

Using Object Storage to Migrate Databases to Oracle Cloud Infrastructure

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Revision History

The following revisions have been made to this white paper since its initial publication:

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You can find the most recent versions of the Oracle Cloud Infrastructure white papers at <https://cloud.oracle.com/iaas/technical-resources>.



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Introduction

Oracle Database is a multiple-model relational database management system that is widely used in many phases of business transactions and deployed in enterprises of all sizes to manage various forms of data. Oracle Database is commonly used for running Online Line Transaction Processing (OLTP), Data Warehousing (DW), and mixed OLTP and DW database workloads. Oracle Cloud Infrastructure provides a comprehensive set of services and tools for deploying Oracle Database workloads from on-premises to Oracle Cloud Infrastructure.

Oracle Cloud Infrastructure provides features to run Oracle Databases either directly in a Oracle Cloud Infrastructure Compute instance or in a Database as a Service (DBaaS) managed instance. Launching Oracle Database in a Compute instance gives you full control over the setup of the entire database and the related infrastructure. This process requires you to set up, configure, and manage all the components, such as the instance, networking, storage volumes, scalability, and security, as needed. Running a database in a Compute instance is similar to running a database on your own server because it provides complete control of the database and the instance at the operating system level. It also allows you to run monitoring and management agents.

This white paper describes in detail how to migrate Oracle Database workloads to an Oracle Cloud Infrastructure Compute instance, and provides options and examples to help you with your migration. Migrating a database to a DBaaS-managed instance is detailed in a corresponding white paper, “Migrating Databases to Oracle Cloud Infrastructure Database Using Object Storage.”

Steps to Migrate Oracle Database by Using Object Storage

Migrating Oracle Database from on-premises to Oracle Cloud Infrastructure is similar to migrating an Oracle Database to your own server. Following are the high-level steps used to migrate Oracle Database to an Oracle Cloud Infrastructure Compute instance:

1. Back up Oracle Database by using Oracle Recovery Manager (RMAN).
2. Use one of the following Oracle Cloud Infrastructure data migration services to copy the backup to Oracle Cloud Infrastructure Object Storage:
 - Data Transfer Disk
 - Data Transfer Appliance
 - Storage Gateway
 - Command Line Interface (CLI)

3. Create the Compute instance and launch the target database.
4. Download and configure the Oracle Database Cloud Backup Module in the Compute instance.
5. Restore the backup from Object Storage as an Oracle Database in a self-managed Compute instance.

Step 1: Back Up Oracle Database by Using RMAN

Oracle RMAN performs and manages Oracle Database backups and restores. RMAN performs full and incremental backups (differential and cumulative) and maintains a catalog of the backups, which makes the restore process straightforward and dependable. RMAN can also duplicate, or clone, a database from a backup or from an active database.

Note: The steps outlined in this section provide a simple method for backing up Oracle small and medium databases by using RMAN. For large databases that demand high availability, we recommend that you follow [Oracle Database backup and recovery best practices](#) for fast and secure database migration with minimal downtime.

Perform a Full (Level 0) Backup

Run the following commands to take an encrypted, full backup of Oracle Database by using RMAN.

RMAN password-based encryption is used in this example, and the RMAN backup is encrypted by using the password `myPassword`. We recommend that you choose a unique and safe password and configure it by using the `SET ENCRYPTION ON IDENTIFIED BY '<password>' only` command while backing up the database. You use the same password when you decrypt the backup at the target instance during the restore.

```
$ rman target /
RMAN> SET ENCRYPTION ON IDENTIFIED BY 'myPassword' only;
executing command: SET encryption
RMAN>set compression algorithm 'medium';
executing command: SET compression
RMAN> run
{
  configure controlfile autobackup off;
  backup as compressed backupset
  device type disk
  tag dta_level0
  incremental level 0
  format '/u01/backups/fullbackup_%U'
  section size 24g
```

```

database
include current controlfile spfile
plus archivelog
format '/u01/backups/Al_fullbackup_%U';
}
Starting backup at 25-SEP-18
current log archived
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=273 device type=DISK
channel ORA_DISK_1: starting compressed archived log backup set
channel ORA_DISK_1: specifying archived log(s) in backup set
input archived log thread=1 sequence=24 RECID=1 STAMP=987786352
input archived log thread=1 sequence=25 RECID=2 STAMP=987786424
input archived log thread=1 sequence=26 RECID=3 STAMP=987786588
input archived log thread=1 sequence=27 RECID=4 STAMP=987786670
.
.
including current control file in backup set
including current SPFILE in backup set
channel ORA_DISK_1: starting piece 1 at 25-SEP-18
channel ORA_DISK_1: finished piece 1 at 25-SEP-18
piece handle=/u01/backups/fullbackup_8cte0snd_1_1 tag=DTA_LEVEL0 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
channel ORA_DISK_1: starting compressed incremental level 0 datafile backup set
channel ORA_DISK_1: specifying datafile(s) in backup set
including current SPFILE in backup set
channel ORA_DISK_1: starting piece 1 at 25-SEP-18
channel ORA_DISK_1: finished piece 1 at 25-SEP-18
piece handle=/u01/backups/fullbackup_8dte0snf_1_1 tag=DTA_LEVEL0 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
Finished backup at 25-SEP-18

Starting backup at 25-SEP-18
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed archived log backup set
channel ORA_DISK_1: specifying archived log(s) in backup set
input archived log thread=1 sequence=38 RECID=15 STAMP=987788017
channel ORA_DISK_1: starting piece 1 at 25-SEP-18
channel ORA_DISK_1: finished piece 1 at 25-SEP-18
piece handle=/u01/backups/Al_fullbackup_8ete0snh_1_1 tag=DTA_LEVEL0 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
Finished backup at 25-SEP-18
RMAN> exit
$

```

The preceding command places the backup files in the /u01/backups file system. After the backup is completed, perform the following steps:

1. Record the names of the controlfile and spfile backup files; you need them to successfully migrate the database. In the example, fullbackup_8cte0snd_1_1 and

fullbackup_8dte0snf_1_1 are the controlfile and spfile names. This controlfile and spfile are restored before the other backup files.

