Oracle Database Deployment and Protection with iSCSI/ASM

NetApp Solutions

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TR-4965: Oracle Database Deployment and Protection in AWS FSx/EC2 with iSCSI/ASM

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Purpose

ASM (Automatic Storage Management) is a popular Oracle storage volume manager that is employed in many Oracle installations. It is also Oracle's recommended storage management solution. It provides an alternative to conventional volume managers and file systems. Since Oracle version 11g, ASM has been packaged with grid infrastructure rather than a database. As a result, in order to utilize Oracle ASM for storage management without RAC, you must install Oracle grid infrastructure in a standalone server, also known as Oracle Restart. Doing so certainly adds more complexity in an otherwise simpler Oracle database deployment. However, as the name implies, when Oracle is deployed in Restart mode, any failed Oracle services are restarted after a host reboot without user intervention, which provides a certain degree of high availability or HA functionality.

In this documentation, we demonstrate how to deploy an Oracle database with the iSCSI protocol and Oracle ASM in an Amazon FSx for ONTAP storage environment with EC2 compute instances. We also demonstrate how to use the NetApp SnapCenter service through the NetApp BlueXP console to backup, restore, and clone your Oracle database for dev/test or other use cases for storage-efficient database operation in the AWS public cloud.

This solution addresses the following use cases:

- Oracle database deployment in Amazon FSx for ONTAP storage and EC2 compute instances with iSCSI/ASM
- Testing and validating an Oracle workload in the public AWS cloud with iSCSI/ASM
- Testing and validating Oracle database Restart functionalities deployed in AWS

Audience

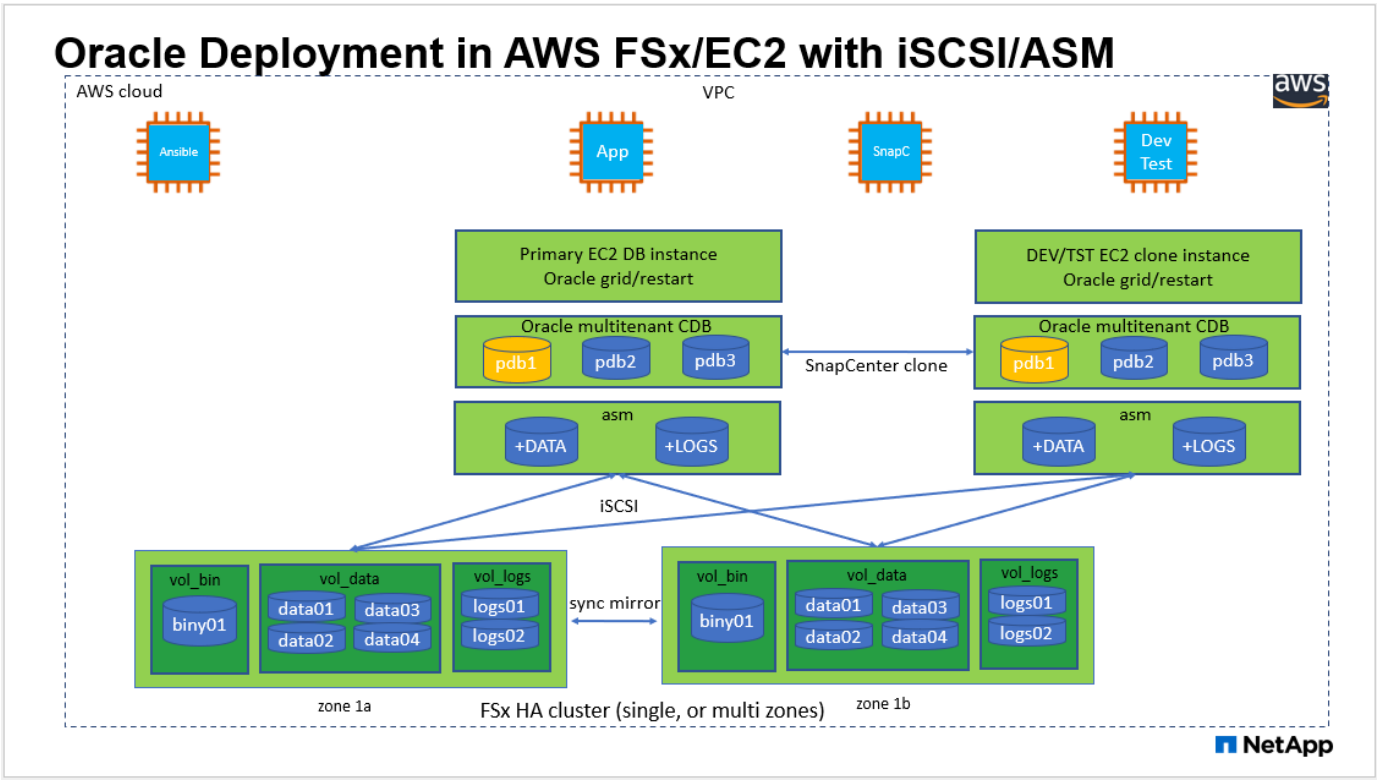
This solution is intended for the following people:

- A DBA who would like to deploy Oracle in an AWS public cloud with iSCSI/ASM.
- A database solution architect who would like to test Oracle workloads in the AWS public cloud.
- The storage administrator who would like to deploy and manage an Oracle database deployed to AWS FSx storage.
- The application owner who would like to stand up an Oracle database in AWS FSx/EC2.

