
ORACLE
Zero Downtime Migration
The easy way to the cloud
Daniel Overby Hansen / Mike Dietrich
Database Upgrade, Utilities and Patching
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NEW Episode 1

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

NEW Seminar 6

Move to the Cloud – Not only for techies

115 minutes – Apr 8, 2021

NEW Episode 7

Cool Features – Not only for DBAs

110 minutes – Jan 14, 2021

NEW Episode 8

Database Upgrade Internals – and so much more

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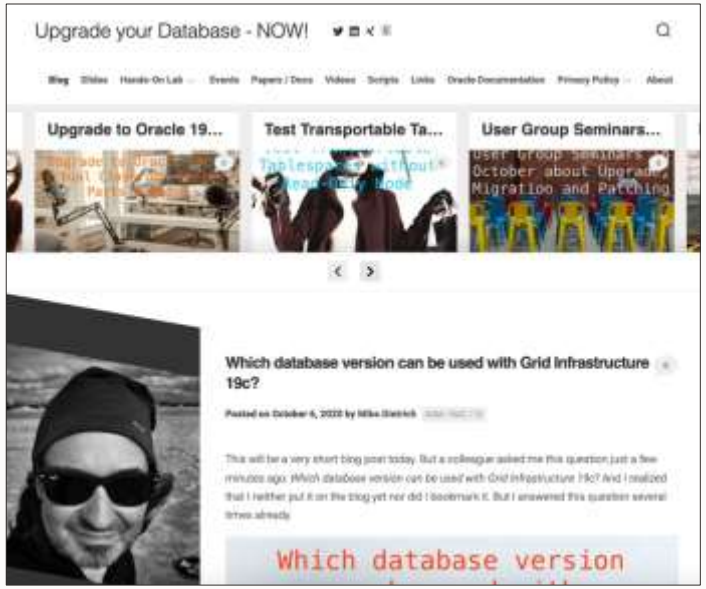

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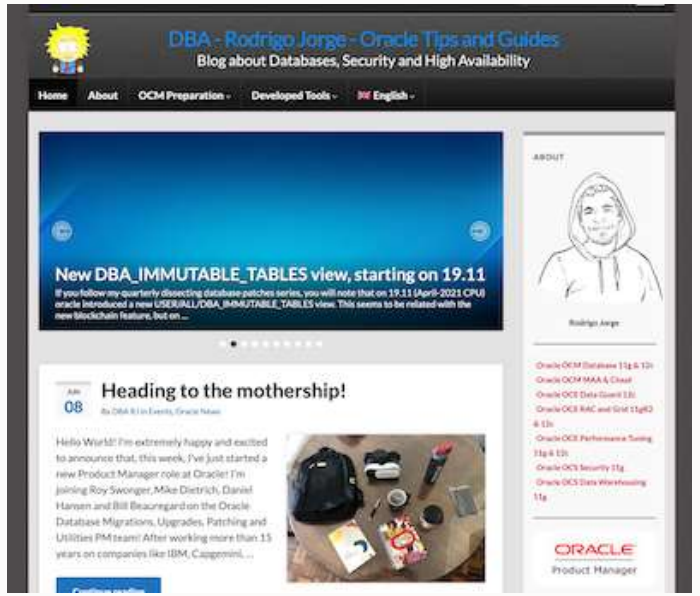

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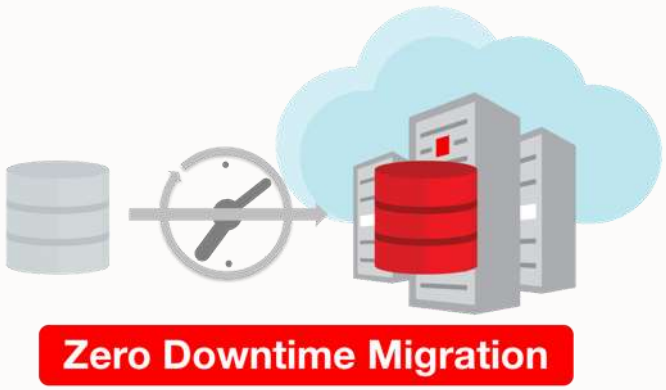
Introduction | Birds-Eye

Introduction | Key Features



- Simple
- Reliable
- Scalable
- Secure
- Proven
- Free

Prerequisites And Features | Location

Location

Release

Platform

Edition

Architecture

Encryption

Source database can be located

- On-premises
- Oracle Cloud Infrastructure Classic (OCI-C)
- Oracle Cloud Infrastructure (OCI)
  - Cross-region / cross-location migration
  - System migration

Prerequisites And Features | Release

- Location
- **Release**
- Platform
- Edition
- Architecture
- Encryption

Source databases

- 11.2.0.4
- And anything newer

Target databases

- Physical migrations: Database release must be the same
- Logical migrations: Database release can be the same or higher

Pro Tip: It is possible to migrate to a higher patch level. If needed, ZDM invokes `datapatch`

Prerequisites And Features | Platform

- Location
- Release
- **Platform**
- Edition
- Architecture
- Encryption

Supported source platform

- Linux

Supported target platforms

- Autonomous (dedicated and shared)
  - ATP
  - ADW
- DB Systems (VM, BM and Exadata)
- Exadata Cloud at Customer
- Exadata (on-prem)

Prerequisites And Features | Edition

- Location
- Release
- Platform
- **Edition**
- Architecture
- Encryption

Supported editions

- Enterprise Edition
- Standard Edition

Standard Edition restriction:

For zero downtime approach select logical migration

Migration between editions

- Restrictions apply

Pro Tip: True *Zero Downtime* requires an MAA compliant application

Prerequisites And Features | Architecture

- Location
- Release
- Platform
- Edition
- **Architecture**
- Encryption

Any architecture supported (non-CDB and CDB)

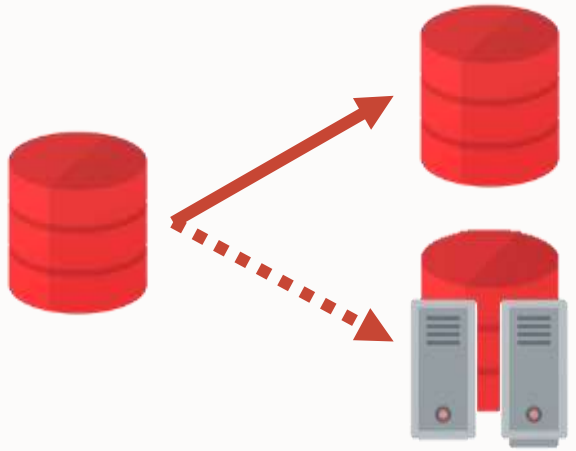
- Non-CDB
  - Migrate directly into a PDB
  - Keep it as a non-CDB
  - Convert to PDB
- CDBs
  - Migrate entire CDB
  - Migrate one PDB only

Prerequisites And Features | Architecture

- Location
- Release
- Platform
- Edition
- **Architecture**
- Encryption

Any type (single instance, RAC One Node, RAC)

- Single instance can be migrated to RAC
- RAC One Node will be migrated to RAC (physical only)
- RAC will be migrated to RAC (physical only)



Prerequisites And Features | Architecture

- Location
- Release
- Platform
- Edition
- **Architecture**
- Encryption

Any type (single instance, RAC One Node, RAC)

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- RAC One Node will be migrated to RAC (physical only)
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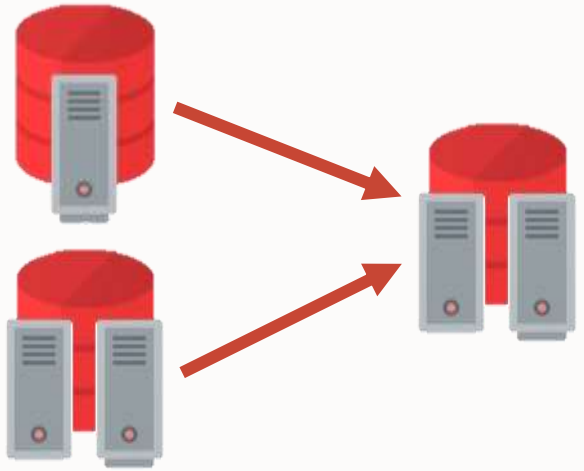