2. If the database is encrypted at the source, copy the `sqlnet.ora` file and the Transparent Data Encryption (TDE) wallet files along with the backup files. These files aren't copied as part of the RMAN backup process and must be copied separately.

Note: As a best practice, do *not* copy TDE wallet file along with the database backup. We recommend copying these files separately for security reasons.

Refer to the `sqlnet.ora` file for the `ENCRYPTION_WALLET_LOCATION`.

```
$ cat $ORACLE_HOME/network/admin/sqlnet.ora
ENCRYPTION_WALLET_LOCATION =
  (SOURCE = (METHOD = FILE)
(METHOD_DATA =
  (DIRECTORY = /etc/oracle/wallets/cdb1/)))
$ ls /etc/oracle/wallets/cdb1/
cwallet.sso cwallet.sso.lck ewallet.p12 ewallet.p12.lck
$
```

Perform an Incremental (Level 1) Backup

Run the following commands to take an incremental backup of the database to capture the delta that has changed since the last full backup.

RMAN password-based encryption is used in this example, and the RMAN backup is encrypted by using the password `myPassword`. We recommend that you choose a unique and safe password and configure it by using the `SET ENCRYPTION ON IDENTIFIED BY '<password>'` only command when backing up the database. You use the same password when you decrypt the backup at the target instance during the restore.

```
$ rman target /
RMAN> SET ENCRYPTION ON IDENTIFIED BY 'myPassword' only;
executing command: SET encryption
RMAN>set compression algorithm 'medium';
executing command: SET compression
RMAN> run
{
  backup as compressed backupset
  device type disk
  tag dta_level1
  cumulative incremental level 1
  format '/u01/backups/Incremental_%U'
  section size 24g
  database
  include current controlfile spfile
```

```

    plus archivelog
    format '/u01/backups/Al_Incremental_%U';
}
Starting backup at 25-SEP-18
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed archived log backup set
channel ORA_DISK_1: specifying archived log(s) in backup set
input archived log thread=1 sequence=24 RECID=1 STAMP=987786352
input archived log thread=1 sequence=25 RECID=2 STAMP=987786424
input archived log thread=1 sequence=26 RECID=3 STAMP=987786588
including current control file in backup set
including current SPFILE in backup set
channel ORA_DISK_1: starting piece 1 at 25-SEP-18
channel ORA_DISK_1: finished piece 1 at 25-SEP-18
piece handle=/u01/backups/Incremental_8lte0spt_1_1 tag=DTA_LEVEL1 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
channel ORA_DISK_1: starting compressed incremental level 1 datafile backup set
channel ORA_DISK_1: specifying datafile(s) in backup set
including current SPFILE in backup set
channel ORA_DISK_1: starting piece 1 at 25-SEP-18
channel ORA_DISK_1: finished piece 1 at 25-SEP-18
piece handle=/u01/backups/Incremental_8mte0spv_1_1 tag=DTA_LEVEL1 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
Finished backup at 25-SEP-18

Starting backup at 25-SEP-18
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed archived log backup set
channel ORA_DISK_1: specifying archived log(s) in backup set
input archived log thread=1 sequence=40 RECID=17 STAMP=987788096
channel ORA_DISK_1: starting piece 1 at 25-SEP-18
channel ORA_DISK_1: finished piece 1 at 25-SEP-18
piece handle=/u01/backups/Al_Incremental_8nte0sq0_1_1 tag=DTA_LEVEL1 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
Finished backup at 25-SEP-18
RMAN>

```

After the backup is completed, perform the following steps:

1. Record the names of the controlfile and spfile backup files; you need them to successfully migrate the database. In the preceding example, `Incremental_8lte0spt_1_1` and `Incremental_8mte0spv_1_1` are the controlfile and spfile names.
2. Run the following query on the source database and note the DBID of the source database. This information is required as part of the restore process to restore the spfile.

```

$ sqlplus / as sysdba;
SQL> select dbid from v$database;
SQL*Plus: Release 12.2.0.1.0 Production on Wed Sep 19 20:01:09 2018
Copyright (c) 1982, 2016, Oracle. All rights reserved.
Connected to:

```

```

Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit Production
SQL> select dbid from v$database;
DBID
-----
960474975
SQL>

```

Step 2: Move the Oracle Database Backup to Object Storage

Oracle Cloud Infrastructure offers different solutions that let you migrate data securely. The type of service to use depends on various factors, including the size of the data and the type of network connectivity between your network and Oracle Cloud Infrastructure.

The following table provides our recommendations for the different use cases in which the data migration services can be used. If uploading data over the public internet takes longer than 1 week, we recommend that you consider using Data Transfer Appliance or Data Transfer Disk. Descriptions of the services follow the table.

Backup Dataset Size	Network Connectivity	Data Transfer Recommendations	Approximate Data Upload/Transfer Time
10 TB	100 Mbps	Data Transfer Appliance Data Transfer Disk	1 week
	1 Gbps	CLI Storage Gateway	22 hours
	10 Gbps	CLI Storage Gateway	2 hours
100 TB	100 Mbps	Data Transfer Appliance Data Transfer Disk	1 week
	1 Gbps	Data Transfer Appliance Data Transfer Disk	1 week
	10 Gbps	CLI Storage Gateway	24 hours



Backup Dataset Size	Network Connectivity	Data Transfer Recommendations	Approximate Data Upload/Transfer Time
500 TB	100 Mbps	Data Transfer Appliance You need multiple transfer appliances. You can transfer only up to 150 TB of data using a single appliance.	1 week
	1 Gbps	Data Transfer Appliance You need multiple transfer appliances. You can transfer only up to 150 TB of data using a single appliance.	1 week
	10 Gbps	CLI	5 days
1 PB	All Bandwidths	Data Transfer Appliance You need multiple transfer appliances. You can transfer only up to 150 TB of data using a single appliance.	2 weeks

Data Transfer Disk

Data Transfer Disk is an offline data migration service that lets you securely migrate data to Object Storage by using hard disk drives. You are responsible for purchasing the required number of hard disk drives, copying data to the drives, and shipping the drives to an Oracle data transfer site where the data is transferred to Object Storage. At the end of the data transfer process, the imported data is available in Object Storage.

