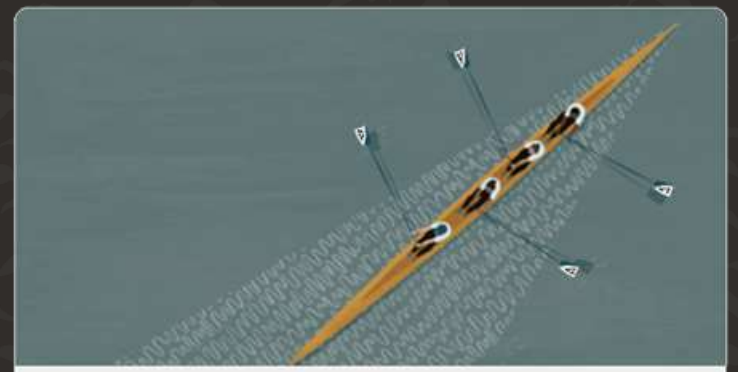
Secure your job - Fallback is your insurance

November 11, 2021 | 09:00 GMT / 10:00 CET

Migrating Very Large Databases

December 9, 2021 | 09:00 GMT / 10:00 CET



Data Pump Extreme - Deep Dive with Development

January 27, 2022 | 09:00 GMT / 10:00 CET

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NEW Episode 1

Release and Patching Strategy

105 minutes – Feb 4, 2021

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AutoUpgrade to Oracle Database 19c

115 minutes – Feb 20, 2021

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Performance Stability, Tips and Tricks and Underscores

120 minutes – Mar 4, 2021

NEW Episode 4

Migration to Oracle Multitenant

120 minutes – Mar 16, 2021

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Migration Strategies – Insights, Tips and Secrets

120 minutes – Mar 25, 2021

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Move to the Cloud – Not only for techies

115 minutes – Apr 8, 2021

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Cool Features – Not only for DBAs

110 minutes – Jan 14, 2021

NEW Episode 8

Database Upgrade Internals – and so much more

Recorded Web Seminars

https://MikeDietrichDE.com/videos/

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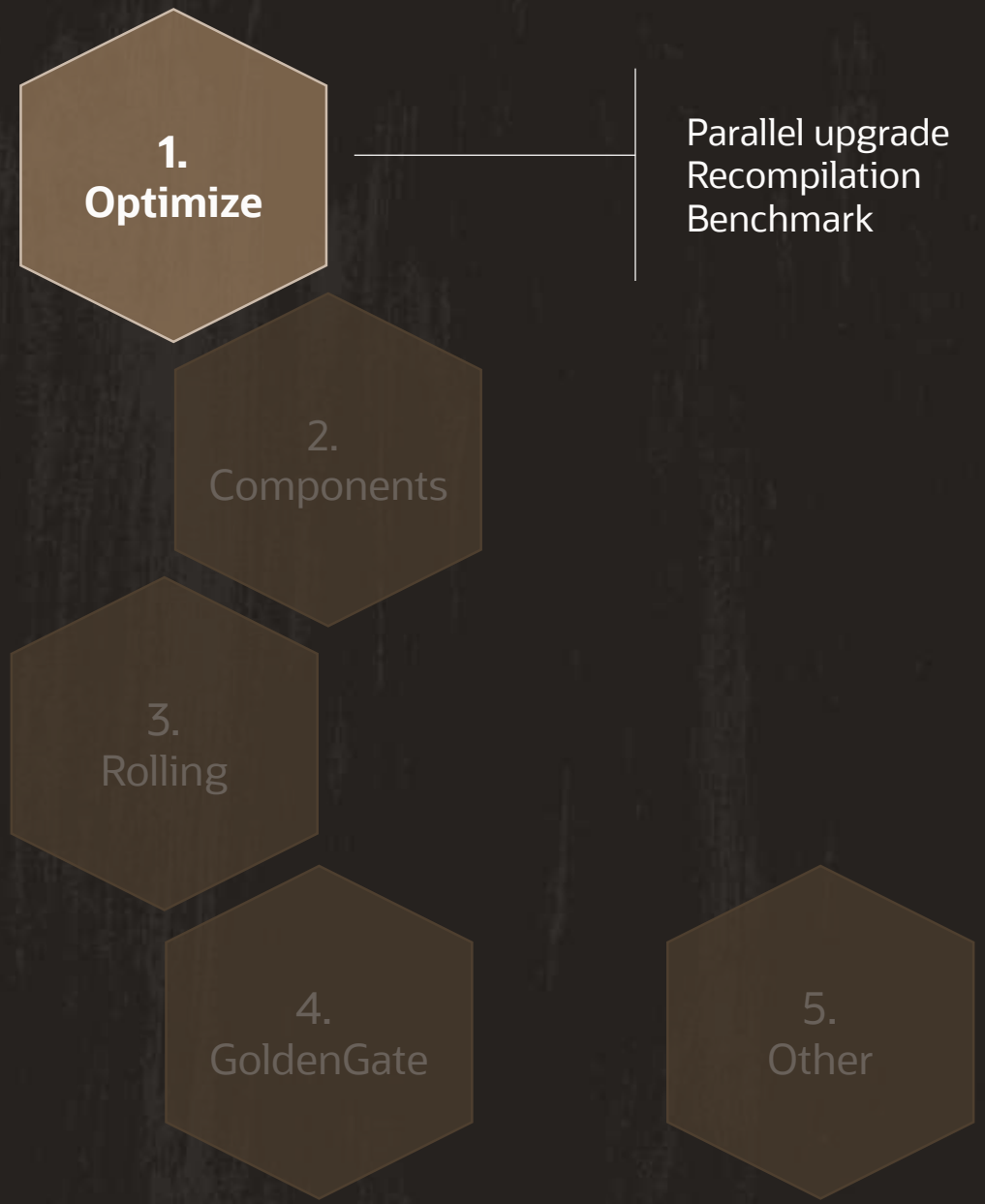
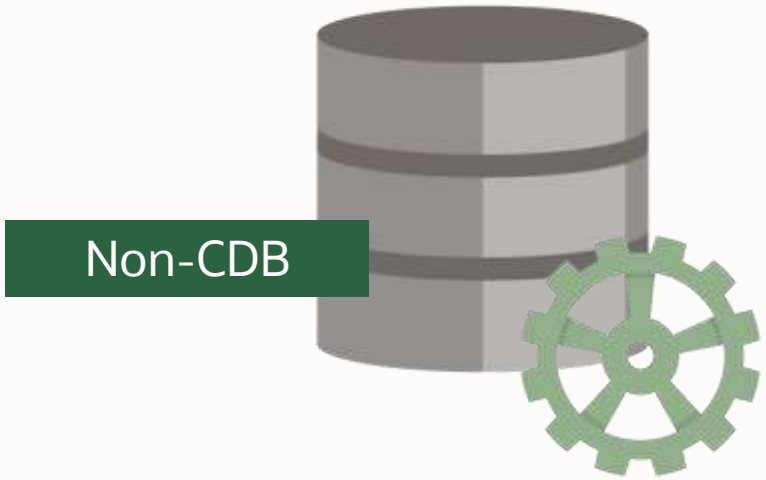
Zero Downtime | Balance

generally speaking,

"the less downtime, the more complex"



Parallel Upgrade | Non-CDB

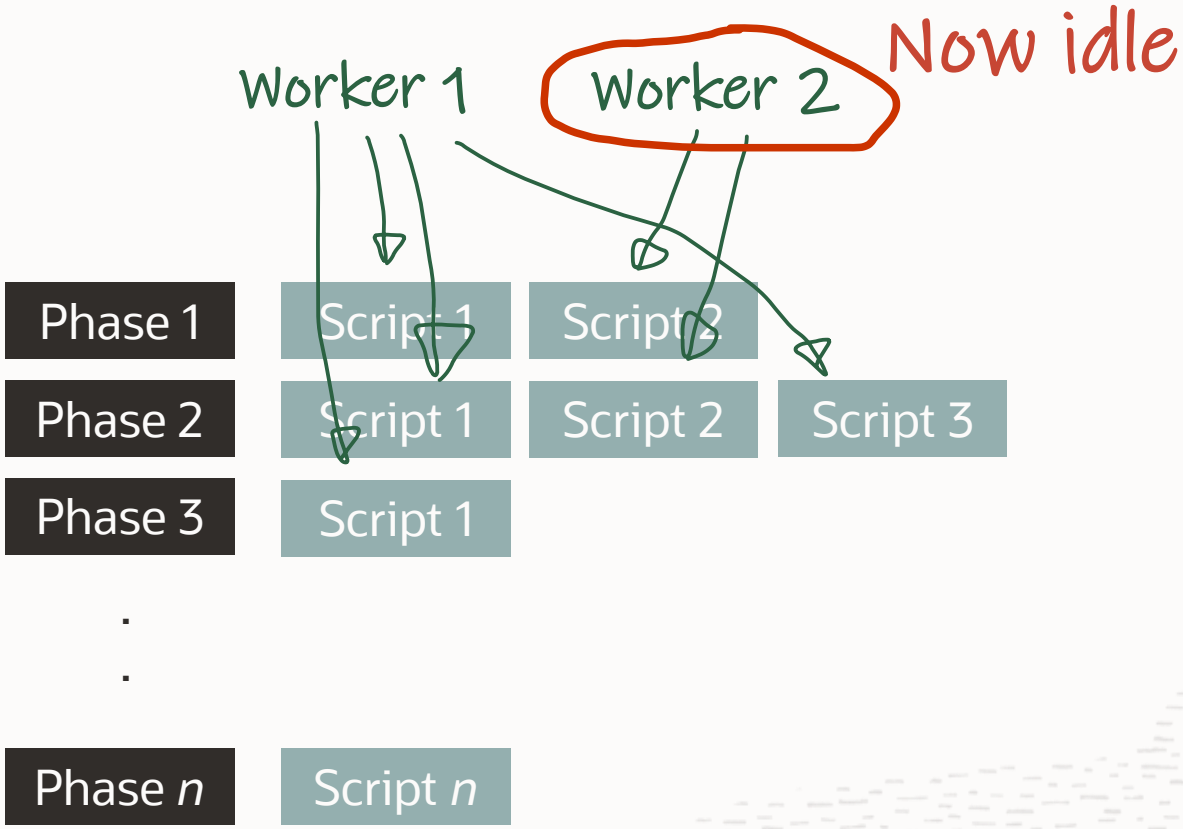


A number of parallel processes

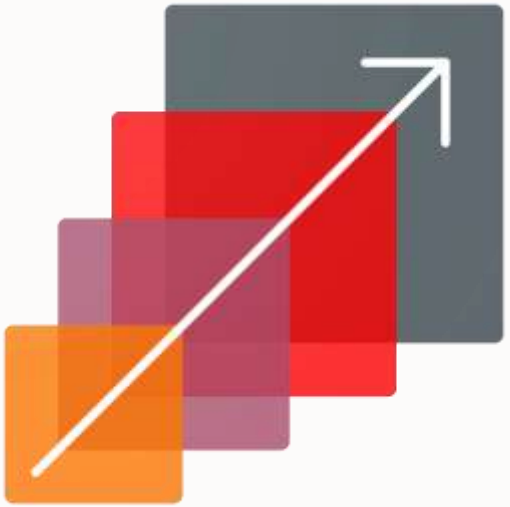
- Minimum 1
- Maximum 8
- Default 4

```
$ dbupgrade -n 2
```

Parallel Upgrade | Non-CDB



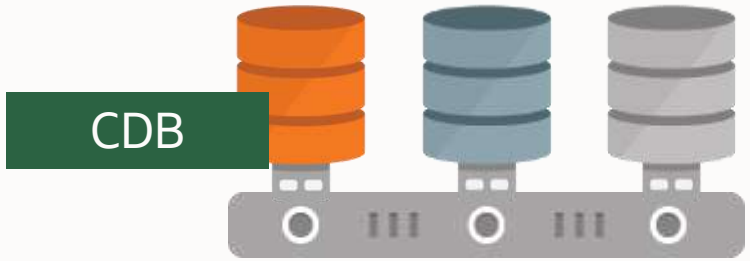
Parallel Upgrade | Non-CDB



Does not scale linear

Contention

Parallel Upgrade | Container Database

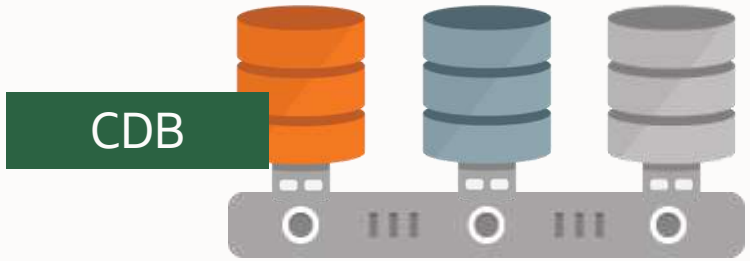


A number of processors are assigned

- Minimum 4
- Maximum unlimited
- Default CPU count

```
$ dbupgrade -n 4
```

Parallel Upgrade | Container Database

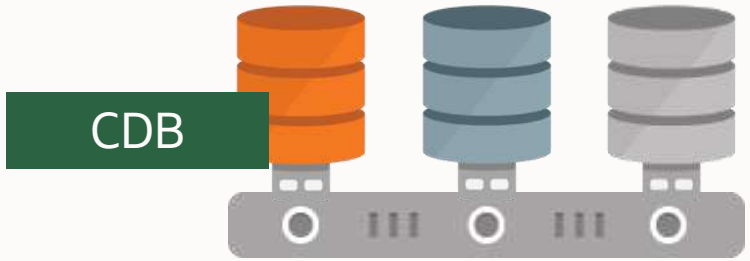


Each PDB gets a number of parallel processes

- Minimum 1
- Maximum 8
- Default 2

```
$ dbupgrade -N 2
```

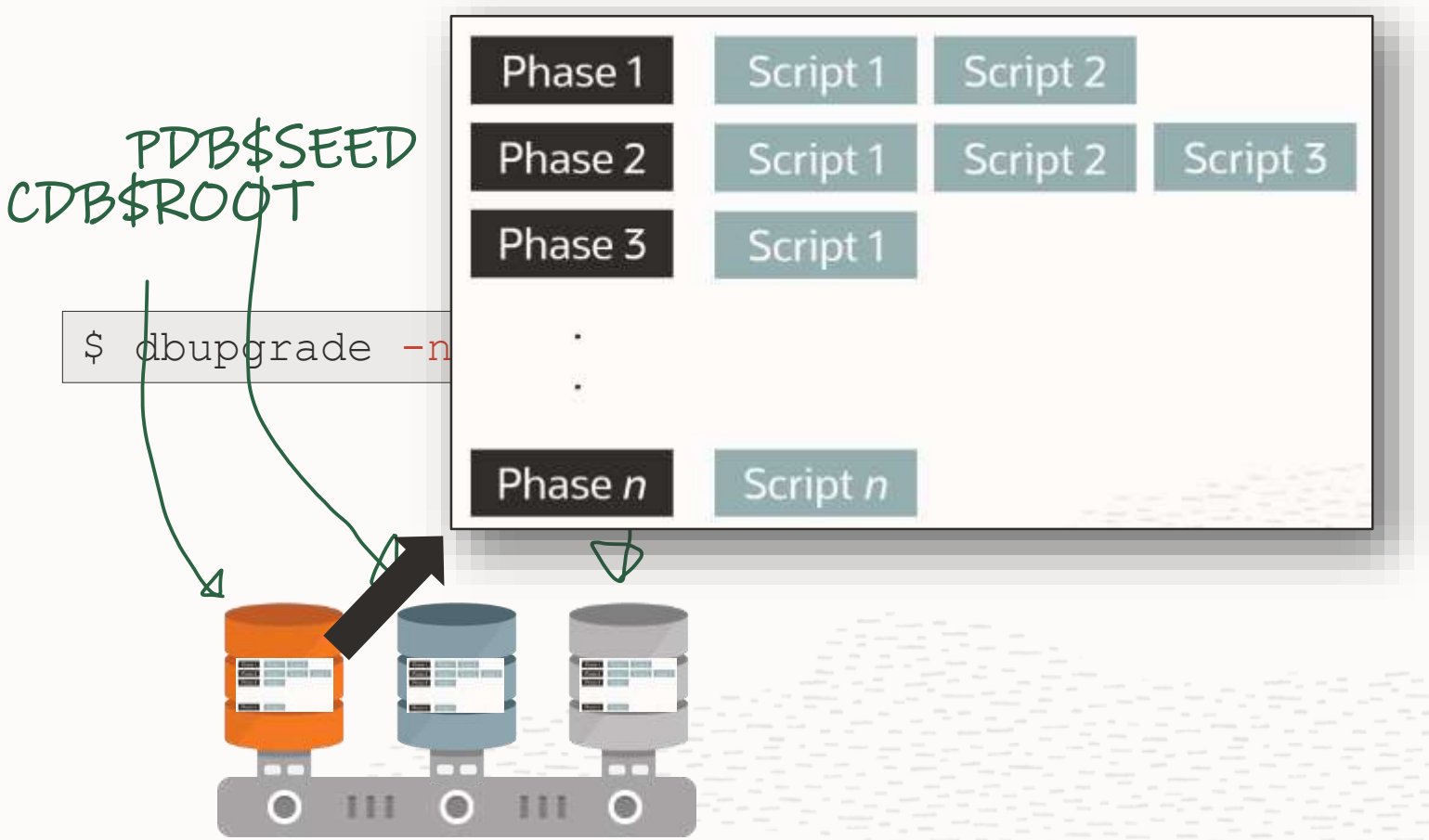
Parallel Upgrade | Container Database



But - there is another limit

$$\frac{\text{Total number of processors (n)}}{\text{Processor per PDB (N)}} = \text{PDBs upgraded simultaneously}$$

