



Enterprise Databases

NetApp Solutions

NetApp

May 16, 2023

This PDF was generated from https://docs.netapp.com/us-en/netapp-solutions/databases/aws_ora_fsx_ec2_iscsi_asm.html on May 16, 2023. Always check docs.netapp.com for the latest.

Table of Contents

NetApp Enterprise Database Solutions	1
Oracle Database	1
Microsoft SQL Server	207
Open Source Databases	302
SnapCenter for databases	319

NetApp Enterprise Database Solutions

Oracle Database

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

Allen Cao, Niyaz Mohamed, NetApp

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

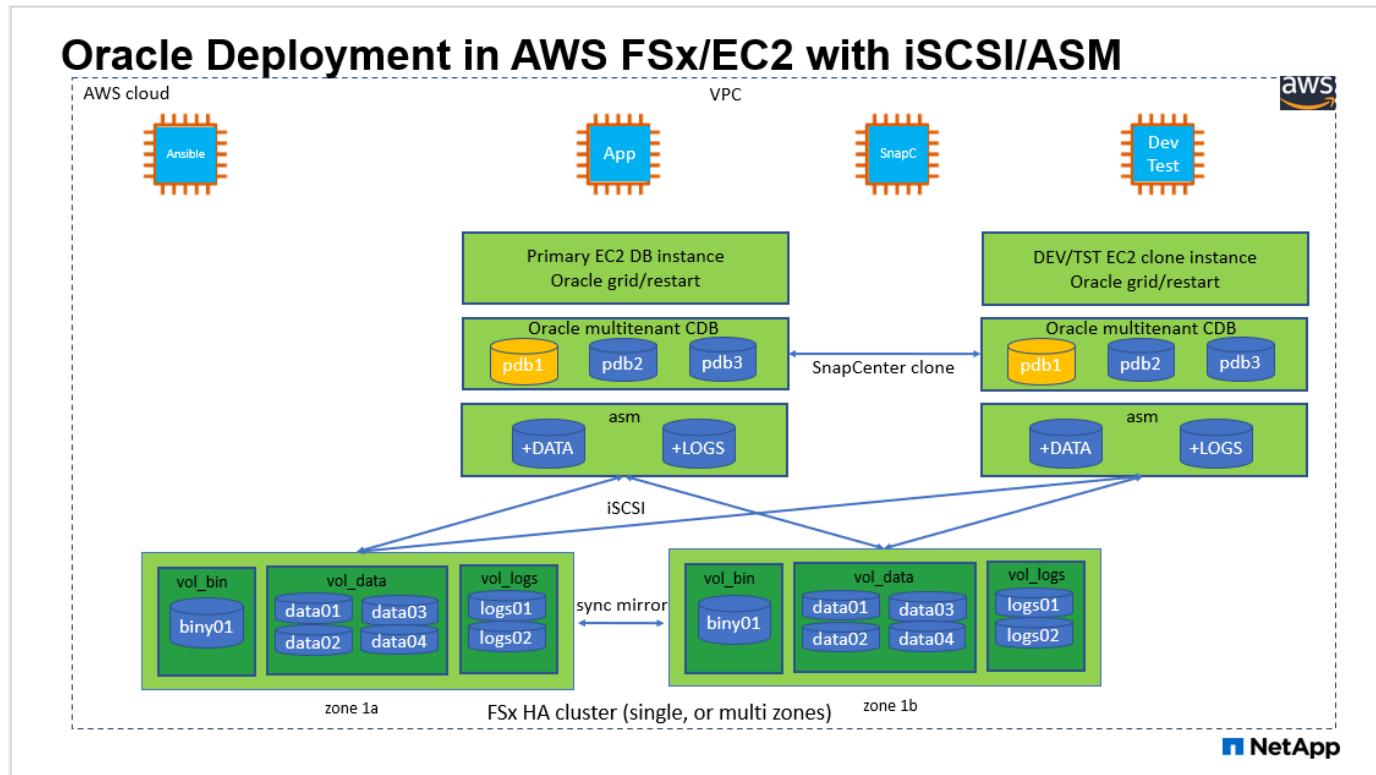
Audience

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 [\[Key Factors for Deployment Consideration\]](#).



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 always 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 actual 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 peak 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.timeout.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_bin -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_bin/ora_01_bin_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.

```
map -path /vol/ora_01_bin/ora_01_bin_01 -igroup ora_01 -vserver  
svm_ora -lun-id 0  
map -path /vol/ora_01_data/ora_01_data_01 -igroup ora_01 -vserver  
svm_ora -lun-id 1  
map -path /vol/ora_01_data/ora_01_data_02 -igroup ora_01 -vserver  
svm_ora -lun-id 2  
map -path /vol/ora_01_data/ora_01_data_03 -igroup ora_01 -vserver  
svm_ora -lun-id 3  
map -path /vol/ora_01_data/ora_01_data_04 -igroup ora_01 -vserver  
svm_ora -lun-id 4  
map -path /vol/ora_01_logs/ora_01_logs_01 -igroup ora_01 -vserver  
svm_ora -lun-id 5  
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_bin/y/ora_01_bin/y_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 iscsiadadm iscsiadadm --mode discovery --op update --type  
sendtargets --portal 172.30.15.51
```

3. Establish iSCSI sessions by logging into each target.

```
sudo iscsiadadm --mode node -l all
```

The expected output from the command is:

```
[ec2-user@ip-172-30-15-58 ~]$ sudo iscsiadadm --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 iscsiadadm --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
}

[source, cli]
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_bin/ora_01_bin_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_bin_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_bin_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_bin_01
```

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

```
sudo mkfs.xfs /dev/mapper/ora_01_bin_01p1
```

13. Mount the binary LUN to /u01.

```
sudo mount -t xfs /dev/mapper/ora_01_bin_01p1 /u01
```

14. Change /u01 mount point ownership to the Oracle user and it's associated primary group.

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

15. Find the UUID of the binary LUN.

```
sudo blkid /dev/mapper/ora_01_bin_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, copy `p6880880_190000_Linux-x86-64.zip` to the `grid_home`, and then unzip it.

```
cp /tmp/archive/p6880880_190000_Linux-x86-64.zip .
unzip 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 information:

```
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*
oracle.install.asm.diskGroup.diskDiscoveryString=/dev/mapper/ora_01_
data_01,/dev/mapper/ora_01_data_02,/dev/mapper/ora_01_data_03,/dev/m
apper/ora_01_data_04
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. Validate 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, copy p6880880_190000_Linux-x86-64.zip to grid_home, and then unzip it.

```
cp /tmp/archive/p6880880_190000_Linux-x86-64.zip .  
unzip 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 software-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    ip-172-30-15-58   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-8225-4784bc9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIzAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixFxnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

Oracle Database Deployment on AWS EC2 and FSx Best Practices

WP-7357: Oracle Database Deployment on EC2 and FSx Best Practices Introduction

Allen Cao, Niyaz Mohamed, Jeffrey Steiner, NetApp

Many mission-critical enterprise Oracle databases are still hosted on-premises, and many enterprises are looking to migrate these Oracle databases to a public cloud. Often, these Oracle databases are application centric and thus require user-specific configurations, a capability that is missing from many database-as-a-service public-cloud offerings. Therefore, the current database landscape calls for a public-cloud-based Oracle database solution built from a high-performance, scalable compute and storage service that can accommodate unique requirements. AWS EC2 compute instances and the AWS FSx storage service might be the missing pieces of this puzzle that you can leverage to build and migrate your mission critical Oracle database workloads to a public cloud.

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides secure, resizable compute capacity in the cloud. It is designed to make web-scale cloud computing easier for enterprises. The simple Amazon EC2 web-service interface allows you to obtain and configure capacity with minimal friction. It provides you with complete control of your computing resources and lets you run on Amazon's proven

computing environment.

Amazon FSx for ONTAP is an AWS storage service that uses industry-leading NetApp ONTAP block and file storage, which exposes NFS, SMB, and iSCSI. With such a powerful storage engine, it has never been easier to relocate mission-critical Oracle database apps to AWS with sub-millisecond response times, multiple Gbps of throughput, and 100,000+ IOPS per database instance. Better yet, the FSx storage service comes with native replication capability that allows you to easily migrate your on-premises Oracle database to AWS or to replicate your mission critical Oracle database to a secondary AWS availability zone for HA or DR.

The goal of this documentation is to provide step-by-step processes, procedures, and best-practice guidance on how to deploy and configure an Oracle database with FSx storage and an EC2 instance that delivers performance similar to an on-premises system. NetApp also provides an automation toolkit that automates most of the tasks that are required for the deployment, configuration, and management of your Oracle database workload in the AWS public cloud.

To learn more about the solution and use case, take a look at following overview video:

[Modernize your Oracle database with hybrid cloud in AWS and FSx ONTAP, Part1 - Use case and solution architecture](#)

[Next: Solutions architecture.](#)

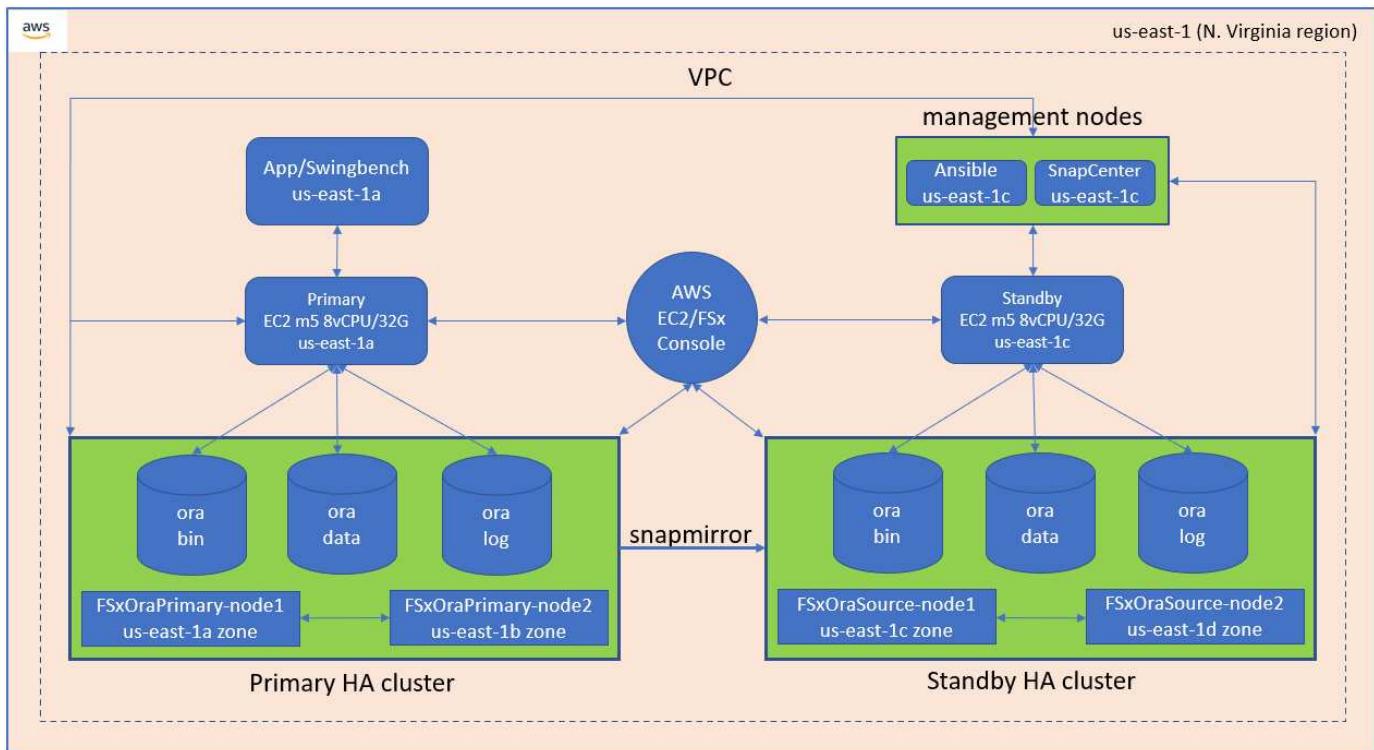
Solution architecture

[Previous: Introduction.](#)

The following architecture diagram illustrates a highly available Oracle database deployment on an AWS EC2 instance with the FSx storage service. A similar deployment scheme but with the standby in a different region can be set up for disaster recovery.

Within the environment, the Oracle compute instance is deployed via an AWS EC2 instance console. There are multiple EC2 instance types available from the console. NetApp recommends deploying a database-oriented EC2 instance type such as an m5 Ami image with RedHat enterprise Linux 8 and up to 10Gps of network bandwidth.

Oracle database storage on FSx volumes on the other hand is deployed with the AWS FSx console or CLI. The Oracle binary, data, or log volumes are subsequently presented and mounted on an EC2 instance Linux host. Each data or log volume can have multiple LUNs allocated depending on the underlying storage protocol employed.



An FSx storage cluster is designed with double redundancy, so that both the primary and standby storage clusters are deployed in two different availability zones. Database volumes are replicated from a primary FSx cluster to a standby FSx cluster at a user-configurable interval for all Oracle binary, data, and log volumes.

This high availability Oracle environment is managed with an Ansible controller node and a SnapCenter backup server and UI tool. Oracle installation, configuration, and replication are automated using Ansible playbook-based tool kits. Any update to the Oracle EC2 instance kernel operating system or Oracle patching can be executed in parallel to keep the primary and standby in sync. In fact, the initial automation setup can be easily expanded to perform some repeating daily Oracle tasks if needed.

SnapCenter provides workflows for Oracle database point-in-time recovery or for database cloning at either the primary or standby zones if needed. Through the SnapCenter UI, you can configure Oracle database backup and replication to standby FSx storage for high availability or disaster recovery based on your RTO or RPO objectives.

The solution provides an alternative process that delivers capabilities similar to those available from Oracle RAC and Data Guard deployment.

[Next: Factors to consider.](#)

Factors to consider for Oracle database deployment

[Previous: Solution architecture.](#)

A public cloud provides many choices for compute and storage, and using the correct type of compute instance and storage engine is a good place to start for database deployment. You should also select compute and storage configurations that are optimized for Oracle databases.

The following sections describe the key considerations when deploying Oracle database in an AWS public cloud on an EC2 instance with FSx storage.

VM performance

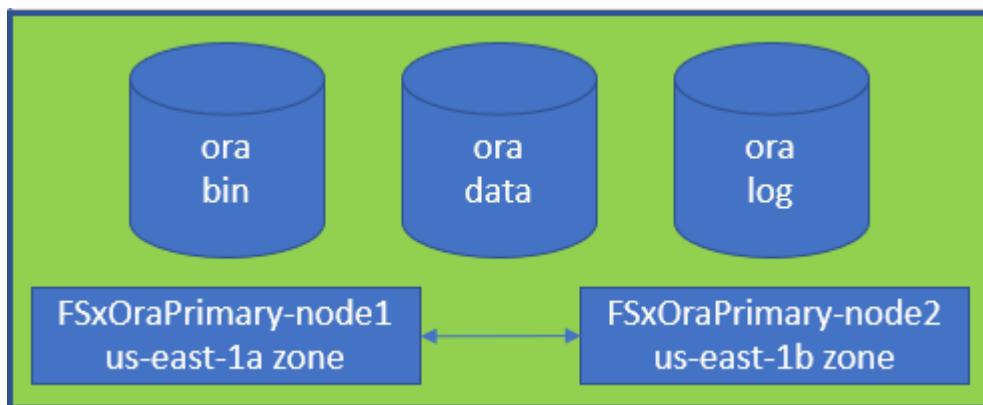
Selecting the right VM size is important for optimal performance of a relational database in a public cloud. For better performance, NetApp recommends using an EC2 M5 Series instance for Oracle deployment, which is optimized for database workloads. The same instance type is also used to power a RDS instance for Oracle by AWS.

- Choose the correct vCPU and RAM combination based on workload characteristics.
- Add swap space to a VM. The default EC2 instance deployment does not create a swap space, which is not optimal for a database.

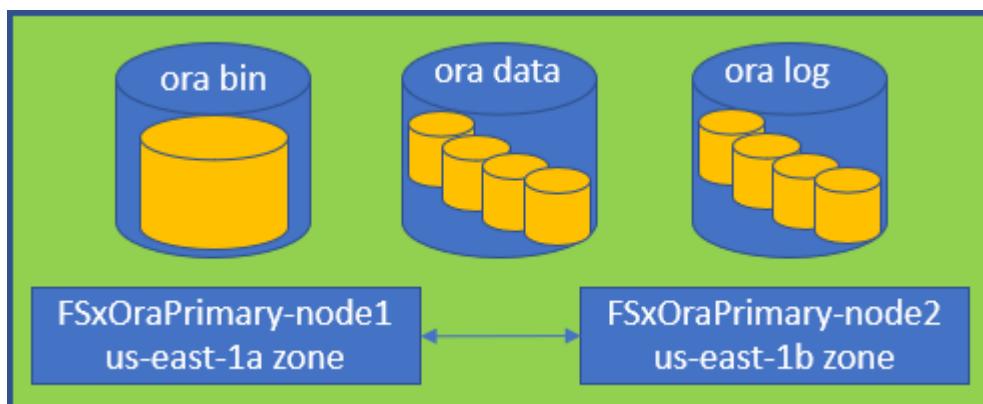
Storage layout and settings

NetApp recommends the following storage layout:

- For NFS storage, the recommended volume layout is three volumes: one for the Oracle binary; one for Oracle data and a duplicate control file; and one for the Oracle active log, archived log, and control file.



- For iSCSI storage, the recommended volume layout is three volumes: one for the Oracle binary; one for Oracle data and a duplicate control file; and one for the Oracle active log, archived log, and control file. However, each data and log volume ideally should contain four LUNs. The LUNs are ideally balanced on the HA cluster nodes.



- For storage IOPS and throughput, you can choose the threshold for provisioned IOPS and throughput for the FSx storage cluster, and these parameters can be adjusted on the fly anytime the workload changes.
 - The auto IOPS setting is three IOPS per GiB of allocated storage capacity or user defined storage up to 80,000.
 - The throughput level is incremented as follow: 128, 256, 512, 1024, 2048 MBps.

Review the [Amazon FSx for NetApp ONTAP performance](#) documentation when sizing throughput and IOPS.

NFS configuration

Linux, the most common operating system, includes native NFS capabilities. Oracle offers the direct NFS (dNFS) client natively integrated into Oracle. Oracle has supported NFSv3 for over 20 years, and NFSv4 is supported with Oracle 12.1.0.2 and later. Automated Oracle deployment using the NetApp automation toolkit automatically configures dNFS on NFSv3.

Other factors to consider:

- TCP slot tables are the NFS equivalent of host-bus-adapter (HBA) queue depth. These tables control the number of NFS operations that can be outstanding at any one time. The default value is usually 16, which is far too low for optimum performance. The opposite problem occurs on newer Linux kernels, which can automatically increase the TCP slot table limit to a level that saturates the NFS server with requests.

For optimum performance and to prevent performance problems, adjust the kernel parameters that control the TCP slot tables to 128.

```
sysctl -a | grep tcp.*.slot_table
```

- The following table provides recommended NFS mount options for Linux NFSv3 - single instance.

File Type	Mount Options
• Control files • Data files • Redo logs	<code>rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wszie=65536</code>
• ORACLE_HOME • ORACLE_BASE	<code>rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wszie=65536</code>

 Before using dNFS, verify that the patches described in Oracle Doc 1495104.1 are installed. Starting with Oracle 12c, dNFS includes support for NFSv3, NFSv4, and NFSv4.1. NetApp support policies cover v3 and v4 for all clients, but, at the time of writing, NFSv4.1 is not supported for use with Oracle dNFS.

High availability

As indicated in the solution architecture, HA is built on storage-level replication. Therefore, the startup and availability of Oracle is contingent on how quickly the compute and storage can be brought up and recovered. See the following key factors:

- Have a standby compute instance ready and synced up with the primary through Ansible parallel update to both hosts.
- Replicate the binary volume from the primary for standby purposes so that you do not need to install Oracle at the last minute and figure out what needs to be installed and patched.
- Replication frequency dictates how fast the Oracle database can be recovered to make service available. There is a trade off between the replication frequency and storage consumption.
- Leverage automation to make recovery and switch over to standby quick and free of human error. NetApp

provides an automation toolkit for this purpose.

[Next: Deployment procedures.](#)

Step-by-Step Oracle Deployment Procedures on AWS EC2 and FSx

[Previous: Solution architecture.](#)

Deploy an EC2 Linux instance for Oracle via EC2 console

If you are new to AWS, you first need to set up an AWS environment. The documentation tab at the AWS website landing page provides EC2 instruction links on how to deploy a Linux EC2 instance that can be used to host your Oracle database via the AWS EC2 console. The following section is a summary of these steps. For details, see the linked AWS EC2-specific documentation.

Setting up your AWS EC2 environment

You must create an AWS account to provision the necessary resources to run your Oracle environment on the EC2 and FSx service. The following AWS documentation provides the necessary details:

- [Set up to use Amazon EC2](#)

Key topics:

- Sign up for AWS.
- Create a key pair.
- Create a security group.

Enabling multiple availability zones in AWS account attributes

For an Oracle high availability configuration as demonstrated in the architecture diagram, you must enable at least four availability zones in a region. The multiple availability zones can also be situated in different regions to meet the required distances for disaster recovery.

The screenshot shows the AWS EC2 Dashboard in the US East (N. Virginia) Region. The left sidebar includes links for New EC2 Experience, EC2 Dashboard, EC2 Global View, Events, Tags, Limits, Instances (with sub-links for Instances, Instance Types, Launch Templates, Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts, Scheduled Instances, Capacity Reservations), Images (AMIs, AMI Catalog), Elastic Block Store (Volumes, Snapshots, Lifecycle Manager), and Network & Security. The main content area displays resource counts: Instances (running) 8, Dedicated Hosts 0, Elastic IPs 5; Instances 12, Key pairs 48, Load balancers 0; Placement groups 25, Security groups 34, Snapshots 0; Volumes 19. A callout box suggests using the AWS Launch Wizard for Microsoft SQL Server Always On availability groups. Below this are sections for Launch instance (with 'Launch instance' and 'Migrate a server' buttons) and Service health (showing four availability zones: us-east-1a, us-east-1b, us-east-1c, us-east-1d, each associated with a Zone ID: use1-az6, use1-az1, use1-az2, use1-az4). The right sidebar contains Account attributes (Supported platforms, Default VPC, Settings, EBS encryption, Zones, EC2 Serial Console, Default credit specification, Console experiments) and Explore AWS (with links to 10 Things You Can Do Today to Reduce AWS Costs, Enable Best Price-Performance with AWS Graviton2, Save Up to 45% on ML Inference, and Additional information).

Creating and connecting to an EC2 instance for hosting Oracle database

See the tutorial [Get started with Amazon EC2 Linux instances](#) for step-by-step deployment procedures and best practices.

Key topics:

- Overview.
- Prerequisites.
- Step 1: Launch an instance.
- Step 2: Connect to your instance.
- Step 3: Clean up your instance.

The following screen shots demonstrate the deployment of an m5-type Linux instance with the EC2 console for running Oracle.

1. From the EC2 dashboard, click the yellow Launch Instance button to start the EC2 instance deployment workflow.

Resources

You are using the following Amazon EC2 resources in the US East (N. Virginia) Region:

Instances (running)	6	Dedicated Hosts	0	Elastic IPs	5
Instances	12	Key pairs	48	Load balancers	0
Placement groups	25	Security groups	33	Snapshots	0
Volumes	19				

Launch instance
To get started, launch an Amazon EC2 instance, which is a virtual server in the cloud.

Service health
[AWS Health Dashboard](#)

Explore AWS
Save up to 90% on EC2 with Spot Instances
Optimize price-performance by combining EC2 purchase options in a single EC2 ASG. [Learn more](#)

- In Step 1, select "Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0b0af3577fe5e3532 (64-bit x86) / ami-01fc429821bf1f4b4 (64-bit Arm)."

Step 1: Choose an Amazon Machine Image (AMI)

Are you launching a database instance? Try Amazon RDS.

Amazon Relational Database Service (RDS) makes it easy to set up, operate, and scale your database on AWS by automating time-consuming database management tasks. With RDS, you can easily deploy Amazon Aurora, MariaDB, MySQL, Oracle, PostgreSQL, and SQL Server databases on AWS. Aurora is a MySQL- and PostgreSQL-compatible, enterprise-class database at 1/10th the cost of commercial databases. Learn more about RDS.

Red Hat **Select**
Free tier eligible

Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0b0af3577fe5e3532 (64-bit x86) / ami-01fc429821bf1f4b4 (64-bit Arm)

SUSE Linux **Select**
Free tier eligible

SUSE Linux Enterprise Server 15 SP3 (HVM), SSD Volume Type - ami-08895422b5f3aa64a (64-bit x86) / ami-08f182b25f271ef79 (64-bit Arm)

- In Step 2, select an m5 instance type with the appropriate CPU and memory allocation based on your Oracle database workload. Click "Next: Configure Instance Details."

Step 2: Choose an Instance Type

	m4	m4.16xlarge	64	256	EBS only	Yes	25 Gigabit	Yes
<input type="checkbox"/>	m5	m5.large	2	8	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.xlarge	4	16	EBS only	Yes	Up to 10 Gigabit	Yes
<input checked="" type="checkbox"/>	m5	m5.2xlarge	8	32	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.4xlarge	16	64	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.8xlarge	32	128	EBS only	Yes	10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.12xlarge	48	192	EBS only	Yes	10 Gigabit	Yes
<input type="checkbox"/>	m5	m5.16xlarge	64	256	EBS only	Yes	20 Gigabit	Yes
<input type="checkbox"/>	m5	m5.24xlarge	96	384	EBS only	Yes	25 Gigabit	Yes
<input type="checkbox"/>	m5	m5.metal	96	384	EBS only	Yes	25 Gigabit	Yes

- In Step 3, choose the VPC and subnet where the instance should be placed and enable public IP assignment. Click "Next: Add Storage."

Screenshot of the AWS EC2 instance creation wizard Step 3: Configure Instance Details.

No default VPC found. Select another VPC, or create a new default VPC.

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot Instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 1

Purchasing option: Request Spot Instances

Network: No default VPC found. Create a new default VPC.

Subnet: 250 IP Addresses available

Auto-assign Public IP: Enable

Hostname type:

DNS Hostname:

- Enable IP name IPv4 (A record) DNS requests
- Enable resource-based IPv4 (A record) DNS requests
- Enable resource-based IPv6 (AAAA record) DNS requests

Placement group: Add instance to placement group

Capacity Reservation:

Domain join directory:

IAM role:

Buttons: Cancel, Previous, **Review and Launch**, Next: Add Storage

5. In Step 4, allocate enough space for the root disk. You may need the space to add a swap. By default, EC2 instance assign zero swap space, which is not optimal for running Oracle.

Screenshot of the AWS EC2 instance creation wizard Step 4: Add Storage.

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. Learn more about storage options in Amazon EC2.

Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/sda1	snap-03a3ad00558b4d17c	50	General Purpose SSD (gp2)	150 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted

Add New Volume

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. Learn more about free usage tier eligibility and usage restrictions.

Shared file systems

You currently don't have any file systems on this instance. Select "Add file system" button below to add a file system.

Add file system

Buttons: Cancel, Previous, **Review and Launch**, Next: Add Tags

6. In Step 5, add a tag for instance identification if needed.

Step 5: Add Tags

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver. A copy of a tag can be applied to volumes, instances or both. Tags will be applied to all instances and volumes. [Learn more about tagging your Amazon EC2 resources.](#)

This resource currently has no tags.

Choose the Add tag button or click to add a Name tag. Make sure your IAM policy includes permissions to create tags.

Add Tag (Up to 50 tags maximum)

Cancel Previous Review and Launch Next: Configure Security Group

- In Step 6, select an existing security group or create a new one with the desired inbound and outbound policy for the instance.

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: Create a new security group Select an existing security group

Security Group ID	Name	Description	Actions
<input type="checkbox"/> sg-0d746a0908b897c48	AviOccm03112021OCCM1635951256631-OCCMSecurityGroup-B3QFHUHJRUWV	NetApp OCCM Instance External Security Group	Copy to new
<input type="checkbox"/> sg-07b0625cd54aae16	AviOCCM0311OCCM1635943382952-OCCMSecurityGroup-1L8D4QX2SC945	NetApp OCCM Instance External Security Group	Copy to new
<input type="checkbox"/> sg-0618122caef6c50e9	AviOccm1103OCCM163594422113-OCCMSecurityGroup-DX5PHX6CKVKC	NetApp OCCM Instance External Security Group	Copy to new
<input type="checkbox"/> sg-0d63ea8c79897e666	AviOccm1209OCCM1631452667252-OCCMSecurityGroup-T5KVZ1Q4SH48	NetApp OCCM Instance External Security Group	Copy to new
<input type="checkbox"/> sg-0aed9f836b48c52d	AviOccmFSxOCCM1638110371156-OCCMSecurityGroup-N0ENZJW3TVYB	NetApp OCCM Instance External Security Group	Copy to new
<input type="checkbox"/> sg-083a6ea5ca9a12375	connector01OCCM1631455604110-OCCMSecurityGroup-1790QV45PH3ZW	NetApp OCCM Instance External Security Group	Copy to new
<input checked="" type="checkbox"/> sg-08148ca915189ac87	default	default VPC security group	Copy to new
<input type="checkbox"/> sg-07fc527620e3bb22	fsx02OCCM163339531669-OCCMSecurityGroup-1XZYC5WM15NP7	NetApp OCCM Instance External Security Group	Copy to new
<input type="checkbox"/> sg-0f359d2ba38db749f	SG-Version10-0CE6MEs-NetAppExternalSecurityGroup-N8B50KGTK8U	ONTAP Cloud firewall rules for management and data interface	Copy to new

Inbound rules for sg-08148ca915189ac87 (Selected security groups: sg-08148ca915189ac87)

Type (i)	Protocol (i)	Port Range (i)	Source (i)	Description (i)
All traffic	All	All	192.168.1.0/24	
All traffic	All	All	sg-08148ca915189ac87 (default)	

Cancel Previous Review and Launch

- In Step 7, review the instance configuration summary, and click Launch to start instance deployment. You are prompted to create a key pair or select a key pair for access to the instance.

Screenshot of the AWS EC2 Instance Launch Wizard Step 7: Review Instance Launch. The page shows the selected AMI (Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0b0af3577fe5e3532), Instance Type (m5.2xlarge), and Security Group (default). A modal window titled "Select an existing key pair or create a new key pair" is open, prompting the user to choose a key pair (accessstkey | RSA) and acknowledge the terms of service.

Step 7: Review Instance Launch
 Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

AMI Details

Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0b0af3577fe5e3532
 Red Hat Enterprise Linux version 8 (HVM), EBS General Purpose (SSD) Volume Type
 Free tier eligible Root Device Type: ebs Virtualization type: hvm

Edit AMI

Instance Type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
m5.2xlarge	-	8	32	EBS only	Yes	Up to 10 Gigabit

Edit instance type

Security Groups

Security Group ID	Name	Description
sg-08148ca915189ac87	default	default VPC security group

All selected security groups inbound rules

Type	Protocol	Port Range	Source	Description
All traffic	All	All	192.168.1.0/24	
All traffic	All	All	sg-08148ca915189ac87 (default)	

Edit security groups

Instance Details

Edit instance details

Storage

Edit storage

Cancel **Previous** **Launch**

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance. Amazon EC2 supports ED25519 and RSA key pair types.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about [removing existing key pairs from a public AMI](#).

Choose an existing key pair

Select a key pair

accessstkey | RSA

I acknowledge that I have access to the corresponding private key file, and that without this file, I won't be able to log into my instance.

Cancel **Launch Instances**

- Log into EC2 instance using an SSH key pair. Make changes to your key name and instance IP address as appropriate.

```
ssh -i ora-db1v2.pem ec2-user@54.80.114.77
```

You need to create two EC2 instances as primary and standby Oracle servers in their designated availability

zone as demonstrated in the architecture diagram.

Provision FSx for ONTAP file systems for Oracle database storage

EC2 instance deployment allocates an EBS root volume for the OS. FSx for ONTAP file systems provides Oracle database storage volumes, including the Oracle binary, data, and log volumes. The FSx storage NFS volumes can be either provisioned from the AWS FSx console or from Oracle installation, and configuration automation that allocates the volumes as the user configures in a automation parameter file.

Creating FSx for ONTAP file systems

Referred to this documentation [Managing FSx for ONTAP file systems](#) for creating FSx for ONTAP file systems.

Key considerations:

- SSD storage capacity. Minimum 1024 GiB, maximum 192 TiB.
- Provisioned SSD IOPS. Based on workload requirements, a maximum of 80,000 SSD IOPS per file system.
- Throughput capacity.
- Set administrator fsxadmin/vsadmin password. Required for FSx configuration automation.
- Backup and maintenance. Disable automatic daily backups; database storage backup is executed through SnapCenter scheduling.
- Retrieve the SVM management IP address as well as protocol-specific access addresses from SVM details page. Required for FSx configuration automation.

The screenshot shows the AWS FSx console interface. On the left, there's a sidebar with navigation links: Services, Resource Groups & Tag Editor, Amazon FSx, File systems, Volumes, Backups, ONTAP, Storage virtual machines, OpenZFS, Snapshots, Windows File Server, Lustre, Data repository tasks, and FSx on Service Quotas. The main content area has a title bar 'fsx (svm-005c6edf027866ca4)' with 'Delete' and 'Update' buttons. Below the title is a 'Summary' section with details like SVM ID, SVM name, UUID, File system ID, and Resource ARN. Underneath is an 'Endpoints' section listing Management DNS name, NFS DNS name, iSCSI DNS name, and their corresponding Management IP address, NFS IP address, and iSCSI IP addresses. The Management IP address (198.19.255.68) and NFS IP address (198.19.255.68) are highlighted with red boxes, and the iSCSI IP addresses (10.0.1.200, 10.0.0.86) are also highlighted with red boxes.

See the following step-by-step procedures for setting up either a primary or standby HA FSx cluster.

1. From the FSx console, click Create File System to start the FSx provision workflow.

2. Select Amazon FSx for NetApp ONTAP. Then click Next.

Select file system type

File system options

- Amazon FSx for NetApp ONTAP
- Amazon FSx for OpenZFS
- Amazon FSx for Windows File Server
- Amazon FSx for Lustre

Amazon FSx for NetApp ONTAP

Amazon FSx for NetApp ONTAP provides feature-rich, high-performance, and highly-reliable storage built on NetApp's popular ONTAP file system and fully managed by AWS.

- Broadly accessible from Linux, Windows, and macOS compute instances and containers (running on AWS or on-premises) via industry-standard NFS, SMB, and iSCSI protocols.
- Provides ONTAP's popular data management capabilities like Snapshots, SnapMirror (for data replication), FlexClone (for data cloning), and data compression / deduplication.
- Delivers hundreds of thousands of IOPS with consistent sub-millisecond latencies, and up to 3 GB/s of throughput.
- Offers highly-available and highly-durable multi-AZ SSD storage with support for cross-region replication and built-in, fully managed backups.
- Automatically tiers infrequently-accessed data to capacity pool storage, a fully elastic storage tier that can scale to petabytes in size and is cost-optimized for infrequently-accessed data.
- Integrates with Microsoft Active Directory (AD) to support Windows-based environments and enterprises.

Cancel

Next

3. Select Standard Create and, in File System Details, name your file system, Multi-AZ HA. Based on your database workload, choose either Automatic or User-Provisioned IOPS up to 80,000 SSD IOPS. FSx storage comes with up to 2TiB NVMe caching at the backend that can deliver even higher measured IOPS.

File system details

File system name - optional [Info](#)

aws_ora_prod

Maximum of 256 Unicode letters, whitespace, and numbers, plus + - = . _ : /

Deployment type [Info](#)

Multi-AZ

Single-AZ

SSD storage capacity [Info](#)

1024

Minimum 1024 GiB; Maximum 192 TiB.

Provisioned SSD IOPS

Amazon FSx provides 3 IOPS per GiB of storage capacity. You can also provision additional SSD IOPS as needed.

Automatic (3 IOPS per GiB of SSD storage)

User-provisioned

40000

Maximum 80,000 IOPS

Throughput capacity [Info](#)

The sustained speed at which the file server hosting your file system can serve data. The file server can also burst to higher speeds for periods of time.

Recommended throughput capacity

128 MB/s

Specify throughput capacity

Throughput capacity

512 MB/s



4. In the Network & Security section, select the VPC, security group, and subnets. These should be created before FSx deployment. Based on the role of the FSx cluster (primary or standby), place the FSx storage nodes in the appropriate zones.

Network & security

Virtual Private Cloud (VPC) [Info](#)

Specify the VPC from which your file system is accessible.

vpc-0474064fc537e5182



VPC Security Groups [Info](#)

Specify VPC Security Groups to associate with your file system's network interfaces.

Choose VPC security group(s)



sg-08148ca915189ac87 (default)

Preferred subnet [Info](#)

Specify the preferred subnet for your file system.

subnet-08c952541f4ab282d (us-east-1a)



Standby subnet

subnet-0a84d6eeeb0f4e5c0 (us-east-1b)



VPC route tables

Specify the VPC route tables associated with your file system.

VPC's default route table

Select one or more VPC route tables

Endpoint IP address range

Specify the IP address range in which the endpoints to access your file system will be created

No preference

Select an IP address range

5. In the Security & Encryption section, accept the default, and enter the fsxadmin password.

Security & encryption

Encryption key [Info](#)

AWS Key Management Service (KMS) encryption key that protects your file system data at rest.

aws/fsx (default)



Description	Account	KMS key ID
Default master key that protects my FSx resources when no other key is defined	759995470648	5b31feff-6759-4306-a852-9c99a743982a

File system administrative password

Password for this file system's "fsxadmin" user, which you can use to access the ONTAP CLI or REST API.

Don't specify a password

Specify a password

Password

Confirm password

6. Enter the SVM name and the vsadmin password.

Default storage virtual machine configuration

Storage virtual machine name

SVM administrative password
Password for this SVM's "vsadmin" user, which you can use to access the ONTAP CLI or REST API.

Don't specify a password
 Specify a password
Password

Confirm password

Active Directory
Joining an Active Directory enables access from Windows and MacOS clients over the SMB protocol.

Do not join an Active Directory
 Join an Active Directory

7. Leave the volume configuration blank; you do not need to create a volume at this point.

Default volume configuration

Volume name

vol1

Maximum of 203 alphanumeric characters, plus _.

Junction path

/vol1

The location within your file system where your volume will be mounted.

Volume size

1024

Minimum 20 MiB; Maximum 104857600 MiB

Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

- Enabled (recommended)
 Disabled

Capacity pool tiering policy

You can optionally enable automatic tiering of your data to lower-cost capacity pool storage.

Auto



► Backup and maintenance - *optional*

► Tags - *optional*

Cancel

Back

Next

8. Review the Summary page, and click Create File System to complete FSx file system provision.

The screenshot shows the 'Create file system' wizard in the AWS Management Console. The left sidebar has three steps: Step 1 (Select file system type), Step 2 (Specify file system details), and Step 3 (Review and create). The current step is Step 2. The main area is titled 'Summary' with the sub-instruction 'Verify the following attributes before proceeding'. A table lists the configuration details:

Attribute	Value	Editable after creation
File system type	Amazon FSx for NetApp ONTAP	
File system name	aws_ora_prod	<input checked="" type="checkbox"/>
Deployment type	Multi-AZ	
Storage type	SSD	
SSD storage capacity	1,024 GiB	<input checked="" type="checkbox"/>
Minimum SSD IOPS	40000 IOPS	<input checked="" type="checkbox"/>
Throughput capacity	512 MB/s	<input checked="" type="checkbox"/>
Virtual Private Cloud (VPC)	vpc-0474064fc537e5182	
VPC Security Groups	sg-08148ca915189ac87	<input checked="" type="checkbox"/>
Preferred subnet	subnet-08c952541f4ab282d	
Standby subnet	subnet-0a84d6eeeb0f4e5c0	
VPC route tables	VPC's default route table	
Endpoint IP address range	No preference	
KMS key ID	arn:aws:kms:us-east-1:759995470648:key/5b31feff-6759-4306-a852-9c99a743982a	
Daily automatic backup window	No preference	<input checked="" type="checkbox"/>
Automatic backup	7 day(s)	<input checked="" type="checkbox"/>

Provisioning of database volumes for Oracle database

See [Managing FSx for ONTAP volumes - creating a volume](#) for details.

Key considerations:

- Sizing the database volumes appropriately.
- Disabling capacity pool tiering policy for performance configuration.
- Enabling Oracle dNFS for NFS storage volumes.
- Setting up multipath for iSCSI storage volumes.

Create database volume from FSx console

From the AWS FSx console, you can create three volumes for Oracle database file storage: one for the Oracle binary, one for the Oracle data, and one for the Oracle log. Make sure that volume naming matches the Oracle host name (defined in the hosts file in the automation toolkit) for proper identification. In this example, we use db1 as the EC2 Oracle host name instead of a typical IP-address-based host name for an EC2 instance.

Create volume

X

File system

ONTAP | fs-0a51a3f08922224d5 | rdscustomfs007



Storage virtual machine

svm-005c6edf027866ca4 | fsx



Volume name

db1_bin

Maximum of 203 alphanumeric characters, plus _.

Junction path

/db1_bin

The location within your file system where your volume will be mounted.

Volume size

51200

Minimum 20 MiB; Maximum 104857600 MiB

Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

- Enabled (recommended)
- Disabled

Capacity pool tiering policy

You can optionally enable automatic tiering of your data to lower-cost capacity pool storage.

None



Cancel

Confirm

Create volume

X

File system

ONTAP | fs-0a51a3f08922224d5 | rdscustomfs007



Storage virtual machine

svm-005c6edf027866ca4 | fsx



Volume name

db1_data

Maximum of 203 alphanumeric characters, plus _.

Junction path

/db1_data

The location within your file system where your volume will be mounted.

Volume size

512000

Minimum 20 MiB; Maximum 104857600 MiB

Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

- Enabled (recommended)
- Disabled

Capacity pool tiering policy

You can optionally enable automatic tiering of your data to lower-cost capacity pool storage.

None



Cancel

Confirm

Create volume

File system

ONTAP | fs-0a51a3f08922224d5 | rdscustomfs007

Storage virtual machine

svm-005c6edf027866ca4 | fsx

Volume name

db1_log

Maximum of 203 alphanumeric characters, plus _.

Junction path

/db1_log

The location within your file system where your volume will be mounted.

Volume size

256000

Minimum 20 MiB; Maximum 104857600 MiB

Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

Enabled (recommended)

Disabled

Capacity pool tiering policy

You can optionally enable automatic tiering of your data to lower-cost capacity pool storage.

None

Cancel **Confirm**



Creating iSCSI LUNs is not currently supported by the FSx console. For iSCSI LUNs deployment for Oracle, the volumes and LUNs can be created by using automation for ONTAP with the NetApp Automation Toolkit.

Install and configure Oracle on an EC2 instance with FSx database volumes

The NetApp automation team provide an automation kit to run Oracle installation and configuration on EC2 instances according to best practices. The current version of the automation kit supports Oracle 19c on NFS with the default RU patch 19.8. The automation kit can be easily adapted for other RU patches if needed.

Prepare a Ansible controller to run automation

Follow the instruction in the section "[Creating and connecting to an EC2 instance for hosting Oracle database](#)" to provision a small EC2 Linux instance to run the Ansible controller. Rather than using RedHat, Amazon Linux t2.large with 2vCPU and 8G RAM should be sufficient.

Retrieve NetApp Oracle deployment automation toolkit

Log into the EC2 Ansible controller instance provisioned from step 1 as ec2-user and from the ec2-user home directory, execute the `git clone` command to clone a copy of the automation code.

```
git clone https://github.com/NetApp-Automation/na_oracle19c_deploy.git
```

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

Execute automated Oracle 19c deployment using automation toolkit

See these detailed instruction [CLI deployment Oracle 19c Database](#) to deploy Oracle 19c with CLI automation. There is a small change in command syntax for playbook execution because you are using an SSH key pair instead of a password for host access authentication. The following list is a high level summary:

1. By default, an EC2 instance uses an SSH key pair for access authentication. From Ansible controller automation root directories `/home/ec2-user/na_oracle19c_deploy`, and `/home/ec2-user/na_rds_fsx_oranfs_config`, make a copy of the SSH key `accesststkey.pem` for the Oracle host deployed in the step "[Creating and connecting to an EC2 instance for hosting Oracle database](#)".
2. Log into the EC2 instance DB host as ec2-user, and install the python3 library.

```
sudo yum install python3
```

3. Create a 16G swap space from the root disk drive. By default, an EC2 instance creates zero swap space. Follow this AWS documentation: [How do I allocate memory to work as swap space in an Amazon EC2 instance by using a swap file?](#).
4. Return to the Ansible controller (`cd /home/ec2-user/na_rds_fsx_oranfs_config`), and execute the preclone playbook with the appropriate requirements and `linux_config` tags.

```
ansible-playbook -i hosts rds_preclone_config.yml -u ec2-user --private
-key accesststkey.pem -e @vars/fsx_vars.yml -t requirements_config
```

```
ansible-playbook -i hosts rds_preclone_config.yml -u ec2-user --private
-key accesststkey.pem -e @vars/fsx_vars.yml -t linux_config
```

5. Switch to the `/home/ec2-user/na_oracle19c_deploy-master` directory, read the README file, and populate the `global vars.yml` file with the relevant global parameters.

6. Populate the `host_name.yml` file with the relevant parameters in the `host_vars` directory.
7. Execute the playbook for Linux, and press Enter when prompted for the `vsadmin` password.

```
ansible-playbook -i hosts all_playbook.yml -u ec2-user --private-key  
accesststkey.pem -t linux_config -e @vars/vars.yml
```

8. Execute the playbook for Oracle, and press enter when prompted for the `vsadmin` password.

```
ansible-playbook -i hosts all_playbook.yml -u ec2-user --private-key  
accesststkey.pem -t oracle_config -e @vars/vars.yml
```

Change the permission bit on the SSH key file to 400 if needed. Change the Oracle host (`ansible_host` in the `host_vars` file) IP address to your EC2 instance public address.

Setting up SnapMirror between primary and standby FSx HA cluster

For high availability and disaster recovery, you can set up SnapMirror replication between the primary and standby FSx storage cluster. Unlike other cloud storage services, FSx enables a user to control and manage storage replication at a desired frequency and replication throughput. It also enables users to test HA/DR without any effect on availability.

The following steps show how to set up replication between a primary and standby FSx storage cluster.

1. Setup primary and standby cluster peering. Log into the primary cluster as the `fsxadmin` user and execute the following command. This reciprocal create process executes the `create` command on both the primary cluster and the standby cluster. Replace `standby_cluster_name` with the appropriate name for your environment.

```
cluster peer create -peer-addrs  
standby_cluster_name,inter_cluster_ip_address -username fsxadmin  
-initial-allowed-vserver-peers *
```

2. Set up vServer peering between the primary and standby cluster. Log into the primary cluster as the `vsadmin` user and execute the following command. Replace `primary_vserver_name`, `standby_vserver_name`, `standby_cluster_name` with the appropriate names for your environment.

```
vserver peer create -vserver primary_vserver_name -peer-vserver  
standby_vserver_name -peer-cluster standby_cluster_name -applications  
snapmirror
```

3. Verify that the cluster and vserver peerings are set up correctly.

```

FsxId00164454fac5591e6::> cluster peer show
Peer Cluster Name          Cluster Serial Number Availability  Authentication
-----
FsxId0b6a95149d07aa82e    1-80-000011           Available      ok

FsxId00164454fac5591e6::> vserver peer show
      Peer      Peer          Peering      Remote
Vserver   Vserver   State     Peer Cluster Applications  Vserver
-----
svm_FsxEraSource
      svm_FsxEraTarget
                  peered      FsxId0b6a95149d07aa82e
                                         snapmirror      svm_FsxEraTarget

FsxId00164454fac5591e6::>

```

4. Create target NFS volumes at the standby FSx cluster for each source volume at the primary FSx cluster. Replace the volume name as appropriate for your environment.

```

vol create -volume dr_db1_bin -aggregate aggr1 -size 50G -state online
-policy default -type DP

```

```

vol create -volume dr_db1_data -aggregate aggr1 -size 500G -state online
-policy default -type DP

```

```

vol create -volume dr_db1_log -aggregate aggr1 -size 250G -state online
-policy default -type DP

```

5. You can also create iSCSI volumes and LUNs for the Oracle binary, Oracle data, and the Oracle log if the iSCSI protocol is employed for data access. Leave approximately 10% free space in the volumes for snapshots.

```

vol create -volume dr_db1_bin -aggregate aggr1 -size 50G -state online
-policy default -unix-permissions ---rwxr-xr-x -type RW

```

```

lun create -path /vol/dr_db1_bin/dr_db1_bin_01 -size 45G -ostype linux

```

```

vol create -volume dr_db1_data -aggregate aggr1 -size 500G -state online
-policy default -unix-permissions ---rwxr-xr-x -type RW

```

```

lun create -path /vol/dr_db1_data/dr_db1_data_01 -size 100G -ostype
linux

```

```
lun create -path /vol/dr_db1_data/dr_db1_data_02 -size 100G -ostype  
linux
```

```
lun create -path /vol/dr_db1_data/dr_db1_data_03 -size 100G -ostype  
linux
```

```
lun create -path /vol/dr_db1_data/dr_db1_data_04 -size 100G -ostype  
linux
```

```
vol create -volume dr_db1_log -aggregate aggr1 -size 250G -state online -policy default -unix-permissions  
---rwxr-xr-x -type RW
```

```
lun create -path /vol/dr_db1_log/dr_db1_log_01 -size 45G -ostype linux
```

```
lun create -path /vol/dr_db1_log/dr_db1_log_02 -size 45G -ostype linux
```

```
lun create -path /vol/dr_db1_log/dr_db1_log_03 -size 45G -ostype linux
```

```
lun create -path /vol/dr_db1_log/dr_db1_log_04 -size 45G -ostype linux
```

6. For iSCSI LUNs, create mapping for the Oracle host initiator for each LUN, using the binary LUN as an example. Replace the igroup with an appropriate name for your environment, and increment the lun-id for each additional LUN.

```
lun mapping create -path /vol/dr_db1_bin/dr_db1_bin_01 -igroup ip-10-0-  
1-136 -lun-id 0
```

```
lun mapping create -path /vol/dr_db1_data/dr_db1_data_01 -igroup ip-10-  
0-1-136 -lun-id 1
```

7. Create a SnapMirror relationship between the primary and standby database volumes. Replace the appropriate SVM name for your environment.s

```
snapmirror create -source-path svm_FSxOraSource:db1_bin -destination  
-path svm_FSxOraTarget:dr_db1_bin -vserver svm_FSxOraTarget -throttle  
unlimited -identity-preserve false -policy MirrorAllSnapshots -type DP
```

```
snapmirror create -source-path svm_FSxOraSource:db1_data -destination  
-path svm_FSxOraTarget:dr_db1_data -vserver svm_FSxOraTarget -throttle  
unlimited -identity-preserve false -policy MirrorAllSnapshots -type DP
```

```
snapmirror create -source-path svm_FSxOraSource:db1_log -destination  
-path svm_FSxOraTarget:dr_db1_log -vserver svm_FSxOraTarget -throttle  
unlimited -identity-preserve false -policy MirrorAllSnapshots -type DP
```

This SnapMirror setup can be automated with a NetApp Automation Toolkit for NFS database volumes. The toolkit is available for download from the NetApp public GitHub site.

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

Read the README instructions carefully before attempting setup and failover testing.



Replicating the Oracle binary from the primary to a standby cluster might have Oracle license implications. Contact your Oracle license representative for clarification. The alternative is to have Oracle installed and configured at the time of recovery and failover.

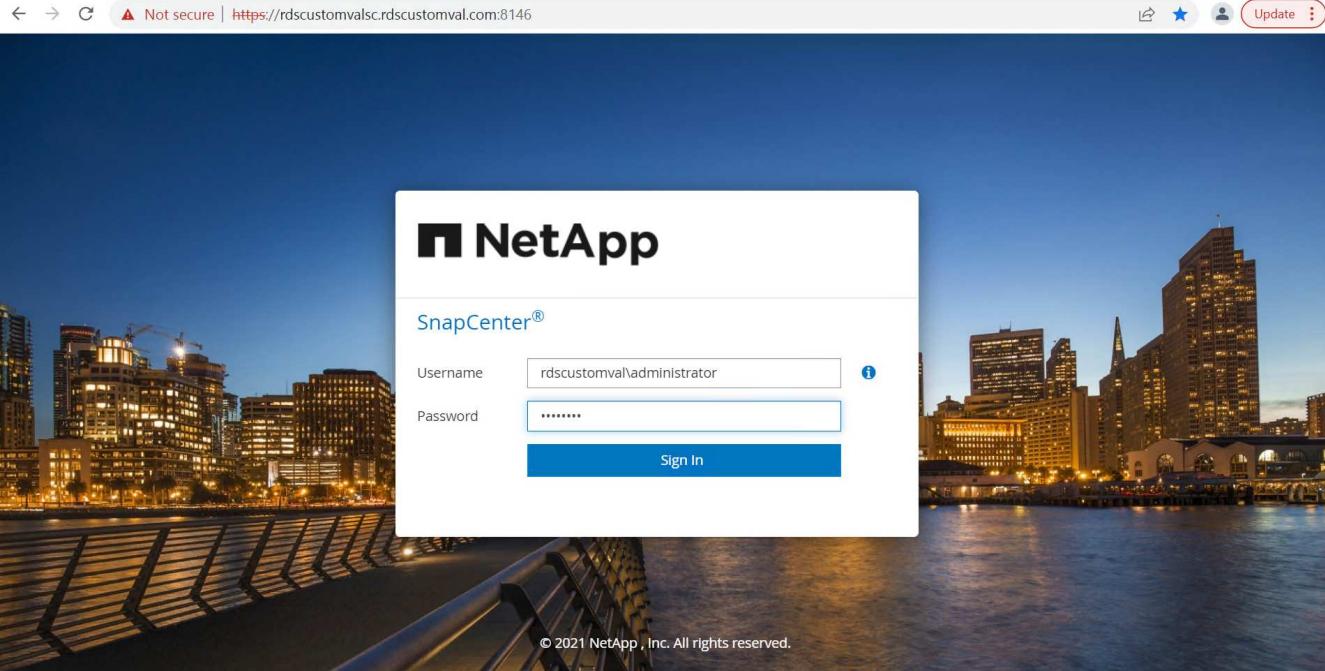
SnapCenter Deployment

SnapCenter installation

Follow [Installing the SnapCenter Server](#) to install SnapCenter server. This documentation covers how to install a standalone SnapCenter server. A SaaS version of SnapCenter is in beta review and could be available shortly. Check with your NetApp representative for availability if needed.

Configure SnapCenter plugin for EC2 Oracle host

1. After automated SnapCenter installation, log into SnapCenter as an administrative user for the Window host on which the SnapCenter server is installed.



- From the left-side menu, click Settings, and then Credential and New to add ec2-user credentials for SnapCenter plugin installation.

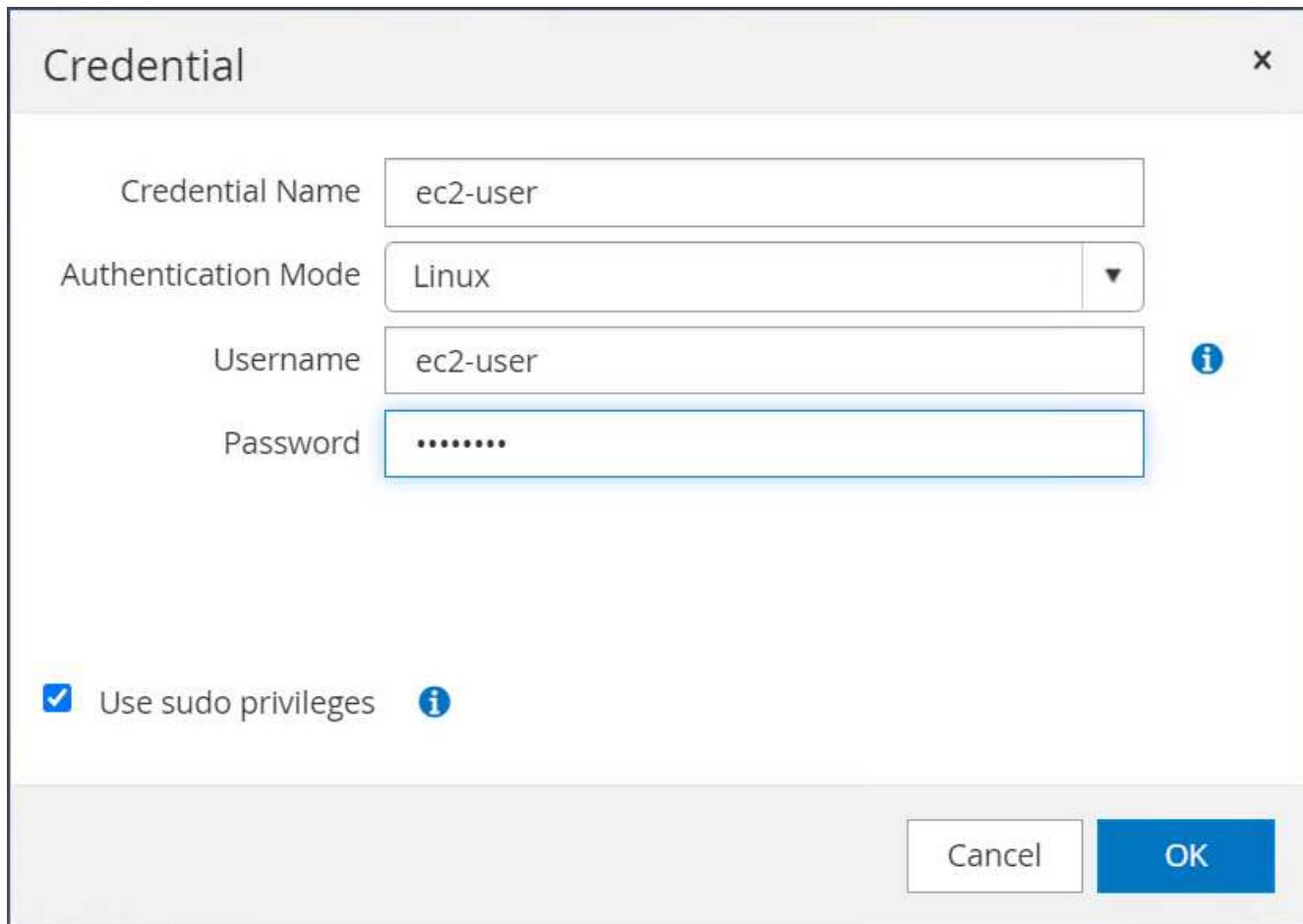
NetApp SnapCenter®

Global Settings Policies Users and Access Roles **Credential** Software

Search by Credential Name

	Credential Name	Authentication Mode	Details
New	244rdscustomdb	SQL	UserId:admin
Modify	42rdscustomdb	SQL	UserId:admin
Delete	admin	SQL	UserId:admin
New	administrator	Windows	UserId:administrator
Modify	ec2-user	Linux	UserId:ec2-user
Delete	onpremSQL	Windows	UserId:rdscustomval\administrator
New	rdsdb2	Windows	UserId:administrator
Modify	rdsdb244	Windows	UserId:administrator
Delete	rdssql	Windows	UserId:administrator
New	tst244	SQL	UserId:admin
Modify	tstcredfordemo	Windows	UserId:administrator

- Reset the ec2-user password and enable password SSH authentication by editing the `/etc/ssh/sshd_config` file on the EC2 instance host.
- Verify that the "Use sudo privileges" checkbox is selected. You just reset the ec2-user password in the previous step.



5. Add the SnapCenter server name and the IP address to the EC2 instance host file for name resolution.

```
[ec2-user@ip-10-0-0-151 ~]$ sudo vi /etc/hosts
[ec2-user@ip-10-0-0-151 ~]$ cat /etc/hosts
127.0.0.1    localhost localhost.localdomain localhost4
localhost4.localdomain4
::1          localhost localhost.localdomain localhost6
localhost6.localdomain6
10.0.1.233   rdscustomvalsc.rdscustomval.com rdscustomvalsc
```

6. On the SnapCenter server Windows host, add the EC2 instance host IP address to the Windows host file C:\Windows\System32\drivers\etc\hosts.

```
10.0.0.151      ip-10-0-0-151.ec2.internal
```

7. In the left-side menu, select Hosts > Managed Hosts, and then click Add to add the EC2 instance host to SnapCenter.

The screenshot shows the NetApp SnapCenter interface. The left sidebar has a 'Hosts' icon highlighted. The main area is titled 'Managed Hosts' and lists two hosts:

	Name	Type	System	Plug-in	Version	Overall Status
<input type="checkbox"/>	RDSAMA7-VJ0DQK0	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Host down
<input type="checkbox"/>	rdscustommssql1.rdscustomval.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Running

Check Oracle Database, and, before you submit, click More Options.

The screenshot shows the 'Add Host' dialog box. It includes fields for Host Type (Linux), Host Name (10.0.0.151), and Credentials (ec2-user). Below these are options for selecting plug-ins:

Select Plug-ins to Install SnapCenter Plug-Ins Package 4.5 P2 for Linux

Oracle Database
 SAP HANA

[More Options](#): Port, Install Path, Custom Plug-Ins...

At the bottom are 'Submit' and 'Cancel' buttons.

Check Skip Preinstall Checks. Confirm Skipping Preinstall Checks, and then click Submit After Save.

More Options

Port	8145	i
Installation Path	/opt/NetApp/snapcenter	i
<input checked="" type="checkbox"/> Skip preinstall checks		
Custom Plug-ins Choose a File <input type="button" value="Browse"/> <input type="button" value="Upload"/> <div style="border: 1px solid #ccc; padding: 5px; height: 40px; margin-top: 10px;"> No plug-ins found. </div>		
<input type="button" value="Save"/>		<input type="button" value="Cancel"/>

You are prompted with Confirm Fingerprint, and then click Confirm and Submit.

Confirm Fingerprint

Authenticity of the host cannot be determined i			
Host name	i	Fingerprint	Valid
ip-10-0-0-151.ec2.internal	ssh-rsa 2048	97:6F:3C:7D:38:42:F6:54:B7:AF:E3:61:61:BA:2E:6F	

After successful plugin configuration, the managed host's overall status show as Running.

Managed Hosts							
		Disks	Shares	Initiator Groups	ISCSI Session		
Search by Name						+ Add	- Remove
	Name	Type	System	Plug-in	Version	Overall Status	More
<input type="checkbox"/>	ip-10-0-0-151.ec2.internal	Linux	Stand-alone	UNIX, Oracle Database	4.5	Running	⋮

Configure backup policy for Oracle database

Refer to this section [Setup database backup policy in SnapCenter](#) for details on configuring the Oracle database backup policy.

Generally you need create a policy for the full snapshot Oracle database backup and a policy for the Oracle archive-log-only snapshot backup.



You can enable Oracle archive log pruning in the backup policy to control log-archive space. Check "Update SnapMirror after creating a local Snapshot copy" in "Select secondary replication option" as you need to replicate to a standby location for HA or DR.

Configure Oracle database backup and scheduling

Database backup in SnapCenter is user configurable and can be set up either individually or as a group in a resource group. The backup interval depends on the RTO and RPO objectives. NetApp recommends that you run a full database backup every few hours and archive the log backup at a higher frequency such as 10-15 mins for quick recovery.

Refer to the Oracle section of [Implement backup policy to protect database](#) for a detailed step-by-step processes for implementing the backup policy created in the section [Configure backup policy for Oracle database](#) and for backup job scheduling.

The following image provides an example of the resources groups that are set up to back up an Oracle database.

The screenshot shows the NetApp SnapCenter interface. On the left, there's a sidebar with icons for Dashboard, Resources (selected), Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area has a title bar 'NetApp SnapCenter®' and a sub-header 'Oracle Database'. Below that is a search bar with dropdowns for 'View' (set to 'Database') and 'Search databases'. A table lists one database entry: ORCL, which is a Single Instance located at ip-10-0-0-151.ec2.internal. It is assigned to two Resource Groups: 'orc1_full_bkup' and 'orc1_log_bkup'. Under 'Policies', it says 'Oracle full backup' and 'Oracle log backup'. The 'Last Backup' column shows '03/24/2022 8:40:08' with a refresh icon. The 'Overall Status' column shows 'Backup succeeded'. At the bottom right of the table are 'Refresh Resources' and 'New Resource Group' buttons.

Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
ORCL	Single Instance	ip-10-0-0-151.ec2.internal	orc1_full_bkup orc1_log_bkup	Oracle full backup Oracle log backup	03/24/2022 8:40:08	Backup succeeded

[Next: Database management.](#)

EC2 and FSx Oracle database management

[Previous: Deployment procedures.](#)

In addition to the AWS EC2 and FSx management console, the Ansible control node and the SnapCenter UI tool are deployed for database management in this Oracle environment.

An Ansible control node can be used to manage Oracle environment configuration, with parallel updates that keep primary and standby instances in sync for kernel or patch updates. Failover, resync, and failback can be automated with the NetApp Automation Toolkit to archive fast application recovery and availability with Ansible. Some repeatable database management tasks can be executed using a playbook to reduce human errors.

The SnapCenter UI tool can perform database snapshot backup, point-in-time recovery, database cloning, and so on with the SnapCenter plugin for Oracle databases. For more information about Oracle plugin features, see the [SnapCenter Plug-in for Oracle Database overview](#).

The following sections provide details on how key functions of Oracle database management are fulfilled with the SnapCenter UI:

- Database snapshot backups
- Database point-in-time restore

- Database clone creation

Database cloning creates a replica of a primary database on a separate EC2 host for data recovery in the event of logical data error or corruption, and clones can also be used for application testing, debugging, patch validation, and so on.

Taking a snapshot

An EC2/FSx Oracle database is regularly backed up at intervals configured by the user. A user can also take a one-off snapshot backup at any time. This applies to both full-database snapshot backups as well as archive-log-only snapshot backups.

Taking a full database snapshot

A full database snapshot includes all Oracle files, including data files, control files, and archive log files.

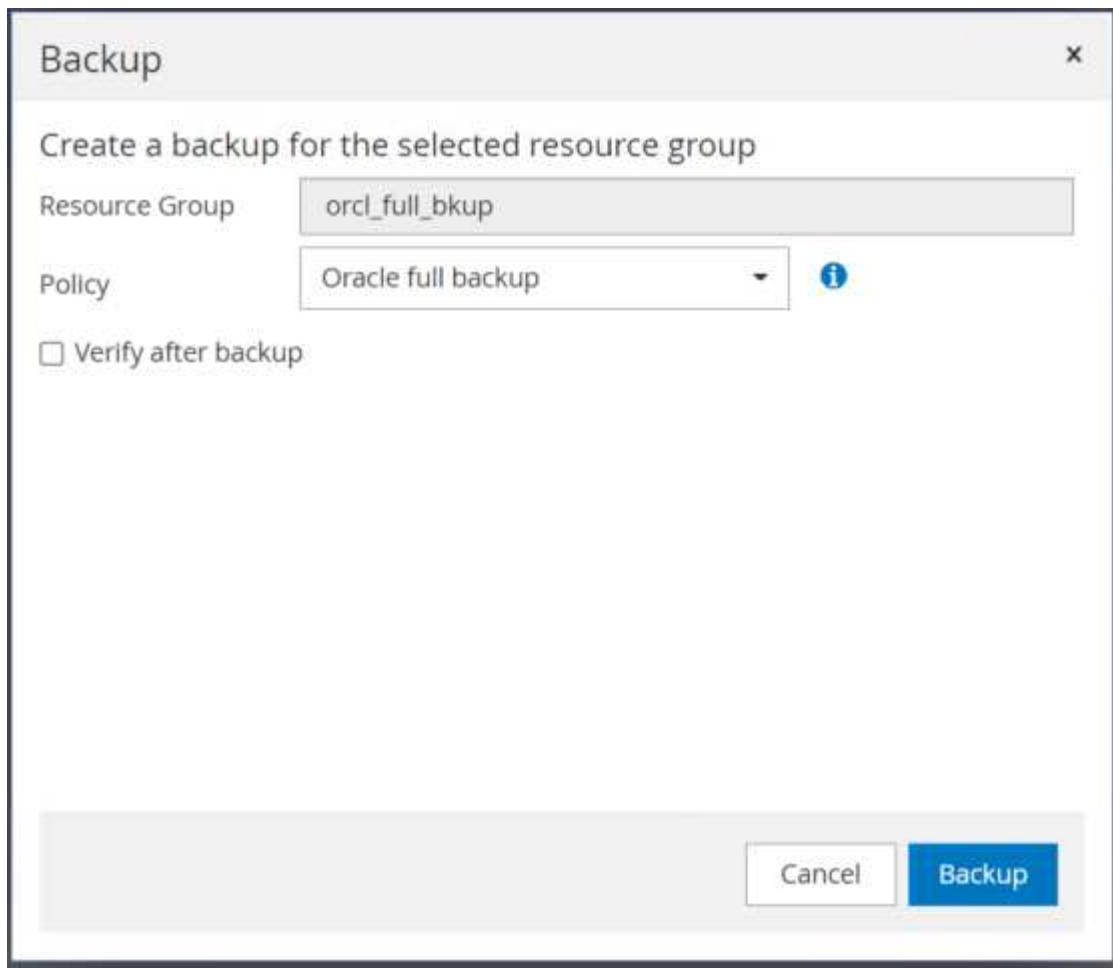
1. Log into the SnapCenter UI and click Resources in the left-side menu. From the View dropdown, change to the Resource Group view.

Name	Resources	Tags	Policies
ordl_full_bkup	1	ora_fullbkup	Oracle full backup
ordl_log_bkup	1	ora_logbkup	Oracle log backup

2. Click the full backup resource name, and then click the Backup Now icon to initiate an add-hoc backup.

Name	Resource Name	Type	Host
ordl_full_bkup	ORCL	Oracle Database	ip-10-0-0-151.ec2.internal

3. Click Backup and then confirm the backup to start a full database backup.



From the Resource view for the database, open the database Managed Backup Copies page to verify that the one-off backup completed successfully. A full database backup creates two snapshots: one for the data volume and one for the log volume.