Prerequisites And Features | Encryption

- Location
- Release
- Platform
- Edition
- Architecture
- **Encryption**

Source database

- Unencrypted
- Encrypted

Target database

- Is always encrypted
- Unencrypted databases gets encrypted on-the-fly

Network connectivity

- Always and transparently encrypted

Migration | Options

PHYSICAL

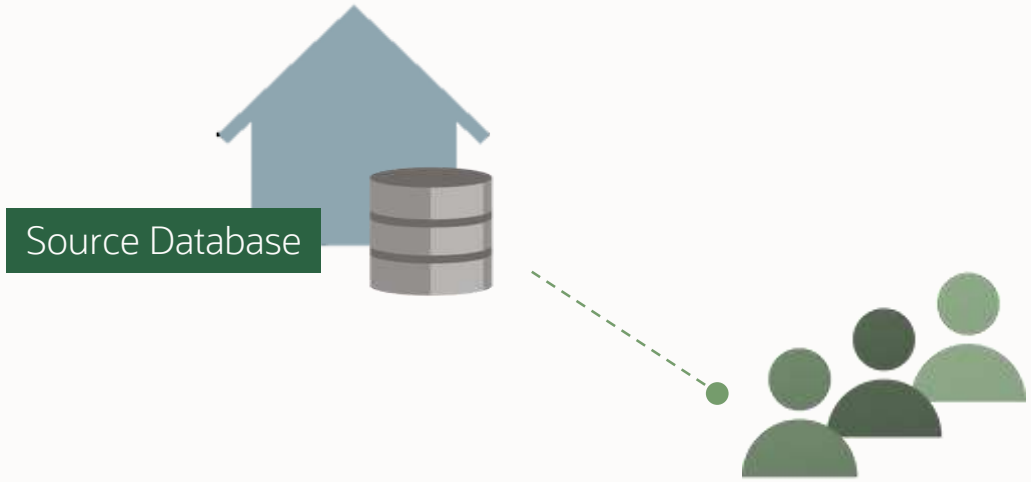
Online: Data Guard + switchover

Offline: Backup + restore

Standard Edition - offline only

Physical Migration | Overview

Users are connected to source database

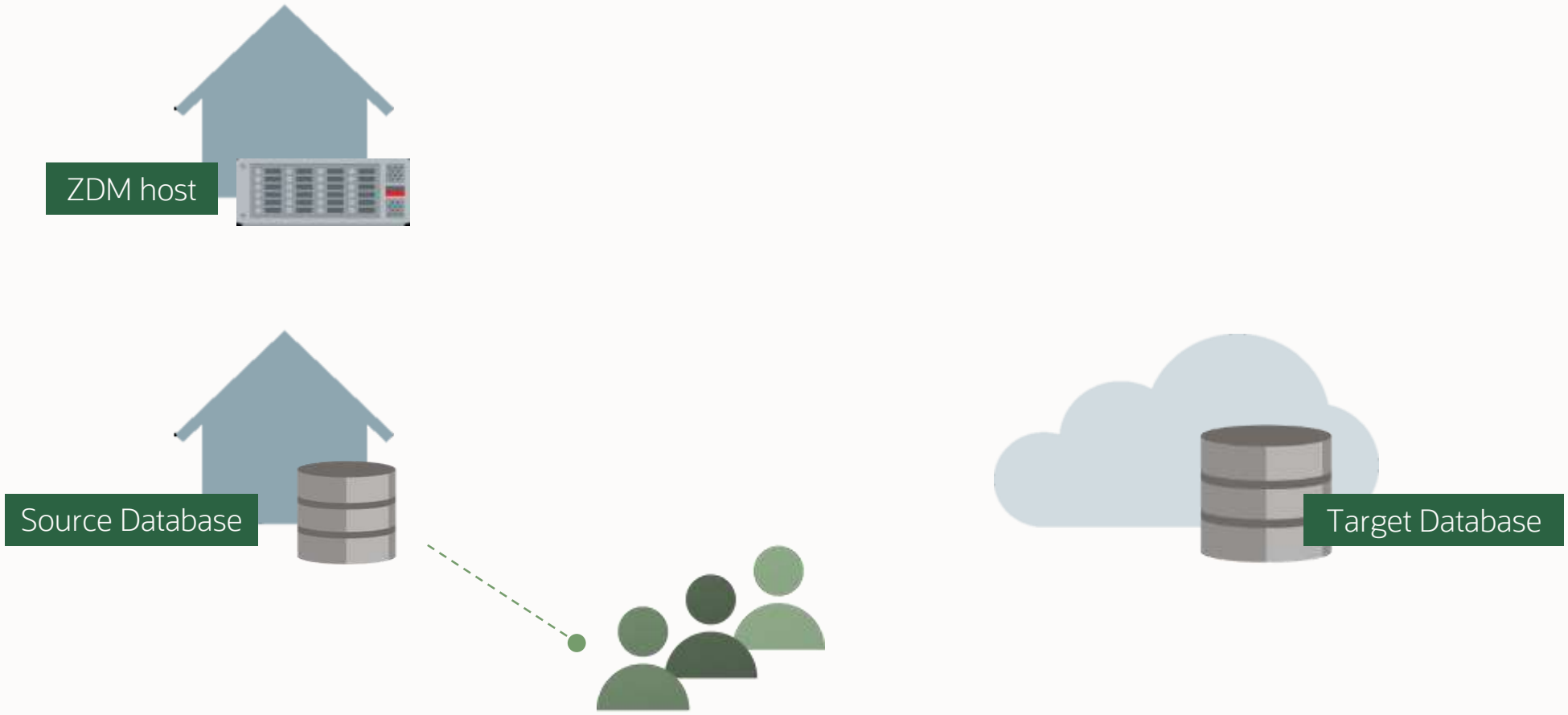


Physical Migration | Overview

Provision target database in OCI

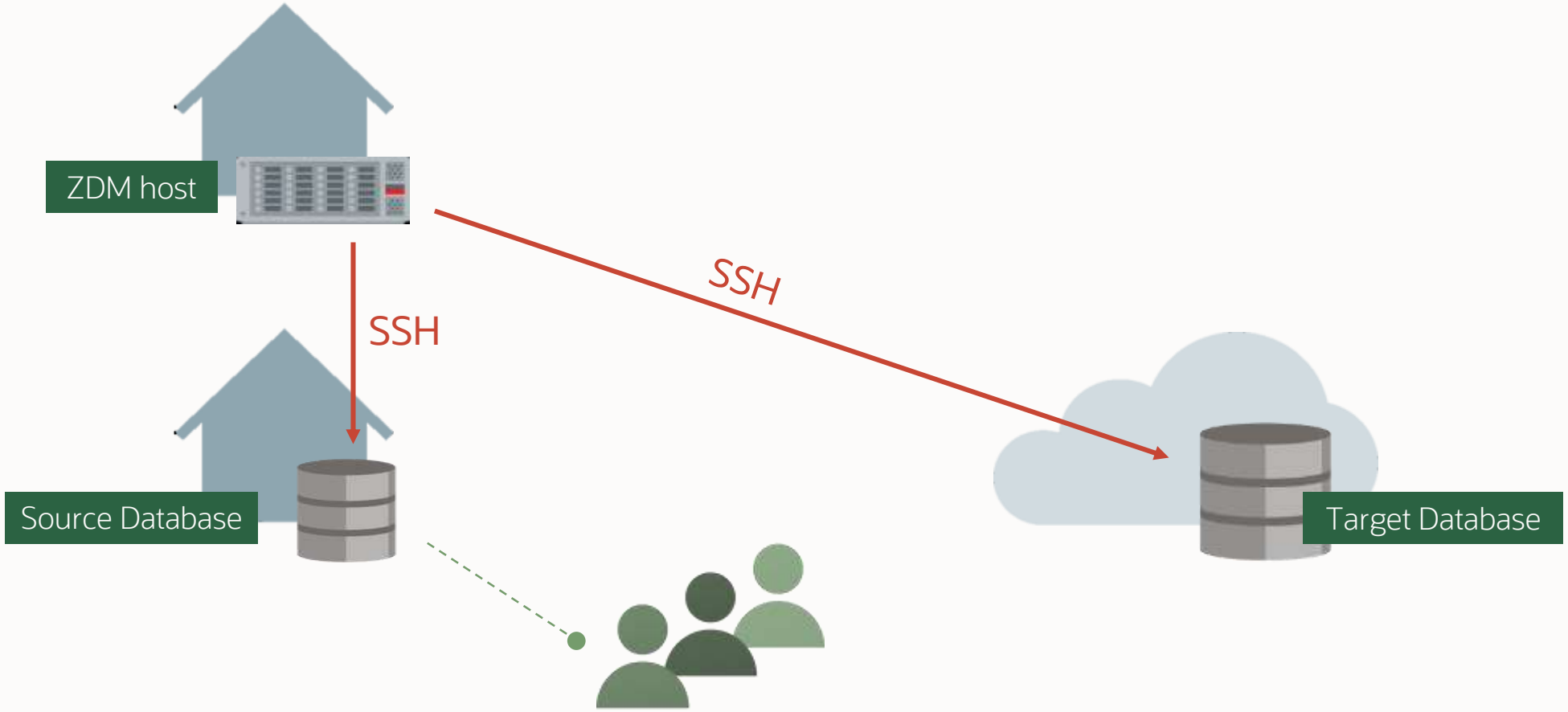
Physical Migration | Overview

Download and install ZDM



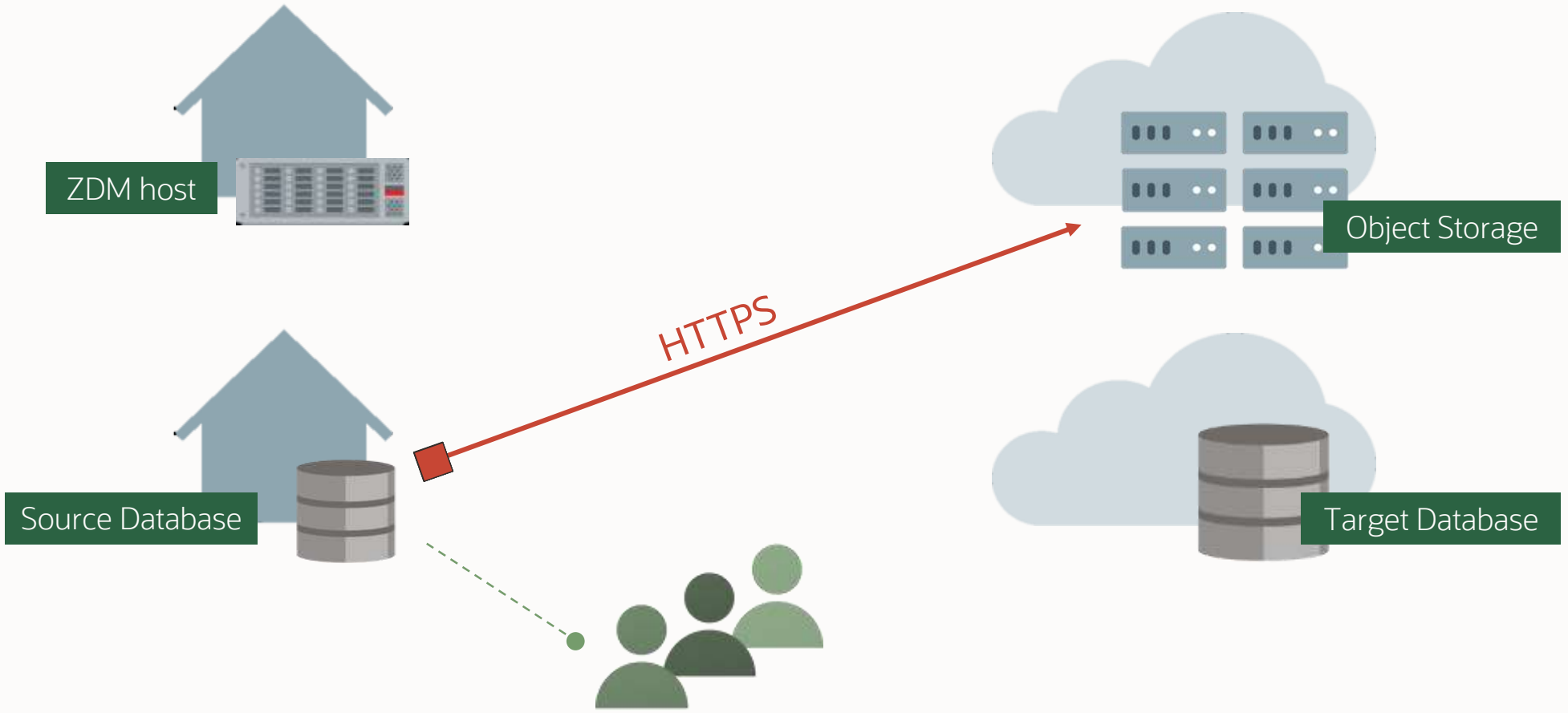
