



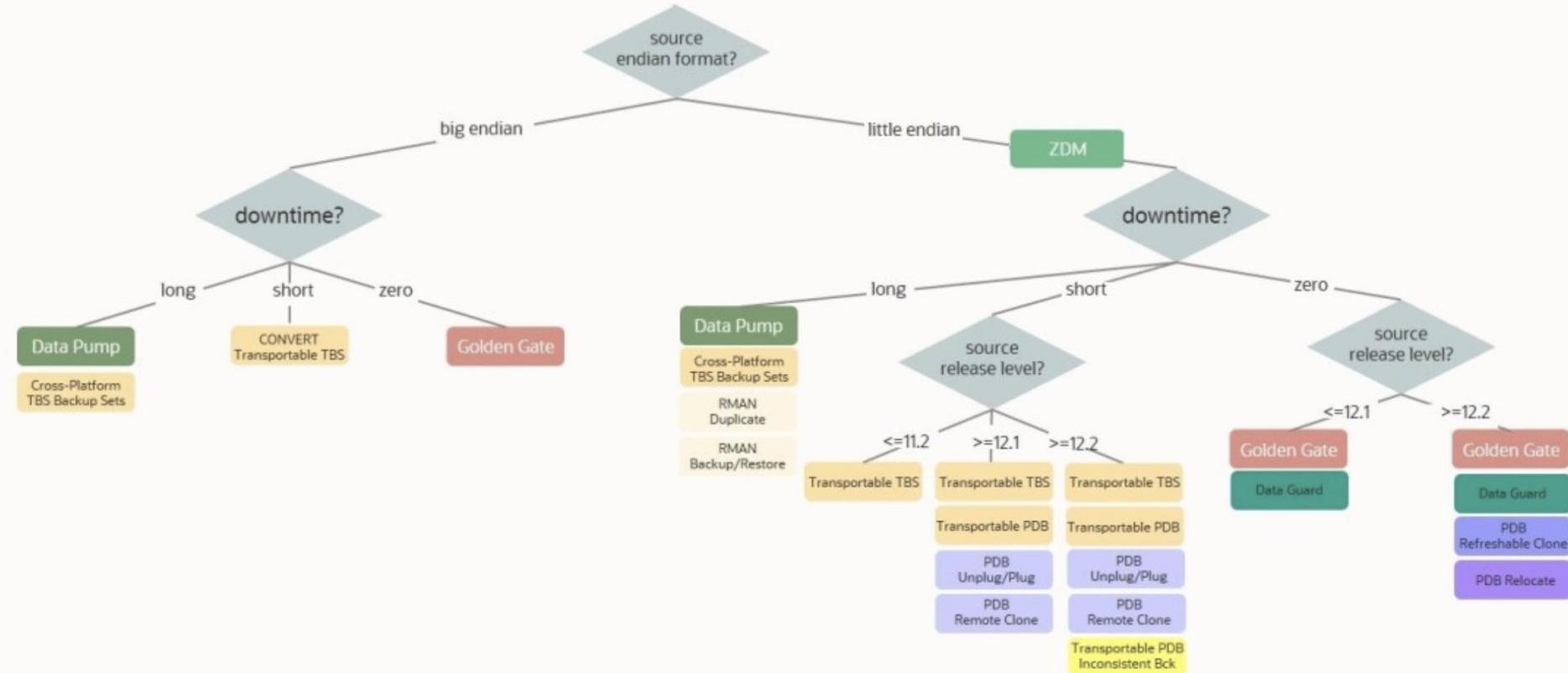
Migrating Databases to ExaCC

Various Methodologies

Alexandre Fagundes

LAD Partner Enablement

Database Migration Decision Tree



Migration requirements and constraints

What you should know before you design a migration strategy...

| Source Database | Target Database | Runtime Constraints |
|--|---|---|
| <ul style="list-style-type: none">• Database version• Database size and number of database tables• Workload Type• Usage and performance requirements• Single/Multi-tenant Architecture• Endian format• Character set | <ul style="list-style-type: none">• Database Type• Database version• HA and DR requirements | <ul style="list-style-type: none">• Bandwidth and Connectivity• Fallback Capability• Down-time requirements for migration• Project resources available for migration |

Oracle Database Migration Solutions

An optimum migration solution from every source database to any target database on OCI

On premises,
public clouds:

ORACLE®
Database 11g

ORACLE®
Database 12c

ORACLE®
Database 18c

ORACLE®
Database 19c

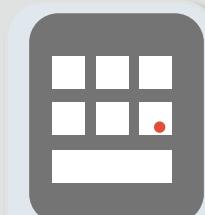
ORACLE®
on
EC2

ORACLE®
on
RDS

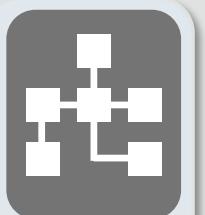
Migration
resources:

- Offline: **Data Pump** (create an exact copy from OnPrem to any target DB)
- Online: **Zero Downtime Migration *** (live sync on-prem to cloud DB)
- Many additional DB Migration Tools for other specific use cases
- Available Oracle consultative options to ensure migration success

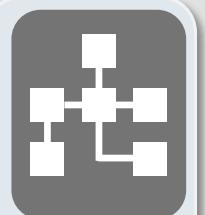
Oracle Cloud
Database options:



ORACLE
Cloud
Infrastructure
Compute /
Storage



ORACLE
Database
Cloud Service
Virtual
Machines



ORACLE
Database
Cloud Service
Bare
Metal



ORACLE
Exadata
Cloud Service



ORACLE
Autonomous
Database
Transaction
Processing



ORACLE
Autonomous
Database
Data
Warehouse

Migration Methods and Tools

What Is the tool?

- ▶ ZDM is Oracle MAA recommended solution that provides a robust, flexible and resumable migration with fallback capability
- ▶ MV2ADB is a utility to migrate data from any source to Autonomous database (ATP and ADW)
- ▶ Plug/Unplug Method can be used when you are moving from a Single Tenant to a multi-tenant Database architecture
- ▶ RMAN tool is available for performing and managing Oracle Database backups, clones, duplications and restorations.
- ▶ Oracle Data Pump provides high performance Export and Import utilities for migrating databases

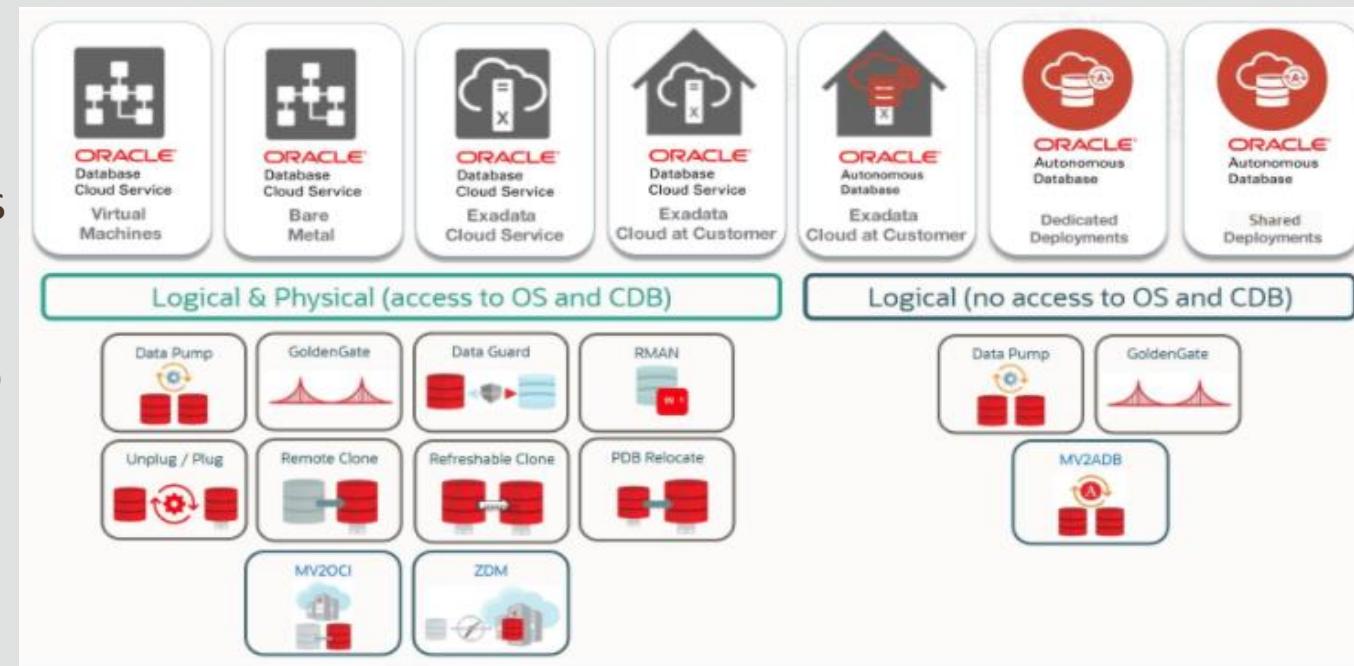
Why Do we use it?

- Migrate to OCI DB, ExaCS or ExaCC
- Source DB 11.2.0.4 or higher
- Small to Large DB
- Zero Downtime
- Structured unstructured data
- CSV, Parquet, AVRO and Dump Files of Database and Tables
- Migrate to Multi-tenant Architecture
- Uses RMAN, Data Pump or other tools to migrate
- Small to Large DB
- Migrate to OCI DB (VM and BM), ExaCS or ExaCC
- Source DB 11.2.0.4 or higher
- Small to Large DB
- Migrate to OCI DB (VM and BM), ExaCS or ExaCC
- Source DB 11.2.0.4 or higher
- Small to Large DB

Oracle Database Migration - Logical vs Physical Database Migration

Depending on your target database system in the cloud, you might be able to choose logical and/or physical migration methods:

- DBCS as target: logical or physical, as access to the underlying database infrastructure and root container databases is possible.
- Autonomous at target: logical, as there is no access to the operating system of the database machine and the root container database.