Solution test and validation environment

The testing and validation of this solution was performed in an AWS FSx and EC2 environment that might not match the final deployment environment. For more information, see the section [Key Factors for Deployment Consideration].

Architecture



Hardware and software components

Hardware		
FSx ONTAP storage	Current version offered by AWS	One FSx HA cluster in the same VPC and availability zone
EC2 instance for compute	t2.xlarge/4vCPU/16G	Two EC2 T2 xlarge EC2 instances, one as primary DB server and the other as a clone DB server
Software		
RedHat Linux	RHEL-8.6.0_HVM-20220503-x86_64-2-Hourly2-GP2	Deployed RedHat subscription for testing
Oracle Grid Infrastructure	Version 19.18	Applied RU patch p34762026_190000_Linux-x86-64.zip
Oracle Database	Version 19.18	Applied RU patch p34765931_190000_Linux-x86-64.zip
Oracle OPatch	Version 12.2.0.1.36	Latest patch p6880880_190000_Linux-x86-64.zip
SnapCenter Service	Version	v2.3.1.2324

Key factors for deployment consideration

- **EC2 compute instances.** In these tests and validations, we used an AWS EC2 t2.xlarge instance type for

the Oracle database compute instance. NetApp recommends using an M5 type EC2 instance as the compute instance for Oracle in production deployment because it is optimized for database workloads. You need to size the EC2 instance appropriately for the number of vCPUs and the amount of RAM based on actual workload requirements.

- **FSx storage HA clusters single- or multi-zone deployment.** In these tests and validations, we deployed an FSx HA cluster in a single AWS availability zone. For production deployment, NetApp recommends deploying an FSx HA pair in two different availability zones. An FSx HA cluster is alway provisioned in a HA pair that is sync mirrored in a pair of active-passive file systems to provide storage-level redundancy. Multi-zone deployment further enhances high availability in the event of failure in a single AWS zone.
- **FSx storage cluster sizing.** An Amazon FSx for ONTAP storage file system provides up to 160,000 raw SSD IOPS, up to 4GBps throughput, and a maximum of 192TiB capacity. However, you can size the cluster in terms of provisioned IOPS, throughput, and the storage limit (minimum 1,024 GiB) based on your actually requirements at the time of deployment. The capacity can be adjusted dynamically on the fly without affecting application availability.
- **Oracle data and logs layout.** In our tests and validations, we deployed two ASM disk groups for data and logs respectively. Within the +DATA asm disk group, we provisioned four LUNs in a data volume. Within the +LOGS asm disk group, we provisioned two LUNs in a logs volume. In general, multiple LUNs laid out within an Amazon FSx for ONTAP volume provides better performance.
- **iSCSI configuration.** The EC2 instance database server connects to FSx storage with the iSCSI protocol. EC2 instances generally deploy with a single network interface or ENI. The single NIC interface carries both iSCSI and application traffic. It is important to gauge the Oracle database peek I/O throughput requirement by carefully analyzing the Oracle AWR report in order to choose a right EC2 compute instance that meets both application and iSCSI traffic-throughput requirements. NetApp also recommends allocating four iSCSI connections to both FSx iSCSI endpoints with multipath properly configured.
- **Oracle ASM redundancy level to use for each Oracle ASM disk group that you create.** Because FSx already mirrors the storage on the FSx cluster level, you should use External Redundancy, which means that the option does not allow Oracle ASM to mirror the contents of the disk group.
- **Database backup.** NetApp provides a SaaS version of SnapCenter software service for database backup, restore, and clone in the cloud that is available through the NetApp BlueXP console UI. NetApp recommends implementing such a service to achieve fast (under a minute) SnapShot backup, quick (few minutes) database restore, and database cloning.

Solution deployment

The following section provides step-by-step deployment procedures.

Prerequisites for deployment

Deployment requires the following prerequisites.

1. An AWS account has been set up, and the necessary VPC and network segments have been created within your AWS account.
2. From the AWS EC2 console, you must deploy two EC2 Linux instances, one as the primary Oracle DB server and an optional alternative clone target DB server. See the architecture diagram in the previous section for more details about the environment setup. Also review the User Guide for Linux instances for more information.
3. From the AWS EC2 console, deploy Amazon FSx for ONTAP storage HA clusters to host the Oracle database volumes. If you are not familiar with the deployment of FSx storage, see the documentation Creating FSx for ONTAP file systems for step-by-step instructions.
4. Steps 2 and 3 can be performed using the following Terraform automation toolkit, which creates an EC2 instance named `ora_01` and an FSx file system named `fsx_01`. Review the instruction carefully and change the variables to suit your environment before execution.

```
git clone https://github.com/NetApp-
Automation/na_aws_fsx_ec2_deploy.git
```

Ensure that you have allocated at least 50G in EC2 instance root volume in order to have sufficient space to stage Oracle installation files.

EC2 instance kernel configuration

With the prerequisites provisioned, log into the EC2 instance as ec2-user and sudo to root user to configure the Linux kernel for Oracle installation.