See the [Data Transfer Disk documentation](#) for prerequisite tasks and detailed instructions for preparing and copying your data to the disk. After the package reaches the data transfer site, the database backup is copied to the bucket in Object Storage in your tenancy.

Data Transfer Appliance

Data Transfer Appliance is an offline data migration service that lets you securely move petabyte-scale datasets to Object Storage by using a purpose-built storage appliance. You send your data as files on one or more secure, high-capacity transfer appliances to a data transfer site. Operators at the data transfer site upload the files to the designated Object Storage bucket in your tenancy.

See the [Data Transfer Appliance documentation](#) for prerequisite tasks and detailed instructions for preparing and copying your data to Data Transfer Appliance.

Points to consider while using Data Transfer Appliance:

- You can transfer up to 150 TB of data by using a single transfer appliance. If you need to transfer more than 150 TB of data, you can request more than one appliance.
- The transfer appliance exposes a network file system (NFS) mount point. Copy the database backup to the transfer appliance by using normal file system commands.

Storage Gateway

Oracle Cloud Infrastructure Storage Gateway helps you bridge your on-premises environment with Object Storage. By using Storage Gateway, any application that can store data on an NFS target can easily and seamlessly move data to Object Storage without having to first modify the application to uptake the REST API. Storage Gateway exposes an NFS mount point, which can be mounted to any host that supports an NFS client. Storage Gateway performs the NFS-to-REST API translations for you.

See the [Storage Gateway documentation](#) for prerequisite tasks and detailed instructions for downloading, installing, and configuring Storage Gateway. After Storage Gateway is configured and the file system is mounted, you copy your data using normal file system commands.

CLI

The Oracle Cloud Infrastructure CLI is the primary command line-based utility for working with Oracle Cloud Infrastructure. You can use the CLI to bulk-upload files to Object Storage.

To use the CLI, you must first set it up. See the [CLI documentation](#) and follow the instructions to install and configure the CLI.

After you set up the CLI utility, run the following command to bulk-upload the backup files. Replace `NAMESPACE` and `BUCKET` with your own values.

```
$ oci os object bulk-upload -ns NAMESPACE -bn BUCKET --src-dir /u01/backups
Uploaded fullbackup_8ate0smf_1_1 [#####] 100%
{
  "skipped-objects": [],
  "upload-failures": {},
  "uploaded-objects": {
    "Al_Incremental_8fte0spl_1_1": {
      "etag": "7759CBAFC7C71DE0E053C224C00A290C",
      "last-modified": "Wed, 03 Oct 2018 20:37:35 GMT",
      "opc-content-md5": "1vDoDp6cgehgR2ruNpT5cQ=="
    },
    "Al_Incremental_8nte0sq0_1_1": {
      "etag": "7759AB55DDD6FB6FE053C224C00A63A0",
      "last-modified": "Wed, 03 Oct 2018 20:37:19 GMT",
```

```

"opc-content-md5": "fUL3C73C99pHYjfUVjxZUG=="
},
"Al_fullbackup_86te0skc_1_1": {
  "etag": "7759C2A94ED31619E053C224C00A8275",
  "last-modified": "Wed, 03 Oct 2018 20:27:50 GMT",
  "opc-content-md5": "JlIi5ql/h402FaM0j7sZvg=="
},
"Al_fullbackup_8ete0snh_1_1": {
  "etag": "77598368C90CD873E053C224C00A4BF8",
  "last-modified": "Wed, 03 Oct 2018 20:37:19 GMT",
  "opc-content-md5": "x9U46uswut5bRzDBStGhLA=="
},
"Incremental_8gte0spp_1_1": {
  "etag": "7759EB66D0C225BBE053C224C00AF220",
  "last-modified": "Wed, 03 Oct 2018 20:37:26 GMT",
  "opc-content-md5": "pKvXd9Zx2dpyw9SIE/rKBQ=="
},
"Incremental_8lte0spt_1_1": {
  "etag": "7759E196205811FDE053C224C00A067E",
  "last-modified": "Wed, 03 Oct 2018 20:37:21 GMT",
  "opc-content-md5": "wg7VWdNtBUykh4yJfu5ZuA=="
},
"Incremental_8mte0spv_1_1": {
  "etag": "7759AFCAFF0F0309E053C224C00AE36F",
  "last-modified": "Wed, 03 Oct 2018 20:37:20 GMT",
  "opc-content-md5": "cos5pHd7X9gtiTWrNp81zg=="
},
"fullbackup_88te0slg_1_1": {
  "etag": "7759B2AC7E6D0806E053C224C00A1917",
  "last-modified": "Wed, 03 Oct 2018 20:40:00 GMT",
  "opc-multipart-md5": "5YXUspvgRDCj6cWF9MjC2g==2"
},
"fullbackup_89te0sm0_1_1": {
  "etag": "7759E196217411FDE053C224C00A067E",
  "last-modified": "Wed, 03 Oct 2018 20:40:00 GMT",
  "opc-multipart-md5": "OKbSRaAIsrwiPGuOMfIXtw==2"
},
"fullbackup_8ate0smf_1_1": {
  "etag": "77594C3415F19D55E053C224C00AC1EF",
  "last-modified": "Wed, 03 Oct 2018 20:30:30 GMT",
  "opc-multipart-md5": "hR0aFDtagw7yq9Sd30GB3g==2"
},
"fullbackup_8bte0smu_1_1": {
  "etag": "77597209CC34B88AE053C224C00A85A0",
  "last-modified": "Wed, 03 Oct 2018 20:40:00 GMT",
  "opc-multipart-md5": "BxPABMX8Yq2vMylkdlmnvw==2"
},
"fullbackup_8cte0snd_1_1": {
  "etag": "7759E18C068211FAE053C224C00AFEFE",
  "last-modified": "Wed, 03 Oct 2018 20:37:21 GMT",
  "opc-content-md5": "QMhVC+z2E7+NxVJQGw6h+Q=="
},
"fullbackup_8dte0snf_1_1": {
  "etag": "7759B476B5240C55E053C224C00A9519",

```

```
"last-modified": "Wed, 03 Oct 2018 20:27:45 GMT",
"opc-content-md5": "zYZbB10SnRXGfvojpiC6rA=="
}
}
}
$
```

Step 3: Create a Compute Instance and Launch the Target Database

Oracle Cloud Infrastructure Compute enables you provision and manage compute instances. You can create instances as needed to meet your compute and application requirements. After you create an instance, you can access it from your computer, restart it, attach and detach volumes, and terminate it when you're done with it. Any changes made to the instance's local drives are lost when you terminate it, but any saved changes to volumes attached to the instance are retained.