Zero Downtime Migration (ZDM)

Simple migration tool for lift and shift use cases

Source databases:

- CDB/PDB Databases 12c, 18c, 19c
- Non-CDB Databases 11g, 12c, 18c, 19c



OCI Target database:

- DBaaS VM, DBaaS BM, ExaCS, ExaCC
- Versions: 11g, 12c, 18c, 19c

When to use

- ✓ Free, easy to use tool
- ✓ Small to Large Database sizes
- ✓ Lift and Shift like to like versions
- ✓ Requires no downtime
- ⚠ In-Flight upgrade not possible
- ⚠ Cross-endian/ Cross-platform not possible



Simple



MAA Enabled



Enterprise fleet-
scale migrations



Free

Zero Downtime Migration (ZDM)

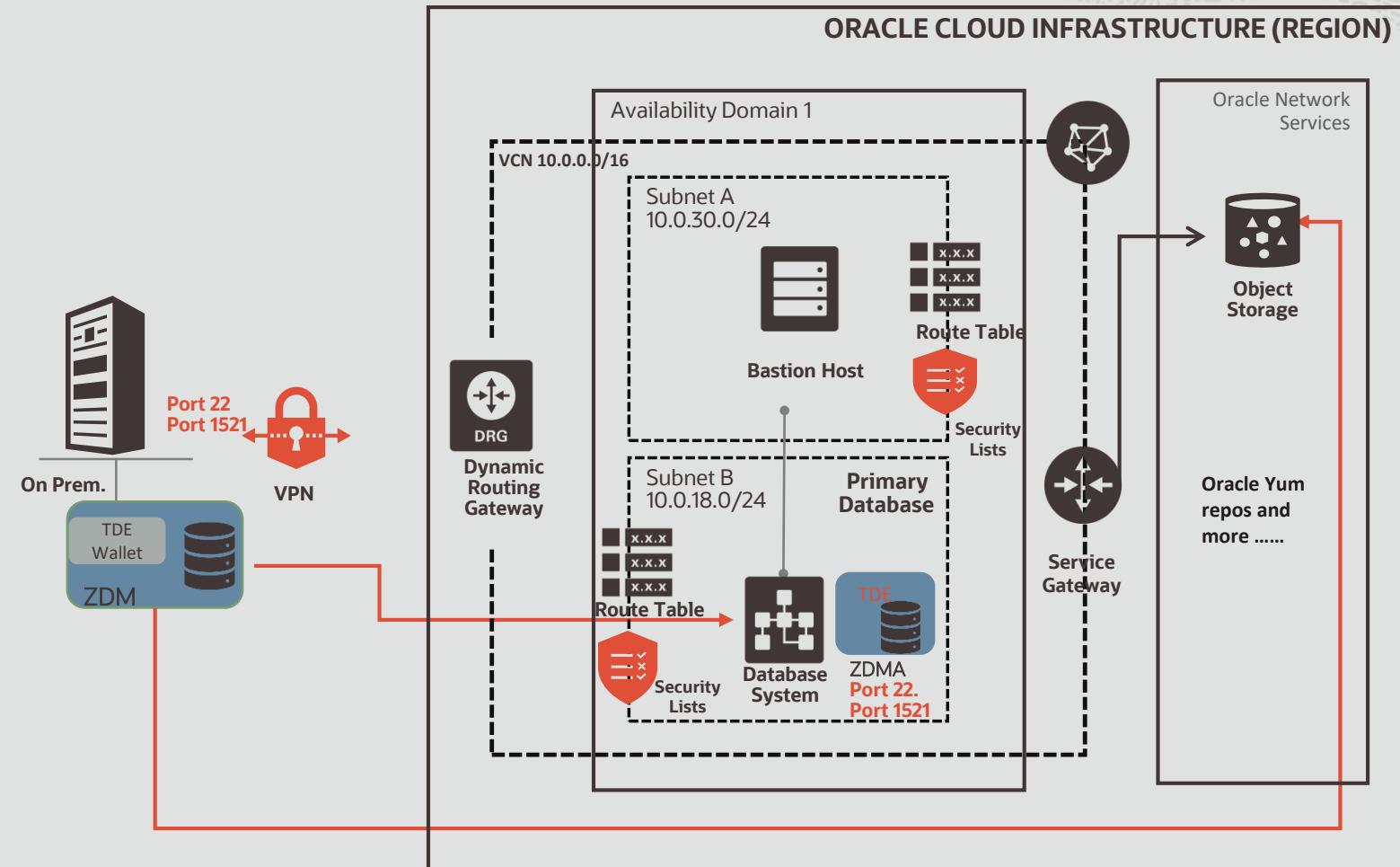
Features and Capabilities

- The source and target databases should be in the same database version
- ZDM supports Oracle Databases hosted on Linux operating systems
- Source database can be a **single** instance database migrating to a **single** instance or **RAC** database
- Oracle ZDM supports
 - Enterprise & Standard Edition Oracle Databases as source databases
 - Enterprise Edition Databases are migrated leveraging Oracle Data Guard
 - Standard Edition Databases are migrated in an offline manner using backup and restore method
- Allows for the source database to be a non-CDB or a CDB with one or more PDBs. If the source is a non-CDB, it will be migrated as a non-CDB
 - In case of a CDB with one or more PDBs, ZDM migrates it to a CDB with the same set of PDBs as in the source CDB

Migration Process using Zero Downtime Migration Tool

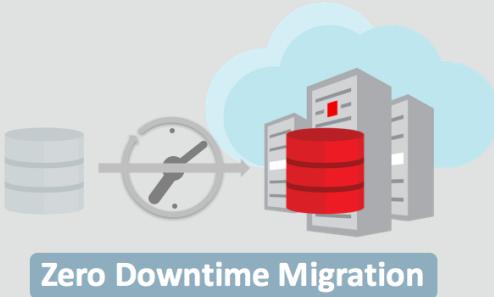
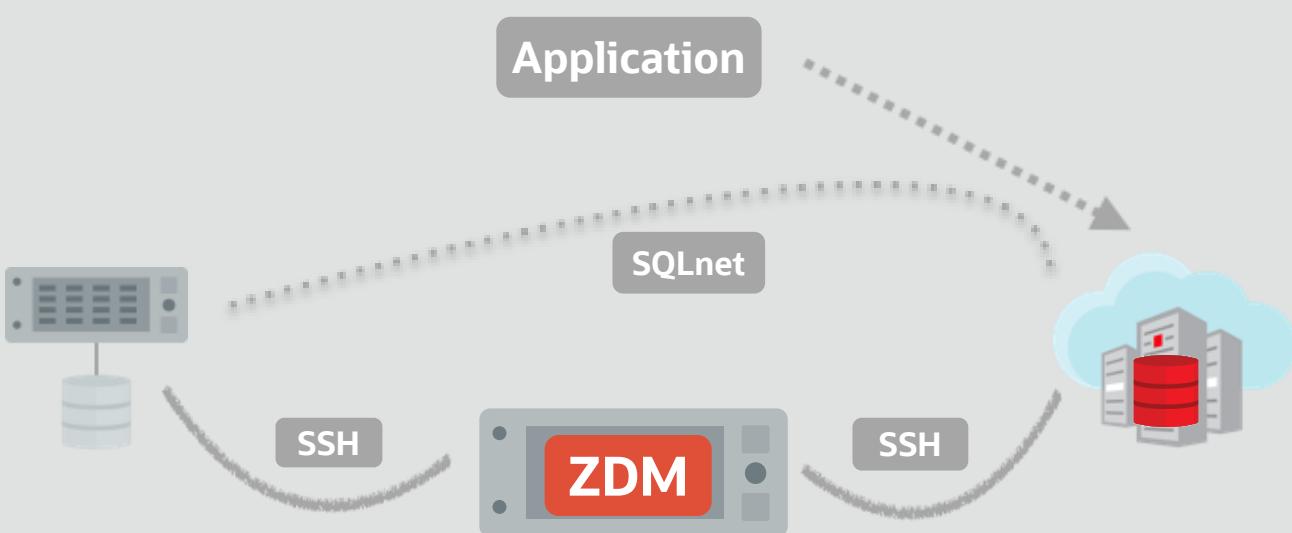
Migration Steps

1. Network Configuration
2. Installing ZDM Tool
3. Setting up communication
4. Checking Encryption Wallet
5. Configuring ZDM Tool
6. Migration pre-check
7. Migrate the Database



Zero Downtime Migration

Workflow



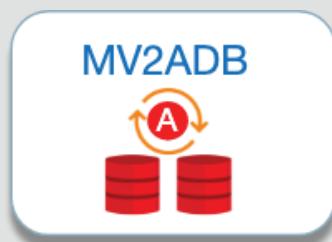
- 1 Migration Pre-check OK?**
- 2 Connects to Source & Target**
- 3 Connects to Object Storage**
- 4 Transfers DB Files**
- 5 Instantiates Standby**
- 6 Syncs Primary & Standby**
- 7 Switches Over & Role Swaps**
- 8 User Finalizes at Will**

MV2ADB

Migration tool for moving to Autonomous Database

Source databases:

- Oracle Database 11g, 12c, 18c, 19c



OCI Target database:

- Autonomous Data Warehouse (ADW)
- Autonomous Transaction Processing (ATP) – Dedicated or Shared
- Oracle 19c and above

When to use

- ✓ Free, easy to use tool
- ✓ Supports both OLTP and OLAP Workloads
- ✓ Small to Large Database sizes
- ✓ Allows in-flight upgrade to ADB versions
- ⚠ Requires some down-time
- ⚠ Only used to migrate to Autonomous Database



Simple



Interoperability
between versions



Enterprise fleet-
scale migrations



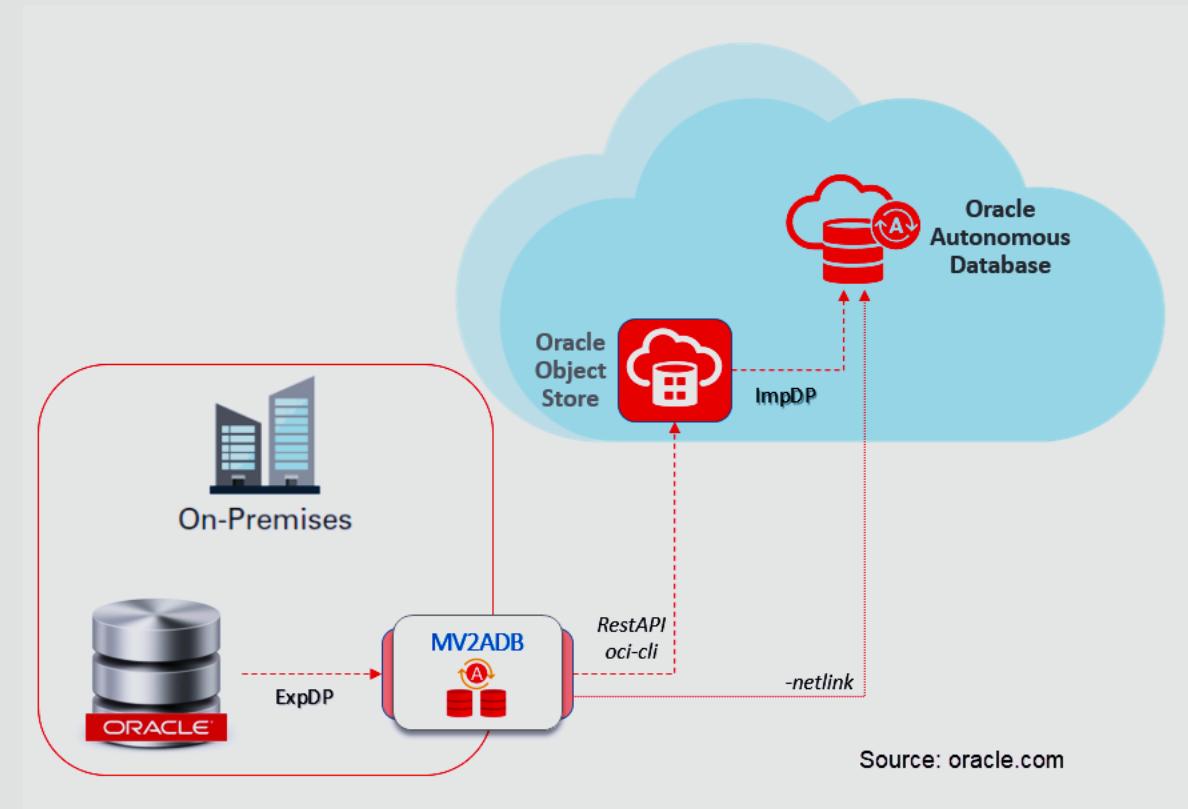
Free



MV2ADB

Features and Capabilities

- MV2ADB fully automates the process of migrating data from on-premise to ADB cloud on OCI
- MV2ADB available from MyOracle Support interface ([Note:2463574.1](#))
- MV2ADB tool with the **auto** option, it internally will run the **expdb**, **putdump** and **impdp** operations automatically
- Apart from MV2ADB there are other ways to loading Data into ADW by using
 - Import Data Using Oracle Data Pump
 - Load Data from Local Files with SQL Developer Web
 - DBMS_CLOUD provides support for loading data from text, Parquet, and Avro files in OCI Object Store
 - Load Data Pump dump files



