

Oracle Zero Downtime Migration 21.5 – Product Overview

Technical Brief

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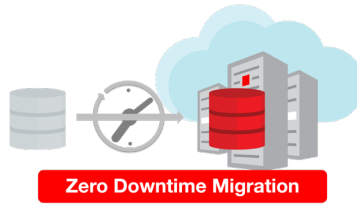


Figure 1. The Oracle Zero Downtime Migration Logo comprises a database and a Clock with an arrow pointing to a database deployed in the Cloud.

Purpose

Oracle customers are accelerating their migration into Oracle Cloud. However, migrating workloads has been challenging for many. Migrating database workloads from one system to another or into the cloud is easier said than done.

Based on years of experience migrating Oracle workloads, Oracle has developed Zero Downtime Migration (ZDM). ZDM is Oracle's premier solution for a simplified and automated database migration experience, providing zero to negligible downtime for the production system during the migration. ZDM allows Oracle customers to migrate their on-premises Oracle Databases directly and seamlessly to Oracle Database@Azure, Oracle Database@Google Cloud, Oracle Database@AWS and any Oracle-owned infrastructure, including Exadata Database Machine on-premises, Exadata Cloud at Customer (ExaDB-C@C), and Oracle Cloud Infrastructure. Oracle ZDM supports a wide range of Oracle Database versions and, as the name implies, ensures minimal to no impact on production databases during the migration.

ZDM follows Oracle Maximum Availability Architecture (MAA) principles¹ and incorporates products such as Oracle GoldenGate and Oracle Data Guard and technologies such as the Recovery Manager (RMAN), Data Pump, and Database Links.

Furthermore, since release 21.1, Oracle ZDM has supported Oracle's Autonomous Database as a cloud target, allowing customers to move their existing workloads into one of Oracle's premier database cloud services, leveraging its self-driving, self-securing, and self-repairing capabilities. Oracle ZDM migrates on-premises databases to Oracle Autonomous Transaction Processing and Oracle Autonomous Data Warehouse on the Serverless and Dedicated Exadata Infrastructure offerings.

In release 21.2, Oracle ZDM introduced support for source Oracle Databases on AWS RDS. This expanded ZDM's list of sources and gave customers a broader choice of migration possibilities. In release 21.3, Oracle ZDM further expanded its support of migrations from AWS RDS sources, enhanced its Data Guard support, and added full cross-platform support for its logical migration workflow.

In release 21.4, Oracle ZDM expanded its physical and logical migration functionality, enhancing control, automation, and ease of use for database migrations.

Starting in 21.5, Oracle ZDM introduces Physical Migration with In-Flight Upgrades, Hybrid Offline Migration, Cloud Native Disaster Recovery Automation, Autonomous to Autonomous Migration, and many more features. This technical brief provides an overview of Oracle Zero Downtime Migration 21.5, the latest version, explaining its underlying workflow and how our customers can efficiently and seamlessly migrate their Oracle Databases.

For more information on Oracle Zero Downtime Migration, please visit ZDM's product website.²

¹ <https://oracle.com/goto/maa>

² <https://www.oracle.com/goto/zdm>

Zero Downtime Migration

Architecture

Oracle Zero Downtime Migration (ZDM) is the Oracle Maximum Availability Architecture (MAA)- recommended solution for migrating Oracle Databases to the Oracle Cloud, including Exadata on-prem. ZDM's inherent design simplifies migration, ensuring negligible impact on production workloads. The Source Database to be migrated can be on-premises, deployed on Oracle Public Cloud Gen 1, Oracle Cloud Infrastructure, or 3rd Party Clouds like AWS. The Target Database deployment can be in a Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, Autonomous Database on Serverless and Dedicated Exadata Infrastructure, Oracle Database@Azure, Oracle Database@Google Cloud, and Oracle Database@AWS. ZDM automates the entire migration process, reducing human errors. ZDM leverages Oracle Database-integrated High Availability (HA) technologies such as Oracle Data Guard and Oracle GoldenGate and follows all MAA best practices that ensure downtime of production environments is eliminated where possible/minimized. Oracle ZDM supports Physical, Logical, and Hybrid Migration workflows.

Supported Configurations

Oracle ZDM 21.5 supports Oracle Database versions 11.2.0.4, 12.1.0.2, 12.2.0.1, 18c, 19c, 21c and 23ai. With ZDM 21c and the Logical Migration workflow, ZDM introduced support for database cross-version migration, providing an in-flight upgrade while migrating to the Oracle Cloud. Starting with ZDM 21.5 and introducing Physical Migration with in-flight upgrade, customers now have a second ZDM option for cross-version migration.

Oracle ZDM supports source Oracle Databases hosted on Linux, Solaris, and AIX operating systems. Oracle ZDM supports single-instance databases, Oracle RAC One Node databases, and Oracle RAC databases as sources. Oracle ZDM supports Oracle Database Enterprise & Standard Edition as Source and Target Databases.

Oracle ZDM allows the source database to be a non-CDB or a container database (CDB) with one or more Pluggable Databases (PDBs). Starting with release 21.1, Oracle ZDM allows non-CDB Databases to be migrated to Pluggable Databases on the fly, allowing for a complete conversion and adding more versatility to the migration workflow.