Parallel Upgrade | Single Tenant

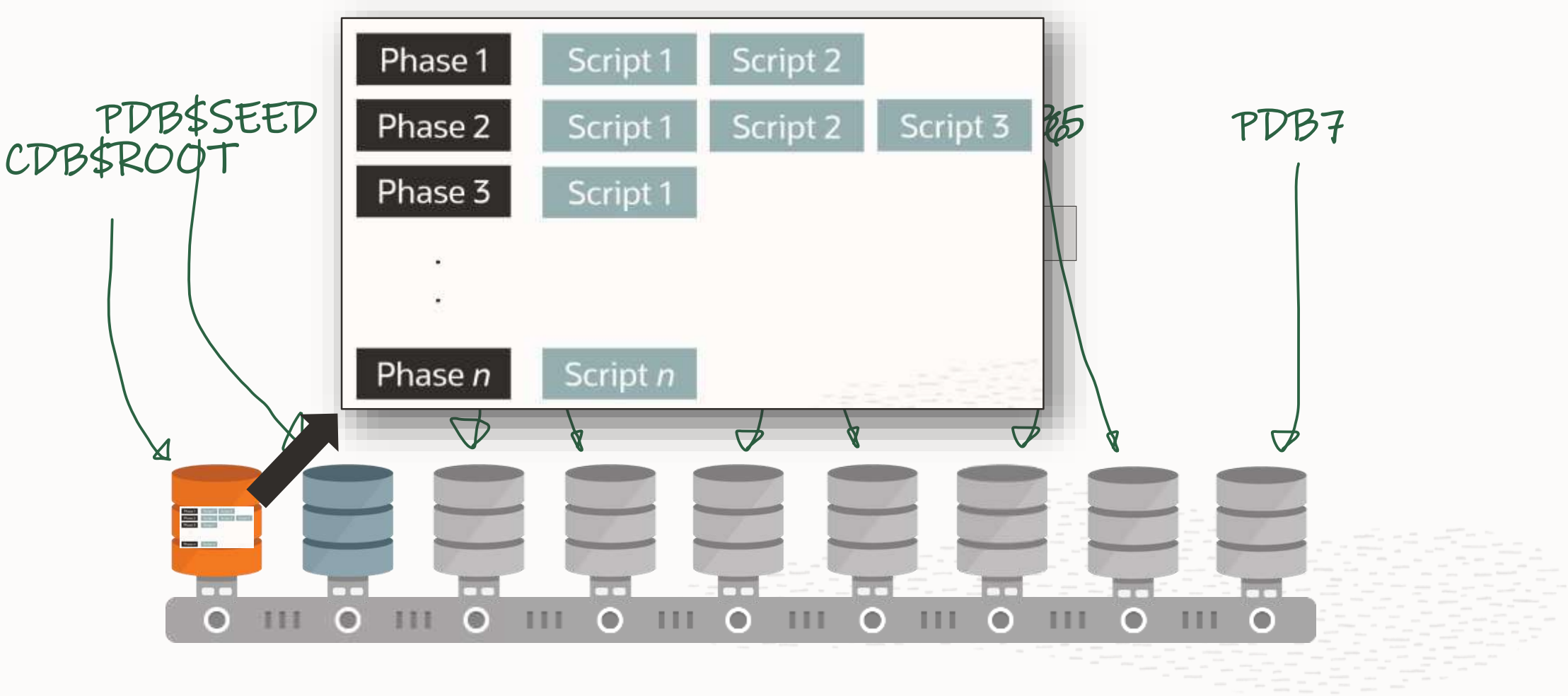


Parallel Upgrade | Non-CDB vs. Single Tenant

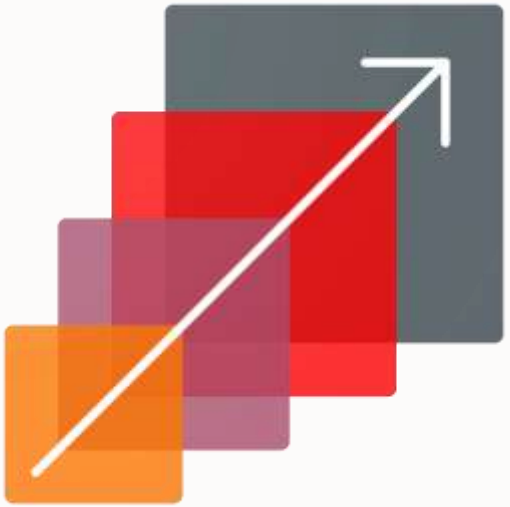
Non-CDB is always faster

than single tenant

Parallel Upgrade | Multitenant

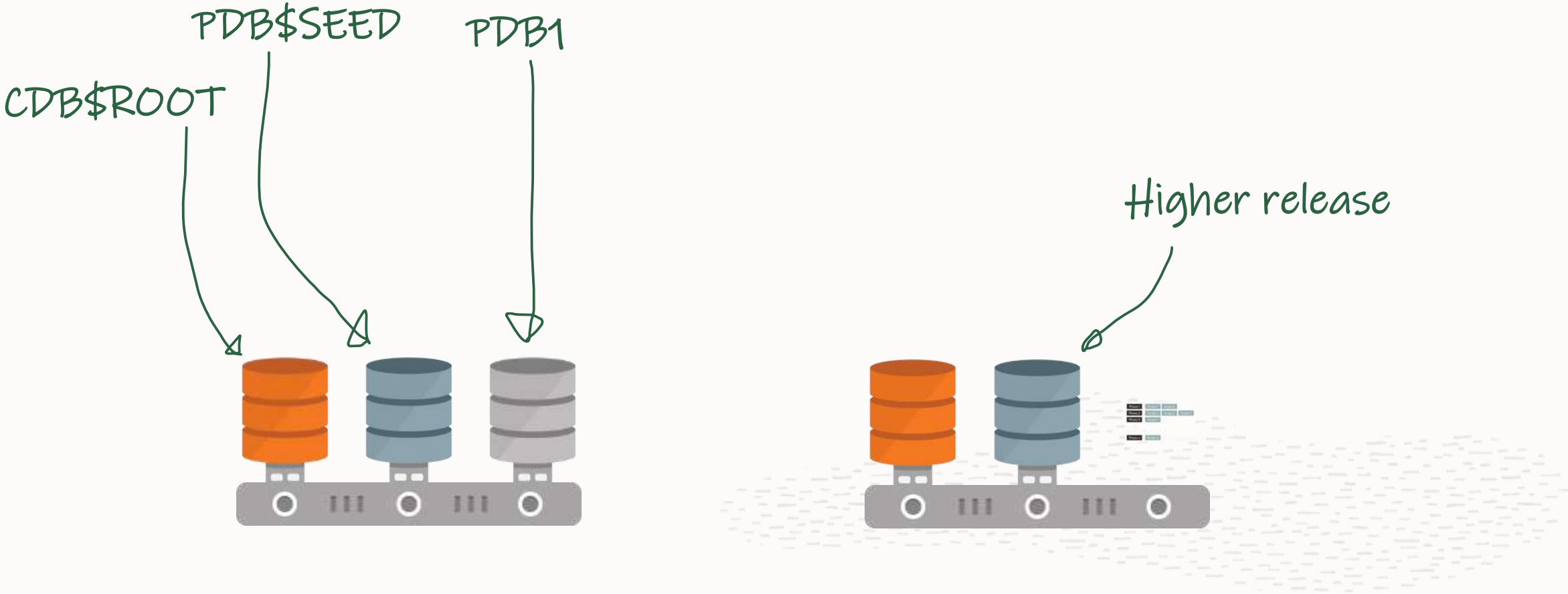


Parallel Upgrade | Multitenant



Scale by upgrading
more PDBs simultaneously

Parallel Upgrade | Unplug-Plug-Upgrade

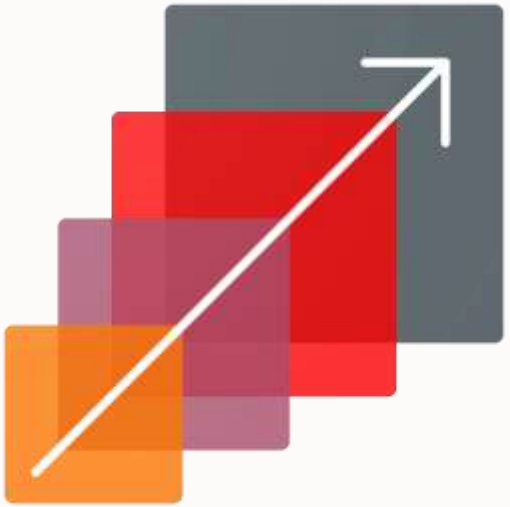


Parallel Upgrade | Unplug-Plug-Upgrade

Unplug-plug always faster than

Non-CDB
Single Tenant
Multitenant

Parallel Upgrade | How Does It Work

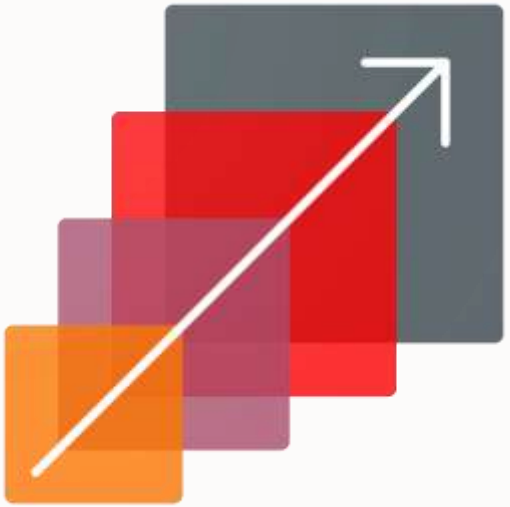


Few PDBs

More processors per PDB

Increase parameter `N`

Parallel Upgrade | How Does It Work

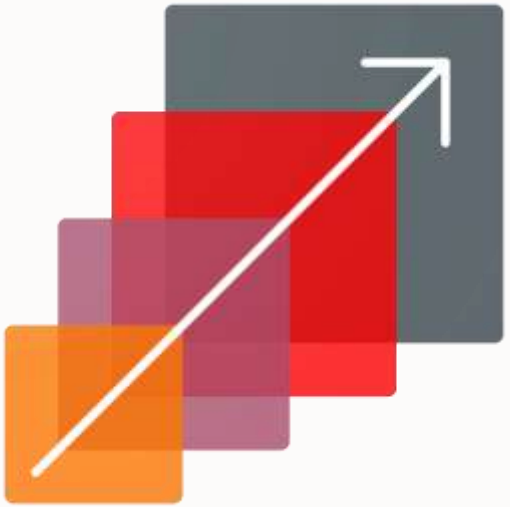


Many PDBs

Less processors per PDB

Decrease parameter `N`

Parallel Upgrade | How Does It Work



But as always

It depends

Statistics

Refresh before upgrade

Dictionary Statistics | Overview

Statistics on SYS and other oracle maintained schemas

Gets executed by automatic optimizer statistics gathering

Fixed Objects Stats | Definition

What is it?

```
SQL> SELECT owner, table_name
     FROM dba_tab_statistics
     WHERE object_type = 'FIXED TABLE';

OWNER    TABLE_NAME
________ _______________
SYS      X$KQFTA
SYS      X$KQFVI
SYS      X$KQFVT
SYS      X$KQFDT
SYS      X$KQFCO
SYS      X$KQFOPT
SYS      X$KYWMPCTAB
...
```

Pro tip: Dynamic statistics (sampling) are not used for X$ tables

Dictionary Statistics | AutoUpgrade

AutoUpgrade will refresh dictionary and fixed objects stats

- But only if they are older than 7 days
- Refresh stats by yourself 24-48 hours before upgrade

CDB$ROOT

CheckName: DICTIONARY_STATS FixUp Available: YES Severity: RECOMMEND Stage: PRECHECKS

Gather stale data dictionary statistics prior to database upgrade in off-peak time using:

EXECUTE DBMS_STATS.GATHER_DICTIONARY_STATS;

Dictionary statistics help the Oracle optimizer find efficient SQL execution plans and are essential for proper upgrade timing. Oracle recommends gathering dictionary statistics in the last 24 hours before database upgrade.

For information on managing optimizer statistics, refer to the 12.2.0.1 Oracle Database SQL Tuning Guide.

Dictionary statistics do not exist or are stale (not up-to-date).

Dictionary Statistics | Checks

1. Is the automatic optimizer statistics gathering job on?

```
SQL> SELECT CLIENT_NAME, STATUS
     FROM   DBA_AUTOTASK_CLIENT
     WHERE  CLIENT_NAME='auto optimizer stats collection';

CLIENT_NAME                                              STATUS
-------------------------------------------------- ------------
auto optimizer stats collection                         ENABLED
```

2. If it is disabled, consider enabling it at least for Oracle maintained objects only

```
SQL> exec DBMS_AUTO_TASK_ADMIN.ENABLE(
        client_name => 'auto optimizer stats collection',
        operation => NULL,
        window_name => NULL);

SQL> exec DBMS_STATS.SET_GLOBAL_PREFS('autostats_target','oracle');
```

Dictionary Statistics | Checks

2. Have my stats been refreshed within the last 7 days?

```
SQL> select con_id, operation, target, end_time from cdb_optstat_operations
where
  (   (operation = 'gather_fixed_objects_stats')
   or (operation = 'gather_dictionary_stats' and (target is null or target in ('SYS', 'SYSTEM')))
   or (operation = 'gather_schema_stats' and target in ('SYS', 'SYSTEM'))
  )
  and end_time > sysdate - 7
order by con_id, end_time;

 CON_ID   OPERATION                      TARGET    END_TIME
_______ _____________________________ _________ ___________________________________
      1 gather_schema_stats           SYS       26-FEB-21 07.00.19.182084000 AM +01:00
      1 gather_schema_stats           SYSTEM    26-FEB-21 07.00.22.351981000 AM +01:00
      1 gather_dictionary_stats                 26-FEB-21 07.05.17.931954000 AM +01:00
      1 gather_fixed_objects_stats              26-FEB-21 07.14.55.088707000 AM +01:00
      2 gather_schema_stats           SYS       26-FEB-21 07.02.40.485494000 AM +01:00
      2 gather_schema_stats           SYSTEM    26-FEB-21 07.02.46.151578000 AM +01:00
      3 gather_schema_stats           SYS       26-FEB-21 07.02.46.171862000 AM +01:00
      3 gather_schema_stats           SYSTEM    26-FEB-21 07.02.49.725878000 AM +01:00
```

Dictionary Statistics | Checks

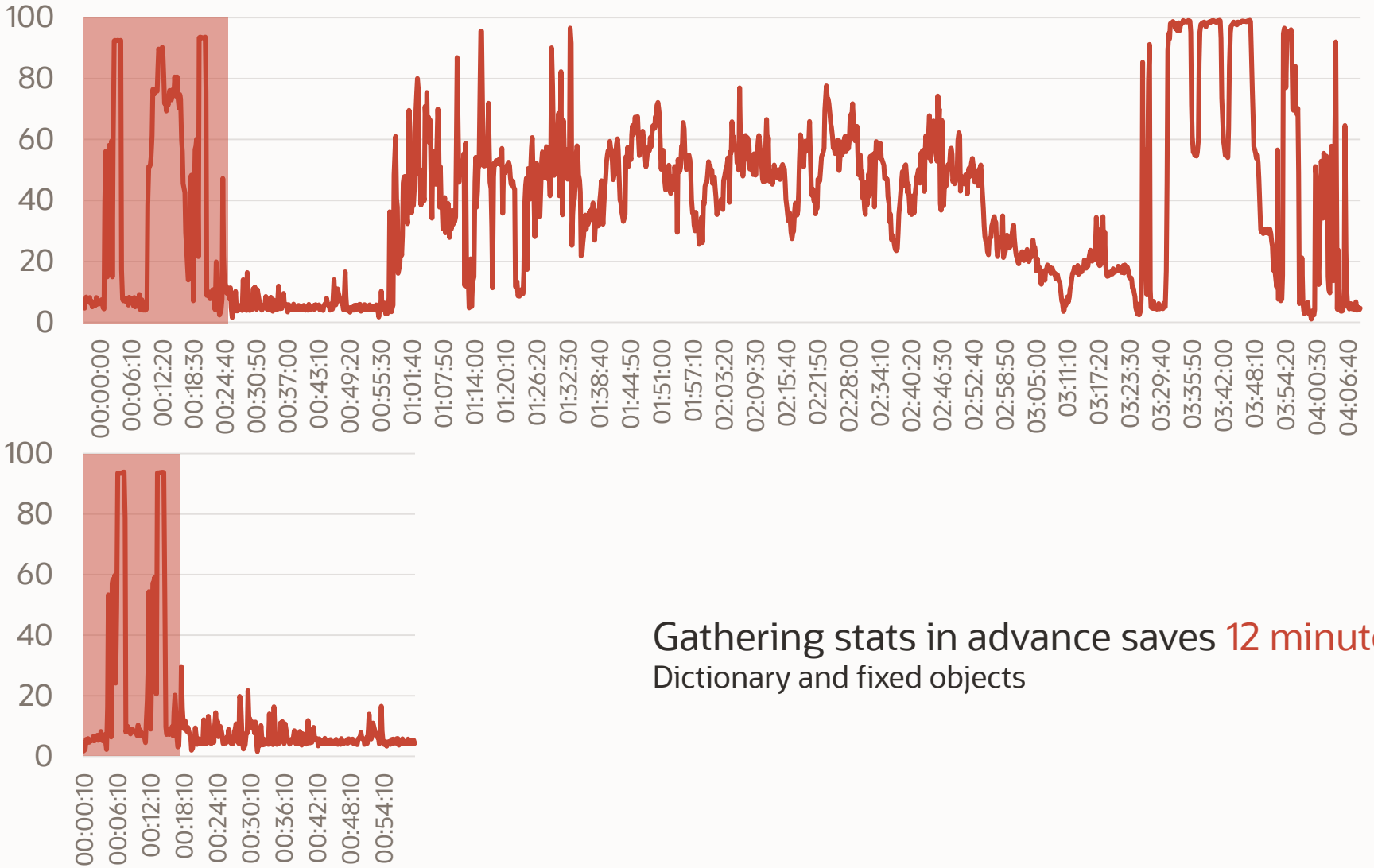
3. If they haven't, refresh them by yourself 24-48 hours before upgrade

```
SQL> BEGIN
        DBMS_STATS.GATHER_SCHEMA_STATS('SYS');
        DBMS_STATS.GATHER_SCHEMA_STATS('SYSTEM');
END;
/
```

- Refresh / create them in all containers

```
$ORACLE_HOME/perl/bin/perl $ORACLE_HOME/rdbms/admin/catcon.pl \
  -l /tmp \
  -b gatherstats -- \
  --x"begin dbms_stats.gather_schema_stats('SYS');
dbms_stats.gather_schema_stats('SYSTEM'); end;"
```

Statistics | Gather Stats Before Upgrade



Gathering stats in advance saves 12 minutes

Dictionary and fixed objects

Statistics | Good Stats During Upgrade

The larger the dictionary, the bigger the effect

	DURATION	REDUCTION
No dictionary and fixed objects stats	15 min 55 sec	
Gathered dictionary and fixed objects stats	14 min 10 sec	11 %
Gathered schema and cluster index stats	13 min 41 sec	3.4 % to previous
Total downtime saved	**2 min 14 sec**	**14 % overall**

This example has been done with one of the tiny Hands-On Lab databases

Statistics | Good Stats During Upgrade

Upgrade duration for Oracle E-Business Suite

	DURATION	REDUCTION
No dictionary and fixed objects stats	10 hrs 56 min 52 sec	
Gathered dictionary and fixed objects stats	52 min 42 sec	93 %
Gathered schema and cluster index stats	52 min 25 sec	0.5 % to previous
Total downtime saved	**10 hrs 4 min 14 sec**	**93.5 % overall**

Statistics | Good Stats During Upgrade

Stale / no stats

```
   ID OPERATION            OPTIONS                 OBJECT_NAME
----- -------------------- ----------------------  -----------
    0 UPDATE STATEMENT
    1   UPDATE                                     DEPENDENCY$
    2     FILTER
    3       TABLE ACCESS   FULL                    DEPENDENCY$
    4       INDEX          FULL SCAN               I_OBJ2
    5       INDEX          FULL SCAN               I_OBJ2
    6       TABLE ACCESS   BY INDEX ROWID BATCHED  OBJ$
    7         INDEX        RANGE SCAN              I_OBJ1
    8     TABLE ACCESS     BY INDEX ROWID BATCH    OBJ$
    9       INDEX          RANGE SCAN              I_OBJ1
```

Good stats

```
 ID OPERATION            OPTIONS                   OBJECT_NAME
----- -------------------- ----------------------    -----------
   0  UPDATE STATEMENT
   1    UPDATE                                      DEPENDENCY$
   2      FILTER
   3        TABLE ACCESS   FULL                      DEPENDENCY$
   4        INDEX          RANGE SCAN                I_OBJ1
   5        INDEX          RANGE SCAN                I_OBJ1
   6        TABLE ACCESS   BY INDEX ROWID BATCHED    OBJ$
   7          INDEX        RANGE SCAN                I_OBJ1
   8      TABLE ACCESS     BY INDEX ROWID BATCH      OBJ$
   9        INDEX          RANGE SCAN                I_OBJ1
```

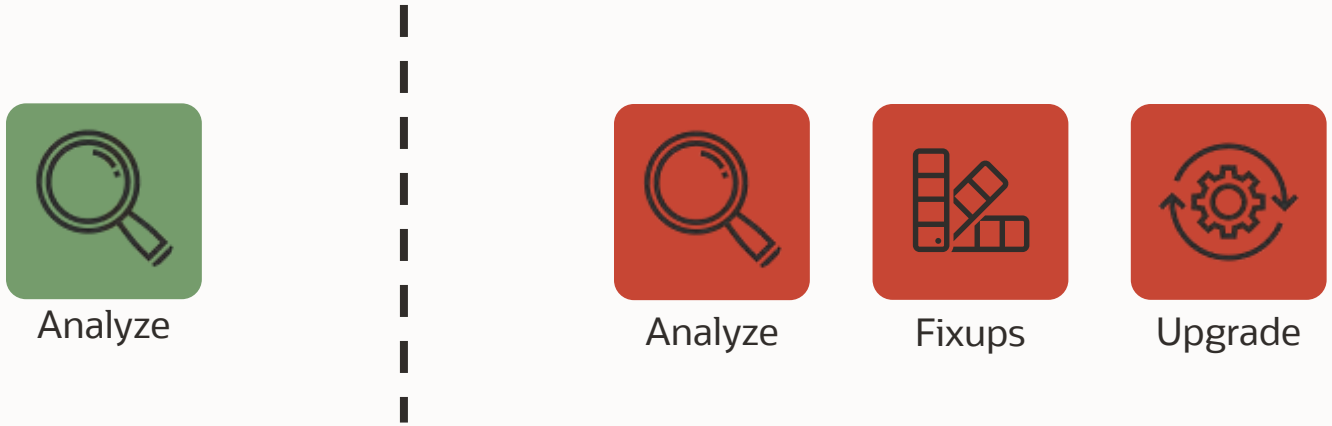
9h 59m 23s 87ms

2s 33ms

Fixups

Fast Deploy

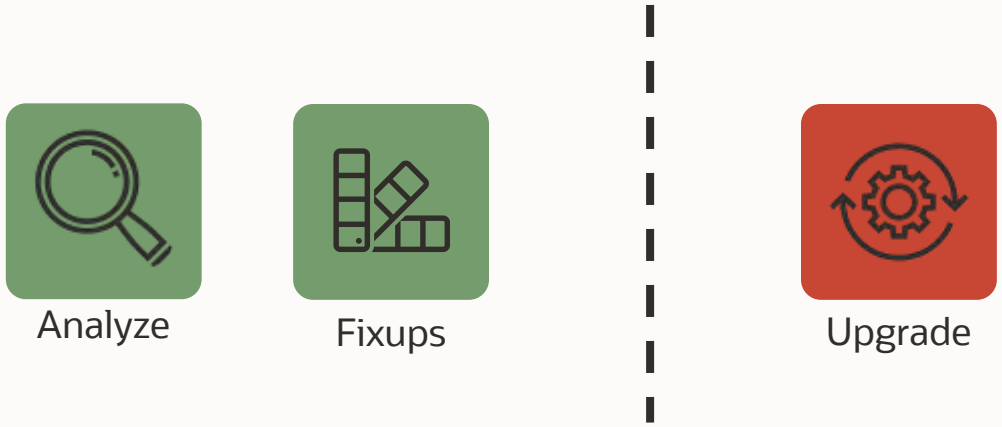
Fixups | Traditional




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

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

Fixups | Fast Deploy




```
$ java -jar autoupgrade.jar -mode analyze
$ java -jar autoupgrade.jar -mode fixups

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

Fixups | Fast Deploy

Between fixups and downtime there is a risk that new, undetected issues are introduced

Pro tip: Blog post with more details

Recompile

How to tune the recompilation?

Recompilation | Check

Invalid objects after upgrade

```
SQL> select con_id, count(*) from CDB_OBJECTS
      where status='INVALID' group by con_id order by 1;

CON_ID     COUNT(*)
---------- ----------
         1         51
         3       6359
         4       6356
         5       6356
```

Recompilation | utlrp.sql

Usually, after upgrade, recompilation should happen

- utlrp.sql
  - Calls utlprp.sql with CPU_COUNT – 1
  - Creates CPU_COUNT – 1 parallel jobs
  - Recompilation happens PDB after PDB
  - Attempts to compile ALL invalid objects

- utlprp.sql
  - Used to override the default parallel degree
  - Example