Source: oracle.com

Reference Architecture MV2ADB

Migration Steps

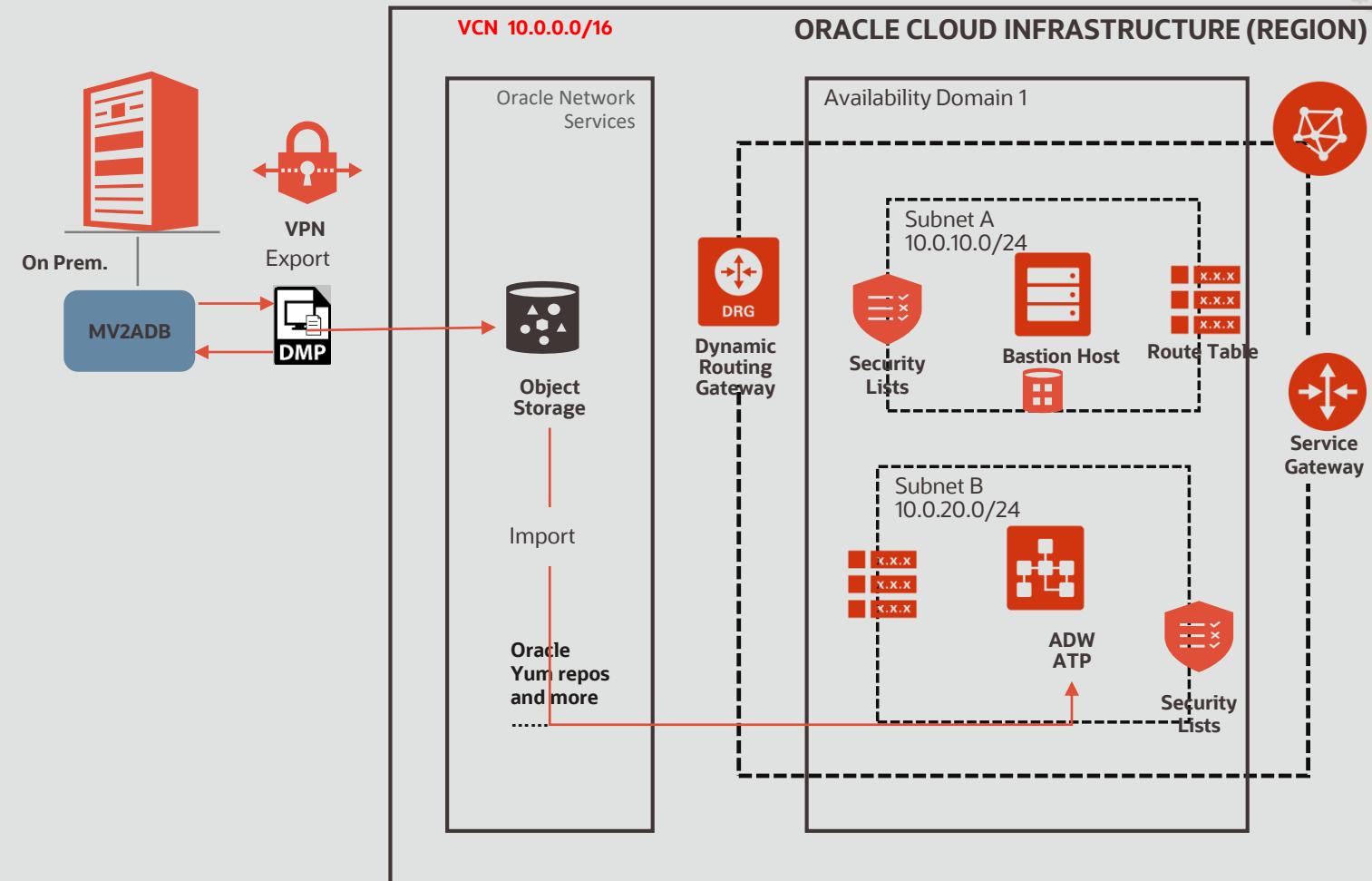
Migration is directed and executed on Source DB System

Source DB system Setup

- Install & Configure Oracle Instant Client
- Install & Configure OCI-Client
- Install & Configure MV2ADB tool
- Validate HTTPS and SQL connectivity between Source and OCI

Migration Process

- Export selected schemas from the source database
- Move the exported dump files to Object Store on OCI
- Import exported dump files into Autonomous Database instance on OCI



Plug/Unplug

Migration Methodology

Source databases:

- CDB Databases 18c, 19c
- Non-CDB or CDB Databases 12c
- Non-CDB Databases 11g (via Upgrade)



Target databases:

- DBaaS VM, DBaaS BM, ExaCS, ExaCC
- Versions: 12c, 18c, 19c

When to use

- ✓ Source DB is Little-endian
- ✓ Supports small to large databases
- ✓ Migrate from non-CDB to CDB
- ⚠ Requires knowledge of migration tools like RMAN and Data Pump
- ⚠ Requires some down-time
- ⚠ Upgrade before migrate for 11g and lower versions



Simple



Flexible
Architecture



Enterprise fleet-
scale migrations

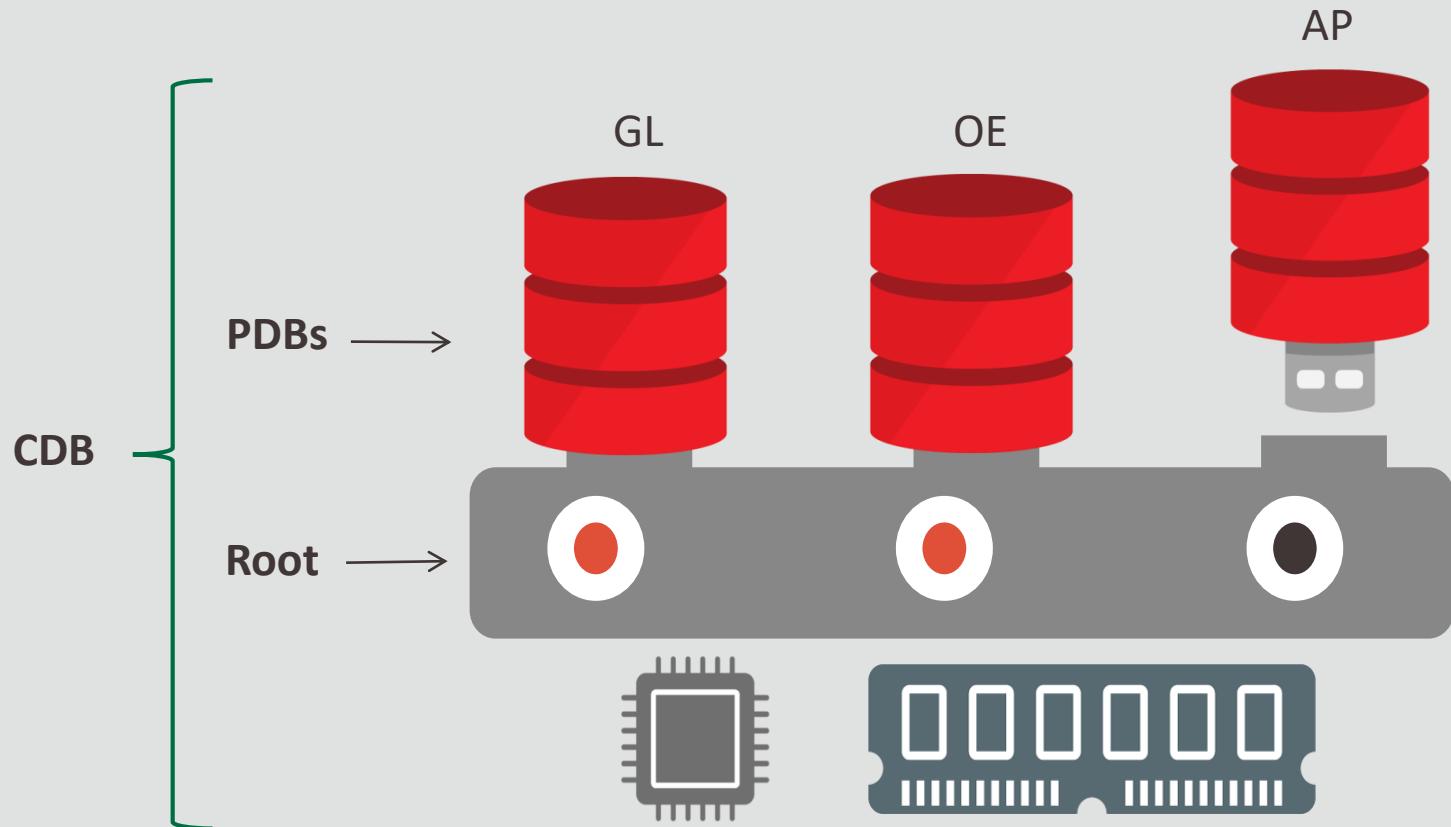


Free



Oracle Database Multitenant Architecture

Architecture for consolidating databases and simplifying operations



Self-contained PDB for each application

- Portability (via pluggability)
- Rapid provisioning (via clones)
- Applications run unchanged
- PDB upgrades via plug/unplug