Create an SSH Key

When you create an instance, you must supply an SSH public key in Open SSH format. This key is used to authenticate your SSH sessions. If you don't have an SSH key pair, you can use the following command to create a new SSH key pair:

```
$ ssh-keygen -t rsa -N "" -b 2048 -f .ssh/linstance_rsa
Generating public/private rsa key pair.
Your identification has been saved in .ssh/linstance_rsa.
Your public key has been saved in .ssh/linstance_rsa.pub.
The key fingerprint is:
SHA256:403i0ZWzkfYEoQDgzyAKU2dXPV88EXukKyrz7N/wtj0
$
```

Note: Replace `PATH` and `ROOT_NAME` with your own values. `PATH` is the location where the key pair will be saved. `ROOT_NAME` is the root name for the files.

Create the Compute Instance

Sign in to the Oracle Cloud Infrastructure Console and click **Create Instance** to create a new instance. The system prompts you to enter the necessary information to create the instance. Remember to choose the public key of the SSH key pair that you created earlier.

For detailed instructions, see the [Compute documentation](#).

Connect to the Compute Instance

After you create the Compute instance, use the following commands to set up permissions and connect to the instance:

```
$ chmod 400 linstance_rsa
$ ssh -i linstance_rsa opc@PUBLIC_IP_ADDRESS
Last failed login: Fri Sep 28 02:03:25 GMT 2018 from 209.141.40.49 on ssh:notty
There were 1 failed login attempts since the last successful login.
Last login: Wed Sep 26 22:57:07 2018 from 160.34.93.141
$
```

Note: Replace PUBLIC_IP_ADDRESS with your own value.

Install Oracle Database

Note: The steps in this section provide instructions for a simple installation of Oracle Database. We recommend that you refer to Oracle best practices for installation when setting up large-scale production instances.

To install Oracle Database in the Compute instance, download the installable file from [Oracle Technology Network \(OTN\)](#) and follow the setup instructions for the version of Oracle Database that you want to install (it must be the same version as that of the source database instance).

1. Run the following commands for Oracle Database installation as the root user:

```
# yum install wget zip unzip -y
# mkdir -p /u01/software
# cd /u01/software
#
```

2. Run the following commands to install the prerequisites automatically. The preinstall depends on the version of the Oracle Database being installed. This example uses the Oracle 12c Release 2 preinstall.

```
# yum install oracle-database-server-12cR2-preinstall -y
# yum update -y
#
```

The Oracle Database preinstall installs all the prerequisites required for Oracle Database installation. The preinstall process also creates the oracle user.

3. Run the following command to reset the password for the oracle user:

```
# passwd oracle
Changing password for user oracle.
New password:
Retype new password:
```

```
passwd: all authentication tokens updated successfully.
#
```

4. Run the following command and set up the environment variables required for Oracle Database installation:

```
# mkdir -p /u01/app/oracle/product/12.2.0.1/db_1
# chown -R oracle:oinstall /u01
# chmod -R 775 /u01
# mkdir /home/oracle/scripts
# cat > /home/oracle/scripts/setEnv.sh <<EOF
# Oracle Settings
export TMP=/tmp
export TMPDIR=\$TMP
export ORACLE_HOSTNAME=ol7-122.localdomain
export ORACLE_UNQNAME=cdb1
export ORACLE_BASE=/u01/app/oracle
export ORACLE_HOME=\$ORACLE_BASE/product/12.2.0.1/db_1
export ORACLE_SID=cdb1
export PATH=/usr/sbin:/usr/local/bin:\$PATH
export PATH=\$ORACLE_HOME/bin:\$PATH
export LD_LIBRARY_PATH=\$ORACLE_HOME/lib:/lib:/usr/lib
export CLASSPATH=\$ORACLE_HOME/jlib:\$ORACLE_HOME/rdbms/jlib
EOF
# echo ". /home/oracle/scripts/setEnv.sh" >> /home/oracle/.bash_profile
#
```

5. Copy the Oracle Database installation software (Oracle 12c Release 2 is used in this example) to the /u01/software directory and run the following commands to begin the installation process:

```
# unzip linuxx64_12201_database.zip
# cd database
# chown -R oracle.oinstall /u01
# su - oracle
$ cd /u01/software/database
$
```

Silent installations are the simplest solution for most cloud-based installations. The following command shows a silent software-only installation that uses a response file named `db_install.rsp`. Preparing the response file for silent installation is out of the scope of this paper. For detailed instructions, see the [Oracle Universal Installer \(OUI\) silent installation](#) documentation.

```
$. /runInstaller -ignoreSysPrereqs -ignorePrereq -waitforcompletion -showProgress -
silent -responseFile /u01/software/database/response/db_install.rsp
Starting Oracle Universal Installer...

Checking Temp space: must be greater than 500 MB. Actual 26602 MB Passed
Checking swap space: must be greater than 150 MB. Actual 8191 MB Passed
Preparing to launch Oracle Universal Installer from /tmp/OraInstall2018-09-21_12-22-
16AM. Please wait ...You can find the log of this install session at:
```

```

/u01/app/oraInventory/logs/installActions2018-09-21_12-22-16AM.log
Prepare in progress.
..... 8% Done.
Prepare successful.
Copy files in progress.
..... 17% Done.
..... 22% Done.
..... 27% Done.
.....
..... 75% Done.
..... 80% Done.
.....
Copy files successful.
Link binaries in progress.
.....
Link binaries successful.
Setup files in progress.
.....
Setup files successful.
Setup Inventory in progress.
Setup Inventory successful.
Finish Setup successful.
The installation of Oracle Database 12c was successful.
Please check '/u01/app/oraInventory/logs/silentInstall2018-09-21_12-22-
16AM.log' for more details.
Setup Oracle Base in progress.
Setup Oracle Base successful.
..... 95% Done.
As a root user, execute the
following script(s):
 1. /u01/app/oraInventory/orainstRoot.sh
 2. /u01/app/oracle/product/12.2.0.1/db_1/root.sh
..... 100% Done.
Successfully Setup Software.
$