```
SQL> start ?/rdbms/admin/utlprp 32
```


Recompilation | AutoUpgrade

By default, AutoUpgrade recompiles after upgrade

- Recompilation attempts to compile everything invalid

Postpone recompilation

```
upg1.source_home=/u01/app/oracle/product/12.2.0.1
upg1.target_home=/u01/app/oracle/product/19
upg1.sid=CDB1
upg1.run_utlrp=no
upg1.after_action=/database/scripts/compile_my_way.sh
```

- But you can't postpone PDB$SEED's recompilation
- CDB$ROOT recompiles partially already, too

Recompilation | Option 1

Run your own compilation script(s)

- Sub scripts
- Scheduler
- Parallel degree

Recompilation | Option 2 *unofficial*

Modify `utlprp.sql`

- Makes sense only when you have a lot of INVALID user objects
- Force recompilation to compile ONLY oracle-maintained objects
- Backport available soon

```
DECLARE
   threads pls_integer := &&1;
BEGIN
   utl_recomp.recomp_parallel(threads);
END;
/
```

```
DECLARE
   threads pls_integer := &&1;
BEGIN
   utl_recomp.recomp_parallel(threads, flags => UTL_RECOMP.ORACLE_MAINTAINED);
END;
/
```

Only attempt tuning the recompilation where it takes UNUSUALLY long!

Benchmark

How does parallelism affect an upgrade?

11.2.0.4 to 19c

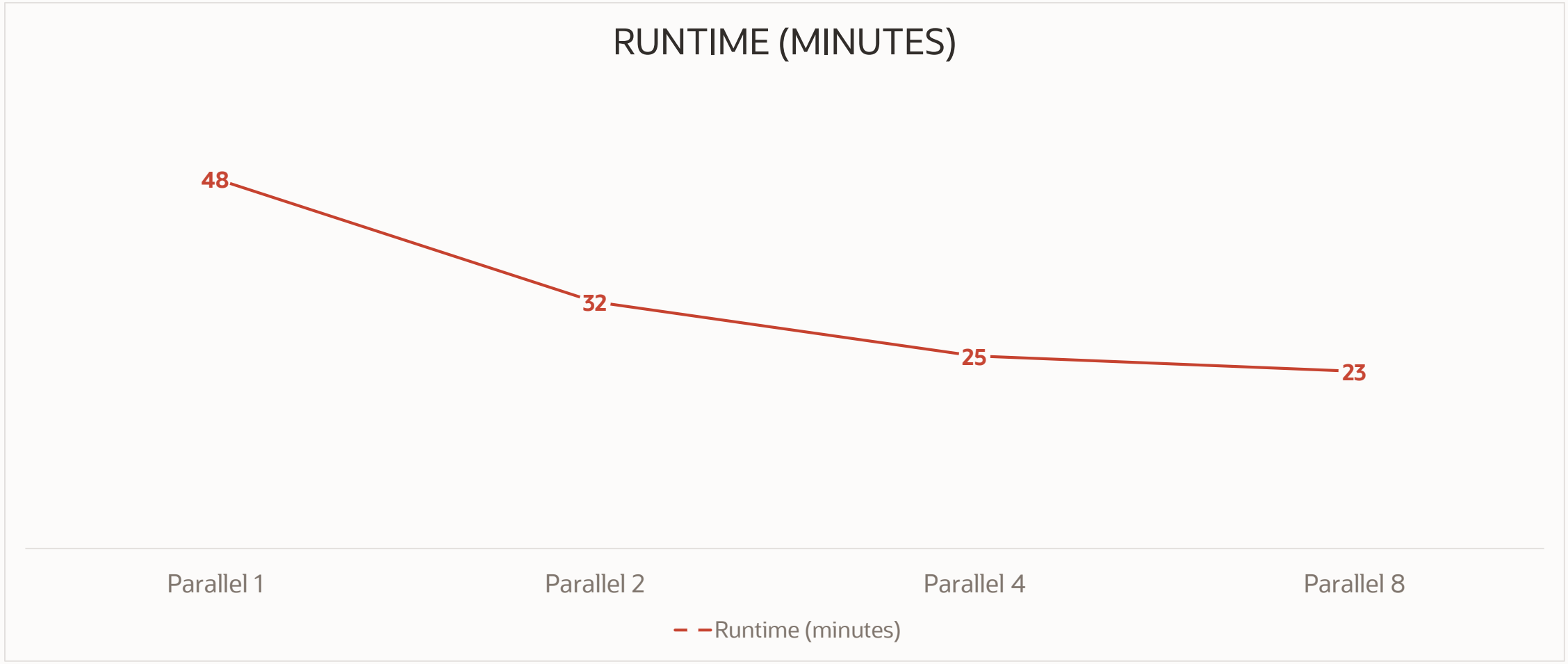
Parallel Upgrade | Benchmark

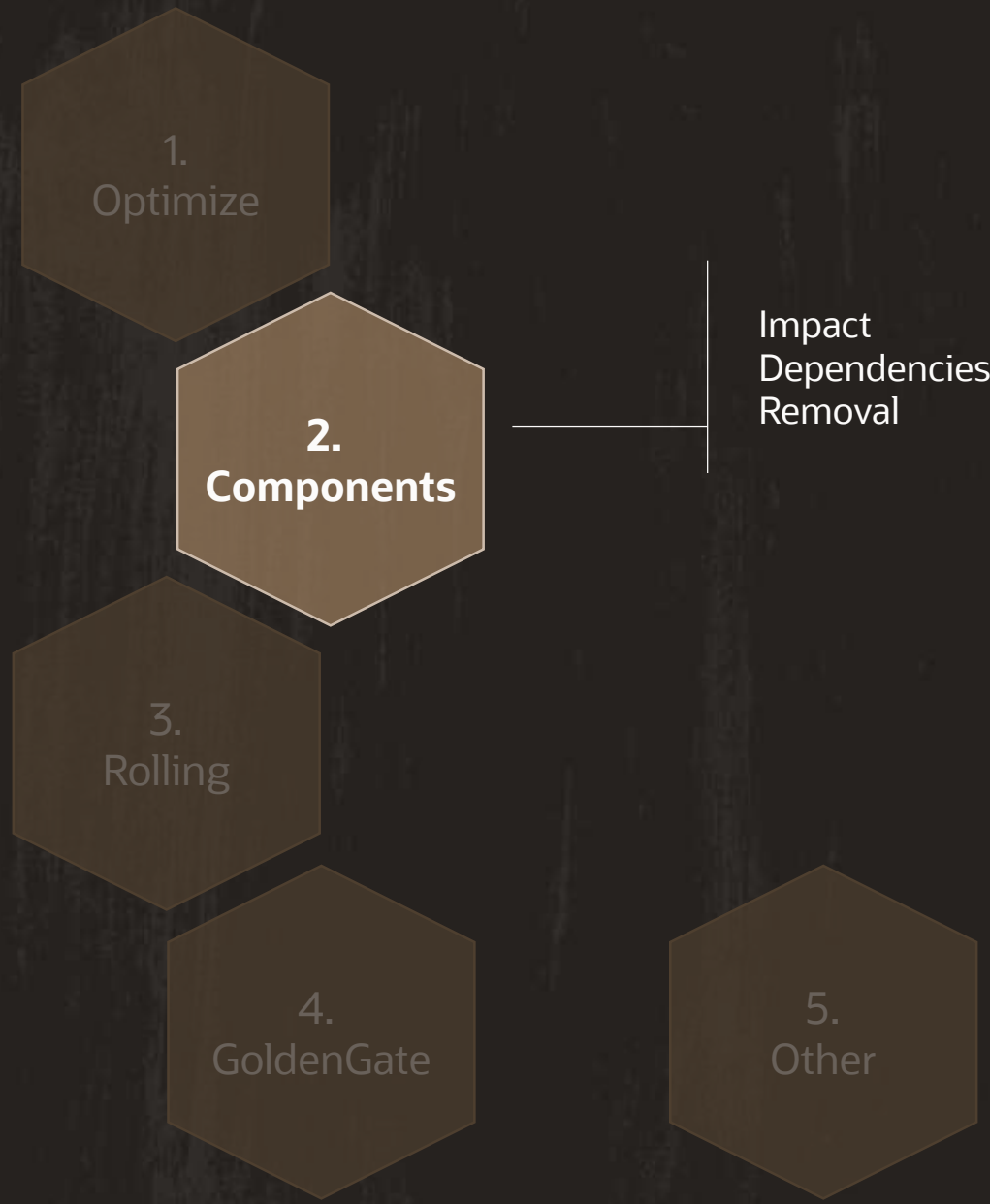
Bare Metal DB System
36 OCPUs
768 GB memory
NVMe disks

11.2.0.4
8 GB SGA
2 GB PGA
8 CPU_COUNT

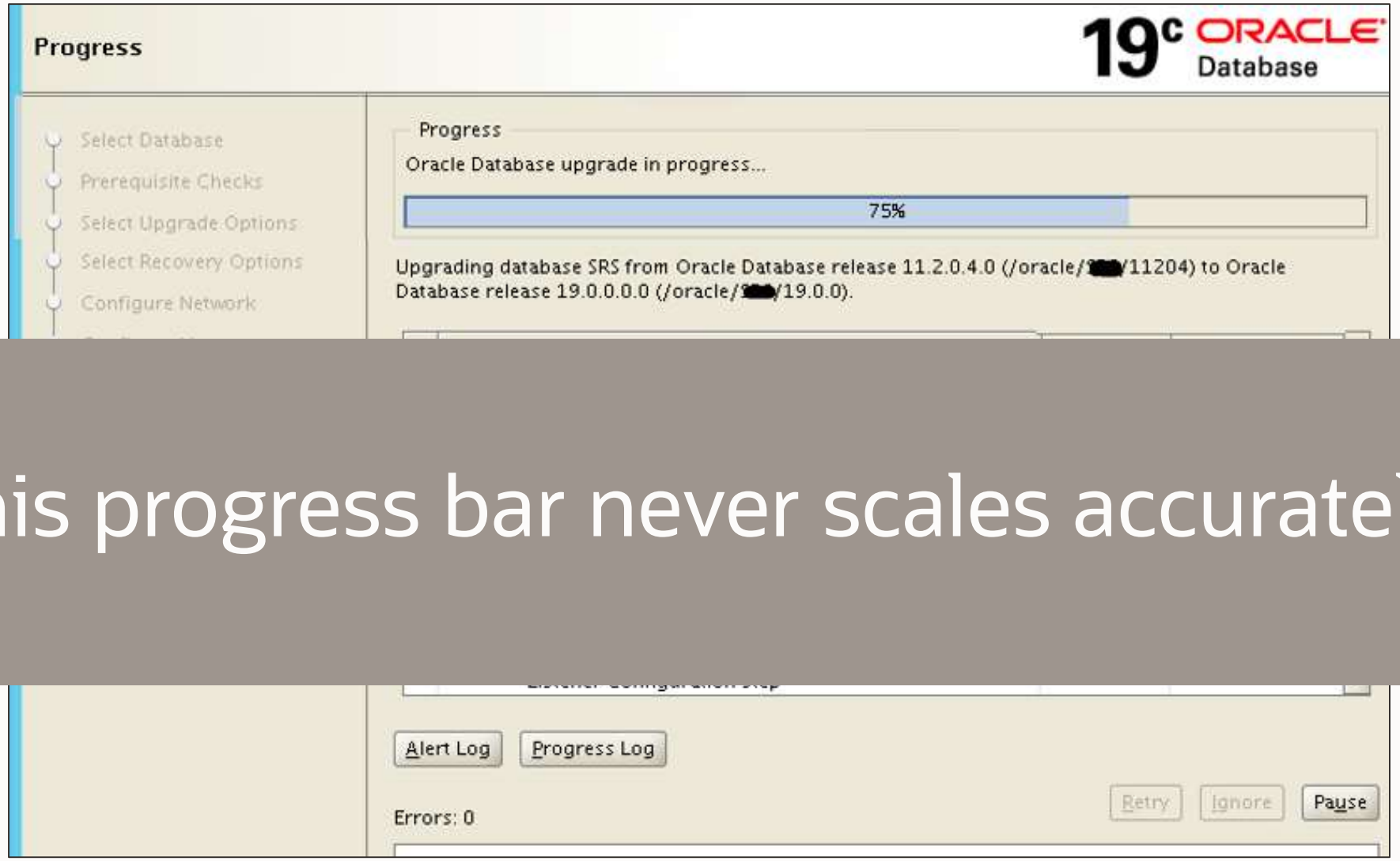
AMD
APS
CATALOG
CATJAVA
CATPROC
CONTEXT
EXF
JAVAVM
ORDIM
OWB
OWM
RUL
SDO
XDB
XML
XOQ

Parallel Upgrade | Benchmark





How long will my upgrade take?



This progress bar never scales accurately!

We can't tell you upfront

Basic Facts | How long does an upgrade take?

Things that matter a lot

- Number of installed components
- Size & complexity of data dictionary

Things that matter a little

- CPU and disk speed
- SGA/PGA

Things that don't matter (usually)

- Amount of user data

We can't change the size or complexity
of the data dictionary,
but we can check components

Remove desupported components
before upgrade

Oracle 19c | Multimedia Removal

> *Oracle Multimedia is desupported in Oracle Database 19c, and the implementation is removed.*

Database 19c Upgrade Guide

- API is removed, component (ORDIM) still exist
- If not in use, recommended to remove before upgrade
- Oracle Locator still exists and works
- Blog post: Simple migration from Oracle multimedia to secure-file blob data type

Components | All vs. Minimum

Oracle Database 19c by default has 15 components in CDB_REGISTRY

- One set in CDB$ROOT
- One set in PDB$SEED
- One set in each PDB

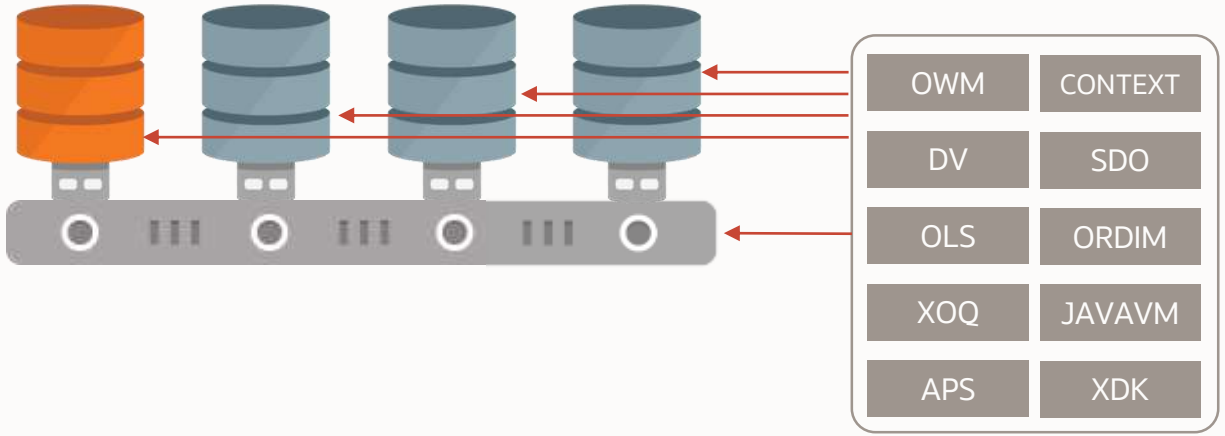
Each component runs upgrade scripts

- Most components upgrade serially, one after another
- Potential contention when many PDB upgrades happen in parallel

Components | Experiment

Container database

- 3 user created PDBs
- PDB$SEED
- Default set of components



Remove component after component

Compare upgrade timings

- 8 CPU cores
- Classic upgrade enforced for parallel processing of PDBs

Components | Experiment

Starting point

- Oracle Database 19.12.0
- 15 components in each container
- 75 entries in REGISTRY$
- CDB$ROOT gets upgraded always at first
- 4 PDBs including PDB$SEED
  - 4 PDBs upgraded in parallel
  - 2 workers each PDB

End point

- Oracle Database 21.3.0
- 4 components in each container
- 20 entries in REGISTRY$

Components | Experiment

Starting point