Common operations performed at CDB level

- Manage many as one (upgrade, backups, HA)
- Granular control
- Simple DR

Shared memory and background processes

- More applications per server

MAA and Multitenant

- Solutions for planned / unplanned outages

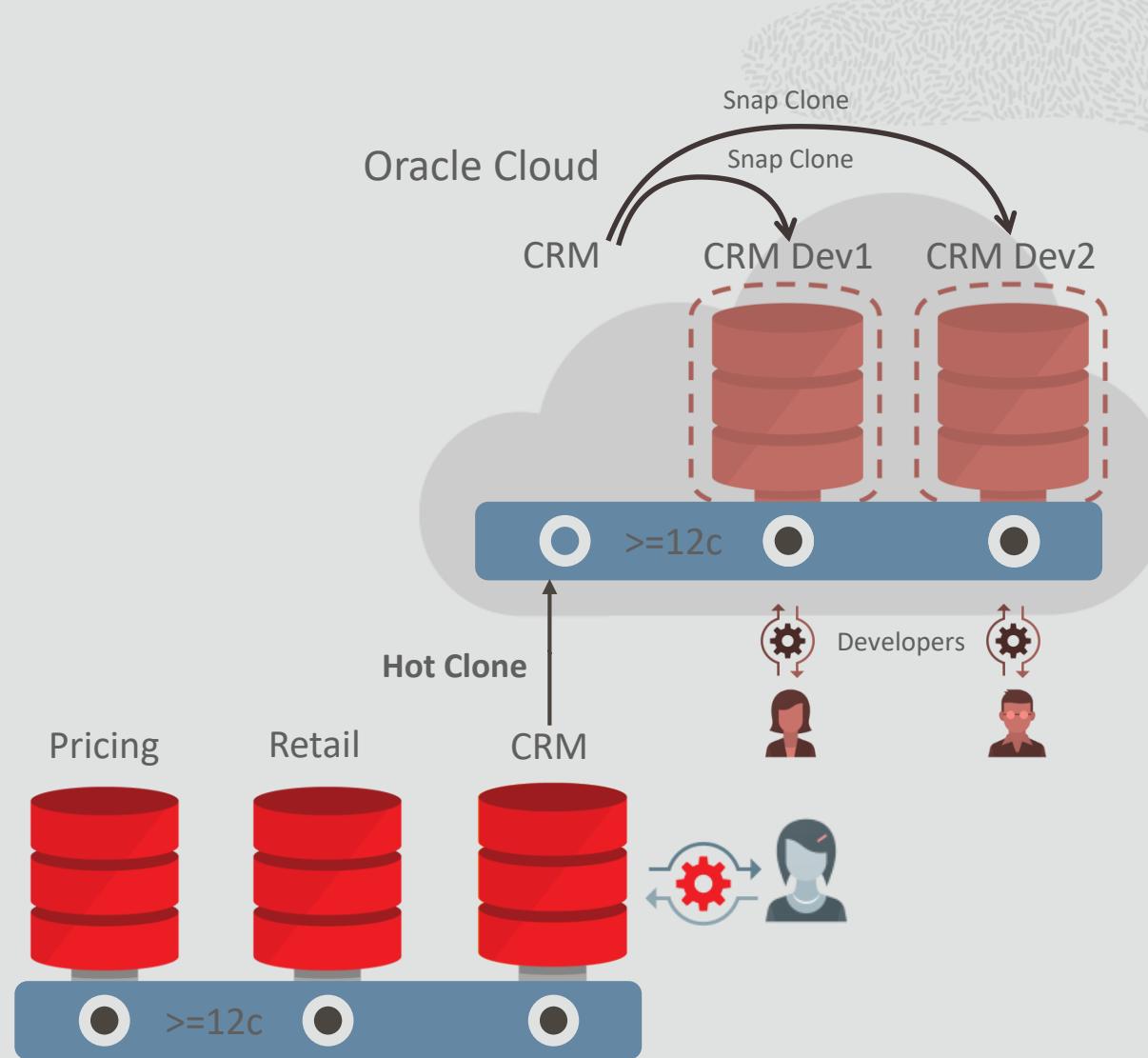
How Many PDBs?

- With No Extra Licenses – 3 PDBs
- EE – 252 PDBs
- OCI – 4096 PDBs

Oracle Database Multitenant Architecture

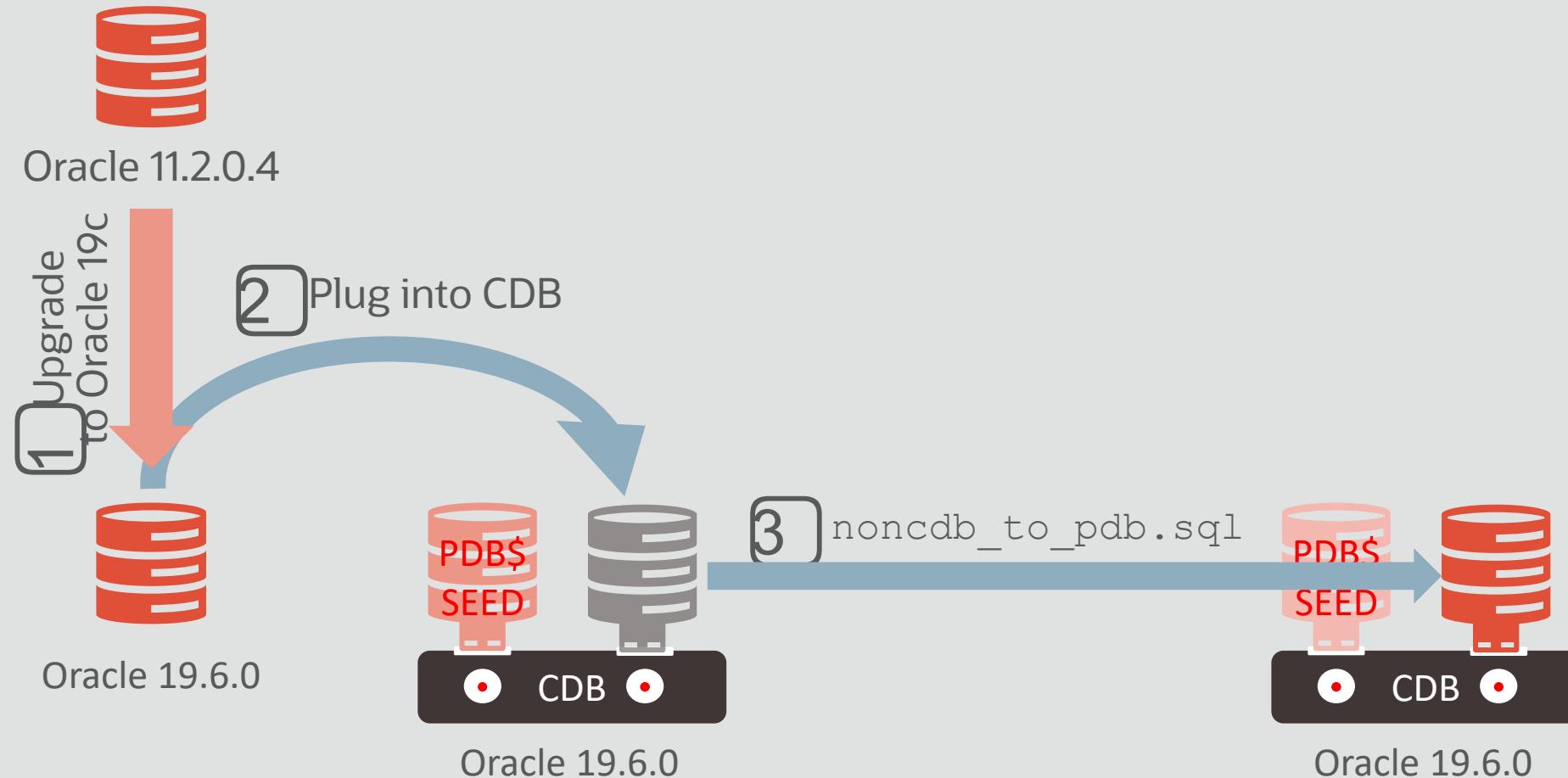
Migration Strategies

- Starting Oracle Database 20c multitenant architecture will be default – along with 18c & 19c
- 12c support both single-tenant (non-CDB) and multitenant (CDB/PDB) architecture
- Oracle Database 11g and lower versions are all single tenant Databases
- Migration Approaches
 - Upgrade to matching version of CDB, then migrate and plugin as new PDB
 - Migrate directly into PDB with Data Pump, RMAN TTS in a CDB to CDB use case
 - Clone PDBs using Database Link

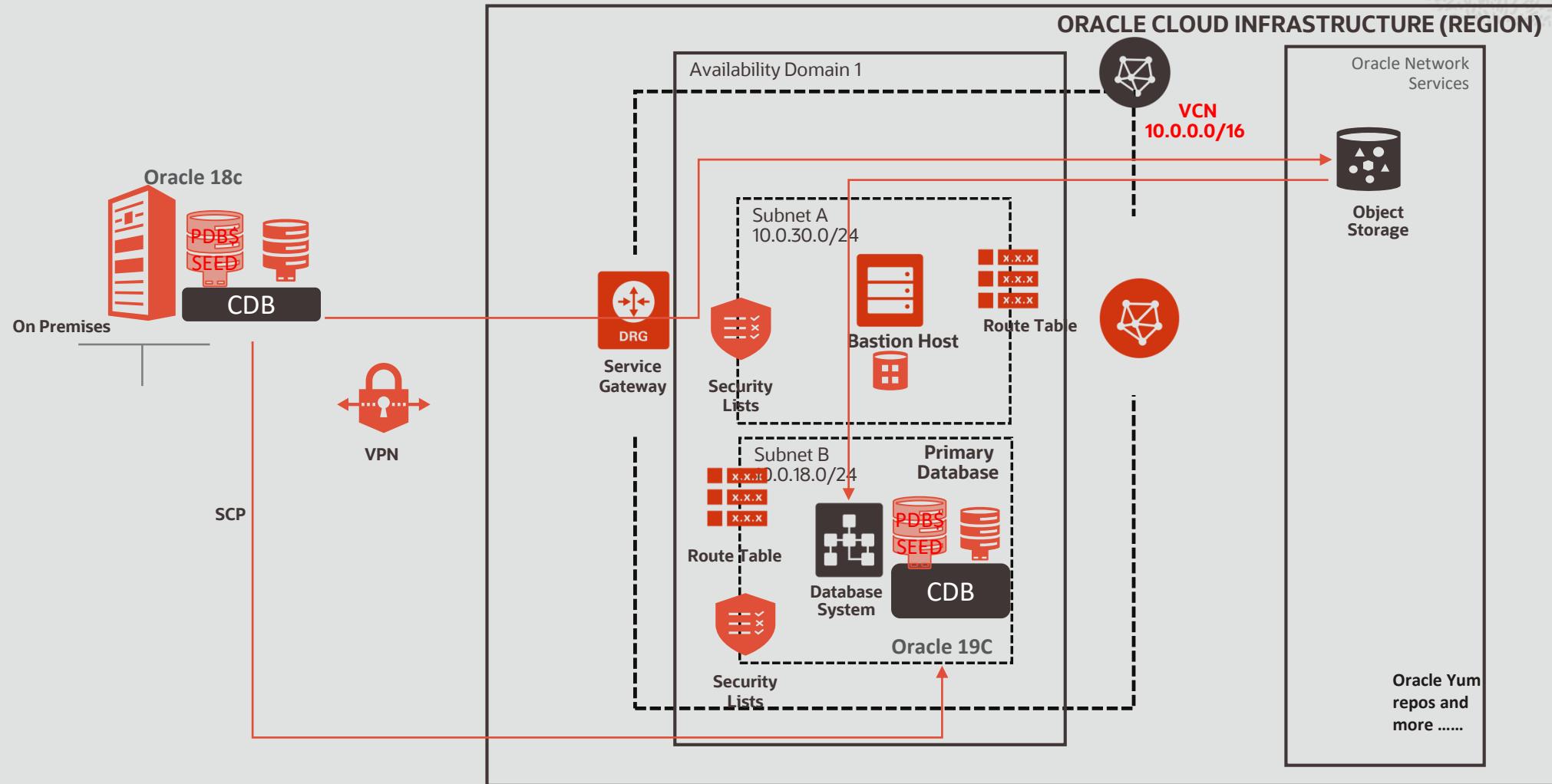


Use Case: Non-CDB to CDB

Upgrade, Plugin, Convert



Plug/Unplug Reference Architecture



Steps...