1. Create a staging directory `/tmp/archive` folder and set the `777` permission.

```
mkdir /tmp/archive

chmod 777 /tmp/archive
```

2. Download and stage the Oracle binary installation files and other required rpm files to the `/tmp/archive` directory.

   See the following list of installation files to be stated in `/tmp/archive` on the EC2 instance.

```
[ec2-user@ip-172-30-15-58 ~]$ ls -l /tmp/archive
total 10537316
-rw-rw-r--. 1 ec2-user ec2-user      19112 Mar 21 15:57 compat-
libcap1-1.10-7.el7.x86_64.rpm
-rw-rw-r--  1 ec2-user ec2-user 3059705302 Mar 21 22:01
LINUX.X64_193000_db_home.zip
-rw-rw-r--  1 ec2-user ec2-user 2889184573 Mar 21 21:09
LINUX.X64_193000_grid_home.zip
-rw-rw-r--. 1 ec2-user ec2-user     589145 Mar 21 15:56
netapp_linux_unified_host_utilities-7-1.x86_64.rpm
-rw-rw-r--. 1 ec2-user ec2-user      31828 Mar 21 15:55 oracle-
database-preinstall-19c-1.0-2.el8.x86_64.rpm
-rw-rw-r--  1 ec2-user ec2-user 2872741741 Mar 21 22:31
p34762026_190000_Linux-x86-64.zip
-rw-rw-r--  1 ec2-user ec2-user 1843577895 Mar 21 22:32
p34765931_190000_Linux-x86-64.zip
-rw-rw-r--  1 ec2-user ec2-user  124347218 Mar 21 22:33
p6880880_190000_Linux-x86-64.zip
-rw-r--r--  1 ec2-user ec2-user     257136 Mar 22 16:25
policycoreutils-python-utils-2.9-9.el8.noarch.rpm
```

3. Install Oracle 19c preinstall RPM, which satisfies most kernel configuration requirements.

```
yum install /tmp/archive/oracle-database-preinstall-19c-1.0-
2.el8.x86_64.rpm
```

4. Download and install the missing `compat-libcap1` in Linux 8.

```
yum install /tmp/archive/compat-libcap1-1.10-7.el7.x86_64.rpm
```

5. From NetApp, download and install NetApp host utilities.

```
yum install /tmp/archive/netapp_linux_unified_host_utilities-7-
1.x86_64.rpm
```

6. Install `policycoreutils-python-utils`, which is not available in the EC2 instance.

```
yum install /tmp/archive/policycoreutils-python-utils-2.9-
9.el8.noarch.rpm
```

7. Install open JDK version 1.8.

```
yum install java-1.8.0-openjdk.x86_64
```

8. Install iSCSI initiator utils.

```
yum install iscsi-initiator-utils
```

9. Install `sg3_utils`.

```
yum install sg3_utils
```

10. Install `device-mapper-multipath`.

```
yum install device-mapper-multipath
```

11. Disable transparent hugepages in the current system.

```
echo never > /sys/kernel/mm/transparent_hugepage/enabled
echo never > /sys/kernel/mm/transparent_hugepage/defrag
```

Add the following lines in `/etc/rc.local` to disable `transparent_hugepage` after reboot:

```
  # Disable transparent hugepages
          if test -f /sys/kernel/mm/transparent_hugepage/enabled;
then
            echo never > /sys/kernel/mm/transparent_hugepage/enabled
          fi
          if test -f /sys/kernel/mm/transparent_hugepage/defrag;
then
            echo never > /sys/kernel/mm/transparent_hugepage/defrag
          fi
```

12. Disable selinux by changing `SELINUX=enforcing` to `SELINUX=disabled`. You must reboot the host to make the change effective.

```
vi /etc/sysconfig/selinux
```

13. Add the following lines to `limit.conf` to set the file descriptor limit and stack size without quotes `" "`.

```
vi /etc/security/limits.conf
  "*               hard    nofile          65536"
  "*               soft    stack           10240"
```

14. Add swap space to EC2 instance by following this instruction: How do I allocate memory to work as swap space in an Amazon EC2 instance by using a swap file? The exact amount of space to add depends on the size of RAM up to 16G.
15. Change `node.session.timeo.replacement_timeout` in the `iscsi.conf` configuration file from 120 to 5 seconds.

```
vi /etc/iscsi/iscsid.conf
```

16. Enable and start the iSCSI service on the EC2 instance.

```
systemctl enable iscsid
systemctl start iscsid
```

17. Retrieve the iSCSI initiator address to be used for database LUN mapping.

```
cat /etc/iscsi/initiatorname.iscsi
```

18. Add the ASM group to be used for the asm sysasm group

```
groupadd asm
```

19. Modify the oracle user to add ASM as a secondary group (the oracle user should have been created after Oracle preinstall RPM installation).

```
usermod -a -G asm oracle
```

20. Reboot the EC2 instance.

Provision and map database volumes and LUNs to the EC2 instance host

Provision three volumes from the command line by login to FSx cluster via ssh as fsxadmin user with FSx cluster management IP to host the Oracle database binary, data, and logs files.

1. Log into the FSx cluster through SSH as the fsxadmin user.

```
ssh fsxadmin@172.30.15.53
```

2. Execute the following command to create a volume for the Oracle binary.

```
vol create -volume ora_01_biny -aggregate aggr1 -size 50G -state
online  -type RW -snapshot-policy none -tiering-policy snapshot-only
```

3. Execute the following command to create a volume for Oracle data.

```
vol create -volume ora_01_data -aggregate aggr1 -size 100G -state
online  -type RW -snapshot-policy none -tiering-policy snapshot-only
```

4. Execute the following command to create a volume for Oracle logs.

```
vol create -volume ora_01_logs -aggregate aggr1 -size 100G -state
online  -type RW -snapshot-policy none -tiering-policy snapshot-only
```

5. Create a binary LUN within the database binary volume.

```
lun create -path /vol/ora_01_biny/ora_01_biny_01 -size 40G -ostype
linux
```

