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Oracle Cloud Infrastructure Database Migration (DMS)

Step-by-Step Guide for Offline Logical Migration
- from On Premises to Oracle Cloud Infrastructure Autonomous Database

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Purpose Statement

This document is an overview of the OCI Data Migration Service concepts and a step-by-step guide for migrating an Oracle database from on-premises to OCI Autonomous Database. It is intended solely to help you assess the requirements, functionality, and complexity as you plan your I.T. projects.

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Introduction

This technical white paper provides an overview of the OCI Database Migration Service (DMS) concepts and includes a step-by-step guide for migrating an Oracle database from on-premises to Oracle Autonomous Database on shared or dedicated infrastructure. You can watch a short video demonstrating its operation [here](#).

DMS is a fully managed cloud service that migrates Oracle databases into the many database service options within Oracle Cloud Infrastructure as well as Oracle databases from on-premises, and third-party clouds to Oracle Autonomous Database. It supports both offline and online migrations methods. For secure and encrypted data movement, it supports data access behind a firewall connection and through private endpoints. High performance is delivered with [OCI FastConnect](#) that connects your source with the Oracle Cloud using a dedicated, private, high-bandwidth network.

DMS is based on the Oracle zero-downtime migration (ZDM) server and provides an easy-to-use user interface for configuration. You can learn more about [ZDM on Oracle.com](#). The Zero Downtime Migration engine is compliant with Oracle Maximum Availability Architecture (MAA) and supports seamless transition from initial load to streamed replication using Oracle GoldenGate.

Database Migration features and capabilities:

- Database Migration from on-premises databases to Oracle Autonomous Data Warehouse (ADW) or Oracle Autonomous Transaction Processing (ATP) shared and dedicated on OCI
- Self-service user experience using the OCI Console
- Offline migration for simple data movement with downtime
- Online migration for minimum downtime using GoldenGate for data replication
- Ability to wait for user action and resume jobs during migration phases
- Data movement through OCI Object Store or Oracle Database Link
- Disconnected offline migration using agent behind firewall if no direct connection between source and target databases
- Ability to migrate database from on-premises, from third party clouds and within OCI to Autonomous Database
- Job pre-checks for migration tasks to prevent errors during database migration using the Cloud Premigration Advisor Tool (CPAT). You can review the free CPAT tool [here](#).

Architecture

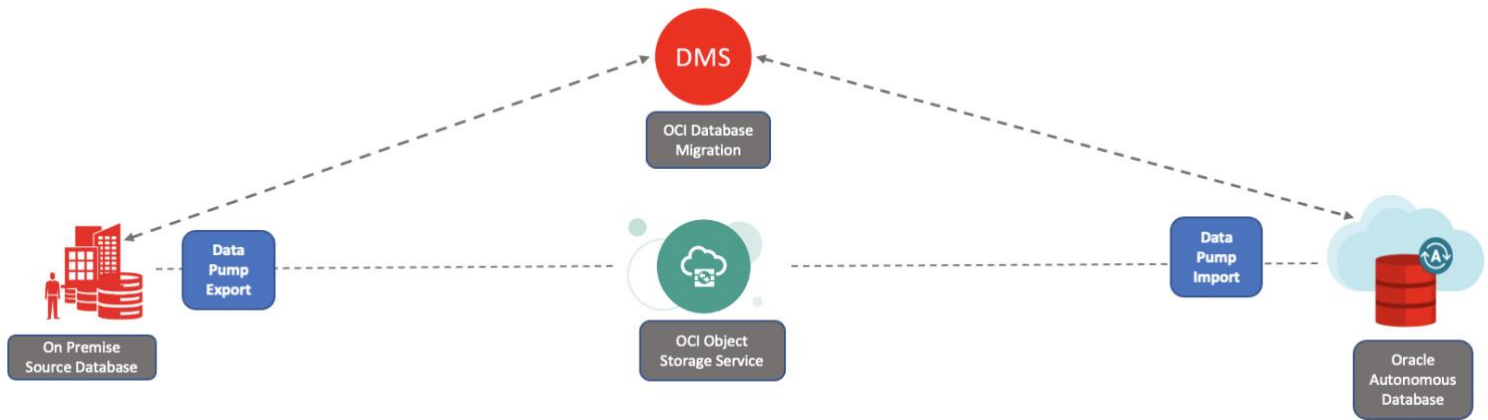
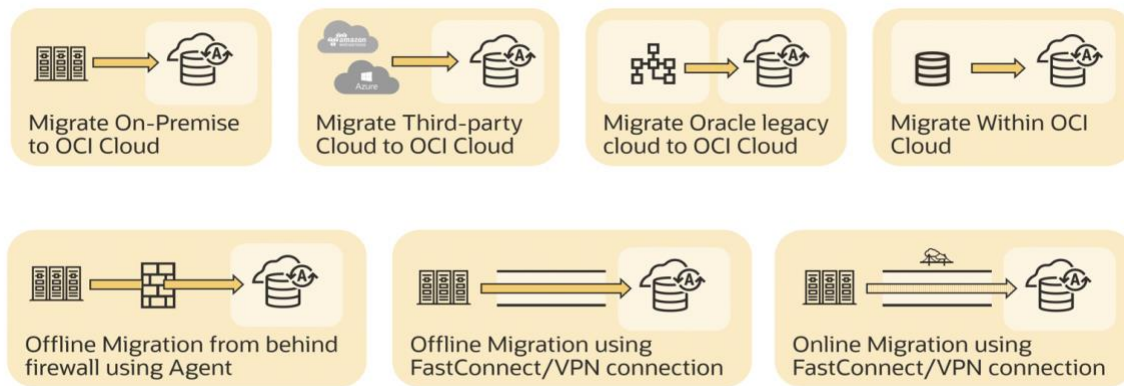


Figure 1 : Step-by-step logical offline migration to Oracle Autonomous Database using OCI Database Migration (DMS)

DMS orchestrates offline migration by performing a data pump export to an OCI Object Storage bucket in the user's OCI tenancy. It then initiates a data pump import from the bucket into the target database in OCI. Alternatively, data pump transfer through DB Link is also possible.