```
COMP_ID    COMP_NAME                              STATUS
---------- -------------------------------------- ---------
APS        OLAP Analytic Workspace                VALID
CATALOG    Oracle Database Catalog Views          VALID
CATJAVA    Oracle Database Java Packages          VALID
CATPROC    Oracle Database Packages and Types     VALID
CONTEXT    Oracle Text                            VALID
DV         Oracle Database Vault                  VALID
JAVAVM     JServer JAVA Virtual Machine           VALID
OLS        Oracle Label Security                  VALID
ORDIM      Oracle Multimedia                      VALID
OWM        Oracle Workspace Manager               VALID
RAC        Oracle Real Application Clusters       OPTION OFF
SDO        Spatial                                VALID
XDB        Oracle XML Database                    VALID
XML        Oracle XDK                             VALID
XOQ        Oracle OLAP API                        VALID
```

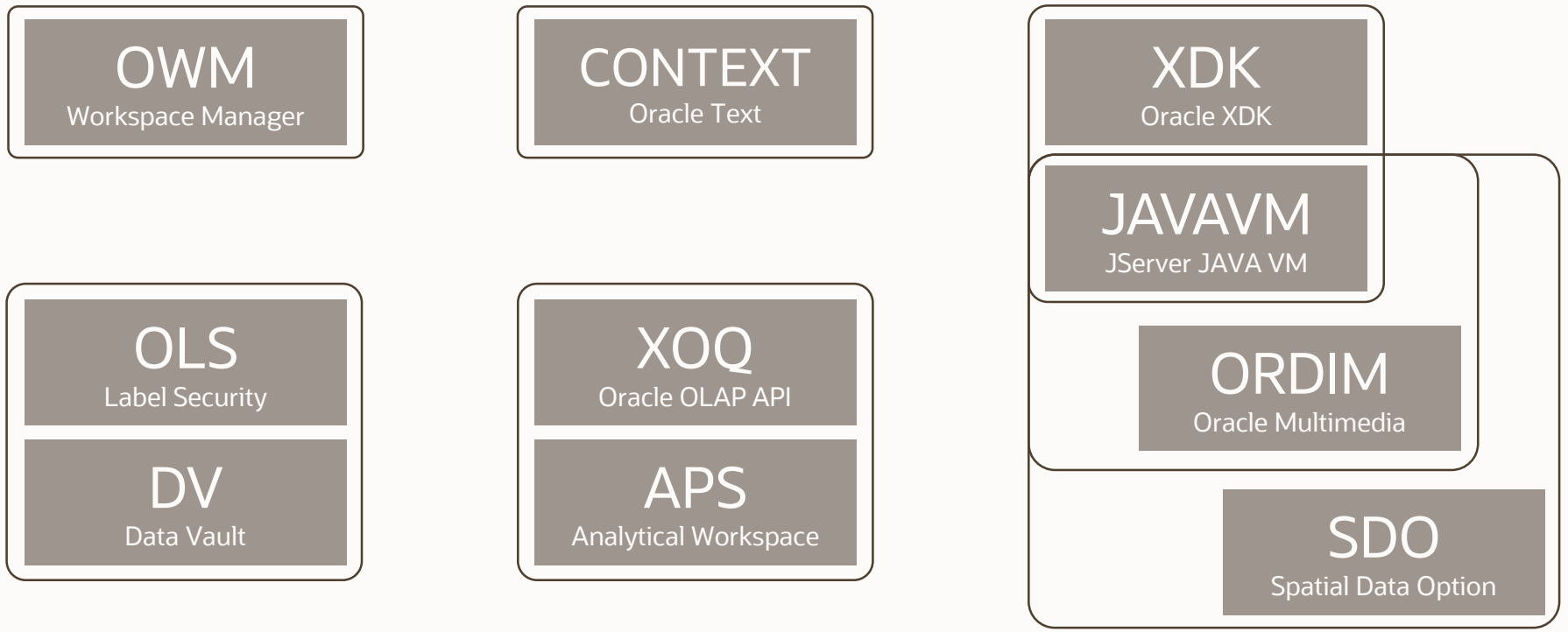
(only one container shown)

End point

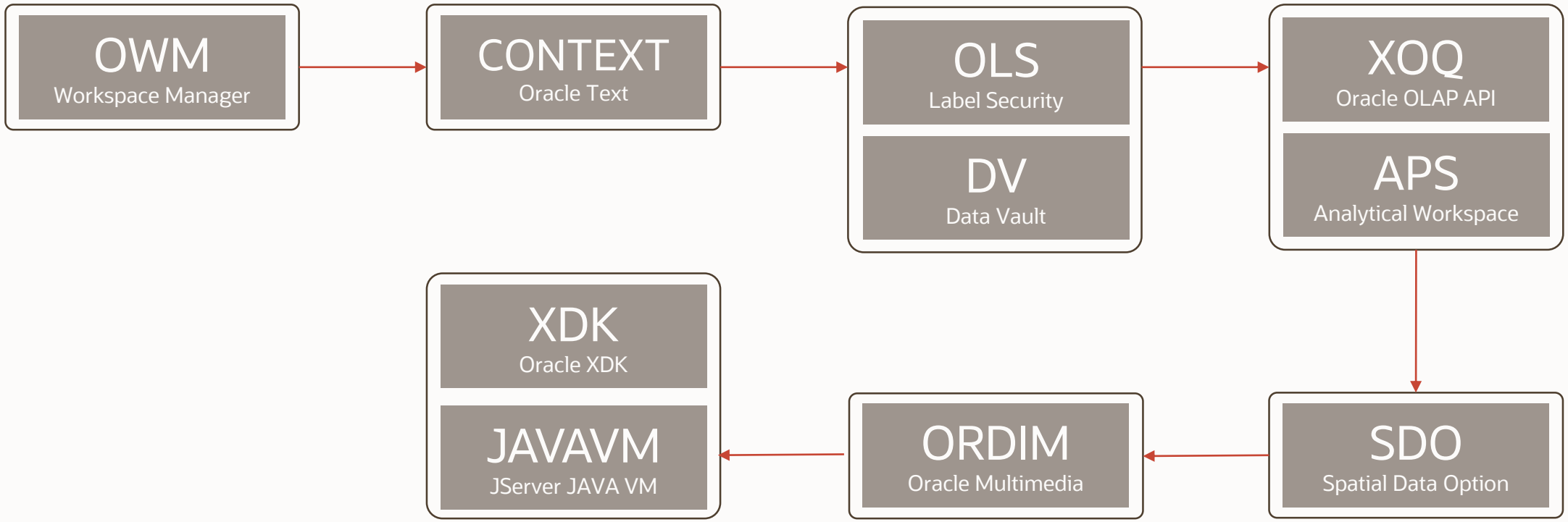
```
COMP_ID    COMP_NAME                              STATUS
---------- -------------------------------------- ----------
CATALOG    Oracle Database Catalog Views          VALID
CATPROC    Oracle Database Packages and Types     VALID
RAC        Oracle Real Application Clusters       OPTION OFF
XDB        Oracle XML Database                    VALID
```

(only one container shown)

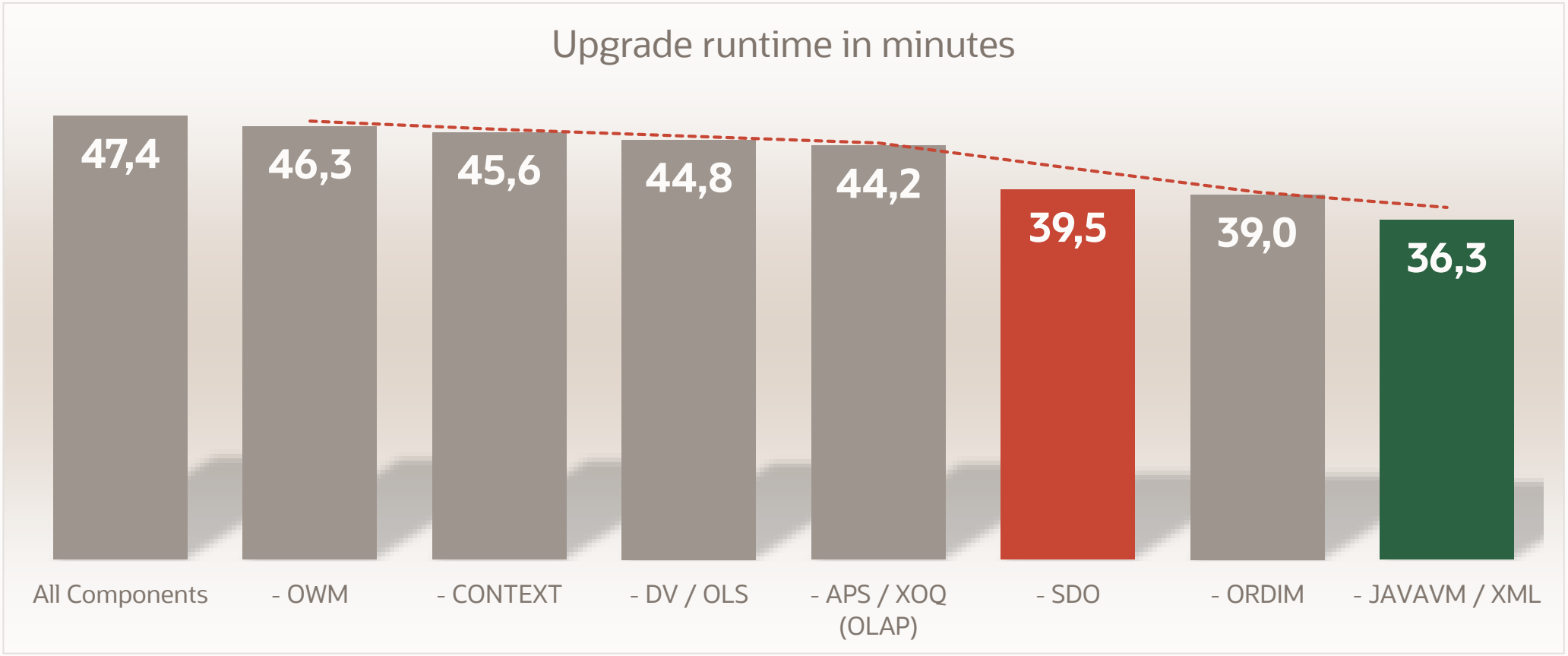
Components | Dependencies



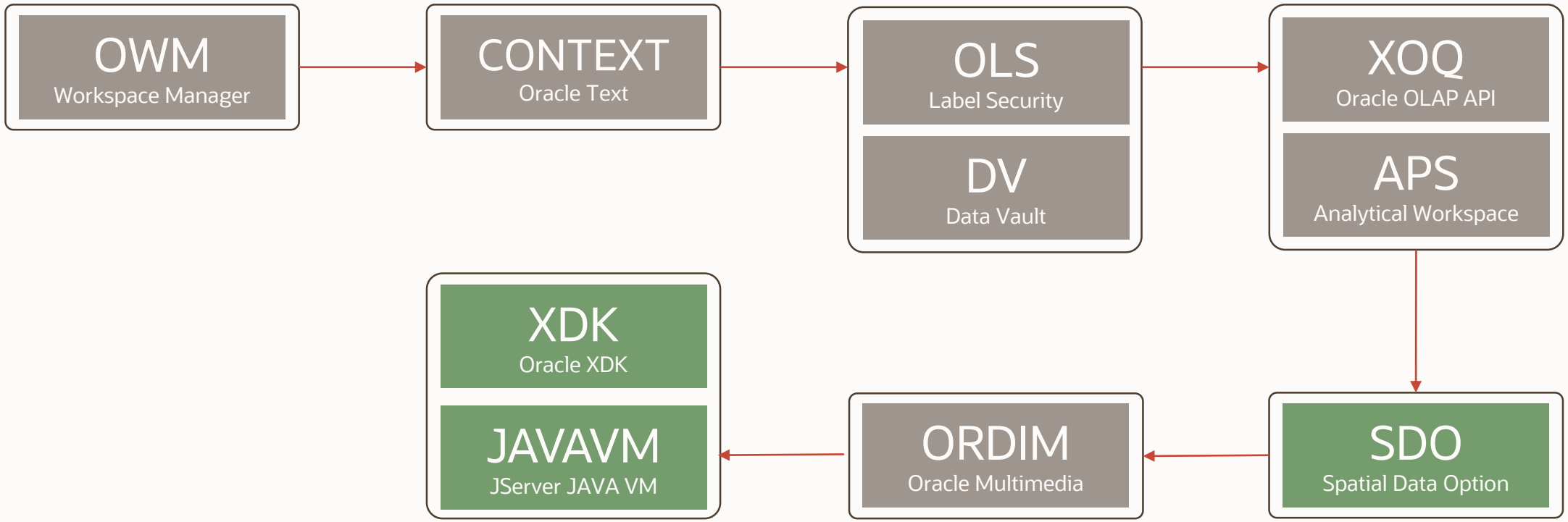
Components | Removal Order



Components | Result

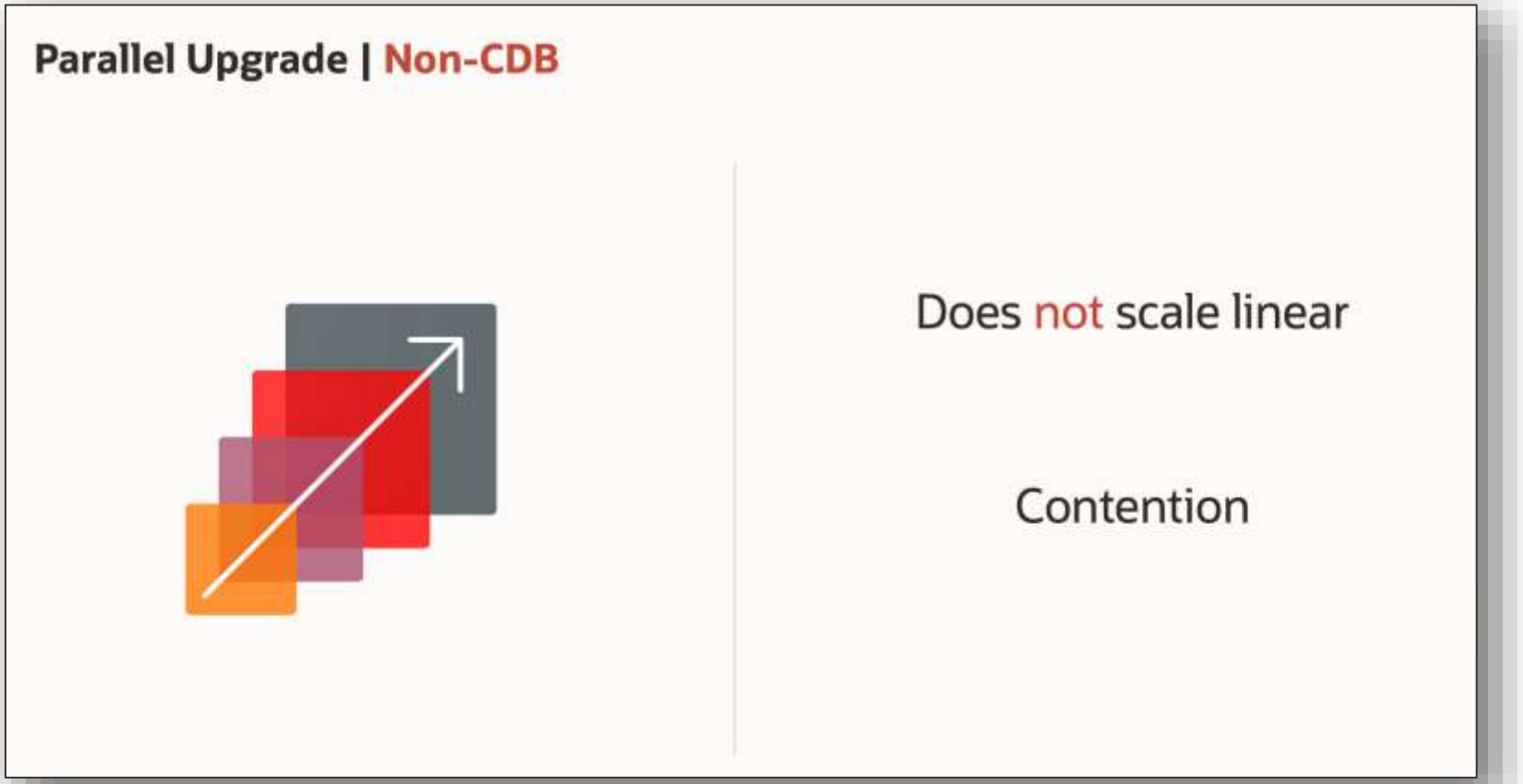


Components | Highest Impact



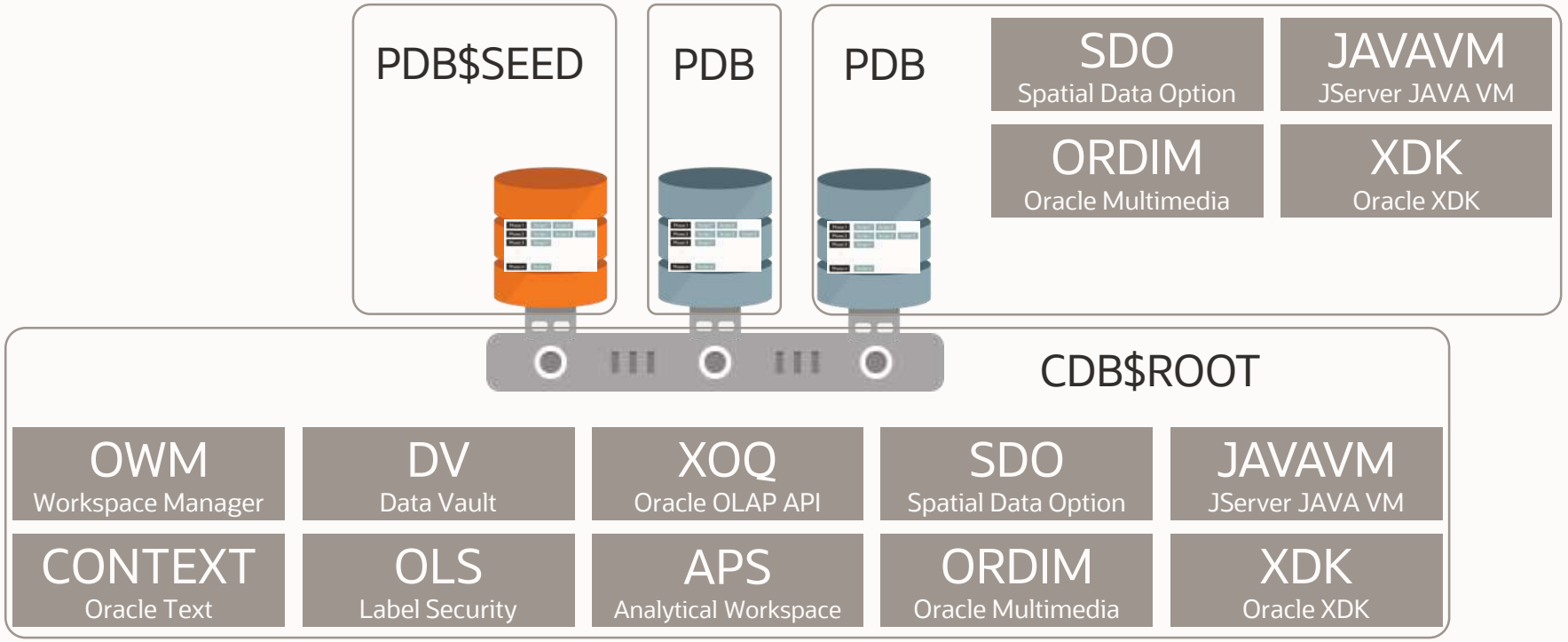
Components | CDB$ROOT vs PDB

Do you remember this slide?

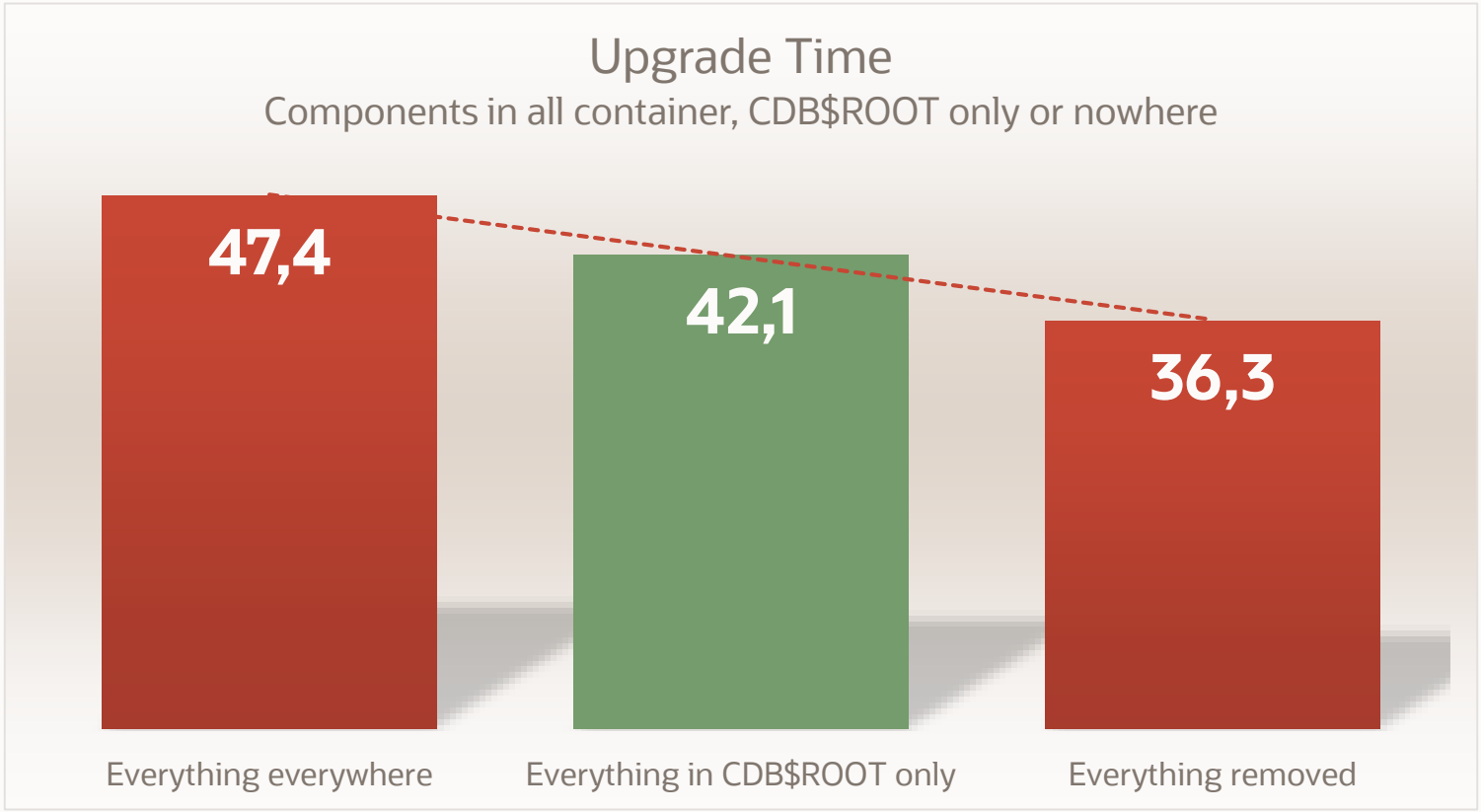


Components | CDB$ROOT vs PDB

This may be a solution

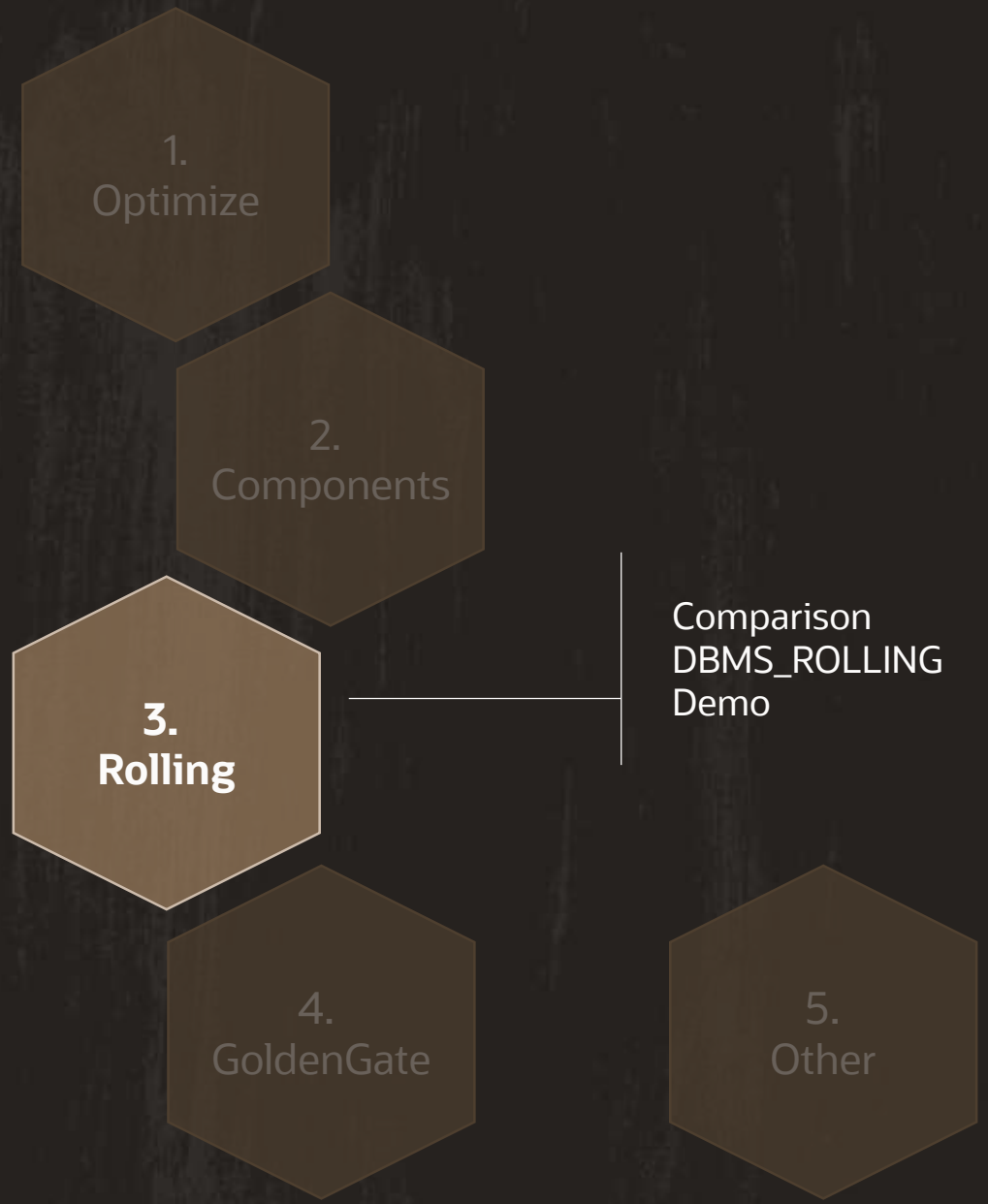


Components | Compromise



Components | Compromise

Find the right balance between functionality and complexity



Rolling Upgrade | Transient Logical Standby

Use a logical standby database to upgrade with very little downtime.

The only downtime is as little as it takes to perform a switchover.

Pro tip: Also useful for other maintenance activities

Rolling Upgrade | Standby Types

PHYSICAL

Redo apply

Updated by changing data block

Exact copy - block-by-block

LOGICAL

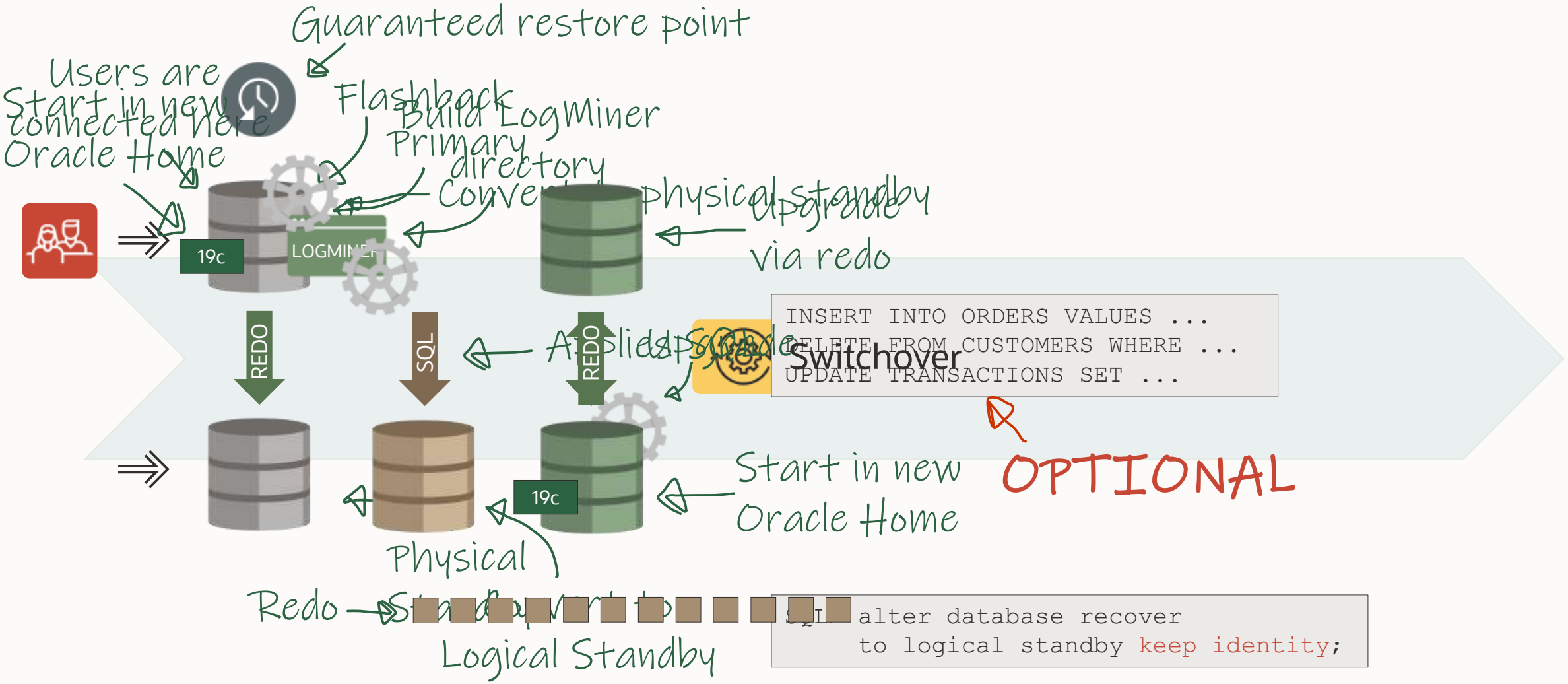
SQL apply

Updated by executing SQLs

Exact copy - table-by-table

Pro tip: Read more about standby types in Data Guard Concepts and Administrations

Rolling Upgrade | Concept



Rolling Upgrade | Options

MANUAL

Part of Enterprise Edition

Source must be 11.1.0.7

Manual approach

Data Guard broker must be disabled

DBMS_ROLLING

Requires Active Data Guard

Source must be 12.1.0.2 or newer

Automated

Data Guard broker can be enabled

Recommended

Rolling Upgrade | Manual

MOS Note: 949322.1

Oracle11g Data Guard: Database Rolling Upgrade Shell Script

- Potentially not adjusted for Oracle 12c and newer
- Requires source is 11.2.0.3 or newer
- Does not work with Multitenant
- Not supported in 19c

Rolling Upgrade | Options

MANUAL	DBMS_ROLLING
Part of Enterprise Edition	Requires Active Data Guard
Source must be 11.1.0.7	Source must be 12.1.0.2 or newer
Manual approach	Automated
Data Guard broker must be disabled	Data Guard broker can be enabled
	Recommended

Rolling Upgrade | DBMS_ROLLING

6 SIMPLE STEPS