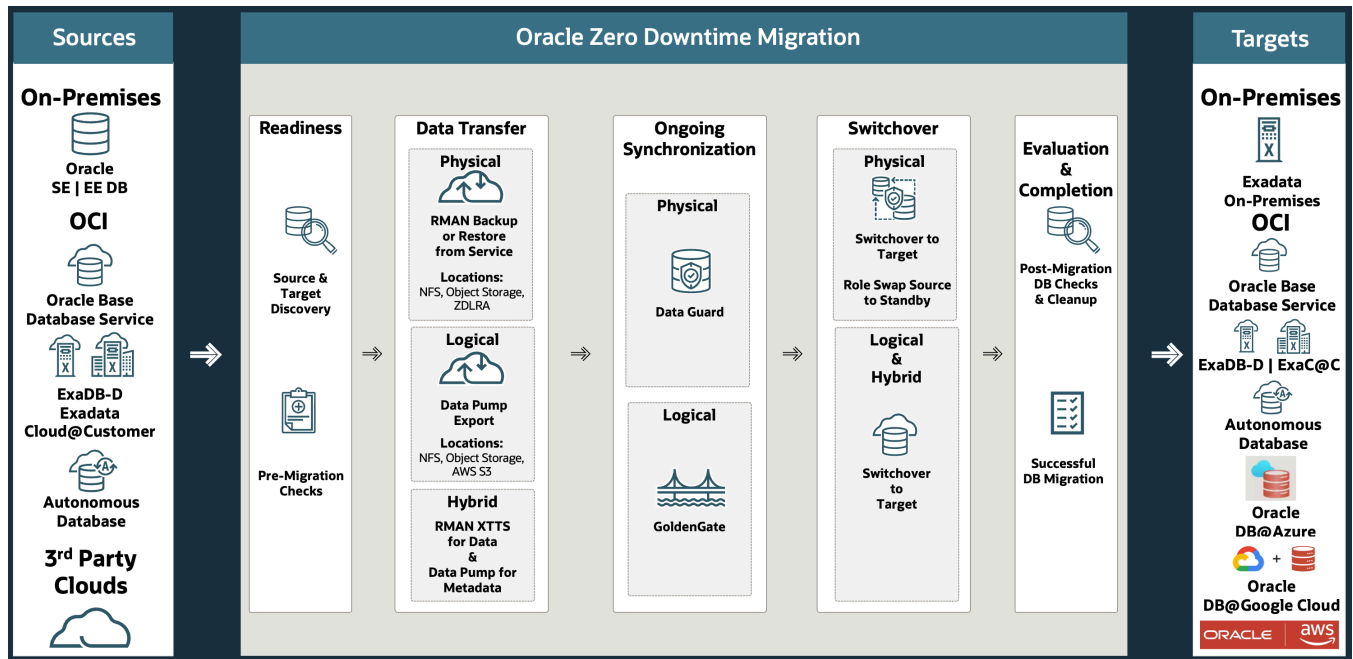


Figure 2. Oracle Zero Downtime Migration diagram, showing supported sources, migration phases, and supported targets.

Benefits

- **Simple & Efficient**
 - Oracle ZDM’s automated workflow seamlessly moves customers’ Oracle Database to the Oracle Cloud. By eliminating the need for manual configurations and operations, Oracle ZDM ensures an error-free and efficient migration to Oracle Cloud or Oracle Database Machine on-premises. Through testing and intensive vetting, customers found that ZDM’s automation results in time savings of up to 50% for planning and design and 30% for engineer hours for migration projects.³
- **Highly Available**
 - Oracle ZDM is Oracle Maximum Availability Architecture compliant. Its tight integration with Oracle Database technologies such as Oracle Data Guard and Oracle GoldenGate ensures the customer’s migration is completed with zero to negligible downtime and no production impact.
- **Cost-Effective**
 - Oracle ZDM has been free of charge since its first release, providing its customers with a comprehensive migration solution at no cost. Further, ZDM’s usage of other technologies like Advanced Security Option (ASO) and Advanced Compression Option (ACO) has a specific provision under Oracle Database’s Restricted License⁴. Finally, Oracle GoldenGate for migrations with ZDM has a special provision for a specific period per the Cloud Marketplace listing licensing agreements⁵.

³ <https://blogs.oracle.com/maa/post/nec-powers-customers-oracle-cloud-journey-with-oracle-zero-downtime-migration-zdm>

⁴ <https://docs.oracle.com/en/database/oracle/oracle-database/23/dblic/Licensing-Information.html#GUID-54E5D57D-DF9B-43EB-8B17-D712A231C6E5>

⁵ https://cloudmarketplace.oracle.com/marketplace/en_US/listing/96175416

What's New in Oracle Zero Downtime Migration 21.5

Physical Migration Enhancements

Introduced in ZDM release 19c, Physical Migration has evolved from a backup/restore and Data Guard automation workflow to a robust, game-changing migration methodology. Over the years, this workflow has been enhanced with new features such as standby as an initial source, Data Guard Broker Integration, Direct Data Transfer, and more. The following are the latest Physical Migration workflow features in ZDM 21.5:

Inflight Upgrades

Before release 21.5, ZDM's Physical Migration workflow only allowed migrations between source and target databases of the same major release version. ZDM's 21.5 release introduces physical migration with in-flight upgrades. This new feature enables customers to migrate their 11.2.0.4 and 12c Oracle databases into Oracle19c databases. It also supports migration from 19c source databases to 23ai targets.

ZDM automates the new in-flight upgrade capabilities by leveraging existing automation in Oracle's rich technology stack. For multitenant source databases, ZDM uses a temporary target database that is the same version as the source database. ZDM performs an initial migration to this temporary target and then leverages Oracle Cloud Infrastructure's tooling to upgrade the desired version of a new database in the cloud.

For non-multitenant source databases, ZDM performs an initial migration using a temporary non-CDB target database for customers to migrate and upgrade a non-CDB database. Upon completing this initial phase, ZDM leverages AutoUpgrade to convert to multitenant and upgrade the database to the desired version.

Cloud Native Disaster Recovery Automation

Primary/standby database configurations using Oracle Data Guard are a staple of Oracle's Maximum Availability Architecture and a best practice followed by many customers. Data protection, high availability, and disaster recovery for enterprise data in an Oracle database are the main goals of an Oracle Data Guard configuration.

ZDM now supports physical migrations with Native Disaster Recovery Configuration in the cloud. Before ZDM 21.5, customers migrated their on-premises Oracle Databases, single instance or RAC databases, and manually created an Oracle Data Guard configuration in the cloud post-migration. ZDM now, post switchover, creates an Oracle Data Guard configuration in the cloud so customers can benefit from a Cloud-Native Disaster Recovery architecture containing a primary and a standby database in the cloud.

Logical Migration Innovations

Introduced in ZDM 21c, Logical Migration expanded ZDM's available workflows and provided customers with three key advantages: migration to Oracle's Autonomous Database, in-flight upgrades, and cross-endian migration. In ZDM 21.5, new features and functionality have further enhanced Logical Migration.

Autonomous Database as a Source

ZDM now supports migration from Oracle Autonomous databases into other Oracle Autonomous Databases. This new feature allows customers to migrate and move Oracle Autonomous Databases between tiers, Serverless or on Dedicated Exadata Infrastructure.