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
[p-10-0-0-151_03-25-2022_00.34.20.4541.1]	1	Log	03/25/2022 12:34:37 AM	Not Applicable	False	Not Cataloged	1733264
[p-10-0-0-151_03-25-2022_00.34.20.4541.0]	1	Data	03/25/2022 12:34:31 AM	Unverified	False	Not Cataloged	1733220

Taking an archive log snapshot

An archive log snapshot is only taken for the Oracle archive log volume.

1. Log into the SnapCenter UI and click the Resources tab in the left-side menu bar. From the View dropdown, change to the Resource Group view.

The screenshot shows the NetApp SnapCenter interface. On the left is a sidebar with icons for Dashboard, Resources (selected), Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area has a dropdown menu set to 'Oracle Database'. Below it, a 'View' dropdown is set to 'Resource Group' and a search bar says 'Search resource group'. A table lists two resources: 'ordl_full_bkup' and 'ordl_log_bkup'. Both have a count of 1 and are associated with tags 'ora_fullbkup' and 'ora_logbkup' respectively. Policies for both are listed as 'Oracle full backup' and 'Oracle log backup'.

2. Click the log backup resource name, and then click the Backup Now icon to initiate an add-hoc backup for archive logs.

This screenshot shows the 'ordl_log_bkup Details' page. The sidebar and top navigation are identical to the previous screen. The main table shows the resource details: Name 'ordl_log_bkup', Resource Name 'ORCL', Type 'Oracle Database', and Host 'ip-10-0-0-151.ec2.internal'. On the right, there are buttons for 'Modify Resource Group', 'Backup Now' (which is highlighted in yellow), 'Maintenance', and 'Delete'.

3. Click Backup and then confirm the backup to start an archive log backup.

A modal dialog box titled 'Backup' is displayed. It asks 'Create a backup for the selected resource group'. The 'Resource Group' field contains 'ordl_log_bkup'. The 'Policy' field is set to 'Oracle log backup'. At the bottom are 'Cancel' and 'Backup' buttons, with 'Backup' being the primary action button.

From the Resource view for the database, open the database Managed Backup Copies page to verify that the one-off archive log backup completed successfully. An archive log backup creates one snapshot for the log volume.

The screenshot shows the NetApp SnapCenter interface for an Oracle Database named ORCL. The left sidebar has a 'Resources' section with 'Database' selected. The main area shows 'ORCL Topology' with a summary card indicating 27 Backups, 2 Data Backups, 25 Log Backups, and 0 Clones. Below this is a 'Manage Copies' section showing 'Local copies' with 27 Backups and 0 Clones. A 'Primary Backup(s)' table lists a single backup entry:

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_01:59:38.0733_1	1	Log	03/25/2022 1:59:46 AM	Not Applicable	False	Not Cataloged	1739201

Restoring to a point in time

SnapCenter-based restore to a point in time is executed on the same EC2 instance host. Complete the following steps to perform the restore:

1. From the SnapCenter Resources tab > Database view, click the database name to open the database backup.

The screenshot shows the NetApp SnapCenter interface with 'Database' selected in the 'View' dropdown. It displays a table for the database ORCL, which is a Single Instance located at ip-10-0-0-151.ec2.internal. The table includes columns for Name, Oracle Database Type, Host/Cluster, Resource Group, Policies, Last Backup, and Overall Status. The Policies column shows 'Oracle full backup' and 'Oracle log backup'. The Last Backup column shows '03/25/2022 1:10:09 PM' and 'Backup succeeded' respectively.

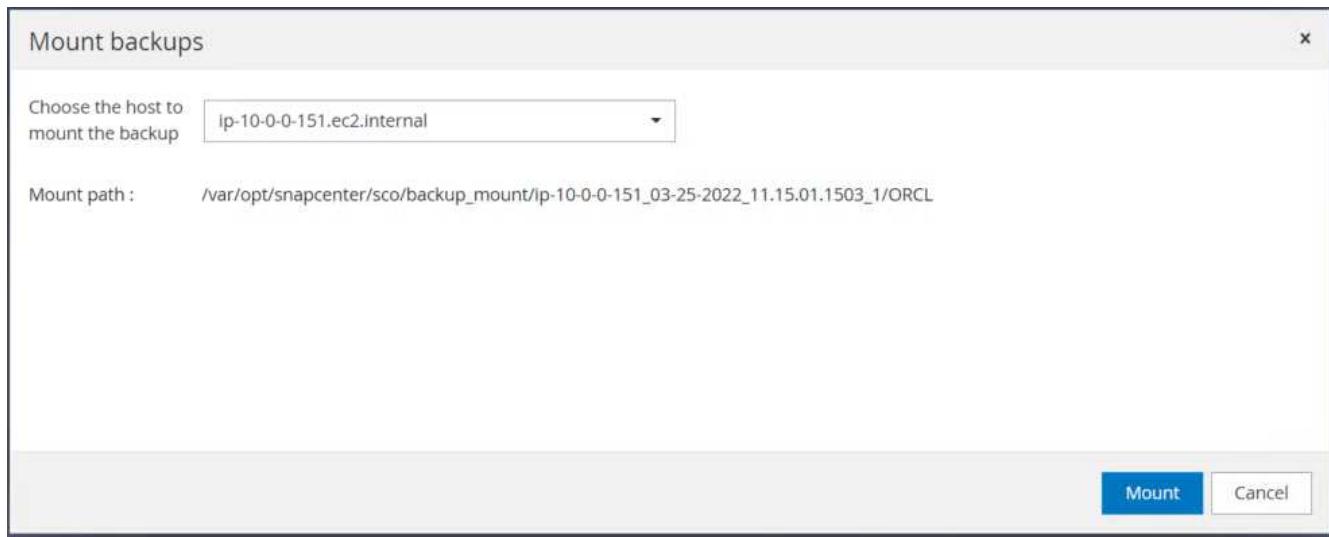
2. Select the database backup copy and the desired point in time to be restored. Also mark down the corresponding SCN number for the point in time. The point-in-time restore can be performed using either the time or the SCN.

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_12.40.01.1098_1	1	Log	03/25/2022 12:40:09 PM	Not Applicable	False	Not Cataloged	1784293
ip-10-0-0-151_03-25-2022_12.25.01.0080_1	1	Log	03/25/2022 12:25:09 PM	Not Applicable	False	Not Cataloged	1783383
ip-10-0-0-151_03-25-2022_12.10.01.1097_1	1	Log	03/25/2022 12:10:09 PM	Not Applicable	False	Not Cataloged	1782417
ip-10-0-0-151_03-25-2022_11.55.01.0500_1	1	Log	03/25/2022 11:55:09 AM	Not Applicable	False	Not Cataloged	1781160
ip-10-0-0-151_03-25-2022_11.40.01.0323_1	1	Log	03/25/2022 11:40:09 AM	Not Applicable	False	Not Cataloged	1780268
ip-10-0-0-151_03-25-2022_11.25.01.0430_1	1	Log	03/25/2022 11:25:09 AM	Not Applicable	False	Not Cataloged	1779368
ip-10-0-0-151_03-25-2022_11.15.01.1503_1	1	Log	03/25/2022 11:15:17 AM	Not Applicable	False	Not Cataloged	1778546
ip-10-0-0-151_03-25-2022_11.15.01.1503_0	1	Data	03/25/2022 11:15:11 AM	Unverified	False	Not Cataloged	1778504
ip-10-0-0-151_03-25-2022_11.10.01.1834_1	1	Log	03/25/2022 11:10:09 AM	Not Applicable	False	Not Cataloged	1778184

3. Highlight the log volume snapshot and click the Mount button to mount the volume.

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_12.40.01.1098_1	1	Log	03/25/2022 12:40:09 PM	Not Applicable	False	Not Cataloged	1784293
ip-10-0-0-151_03-25-2022_12.25.01.0080_1	1	Log	03/25/2022 12:25:09 PM	Not Applicable	False	Not Cataloged	1783383
ip-10-0-0-151_03-25-2022_12.10.01.1097_1	1	Log	03/25/2022 12:10:09 PM	Not Applicable	False	Not Cataloged	1782417
ip-10-0-0-151_03-25-2022_11.55.01.0500_1	1	Log	03/25/2022 11:55:09 AM	Not Applicable	False	Not Cataloged	1781160
ip-10-0-0-151_03-25-2022_11.40.01.0323_1	1	Log	03/25/2022 11:40:09 AM	Not Applicable	False	Not Cataloged	1780268
ip-10-0-0-151_03-25-2022_11.25.01.0430_1	1	Log	03/25/2022 11:25:09 AM	Not Applicable	False	Not Cataloged	1779368
ip-10-0-0-151_03-25-2022_11.15.01.1503_1	1	Log	03/25/2022 11:15:17 AM	Not Applicable	False	Not Cataloged	1778546
ip-10-0-0-151_03-25-2022_11.15.01.1503_0	1	Data	03/25/2022 11:15:11 AM	Unverified	False	Not Cataloged	1778504
ip-10-0-0-151_03-25-2022_11.10.01.1834_1	1	Log	03/25/2022 11:10:09 AM	Not Applicable	False	Not Cataloged	1778184

4. Choose the primary EC2 instance to mount the log volume.



5. Verify that the mount job completes successfully. Also check on the EC2 instance host to see that log volume mounted and also the mount point path.

```
[root@ip-10-0-0-151 ec2-user]# df -h
Filesystem      Size  Used Avail Mounted on
/devtmpfs        7.6G   0    7.6G  0% /dev
tmpfs           1.6G  7.0G  8.3G  46% /dev/shm
tmpfs           7.7G  604K  7.6G  1% /run
tmpfs           7.7G   0    7.7G  0% /sys/fs/cgroup
/dev/nvme0n1p1   9.8G  5.4G  4.3G  56% /
198.19.255.68:/ora_nfs_log  48G  95M  48G  1% /ora_nfs_log
198.19.255.68:/ora_nfs_data  48G  3.4G  45G  8% /ora_nfs_data
/dev/mapper/bdata01-lvdbdata01  40G  471M  38G  2% /rdsdbdata
/dev/nvme5n1     25G   12G  13G  49% /rdsdbbin
tmpfs           1.6G   0    1.6G  0% /run/user/61001
tmpfs           1.6G   0    1.6G  0% /run/user/61005
198.19.255.68:/Scef91c793-5583-480d-9a34-6275dab17f5b  48G  91M  48G  1% /var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_11.15.01.1503_1/ORCL/
[root@ip-10-0-0-151 ec2-user]#
```

6. Copy the archive logs from the mounted log volume to the current archive log directory.

```
[ec2-user@ip-10-0-0-151 ~]$ cp /var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_11.15.01.1503_1/ORCL/1/db/ORCL_A/arch/*.arc /ora_nfs_log/db/ORCL_A/arch/
```

7. Return to the SnapCenter Resource tab > database backup page, highlight the data snapshot copy, and click the Restore button to start the database restore workflow.

Manage Copies

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_12.10.01.1097_1	1	Log	03/25/2022 12:10:09 PM	Not Applicable	False	Not Cataloged	1782417
ip-10-0-0-151_03-25-2022_11.55.01.0500_1	1	Log	03/25/2022 11:55:09 AM	Not Applicable	False	Not Cataloged	1781160
ip-10-0-0-151_03-25-2022_11.40.01.0323_1	1	Log	03/25/2022 11:40:09 AM	Not Applicable	False	Not Cataloged	1780268
ip-10-0-0-151_03-25-2022_11.25.01.0430_1	1	Log	03/25/2022 11:25:09 AM	Not Applicable	False	Not Cataloged	1779368
ip-10-0-0-151_03-25-2022_11.15.01.1503_1	1	Log	03/25/2022 11:15:17 AM	Not Applicable	True	Not Cataloged	1778546
ip-10-0-0-151_03-25-2022_11.15.01.1503_0	1	Data	03/25/2022 11:15:11 AM	Unverified	False	Not Cataloged	1778504
ip-10-0-0-151_03-25-2022_11.10.01.1834_1	1	Log	03/25/2022 11:10:09 AM	Not Applicable	False	Not Cataloged	1778184

8. Check "All Datafiles" and "Change database state if needed for restore and recovery", and click Next.

Restore ORCL

1 Restore Scope

Restore Scope ⓘ

All Datafiles

Tablespaces

Control files

Database State

Change database state if needed for restore and recovery

Restore Mode ⓘ

Force in place restore

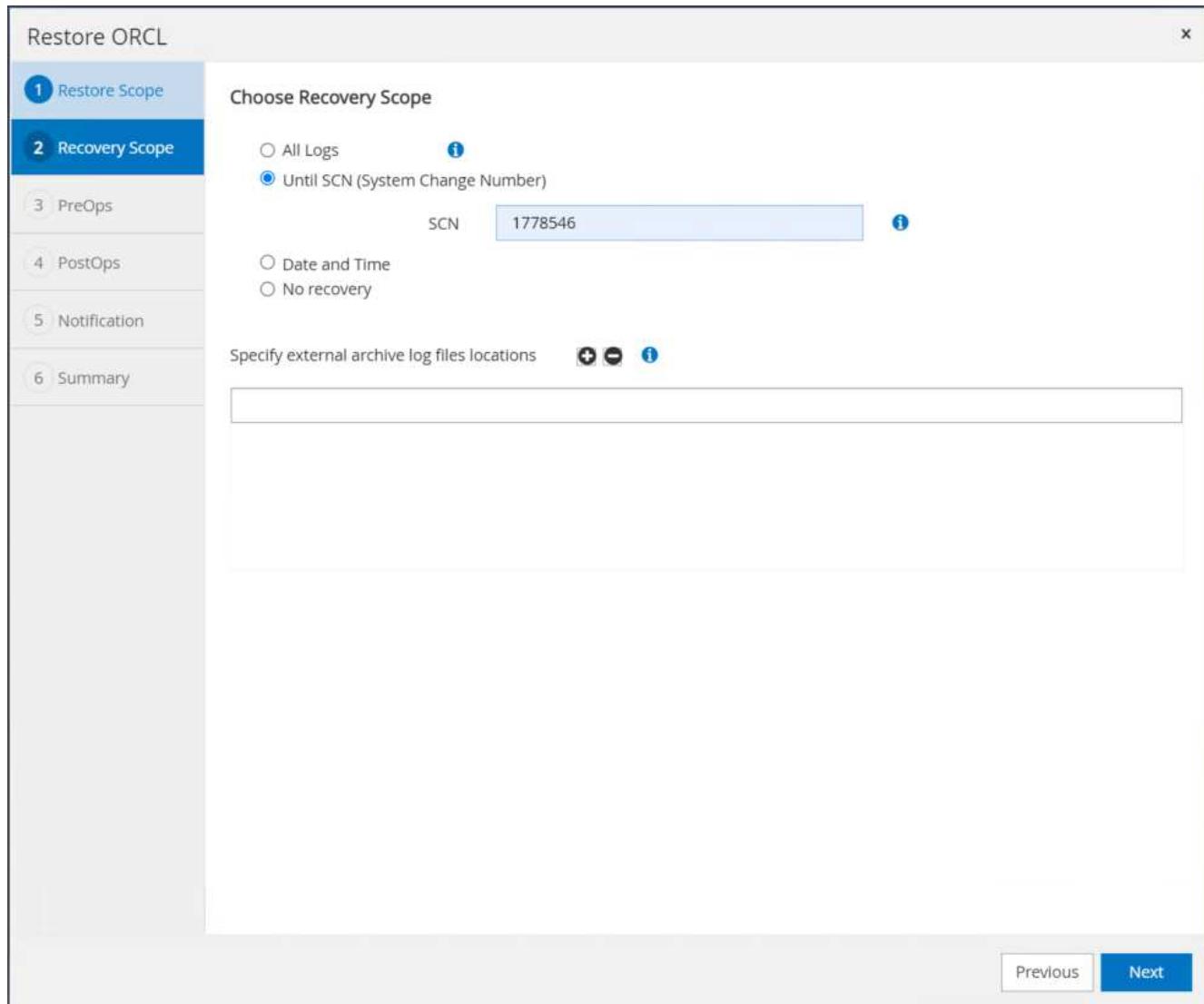
If this check box is not selected and if any of the in place restore criteria is not met, restore will be performed using the connect and copy method. The connect and copy restore method might take time based on the files being restored.

Previous

Next

9. Choose a desired recovery scope using either SCN or time. Rather than copying the mounted archive logs

to the current log directory as demonstrated in step 6, the mounted archive log path can be listed in "Specify external archive log files locations" for recovery.



10. Specify an optional prescript to run if necessary.

Restore ORCL

1 Restore Scope

2 Recovery Scope

3 PreOps

4 PostOps

5 Notification

6 Summary

Specify optional scripts to run before performing a restore job i

Prescript full path Enter Prescript path

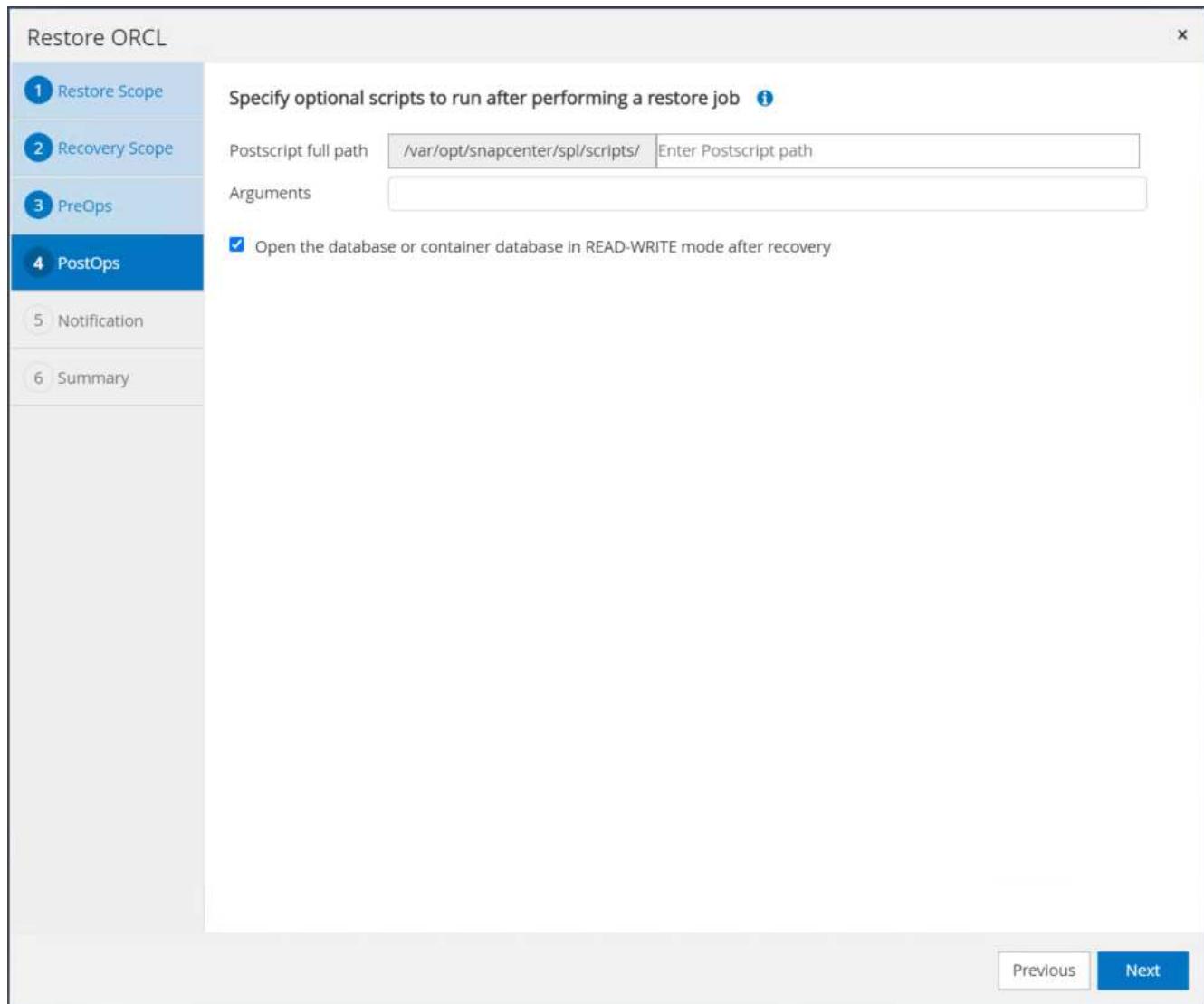
Arguments

Script timeout

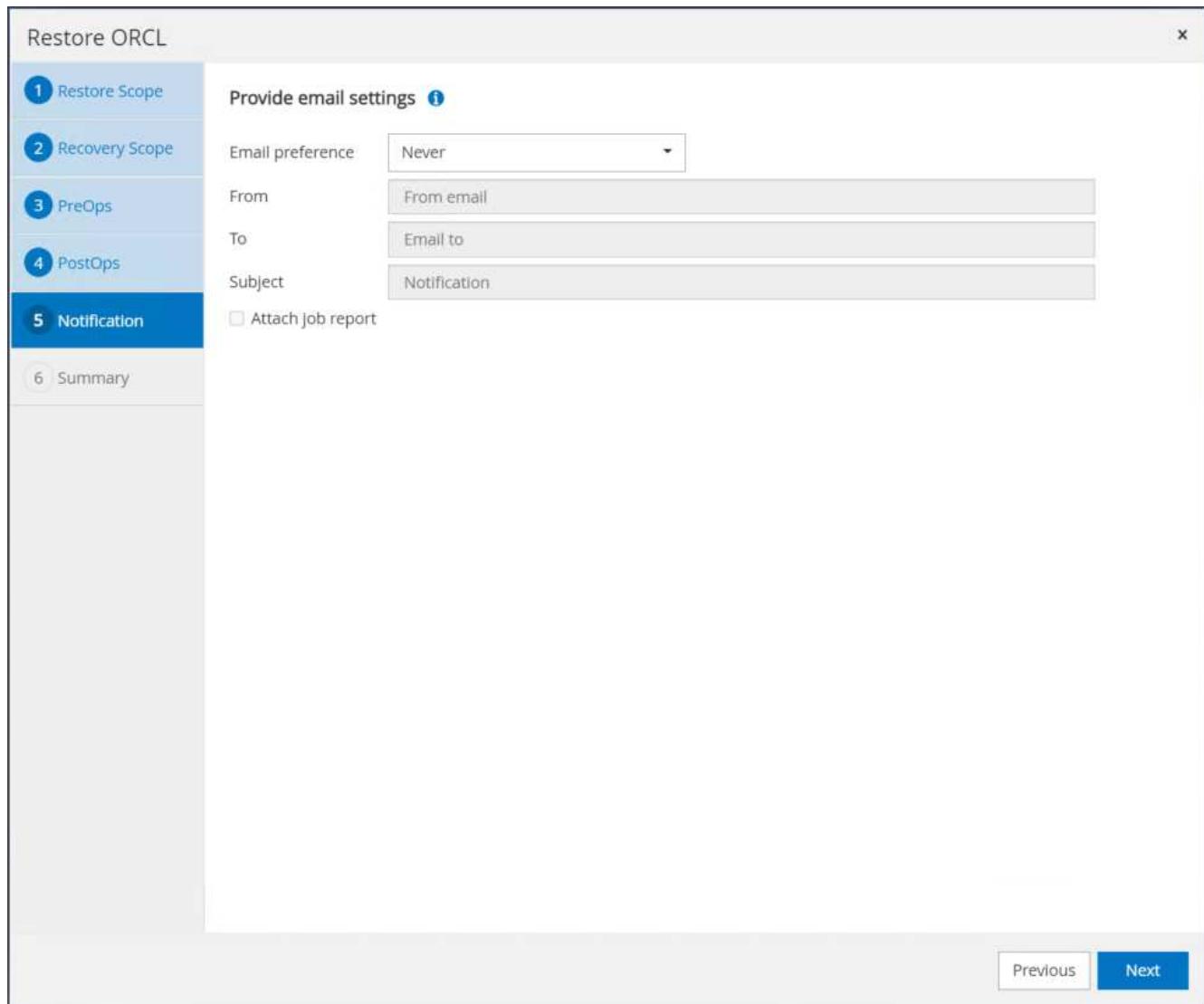
Previous Next

The screenshot shows the Oracle SnapCenter Restore wizard interface. The title bar says 'Restore ORCL'. On the left is a vertical navigation menu with steps 1 through 6. Step 3, 'PreOps', is selected and highlighted in blue. The main panel title is 'Specify optional scripts to run before performing a restore job'. It contains fields for 'Prescript full path' (set to '/var/opt/snapcenter/spl/scripts/'), 'Arguments' (empty), and 'Script timeout' (set to '60 secs'). At the bottom are 'Previous' and 'Next' buttons.

11. Specify an optional afterscript to run if necessary. Check the open database after recovery.



12. Provide an SMTP server and email address if a job notification is needed.



13. Restore the job summary. Click finish to launch the restore job.

Restore ORCL

X

1 Restore Scope

2 Recovery Scope

3 PreOps

4 PostOps

5 Notification

6 Summary

Summary

Backup name	ip-10-0-0-151_03-25-2022_11.15.01.1503_0
Backup date	03/25/2022 11:15:11 AM
Restore scope	All DataFiles
Recovery scope	Until SCN 1778546
Auxiliary destination	
Options	Change database state if necessary , Open the database or container database in READ-WRITE mode after recovery
Prescript full path	None
Prescript arguments	
Postscript full path	None
Postscript arguments	
Send email	No

Previous Finish

14. Validate the restore from SnapCenter.

Job Details

Restore 'ip-10-0-0-151.ec2.internal\ORCL'

- ✓ ▾ Restore 'ip-10-0-0-151.ec2.internal\ORCL'
- ✓ ▾ ip-10-0-0-151.ec2.Internal
 - ✓ ► Prescripts
 - ✓ ► Pre Restore
 - ✓ ► Restore
 - ✓ ► Post Restore
 - ✓ ► Postscripts
 - ✓ ► Post Restore Cleanup
 - ✓ ► Data Collection
 - ✓ ► Send EMS Messages

Task Name: ip-10-0-0-151.ec2.Internal Start Time: 03/25/2022 3:33:53 PM End Time: 03/25/2022 3:35:10 PM

[View Logs](#) [Cancel job](#) [Close](#)

15. Validate the restore from the EC2 instance host.

```

-bash-4.2$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Mar 25 15:44:08 2022
Version 19.8.0.0.0

Copyright (c) 1982, 2020, Oracle. All rights reserved.

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0

SQL> select name, RESETLOGS_CHANGE#, RESETLOGS_TIME, open_mode from v$database;

NAME      RESETLOGS_CHANGE# RESETLOGS OPEN_MODE
-----  -----
ORCL          1778547 25-MAR-22 READ WRITE

SQL>

```

16. To unmount the restore log volume, reverse the steps in step 4.

Creating a database clone

The following section demonstrates how to use the SnapCenter clone workflow to create a database clone from a primary database to a standby EC2 instance.

1. Take a full snapshot backup of the primary database from SnapCenter using the full backup resource group.

The screenshot shows the NetApp SnapCenter interface. On the left, there's a sidebar with various icons. The main area has a blue header bar with the title 'NetApp SnapCenter®'. Below the header, there's a search bar labeled 'Search resource groups' and a dropdown menu set to 'Oracle Database'. A table lists resources under the heading 'Name'. One row is highlighted in yellow, showing 'orc_full_bkup' as the Resource Name, 'ORCL' as the Type, and 'ip-10-0-0-151.ec2.internal' as the Host. To the right of the table are several buttons: 'Modify Resource Group', 'Backup Now', 'Maintenance', and 'Delete'.

2. From the SnapCenter Resource tab > Database view, open the Database Backup Management page for the primary database that the replica is to be created from.

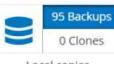
The screenshot shows the NetApp SnapCenter interface. The top navigation bar includes the title 'NetApp SnapCenter®', user information ('rdscustomval/administrator', 'SnapCenterAdmin'), and a 'Sign Out' button. The main area has a blue header bar with the title 'Oracle Database'. Below the header, there's a search bar labeled 'Search databases' and a dropdown menu set to 'Oracle Database'. A table lists databases under the heading 'Name', with 'ORCL' selected. To the right, there's a summary card for '93 Backups', '6 Data Backups', '87 Log Backups', and '0 Clones'. Below this, a section titled 'Primary Backup(s)' shows a table of backups. The table columns include 'Backup Name', 'Count', 'Type', 'End Date', 'Verified', 'Mounted', 'RMAN Cataloged', and 'SCN'. Several backup entries are listed, such as 'ip-10-0-151_03-25-2022_17.55.01.0197_1' and 'ip-10-0-151_03-25-2022_17.50.55.0853_1'.

3. Mount the log volume snapshot taken in step 4 to the standby EC2 instance host.

ORCL Topology

Manage Copies

Local copies

Summary Card						
95 Backups	6 Data Backups	89 Log Backups	0 Clones			
 95 Backups 0 Clones						

Primary Backup(s)

Backup Name	Count	Type	IF	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_18.55.01.0309_1	1	Log		03/25/2022 6:55:09 PM	Not Applicable	False	Not Cataloged	1892563
ip-10-0-0-151_03-25-2022_18.40.00.9602_1	1	Log		03/25/2022 6:40:23 PM	Not Applicable	False	Not Cataloged	1891375
ip-10-0-0-151_03-25-2022_17.55.01.0197_1	1	Log		03/25/2022 5:55:09 PM	Not Applicable	False	Not Cataloged	1789099
ip-10-0-0-151_03-25-2022_17.50.55.0853_1	1	Log		03/25/2022 5:51:12 PM	Not Applicable	False	Not Cataloged	1788879
ip-10-0-0-151_03-25-2022_17.50.55.0853_0	1	Data		03/25/2022 5:51:05 PM	Unverified	False	Not Cataloged	1788832
ip-10-0-0-151_03-25-2022_17.40.00.9758_1	1	Log		03/25/2022 5:40:08 PM	Not	False	Not Cataloged	1788110

Mount backups

Choose the host to mount the backup : ip-10-0-0-47.ec2.internal

Mount path : /var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_17.50.55.0853_1/ORCL

Mount Cancel

- Highlight the snapshot copy to be cloned for the replica, and click the Clone button to start the clone procedure.

ORCL Topology

Manage Copies

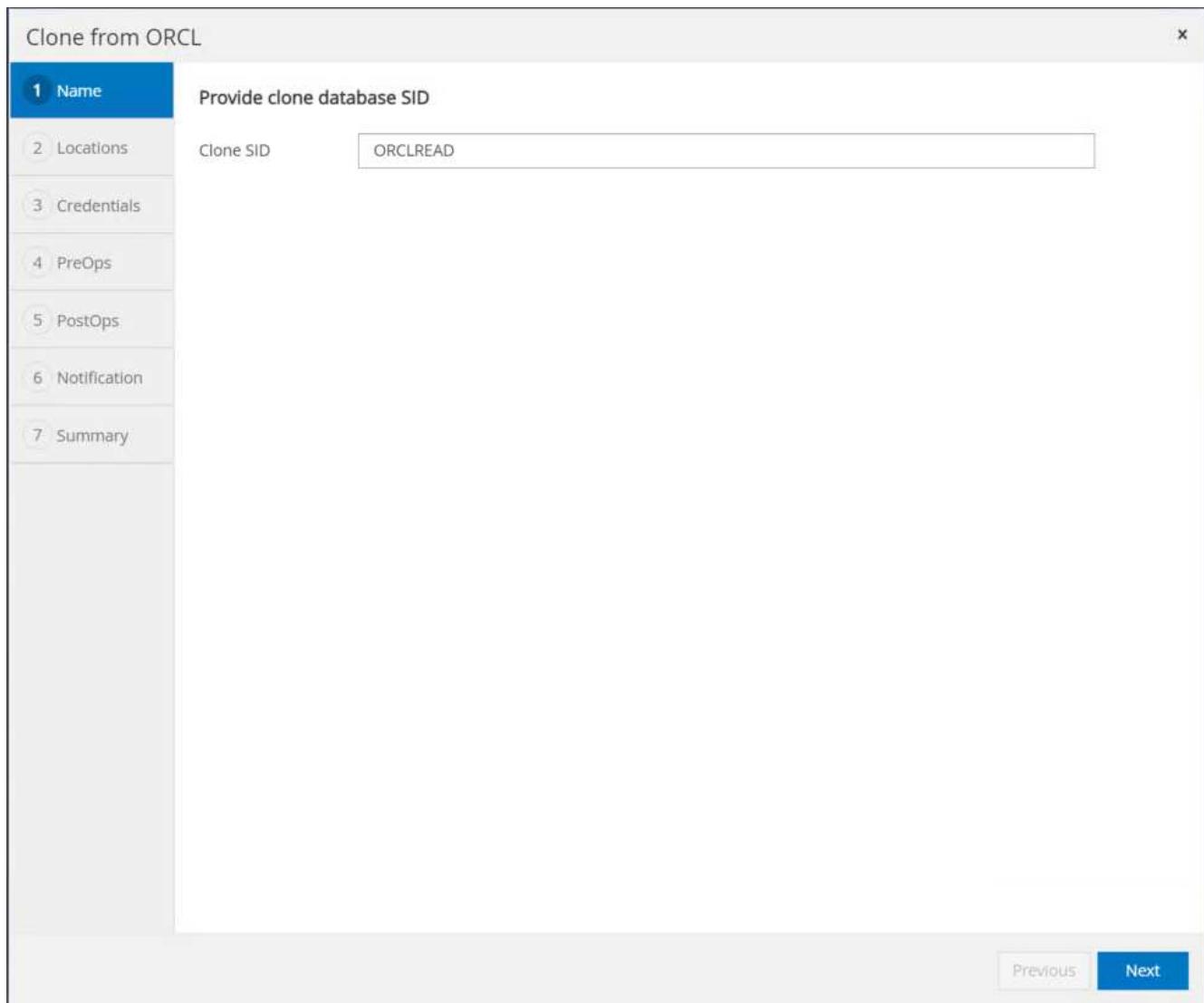
Local copies

Summary Card						
93 Backups	6 Data Backups	87 Log Backups	0 Clones			
 93 Backups 0 Clones						

Primary Backup(s)

Backup Name	Count	Type	IF	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_17.55.01.0197_1	1	Log		03/25/2022 5:55:09 PM	Not Applicable	False	Not Cataloged	1789099
ip-10-0-0-151_03-25-2022_17.50.55.0853_1	1	Log		03/25/2022 5:51:12 PM	Not Applicable	False	Not Cataloged	1788879
ip-10-0-0-151_03-25-2022_17.50.55.0853_0	1	Data		03/25/2022 5:51:05 PM	Unverified	False	Not Cataloged	1788832
ip-10-0-0-151_03-25-2022_17.40.00.9758_1	1	Log		03/25/2022 5:40:08 PM	Not Applicable	False	Not Cataloged	1788110
ip-10-0-0-151_03-25-2022_17.25.01.0539_1	1	Log		03/25/2022 5:25:08 PM	Not	False	Not Cataloged	1787180

5. Change the replica copy name so that it is different from the primary database name. Click Next.



6. Change the clone host to the standby EC2 host, accept the default naming, and click Next.

Clone from ORCL

1 Name

Select the host to create a clone

Clone host: ip-10-0-0-47.ec2.internal

2 Locations

Datafile locations: /ora_nfs_data_ORCLREAD

Control files: /ora_nfs_data_ORCLREAD/ORCLREAD/control/control01.ctl

Redo logs:

Group	Size	Unit	Number of files
RedoGroup 1	128	MB	1
RedoGroup 2	128	MB	1

Previous Next

The screenshot shows the Oracle Database Clone wizard in progress, specifically Step 2: Locations. The left sidebar lists steps 1 through 7. Step 2 is currently active, indicated by a blue background. The main area displays configuration options for cloning a database from the source 'ORCL'. Under 'Datafile locations', the path '/ora_nfs_data_ORCLREAD' is specified. Under 'Control files', the path '/ora_nfs_data_ORCLREAD/ORCLREAD/control/control01.ctl' is listed. The 'Redo logs' section contains two entries: 'RedoGroup 1' and 'RedoGroup 2', each with a size of 128 MB and one file. At the bottom right, there are 'Previous' and 'Next' buttons.

7. Change your Oracle home settings to match those configured for the target Oracle server host, and click Next.

Clone from ORCL

1 Name

2 Locations

3 Credentials

4 PreOps

5 PostOps

6 Notification

7 Summary

Database Credentials for the clone

Credential name for sys user - + ⓘ

Database port

Oracle Home Settings ⓘ

Oracle Home

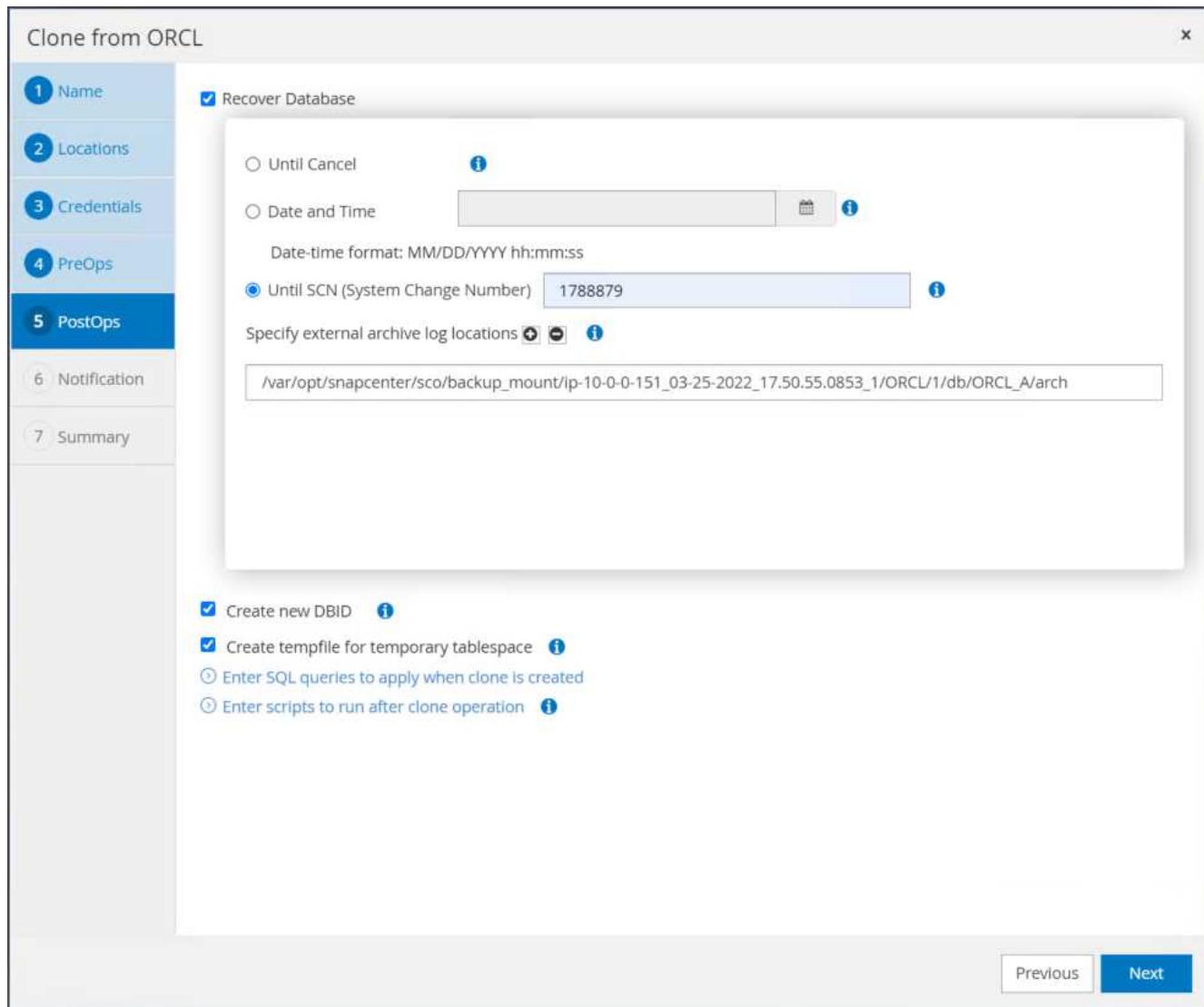
Oracle OS User

Oracle OS Group

Previous Next

The screenshot shows the 'Clone from ORCL' wizard in progress, specifically the 'Credentials' step (step 3). On the left, a vertical navigation bar lists steps 1 through 7. Step 3, 'Credentials', is highlighted. The main area contains two sections: 'Database Credentials for the clone' and 'Oracle Home Settings'. In the 'Database Credentials' section, the 'Credential name for sys user' dropdown is set to 'None', with a '+' button and an information icon next to it. The 'Database port' field is set to '1521'. In the 'Oracle Home Settings' section, the 'Oracle Home' field is '/rdsdbbin/oracle', 'Oracle OS User' is 'rdsdb', and 'Oracle OS Group' is 'database'. At the bottom right, there are 'Previous' and 'Next' buttons.

8. Specify a recovery point using either time or the SCN and mounted archive log path.



9. Send the SMTP email settings if needed.

Clone from ORCL

Provide email settings i

Email preference	Never
From	From email
To	Email to
Subject	Notification

Attach job report

6 Notification

7 Summary

Previous **Next**

10. Clone the job summary, and click Finish to launch the clone job.

Clone from ORCL

	Summary
1 Name	
2 Locations	Clone from backup ip-10-0-0-151_03-25-2022_17.50.55.0853_0
3 Credentials	Clone SID ORCLREAD
4 PreOps	Clone server ip-10-0-0-47.ec2.internal
5 PostOps	Oracle home /rdsdbbin/oracle
6 Notification	Oracle OS user rdsdb
7 Summary	Oracle OS group database Datafile mountpaths /ora_nfs_data_ORCLREAD Control files /ora_nfs_data_ORCLREAD/ORCLREAD/control/control01.ctl Redo groups RedoGroup =1 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog redo04.log RedoGroup =2 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog redo03.log RedoGroup =3 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog redo02.log RedoGroup =4 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog redo01.log Recovery scope Until SCN 1788879 Prescript full path none Prescript arguments Postscript full path none Postscript arguments Send email No

[Previous](#) **Finish**

11. Validate the replica clone by reviewing the clone job log.

Job Details

Clone from backup 'ip-10-0-0-151_03-25-2022_17.50.55.0853_0'

- ✓ ▾ Clone from backup 'ip-10-0-0-151_03-25-2022_17.50.55.0853_0'
- ✓ ▾ ip-10-0-0-47.ec2.internal
 - ✓ ► Prescripts
 - ✓ ► Query Host Information
 - ✓ ► Prepare for Cloning
 - ✓ ► Cloning Resources
 - ✓ ► FileSystem Clone
 - ✓ ► Application Clone
 - ✓ ► Postscripts
 - ✓ ► Register Clone
 - ✓ ► Unmount Clone
 - ✓ ► Data Collection
 - ✓ ► Send EMS Messages

Task Name: ip-10-0-0-47.ec2.internal Start Time: 03/25/2022 9:08:32 PM End Time: 03/25/2022 9:12:03 PM

[View Logs](#) [Cancel Job](#) [Close](#)

The cloned database is registered in SnapCenter immediately.

NetApp SnapCenter®

Oracle Database

View	Database	Search databases	
Resources	ORCL	Single Instance	Host/Cluster: ip-10-0-0-151.ec2.internal Resource Group: orcl_full_bkup, orcl_log_bkup Policies: Oracle full backup, Oracle log backup Last Backup: 03/25/2022 9:10:09 PM Overall Status: Backup succeeded
	ORCLREAD	Single Instance	Host/Cluster: ip-10-0-0-47.ec2.internal Resource Group: (empty) Policies: (empty) Last Backup: (empty) Overall Status: Not protected

12. Turn off Oracle archive log mode. Log into the EC2 instance as oracle user and execute following command:

```
sqlplus / as sysdba
```

```
shutdown immediate;
```

```
startup mount;
```

```
alter database noarchivelog;
```

```
alter database open;
```



Instead primary Oracle backup copies, a clone can also be created from replicated secondary backup copies on target FSx cluster with same procedures.

HA failover to standby and resync

The standby Oracle HA cluster provides high availability in the event of failure in the primary site, either in the compute layer or in the storage layer. One significant benefit of the solution is that a user can test and validate the infrastructure at any time or with any frequency. Failover can be user simulated or triggered by real failure. The failover processes are identical and can be automated for fast application recovery.

See the following list of failover procedures:

1. For a simulated failover, run a log snapshot backup to flush the latest transactions to the standby site, as demonstrated in the section [Taking an archive log snapshot](#). For a failover triggered by an actual failure, the last recoverable data is replicated to the standby site with the last successful scheduled log volume backup.
2. Break the SnapMirror between primary and standby FSx cluster.
3. Mount the replicated standby database volumes at the standby EC2 instance host.
4. Relink the Oracle binary if the replicated Oracle binary is used for Oracle recovery.
5. Recover the standby Oracle database to the last available archive log.
6. Open the standby Oracle database for application and user access.
7. For an actual primary site failure, the standby Oracle database now takes the role of the new primary site and database volumes can be used to rebuild the failed primary site as a new standby site with the reverse SnapMirror method.
8. For a simulated primary site failure for testing or validation, shut down the standby Oracle database after the completion of testing exercises. Then unmount the standby database volumes from the standby EC2 instance host and resync replication from the primary site to the standby site.

These procedures can be performed with the NetApp Automation Toolkit available for download at the public NetApp GitHub site.

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

Read the README instruction carefully before attempting setup and failover testing.

[Next: Database migration.](#)

Database migration from on-prem to public cloud

[Previous: Database management.](#)

Database migration is a challenging endeavor by any means. Migrating an Oracle database from on-premises to the cloud is no exception.

The following sections provide key factors to consider when migrating Oracle databases to the AWS public cloud with the AWS EC2 compute and FSx storage platform.

ONTAP storage is available on-premises

If the on-premises Oracle database is sitting on an ONTAP storage array, then it is easier to set up replication for database migration using the NetApp SnapMirror technology that is built into AWS FSx ONTAP storage. The migration process can be orchestrated using NetApp BlueXP console.

1. Build a target compute EC2 instance that matches the on-premises instance.
2. Provision matching, equally sized database volumes from FSx console.
3. Mount the FSx database volumes to the EC2 instance.
4. Set up SnapMirror replication between the on-premises database volumes to the target FSx database volumes. The initial sync might take some time to move the primary source data, but any following incremental updates are much quicker.
5. At the time of switchover, shut down the primary application to stop all transactions. From the Oracle sqlplus CLI interface, execute an Oracle online log switch and allow SnapMirror sync to push the last archived log to the target volume.
6. Break up the mirrored volumes, run Oracle recovery at the target, and bring up the database for service.
7. Point applications to the Oracle database in the cloud.

The following video demonstrates how to migrate an Oracle database from on-premises to AWS FSx/EC2 using the NetApp BlueXP console and SnapMirror replication.

[Oracle Database Migration from On-premises to FSx/EC2 via SnapMirror and BlueXP](#)

ONTAP storage is not available on premises

If the on-premises Oracle database is hosted on third-party storage other than ONTAP, database migration is based on the restore of a Oracle database backup copy. You must play the archive log to make it current before switching over.

AWS S3 can be used as a staging storage area for database move and migration. See the following high level

steps for this method:

1. Provision a new, matching EC2 instance that is comparable with the on-premises instance.
2. Provision equal database volumes from FSx storage and mount the volumes to the EC2 instance.
3. Create a disk-level Oracle backup copy.
4. Move the backup copy to AWS S3 storage.
5. Recreate the Oracle control file and restore and recover the database by pulling data and the archive log from S3 storage.
6. Sync the target Oracle database with the on-premises source database.
7. At switchover, shut down the application and source Oracle database. Copy the last few archive logs and apply them to the target Oracle database to bring it up to date.
8. Start up the target database for user access.
9. Redirect application to the target database to complete the switchover.

Migrate on-premises Oracle databases to AWS FSx/EC2 using PDB relocation with maximum availability

This migration approach is best suited to Oracle databases that are already deployed in PDB/CDB multitenant model, and ONTAP storage is not available on-premises. The PDB relocation method utilizes Oracle PDB hot clone technology to move PDBs between a source CDB and a target CDB while minimizing service interruption.

First, create CDB in the AWS FSx/EC2 with sufficient storage to host PDBs to be migrated from on-premises. Multiple on-premises PDBs can be relocated one at a time.

1. If the on-premises database is deployed in a single instance rather than in the multitenant PDB/CDB model, follow the instructions in [Converting a single instance non-CDB to a PDB in a multitenant CDB](#) to convert the single instance to multitenant PDB/CDB. Then follow the next step to migrate the converted PDB to CDB in AWS FSx/EC2.
2. If the on-premises database is already deployed in the multitenant PDB/CDB model, follow the instructions in [Migrate on-premises Oracle databases to cloud with PDB relocation](#) to perform the migration.

The following video demonstrates how an Oracle database (PDB) can be migrated to FSx/EC2 using PDB relocation with maximum availability.

[Migrate on-prem Oracle PDB to AWS CDB with max availability](#)



Although the instructions in step 1 and 2 are illustrated in the context of Azure public cloud, the procedures are applicable to AWS cloud without any changes.

The NetApp Solutions Automation team provides a migration toolkit that can facilitate Oracle database migration from on-premises to the AWS cloud. Use following command to download the Oracle database migration toolkit for PDB relocation.

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

Oracle Database Deployment and Protection on Azure NetApp Files

TR-4954: Oracle Database Deployment and Protection on Azure NetApp Files

Author(s): Allen Cao, Niyaz Mohamed, NetApp

Overview

Many mission-critical Oracle enterprise databases are still hosted on-premises, and many enterprises are looking to migrate these Oracle databases to a public cloud. Often, these Oracle databases are application centric and thus require user-specific configurations, a capability that is missing from many database-as-a-service public-cloud offerings. Therefore, the current database landscape calls for a public-cloud-based Oracle database solution built from a high-performance, scalable compute and storage service that can accommodate unique requirements. Azure virtual machine compute instances and the Azure NetApp Files storage service might be the missing pieces of this puzzle that you can leverage to build and migrate your mission-critical Oracle database workloads to a public cloud.

Azure Virtual Machine

Azure virtual machines are one of several types of on-demand, scalable computing resources that Azure offers. Typically, you choose a virtual machine when you need more control over the computing environment than the other choices offer. Azure virtual machines offer a quick and easy way to create a computer with specific configurations required to run your Oracle database, whether it is for compute- or memory-intensive workloads. Virtual machines in an Azure virtual network can easily be connected to your organization's network, for example through a secured VPN tunnel.

Azure NetApp Files (ANF)

Azure NetApp Files is a fully managed Microsoft service that will take your database workload to the cloud faster and more securely than ever before. It was designed to meet the core requirements of running high-performance workloads such as Oracle databases in the cloud, and it provides performance tiers that reflect the real-world range of IOPS demands, low latency, high availability, high durability, manageability at scale, and fast and efficient backup, recovery, and cloning. These capabilities are possible because Azure NetApp Files is based on physical all-flash NetApp ONTAP systems running within the Azure data center environment. Azure NetApp Files is completely integrated into the Azure DCs and portal, and customers can use the same comfortable graphical interface and APIs for creating and managing shared files as with any other Azure object. With Azure NetApp file, you can unlock the full capabilities of Azure without extra risk, cost, or time and trust the only enterprise file service native to Azure.

Conclusion

This documentation describes in detail how to deploy, configure, and protect an Oracle database with an Azure virtual machine and Azure NetApp Files storage service that delivers performance and durability similar to an on-premises system. For best-practices guidance, see TR-4780 [Oracle Databases on Microsoft Azure](#). More importantly, NetApp also provides automation toolkits that automate most of the tasks that are required for the deployment, configuration, data protection, migration, and management of your Oracle database workload in the Azure public cloud. The automation toolkits are available for download at NetApp public GitHub site: [NetApp-Automation](#).

[Next: Solutions architecture.](#)

Solution Architecture

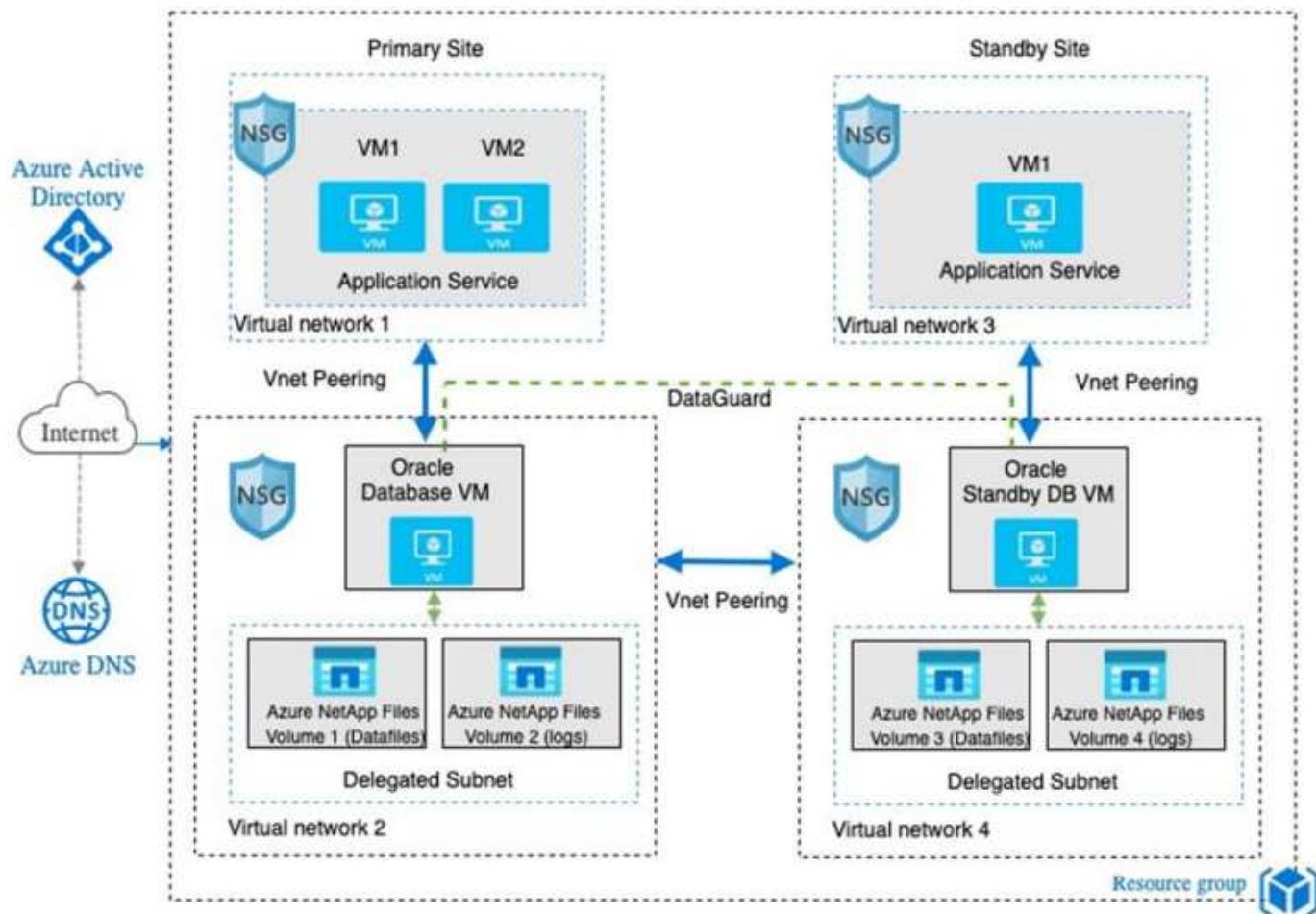
[Previous: Introduction.](#)

The following architecture diagram illustrates a highly available Oracle database

deployment on Azure VM instances and the Azure NetApp Files storage.

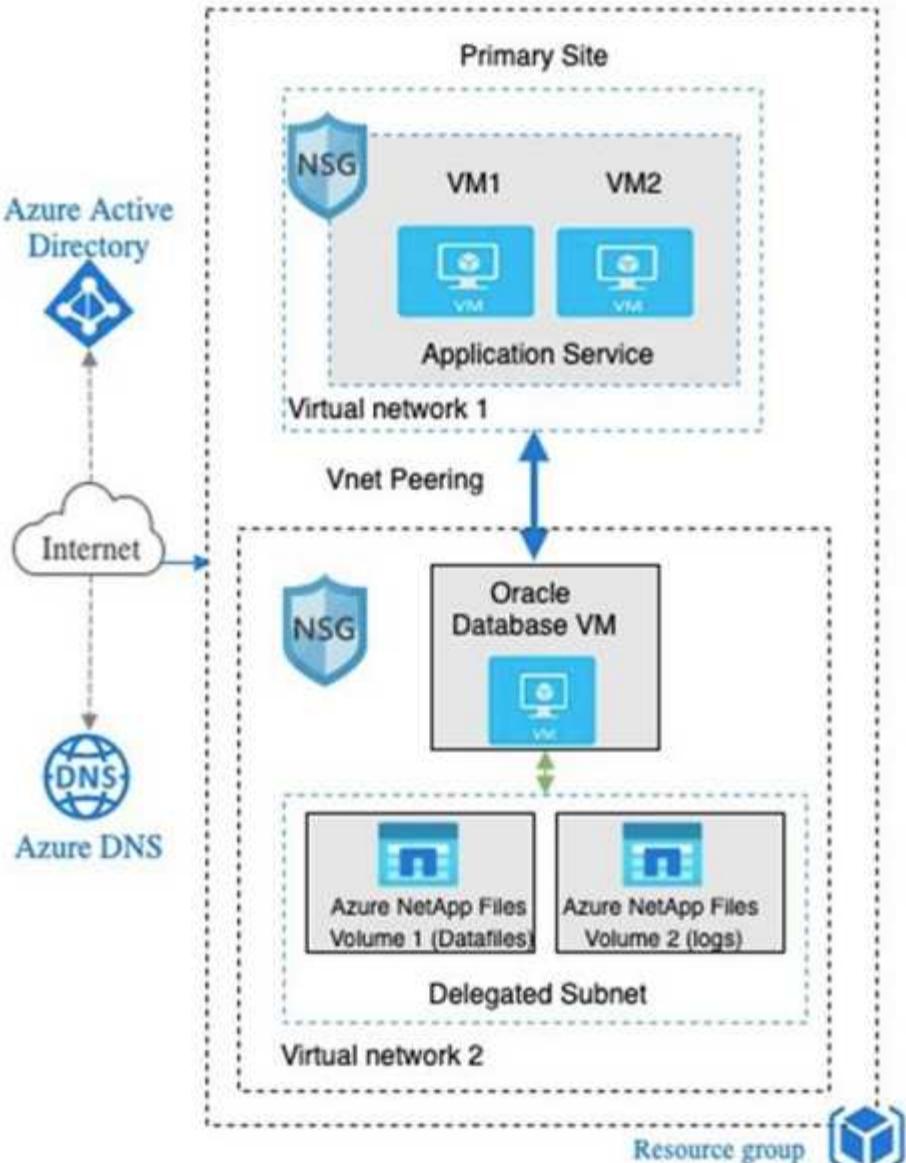
Within the environment, the Oracle compute instance is deployed via an Azure services VM console. There are multiple Azure instance types available from the console. NetApp recommends deploying a database-oriented Azure VM instance that meets your expected workload.

Oracle database storage on the other hand is deployed with the Azure NetApp Files service available from Azure console. The Oracle binary, data, or log volumes are subsequently presented and mounted on an Azure VM instance Linux host.



In many respects, the implementation of Azure NetApp Files in Azure cloud is very similar to an on-premises ONTAP data storage architecture with many built-in redundancies, such as RAID and dual controllers. For disaster recovery, a standby site can be setup in different regions and database can be synced up with the primary site using application-level replication (for example, Oracle Data Guard).

In our test validation for Oracle database deployment and data protection, the Oracle database is deployed on a single Azure VM as illustrated in the following diagram:



The Azure Oracle environment can be managed with an Ansible controller node for automation using tool kits provided by NetApp for database deployment, backup, recovery, and database migration. Any updates to the Oracle Azure VM instance operating-system kernel or Oracle patching can be performed in parallel to keep the primary and standby in sync. In fact, the initial toolkits can be easily expanded to perform daily Oracle tasks if needed. If you need help to set up a CLI Ansible controller, see [NetApp Solution Automation](#) to get started.

Next: Factors to consider.

Factors to consider for Oracle database deployment

[Previous: Solution architecture.](#)

A public cloud provides many choices for compute and storage, and using the correct type of compute instance and storage engine is a good place to start for database deployment. You should also select compute and storage configurations that are optimized for Oracle databases.

The following sections describe the key considerations when deploying an Oracle database in the Azure public cloud on an Azure virtual machine instance with Azure NetApp Files storage.

VM type and sizing

Selecting the right VM type and size is important for optimal performance of a relational database in a public cloud. An Azure virtual machine provides a variety of compute instances that can be used to host Oracle database workloads. See the Microsoft documentation [Sizes for virtual machines in Azure](#) for different types of Azure virtual machines and their sizing. In general, NetApp recommends using a general-purpose Azure virtual machine for the deployment of small- and medium-sized Oracle databases. For the deployment of larger Oracle databases, a memory-optimized Azure VM is appropriate. With more available RAM, a larger Oracle SGA or smart flash cache can be configured to reduce the physical I/O, which in turn improves database performance.

Azure NetApp Files works as an NFS mount attached to an Azure virtual machine, which offers higher throughput and overcomes the storage-optimized VM throughput limit with local storage. Therefore, running Oracle on Azure NetApp Files could reduce the licensable Oracle CPU core count and licensing costs. See [TR-4780: Oracle Databases on Microsoft Azure](#), Section 7 - How Does Oracle Licensing Work?

Other factors to consider include the following:

- Choose the correct vCPU and RAM combination based on workload characteristics. As the RAM size increases on the VM, so does the number of vCPU cores. There should be a balance at some point as the Oracle license fees are charged on the number of vCPU cores.
- Add swap space to a VM. The default Azure VM deployment does not create a swap space, which is not optimal for a database.

Azure NetApp Files performance

Azure NetApp Files volumes are allocated from a capacity pool the customer must provision in their Azure NetApp Files storage account. Each capacity pool is assigned as follows:

- To a service level that defines the overall performance capability.
- The initially provisioned storage capacity or tiering for that capacity pool. A quality of service (QoS) level that defines the overall maximum throughput per provisioned space.

The service level and initially provisioned storage capacity determines the performance level for a particular Oracle database volume.

1. Service Levels for Azure NetApp Files

Azure NetApp Files supports three service levels: Ultra, Premium, and Standard.

- **Ultra storage.** This tier provides up to 128MiBps of throughput per 1TiB of volume quota assigned.
- **Premium storage.** This tier provides up to 64MiBps of throughput per 1TiB of volume quota assigned.
- **Standard storage.** This tier provides up to 16MiBps of throughput per 1TiB of volume quota assigned.

2. Capacity pool and quality of service

Each of the desired service levels has an associated cost for provisioned capacity and includes a quality-of-service (QoS) level that defines the overall maximum throughput for provisioned space.

For example, a 10TiB-provisioned single-capacity pool with the premium service level provides an overall

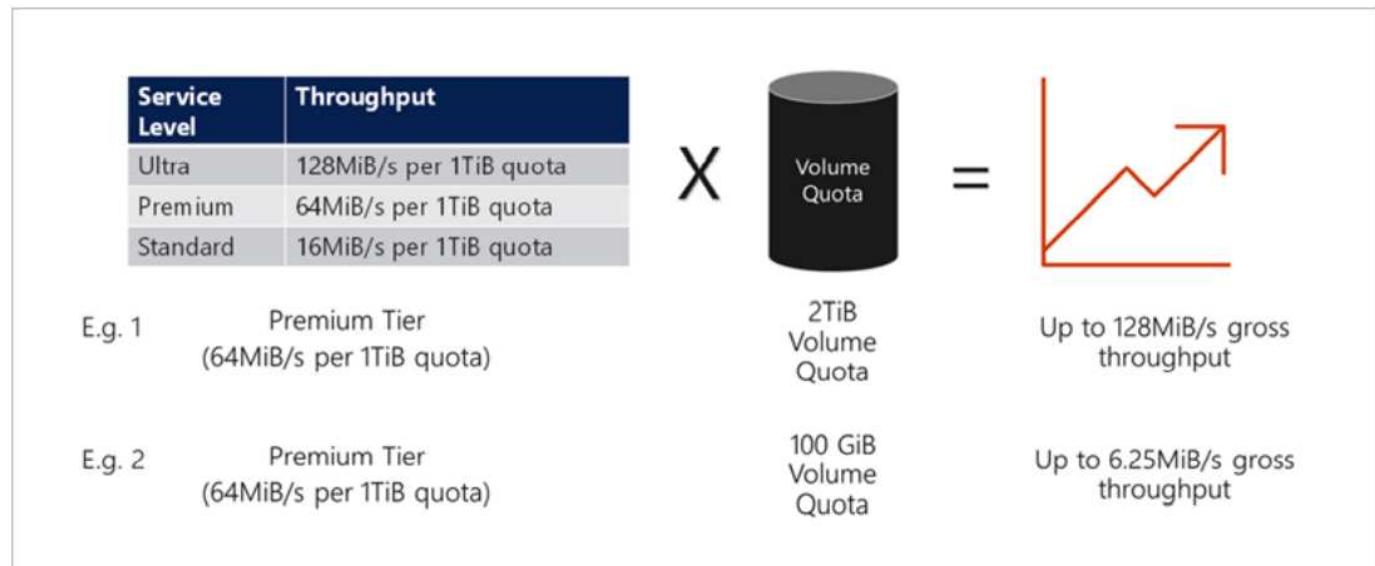
available throughput for all volumes in this capacity pool of 10x 64MBps, so 640MBps with 40,000 (16K) IOPs or 80,000 (8K) IOPs.

The minimum capacity pool size is 4TiB. You can change the size of a capacity pool in 1TiB increments in response to changes in your workload requirements to manage storage needs and costs.

3. Calculate the service level at a database volume

The throughput limit for an Oracle database volume is determined by a combination of the following factors:
The service level of the capacity pool to which the volume belongs and The quota assigned to the volume.

The following diagram shows how the throughput limit for an Oracle database volume is calculated.



In example 1, a volume from a capacity pool with the Premium storage tier that is assigned 2TiB of quota is assigned a throughput limit of 128MiBps ($2\text{TiB} * 64\text{MiBps}$). This scenario applies regardless of the capacity pool size or the actual volume consumption.

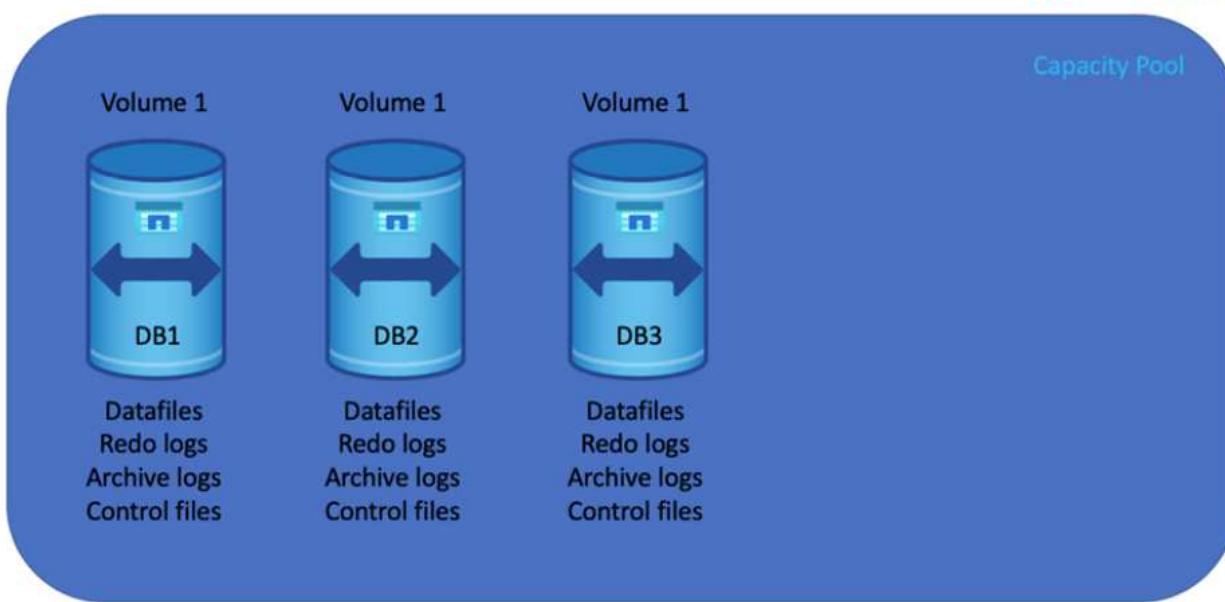
In example 2, a volume from a capacity pool with the Premium storage tier that is assigned 100GiB of quota is assigned a throughput limit of 6.25MiBps ($0.09765625\text{TiB} * 64\text{MiBps}$). This scenario applies regardless of the capacity pool size or the actual volume consumption.

Please note that the minimum volume size is 100GiB.

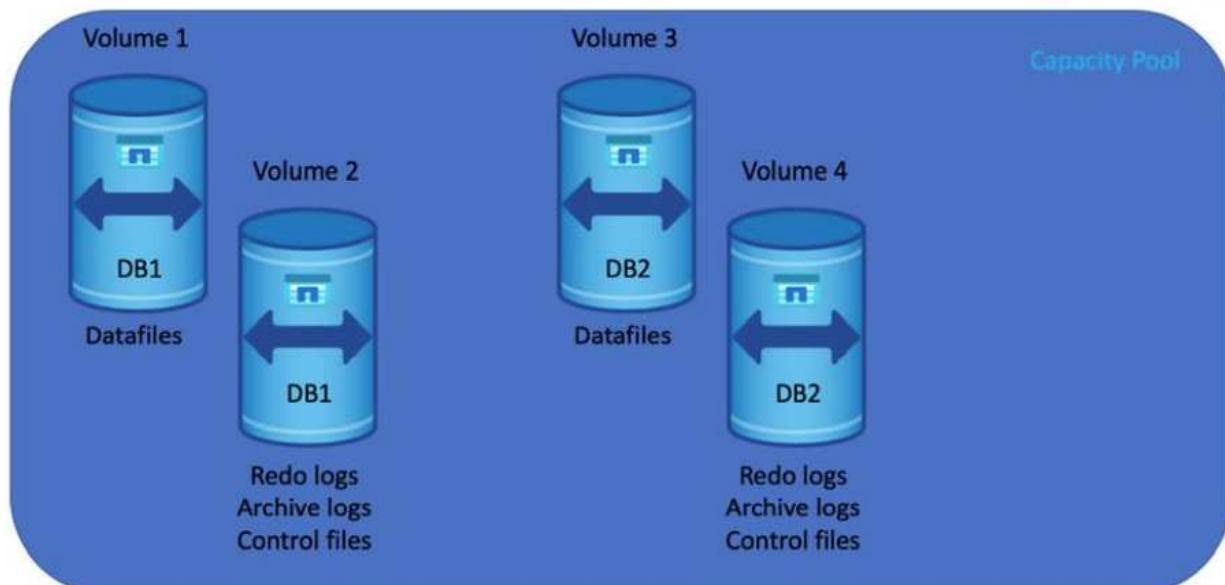
Storage layout and settings

NetApp recommends the following storage layout:

- For small databases, using single volume layout for all Oracle files.