Physical Migration | Overview

ZDM connects to source and target database



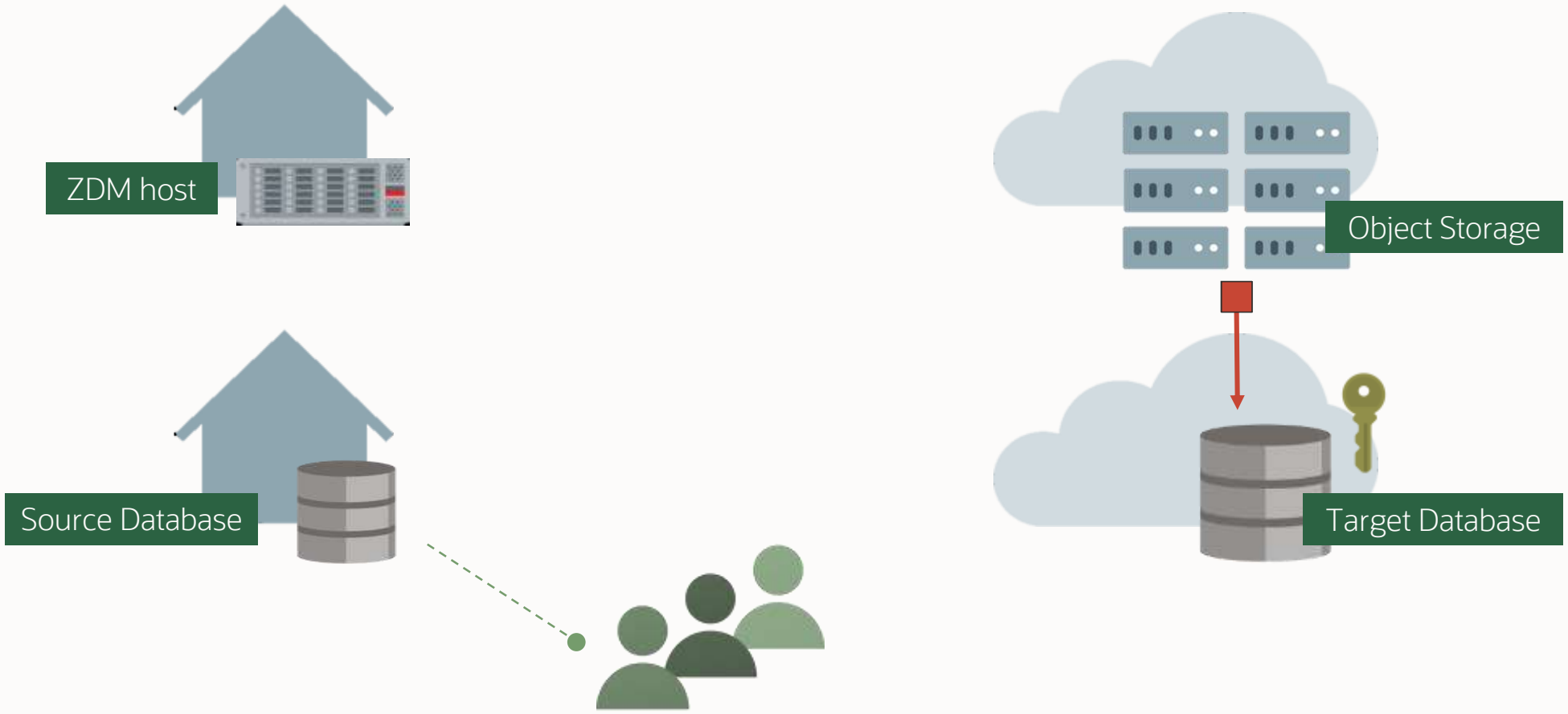
Physical Migration | Overview

Back up source database to object storage



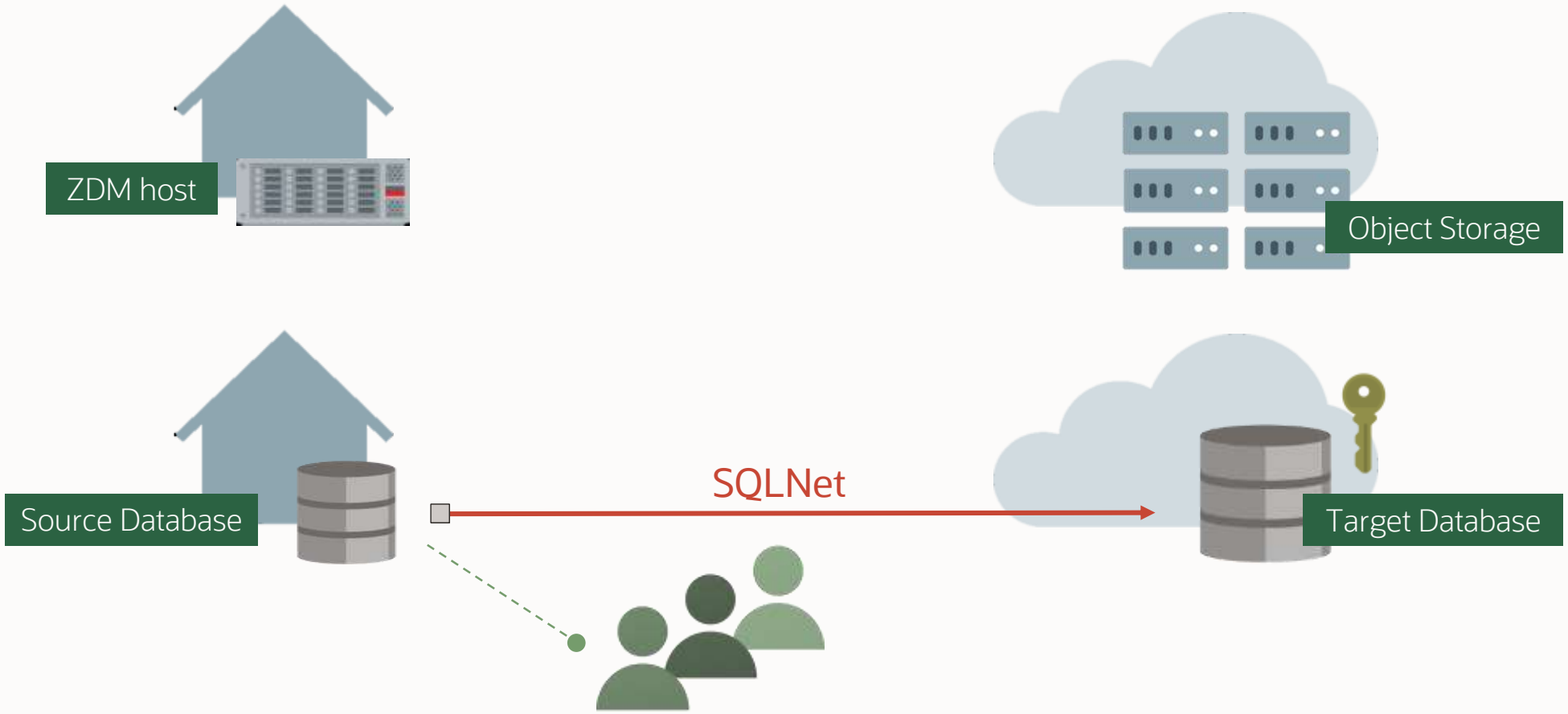
Physical Migration | Overview

Instantiate standby database from backup



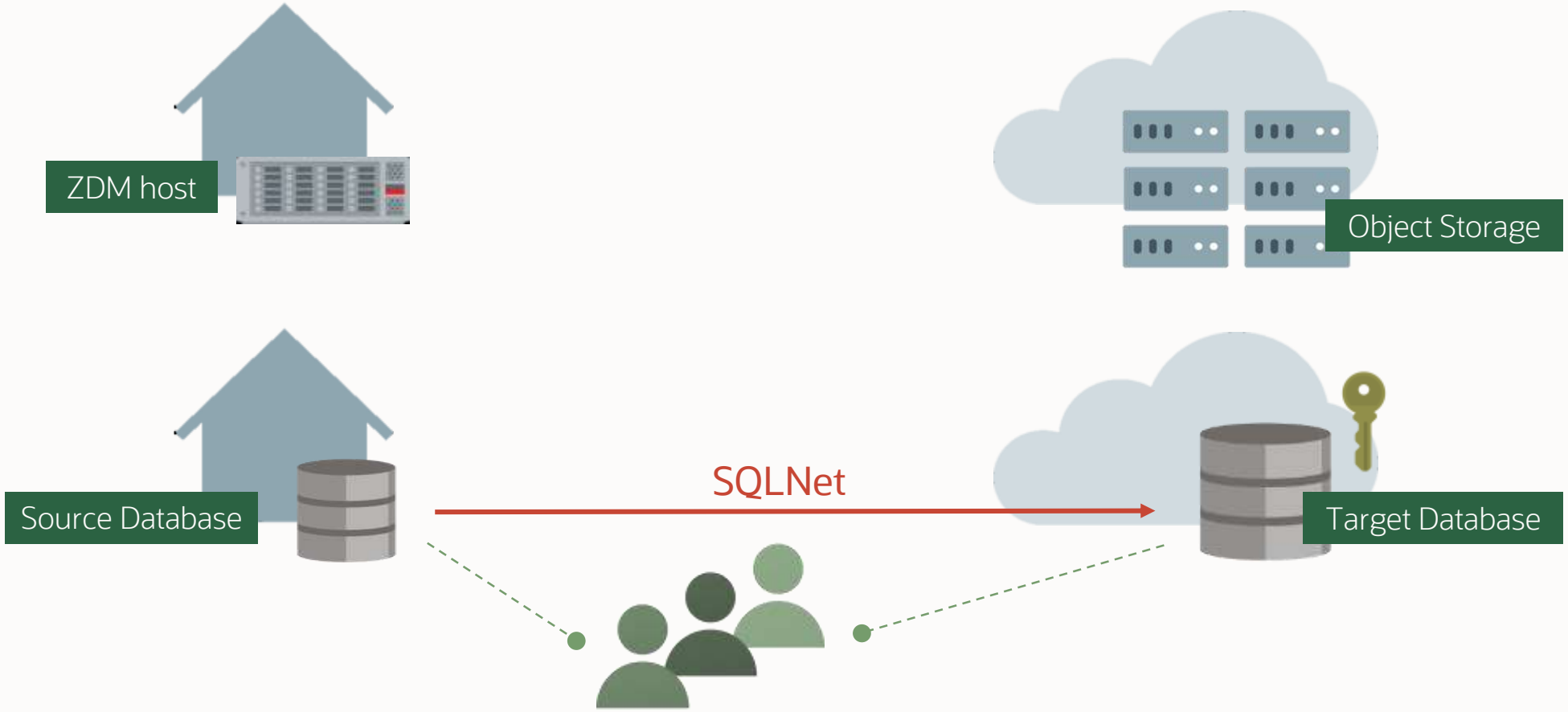
Physical Migration | Overview

Synchronize via redo apply



Physical Migration | Overview

At your will, switchover sessions



Physical Migration | Overview

Migration | Options

PHYSICAL

Online: Data Guard + switchover

Offline: Backup + restore

Standard Edition - offline only

LOGICAL

Online: Data Pump + GoldenGate

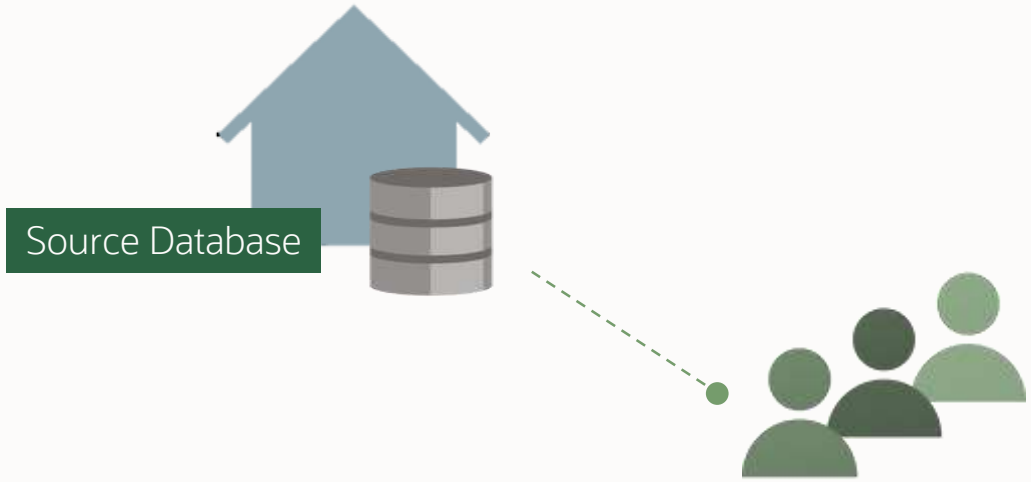
Offline: Data Pump

Via dump file or database link

Standard Edition - any approach