GoldenGate Enhancements

- **Replication Mode** now supports integrated and non-integrated modes, allowing customers to choose GoldenGate's mode versatility according to their specific migration use case.
- **Audit Trail** import is now enabled, with a specific parameter at the response file level.
- **Large Transaction** split support. Customers can now specify large transaction sizes via the response file; ZDM will then divide large transactions into pieces that will be applied in parallel by individual GoldenGate appliers, resulting in faster processing by GoldenGate.
- **Feature Groups** are now supported via a response file parameter. Customers can specify which feature groups of procedural calls will be replicated (for instance, all_supported, AQ, FGA, DBFS, etc.)
- **Constraint Handling** is now optimized via DBOPTIOS DEFERREFCONST for the Oracle GoldenGate Replicat.
- **Concurrent Migrations** are now supported with the same Oracle GoldenGate deployment, allowing each job to the specific database wallet required for the migration. This new feature is valid for both autonomous and non-autonomous targets.
- **Pre-checks** for ggsadmin have been improved, and ZDM will notify users about missing privileges.
- **GoldenGate Schema** can now be user-specified and different from the standard ggsadmin.

Data Pump Enhancements

- **Dump File** retention and reuse. This new feature allows customers to store exported data pump files and reuse them for future migrations, thus saving time and avoiding repeated export jobs.
- **Advanced Queue** objects are now supported for post-import reload if specified via the user's response file.

Further Logical Migration Enhancements

- **OCI File Storage Service (FSS)** is now supported as a data transfer medium for Oracle Autonomous Database targets.
- **Materialized Views Automated Refresh** customers can leverage this feature by providing a response file parameter indicating that ZDM will automatically refresh materialized views and then post a data pump import.

New Migration Workflow: Offline Hybrid Migration

For the first time since Oracle ZDM 21c, we are introducing a new migration workflow, Hybrid Migration. This new offline workflow leverages RMAN transportable tablespaces for data migration and Data Pump Import/Export for metadata. Hybrid Migration requires NFS to be configured as a backup location, allows for cross-endian and cross-version migration, and is supported for the following targets: Oracle Base Database Service (BaseDB), Oracle Exadata Database Service on Dedicated Infrastructure (ExaDB-D), Oracle Exadata Database Service on Cloud@Customer (ExaDB-C@C), Oracle Exadata On-premises, ExaDB-D on Oracle Database@Azure.

Oracle Zero Downtime Migration - Migration Workflows

Physical Migration

Physical Offline Migration with a Backup Location

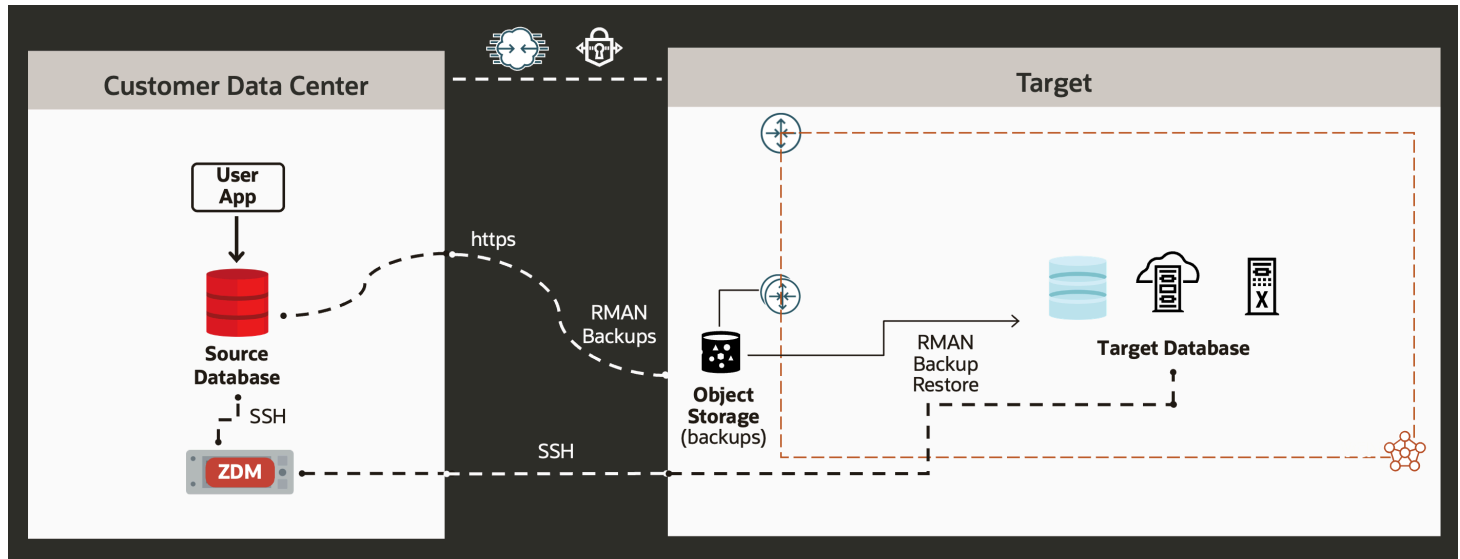


Figure 3. ZDM Physical Offline Migration Architectural Diagram

A standard physical offline migration with a backup location includes/consists of the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration
3. ZDM connects the source database to the backup location.
4. ZDM orchestrates the transfer of database backup files.
5. ZDM instantiates the target database.
6. ZDM switches over and finalizes the migration process.

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Physical Online Migration with a Backup Location