- For large databases, the recommended volume layout is multiple volumes: one for Oracle data and a duplicate control file and one for the Oracle active log, archived log, and control file. NetApp highly recommends allocating a volume for the Oracle binary instead of the local drive so that the database can be relocated to a new host and quickly restored.



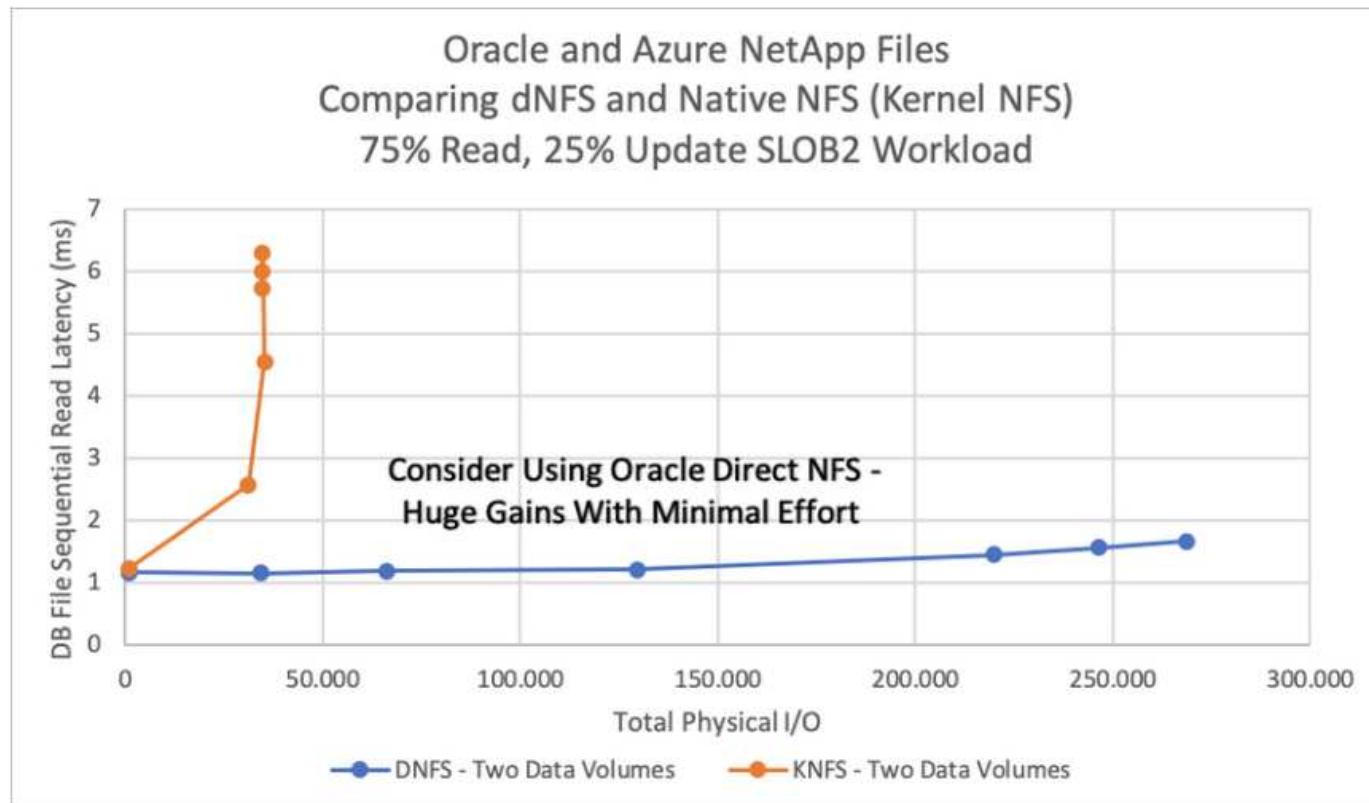
NFS configuration

Linux, the most common operating system, includes native NFS capabilities. Oracle offers a direct NFS (dNFS) client natively integrated into Oracle. Oracle dNFS bypasses the OS cache and enables parallel processing to

improve database performance. Oracle has supported NFSv3 for over 20 years, and NFSv4 is supported with Oracle 12.1.0.2 and later.

By using dNFS (available since Oracle 11g), an Oracle database running on an Azure Virtual Machine can drive significantly more I/O than the native NFS client. Automated Oracle deployment using the NetApp automation toolkit automatically configures dNFS on NFSv3.

The following diagram demonstrates the SLOB benchmark on Azure NetApp Files with Oracle dNFS.



Other factors to consider:

- TCP slot tables are the NFS equivalent of host-bus-adapter (HBA) queue depth. These tables control the number of NFS operations that can be outstanding at any one time. The default value is usually 16, which is far too low for optimum performance. The opposite problem occurs on newer Linux kernels, which can automatically increase the TCP slot table limit to a level that saturates the NFS server with requests.

For optimum performance and to prevent performance problems, adjust the kernel parameters that control TCP slot tables to 128.

```
sysctl -a | grep tcp.*.slot_table
```

- The following table provides recommended NFS mount options for a single instance of Linux NFSv3.

File Type	Mount Options
<ul style="list-style-type: none"> • Control files • Data files • Redo logs 	<code>rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536</code>
<ul style="list-style-type: none"> • ORACLE_HOME • ORACLE_BASE 	<code>rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536</code>

 Before using dNFS, verify that the patches described in Oracle Doc 1495104.1 are installed. Starting with Oracle 12c, DNFS includes support for NFSv3, NFSv4, and NFSv4.1. NetApp support policies cover v3 and v4 for all clients, but, at the time of writing, NFSv4.1 is not supported for use with Oracle dNFS.

Next: [Deployment procedures](#).

Step-by-Step Oracle deployment procedures on Azure VM and Azure NetApp Files

Previous: [Factors to consider](#).

Deploy an Azure VM with ANF for Oracle via Azure portal console

If you are new to Azure, you first need to set up an Azure account environment. This includes signing up your organization to use Azure Active Directory. The following section is a summary of these steps. For details, see the linked Azure-specific documentation.

Create and consume Azure resources

After your Azure environment is set up and an account is created and associated with a subscription, you can log into Azure portal with the account to create the necessary resources to run Oracle.

1. Create a virtual network or VNet

Azure Virtual Network (VNet) is the fundamental building block for your private network in Azure. VNet enables many types of Azure resources, such as Azure Virtual Machines (VMs), to securely communicate with each other, the internet, and on-premises networks. Before provisioning an Azure VM, a VNet (where a VM is deployed) must first be configured.

See [Create a virtual network using the Azure portal](#) to create a VNet.

2. Create a NetApp storage account and capacity pool for ANF

In this deployment scenario, an Azure VM OS is provisioned using regular Azure storage, but ANF volumes are provisioned to run Oracle database via NFS. First, you need to create a NetApp storage account and a capacity pool to host the storage volumes.

See [Set up Azure NetApp Files and create an NFS volume](#) to set up an ANF capacity pool.

3. Provision Azure VM for Oracle

Based on your workload, determine what type of Azure VM you need and the size of the VM vCPU and RAM to deploy for Oracle. Then, from the Azure console, click the VM icon to launch the VM deployment workflow.

- From the Azure VM page, click **Create** and then choose **Azure virtual machine**.

Name	Type	Subscription	Resource group	Location	Status	Operating system	Size	Public IP address	Disks
acao-ora01	Virtual machine	Hybrid Cloud TME Onprem	TMEstorres	South Central US	Stopped (deallocated)	Linux	Standard_B4ms	13.65.63.157	1
ANFAVFW02JH	Virtual machine	Hybrid Cloud TME Onprem	ANFAVSVAL2	West Europe	Running	Windows	Standard_DS2_v2	20.229.80.88	1
ANFAVSfio01	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Stopped (deallocated)	Linux	Standard_D32ds_v4	-	1
ANFAVSfioAZ1	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Running	Linux	Standard_E32as_v4	40.124.74.246	1
ANFAVSfioAZ2	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Stopped (deallocated)	Linux	Standard_E32as_v4	40.124.178.111	1
ANFAVSfioAZ3	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Stopped (deallocated)	Linux	Standard_E32as_v4	40.124.194.32	1
ANFAVsialDC	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Stopped (deallocated)	Windows	Standard_B4ms	-	1
ANFAVsialH	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Running	Windows	Standard_B2ms	70.37.66.218	1
ANFAVsialH2	Virtual machine	Hybrid Cloud TME Onprem	anfavsg	South Central US	Running	Windows	Standard_B2s	20.225.210.195	1
ANFCVOCM	Virtual machine	Hybrid Cloud TME Onprem	anfcval2	West Europe	Running	Linux	Standard_DS3_v2	-	1
ANFCVOORDC2	Virtual machine	Hybrid Cloud TME Onprem	anfcval2	West Europe	Running	Windows	Standard_B2s	-	1
ANFCVOORDemo	Virtual machine	Hybrid Cloud TME Onprem	anfcvordemo-rg	West Europe	Running	Linux	Standard_E4s_v3	-	5
AVSCVOPerfinguest	Virtual machine	Hybrid Cloud TME Onprem	avscvoperfinguest-rg	West Europe	Stopped (deallocated)	Linux	Standard_DS15_v2	-	5

- Choose the subscription ID for the deployment, and then choose the resource group, region, host name, VM image, size, and authentication method. Go to the Disk page.

[Home](#) > [Virtual machines](#) >

Create a virtual machine

...

[Basics](#) [Disks](#) [Networking](#) [Management](#) [Advanced](#) [Tags](#) [Review + create](#)

Create a virtual machine that runs Linux or Windows. Select an image from Azure marketplace or use your own customized image. Complete the Basics tab then Review + create to provision a virtual machine with default parameters or review each tab for full customization. [Learn more](#)

Project details

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription * ⓘ

Hybrid Cloud TME Onprem

Resource group * ⓘ

ANFAVSRG

[Create new](#)

Instance details

Virtual machine name * ⓘ

acao-ora01



Region * ⓘ

(US) South Central US



Availability options ⓘ

No infrastructure redundancy required



Security type ⓘ

Standard



Image * ⓘ

Red Hat Enterprise Linux 8.0 (LVM) - Gen2

[See all images](#) | [Configure VM generation](#)

Run with Azure Spot discount ⓘ



Size * ⓘ

Standard_D8s_v3 - 8 vcpus, 32 GiB memory (\$273.02/month)

[See all sizes](#)

Administrator account

Authentication type ⓘ

 SSH public key Password[Review + create](#)[< Previous](#)[Next : Disks >](#)

[Home](#) > [Virtual machines](#) >

Create a virtual machine

Size * ⓘ

Standard_D8s_v3 - 8 vcpus, 32 GiB memory (\$273.02/month)

[See all sizes](#)

Administrator account

Authentication type ⓘ

 SSH public key Password

Username * ⓘ

azureuser



Password * ⓘ



Confirm password * ⓘ



Inbound port rules

Select which virtual machine network ports are accessible from the public internet. You can specify more limited or granular network access on the Networking tab.

Public inbound ports * ⓘ

 None Allow selected ports

Select inbound ports *

SSH (22)



⚠ This will allow all IP addresses to access your virtual machine. This is only recommended for testing. Use the Advanced controls in the Networking tab to create rules to limit inbound traffic to known IP addresses.

Licensing

If you have eligible Red Hat Enterprise Linux subscriptions that are enabled for Red Hat Cloud Access, you can use Azure Hybrid Benefit to attach your Red Hat subscriptions to this VM and save money on compute costs [Learn more ↗](#)

Your Azure subscription is currently not a part of Red Hat Cloud Access. In order to enable AHB for this VM, you must add this Azure subscription to Cloud Access. [Learn more ↗](#)

[Review + create](#)[< Previous](#)[Next : Disks >](#)

3. Choose **premium SSD** for OS local redundancy and leave the data disk blank because the data disks are mounted from ANF storage. Go to the Networking page.

[Home](#) > [Virtual machines](#) >

Create a virtual machine

[Basics](#) [Disks](#) [Networking](#) [Management](#) [Advanced](#) [Tags](#) [Review + create](#)

Azure VMs have one operating system disk and a temporary disk for short-term storage. You can attach additional data disks. The size of the VM determines the type of storage you can use and the number of data disks allowed. [Learn more](#)

Disk options

OS disk type * ⓘ

Premium SSD (locally-redundant storage)

Delete with VM ⓘ



Enable encryption at host ⓘ



Encryption at host is not registered for the selected subscription. [Learn more about enabling this feature](#)

Encryption type *

(Default) Encryption at-rest with a platform-managed key

Enable Ultra Disk compatibility ⓘ



Data disks for acao-ora01

You can add and configure additional data disks for your virtual machine or attach existing disks. This VM also comes with a temporary disk.

LUN	Name	Size (GiB)	Disk type	Host caching	Delete with VM ⓘ
-----	------	------------	-----------	--------------	------------------

[Create and attach a new disk](#) [Attach an existing disk](#)

▼ Advanced

[Review + create](#)[< Previous](#)[Next : Networking >](#)

4. Choose the VNet and subnet. Allocate a public IP for external VM access. Then go to the Management page.

[Home](#) > [Virtual machines](#) >

Create a virtual machine

Network interface

When creating a virtual machine, a network interface will be created for you.

Virtual network * ⓘ

▼

[Create new](#)

Subnet * ⓘ

▼

[Manage subnet configuration](#)

Public IP ⓘ

▼

[Create new](#)

NIC network security group ⓘ

- None
 Basic
 Advanced

Public inbound ports * ⓘ

- None
 Allow selected ports

Select inbound ports *

▼

⚠️ This will allow all IP addresses to access your virtual machine. This is only recommended for testing. Use the Advanced controls in the Networking tab to create rules to limit inbound traffic to known IP addresses.

Delete public IP and NIC when VM is deleted ⓘ

Enable accelerated networking ⓘ

Load balancing

You can place this virtual machine in the backend pool of an existing Azure load balancing solution. [Learn more ↗](#)

Place this virtual machine behind an existing load balancing solution?

[Review + create](#)

[< Previous](#)

[Next : Management >](#)

5. Keep all defaults for Management and move to the Advanced page.

Home > Virtual machines >

Create a virtual machine

[Basics](#) [Disks](#) [Networking](#) [Management](#) [Advanced](#) [Tags](#) [Review + create](#)

Configure monitoring and management options for your VM.

Microsoft Defender for Cloud

Microsoft Defender for Cloud provides unified security management and advanced threat protection across hybrid cloud workloads. [Learn more ↗](#)

Your subscription is protected by Microsoft Defender for Cloud basic plan.

Monitoring

Boot diagnostics ⓘ

- Enable with managed storage account (recommended)
 Enable with custom storage account
 Disable

Enable OS guest diagnostics ⓘ

Identity

Enable system assigned managed identity ⓘ

Azure AD

Login with Azure AD ⓘ

RBAC role assignment of Virtual Machine Administrator Login or Virtual Machine User Login is required when using Azure AD login. [Learn more ↗](#)

Azure AD login now uses SSH certificate-based authentication. You will need to use an SSH client that supports OpenSSH certificates. You can use Azure CLI or Cloud Shell from the Azure Portal. [Learn more ↗](#)

Auto-shutdown

Enable auto-shutdown ⓘ

Backup

[Review + create](#)< PreviousNext : Advanced >

6. Keep all defaults for the Advanced page unless you need to customize a VM after deployment with custom scripts. Then go to Tags page.

[Home](#) > [Virtual machines](#) >

Create a virtual machine

[Basics](#) [Disks](#) [Networking](#) [Management](#) [Advanced](#) [Tags](#) [Review + create](#)

Add additional configuration, agents, scripts or applications via virtual machine extensions or cloud-init.

Extensions

Extensions provide post-deployment configuration and automation.

[Extensions](#) ⓘ[Select an extension to install](#)

VM applications

VM applications contain application files that are securely and reliably downloaded on your VM after deployment. In addition to the application files, an install and uninstall script are included in the application. You can easily add or remove applications on your VM after create. [Learn more ↗](#)

[Select a VM application to install](#)

Custom data

Pass a script, configuration file, or other data into the virtual machine **while it is being provisioned**. The data will be saved on the VM in a known location. [Learn more about custom data for VMs ↗](#)

[Custom data](#)

Your image must have a code to support consumption of custom data. If your image supports cloud-init, custom-data will be processed by cloud-init. [Learn more about custom data for VMs ↗](#)

User data

Pass a script, configuration file, or other data that will be accessible to your applications **throughout the lifetime of the virtual machine**. Don't use user data for storing your secrets or passwords. [Learn more about user data for VMs ↗](#)

[Enable user data](#)[Review + create](#)< PreviousNext : Tags >

7. Add a tag for the VM if desired. Then, go to the Review + create page.

[Home](#) > [Virtual machines](#) >

Create a virtual machine

Basics Disks Networking Management Advanced **Tags** Review + create

Tags are name/value pairs that enable you to categorize resources and view consolidated billing by applying the same tag to multiple resources and resource groups. [Learn more about tags](#)

Note that if you create tags and then change resource settings on other tabs, your tags will be automatically updated.

Name ⓘ	Value ⓘ	Resource
database	:	oracle 12 selected <input type="button" value="▼"/> <input type="button" value="Delete"/>
	:	12 selected <input type="button" value="▼"/>

[Review + create](#)

[< Previous](#)

[Next : Review + create >](#)

8. The deployment workflow runs a validation on the configuration, and, if the validation passes, click **Create** to create the VM.

4. Provision ANF database volumes for Oracle

You must create three NFS volumes for an ANF capacity pool for the Oracle binary, data, and log volumes respectively.

- From the Azure console, under the list of Azure services, click Azure NetApp Files to open a volume creation workflow. If you have more than one ANF storage account, click the account that you would like to provision volumes from.

The screenshot shows the Microsoft Azure portal's main dashboard. At the top, there's a blue header bar with the 'Microsoft Azure' logo and a search bar. Below the header, the 'Azure services' section is displayed, featuring various icons for different services: Create a resource, Azure NetApp Files (highlighted with a yellow box), Virtual networks, Virtual machines, Storage accounts, Users, Subscriptions, Azure Active Directory, Quickstart Center, and More services. Under the 'Resources' section, there's a table listing recent resources. The columns are Name, Type, and Last Viewed. The listed resources include ANFAVSAcct (NetApp account), ANFAVSAval (Virtual network), acao-ora01 (Virtual machine), Hybrid Cloud TME Onprem (Subscription), WEANFAVSAcct (NetApp account), ANFAVSAcct/CapPool/acao-ora01-u03 (Volume), ANFAVSAcct/CapPool/acao-ora01-u02 (Volume), ANFAVSAcct/CapPool/acao-ora01-u01 (Volume), acao-ora01_OsDisk_1_673bad70ccce4709af8c1278e2bc97cb (Disk), acao-ora0166 (Network Interface), and TIMEtstres (Resource group). A 'See all' link is at the bottom of the table.

- Under your NetApp storage account, click **Volumes**, and then **Add volume** to create new Oracle volumes.

The screenshot shows the 'ANFAVSAcct' blade in the Azure NetApp Files service. The left sidebar has a tree view with 'Overview' selected, and other options like 'Activity log', 'Access control (IAM)', 'Tags', 'Settings', 'Quota', 'Properties', and 'Locks'. The main content area shows the 'Essentials' section with details: Resource group (move) : ANFAVSRG, Location : South Central US, Subscription (move) : Hybrid Cloud TME Onprem, Subscription ID : 0efazdfb-917c-4497-b56a-b3f4eadb8111, and Tags (edit) : product_line : Field use - various. Below this, there's a section titled 'Enterprise files storage, powered by NetApp' with a sub-section about connecting to Active Directory. The right side of the blade has three cards: 'Connect to Active Directory', 'Capacity pools', and 'Volumes'. At the bottom, there are buttons for 'View AD connections', 'View capacity pools', and 'View volumes'. The bottom left shows a page navigation bar with 'Page 1 of 1'.

3. As a good practice, identify Oracle volumes with the VM hostname as a prefix and then followed by the mount point on the host, such as u01 for Oracle binary, u02 for Oracle data, and u03 for Oracle log. Choose the same VNet for the volume as for the VM. Click **Next: Protocol>**.

4. Choose the NFS protocol, add the Oracle host IP address to the allowed client, and remove the default policy that allows all IP addresses 0.0.0.0/0. Then click **Next: Tags>**.

Microsoft Azure

Search resources, services, and docs (G+)

Home > Azure NetApp Files > ANFAVSAcct | Volumes >

ANFAVSAcct | Volumes

NetApp account

Create a volume

Basics Protocol Tags Review + create

Configure access to your volume.

Access

Protocol type: NFS SMB Dual-protocol

Configuration

File path *

Versions *

Kerberos: Enabled Disabled

LDAP: Enabled Disabled

Azure VMware Solution DataStore

Export policy

Configure the volume's export policy. This can be edited later. [Learn more](#)

Index	Allowed clients	Access	Root Access	...
1	172.30.137.142	Read & Write	On	<input type="checkbox"/>
2	172.30.137.142	Read & Write	On	<input type="checkbox"/>

Review + create < Previous Next : Tags >

5. Add a volume tag if desired. Then click **Review + Create>**.

Microsoft Azure

Search resources, services, and docs (G+)

Home > Azure NetApp Files > ANFAVSAcct | Volumes >

ANFAVSAcct | Volumes

NetApp account

Search (Ctrl+ /) Add volume ...

Overview

Activity log

Access control (IAM)

Tags

Settings

Quota

Properties

Locks

Azure NetApp Files

Active Directory connections

Storage service

Capacity pools

Volumes

Data protection

Snapshot policies

Storage service add-ons

NetApp add-ons

Automation

Tasks (preview)

Export template

Support + troubleshooting

New Support Request

+ Add volume ...

Search volumes

Name	↑↓	Quota
anf2-z1-stdds01	200 GiB	
anf2-z1-stdds02	200 GiB	
anf2-z1-stdds03	100 GiB	
anf2-z1-stdds04	100 GiB	
anf2-z1-stdds05	100 GiB	
anf2-z1-stdds06	100 GiB	
anf2-z1-stdds07	100 GiB	
anf2-z1-stdds08	100 GiB	
anf-z1-stdds01	6 TiB	
anf-z1-stdds02	200 GiB	
anf-z1-stdds03	1 TiB	
anf-z1-stdds04	200 GiB	
anf-z1-stdds06	200 GiB	
anf-z1-stdds07	200 GiB	
anf-z1-stdds08	200 GiB	
anf-zq-stdds05	1 TiB	
vol1	1 TiB	
vol3basic	100 GiB	
volnfsbasic	100 GiB	
volnfsstd	100 GiB	
volnfsstdnew	100 GiB	
zone1basic	6 TiB	
zone2basic	100 GiB	

Create a volume ...

Basics Protocol Tags Review + create

Tags are name/value pairs that enable you to categorize resources and view consolidated billing by applying the same tag to multiple resources and resource groups. [Learn more about tags](#)

Note that if you create tags and then change resource settings on other tabs, your tags will be automatically updated.

Name database Value oracle

Review + create < Previous Next : Review + create >

6. If the validation passes, click **Create** to create the volume.

Install and configure Oracle on Azure VM with ANF

The NetApp solutions team has created many Ansible-based automation toolkits to help you deploy Oracle in Azure smoothly. Follow these steps to deploy Oracle on an Azure VM.

Set up an Ansible controller

If you have not set up an Ansible controller, see [NetApp Solution Automation](#), which has detailed instructions on how to setup an Ansible controller.

Obtain Oracle deployment automation toolkit

Clone a copy of the Oracle deployment toolkit in your home directory under the user ID that you use to log into the Ansible controller.

```
git clone https://github.com/NetApp-Automation/na_oracle19c_deploy.git
```

Execute the toolkit with your configuration

See the [CLI deployment Oracle 19c Database](#) to execute the playbook with the CLI. You can ignore the ONTAP portion of the variables configuration in the global VARS file when you create database volumes from

the Azure console rather than the CLI.



The toolkit default deploys Oracle 19c with RU 19.8. It can be easily adapted for any other patch level with minor default configuration changes. Also default seed-database active log files are deployed into the data volume. If you need active log files on the log volume, it should be relocated after initial deployment. Reach out to the NetApp Solution team for help if needed.

Set up AzAcSnap backup tool for app-consistent snapshots for Oracle

The Azure Application-Consistent Snapshot tool (AzAcSnap) is a command-line tool that enables data protection for third-party databases by handling all the orchestration required to put them into an application-consistent state before taking a storage snapshot. It then returns these databases to an operational state. NetApp recommends installing the tool on the database server host. See the following installation and configuration procedures.

Install AzAcSnap tool

1. Get the most recent version of the [the AzArcSnap Installer](#).
2. Copy the downloaded self-installer to the target system.
3. Execute the self-installer as the root user with the default installation option. If necessary, make the file executable using the `chmod +x *.run` command.

```
./azacsnap_installer_v5.0.run -I
```

Configure Oracle connectivity

The snapshot tools communicate with the Oracle database and need a database user with appropriate permissions to enable or disable backup mode.

1. Set up AzAcSnap database user

The following examples show the setup of the Oracle database user and the use of sqlplus for communication to the Oracle database. The example commands set up a user (AZACSNAP) in the Oracle database and change the IP address, usernames, and passwords as appropriate.

1. From the Oracle database installation, launch sqlplus to log into the database.

```
su - oracle  
sqlplus / AS SYSDBA
```

2. Create the user.

```
CREATE USER azacsnap IDENTIFIED BY password;
```

3. Grant the user permissions. This example sets the permission for the AZACSNAP user to enable putting the database into backup mode.

```
GRANT CREATE SESSION TO azacsnap;  
GRANT SYSBACKUP TO azacsnap;
```

4. Change the default user's password expiration to unlimited.

```
ALTER PROFILE default LIMIT PASSWORD_LIFE_TIME unlimited;
```

5. Validate azacsnap connectivity for the database.

```
connect azacsnap/password  
quit;
```

2. Configure Linux-user azacsnap for DB access with Oracle wallet

The AzAcSnap default installation creates an azacsnap OS user. It's Bash shell environment must be configured for Oracle database access with the password stored in an Oracle wallet.

1. As root user, run the `cat /etc/oratab` command to identify the ORACLE_HOME and ORACLE_SID variables on the host.

```
cat /etc/oratab
```

2. Add ORACLE_HOME, ORACLE_SID, TNS_ADMIN, and PATH variables to the azacsnap user bash profile. Change the variables as needed.

```
echo "export ORACLE_SID=ORATEST" >> /home/azacsnap/.bash_profile  
echo "export ORACLE_HOME=/u01/app/oracle/product/19800/ORATST" >>  
/home/azacsnap/.bash_profile  
echo "export TNS_ADMIN=/home/azacsnap" >> /home/azacsnap/.bash_profile  
echo "export PATH=\$PATH:\$ORACLE_HOME/bin" >>  
/home/azacsnap/.bash_profile
```

3. As the Linux user azacsnap, create the wallet. You are prompted for the wallet password.

```
sudo su - azacsnap  
  
mkstore -wrl $TNS_ADMIN/.oracle_wallet/ -create
```

4. Add the connect string credentials to the Oracle Wallet. In the following example command, AZACSNAP is the ConnectString to be used by AzAcSnap, azacsnap is the Oracle Database User, and AzPasswd1 is the Oracle User's database password. You are again prompted for the wallet password.

```
mkstore -wrl $TNS_ADMIN/.oracle_wallet/ -createCredential AZACSNAP  
azacsnap AzPasswd1
```

5. Create the `tnsnames.ora` file. In the following example command, HOST should be set to the IP address of the Oracle Database and the Server SID should be set to the Oracle Database SID.

```
echo "# Connection string  
AZACSNAP=(DESCRIPTION=(ADDRESS=(PROTOCOL=TCP) (HOST=172.30.137.142) (POR  
T=1521)) (CONNECT_DATA=(SID=ORATST)))\"  
" > $TNS_ADMIN/tnsnames.ora
```

6. Create the `sqlnet.ora` file.

```
echo "SQLNET.WALLET_OVERRIDE = TRUE  
WALLET_LOCATION= (  
    SOURCE=(METHOD=FILE)  
    (METHOD_DATA=(DIRECTORY=$TNS_ADMIN/.oracle_wallet))  
)" > $TNS_ADMIN/sqlnet.ora
```

7. Test Oracle access using the wallet.

```
sqlplus /@AZACSNAP as SYSBACKUP
```

The expected output from the command:

```
[azacsnap@acao-ora01 ~]$ sqlplus /@AZACSNAP as SYSBACKUP  
  
SQL*Plus: Release 19.0.0.0.0 - Production on Thu Sep 8 18:02:07 2022  
Version 19.8.0.0.0  
  
Copyright (c) 1982, 2019, Oracle. All rights reserved.  
  
Connected to:  
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production  
Version 19.8.0.0.0  
  
SQL>
```

Configure ANF connectivity

This section explains how to enable communication with Azure NetApp Files (with a VM).

1. Within an Azure Cloud Shell session, make sure that you are logged into the subscription that you want to be associated with the service principal by default.

```
az account show
```

2. If the subscription isn't correct, use the following command:

```
az account set -s <subscription name or id>
```

3. Create a service principal using the Azure CLI as in the following example:

```
az ad sp create-for-rbac --name "AzAcSnap" --role Contributor --scopes /subscriptions/{subscription-id} --sdk-auth
```

The expected output:

```
{
  "clientId": "00aa000a-aaaa-0000-00a0-00aa000aaa0a",
  "clientSecret": "00aa000a-aaaa-0000-00a0-00aa000aaa0a",
  "subscriptionId": "00aa000a-aaaa-0000-00a0-00aa000aaa0a",
  "tenantId": "00aa000a-aaaa-0000-00a0-00aa000aaa0a",
  "activeDirectoryEndpointUrl": "https://login.microsoftonline.com",
  "resourceManagerEndpointUrl": "https://management.azure.com/",
  "activeDirectoryGraphResourceId": "https://graph.windows.net/",
  "sqlManagementEndpointUrl": "https://management.core.windows.net:8443",
  "galleryEndpointUrl": "https://gallery.azure.com/",
  "managementEndpointUrl": "https://management.core.windows.net"
}
```

4. Cut and paste the output content into a file called `oracle.json` stored in the Linux user `azacsnap` user bin directory and secure the file with the appropriate system permissions.



Make sure the format of the JSON file is exactly as described above, especially with the URLs enclosed in double quotes (").

Complete the setup of AzAcSnap tool

Follow these steps to configure and test the snapshot tools. After successful testing, you can perform the first database-consistent storage snapshot.

1. Change into the snapshot user account.

```
su - azacsnap
```

2. Change the location of commands.

```
cd /home/azacsnap/bin/
```

3. Configure a storage backup detail file. This creates an `azacsnap.json` configuration file.

```
azacsnap -c configure --configuration new
```

The expected output with three Oracle volumes:

```
[azacsnap@acao-ora01 bin]$ azacsnap -c configure --configuration new
Building new config file
Add comment to config file (blank entry to exit adding comments): Oracle
snapshot bkup
Add comment to config file (blank entry to exit adding comments):
Enter the database type to add, 'hana', 'oracle', or 'exit' (for no
database): oracle

==== Add Oracle Database details ====
Oracle Database SID (e.g. CDB1): ORATST
Database Server's Address (hostname or IP address): 172.30.137.142
Oracle connect string (e.g. /@AZACSNAP): /@AZACSNAP

==== Azure NetApp Files Storage details ====
Are you using Azure NetApp Files for the database? (y/n) [n]: y
--- DATA Volumes have the Application put into a consistent state before
they are snapshot ---
Add Azure NetApp Files resource to DATA Volume section of Database
configuration? (y/n) [n]: y
Full Azure NetApp Files Storage Volume Resource ID (e.g.
/subscriptions/.../resourceGroups/.../providers/Microsoft.NetApp/netAppA
ccounts/.../capacityPools/Premium/volumes/...): /subscriptions/0efa2dfb-
917c-4497-b56a-
b3f4eadb8111/resourceGroups/ANFAVSRG/providers/Microsoft.NetApp/netAppAc
counts/ANFAVSAcct/capacityPools/CapPool/volumes/acao-ora01-u01
Service Principal Authentication filename or Azure Key Vault Resource ID
(e.g. auth-file.json or https://...): oracle.json
Add Azure NetApp Files resource to DATA Volume section of Database
configuration? (y/n) [n]: y
Full Azure NetApp Files Storage Volume Resource ID (e.g.
/subscriptions/.../resourceGroups/.../providers/Microsoft.NetApp/netAppA
```

```

ccounts/.../capacityPools/Premium/volumes/...): /subscriptions/0efa2dfb-
917c-4497-b56a-
b3f4eadb8111/resourceGroups/ANFAVSRG/providers/Microsoft.NetApp/netAppAc-
counts/ANFAVSACct/capacityPools/CapPool/volumes/acao-ora01-u02
Service Principal Authentication filename or Azure Key Vault Resource ID
(e.g. auth-file.json or https://...): oracle.json
Add Azure NetApp Files resource to DATA Volume section of Database
configuration? (y/n) [n]: n
--- OTHER Volumes are snapshot immediately without preparing any
application for snapshot ---
Add Azure NetApp Files resource to OTHER Volume section of Database
configuration? (y/n) [n]: y
Full Azure NetApp Files Storage Volume Resource ID (e.g.
/subscriptions/.../resourceGroups/.../providers/Microsoft.NetApp/netAppA-
ccounts/.../capacityPools/Premium/volumes/...): /subscriptions/0efa2dfb-
917c-4497-b56a-
b3f4eadb8111/resourceGroups/ANFAVSRG/providers/Microsoft.NetApp/netAppAc-
counts/ANFAVSACct/capacityPools/CapPool/volumes/acao-ora01-u03
Service Principal Authentication filename or Azure Key Vault Resource ID
(e.g. auth-file.json or https://...): oracle.json
Add Azure NetApp Files resource to OTHER Volume section of Database
configuration? (y/n) [n]: n

==== Azure Managed Disk details ====
Are you using Azure Managed Disks for the database? (y/n) [n]: n

==== Azure Large Instance (Bare Metal) Storage details ====
Are you using Azure Large Instance (Bare Metal) for the database? (y/n)
[n]: n

Enter the database type to add, 'hana', 'oracle', or 'exit' (for no
database): exit

Editing configuration complete, writing output to 'azacsnap.json'.

```

- As the azacsnap Linux user, run the azacsnap test command for an Oracle backup.

```

cd ~/bin
azacsnap -c test --test oracle --configfile azacsnap.json

```

The expected output:

```
[azacsnap@acao-ora01 bin]$ azacsnap -c test --test oracle --configfile azacsnap.json
BEGIN : Test process started for 'oracle'
BEGIN : Oracle DB tests
PASSED: Successful connectivity to Oracle DB version 1908000000
END   : Test process complete for 'oracle'
[azacsnap@acao-ora01 bin]$
```

5. Run your first snapshot backup.

```
azacsnap -c backup --volume data --prefix ora_test --retention=1
```

[Next: Database protection.](#)

[Protect your Oracle database in Azure cloud](#)

[Previous: Deployment procedures.](#)

Author(s): Allen Cao, NetApp Solutions Engineering

[Backup Oracle database with snapshot using AzAcSnap tool](#)

The Azure Application-Consistent Snapshot tool (AzAcSnap) is a command-line tool that enables data protection for third-party databases by handling all the orchestration required to put them into an application-consistent state before taking a storage snapshot, after which it returns the databases to an operational state.

In the case of Oracle, you put the database in backup mode to take a snapshot and then take the database out of backup mode.

Backup data and log volumes

The backup can be set up on the database server host with simple shell script that executes the snapshot command. Then, the script can be scheduled to run from crontab.

Generally, the frequency of backup depends on the desired RTO and RPO. Frequent snapshot creation consumes more storage space. There is a trade off between the frequency of backup and space consumption.

Data volumes typically consume more storage space than log volumes. Therefore, you can take snapshots on data volumes every few hours and more frequent snapshots on log volumes every 15 to 30 minutes.

See the following examples of backup scripts and scheduling.

For data volume snapshots:

```
# /bin/sh
cd /home/azacsnap/bin
. ~/.bash_profile
azacsnap -c backup --volume data --prefix acao-ora01-data --retention 36
azacsnap -c backup --volume other --prefix acao-ora01-log --retention 250
```

For log volume snapshots:

```
# /bin/sh
cd /home/azacsnap/bin
. ~/.bash_profile
azacsnap -c backup --volume other --prefix acao-ora01-log --retention 250
```

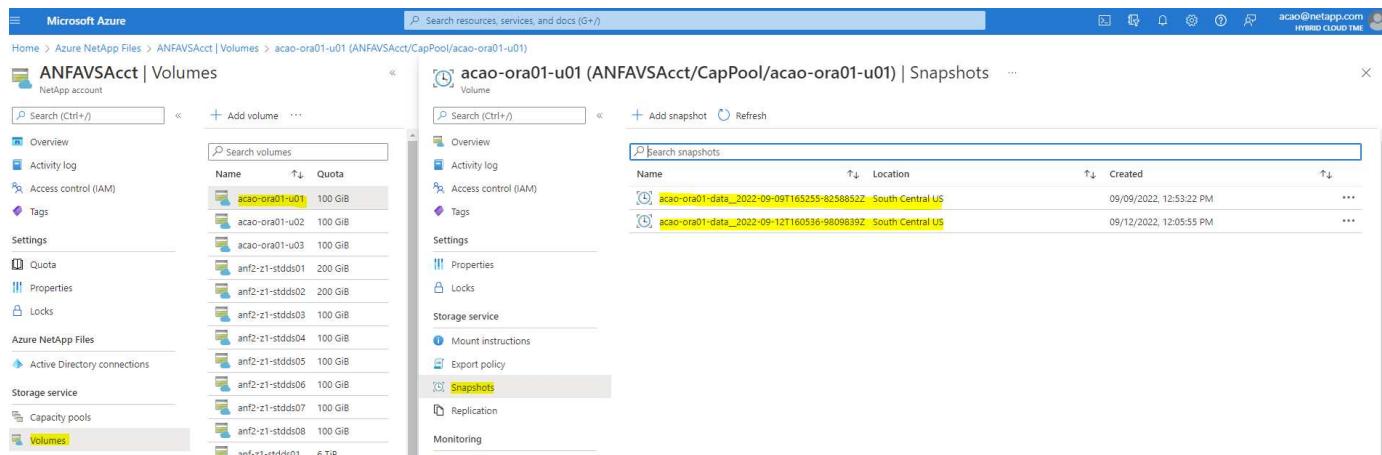
Crontab schedule:

```
15,30,45 * * * * /home/azacsnap/snap_log.sh
0 */2 * * * /home/azacsnap/snap_data.sh
```

 When setting up the backup `azacsnap.json` configuration file, add all data volumes, including the binary volume, to `dataVolume` and all log volumes to `otherVolume`. The maximum retention of snapshots is 250 copies.

Validate the snapshots

Go to the Azure portal > Azure NetApp Files/volumes to check if the snapshots have been successfully created.



Name	Location	Created
acao-ora01-data_2022-09-09T165255-82588522	South Central US	09/09/2022, 12:53:22 PM
acao-ora01-data_2022-09-12T160536-98098392	South Central US	09/12/2022, 12:05:55 PM

The screenshot shows the Microsoft Azure portal interface. On the left, the 'NetApp account' sidebar lists various sections: Overview, Activity log, Access control (IAM), Tags, Settings, Quota, Properties, Locks, Azure NetApp Files, Active Directory connections, Storage service, Capacity pools, and Volumes. The 'Volumes' section is currently selected. The main area displays the 'acao-ora01-u03' volume details, including its name, size (100 GiB), and properties like 'Volume Type' (Standard). Below this, a list of snapshots is shown, each with a preview icon, name, location, and creation date. The 'Schemas' section is also visible.

Name	Location	Created
acao-ora01-data_2022-09-12T160628-87547982	South Central US	09/12/2022, 12:06:31 PM
acao-ora01-log_2022-09-12T164501-79659252	South Central US	09/12/2022, 12:45:04 PM
acao-ora01-log_2022-09-12T171501-80326612	South Central US	09/12/2022, 01:15:04 PM
acao-ora01-log_2022-09-12T173001-47879192	South Central US	09/12/2022, 01:30:04 PM
acao-ora01-log_2022-09-12T174501-50106142	South Central US	09/12/2022, 01:45:04 PM
acao-ora01-log_2022-09-12T180053-50298742	South Central US	09/12/2022, 02:00:55 PM
acao-ora01-log_2022-09-12T181502-38570272	South Central US	09/12/2022, 02:15:05 PM
acao-ora01-log_2022-09-12T183002-44078952	South Central US	09/12/2022, 02:30:07 PM

Oracle restore and recovery from local backup

One of key benefits of snapshot backup is that it coexists with source database volumes, and the primary database volumes can be rolled back almost instantly.

Restore and recovery of Oracle on the primary server

The following example demonstrates how to restore and recover an Oracle database from the Azure dashboard and CLI on the same Oracle host.

1. Create a test table in the database to be restored.

```
[oracle@acao-ora01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Mon Sep 12 19:02:35 2022
Version 19.8.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0

SQL> create table testsnapshot(
  id integer,
  event varchar(100),
  dt timestamp);

Table created.

SQL> insert into testsnapshot values(1,'insert a data marker to validate
snapshot restore',sysdate);

1 row created.

SQL> commit;

Commit complete.

SQL> select * from testsnapshot;

ID
-----
EVENT
-----
DT
-----
---
   1
insert a data marker to validate snapshot restore
12-SEP-22 07.07.35.000000 PM
```

2. Drop the table after the snapshot backups.

```
[oracle@acao-ora01 ~]$ sqlplus / as sysdba
```

```
SQL*Plus: Release 19.0.0.0.0 - Production on Tue Sep 13 14:20:22 2022
Version 19.8.0.0.0
```

```
Copyright (c) 1982, 2019, Oracle. All rights reserved.
```

Connected to:

```
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0
```

```
SQL> drop table testsnapshot;
```

```
Table dropped.
```

```
SQL> select * from testsnapshot;
```

```
select * from testsnapshot
*
```

```
ERROR at line 1:
```

```
ORA-00942: table or view does not exist
```

```
SQL> shutdown immediate;
```

```
Database closed.
```

```
Database dismounted.
```

```
ORACLE instance shut down.
```

```
SQL> exit
```

```
Disconnected from Oracle Database 19c Enterprise Edition Release
19.0.0.0.0 - Production
```

```
Version 19.8.0.0.0
```

- From the Azure NetApp Files dashboard, restore the log volume to the last available snapshot. Choose **Revert volume**.

The screenshot shows the Microsoft Azure Azure NetApp Files dashboard. On the left, there's a sidebar with options like Overview, Activity log, Access control (IAM), Tags, Settings, Quota, Properties, Locks, Active Directory connections, Capacity pools, Application volume groups, and Data protection. The main area shows the 'ANFAVSAcc1 | Volumes' section, which lists volumes such as 'acao-ora01-u01' (100 GiB), 'acao-ora01-u02' (100 GiB), 'acao-ora01-u03' (100 GiB), 'anf2-z1-std001' (200 GiB), 'anf2-z1-std002' (200 GiB), 'anf2-z1-std003' (100 GiB), 'anf2-z1-std004' (100 GiB), 'anf2-z1-std005' (100 GiB), 'anf2-z1-std007' (100 GiB), 'anf2-z1-std008' (100 GiB), 'anf2-z1-std001' (6 TiB), 'anf2-z1-std002' (200 GiB), and 'anf2-z1-std003' (1 TiB). To the right, there's a 'Solutions' section with a 'Revert volume' button highlighted with a yellow box. The 'Revert volume' button has a tooltip that says 'Revert to new volume'.

4. Confirm revert volume and click **Revert** to complete the volume reversion to the latest available backup.

Revert volume to snapshot

Revert volume acao-ora01-u03 to snapshot acao-ora01-log_2022-09-13T134502-04499192

acao-ora01-u03 (ANFAVSAcc/CapPool/acao-ora01-u03) | Snapshots

Name	Location
acao-ora01-data_2022-09-12T160628-87547982	South Central US
acao-ora01-log_2022-09-13T120122-61736452	South Central US
acao-ora01-log_2022-09-13T123001-80005482	South Central US
acao-ora01-log_2022-09-13T124501-74729672	South Central US
acao-ora01-log_2022-09-13T131501-62704482	South Central US
acao-ora01-log_2022-09-13T133001-77736192	South Central US
acao-ora01-log_2022-09-13T134502-04499192	South Central US

acao-ora01-u03 (ANFAVSAcc/CapPool/acao-ora01-u03) | Volumes

Name	Quota
acao-ora01-u01	100 GiB
acao-ora01-u02	100 GiB
acao-ora01-u03	100 GiB
anf2-z1-std5d01	200 GiB
anf2-z1-std5d02	200 GiB
anf2-z1-std5d03	100 GiB
anf2-z1-std5d04	100 GiB
anf2-z1-std5d05	100 GiB
anf2-z1-std5d06	100 GiB
anf2-z1-std5d07	100 GiB
anf2-z1-std5d08	100 GiB
anf2-z1-std5d01	6 TiB
anf2-z1-std5d02	200 GiB
anf2-z1-std5d03	1 TiB
anf2-z1-std5d04	200 GiB
anf2-z1-std5d06	200 GiB
anf2-z1-std5d07	200 GiB
anf2-z1-std5d08	200 GiB
anf2-z1-std5d05	1 TiB
vol1	1 TiB
vol3basic	100 GiB

Revert **Cancel**

5. Repeat the same steps for the data volume, and make sure that the backup contains the table to be recovered.

Revert volume to snapshot

Revert volume acao-ora01-u02 to snapshot acao-ora01-data_2022-09-13T134502-04499192

acao-ora01-u02 (ANFAVSAcc/CapPool/acao-ora01-u02) | Snapshots

Name	Location	Created
acao-ora01-data_2022-09-13T020001-95033842	South Central US	09/12/2022, 10:00:19 PM
acao-ora01-data_2022-09-13T040001-93413402	South Central US	09/13/2022, 12:00:18 AM
acao-ora01-data_2022-09-13T060002-12409142	South Central US	09/13/2022, 02:00:19 AM
acao-ora01-data_2022-09-13T080001-83834982	South Central US	09/13/2022, 04:00:18 AM
acao-ora01-data_2022-09-13T100002-43474562	South Central US	09/13/2022, 06:00:18 AM
acao-ora01-data_2022-09-13T120002-34062902	South Central US	09/13/2022, 08:00:18 AM
acao-ora01-data_2022-09-13T140001-85298172	South Central US	09/13/2022, 10:00:17 AM

acao-ora01-u02 (ANFAVSAcc/CapPool/acao-ora01-u02) | Volumes

Name	Quota
acao-ora01-u01	100 GiB
acao-ora01-u02	100 GiB
acao-ora01-u03	100 GiB
anf2-z1-std5d01	200 GiB
anf2-z1-std5d02	200 GiB
anf2-z1-std5d03	100 GiB
anf2-z1-std5d04	100 GiB
anf2-z1-std5d05	100 GiB
anf2-z1-std5d06	100 GiB
anf2-z1-std5d07	100 GiB
anf2-z1-std5d08	100 GiB
anf2-z1-std5d01	6 TiB
anf2-z1-std5d02	200 GiB

6. Again confirm the volume reversion, and click "Revert."

7. Resync the control files if you have multiple copies of them, and replace the old control file with the latest copy available.

```
[oracle@acao-ora01 ~]$ mv /u02/oradata/ORATST/control01.ctl
/u02/oradata/ORATST/control01.ctl.bk
[oracle@acao-ora01 ~]$ cp /u03/orareco/ORATST/control02.ctl
/u02/oradata/ORATST/control01.ctl
```

8. Log into the Oracle server VM and run database recovery with sqlplus.

```
[oracle@acao-ora01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Tue Sep 13 15:10:17 2022
Version 19.8.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Connected to an idle instance.

SQL> startup mount;
ORACLE instance started.

Total System Global Area 6442448984 bytes
Fixed Size                  8910936 bytes
Variable Size                1090519040 bytes
Database Buffers              5335154688 bytes
Redo Buffers                  7864320 bytes
Database mounted.
```

```
SQL> recover database using backup controlfile until cancel;
ORA-00279: change 3188523 generated at 09/13/2022 10:00:09 needed for
thread 1
ORA-00289: suggestion :
/u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_43__22rnjq9q_.arc
ORA-00280: change 3188523 for thread 1 is in sequence #43

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}

ORA-00279: change 3188862 generated at 09/13/2022 10:01:20 needed for
thread 1
ORA-00289: suggestion :
/u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_44__29f21gb5_.arc
ORA-00280: change 3188862 for thread 1 is in sequence #44
ORA-00278: log file
'./u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_43__22rnjq9q_.arc' no
longer
needed for this recovery

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}

ORA-00279: change 3193117 generated at 09/13/2022 12:00:08 needed for
thread 1
ORA-00289: suggestion :
./u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_45__29h6qqyw_.arc
ORA-00280: change 3193117 for thread 1 is in sequence #45
ORA-00278: log file
'./u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_44__29f21gb5_.arc' no
longer
needed for this recovery

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}

ORA-00279: change 3193440 generated at 09/13/2022 12:01:20 needed for
thread 1
ORA-00289: suggestion :
./u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_46_%u_.arc
ORA-00280: change 3193440 for thread 1 is in sequence #46
ORA-00278: log file
'./u03/orareco/ORATST/archivelog/2022_09_13/o1_mf_1_45__29h6qqyw_.arc' no
longer
needed for this recovery

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
cancel
Media recovery cancelled.
```

```
SQL> alter database open resetlogs;

Database altered.

SQL> select * from testsnapshot;

ID
-----
EVENT
-----
DT
-----
---
1
insert a data marker to validate snapshot restore
12-SEP-22 07.07.35.000000 PM

SQL> select systimestamp from dual;

SYSTIMESTAMP
-----
13-SEP-22 03.28.52.646977 PM +00:00
```

This screen demonstrates that the dropped table has been recovered using local snapshot backups.

[Next: Database migration.](#)

Database migration from on-premises to Azure cloud

[Previous: Database protection.](#)

As a result of the Oracle decision to phase out single-instance databases, many organizations have converted single-instance Oracle databases to multitenant container databases. This enables the easy relocation of a subset of container databases called PDB to cloud with the maximum availability option, which minimize downtime during migration.

However, if you still have a single instance of a Oracle database, it can first be converted into a multitenant container database in place before attempting PDB relocation.

The following sections provide details for the migration of on-premises Oracle databases to Azure cloud in either scenarios.

Converting a single instance non-CDB to a PDB in a multitenant CDB

If you still have a single-instance Oracle database, it must be converted into a multitenant container database

whether you wish to migrate it to the cloud or not, because Oracle will stop supporting single-instance databases some time soon.

The following procedures plug a single instance database into a container database as a pluggable database or PDB.

1. Build a shell container database on the same host as the single-instance database in a separate ORACLE_HOME.
2. Shut down the single instance database and restart it in read-only mode.
3. Run the DBMS_PDB.DESCRIBE procedure to generate the database metadata.

```
BEGIN
    DBMS_PDB.DESCRIBE(
        pdb_descr_file => '/home/oracle/ncdb.xml');
END;
/
```

4. Shut down the single-instance database.
5. Start up the container database.
6. Run the DBMS_PDB.CHECK_PLUG_COMPATIBILITY function to determine whether the non-CDB is compatible with the CDB.

```
SET SERVEROUTPUT ON
DECLARE
    compatible CONSTANT VARCHAR2(3) :=
        CASE DBMS_PDB.CHECK_PLUG_COMPATIBILITY(
            pdb_descr_file => '/disk1/oracle/ncdb.xml',
            pdb_name       => 'NCDB')
        WHEN TRUE THEN 'YES'
        ELSE 'NO'
    END;
BEGIN
    DBMS_OUTPUT.PUT_LINE(compatible);
END;
/
```

If the output is YES, then the non-CDB is compatible, and you can continue with the next step.

If the output is NO, then the non-CDB is not compatible, and you can check the PDB_PLUG_IN_VIOLATIONS view to see why it is not compatible. All violations must be corrected before you continue. For example, any version or patch mismatches should be resolved by running an upgrade or the opatch utility. After correcting the violations, run DBMS_PDB.CHECK_PLUG_COMPATIBILITY again to ensure that the non-CDB is compatible with the CDB.

7. Plug in the single instance non-CDB.

```
CREATE PLUGGABLE DATABASE ncdb USING '/home/oracle/ncdb.xml'
COPY
FILE_NAME_CONVERT = ('/disk1/oracle/dbs/', '/disk2/oracle/ncdb/')
;
```



If there is not sufficient space on the host, the NOCOPY option can be used to create the PDB. In that case, a single-instance non-CDB is not useable after plug in as a PDB because the original data files has been used for the PDB. Make sure to create a backup before the conversion so that there is something to fall back on if anything goes wrong.

8. Start with PDB upgrade after conversion if the version between the source single-instance non-CDB and the target CDB are different. For the same-version conversion, this step can be skipped.

```
sqlplus / as sysdba;
alter session set container=ncdb
alter pluggable database open upgrade;
exit;
dbupgrade -c ncdb -l /home/oracle
```

Review the upgrade log file in the /home/oracle directory.

9. Open the pluggable database, check for pdb plug-in violations, and recompile the invalid objects.

```
alter pluggable database ncdb open;
alter session set container=ncdb;
select message from pdb_plug_inViolations where type like '%ERR%' and
status <> 'RESOLVED';
$ORACLE_HOME/perl/bin/perl $ORACLE_HOME/rdbms/admin/catcon.pl -n 1 -c
'ncdb' -e -b utlrp -d $ORACLE_HOME/rdbms/admin utlrp.sql
```

10. Execute `noncdb_to_pdb.sql` to update the data dictionary.

```
sqlplus / as sysdba
alter session set container=ncdb;
@$ORACLE_HOME/rdbms/admin/noncdb_to_pdb.sql;
```

Shut down and restart the container DB. The ncdb is taken out of restricted mode.

Migrate on-premises Oracle databases to Azure with PDB relocation

Oracle PDB relocation with the maximum-availability option uses PDB hot-clone technology, which enables source PDB availability while the PDB is being copied over to the target. Upon switchover, sessions and connections are redirected to the target PDB automatically. Thus, down time is minimized independent of the size of the PDB being relocated. NetApp provides an Ansible-based toolkit that automates the migration

procedure.

1. Create a CDB in the Azure public cloud on an Azure VM with the same version and patch level.
2. From the Ansible controller, clone a copy of the automation toolkit.

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

3. Read the instruction in the README file.
4. Configure the Ansible host variable files for both the source and target Oracle servers and the DB server host's configuration file for name resolution.
5. Install the Ansible controller prerequisites on Ansible controller.

```
ansible-playbook -i hosts requirements.yml  
ansible-galaxy collection install -r collections/requirements.yml  
--force
```

6. Execute any pre-migration tasks against the on-premises server.

```
ansible-playbook -i hosts ora_pdb_relocate.yml -u admin -k -K -t  
ora_pdb_relo_onprem
```



The admin user is the management user on the on-premises Oracle server host with sudo privileges. The admin user is authenticated with a password.

7. Execute Oracle PDB relocation from on-premises to the target Azure Oracle host.

```
ansible-playbook -i hosts ora_pdb_relocate.yml -u azureuser --private  
-key db1.pem -t ora_pdb_relo_primary
```



The Ansible controller can be located either on-premises or in the Azure cloud. The controller needs connectivity to the on-premises Oracle server host and the Azure Oracle VM host. The Oracle database port (such as 1521) is open between the on-premises Oracle server host and the Azure Oracle VM host.

Additional Oracle database migration options

Please see the Microsoft documentation for additional migration options: [Oracle database migration decision process](#).

NVA-1155: Oracle 19c RAC databases on FlexPod Datacenter with Cisco UCS and NetApp AFF A800 over FC - Design and deployment guide

Allen Cao, NetApp

This design and deployment guide for Oracle 19c RAC databases on FlexPod Datacenter with Cisco UCS and NetApp AFF A800 over FC provides details of the solution design as well as step-by-step deployment processes for hosting Oracle RAC databases on most recent FlexPod Datacenter infrastructure with the Oracle Linux 8.2 operating system and a Red Hat compatible kernel.

[NVA-1155: Oracle 19c RAC databases on FlexPod Datacenter with Cisco UCS and NetApp AFF A800 over FC](#)

TR-4250: SAP with Oracle on UNIX and NFS with NetApp Clustered Data ONTAP and SnapManager for SAP 3.4

Nils Bauer, NetApp

TR-4250 addresses the challenges of designing storage solutions to support SAP business suite products using an Oracle database. The primary focus of this document is the common storage infrastructure design, deployment, operation, and management challenges faced by business and IT leaders who use the latest generation of SAP solutions. The recommendations in this document are generic; they are not specific to an SAP application or to the size and scope of the SAP implementation. TR-4250 assumes that the reader has a basic understanding of the technology and operation of NetApp and SAP products. TR-4250 was developed based on the interaction of technical staff from NetApp, SAP, Oracle, and our customers.

[TR-4250: SAP with Oracle on UNIX and NFS with NetApp Clustered Data ONTAP and SnapManager for SAP 3.4](#)

Deploying Oracle Database

TR-3633: Oracle databases on ONTAP

Jeffrey Steiner, NetApp

Consult the [Interoperability Matrix Tool \(IMT\)](#) to determine whether the environment, configurations, and versions specified in TR-3633 support your environment.

[TR-3633: Oracle databases on ONTAP](#)

Solution Overview

Automated Deployment of Oracle19c for ONTAP on NFS

Organizations are automating their environments to gain efficiencies, accelerate deployments, and reduce manual effort. Configuration management tools like Ansible are being used to streamline enterprise database operations. In this solution, we demonstrate how you can use Ansible to automate the provisioning and configuration of Oracle 19c with NetApp ONTAP. By enabling storage administrators, systems administrators, and DBAs to consistently and rapidly deploy new storage, configure database servers, and install Oracle 19c software, you achieve the following benefits:

- Eliminate design complexities and human errors, and implement a repeatable consistent deployment and best practices
- Decrease time for provisioning of storage, configuration of DB hosts, and Oracle installation
- Increase database administrators, systems and storage administrators productivity
- Enable scaling of storage and databases with ease

NetApp provides customers with validated Ansible modules and roles to accelerate deployment, configuration, and lifecycle management of your Oracle database environment. This solution provides instruction and Ansible

playbook code, to help you:

- Create and configure ONTAP NFS storage for Oracle Database
- Install Oracle 19c on RedHat Enterprise Linux 7/8 or Oracle Linux 7/8
- Configure Oracle 19c on ONTAP NFS storage

For more details or to begin, please see the overview videos below.

AWX/Tower Deployments

- Part 1: Getting Started, Requirements, Automation Details and Initial AWX/Tower Configuration
 - ▶ https://docs.netapp.com/us-en/netapp-solutions/media/oracle_deployment_auto_v1.mp4 (video)
- Part 2: Variables and Running the Playbook
 - ▶ https://docs.netapp.com/us-en/netapp-solutions/media/oracle_deployment_auto_v2.mp4 (video)

CLI Deployment

- Part 1: Getting Started, Requirements, Automation Details and Ansible Control Host Setup
 - ▶ https://docs.netapp.com/us-en/netapp-solutions/media/oracle_deployment_auto_v4.mp4 (video)
- Part 2: Variables and Running the Playbook
 - ▶ <https://docs.netapp.com/us-en/netapp-solutions/media/oracle3.mp4> (video)

Getting started

This solution has been designed to be run in an AWX/Tower environment or by CLI on an Ansible control host.

AWX/Tower

For AWX/Tower environments, you are guided through creating an inventory of your ONTAP cluster management and Oracle server (IPs and hostnames), creating credentials, configuring a project that pulls the Ansible code from NetApp Automation Github, and the Job Template that launches the automation.

1. Fill out the variables specific to your environment, and copy and paste them into the Extra Vars fields in your job template.
2. After the extra vars have been added to your job template, you can launch the automation.
3. The job template is run in three phases by specifying tags for ontap_config, linux_config, and oracle_config.

CLI via the Ansible control host

1. To configure the Linux host so that it can be used as an Ansible control host
[click here for detailed instructions](#)
2. After the Ansible control host is configured, you can git clone the Ansible Automation repository.
3. Edit the hosts file with the IPs and/or hostnames of your ONTAP cluster management and Oracle server's management IPs.

4. Fill out the variables specific to your environment, and copy and paste them into the `vars.yml` file.
5. Each Oracle host has a variable file identified by its hostname that contains host-specific variables.
6. After all variable files have been completed, you can run the playbook in three phases by specifying tags for `ontap_config`, `linux_config`, and `oracle_config`.

Requirements

Environment	Requirements
Ansible environment	AWX/Tower or Linux host to be the Ansible control host Ansible v.2.10 and higher Python 3 Python libraries - netapp-lib - xmltodict - jmespath
ONTAP	ONTAP version 9.3 - 9.7 Two data aggregates NFS vlan and ifgrp created
Oracle server(s)	RHEL 7/8 Oracle Linux 7/8 Network interfaces for NFS, public, and optional mgmt Oracle installation files on Oracle servers

Automation Details

This automated deployment is designed with a single Ansible playbook that consists of three separate roles. The roles are for ONTAP, Linux, and Oracle configurations. The following table describes which tasks are being automated.

Role	Tasks
<code>ontap_config</code>	Pre-check of the ONTAP environment Creation of NFS based SVM for Oracle Creation of export policy Creation of volumes for Oracle Creation of NFS LIFs

Role	Tasks
linux_config	Create mount points and mount NFS volumes Verify NFS mounts OS specific configuration Create Oracle directories Configure hugepages Disable SELinux and firewall daemon Enable and start chronyd service increase file descriptor hard limit Create pam.d session file
oracle_config	Oracle software installation Create Oracle listener Create Oracle databases Oracle environment configuration Save PDB state Enable instance archive mode Enable DNFS client Enable database auto startup and shutdown between OS reboots

Default parameters

To simplify automation, we have preset many required Oracle deployment parameters with default values. It is generally not necessary to change the default parameters for most deployments. A more advanced user can make changes to the default parameters with caution. The default parameters are located in each role folder under defaults directory.

Deployment instructions

Before starting, download the following Oracle installation and patch files and place them in the /tmp/archive directory with read, write, and execute access for all users on each DB server to be deployed. The automation tasks look for the named installation files in that particular directory for Oracle installation and configuration.

```
LINUX.X64_193000_db_home.zip -- 19.3 base installer
p31281355_190000_Linux-x86-64.zip -- 19.8 RU patch
p6880880_190000_Linux-x86-64.zip -- opatch version 12.2.0.1.23
```

License

You should read license information as stated in the Github repository. By accessing, downloading, installing, or using the content in this repository, you agree the terms of the license laid out [here](#).

Note that there are certain restrictions around producing and/or sharing any derivative works with the content in this repository. Please make sure you read the terms of the [License](#) before using the content. If you do not agree to all of the terms, do not access, download, or use the content in this repository.

After you are ready, click [here for detailed AWX/Tower deployment procedures](#) or [here for CLI deployment](#).

Step-by-step deployment procedure

AWX/Tower deployment Oracle 19c Database

1. Create the inventory, group, hosts, and credentials for your environment

This section describes the setup of inventory, groups, hosts, and access credentials in AWX/Ansible Tower that prepare the environment for consuming NetApp automated solutions.

1. Configure the inventory.
 - a. Navigate to Resources → Inventories → Add, and click Add Inventory.
 - b. Provide the name and organization details, and click Save.
 - c. On the Inventories page, click the inventory created.
 - d. If there are any inventory variables, paste them in the variables field.
 - e. Navigate to the Groups sub-menu and click Add.
 - f. Provide the name of the group for ONTAP, paste the group variables (if any) and click Save.
 - g. Repeat the process for another group for Oracle.
 - h. Select the ONTAP group created, go to the Hosts sub-menu and click Add New Host.
 - i. Provide the IP address of the ONTAP cluster management IP, paste the host variables (if any), and click Save.
 - j. This process must be repeated for the Oracle group and Oracle host(s) management IP/hostname.
2. Create credential types. For solutions involving ONTAP, you must configure the credential type to match username and password entries.
 - a. Navigate to Administration → Credential Types, and click Add.
 - b. Provide the name and description.
 - c. Paste the following content in Input Configuration:

```

fields:
  - id: username
    type: string
    label: Username
  - id: password
    type: string
    label: Password
    secret: true
  - id: vsadmin_password
    type: string
    label: vsadmin_password
    secret: true

```

- d. Paste the following content into Injector Configuration:

```

extra_vars:
  password: '{{ password }}'
  username: '{{ username }}'
  vsadmin_password: '{{ vsadmin_password }}'

```

3. Configure the credentials.

- a. Navigate to Resources → Credentials, and click Add.
- b. Enter the name and organization details for ONTAP.
- c. Select the custom Credential Type you created for ONTAP.
- d. Under Type Details, enter the username, password, and vsadmin_password.
- e. Click Back to Credential and click Add.
- f. Enter the name and organization details for Oracle.
- g. Select the Machine credential type.
- h. Under Type Details, enter the Username and Password for the Oracle hosts.
- i. Select the correct Privilege Escalation Method, and enter the username and password.

2. Create a project

1. Go to Resources → Projects, and click Add.
 - a. Enter the name and organization details.
 - b. Select Git in the Source Control Credential Type field.
 - c. enter https://github.com/NetApp-Automation/na_oracle19c_deploy.git as the source control URL.
 - d. Click Save.
 - e. The project might need to sync occasionally when the source code changes.

3. Configure Oracle host_vars

The variables defined in this section are applied to each individual Oracle server and database.

1. Input your environment-specific parameters in the following embedded Oracle hosts variables or host_vars form.



The items in blue must be changed to match your environment.

Host VARS Config

```
<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}
button {
transition-duration: 0.4s;
background-color: white;
color: #1563a3;
border: 2px solid #1563a3;
}
button:hover {
background-color: #1563a3;
color: white;
}
#more_datastores_nfs {
display: block;
}
#more_datastores_nfs_button {
display: none;
}
</style>
<div class="listingblock"><div class="content"><div><button id="copy-
button1" onclick="CopyClassText1()">Copy</button></div><pre><code><div
class="CopyMeClass1" id="CopyMeID1">
#####
#####          Host Variables Configuration          #####
#####
# Add your Oracle Host
ansible_host: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
```

```

decoration:underline;"/><i>10.61.180.15</i></span>

# Oracle db log archive mode: true - ARCHIVELOG or false - NOARCHIVELOG
log_archive_mode: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>true</i></span>

# Number of pluggable databases per container instance identified by sid.
Pdb_name specifies the prefix for container database naming in this case
cdb2_pdb1, cdb2_pdb2, cdb2_pdb3
oracle_sid: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>cdb2</i></span>
pdb_num: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>3</i></span>
pdb_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>"{{ oracle_sid }}_pdb"</i></span>

# CDB listener port, use different listener port for additional CDB on same host
listener_port: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>1523</i></span>

# CDB is created with SGA at 75% of memory_limit, MB. Consider how many databases to be hosted on the node and how much ram to be allocated to each DB. The grand total SGA should not exceed 75% available RAM on node.
memory_limit: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>5464</i></span>

# Set "em_configuration: DBEXPRESS" to install enterprise manager express and choose a unique port from 5500 to 5599 for each sid on the host.
# Leave them black if em express is not installed.
em_configuration: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>DBEXPRESS</i></span>
em_express_port: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>5501</i></span>

# "{{groups.oracle[0]}}" represents first Oracle DB server as defined in Oracle hosts group [oracle]. For concurrent multiple Oracle DB servers deployment, [0] will be incremented for each additional DB server. For

```

example, "`">{{groups.oracle[1]}}`" represents DB server 2, "`{{groups.oracle[2]}}`" represents DB server 3 ... As a good practice and the default, minimum three volumes is allocated to a DB server with corresponding /u01, /u02, /u03 mount points, which store oracle binary, oracle data, and oracle recovery files respectively. Additional volumes can be added by click on "More NFS volumes" but the number of volumes allocated to a DB server must match with what is defined in global vars file by `volumes_nfs` parameter, which dictates how many volumes are to be created for each DB server.

```

host_datastores_nfs:
  - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u01</i></span>", aggr_name: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>aggr01_node01</i></span>, lif: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span>, size: <span <div contenteditable='true'><i>25</i></span>}"
    - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u02</i></span>", aggr_name: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>aggr01_node01</i></span>, lif: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span>, size: <span <div contenteditable='true'><i>25</i></span>}"
      - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u03</i></span>", aggr_name: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>aggr01_node01</i></span>, lif: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span>, size: <span <div contenteditable='true'><i>25</i></span>}"
        <a id="more_datastores_nfs" href="javascript:datastoredropdown();">More NFS volumes</a><div id="select_more_datastores_nfs"></div><a id="more_datastores_nfs_button"
          href="javascript:adddatastorevolumes();">Enter NFS volumes' details</a><div id="extra_datastores_nfs"></div>
        </div></code></pre></div></div>
<script>
function CopyClassText1(){
  var textToCopy = document.getElementById("CopyMeID1");

```

```

var currentRange;
if(document.getSelection().rangeCount > 0)
{
    currentRange = document.getSelection().getRangeAt(0);
    window.getSelection().removeRange(currentRange);
}
else
{
    currentRange = false;
}
var CopyRange = document.createRange();
CopyRange.selectNode(textToCopy);
window.getSelection().addRange(CopyRange);
document.getElementById("more_datastores_nfs").style.display = "none";
var command = document.execCommand("copy");
if (command)
{
    document.getElementById("copy-button1").innerHTML = "Copied!";
    setTimeout(revert_copy, 3000);
}
window.getSelection().removeRange(CopyRange);
if(currentRange)
{
    window.getSelection().addRange(currentRange);
}
}

function revert_copy() {
    document.getElementById("copy-button1").innerHTML = "Copy";
    document.getElementById("more_datastores_nfs").style.display =
"block";
}

function datastoredropdown() {
    document.getElementById("more_datastores_nfs").style.display = "none";
    document.getElementById("more_datastores_nfs_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_datastores_nfs");
    while (x < 100) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_datastores_nfs">How many extra NFS volumes do
you wish to add?</a><select name="number_of_extra_datastores_nfs"

```

```

        id="number_of_extra_datastores_nfs">' + buildup + '</select>';
        wrapper.innerHTML = myHTML;
    }
    function adddatastorevolumes() {
        var y =
document.getElementById("number_of_extra_datastores_nfs").value;
        var j=0;
        var myHTML = '';
        var wrapper = document.getElementById("extra_datastores_nfs");
        while (j < y) {
            j++;
            myHTML += ' - {vol_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.oracle[0]}}_u01</i></span>,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node02</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.201</i></span>,
size: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>25</i></span>}<br>';
        }
        wrapper.innerHTML = myHTML;
        document.getElementById("select_more_datastores_nfs").style.display =
"none";
        document.getElementById("more_datastores_nfs_button").style.display =
"none";
    }

</script>

```

- Fill in all variables in the blue fields.
- After completing variables input, click the Copy button on the form to copy all variables to be transferred to AWX or Tower.
- Navigate back to AWX or Tower and go to Resources → Hosts, and select and open the Oracle server configuration page.
- Under the Details tab, click edit and paste the copied variables from step 1 to the Variables field under the YAML tab.
- Click Save.
- Repeat this process for any additional Oracle servers in the system.