```
SQL> exec dbms_rolling.init_plan;
SQL> exec dbms_rolling.build_plan;
SQL> exec dbms_rolling.start_plan;
```

Upgrade database

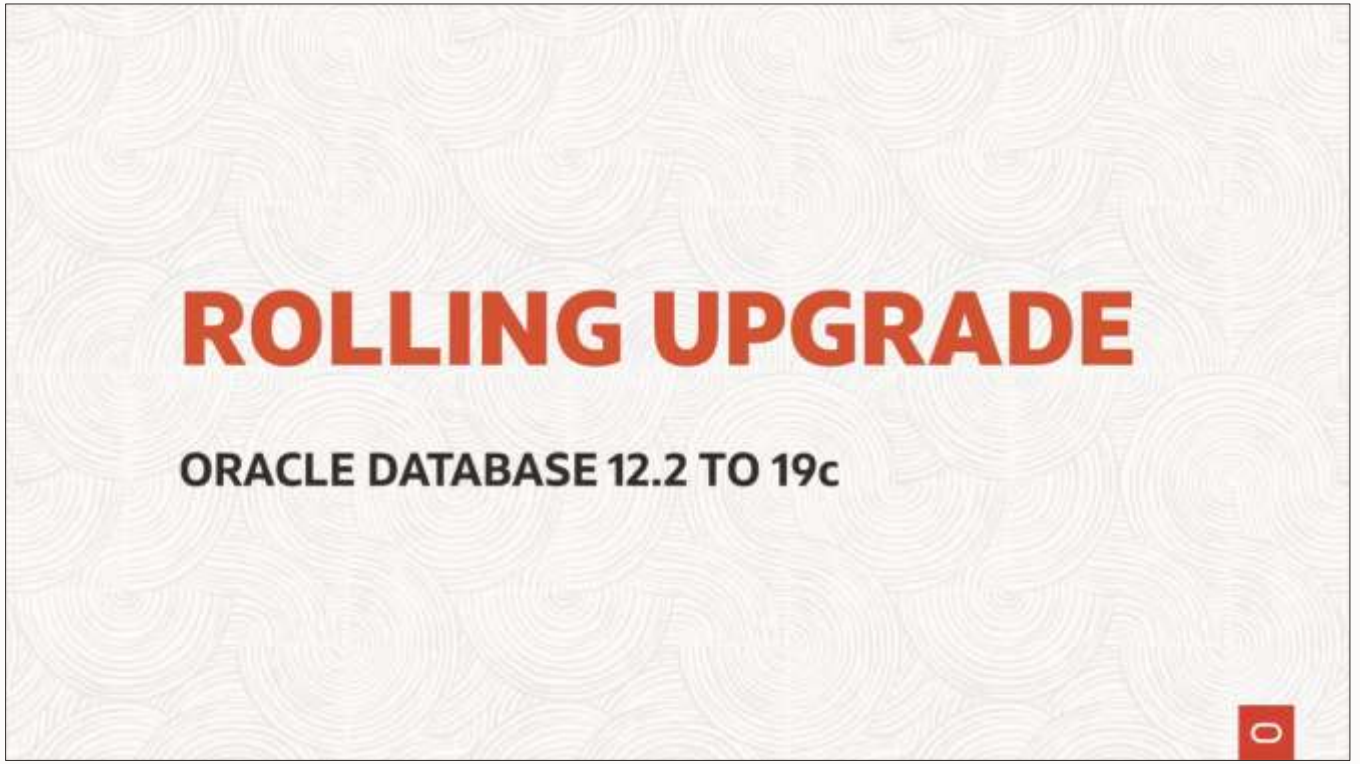
```
SQL> exec dbms_rolling.switchover;
SQL> exec dbms_rolling.finish_plan;
```


Rolling Upgrade | DBMS_ROLLING

```
...
Get current redo branch of the primary database
Wait until recovery is active on the primary's redo
branch
Reduce to a single instance if database is a RAC
Verify only a single instance is active if future
primary is RAC
Stop media recovery
Execute dbms_logstdby.build
Convert into a transient logical standby
Open database including instance-peers if RAC
Verify logical standby is open read/write
Get redo branch of transient logical standby
Get reset scn of transient logical redo branch
Configure logical standby parameters
Start logical standby apply
Wait until apply lag has fallen below 600 seconds
Notify Data Guard broker that switchover to logical
standby database is starting
Log post-switchover instructions to events table
Switch database to a logical standby
Notify Data Guard broker that switchover to logical
standby database has completed
Wait until end-of-redo has been applied
...
```

86 INSTRUCTIONS OR CHECKS

Rolling Upgrade | DBMS_ROLLING



Watch on YouTube

Rolling Upgrade | Backups

After converting to logical standby database, take a level 0 backup

Rolling Upgrade | Database Readiness

Can I use rolling upgrade on my database?

Rolling Upgrade | Database Readiness

Do not create the logical standby
on the same server as the primary database

Rolling Upgrade | Database Readiness

Not all data types and partitioning types are supported

Pro tip: Check the documentation for details

Rolling Upgrade | Performance

For optimal performance all tables should have primary keys or unique keys

Pro tip: For further information, read Prerequisite Conditions for Creating a Logical Standby Database

Rolling Upgrade | Multitenant

- Rolling upgrade on container databases is fully supported
- Upgrade happens on CDB level - when you switchover - the entire CDB switches over
- The Transient Logical Standby can have a subset of the PDBs
- Adding new PDBs in primary after instantiating logical standby is possible, but cumbersome

Rolling Upgrade | Additional Information - 1

Technical Briefs:

- Oracle Database Rolling Upgrades Using a Data Guard Physical Standby Database

Documentation:

- Oracle 19c Data Guard Concepts and Administration

MOS Notes:

- Transient Rolling Upgrade Using DBMS_ROLLING - Beginners Guide
- Rolling upgrade using DBMS_ROLLING - Complete Reference (Doc ID 2086512.1)
- MAA Whitepaper: SQL Apply Best Practices (Doc ID 1672310.1)
- Step by Step How to Do Swithcover/Failover on Logical Standby Environment (Doc ID 2535950.1)
- How To Skip A Complete Schema From Application on Logical Standby Database (Doc ID 741325.1)
- How to monitor the progress of the logical standby (Doc ID 1296954.1)
- How To Reduce The Performance Impact Of LogMiner Usage On A Production Database (Doc ID 1629300.1)

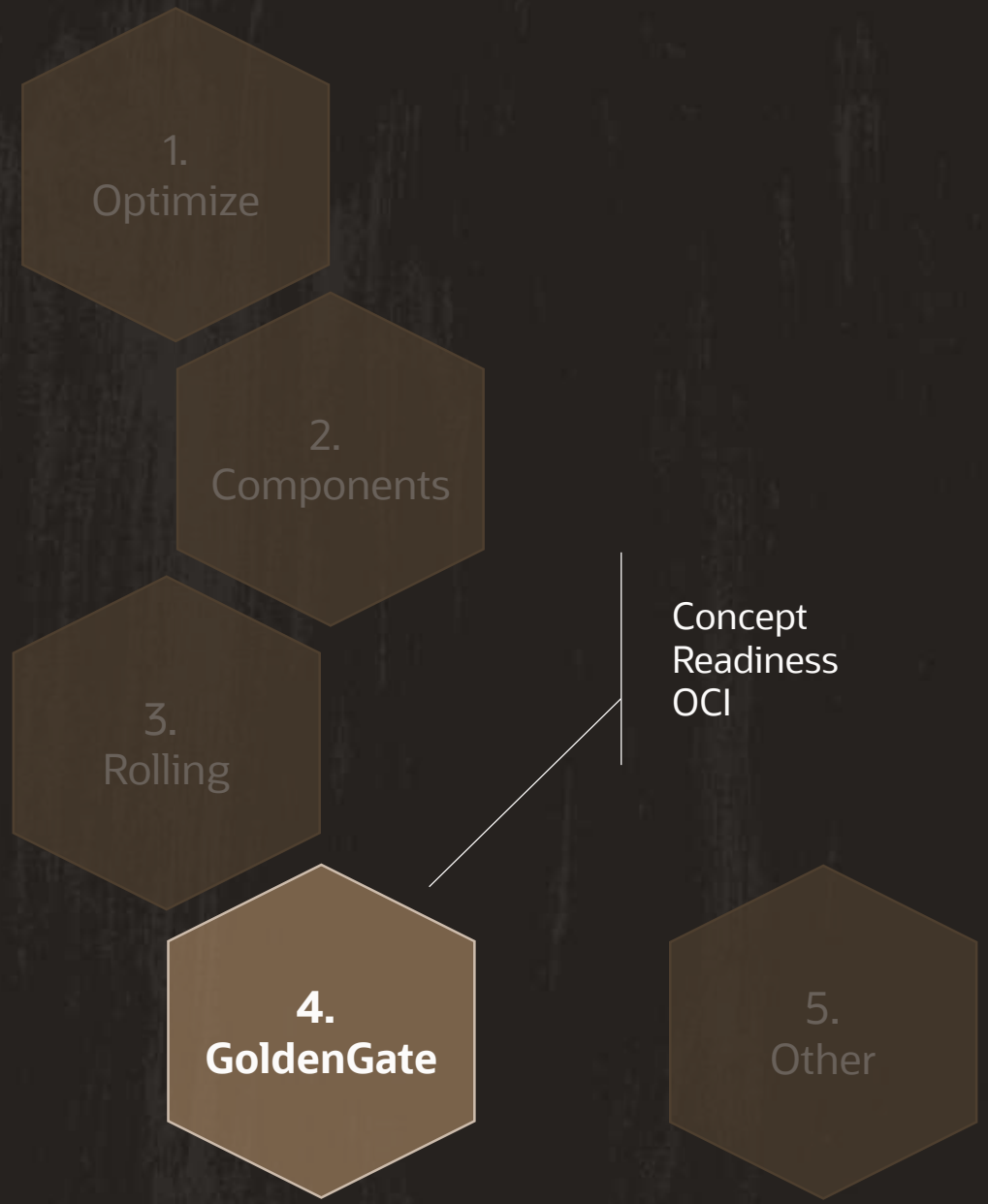
Rolling Upgrade | Additional Information - 2

MOS Notes:

- Handling ORA-1403 ora-12801 on logical standby apply (Doc ID 1178284.1)
- Troubleshooting Example - Rolling Upgrade using DBMS_ROLLING (Doc ID 2535940.1)
- DBMS Rolling Upgrade Switchover Fails with ORA-45427: Logical Standby Redo Apply Process Was Not Running (Doc ID 2696017.1)
- SRDC - Collect Logical Standby Database Information (Doc ID 1910065.1)
- MRP fails with ORA-19906 after Flashback of Transient Logical Standby used for Rolling Upgrade (Doc ID 2069325.1)

Bugs:

- BUG 22541208 - REPLICATION FAILS WITH ORA-02149 DROPING PARTITION WITH SYSTEM GENERATED NAME (fixed in 12.2 backport available for 12.1)

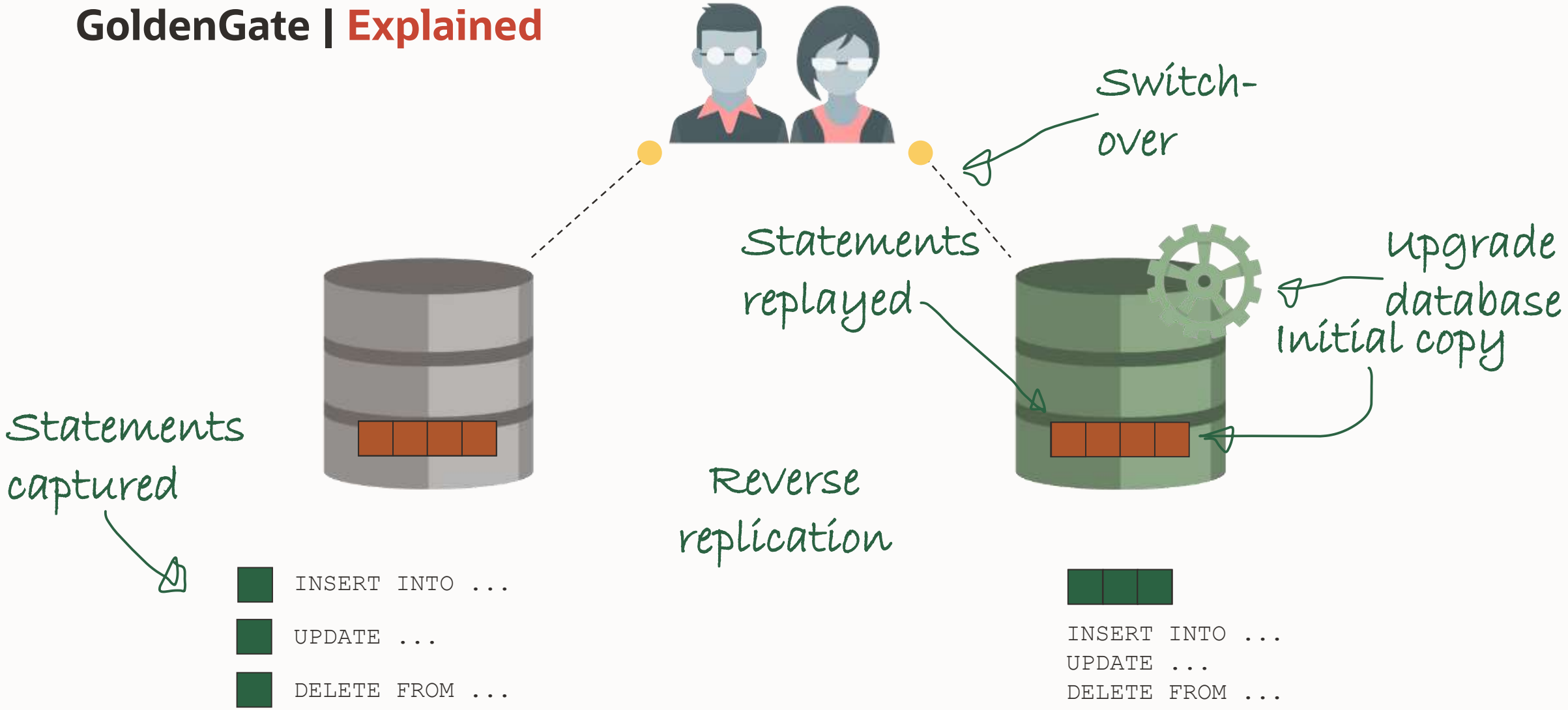


GoldenGate | Overview

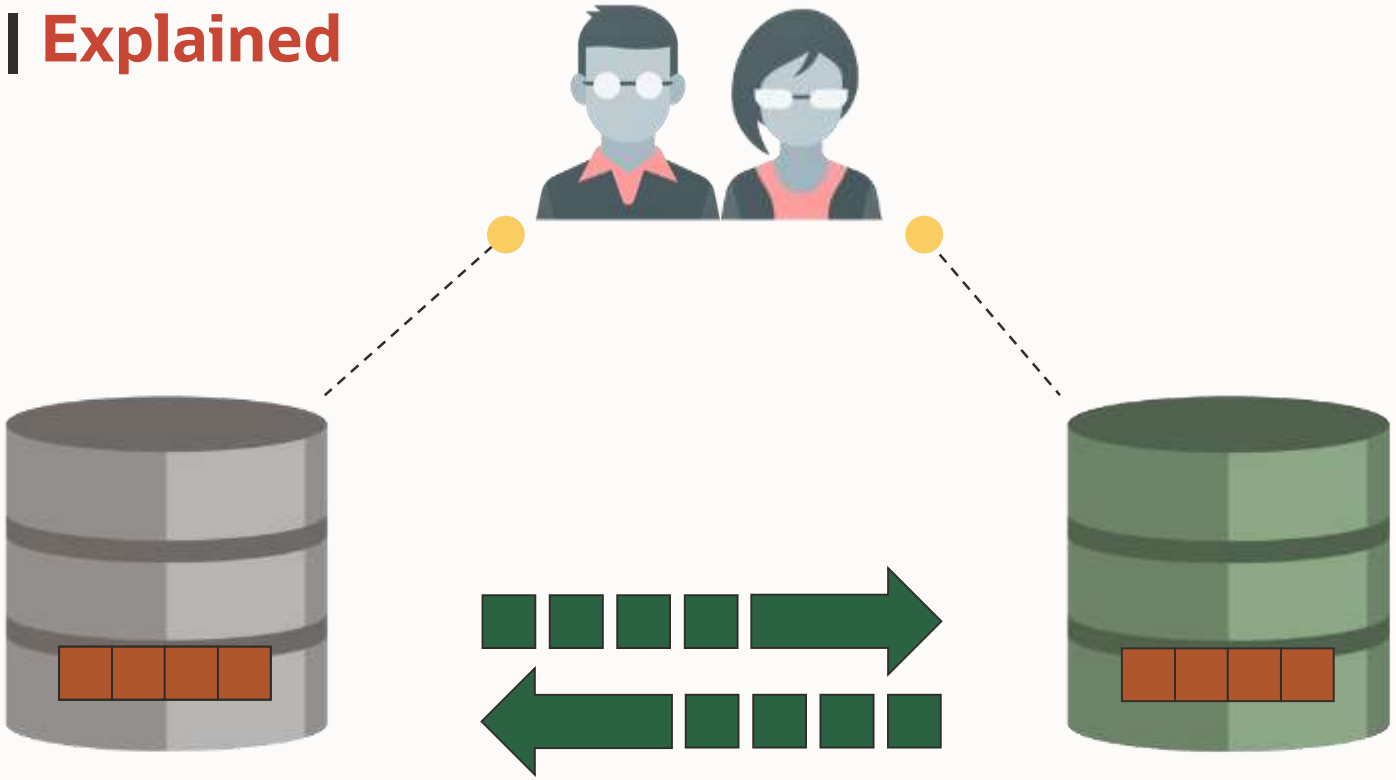
GoldenGate offers true zero downtime upgrades combined with excellent fallback capabilities and extreme flexibility

Pro tip: Active Data Guard included in GoldenGate license

GoldenGate | Explained



GoldenGate | Explained



GoldenGate | Benefits

- Integrated extract supports TDE encrypted databases
- GoldenGate trail files can be encrypted and compressed
- Test before go-live
  - Does Goldengate Support Oracle RDBMS Flashback Features? (Doc ID 966212.1)
- Cross-endian support

GoldenGate | Data Pump Integration

No longer needed to specify from which SCN replication should start

New Replicat parameter
`DBOPTIONS ENABLE_INSTANTIATION_FILTERING`

Requires Oracle GoldenGate 12.2

MOS Note: 1276058.1

```
SQL> select source_object_name,
instantiation_scn from
dba_apply_instantiated_objects where
source_object_owner = 'APPS' ;

SOURCE_OBJECT_NAME INSTANTIATION_SCN
-----------------------------------
TCUSTMER                  829723224
TCUSTORD                  829723223



2017-07-17 15:02:51 INFO OGG-10155
Instantiation CSN filtering is enabled
on table APPS.TCUSTMER at CSN
829,723,224.