6. Create data LUNs within the database data volume.

```
lun create -path /vol/ora_01_data/ora_01_data_01 -size 20G -ostype
linux

lun create -path /vol/ora_01_data/ora_01_data_02 -size 20G -ostype
linux

lun create -path /vol/ora_01_data/ora_01_data_03 -size 20G -ostype
linux

lun create -path /vol/ora_01_data/ora_01_data_04 -size 20G -ostype
linux
```

7. Create log LUNs within the database logs volume.

```
lun create -path /vol/ora_01_logs/ora_01_logs_01 -size 40G -ostype
linux

lun create -path /vol/ora_01_logs/ora_01_logs_02 -size 40G -ostype
linux
```

8. Create an igroup for the EC2 instance with the initiator retrieved from step 14 of the EC2 kernel configuration above.

```
igroup create -igroup ora_01 -protocol iscsi -ostype linux
-initiator iqn.1994-05.com.redhat:f65fed7641c2
```

9. Map the LUNs to the igroup created above. Increment the LUN ID sequentially for each additional LUN within a volume.

```
lun map -path /vol/ora_01_biny/ora_01_biny_01 -igroup ora_01
-vserver svm_ora -lun-id 0
lun map -path /vol/ora_01_data/ora_01_data_01 -igroup ora_01
-vserver svm_ora -lun-id 1
lun map -path /vol/ora_01_data/ora_01_data_02 -igroup ora_01
-vserver svm_ora -lun-id 2
lun map -path /vol/ora_01_data/ora_01_data_03 -igroup ora_01
-vserver svm_ora -lun-id 3
lun map -path /vol/ora_01_data/ora_01_data_04 -igroup ora_01
-vserver svm_ora -lun-id 4
lun map -path /vol/ora_01_logs/ora_01_logs_01 -igroup ora_01
-vserver svm_ora -lun-id 5
lun map -path /vol/ora_01_logs/ora_01_logs_02 -igroup ora_01
-vserver svm_ora -lun-id 6
```

10. Validate the LUN mapping.

```
mapping show
```

This is expected to return:

```
FsxId02ad7bf3476b741df::> mapping show
  (lun mapping show)
Vserver    Path                                      Igroup   LUN ID
Protocol
---------- ----------------------------------------  -------  ------
--------
svm_ora    /vol/ora_01_biny/ora_01_biny_01           ora_01        0
iscsi
svm_ora    /vol/ora_01_data/ora_01_data_01           ora_01        1
iscsi
svm_ora    /vol/ora_01_data/ora_01_data_02           ora_01        2
iscsi
svm_ora    /vol/ora_01_data/ora_01_data_03           ora_01        3
iscsi
svm_ora    /vol/ora_01_data/ora_01_data_04           ora_01        4
iscsi
svm_ora    /vol/ora_01_logs/ora_01_logs_01           ora_01        5
iscsi
svm_ora    /vol/ora_01_logs/ora_01_logs_02           ora_01        6
iscsi
```

Database storage configuration

Now, import and set up the FSx storage for the Oracle grid infrastructure and database installation on the EC2 instance host.

1. Log into the EC2 instance via SSH as the ec2-user with your SSH key and EC2 instance IP address.

```
ssh -i ora_01.pem ec2-user@172.30.15.58
```

2. Discover the FSx iSCSI endpoints using either SVM iSCSI IP address. Then change to your environment-specific portal address.

```
sudo iscsiadm iscsiadm --mode discovery --op update --type
sendtargets --portal 172.30.15.51
```

3. Establish iSCSI sessions by logging into each target.

```
sudo iscsiadm --mode node -l all
```

   The expected output from the command is:

```
[ec2-user@ip-172-30-15-58 ~]$ sudo iscsiadm --mode node -l all
Logging in to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
172.30.15.51,3260]
Logging in to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
172.30.15.13,3260]
Login to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
172.30.15.51,3260] successful.
Login to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
172.30.15.13,3260] successful.
```

4. View and validate a list of active iSCSI sessions.

```
sudo iscsiadm --mode session
```

   Return the iSCSI sessions.

```
[ec2-user@ip-172-30-15-58 ~]$ sudo iscsiadm --mode session
tcp: [1] 172.30.15.51:3260,1028 iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3 (non-flash)
tcp: [2] 172.30.15.13:3260,1029 iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3 (non-flash)
```

5. Verify that the LUNs were imported into the host.

```
sudo sanlun lun show
```

This will return a list of Oracle LUNs from FSx.

```
[ec2-user@ip-172-30-15-58 ~]$ sudo sanlun lun show
controller(7mode/E-Series)/                                    device
host                  lun
vserver(cDOT/FlashRay)        lun-pathname
filename        adapter    protocol   size    product

svm_ora                       /vol/ora_01_logs/ora_01_logs_02
/dev/sdn        host3      iSCSI      40g     cDOT
svm_ora                       /vol/ora_01_logs/ora_01_logs_01
/dev/sdm        host3      iSCSI      40g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_03
/dev/sdk        host3      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_04
/dev/sdl        host3      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_01
/dev/sdi        host3      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_02
/dev/sdj        host3      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_biny/ora_01_biny_01
/dev/sdh        host3      iSCSI      40g     cDOT
svm_ora                       /vol/ora_01_logs/ora_01_logs_02
/dev/sdg        host2      iSCSI      40g     cDOT
svm_ora                       /vol/ora_01_logs/ora_01_logs_01
/dev/sdf        host2      iSCSI      40g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_04
/dev/sde        host2      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_02
/dev/sdc        host2      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_03
/dev/sdd        host2      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_data/ora_01_data_01
/dev/sdb        host2      iSCSI      20g     cDOT
svm_ora                       /vol/ora_01_biny/ora_01_biny_01
/dev/sda        host2      iSCSI      40g     cDOT
```