Logical Migration | Overview

Users are connected to source database

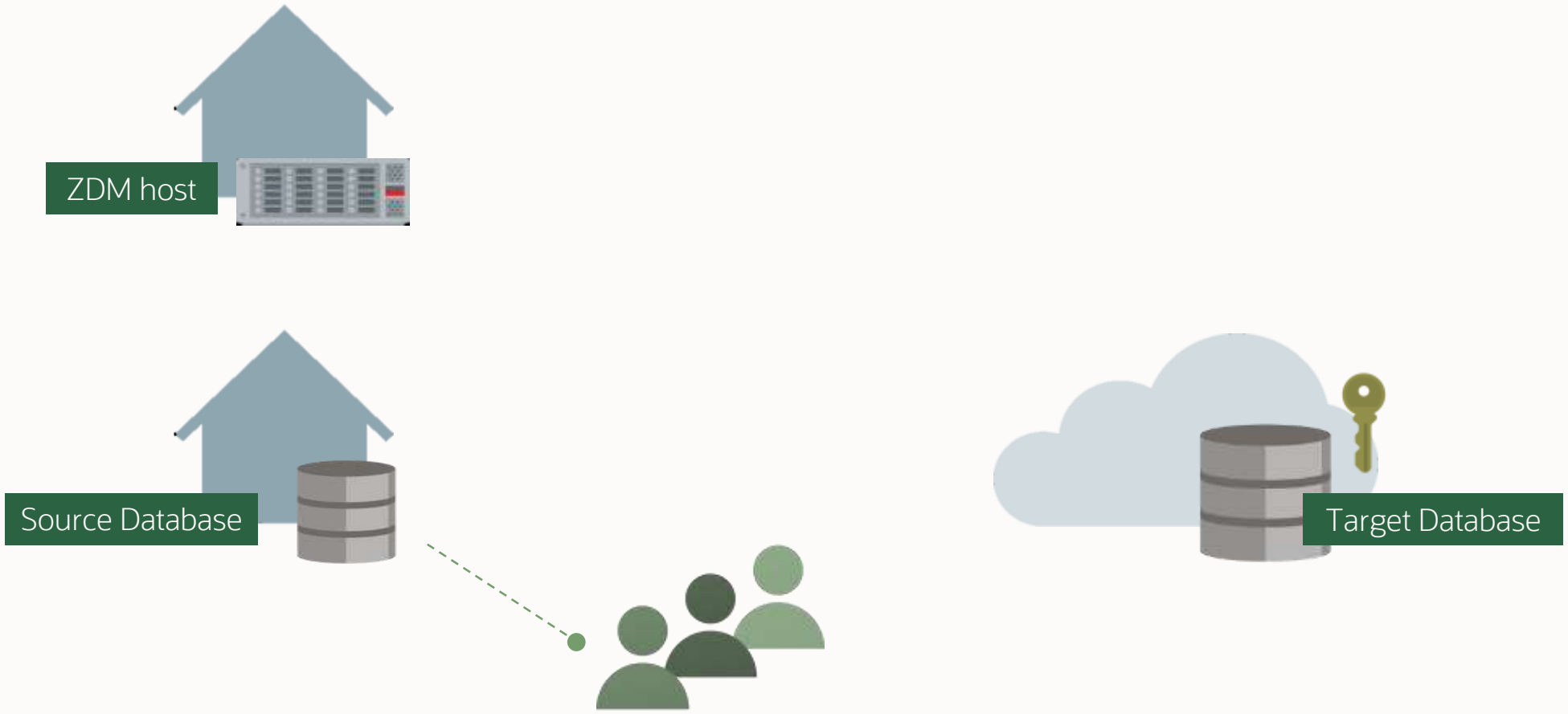


Logical Migration | Overview

Provision target database in OCI

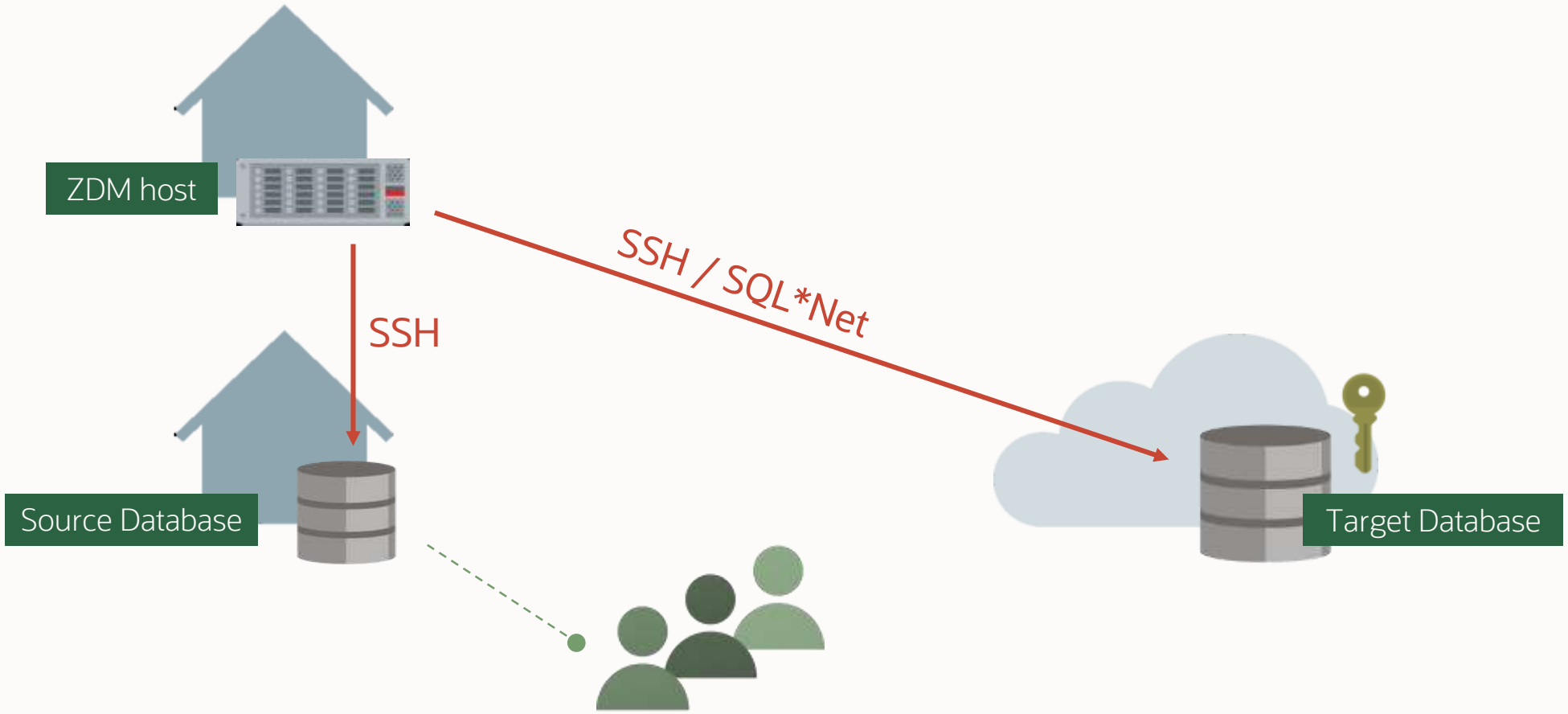
Logical Migration | Overview

Download and install ZDM



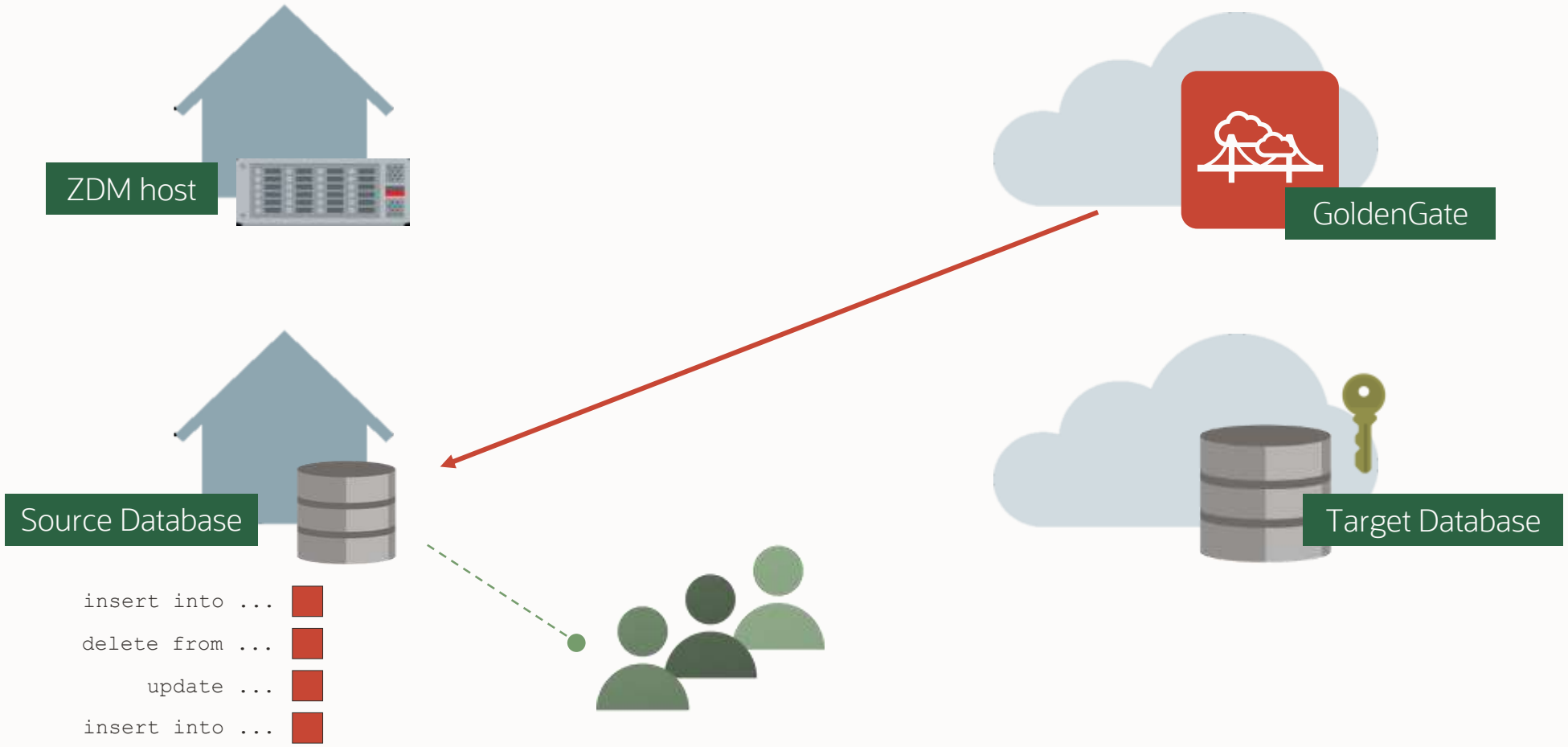
Logical Migration | Overview

ZDM connects to source and target database



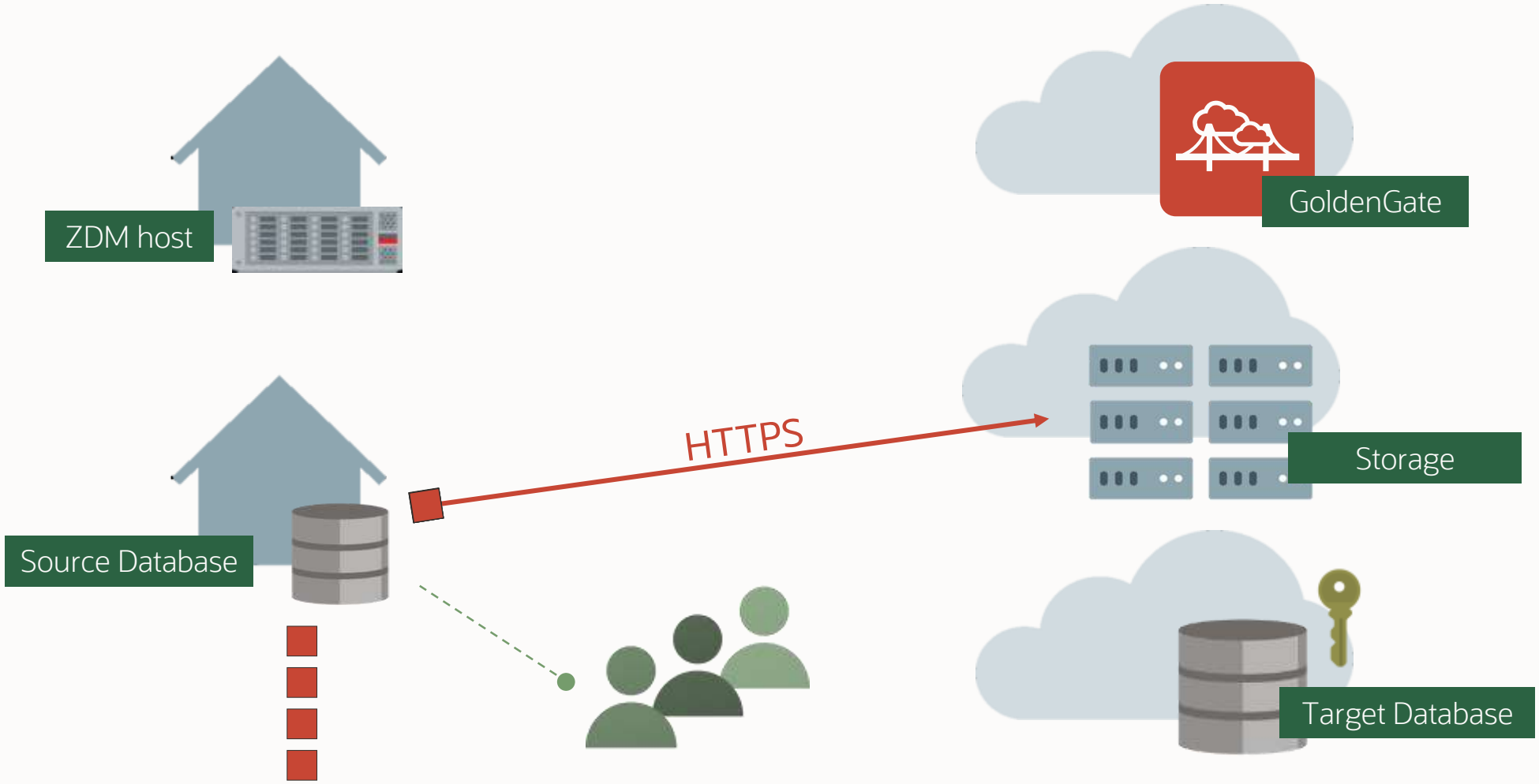
Logical Migration | Overview

Provision GoldenGate and capture on source



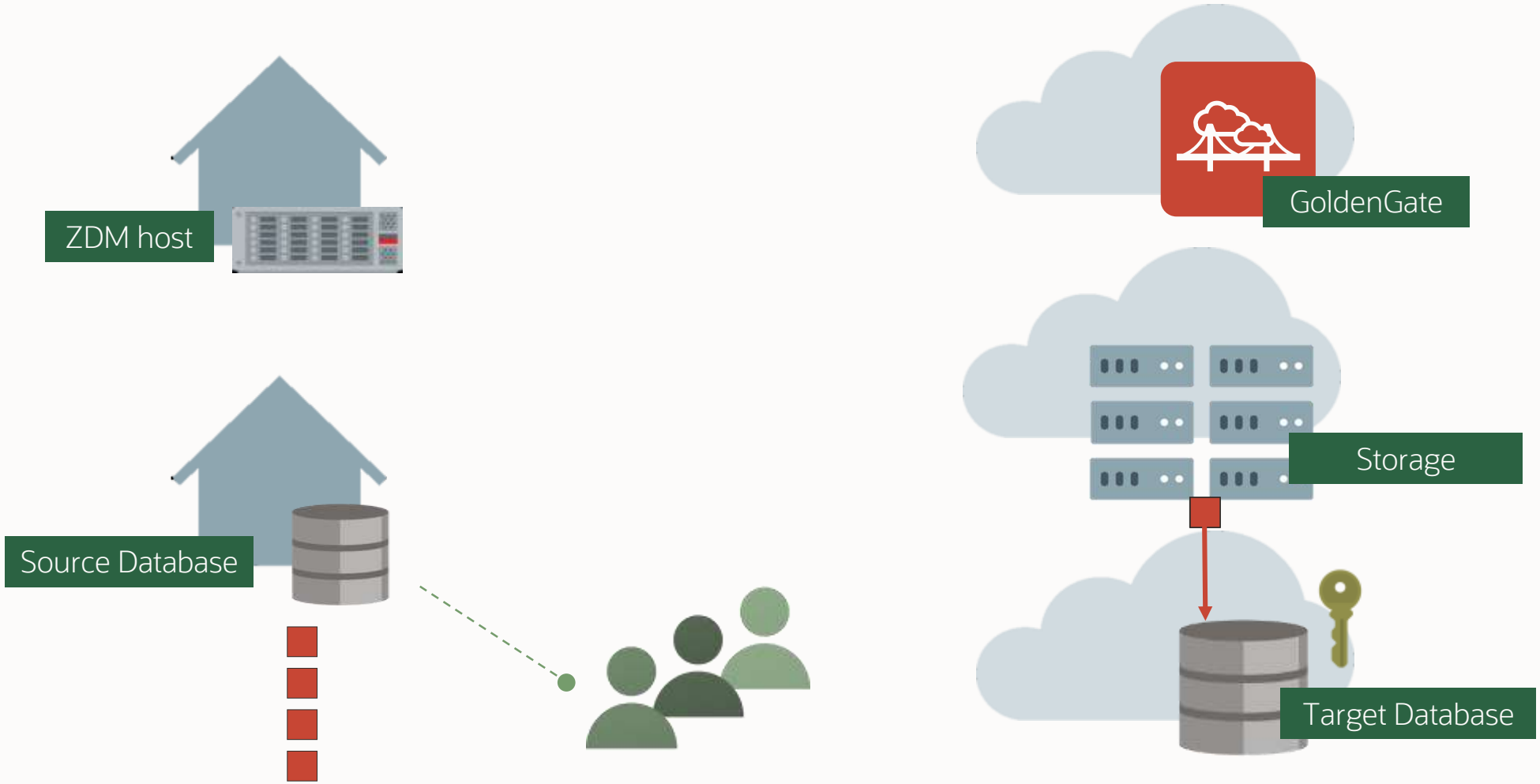
Logical Migration | Overview

Data Pump export to storage



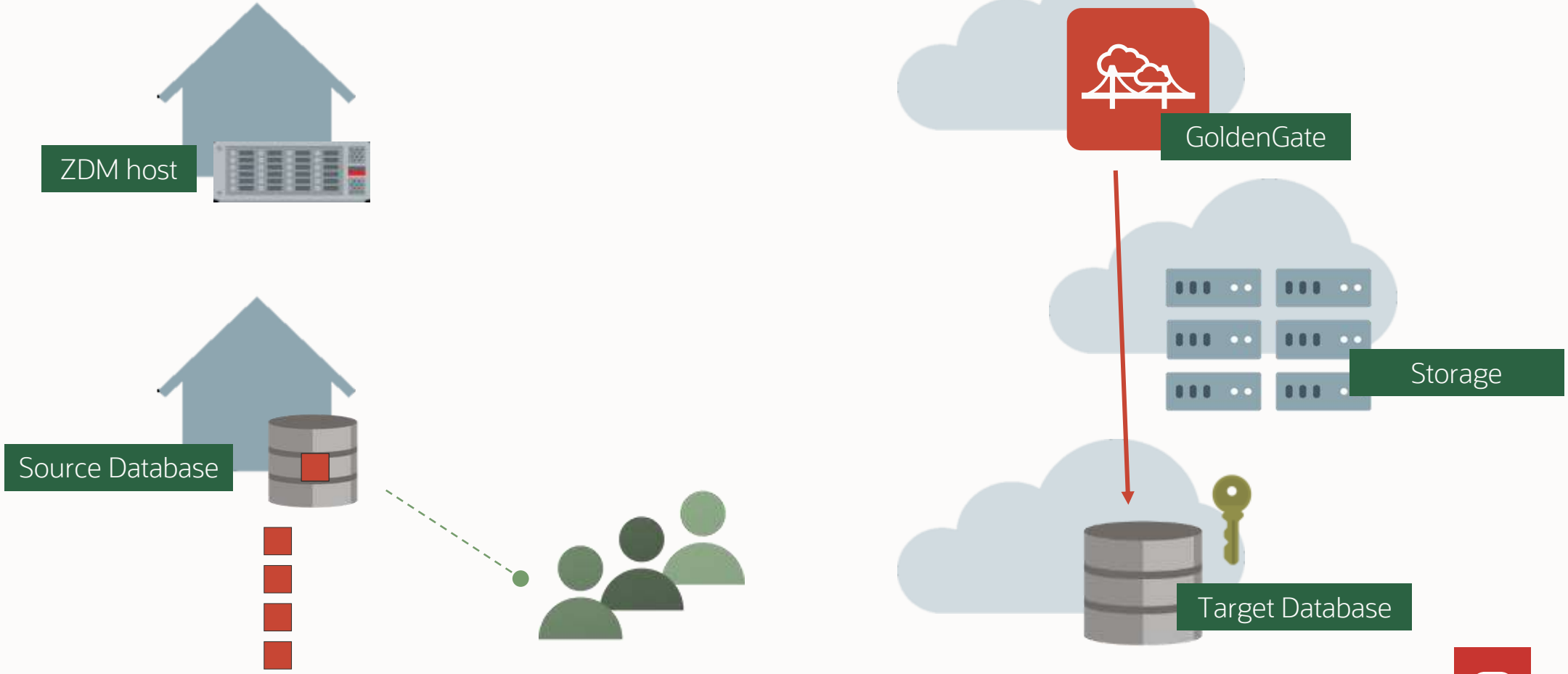
Logical Migration | Overview

Data Pump import from storage



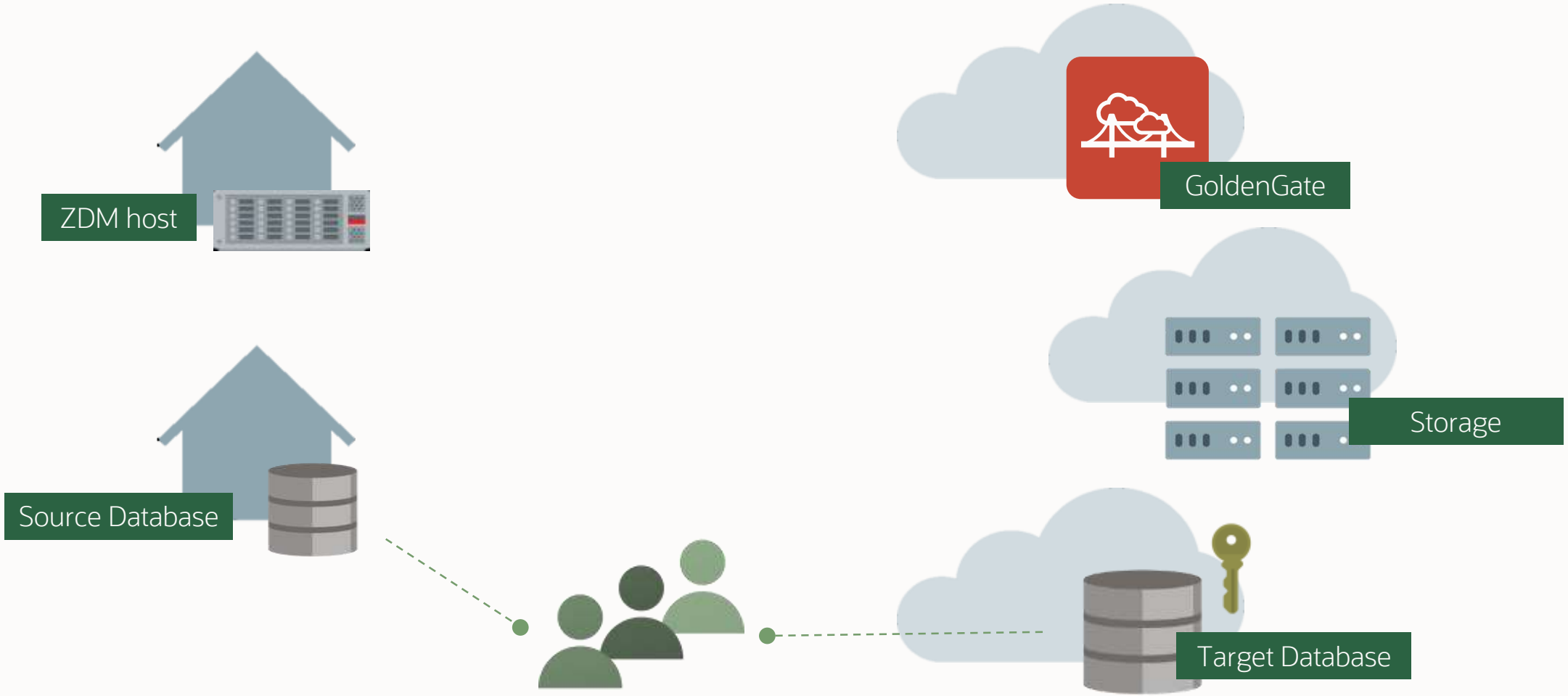
Logical Migration | Overview

Configure apply on target



Logical Migration | Overview

At your will, switchover sessions



Logical Migration | Overview

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Senior Principal Product Manager for Cloud Migrations at Oracle. See you in the cloud. Views expressed are my own.

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Daniel Overby Hansen posted in Zero Downtime Migration – The easy way to the cloud ...

Zero Downtime Migration – The easy way to the cloud

Daniel Overby Hansen
Senior Principal Product Manager for Cloud Migrations at Oracle. See you in the c...
4d •

I am really looking forward to talking at AIOUG. I will cover both migration methods on a high level. But I only have time to go into details with one of them. Which one should it be?

Which method should I spend most time on?