2017-07-17 15:02:51 INFO OGG-10155
Instantiation CSN filtering is enabled
on table APPS.TCUSTORD at CSN
829,723,223.
```

GoldenGate | Considerations

- Target database time zone file version must be equal to or higher than source

```
SQL> select * from v$timezone_file;
```

- Possibly patches are recommended on source database to support GoldenGate
  - 11g
  - 12c and newer

- GoldenGate supported data types

- DDL replication
  - Truncate
  - Sequences

GoldenGate | Considerations

- Export or re-create public and other not exported objects
  - Synonyms
  - Database links
  - ...
- Diagnostic and tuning related information
  - AWR
  - SQL Plan Baselines
  - SQL Profiles
  - SQL Patches
  - ...

GoldenGate | Very Large Databases

- Extract supports Data Guard
  - Switchover need additional configuration
  - Failover not supported

- Data Pump export does not use `FLASHBACK_SCN` or `FLASHBACK_TIME`

- GoldenGate trail files typically
  - 30-40 % of redo
  - Compress at least 1:4, most likely up to 1:8

Offload extract from production database via downstream database

- Get archive logs from source and process to trail file

GoldenGate | Data Guard

Supported configuration

1. Replicate to primary database
   - Changes applied on standby via redo
2. Additional GoldenGate configuration needed
   - To handle switchover/failover during replication
3. New data files requires `STANDBY_FILE_MANAGEMENT=AUTO`
   - Optionally, configure `DB_FILE_NAME_CONVERT` as well

Can I use GoldenGate on my database?

GoldenGate | Database Readiness

```
SQL> select * from dba_goldengate_support_mode;

OWNER OBJECT_NAME                    SUPPORT_MODE
CO    CUSTOMERS                      ID KEY
CO    ORDERS                         ID KEY
CO    ORDER_ITEMS                    FULL
CO    PRODUCTS                       ID KEY
CO    STORES                         ID KEY
```


GoldenGate | Database Readiness

			
SUPPORT_MODE	FULL	ID KEY PLSQL	INTERNAL NONE

Pro tip: Visit the documentation for more details

GoldenGate | Database Readiness

SUPPORT_MODE	FULL	ID KEY PLSQL	INTERNAL NONE

Pro tip: Visit the documentation for more details

GoldenGate | Database Readiness

SUPPORT_MODE	FULL	ID KEY PLSQL	INTERNAL NONE

Pro tip: Visit the documentation for more details

GoldenGate | Database Readiness

What's wrong in this Oracle Database running 12.2?

Identify columns supported as of Oracle Database 18c …

```
SQL> select * from dba_goldengate_support_mode;

OWNER OBJECT_NAME          SUPPORT_MODE
CO    CUSTOMERS            ID KEY
CO    ORDERS               ID KEY
CO    ORDER_ITEMS          FULL
CO    PRODUCTS             ID KEY
CO    STORES               ID KEY
```

GoldenGate | Database Readiness

Oracle Database 21c New Feature

```
SQL> select * from dba_goldengate_support_mode;

OWNER OBJECT_NAME          SUPPORT_MODE       DESCRIPTION
CO    CUSTOMERS            ID KEY             A very good explanation
CO    ORDERS               ID KEY             Another good explanation
CO    ORDER_ITEMS          FULL
CO    PRODUCTS             ID KEY             A third explanation
CO    STORES               ID KEY             Good explanation comes in
                                              abundance these days
```

GoldenGate | Database Readiness

For optimal performance all tables should have primary keys or unique keys

GoldenGate | Database Readiness

```
SQL> select * from dba_goldengate_not_unique;

OWNER  TABLE_NAME                          BAD_COLUMN
IX     AQ$_ORDERS_QUEUETABLE_L             N
IX     AQ$_STREAMS_QUEUE_TABLE_L           N
SH     SALES                               N
SH     COSTS                               N
SH     SUPPLEMENTARY_DEMOGRAPHICS          N
SH     CAL_MONTH_SALES_MV                  N
SH     FWEEK_PSCAT_SALES_MV                N
```


GoldenGate | Database Readiness

If the application maintains uniqueness,
but it is not enforced on the database,
use a `KEYCOLS` clause to let GoldenGate use it

Pro tip: For further information, read Ensuring Row Uniqueness in Source and Target Tables

GoldenGate | Database Readiness

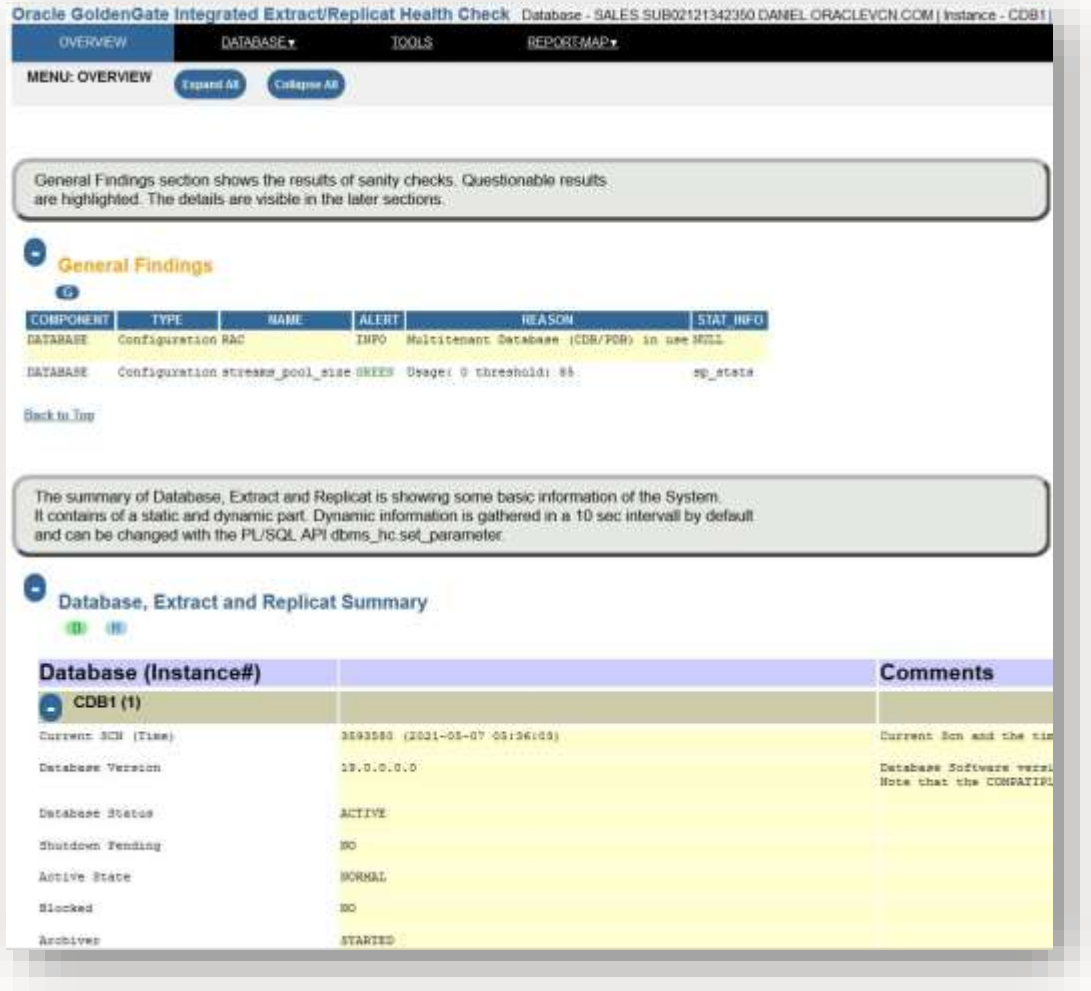
Older databases (classic extract/replicat)

- Oracle GoldenGate database Complete Database Profile check script for Oracle DB (All Schemas) Classic Extract (Doc ID 1298562.1)
- Oracle GoldenGate database Schema Profile check script for Oracle DB (Doc ID 1296168.1)

GoldenGate | Health Check

Generate report:

- Check prerequisites
- Database characteristics
- Find database objects of interest
- Extract/replicat statistics
- Check database readiness



GoldenGate | Health Check

Generate report by:

- Installing objects in database: `ogghc_install.sql`
- Execute health check: `ogghc_run.sql`
- Optionally, clean-up objects: `ogghc_uninstall.sql`

For GoldenGate MicroServices Architecture find the scripts:

`/u01/app/ogg/oraclenn/lib/sql/healthcheck`

Upgrading a database in OCI?

OCI GoldenGate | Cloud Native

New Cloud Native service: OCI GoldenGate

Runs GoldenGate 21c, managed by Oracle

Auto-scale: true cloud elasticity, low operations cost

Very attractive pricing

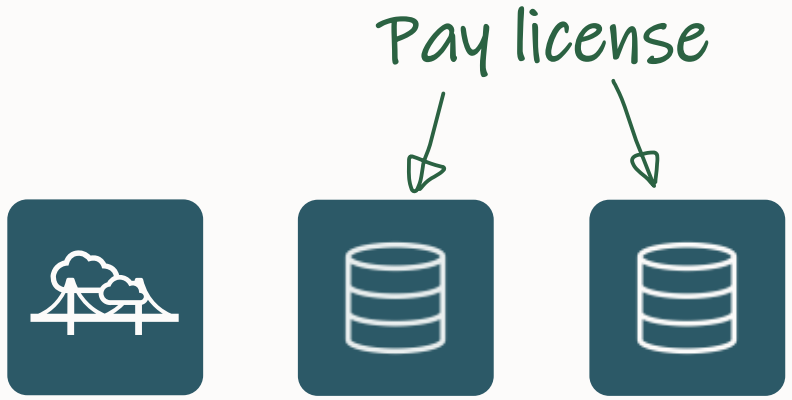
Supports:

- Oracle Database 11.2.0.4 and higher

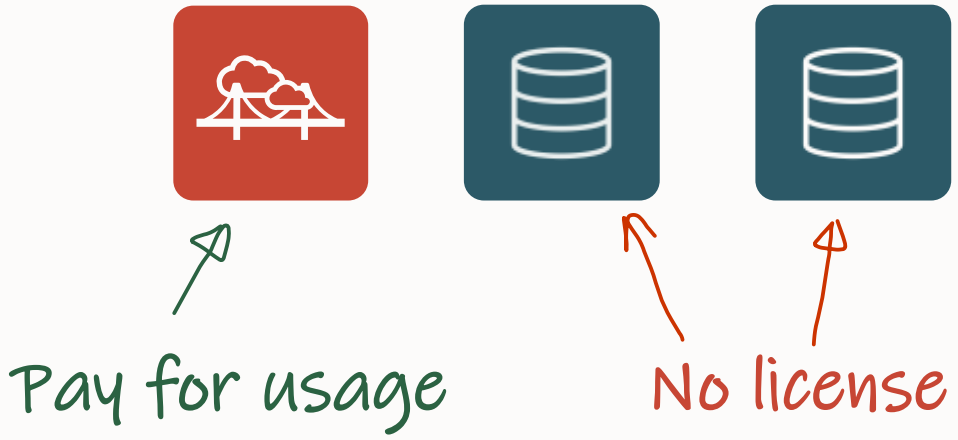
Pro Tip: Watch a short intro on YouTube

OCI GoldenGate | Pricing

Traditional

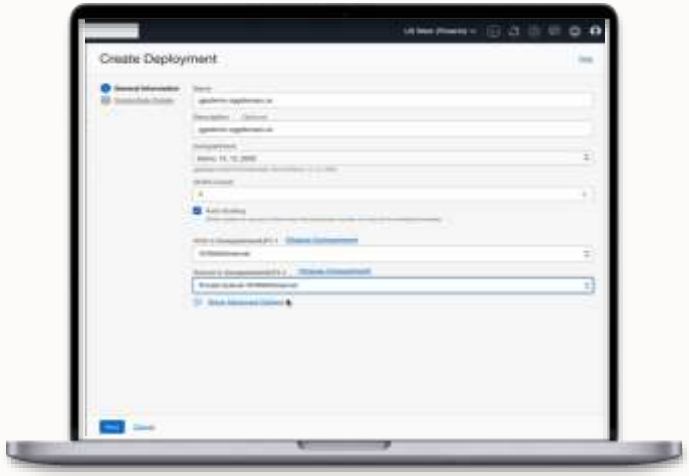


OCI GoldenGate



OCI GoldenGate | Start small, grow to massive scale

Get started for
$1.34 per OCPU per hour



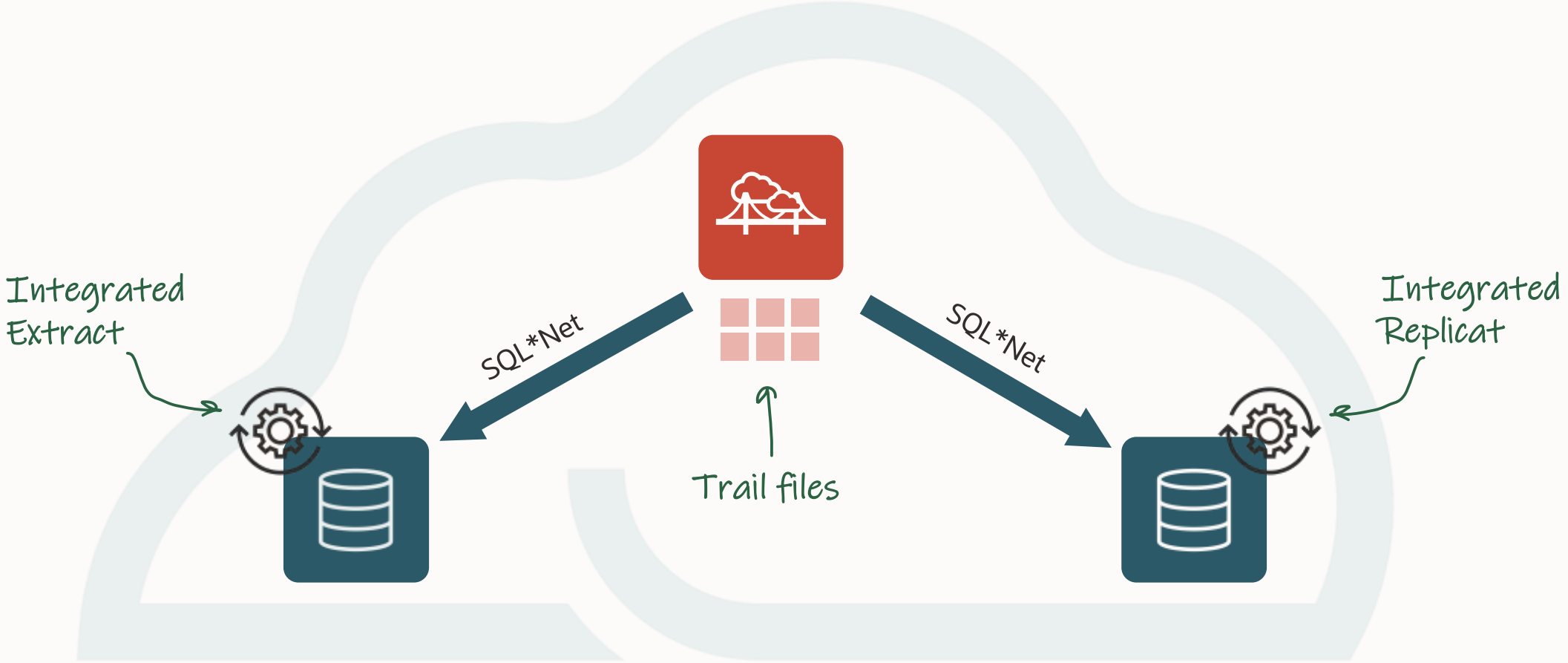
Try it for free:
https://www.oracle.com/cloud/free/

GoldenGate moves petabytes of real-time data per day at Web scale

84%

of Fortune 100 use GoldenGate

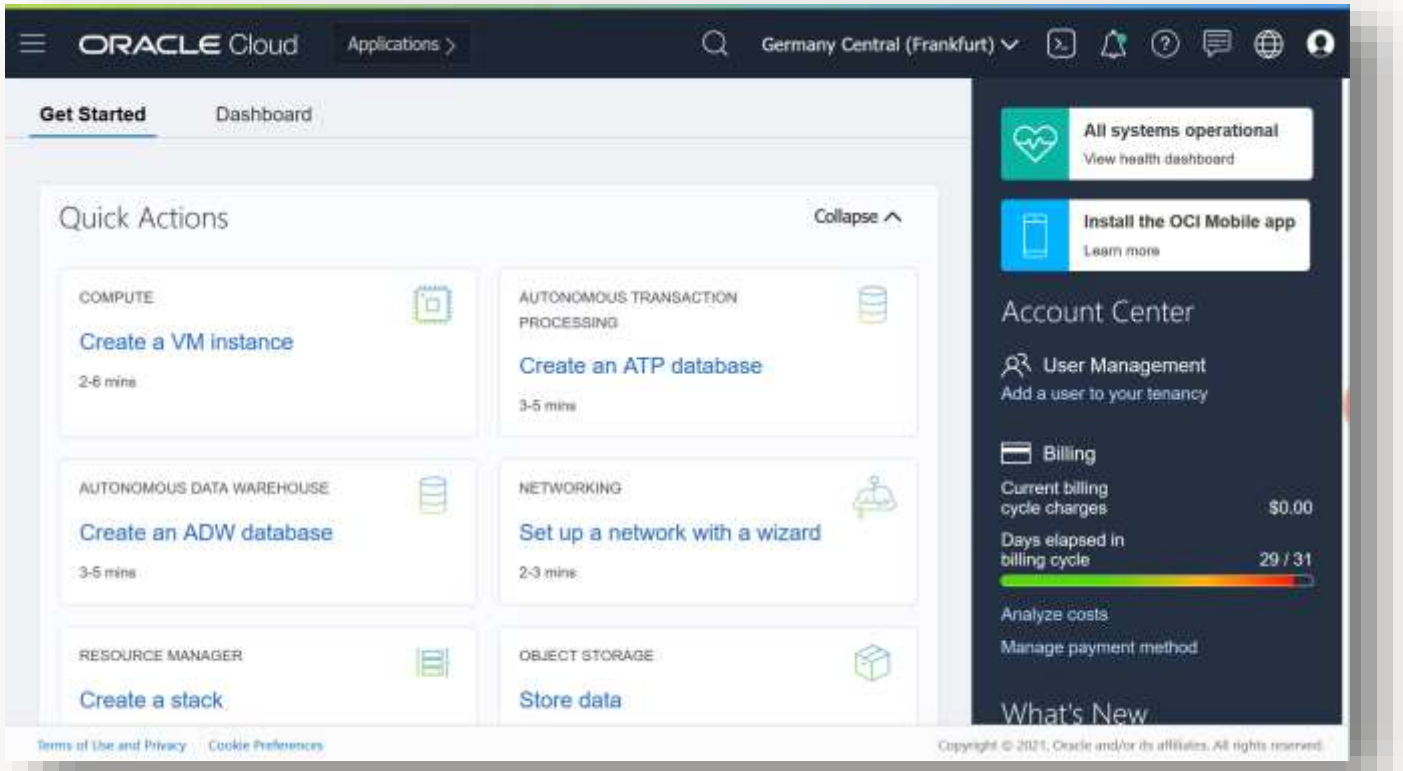
OCI GoldenGate | Architecture



OCI GoldenGate | Overview

	GoldenGate	GG OCI Marketplace	OCI GoldenGate
Solution Management			
Create and Manage GoldenGate Deployments	<-------- customer responsibility -------->		
Platform Services			
Oracle Cloud Automations	*Not Available*	*Not Available*	Oracle Managed
Automatic Scaling (up to 3x)			
OCI Monitoring / Service Telemetry			
Metering and Billing per second			
Full REST API for Control Plane and Data Plane	Customer Managed	Customer Managed	
Disaster Recovery, Backup and Restore			
Upgrades and Patching			
Private Endpoints and Secure Vault			
Wallet Integration w/Autonomous DB			
Operating System Administration			
Infrastructure Management			
Virtualization & Terraform Stack Automation	Customer Provided	Oracle Provided	Oracle Provided
Install / Rapid Provisioning			
Server Administration			
Storage and Durability Guarantees			
Core Networking			

OCI GoldenGate | Cloud Native



Watch on YouTube

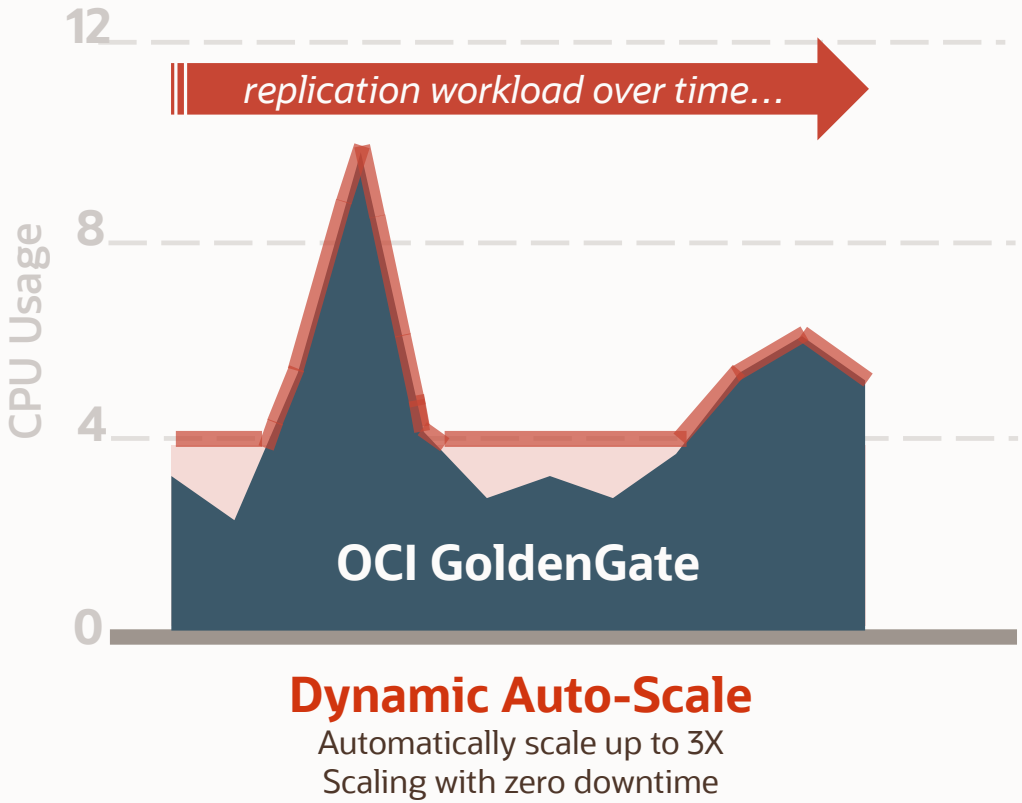
OCI GoldenGate | Auto scaling

Same experience as Autonomous Database

- Choose a base size
- Turn on auto scale feature
- Automatic 3x scaling factor

Pay only for what you use

- Scaling happens online / no downtime
- Per-second billing



Dynamic Auto-Scale

Automatically scale up to 3X
Scaling with zero downtime

OCI GoldenGate | Recommended sizing

Development / Trials

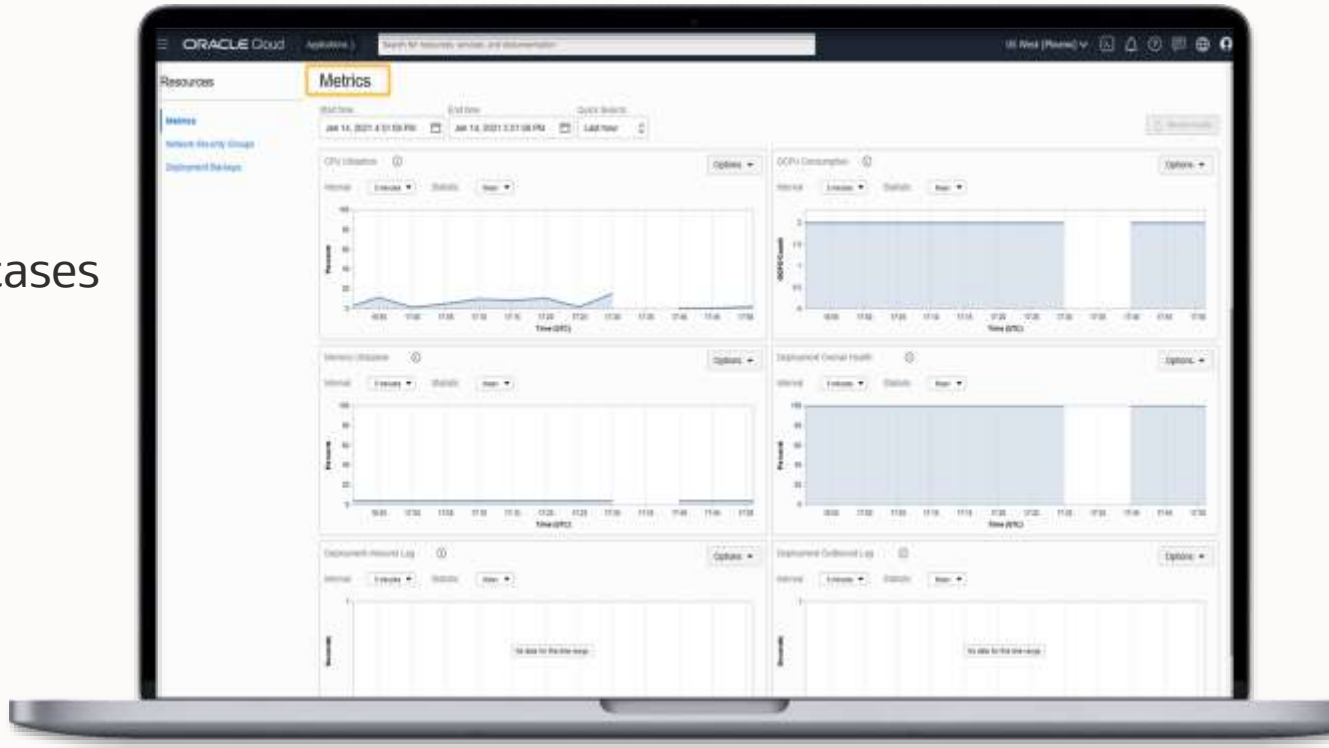
- Start with 1 OCPU and Auto-scale on

Typical production use cases

- 4 OCPU with Auto-scale, covers 80% of use cases
- Cover >60GB/hr of DB Redo

Extreme scale and performance

- 8 OCPU with Auto-scale to 24 OCPU
- Up to:
    - 24 GB of memory
    - 24 Gbps network
    - 6TB of storage



Easily manage OCI-GG deployments from your console

OCI GoldenGate and on-prem databases?

Probably not …

Unless you have a lightning-fast connection
and your database is physically close to OCI

OCI GoldenGate | Network recommendations

Running Oracle GoldenGate remotely

Network round trip ping time:

Extract	less than 80 ms
Replicat	less than 5 ms

Bandwidth:

Integrated Extract - only the changes to tables that are being captured will be sent to the Extract process itself

GoldenGate | Additional Resources

Certifications

GoldenGate 19.1: Using Oracle GoldenGate on Oracle Cloud Marketplace

OCI Marketplace: Oracle GoldenGate for Oracle

Oracle GoldenGate Best Practices: Instantiation from an Oracle Source Database (Doc ID 1276058.1)

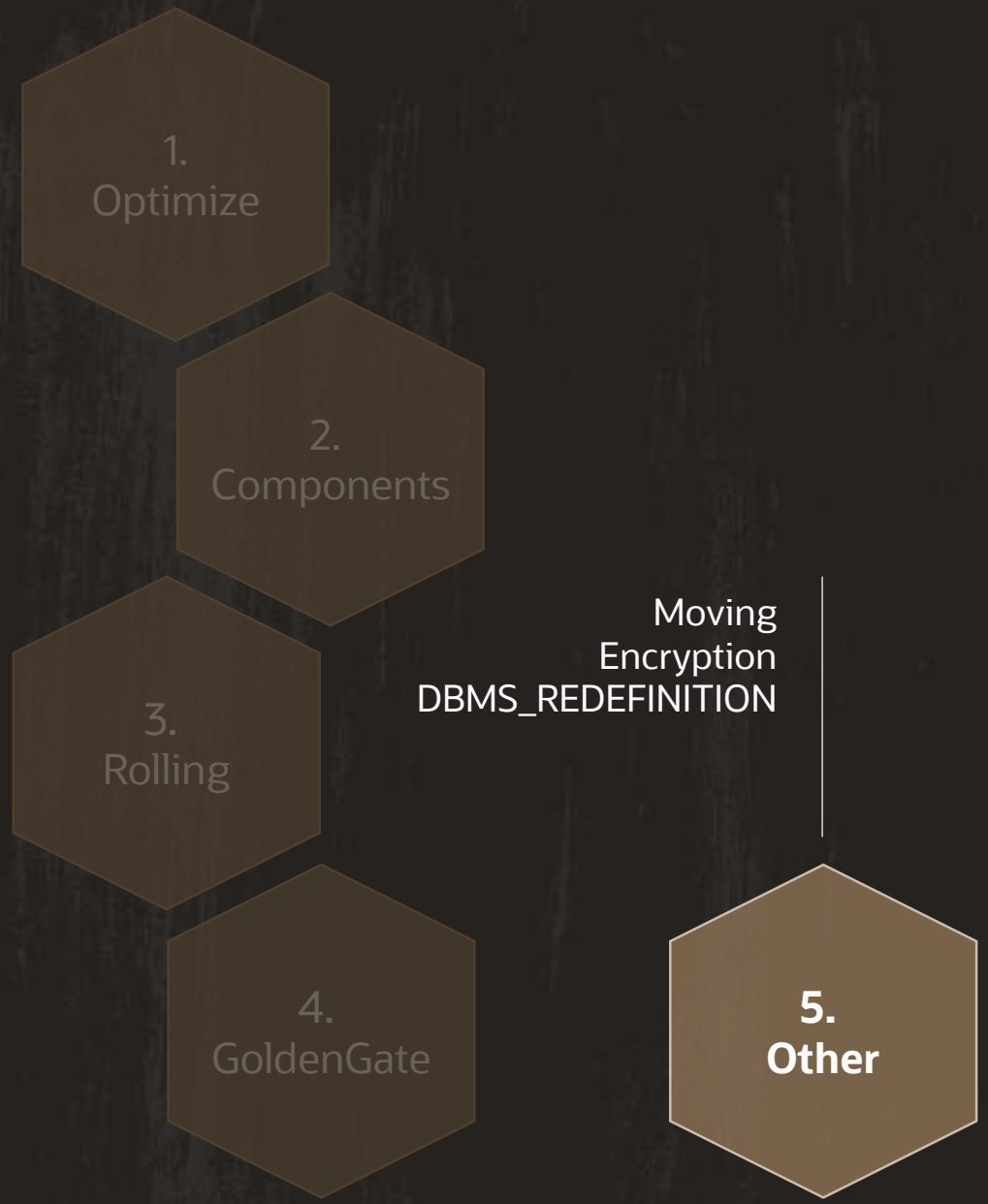
GoldenGate | Technical Briefs

Oracle Database Migration with an Oracle GoldenGate Hub Configuration

Zero Downtime Database Upgrade Using Oracle GoldenGate

Oracle GoldenGate with Oracle RAC Configuration Best Practices

Transparent Role Transitions With Oracle Data Guard and Oracle GoldenGate



Online Data File Move

Online Data File Move | Overview

Rename:

```
SQL> ALTER DATABASE
     MOVE DATAFILE '/u01/oracle/rbdb1/user1.dbf'
     TO            '/u01/oracle/rbdb1/user01.dbf';
```

Relocate to ASM:

```
SQL> ALTER DATABASE
     MOVE DATAFILE '/u01/oracle/rbdb1/user1.dbf'
     TO            '+DATA';
```

Pro tip: Works for `SYSTEM`, `UNDO` and `SYSAUX` as well.

Online Data File Move | Overview

Generate OMF name:

```
SQL> ALTER DATABASE
     MOVE DATAFILE 12;
```

Pro tip: On 12.1 and 12.2 be aware of bug 24836489: DATAFILES ARE CREATED WRONG LOCATION IN OMF DEFINED PDB DATABASE

Online Data File Move | Overview

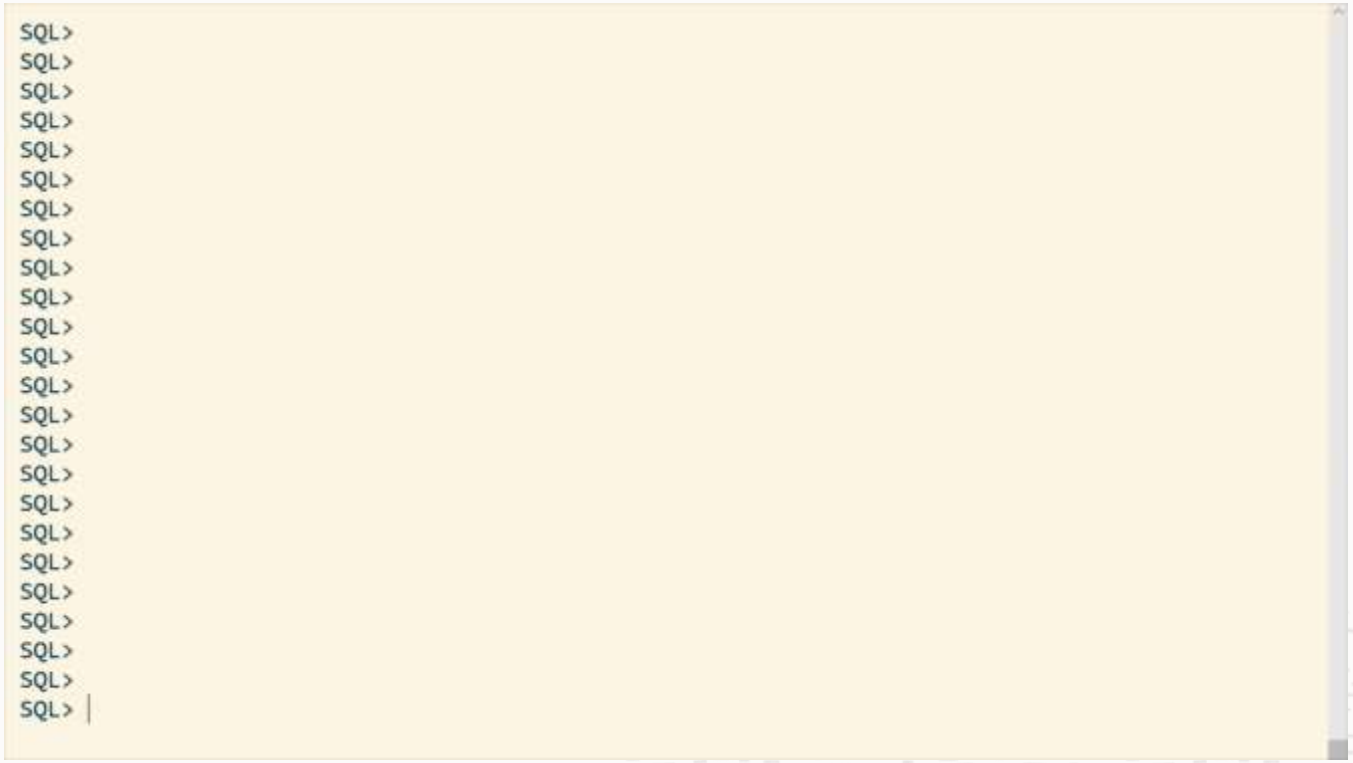
Only works for data files
that belong to the current container

Data file is copied block-by-block

- Physical file size remains the same
- High Water Mark is not affected

Documentation: Concept and syntax

Online Data File Move | Demo



Watch on YouTube

Online Table Move

Online Table Move | Overview

Move table:

```
SQL> alter table lots_of_data move online tablespace users;
```

In parallel:

```
SQL> alter table lots_of_data move online tablespace users parallel 4;
```

Pro tip: Requires a short lock at the end of the operation

Online Table Move | Overview

Indexes remain `VALID` during and after online move

Optionally, change index as well:

```
SQL> alter table lots_of_data
     move online tablespace users
     update indexes(i1 tablespace users);
```

Pro tip: You can also move IOTs online, but not partitioned IOTs

Online Table Move | Overview

To also move LOB segments:

```
SQL> alter table lots_of_data
     move online tablespace users
     lob(clob1) store as (tablespace users);
```

Pro tip: Unused columns are preserved during a move operation

Online Table Move | Overview

Compress:

```
SQL> alter table lots_of_data
     move online tablespace users
     row store compress advanced;
```

Uncompress:

```
SQL> alter table lots_of_data
     move online tablespace users
     nocompress;
```

Documentation: Syntax

Pro tip: You can also move individual partitions of a partitioned table

Online Table Move | Overview

Caution:

- Move invalidates statistics
- ROWIDs change
- Free space needed

Online Table Move | Demo

```
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
```

Watch on YouTube

Online Convert to Partitioned Table | Overview

Convert:

```
SQL> alter table lots_of_data
     modify partition by hash (object_id) partitions 8
     online
     update indexes (i_lots_of_data global);
```

Does not work for an already partitioned table

Pro tip: Number of hash partitions should always be power of 2

Documentation: Syntax and partition options

Online Convert to Partitioned Table | Demo

```
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
SQL>
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SQL>
SQL>
SQL>
SQL>
```

Watch on YouTube

Online Encryption

Online Encryption | Overview

Online encryption of existing database tablespace files

- `alter tablespace <tbs> encryption online encrypt;`
- Storage overhead: 2x largest file of tbs

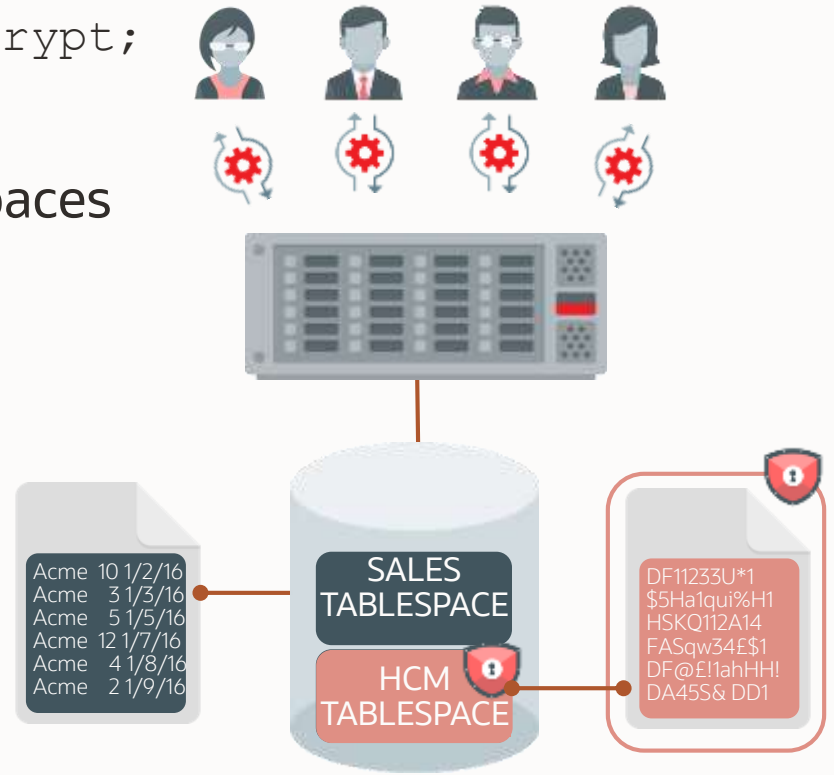
Full encryption of SYSTEM, SYSAUX, and UNDO tablespaces

- Not recommended

Offline tablespace encryption

- No storage overhead

RMAN decrypted restore with 18c



Online Encryption | Step By Step

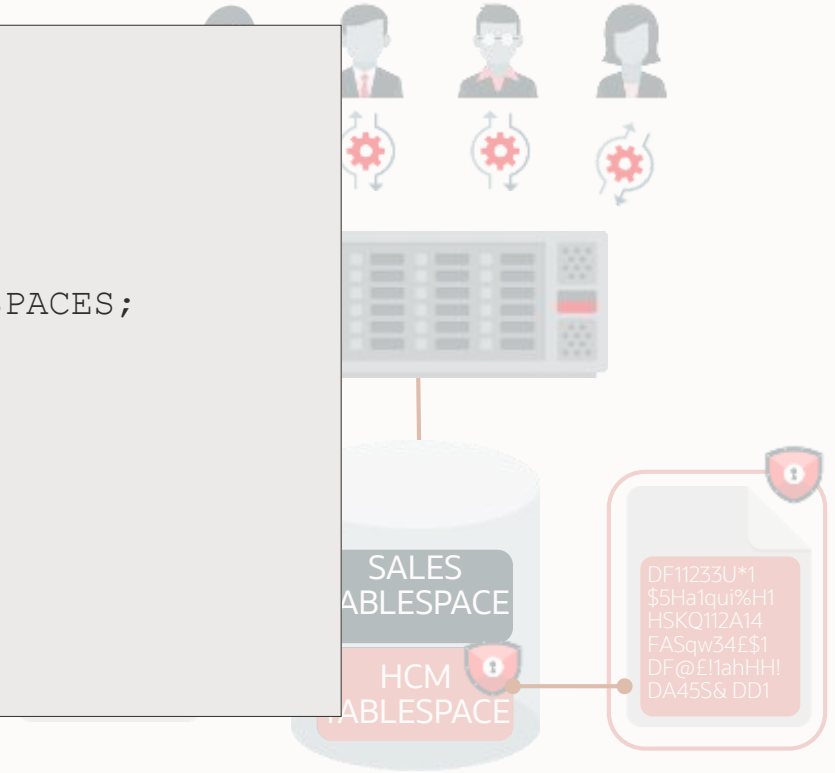
6. Encrypt Tablespaces Online