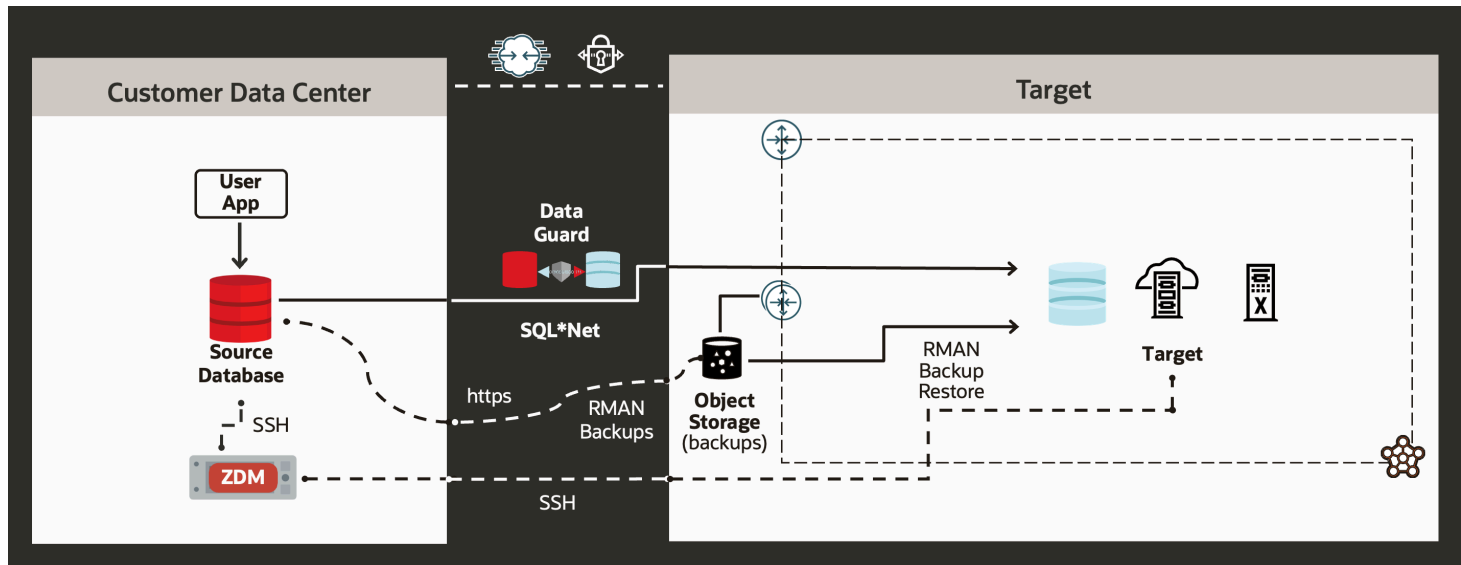


Figure 4. ZDM Physical Online Migration with Backup Location Architectural Diagram

A standard physical online migration with a backup location will take the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration
3. ZDM connects the source database to the backup location.
4. ZDM orchestrates the transfer of database backup files.
5. ZDM instantiates a standby database on the target.
6. ZDM synchronizes primary and standby.
7. ZDM switches over and swaps roles.
8. ZDM finalizes the migration process.

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Physical Online Migration with Direct Data Transfer

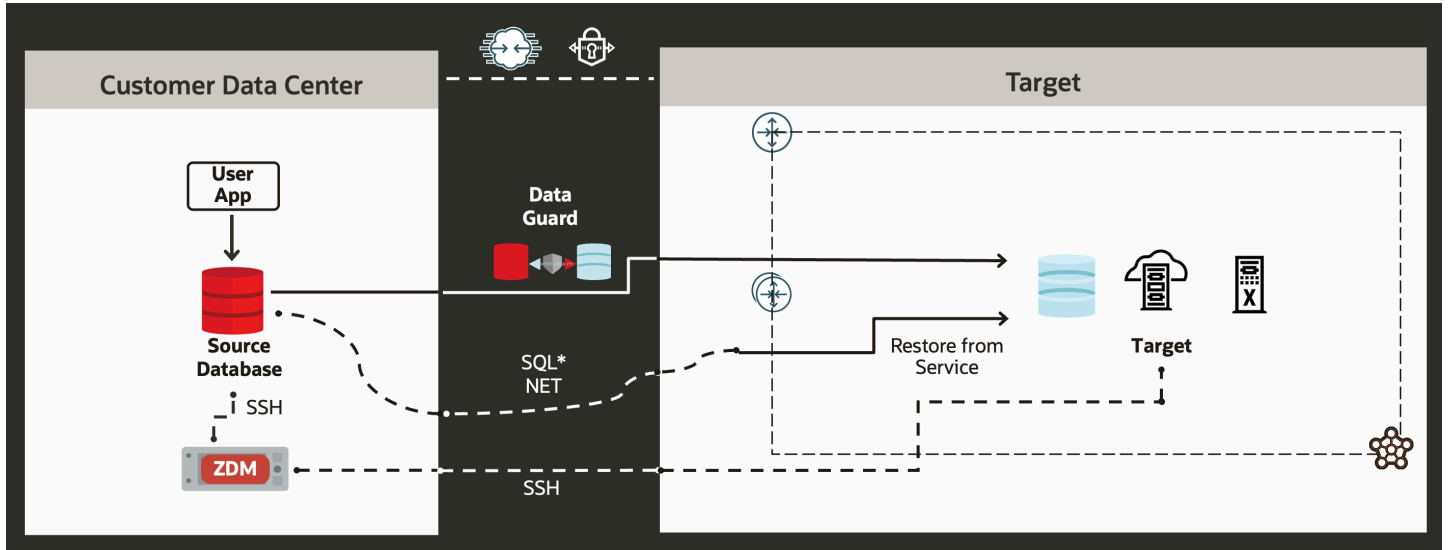


Figure 5. ZDM Physical Online Migration with Direct Data Transfer Architectural Diagram

A standard physical online migration with direct data transfer will take the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration
3. ZDM orchestrates a restore from service between source and target.
4. ZDM instantiates a standby database on the target.
5. ZDM synchronizes primary and standby.
6. ZDM switches over and swaps roles.
7. ZDM finalizes the migration process.

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Physical Online Migration with Non-CDB to PDB Conversion