- 1) Check if a pluggable database exists to Unplug. If it does not exist, Create a Pluggable Database.
- 2) Check the Status of the PDB
- 3) Make it ReadWrite.
- 4) Close the PDB
- 5) Save the PDB to OnPrem File System.
- 6) Create the DB System and Bastion Host on OCI
- 7) Log into the DB Node and Copy the Pluggable DB File.
- 8) I will Create the PDB on the DB Node from the File I moved from my On Prem.
- 9) PDB Created on OCI.

Recovery Manager (RMAN)

Reliable and Versatile offline migration tool

Source databases:

- CDB/PDB Databases 12c, 18c, 19c
- Non-CDB Databases 11g, 12c, 18c, 19c



Target databases:

- DBaaS VM, DBaaS BM, ExaCS, ExaCC
- Versions: 12c, 18c, 19c

When to use

- ✓ Cross-platform migration possible
 - ✓ Allows point-in time recovery
 - ✓ Migrate from non-CDB to CDB
 - ✓ Small to Large Database size
- ⚠ Requires knowledge of various RMAN methods
- ⚠ Requires some down-time



Point-in-Time
Recovery



Interoperability
with versions



Enterprise fleet-
scale migrations



Free

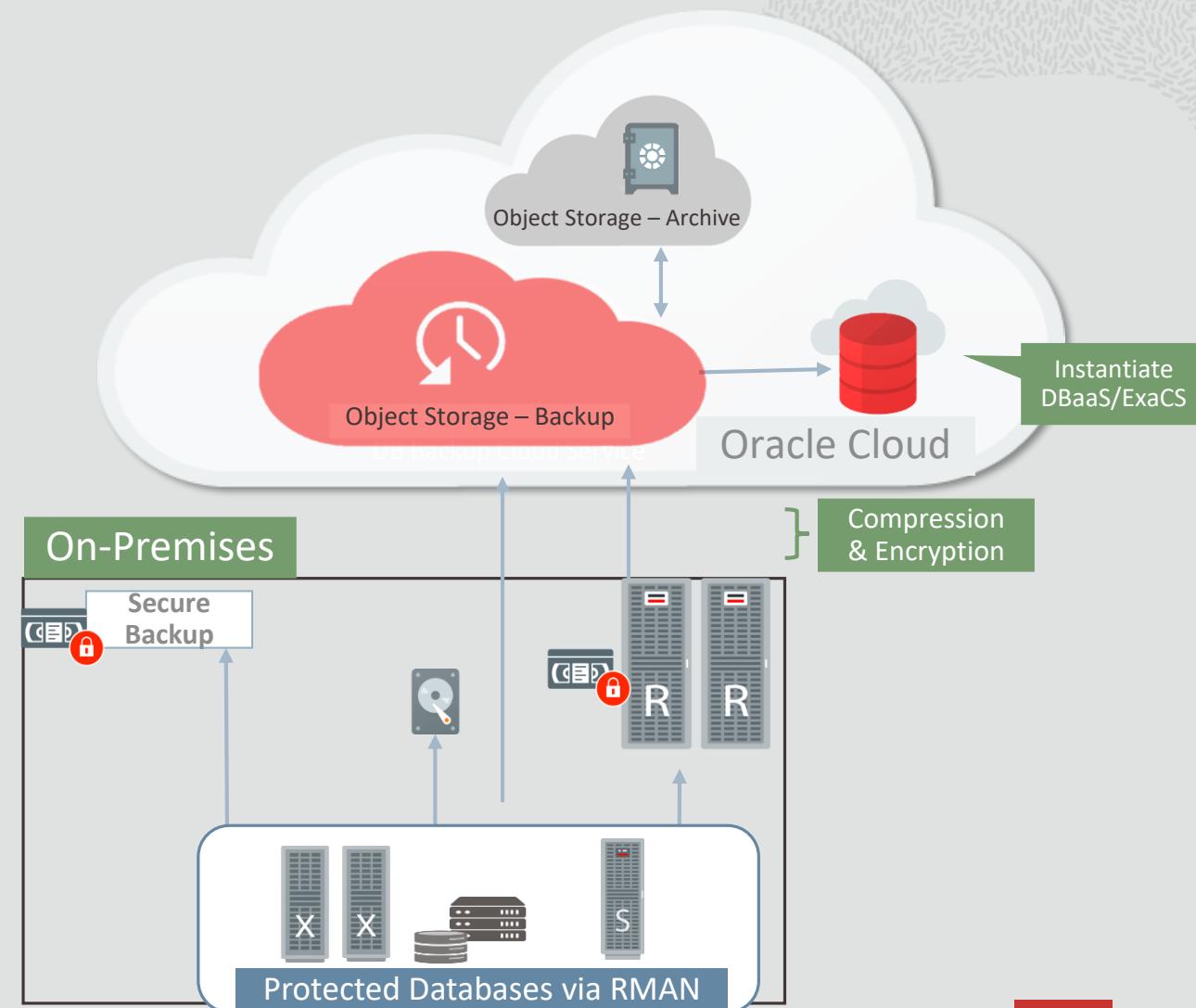
Recovery Manager (RMAN)

Features and Capabilities

License Included with Oracle Database Cloud & On-Premises

RMAN can be used for:

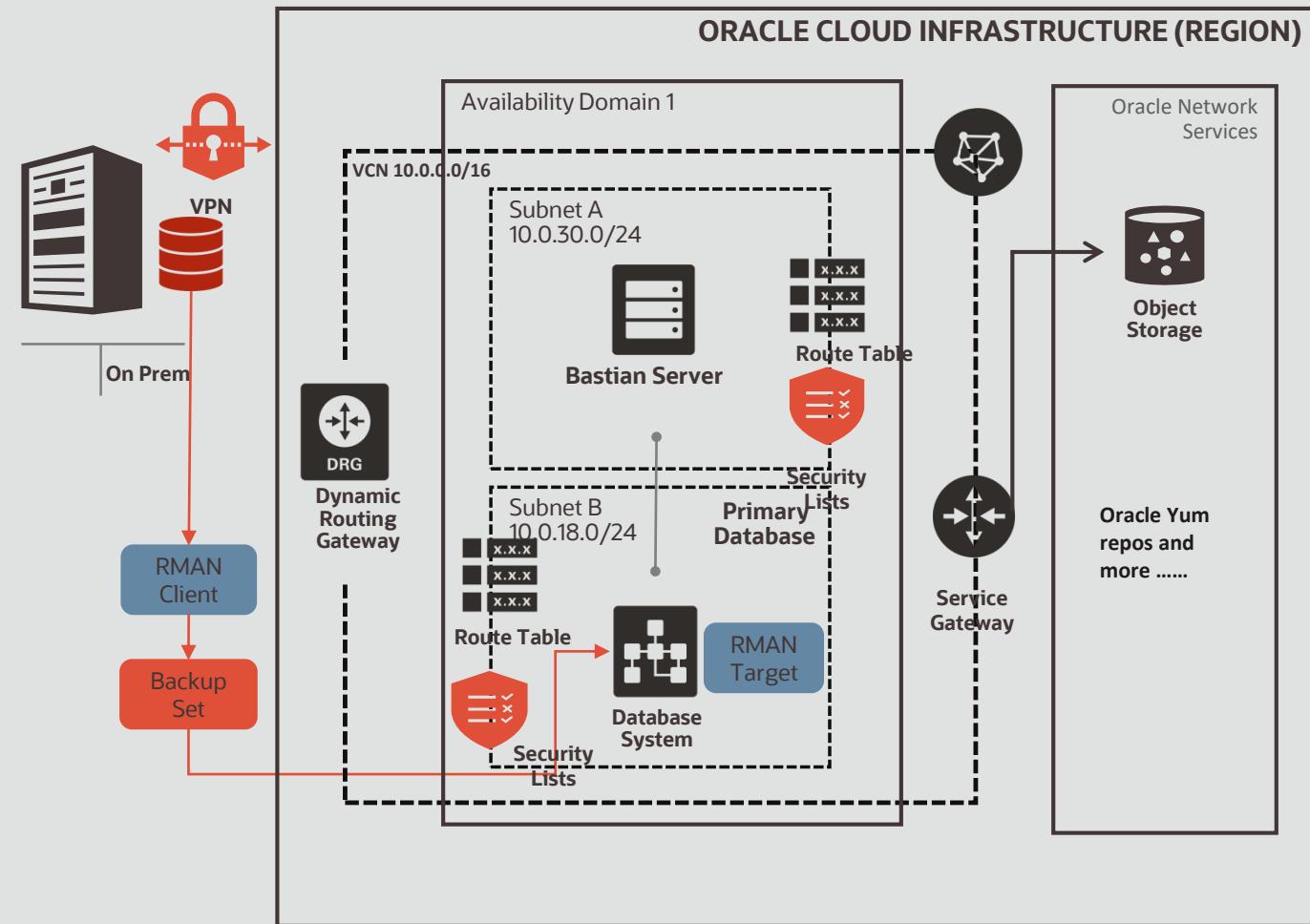
- Migrate on-premises PDB to OCI CDB – offline
- Migrate DB contained within one or more user table space(s) (selective data) - offline
- Migrate DB in an active container database (CDB) or non-CDB database to OCI – offline
- Migrate workload cross platforms with different endianness (byte order) – offline



RMAN Reference Architecture

Migration Steps

- On-premises Target Database – perform backup & recovery operations
- RMAN Client – command line interface to interpret and execute
- RMAN Methods
 - RMAN Cross-Platform Transportable PDB
 - RMAN Cross-Platform Transportable Tablespace Backup Sets
 - RMAN Transportable Tablespace with Data Pump
 - RMAN DUPLICATE from an Active Database
 - RMAN CONVERT Transportable Tablespace with Data Pump