```
alter session set container=PDB1;

alter tablespace TEST encryption online encrypt;


select TABLESPACE_NAME, STATUS, ENCRYPTED from DBA_TABLESPACES;

TABLESPACE_NAME        STATUS    ENC
---------------------- --------- ---
SYSTEM                 ONLINE    NO
SYSAUX                 ONLINE    NO
UNDOTBS1               ONLINE    NO
TEMP                   ONLINE    NO
TEST                   ONLINE    YES
```



Online Encryption | Step By Step

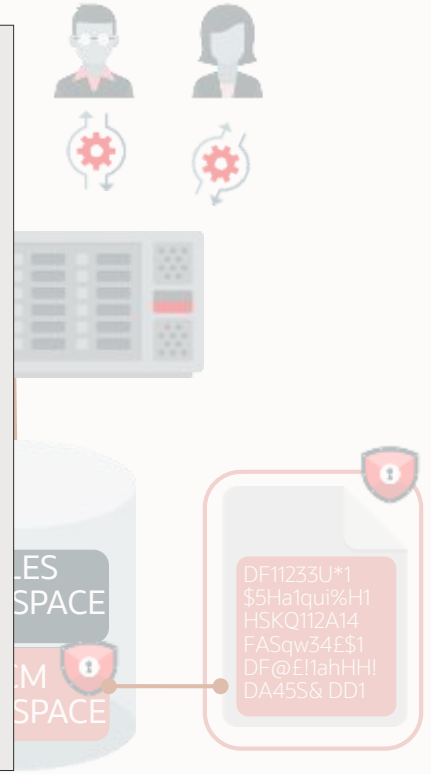
7. Encrypt New Tablespaces

```
alter system set ENCRYPT_NEW_TABLESPACES=ALWAYS scope=both;

create tablespace FUTURE datafile '/u02/oradata/CDB2/pdb1/future01.dbf'
 size 100M autoextend on online;


select TABLESPACE_NAME, STATUS, ENCRYPTED from DBA_TABLESPACES;

TABLESPACE_NAME        STATUS    ENC
---------------------- --------- ---
SYSTEM                 ONLINE    NO
SYSAUX                 ONLINE    NO
UNDOTBS1               ONLINE    NO
TEMP                   ONLINE    NO
TEST                   ONLINE    YES
FUTURE                 ONLINE    YES
```



Online Encryption | Demo

Watch on YouTube

DBMS_REDEFINITION

DBMS_REDEFINITION | Concept

> *You can redefine tables online with the DBMS_REDEFINITION package.*
>
> *... it is accessible to both queries and DML during much of the redefinition process. Typically, the table is locked in the exclusive mode only during a very small window ...*

Database 19c Administrator'sGuide

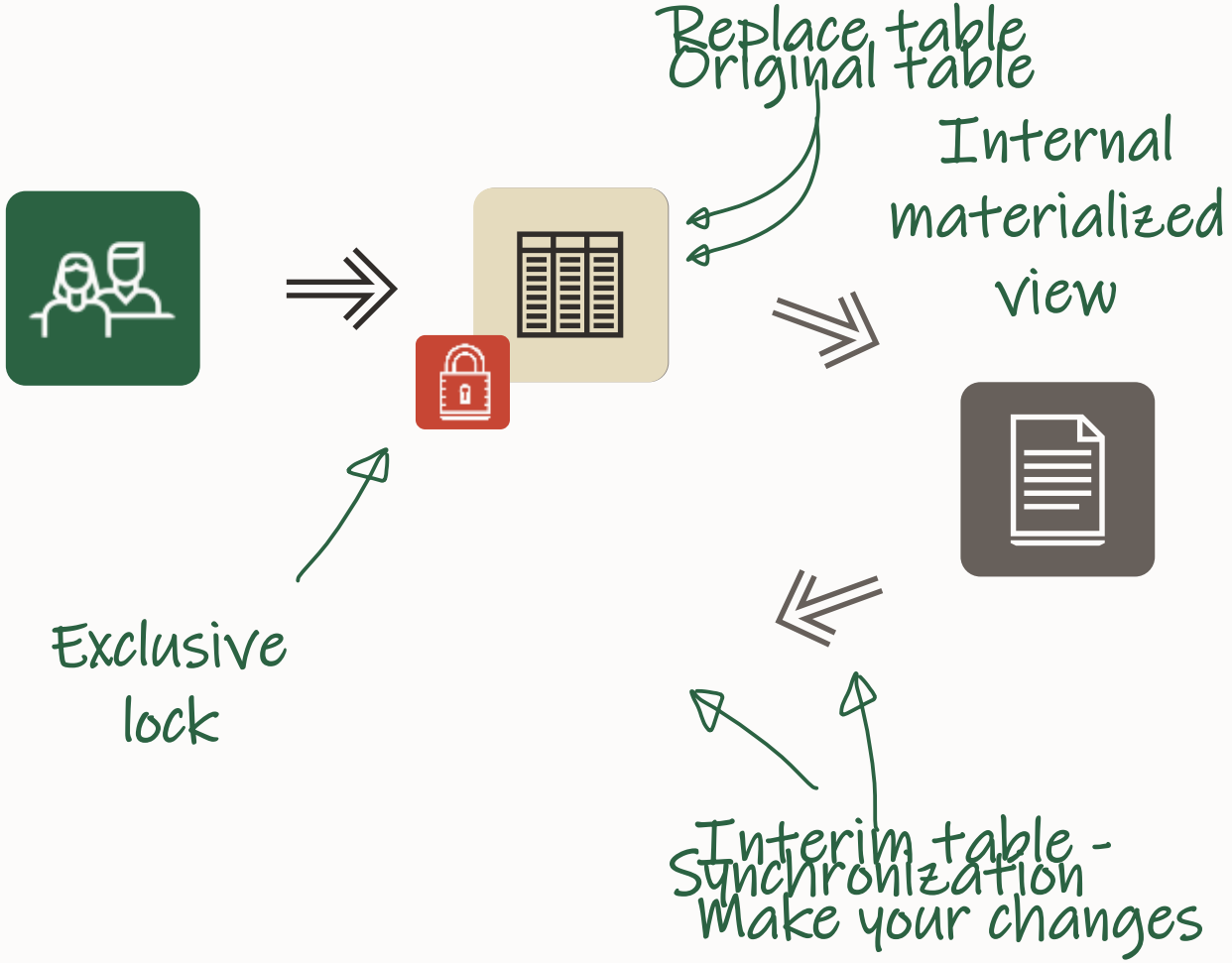
- Lock duration independent of table size
- Requires Enterprise Edition
- Use for bulk updates as well

DBMS_REDEFINITION | Use Cases

Some of the use cases:

- Convert BasicFile LOBs to SecureFile LOBs
- Modify the storage parameters of a table
- Add, modify, or drop one or more columns
- Add or drop partitioning support
- Change partition structure
- Convert to IOT (or reverse)
- Add attribute clustering to a table
- Optimized bulk updates
- … plus, more in the documentation

DBMS_REDEFINITION | Concept



DBMS_REDEFINITION | Benefits

In case of failures the redefinition process is often resumable

Pro tip: For more information about restarting, check the documentation

DBMS_REDEFINITION | Benefits

You can roll back the redefinition process, even after it has successfully completed

Pro tip: Rollbacks are described in detail in the documentation

DBMS_REDEFINITION | Considerations

Requires space to hold a copy of the table

DBMS_REDEFINITION | Considerations

Increased redo generation affects
Fast Recovery Area, backups and standby redo apply

DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
```


DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
SQL> create table interim_table ( ...
```

Pro tip: Use `DBMS_METADATA.GET_DDL` to create the interim table

DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
SQL> create table interim_table ( ...
SQL> exec dbms_redefinition.start_redef_table( ...
```

Pro tip: Speed up this step by enabling parallel query and DML in the session

DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
SQL> create table interim_table ( ...
SQL> exec dbms_redefinition.start_redef_table( ...
SQL> exec dbms_redefinition.sync_interim_table( ...
```

Pro tip: The more you run this procedure, the less time the final lock will need

DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
SQL> create table interim_table ( ...
SQL> exec dbms_redefinition.start_redef_table( ...
SQL> exec dbms_redefinition.sync_interim_table( ...
SQL> exec dbms_redefinition.copy_table_dependents( ...
```

Pro tip: You can also do this manually

DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
SQL> create table interim_table ( ...
SQL> exec dbms_redefinition.start_redef_table( ...
SQL> exec dbms_redefinition.sync_interim_table( ...
SQL> exec dbms_redefinition.copy_table_dependents( ...
SQL> select * from dba_redefinition_errors;
```


DBMS_REDEFINITION | Example

```
SQL> exec dbms_redefinition.can_redef_table( ...
SQL> create table interim_table ( ...
SQL> exec dbms_redefinition.start_redef_table( ...
SQL> exec dbms_redefinition.sync_interim_table( ...
SQL> exec dbms_redefinition.copy_table_dependents( ...
SQL> select * from dba_redefinition_errors;
SQL> exec dbms_redefinition.finish_redef_table( ...
```

Pro tip: The original table is shortly locked during this phase

DBMS_REDEFINITION | Considerations

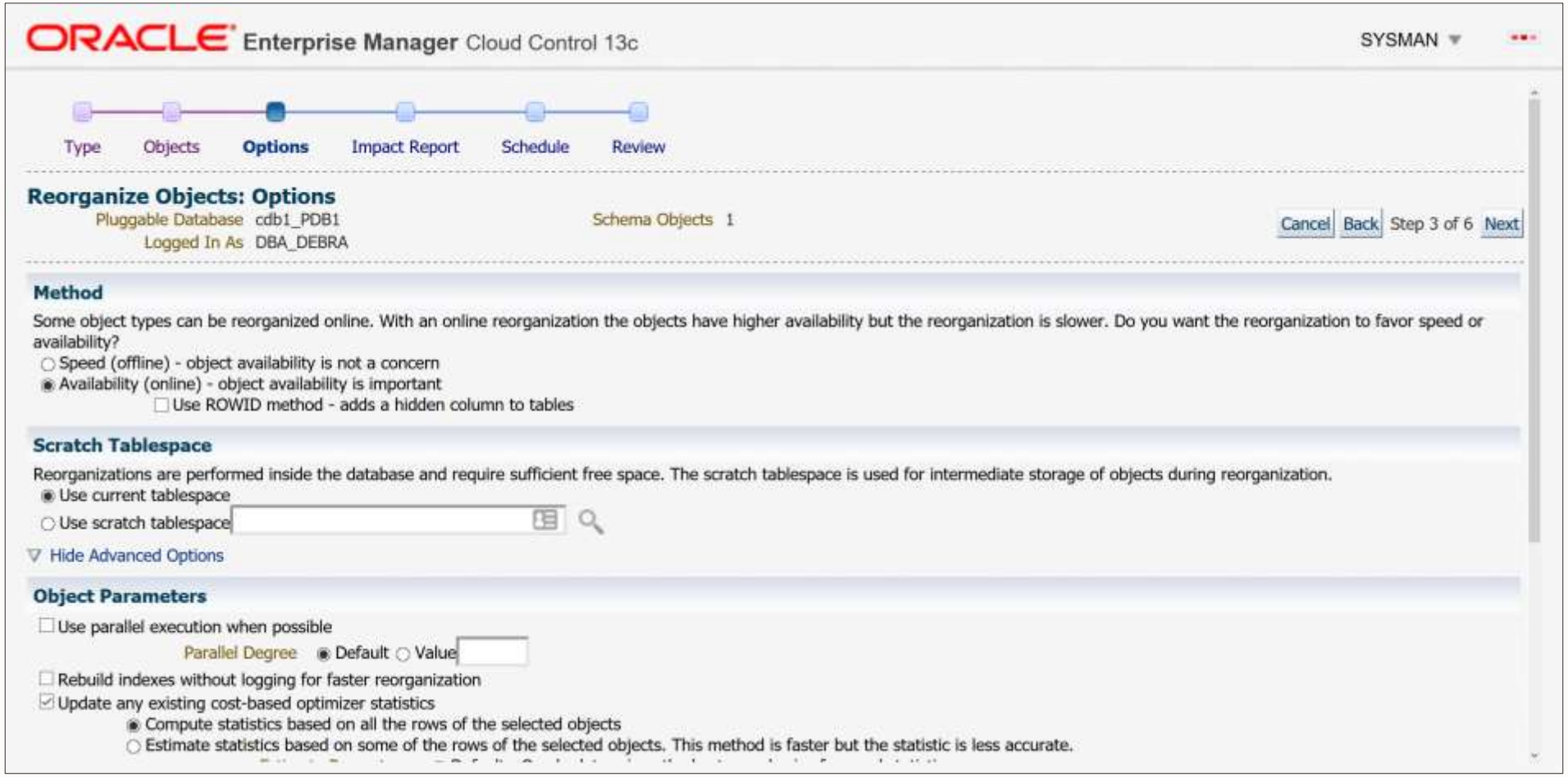
Statistics can be copied from source table.
Optionally, gather statistics using `DBMS_STATS`

DBMS_REDEFINITION | Easy

One button approach:

```
DBMS_REDEFINITION.REDEF_TABLE
```

DBMS_REDEFINITION | Enterprise Manager



DBMS_REDEFINITION | Nice To Know

Documentation:

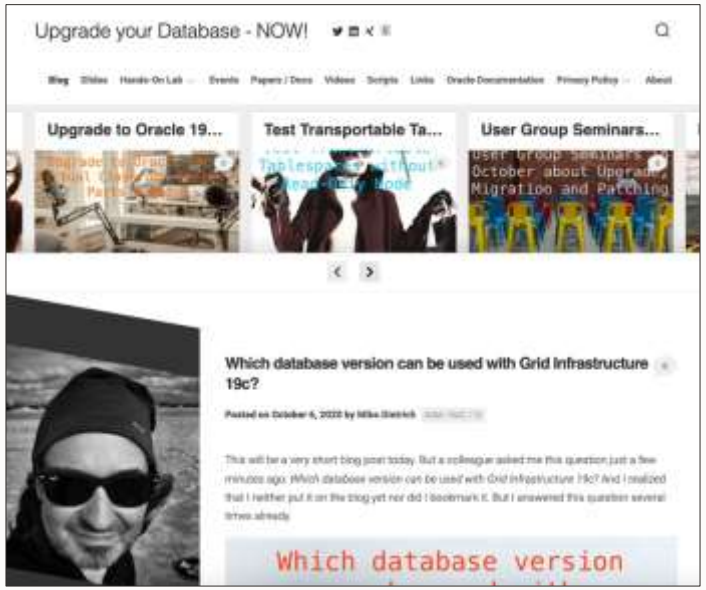
- Redefining Tables Online, Database Administrator's Guide 19c

Views:

- `V$ONLINE_REDEF`
- `DBA_REDEFINITION_STATUS`

Visit our Blogs

https://MikeDietrichDE.com



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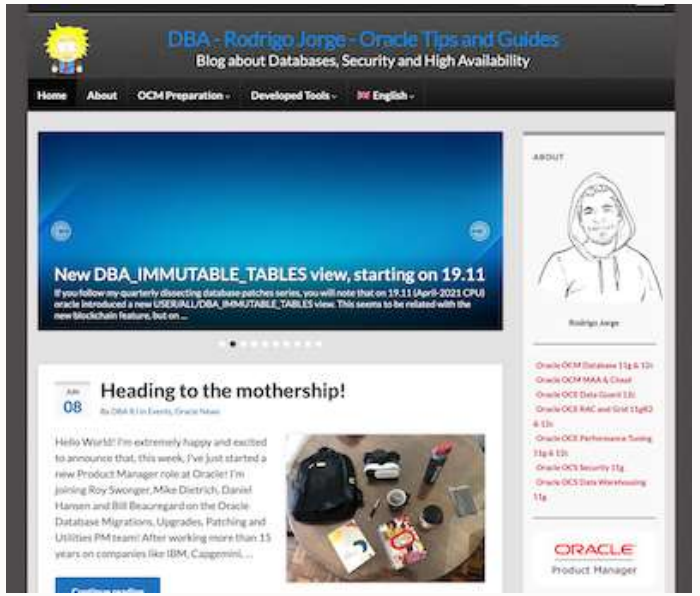

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Release and Patching Strategy

105 minutes – Feb 4, 2021

NEW Episode 2

AutoUpgrade to Oracle Database 19c

115 minutes – Feb 20, 2021

NEW Episode 3

Performance Stability, Tips and Tricks and Underscores

120 minutes – Mar 4, 2021

NEW Episode 4

Migration to Oracle Multitenant

120 minutes – Mar 16, 2021

NEW Seminar 5

Migration Strategies – Insights, Tips and Secrets

120 minutes – Mar 25, 2021

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Move to the Cloud – Not only for techies

115 minutes – Apr 8, 2021

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110 minutes – Jan 14, 2021

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Database Upgrade Internals – and so much more

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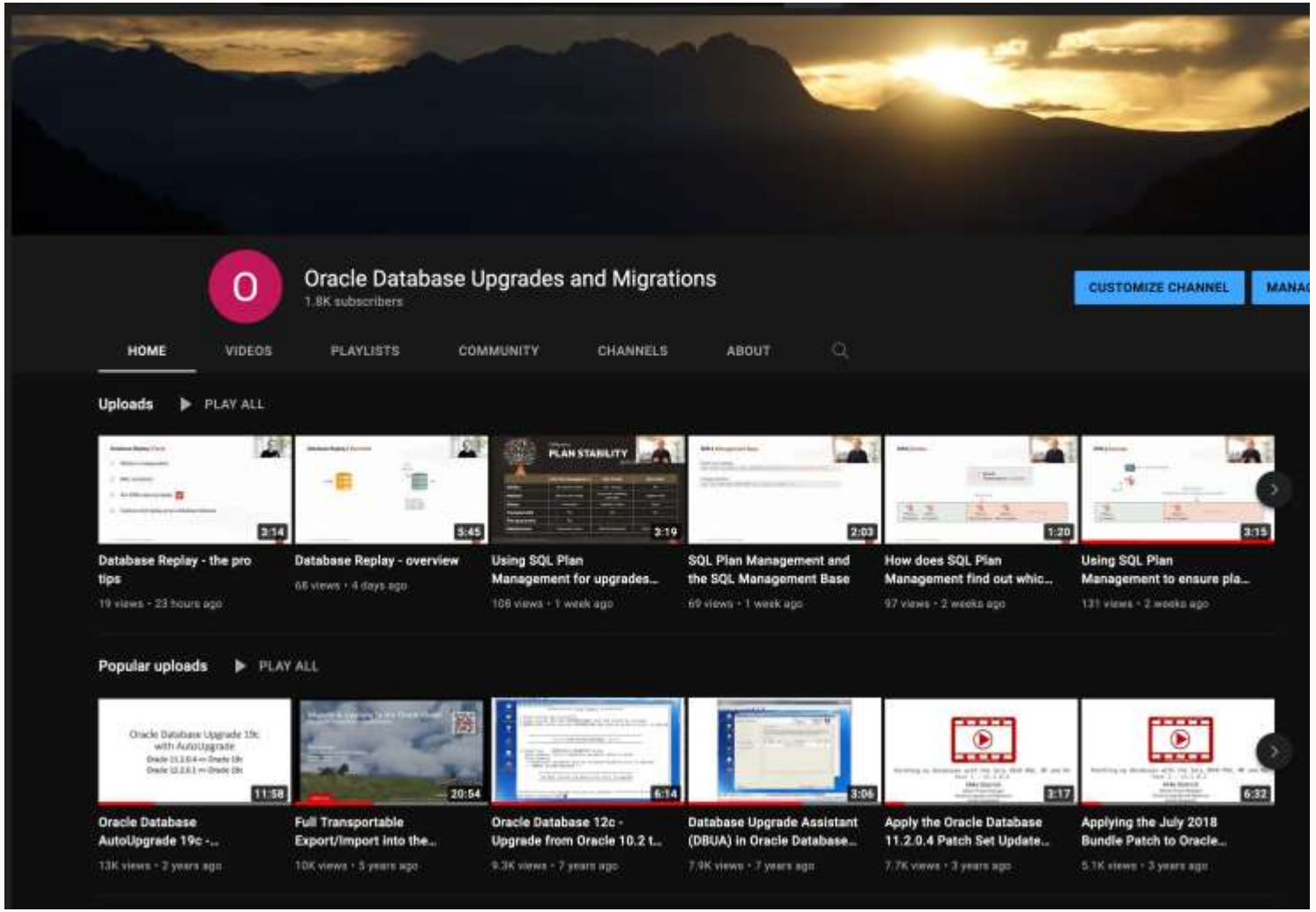

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Thank you!