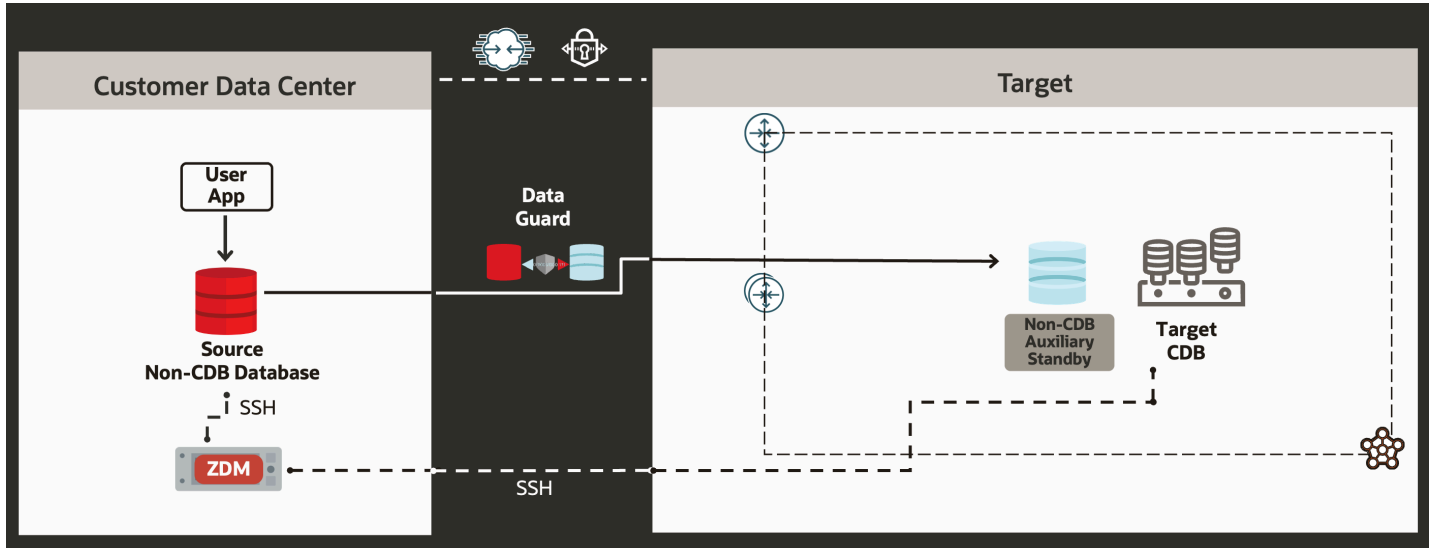


Figure 6. ZDM Physical Online Migration with Non-CDB to PDB Conversion Architectural Diagram

A standard physical online migration with Non-CDB to CDB conversion will take the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration
3. ZDM orchestrates the transfer of database backup files
4. ZDM instantiates an auxiliary temporary non-cDB database at the target
5. ZDM synchronizes primary and auxiliary standby
6. ZDM switches over and swaps roles
7. ZDM performs post-validations
8. ZDM performs an unplug/plug operation
9. ZDM finalizes the migration process

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Physical Online Migration with In-Flight Upgrade of a CDB Database

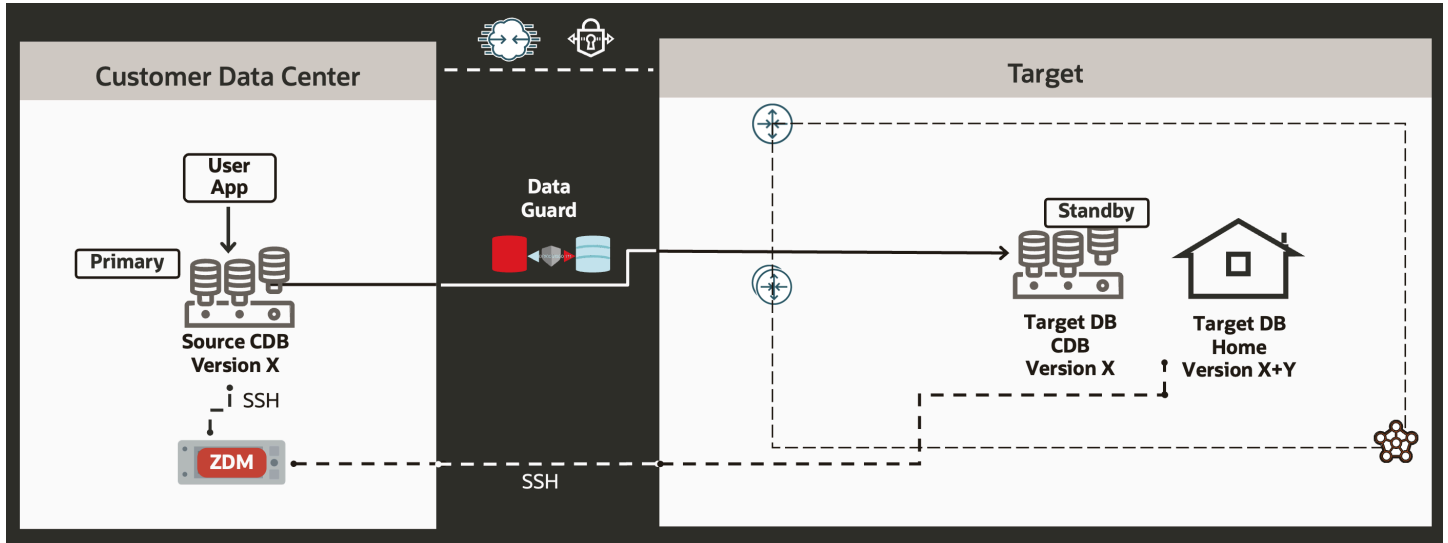


Figure 7. ZDM Physical Online Migration with In-Flight Upgrade of a CDB Database Architectural Diagram

A standard physical online migration with an In-Flight Upgrade of a CDB Database will take the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration
3. ZDM orchestrates the transfer of database backup files
4. ZDM instantiates a target database of the same version as the source
5. ZDM synchronizes primary and temporary same-version standby
6. ZDM switches over and swaps roles
7. ZDM performs post-validations
8. ZDM performs an upgrade
9. ZDM finalizes the migration process

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Physical Online Migration with In-Flight Upgrade and Non-CDB to PDB Conversion