You can see how people vote. Learn more

Physical (Data Guard)	43%
Logical (Data Pump GoldenGate)	57%

7 votes • Poll closed

2

Reactions

Photo by eelias on Unsplash

Migration

Logical

Logical Migration | Options

PHYSICAL

Online: Data Guard + switchover

Offline: Backup + restore

Standard Edition - offline only

LOGICAL

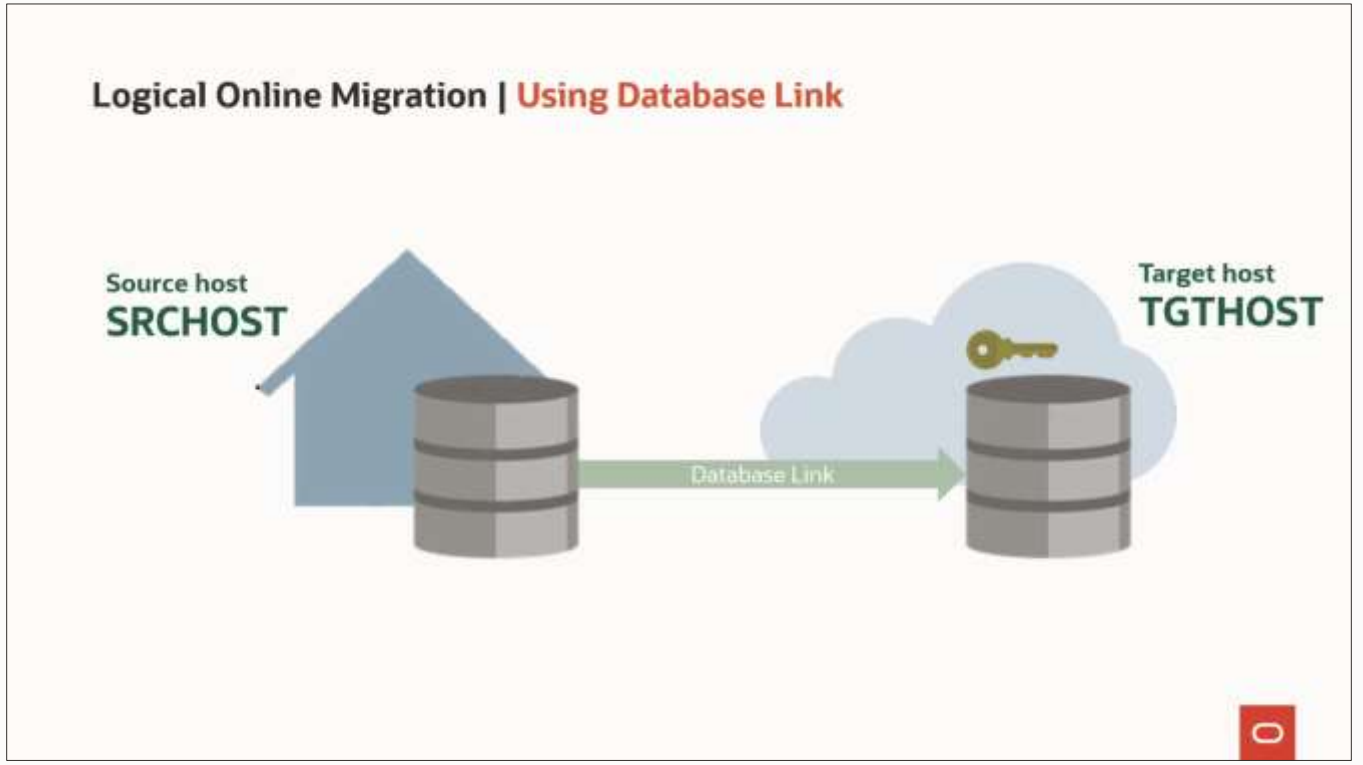
Online: Data Pump + GoldenGate

Offline: Data Pump

Via dump file or database link

Standard Edition - any approach

Logical Migration | Demo



Watch on YouTube

When I say Oracle GoldenGate

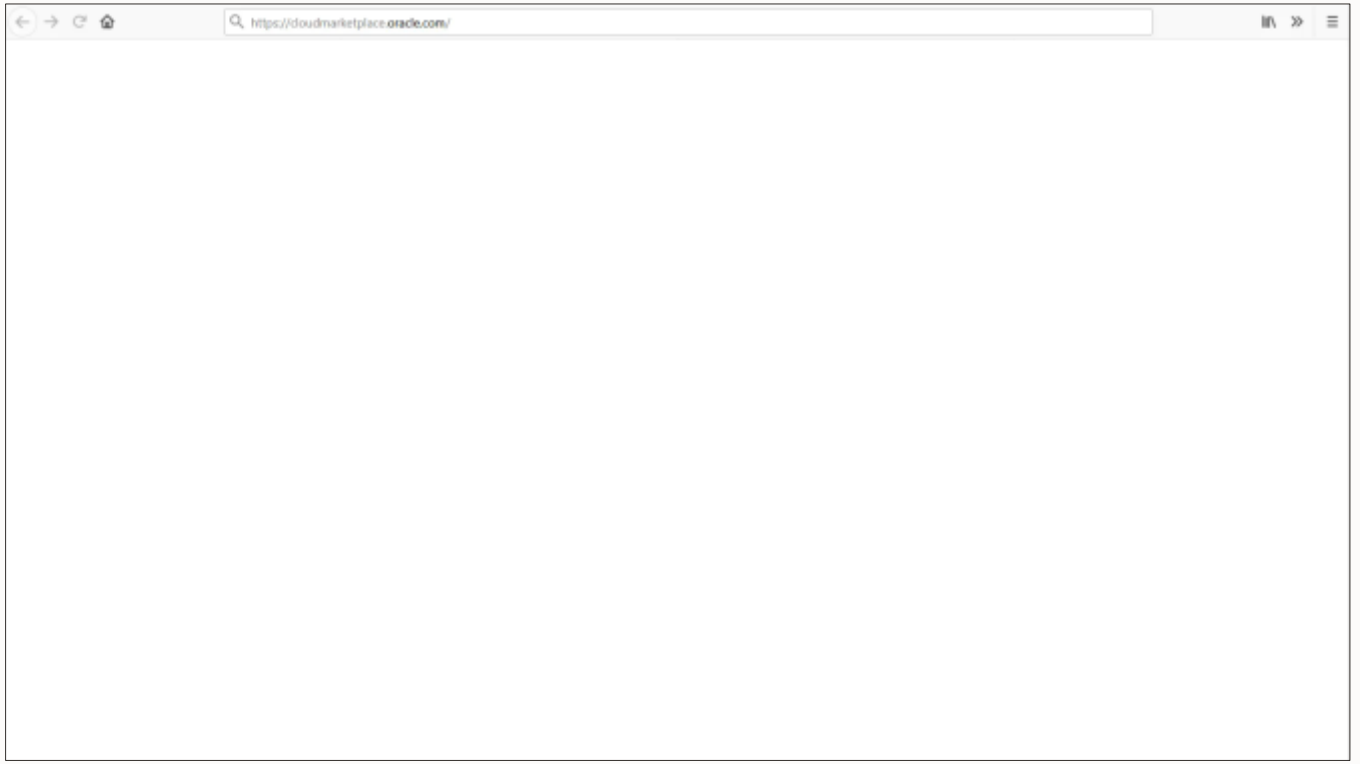
What do you say?

Logical Migration | GoldenGate

> ***Oracle GoldenGate for Oracle – Database Migrations*** *can be used for 183 days to perform migrations into Oracle databases located in Oracle Cloud Infrastructure using the following tools:*
> *Oracle Zero Downtime Migration*
> *Oracle Cloud Infrastructure Database Migration*

Cloud Marketplace: Oracle GoldenGate for Oracle – Database Migrations

Logical Migration | GoldenGate



Watch on YouTube

Logical Migration | Recommendations

Use Data Pump in schema mode

```
DATAPUMPSETTINGS_JOBMODE=SCHEMA
INCLUDEOBJECTS-1=owner:SH
INCLUDEOBJECTS-2=owner:OE
```

Use parallel option (on-prem = 2 x physical cores - OCI = number of OCPUs)

```
DATAPUMPSETTINGS_DATAPUMPPARAMETERS_EXPORTPARALLELISMDEGREE=n
DATAPUMPSETTINGS_DATAPUMPPARAMETERS_IMPORTPARALLELISMDEGREE=n
```

Optionally, change the ignorable Data Pump errors

- Default: ORA-31684, ORA-39111, ORA-39082

Pro Tip: ZDM automatically adds compression and encryption to Data Pump exports

Logical Migration | CPAT

Get up-to-date recommendations on your migration

- You can run CPAT manually
- Replace CPAT in ZDM with newer version

Cloud Premigration Advisor Tool (CPAT) Analyzes Databases for Suitability of Cloud Migration (Doc ID 2758371.1)

Logical Migration | CPAT

Sample output

```
Premigration advisor output:
Cloud Premigration Advisor Tool Version 21.0.0
Cloud Premigration Advisor Tool completed with overall result: WARNING
Cloud Premigration Advisor Tool generated report location:
/u01/app/oracle/zdm/zdm_SALES_fra3wg_1/out/premigration_advisor_report.json
 RESULT: WARNING

Schemas Analyzed (1): SH
A total of 15 checks were performed
There were 0 checks with FATAL results
There were 0 checks with BLOCKER results
There were 3 checks with WARNING results
```


Logical Migration | CPAT

Sample output

```
timezone_table_compatibility_higher

RESULT: WARNING

DESCRIPTION: The source database TZ_VERSION cannot be lower than the target
TZ_VERSION.

ACTION: Request that Cloud Database Support change the Timezone Version on
your target Database.
```


Logical Migration | Benefits

- Free features
  - GoldenGate
  - Data Pump Compression
  - Data Pump Encryption

- Optionally, remodel your schema and data
  - Migrate to SecureFile LOBs is default

Logical Migration | SecureFile

> *SecureFiles is the default storage mechanism for LOBs starting with Oracle Database 12c, and Oracle strongly recommends SecureFiles for storing and managing LOBs, rather then BasicFiles. BasicFiles will be deprecated in a future release.*

Database SecureFiles and Large Objects Developer's Guide

Always transform LOBs to SecureFiles LOBs

```
$ impdp ... TRANSFORM=LOB_STORAGE:SECUREFILE
```

Logical Migration | SecureFile

Importing as BasicFiles

```
10-OCT-20 21:43:21.848: W-3 . . imported "SCHEMA"."TABLE"      31.83 GB   681025 rows in 804 seconds using direct_path
```

Importing as SecureFiles

```
15-OCT-20 18:16:48.663: W-13 . . imported "SCHEMA"."TABLE"     31.83 GB   681025 rows in 261 seconds using external_table
```

Logical Migration | Benefits

- Migrate to higher release
- Migrate directly into a PDB
- Online option for SE2
- Configure backup of target database in advance
  - Test backup/restore functionality
- Configure Data Guard in advance
  - Protect database immediately after switch over to OCI

Logical Migration | 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
  - 11g
  - 12c and newer

- GoldenGate supported data types

Logical Migration | 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
  - ...

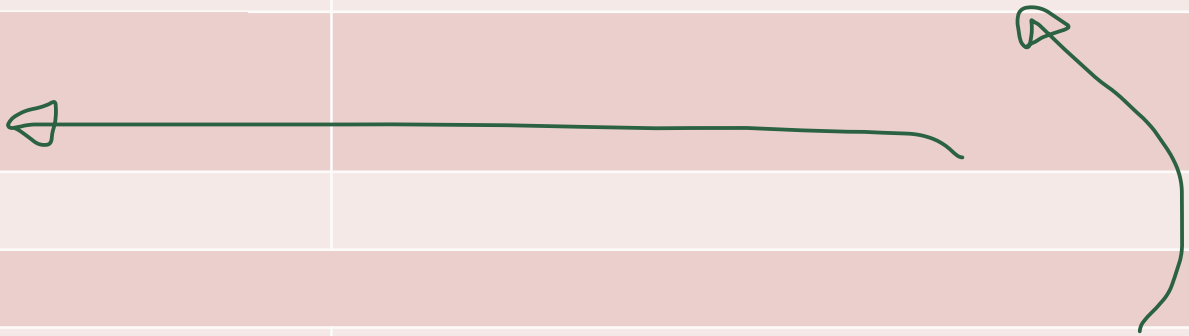
Logical Migration | Considerations

- Fallback
- DDL is not replicated
  - Unless you manually change the GoldenGate configuration
- Character set must match

Logical Migration | Considerations

- Sequences must be *forwarded* on switch-over

SOURCE	TARGET
Sequence *seq1.currval* = 100	



Logical Migration | Considerations

- Sequences must be *forwarded* on switch-over
  - Recreate sequences after switchover
  - Set sequence

```
alter sequence seq1 increment by 5473;
select seq1.nextval from dual;
alter sequence seq1 increment by 1;
```

Increment by source nextval - target nextval

Logical Migration | Testing

- Oracle GoldenGate supports Flashback Database
  - Does Goldengate Support Oracle RDBMS Flashback Features? (Doc ID 966212.1)

- Use backup/restore or cloning for
  - Autonomous Database
  - Standard Edition 2

Logical Migration | Very Large Databases

- Can co-exist with existing Data Guard
  - Switchover and failovers not supported
- Scaling up on CPUs is advantagous
- 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
- Automatic backup and Data Guard can be configured on OCI database before switchover

Photo by Alexander Andrews on Unsplash

Details

Pro Tips | Troubleshooting

ZDM service host

- `$ZDM_BASE/chkbase/scheduled`
- `$ZDM_BASE/crsdata/hostname/rhp`

Source and target hosts

- `$ORACLE_BASE/zdm/zdm_<db_unique_name_<zdm job id>/zdm/log`

Clear ZDM logs for easier troubleshooting

```
$ $ZDM_HOME/bin/zdmservice stop
$ rm $ZDM_BASE/crsdata/*/rhp/rhpserver.log*
$ rm $ZDM_BASE/chkbase/scheduled/*
$ $ZDM_HOME/bin/zdmservice start
```

Pro Tip: You can abort a job using `zdmcli abort job -jobid n`

Pro Tips | Troubleshooting

Other sources:

- Alert log
- Data Pump process trace file *DM00*
- Data Pump log file
  - Directory referenced by directory object
  - `$ORACLE_HOME/rdbms/log/<PDB GUID>`

Pro Tip: Before creating a Service Request: SRDC - Data Collection For Database Migration Using Zero Downtime Migration (ZDM) (Doc ID 2595205.1)