```

After Oracle Database is installed, the Oracle Universal Installer prompts you to run the following scripts:

- /u01/app/oraInventory/orainstRoot.sh
- /u01/app/oracle/product/12.2.0.1/db_1/root.sh

```

# /u01/app/oraInventory/orainstRoot.sh
Changing permissions of /u01/app/oraInventory.
Adding read, write permissions for group.
Removing read, write,execute permissions for world
Changing groupname of /u01/app/oraInventory to oinstall.
The execution of script is complete.
# $ORACLE_HOME/root.sh
Performing root user operation.
The following environment variables are set as:
  ORACLE_OWNER= oracle
  ORACLE_HOME= /u01/app/oracle/product/12.2.0/dbhome_1

```

```

Enter the full pathname of the local bin directory: [/usr/local/bin]:
  Copying dbhome to /usr/local/bin ...
  Copying oraenv to /usr/local/bin ...
  Copying coraenv to /usr/local/bin ....
Creating /etc/oratab file...
Entries will be added to the /etc/oratab file as needed by
Database Configuration Assistant when a database is created
Finished running generic part of root script.
Now product-specific root actions will be performed.
Do you want to setup Oracle Trace File Analyzer (TFA) now? yes|[no] : yes
Installing Oracle Trace File Analyzer (TFA).
Log File: /u01/app/oracle/product/12.2.0/dbhome_1/install/root_instance-20180911-
1539_2018-09-11_23-22-25-911263805.log
Finished installing Oracle Trace File Analyzer (TFA)
#

```

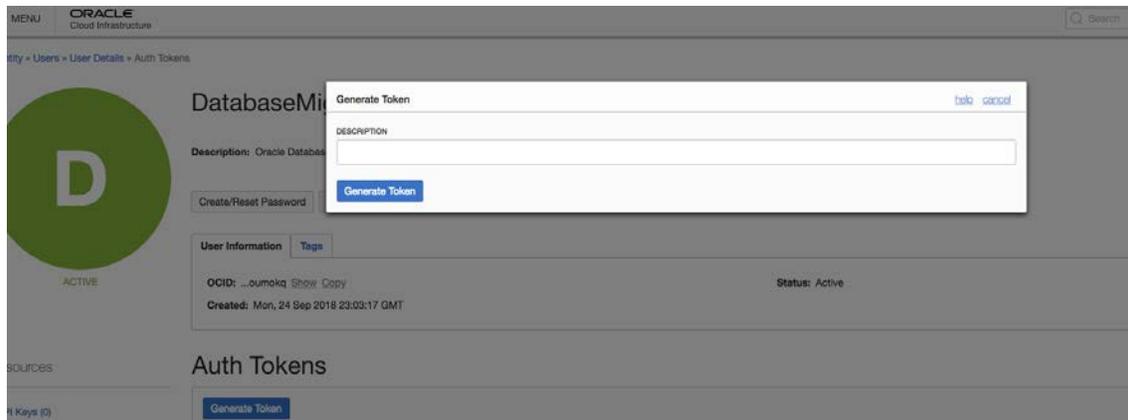
Step 4: Configure the Database Cloud Backup Module

The Oracle Database Cloud Backup Module makes it possible to perform cloud backups and restores. The module is a system backup to tape (SBT) interface that's integrated with RMAN; you can use standard RMAN commands for backup, restore, recovery, and maintenance operations.

Generate an Auth Token

The Oracle Database Cloud Backup Module uses the Swift protocol to interact with Object Storage. Swift access to Object Storage is authenticated by using *auth tokens*. To generate an auth token, sign in to the Oracle Cloud Infrastructure Console and perform the following steps:

1. Open the menu and navigate to **Identity** and then **Users**.
2. Select your user ID and then select **Auth Tokens**.
3. Click **Generate Token** to create authentication token.



For more information about generating an auth token, see the [documentation](#).

Download the Database Cloud Backup Module

Download the Database Cloud Backup Module from [Oracle Technology Network \(OTN\)](#) and upload it to the `/tmp` directory of the target instance. Then, unzip the `opc_installer.zip` file.

Install the Database Cloud Backup Module

Run the following commands to install the Database Cloud Backup Module. Replace `USER_ID`, `BUCKET_NAME`, `AUTH_TOKEN`, `REGION`, and `TENANCY` with your own values.

```
# mkdir -p /home/oracle/cbm/cbm_lib
# export vcbm_lib=/home/oracle/cbm/cbm_lib
# export vcbm_config=/home/oracle/cbm/cbm_config
# export vcbm_wallet=/home/oracle/cbm/cbm_wallet
# su - oracle
$ cd /tmp/opc_installer
$ $ORACLE_HOME/jdk/bin/java -jar opc\_install.jar -opcId USER_ID -
opcPass 'AUTH_TOKEN' -container BUCKET_NAME -walletDir $vcbm_wallet -libDir $vcbm_lib
-configfile $vcbm_config -host
https://swiftobjectstorage.REGION.oraclecloud.com/v1/TENANCY
Oracle Database Cloud Backup Module Install Tool, build 12.2.0.1.0DBBKPCSBP_2018-06-
12
Oracle Database Cloud Backup Module credentials are valid.
Backups would be sent to container <bucket_name>
Oracle Database Cloud Backup Module wallet created in directory
/home/oracle/cbm/cbm_wallet.
Oracle Database Cloud Backup Module initialization file /home/oracle/cbm/cbm_config
created.
Downloading Oracle Database Cloud Backup Module Software Library from
file opc\_linux64.zip.
Download Completed.
$
```

Step 5: Restore the Backup from Object Storage

If the database being migrated is encrypted at the source, download the `sqlnet.ora` and TDE wallet files that you copied during the backup process and place them in the wallet location. Create an auto login wallet before proceeding with the database restore process. Ensure that `sqlnet.ora` has the right `ENCRYPTION_WALLET_LOCATION`.

```
$ cat $ORACLE_HOME/network/admin/sqlnet.ora
ENCRYPTION_WALLET_LOCATION
=(SOURCE=(METHOD=FILE)(METHOD_DATA=(DIRECTORY=/etc/oracle/wallets/cdb1/))
$ cd /etc/oracle/wallets/cdb1
$ ls
cwallet.sso cwallet.sso.lck ewallet.p12 ewallet.p12.lck
$
```

Create System Backup to Tape Metadata Files

In this example, the backup files were created directly by RMAN without using the Database Cloud Backup Module at the source. For backups generated without the Database Cloud Backup Module, you must create system backup to tape (SBT) metadata files to restore the backup from Object Storage by using the Database Cloud Backup Module.