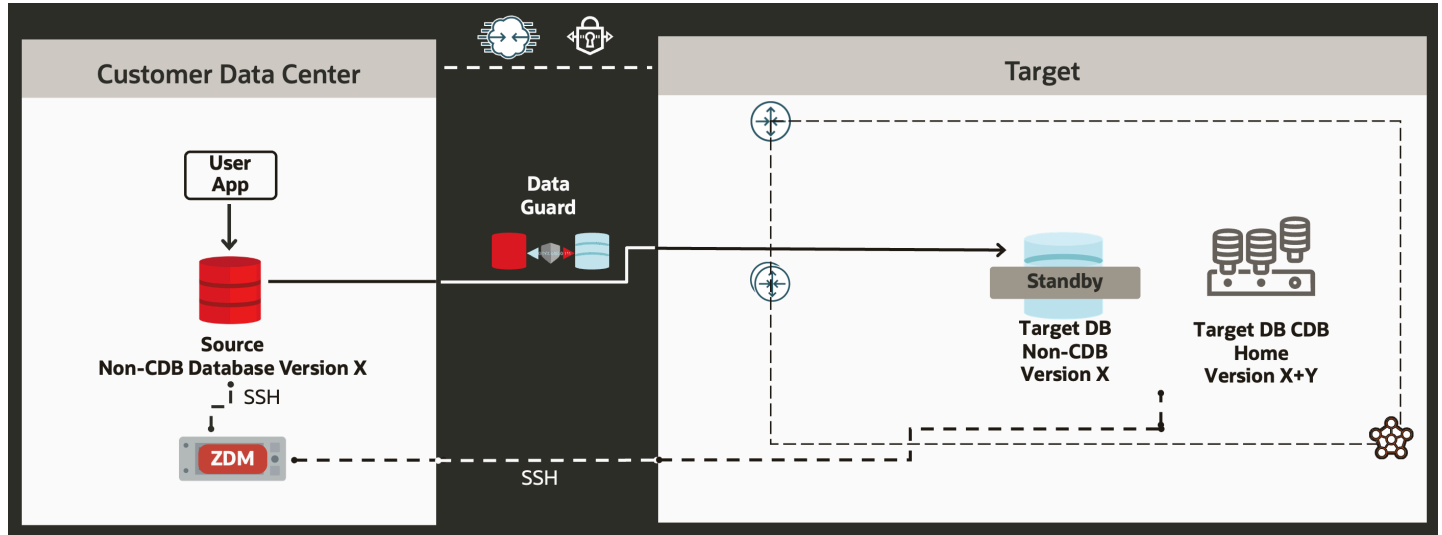


Figure 8. ZDM Physical Online Migration with In-Flight Upgrade and Non-CDB to PDB Conversion Architectural Diagram

A standard physical online migration with In-Flight Upgrade and Non-CDB to PDB conversion will take the following steps:

1. Download and Configure ZDM.
2. ZDM starts database migration
3. ZDM orchestrates the transfer of database backup files
4. ZDM instantiates an auxiliary temporary non-CDB database at the target
5. ZDM synchronizes primary and auxiliary standby
6. ZDM switches over and swaps roles
7. ZDM performs post-validations
8. ZDM leverages autoupgrade to perform an upgrade plus an unplug/plug operation
9. ZDM finalizes the migration process

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Physical Online Migration with Cloud Native Disaster Recovery Automation

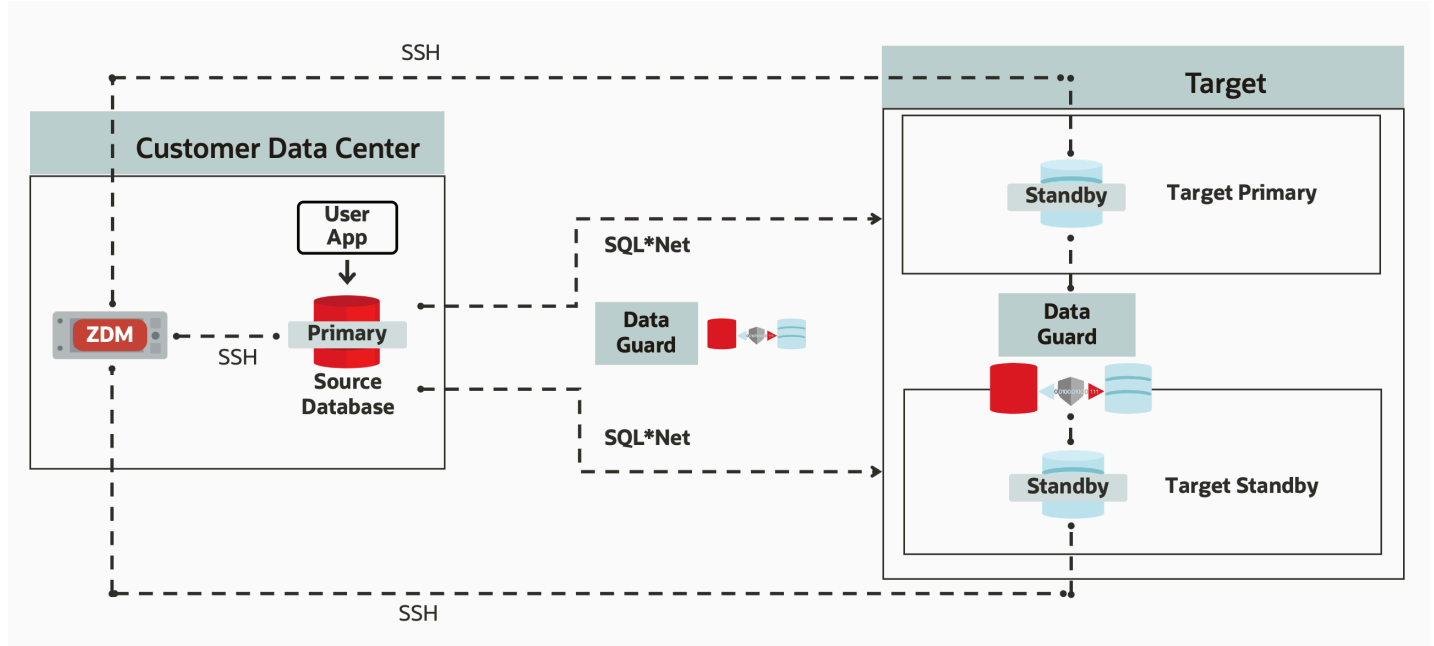


Figure 9. ZDM Physical Online Migration with Cloud Native Disaster Recovery Automation Architectural Diagram

A standard physical online migration with Cloud Native Disaster Recovery Automation will take the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration
3. ZDM starts a restore from service operation
4. ZDM instantiates a standby database on the target primary
5. ZDM synchronizes primary and standby on the target primary
6. ZDM starts a restore from service operation
7. ZDM instantiates a standby database on the target standby
8. ZDM synchronizes source and target standbys
9. ZDM monitors switchover readiness
10. ZDM performs switchover and swaps roles
11. ZDM configures the target primary and restores the cloud broker configuration
 - a. ZDM restores cloud broker configuration between cloud target primary and cloud target standby
 - b. ZDM configures the target primary to ship redo logs to the target standby
12. ZDM performs post-validations
13. ZDM finalizes the migration process