Pro Tips | Troubleshooting

Oracle Zero Downtime Migration 21 .1 Release Notes

- Troubleshooting
- Known Issues

Move to Oracle Cloud Using Zero Downtime Migration

- Troubleshooting

Pro Tips | ZDM Log File

Tailing migration log file:

```
$ $ZDM_HOME/bin/zdmcli migrate database \
     -rsp /home/zdmuser/std.rsp \
     ...

$ tail -n 50 -f "`ls -td /u01/app/oracle/chkbase/scheduled/*log | head -1`"

zdmhost: 2021-05-06T18:14:25.590Z : Starting zero downtime migrate operation ...
zdmhost: 2021-05-06T18:14:25.625Z : Executing phase ZDM_VALIDATE_TGT
zdmhost: 2021-05-06T18:14:25.634Z : Fetching details of user-managed OCI database "ocid1.database..."
zdmhost: 2021-05-06T18:14:26.840Z : Lifecycle state of OCI database "ocid1.database...": "Available"
zdmhost: 2021-05-06T18:14:29.365Z : Type of OCI database "ocid1.database...": "Virtual Machine Database System"
zdmhost: 2021-05-06T18:14:29.466Z : Verifying configuration and status of target database "sales"
zdmhost: 2021-05-06T18:14:33.889Z : Global database name: SALES.SUB02121342350.DANIEL.ORACLEVCN.COM
zdmhost: 2021-05-06T18:14:33.890Z : Target PDB name : SALES
zdmhost: 2021-05-06T18:14:33.891Z : Database major version : 19
zdmhost: 2021-05-06T18:14:36.711Z : Database parameter ENABLE_GOLDENGATE_REPLICATION is set to true.
zdmhost: 2021-05-06T18:14:36.713Z : Oracle GoldenGate database admin user "GGADMIN" has required privileges.
zdmhost: 2021-05-06T18:14:36.714Z : Execution of phase ZDM_VALIDATE_TGT completed
zdmhost: 2021-05-06T18:14:36.742Z : Executing phase ZDM_VALIDATE_SRC
```

Pro Tips | Custom Scripts

Run your own script before or after any phase

The script is executed on either source or target

- Autonomous DB only .sql scripts are possible

Relevant information is available as environment variables

- Database
- Oracle Home
- ZDM Phase
- …

Pro Tip:
To list all phases: `zdmcli migrate database -rsp .... -listphases`

Pro Tips | GoldenGate Certificate

GoldenGate Hub provided by OCI Marketplace image comes with a self-signed certificate

Best:

- Implement your own properly signed certificates

Or, for test environments:

- GoldenGate and self signed certificate? Zero Downtime Migration - GoldenGate Hub Certificate Known Issues (Doc ID 2768483.1)

Pro Tips | GoldenGate Privileges

Replicat process connects a regular database user

Determine how to grant privileges:

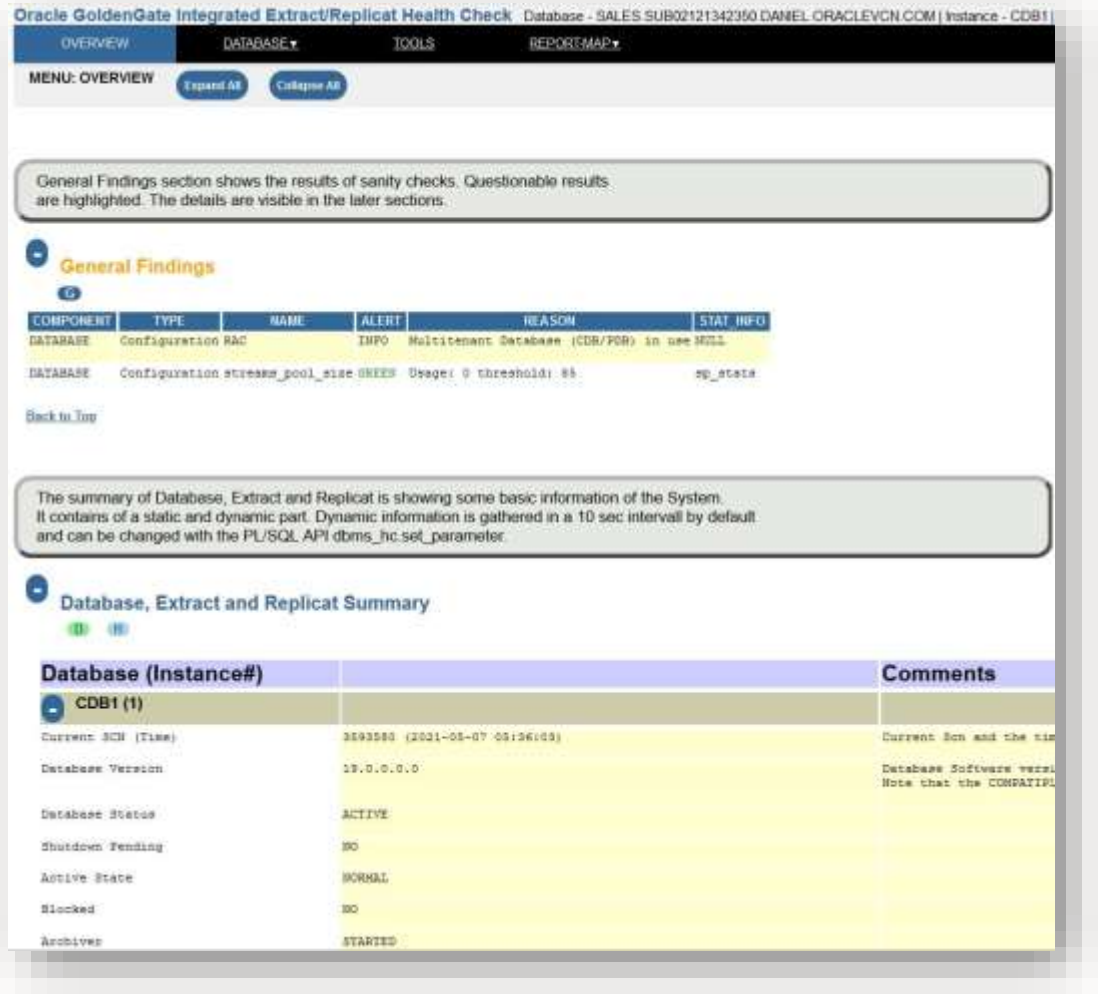
- DBA / PDB_DBA role
- `INSERT ANY, DELETE ANY, UPDATE ANY`
- Connor McDonald's schema grant

In doubt? Do like in Autonomous Databases...

Pro Tips | GoldenGate Health Check

Generate report:

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



Pro Tips | 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`

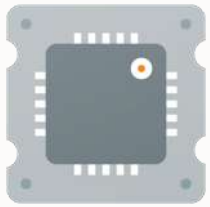
Photo by Carolina Pimenta on Unsplash

Finally …

It is time to wrap up

Migration | Scaling

Typically, during migration, you need:

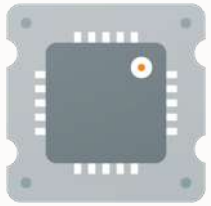


CPU

I/O throughput

Network throughput

Migration | Scaling Virtual Machines



Change shape up and down
Shape changes offline
X7 offers from 2 to 24 OCPUs

Scales online, but up only with amount of total storage
Allocated in quota between DATA and RECO
Storage is network attached - needs network bandwidth to read/write

Scales with number of OCPUs

Migration | Scaling Virtual Machines

Blog post

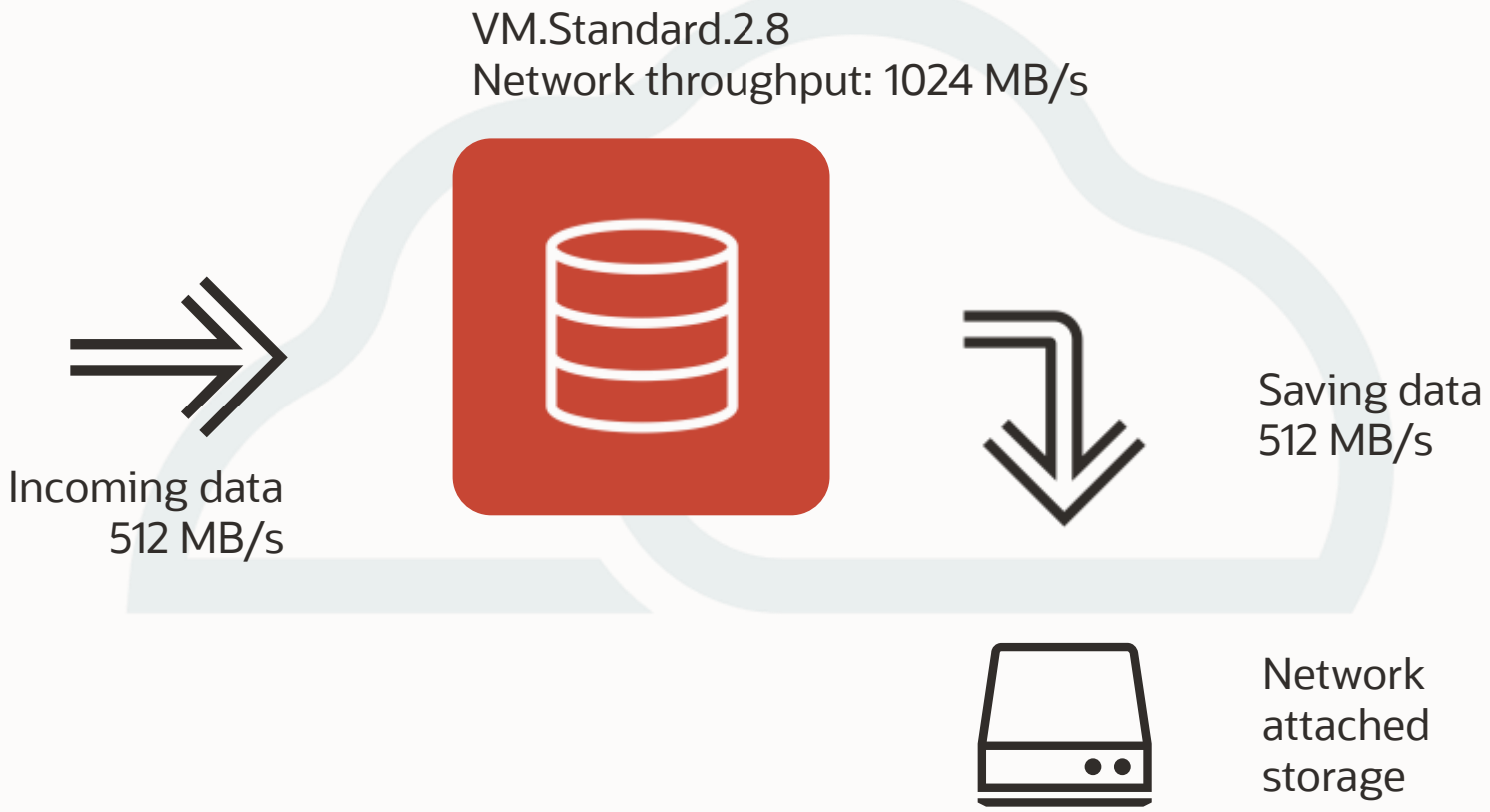
Network throughput

Shape	Throughput MB/s
VM.Standard.2.1	128
VM.Standard.2.2	256
VM.Standard.2.4	512
VM.Standard.2.8	1024
VM.Standard.2.16	2048
VM.Standard.2.24	3200

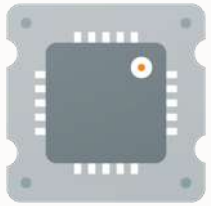
I/O throughput

Storage (GB)	Throughput MB/s
256	120
1024	480
2048	960
4096	1280
10240	1600
20480	3200