4. Configure global variables

Variables defined in this section apply to all Oracle hosts, databases, and the ONTAP cluster.

1. Input your environment-specific parameters in following embedded global variables or vars form.



The items in blue must be changed to match your environment.

VARS

```
<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}
button {
transition-duration: 0.4s;
background-color: white;
color: #1563a3;
border: 2px solid #1563a3;
}
button:hover {
background-color: #1563a3;
color: white;
}
#more_storage_vlans {
display: block;
}
#more_storage_vlans_button {
display: none;
}
#more_nfs_volumes {
display: block;
}
#more_nfs_volumes_button {
display: none;
}
</style>
<div class="listingblock"><div class="content"><div><button id="copy-
button" onclick="CopyClassText()">Copy</button></div><pre><code><div
class="CopyMeClass" id="CopyMeID">
#####
##### Oracle 19c deployment global user configuration variables #####
##### Consolidate all variables from ontap, linux and oracle #####
#####
#####
```

```

#####
### Ontap env specific config variables #####
#####

#Inventory group name
#Default inventory group name - 'ontap'
#Change only if you are changing the group name either in inventory/hosts
file or in inventory groups in case of AWX/Tower
hosts_group: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>ontap</i></span>

#CA_signed_certificates (ONLY CHANGE to 'true' IF YOU ARE USING CA SIGNED
CERTIFICATES)
ca_signed_certs: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>false</i></span>

#Names of the Nodes in the ONTAP Cluster
nodes:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>AFF-
01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>AFF-
02</i></span>

#Storage VLANs
#Add additional rows for vlans as necessary
storage_vlans:
  - {vlan_id: ""<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>203</i></span>", name: ""<span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>infra_NFS</i></span>",
protocol: ""<span <div
contenteditable="true"/><i>NFS</i></span>",
More Storage VLANs</a><div id="select_more_storage_vlans"></div><a
id="more_storage_vlans_button" href="javascript:addstoragevlans();">Enter
Storage VLANs details</a><div id="extra_storage_vlans"></div>
#Details of the Data Aggregates that need to be created
#If Aggregate creation takes longer, subsequent tasks of creating volumes
may fail.

```

```

#There should be enough disks already zeroed in the cluster, otherwise
aggregate create will zero the disks and will take long time
data_aggregates:
  - {aggr_name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node01</i></span>}
  - {aggr_name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node02</i></span>}

#SVM name
svm_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>ora_svm</i></span>

# SVM Management LIF Details
svm_mgmt_details:
  - {address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>172.21.91.100</i></span>, netmask: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>255.255.255.0</i></span>,
home_port: <span <div contenteditable="true"/><i>e0M</i></span>}

# NFS storage parameters when data_protocol set to NFS. Volume named after
Oracle hosts name identified by mount point as follow for oracle DB server
1. Each mount point dedicates to a particular Oracle files: u01 - Oracle
binary, u02 - Oracle data, u03 - Oracle redo. Add additional volumes by
click on "More NFS volumes" and also add the volumes list to corresponding
host_vars as host_datastores_nfs variable. For multiple DB server
deployment, additional volumes sets needs to be added for additional DB
server. Input variable "{{groups.oracle[1]}}_u01",
"{{groups.oracle[1]}}_u02", and "{{groups.oracle[1]}}_u03" as vol_name for
second DB server. Place volumes for multiple DB servers alternatingly
between controllers for balanced IO performance, e.g. DB server 1 on
controller node1, DB server 2 on controller node2 etc. Make sure match lif
address with controller node.

volumes_nfs:
  - {vol_name: "<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.oracle[0]}}_u01</i></span>",
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node01</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-

```

```

style:italic; text-decoration:underline;"/><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true"/><i>25</i></span>
    - {vol_name: &quot<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.oracle[0]}}_u02</i></span>&quot,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node01</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true"/><i>25</i></span>
    - {vol_name: &quot<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.oracle[0]}}_u03</i></span>&quot,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node01</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true"/><i>25</i></span>
<a id="more_nfs_volumes" href="javascript:nfsvolumesdropdown();">More NFS
volumes</a><div id="select_more_nfs_volumes"></div><a
id="more_nfs_volumes_button" href="javascript:adnnfsvolumes();">Enter NFS
volumes' details</a><div id="extra_nfs_volumes"></div>

#NFS LIFs IP address and netmask
nfs_lifs_details:
    - address: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>172.21.94.200</i></span> #for node-1
        netmask: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>255.255.255.0</i></span>
    - address: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>172.21.94.201</i></span> #for node-2
        netmask: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>255.255.255.0</i></span>

#NFS client match
client_match: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>172.21.94.0/24</i></span>

#####

```

```

### Linux env specific config variables ###

#####
#NFS Mount points for Oracle DB volumes
mount_points:
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u02</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u03</i></span>

# Up to 75% of node memory size divided by 2mb. Consider how many databases to be hosted on the node and how much ram to be allocated to each DB.
# Leave it blank if hugepage is not configured on the host.
hugepages_nr: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>1234</i></span>

# RedHat subscription username and password
redhat_sub_username: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxx</i></span>
redhat_sub_password: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxx</i></span>

#####
## DB env specific install and config variables ##
#####

db_domain: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>your.domain.com</i></span>

# Set initial password for all required Oracle passwords. Change them after installation.
initial_pwd_all: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>netapp123</i></span>

</div></code></pre></div></div>

```

```

<script>
function CopyClassText() {
    var textToCopy = document.getElementById("CopyMeID");
    var currentRange;
    if(document.getSelection().rangeCount > 0)
    {
        currentRange = document.getSelection().getRangeAt(0);
        window.getSelection().removeRange(currentRange);
    }
    else
    {
        currentRange = false;
    }
    var CopyRange = document.createRange();
    CopyRange.selectNode(textToCopy);
    window.getSelection().addRange(CopyRange);
    document.getElementById("more_storage_vlans").style.display = "none";
    document.getElementById("more_nfs_volumes").style.display = "none";
    var command = document.execCommand("copy");
    if (command)
    {
        document.getElementById("copy-button").innerHTML = "Copied!";
        setTimeout(revert_copy, 3000);
    }
    window.getSelection().removeRange(CopyRange);
    if(currentRange)
    {
        window.getSelection().addRange(currentRange);
    }
}
function revert_copy() {
    document.getElementById("copy-button").innerHTML = "Copy";
    document.getElementById("more_storage_vlans").style.display =
"block";
    document.getElementById("more_nfs_volumes").style.display = "block";
}
function storagevlandropdown() {
    document.getElementById("more_storage_vlans").style.display = "none";
    document.getElementById("more_storage_vlans_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_storage_vlans");
    while (x < 10) {
        buildup += '<option value="' + x + '">' + x + '</option>';

```

```

        x++;
    }
    myHTML += '<a id="more_storage_vlans_info">How many extra VLANs do you
wish to add?</a><select name="number_of_extra_storage_vlans"
id="number_of_extra_storage_vlans">' + buildup + '</select>';
    wrapper.innerHTML = myHTML;
}
function addstoragevlans() {
    var y =
document.getElementById("number_of_extra_storage_vlans").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_storage_vlans");
    while (j < y) {
        j++;
        myHTML += ' - {vlan_id: ""<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>203</i></span>&quot;, name: ""<span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>infra_NFS</i></span>&quot;,,
protocol: ""<span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>NFS</i></span>&quot;}<br>';
    }
    wrapper.innerHTML = myHTML;
    document.getElementById("select_more_storage_vlans").style.display =
"none";
    document.getElementById("more_storage_vlans_button").style.display =
"none";
}
function nfsvolumesdropdown() {
    document.getElementById("more_nfs_volumes").style.display = "none";
    document.getElementById("more_nfs_volumes_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_nfs_volumes");
    while (x < 100) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_nfs_volumes_info">How many extra NFS volumes do
you wish to add?</a><select name="number_of_extra_nfs_volumes"
id="number_of_extra_nfs_volumes">' + buildup + '</select>';
    wrapper.innerHTML = myHTML;
}

```

```

}

function addnfsvolumes() {
    var y = document.getElementById("number_of_extra_nfs_volumes").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_nfs_volumes");
    while (j < y) {
        j++;
        myHTML += ' - {vol_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>rtpora04_u01</i></span>, aggr_name: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>aggr01_node02</i></span>,
lif: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>172.21.94.201</i></span>, size: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>25</i></span>}<br>';
    }
    wrapper.innerHTML = myHTML;
    document.getElementById("select_more_nfs_volumes").style.display =
"none";
    document.getElementById("more_nfs_volumes_button").style.display =
"none";
}

</script>

```

1. Fill in all variables in blue fields.
2. After completing variables input, click the Copy button on the form to copy all variables to be transferred to AWX or Tower into the following job template.

5. Configure and launch the job template.

1. Create the job template.
 - a. Navigate to Resources → Templates → Add and click Add Job Template.
 - b. Enter the name and description
 - c. Select the Job type; Run configures the system based on a playbook, and Check performs a dry run of a playbook without actually configuring the system.
 - d. Select the corresponding inventory, project, playbook, and credentials for the playbook.
 - e. Select the all_playbook.yml as the default playbook to be executed.
 - f. Paste global variables copied from step 4 into the Template Variables field under the YAML tab.
 - g. Check the box Prompt on Launch in the Job Tags field.
 - h. Click Save.

2. Launch the job template.
 - a. Navigate to Resources → Templates.
 - b. Click the desired template and then click Launch.
 - c. When prompted on launch for Job Tags, type in requirements_config. You might need to click the Create Job Tag line below requirements_config to enter the job tag.

 requirements_config ensures that you have the correct libraries to run the other roles.

 - d. Click Next and then Launch to start the job.
 - e. Click View → Jobs to monitor the job output and progress.
 - f. When prompted on launch for Job Tags, type in ontap_config. You might need to click the Create "Job Tag" line right below ontap_config to enter the job tag.
 - g. Click Next and then Launch to start the job.
 - h. Click View → Jobs to monitor the job output and progress
 - i. After the ontap_config role has completed, run the process again for linux_config.
 - j. Navigate to Resources → Templates.
 - k. Select the desired template and then click Launch.
 - l. When prompted on launch for the Job Tags type in linux_config, you might need to select the Create "job tag" line right below linux_config to enter the job tag.
 - m. Click Next and then Launch to start the job.
 - n. Select View → Jobs to monitor the job output and progress.
 - o. After the linux_config role has completed, run the process again for oracle_config.
 - p. Go to Resources → Templates.
 - q. Select the desired template and then click Launch.
 - r. When prompted on launch for Job Tags, type oracle_config. You might need to select the Create "Job Tag" line right below oracle_config to enter the job tag.
 - s. Click Next and then Launch to start the job.
 - t. Select View → Jobs to monitor the job output and progress.

6. Deploy additional database on same Oracle host

The Oracle portion of the playbook creates a single Oracle container database on an Oracle server per execution. To create additional container databases on the same server, complete the following steps.

1. Revise host_vars variables.
 - a. Go back to step 2 - Configure Oracle host_vars.
 - b. Change the Oracle SID to a different naming string.
 - c. Change the listener port to different number.
 - d. Change the EM Express port to a different number if you are installing EM Express.
 - e. Copy and paste the revised host variables to the Oracle Host Variables field in the Host Configuration Detail tab.
2. Launch the deployment job template with only the oracle_config tag.

Validate Oracle installation

1. Log in to Oracle server as oracle user and execute the following commands:

```
ps -ef | grep ora
```



This will list oracle processes if installation completed as expected and oracle DB started

2. Log in to the database to check the db configuration settings and the PDBs created with the following command sets.

```
sqlplus / as sysdba
```

```
[oracle@localhost ~]$ sqlplus / as sysdba
```

```
SQL*Plus: Release 19.0.0.0.0 - Production on Thu May 6 12:52:51 2021
Version 19.8.0.0.0
```

```
Copyright (c) 1982, 2019, Oracle. All rights reserved.
```

```
Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0
```

```
SQL>
```

```
select name, log_mode from v$database;
```

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

```
NAME LOG_MODE
```

```
-----
```

```
CDB2 ARCHIVELOG
```

```
show pdbs;
```

```
SQL> show pdbs
```

CON_ID	CON_NAME	OPEN	MODE	RESTRICTED
2	PDB\$SEED	READ	ONLY	NO
3	CDB2_PDB1	READ	WRITE	NO
4	CDB2_PDB2	READ	WRITE	NO
5	CDB2_PDB3	READ	WRITE	NO

```
col svrname form a30
col dirname form a30
select svrname, dirname, nfsversion from v$dnfs_servers;
```

SQL> col svrname form a30
SQL> col dirname form a30
SQL> select svrname, dirname, nfsversion from v\$dnfs_servers;

SVRNAME	DIRNAME	NFSVERSION
172.21.126.200	/rhelora03_u02	NFSv3.0
172.21.126.200	/rhelora03_u03	NFSv3.0
172.21.126.200	/rhelora03_u01	NFSv3.0

This confirms that dNFS is working properly.

3. Connect to database via listener to check the Oracle listener configuration with the following command. Change to the appropriate listener port and database service name.

```
sqlplus system@//localhost:1523/cdb2_pdb1.cie.netapp.com
```

[oracle@localhost ~]\$ sqlplus system@//localhost:1523/cdb2_pdb1.cie.netapp.com

SQL*Plus: Release 19.0.0.0.0 - Production on Thu May 6 13:19:57 2021
Version 19.8.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Enter password:
Last Successful login time: Wed May 05 2021 17:11:11 -04:00

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0

SQL> show user

```
USER is "SYSTEM"
SQL> show con_name
CON_NAME
CDB2_PDB1
```

This confirms that Oracle listener is working properly.

Where to go for help?

If you need help with the toolkit, please join the [NetApp Solution Automation community support slack channel](#) and look for the solution-automation channel to post your questions or inquires.

Step-by-step deployment procedure

CLI deployment Oracle 19c Database

This section covers the steps required to prepare and deploy Oracle19c Database with the CLI. Make sure that you have reviewed the [Getting Started and Requirements section](#) and prepared your environment accordingly.

Download Oracle19c repo

1. From your ansible controller, run the following command:

```
git clone https://github.com/NetApp-Automation/na_oracle19c_deploy.git
```

2. After downloading the repository, change directories to na_oracle19c_deploy <cd na_oracle19c_deploy>.

Edit the hosts file

Complete the following before deployment:

1. Edit your hosts file na_oracle19c_deploy directory.
2. Under [ontap], change the IP address to your cluster management IP.
3. Under the [oracle] group, add the oracle hosts names. The host name must be resolved to its IP address either through DNS or the hosts file, or it must be specified in the host.
4. After you have completed these steps, save any changes.

The following example depicts a host file:

```
#ONTAP Host<div>
[ontap]
<div>
<span <div contenteditable="false" style="color:#7EAF97
; font-weight:bold; font-style:italic; text-
decoration:;"/>10.61.184.183<i></i></span>
</div>
#Oracle hosts<div>
<div>
[oracle]<div>
<span <div contenteditable="false" style="color:#7EAF97
; font-weight:bold; font-style:italic; text-
decoration:;"/>rtpora01<i></i></span>
<div>
<span <div contenteditable="false" style="color:#7EAF97
; font-weight:bold; font-style:italic; text-
decoration:;"/>rtpora02<i></i></span>
</div>
```

This example executes the playbook and deploys oracle 19c on two oracle DB servers concurrently. You can also test with just one DB server. In that case, you only need to configure one host variable file.



The playbook executes the same way regardless of how many Oracle hosts and databases you deploy.

Edit the host_name.yml file under host_vars

Each Oracle host has its host variable file identified by its host name that contains host-specific variables. You can specify any name for your host. Edit and copy the host_vars from the Host VARS Config section and paste it into your desired host_name.yml file.



The items in blue must be changed to match your environment.

Host VARS Config

```
<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}
button {
```

```

transition-duration: 0.4s;
background-color: white;
color: #1563a3;
border: 2px solid #1563a3;
}
button:hover {
background-color: #1563a3;
color: white;
}
#more_datastores_nfs {
display: block;
}
#more_datastores_nfs_button {
display: none;
}
</style>
<div class="listingblock"><div class="content"><div><button id="copy-
button1" onclick="CopyClassText1()">Copy</button></div><pre><code><div
class="CopyMeClass1" id="CopyMeID1">
#####
#####          Host Variables Configuration          #####
#####
# Add your Oracle Host
ansible_host: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>10.61.180.15</i></span>

# Oracle db log archive mode: true - ARCHIVELOG or false - NOARCHIVELOG
log_archive_mode: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>true</i></span>

# Number of pluggable databases per container instance identified by sid.
Pdb_name specifies the prefix for container database naming in this case
cdb2_pdb1, cdb2_pdb2, cdb2_pdb3
oracle_sid: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>cdb2</i></span>
pdb_num: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>3</i></span>
pdb_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>"{{ oracle_sid }}_pdb"</i></span>

```

```

# CDB listener port, use different listener port for additional CDB on
same host
listener_port: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>1523</i></span>

# CDB is created with SGA at 75% of memory_limit, MB. Consider how many
databases to be hosted on the node and how much ram to be allocated to
each DB. The grand total SGA should not exceed 75% available RAM on node.
memory_limit: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>5464</i></span>

# Set "em_configuration: DBEXPRESS" to install enterprise manager express
and choose a unique port from 5500 to 5599 for each sid on the host.
# Leave them black if em express is not installed.
em_configuration: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>DBEXPRESS</i></span>
em_express_port: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>5501</i></span>

# "{{groups.oracle[0]}}" represents first Oracle DB server as defined in
Oracle hosts group [oracle]. For concurrent multiple Oracle DB servers
deployment, [0] will be incremented for each additional DB server. For
example, "{{groups.oracle[1]}}" represents DB server 2,
"{{groups.oracle[2]}}" represents DB server 3 ... As a good practice and
the default, minimum three volumes is allocated to a DB server with
corresponding /u01, /u02, /u03 mount points, which store oracle binary,
oracle data, and oracle recovery files respectively. Additional volumes
can be added by click on "More NFS volumes" but the number of volumes
allocated to a DB server must match with what is defined in global vars
file by volumes_nfs parameter, which dictates how many volumes are to be
created for each DB server.
host_datastores_nfs:
  - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u01</i></span>",
    aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node01</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.200</i></span>,
    size: <span <div contenteditable="true"/><i>25</i></span>}
  - {vol_name: ""<span <div contenteditable="true"

```

```

style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>{{groups.oracle[0]}}_u02</i></span>" ,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>aggr01_node01</i></span>, lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true"/><i>25</i></span>
- {vol_name: ""<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>{{groups.oracle[0]}}_u03</i></span>" ,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>aggr01_node01</i></span>, lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true"/><i>25</i></span>}
<a id="more_datastores_nfs" href="javascript:datastoredropdown();">More NFS volumes</a><div id="select_more_datastores_nfs"></div><a id="more_datastores_nfs_button"
href="javascript:adddatastorevolumes();">Enter NFS volumes' details</a><div id="extra_datastores_nfs"></div>
</div></code></pre></div>
<script>
function CopyClassText1() {
    var textToCopy = document.getElementById("CopyMeID1");
    var currentRange;
    if(document.getSelection().rangeCount > 0)
    {
        currentRange = document.getSelection().getRangeAt(0);
        window.getSelection().removeRange(currentRange);
    }
    else
    {
        currentRange = false;
    }
    var CopyRange = document.createRange();
    CopyRange.selectNode(textToCopy);
    window.getSelection().addRange(CopyRange);
    document.getElementById("more_datastores_nfs").style.display = "none";
    var command = document.execCommand("copy");
    if (command)
    {
        document.getElementById("copy-button1").innerHTML = "Copied!";
        setTimeout(revert_copy, 3000);
    }
}

```

```

        window.getSelection().removeRange(CopyRange);
        if(currentRange)
        {
            window.getSelection().addRange(currentRange);
        }
    }

    function revert_copy() {
        document.getElementById("copy-button1").innerHTML = "Copy";
        document.getElementById("more_datastores_nfs").style.display =
"block";
    }

    function datastoredropdown() {
        document.getElementById("more_datastores_nfs").style.display = "none";
        document.getElementById("more_datastores_nfs_button").style.display =
"block";
        var x=1;
        var myHTML = '';
        var buildup = '';
        var wrapper = document.getElementById("select_more_datastores_nfs");
        while (x < 100) {
            buildup += '<option value="' + x + '">' + x + '</option>';
            x++;
        }
        myHTML += '<a id="more_datastores_nfs">How many extra NFS volumes do
you wish to add?</a><select name="number_of_extra_datastores_nfs"
id="number_of_extra_datastores_nfs">' + buildup + '</select>';
        wrapper.innerHTML = myHTML;
    }

    function adddatastorevolumes() {
        var y =
document.getElementById("number_of_extra_datastores_nfs").value;
        var j=0;
        var myHTML = '';
        var wrapper = document.getElementById("extra_datastores_nfs");
        while (j < y) {
            j++;
            myHTML += ' - {vol_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.oracle[0]}}_u01</i></span>,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node02</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.201</i></span>,
size: <span <div contenteditable="true" style="color:#004EFF; font-

```

```

        weight:bold; font-style:italic; text-
decoration:underline;"/><i>25</i></span>}<br>';
    }
    wrapper.innerHTML = myHTML;
    document.getElementById("select_more_datastores_nfs").style.display =
"none";
    document.getElementById("more_datastores_nfs_button").style.display =
"none";
}

</script>

```

Edit the vars.yml file

The `vars.yml` file consolidates all environment-specific variables (ONTAP, Linux, or Oracle) for Oracle deployment.

- Edit and copy the variables from the VARS section and paste these variables into your `vars.yml` file.

VARS

```

<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}
button {
transition-duration: 0.4s;
background-color: white;
color: #1563a3;
border: 2px solid #1563a3;
}
button:hover {
background-color: #1563a3;
color: white;
}
#more_storage_vlans {
display: block;
}
#more_storage_vlans_button {
display: none;
}

```

```

#more_nfs_volumes {
    display: block;
}
#more_nfs_volumes_button {
    display: none;
}
</style>
<div class="listingblock"><div class="content"><div><button id="copy-
button" onclick="CopyClassText()">Copy</button></div><pre><code><div
class="CopyMeClass" id="CopyMeID">
#####
##### Oracle 19c deployment global user configuration variables #####
##### Consolidate all variables from ontap, linux and oracle #####
#####

#####
### Ontap env specific config variables ##
#####

#Inventory group name
#Default inventory group name - 'ontap'
#Change only if you are changing the group name either in inventory/hosts
file or in inventory groups in case of AWX/Tower
hosts_group: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>ontap</i></span>

#CA_signed_certificates (ONLY CHANGE to 'true' IF YOU ARE USING CA SIGNED
CERTIFICATES)
ca_signed_certs: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>false</i></span>

#Names of the Nodes in the ONTAP Cluster
nodes:
    - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>AFF-
01</i></span>
    - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>AFF-
02</i></span>

#Storage VLANs
#Add additional rows for vlans as necessary
storage_vlans:

```

```

- {vlan_id: ""<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>203</i></span>"; name: "<span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"/><i>infra_NFS</i></span>";,
protocol: "<span <div
contenteditable="true"/><i>NFS</i></span>"}
<a id="more_storage_vlans" href="javascript:storagevlandropdown();">More
Storage VLANs</a><div id="select_more_storage_vlans"></div><a
id="more_storage_vlans_button" href="javascript:addstoragevlans();">Enter
Storage VLANs details</a><div id="extra_storage_vlans"></div>

#Details of the Data Aggregates that need to be created
#If Aggregate creation takes longer, subsequent tasks of creating volumes
may fail.
#There should be enough disks already zeroed in the cluster, otherwise
aggregate create will zero the disks and will take long time
data_aggregates:
- {aggr_name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>aggr01_node01</i></span>}
- {aggr_name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>aggr01_node02</i></span>}

#SVM name
svm_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"/><i>ora_svm</i></span>

# SVM Management LIF Details
svm_mgmt_details:
- {address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>172.21.91.100</i></span>, netmask: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"/><i>255.255.255.0</i></span>,
home_port: <span <div contenteditable="true"/><i>e0M</i></span>}

# NFS storage parameters when data_protocol set to NFS. Volume named after
Oracle hosts name identified by mount point as follow for oracle DB server
1. Each mount point dedicated to a particular Oracle files: u01 - Oracle
binary, u02 - Oracle data, u03 - Oracle redo. Add additional volumes by
click on "More NFS volumes" and also add the volumes list to corresponding
host_vars as host_datastores_nfs variable. For multiple DB server

```

deployment, additional volumes sets needs to be added for additional DB server. Input variable "{{groups.oracle[1]}}_u01", "{{groups.oracle[1]}}_u02", and "{{groups.oracle[1]}}_u03" as vol_name for second DB server. Place volumes for multiple DB servers alternatingly between controllers for balanced IO performance, e.g. DB server 1 on controller node1, DB server 2 on controller node2 etc. Make sure match lif address with controller node.

```

volumes_nfs:
  - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u01</i></span>", aggr_name: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>aggr01_node01</i></span>, lif: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span>, size: <span <div contenteditable='true'><i>25</i></span>}"
    - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u02</i></span>", aggr_name: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>aggr01_node01</i></span>, lif: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span>, size: <span <div contenteditable='true'><i>25</i></span>}"
      - {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.oracle[0]}}_u03</i></span>", aggr_name: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>aggr01_node01</i></span>, lif: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span>, size: <span <div contenteditable='true'><i>25</i></span>}"
        <a id="more_nfs_volumes" href="javascript:nfsvolumesdropdown();">More NFS volumes</a><div id="select_more_nfs_volumes"></div><a id="more_nfs_volumes_button" href="javascript:addnfsvolumes();">Enter NFS volumes' details</a><div id="extra_nfs_volumes"></div>

#NFS LIFs IP address and netmask
nfs_lifs_details:
  - address: <span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>172.21.94.200</i></span> #for node-1
    netmask: <span <div contenteditable='true' style='color:#004EFF; font-
```

```

weight:bold; font-style:italic; text-
decoration:underline;"/><i>255.255.255.0</i></span>
- address: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"/><i>172.21.94.201</i></span> #for node-2
    netmask: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"/><i>255.255.255.0</i></span>

#NFS client match
client_match: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>172.21.94.0/24</i></span>

#####
### Linux env specific config variables ###
#####

#NFS Mount points for Oracle DB volumes
mount_points:
- <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"/><i>/u01</i></span>
- <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"/><i>/u02</i></span>
- <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"/><i>/u03</i></span>

# Up to 75% of node memory size divided by 2mb. Consider how many
databases to be hosted on the node and how much ram to be allocated to
each DB.
# Leave it blank if hugepage is not configured on the host.
hugepages_nr: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>1234</i></span>

# RedHat subscription username and password
redhat_sub_username: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>xxx</i></span>
redhat_sub_password: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"/><i>xxx</i></span>

```

```

#####
### DB env specific install and config variables #####
#####

db_domain: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>your.domain.com</i></span>

# Set initial password for all required Oracle passwords. Change them after installation.
initial_pwd_all: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>netapp123</i></span>

</div></code></pre></div></div>
<script>
function CopyClassText() {
    var textToCopy = document.getElementById("CopyMeID");
    var currentRange;
    if(document.getSelection().rangeCount > 0)
    {
        currentRange = document.getSelection().getRangeAt(0);
        window.getSelection().removeRange(currentRange);
    }
    else
    {
        currentRange = false;
    }
    var CopyRange = document.createRange();
    CopyRange.selectNode(textToCopy);
    window.getSelection().addRange(CopyRange);
    document.getElementById("more_storage_vlans").style.display = "none";
    document.getElementById("more_nfs_volumes").style.display = "none";
    var command = document.execCommand("copy");
    if (command)
    {
        document.getElementById("copy-button").innerHTML = "Copied!";
        setTimeout(revert_copy, 3000);
    }
    window.getSelection().removeRange(CopyRange);
    if(currentRange)
    {
        window.getSelection().addRange(currentRange);
    }
}
function revert_copy() {

```

```

        document.getElementById("copy-button").innerHTML = "Copy";
        document.getElementById("more_storage_vlans").style.display =
"block";
        document.getElementById("more_nfs_volumes").style.display = "block";
    }
    function storagevlandropdown() {
        document.getElementById("more_storage_vlans").style.display = "none";
        document.getElementById("more_storage_vlans_button").style.display =
"block";
        var x=1;
        var myHTML = '';
        var buildup = '';
        var wrapper = document.getElementById("select_more_storage_vlans");
        while (x < 10) {
            buildup += '<option value="' + x + '">' + x + '</option>';
            x++;
        }
        myHTML += '<a id="more_storage_vlans_info">How many extra VLANs do you
wish to add?</a><select name="number_of_extra_storage_vlans"
id="number_of_extra_storage_vlans">' + buildup + '</select>';
        wrapper.innerHTML = myHTML;
    }
    function addstoragevlans() {
        var y =
document.getElementById("number_of_extra_storage_vlans").value;
        var j=0;
        var myHTML = '';
        var wrapper = document.getElementById("extra_storage_vlans");
        while (j < y) {
            j++;
            myHTML += ' - {vlan_id: ""<span contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>203</i></span>", name: ""<span contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>infra_NFS</i></span>", protocol:
"&quot;<span contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>NFS</i></span>&quot;}<br>';
        }
        wrapper.innerHTML = myHTML;
        document.getElementById("select_more_storage_vlans").style.display =
"none";
        document.getElementById("more_storage_vlans_button").style.display =
"none";
    }
    function nfsvolumesdropdown() {

```

```

document.getElementById("more_nfs_volumes").style.display = "none";
document.getElementById("more_nfs_volumes_button").style.display =
"block";
var x=1;
var myHTML = '';
var buildup = '';
var wrapper = document.getElementById("select_more_nfs_volumes");
while (x < 100) {
    buildup += '<option value="' + x + '">' + x + '</option>';
    x++;
}
myHTML += '<a id="more_nfs_volumes_info">How many extra NFS volumes do
you wish to add?</a><select name="number_of_extra_nfs_volumes"
id="number_of_extra_nfs_volumes">' + buildup + '</select>';
wrapper.innerHTML = myHTML;
}

function addnfsvolumes() {
var y = document.getElementById("number_of_extra_nfs_volumes").value;
var j=0;
var myHTML = '';
var wrapper = document.getElementById("extra_nfs_volumes");
while (j < y) {
    j++;
    myHTML += ' - {vol_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>rtpora04_u01</i></span>, aggr_name: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>aggr01_node02</i></span>,
lif: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>172.21.94.201</i></span>, size: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>25</i></span>}<br>';
}
wrapper.innerHTML = myHTML;
document.getElementById("select_more_nfs_volumes").style.display =
"none";
document.getElementById("more_nfs_volumes_button").style.display =
"none";
}

</script>

```

Run the playbook

After completing the required environment prerequisites and copying the variables into `vars.yml` and

`your_host.yml`, you are now ready to deploy the playbooks.



<username> must be changed to match your environment.

1. Run the ONTAP playbook by passing the correct tags and ONTAP cluster username. Fill the password for ONTAP cluster, and vsadmin when prompted.

```
ansible-playbook -i hosts all_playbook.yml -u username -k -K -t  
ontap_config -e @vars/vars.yml
```

2. Run the Linux playbook to execute Linux portion of deployment. Input for admin ssh password as well as sudo password.

```
ansible-playbook -i hosts all_playbook.yml -u username -k -K -t  
linux_config -e @vars/vars.yml
```

3. Run the Oracle playbook to execute Oracle portion of deployment. Input for admin ssh password as well as sudo password.

```
ansible-playbook -i hosts all_playbook.yml -u username -k -K -t  
oracle_config -e @vars/vars.yml
```

Deploy Additional Database on Same Oracle Host

The Oracle portion of the playbook creates a single Oracle container database on an Oracle server per execution. To create additional container database on the same server, complete the following steps:

1. Revise the `host_vars` variables.
 - a. Go back to step 3 - Edit the `host_name.yml` file under `host_vars`.
 - b. Change the Oracle SID to a different naming string.
 - c. Change the listener port to different number.
 - d. Change the EM Express port to a different number if you have installed EM Express.
 - e. Copy and paste the revised host variables to the Oracle host variable file under `host_vars`.
2. Execute the playbook with the `oracle_config` tag as shown above in [Run the playbook](#).

Validate Oracle installation

1. Log in to Oracle server as oracle user and execute the following commands:

```
ps -ef | grep ora
```



This will list oracle processes if installation completed as expected and oracle DB started

2. Log in to the database to check the db configuration settings and the PDBs created with the following command sets.

```
sqlplus / as sysdba
```

```
[oracle@localhost ~]$ sqlplus / as sysdba
```

```
SQL*Plus: Release 19.0.0.0.0 - Production on Thu May 6 12:52:51 2021
Version 19.8.0.0.0
```

```
Copyright (c) 1982, 2019, Oracle. All rights reserved.
```

```
Connected to:
```

```
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0
```

```
SQL>
```

```
select name, log_mode from v$database;
```

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

```
NAME LOG_MODE
```

```
-----
```

```
CDB2 ARCHIVELOG
```

```
show pdbs;
```

```
SQL> show pdbs
```

CON_ID	CON_NAME	OPEN	MODE	RESTRICTED
2	PDB\$SEED	READ	ONLY	NO
3	CDB2_PDB1	READ	WRITE	NO
4	CDB2_PDB2	READ	WRITE	NO
5	CDB2_PDB3	READ	WRITE	NO

```
col svrname form a30
col dirname form a30
select svrname, dirname, nfsversion from v$dnfs_servers;
```

SQL> col svrname form a30
SQL> col dirname form a30
SQL> select svrname, dirname, nfsversion from v\$dnfs_servers;

SVRNAME	DIRNAME	NFSVERSION
172.21.126.200	/rhelora03_u02	NFSv3.0
172.21.126.200	/rhelora03_u03	NFSv3.0
172.21.126.200	/rhelora03_u01	NFSv3.0

This confirms that dNFS is working properly.

3. Connect to database via listener to check the Oracle listener configuration with the following command. Change to the appropriate listener port and database service name.

```
sqlplus system@//localhost:1523/cdb2_pdb1.cie.netapp.com
```

[oracle@localhost ~]\$ sqlplus system@//localhost:1523/cdb2_pdb1.cie.netapp.com

SQL*Plus: Release 19.0.0.0.0 - Production on Thu May 6 13:19:57 2021
Version 19.8.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Enter password:
Last Successful login time: Wed May 05 2021 17:11:11 -04:00

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.8.0.0.0

SQL> show user

```
USER is "SYSTEM"
SQL> show con_name
CON_NAME
CDB2_PDB1
```

This confirms that Oracle listener is working properly.

Where to go for help?

If you need help with the toolkit, please join the [NetApp Solution Automation community support slack channel](#) and look for the solution-automation channel to post your questions or inquiries.

Oracle Database Data Protection

Solution Overview

Automated Data Protection for Oracle Databases

Organizations are automating their environments to gain efficiencies, accelerate deployments, and reduce manual effort. Configuration management tools like Ansible are being used to streamline enterprise database operations. In this solution, we demonstrate how you can use Ansible to automate the data protection of Oracle with NetApp ONTAP. By enabling storage administrators, systems administrators, and DBAs to consistently and rapidly setup data replication to an offsite data center or to public cloud, you achieve the following benefits:

- Eliminate design complexities and human errors, and implement a repeatable consistent deployment and best practices
- Decrease time for configuration of Intercluster replication, CVO instantiation, and recovery of Oracle databases
- Increase database administrators, systems and storage administrators productivity
- Provides database recovery workflow for ease of testing a DR scenario.

NetApp provides customers with validated Ansible modules and roles to accelerate deployment, configuration, and lifecycle management of your Oracle database environment. This solution provides instruction and Ansible playbook code, to help you:

On Prem to on prem replication

- Create intercluster lifs on source and destination
- Establish cluster and vserver peering
- Create and initialize SnapMirror of Oracle volumes
- Create a replication schedule through AWX/Tower for Oracle binaries, databases, and logs
- Restore Oracle DB on the destination, and bring database online

On Prem to CVO in AWS

- Create AWS connector
- Create CVO instance in AWS
- Add On-Prem cluster to Cloud Manager

- Create intercluster lifs on source
- Establish cluster and vserver peering
- Create and initialize SnapMirror of Oracle volumes
- Create a replication schedule through AWX/Tower for Oracle binaries, databases, and logs
- Restore Oracle DB on the destination, and bring database online

For more details or to begin, please see the overview videos below.

AWX/Tower Deployments

- Part 1: TBD

[video](#)

- Part 2: TBD

[video](#)

After you are ready, click [here](#) for getting started with the solution.

Getting started

This solution has been designed to be run in an AWX/Tower environment.

AWX/Tower

For AWX/Tower environments, you are guided through creating an inventory of your ONTAP cluster management and Oracle server (IPs and hostnames), creating credentials, configuring a project that pulls the Ansible code from NetApp Automation Github, and the Job Template that launches the automation.

1. The solution has been designed to run in a private cloud scenario (on-premise to on-premise), and hybrid cloud (on-premise to public cloud Cloud Volumes ONTAP [CVO])
2. Fill out the variables specific to your environment, and copy and paste them into the Extra Vars fields in your job template.
3. After the extra vars have been added to your job template, you can launch the automation.
4. The automation is set to be ran three phases (Setup, Replication Schedule for Oracle Binaries, Database, Logs, and Replication Schedule just for Logs), and a forth phase to recovering the database at a DR site.
5. For detailed instructions for obtaining the keys and tokens necessary for the CVO Data Protection visit [Gather Pre-requisites For CVO and Connector Deployments](#)

Requirements

On-Prem |

Environment	Requirements
Ansible environment	AWX/Tower Ansible v.2.10 and higher Python 3 Python libraries - netapp-lib - xmltodict - jmespath
ONTAP	ONTAP version 9.8 + Two data aggregates NFS vlan and ifgrp created
Oracle server(s)	RHEL 7/8 Oracle Linux 7/8 Network interfaces for NFS, public, and optional mgmt Existing Oracle environment on source, and the equivalent Linux operating system at the destination (DR Site or Public Cloud)

CVO

Environment	Requirements
Ansible environment	AWX/Tower Ansible v.2.10 and higher Python 3 Python libraries - netapp-lib - xmltodict - jmespath
ONTAP	ONTAP version 9.8 + Two data aggregates NFS vlan and ifgrp created
Oracle server(s)	RHEL 7/8 Oracle Linux 7/8 Network interfaces for NFS, public, and optional mgmt Existing Oracle environment on source, and the equivalent Linux operating system at the destination (DR Site or Public Cloud) Set appropriate swap space on the Oracle EC2 instance, by default some EC2 instances are deployed with 0 swap

Environment	Requirements
Cloud Manager/AWS	AWS Access/Secret Key
	NetApp Cloud Manager Account
	NetApp Cloud Manager Refresh Token

Automation Details

On-Prem |

This automated deployment is designed with a single Ansible playbook that consists of three separate roles. The roles are for ONTAP, Linux, and Oracle configurations. The following table describes which tasks are being automated.

Playbook	Tasks
ontap_setup	Pre-check of the ONTAP environment
	Creation of Intercluster LIFs on source cluster (OPTIONAL)
	Creation of Intercluster LIFs on destination cluster (OPTIONAL)
	Creation of Cluster and SVM Peering
	Creation of destination SnapMirror and Initialization of designated Oracle volumes
ora_replication_cg	Enable backup mode for each database in /etc/oratab
	Snapshot taken of Oracle Binary and Database volumes
	Snapmirror Updated
	Turn off backup mode for each database in /etc/oratab
ora_replication_log	Switch current log for each database in /etc/oratab
	Snapshot taken of Oracle Log volume
	Snapmirror Updated
ora_recovery	Break SnapMirror
	Enable NFS and create junction path for Oracle volumes on the destination
	Configure DR Oracle Host
	Mount and verify Oracle volumes
	Recover and start Oracle database

CVO

This automated deployment is designed with a single Ansible playbook that consists of three separate roles. The roles are for ONTAP, Linux, and Oracle configurations. The following table describes which tasks are being automated.

Playbook	Tasks
cvo_setup	Pre-check of the environment AWS Configure/AWS Access Key ID/Secret Key/Default Region Creation of AWS Role Creation of NetApp Cloud Manager Connector instance in AWS Creation of Cloud Volumes ONTAP (CVO) instance in AWS Add On-Prem Source ONTAP Cluster to NetApp Cloud Manager Creation of destination SnapMirror and Initialization of designated Oracle volumes
ora_replication_cg	Enable backup mode for each database in /etc/oratab Snapshot taken of Oracle Binary and Database volumes Snapmirror Updated Turn off backup mode for each database in /etc/oratab
ora_replication_log	Switch current log for each database in /etc/oratab Snapshot taken of Oracle Log volume Snapmirror Updated
ora_recovery	Break SnapMirror Enable NFS and create junction path for Oracle volumes on the destination CVO Configure DR Oracle Host Mount and verify Oracle volumes Recover and start Oracle database

Default parameters

To simplify automation, we have preset many required Oracle parameters with default values. It is generally not necessary to change the default parameters for most deployments. A more advanced user can make changes to the default parameters with caution. The default parameters are located in each role folder under defaults directory.

License

You should read license information as stated in the Github repository. By accessing, downloading, installing, or using the content in this repository, you agree the terms of the license laid out [here](#).

Note that there are certain restrictions around producing and/or sharing any derivative works with the content in this repository. Please make sure you read the terms of the [License](#) before using the content. If you do not agree to all of the terms, do not access, download, or use the content in this repository.

After you are ready, click [here for detailed AWX/Tower procedures](#).

Step-by-step deployment procedure

AWX/Tower Oracle Data Protection

Create the inventory, group, hosts, and credentials for your environment

This section describes the setup of inventory, groups, hosts, and access credentials in AWX/Ansible Tower that prepare the environment for consuming NetApp automated solutions.

1. Configure the inventory.
 - a. Navigate to Resources → Inventories → Add, and click Add Inventory.
 - b. Provide the name and organization details, and click Save.
 - c. On the Inventories page, click the inventory created.
 - d. Navigate to the Groups sub-menu and click Add.
 - e. Provide the name oracle for your first group and click Save.
 - f. Repeat the process for a second group called dr_oracle.
 - g. Select the oracle group created, go to the Hosts sub-menu and click Add New Host.
 - h. Provide the IP address of the Source Oracle host's management IP, and click Save.
 - i. This process must be repeated for the dr_oracle group and add the DR/Destination Oracle host's management IP/hostname.



Below are instructions for creating the credential types and credentials for either On-Prem with ONTAP, or CVO on AWS.

On-Prem

1. Configure the credentials.
2. Create Credential Types. For solutions involving ONTAP, you must configure the credential type to match username and password entries.
 - a. Navigate to Administration → Credential Types, and click Add.
 - b. Provide the name and description.
 - c. Paste the following content in Input Configuration:

```
fields:  
  - id: dst_cluster_username  
    type: string  
    label: Destination Cluster Username  
  - id: dst_cluster_password  
    type: string  
    label: Destination Cluster Password  
    secret: true  
  - id: src_cluster_username  
    type: string  
    label: Source Cluster Username  
  - id: src_cluster_password  
    type: string  
    label: Source Cluster Password  
    secret: true
```

- d. Paste the following content into Injector Configuration and then click Save:

```
extra_vars:  
  dst_cluster_username: '{{ dst_cluster_username }}'  
  dst_cluster_password: '{{ dst_cluster_password }}'  
  src_cluster_username: '{{ src_cluster_username }}'  
  src_cluster_password: '{{ src_cluster_password }}'
```

3. Create Credential for ONTAP

- a. Navigate to Resources → Credentials, and click Add.
- b. Enter the name and organization details for the ONTAP Credentials
- c. Select the credential type that was created in the previous step.
- d. Under Type Details, enter the Username and Password for your Source and Destination Clusters.
- e. Click Save

4. Create Credential for Oracle

- a. Navigate to Resources → Credentials, and click Add.
- b. Enter the name and organization details for Oracle

- c. Select the Machine credential type.
- d. Under Type Details, enter the Username and Password for the Oracle hosts.
- e. Select the correct Privilege Escalation Method, and enter the username and password.
- f. Click Save
- g. Repeat process if needed for a different credential for the dr_oracle host.

CVO

1. Configure the credentials.
2. Create credential types. For solutions involving ONTAP, you must configure the credential type to match username and password entries, we will also add entries for Cloud Central and AWS.
 - a. Navigate to Administration → Credential Types, and click Add.
 - b. Provide the name and description.
 - c. Paste the following content in Input Configuration:

```
fields:
  - id: dst_cluster_username
    type: string
    label: CVO Username
  - id: dst_cluster_password
    type: string
    label: CVO Password
    secret: true
  - id: cvo_svm_password
    type: string
    label: CVO SVM Password
    secret: true
  - id: src_cluster_username
    type: string
    label: Source Cluster Username
  - id: src_cluster_password
    type: string
    label: Source Cluster Password
    secret: true
  - id: regular_id
    type: string
    label: Cloud Central ID
    secret: true
  - id: email_id
    type: string
    label: Cloud Manager Email
    secret: true
  - id: cm_password
    type: string
    label: Cloud Manager Password
    secret: true
  - id: access_key
    type: string
    label: AWS Access Key
    secret: true
  - id: secret_key
    type: string
    label: AWS Secret Key
    secret: true
  - id: token
    type: string
    label: Cloud Central Refresh Token
    secret: true
```

d. Paste the following content into Injector Configuration and click Save:

```

extra_vars:
  dst_cluster_username: '{{ dst_cluster_username }}'
  dst_cluster_password: '{{ dst_cluster_password }}'
  cvo_svm_password: '{{ cvo_svm_password }}'
  src_cluster_username: '{{ src_cluster_username }}'
  src_cluster_password: '{{ src_cluster_password }}'
  regular_id: '{{ regular_id }}'
  email_id: '{{ email_id }}'
  cm_password: '{{ cm_password }}'
  access_key: '{{ access_key }}'
  secret_key: '{{ secret_key }}'
  token: '{{ token }}'

```

3. Create Credential for ONTAP/CVO/AWS

- Navigate to Resources → Credentials, and click Add.
- Enter the name and organization details for the ONTAP Credentials
- Select the credential type that was created in the previous step.
- Under Type Details, enter the Username and Password for your Source and CVO Clusters, Cloud Central/Manager, AWS Access/Secret Key and Cloud Central Refresh Token.
- Click Save

4. Create Credential for Oracle (Source)

- Navigate to Resources → Credentials, and click Add.
- Enter the name and organization details for Oracle host
- Select the Machine credential type.
- Under Type Details, enter the Username and Password for the Oracle hosts.
- Select the correct Privilege Escalation Method, and enter the username and password.
- Click Save

5. Create Credential for Oracle Destination

- Navigate to Resources → Credentials, and click Add.
- Enter the name and organization details for the DR Oracle host
- Select the Machine credential type.
- Under Type Details, enter the Username (ec2-user or if you have changed it from default enter that), and the SSH Private Key
- Select the correct Privilege Escalation Method (sudo), and enter the username and password if needed.
- Click Save

Create a project

- Go to Resources → Projects, and click Add.

- a. Enter the name and organization details.
- b. Select Git in the Source Control Credential Type field.
- c. enter https://github.com/NetApp-Automation/na_oracle19c_data_protection.git as the source control URL.
- d. Click Save.
- e. The project might need to sync occasionally when the source code changes.

Configure global variables

Variables defined in this section apply to all Oracle hosts, databases, and the ONTAP cluster.

1. Input your environment-specific parameters in following embedded global variables or vars form.



The items in blue must be changed to match your environment.

On-Prem

```
<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}
button {
transition-duration: 0.4s;
background-color: white;
color: #1563a3;
border: 2px solid #1563a3;
}
button:hover {
background-color: #1563a3;
color: white;
}
#more_binary_vols {
display: block;
}
#more_binary_vols_button {
display: none;
}
#more_database_vols {
display: block;
}
#more_database_vols_button {
display: none;
}
#more_log_vols {
display: block;
}
#more_log_vols_button {
display: none;
}
</style>
<div class="listingblock"><div class="content"><div><button id="copy-button-onprem" onclick="CopyClassText ()">Copy</button></div><pre><code><div class="CopyMeClass" id="CopyOnPrem">#####
<##</div>
```

```

##### Oracle Data Protection global user configuration variables
#####
##### Consolidate all variables from ontap, aws, and oracle
#####
#####
#####
#####

#####
### Ontap env specific config variables #####
#####

#Inventory group name
#Default inventory group name - 'ontap'
#Change only if you are changing the group name either in
inventory/hosts file or in inventory groups in case of AWX/Tower
hosts_group: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>ontap</i></span>

#CA_signed_certificates (ONLY CHANGE to 'true' IF YOU ARE USING CA
SIGNED CERTIFICATES)
ca_signed_certs: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>false</i></span>

#####
# Inter-cluster LIF details
#####
#Names of the Nodes in the Source ONTAP Cluster
src_nodes:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>AFF-
01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>AFF-
02</i></span>

#Names of the Nodes in the Destination ONTAP Cluster
dst_nodes:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>DR-
AFF-01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>DR-
AFF-02</i></span>

```

```

#define whether or not to create intercluster lifs on source cluster
(ONLY CHANGE to 'No' IF YOU HAVE ALREADY CREATED THE INTERCLUSTER
LIFs)

create_source_intercluster_lifs: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>

source_intercluster_network_port_details:
    using_dedicated_ports: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>
    using_ifgrp: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>
    using_vlans: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>
    failover_for_shared_individual_ports: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline; text-
decoration:underline;" /><i>yes</i></span>
    ifgrp_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>a0a</i></span>
    vlan_id: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>10</i></span>
    ports:
        - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;" /><i>e0b</i></span>
        - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;" /><i>e0g</i></span>
    broadcast_domain: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>NFS</i></span>
    ipspace: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>Default</i></span>
    failover_group_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;" /><i>iclifs</i></span>

source_intercluster_lif_details:

```

```

    - name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>ic1_1</i></span>
        address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>10.0.0.1</i></span>
        netmask: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>255.255.255.0</i></span>
        home_port: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>a0a-
10</i></span>
        node: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>AFF-01</i></span>
    - name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>ic1_2</i></span>
        address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>10.0.0.2</i></span>
        netmask: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>255.255.255.0</i></span>
        home_port: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>a0a-
10</i></span>
        node: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>AFF-02</i></span>

#Define whether or not to create intercluster lifs on destination
cluster (ONLY CHANGE to 'No' IF YOU HAVE ALREADY CREATED THE
INTERCLUSTER LIFS)
create_destination_intercluster_lifs: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline; text-
decoration:underline;" /><i>yes</i></span>

destination_intercluster_network_port_details:
    using_dedicated_ports: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>
    using_ifgrp: <span <div contenteditable="true"

```

```

        style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>yes</i></span>
    using_vlans: <span <div contenteditable="true"
        style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>yes</i></span>
    failover_for_shared_individual_ports: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>yes</i></span>
    ifgrp_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>a0a</i></span>
    vlan_id: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>10</i></span>
    ports:
        - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"/><i>e0b</i></span>
        - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"/><i>e0g</i></span>
    broadcast_domain: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>NFS</i></span>
    ipspace: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>Default</i></span>
    failover_group_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"/><i>iclifs</i></span>

destination_intercluster_lif_details:
    - name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>icl_1</i></span>
        address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>10.0.0.3</i></span>
        netmask: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>255.255.255.0</i></span>
        home_port: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>a0a-

```

```

10</i></span>
    node: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>DR-AFF-01</i></span>
      - name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>icl_2</i></span>
        address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>10.0.0.4</i></span>
        netmask: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>255.255.255.0</i></span>
        home_port: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"><i>a0a-
10</i></span>
        node: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>DR-AFF-02</i></span>

#####
#####
# Variables for SnapMirror Peering
#####
#####
######
#src_lif: #Will be retrieve through Ansible Task
#dst_lif: #Will be retrieve through Ansible Task
passphrase: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>your-passphrase</i></span>

#####
#####
#####
# Source & Destination List
#####
#####
#####
#Please Enter Destination Cluster Name
dst_cluster_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"><i>dst-cluster-
name</i></span>

#Please Enter Destination Cluster
dst_cluster_ip: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-

```

```

decoration:underline; text-decoration:underline;"/><i>dst-cluster-
ip</i></span>

#Please Enter Destination SVM to create mirror relationship
dst_vserver: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>dst-vserver</i></span>

#Please Enter NFS Lif for dst vserver
dst_nfs_lif: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>dst-nfs-lif</i></span>

#Please Enter Source Cluster Name
src_cluster_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"><i>src-cluster-
name</i></span>

#Please Enter Source Cluster
src_cluster_ip: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"><i>src-cluster-
ip</i></span>

#Please Enter Source SVM
src_vserver: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>src-vserver</i></span>

#####
#####
#
# Variable for Oracle Volumes and SnapMirror Details
#####
#####
#
#Please Enter Source Snapshot Prefix Name
cg_snapshot_name_prefix: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>oracle</i></span>

#Please Enter Source Oracle Binary Volume(s)
src_orabinary_vols:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>binary_vol</i></span>

```

```

<a id="more_binary_vols"
    href="javascript:binaryvolsdropdown();">More Binary Vols</a><div
    id="select_more_binary_vols"></div><a id="more_binary_vols_button"
    href="javascript:addbinaryvols();">Enter Volume details</a><div
    id="extra_binary_vols"></div>
#Please Enter Source Database Volume(s)
src_db_vols:
    - <span <div contenteditable="true" style="color:#004EFF; font-
        weight:bold; font-style:italic; text-decoration:underline; text-
        decoration:underline;"><i>db_vol</i></span>
<a id="more_database_vols"
    href="javascript:databasevolsdropdown();">More Database Vols</a><div
    id="select_more_database_vols"></div><a
    id="more_database_vols_button"
    href="javascript:adddatabasevols();">Enter Volume details</a><div
    id="extra_database_vols"></div>
#Please Enter Source Archive Volume(s)
src_archivelog_vols:
    - <span <div contenteditable="true" style="color:#004EFF; font-
        weight:bold; font-style:italic; text-decoration:underline; text-
        decoration:underline;"><i>log_vol</i></span>
<a id="more_log_vols" href="javascript:logvolsdropdown();">More Log
Vols</a><div id="select_more_log_vols"></div><a
    id="more_log_vols_button" href="javascript:addlogvols();">Enter
    Volume details</a><div id="extra_log_vols"></div>
#Please Enter Destination Snapmirror Policy
snapmirror_policy: <span <div contenteditable="true"
    style="color:#004EFF; font-weight:bold; font-style:italic; text-
    decoration:underline; text-
    decoration:underline;"><i>async_policy_oracle</i></span>

#####
#####
# Export Policy Details
#####
#####
#Enter the destination export policy details
export_policy_details:
    name: <span <div contenteditable="true" style="color:#004EFF;
        font-weight:bold; font-style:italic; text-decoration:underline;
        text-decoration:underline;"><i>nfs_export_policy</i></span>
        client_match: <span <div contenteditable="true"
            style="color:#004EFF; font-weight:bold; font-style:italic; text-
            decoration:underline; text-
            decoration:underline;"><i>0.0.0.0/0</i></span>
        ro_rule: sys

```

```

rw_rule: sys

#####
### Linux env specific config variables #####
#####

#NFS Mount points for Oracle DB volumes
mount_points:
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u02</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u03</i></span>

# Up to 75% of node memory size divided by 2mb. Consider how many databases to be hosted on the node and how much ram to be allocated to each DB.
# Leave it blank if hugepage is not configured on the host.
hugepages_nr: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>1234</i></span>

# RedHat subscription username and password
redhat_sub_username: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxx</i></span>
redhat_sub_password: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxx</i></span>

#####
### DB env specific install and config variables #####
#####

#Recovery Type (leave as scn)
recovery_type: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>scn</i></span>

#Oracle Control Files
control_files:
  - <span <div contenteditable="true" style="color:#004EFF; font-

```

```

    weight:bold; font-style:italic; text-decoration:underline;"/><i>/u02/oradata/CDB2/control01.ctl</i></span>
    - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>/u03/orareco/CDB2/control02.ctl</i></span>
    >

</div></code></pre></div></div>
<script>
function CopyClassText() {
    var textToCopy = document.getElementById("CopyOnPrem");
    var currentRange;
    if(document.getSelection().rangeCount > 0)
    {
        currentRange = document.getSelection().getRangeAt(0);
        window.getSelection().removeRange(currentRange);
    }
    else
    {
        currentRange = false;
    }
    var CopyRange = document.createRange();
    CopyRange.selectNode(textToCopy);
    window.getSelection().addRange(CopyRange);
    document.getElementById("more_binary_vols").style.display =
    "none";
    document.getElementById("more_database_vols").style.display =
    "none";
    document.getElementById("more_log_vols").style.display = "none";
    var command = document.execCommand("copy");
    if (command)
    {
        document.getElementById("copy-button-onprem").innerHTML =
        "Copied!";
        setTimeout(revert_copy, 3000);
    }
    window.getSelection().removeRange(CopyRange);
    if(currentRange)
    {
        window.getSelection().addRange(currentRange);
    }
}
function revert_copy() {
    document.getElementById("copy-button-onprem").innerHTML =
    "Copy";
}

```

```

        document.getElementById("more_binary_vols").style.display =
"block";
        document.getElementById("more_database_vols").style.display =
"block";
        document.getElementById("more_log_vols").style.display =
"block";
    }
    function binaryvolsdropdown() {
        document.getElementById("more_binary_vols").style.display =
"none";
        document.getElementById("more_binary_vols_button").style.display =
"block";
        var x=1;
        var myHTML = '';
        var buildup = '';
        var wrapper =
document.getElementById("select_more_binary_vols");
        while (x < 10) {
            buildup += '<option value="' + x + '">' + x + '</option>';
            x++;
        }
        myHTML += '<a id="more_binary_vols_info">How many extra volumes
do you wish to add?</a><select name="number_of_extra_binary_vols"
id="number_of_extra_binary_vols">' + buildup + '</select>';
        wrapper.innerHTML = myHTML;
    }
    function addbinaryvols() {
        var y =
document.getElementById("number_of_extra_binary_vols").value;
        var j=0;
        var myHTML = '';
        var wrapper = document.getElementById("extra_binary_vols");
        while (j < y) {
            j++;
            myHTML += ' - <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>binary_vols</i></span><br>';
        }
        wrapper.innerHTML = myHTML;
        document.getElementById("select_more_binary_vols").style.display =
"none";
        document.getElementById("more_binary_vols_button").style.display =
"none";
    }
    function databasevolsdropdown() {

```

```

        document.getElementById("more_database_vols").style.display =
    "none";

document.getElementById("more_database_vols_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper =
document.getElementById("select_more_database_vols");
    while (x < 10) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_database_vols_info">How many extra
volumes do you wish to add?</a><select
name="number_of_extra_database_vols"
id="number_of_extra_database_vols">' + buildup + '</select>';
    wrapper.innerHTML = myHTML;
}
function adddatabasevols() {
    var y =
document.getElementById("number_of_extra_database_vols").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_database_vols");
    while (j < y) {
        j++;
        myHTML += ' - <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>db_vol</i></span><br>';
    }
    wrapper.innerHTML = myHTML;

document.getElementById("select_more_database_vols").style.display =
"none";

document.getElementById("more_database_vols_button").style.display =
"none";
}

function logvolsdropdown() {
    document.getElementById("more_log_vols").style.display = "none";
    document.getElementById("more_log_vols_button").style.display =
"block";
    var x=1;

```

```

var myHTML = '';
var buildup = '';
var wrapper = document.getElementById("select_more_log_vols");
while (x < 10) {
    buildup += '<option value="' + x + '">' + x + '</option>';
    x++;
}
myHTML += '<a id="more_database_vols_info">How many extra
volumes do you wish to add?</a><select
name="number_of_extra_log_vols" id="number_of_extra_log_vols">' +
buildup + '</select>';
wrapper.innerHTML = myHTML;
}

function addlogvols() {
    var y =
document.getElementById("number_of_extra_log_vols").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_log_vols");
    while (j < y) {
        j++;
        myHTML += ' - <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>log_vol</i></span><br>';
    }
    wrapper.innerHTML = myHTML;
    document.getElementById("select_more_log_vols").style.display =
"none";
    document.getElementById("more_log_vols_button").style.display =
"none";
}

</script>

```

CVO

```

<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}

```

```

button {
    transition-duration: 0.4s;
    background-color: white;
    color: #1563a3;
    border: 2px solid #1563a3;
}
button:hover {
    background-color: #1563a3;
    color: white;
}
#more_binary_vols1 {
    display: block;
}
#more_binary_vols1_button {
    display: none;
}
#more_database_vols1 {
    display: block;
}
#more_database_vols1_button {
    display: none;
}
#more_log_vols1 {
    display: block;
}
#more_log_vols1_button {
    display: none;
}

```

</style>

```

<div class="listingblock"><div class="content"><div><button
id="copy-button-cvo"
onclick="CopyClassTextCVO () ">Copy</button></div><pre><code><div
class="CopyMeClassCVO" id="CopyCVO">
#####
## Oracle Data Protection global user configuration variables
#####
##### Consolidate all variables from ontap, aws, CVO and oracle
#####
#####
##### Ontap env specific config variables #####
#####
#####
#####
```

```

#Inventory group name
#Default inventory group name - 'ontap'
#Change only if you are changing the group name either in
inventory/hosts file or in inventory groups in case of AWX/Tower
hosts_group: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;" /><i>ontap</i></span>

#CA_signed_certificates (ONLY CHANGE to 'true' IF YOU ARE USING CA
SIGNED CERTIFICATES)
ca_signed_certs: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;" /><i>false</i></span>

#Names of the Nodes in the Source ONTAP Cluster
src_nodes:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;" /><i>AFF-
01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;" /><i>AFF-
02</i></span>

#Names of the Nodes in the Destination CVO Cluster
dst_nodes:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;" /><i>DR-
AFF-01</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;" /><i>DR-
AFF-02</i></span>

#Define whether or not to create intercluster lifs on source cluster
(ONLY CHANGE to 'No' IF YOU HAVE ALREADY CREATED THE INTERCLUSTER
LIFS)
create_source_intercluster_lifs: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>

source_intercluster_network_port_details:
  using_dedicated_ports: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>yes</i></span>
  using_ifgrp: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-

```

```

decoration:underline; text-decoration:underline;"/><i>yes</i></span>
    using_vlans: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>yes</i></span>
    failover_for_shared_individual_ports: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline; text-
decoration:underline;"/><i>yes</i></span>
    ifgrp_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>a0a</i></span>
    vlan_id: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>10</i></span>
    ports:
        - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"/><i>e0b</i></span>
        - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"/><i>e0g</i></span>
    broadcast_domain: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>NFS</i></span>
    ipspace: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>Default</i></span>
    failover_group_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"/><i>iclifs</i></span>

source_intercluster_lif_details:
    - name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>icl_1</i></span>
        address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>10.0.0.1</i></span>
        netmask: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>255.255.255.0</i></span>
        home_port: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>a0a-
10</i></span>

```

```

        node: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>AFF-01</i></span>
      - name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>icl_2</i></span>
        address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>10.0.0.2</i></span>
        netmask: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>255.255.255.0</i></span>
        home_port: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;" /><i>a0a-
10</i></span>
        node: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;" /><i>AFF-02</i></span>

#####
### CVO Deployment Variables ###
#####

##### Access Keys Variables #####
# Region where your CVO will be deployed.
region_deploy: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;" /><i>us-east-1</i></span>

##### CVO and Connector Vars #####
# AWS Managed Policy required to give permission for IAM role
creation.
aws_policy: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;" /><i>arn:aws:iam::1234567:policy/OCCM</i></spa
n>

# Specify your aws role name, a new role is created if one already
does not exist.
aws_role_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;" /><i>arn:aws:iam::1234567:policy/OCCM</i></spa
n>
```

```

# Name your connector.
connector_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>awx_connector</i></span>

# Name of the key pair generated in AWS.
key_pair: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>key_pair</i></span>

# Name of the Subnet that has the range of IP addresses in your VPC.
subnet: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>subnet-12345</i></span>

# ID of your AWS security group that allows access to on-prem
resources.
security_group: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>sg-123123123</i></span>

# Your Cloud Manager Account ID.
account: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>account-A23123A</i></span>

# Name of your CVO instance
cvo_name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>test_cvo</i></span>

# ID of the VPC in AWS.
vpc: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline;"><i>vpc-
123123123</i></span>

#####
#####
# Variables for - Add on-prem ONTAP to Connector in Cloud Manager
#####
#####

# For Federated users, Client ID from API Authentication Section of
Cloud Central to generate access token.
sso_id: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-

```



```

text-decoration:underline;"/><i>dst-nfs-lif</i></span>

#Please Enter Source Cluster Name
src_cluster_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>src-cluster-
name</i></span>

#Please Enter Source Cluster
src_cluster_ip: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-decoration:underline;"/><i>src-cluster-
ip</i></span>

#Please Enter Source SVM
src_vserver: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"/><i>src-vserver</i></span>

#####
#####
#
# Variable for Oracle Volumes and SnapMirror Details
#####
#####
#####
#
# Please Enter Source Snapshot Prefix Name
cg_snapshot_name_prefix: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"/><i>oracle</i></span>

#Please Enter Source Oracle Binary Volume(s)
src_orabinary_vols:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"/><i>binary_vol</i></span>
<a id="more_binary_vols1"
href="javascript:binaryvols1dropdown();">More Binary Vols</a><div
id="select_more_binary_vols1"></div><a id="more_binary_vols1_button"
href="javascript:addbinaryvols1();">Enter Volume details</a><div
id="extra_binary_vols1"></div>
#Please Enter Source Database Volume(s)
src_db_vols:
  - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"/><i>db_vol</i></span>
<a id="more_database_vols1"

```

```

    href="javascript:databasevols1dropdown();">More Database
Vols</a><div id="select_more_database_vols1"></div><a
id="more_database_vols1_button"
href="javascript:adddatabasevols1();">Enter Volume details</a><div
id="extra_database_vols1"></div>
#Please Enter Source Archive Volume(s)
src_archivelog_vols:
    - <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>log_vol</i></span>
<a id="more_log_vols1" href="javascript:logvols1dropdown();">More
Log Vols</a><div id="select_more_log_vols1"></div><a
id="more_log_vols1_button" href="javascript:addlogvols1();">Enter
Volume details</a><div id="extra_log_vols1"></div>
#Please Enter Destination Snapmirror Policy
snapmirror_policy: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>async_policy_oracle</i></span>

#####
#####
#
# Export Policy Details
#####
#####
#
#Enter the destination export policy details (Once CVO is Created
Add this Variable to all templates)
export_policy_details:
    name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline;
text-decoration:underline;"><i>nfs_export_policy</i></span>
    client_match: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>0.0.0.0/0</i></span>
    ro_rule: sys
    rw_rule: sys

#####
#####
#
### Linux env specific config variables ###
#####
#####
#
#NFS Mount points for Oracle DB volumes
mount_points:

```

```

    - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u01</i></span>
    - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u02</i></span>
    - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u03</i></span>

# Up to 75% of node memory size divided by 2mb. Consider how many databases to be hosted on the node and how much ram to be allocated to each DB.
# Leave it blank if hugepage is not configured on the host.
hugepages_nr: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>1234</i></span>

# RedHat subscription username and password
redhat_sub_username: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxx</i></span>
redhat_sub_password: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxx</i></span>

#####
### DB env specific install and config variables ###
#####
#Recovery Type (leave as scn)
recovery_type: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>scn</i></span>

#Oracle Control Files
control_files:
    - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u02/oradata/CDB2/control01.ctl</i></span>
    - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/u03/orareco/CDB2/control02.ctl</i></span>

```

```

</div></code></pre></div></div>
<script>
function CopyClassTextCVO() {
    var textToCopy = document.getElementById("CopyCVO");
    var currentRange;
    if(document.getSelection().rangeCount > 0)
    {
        currentRange = document.getSelection().getRangeAt(0);
        window.getSelection().removeRange(currentRange);
    }
    else
    {
        currentRange = false;
    }
    var CopyRange = document.createRange();
    CopyRange.selectNode(textToCopy);
    window.getSelection().addRange(CopyRange);
    document.getElementById("more_binary_vols1").style.display =
"none";
    document.getElementById("more_database_vols1").style.display =
"none";
    document.getElementById("more_log_vols1").style.display =
"none";
    var command = document.execCommand("copy");
    if (command)
    {
        document.getElementById("copy-button-cvo").innerHTML =
"Copied!";
        setTimeout(revert_copy, 3000);
    }
    window.getSelection().removeRange(CopyRange);
    if(currentRange)
    {
        window.getSelection().addRange(currentRange);
    }
}
function revert_copy() {
    document.getElementById("copy-button-cvo").innerHTML = "Copy";
    document.getElementById("more_binary_vols1").style.display =
"block";
    document.getElementById("more_database_vols1").style.display =
"block";
    document.getElementById("more_log_vols1").style.display =
"block";
}
function binaryvols1dropdown() {

```

```

        document.getElementById("more_binary_vols1").style.display =
"none";

document.getElementById("more_binary_vols1_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper =
document.getElementById("select_more_binary_vols1");
    while (x < 10) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_binary_vols1_info">How many extra volumes
do you wish to add?</a><select name="number_of_extra_binary_vols1"
id="number_of_extra_binary_vols1">' + buildup + '</select>';
    wrapper.innerHTML = myHTML;
}
function addbinaryvols1() {
    var y =
document.getElementById("number_of_extra_binary_vols1").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_binary_vols1");
    while (j < y) {
        j++;
        myHTML += ' - <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>binary_vol</i></span><br>';
    }
    wrapper.innerHTML = myHTML;

document.getElementById("select_more_binary_vols1").style.display =
"none";
}

document.getElementById("more_binary_vols1_button").style.display =
"none";
}

function databasevols1dropdown() {
    document.getElementById("more_database_vols1").style.display =
"none";

document.getElementById("more_database_vols1_button").style.display =
"block";

```

```

var x=1;
var myHTML = '';
var buildup = '';
var wrapper =
document.getElementById("select_more_database_vols1");
while (x < 10) {
    buildup += '<option value="' + x + '">' + x + '</option>';
    x++;
}
myHTML += '<a id="more_database_vols1_info">How many extra
volumes do you wish to add?</a><select
name="number_of_extra_database_vols1"
id="number_of_extra_database_vols1">' + buildup + '</select>';
wrapper.innerHTML = myHTML;
}

function adddatabasevols1() {
    var y =
document.getElementById("number_of_extra_database_vols1").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_database_vols1");
    while (j < y) {
        j++;
        myHTML += ' - <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>db_vol</i></span><br>';
    }
    wrapper.innerHTML = myHTML;

document.getElementById("select_more_database_vols1").style.display
= "none";

document.getElementById("more_database_vols1_button").style.display
= "none";
}
function logvols1dropdown() {
    document.getElementById("more_log_vols1").style.display =
"none";
    document.getElementById("more_log_vols1_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_log_vols1");
    while (x < 10) {

```

```

        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_database_vols_info">How many extra
volumes do you wish to add?</a><select
name="number_of_extra_log_vols1" id="number_of_extra_log_vols1">' +
buildup + '</select>';
    wrapper.innerHTML = myHTML;
}
function addlogvols1() {
    var y =
document.getElementById("number_of_extra_log_vols1").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_log_vols1");
    while (j < y) {
        j++;
        myHTML += ' - <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline; text-
decoration:underline;"><i>log_vol</i></span><br>';
    }
    wrapper.innerHTML = myHTML;
    document.getElementById("select_more_log_vols1").style.display =
"none";
    document.getElementById("more_log_vols1_button").style.display =
"none";
}

```

</script>

Automation Playbooks

There are four separate playbooks that need to be ran.