Use Case: Cross Platform Migration

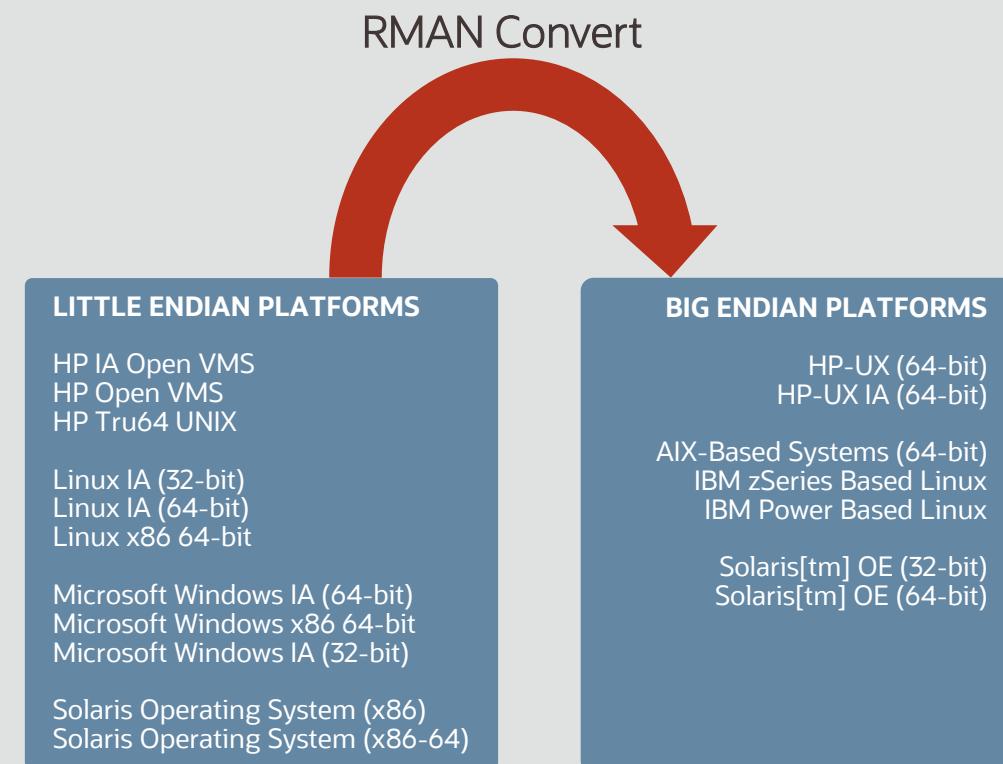
RMAN Convert Method

Prepare On-premises database host for Transportable Tablespace export

1. Invoke SQL*Plus and set all tablespaces to be migrated to READ ONLY mode
2. Launch Data Pump (expdp) as SYSTEM and perform transportable tablespace export
3. Invoke and execute RMAN CONVERT TABLESPACE command
4. Use a secure copy utility to transfer Data Pump Export file and converted tablespace datafiles to the Database service compute node

Prepare Database Service node for Transportable Tablespace import

1. Invoke SQL*Plus to create directory object and necessary database user(s).
2. Launch Data Pump (impdp) as root and perform transportable tablespace import
3. Set the imported tablespaces in the database to READ WRITE mode

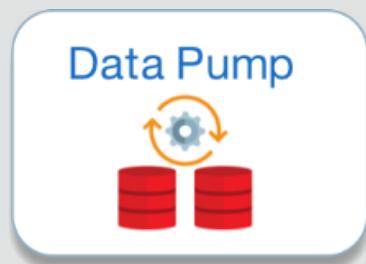


Data Pump

Fast, full offline database migration tool

Source databases:

- CDB/PDB Databases 12c, 18c, 19c
- Non-CDB Databases 11g, 12c, 18c, 19c



Target databases:

- DBaaS VM, DBaaS BM, ExaCS, ExaCC
- Versions: 12c, 18c, 19c

When to use

- ✓ Supports small to large databases
- ✓ Supports cross-endian and character-set
- ✓ In-flight Upgrade possible
- ✓ Changes to database structure possible
- ⚠ Requires knowledge of various methods
- ⚠ Requires some down-time



Simple



Interoperability
with versions



Enterprise fleet-
scale migrations



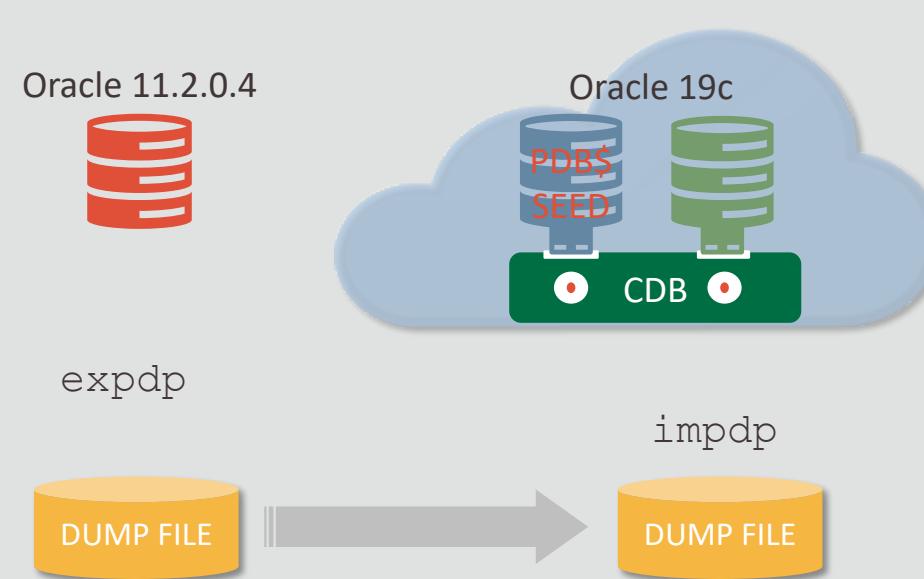
Free



Data Pump

Features and Capabilities

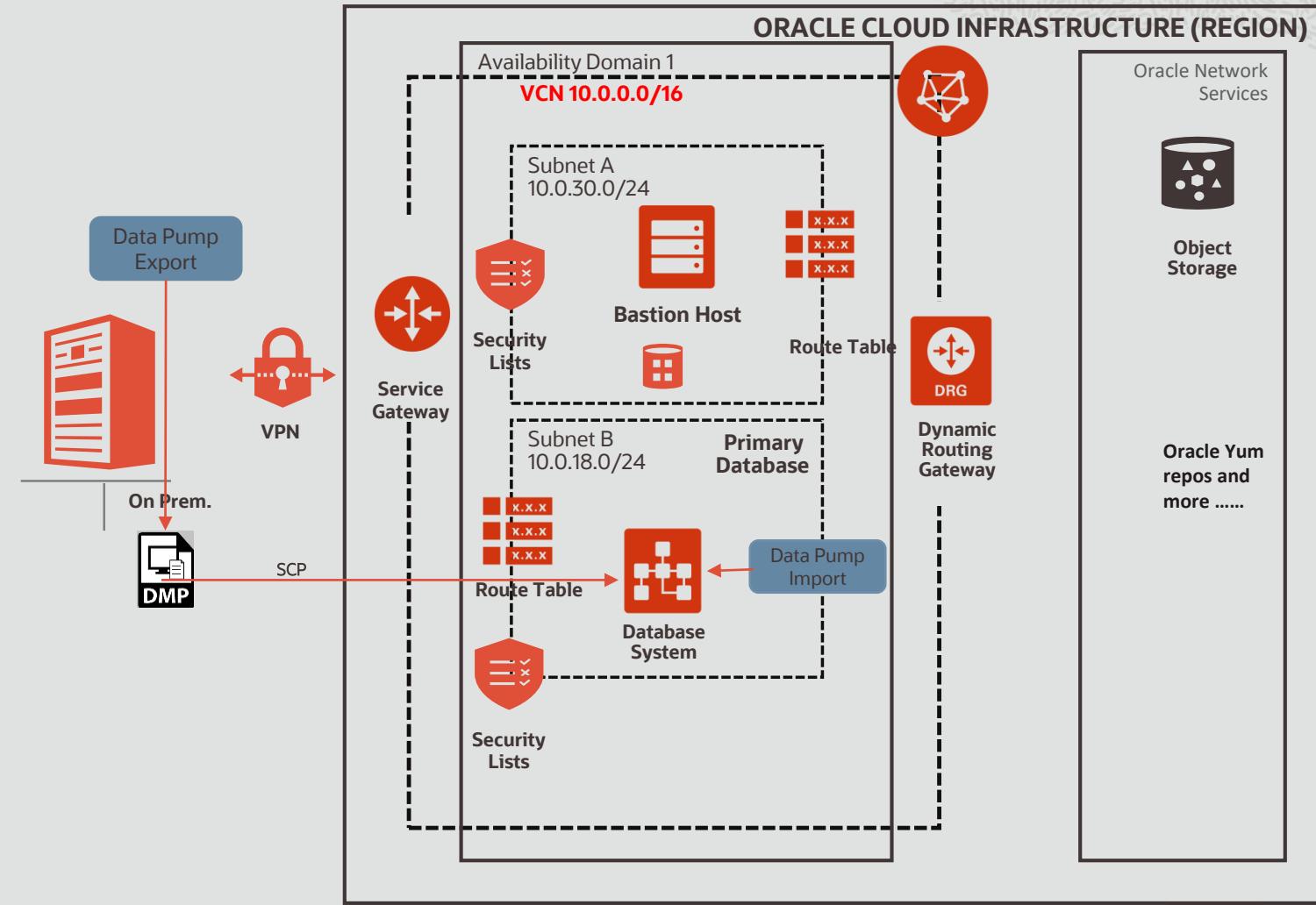
- Oracle Data Pump enables high-speed movement of data and metadata from one database to another
- Oracle Data Pump is available on Oracle Database 10g & later
- There are five different modes of data unloading
 - **Schema Mode** - default mode, specific schemas
 - **Table Mode** - specified set of tables dependent objects
 - **Tablespace Mode** - the tables in the specified tablespace
 - **Transportable Tablespace Mode** - only the metadata for the tables and dependent objects within a specified set of tablespaces
 - **Full Export Mode** - entire database



Use Case: Data Pump Migration Conventional Export/Import

Migration Steps

- Invoke Data Pump Export on-premises DB
- Secure copy the dump file to the OCI Database System
 - On OCI DB System invoke Data Pump Import
 - Validate the import



Data Guard

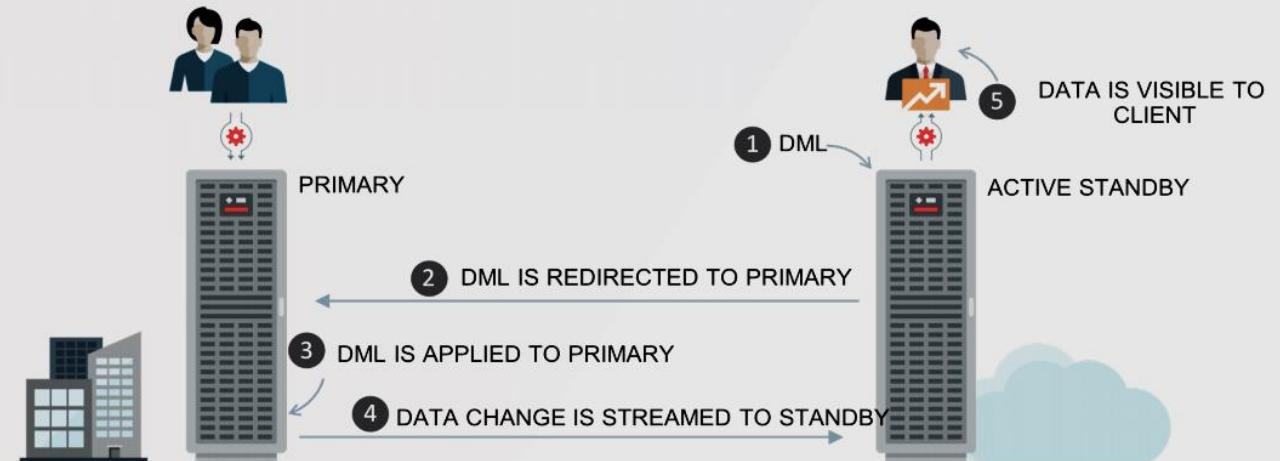
Real-time Data Protection & Availability

When to use

- ✓ Provides HA and DR solutions
- ✓ Minimal downtime migration
- ✓ Source version 11.2.0.4, 12.1.0.2, 12.2.0.1, 18, 19
- ✓ Only for Little Endian platforms
Only non-CDB to non-CDB or PDB to PDB
- ⚠ No structural changes
- ⚠ No upgrade to new version

Oracle Data Guard ensures high availability, data protection, and disaster recovery for enterprise data.