6. Configure the `multipath.conf` file with following default and blacklist entries.

```
sudo vi /etc/multipath.conf

defaults {
    find_multipaths yes
    user_friendly_names yes
}

blacklist {
    devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
    devnode "^hd[a-z]"
    devnode "^cciss.*"
}
```

7. Start the multipath service.

```
sudo systemctl start multipathd
```

Now multipath devices appear in the `/dev/mapper` directory.

```
[ec2-user@ip-172-30-15-58 ~]$ ls -l /dev/mapper
total 0
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e68512d -> ../dm-0
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e685141 -> ../dm-1
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e685142 -> ../dm-2
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e685143 -> ../dm-3
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e685144 -> ../dm-4
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e685145 -> ../dm-5
lrwxrwxrwx 1 root root       7 Mar 21 20:13
3600a09806c574235472455534e685146 -> ../dm-6
crw------- 1 root root 10, 236 Mar 21 18:19 control
```

8. Log into the FSx cluster as the fsxadmin user via SSH to retrieve the serial-hex number for each LUN start with 6c574xxx…, the HEX number start with 3600a0980, which is AWS vendor ID.

```
lun show -fields serial-hex
```

and return as follow:

```
FsxId02ad7bf3476b741df::> lun show -fields serial-hex
vserver path                            serial-hex
------- ------------------------------- ------------------------
svm_ora /vol/ora_01_biny/ora_01_biny_01 6c574235472455534e68512d
svm_ora /vol/ora_01_data/ora_01_data_01 6c574235472455534e685141
svm_ora /vol/ora_01_data/ora_01_data_02 6c574235472455534e685142
svm_ora /vol/ora_01_data/ora_01_data_03 6c574235472455534e685143
svm_ora /vol/ora_01_data/ora_01_data_04 6c574235472455534e685144
svm_ora /vol/ora_01_logs/ora_01_logs_01 6c574235472455534e685145
svm_ora /vol/ora_01_logs/ora_01_logs_02 6c574235472455534e685146
7 entries were displayed.
```

9. Update the `/dev/multipath.conf` file to add a user-friendly name for the multipath device.

```
sudo vi /etc/multipath.conf
```

with following entries:

```
multipaths {
        multipath {
                wwid            3600a09806c574235472455534e68512d
                alias           ora_01_biny_01
        }
        multipath {
                wwid            3600a09806c574235472455534e685141
                alias           ora_01_data_01
        }
        multipath {
                wwid            3600a09806c574235472455534e685142
                alias           ora_01_data_02
        }
        multipath {
                wwid            3600a09806c574235472455534e685143
                alias           ora_01_data_03
        }
        multipath {
                wwid            3600a09806c574235472455534e685144
                alias           ora_01_data_04
        }
        multipath {
                wwid            3600a09806c574235472455534e685145
                alias           ora_01_logs_01
        }
        multipath {
                wwid            3600a09806c574235472455534e685146
                alias           ora_01_logs_02
        }
}
```

10. Reboot the multipath service to verify that the devices under `/dev/mapper` have changed to LUN names versus serial-hex IDs.

```
sudo systemctl restart multipathd
```

Check `/dev/mapper` to return as following:

```
[ec2-user@ip-172-30-15-58 ~]$ ls -l /dev/mapper
total 0
crw------- 1 root root 10, 236 Mar 21 18:19 control
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_biny_01 -> ../dm-
0
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_data_01 -> ../dm-
1
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_data_02 -> ../dm-
2
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_data_03 -> ../dm-
3
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_data_04 -> ../dm-
4
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_logs_01 -> ../dm-
5
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_01_logs_02 -> ../dm-
6
```

11. Partition the binary LUN with a single primary partition.

```
sudo fdisk /dev/mapper/ora_01_biny_01
```

12. Format the partitioned binary LUN with an XFS file system.

```
sudo mkfs.xfs /dev/mapper/ora_01_biny_01p1
```

13. Mount the binary LUN to `/u01`.

```
sudo mount -t xfs /dev/mapper/ora_01_biny_01p1 /u01
```

14. Change `/u01` mount point ownership to the Oracle user and it’s asssociated primary group.

```
sudo chown oracle:oinstall /u01
```

15. Find the UUI of the binary LUN.

```
sudo blkid /dev/mapper/ora_01_biny_01p1
```

16. Add a mount point to `/etc/fstab`.

```
sudo vi /etc/fstab
```

Add the following line.

```
UUID=d89fb1c9-4f89-4de4-b4d9-17754036d11d       /u01    xfs
defaults,nofail 0       2
```

> It is important to mount the binary with only the UUID and with the nofail option to avoid possible root-lock issues during EC2-instance reboot.