1. Playbook for Setting up your environment, On-Prem or CVO.
2. Playbook for replicating Oracle Binaries and Databases on a schedule
3. Playbook for replicating Oracle Logs on a schedule
4. Playbook for Recovering your database on a destination host

ONTAP/CVO Setup

ONTAP and CVO Setup

Configure and launch the job template.

1. Create the job template.
 - a. Navigate to Resources → Templates → Add and click Add Job Template.
 - b. Enter the name ONTAP/CVO Setup
 - c. Select the Job type; Run configures the system based on a playbook.
 - d. Select the corresponding inventory, project, playbook, and credentials for the playbook.
 - e. Select the ontap_setup.yml playbook for an On-Prem environment or select the cvo_setup.yml for replicating to a CVO instance.
 - f. Paste global variables copied from step 4 into the Template Variables field under the YAML tab.
 - g. Click Save.
2. Launch the job template.
 - a. Navigate to Resources → Templates.
 - b. Click the desired template and then click Launch.



We will use this template and copy it out for the other playbooks.

Replication For Binary and Database Volumes

Scheduling the Binary and Database Replication Playbook

Configure and launch the job template.

1. Copy the previously created job template.
 - a. Navigate to Resources → Templates.
 - b. Find the ONTAP/CVO Setup Template, and on the far right click on Copy Template
 - c. Click Edit Template on the copied template, and change the name to Binary and Database Replication Playbook.
 - d. Keep the same inventory, project, credentials for the template.
 - e. Select the ora_replication_cg.yml as the playbook to be executed.
 - f. The variables will remain the same, but the CVO cluster IP will need to be set in the variable dst_cluster_ip.
 - g. Click Save.
2. Schedule the job template.
 - a. Navigate to Resources → Templates.
 - b. Click the Binary and Database Replication Playbook template and then click Schedules at the top set of options.
 - c. Click Add, add Name Schedule for Binary and Database Replication, choose the Start date/time at the beginning of the hour, choose your Local time zone, and Run frequency. Run frequency will be often the SnapMirror replication will be updated.



A separate schedule will be created for the Log volume replication, so that it can be replicated on a more frequent cadence.

Replication for Log Volumes

Scheduling the Log Replication Playbook

Configure and launch the job template.

1. Copy the previously created job template.
 - a. Navigate to Resources → Templates.
 - b. Find the ONTAP/CVO Setup Template, and on the far right click on Copy Template
 - c. Click Edit Template on the copied template, and change the name to Log Replication Playbook.
 - d. Keep the same inventory, project, credentials for the template.
 - e. Select the ora_replication_logs.yml as the playbook to be executed.
 - f. The variables will remain the same, but the CVO cluster IP will need to be set in the variable dst_cluster_ip.
 - g. Click Save.
2. Schedule the job template.
 - a. Navigate to Resources → Templates.
 - b. Click the Log Replication Playbook template and then click Schedules at the top set of options.
 - c. Click Add, add Name Schedule for Log Replication, choose the Start date/time at the beginning of the hour, choose your Local time zone, and Run frequency. Run frequency will be often the SnapMirror replication will be updated.



It is recommended to set the log schedule to update every hour to ensure the recovery to the last hourly update.

Restore and Recover Database

Scheduling the Log Replication Playbook

Configure and launch the job template.

1. Copy the previously created job template.
 - a. Navigate to Resources → Templates.
 - b. Find the ONTAP/CVO Setup Template, and on the far right click on Copy Template
 - c. Click Edit Template on the copied template, and change the name to Restore and Recovery Playbook.
 - d. Keep the same inventory, project, credentials for the template.
 - e. Select the ora_recovery.yml as the playbook to be executed.
 - f. The variables will remain the same, but the CVO cluster IP will need to be set in the variable dst_cluster_ip.
 - g. Click Save.



This playbook will not be ran until you are ready to restore your database at the remote site.

Recovering Oracle Database

1. On-premises production Oracle databases data volumes are protected via NetApp SnapMirror replication to either a redundant ONTAP cluster in secondary data center or Cloud Volume ONTAP in public cloud. In a fully configured disaster recovery environment, recovery compute instances in secondary data center or public cloud are standby and ready to recover the production database in the case of a disaster. The standby compute instances are kept in sync with on-prem instances by running parallel updates on OS kernel patch or upgrade in a lockstep.
2. In this solution demonstrated, Oracle binary volume is replicated to target and mounted at target instance to bring up Oracle software stack. This approach to recover Oracle has advantage over a fresh installation of Oracle at last minute when a disaster occurred. It guarantees Oracle installation is fully in sync with current on-prem production software installation and patch levels etc. However, this may or may not have additional software licensing implication for the replicated Oracle binary volume at recovery site depending on how the software licensing is structured with Oracle. User is recommended to check with its software licensing personnel to assess the potential Oracle licensing requirement before deciding to use the same approach.
3. The standby Oracle host at the destination is configured with the Oracle prerequisite configurations.
4. The SnapMirrors are broken and the volumes are made writable and mounted to the standby Oracle host.
5. The Oracle recovery module performs following tasks to recovery and startup Oracle at recovery site after all DB volumes are mounted at standby compute instance.
 - a. Sync the control file: We deployed duplicate Oracle control files on different database volume to protect critical database control file. One is on the data volume and another is on log volume. Since data and log volumes are replicated at different frequency, they will be out of sync at the time of recovery.
 - b. Relink Oracle binary: Since the Oracle binary is relocated to a new host, it needs a relink.
 - c. Recover Oracle database: The recovery mechanism retrieves last System Change Number in last available archived log in Oracle log volume from control file and recovers Oracle database to recoup all business transactions that was able to be replicated to DR site at the time of failure. The database is then started up in a new incarnation to carry on user connections and business transaction at recovery site.

Before running the Recovering playbook make sure you have the following:

Make sure it copy over the /etc/oratab and /etc/oralInst.loc from the source Oracle host to the destination host

TR-4794: Oracle databases on NetApp EF-Series

Mitch Blackburn, Ebin Kadavy, NetApp

TR-4794 is intended to help storage administrators and database administrators successfully deploy Oracle on NetApp EF-Series storage.

[TR-4794: Oracle databases on NetApp EF-Series](#)

Microsoft SQL Server

TR-4897: SQL Server on Azure NetApp Files - Real Deployment View

Niyaz Mohamed, NetApp

IT organizations face constant change. Gartner reports nearly 75% of all databases will require cloud-based storage by 2022. As a leading relational database management system (RDBMS), Microsoft SQL Server is the go-to choice for Windows platform-designed applications and organizations that rely on SQL Server for everything from enterprise resource planning (ERP) to analytics to content management. SQL Server has helped to revolutionize the way enterprises manage massive data sets and power their applications to meet the schema and query performance demands.

Most IT organizations follow a cloud-first approach. Customers in a transformation phase evaluate their current IT landscape and then migrate their database workloads to the cloud based on an assessment and discovery exercise. Some factors driving customers toward cloud migration include elasticity/burst, data center exit, data center consolidation, end-of-life scenarios, mergers, acquisitions, and so on. The reason for migration can vary based on each organization and their respective business priorities. When moving to the cloud, choosing the right cloud storage is very important in order to unleash the power of SQL Server database cloud deployment.

Use case

Moving the SQL Server estate to Azure and integrating SQL Server with Azure's vast array of platform-as-a-service (PaaS) features such as Azure Data Factory, Azure IoT Hub, and Azure Machine Learning creates tremendous business value to support digital transformation. Adopting the cloud also enables the respective business unit to focus on productivity and delivering new features and enhancements faster (Dev/Test use case) than relying on the CAPEX model or traditional private cloud models. This document covers a real-time deployment of SQL Server Always On availability group (AOAG) on Azure NetApp Files leveraging Azure Virtual Machines.

Azure NetApp Files provides enterprise-grade storage with continuously available file shares. Continuously available shares are required by SQL Server production databases on SMB file share to make sure that the node always has access to the database storage, including during disruptive scenarios such as controller upgrades or failures. Continuously available file shares eliminate the need to replicate data between storage nodes. Azure NetApp Files uses SMB 3.0 scale-out, persistent handles, and transparent failover to support nondisruptive operations (NDOs) for planned and unplanned downtime events, including many administrative tasks.

When planning cloud migrations, you should always evaluate the best approach to use. The most common and easiest approach for application migration is rehosting (also known as lift and shift). The example scenario provided in this document uses the rehosting method. SQL Server on Azure virtual machines with Azure NetApp Files allows you to use full versions of SQL Server in the cloud without having to manage on-premises hardware. SQL Server virtual machines (VMs) also simplify licensing costs when you pay as you go and provides elasticity and bursting capabilities for development, test, and estate refresh scenarios.

Factors to consider

VM performance

Selecting the right VM size is important for optimal performance of a relational database in a public cloud. Microsoft recommends that you continue using the same database performance-tuning options that are applicable to SQL Server in on-premises server environments. Use [memory-optimized](#) VM sizes for the best performance of SQL Server workloads. Collect the performance data of existing deployment to identify the RAM and CPU utilization while choosing the right instances. Most deployments choose between the D, E, or M

series.

Notes:

- For the best performance of SQL Server workloads, use memory-optimized VM sizes.
- NetApp and Microsoft recommend that you identify the storage performance requirements before choosing the instance type with the appropriate memory-to-vCore ratio. This also helps select a lower-instance type with the right network bandwidth to overcome storage throughput limits of the VM.

VM redundancy

To increase redundancy and high availability, SQL Server VMs should either be in the same [availability set](#) or different [availability zones](#). When creating Azure VMs, you must choose between configuring availability sets versus availability zones; an Azure VM cannot participate in both.

High availability

For high availability, configuring SQL Server AOAG or Always On Failover Cluster Instance (FCI) is the best option. For AOAG, this involves multiple instances of SQL Server on Azure Virtual Machines in a virtual network. If high availability is required at the database level, consider configuring SQL Server availability groups.

Storage configuration

Microsoft SQL Server can be deployed with an SMB file share as the storage option. Starting with SQL Server 2012, system databases (master, model, msdb, or tempdb), and user databases can be installed with Server Message Block (SMB) file server as a storage option. This applies to both SQL Server stand-alone and SQL Server FCI.



File share storage for SQL Server databases should support continuously available property. This provides uninterrupted access to the file-share data.

Azure NetApp Files provides high performing file storage to meet any demanding workload, and it reduces SQL Server TCO as compared to block storage solutions. With block storage, VMs have imposed limits on I/O and bandwidth for disk operations; network bandwidth limits alone are applied against Azure NetApp Files. In other words, no VM-level I/O limits are applied to Azure NetApp Files. Without these I/O limits, SQL Server running on smaller VMs connected to Azure NetApp Files can perform as well as SQL Server running on much larger VMs. Azure NetApp Files reduce SQL Server deployment costs by reducing compute and software licensing costs. For detailed cost analysis and performance benefits of using Azure NetApp Files for SQL Server deployment, see the [Benefits of using Azure NetApp Files for SQL Server deployment](#).

Benefits

The benefits of using Azure NetApp Files for SQL Server include the following:

- Using Azure NetApp Files allows you to use smaller instances, thus reducing compute cost.
- Azure NetApp Files also reduces software licensing costs, which reduce the overall TCO.
- Volume reshaping and dynamic service level capability optimizes cost by sizing for steady-state workloads and avoiding overprovisioning.

Notes:

- To increase redundancy and high availability, SQL Server VMs should either be in the same [availability set](#)

or in different [availability zones](#). Consider file path requirements if user-defined data files are required; in which case, select SQL FCI over SQL AOAG.

- The following UNC path is supported: `\ANFSMB-b4ca.anf.test\SQLDB` and `\ANFSMB-b4ca.anf.test\SQLDB\`.
- The loopback UNC path is not supported.
- For sizing, use historic data from your on-premises environment. For OLTP workloads, match the target IOPS with performance requirements using workloads at average and peak times along with the disk reads/sec and disk writes/sec performance counters. For data warehouse and reporting workloads, match the target throughput using workloads at average and peak times and the disk read bytes/sec and disk write bytes/sec. Average values can be used in conjunction with volume reshaping capabilities.

Create continuously available shares

Create continuously available shares with the Azure portal or Azure CLI. In the portal, select the Enable Continuous Availability property option. for the Azure CLI, specify the share as a continuously available share by using the `az netappfiles volume create` with the `smb-continuously-avl` option set to `$True`. To learn more about creating a new, continuous availability-enabled volume, see [Creating a Continuously Available Share](#).

Notes:

- Enable continuous availability for the SMB volume as shown in the following image.
- If a non-administrator domain account is used, make sure the account has the required security privilege assigned.
- Set the appropriate permissions at the share level and proper file-level permissions.
- A continuously available property cannot be enabled on existing SMB volumes. To convert an existing volume to use a continuously available share, use NetApp Snapshot technology. For more information, see [Convert existing SMB volumes to use Continuous Availability](#).

Create a volume

X

Basics **Protocol** Tags Review + create

Configure access to your volume.

Access

Protocol type NFS SMB Dual-protocol (NFSv3 and SMB)

Configuration

Active Directory * <small>(i)</small>	<input type="text" value="10.0.0.100 - anf.test/join"/>	<small>▼</small>
Share name * <small>(i)</small>	<input type="text" value="SQLDB"/>	
Enable Continuous Availability <small>(i)</small>	<input checked="" type="checkbox"/>	

Review + create

< Previous

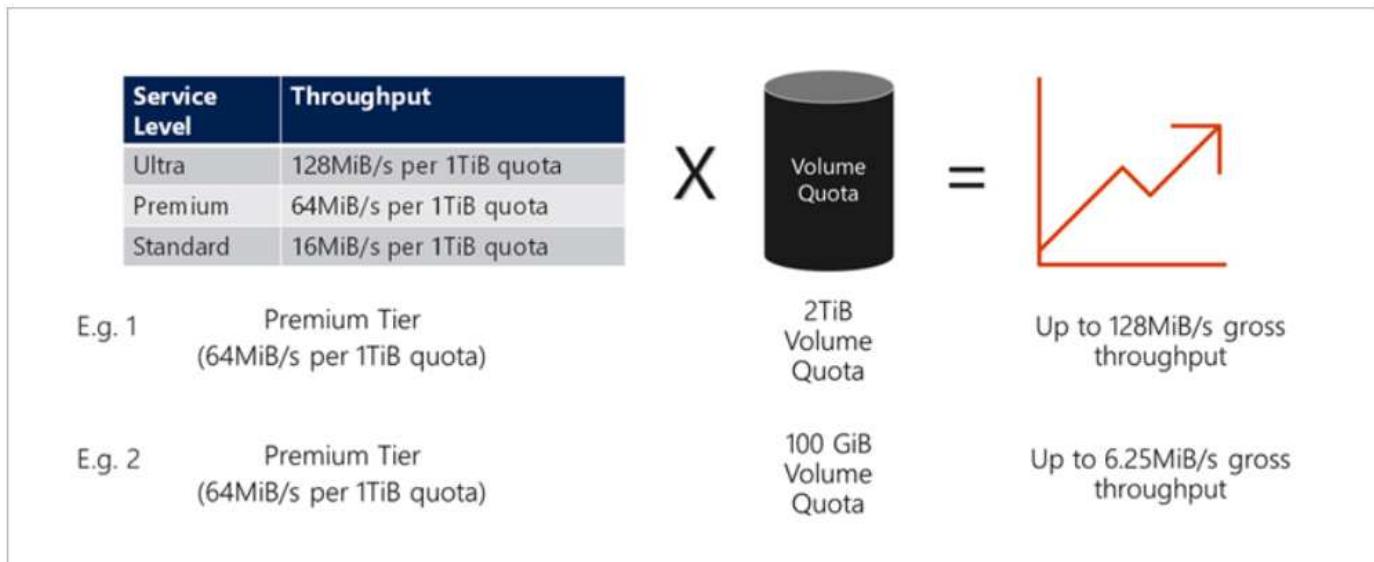
Next : Tags >

Performance

Azure NetApp Files supports three service levels: Standard (16MBps per terabyte), Premium (64MBps per terabyte), and Ultra (128MBps per terabyte). Provisioning the right volume size is important for optimal performance of the database workload. With Azure NetApp Files, volume performance and the throughput limit are based on a combination of the following factors:

- The service level of the capacity pool to which the volume belongs
- The quota assigned to the volume
- The quality of service (QoS) type (auto or manual) of the capacity pool

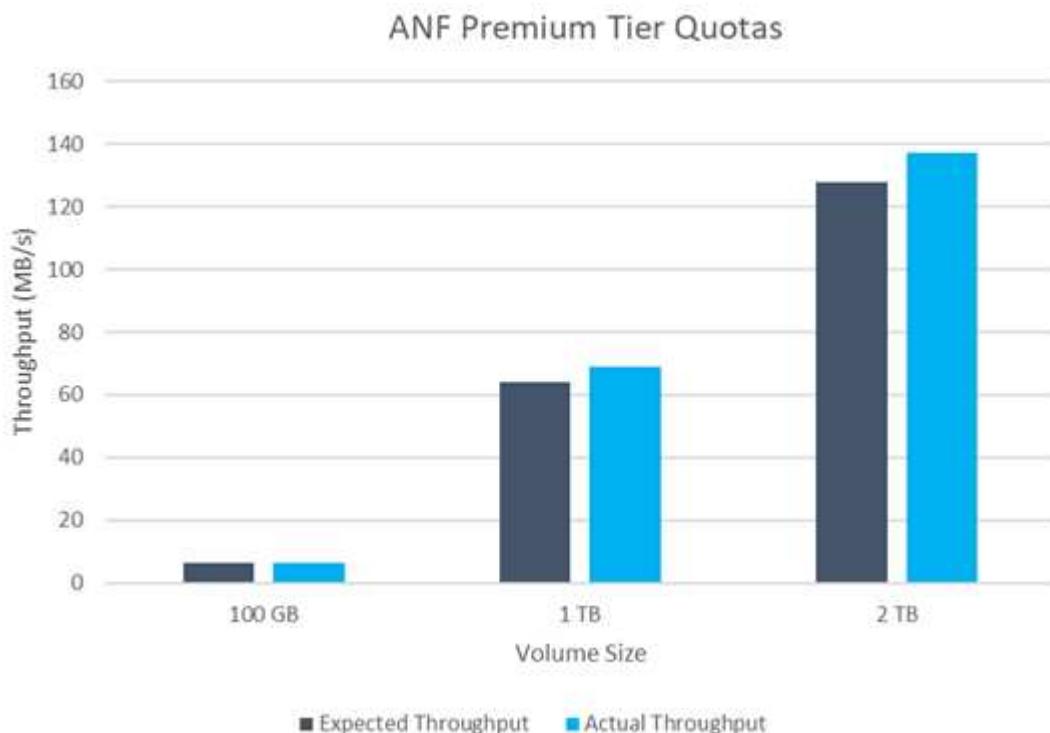
For more information, see [Service levels for Azure NetApp Files](#).



Performance validation

As with any deployment, testing the VM and storage is critical. For storage validation, tools such as HammerDB, Apploader, the [SQL Server storage benchmark \(SB\) tool](#), or any custom script or FIO with the appropriate read/write mix should be used. Keep in mind however that most SQL Server workloads, even busy OLTP workloads, are closer to 80%–90% read and 10%–20% write.

To showcase performance, a quick test was performed against a volume using premium service levels. In this test, the volume size was increased from 100GB to 2TB on the fly without any disruption to application access and zero data migration.



Here is another example of real time performance testing with HammerDB performed for the deployment covered in this paper. For this testing, we used a small instance with eight vCPUs, a 500GB Premium SSD, and a 500GB SMB Azure NetApp Files volume. HammerDB was configured with 80 warehouses and eight

users.

The following chart shows that Azure NetApp Files was able to deliver 2.6x the number of transactions per minute at 4x lower latency when using a comparable sized volume (500GB).

An additional test was performed by resizing to a larger instance with 32x vCPUs and a 16TB Azure NetApp Files volume. There was a significant increase in transactions per minute with consistent 1ms latency. HammerDB was configured with 80 warehouses and 64 users for this test.



Cost optimization

Azure NetApp Files allows nondisruptive, transparent volume resizing and the ability to change the service levels with zero downtime and no effect on applications. This is a unique capability allowing dynamic cost management that avoids the need to perform database sizing with peak metrics. Rather, you can use steady state workloads, which avoids upfront costs. The volume reshaping and dynamic service-level change allows you to adjust the bandwidth and service level of Azure NetApp Files volumes on demand almost instantaneously without pausing I/O, while retaining data access.

Azure PaaS offerings such as LogicApp or Functions can be used to easily resize the volume based on a specific webhook or alert rule trigger to meet the workload demands while dynamically handling the cost.

For example, consider a database that needs 250MBps for steady state operation; however, it also requires a peak throughput of 400MBps. In this case, the deployment should be performed with a 4TB volume within the Premium service level to meet the steady-state performance requirements. To handle the peak workload, increase the volume size using Azure functions to 7TB for that specific period, and then downsize the volume to make the deployment cost effective. This configuration avoids overprovisioning of the storage.

Real-time, high-level reference design

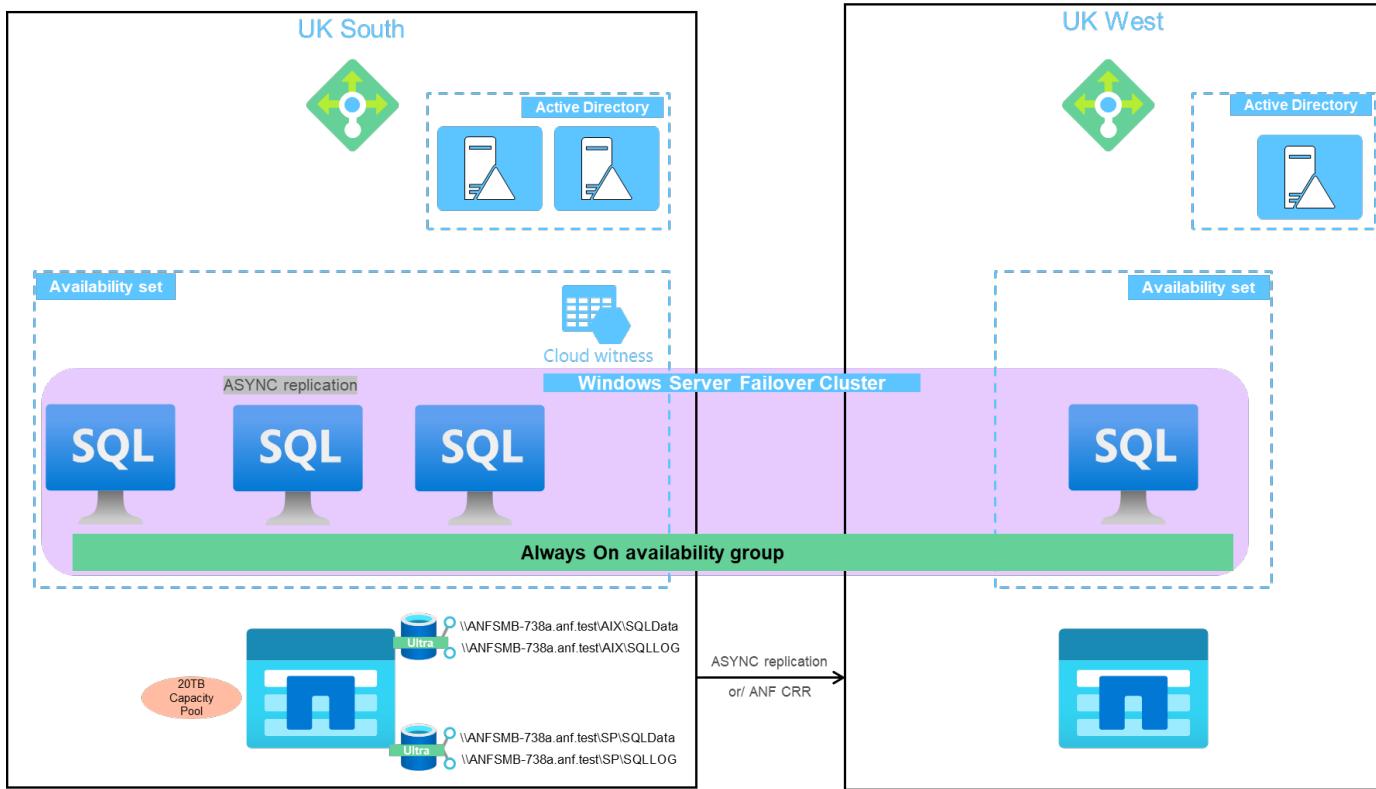
This section covers a real-time deployment of a SQL database estate in an AOAG configuration using an Azure NetApp Files SMB volume.

- Number of nodes: 4
- Number of databases: 21
- Number of availability groups: 4

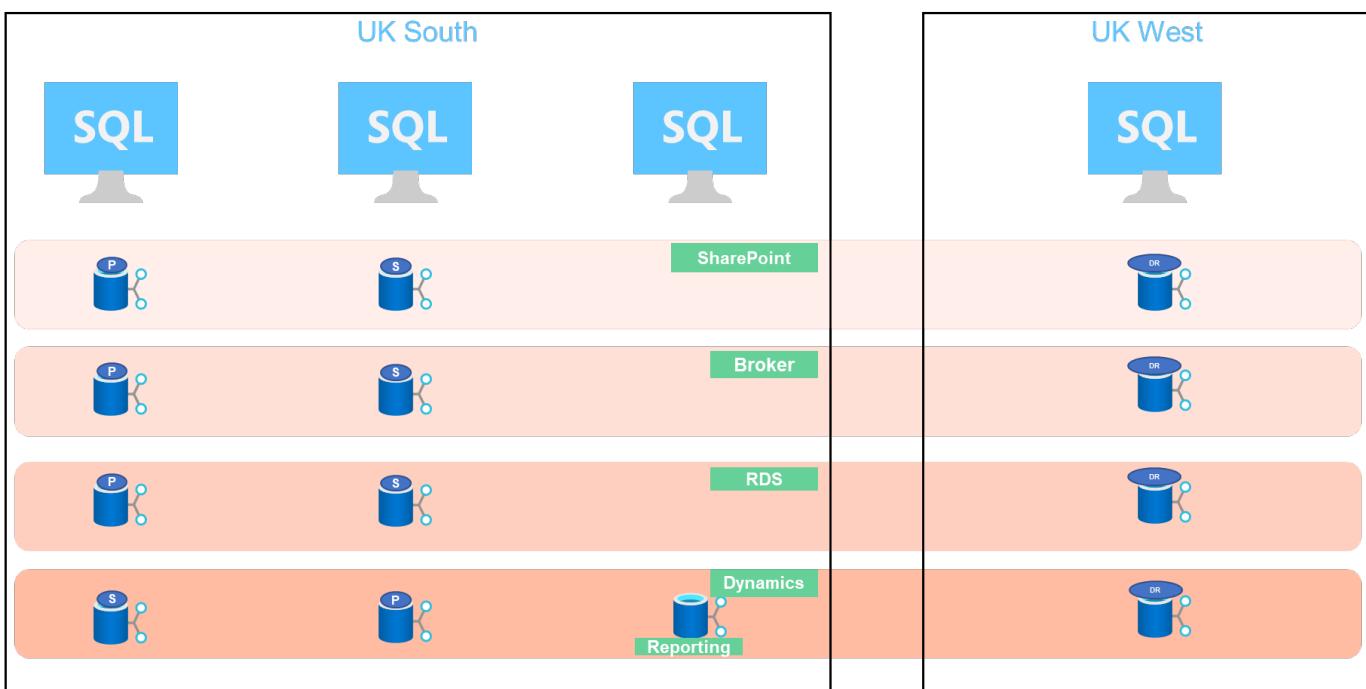
- Backup retention: 7 days
- Backup archive: 365 days



Deploying FCI with SQL Server on Azure virtual machines with an Azure NetApp Files share provides a cost-efficient model with a single copy of the data. This solution can prevent add-file operation issues if the file path differs from the secondary replica.



The following image shows the databases within AOAG spread across the nodes.



Data layout

The user database files (.mdf) and user database transaction log files (.ldf) along with tempDB are stored on the same volume. The service level is Ultra.

The configuration consists of four nodes and four AGs. All 21 databases (part of Dynamic AX, SharePoint, RDS connection broker, and indexing services) are stored on the Azure NetApp Files volumes. The databases are balanced between the AOAG nodes to use the resources on the nodes effectively. Four D32 v3 instances are added in the WSFC, which participates in the AOAG configuration. These four nodes are provisioned in the Azure virtual network and are not migrated from on-premises.

Notes:

- If the logs require more performance and throughput depending on the nature of the application and the queries executed, the database files can be placed on the Premium service level, and the logs can be stored at the Ultra service level.
- If the tempdb files have been placed on Azure NetApp Files, then the Azure NetApp Files volume should be separated from the user database files. Here is an example distribution of the database files in AOAG.

Notes:

- To retain the benefits of Snapshot copy-based data protection, NetApp recommends not combining data and log data into the same volume.
- An add-file operation performed on the primary replica might fail on the secondary databases if the file path of a secondary database differs from the path of the corresponding primary database. This can happen if the share path is different on primary and secondary nodes (due to different computer accounts). This failure could cause the secondary databases to be suspended. If the growth or performance pattern cannot be predicted and the plan is to add files later, a SQL Server failover cluster with Azure NetApp Files is an acceptable solution. For most deployments, Azure NetApp Files meets the performance requirements.

Migration

There are several ways to migrate an on-premises SQL Server user database to SQL Server in an Azure virtual machine. The migration can be either online or offline. The options chosen depend on the SQL Server version, business requirements, and the SLAs defined within the organization. To minimize downtime during the database migration process, NetApp recommends using either the AlwaysOn option or the transactional replication option. If it is not possible to use these methods, you can migrate the database manually.

The simplest and most thoroughly tested approach for moving databases across machines is backup and restore. Typically, you can start with a database backup followed by a copy of the database backup into Azure. You can then restore the database. For the best data transfer performance, migrate the database files into the Azure VM using a compressed backup file. The high-level design referenced in this document uses the backup approach to Azure file storage with Azure file sync and then restore to Azure NetApp files.



Azure Migrate can be used to discover, assess, and migrate SQL Server workloads.

To perform a migration, complete the following high-level steps:

1. Based on your requirements, set up connectivity.
2. Perform a full database backup to an on-premises file-share location.
3. Copy the backup files to an Azure file share with Azure file sync.
4. Provision the VM with the desired version of SQL Server.
5. Copy the backup files to the VM by using the `copy` command from a command prompt.
6. Restore the full databases to SQL Server on Azure virtual machines.



To restore 21 databases, it took approximately nine hours. This approach is specific to this scenario. However, other migration techniques listed below can be used based on your situation and requirements.

Other migration options to move data from an on-premises SQL Server to Azure NetApp Files include the following:

- Detach the data and log files, copy them to Azure Blob storage, and then attach them to SQL Server in the Azure VM with an ANF file share mounted from the URL.
- If you are using Always On availability group deployment on-premises, use the [Add Azure Replica Wizard](#) to create a replica in Azure and then perform failover.
- Use SQL Server [transactional replication](#) to configure the Azure SQL Server instance as a subscriber, disable replication, and point users to the Azure database instance.
- Ship the hard drive using the Windows Import/Export Service.

Backup and recovery

Backup and recovery are an important aspect of any SQL Server deployment. It is mandatory to have the appropriate safety net to quickly recover from various data failure and loss scenarios in conjunction with high availability solutions such as AOAG. SQL Server Database Quiesce Tool, Azure Backup (streaming), or any third-party backup tool such as Commvault can be used to perform an application-consistent backup of the databases,

Azure NetApp Files Snapshot technology allows you to easily create a point-in-time (PiT) copy of the user databases without affecting performance or network utilization. This technology also allows you to restore a

Snapshot copy to a new volume or quickly revert the affected volume to the state it was in when that Snapshot copy was created by using the revert volume function. The Azure NetApp Files snapshot process is very quick and efficient, which allows for multiple daily backups, unlike the streaming backup offered by Azure backup. With multiple Snapshot copies possible in a given day, the RPO and RTO times can be significantly reduced. To add application consistency so that data is intact and properly flushed to the disk before the Snapshot copy is taken, use the SQL Server database quiesce tool ([SCSQLAPI tool](#); access to this link requires NetApp SSO login credentials). This tool can be executed from within PowerShell, which quiesces the SQL Server database and in turn can take the application-consistent storage Snapshot copy for backups.

*Notes: *

- The SCSSQLAPI tool only supports the 2016 and 2017 versions of SQL Server.
- The SCSSQLAPI tool only works with one database at a time.
- Isolate the files from each database by placing them onto a separate Azure NetApp Files volume.

Because of SCSSQL API's vast limitations, [Azure Backup](#) was used for data protection in order to meet the SLA requirements. It offers a stream-based backup of SQL Server running in Azure Virtual Machines and Azure NetApp Files. Azure Backup allows a 15-minute RPO with frequent log backups and PiT recovery up to one second.

Monitoring

Azure NetApp Files is integrated with Azure Monitor for the time series data and provides metrics on allocated storage, actual storage usage, volume IOPS, throughput, disk read bytes/sec, disk write bytes/sec, disk reads/sec and disk writes/sec, and associated latency. This data can be used to identify bottlenecks with alerting and to perform health checks to verify that your SQL Server deployment is running in an optimal configuration.

In this HLD, ScienceLogic is used to monitor Azure NetApp Files by exposing the metrics using the appropriate service principal. The following image is an example of the Azure NetApp Files Metric option.

Avg Total throughput for volume1 [edit]

Add metric Add filter Apply splitting Line chart ▼ Drill into Logs ▼ New alert rule Pin to dashboard ...

Scope	Metric Namespace	Metric	Aggregation
volume1	NetApp Volumes stand...	Total throughput	Avg

Percentage Volume Consumed Size
Read iops
Read throughput
Total throughput
Volume allocated size
Volume Backup Bytes

Dev/Test using thick clones

With Azure NetApp Files, you can create instantaneous copies of databases to test functionality that should be implemented by using the current database structure and content during the application development cycles, to use the data extraction and manipulation tools when populating data warehouses, or to even recover data that was mistakenly deleted or changed. This process does not involve copying data from Azure Blob containers, which makes it very efficient. After the volume is restored, it can be used for read/write operations, which significantly reduces validation and time to market. This needs to be used in conjunction with SCSSQLAPI for application consistency. This approach provides yet another continuous cost optimization technique along with

Azure NetApp Files leveraging the Restore to New volume option.

Notes:

- The volume created from the Snapshot copy using the Restore New Volume option consumes capacity from the capacity pool.
- You can delete the cloned volumes by using REST or Azure CLI to avoid additional costs (in case the capacity pool must be increased).

Hybrid storage options

Although NetApp recommends using the same storage for all the nodes in SQL Server availability groups, there are scenarios in which multiple storage options can be used. This scenario is possible for Azure NetApp Files in which a node in AOAG is connected with an Azure NetApp Files SMB file share and the second node is connected with an Azure Premium disk. In these instances, make sure that the Azure NetApp Files SMB share is holding the primary copy of the user databases and the Premium disk is used as the secondary copy.

Notes:

- In such deployments, to avoid any failover issues, make sure that continuous availability is enabled on the SMB volume. With no continuously available attribute, the database can fail if there is any background maintenance at the storage layer.
- Keep the primary copy of the database on the Azure NetApp Files SMB file share.

Business continuity

Disaster recovery is generally an afterthought in any deployment. However, disaster recovery must be addressed during the initial design and deployment phase to avoid any impact to your business. With Azure NetApp Files, the cross-region replication (CRR) functionality can be used to replicate the volume data at the block level to the paired region to handle any unexpected regional outage. The CRR-enabled destination volume can be used for read operations, which makes it an ideal candidate for disaster recovery simulations. In addition, the CRR destination can be assigned with the lowest service level (for instance, Standard) to reduce the overall TCO. In the event of a failover, replication can be broken, which makes the respective volume read/write capable. Also, the service level of the volume can be changed by using the dynamic service level functionality to significantly reduce disaster recovery cost. This is another unique feature of Azure NetApp Files with block replication within Azure.

Long-term Snapshot copy archive

Many organizations must perform long-term retention of snapshot data from database files as a mandatory compliance requirement. Although this process is not used in this HLD, it can be easily accomplished by using a simple batch script using [AzCopy](#) to copy the snapshot directory to the Azure Blob container. The batch script can be triggered based on a specific schedule by using scheduled tasks. The process is straightforward—it includes the following steps:

1. Download the AzCopy V10 executable file. There is nothing to install because it is an exe file.
2. Authorize AzCopy by using a SAS token at the container level with the appropriate permissions.
3. After AzCopy is authorized, the data transfer begins.

Notes:

- In batch files, make sure to escape the % characters that appear in SAS tokens. This can be done by adding an additional % character next to existing % characters in the SAS token string.

- The **Secure Transfer Required** setting of a storage account determines whether the connection to a storage account is secured with Transport Layer Security (TLS). This setting is enabled by default. The following batch script example recursively copies data from the Snapshot copy directory to a designated Blob container:

```
SET source="Z:\~snapshot"
echo %source%
SET
dest="https://testanfacct.blob.core.windows.net/azcopts?sp=racwdl&st=2020
-10-21T18:41:35Z&se=2021-10-22T18:41:00Z&sv=2019-12
-12&sr=c&sig=ZxRUJwF1LXgHS8As7HzXJOaDXXVJ7PxxIX3ACpx56XY%%3D"
echo %dest%
```

The following example cmd is executed in PowerShell:

```
-recursive
```

```
INFO: Scanning...
INFO: Any empty folders will not be processed, because source and/or
destination doesn't have full folder support
Job b3731dd8-da61-9441-7281-17a4db09ce30 has started
Log file is located at: C:\Users\niyaz\.azcopy\b3731dd8-da61-9441-7281-
17a4db09ce30.log
0.0 %, 0 Done, 0 Failed, 2 Pending, 0 Skipped, 2 Total,
INFO: azcopy.exe: A newer version 10.10.0 is available to download
0.0 %, 0 Done, 0 Failed, 2 Pending, 0 Skipped, 2 Total,
Job b3731dd8-da61-9441-7281-17a4db09ce30 summary
Elapsed Time (Minutes): 0.0333
Number of File Transfers: 2
Number of Folder Property Transfers: 0
Total Number of Transfers: 2
Number of Transfers Completed: 2
Number of Transfers Failed: 0
Number of Transfers Skipped: 0
TotalBytesTransferred: 5
Final Job Status: Completed
```

Notes:

- A similar backup feature for long-term retention will soon be available in Azure NetApp Files.
- The batch script can be used in any scenario that requires data to be copied to Blob container of any region.

Cost optimization

With volume reshaping and dynamic service level change, which is completely transparent to the database, Azure NetApp Files allows continuous cost optimizations in Azure. This capability is used in this HLD extensively to avoid overprovisioning of additional storage to handle workload spikes.

Resizing the volume can be easily accomplished by creating an Azure function in conjunction with the Azure alert logs.

Conclusion

Whether you are targeting an all-cloud or hybrid cloud with stretch databases, Azure NetApp Files provides excellent options to deploy and manage the database workloads while reducing your TCO by making data requirements seamless to the application layer.

This document covers recommendations for planning, designing, optimizing, and scaling Microsoft SQL Server deployments with Azure NetApp Files, which can vary greatly between implementations. The right solution depends on both the technical details of the implementation and the business requirements driving the project.

Takeaways

The key points of this document include:

- You can now use Azure NetApp Files to host the database and file share witness for SQL Server cluster.
- You can boost the application response times and deliver 99.9999% availability to provide access to SQL Server data when and where it is needed.
- You can simplify the overall complexity of the SQL Server deployment and ongoing management, such as raid striping, with simple and instant resizing.
- You can rely on intelligent operations features to help you deploy SQL Server databases in minutes and speed development cycles.
- If Azure Cloud is the destination, Azure NetApp Files is the right storage solution for optimized deployment.

Where to find additional information

To learn more about the information described in this document, refer to the following website links:

- Solution architectures using Azure NetApp Files

<https://docs.microsoft.com/en-us/azure/azure-netapp-files/azure-netapp-files-solution-architectures>

- Benefits of using Azure NetApp Files for SQL Server deployment

<https://docs.microsoft.com/en-us/azure/azure-netapp-files/solutions-benefits-azure-netapp-files-sql-server>

- SQL Server on Azure Deployment Guide Using Azure NetApp Files

<https://www.netapp.com/pdf.html?item=/media/27154-tr-4888.pdf>

- Fault tolerance, high availability, and resilience with Azure NetApp Files

<https://cloud.netapp.com/blog/azure-anf-blr-fault-tolerance-high-availability-and-resilience-with-azure-netapp-files>

TR-4923: SQL Server on AWS EC2 using Amazon FSx for NetApp ONTAP

Authors: Pat Sinthusan and Niyaz Mohamed, NetApp

Introduction

Many companies that would like to migrate applications from on-premises to the cloud find that the effort is hindered by the differences in capabilities offered by on-premises storage systems and cloud storage services. That gap has made migrating enterprise applications such as Microsoft SQL Server much more problematic. In particular, gaps in the services needed to run an enterprise application such as robust snapshots, storage efficiency capabilities, high availability, reliability, and consistent performance have forced customers to make design tradeoffs or forgo application migration. With FSx for NetApp ONTAP, customers no longer need to compromise. FSx for NetApp ONTAP is a native (1st party) AWS service sold, supported, billed, and fully managed by AWS. It uses the power of NetApp ONTAP to provide the same enterprise grade storage and data management capabilities NetApp has provided on-premises for three decades in AWS as a managed service.

With SQL Server on EC2 instances, database administrators can access and customize their database environment and the underlying operating system. A SQL Server on EC2 instance in combination with [AWS FSx ONTAP](#) to store the database files, enables high performance, data management, and a simple and easy migration path using block-level replication. Therefore, you can run your complex database on AWS VPC with an easy lift-and-shift approach, fewer clicks, and no schema conversions.

Benefits of using Amazon FSx for NetApp ONTAP with SQL Server

Amazon FSx for NetApp ONTAP is the ideal file storage for SQL Server deployments in AWS. Benefits include the following:

- Consistent high performance and throughput with low latency
- Intelligent caching with NVMe cache to improve performance
- Flexible sizing so that you can increase or shrink capacity, throughput, and IOPs on the fly
- Efficient on-premises-to-AWS block replication
- The use of iSCSI, a well-known protocol for the database environment
- Storage efficiency features like thin provisioning and zero-footprint clones
- Backup time reduction from hours to mins, thereby reducing the RTO
- Granular backup and recovery of SQL databases with the intuitive NetApp SnapCenter UI
- The ability to perform multiple test migrations before actual migration
- Shorter downtime during migration and overcoming migration challenges with file-level or I/O-level copy
- Reducing MTTR by finding the root cause after a major release or patch update

Deploying SQL Server databases on FSx ONTAP with the iSCSI protocol, as is commonly used on-premises, provides an ideal database storage environment with superior performance, storage efficiency, and data-management capabilities. Using multiple iSCSI sessions, assuming a 5% working set size, fitting a Flash Cache delivers over 100K IOPs with the FSx ONTAP service. This configuration provides complete control over performance for the most demanding applications. SQL Server running on smaller EC2 instances connected to FSx for ONTAP can perform the same as SQL Server running on a much larger EC2 instance, because only network bandwidth limits are applied against FSx for ONTAP. Reducing the size of instances also reduces the compute cost, which provides a TCO-optimised deployment. The combination of SQL using iSCSI, SMB3.0 with multichannel, continuous availability shares on FSx for ONTAP provides great advantages for SQL workloads.

Before you begin

The combination of Amazon FSx for NetApp ONTAP and SQL Server on EC2 instance enables the creation of enterprise-level database storage designs that can meet today's most demanding application requirements. To optimize both technologies, it is vital to understand SQL Server I/O patterns and characteristics. A well-designed storage layout for a SQL Server database supports the performance of SQL Server and the management of the SQL Server infrastructure. A good storage layout also allows the initial deployment to be successful and the environment to grow smoothly over time as your business grows.

Prerequisites

Before you complete the steps in this document, you should have the following prerequisites:

- An AWS account
- Appropriate IAM roles to provision EC2 and FSx for ONTAP
- A Windows Active Directory domain on EC2
- All SQL Server nodes must be able to communicate with each other
- Make sure DNS resolution works and host names can be resolved. If not, use host file entry.
- General knowledge of SQL Server installation

Also, please refer to the NetApp Best Practices for SQL Server environments to ensure the best storage configuration.

Best practice configurations for SQL Server environments on EC2

With FSx ONTAP, procuring storage is the easiest task and can be performed by updating the file system. This simple process enables dynamic cost and performance optimization as needed, it helps to balance the SQL workload, and it is also a great enabler for thin provisioning. FSx ONTAP thin provisioning is designed to present more logical storage to EC2 instances running SQL Server than what is provisioned in the file system. Instead of allocating space upfront, storage space is dynamically allocated to each volume or LUN as data is written. In most configurations, free space is also released back when data in the volume or LUN is deleted (and is not being held by any Snapshot copies). The following table provides configuration settings for dynamically allocating storage.

Setting	Configuration
Volume guarantee	None (set by default)
LUN reservation	Enabled
fractional_reserve	0% (set by default)
snap_reserve	0%
Autodelete	volume / oldest_first
Autosize	On
try_first	Autogrow
Volume tiering policy	Snapshot only
Snapshot policy	None

With this configuration, the total size of the volumes can be greater than the actual storage available in the file system. If the LUNs or Snapshot copies require more space than is available in the volume, the volumes automatically grow, taking more space from the containing file system. Autogrow allows FSx ONTAP to automatically increase the size of the volume up to a maximum size that you predetermine. There must be space available in the containing file system to support the automatic growth of the volume. Therefore, with autogrow enabled, you should monitor the free space in the containing filesystem and update the file system when needed.

Along with this, set the [space-allocation](#) option on LUN to enabled so that FSx ONTAP notifies the EC2 host when the volume has run out of space and the LUN in the volume cannot accept writes. Also, this option enables FSx for ONTAP to reclaim space automatically when the SQL Server on EC2 host deletes data. The space-allocation option is set to disabled by default.



If a space-reserved LUN is created in a none-guaranteed volume, then the LUN behaves the same as a non-space-reserved LUN. This is because a none-guaranteed volume has no space to allocate to the LUN; the volume itself can only allocate space as it is written to due to its none guarantee.

With this configuration, FSx ONTAP administrators can generally size the volume so that they must manage and monitor the used space in the LUN on the host side and in the file system.



NetApp recommends using a separate file system for SQL server workloads. If the file system is used for multiple applications, monitor the space usage of both the file system and volumes within the file system to make sure that volumes are not competing for available space.



Snapshot copies used to create FlexClone volumes are not deleted by the autodelete option.



Overcommitment of storage must be carefully considered and managed for a mission-critical application such as SQL server for which even a minimal outage cannot be tolerated. In such a case, it is best to monitor storage consumption trends to determine how much, if any, overcommitment is acceptable.

Best Practices

- For optimal storage performance, provision file-system capacity to 1.35x times the size of total database usage.
- Appropriate monitoring accompanied by an effective action plan is required when using thin provisioning to avoid application downtime.
- Make sure to set Cloudwatch and other monitoring tool alerts so that people are contacted with enough time to react as storage is filled.

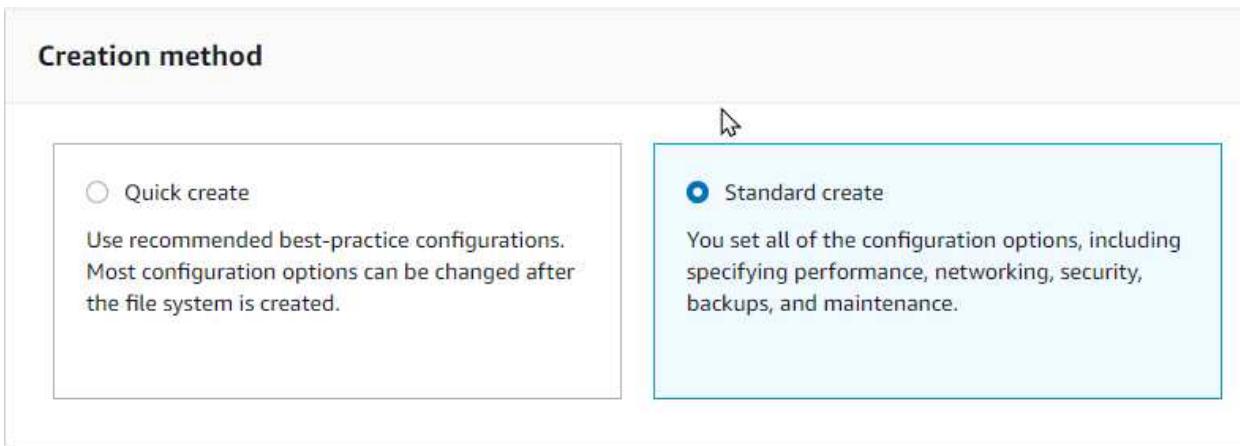
Configure Storage for SQL Server and deploy Snapcenter for Backup, Restore and clone operations

In order to perform SQL server operations with SnapCenter, you must first create volumes and LUNs for SQL server.

Create volumes and LUNs for SQL Server

To create volumes and LUNs for SQL Server, complete the following steps:

1. Open the Amazon FSx console at <https://console.aws.amazon.com/fsx/>
2. Create an Amazon FSx for the NetApp ONTAP file system using the Standard Create option under Creation Method. This allows you to define FSxadmin and vsadmin credentials.



3. Specify the password for fsxadmin.

File system administrative password
Password for this file system's "fsxadmin" user, which you can use to access the ONTAP CLI or REST API.

- Don't specify a password
 Specify a password

Password

Confirm password

4. Specify the password for SVMs.

SVM administrative password
Password for this SVM's "vsadmin" user, which you can use to access the ONTAP CLI or REST API.

- Don't specify a password
 Specify a password

Password

Confirm password

5. Create volumes by following the step listed in [Creating a volume on FSx for NetApp ONTAP](#).

Best practices

- Disable storage Snapshot copy schedules and retention policies. Instead, use NetApp SnapCenter to coordinate Snapshot copies of the SQL Server data and log volumes.
- Configure databases on individual LUNs on separate volumes to leverage fast and granular restore functionality.
- Place user data files (.mdf) on separate volumes because they are random read/write workloads. It is common to create transaction log backups more frequently than database backups. For this reason, place transaction log files (.ldf) on a separate volume from the data files so that independent backup schedules can be created for each. This separation also isolates the sequential write I/O of the log files from the random read/write I/O of data files and significantly improves SQL Server performance.
- Tempdb is a system database used by Microsoft SQL Server as a temporary workspace, especially for I/O intensive DBCC CHECKDB operations. Therefore, place this database on a dedicated volume. In large environments in which volume count is a challenge, you can consolidate tempdb into fewer volumes and store it in the same volume as other system databases after careful planning. Data protection for tempdb is not a high priority because this database is recreated every time Microsoft SQL Server is restarted.

6. Use the following SSH command to create volumes:

```
Vol create -vserver svm001 -volume vol_awssqlprod01_data -aggregate aggr1 -size 800GB -state online -tiering-policy snapshot-only -percent-snapshot-space 0 -autosize-mode grow -snapshot-policy none -security-style ntfs -aggregate aggr1
volume modify -vserver svm001 -volume vol_awssqlprod01_data -fractional-reserve 0
volume modify -vserver svm001 -volume vol_awssqlprod01_data -space -mgmt-try-first vol_grow
volume snapshot autodelete modify -vserver svm001 -volume vol_awssqlprod01_data -delete-order oldest_first
```

7. Start the iSCSI service with PowerShell using elevated privileges in Windows Servers.

```
Start-service -Name msiscsi
Set-Service -Name msiscsi -StartupType Automatic
```

8. Install Multipath-IO with PowerShell using elevated privileges in Windows Servers.

```
Install-WindowsFeature -name Multipath-IO -Restart
```

9. Find the Windows initiator Name with PowerShell using elevated privileges in Windows Servers.

```
Get-InitiatorPort | select NodeAddress
```

```
PS C:\Users\administrator.CONTOSO> Get-InitiatorPort | select NodeAddress  
NodeAddress  
-----  
iqn.1991-05.com.microsoft:ws2019-sql1.contoso.net
```

10. Connect to Storage virtual machines (SVM) using putty and create an iGroup.

```
igroup create -igroup igrp_ws2019sql1 -protocol iscsi -ostype windows -initiator iqn.1991-05.com.microsoft:ws2019-sql1.contoso.net
```

11. Use the following SSH command to create LUNs:

```
lun create -path /vol/vol_awssqlprod01_data/lun_awssqlprod01_data -size 700GB -ostype windows_2008 -space-reserve enabled -space-allocation enabled lun create -path /vol/vol_awssqlprod01_log/lun_awssqlprod01_log -size 100GB -ostype windows_2008 -space-reserve enabled -space-allocation enabled
```

```
svmsql::> lun create -path /vol/vol_awssqlprod01_data/lun_awssqlprod01_data -size 700GB -ostype windows_2008  
created a LUN of size 700g (751619276800)  
svmsql::> lun create -path /vol/vol_awssqlprod01_log/lun_awssqlprod01_log -size 100GB -ostype windows_2008  
Created a LUN of size 100g (107374182400)  
svmsql::> lun show  
Vserver Path State Mapped Type Size  
-----  
svmsql /vol/vol_awssqlprod01_data/lun_awssqlprod01_data online unmapped windows_2008  
700GB  
svmsql /vol/vol_awssqlprod01_log/lun_awssqlprod01_log online unmapped windows_2008  
100GB  
2 entries were displayed.
```

12. To achieve I/O alignment with the OS partitioning scheme, use windows_2008 as the recommended LUN type. Refer [here](#) for additional information.
13. Use the following SSH command to map igroup to the LUNs that you just created.

```
lun show  
lun map -path /vol/vol_awssqlprod01_data/lun_awssqlprod01_data -igroup igrp_awssqlprod01 lun map -path /vol/vol_awssqlprod01_log/lun_awssqlprod01_log -igroup igrp_awssqlprod01
```

```

svmsql::> lun show
Vserver   Path           State  Mapped  Type      Size
-----  -----
svmsql    /vol/vol_awssqlprod01_data/lun_awssqlprod01_data
          online  unmapped windows_2008
                           700GB
svmsql    /vol/vol_awssqlprod01_log/lun_awssqlprod01_log
          online  unmapped windows_2008
                           100GB
2 entries were displayed.

svmsql::> lun map -path /vol/vol_awssqlprod01_data/lun_awssqlprod01_data -igroup igrp_awssqlprod01
svmsql::> lun map -path /vol/vol_awssqlprod01_log/lun_awssqlprod01_log -igroup igrp_awssqlprod01
svmsql::>
svmsql::> lun show
Vserver   Path           State  Mapped  Type      Size
-----  -----
svmsql    /vol/vol_awssqlprod01_data/lun_awssqlprod01_data
          online  mapped   windows_2008
                           700GB
svmsql    /vol/vol_awssqlprod01_log/lun_awssqlprod01_log
          online  mapped   windows_2008
                           100GB
2 entries were displayed.

```

14. For a shared disk that uses the Windows Failover Cluster, run an SSH command to map the same LUN to the igroup that belong to all servers that participate in the Windows Failover Cluster.
15. Connect Windows Server to an SVM with an iSCSI target. Find the target IP address from AWS Portal.

svmsql (svm-09e98ab33a31b724a)

Summary	
SVM ID	Creation time 2021-09-21T13:19:34-07:00
svm-09e98ab33a31b724a	Lifecycle state Created
SVM name	Subtype DEFAULT
svmsql	
UUID	
ea00ea2d-1b1d-11ec-9de1-6f9cef731025	
File system ID	
fs-0ab4b447ebd6082aa	
Resource ARN	
arn:aws:fsx:us-west-2:139763910815:storage-virtual-machine/fs-0ab4b447ebd6082aa/svm-09e98ab33a31b724a	

Endpoints	
Management DNS name	Management IP address 198.19.255.153
svm-09e98ab33a31b724a.fs-0ab4b447ebd6082aa.fsx.us-west-2.amazonaws.com	
NFS DNS name	NFS IP address 198.19.255.153
svm-09e98ab33a31b724a.fs-0ab4b447ebd6082aa.fsx.us-west-2.amazonaws.com	
iSCSI DNS name	iSCSI IP addresses 10.2.1.167, 10.2.2.12
iscsi.svm-09e98ab33a31b724a.fs-0ab4b447ebd6082aa.fsx.us-west-2.amazonaws.com	

16. From Server Manager and the Tools menu, select the iSCSI Initiator. Select the Discovery tab and then select Discover Portal. Supply the iSCSI IP address from previous step and select Advanced. From Local Adapter, select Microsoft iSCSI Initiator. From Initiator IP, select the IP of the server. Then select OK to close all windows.

The screenshot shows the 'iSCSI Initiator Properties' window with the 'Targets' tab selected. In the 'Target portals' section, it says 'The system will look for Targets on following portals:' followed by a table with columns: Address, Port, Adapter, and IP address. Below the table is a note: 'To add a target portal, click Discover Portal...' and a button 'Discover Portal...'. Another note says: 'To remove a target portal, select the address above and then click Remove.' In the bottom left, there's a section for 'iSNS servers' with a note: 'The system is registered on the following iSNS servers:' and a table with a single row 'Name'. A note below says: 'To add an iSNS server, click Add Server.' On the right, a 'Discover Target Portal' dialog box is open, containing fields for 'IP address or DNS name:' (10.2.1.167) and 'Port:' (3260). It also has an 'Advanced...' button, an 'OK' button, and a 'Cancel' button.

17. Repeat step 12 for the second iSCSI IP from the SVM.
18. Select the **Targets** tab, select **Connect**, and select **Enable multi-path**.

The screenshot shows the 'iSCSI Initiator Properties' window with the 'Targets' tab selected. In the 'Quick Connect' section, there's a 'Target:' input field and a 'Quick Connect...' button. Below it is a 'Discovered targets' table with one entry: 'Name: iqn.1992-08.com.netapp:sn.ea00ea2d1b1d11ec9de16f9... Status: Inactive'. A note at the bottom says: 'To connect using advanced options, select a target and then click Connect.' On the right, a 'Connect To Target' dialog box is open, containing a 'Target name:' field with '92-08.com.netapp:sn.ea00ea2d1b1d11ec9de16f9cef731025:vs.3', two checked checkboxes ('Add this connection to the list of Favorite Targets.' and 'Enable multi-path'), and buttons for 'Advanced...', 'OK', and 'Cancel'.

19. For best performance, add more sessions; NetApp recommends creating five iSCSI sessions. Select **Properties** > ***Add session** > ***Advanced** and repeat step 12.

```
$TargetPortals = ('10.2.1.167', '10.2.2.12')
foreach ($TargetPortal in $TargetPortals) {New-IscsiTargetPortal
-TargetPortalAddress $TargetPortal}
```

```
$TargetPortals = ('10.2.1.167', '10.2.2.12')
foreach ($TargetPortal in $TargetPortals) {New-IscsiTargetPortal -TargetPortalAddress $TargetPortal}

InitiatorInstanceName :
InitiatorPortalAddress :
IsDataDigest : False
IsHeaderDigest : False
TargetPortalAddress : 10.2.1.167
TargetPortalPortNumber : 3260
PSCoputerName :

InitiatorInstanceName :
InitiatorPortalAddress :
IsDataDigest : False
IsHeaderDigest : False
TargetPortalAddress : 10.2.2.12
TargetPortalPortNumber : 3260
PSCoputerName :
```

Best Practices

- Configure five iSCSI sessions per target interface for optimal performance.
- Configure a round-robin policy for the best overall iSCSI performance.
- Make sure that the allocation unit size is set to 64K for partitions when formatting the LUNs

20. Run the following PowerShell command to make sure that the iSCSI session is persisted.

```
$targets = Get-IscsiTarget
foreach ($target in $targets)
{
    Connect-IscsiTarget -IsMultipathEnabled $true -NodeAddress
    $target.NodeAddress -IsPersistent $true
}
```

```
PS C:\Windows\system32> Connect-IscsiTarget -NodeAddress (Get-IscsiTarget | select -ExpandProperty NodeAddress)

AuthenticationType : NONE
InitiatorInstanceName : ROOT\ISCSIPRT\0000_0
InitiatorNodeAddress : iqn.1991-05.com.microsoft:awssqlprod01.cloudheroes.dom
InitiatorPortalAddress : 0.0.0
InitiatorSideIdentifier : 400001370000
IsConnected : True
IsDataDigest : False
IsDiscovered : True
IsHeaderDigest : False
IsPersistent : True
NumberOfConnections : 1
SessionIdentifier : ffff9988350ff010-4000013700000012
TargetNodeAddress : iqn.1992-08.com.netapp:sn.ea00ea2d1b1d11ec9de16f9cef731025:vs.3
TargetsSideIdentifier : 0200
PSCoputerName :
```

21. Initialize disks with the following PowerShell command.

```
$disks = Get-Disk | where PartitionStyle -eq raw
foreach ($disk in $disks) {Initialize-Disk $disk.Number}
```

Number Friendly Name		Serial Number	HealthStatus	OperationalStatus	Total Size	Partition Style
0	AWS PVDISK	vo10541c31fc4c790ab	Healthy	Online	30 GB	MBR
1	NETAPP LUN C-Mode	TwB0p7RmR2s2	Healthy	Online	700 GB	GPT
2	NETAPP LUN C-Mode	TwB0p7RmR2s3	Healthy	Online	100 GB	GPT

22. Run the Create Partition and Format Disk commands with PowerShell.

```
New-Partition -DiskNumber 1 -DriveLetter F -UseMaximumSize
Format-Volume -DriveLetter F -FileSystem NTFS -AllocationUnitSize
65536
New-Partition -DiskNumber 2 -DriveLetter G -UseMaximumSize
Format-Volume -DriveLetter G -FileSystem NTFS -AllocationUnitSize
65536
```

You can automate volume and LUN creation using the PowerShell script from Appendix B. LUNs can also be created using SnapCenter.

Once the volumes and LUNs are defined, you need to set up SnapCenter to be able to perform the database operations.

SnapCenter overview

NetApp SnapCenter is next-generation data protection software for tier-1 enterprise applications. SnapCenter, with its single-pane-of-glass management interface, automates and simplifies the manual, complex, and time-consuming processes associated with the backup, recovery, and cloning of multiple databases and other application workloads. SnapCenter leverages NetApp technologies, including NetApp Snapshots, NetApp SnapMirror, SnapRestore, and NetApp FlexClone. This integration allows IT organizations to scale their storage infrastructure, meet increasingly stringent SLA commitments, and improve the productivity of administrators across the enterprise.

SnapCenter Server requirements

The following table lists the minimum requirements for installing the SnapCenter Server and plug-in on Microsoft Windows Server.

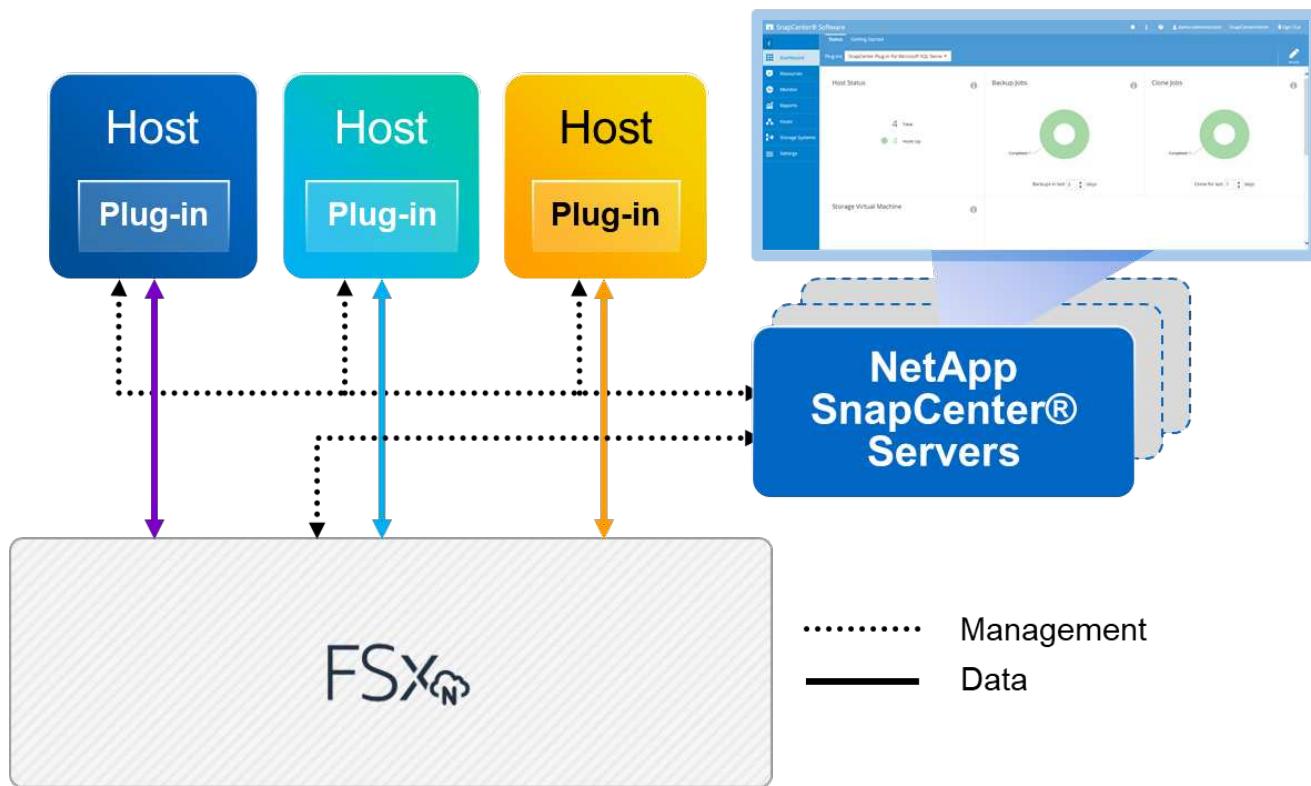
Components	Requirement
Minimum CPU count	Four cores/vCPUs
Memory	Minimum: 8GB Recommended: 32GB
Storage space	Minimum space for installation: 10GB Minimum space for repository: 10GB
Supported operating system	<ul style="list-style-type: none">Windows Server 2012Windows Server 2012 R2Windows Server 2016Windows Server 2019
Software packages	<ul style="list-style-type: none">.NET 4.5.2 or laterWindows Management Framework (WMF) 4.0 or laterPowerShell 4.0 or later

For detailed information, refer to Space and sizing requirements (https://docs.netapp.com/us-en/snapcenter/install/reference_space_and_sizing_requirements.html)

For version compatibility, see the [NetApp Interoperability Matrix Tool](#).

Database storage layout

The following figure depicts some considerations for creating the Microsoft SQL Server database storage layout when backing up with SnapCenter.



Best practices

- Place databases with I/O-intensive queries or with large database size (say 500GB or more) on a separate volume for faster recovery. This volume should also be backed up by separate jobs.
- Consolidate small-to-medium size databases that are less critical or have fewer I/O requirements to a single volume. Backing up a large number of databases residing in the same volume leads to fewer Snapshot copies that need to be maintained. It is also a best practice to consolidate Microsoft SQL Server instances to use the same volumes to control the number of backup Snapshot copies taken.
- Create separate LUNs to store full text-related files and file-streaming related files.
- Assign separate LUNs per host to store Microsoft SQL Server log backups.
- System databases that store database server metadata configuration and job details are not updated frequently. Place system databases/tempdb in separate drives or LUNs. Do not place system databases in the same volume as the user databases. User databases have a different backup policy, and the frequency of user database backup is not same for system databases.
- For Microsoft SQL Server Availability Group setup, place the data and log files for replicas in an identical folder structure on all nodes.