Source Locations and Connections



Oracle Cloud Infrastructure Database Migration supports multiple source locations:

- Migrating On-premises Oracle Database to Oracle Cloud Infrastructure
- Migrating Oracle Database from Third Party Cloud to Oracle Cloud Infrastructure (e.g. AWS)
- Migrating Oracle Database from Oracle Legacy Cloud to Autonomous Database on OCI
- Migrating Oracle Database within OCI to Autonomous Database (e.g. from an Oracle Database Cloud Service, Oracle Exadata Cloud Service, or any database self-managed in compute)

Migration Modes and Connections

Oracle Database migration to Oracle Autonomous Database is supported in offline and online modes with FastConnect or VPN connection between source and target databases.

- Offline Database Migration using Agent behind firewall
- Offline Database Migration using FastConnect or VPN connection between source and target database
- Online Migration using FastConnect or VPN connection between source and target database with Oracle GoldenGate Support

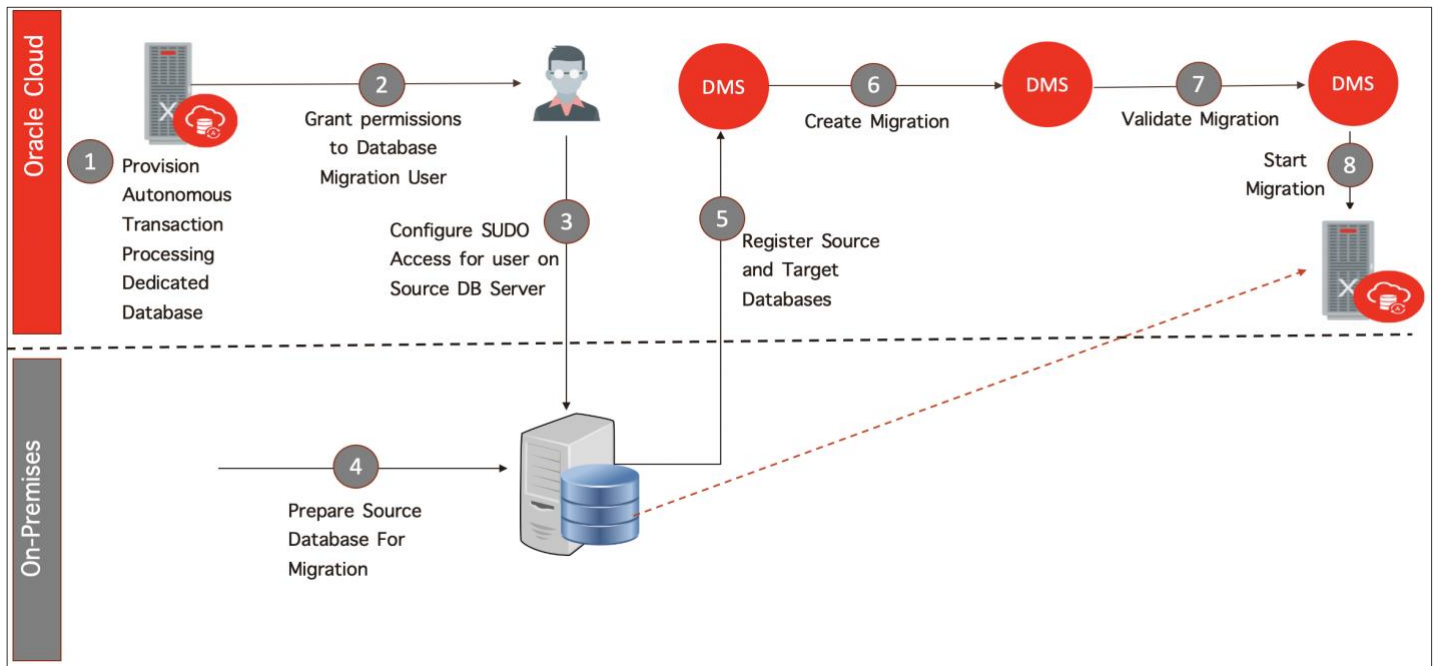
Database Migration Prerequisites

1. Source database prerequisites
 - Source Database must meet below requirements to use Oracle Cloud Infrastructure Database Migration to migrate database to Oracle Cloud.
2. Source database versions
 - Oracle Database 11g Release 2 (11.2.0.4)
 - Oracle Database 12c Release 1 (12.1.0.2)
 - Oracle Database 12c Release 2 (12.2.0.1)
 - Oracle Database 18 Release 3 (18.3)
 - Oracle Database 19c and all subsequent Oracle Database releases
3. Source platform
 - Linux x-86-64
4. Target database prerequisites
 - Oracle Autonomous Database with Shared Exadata Infrastructure
 - Oracle Autonomous Database with Dedicated Exadata Infrastructure
 - Oracle Cloud Infrastructure co-managed Oracle Database service (Virtual Machine Database System, Bare Metal Database System, or Exadata Cloud Service)
5. Database migration port requirements
 - OCI DMS uses Port 443 to copy database export dump files from source database to Oracle object store.