Run the following command to generate SBT metadata for the backup files that are stored in Object Storage:

```
$ rman target /
RMAN> startup nomount force;
RMAN> set decryption identified by 'myPassword';
RMAN> run {
allocate channel t1 device type sbt
parms='SBT_LIBRARY=/home/oracle/cbm/cbm_lib/libopc.so, SBT_PARAMS=(OPC_PFILE=/home/oracle/cbm/cbm_config)';
send channel t1 '
export backuppiece fullbackup_8ate0smf_1_1;
export backuppiece fullbackup_8bte0smu_1_1;
export backuppiece fullbackup_8cte0snd_1_1;
export backuppiece fullbackup_8dte0snf_1_1;
export backuppiece fullbackup_87te0skd_1_1;
export backuppiece fullbackup_88te0slg_1_1;
export backuppiece fullbackup_89te0sm0_1_1;
export backuppiece Incremental_8gte0spp_1_1;
export backuppiece Incremental_8lte0spt_1_1;
export backuppiece Incremental_8mte0spv_1_1;
export backuppiece Al_fullbackup_8ete0snh_1_1;
export backuppiece Al_fullbackup_86te0skc_1_1;
export backuppiece Al_Incremental_8fte0spl_1_1;
export backuppiece Al_Incremental_8nte0sq0_1_1;
';
}
allocated channel: t1
channel t1: SID=120 device type=SBT_TAPE
channel t1: Oracle Database Backup Service Library VER=12.2.0.2
sent command to channel: t1
released channel: t1
RMAN>
```

The preceding command creates the following metadata files in the Object Storage bucket:

- sbt_catalog/fullbackup_8ate0smf_1_1/metadata.xml
- sbt_catalog/fullbackup_8bte0smu_1_1/metadata.xml
- sbt_catalog/fullbackup_8cte0snd_1_1/metadata.xml
- sbt_catalog/fullbackup_8dte0snf_1_1/metadata.xml
- sbt_catalog/fullbackup_87te0skd_1_1/metadata.xml
- sbt_catalog/fullbackup_88te0slg_1_1/metadata.xml
- sbt_catalog/fullbackup_89te0sm0_1_1/metadata.xml

- sbt_catalog/Incremental_8gte0spp_1_1/metadata.xml
- sbt_catalog/Incremental_8lte0spt_1_1/metadata.xml
- sbt_catalog/Incremental_8mte0spv_1_1/metadata.xml
- sbt_catalog/Al_fullbackup_8ete0snh_1_1/metadata.xml
- sbt_catalog/Al_fullbackup_86te0skc_1_1/metadata.xml
- sbt_catalog/Al_Incremental_8fte0spl_1_1/metadata.xml
- sbt_catalog/Al_Incremental_8nte0sq0_1_1/metadata.xml

Restore the Parameter Files

To restore the spfile, configure the RMAN parameters to restore the spfile from a tape device, which is configured to point to Object Storage. Use the DBID that you noted from the source database, and use the same password (in `set decryption`) that you used to encrypt the backup on the source instance.

Run the following command to restore the spfile:

```
$ rman target /
RMAN> set dbid 960474975;
RMAN> startup force nomount;
RMAN> set decryption identified by 'myPassword';
RMAN> run
{
allocate channel t1 device type sbt
parms='SBT_LIBRARY=/home/oracle/cbm/cbm_lib/libopc.so, SBT_PARAMS=(OPC_PFILE=/home/oracle/cbm/cbm_config)';
restore spfile from 'fullbackup_8dte0snf_1_1';
}
released channel: ORA_DISK_1
allocated channel: t1
channel t1: SID=120 device type=SBT_TAPE
channel t1: Oracle Database Backup Service Library VER=12.2.0.2

Starting restore at 25-SEP-18
channel t1: restoring spfile from AUTOBACKUP fullbackup_8dte0snf_1_1
channel t1: SPFILE restore from AUTOBACKUP complete
Finished restore at 25-SEP-18
released channel: t1
RMAN>
```

Prepare the Control File Location

Run the following commands to create the controlfile location:

```
$ sqlplus / as sysdba;
SQL> create pfile='/tmp/pfile.ora' from spfile;
File created.
SQL>exit
```

```
Disconnected
# mkdir /u01/app/oracle/admin/cdb1/adump
# mkdir /u01/app/oracle/oradata/cdb1/
# chown -R oracle.oinstall /u01/app/oracle/oradata/cdb1/
# chown -R oracle.oinstall /u01/app/oracle/admin/cdb1/
#
```

Restore the Control File

Run the following commands to restore the database controlfiles from the incremental control file backup. Use the same password (in `set decryption`) that you used to encrypt the backup on the source instance.

```
$ rman target /
RMAN> set decryption identified by 'myPassword';
RMAN >run {
  allocate channel c1 device type sbt
PARMS 'SBT_LIBRARY=/home/oracle/cbm/cbm_lib/libopc.so, SBT_PARAMS=(OPC_PFILE=/home/oracle/cbm/cbm_config)';
  restore controlfile from 'Incremental_8lte0spt_1_1';
}
allocated channel: t1
channel t1: SID=237 device type=SBT_TAPE
channel t1: Oracle Database Backup Service Library VER=12.2.0.2
Starting restore at 25-SEP-18

channel t1: restoring control file
channel t1: restore complete, elapsed time: 00:00:03
output file name=/u01/app/oracle/oradata/cdb1/control01.ctl
output file name=/u01/app/oracle/oradata/cdb1/control02.ctl
Finished restore at 25-SEP-18
released channel: t1
RMAN> alter database mount;
Statement processed
RMAN>
```