In addition to the performance benefit of segregating the user database layout into different volumes, the database also significantly affects the time required to back up and restore. Having separate volumes for data and log files significantly improves the restore time as compared to a volume hosting multiple user data files. Similarly, user databases with a high I/O intensive application are prone to an increase in the

backup time. A more detailed explanation about backup and restore practices is provided later in this document.



Starting with SQL Server 2012 (11.x), system databases (Master, Model, MSDB, and TempDB), and Database Engine user databases can be installed with an SMB file server as a storage option. This applies to both stand-alone SQL Server and SQL Server failover cluster installations. This enables you to use FSx for ONTAP with all its performance and data management capabilities, including volume capacity, performance scalability, and data protection features, which SQL Server can take advantage of. Shares used by the application servers must be configured with the continuously available property set and the volume should be created with NTFS security style. NetApp Snapcenter cannot be used with databases placed on SMB shares from FSx for ONTAP.



For SQL Server databases that do not use SnapCenter to perform backups, Microsoft recommends placing the data and log files on separate drives. For applications that simultaneously update and request data, the log file is write intensive, and the data file (depending on your application) is read/write intensive. For data retrieval, the log file is not needed. Therefore, requests for data can be satisfied from the data file placed on its own drive.



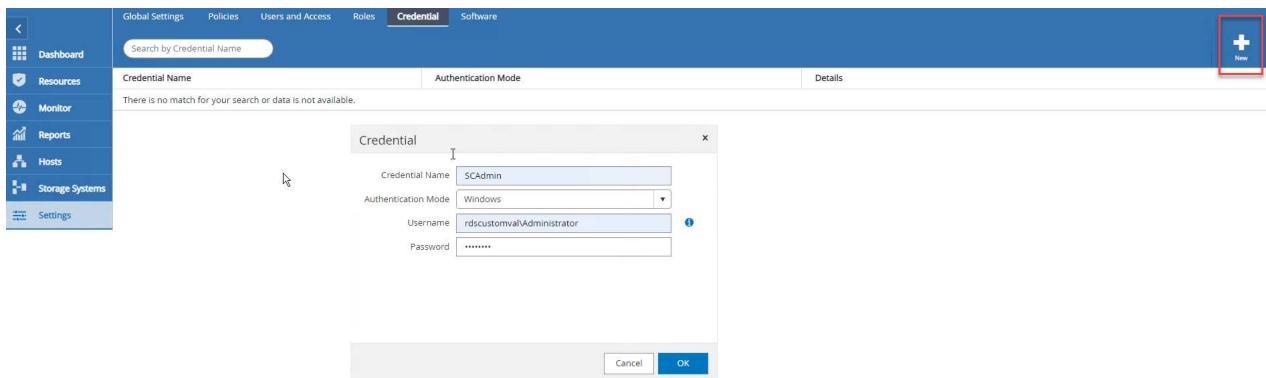
When you create a new database, Microsoft recommends specifying separate drives for the data and logs. To move files after the database is created, the database must be taken offline. For more Microsoft recommendations, see [Place Data and Log Files on Separate Drives](#).

Installation and setup for SnapCenter

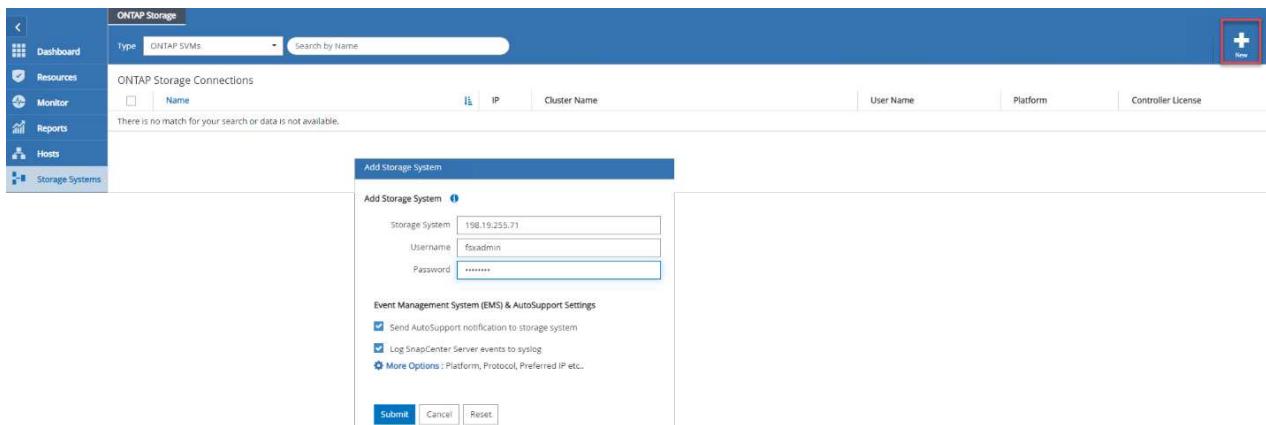
Follow the [Install the SnapCenter Server](#) and [Installing SnapCenter Plug-in for Microsoft SQL Server](#) to install and setup SnapCenter.

After Installing SnapCenter, complete the following steps to set it up.

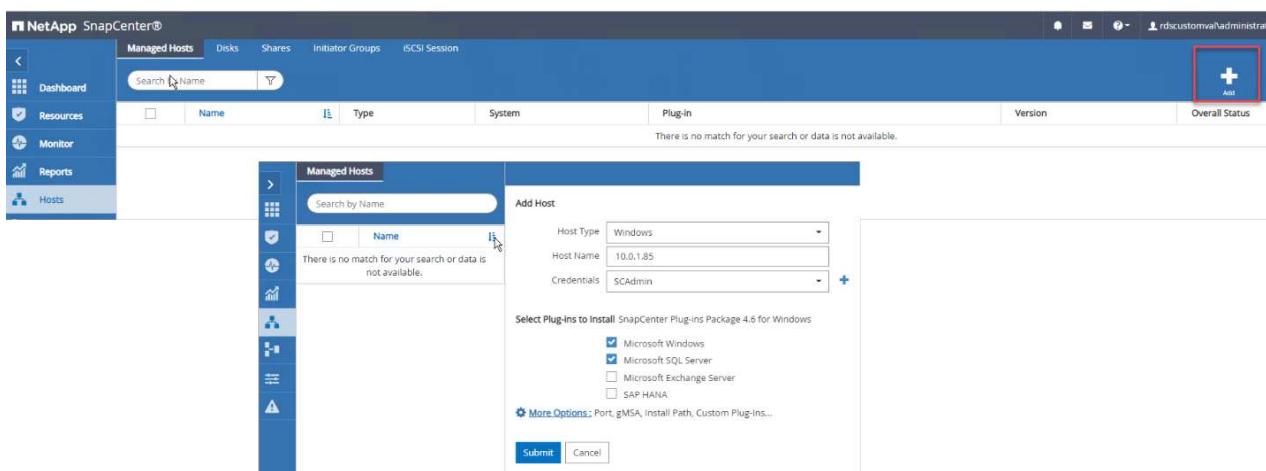
1. To set up credentials, select **Settings > New** and then enter the credential information.



2. Add the storage system by selecting **Storage Systems > New** and the provide the appropriate FSx for ONTAP storage information.



3. Add hosts by selecting **Hosts > Add**, and then provide the host information. SnapCenter automatically installs the Windows and SQL Server plug-in. This process might take some time.



After all Plug-ins are installed, you must configure the log directory. This is the location where the transaction log backup resides. You can configure the log directory by selecting the host and then select configure the log directory.



SnapCenter uses a host log directory to store transaction log backup data. This is at the host and instance level. Each SQL Server host used by SnapCenter must have a host log directory configured to perform log backups. SnapCenter has a database repository, so metadata related to backup, restore, or cloning operations is stored in a central database repository.

The size of the host log directory is calculated as follows:

$$\text{Size of host log directory} = \text{system database size} + (\text{maximum DB LDF size} \times \text{daily log change rate \%}) \\ (\text{Snapshot copy retention}) \div (1 - \text{LUN overhead space \%})$$

The host log directory sizing formula assumes the following:

- A system database backup that does not include the tempdb database
- A 10% LUN overhead spacePlace the host log directory on a dedicated volume or LUN. The amount of data in the host log directory depends on the size of the backups and the number of days that backups are retained.

The screenshot shows the 'Managed Hosts' section on the left with a search bar and a table listing hosts. One host, 'RDSAMAZ-FFIDFMR.rdscustomval.com', is selected and highlighted in blue. The main panel on the right is titled 'Host Details' and displays the following information:

Host Name	RDSAMAZ-FFIDFMR.rdscustomval.com
Host IP	10.0.1.56
Overall Status	Configure log directory
Host Type	Windows
System	Stand-alone
Credentials	SCAdmin
Plug-ins	SnapCenter Plug-ins package 4.6.0.6965 for Windows
	✓ Microsoft Windows
	✓ Microsoft SQL Server Remove Configure log directory ⓘ

At the bottom, there is a 'More Options' button followed by 'Submit', 'Cancel', and 'Reset' buttons.

If the LUNs have already been provisioned, you can select the mount point to represent the host log directory.

Configure Plug-in for SQL Server

X

Configure the log backup directory for RDSAMAZ-FFIDFMR.rdscustomval.com

Configure host log directory

Host log directory

dedicated disk directory path

Browse

Choose directory on NetApp Storage

 RDSAMAZ-FFIDFMR.rdscustomval.com

- D:\FSxN\Data\
- D:\FSxN\HLD\
- D:\FSxN\Log\

Save

Close

Now you are ready to perform backup, restore and clone operations for SQL Server.

Backup database with SnapCenter

After placing the database and log files on the FSx ONTAP LUNs, SnapCenter can be used to back up the databases. The following processes are used to create a full backup.

Best Practices

- In SnapCenter terms, RPO can be identified as the backup frequency, for example, how frequently you want to schedule the backup so that you can reduce the loss of data to up to few minutes. SnapCenter allows you to schedule backups as frequently as every five minutes. However, there might be a few instances in which a backup might not complete within five minutes during peak transaction times or when the rate of change of data is more in the given time. A best practice is to schedule frequent transaction log backups instead of full backups.
- There are numerous approaches to handle the RPO and RTO. One alternative to this backup approach is to have separate backup policies for data and logs with different intervals. For example, from SnapCenter, schedule log backups in 15-minute intervals and data backups in 6-hour intervals.
- Use a resource group for a backup configuration for Snapshot optimization and the number of jobs to be managed.

- Select **Resources**, and then select **Microsoft SQL Server** *on the drop-down menu on the top left. Select *Refresh Resources.

The screenshot shows the NetApp SnapCenter interface. On the left, a sidebar navigation bar includes options like Dashboard, Resources (which is selected), Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main content area has a title "Microsoft SQL Server". Below it, there's a search bar with "search by name" and a dropdown menu set to "View: Database". A table lists the following databases:

Name	Instance	Host	Last Backup	Overall Status	Type
DWConfiguration	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	User database
DWDiagnostics	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	User database
DWQueue	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	User database
master	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	System database
model	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	System database
msdb	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	System database
SeattleRetail	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not protected	User database
tempdb	RDSAMAZ-FRIDFMR	RDSAMAZ-FRIDFMR.rdscustomval.com		Not available for backup	System database

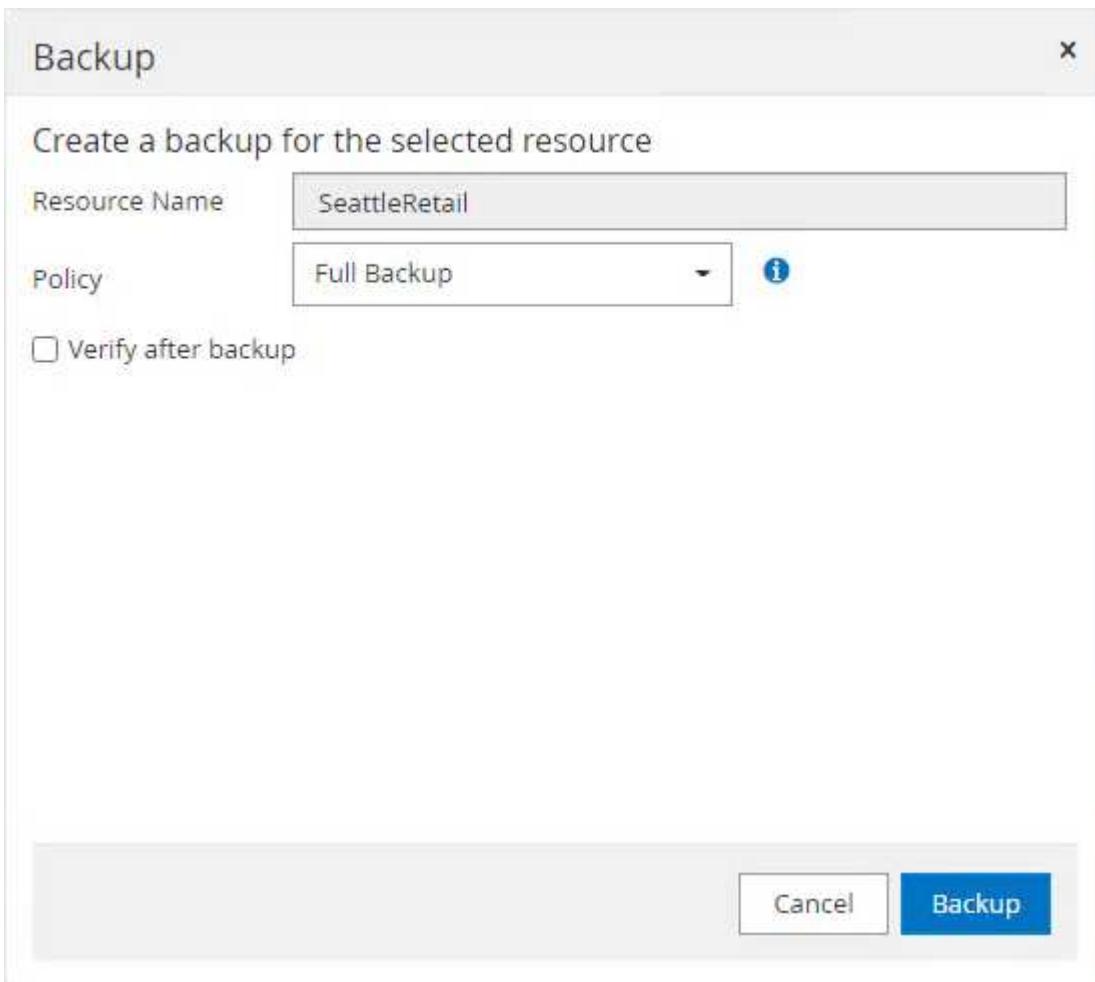
- Select the database to be backed up, then select **Next** and (+) to add the policy if one has not been created. Follow the **New SQL Server Backup Policy** to create a new policy.

The screenshot shows the "New SQL Server Backup Policy" wizard. The steps are numbered 1 through 5: 1. Resource, 2. Policies, 3. Verification, 4. Notification, and 5. Summary. Step 2 is currently active, showing a list of databases: DWConfiguration, DWDiagnostics, DWQueue, master, model, msdb, SeattleRetail (selected), and tempdb. Below the list is a section titled "Select one or more policies and configure schedules" with a dropdown menu set to "Full Backup" and a "+" button. Step 3 shows a table for "Configure schedules for selected policies":

Policy	Applied Schedules	Configure Schedules
Full Backup	None	To schedule operations select a policy that has the appropriate schedule associated, or modify the selected policy to allow schedules.

- Select the verification server if necessary. This server is the server that SnapCenter runs DBCC CHECKDB after a full backup has been created. Click **Next** for notification, and then select **Summary** to review. After reviewing, click **Finish**.

4. Click **Back up Now** to test the backup. In the pop-up windows, select **Backup**.



5. Select **Monitor** to verify that the backup has been completed.

ID	Status	Name	Start date	End date	Owner
94	✓	Backup of Resource Group 'RDSAMAZ-FRIDFMR_SeattleRetail' with policy 'Full Backup'	03/29/2022 1:47:30 AM	03/29/2022 1:47:41 AM	RDSCUSTOM\AL\administrator
93	✓	Create Resource Group 'RDSAMAZ-FRIDFMR_SeattleRetail'	03/29/2022 1:45:24 AM	03/29/2022 1:45:26 AM	RDSCUSTOM\AL\administrator
92	✓	Create Policy 'Full Backup'	03/29/2022 1:41:37 AM	03/29/2022 1:41:40 AM	RDSCUSTOM\AL\administrator
91	✓	Discover resources for all hosts	03/29/2022 1:38:12 AM	03/29/2022 1:38:17 AM	RDSCUSTOM\AL\administrator

Best Practices

- Backup the transaction log backup from SnapCenter so that during the restoration process, SnapCenter can read all the backup files and restore in sequence automatically.
- If third party products are used for backup, select Copy backup in SnapCenter to avoid log sequence issues, and test the restore functionality before rolling into production.

Restore database with SnapCenter

One of the major benefits of using FSx ONTAP with SQL Server on EC2 is its ability to perform fast and granular restore at each database level.

Complete the following steps to restore an individual database to a specific point in time or up to the minute with SnapCenter.

1. Select Resources and then select the database that you would like to restore.



The screenshot shows the Microsoft SQL Server Management Studio interface. On the left, a tree view lists databases: Name (DWConfiguration, DW.Diagnostics, DWQueue, master, model, msdb, SeattleRetail, tempdb). The 'SeattleRetail' database is selected. In the center, under 'Manage Copies', there is a summary card: 'Summary Card' (1 Backup, 0 Clones). Below it, a table titled 'Primary Backup(s)' shows one full backup: 'RDSAMAZ-FFIDFMR_SeattleRetail_RDSAMAZ-FFIDFMR_03-29-2022_01.47.31.3117' (Count: 1, Type: Full backup, End Date: 03/29/2022 1:47:37 AM, Verified: Unverified).

2. Select the backup name that the database needs to be restored from and then select restore.
3. Follow the **Restore** pop-up windows to restore the database.
4. Select **Monitor** to verify that the restore process is successful.



The screenshot shows the NetApp SnapCenter interface. On the left, a sidebar lists categories: Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The 'Jobs' tab is selected. A table titled 'Jobs - Filter' lists several tasks:

ID	Status	Name	Start date	End date	Owner
96	✓	Restore 'RDSAMAZ-FFIDFMR.SeattleRetail'	03/29/2022 1:54:31 AM	03/29/2022 1:56:26 AM	RDSCUSTOMVAL\administrator
94	✓	Backup of Resource Group 'RDSAMAZ-FFIDFMR_SeattleRetail' with policy 'Full Backup'	03/29/2022 1:47:30 AM	03/29/2022 1:47:41 AM	RDSCUSTOMVAL\administrator
93	✓	Create Resource Group 'RDSAMAZ-FFIDFMR_SeattleRetail'	03/29/2022 1:45:24 AM	03/29/2022 1:45:26 AM	RDSCUSTOMVAL\administrator
92	✓	Create Policy 'Full Backup'	03/29/2022 1:41:37 AM	03/29/2022 1:41:40 AM	RDSCUSTOMVAL\administrator
91	✓	Discover resources for all hosts	03/29/2022 1:38:12 AM	03/29/2022 1:38:17 AM	RDSCUSTOMVAL\administrator
88	✓	Discover resources for host 'RDSAMAZ-FFIDFMR.rdscustomval.com'	03/28/2022 10:55:17 PM	03/28/2022 10:55:18 PM	RDSCUSTOMVAL\administrator
87	✓	Discover resources for host 'RDSAMAZ-FFIDFMR.rdscustomval.com'	03/28/2022 10:41:18 PM	03/28/2022 10:41:19 PM	RDSCUSTOMVAL\administrator

Considerations for an instance with a large number of small-to-large size databases

SnapCenter can back up a large number of sizeable databases in an instance or group of instances within a resource group. The size of a database is not the major factor in backup time. The duration of a backup can vary depending on number of LUNs per volume, the load on Microsoft SQL Server, the total number of databases per instance, and, specifically, the I/O bandwidth and usage. While configuring the policy to back up databases from an instance or resource group, NetApp recommends that you restrict the maximum database backed up per Snapshot copy to 100 per host. Make sure the total number of Snapshot copies does not exceed the 1,023-copy limit.

NetApp also recommends that you limit the backup jobs running in parallel by grouping the number of databases instead of creating multiple jobs for each database or instance. For optimal performance of the backup duration, reduce the number of backup jobs to a number that can back up around 100 or fewer databases at a time.

As previously mentioned, I/O usage is an important factor in the backup process. The backup process must wait to quiesce until all the I/O operations on a database are complete. Databases with highly intensive I/O operations should be deferred to another backup time or should be isolated from other backup jobs to avoid affecting other resources within the same resource group that are to be backed up.

For an environment that has six Microsoft SQL Server hosts hosting 200 databases per instance, assuming four LUNs per host and one LUN per volume created, set the full backup policy with the maximum databases backed up per Snapshot copy to 100. Two hundred databases on each instance are laid out as 200 data files distributed equally on two LUNs, and 200 log files are distributed equally on two LUNs, which is 100 files per LUN per volume.

Schedule three backup jobs by creating three resource groups, each grouping two instances that include a total of 400 databases.

Running all three backup jobs in parallel backs up 1,200 databases simultaneously. Depending on the load on the server and I/O usage, the start and end time on each instance can vary. In this instance, a total of 24 Snapshot copies are created.

In addition to the full backup, NetApp recommends that you configure a transaction log backup for critical databases. Make sure that the database property is set to full recovery model.

Best practices

- Do not include the tempdb database in a backup because the data it contains is temporary. Place tempdb on a LUN or an SMB share that is in a storage system volume in which Snapshot copies will not be created.
- A Microsoft SQL Server instance with a high I/O intensive application should be isolated in a different backup job to reduce the overall backup time for other resources.
- Limit the set of databases to be simultaneously backed up to approximately 100 and stagger the remaining set of database backups to avoid a simultaneous process.
- Use the Microsoft SQL Server instance name in the resource group instead of multiple databases because whenever new databases are created in Microsoft SQL Server instance, SnapCenter automatically considers a new database for backup.
- If you change the database configuration, such as changing the database recovery model to the full recovery model, perform a backup immediately to allow up-to-the-minute restore operations.
- SnapCenter cannot restore transaction log backups created outside of SnapCenter.
- When cloning FlexVol volumes, make sure that you have sufficient space for the clone metadata.
- When restoring databases, make sure that sufficient space is available on the volume.
- Create a separate policy to manage and back up system databases at least once a week.

Cloning databases with SnapCenter

To restore a database onto another location on a dev or test environment or to create a copy for business analysis purposes, the NetApp best practice is to leverage the cloning methodology to create a copy of the database on the same instance or an alternate instance.

The cloning of databases that are 500GB on an iSCSI disk hosted on a FSx for ONTAP environment typically takes less than five minutes. After cloning is complete, the user can then perform all the required read/write operation on the cloned database. Most of the time is consumed for disk scanning (diskpart). The NetApp cloning procedure typically take less than 2 minutes regardless of the size of the databases.

The cloning of a database can be performed with the dual method: you can create a clone from the latest backup or you can use clone life-cycle management through which the latest copy can be made available on the secondary instance.

SnapCenter allows you to mount the clone copy on the required disk to maintain the format of the folder structure on the secondary instance and continue to schedule backup jobs.

Clone databases to the new database name in the same instance

The following steps can be used to clone databases to the new database name in the same SQL server instance running on EC2:

1. Select Resources and then the database that need to be cloned.
2. Select the backup name that you would like to clone and select Clone.
3. Follow the clone instructions from the backup windows to finish the clone process.
4. Select Monitor to make sure that cloning is completed.

Clone databases into the new SQL Server instance running on EC2

The following step are used to clone databases to the new SQL server instance running on EC2:

1. Create a new SQL Server on EC2 in the same VPC.
2. Enable the iSCSI protocol and MPIO, and then setup the iSCSI connection to FSx for ONTAP by following step 3 and 4 in the section “Create volumes and LUNs for SQL Server.”
3. Add a new SQL Server on EC2 into SnapCenter by follow step 3 in the section “Installing and setup for SnapCenter.”
4. Select Resource > View Instance, and then select Refresh Resource.
5. Select Resources, and then the database that you would like to clone.
6. Select the backup name that you would like to clone, and then select Clone.

The screenshot shows the NetApp SnapCenter interface. On the left sidebar, under 'Resources', 'SeattleRetail' is selected. In the main pane, 'Manage Copies' is open, showing a summary card with 1 Backup and 0 Clones. Below it, 'Primary Backup(s)' is listed with a search bar and a table. The table has columns for 'Backup Name', 'Count', 'Type', 'LF', 'End Date', and 'Verified'. One entry is shown: 'RDSAMAZ-FFDFMR_SeattleRetail_RDSAMAZ-FFDFMR_03-29-2022_01.47.31.3117' with a count of 1, type 'Full backup', end date '03/29/2022 1:47:37 AM', and status 'Unverified'.

7. Follow the Clone from Backup instructions by providing the new SQL Server instance on EC2 and instance name to finish the clone process.
8. Select Monitor to make sure that cloning is completed.

The screenshot shows the NetApp SnapCenter interface with the 'Jobs' tab selected. It displays a table of tasks. One task is visible: 'Clone from backup RDSAMAZ-FFDFMR_SeattleRetail_RDSAMAZ-FFDFMR_03-29-2022_01.47.31.3117' with ID 108, status 'Success', and details 'Discover resources for all hosts'. Another task, 'Discover resources for all hosts', has ID 107 and status 'Success'. The table includes columns for 'ID', 'Status', 'Name', 'Start date', 'End date', and 'Owner'.

To learn more about this process, watch the following video:

- ▶ <https://docs.netapp.com/us-en/netapp-solutions/media/SQLonFSxN.mp4> (video)

Appendices

Appendix A: YAML file for use in Cloud Formation Template

The following .yaml file can be used with the Cloud Formation Template in AWS Console.

- <https://github.com/NetApp-Automation/fsxn-iscsisetup-cft>

To automate ISCSI LUN creation and NetApp SnapCenter installation with PowerShell, clone the repo from [this GitHub link](#).

Appendix B: Powershell scripts for provisioning volumes and LUNs

The following script is used to provision volumes and LUNs and also to set up iSCSI based on the instruction provided above. There are two PowerShell scripts:

- `_EnableMPIO.ps1`

```
Function Install_MPIO_ssh {
    $hostname = $env:COMPUTERNAME
    $hostname = $hostname.Replace('-', '_')

    #Add schedule action for the next step
    $path = Get-Location
    $path = $path.Path + '\2_CreateDisks.ps1'
    $arg = '-NoProfile -WindowStyle Hidden -File ' +$path
    $schAction = New-ScheduledTaskAction -Execute "Powershell.exe"
    -Argument $arg
    $schTrigger = New-ScheduledTaskTrigger -AtStartup
    $schPrincipal = New-ScheduledTaskPrincipal -UserId "NT
AUTHORITY\SYSTEM" -LogonType ServiceAccount -RunLevel Highest
    $return = Register-ScheduledTask -Action $schAction -Trigger
    $schTrigger -TaskName "Create Vols and LUNs" -Description "Scheduled
Task to run configuration Script At Startup" -Principal $schPrincipal
    #Install -Module Posh-SSH
    Write-host 'Enable MPIO and SSH for PowerShell' -ForegroundColor
    Yellow
    $return = Find-PackageProvider -Name 'Nuget' -ForceBootstrap
    -IncludeDependencies
    $return = Find-Module PoSH-SSH | Install-Module -Force
    #Install Multipath-IO with PowerShell using elevated privileges in
    Windows Servers
    Write-host 'Enable MPIO' -ForegroundColor Yellow
    $return = Install-WindowsFeature -name Multipath-IO -Restart
}
Install_MPIO_ssh
Remove-Item -Path $MyInvocation.MyCommand.Source
```

- `_CreateDisks.ps1`

```
#Enable MPIO and Start iSCSI Service
Function PrepISCSI {
    $return = Enable-MSDSMAutomaticClaim -BusType iSCSI
    #Start iSCSI service with PowerShell using elevated privileges in
    Windows Servers
    $return = Start-service -Name msiscsi
```

```

$return = Set-Service -Name msiscsi -StartupType Automatic
}

Function Create_igroup_vols_luns ($fsxN) {
    $hostname = $env:COMPUTERNAME
    $hostname = $hostname.Replace('-', '_')
    $volsluns = @()
    for ($i = 1;$i -lt 10;$i++) {
        if ($i -eq 9){
            $volsluns
        +=(@{volname=('v_'+$hostname+'_log');volsize=$fsxN.logvolsize;lunname=(

'1_'+$hostname+'_log');lunsize=$fsxN.loglunsize})
        } else {
            $volsluns
        +=(@{volname=('v_'+$hostname+'_data'+[string]$i);volsize=$fsxN.datavols

ize;lunname=('1_'+$hostname+'_data'+[string]$i);lunsize=$fsxN.datalunsi

ze})
        }
    }
    $secStringPassword = ConvertTo-SecureString $fsxN.password
    -AsPlainText -Force
    $credObject = New-Object System.Management.Automation.PSCredential
    ($fsxN.login, $secStringPassword)
    $igroup = 'igrp_'+$hostname
    #Connect to FSx N filesystem
    $session = New-SSHSession -ComputerName $fsxN.svmip -Credential
    $credObject -AcceptKey:$true
    #Create igroup
    Write-host 'Creating igroup' -ForegroundColor Yellow
    #Find Windows initiator Name with PowerShell using elevated
    privileges in Windows Servers
    $initport = Get-InitiatorPort | select -ExpandProperty NodeAddress
    $sshcCmd = 'igroup create -igroup ' + $igroup + ' -protocol iscsi
    -ostype windows -initiator ' + $initport
    $ret = Invoke-SSHCommand -Command $sshcCmd -SSHSession $session
    #Create vols
    Write-host 'Creating Volumes' -ForegroundColor Yellow
    foreach ($vollun in $volsluns){
        $sshcCmd = 'vol create ' + $vollun.volname + ' -aggregate aggr1
        -size ' + $vollun.volsize #+ ' -vserver ' + $vserver
        $return = Invoke-SSHCommand -Command $sshcCmd -SSHSession
    $session
    }
    #Create LUNs and mapped LUN to igroup
    Write-host 'Creating LUNs and map to igroup' -ForegroundColor
    Yellow
    foreach ($vollun in $volsluns){

```

```

        $sshcmd = "lun create -path /vol/" + $vollun.volname + "/" +
$vollun.lunname + " -size " + $vollun.lunsize + " -ostype Windows_2008
" #-vserver " +$vserver
        $return = Invoke-SSHCommand -Command $sshcmd -SSHSession
$session
        #map all luns to igroup
        $sshcmd = "lun map -path /vol/" + $vollun.volname + "/" +
$vollun.lunname + " -igroup " + $igroup
        $return = Invoke-SSHCommand -Command $sshcmd -SSHSession
$session
    }
}

Function Connect_iSCSI_to_SVM ($TargetPortals){
    Write-host 'Online, Initialize and format disks' -ForegroundColor Yellow
    #Connect Windows Server to svm with iSCSI target.
    foreach ($TargetPortal in $TargetPortals) {
        New-IscsiTargetPortal -TargetPortalAddress $TargetPortal
        for ($i = 1; $i -lt 5; $i++){
            $return = Connect-IscsiTarget -IsMultipathEnabled $true
-IsPersistent $true -NodeAddress (Get-iscsiTarget | select
-ExpandProperty NodeAddress)
        }
    }
}

Function Create_Partition_Format_Disks{

    #Create Partition and format disk
    $disks = Get-Disk | where PartitionStyle -eq raw
    foreach ($disk in $disks) {
        $return = Initialize-Disk $disk.Number
        $partition = New-Partition -DiskNumber $disk.Number
-AssignDriveLetter -UseMaximumSize | Format-Volume -FileSystem NTFS
-AllocationUnitSize 65536 -Confirm:$false -Force
        #$return = Format-Volume -DriveLetter $partition.DriveLetter
-FileSystem NTFS -AllocationUnitSize 65536
    }
}

Function UnregisterTask {
    Unregister-ScheduledTask -TaskName "Create Vols and LUNS"
-Confirm:$false
}

Start-Sleep -s 30
$fsxN = @{svmip ='198.19.255.153';login =
'vesadmin';password='net@pp11';datavolsize='10GB';datalunsize='8GB';logv
olsize='8GB';loglunsize='6GB'}

```

```

$TargetPortals = ('10.2.1.167', '10.2.2.12')
PrepISCSI
Create_igroup_vols_luns $fsxN
Connect_iSCSI_to_SVM $TargetPortals
Create_Partition_Format_Disks
UnregisterTask
Remove-Item -Path $MyInvocation.MyCommand.Source

```

Run the file EnableMPIO.ps1 first and the second script executes automatically after the server has been rebooted. These PowerShell scripts can be removed after they have been executed due to credential access to the SVM.

Where to find additional information

- Amazon FSx for NetApp ONTAP

<https://docs.aws.amazon.com/fsx/latest/ONTAPGuide/what-is-fsx-ontap.html>

- Getting Started with FSx for NetApp ONTAP

<https://docs.aws.amazon.com/fsx/latest/ONTAPGuide/getting-started.html>

- Overview of the SnapCenter interface

<https://www.youtube.com/watch?v=lVEBF4kV6Ag&t=0s>

- Tour through SnapCenter navigation pane options

https://www.youtube.com/watch?v=_IDKt-koySQ

- Setup SnapCenter 4.0 for SQL Server plug-in

<https://www.youtube.com/watch?v=MopbUFSdHKE>

- How to back up and restore databases using SnapCenter with SQL Server plug-in

https://www.youtube.com/watch?v=K343qPD5_Ys

- How to clone a database using SnapCenter with SQL Server plug-in

<https://www.youtube.com/watch?v=ogEc4DkGv1E>

TR-4951: Backup and Recovery for Microsoft SQL Server on AWS FSx for ONTAP

Author(s): Niyaz Mohammed, Carine Ngwekwe - NetApp Solutions Engineering

This document covers the steps necessary to perform backup and recovery for Microsoft SQL Server on AWS FSx for ONTAP with SnapCenter. This includes the following information:

- NetApp SnapCenter configuration
- SnapCenter backup operations

- Backup operation for an FCI database
- Backup operation for multiple databases
- Restore and recovery

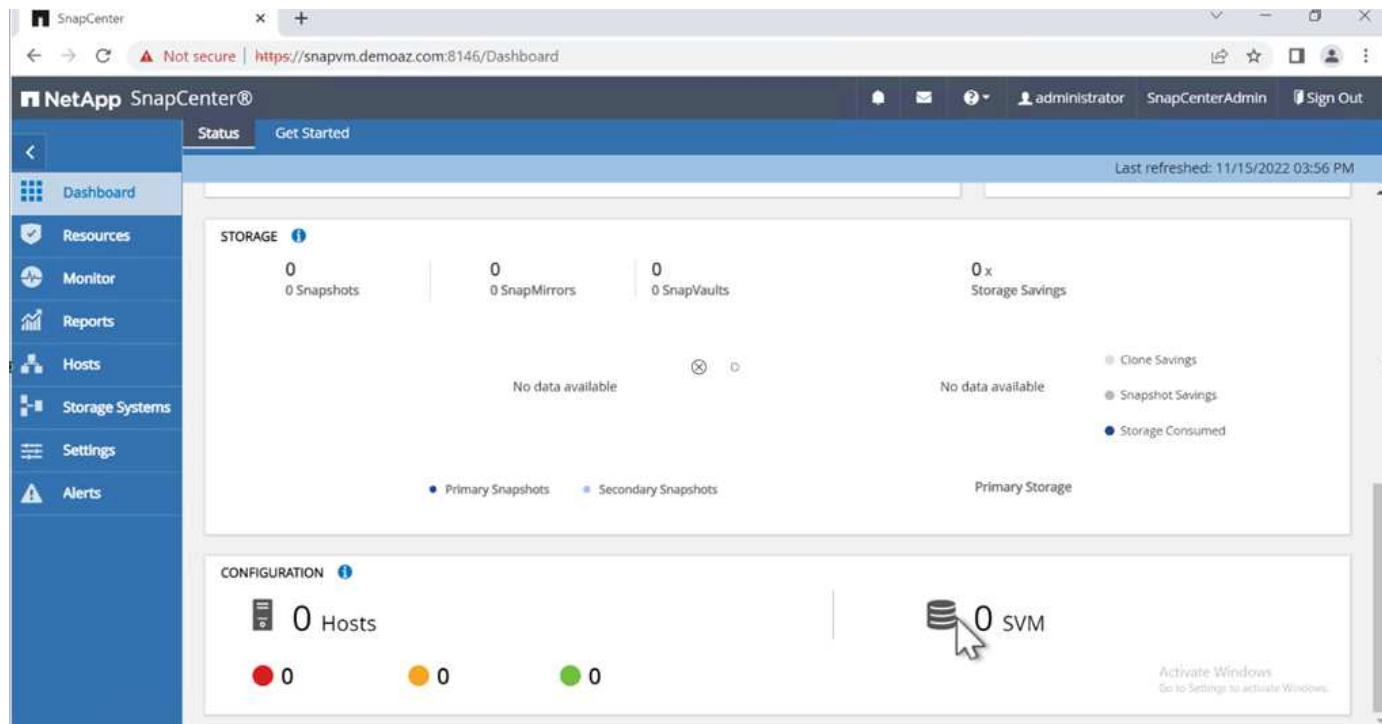
SnapCenter Configuration

The following steps must be performed for SnapCenter configuration and the protection of Microsoft SQL Server resources. Each of the following steps is detailed in the following sections.

1. Configure sysadmin credentials for the SQL Server backup and restore user.
2. Configure storage settings. Provide Amazon Web Services (AWS) management credential to access the Amazon FSx for NetApp ONTAP storage virtual machines (SVMs) from SnapCenter.
3. Add a SQL Server host to SnapCenter. Deploy and install the required SnapCenter Plug-ins.
4. Configure policies. Define the backup operation type, retention, and optional Snapshot backup replication.
5. Configure and protect the Microsoft SQL Server database.

SnapCenter newly installed user interface

Configure credentials for SQL Server backup and restore the user with sysadmin rights.



NetApp recommends using role-based access control (RBAC) to delegate data protection and management capabilities to individual users across the SnapCenter and window hosts. The user must have access to the SQL Server hosting the database. For multiple hosts, the username and password must be the same across the various hosts. Furthermore, to enable SnapCenter to deploy the required plug-in on SQL Server hosts, you must register the domain information for SnapCenter to validate your credentials and hosts.

Expand the following sections to see the detailed instructions on how to complete each step.

Add the credentials

Go to **Settings**, select **Credentials**, and click (+).

The screenshot shows the NetApp SnapCenter web interface. The top navigation bar includes links for Global Settings, Policies, Users and Access, Roles, Credential (which is highlighted in blue), and Software. Below the navigation is a search bar labeled "Search by Credential Name". A main table displays columns for "Credential Name" and "Authentication Mode". A message at the bottom of the table states, "There is no match for your search or data is not available." On the left side, there is a vertical sidebar with icons for Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings (which is also highlighted in blue), and Alerts.

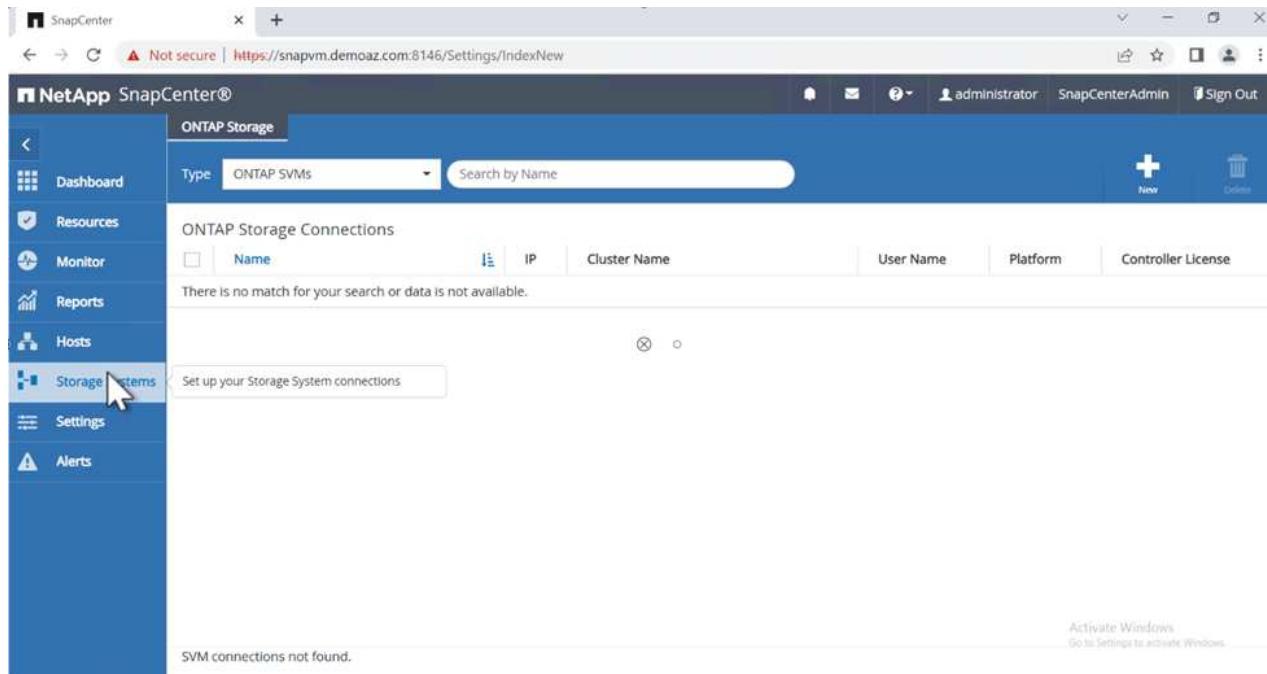
The new user must have administrator rights on the SQL Server host.

This screenshot shows a modal dialog titled "Credential". It contains four input fields: "Credential Name" with the value "Demoaz", "Authentication Mode" set to "Windows", "Username" with the value "demoaz\clusteradmin", and "Password" represented by a series of dots. Below the password field is an information icon (an exclamation mark inside a circle). At the bottom of the dialog are two buttons: "Cancel" and "OK". A progress bar at the bottom indicates the task is "Setting credential...".

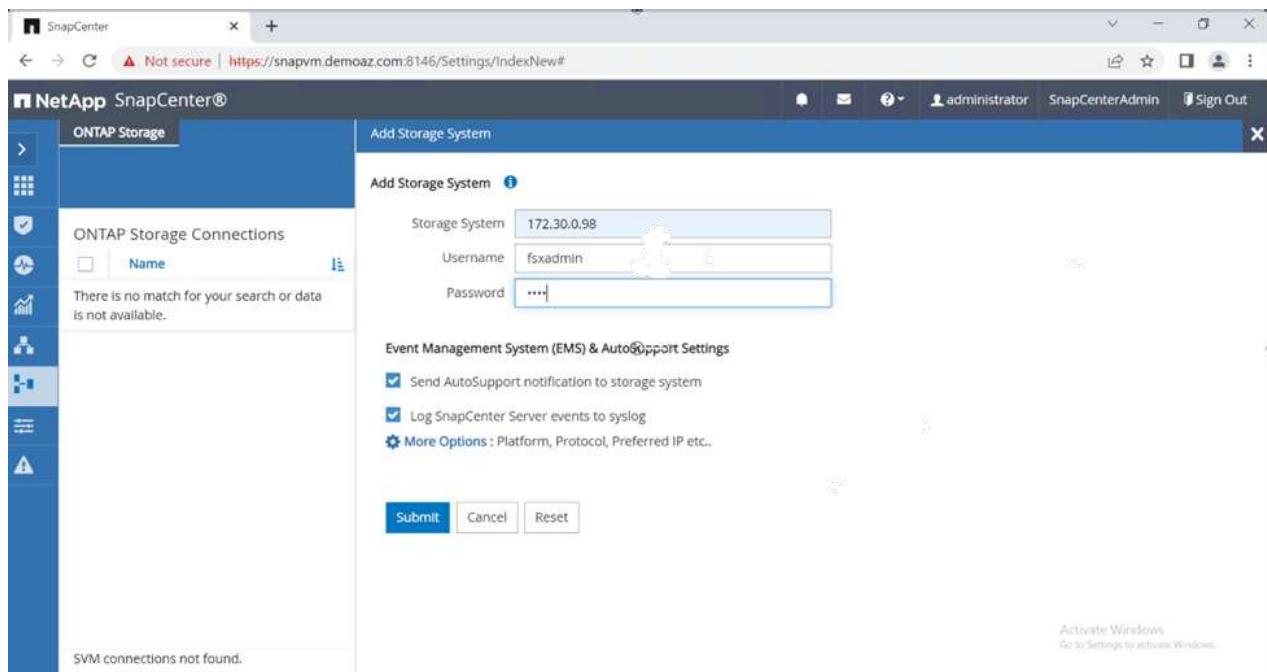
Configure storage

To configure storage in SnapCenter, complete the following steps:

1. In the SnapCenter UI, select **Storage Systems**. There are two storage types, **ONTAP SVM** and **ONTAP Cluster**. By default, the storage type is **ONTAP SVM**.
2. Click (+) to add the storage system information.



3. Provide the **FSx for ONTAP management endpoint**.



4. The SVM is now configured in SnapCenter.

SnapCenter

Not secure | https://snapvm.demoaz.com:8146/Settings/IndexNew#

NetApp SnapCenter®

ONTAP Storage

Type: ONTAP SVMs Search by Name

ONTAP Storage Connections

Name	IP	Cluster Name	User Name	Platform	Controller License
ESXSVMTESRDS		rdsfsxTest01		PSX	Not applicable

Total 1

Activate Windows
Go to Settings to activate Windows.

The screenshot shows the NetApp SnapCenter web interface. The left sidebar contains navigation links: Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main content area is titled 'ONTAP Storage' and shows 'ONTAP Storage Connections'. A table lists one connection: 'ESXSVMTESRDS' (Cluster Name: rdsfsxTest01, Platform: PSX, Controller License: Not applicable). The top right of the interface includes user information (administrator, SnapCenterAdmin) and a 'Sign Out' link. A 'Not secure' warning is visible at the top. A cursor is positioned over the 'ESXSVMTESRDS' row in the table.

Add a SQL Server host to SnapCenter

To add a SQL Server host, complete the following steps:

1. From the Host tab, click (+) to add the Microsoft SQL Server host.

2. Provide the fully qualified domain name (FQDN) or IP address of the remote host.



The credentials are populated by default.

3. Select the option for Microsoft windows and Microsoft SQL Server and then submit.

The SQL Server packages are installed.

The screenshot shows the NetApp SnapCenter interface. The left sidebar has tabs for Dashboard, Resources, Monitor, Reports, Hosts (which is selected), Storage Systems, Settings, and Alerts. The main content area is titled "Managed Hosts" and shows a table with one row:

Name	Type	System	Plug-in	Version	Overall Status
FSXCLUSTER.Demoaz.com	Windows	Cluster			Installing plug-in

At the bottom right of the main area, there is a link: "Activate Windows" and "Go to Settings to activate Windows".

1. After the installation is complete, go to the **Resource** tab to verify whether all FSx for ONTAP iSCSI volumes are present.

The screenshot shows the NetApp SnapCenter interface. The left sidebar has tabs for Dashboard, Resources (selected), Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main content area is titled "File Systems" and shows a table with six rows:

Name	Host	Storage Layout	Resource Groups	Policies	Last Backup	Overall Status
D:\	FSXCLUSTER.Demo...STER.Demoaz.com	FSXSVMTESRDS:/..._FCIDATA/FCIDATA				Not protected
E:\	FSXCLUSTER.Demo...STER.Demoaz.com	FSXSVMTESRDS:/..._I/FCILOG/FCILOG				Not protected
F:\	FSXCLUSTER.Demo...STER.Demoaz.com	FSXSVMTESRDS:/..._ACKUP/FCIBACKUP				Not protected
G:\	FSXCLUSTER.Demo...STER.Demoaz.com	FSXSVMTESRDS:/..._SNAPLOG/SNAPLOG				Not protected
H:\	FSXCLUSTER.Demo...STER.Demoaz.com	FSXSVMTESRDS:/..._FCITEMP/FCITEMP				Not protected
K:\	FSXCLUSTER.Demo...STER.Demoaz.com	FSXSVMTESRDS:/..._UORUM/FCIQUORUM				Not protected

At the bottom left, there is a "Total 6" label. At the bottom right, there is a link: "Activate Windows" and "Go to Settings to activate Windows".

Configure log directory

To configure a host log directory, complete the following steps:

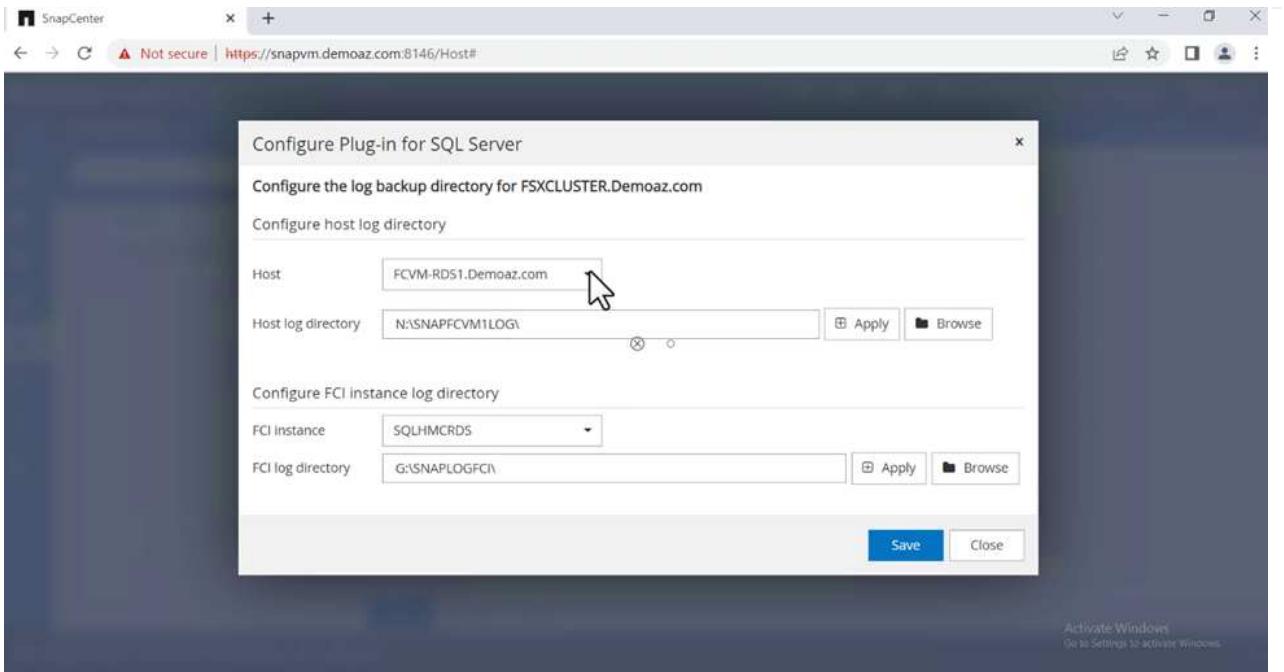
1. Click the check box. A new tab opens.

The screenshot shows the NetApp SnapCenter web interface. On the left, there's a sidebar with icons for Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area is titled "Managed Hosts" and contains a table with three rows. The first row has a checked checkbox and is highlighted in blue. The second and third rows have unchecked checkboxes. The columns are: Name, Type, System, Plug-in, Version, and Overall Status. The first host (FSXCLUSTER.Demoaz.com) has a status of "Configure log directory". A cursor is shown clicking the checkbox for the first host. At the bottom right of the interface, there's a message: "Activate Windows Go to Settings to activate Windows".

2. Click the **configure log directory** link.

This screenshot shows the "Host Details" page for the host FSXCLUSTER.Demoaz.com. The left sidebar shows the "Managed Hosts" list with the first host selected. The main panel displays the host's name, IP address, overall status (which includes a "Configure log directory" link), host type, system, credentials, and plug-ins. The plug-ins section lists "Microsoft Windows" and "Microsoft SQL Server" with "Remove" and "Configure" buttons. Below this is a "More Options" link. At the bottom are "Submit", "Cancel", and "Reset" buttons. A message at the bottom right says "Activate Windows Go to Settings to activate Windows".

3. Select the drive for the host log directory and the FCI instance log directory. Click **Save**. Repeat the same process for the second node in the cluster. Close the window.



The host is now in a running state.

NetApp SnapCenter®

Managed Hosts Disks Shares Initiator Groups iSCSI Session

	Name	Type	System	Plug-in	Version	Overall Status
<input type="checkbox"/>	FSXCLUSTER.Demoaz.com	Windows	Cluster	Microsoft Windows Server, Microsoft SQL Server	4.7	Running

Activate Windows
Go to Settings to activate Windows.

1. From the **Resources** tab, we have all the servers and databases.

The screenshot shows the NetApp SnapCenter interface for managing Microsoft SQL Server databases. The left sidebar includes links for Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main content area displays a table of databases with columns: Name, Instance, Host, Last Backup, Overall Status, and Type. The table lists seven user databases (INVENTORYDB1 through INVENTORYDB5) and two system databases (master and model). All databases are listed as 'Not protected'. The interface also shows activity metrics at the bottom.

Name	Instance	Host	Last Backup	Overall Status	Type
INVENTORYDB1	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB2	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB3	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB4	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB5	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	User database
master	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	System database
model	SQLHMCARDS	FSXCLUSTER.Demoaz.com		Not protected	System database

Configure a backup policy

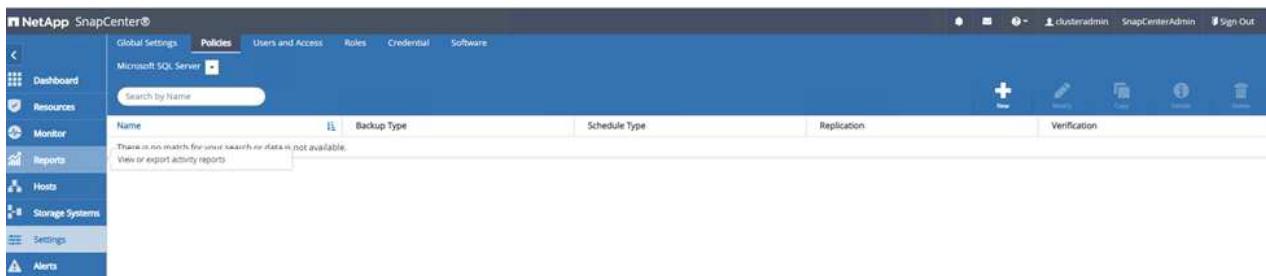
A backup policy is a set of rules that govern how to manage, schedule, and retain backup. It helps with the backup type and frequency based on your company's SLA.

Expand the following sections to see the detailed instructions on how to complete each step.

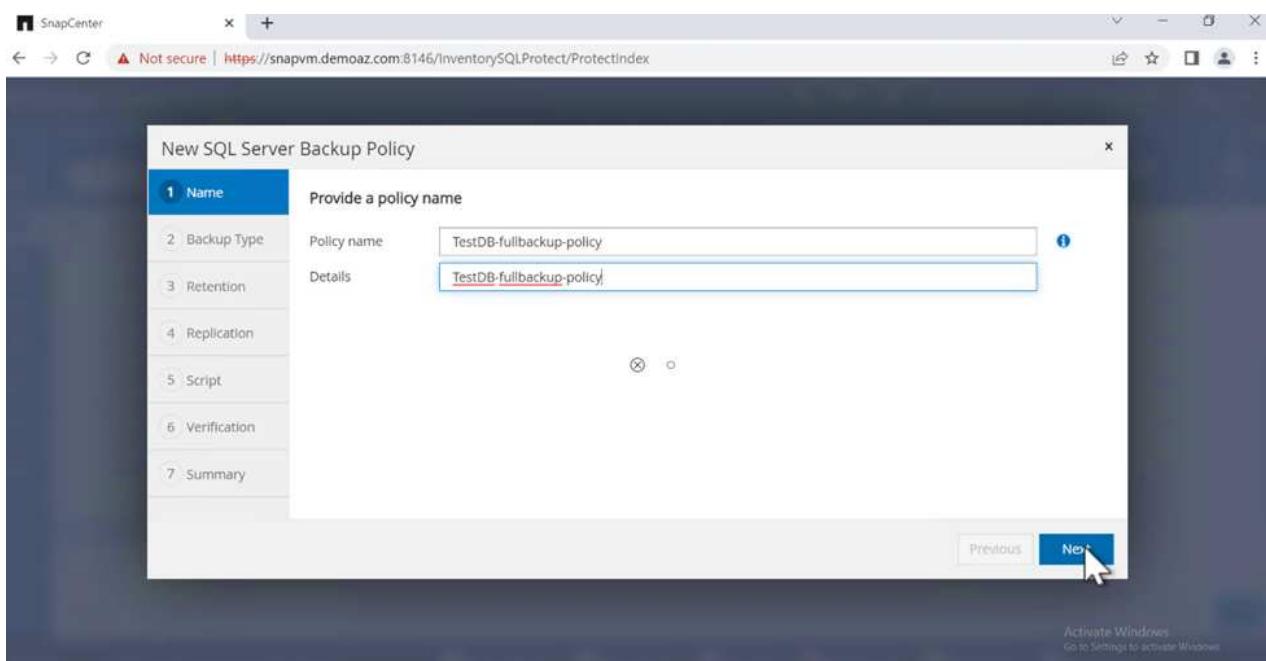
Configure back-up operation for an FCI database

To configure a backup policy for an FCI database, complete the following steps:

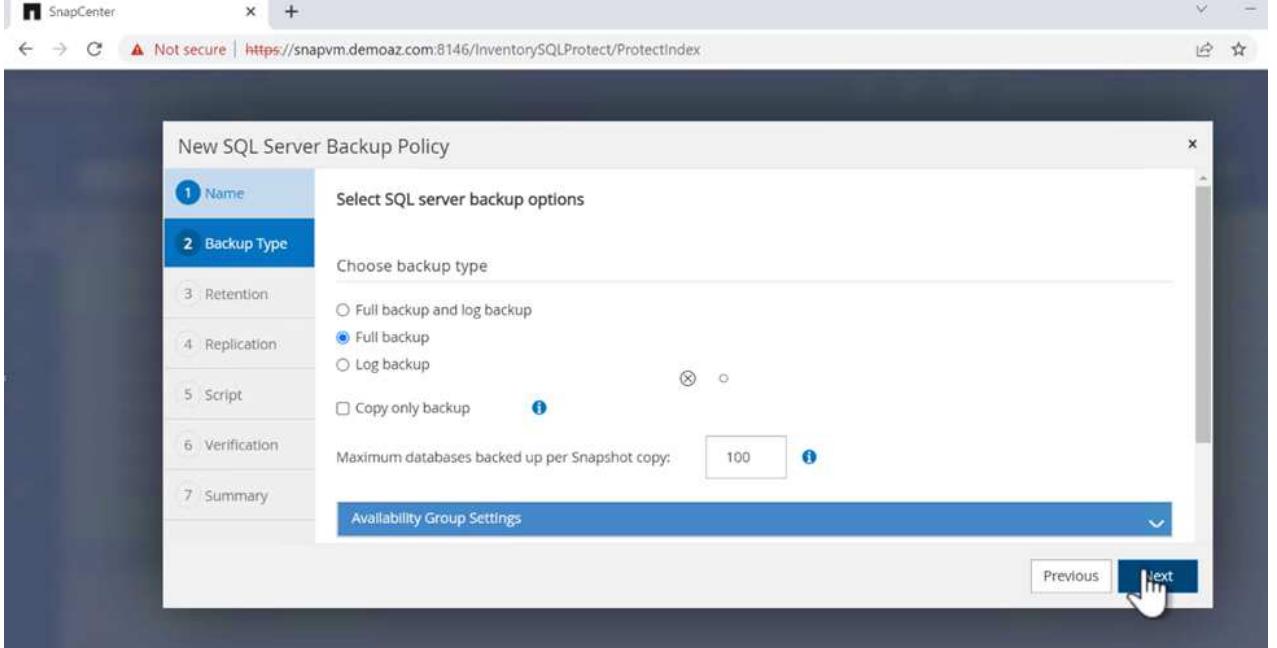
1. Go to **Settings** and select **Policies** on the top left. Then click **New**.



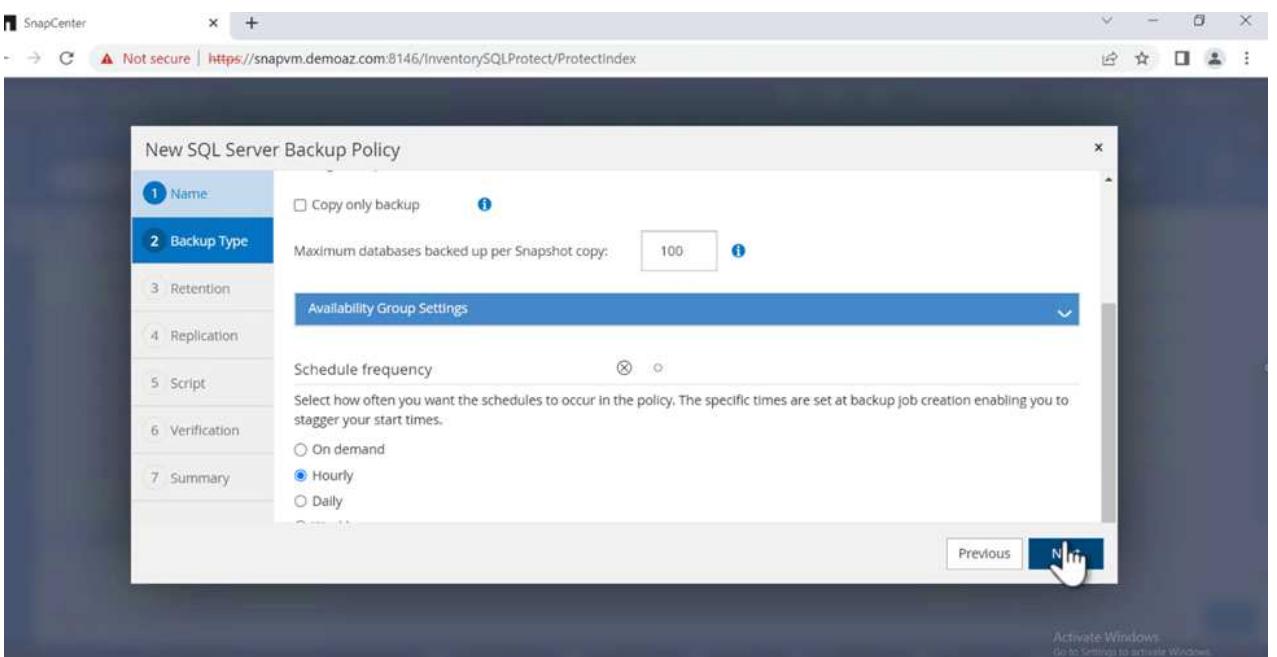
2. Enter the policy name and a description. Click **Next**.



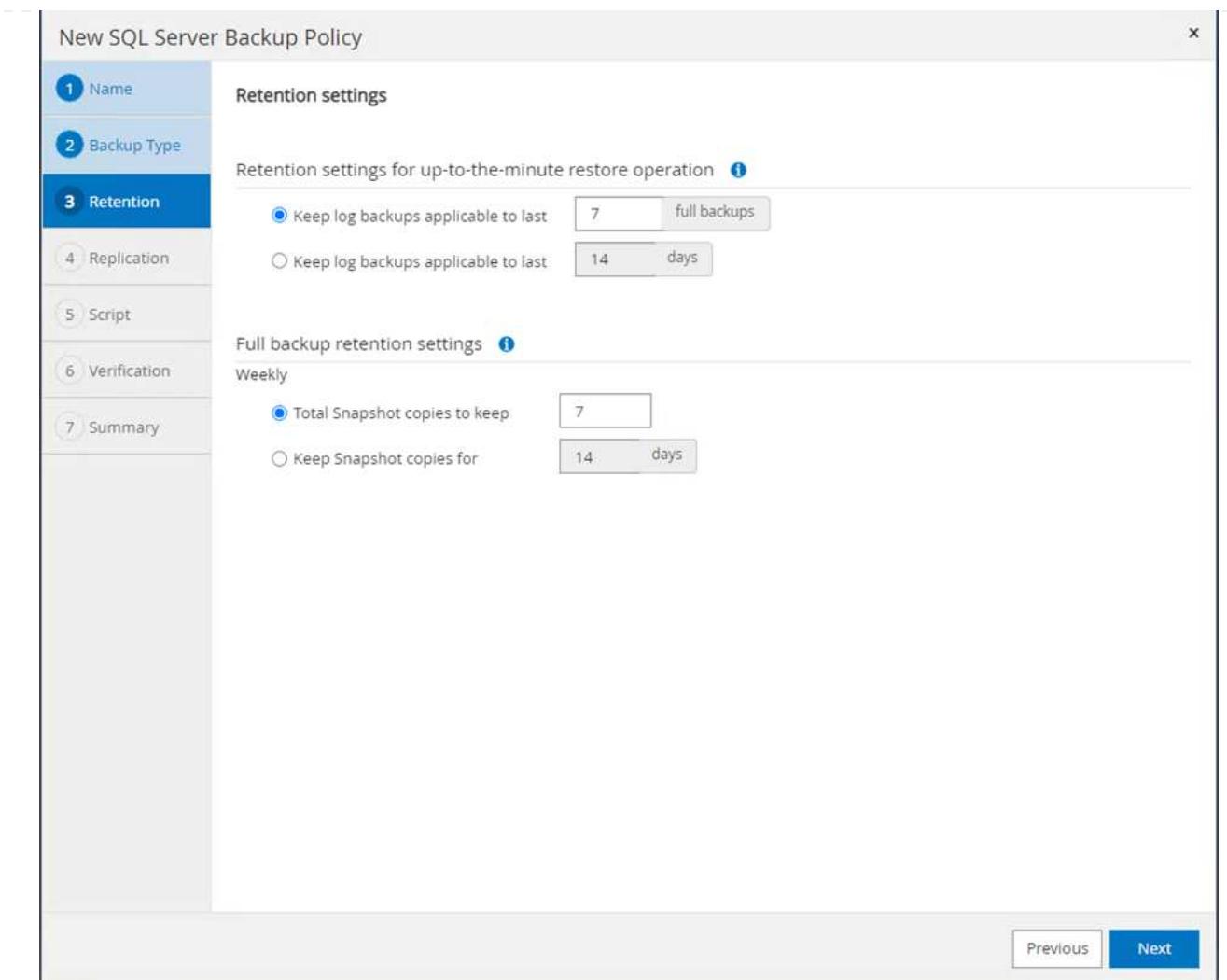
3. Select **Full backup** as the backup type.



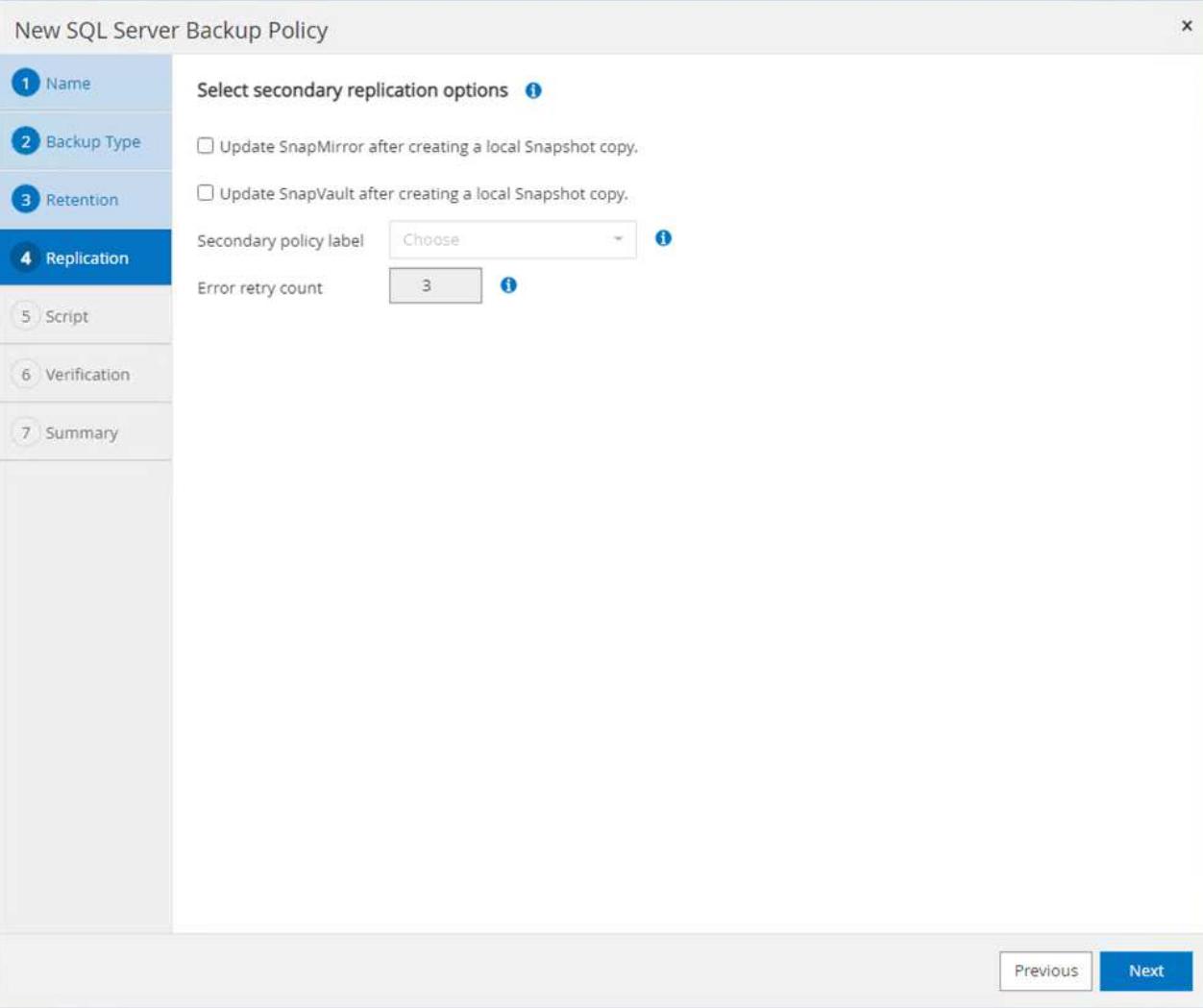
4. Select the schedule frequency (this is based on the company SLA). Click **Next**.