INITIATOR	TARGET	PROTOCOL	PORT	PURPOSE
Source server	Oracle Cloud Object Storage Service	SSL	443	This port allows Data Pump dumps to be uploaded to Oracle Cloud Storage

Step-by-Step Process to Migrate from On-premises to OCI

The following example illustrates migrating an on-premises Oracle Database to Oracle Autonomous Transaction Processing Dedicated in offline mode using a FastConnect network setup between on-premises and OCI. The source database version is 19c (19.0.0.0) with platform as Linux x86-64.



Provision Autonomous Transaction Processing Dedicated Database

Autonomous Transaction Processing is a cloud database service that simplifies database operations for OLTP and real-time analytical applications. Reduce runtime costs by up to 90% and get unparalleled scale, performance, and security with embedded machine-learning based automations. Oracle Autonomous Dedicated Database runs on a dedicated Exadata Hardware. It enables a customizable private database cloud in the public cloud.

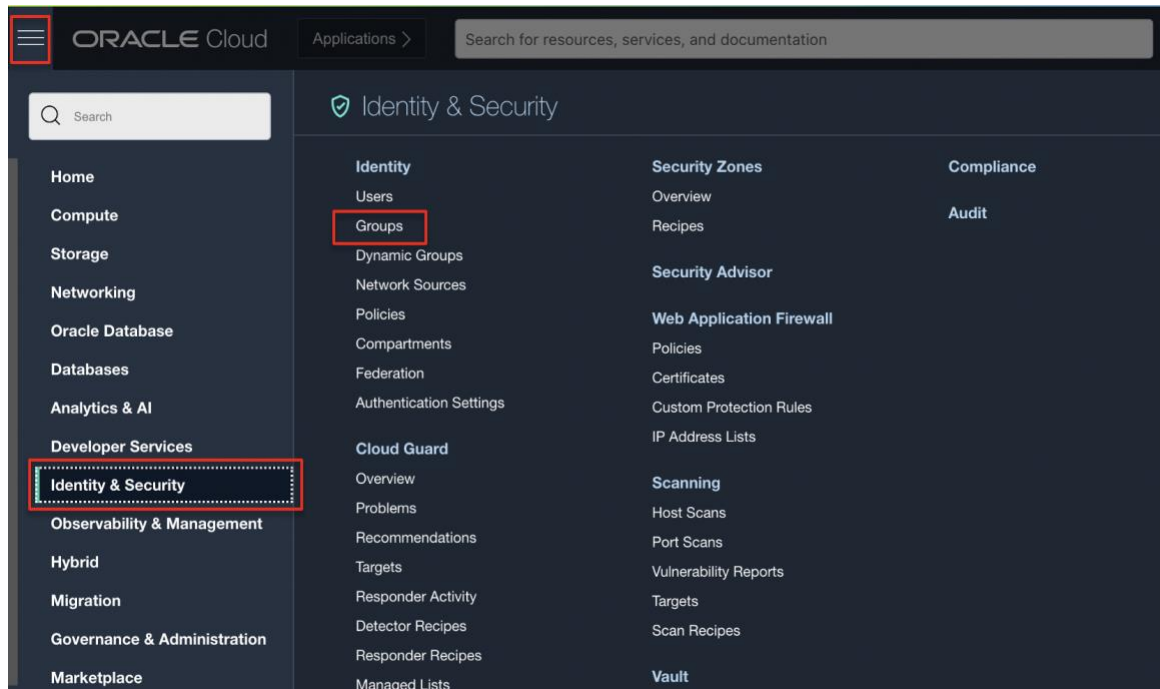
Autonomous Databases on dedicated Exadata infrastructure have a three-level database architecture model that makes use of Oracle multitenant database architecture.

1. Autonomous Exadata Infrastructure (AEI)
2. Autonomous Container Database (ACD)
3. Autonomous Database (PDB)

Create autonomous database in a private endpoint running on dedicated Autonomous Exadata Infrastructure (AEI) in private subnet.

Grant Permissions to Database Migration User on OCI

Create a group in OCI for a migration user which will manage database registrations, migrations, and jobs. Need to grant permissions by creating the following policies for the group.



- allow group dms to manage odms-connection in compartment dmsCompartment
- allow group dms to manage odms-migration in compartment dmsCompartment
- allow group dms to manage virtual-network-family in compartment dmsCompartment
- allow group dms to manage tag-namespaces in compartment dmsCompartment

Configure SUDO Access for User on Source Database Server

Identify the OS user with ssh access to the source database server and grant sudo permissions to them. They can then run sudo operations without prompting for a password.

For example, use `sudo su -` for the root user, and if your database owner is an Oracle user, then run `sudo su - oracle`.

Prepare Source Database for Migration

Before starting database migration using OCI Database Migration, source database must be configured as below.