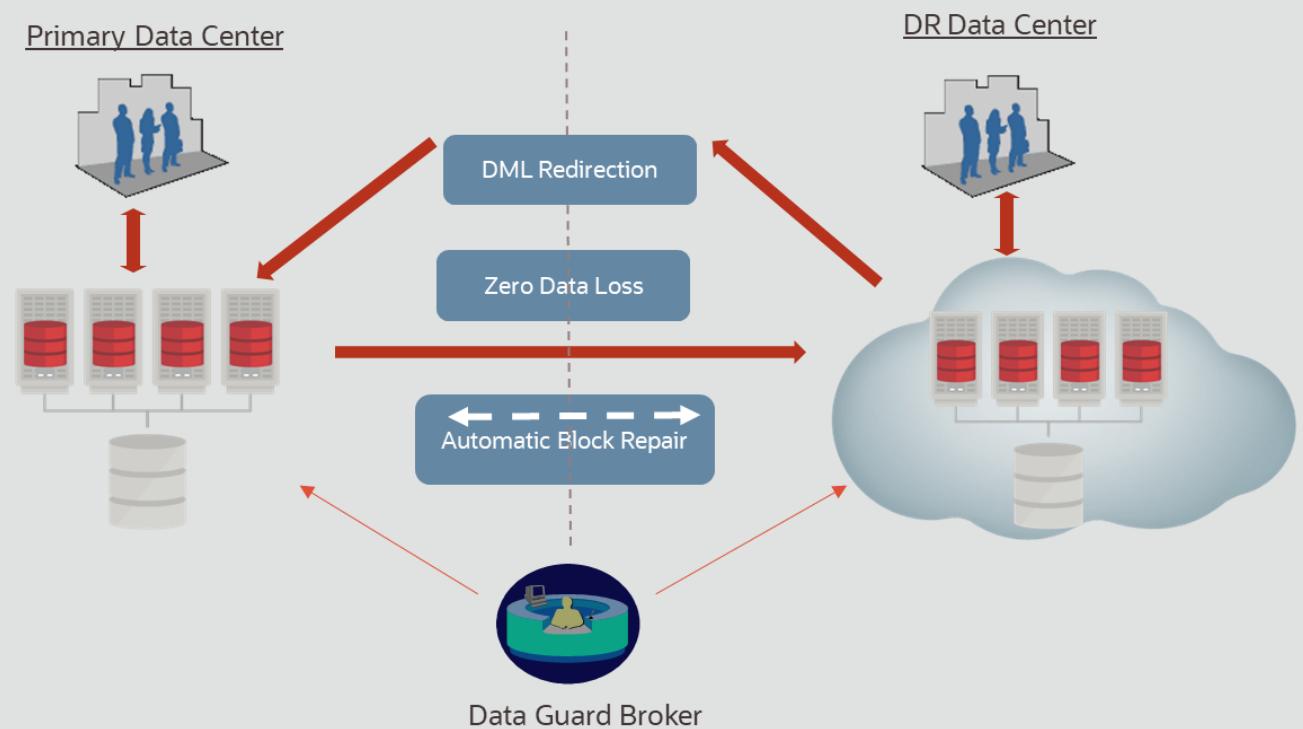
It provides a comprehensive set of services that create, maintain, manage, and monitor one or more standby databases.



Active Data Guard

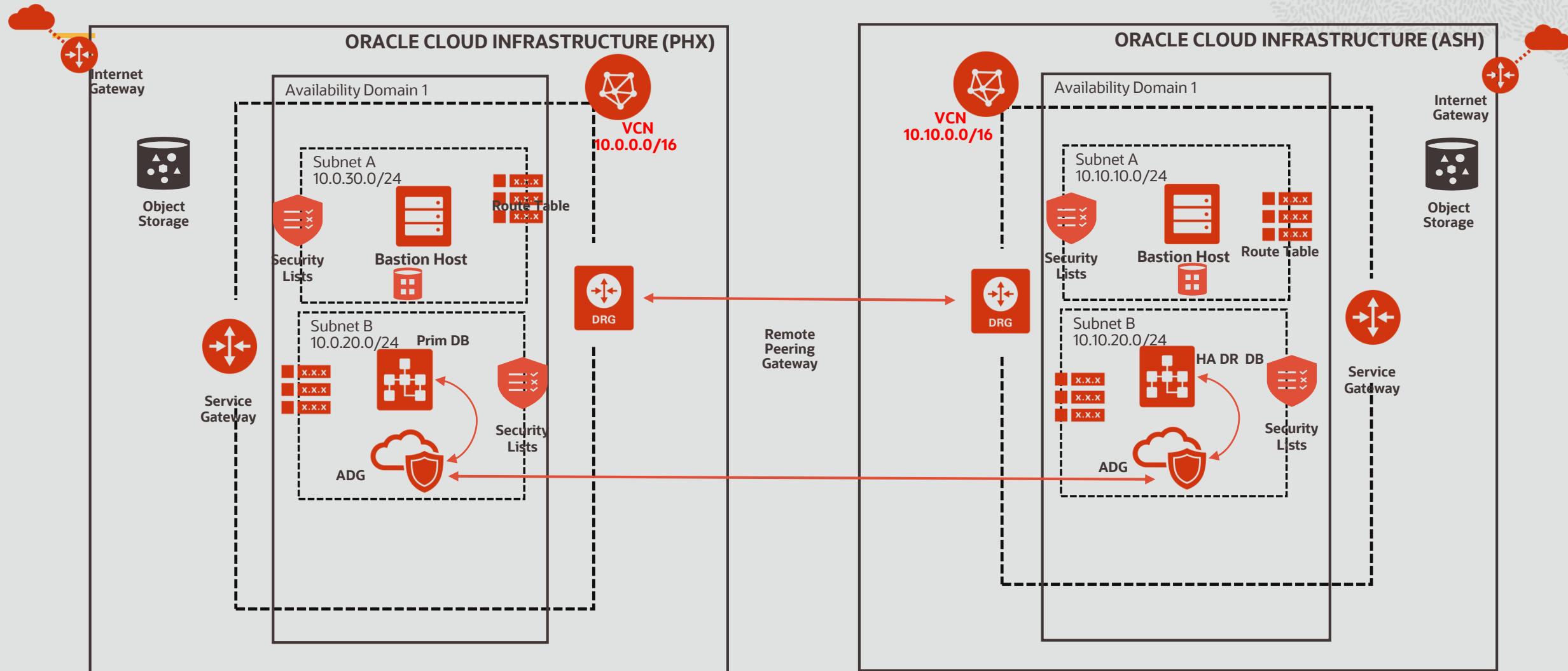
Oracle solution for Active Disaster Recovery

- Eliminates single point of failure
- Efficiently uses network bandwidth
- Provides unique levels of data protection
- Fast-Start failover to the standby
- Switchover to a standby
- Read Write mode on Standby.
- A True Sync between Primary and Secondary Instances.



Disaster Recovery Across Regions – Reference Architecture

Active Data Guard



Summary

Identify the Migration Methods and Tools

| Requirements | Advantages | Constraints | Technology/ Methods | Method/Tool |
|--|--|--|--|------------------------------|
| <ul style="list-style-type: none">• Source Size: Small to Large• Source DB 11.2.0.4 or higher• Oracle Linux 7 or higher• Target DB: OCI DB (VM or BM), ExaCS or ExaCS | <ul style="list-style-type: none">• Zero Downtime Migration• Free, Simple, easy to use tool• MAA Recommended tool for Enterprise Fleet Management and Migration | <ul style="list-style-type: none">• Migrate like-for-like versions• In-Flight upgrade not possible• CDB/PDB Conversion not supported OOTB• Doesn't support ADB (ATP or ADW) | <ul style="list-style-type: none">• RMAN• DataGuard | ZDM |
| <ul style="list-style-type: none">• Source Size: Small to Large• Source DB 12.1.0.2 or higher• Target OCI service ADB (ATP or ADW)• Oracle Linux 7 or higher | <ul style="list-style-type: none">• Structured unstructured data in CSV, AVRO, Parquet Dump Files• Supports both OLTP and OLAP Workloads• Supports in-flight upgrade of DB | <ul style="list-style-type: none">• Lift and Shift of any Workloads to ADW and ATP ONLY | <ul style="list-style-type: none">• DataPump | MV2ADB |
| <ul style="list-style-type: none">• Source Size: Small to Large• Source DB 11.2.0.4 or higher• Oracle Linux 7 or higher• Target DB: OCI DB (VM or BM), ExaCS or ExaCS | <ul style="list-style-type: none">• Free, Simple, easy to use tool• MAA Recommended tool for Enterprise Fleet Management and Migration• Allows Non-CDB to CDB | <ul style="list-style-type: none">• Same Source and Target platform• Doesn't support ADB (ATP or ADW)• Source DB is Little-endian | <ul style="list-style-type: none">• RMAN• DataPump | Plug/Unplug (PDB/CDB) |
| <ul style="list-style-type: none">• Source Size: Small to Large• Source DB 11.2.0.4 or higher• Oracle Linux 7 or higher, Linux IA (32/64), X86• HP IA Open VMS, Open VMS, Tru64 UNIX• Microsoft Windows IA (64-bit), X86, IA(32 bit)• Solaris Operating System (x86, x86-64)• Target DB: OCI DB (VM or BM), ExaCS or ExaCS | <ul style="list-style-type: none">• A point-in-time migration of an entire database varied workloads• Online or offline migration• Cross-platform migration possible• Allows point-in time recovery• Migrate from non-CDB to CDB | <ul style="list-style-type: none">• Requires some down time• Requires understanding of various methods | <ul style="list-style-type: none">• Cross-Platform Transportable PDB• Cross-Platform Transportable Tablespace Backup Sets• Transportable Tablespace with Data Pump• DUPLICATE from an Active Database• CONVERT Transportable Tablespace with Data Pump | RMAN |
| <ul style="list-style-type: none">• Source Size: Small to Large• Source DB 11.2.0.4 or higher• Oracle Linux 7 or higher• Target DB: OCI DB (VM or BM), ExaCS or ExaCS | <ul style="list-style-type: none">• Changes to database structure possible• In-flight Upgrade possible• Supports cross-endian & character-set | <ul style="list-style-type: none">• Requires some down time• Requires understanding of various methods | <ul style="list-style-type: none">• Schema Mode• Table Mode• Tablespace Mode• Transportable Tablespace Mode• Full Export Mode | Data Pump |