5. Configure the retention settings for the backup.



6. Configure the replication options.



7. Specify a run script to run before and after a backup job is run (if any).

New SQL Server Backup Policy

- 1 Name
- 2 Backup Type
- 3 Retention
- 4 Replication
- 5 Script**
- 6 Verification
- 7 Summary

Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments

Choose optional arguments...

Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments

Choose optional arguments...

Script timeout

60 secs

Previous

Next

8. Run verification based on the backup schedule.

New SQL Server Backup Policy

1 Name

Select the options to run backup verification

2 Backup Type

Run verifications for the following backup schedules

Select how often you want the schedules to occur in the policy. The specific verification times are set at backup job creation enabling you to stagger your verification start times.

Weekly

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Database consistency checks options

Limit the integrity structure to physical structure of the database (PHYSICAL_ONLY)

Suppress all information message (NO_INFOMSGS)

Display all reported error messages per object (ALL_ERRORMSG)

Do not check non-clustered indexes (NOINDEX)

Limit the checks and obtain the locks instead of using an internal database Snapshot copy (TABLOCK)

Verification script settings

Script timeout: 60 secs

Prescript full path:

Prescript arguments: Choose optional arguments...

Postscript full path:

Postscript arguments: Choose optional arguments...

Previous Next

9. The **Summary** page provides details of the backup policy. Any errors can be corrected here.

SnapCenter

Not secure | https://snapvm.demoaz.com:8146/InventorySQLProtect/ProtectIndex

New SQL Server Backup Policy

1 Name

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Summary	
Policy name	TestDB-fullbackup-policy
Details	TestDB-fullbackup-policy
Backup type	Full backup
Availability group settings	Backup only on preferred backup replica
Schedule Type	Hourly <input checked="" type="radio"/> <input type="radio"/>
UTM retention	Total backup copies to retain : 7
Hourly Full backup retention	Total backup copies to retain : 7
Replication	none
Backup prescript settings	undefined Prescript arguments:

Previous Finish

Configure and protect MSSQL Server database

1. Set up the starting date and expiration date of the backup policy.

The screenshot shows the 'Database - Protect Resource' interface in NetApp SnapCenter. On the left, a sidebar lists various Microsoft SQL Server databases, with 'TestDB' currently selected. The main pane displays a 5-step wizard: 'Resource' (step 1), 'Policies' (step 2, highlighted in blue), 'Verification' (step 3), 'Notification' (step 4), and 'Summary' (step 5). Below the steps, a section titled 'Select one or more policies and configure schedules' shows a dropdown menu containing 'TestDB-fullbackup-policy'. A 'Configure Schedules' button is visible, with a hand cursor hovering over it. The status bar at the bottom indicates 'Created backup policy TestDB-fullbackup-policy'.

2. Define the schedule for the backup. To do that, click (+) to configure a schedule. Enter the **Start date** and **Expires on** date. Set the time based on the company's SLA.

The screenshot shows a modal dialog titled 'Add schedules for policy TestDB-fullbackup-policy'. The 'Hourly' tab is selected. The 'Start date' field is set to '11/18/2022 03:42 pm'. The 'Expires on' field is set to '12/18/2022 03:42 pm'. The 'Repeat every' field shows '6 hours 0 mins'. A tooltip message states: 'The schedules are triggered in the SnapCenter Server time zone.' At the bottom right of the dialog, a hand cursor is clicking the 'OK' button.

3. Configure the verification server. From the drop- down menu, select the server.

The screenshot shows the 'Database - Protect Resource' page in NetApp SnapCenter. On the left, a sidebar lists databases: DEMODB1, DEMODB2, DEMODB3, INVENTORYDB1, INVENTORYDB2, master, model, msdb, tempdb, and TestDB, with 'TestDB' selected. The main area displays a five-step process: 1. Resource (blue), 2. Policies (blue), 3. Verification (blue), 4. Notification (gray), and 5. Summary (gray). Step 3 is active. A dropdown 'Verification server' is set to 'SQLHMCRD(14.0.1000)' with one option checked. Below it, a section for 'Configure verification schedules' shows tabs for 'Policy' (selected), 'Schedule Type', 'Applied Schedules', and 'Configure Schedules'. A message states 'There is no match for your search or data is not available.' Navigation buttons 'Previous' and 'Next' are at the bottom.

4. Confirm the configured schedule by clicking the plus sign and confirm.
5. Provide information for email notification. Click **Next**.

The screenshot shows the 'Database - Protect Resource' page in NetApp SnapCenter. The sidebar lists databases: master, model, msdb, tempdb, testdb, master, model, msdb, KTFDB, and tempdb, with 'KTFDB' selected. An orange banner at the top right says: 'If you want to send notifications for scheduled or on demand jobs, an SMTP server must be configured. Continue to the summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.' The main area shows the five-step process: 1. Resource (blue), 2. Policies (blue), 3. Verification (blue), 4. Notifications (blue), and 5. Summary (gray). Step 4 is active. A section titled 'Provide email settings' asks to select service accounts or people to notify regarding protection issues. It includes fields for 'Email preference' (set to 'Never'), 'From' (From email), 'To' (Email to), 'Subject' (Notification), and a checkbox for 'Attach job report'. Navigation buttons 'Previous' and 'Next' are at the bottom.

The summary of the backup policy for SQL Server database is now configured.

If you want to send notifications for scheduled or on demand jobs, an SMTP server must be configured. Continue to the summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

Resource Policies Verification Notification Summary

Database name: TestDB
Policy: TestDB-fullbackup-policy: Hourly
Verification servers: SQLHMCARDS
Verification enabled for policy: None
Send email: No

SnapCenter backup operations

To create on-demand SQL Server backups, complete the following steps:

1. From the **Resource** view, select the resource and select **Backup now**.

TestDB Topology

Black up Now

Manage Copies

0 Backups
0 Clones

Local copies

Summary Card

0 Backups
0 Clones

Primary Backup(s)

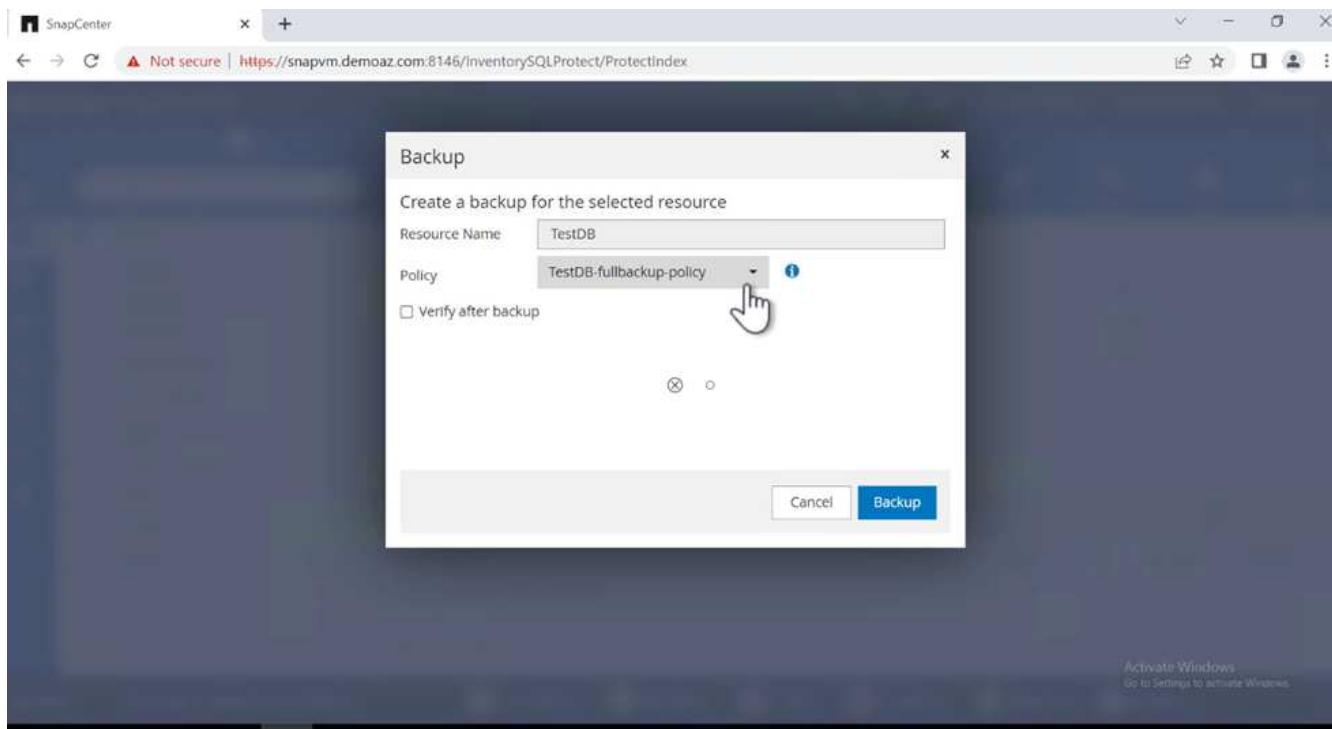
search

Backup Name Count Type End Date Verified

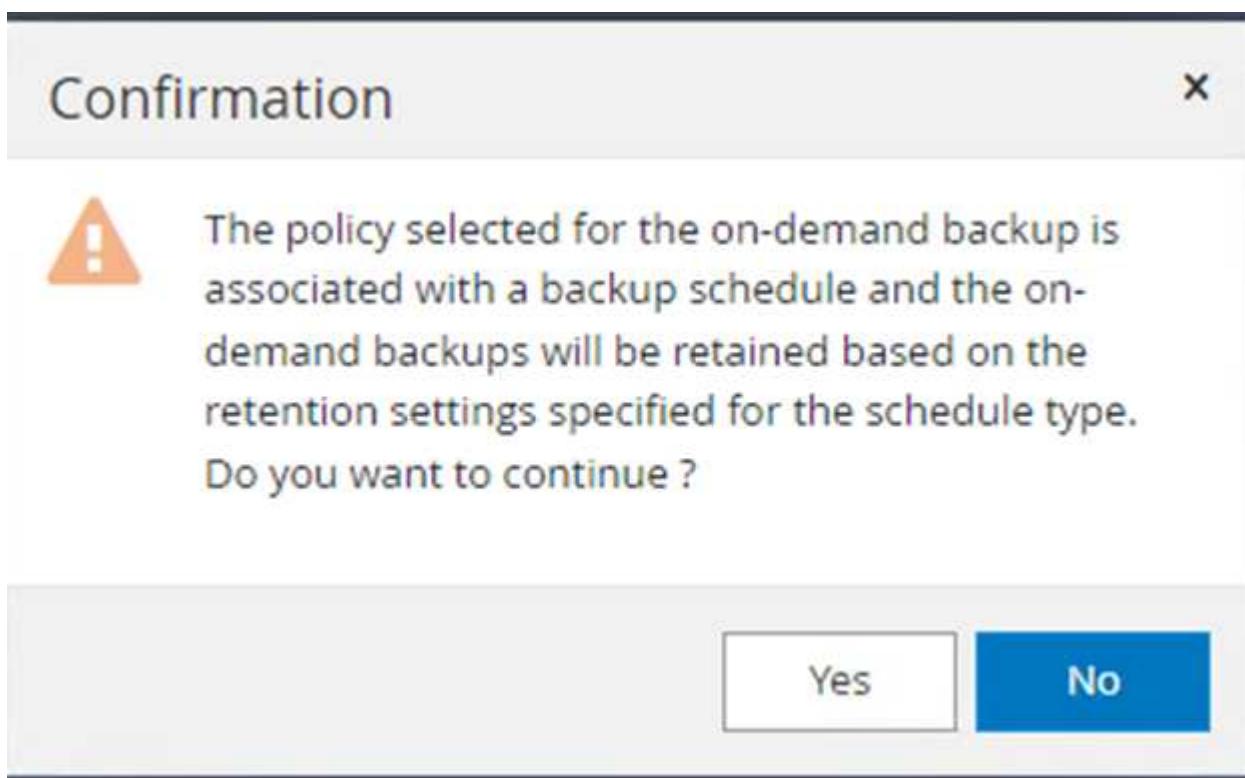
There is no match for your search.

Backups not found

2. In the **Backup** dialog box, click **Backup**.



3. A confirmation screen is displayed. Click **Yes** to confirm.



Monitor backup job

1. From the **Monitor** tab, click the job and select **Details** on the right to view the jobs.

The screenshot shows the NetApp SnapCenter interface. The top navigation bar includes links for 'Jobs', 'Schedules', 'Events', and 'Logs'. A search bar labeled 'search by name' is present. On the left, a sidebar lists 'Dashboard', 'Resources' (selected), 'Monitor', 'Reports', 'Hosts', 'Storage Systems', 'Settings', and 'Alerts'. The main content area displays a table titled 'Jobs - Filter' with columns for 'ID', 'Status', 'Name', 'Start date', 'End date', and 'Owner'. One job is highlighted: 'Backup of Resource Group 'SQLHMCRD5_TestDB' with policy 'TestDB-fullbackup-policy''. The status is green checkmark. The start date is 11/18/2022 3:43:12 PM and the end date is 11/18/2022 3:47:05 PM. The owner is Administrator. A hand cursor is hovering over the 'Details' icon in the top right corner of the job row.

This screenshot shows a 'Job Details' dialog box overlaid on the SnapCenter interface. The dialog title is 'Job Details' and the sub-section is 'Backup of Resource Group 'SQLHMCRD5_TestDB' with policy 'TestDB-fullbackup-policy''. The task tree shows the following steps: Backup of Resource Group 'SQLHMCRD5_TestDB' with policy 'TestDB-fullbackup-policy', fcm-rds1.demoaz.com, Preparing for Backup, Creating SQL Backup, Finalizing Backup, Data Collection (which is currently selected and highlighted in grey), and Send EMS Messages. Below the tree, a message states: 'Task Name: Data Collection Start Time: 11/18/2022 3:47:05 PM End Time: 11/18/2022 3:47:05 PM'. At the bottom of the dialog are three buttons: 'View Logs', 'Cancel Job', and 'Close'. A hand cursor is hovering over the 'Close' button. The background of the dialog has a dark blue gradient.

When the backup is completed, a new entry is shown in the Topology view.

Backup operation for multiple databases

To configure a backup policy for multiple SQL Server databases, create resource group policies by completing the following steps:

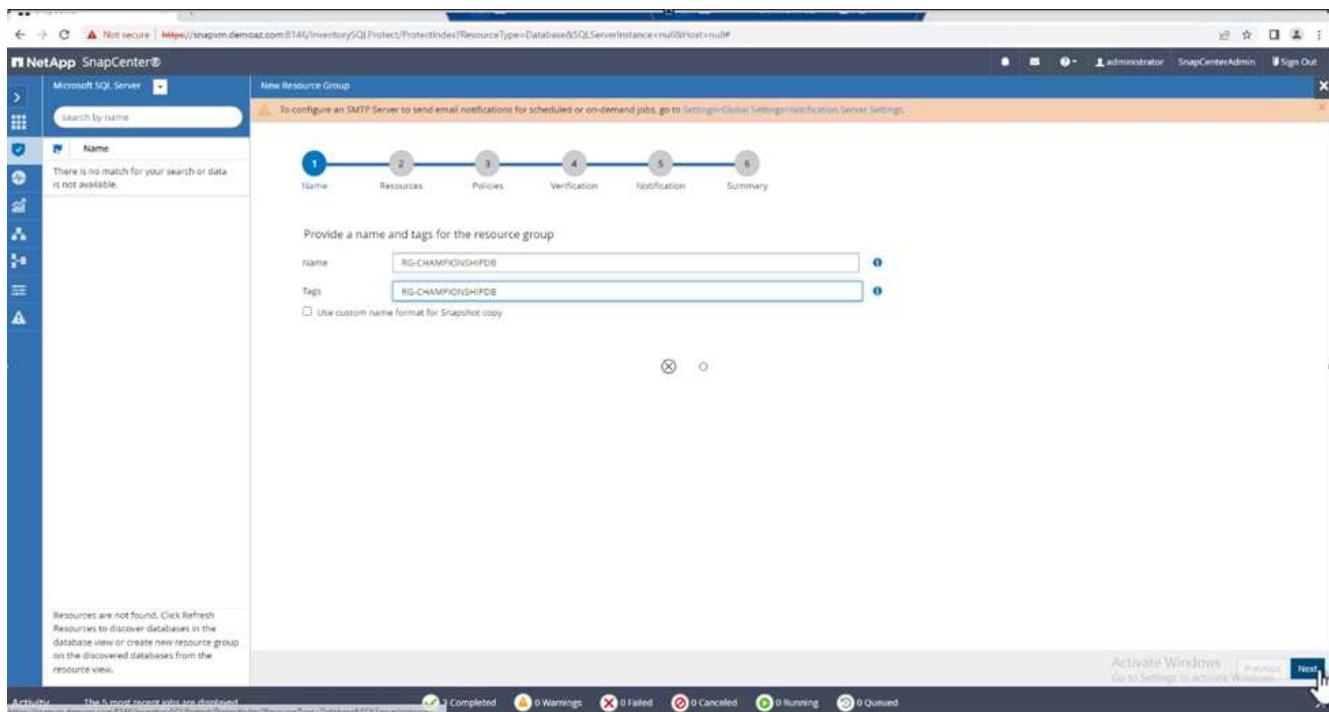
1. In the **Resources** tab from the **View** menu, change to a resource group using the drop-down menu.

The screenshot shows the NetApp SnapCenter interface for Microsoft SQL Server. The left sidebar has 'Resources' selected. The main area shows a table of databases with columns: Instance, Host, Last Backup, Overall Status, and Type. The 'View' dropdown is set to 'Database'. A context menu is open over the first database entry, with 'Availability Group' highlighted. The bottom status bar shows 'Activity' with 5 completed jobs, 0 warnings, 0 failed, 0 canceled, 0 running, and 0 queued.

2. Click (+) for a new resource group.

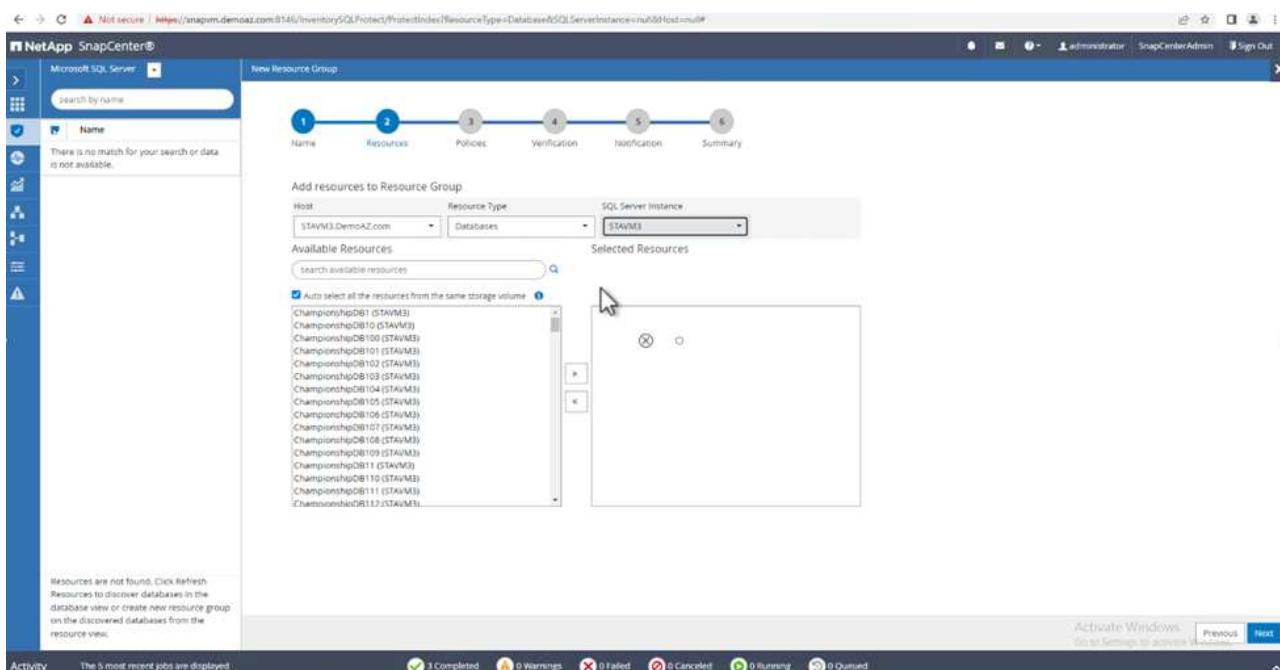
The screenshot shows the NetApp SnapCenter interface for Microsoft SQL Server. The left sidebar has 'Resources' selected. The main area shows a table with columns: Name, Resource Count, Tags, Policies, Last Backup, and Overall Status. A message at the top says 'There is no match for your search or data is not available.' Below it, another message says 'Resources are not found. Click Refresh Resources to discover databases in the database view or create new resource group on the discovered databases from the resource view.' The bottom status bar shows 'Activity' with 5 completed jobs, 0 warnings, 0 failed, 0 canceled, 0 running, and 0 queued.

3. Provide a name and tag. Click Next.

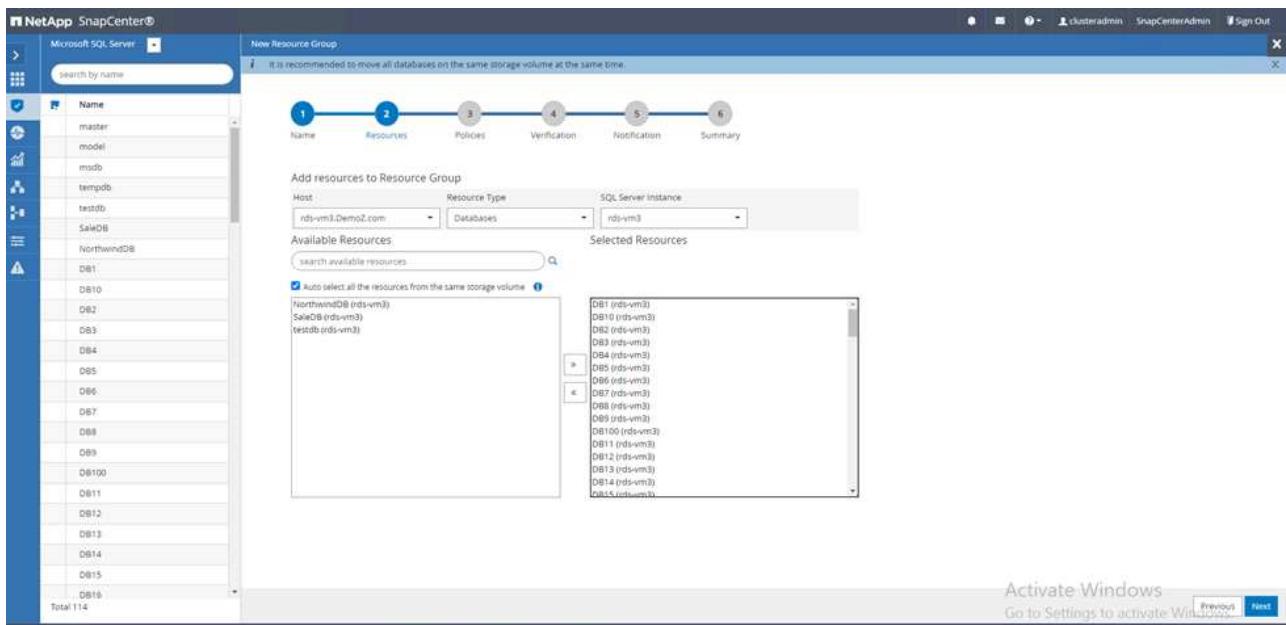


4. Add resources to the resource group:

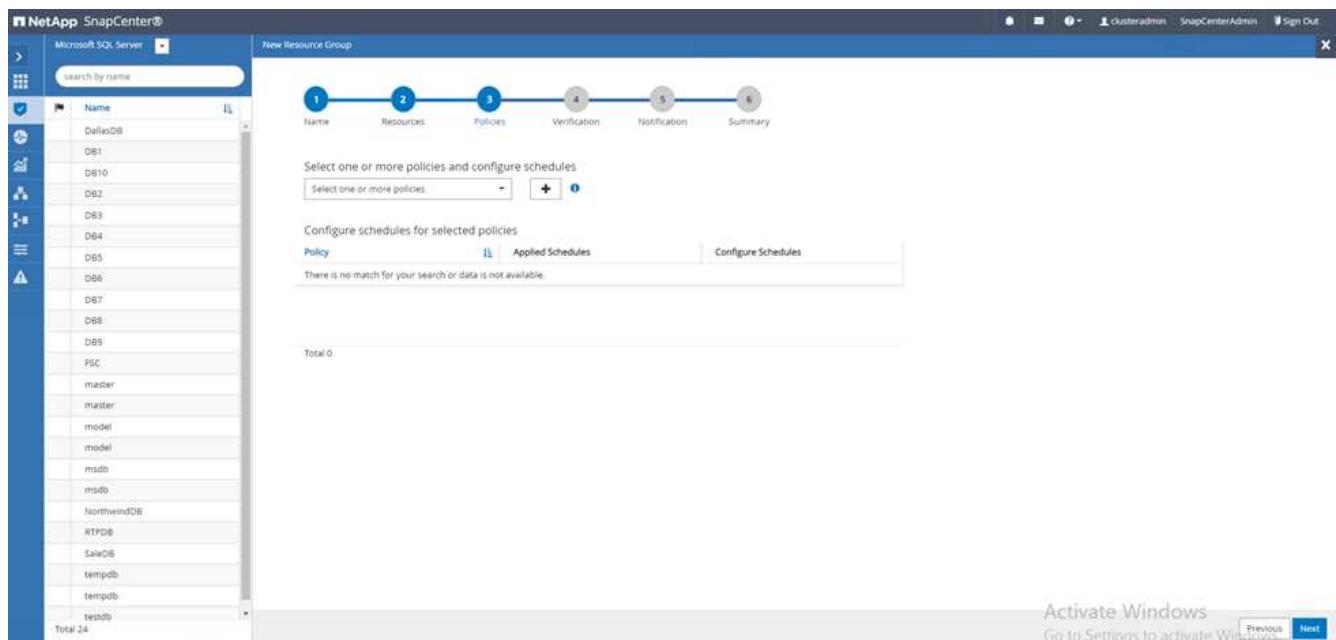
- **Host.** Select the server from the drop-down menu hosting the database.
- **Resource type.** From the drop-down menu, select **Database**.
- **SQL Server instance.** Select the server.



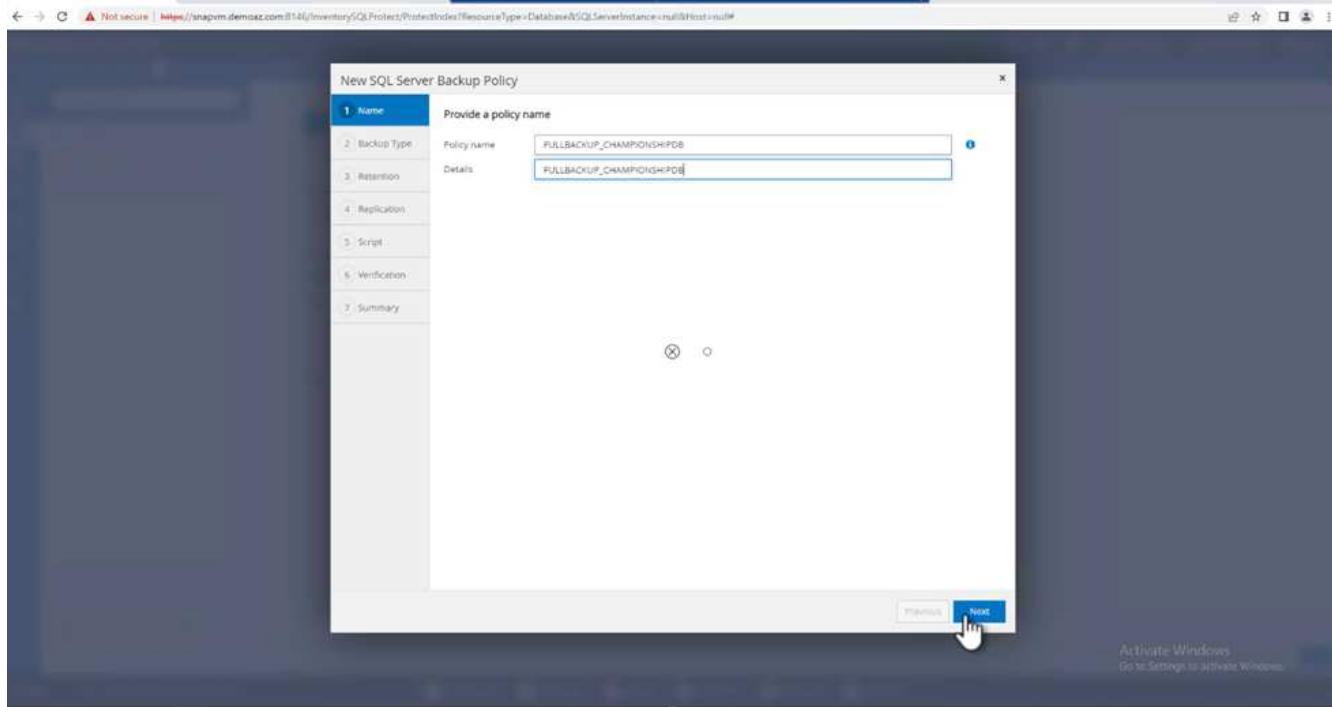
The **option Auto Selects All the Resources from the Same Storage Volume*** is selected by default. Clear the option and select only the databases you need to add to the resource group, Click the arrow to add and click **Next**.



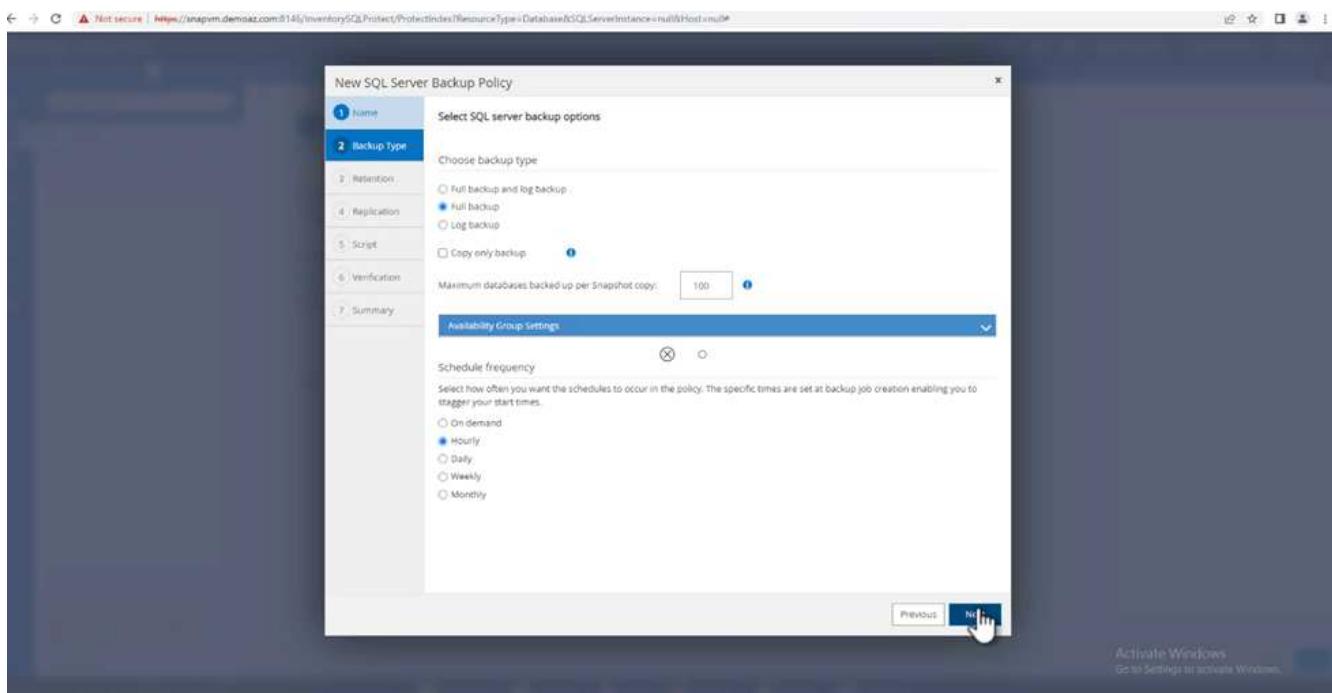
5. On the policies, click (+).



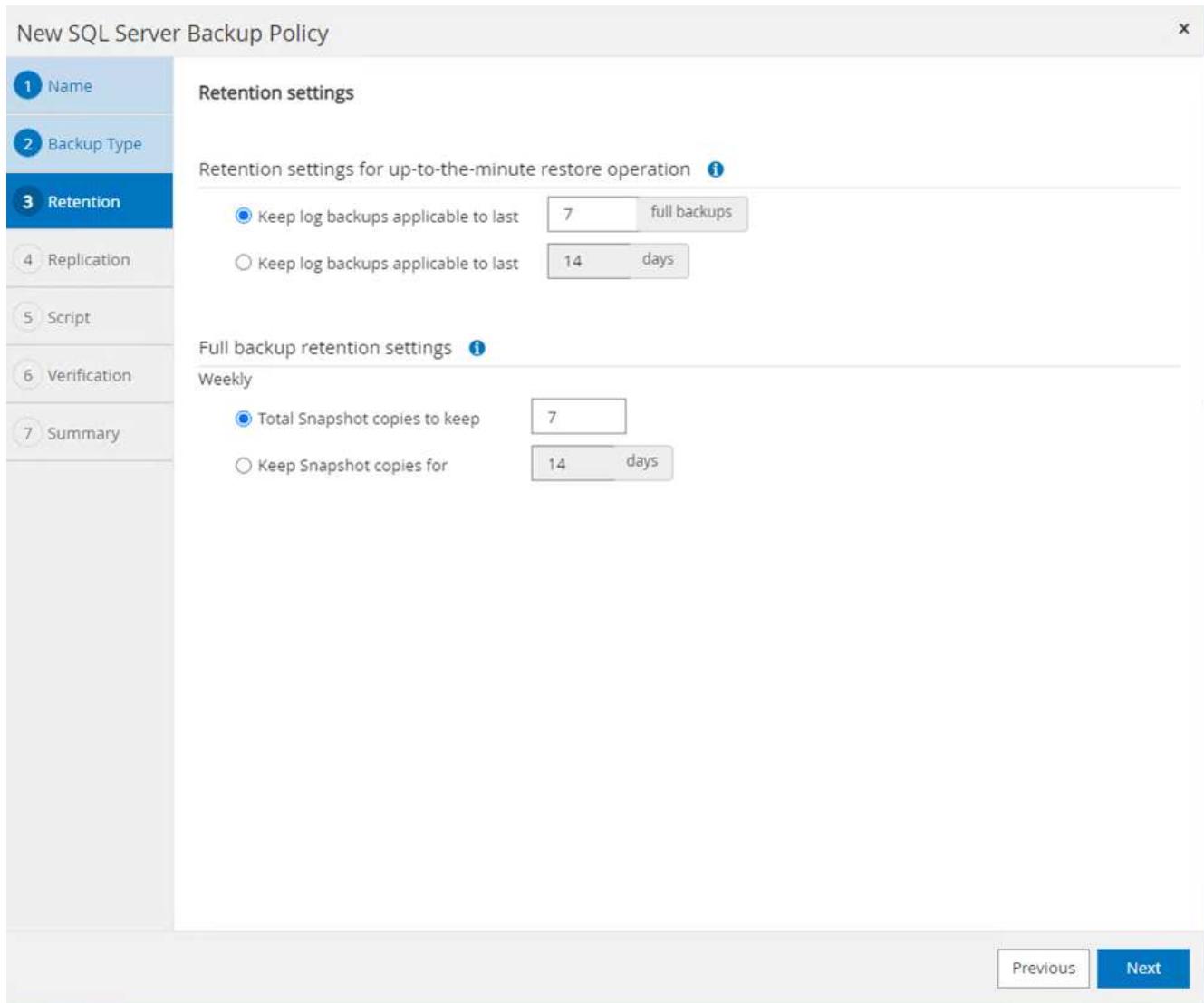
6. Enter the resource group policy name.



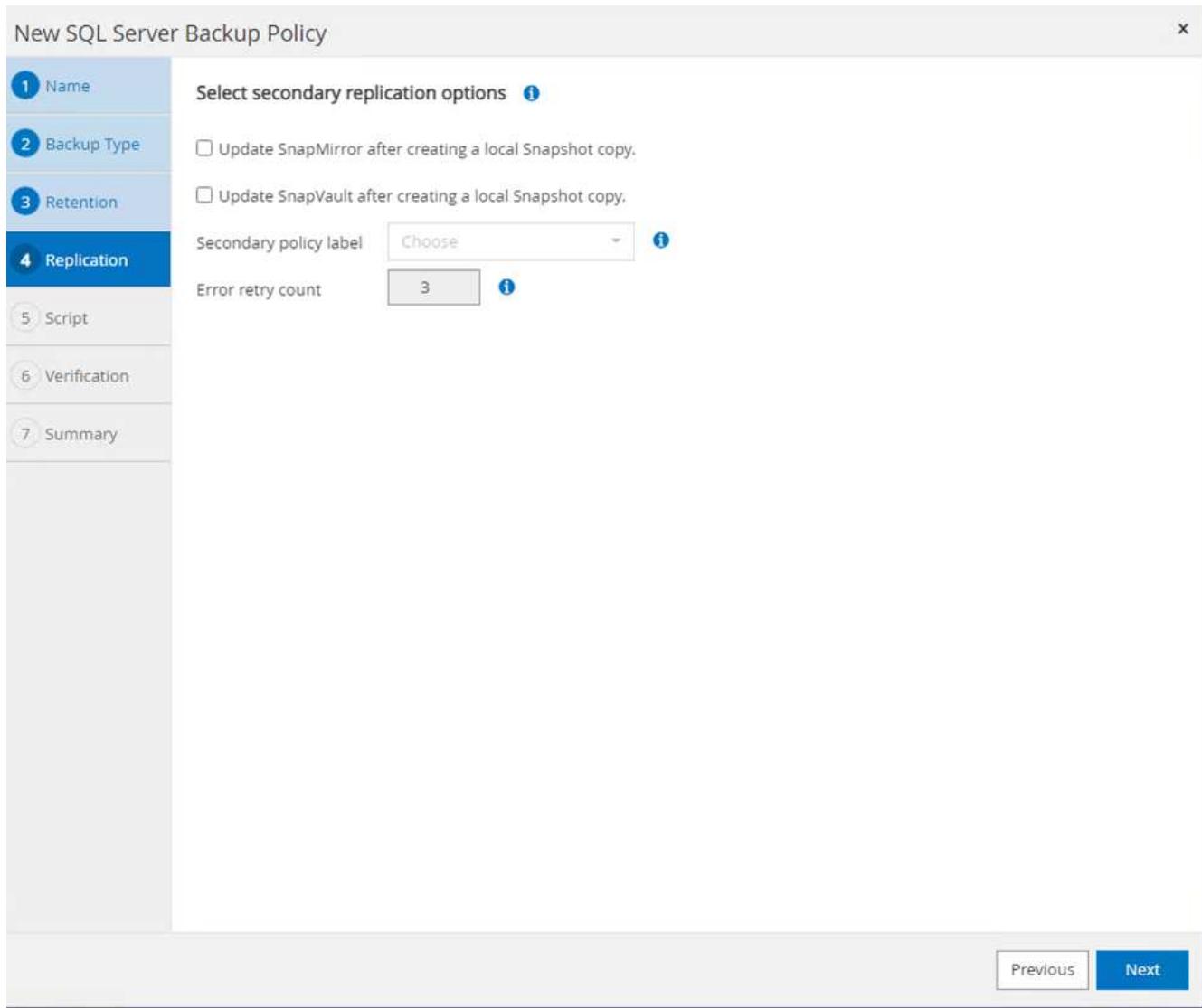
7. Select **Full backup** and the schedule frequency depending on your company's SLA.



8. Configure the retention settings.



9. Configure the replication options.



10. Configure the scripts to run before performing a backup. Click **Next**.

New SQL Server Backup Policy

X

1 Name

Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments Choose optional arguments...

2 Backup Type

3 Retention

4 Replication

5 Script

Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments Choose optional arguments...

6 Verification

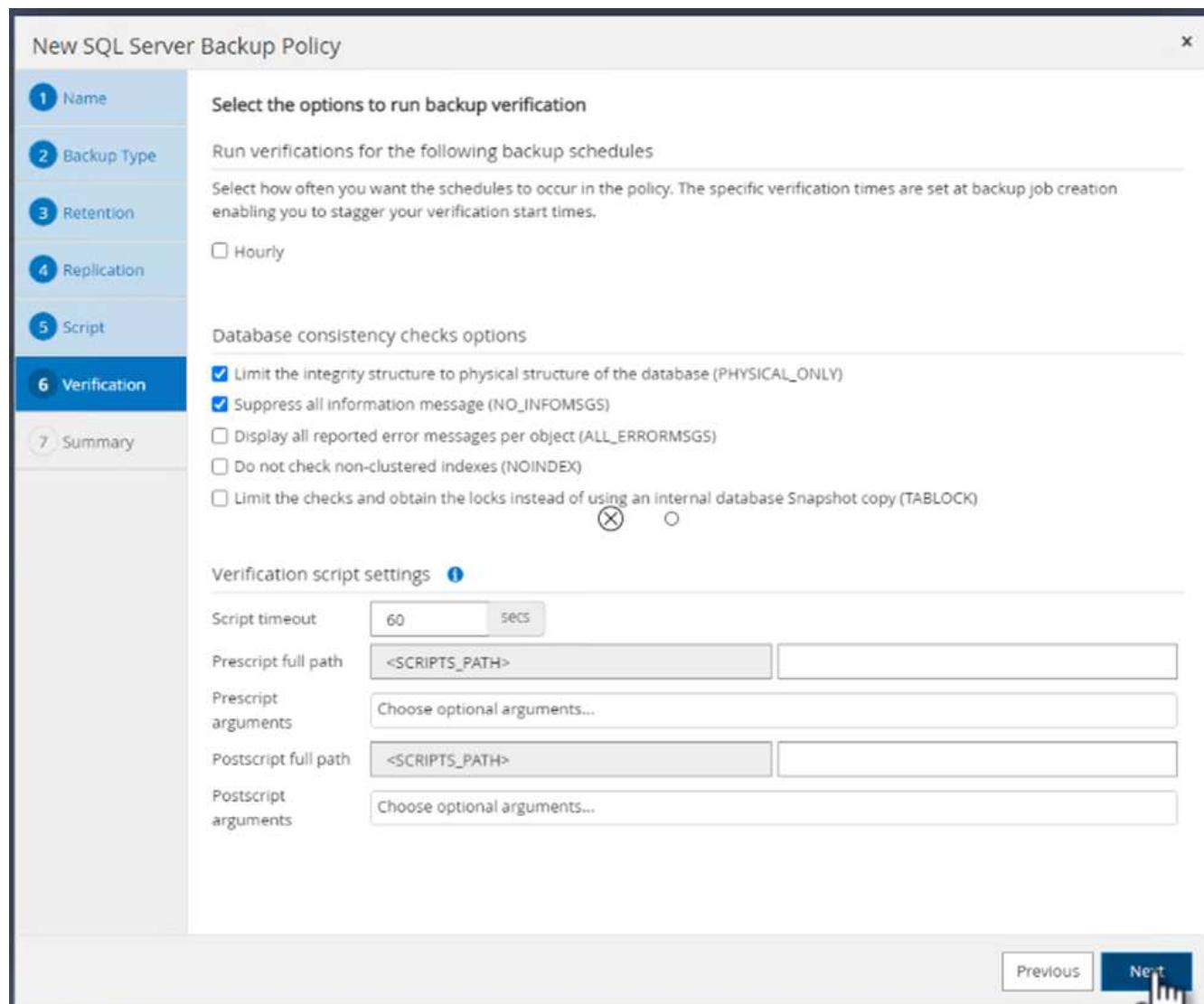
7 Summary

Script timeout 60 secs

Previous Next

The screenshot shows the 'New SQL Server Backup Policy' configuration window. The 'Script' tab is active. On the left, a vertical navigation bar lists steps 1 through 7. The 'Script' step is highlighted with a blue background. The main area contains sections for 'Prescript' and 'Postscript' scripts, each with a 'full path' input field and an 'optional arguments...' button. A 'Script timeout' field is set to 60 seconds. At the bottom right are 'Previous' and 'Next' buttons.

11. Confirm the verification for the following backup schedules.



12. On the **Summary** page, verify the information, and click **Finish**.

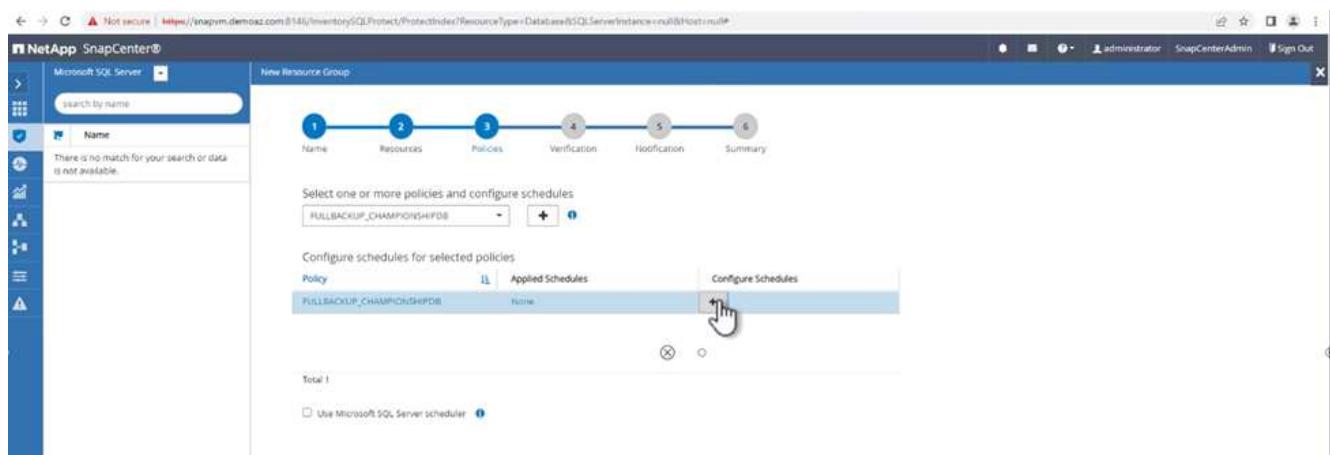
New SQL Server Backup Policy

1 Name	Summary
2 Backup Type	Policy name: FULLBACKUP_CHAMPIONSHIPDB
3 Retention	Details: FULLBACKUP_CHAMPIONSHIPDB
4 Replication	Backup type: Full backup
5 Script	Availability group settings: Backup only on preferred backup replica
6 Verification	Schedule Type: Hourly UTM retention: Total backup copies to retain : 7
7 Summary	Hourly Full backup retention: Total backup copies to retain : 7 Replication: none Backup prescript settings: undefined Prescript arguments: Backup postscript settings: undefined Postscript arguments: Verification for backup schedule type: Hourly Verification prescript settings: undefined Prescript arguments: Verification postscript settings: undefined Postscript arguments:

[Previous](#) **Finish** 

Configure and protect multiple SQL Server databases

1. Click the (+) sign to configure the start date and the expire- on date.



The screenshot shows the NetApp SnapCenter interface for configuring a new resource group for a Microsoft SQL Server database. The left sidebar shows a tree view with 'Microsoft SQL Server' selected. The main pane displays a 'New Resource Group' wizard with six steps: Name, Resources, Policies, Verification, Notification, and Summary. Step 1 (Name) is active, showing a dropdown menu for selecting a policy. A tooltip indicates 'Select one or more policies and configure schedules'. Below the dropdown, there's a table for 'Configure schedules for selected policies' with a row for 'FULLBACKUP_CHAMPIONSHIPDB' and a 'Configure Schedules' button. A hand cursor is hovering over this button. At the bottom, there's a note about using the Microsoft SQL Server scheduler and a 'Total 1' indicator.

2. Set the time.

Add schedules for policy FULLBACKUP_CHAMPIONSHIPDB

x

Hourly

Start date

11/11/2022 05:30 pm



Expires on

12/11/2022 05:27 pm



Repeat every

8



hours

0

mins



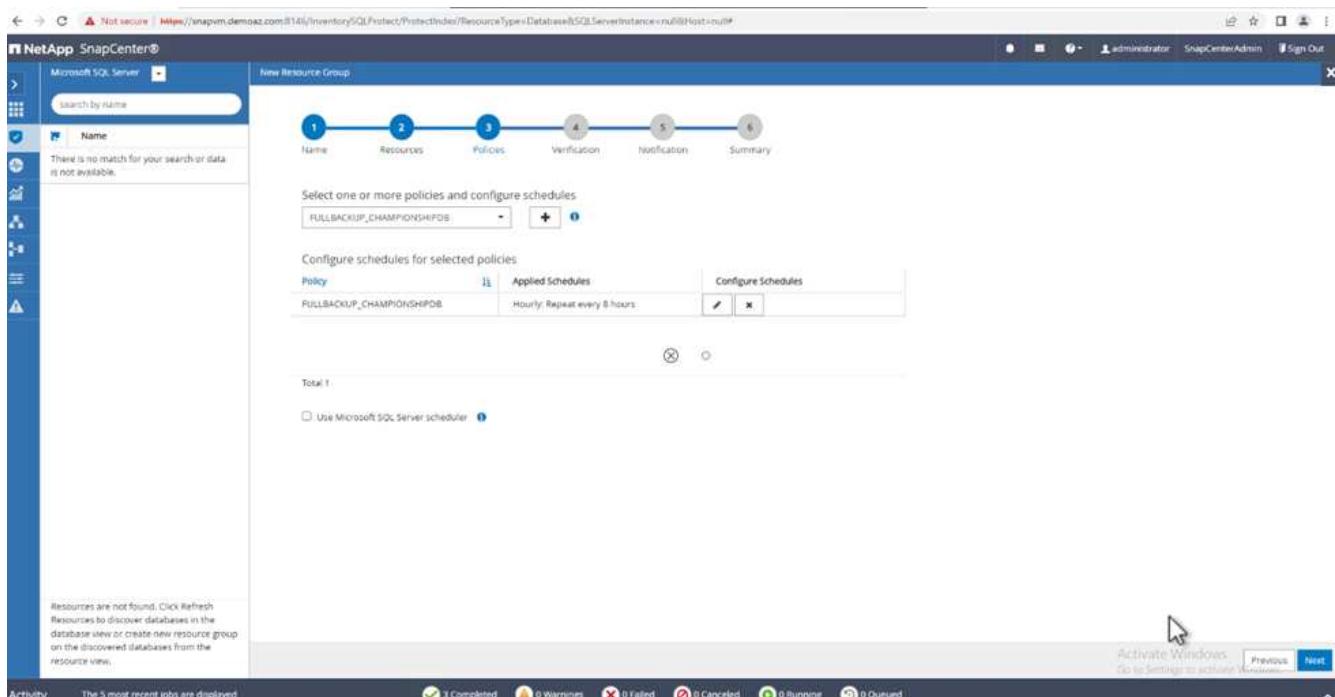
The schedules are triggered in the SnapCenter Server time zone.



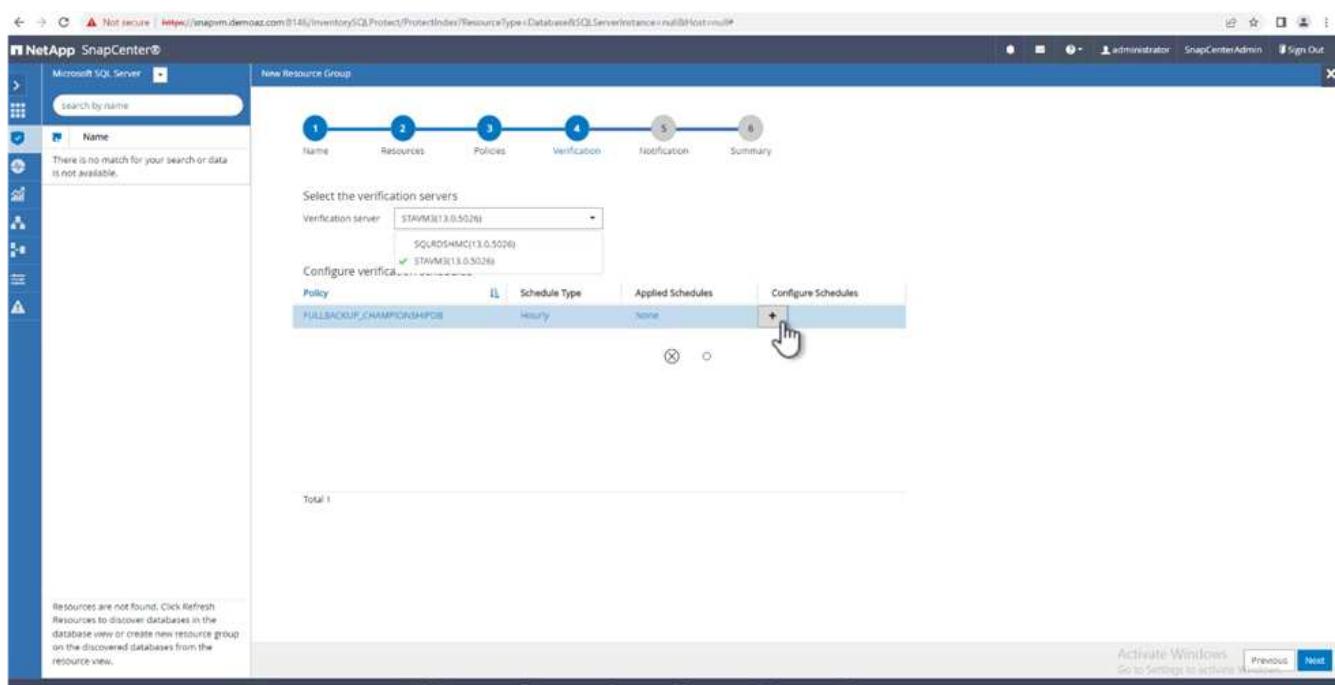
Cancel

OK

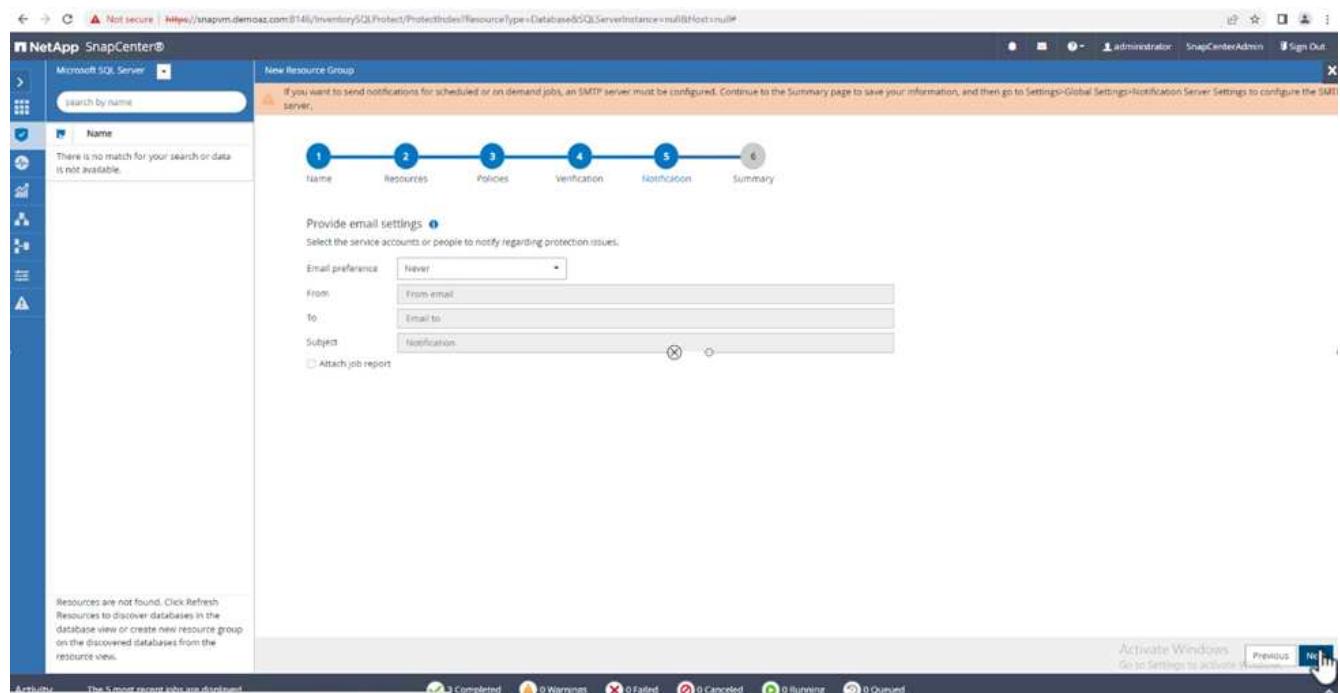




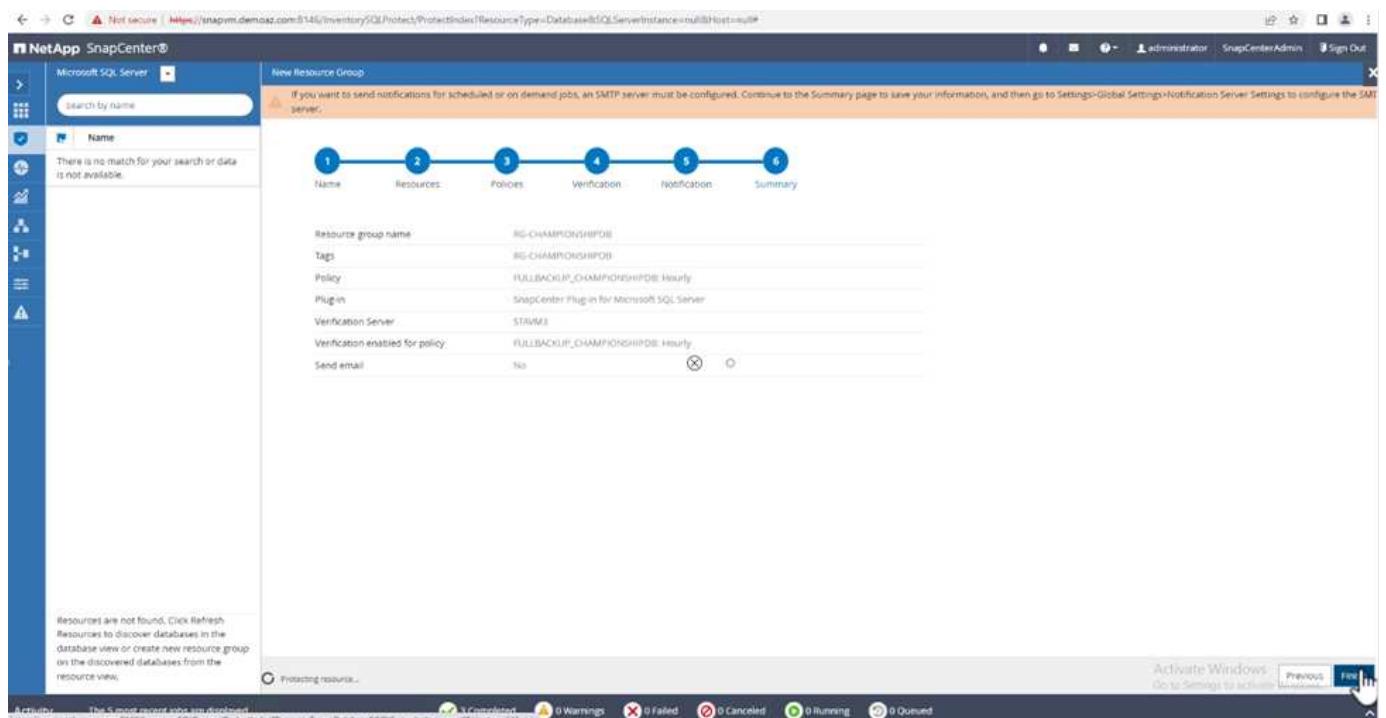
3. From the **Verification** tab, select the server, configure the schedule, and click **Next**.



4. Configure notifications to send an email.



The policy is now configured for backing up multiple SQL Server databases.



Trigger on-demand backup for multiple SQL Server databases

1. From the **Resource** tab, select view. From the drop-down menu, select **Resource Group**.

Not secure | <https://xnapvm.demoaz.com:8443/inventorySQLProject/ProtectedIndex/ResourcesType=Database&SQLServerInstance=null&Host=null>

NetApp SnapCenter®

Microsoft SQL Server

RG-O-MMPHNSH6/DS Details

Name	Resource Name	Type	Host
RG-CHAMPIONSHIPDB	ChampionshipDB1 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB10 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB100 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB101 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB102 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB103 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB104 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB105 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB106 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB107 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB108 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB109 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB11 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB110 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB111 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB112 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB113 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB114 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB115 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB116 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB117 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB118 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB119 (STAVM3)	SQL Database	STAVM3.DemoAZ.com
	ChampionshipDB12 (STAVM3)	SQL Database	STAVM3.DemoAZ.com

Total 114

Activity The 5 most recent jobs are displayed

Activate Windows Go to Settings to activate Windows.

Modify Resource Group Backup now Done Lifecycle Maintenance Edit/View Details Delete

2. Select the resource group name.
3. Click **Backup now** in the upper right.

Not secure | <https://xnapvm.demoaz.com:8443/inventorySQLProject/ProtectedIndex/ResourcesType=Database&SQLServerInstance=null&Host=null>

NetApp SnapCenter®

Microsoft SQL Server

RG-1 Details

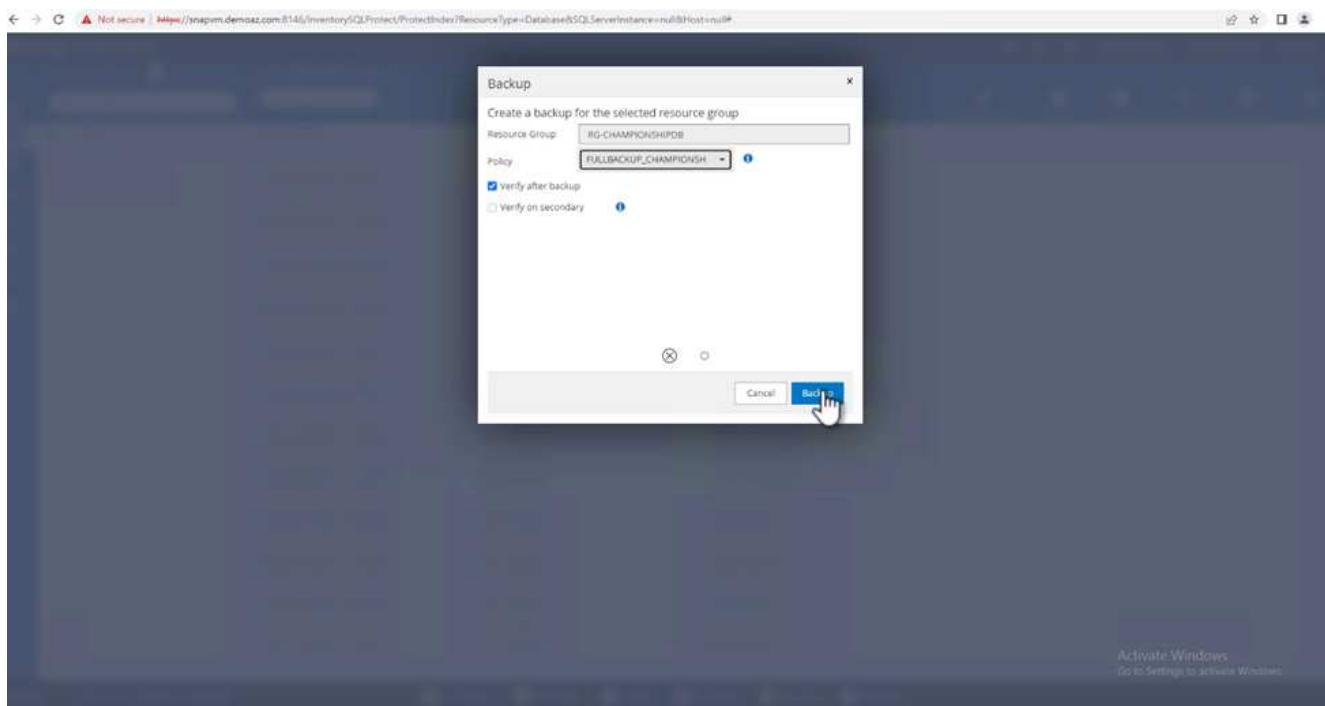
Name	Resource Name	Type	Host
master	DB1 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
model	DB10 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
msdb	DB2 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
tempdb	DB3 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
testdb	DB4 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
SaleDB	DB5 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
NorthwindDB	DB6 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB1	DB7 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB10	DB8 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB2	DB9 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB3	DB100 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB4	DB11 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB5	DB12 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB6	DB13 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB7	DB14 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB8	DB15 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB9	DB16 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB100	DB17 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB11	DB18 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB12	DB19 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB13	DB20 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB14	DB21 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB15	DB22 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com
DB16	DB23 (rds-vm3)	SQL Database	rds-vm3.DemoAZ.com

Total 114

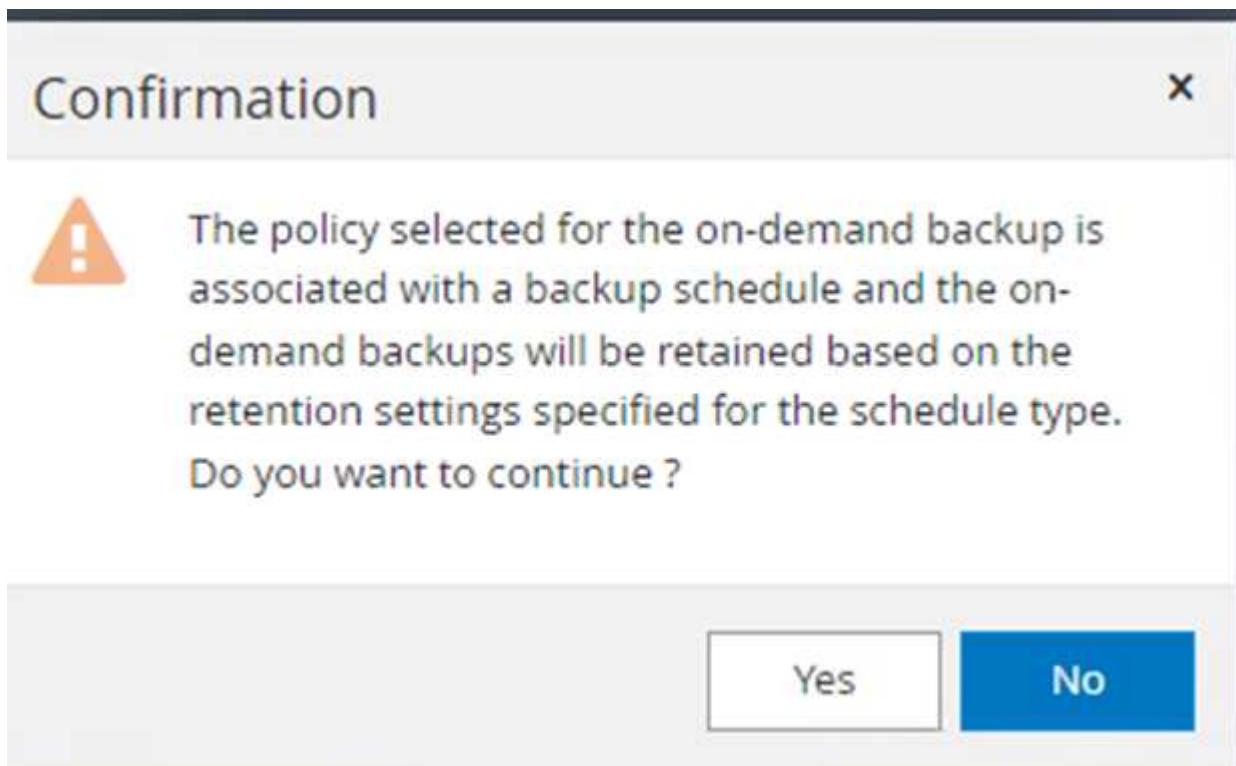
Activate Windows Go to Settings to activate Windows.