1. Configure the streams pool with the initialization parameter `STREAMS_POOL_SIZE`

For offline logical migration it is required to set `STREAMS_POOL_SIZE` to minimum of 256MB – 350MB

```
SQL> show parameter STREAMS_POOL_SIZE;

NAME                                TYPE                                VALUE
-----                                -                                -
streams_pool_size                    big integer                          0
SQL> ALTER SYSTEM SET STREAMS_POOL_SIZE = 256M;

System altered.
```

2. Check parameter `GLOBAL_NAMES` and if it's set to `TRUE`, change it to `FALSE`

```
SQL> show parameter global_names;

NAME                                TYPE                                VALUE
-----                                -                                -
global_names                          boolean                              TRUE
SQL> alter system set global_names=false;

System altered.
```

3. Enable ARCHIVELOG if it's not already enabled.

```
SQL> archive log list;
Database log mode                Archive Mode
Automatic archival              Enabled
Archive destination             USE_DB_RECOVERY_FILE_DEST
Oldest online log sequence      77
Next log sequence to archive    79
Current log sequence            79
```

4. Enable Logging

```
SQL> SELECT supplemental_log_data_min, force_logging FROM v$database;

SUPPLEME  FORCE_LOGGING
-----
NO        NO

SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA;

Database altered.

SQL> ALTER DATABASE FORCE LOGGING;

Database altered.
```

5. Create a filesystem directory on database server which will be used for export dump files by Database Migration job. If data transfer is planned with database link, then this is not required. Data Pump with a database link to Autonomous Database targets requires that the source database have SSL encryption enabled.

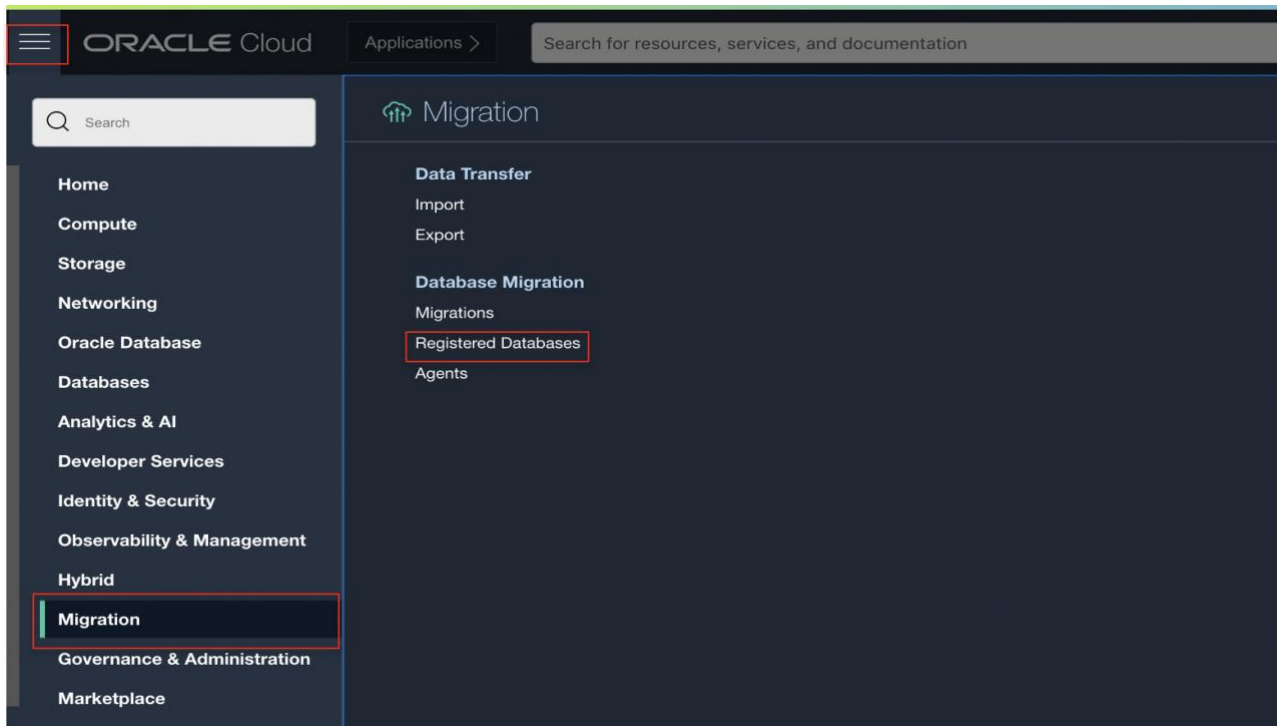
Prepare Target Database for Migration

1. Check parameter GLOBAL_NAMES and if it's set to TRUE, change to FALSE.

```
SQL> show parameter global_names;
NAME                                TYPE                                VALUE
-----                                -                                -
global_names                          boolean                             TRUE
SQL> alter system set global_names=false;
System altered.
```

Register Source Database in Database Migration

1. Log in to Oracle Cloud Console. Under Migration, navigate to Database Migration and click Registered Databases. Click Register Database and provide inputs. If the source database is a container database, register both container and pluggable databases.



- Input the following fields: Database connection string, database admin user credentials, database SSH hostname and IP address, SSH username, Oracle Vault key, and encryption key. Use either an existing key vault or create a key vault and encryption key. Data Migration uses this key for encryption during database export and import. Data in-transit is secured while uploading it to an Oracle Object Storage service bucket.