Migration Performance Validation Tools and Best Practices

Tools freely available with Oracle Database Licenses

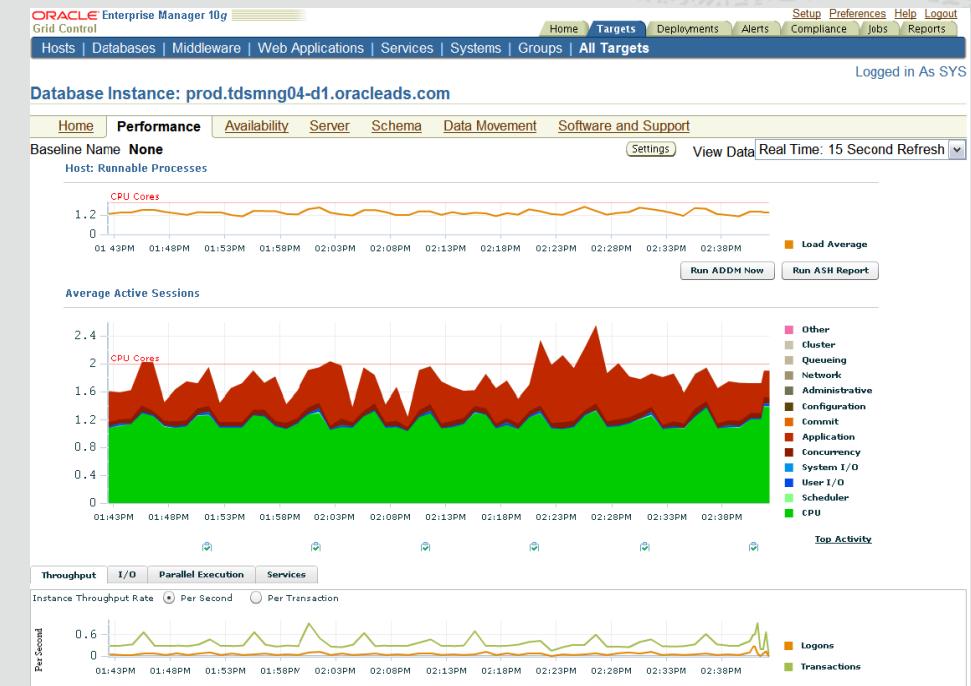
| Validation Step | Tool(s) | Best Practice |
|----------------------------|--------------------|--|
| Performance Baseline | AWR | Use "Automatic Workload Repository" (AWR) to capture ~30 days of performance data from the source database |
| SQL Profiles | AWR | Create a SQL Tuning Set (STS), a collection of SQL statements, execution plans, and performance statistics from the source database |
| Throughput Measurement | DB Replay | Capture and replay for a manageable amount of time – e.g. 1 to 2 hours. Key metric for Database Replay is DB Time. Capture STSs during capture and replay for additional validation. |
| Preserve Validation Assets | - | Load AWR baseline data, STS tuning profiles and Replay data into the target database |
| Validation | AWR / SPA / Replay | Use AWR diff reports to compare source and target systems. Use SQL Performance Analyzer (SPA) to compare source and target STSs. Use Replay to compare throughput data (DBTime) |



Performance Baseline Measurement with Automatic Workload Repository (AWR)

(AWR is available in the “Real Application Testing” option for OracleDB Enterprise Edition, in Enterprise Manager Cloud Control, and as part of DBCS EE, ATP, and ADW)

- Analyze source (production) and target performance to compare resource requirements:
 - CPU, Memory, Storage & Network Performance
- OracleDB AWR feature provides easy to access performance metrics.
 - Metrics collected at regular intervals
 - Retention to include workload surges, for example end-of-month processing
- Run baseline report on target database and use AWR Diff to compare

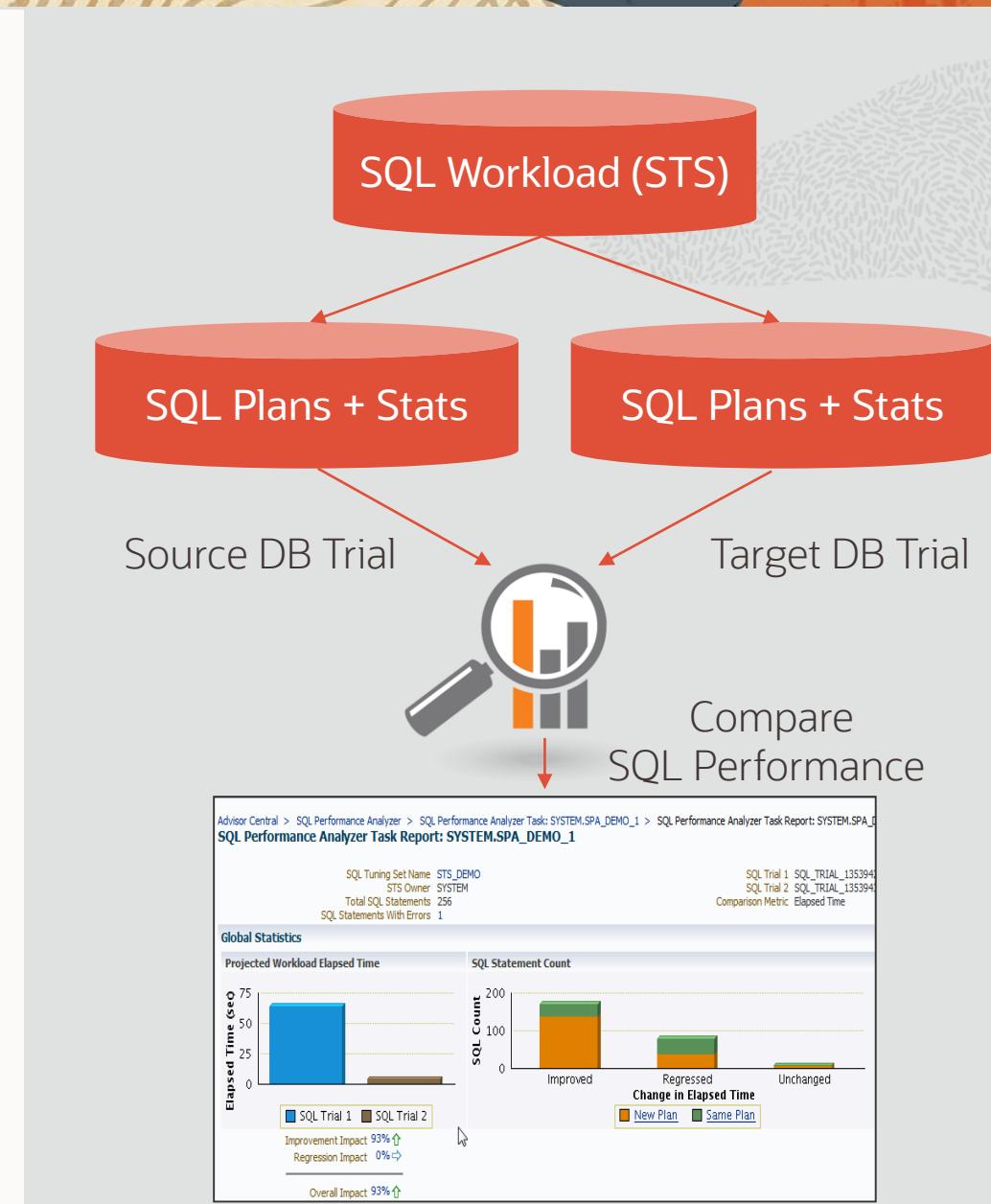


Migration Validation with SQL Performance Analyzer (SPA)

(SPA is available in the “Real Application Testing” option for OracleDB Enterprise Edition, in Enterprise Manager Cloud Control, and as part of DBCS EE, ATP, and ADW)

- Helps users predict the impact of a database migration and system changes on SQL workloads
- Low overhead capture of SQL Tuning Sets (STS) on source (production) system
- Build different SQL trials (experiments) of SQL statements performance by test execution or explain plan
- Integrated with STS, SQL Plan Baselines, & SQL Tuning Advisor to form an end-to-end solution

More information: [Real Application Testing - SQL Performance Analyzer](#)



Solution Blueprint for Oracle Cloud Database Migration

Source Database
on-premise



Migration
Methods & Tools



Oracle Cloud Database



ORACLE
Database
Cloud Service
Bare
Metal



ORACLE
Database
Cloud Service
Virtual
Machines



ORACLE
Database
Cloud Service
Exadata
Cloud Service



ORACLE
Autonomous
Database
Transaction
Processing



ORACLE
Autonomous
Database
Data
Warehouse

Oracle Cloud Infrastructure

Keep in mind

ExaCC migration relies on proper Exa Setup & Connectivity

Physical Migration whenever possible!! (RMAN)

Sometimes, consider manual method using RMAN + DG

Also, Consider migrate using RMAN + GG (if not EBS)

Hypothetical scenario:

DB 11g 30T+ total data size? Solaris? Or AIX?

In ExaCC you can have 11g, “the rack is yours!”

However, perhaps you should migrate with RMAN +
incremental backups

Unfortunately, will have downtime.



Useful Docs

Creating a Physical Standby Database for 11g Through 19c Databases (Doc ID 2275154.1)

Creating a Physical Standby using RMAN Duplicate (RAC or Non-RAC) (Doc ID 1617946.1)

Using Transportable Tablespaces to Migrate Oracle E-Business Suite Release 12.2 Using Oracle Database 19c Enterprise Edition On a Multitenant Environment (Doc ID 2674405.1)

V4 Reduce Transportable Tablespace Downtime using Cross Platform Incremental Backup (Doc ID 2471245.1)

Is GG certified for EBS Database Migrations and upgrades (Doc ID 2491869.1)

<https://www.oracle.com/webfolder/s/assets/webtool/cloud-migration-advisor/index.html>

<https://docs.oracle.com/en-us/iaas/Content/Database/Tasks/mig-onprembackup.htm>

<https://docs.oracle.com/en/cloud/paas/database-dbaas-cloud/csdbi/create-hybrid-dr-deployment.html>

Thank you

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Migrating Databases to ExaCC - Various methodologies