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Logical Migration

Logical Offline Migration with a Backup Location

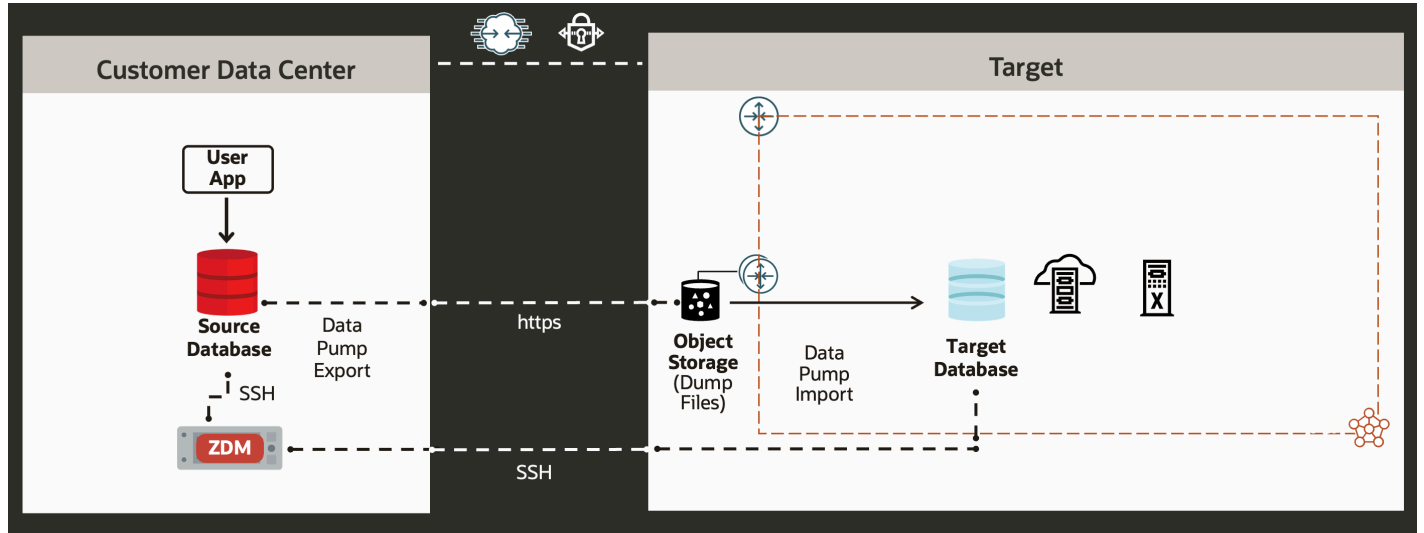


Figure 10. ZDM Logical Offline Migration Architectural Diagram

A standard logical offline migration with a backup location will take the following steps:

1. Download and configure ZDM.
2. ZDM starts database migration.
3. ZDM connects the source database to the backup location
4. If the target is an autonomous database, ZDM will leverage the cloud pre-migration advisor to assess the source database and provide valuable insights.
5. ZDM exports via data pump from the source to a backup location.
6. ZDM imports data dump files from the backup location and sends them to the target.
7. ZDM instantiates the target database.
8. ZDM switches over and finalizes the migration process.

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, Autonomous Database on OCI, and Oracle Database@Azure support this workflow.

Logical Online Migration with a Backup Location

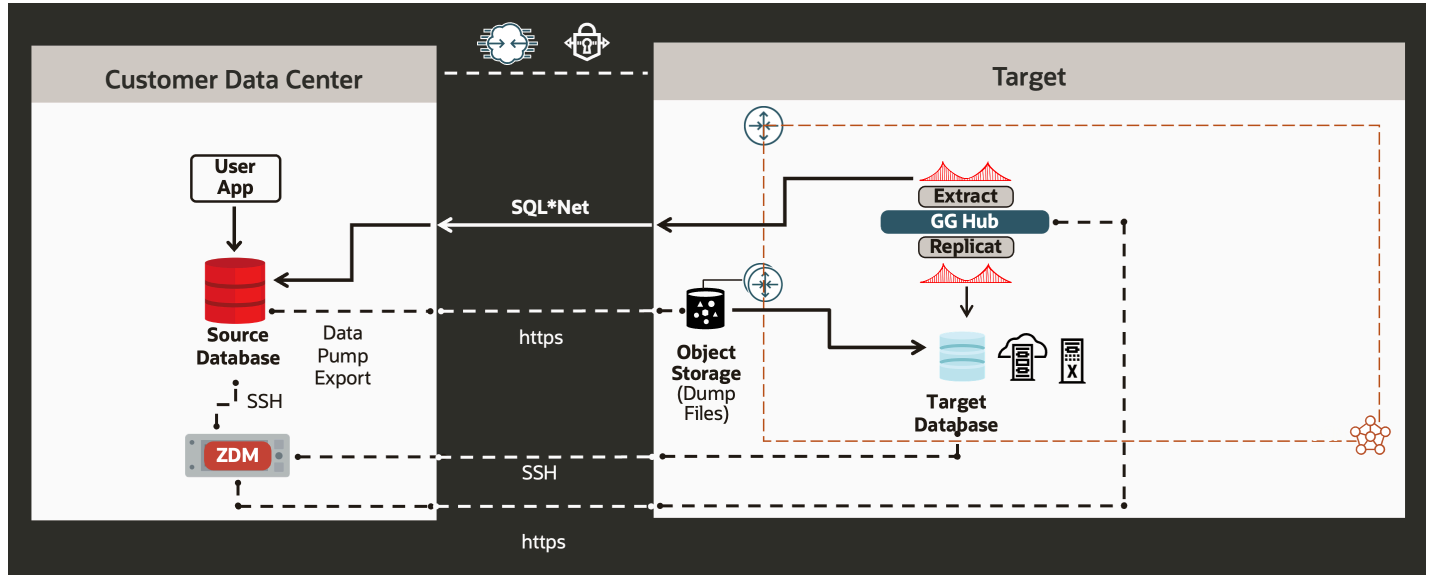


Figure 11. ZDM Logical Online Migration Architectural Diagram

A standard logical online migration will take the following steps:

1. Download & configure ZDM.
2. ZDM starts database migration.
3. ZDM connects to the source, target, and backup location.
4. If the target is an autonomous database, ZDM will leverage the cloud pre-migration advisor to assess the source database and provide valuable insights.
5. ZDM configures GoldenGate and captures source transactions.
6. ZDM exports via data pump from the source to a backup location.
7. ZDM imports data dump files from the backup location and sends them to the target.
8. ZDM configures GoldenGate and starts applying changes.
9. ZDM switches over and finalizes the migration process.