The screenshot shows a configuration form for database migration with the following fields and values:

- Host: [Redacted]
- Port: 1521
- Service Name: [Redacted]sub05300651350.dbvcn.oraclevcn.com
- Database Administrator Username: system
- Database Administrator Password:
- SSH Database Server Hostname: [Redacted]
- SSH private key options:
 - Keep existing SSH private key
 - Update SSH private key
- SSH Username: opc
- SSH Sudo Location: /usr/bin/sudo
- Buttons: Save Changes, Cancel

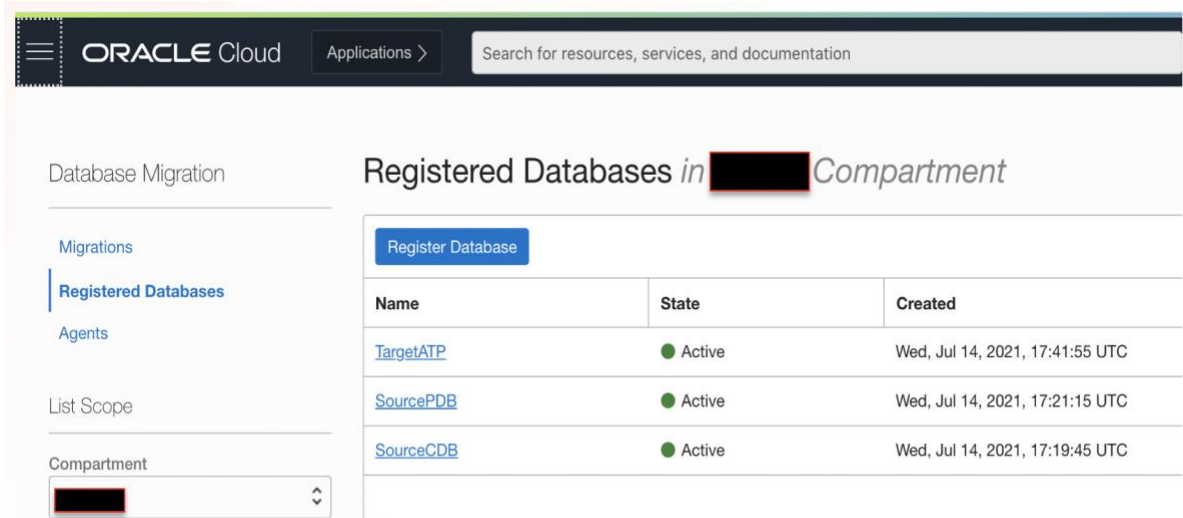
Register Target Database in Database Migration

- Set the target as Oracle Autonomous Database. In this example, we use Oracle Autonomous Transaction Processing Dedicated. To register a target autonomous database, you need an autonomous database name, compartment name, Oracle Key Vault, encryption-key details, and database admin user credentials. As Autonomous Database is in private subnet with no public access, need to select checkbox 'Network connectivity via Private End Point' as shown in below image. It auto populates the field 'Subnet in Compartment'.

The screenshot shows the 'Register Database' form with the following configuration:

- Name: TargetATP
- Compartment: [Redacted]
- Vault in sanjay: dbmigvault
- Encryption Key in sanjay: newkey
- Database Type: Autonomous Database
- Database in sanjay: ATPDemo
- Network Connectivity via Private Endpoint: (highlighted with a red box)
- Subnet in [Redacted]: (Change Compartment)
- Show Advanced Options: [Show Advanced Options](#)
- Buttons: Next, Cancel

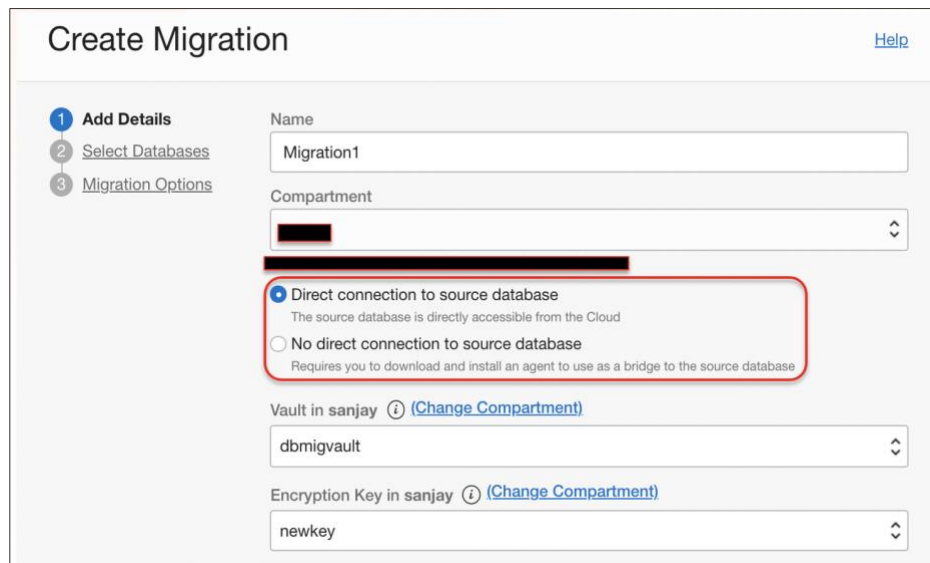
- After registering source and target database in database migration it allows to view the details as shown in below image. After successful registration of both source and target databases in Database Migration state is reflected as 'Active'. Database Name, connection details and subnet details are allowed to change after creation.