17. As the root user, add the udev rule for Oracle devices.

```
vi /etc/udev/rules.d/99-oracle-asmdevices.rules
```

Include following entries:

```
ENV{DM_NAME}=="ora*", GROUP:="oinstall", OWNER:="oracle",
MODE:="660"
```

18. As the root user, reload the udev rules.

```
udevadm control --reload-rules
```

19. As the root user, trigger the udev rules.

```
udevadm trigger
```

20. As the root user, reload multipathd.

```
systemctl restart multipathd
```

21. Reboot the EC2 instance host.

Oracle grid infrastructure installation

1. Log into the EC2 instance as the ec2-user via SSH and enable password authentication by uncommenting `PasswordAuthentication yes` and then commenting out `PasswordAuthentication no`.

```
sudo vi /etc/ssh/sshd_config
```

2. Restart the sshd service.

```
sudo systemctl restart sshd
```

3. Reset the Oracle user password.

```
sudo passwd oracle
```

4. Log in as the Oracle Restart software owner user (oracle). Create an Oracle directory as follows:

```
mkdir -p /u01/app/oracle
mkdir -p /u01/app/oraInventory
```

5. Change the directory permission setting.

```
chmod -R 775 /u01/app
```

6. Create a grid home directory and change to it.

```
mkdir -p /u01/app/oracle/product/19.0.0/grid
cd /u01/app/oracle/product/19.0.0/grid
```

7. Unzip the grid installation files.

```
unzip -q /tmp/archive/LINUX.X64_193000_grid_home.zip
```

8. From grid home, delete the `OPatch` directory.

```
rm -rf OPatch
```

9. From grid home, unzip `p6880880_190000_Linux-x86-64.zip`.

```
unzip -q /tmp/archive/p6880880_190000_Linux-x86-64.zip
```

10. From grid home, revise `cv/admin/cvu_config`, uncomment and replace `CV_ASSUME_DISTID=OEL5` with `CV_ASSUME_DISTID=OL7`.

```
vi cv/admin/cvu_config
```

11. Prepare a `gridsetup.rsp` file for silent installation and place the rsp file in the `/tmp/archive` directory. The rsp file should cover sections A, B, and G with the following infomation:

```
INVENTORY_LOCATION=/u01/app/oraInventory
oracle.install.option=HA_CONFIG
ORACLE_BASE=/u01/app/oracle
oracle.install.asm.OSDBA=dba
oracle.install.asm.OSOPER=oper
oracle.install.asm.OSASM=asm
oracle.install.asm.SYSASMPassword="SetPWD"
oracle.install.asm.diskGroup.name=DATA
oracle.install.asm.diskGroup.redundancy=EXTERNAL
oracle.install.asm.diskGroup.AUSize=4
oracle.install.asm.diskGroup.disks=/dev/mapper/ora_01_data_01,/dev/m
apper/ora_01_data_02,/dev/mapper/ora_01_data_03,/dev/mapper/ora_01_d
ata_04
oracle.install.asm.diskGroup.diskDiscoveryString=/dev/mapper/*
oracle.install.asm.monitorPassword="SetPWD"
oracle.install.asm.configureAFD=true
```

12. Log into the EC2 instance as the root user and set `ORACLE_HOME` and `ORACLE_BASE`.

```
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/grid
export ORACLE_BASE=/tmp
cd /u01/app/oracle/product/19.0.0/grid/bin
```

13. Provision disk devices for use with the Oracle ASM filter driver.

```
 ./asmcmd afd_label DATA01 /dev/mapper/ora_01_data_01 --init

 ./asmcmd afd_label DATA02 /dev/mapper/ora_01_data_02 --init

 ./asmcmd afd_label DATA03 /dev/mapper/ora_01_data_03 --init

 ./asmcmd afd_label DATA04 /dev/mapper/ora_01_data_04 --init

 ./asmcmd afd_label LOGS01 /dev/mapper/ora_01_logs_01 --init

 ./asmcmd afd_label LOGS02 /dev/mapper/ora_01_logs_02 --init
```

14. Install `cvuqdisk-1.0.10-1.rpm`.

```
rpm -ivh /u01/app/oracle/product/19.0.0/grid/cv/rpm/cvuqdisk-1.0.10-
1.rpm
```

15. Unset `$ORACLE_BASE`.

```
unset ORACLE_BASE
```

16. Log into the EC2 instance as the Oracle user and extract the patch in the `/tmp/archive` folder.

```
unzip p34762026_190000_Linux-x86-64.zip
```

17. From grid home /u01/app/oracle/product/19.0.0/grid and as the oracle user, launch `gridSetup.sh` for grid infrastructure installation.

```
 ./gridSetup.sh -applyRU /tmp/archive/34762026/ -silent
-responseFile /tmp/archive/gridsetup.rsp
```

    Ignore the warnings about wrong groups for grid infrastructure. We are using a single Oracle user to manage Oracle Restart, so this is expected.

18. As root user, execute the following script(s):

```
/u01/app/oraInventory/orainstRoot.sh

/u01/app/oracle/product/19.0.0/grid/root.sh
```

19. As root user, reload the multipathd.

```
systemctl restart multipathd
```

20. As the Oracle user, execute the following command to complete the configuration:

```
/u01/app/oracle/product/19.0.0/grid/gridSetup.sh -executeConfigTools
-responseFile /tmp/archive/gridsetup.rsp -silent
```

21. As the Oracle user, create the LOGS disk group.

```
bin/asmca -silent -sysAsmPassword 'yourPWD' -asmsnmpPassword
'yourPWD' -createDiskGroup -diskGroupName LOGS -disk 'AFD:LOGS*'
-redundancy EXTERNAL -au_size 4
```

22. As the Oracle user, validate grid services after installation configuration.

```
bin/crsctl stat res -t
+
Name                Target  State        Server
State details
Local Resources
ora.DATA.dg         ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.LISTENER.lsnr   ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.LOGS.dg         ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.asm             ONLINE  ONLINE       ip-172-30-15-58
Started,STABLE
ora.ons             OFFLINE OFFLINE      ip-172-30-15-58
STABLE
Cluster Resources
ora.cssd            ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.diskmon         OFFLINE OFFLINE
STABLE
ora.driver.afd      ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.evmd            ONLINE  ONLINE       ip-172-30-15-58
STABLE
```