Migration | Scaling Virtual Machines



Migration | Scaling Bare Metal

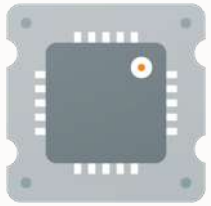


Scales up and down
Scales online

Locally attached NVMe disks

25 Gbps network interface
Theoretically 3200 MB/s

Migration | Scaling Exadata



Scales up and down
Scales online

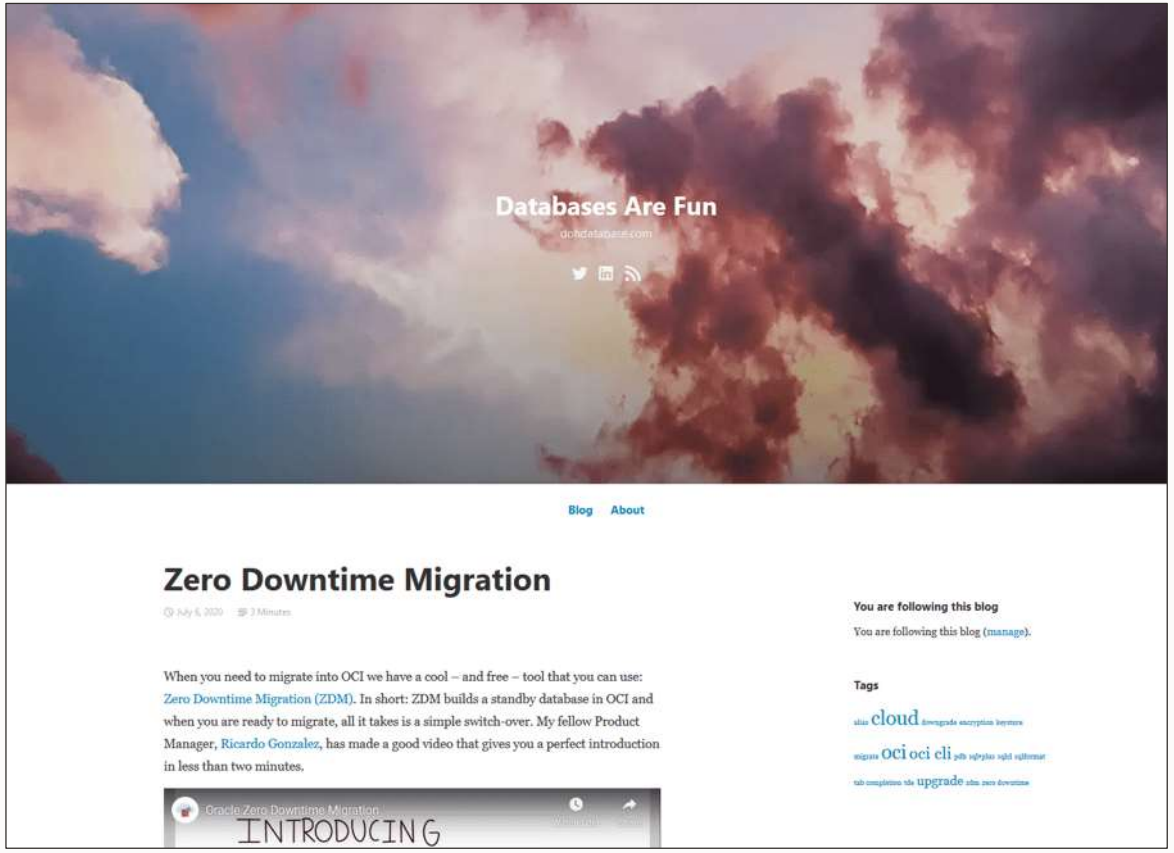
Exadata storage system

2 x 25 Gbps network interface
Theoretically 6400 MB/s

Migration | Comparison

PHYSICAL	LOGICAL
Migrate entire database	Migrate schemas
No data customization	Remodel your data
Same version / same architecture	Cross-version / cross-architecture
Well-known	New skills
No online option for SE2	Online option for SE2
Excellent fallback	Complicated fallback

Wrapping Up | Blog Posts



[A walthrough with all the details]

- includes one on ExaCS

Wrapping Up | YouTube

YouTube Playlist

#aioug

aioug

ALL INDIA ORACLE USERS GROUP

WEBINAR SERIES

DATABASE UPGRADES & MIGRATIONS ONLINE SUMMIT

Session 5

DEEP DIVE INTO AUTOUPGRADE FROM ONE OF THE AUTOUPGRADE ARCHITECTS - AN ENGINEERING APPROACH

Frederick Valentin Alvarez Flores

Principal Member of Technical Staff, Database Upgrade

@idonhk

16 July 2021

6:00 - 7:15 PM IST

(GMT+5:30)

Wrapping Up | Further Information

Oracle Zero Downtime Migration Product Page

Oracle Zero Downtime Migration Documentation

Oracle Zero Downtime Migration Release Notes

Oracle Zero Downtime Migration Tech Brief

MAA Practices for Cloud Migration Using ZDM (Doc ID 2562063.1)

Thank you!

Photo by Mick Truyts on Unsplash

Migration

Physical

Migration | Options

PHYSICAL

Online: Data Guard + switchover

Offline: Backup + restore

Standard Edition - offline only

LOGICAL

Online: Data Pump + GoldenGate

Offline: Data Pump

Via dump file or database link

Standard Edition - any approach

Physical Migration | Demo

Watch on YouTube

Physical Migration | Testing

Watch on YouTube

Physical Migration | Benefits

- Well-known method
- Seemless switchover with properly configured application
- Excellent fallback
  - Requires license for ASO on-prem
- Migrate entire database
  - AWR
  - SQL Plan Baseline
  - SQL Profiles
  - ...

Physical Migration | Benefits

- RMAN compression automatically applied
  - Advanced Compression Option not needed during migration

Physical Migration | Considerations

- Migrate to same version only
- Convert to PDB requires additional downtime
- Entire database is migrated
  - *Old bagage*
- Standard Edition is offline only (backup/restore)

Physical Migration | Very Large Databases

- Can co-exist with existing Data Guard
  - Switchovers supported
  - Must be disabled prior to OCI switchover

- Level 0 backup is required
  - Backup is streamed directly to OCI
  - The faster the connection to OCI, the faster the backup
  - Must suspend other backup activities
  - No disk space required for backup
  - Potentially large amount of archive logs must be stored on disk
  - Number of channels and compression algorithm configurable
  - Exadata on-prem and ExaCC can use existing backup or ZDLRA

Physical Migration | Very Large Databases

- Redo can be compressed
  - Requires Advanced Compression Option

- Automatic backup and Data Guard must be configured on OCI database after switchover
  - No support for cascading standby
  - Increases downtime

REDO APPLY

benchmark

Redo apply, TB/Day	11.2.0.4	12.1.0.2	12.2	MIRA 2x 12.2	MIRA 4x 12.2
Batch	57	57	57	115	226
OLTP	14	15	15	29	60

Source: Redo Apply Best Practices – Oracle Data Guard and Active Data Guard

redo

TRANSPORT AND APPLY

benchmark

Connection, Gbps	11.2.0.4	12.1.0.2	12.2	MIRA 2x 12.2	MIRA 4x 12.2
Batch	57 / 6	57 / 6	57 / 6	115 / 11	226 / 22
OLTP	14 / 2	15 / 2	15 / 2	29 / 3	60 / 6

Source: Redo Apply Best Practices – Oracle Data Guard and Active Data Guard

Physical Migration | Redo Apply Best Practices

Redo Apply Best Practices - Oracle Data Guard and Active Data Guard

Physical Migration | Different Patch Level

You can migrate to a higher patch level

- Example: 19.7.0 to 19.11.0

Procedure

- Switch over to OCI database
- ZDM executes `datapatch`
- Patch on-premises Oracle Home

Oracle Patch Assurance - Data Guard Standby-First Patch Apply (Doc ID 1265700.1)

Physical Migration | Fallback

Caution: Fallback requires license for Advanced Security Option on source database

Procedure:

```
$ $ZDM_HOME/bin/zdmcli abort job -jobid n

--OCI database
SQL> ALTER DATABASE COMMIT TO SWITCHOVER TO PHYSICAL STANDBY;

--On-premises database
srvctl modify database -d CDB1 -role primary -startoption open
SQL> ALTER DATABASE COMMIT TO SWITCHOVER TO PRIMARY;
SQL> ALTER DATABASE OPEN;
```

- MAA Practices for Cloud Migration Using ZDM (Doc ID 2562063.1)

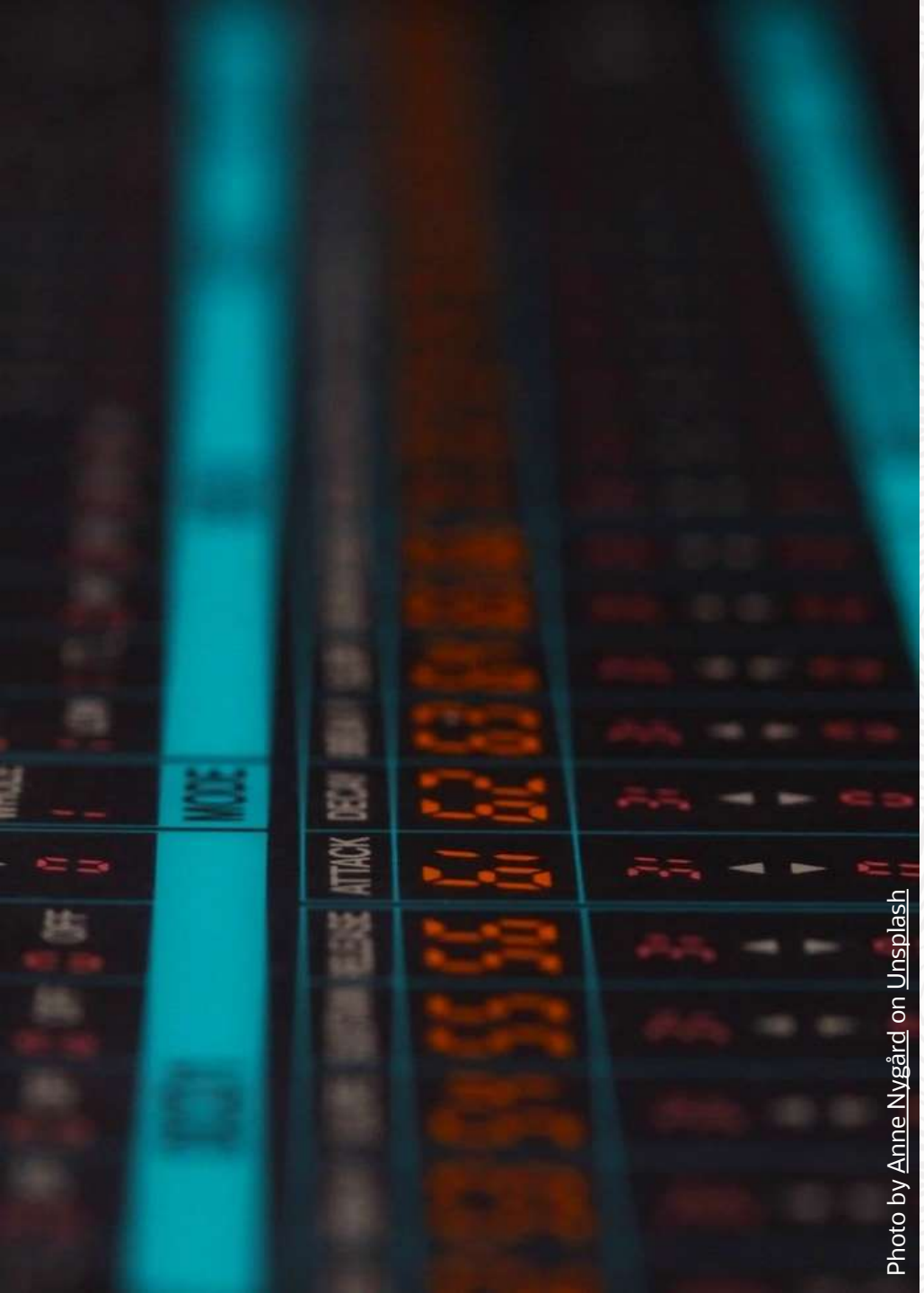


Photo by Anne Nygård on Unsplash

Install

ZDM Service Host

Service Host | Prerequisites

- Oracle Linux 7
- Install on dedicated server (recommended)
- Network connectivity to source and target database host
- Check the documentation

Service Host | SSH Key Format

SSH key format must be PEM format

```
$ ssh-keygen -t rsa -m PEM

$ cat ~/.ssh/id_rsa

-----BEGIN RSA PRIVATE KEY-----
MIIG5QIBAAKCAYEA0GPlWoSFfU8+6zgOymj47d9NTxRJYr5U9seFAcz3/aaWEP5k
ZT0FjipCIziBcnYzs0jKPLSrSoPnYGJxJuYbDj6pwMNH/f0SfhAibjHD3+Buj5cc
...
```

Service Host | Installation

Watch on YouTube