Restore and Recover the Database

Run the following commands to restore and recover the database:

```
$ rman target /
RMAN> configure channel device
type 'sbt_tape' PARMS 'SBT_LIBRARY=/home/oracle/cbm/cbm_lib/libopc.so, SBT_PARAMS=(OPC_PFILE=/home/oracle/cbm/cbm_config)';
new RMAN configuration parameters:
CONFIGURE CHANNEL DEVICE
TYPE 'SBT_TAPE' PARMS 'SBT_LIBRARY=/home/oracle/cbm/cbm_lib/libopc.so, SBT_PARAMS=(OPC_PFILE=/home/oracle/cbm/cbm_config)';
new RMAN configuration parameters are successfully stored
RMAN> CONFIGURE DEFAULT DEVICE TYPE TO SBT_TAPE;
new RMAN configuration parameters:
```

```

CONFIGURE DEFAULT DEVICE TYPE TO 'SBT_TAPE';
new RMAN configuration parameters are successfully stored
RMAN> crosscheck backup device type sbt;
allocated channel: ORA_SBT_TAPE_1
channel ORA_SBT_TAPE_1: SID=258 device type=SBT_TAPE
channel ORA_SBT_TAPE_1: Oracle Database Backup Service Library VER=12.2.0.2
RMAN> delete noprompt expired backup;
using channel ORA_DISK_1
specification does not match any backup in the repository
RMAN> catalog device type sbt
backuppiece 'fullbackup_8ate0smf_1_1', 'fullbackup_8bte0smu_1_1', 'fullbackup_8cte0snd_1_1', 'fullbackup_8dte0snf_1_1', 'fullbackup_87te0skd_1_1', 'fullbackup_88te0slg_1_1', 'fullbackup_89te0sm0_1_1', 'Incremental_8gte0spp_1_1', 'Incremental_8lte0spt_1_1', 'Incremental_8mte0spv_1_1', 'Al_fullbackup_8ete0snh_1_1', 'Al_fullbackup_86te0skc_1_1', 'Al_Incremental_8fte0spl_1_1', 'Al_Incremental_8nte0sq0_1_1';
released channel: ORA_SBT_TAPE_1
allocated channel: ORA_SBT_TAPE_1
channel ORA_SBT_TAPE_1: SID=258 device type=SBT_TAPE
channel ORA_SBT_TAPE_1: Oracle Database Backup Service Library VER=12.2.0.2
cataloged backup piece
backup piece handle=fullbackup_8ate0smf_1_1 RECID=160 STAMP=987804189
cataloged backup piece
backup piece handle=fullbackup_8bte0smu_1_1 RECID=161 STAMP=987804189
cataloged backup piece
backup piece handle=fullbackup_8cte0snd_1_1 RECID=162 STAMP=987804189
cataloged backup piece
backup piece handle=fullbackup_8dte0snf_1_1 RECID=163 STAMP=987804302
cataloged backup piece
backup piece handle=fullbackup_87te0skd_1_1 RECID=164 STAMP=987804302
cataloged backup piece
backup piece handle=fullbackup_88te0slg_1_1 RECID=165 STAMP=987804303
.
.
.
cataloged backup piece
backup piece handle=Al_Incremental_8nte0sq0_1_1 RECID=173 STAMP=987804463
RMAN>restore device type sbt database;
Starting restore at 25-SEP-18
released channel: ORA_SBT_TAPE_1
allocated channel: ORA_SBT_TAPE_1
channel ORA_SBT_TAPE_1: SID=258 device type=SBT_TAPE
channel ORA_SBT_TAPE_1: Oracle Database Backup Service Library VER=12.2.0.2
channel ORA_SBT_TAPE_1: starting datafile backup set restore
channel ORA_SBT_TAPE_1: specifying datafile(s) to restore from backup set
channel ORA_SBT_TAPE_1: restoring datafile 00001 to
/u01/app/oracle/oradata/cdb1/system01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00003 to
/u01/app/oracle/oradata/cdb1/sysaux01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00004 to
/u01/app/oracle/oradata/cdb1/undotbs01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00007 to
/u01/app/oracle/oradata/cdb1/users01.dbf