23. Valiate ASM filter driver status.

```
[oracle@ip-172-30-15-58 grid]$ export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/grid
[oracle@ip-172-30-15-58 grid]$ export ORACLE_SID=+ASM
[oracle@ip-172-30-15-58 grid]$ export PATH=$PATH:$ORACLE_HOME/bin
[oracle@ip-172-30-15-58 grid]$ asmcmd
ASMCMD> lsdg
State    Type    Rebal  Sector  Logical_Sector  Block       AU
Total_MB  Free_MB  Req_mir_free_MB  Usable_file_MB  Offline_disks
Voting_files  Name
MOUNTED  EXTERN  N         512             512   4096  1048576
81920    81847                0           81847              0
N  DATA/
MOUNTED  EXTERN  N         512             512   4096  1048576
81920    81853                0           81853              0
N  LOGS/
ASMCMD> afd_state
ASMCMD-9526: The AFD state is 'LOADED' and filtering is 'ENABLED' on
host 'ip-172-30-15-58.ec2.internal'
```

Oracle database installation

1. Log in as the Oracle user and unset `$ORACLE_HOME` and `$ORACLE_SID` if it is set.

```
unset ORACLE_HOME
unset ORACLE_SID
```

2. Create the Oracle DB home directory and change to it.

```
mkdir /u01/app/oracle/product/19.0.0/db1
cd /u01/app/oracle/product/19.0.0/db1
```

3. Unzip the Oracle DB installation files.

```
unzip -q /tmp/archive/LINUX.X64_193000_db_home.zip
```

4. From the DB home, delete the `OPatch` directory.

```
rm -rf OPatch
```

5. From DB home, unzip `p6880880_190000_Linux-x86-64.zip`.

```
unzip -q /tmp/archive/p6880880_190000_Linux-x86-64.zip
```

6. From DB home, revise `cv/admin/cvu_config`, and uncomment and replace `CV_ASSUME_DISTID=OEL5` with `CV_ASSUME_DISTID=OL7`.

```
vi cv/admin/cvu_config
```

7. From the `/tmp/archive` directory, unpack the DB 19.18 RU patch.

```
unzip p34765931_190000_Linux-x86-64.zip
```

8. Prepare the DB silent install rsp file in `/tmp/archive/dbinstall.rsp` directory with the following values:

```
oracle.install.option=INSTALL_DB_SWONLY
UNIX_GROUP_NAME=oinstall
INVENTORY_LOCATION=/u01/app/oraInventory
ORACLE_HOME=/u01/app/oracle/product/19.0.0/db1
ORACLE_BASE=/u01/app/oracle
oracle.install.db.InstallEdition=EE
oracle.install.db.OSDBA_GROUP=dba
oracle.install.db.OSOPER_GROUP=oper
oracle.install.db.OSBACKUPDBA_GROUP=oper
oracle.install.db.OSDGDBA_GROUP=dba
oracle.install.db.OSKMDBA_GROUP=dba
oracle.install.db.OSRACDBA_GROUP=dba
oracle.install.db.rootconfig.executeRootScript=false
```

9. From db1 home /u01/app/oracle/product/19.0.0/db1, execute silent software-only DB installation.

```
 ./runInstaller -applyRU /tmp/archive/34765931/ -silent
-ignorePrereqFailure -responseFile /tmp/archive/dbinstall.rsp
```

10. As root user, run the `root.sh` script after sofware-only installation.

```
/u01/app/oracle/product/19.0.0/db1/root.sh
```

11. As Oracle user, create the `dbca.rsp` file with the following entries:

```
gdbName=db1.demo.netapp.com
sid=db1
createAsContainerDatabase=true
numberOfPDBs=3
pdbName=db1_pdb
useLocalUndoForPDBs=true
pdbAdminPassword="yourPWD"
templateName=General_Purpose.dbc
sysPassword="yourPWD"
systemPassword="yourPWD"
dbsnmpPassword="yourPWD"
storageType=ASM
diskGroupName=DATA
characterSet=AL32UTF8
nationalCharacterSet=AL16UTF16
listeners=LISTENER
databaseType=MULTIPURPOSE
automaticMemoryManagement=false
totalMemory=8192
```

12. As Oracle user, lauch DB creation with dbca.

```
bin/dbca -silent -createDatabase -responseFile /tmp/archive/dbca.rsp

output:
Prepare for db operation
7% complete
Registering database with Oracle Restart
11% complete
Copying database files
33% complete
Creating and starting Oracle instance
35% complete
38% complete
42% complete
45% complete
48% complete
Completing Database Creation
53% complete
55% complete
56% complete
Creating Pluggable Databases
60% complete
64% complete
69% complete
78% complete
Executing Post Configuration Actions
100% complete
Database creation complete. For details check the logfiles at:
 /u01/app/oracle/cfgtoollogs/dbca/db1.
Database Information:
Global Database Name:db1.demo.netapp.com
System Identifier(SID):db1
Look at the log file "/u01/app/oracle/cfgtoollogs/dbca/db1/db1.log"
for further details.
```