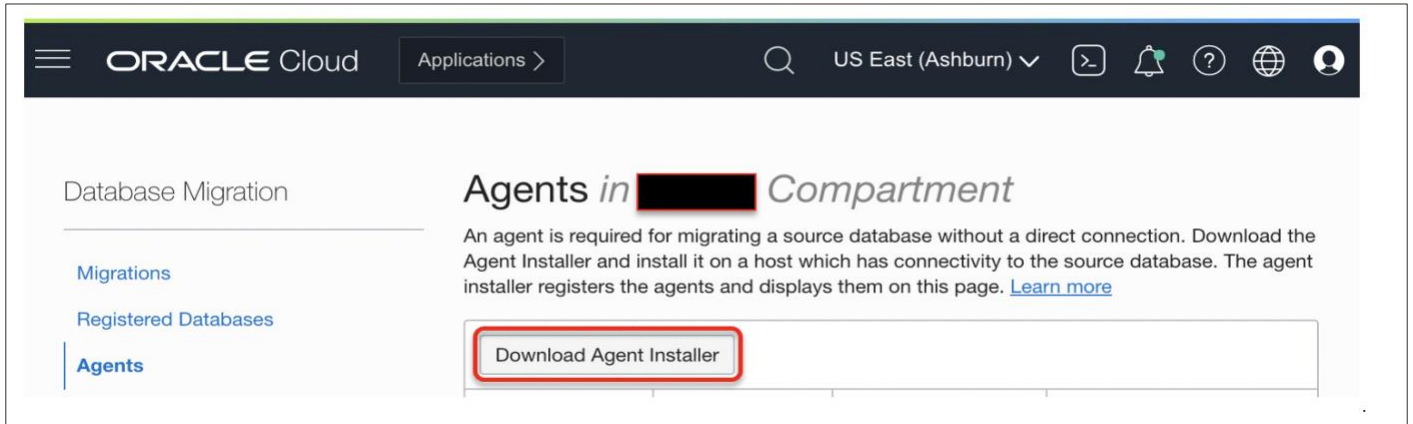
Create a Migration

- Log in to the OCI Console. Under Migration, navigate to Database Migration, Migrations, and then click **Create Migration**. Provide the source database name, target database name, migration type, encryption vault and key, database schema details, Object Storage bucket name, and source database directory path with read/write permission for the database owner user.

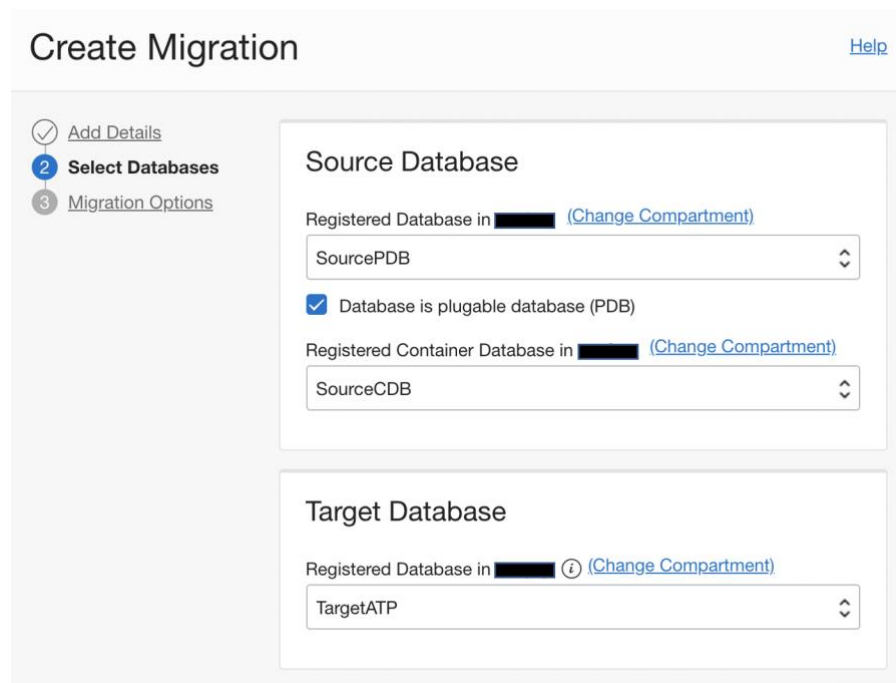
We can remap schemas and tablespaces while creating a migration. If you need to exclude any objects from a schema while migrating the schema, you can designate them while creating a migration. Excluded objects aren't migrated to target database.



- If source database is directly accessible from the Cloud, option 'Direct connection to source database' needs to be selected as shown in above image. Database Migration connects to source database over the network already setup between OCI and on-premises. If there is no direct connection to source database from OCI then option 'No direct connection to source database' needs to be selected as shown in above image. In such case, an agent needs to be downloaded and installed on on-premises to use as a bridge between OCI and source database.



- If source database is multitenant container database then both container and pluggable database names needs to be selected from the drop-down list which populated automatically based on the databases registered in earlier step.



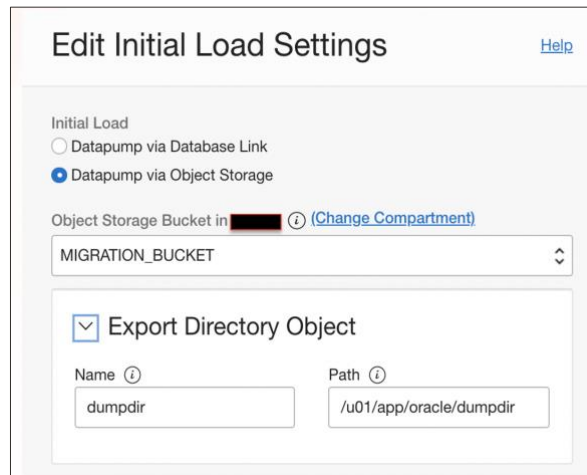
INITIAL LOAD OPTIONS

- Datapump via Database Link

Enable this option to use a direct SQL*Net connection between the source and target databases. Using Data Pump with a database link to Autonomous Database targets requires that the source database be set up with SSL encryption.