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, Autonomous Database on OCI, and Oracle Database@Azure support this workflow.

Hybrid Migration

Hybrid Offline Migration with a Backup Location

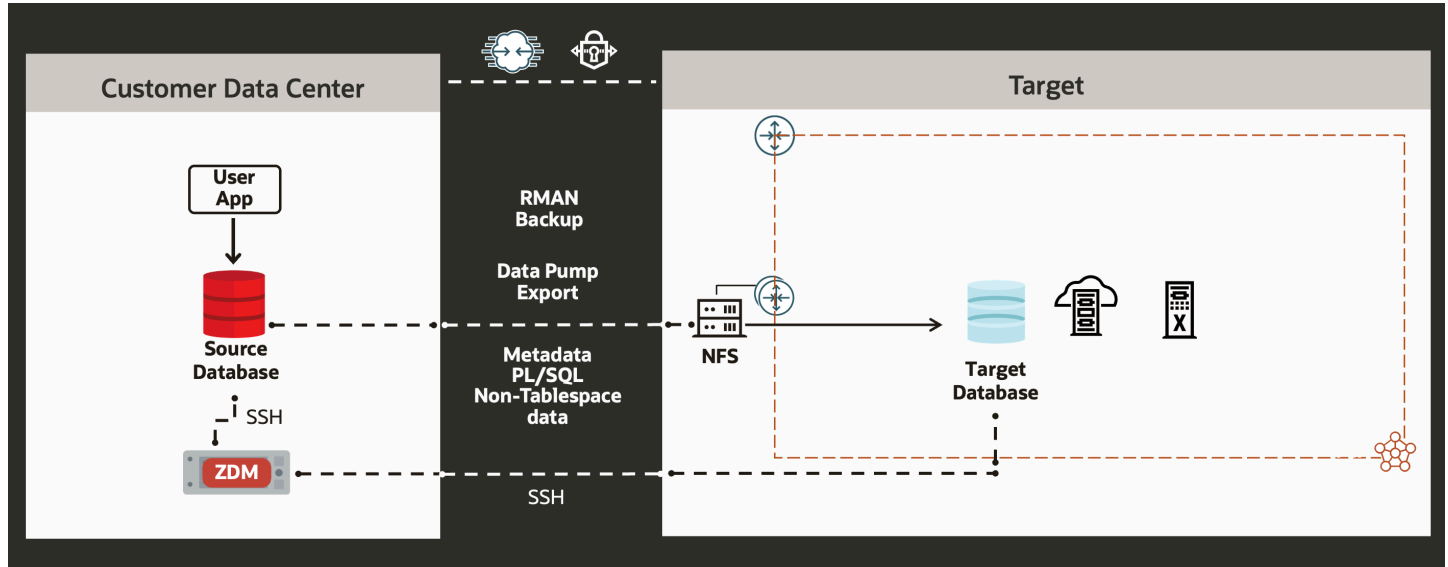


Figure 12. ZDM Hybrid Offline Migration Architectural Diagram

A standard Hybrid Offline migration will take the following steps:

1. ZDM connects to the source, target
2. ZDM orchestrates tablespace-level backups
 - a. Performs a full backup of the tablespaces
 - b. Performs an incremental backup of the tablespaces
 - c. Copies wallet files as required
3. ZDM performs a full restore of tablespaces as foreign tablespaces
4. ZDM sets source tablespaces as read-only and performs final incremental backup
 - a. Performs an incremental backup of the tablespaces and metadata export of the tablespaces using RMAN
 - b. Copies wallet files as required
5. ZDM exports metadata via Data Pump
 - a. Export includes:
 - i. Metadata, PL/SQL objects, and non-tablespaces data
6. ZDM imports metadata and performs an incremental restore
 - a. 1st Import of user metadata from data pump
 - b. 2nd Incremental restore with RMAN + import of tablespace metadata generated by RMAN
 - c. 3rd import of all other metadata (objects and non-tablespace data)
7. ZDM performs post actions, cleans up, and finalizes

Oracle Base Database Service, Exadata Database Service on Dedicated Infrastructure, Exadata Database Service on Cloud@Customer, Exadata On-premises, and ExaDB-D on Oracle Database@Azure support this workflow.

Summary

Oracle Zero Downtime Migration is Oracle's premier solution for a simplified and automated database migration experience, providing zero to negligible downtime for the production system during the migration. Oracle ZDM provides customers with a direct and seamless migration for Oracle Databases to Oracle Cloud Infrastructure, Oracle Database@Azure, Oracle Database@Google Cloud, and Exadata Database Machine On-premises, supporting a wide range of Oracle Database versions as sources and Oracle Database Cloud Services as targets. Customers have a wide array of Source Oracle Database for their migration; Oracle ZDM supports Oracle databases on Solaris, Linux, AIX, and AWS RDS.

Oracle ZDM supports Standard Edition and Enterprise Edition Oracle Databases, offering different migration approaches ranging from offline backup and restore, over Data Pump and Database Links-based migrations, to using technologies such as Oracle Data Guard and Oracle GoldenGate for physical, logical, and hybrid migration workflows. Customers can leverage features like ZDM's Physical Direct Data Transfer to avoid using a backup location and thus achieve a faster and more efficient migration.

Migration to Oracle Cloud Infrastructure, Oracle Database@Azure, Oracle Database@Google Cloud, and, Oracle Database@AWS can be achieved in as little as six simple steps for offline migrations and eight for online-based migrations. In any scenario, Oracle ZDM provides a Maximum Availability Architecture-compliant migration, ensuring high availability, data protection, and disaster recovery for our customer's journey to the Cloud.

Oracle ZDM offers fleet-level migrations, catering to all single instance, Oracle RAC, and RAC One Node database migration scenarios, making it the Best-In-Class solution for moving our customer's databases to the Oracle Cloud Infrastructure, Oracle Database@Azure, Oracle Database@Google Cloud, and Exadata Database Machine On-premises. It provides:

- A wide array of migration sources and targets
- Multiple migration workflows
- Best-in-Class features & functionality
- Fully automated migrations
- Cost-effectiveness

For more information, step-by-step guides, and product documentation, please visit the Oracle Zero Downtime Migration website at www.oracle.com/goto/zdm.

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