13. As Oracle user, validate Oracle Restart HA services after DB creation.

```
[oracle@ip-172-30-15-58 db1]$ ../grid/bin/crsctl stat res -t

Name            Target  State        Server                   State
details

Local Resources

ora.DATA.dg     ONLINE  ONLINE       ip-172-30-15-58          STABLE
ora.LISTENER.lsnr   ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.LOGS.dg     ONLINE  ONLINE       ip-172-30-15-58          STABLE
ora.asm     ONLINE  ONLINE       ip-172-30-15-58
Started,STABLE
ora.ons     OFFLINE OFFLINE      ip-172-30-15-58          STABLE

Cluster Resources

ora.cssd            ONLINE  ONLINE       ip-172-30-15-58
STABLE
ora.db1.db      ONLINE  ONLINE       ip-172-30-15-58
Open,HOME=/u01/app/oracle/product/19.0.0/db1,STABLE
ora.diskmon     OFFLINE OFFLINE                               STABLE
ora.driver.afd  ONLINE  ONLINE       ip-172-30-15-58          STABLE
ora.evmd        ONLINE  ONLINE       ip-172-30-15-58          STABLE
```

14. Set the Oracle user `.bash_profile`.

```
vi ~/.bash_profile
```

15. Add following entries:

```
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/db1
export ORACLE_SID=db1
export PATH=$PATH:$ORACLE_HOME/bin
alias asm='export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/grid;export
ORACLE_SID=+ASM;export PATH=$PATH:$ORACLE_HOME/bin'
```

16. Validate the CDB/PDB created.

```
/home/oracle/.bash_profile

sqlplus / as sysdba
```

```
SQL> select name, open_mode from v$database;

NAME      OPEN_MODE

DB1       READ WRITE

SQL> select name from v$datafile;

NAME

+DATA/DB1/DATAFILE/system.256.1132176177
+DATA/DB1/DATAFILE/sysaux.257.1132176221
+DATA/DB1/DATAFILE/undotbs1.258.1132176247
+DATA/DB1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/system.265.11321
77009
+DATA/DB1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/sysaux.266.11321
77009
+DATA/DB1/DATAFILE/users.259.1132176247
+DATA/DB1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/undotbs1.267.113
2177009
+DATA/DB1/F7852758DCD6B800E0533A0F1EAC1DC6/DATAFILE/system.271.11321
77853
+DATA/DB1/F7852758DCD6B800E0533A0F1EAC1DC6/DATAFILE/sysaux.272.11321
77853
+DATA/DB1/F7852758DCD6B800E0533A0F1EAC1DC6/DATAFILE/undotbs1.270.113
2177853
+DATA/DB1/F7852758DCD6B800E0533A0F1EAC1DC6/DATAFILE/users.274.113217
7871

NAME

+DATA/DB1/F785288BBCD1BA78E0533A0F1EACCD6F/DATAFILE/system.276.11321
77871
+DATA/DB1/F785288BBCD1BA78E0533A0F1EACCD6F/DATAFILE/sysaux.277.11321
77871
+DATA/DB1/F785288BBCD1BA78E0533A0F1EACCD6F/DATAFILE/undotbs1.275.113
2177871
+DATA/DB1/F785288BBCD1BA78E0533A0F1EACCD6F/DATAFILE/users.279.113217
7889
+DATA/DB1/F78529A14DD8BB18E0533A0F1EACB8ED/DATAFILE/system.281.11321
77889
+DATA/DB1/F78529A14DD8BB18E0533A0F1EACB8ED/DATAFILE/sysaux.282.11321
77889
+DATA/DB1/F78529A14DD8BB18E0533A0F1EACB8ED/DATAFILE/undotbs1.280.113
2177889
```

```
+DATA/DB1/F78529A14DD8BB18E0533A0F1EACB8ED/DATAFILE/users.284.113217
7907

19 rows selected.

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED

         2 PDB$SEED                       READ ONLY  NO
         3 DB1_PDB1                       READ WRITE NO
         4 DB1_PDB2                       READ WRITE NO
         5 DB1_PDB3                       READ WRITE NO
SQL>
```

17. Set the DB recovery location to the +LOGS disk group.

```
alter system set db_recovery_file_dest_size = 80G scope=both;

alter system set db_recovery_file_dest = '+LOGS' scope=both;
```

18. Log into the database with sqlplus and enable archive log mode.

```
sqlplus /as sysdba.

shutdown immediate;

startup mount;

alter database archivelog;

alter database open;
```

This completes Oracle 19c version 19.18 Restart deployment on an Amazon FSx for ONTAP and EC2 compute instance. If desired, NetApp recommends relocating the Oracle control file and online log files to the +LOGS disk group.

Automated deployment option

NetApp will release a fully automated solution deployment toolkit with Ansible to facilitate the implementation of this solution. Please check back for the availability of the toolkit. After it is released, a link will be posted here.

Oracle Database backup, restore, and clone with SnapCenter Service

See SnapCenter Services for Oracle for details on Oracle database backup, restore, and clone with NetApp BlueXP console.

Where to find additional information

To learn more about the information described in this document, review the following documents and/or websites:

- Installing Oracle Grid Infrastructure for a Standalone Server with a New Database Installation

  https://docs.oracle.com/en/database/oracle/oracle-database/19/ladbi/installing-oracle-grid-infrastructure-for-a-standalone-server-with-a-new-database-installation.html#GUID-0B1CEE8C-C893-46AA-8A6A-7B5FAAEC72B3

- Installing and Configuring Oracle Database Using Response Files

  https://docs.oracle.com/en/database/oracle/oracle-database/19/ladbi/installing-and-configuring-oracle-database-using-response-files.html#GUID-D53355E9-E901-4224-9A2A-B882070EDDF7

- Amazon FSx for NetApp ONTAP

  https://aws.amazon.com/fsx/netapp-ontap/

- Amazon EC2

  https://aws.amazon.com/pm/ec2/?trk=36c6da98-7b20-48fa-8225-4784bced9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIsAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixF-xnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

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