- Datapump via Object Storage

This option lets Data Pump temporarily store the exported database in an Object Storage bucket. If this option is enabled, you need to configure Object Storage Bucket with read-write access to database migration and name and path to create database directory object. Users need to provide a directory object name and file system path for intermediate storage on the source database server. Database Migration creates database directory in source database to use in datapump export.



Edit Initial Load Settings [Help](#)

Initial Load

Datapump via Database Link

Datapump via Object Storage

Object Storage Bucket in ██████████ ⓘ [\(Change Compartment\)](#)

MIGRATION_BUCKET

Export Directory Object

Name ⓘ

Path ⓘ

OPTIONAL INITIAL LOAD OPTIONS

While creating a migration in OCI Database Migration it has optional configurations which allows to exclude user specified objects from source which are not required to be migrated to the target autonomous database.

The following Initial Load options can be set by the user:

- Table Exists Action(Skip/Truncate/Replace/Append)
- Export Parallelism Degree
- Import Parallelism Degree
- Metadata Remap(Old Value and New Value)

Table Exists Action sets the Data Pump `TABLE_EXISTS_ACTION` parameter, which specifies the action to be performed when data is loaded into a pre-existing table. It allows to choose either skip or truncate or replace or append the rows to existing table in target. Default parallelism degree for both export and import is $2 \times$ Number of OCPUs and maximum up to 32. It can be provided explicitly by configuring during creation of migration job. If you want to rename database objects during migration then it has to configure in

Metadata Remap option as shown in below image. Need to select type of object and then old and new value for an object. Supported objects are datafile, schema, table and tablespace.

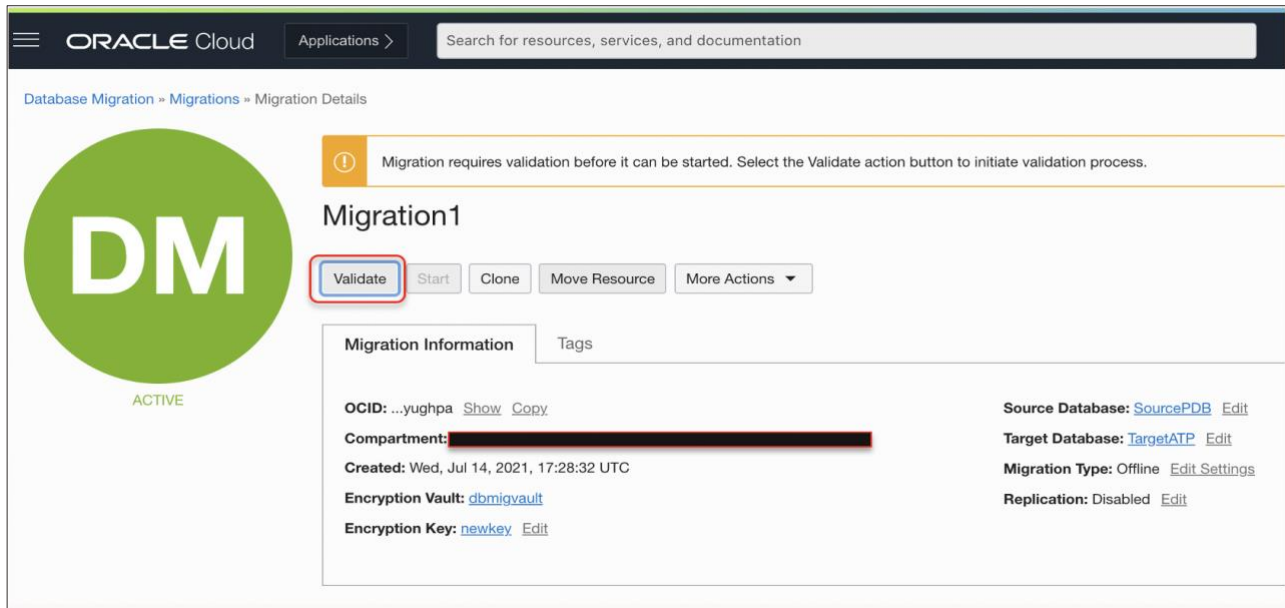
VALIDATION OPTIONS

As part of its validation, DMS analyses the source database to be compatible with the selected target database using the Cloud Premigration Advisor (CPAT). This is important as Oracle Autonomous Database has a number of restrictions in supported database types and objects. Users can disable this validation or select that issues in CPAT validation do not cause the validation to fail. This setting is useful if you have reviewed the CPAT report and determined that the detected issues are not relevant to your migration.

The screenshot displays the 'Create Migration' interface, specifically the 'Initial Load' tab. On the left, a progress indicator shows three steps: 'Add Details', 'Select Databases', and 'Migration Options' (the current step). The main area is divided into 'Excluded Objects' and 'Initial Load'. Under 'Initial Load', there are several configuration options: 'Job Mode' is set to 'Schema'; 'Table Exists Action' is set to 'Skip'; the 'Cluster' checkbox is checked with the note 'Force datapump worker process to run on multiple instances'; 'Export Parallelism Degree' and 'Import Parallelism Degree' are both empty, with a note below each stating 'If left empty defaults to 2x number of OCPUs (max 32)'. The 'Metadata Remaps' section is highlighted, containing a description: 'Map source database objects to a different name in the target database. Learn more. The tablespace USERS is automatically mapped to DATA. You can override this by mapping USERS to a different tablespace.' Below this, a 'Type' dropdown is set to 'Schema'. Underneath, 'Old Value' is 'USERS' and 'New Value' is 'DATA'. A '+ Another Metadata Remap' button is at the bottom right of this section. At the bottom of the interface are 'Previous', 'Create', and 'Cancel' buttons, along with a help icon.