```

```
channel ORA_SBT_TAPE_1: reading from backup piece fullbackup_87te0skd_1_1
channel ORA_SBT_TAPE_1: piece handle=fullbackup_87te0skd_1_1 tag=DTA_LEVEL0
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:45
channel ORA_SBT_TAPE_1: starting datafile backup set restore
channel ORA_SBT_TAPE_1: specifying datafile(s) to restore from backup set
channel ORA_SBT_TAPE_1: restoring datafile 00009 to
/u01/app/oracle/oradata/cdbl/pdbl/system01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00010 to
/u01/app/oracle/oradata/cdbl/pdbl/sysaux01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00011 to
/u01/app/oracle/oradata/cdbl/pdbl/undotbs01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00012 to
/u01/app/oracle/oradata/cdbl/pdbl/users01.dbf
channel ORA_SBT_TAPE_1: reading from backup piece fullbackup_88te0slg_1_1
channel ORA_SBT_TAPE_1: piece handle=fullbackup_88te0slg_1_1 tag=DTA_LEVEL0
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:25
channel ORA_SBT_TAPE_1: starting datafile backup set restore
channel ORA_SBT_TAPE_1: specifying datafile(s) to restore from backup set
channel ORA_SBT_TAPE_1: restoring datafile 00005 to
/u01/app/oracle/oradata/cdbl/pdbseed/system01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00006 to
/u01/app/oracle/oradata/cdbl/pdbseed/sysaux01.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00008 to
/u01/app/oracle/oradata/cdbl/pdbseed/undotbs01.dbf
channel ORA_SBT_TAPE_1: reading from backup piece fullbackup_89te0sm0_1_1
channel ORA_SBT_TAPE_1: piece handle=fullbackup_89te0sm0_1_1 tag=DTA_LEVEL0
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:25
channel ORA_SBT_TAPE_1: starting datafile backup set restore
channel ORA_SBT_TAPE_1: specifying datafile(s) to restore from backup set
channel ORA_SBT_TAPE_1: restoring datafile 00016 to
/u01/app/oracle/oradata/CDB1/760AE48A954574F3E0530F00000A94CB/datafile/ol_mf_system_f
sydl0sk_.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00017 to
/u01/app/oracle/oradata/CDB1/760AE48A954574F3E0530F00000A94CB/datafile/ol_mf_sysaux_f
sydl0ss_.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00018 to
/u01/app/oracle/oradata/CDB1/760AE48A954574F3E0530F00000A94CB/datafile/ol_mf_undotbs1
fsydl0st_.dbf
channel ORA_SBT_TAPE_1: reading from backup piece fullbackup_8ate0smf_1_1
channel ORA_SBT_TAPE_1: piece handle=fullbackup_8ate0smf_1_1 tag=DTA_LEVEL0
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:25
channel ORA_SBT_TAPE_1: starting datafile backup set restore
channel ORA_SBT_TAPE_1: specifying datafile(s) to restore from backup set
channel ORA_SBT_TAPE_1: restoring datafile 00019 to
/u01/app/oracle/oradata/CDB1/760AE48A954674F3E0530F00000A94CB/datafile/ol_mf_system_f
sydmotq_.dbf
channel ORA_SBT_TAPE_1: restoring datafile 00020 to
/u01/app/oracle/oradata/CDB1/760AE48A954674F3E0530F00000A94CB/datafile/ol_mf_sysaux_f
sydmotq_.dbf
```

```
channel ORA_SBT_TAPE_1: restoring datafile 00021 to
/u01/app/oracle/oradata/CDB1/760AE48A954674F3E0530F00000A94CB/datafile/o1_mf_undotbs1
_fsydmotr_.dbf
channel ORA_SBT_TAPE_1: reading from backup piece fullbackup_8bte0smu_1_1
channel ORA_SBT_TAPE_1: piece handle=fullbackup_8bte0smu_1_1 tag=DTA_LEVEL0
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:25
Finished restore at 25-SEP-18
RMAN>recover database ;
Starting recover at 25-SEP-18
using channel ORA_SBT_TAPE_1
using channel ORA_DISK_1
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup set
.
.
channel ORA_SBT_TAPE_1: starting archived log restore to default destination
channel ORA_SBT_TAPE_1: restoring archived log
archived log thread=1 sequence=40
channel ORA_SBT_TAPE_1: reading from backup piece Al_Incremental_8nte0sq0_1_1
channel ORA_SBT_TAPE_1: piece handle=Al_Incremental_8nte0sq0_1_1 tag=DTA_LEVEL1
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:01
RMAN>alter database open resetlogs;
Statement processed
RMAN>
```

Conclusion

By migrating your Oracle Databases to Oracle Cloud Infrastructure, you can take advantage of a world-class database running on an enterprise-class cloud platform. This white paper provided detailed instructions for migrating and deploying Oracle Database from on-premises to Oracle Cloud Infrastructure. The type of data migration service to use depends on the size of the database and the network connectivity between the source instance and Object Storage. For fast and secure database migration, it is critical to choose the appropriate data migration services. By following the steps outlined in this paper, you can migrate Oracle Databases to Oracle Cloud Infrastructure securely with minimal downtime for small-to-medium-size databases. For large-scale databases, you can use the steps provided in this paper to establish a standby instance, and you can use tools like Oracle GoldenGate to keep the source and target databases synchronized in preparation for migration.

Appendix: Database Migration Security

Oracle Cloud Infrastructure provides various security features for the Oracle Databases migrated to it.

Encryption

- **Object Storage:** Database backups stored in Object Storage are encrypted at rest by using AES-256. Encryption is on by default and can't be turned off. Each object is encrypted with its encryption key, and the object encryption keys are encrypted with a master encryption key. In addition, customers can use RMAN backup encryption to encrypt RMAN backups before storing them in Object Storage buckets.
- **Data Transfer Appliance:** Data Transfer Appliance encrypts any data that is in transit by using AES-256. All the network communication between the data transfer utility and Oracle Cloud Infrastructure is encrypted in transit by using Transport Layer Security (TLS).
- **Data in transit:** Backups in transit between customer clients (for example, the CLI) and Object Storage public endpoints are encrypted with TLS 1.2 by default. FastConnect public peering allows on-premises access to Object Storage to go over a private circuit rather than public internet.
- **Storage Gateway:** Storage Gateway transfers backups to Oracle Cloud Infrastructure using HTTPS, which encrypts data packets in flight between Storage Gateway and the cloud.

Fine-Grained Access Control

- **Data Transfer Appliance and Data Transfer Disk:** Data Transfer Appliance and Data Transfer Disk require you to create an Identity and Access Management (IAM) group for data transfer administrators and also for data transfer upload users. Only users who are part of this group have access to transfer and upload backups into data transfer appliances and disks. Additionally, Data Transfer Appliance uploads the backup only to the customer-designated bucket in their tenancy, which is configured by the user during the data transfer process.
- **Storage Gateway:** When you use Storage Gateway, IAM requires you to create Storage Gateway administrators with strong and secure passwords. Storage Gateway administrators can create, modify, and delete file systems.
- **Object Storage:** We recommend users who set up IAM policies to limit who can access objects in the buckets. Anyone with permission to read or modify any object in the bucket can read or modify all the objects in the bucket.



Authentication and Authorization

- **Compute Instances:** Compute instances use key-based SSH by default. Customers provide the SSH public keys to Oracle Cloud Infrastructure and securely use the SSH private keys for accessing the instances. We recommend using key-based SSH to access Compute instances. Password-based SSH could be susceptible to brute-forcing attacks.
- **Storage Gateway and Data Transfer Appliance:** When you define the file systems for Storage Gateway and Data Transfer Appliance, we recommend and provide options to set up restrictive export options so that only trusted NFS clients can access the file system data and metadata. Modify the advanced file system settings for NFS Allowed Hosts and NFS Export Options to restrict access to a file system.



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Integrated Cloud Applications & Platform Services

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Using Object Storage to Migrate Databases to Oracle Cloud Infrastructure
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