Validate Migration

Before starting a database migration, the migration parameters need to be validated. Log in to the OCI Console. Under Migration, navigate to Database Migration, Migrations, and then click **Validate** to validate the migration. At the completion of the validation step, the job status changes to “Succeeded” and you then download the log file from the Console.



VALIDATION PHASE DESCRIPTIONS

- **Validate Source**

Source database details provided during database registration will be validated in this phase. It includes ssh connectivity to source database server and database connection.

- **Validate Target**

Target Autonomous Database details provided during database registration will be validated in this phase. It includes connectivity over private endpoint, check and validate target OCPU count for parallelism.

- **Validate Pre-migration Advisor**

Analyzes the source database for incompatibilities with the selected targets and produces a report for any detected issues.

- **Validate Data Pump Source Settings**

It evaluates details required for datapump pre-requisites. Export directory object path is validated to create a database directory.

- **Validate Data Pump Target Settings**

This phase evaluates target Autonomous Database (ATP-D) datapump settings.

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job-20210713232554

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SUCCEEDED

Job Information Tags

OCID: ...zcvj3a [Show](#) [Copy](#) Type: Evaluation
Created: Tue, Jul 13, 2021, 23:25:54 UTC

Resources

- Metrics
- Phases**
- Unsupported Objects

Phases

Name	Status	Duration
Validate Source	Completed	15 s
Validate Target	Completed	46 s
Validate Datapump Source Settings	Completed	26 s
Validate Datapump Target Settings	Completed	23 s

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Start Migration

Under Migration, navigate to Database Migration, Migrations, and click [Create Migration](#). Then click [Start](#).

The migration process has seven phases as shown in the image below. It validates the source and target database details, takes an export of schemas from the source database, uploads the export to an Object Storage bucket, and then imports it into Autonomous Database using a private endpoint.

When the data is imported to Autonomous Transaction Processing, it compiles the objects to remove invalid objects and cleans up at the end. All database objects present in the source database schema are created in the target database, except objects that don't support Autonomous Database.

Before starting the migration to Autonomous Database using DMS, it is recommended to create the database user profiles and roles that are present in the source in the target. Also, remap all user-specific custom tablespaces with DATA and TEMP tablespaces in the target. Use autonomous dedicated support when creating table spaces with BIGFILE.

Database Migration Phases

DMS PHASE NAME	DESCRIPTION
Validate	Performs validation of the source and target database, Data Pump configuration and GoldenGate Hub if applicable.
Prepare	Creates any necessary directory objects for Data Pump, and creates a DB Link, if applicable. Prepares for and starts the GoldenGate Extract process, and enables supplemental logging if applicable
Export Initial Load	Starts and monitors the Data Pump Export on the source database.
Upload Data	Uploads Data Pump dump files from the source to OCI OSS.
Import Initial Load	Starts import of Data Pump Dumps to the target database, either from the OCI OSS bucket or via DBLINK, and monitors the Data Pump import progress.
Post Initial Load	Removes directory objects, access credentials, and DBLINK that were created for Data Pump by Database Migration.
Clean-up	Removes Autonomous Database access wallet from Database Migration.

When all seven phases are complete, data can be validated in target database. Datapump import log file is uploaded to Object Storage bucket provided in the migration job. Migration job log file is downloadable from console from the same page from where job is started.

The screenshot displays the Oracle Cloud console interface for a database migration job. At the top, the Oracle Cloud logo and search bar are visible. The breadcrumb trail indicates the path: Database Migration > Migrations > Migration Details > Job Details. The job ID is 'job-20210722094900'. A large green circle with the word 'JOB' and 'SUCCEEDED' below it indicates the job's status. Below this, there are buttons for 'Resume', 'Abort', 'Download Log', 'Add Tags', and 'Delete'. The 'Job Information' tab is active, showing the OCID as '...at5ba' and the creation time as 'Thu, Jul 22, 2021, 09:49:00 UTC'. The 'Phases' section contains a table with the following data:

Name	Status	Duration
Validate	Completed	4 s
Prepare	Completed	3 s
Export Initial Load	Completed	1 s
Upload Data	Completed	1 s
Import Initial Load	Completed	1 m 58 s
Post Initial Load	Completed	28 s
Cleanup	Completed	1 s

At the bottom of the console, there are links for 'Terms of Use and Privacy' and 'Cookie Preferences', and a footer indicating 'Showing 7 items' and 'Copyright © 2021, Oracle and/or its affiliates. All rights reserved.'

Troubleshooting and other Resources

DMS Job Logs

- The Database Migration Jobs Details page provides detailed information and logs for troubleshooting performance. On the Job Details page click *Download Log* to download a log of output from the migration job.

Datapump Export/Import Logs

- Datapump Export and Import logs are uploaded to the object storage location provided during creation of migration. They can be downloaded from the respective Job Phases “Export Initial Load” and “Import Initial Load” in the Migration Job page.

Database Error Messages

- https://docs.oracle.com/en/database/oracle/oracle-database/21/errmg/using_messages.html#GUID-CA5A766D-6CBF-4235-982F-86A6F34266CC

Troubleshooting Connection Creation Failures for Registered Databases

- <https://docs.oracle.com/en/cloud/paas/database-migration/dmsus/troubleshooting-database-migration-service.html#GUID-F110F161-4564-46C7-A379-ED5AE25E7553>

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