Modify Resource Group Backup now Done Lifecycle Maintenance Edit/View Details Delete

4. A new window opens. Click the **Verify after backup** checkbox and then click backup.

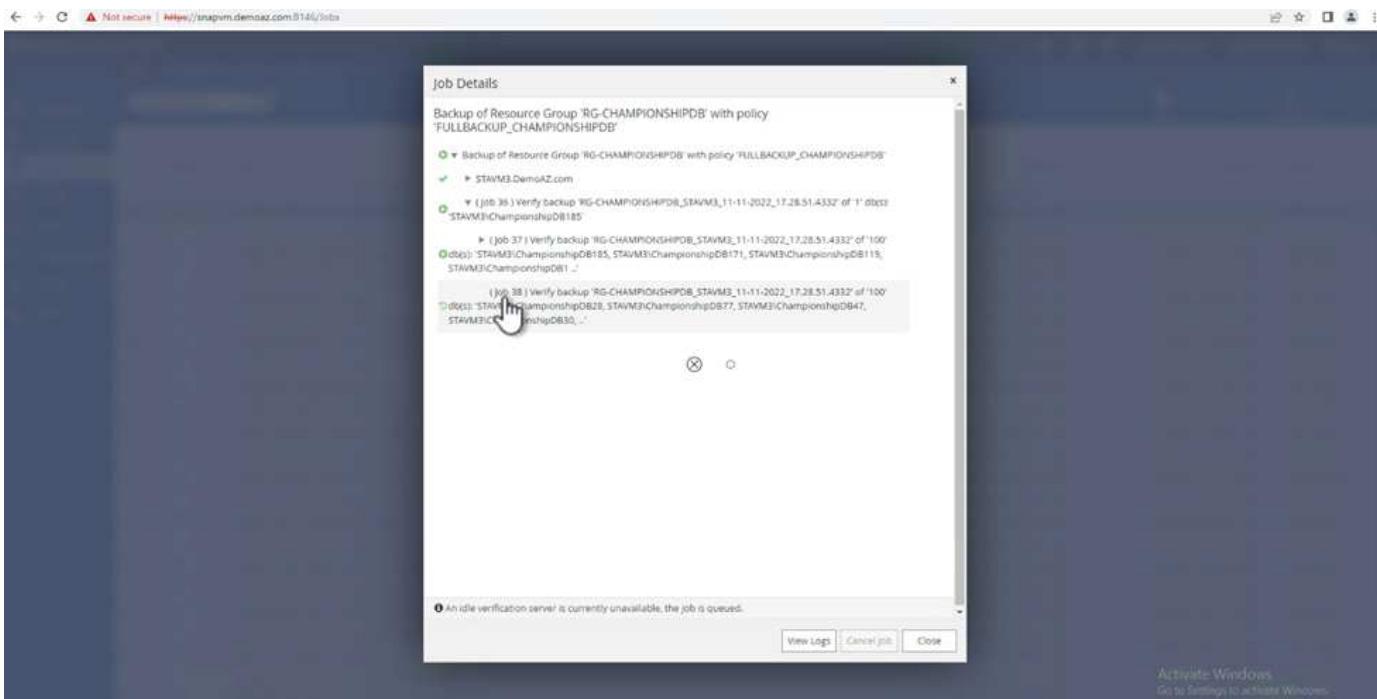


5. A confirmation message is displayed. Click **Yes**.



Monitor multiple-database backup jobs

From the left navigation bar, click **Monitor**, select the backup job, and click **Details** to view job progress.



Click the **Resource** tab to see the time it takes for the backup to be completed.

A screenshot of the NetApp SnapCenter interface. On the left is a navigation sidebar with options like Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area is titled 'Microsoft SQL Server' and shows a table for 'RG-CHAMPIONSHIPDB'. The columns are Name, Resource Count, Tags, Policies, Last Backup, and Overall Status. The 'Overall Status' for the resource group is 'Queued'. A hand cursor is pointing at the 'Overall Status' cell. At the bottom right of the interface are 'Activate Windows' and 'Go to Settings to activate Windows' buttons.

Transaction log backup for multiple database backup

SnapCenter supports the full, bulked logged, and simple recovery models. The simple recovery mode does not support transactional log backup.

To perform a transaction log backup, complete the following steps:

1. From the **Resources** tab, change the view menu from **Database** to **Resource group**.

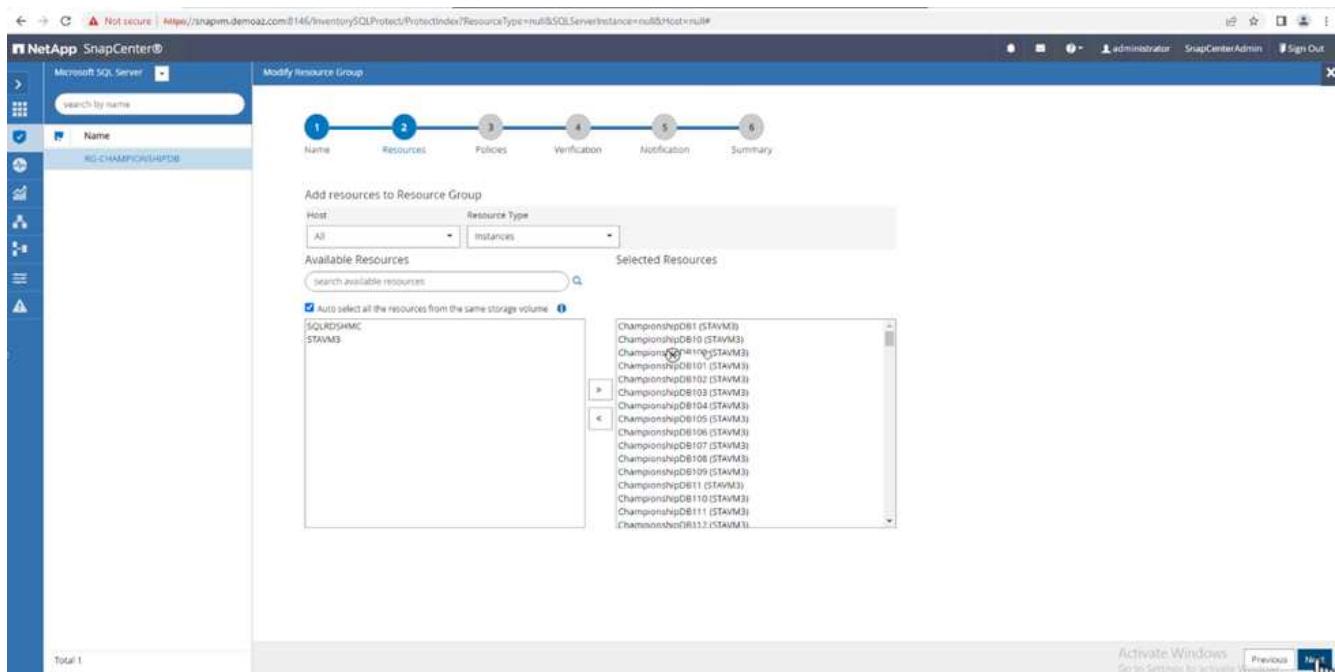
The screenshot shows the NetApp SnapCenter interface for Microsoft SQL Server. The left sidebar includes tabs for Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area displays a table of databases with columns for Instance, Host, Last Backup, Overall Status, and Type. The table lists 213 entries, including system databases like master, model, msdb, tempdb, and user databases such as ChampionshipDB1 through ChampionshipDB11. The status column indicates various backup outcomes: Backup succeeded, Not protected, or Backup succeeded (User database). The overall status for most databases is 'Not protected'. The interface also shows a summary of recent jobs at the bottom.

2. Select the resource group backup policy created.
3. Select **Modify Resource Group** in the upper right.

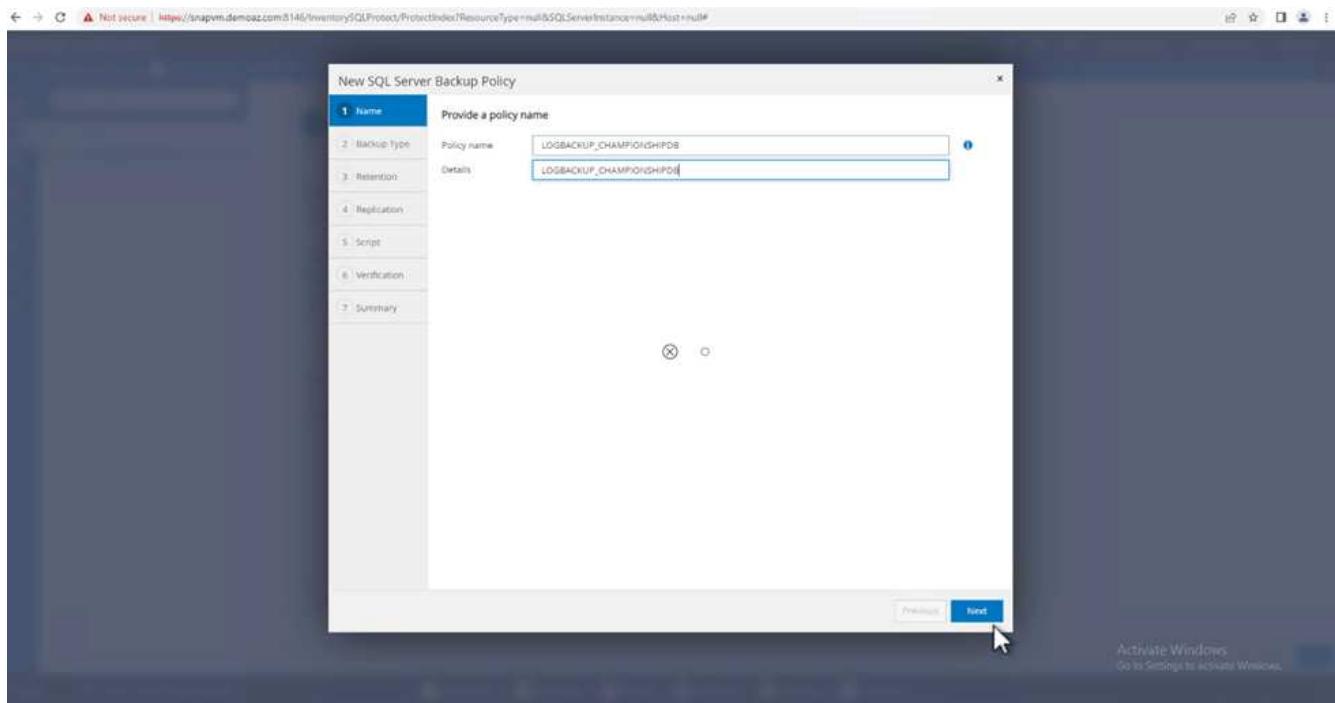
The screenshot shows the NetApp SnapCenter interface for the 'RG-CHAMPIONSHIPDB1' resource group. The left sidebar shows the 'Resources' tab is selected. The main area displays a table of resources with columns for Name, Resource Name, Type, and Host. The table lists 213 entries, all of which are SQL Databases on host STAVM3.DemoAZ.com. The 'Name' section in the table header is highlighted, indicating it's the current configuration being modified. The interface also shows a summary of recent jobs at the bottom.

4. The **Name** section defaults to the backup policy name and tag. Click **Next**.

The **Resources** tab highlights the bases to which the transaction backup policy is to be configured.



5. Enter the policy name.



6. Select the SQL Server backup options.
7. Select log backup.
8. Set the schedule frequency based on your company's RTO. Click **Next**.

New SQL Server Backup Policy X

1 Name Select SQL server backup options

2 Backup Type Choose backup type

Full backup and log backup
 Full backup
 Log backup
 Copy only backup i

Maximum databases backed up per Snapshot copy: i

Availability Group Settings ▼

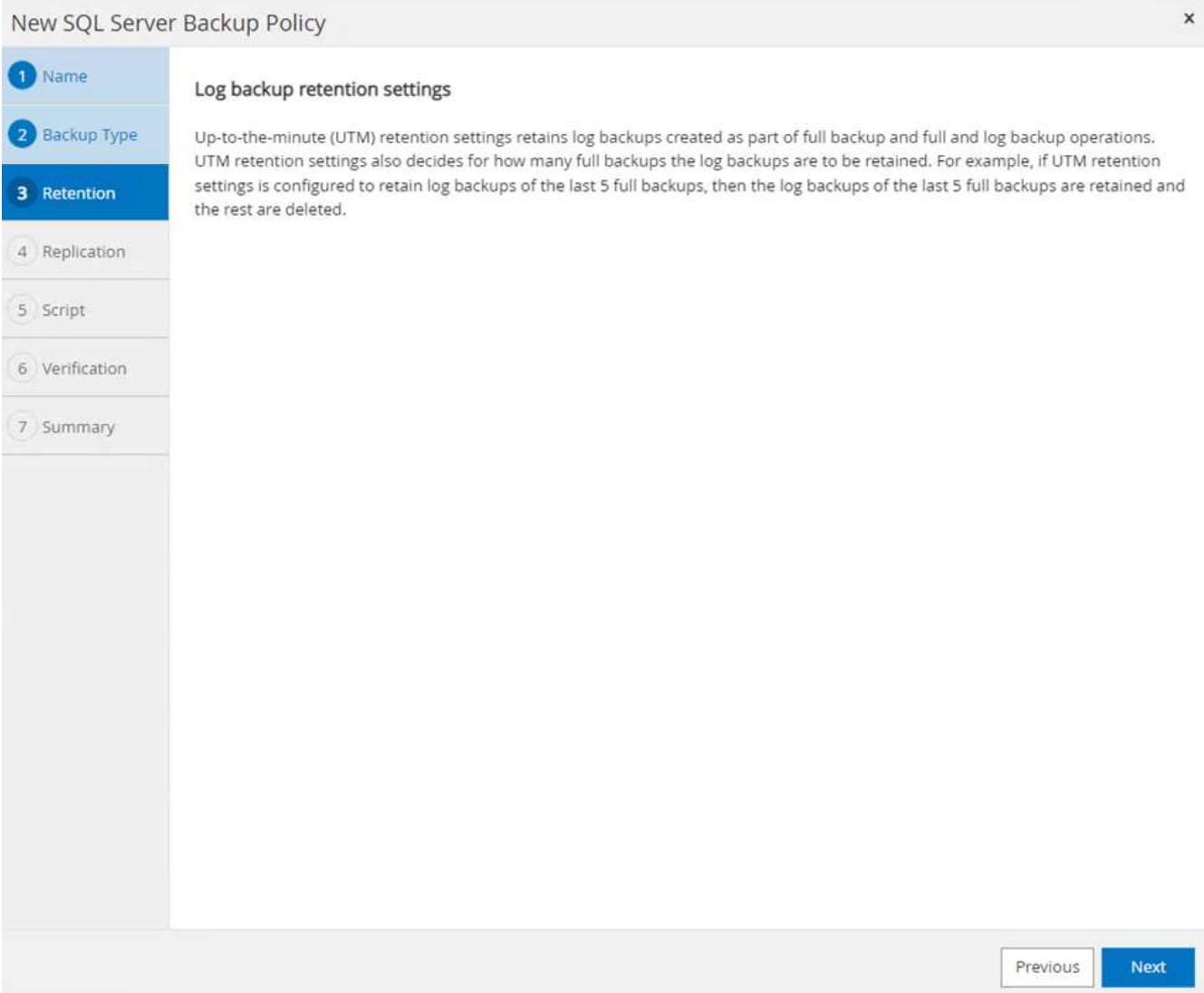
Schedule frequency

Select how often you want the schedules to occur in the policy. The specific times are set at backup job creation enabling you to stagger your start times.

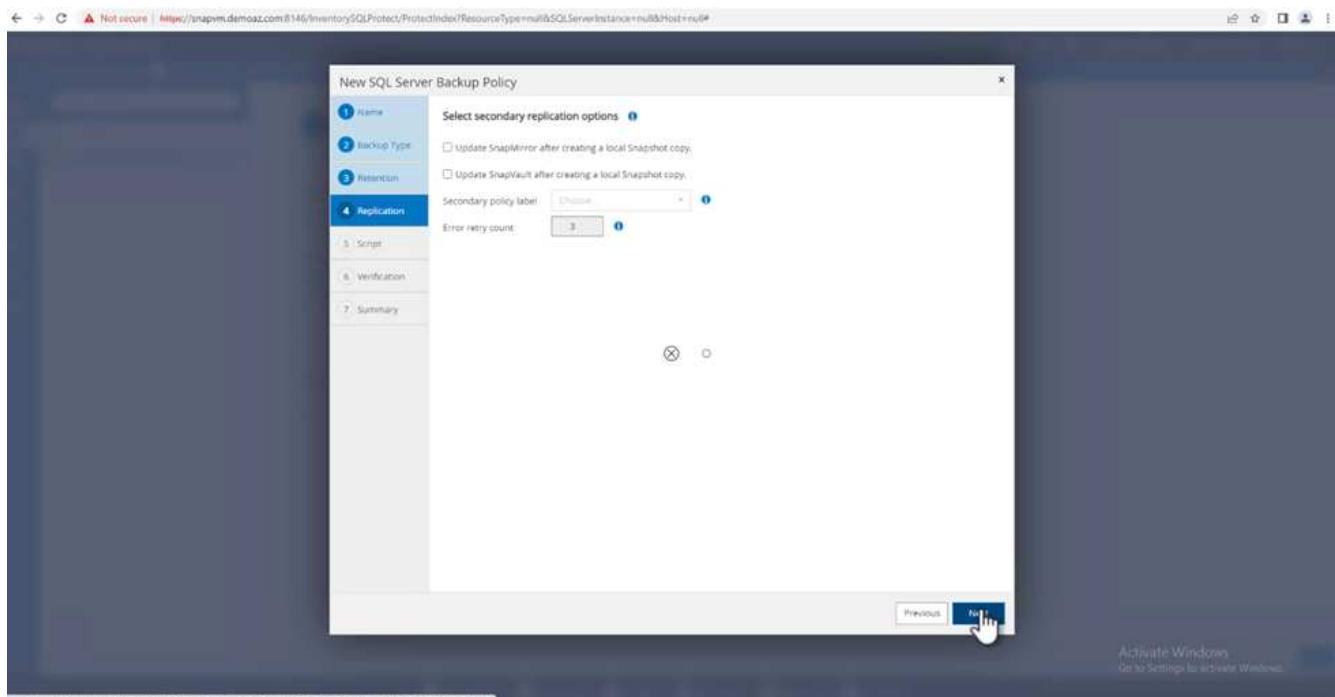
On demand
 Hourly
 Daily
 Weekly
 Monthly

Previous Next

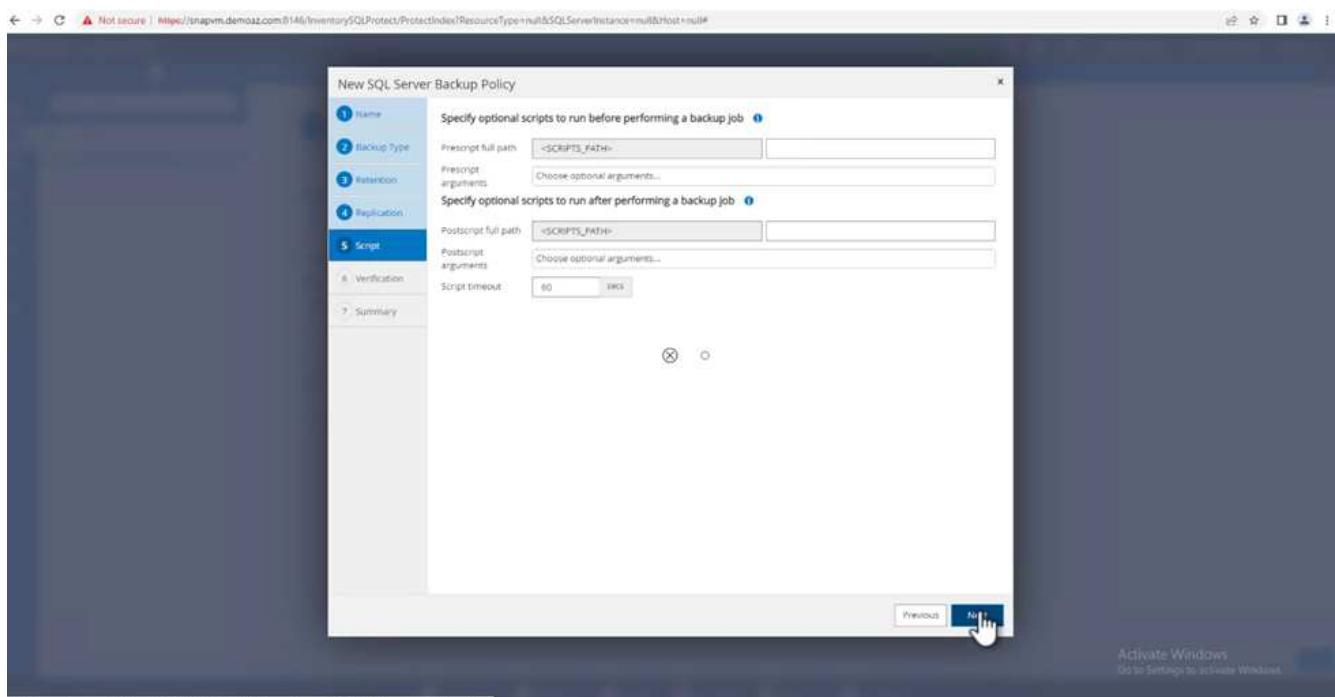
9. Configure the log backup retention settings. Click **Next**.



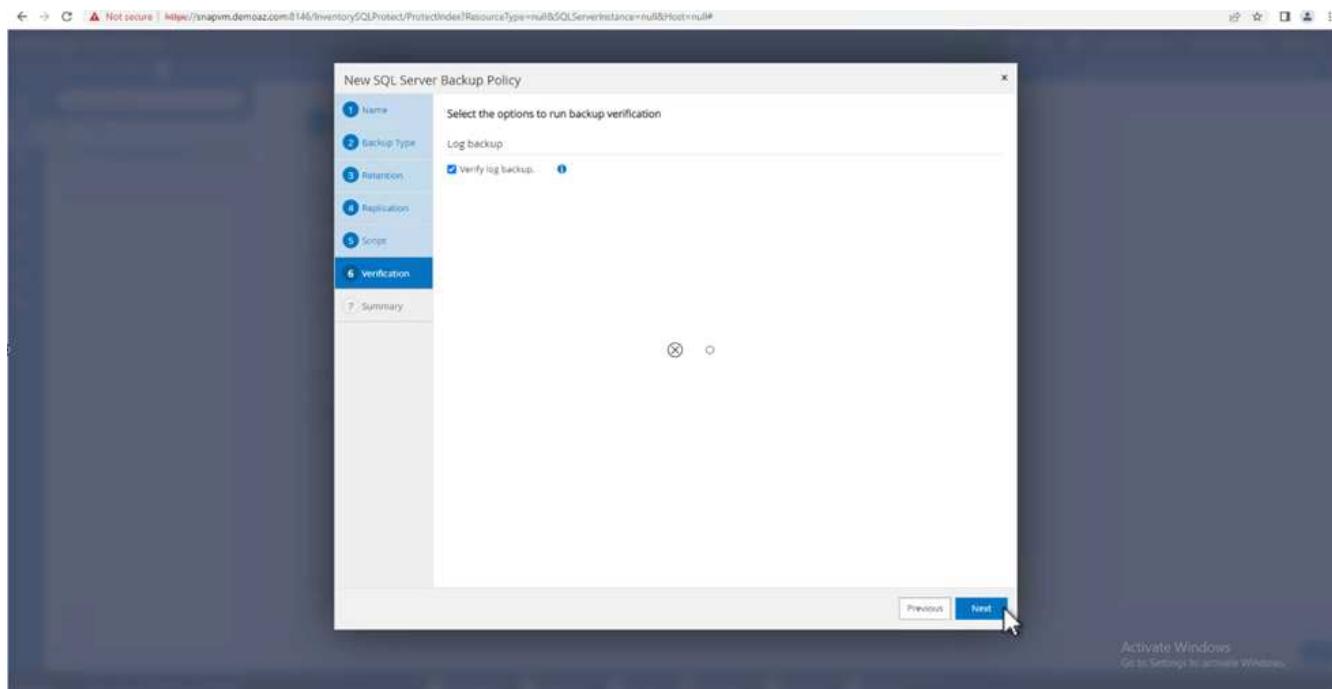
10. (Optional) Configure the replication options.



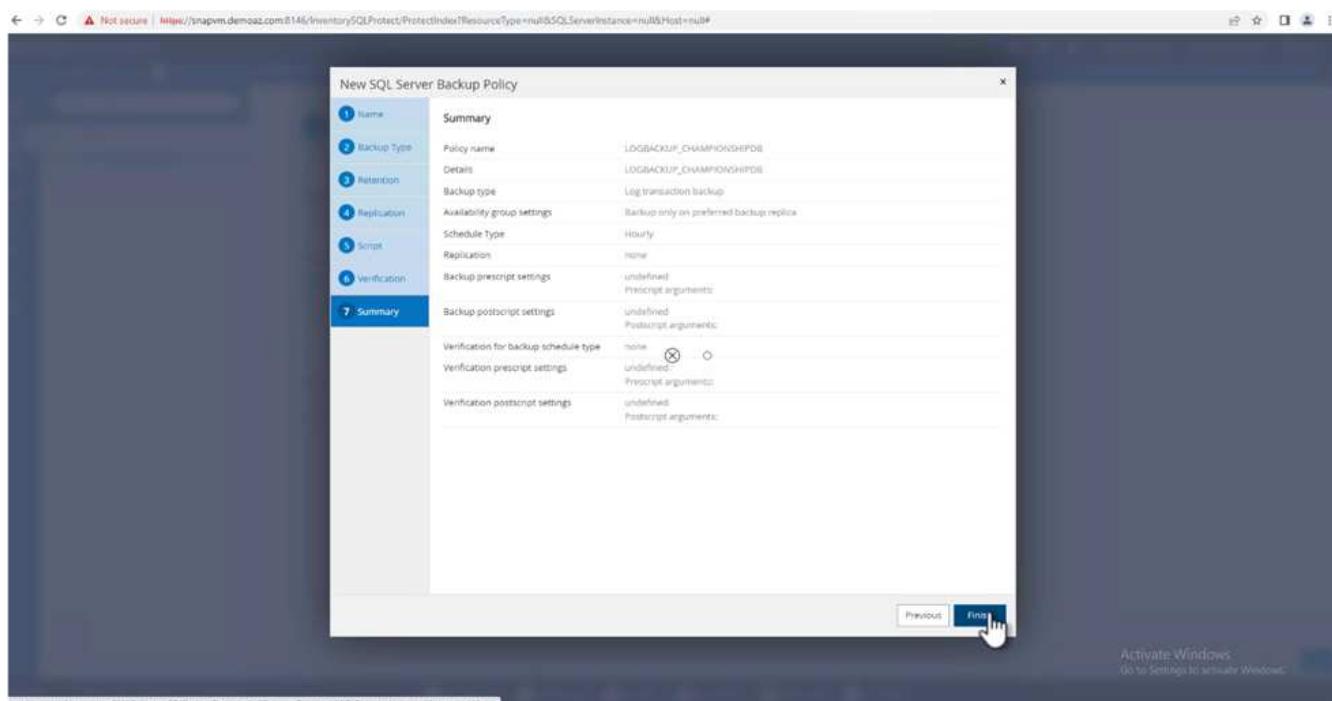
11. (Optional) Configure any scripts to run before performing a backup job.



12. (Optional) Configure backup verification.



13. On the **Summary** page, click **Finish**.



Configure and protect multiple MSSQL Server databases

1. Click the newly created transaction log backup policy.

NetApp SnapCenter®

Microsoft SQL Server

Modify Resource Group

Name: RG-CHAMPIONSHIPDB

Select one or more policies and configure schedules:

FULLBACKUP_CHAMPIONSHIPDB + LOGBACKUP

Configure schedules for selected policies:

Policy	Applied Schedules	Configure Schedules
FULLBACKUP_CHAMPIONSHIPDB	Hourly: Repeat every 8 hours	Edit Delete
LOGBACKUP_CHAMPIONSHIPDB	None	Edit Delete

Total 2

Use Microsoft SQL Server scheduler

Created backup policy LOGBACKUP_CHAMPIONSHIPDB

Activate Windows Go to Settings to activate Windows

2. Set the **Start date** and **Expires on** date.
3. Enter the frequency of the log backup policy depending on the SLA, RTP, and RPO. Click OK.

Add schedules for policy LOGBACKUP_CHAMPIONSHIPDB

Hourly

Start date: 11/11/2022 07:30 pm Edit

Expires on: 12/11/2022 06:30 pm Edit

Repeat every: 2 hours 0 mins

The schedules are triggered on the SnapCenter Server time zone.

Cancel OK

Activate Windows Go to Settings to activate Windows

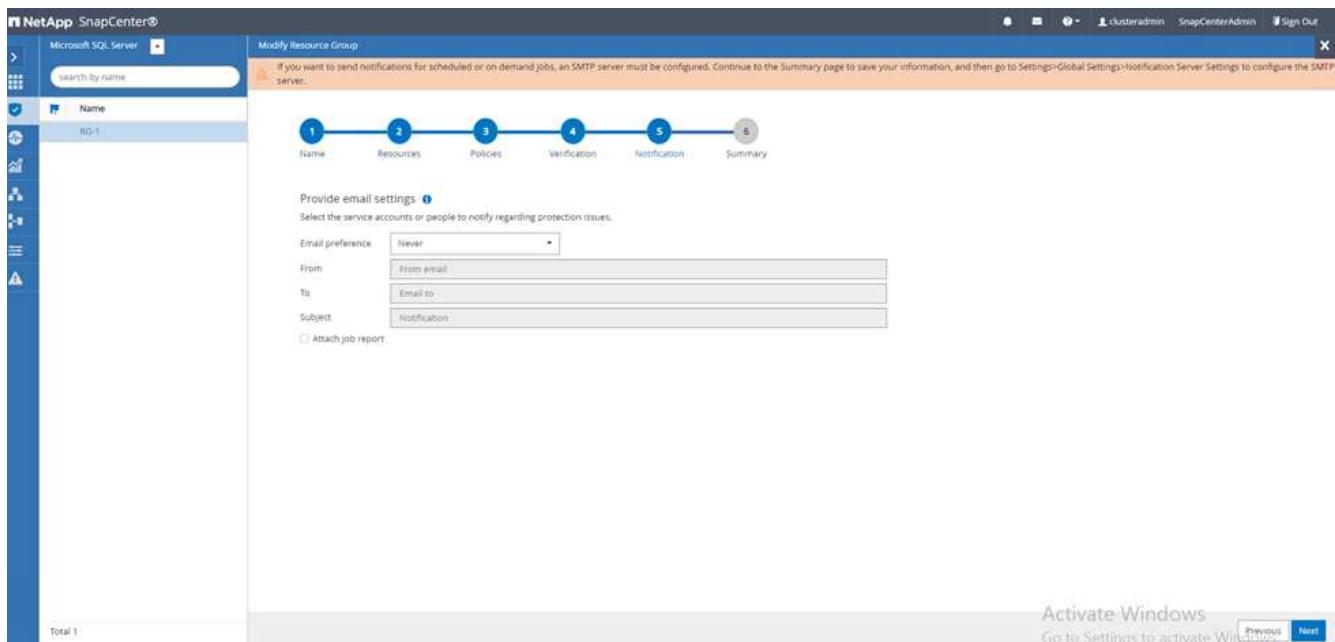
4. You can see both policies. Click **Next**.

The screenshot shows the 'Modify Resource Group' wizard in the NetApp SnapCenter interface. The current step is 'Policies'. A progress bar at the top shows steps 1 through 6. Step 1 (Name) is highlighted. Step 2 (Resources) is shown with a blue background. Step 3 (Policies) is shown with a light gray background. Step 4 (Verification) is shown with a light gray background. Step 5 (Notification) is shown with a light gray background. Step 6 (Summary) is shown with a light gray background. Below the progress bar, a message says 'Select one or more policies and configure schedules'. A table lists two policies: 'FULLBACKUP_CHAMPIONSHIPDB' and 'LOGBACKUP_CHAMPIONSHIPDB'. Both policies have their 'Applied Schedules' set to 'Hourly: Repeat every 8 hours'. There is a checkbox 'Configure Schedules' which is checked for both policies. Below the table, it says 'Total 2'. At the bottom, there is a checkbox 'Use Microsoft SQL Server scheduler' which is unchecked. The status bar at the bottom shows 'Activity' with 'The 5 most recent jobs are displayed', and job statistics: 3 Completed, 0 Warnings, 0 Failed, 0 Cancelled, 0 Running, and 1 Queued.

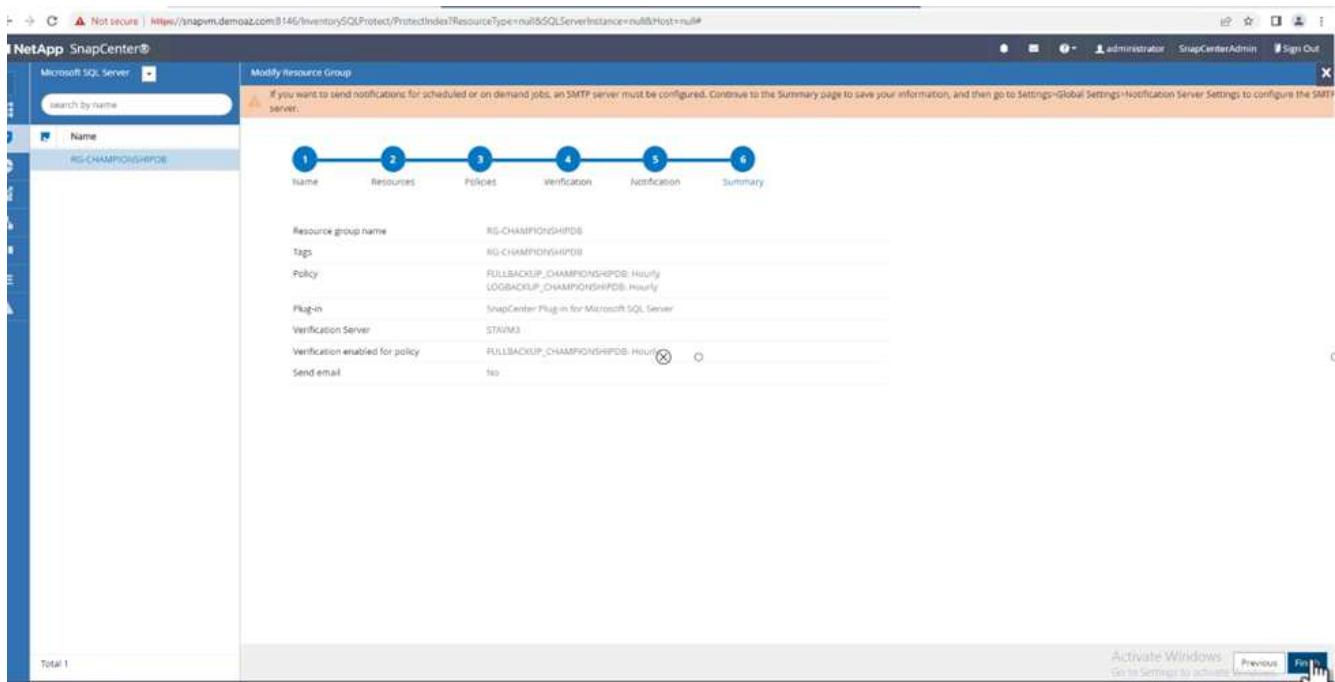
5. Configure the verification server.

The screenshot shows the 'Modify Resource Group' wizard in the NetApp SnapCenter interface. The current step is 'Verification'. A progress bar at the top shows steps 1 through 6. Step 1 (Name) is highlighted. Step 2 (Resources) is shown with a blue background. Step 3 (Policies) is shown with a light gray background. Step 4 (Verification) is highlighted with a blue background. Step 5 (Notification) is shown with a light gray background. Step 6 (Summary) is shown with a light gray background. Below the progress bar, a message says 'Select the verification servers'. A dropdown menu shows 'STAVM3(13.0.5026)' selected. Below the dropdown, a table shows a policy 'FULLBACKUP_CHAMPIONSHIPDB' with its 'Schedule Type' set to 'Hourly' and 'Applied Schedules' set to 'Verify after backup'. There is a checkbox 'Configure Schedules' which is checked. Below the table, it says 'Total 1'. At the bottom, there is a checkbox 'Use Microsoft SQL Server scheduler' which is unchecked. The status bar at the bottom shows 'Activity' with 'The 5 most recent jobs are displayed', and job statistics: 3 Completed, 0 Warnings, 0 Failed, 0 Cancelled, 0 Running, and 1 Queued.

6. Configure email notification.



7. On the **Summary** page, click **Finish**.



Triggering an on-demand transaction log backup for multiple SQL Server databases

To trigger an on-demand backup of the transactional log for multiple SQL server databases, complete the following steps:

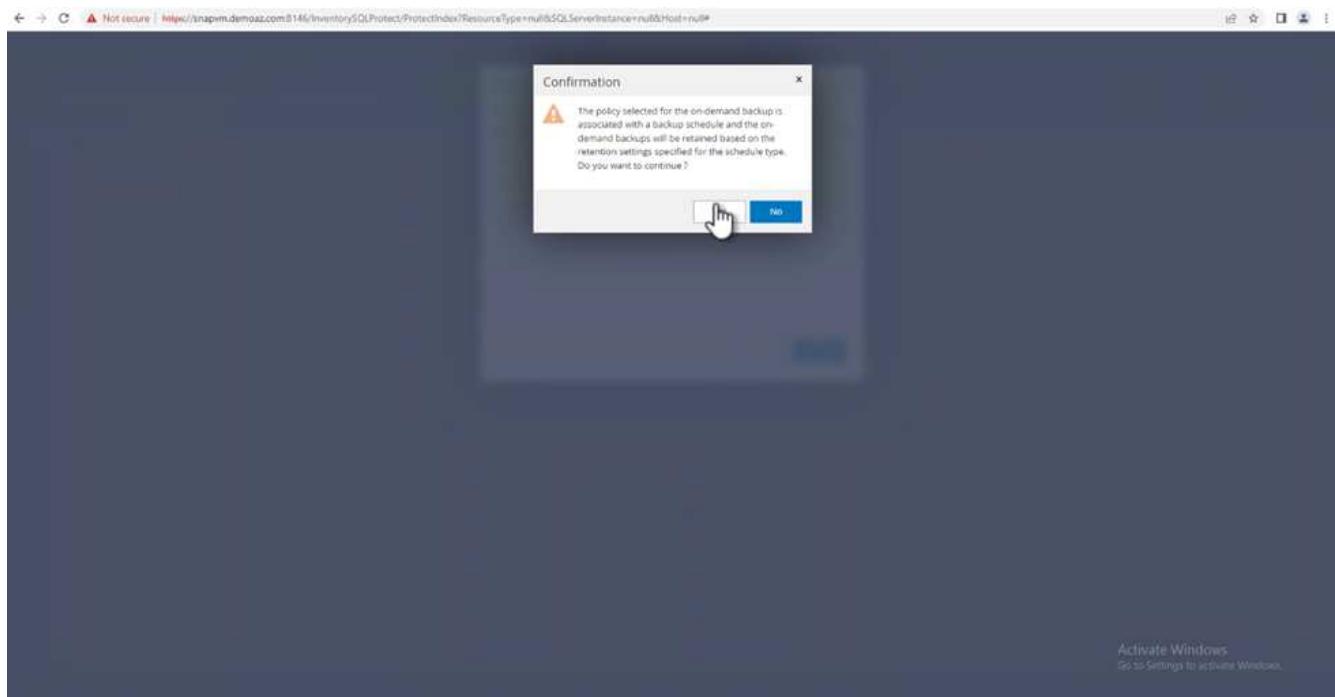
1. On the newly created policy page, select **Backup now** at the upper right of the page.

The screenshot shows the NetApp SnapCenter interface for managing Microsoft SQL Server resources. The main window displays a table titled "RG-CHAMPIONSHIPDB Details" containing 24 entries, each representing a database named "ChampionshipDB1" through "ChampionshipDB18". The columns are "Name", "Resource Name", "Type", and "Host". All databases are listed as "SQL Database" type and hosted on "STAVM3.DemoAZ.com". A tooltip on the left side of the table area says: "Set up your policies, global settings, credential and configure roles, permissions and load balancing." The top navigation bar includes tabs for "Microsoft SQL Server" and "Search by name", along with various administrative icons like "Modify Resource Group", "Backup Now", "Liberate", "Maintenance", "Edit View Details", and "Delete".

2. From the pop-up on the **Policy** tab, select the drop-down menu, select the backup policy, and configure the transaction log backup.

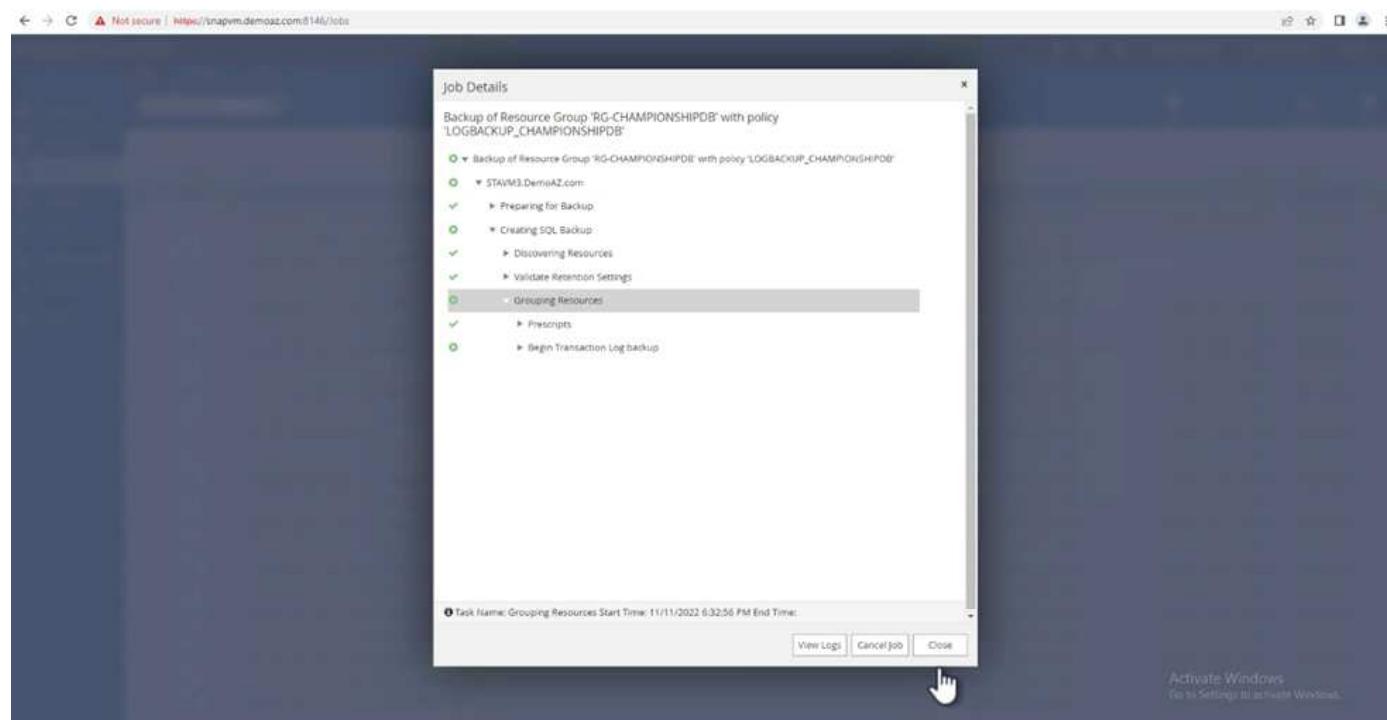
The screenshot shows a "Backup" dialog box overlaid on the previous interface. It prompts the user to "Create a backup for the selected resource group". The "Resource Group" dropdown is set to "RG-CHAMPIONSHIPDB". The "Policy" dropdown is currently set to "FULLBACKUP_CHAMPIONSHIPDB", with a tooltip indicating "Verify after backup". A second option, "LOGBACKUP_CHAMPIONSHIPDB", is visible in the dropdown menu. The "Backup" button at the bottom right is highlighted with a mouse cursor. The background shows the same list of databases from the previous screenshot.

3. Click **Backup**. A new window is displayed.
4. Click **Yes** to confirm the backup policy.



Monitoring

Move to the **Monitoring** tab and monitor the progress of the backup job.



Restore and recovery

See the following prerequisites necessary for restoring a SQL Server database in SnapCenter.

- The target instance must be online and running before a restore job completes.
- SnapCenter operations that are scheduled to run against the SQL Server database must be disabled,

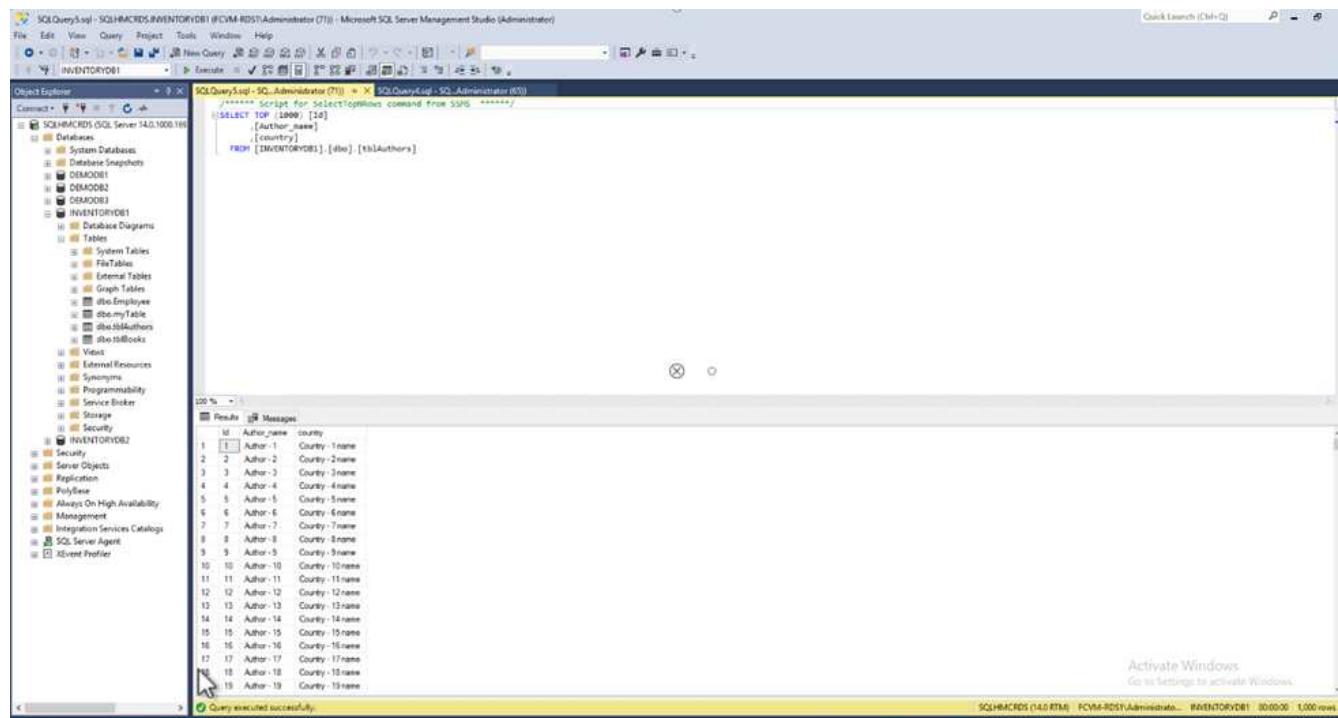
including any jobs scheduled on remote management or remote verification servers.

- If you are restoring custom log directory backups to an alternate host, the SnapCenter server and the plugin host must have the same SnapCenter version installed.
- You can restore the system database to an alternate host.
- SnapCenter can restore a database in a Windows cluster without taking the SQL Server cluster group offline.

Restoring deleted tables on a SQL Server database to a point in time

To restore a SQL Server database to a point in time, complete the following steps:

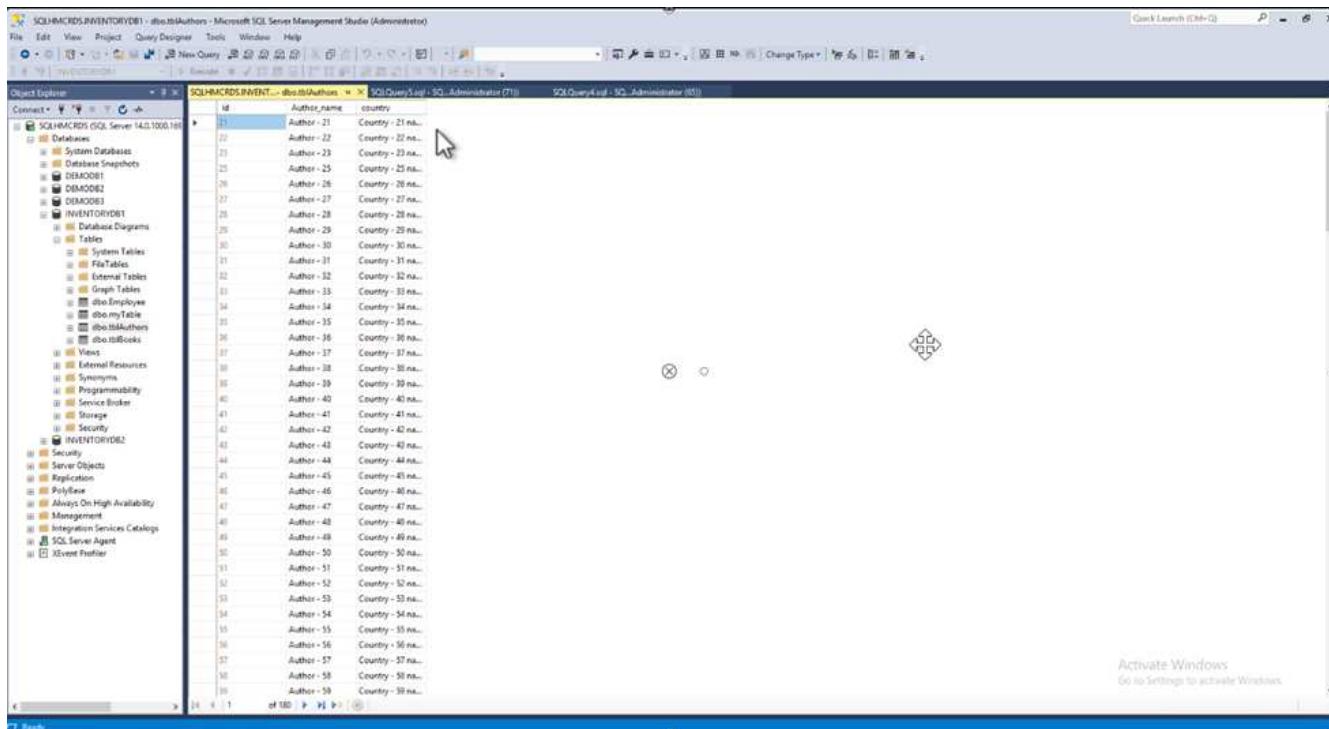
1. The following screenshot shows the initial state of the SQL Server database before the deleted tables.



The screenshot shows a Microsoft SQL Server Management Studio (SSMS) interface. The Object Explorer on the left shows the database structure, including the INVENTORYDB1 database which contains several tables like Authors, Employees, and Books. The central Results pane displays a query result set for the Authors table, showing 20 rows of data with columns Id, Author_name, and country. The bottom status bar indicates "Query executed successfully".

ID	Author_name	country
1	Author - 1	Country - 1name
2	Author - 2	Country - 2name
3	Author - 3	Country - 3name
4	Author - 4	Country - 4name
5	Author - 5	Country - 5name
6	Author - 6	Country - 6name
7	Author - 7	Country - 7name
8	Author - 8	Country - 8name
9	Author - 9	Country - 9name
10	Author - 10	Country - 10name
11	Author - 11	Country - 11name
12	Author - 12	Country - 12name
13	Author - 13	Country - 13name
14	Author - 14	Country - 14name
15	Author - 15	Country - 15name
16	Author - 16	Country - 16name
17	Author - 17	Country - 17name
18	Author - 18	Country - 18name
19	Author - 19	Country - 19name

The screenshot shows that 20 rows were deleted from the table.



2. Log into SnapCenter Server. From the **Resources** tab, select the database.

Name	Instance	Host	Last Backup	Overall Status	Type
INVENTORYDB1	SQLHMC0DS	PSXCLUSTER.Demoaz.com	11/16/2022 10:52:44 PM	Backup succeeded	User database
INVENTORYDB2	SQLHMC0DS	PSXCLUSTER.Demoaz.com	11/16/2022 10:59:49 PM	Backup succeeded	User database
master	SQLHMC0DS	PSXCLUSTER.Demoaz.com		Not protected	System database
model	SQLHMC0DS	PSXCLUSTER.Demoaz.com		Not protected	System database
msdb	SQLHMC0DS	PSXCLUSTER.Demoaz.com		Not protected	System database
tempdb	SQLHMC0DS	PSXCLUSTER.Demoaz.com		Not available for backup	System database
DEMO0B1	SQLHMC0DS	PSXCLUSTER.Demoaz.com	11/16/2022 11:03:57 PM	Backup succeeded	User database
DEMO0B2	SQLHMC0DS	PSXCLUSTER.Demoaz.com	11/16/2022 11:03:57 PM	Backup succeeded	User database
DEMO0B3	SQLHMC0DS	PSXCLUSTER.Demoaz.com	11/16/2022 11:03:57 PM	Backup succeeded	User database

The interface also includes a sidebar with 'Dashboard', 'Monitor', 'Reports', 'Hosts', 'Storage Systems', 'Settings', and 'Alerts'. At the bottom, it shows activity logs: 2 Completed, 0 Warnings, 0 Failed, 0 Canceled, 2 Running, 1 Queued. A watermark for 'Activate Windows' is present in the bottom right.

3. Select the most recent backup.

4. On the right, select **Restore**.

The screenshot shows the NetApp SnapCenter interface for managing Microsoft SQL Server databases. The left sidebar lists databases: INVENTORYDB1, INVENTORYDB2, master, model, msdb, tempdb, DEMO0B1, DEMO0B2, and DEMO0B3. The main pane displays the 'INVENTORYDB1 (SQL.HMCROSS) Topology'. A summary card indicates 4 Backups and 0 Clones. Below it, a table shows Primary Backup(s) with columns: Backup Name, Count, Type, LF, End Date, and Verified. The table lists four full backups from 11/15/2022 at various times, all marked as verified.

Backup Name	Count	Type	LF	End Date	Verified
SQLHMCROSS_INVENTORYDB1_fovm-rtst1_11-16-2022_16.30.47.9645	1	Full backup		11/16/2022 4:52:06 PM	Verified
SQLHMCROSS_INVENTORYDB1_fovm-rtst1_11-15-2022_18.44.24.9788	1	Full backup		11/15/2022 6:48:03 PM	Verified
SQLHMCROSS_INVENTORYDB1_fovm-rtst1_11-15-2022_16.31.08.0038	1	Full backup		11/15/2022 4:41:10 PM	Verified
SQLHMCROSS_INVENTORYDB1_fovm-rtst1_11-15-2022_16.27.32.3923	1	Full backup		11/15/2022 4:31:16 PM	Verified

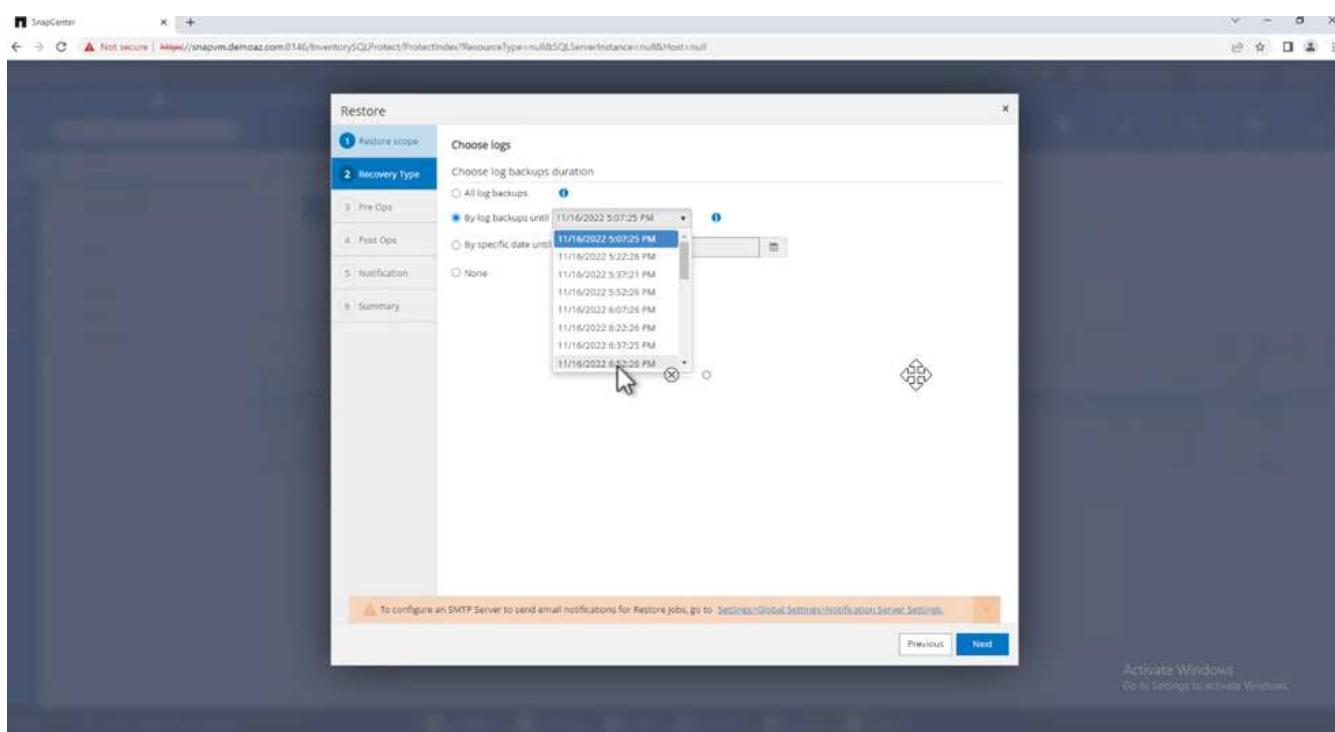
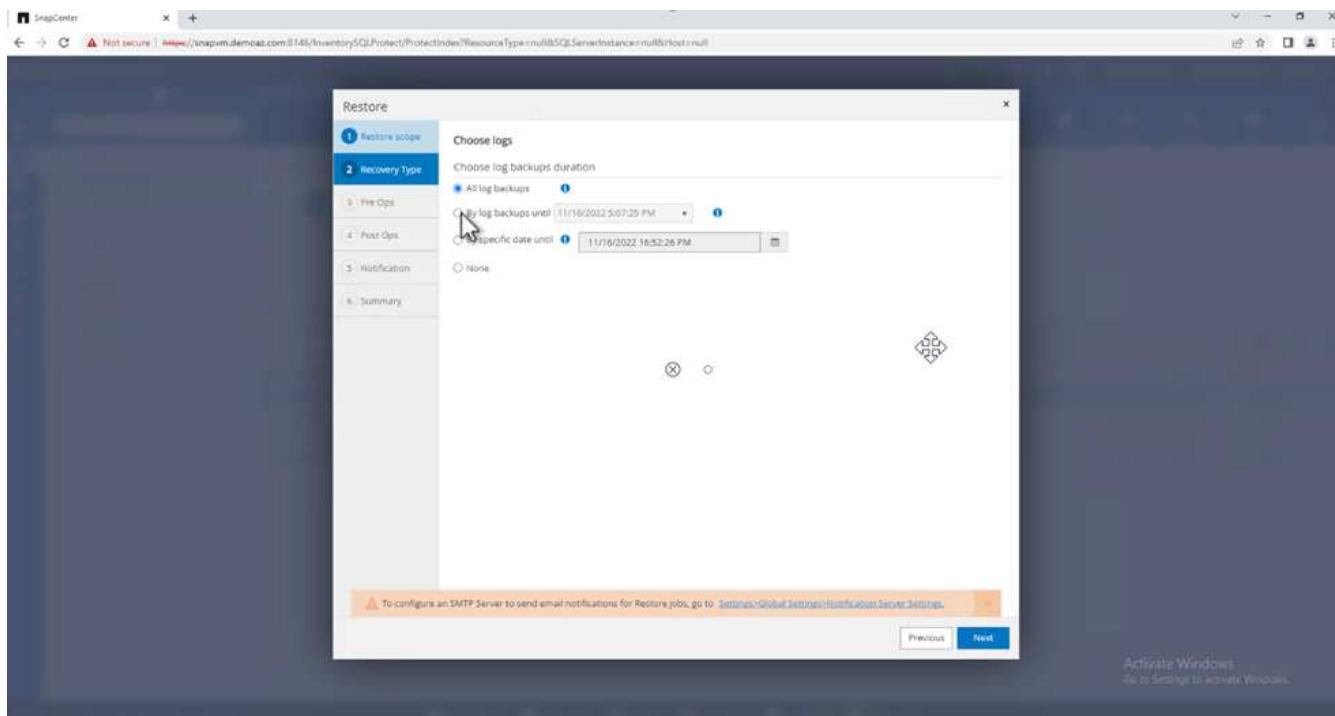
5. A new window is displayed. Select the **Restore** option.
6. Restore the database to the same host where the backup was created. Click **Next**.

The screenshot shows the 'Restore' dialog box. The left sidebar lists steps: 1. Restore scope, 2. Recovery type, 3. Pre Ops, 4. Post Ops, 5. Notification, 6. Summary. The main area shows the 'Restore database files using' section with three options:

- Restore the database to the same host where the backup was created
- Restore the database to an alternate host
- Restore the database using existing database files

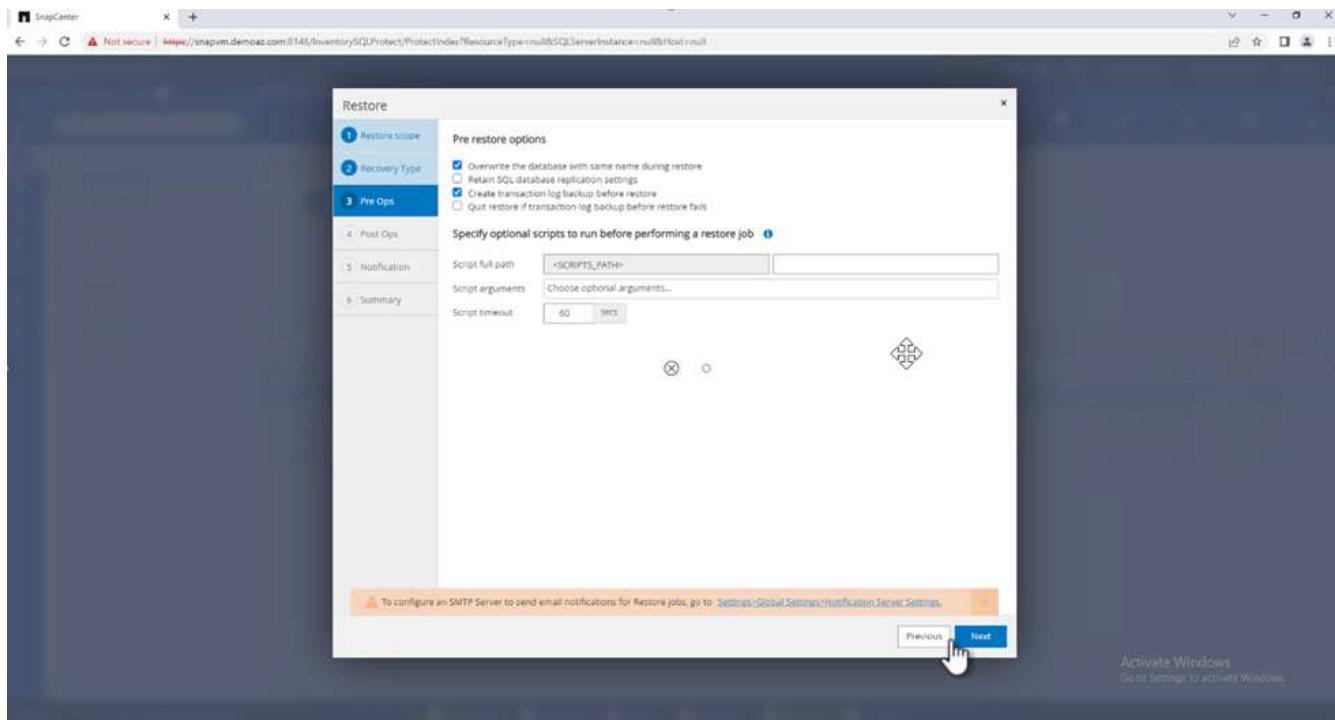
A note at the bottom states: "To configure an SMTP Server to send email notifications for Restore jobs, go to Settings>Global Settings>Notification Server Settings." At the bottom right are 'Previous' and 'Next' buttons.

7. For the **Recovery type**, select **All log backups**. Click **Next**.



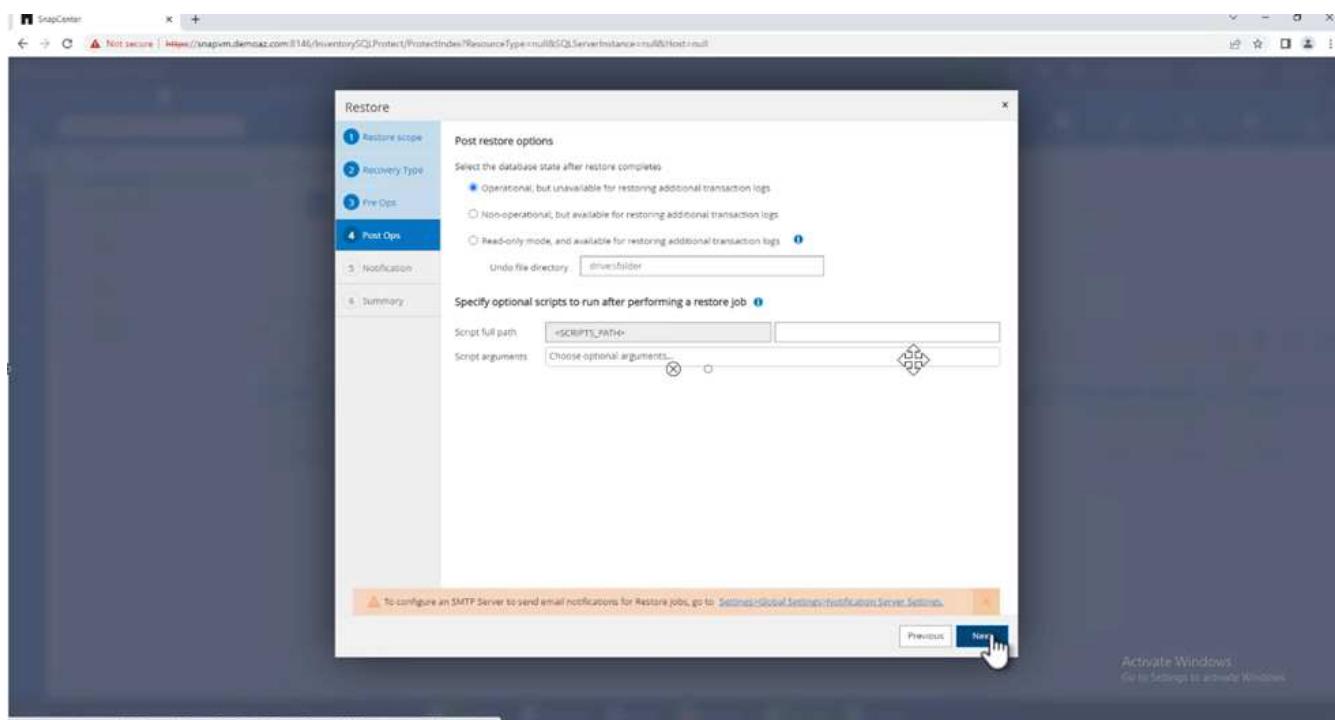
Pre- restore options:

1. Select the option **Overwrite the database with same name during restore**. Click **Next**.

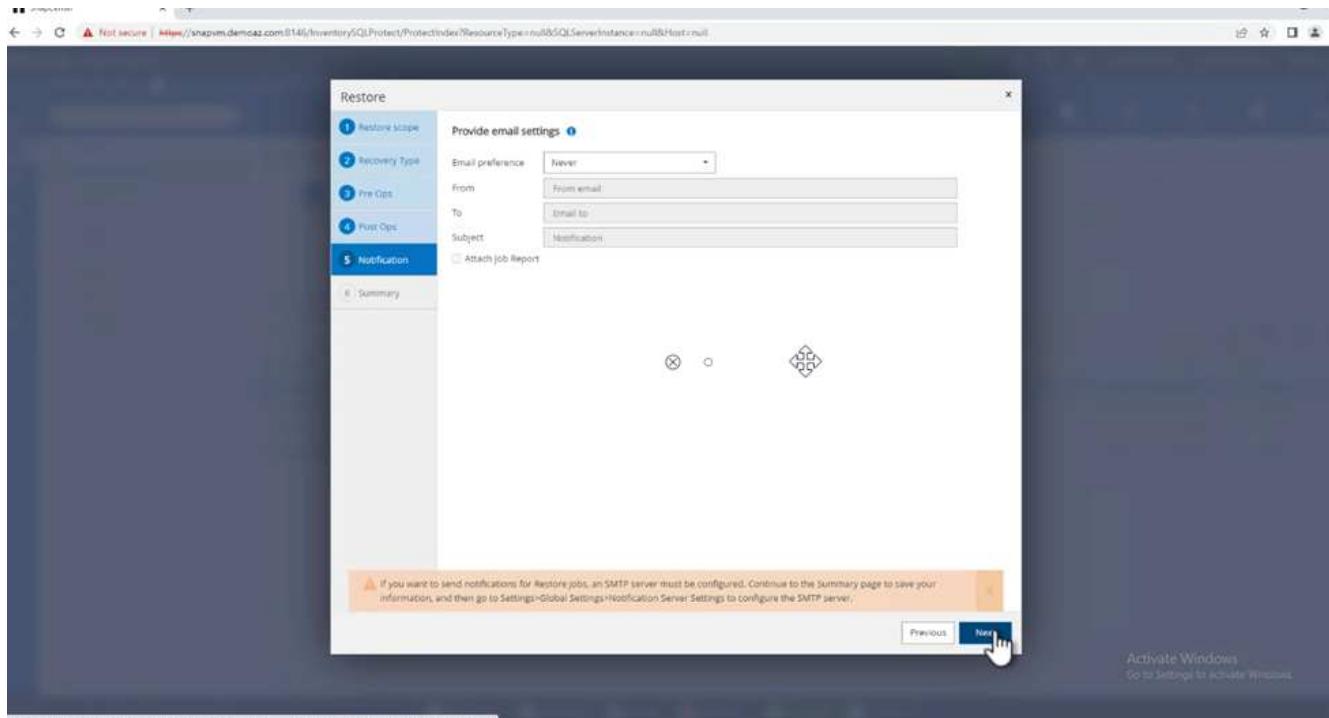


Post- restore options:

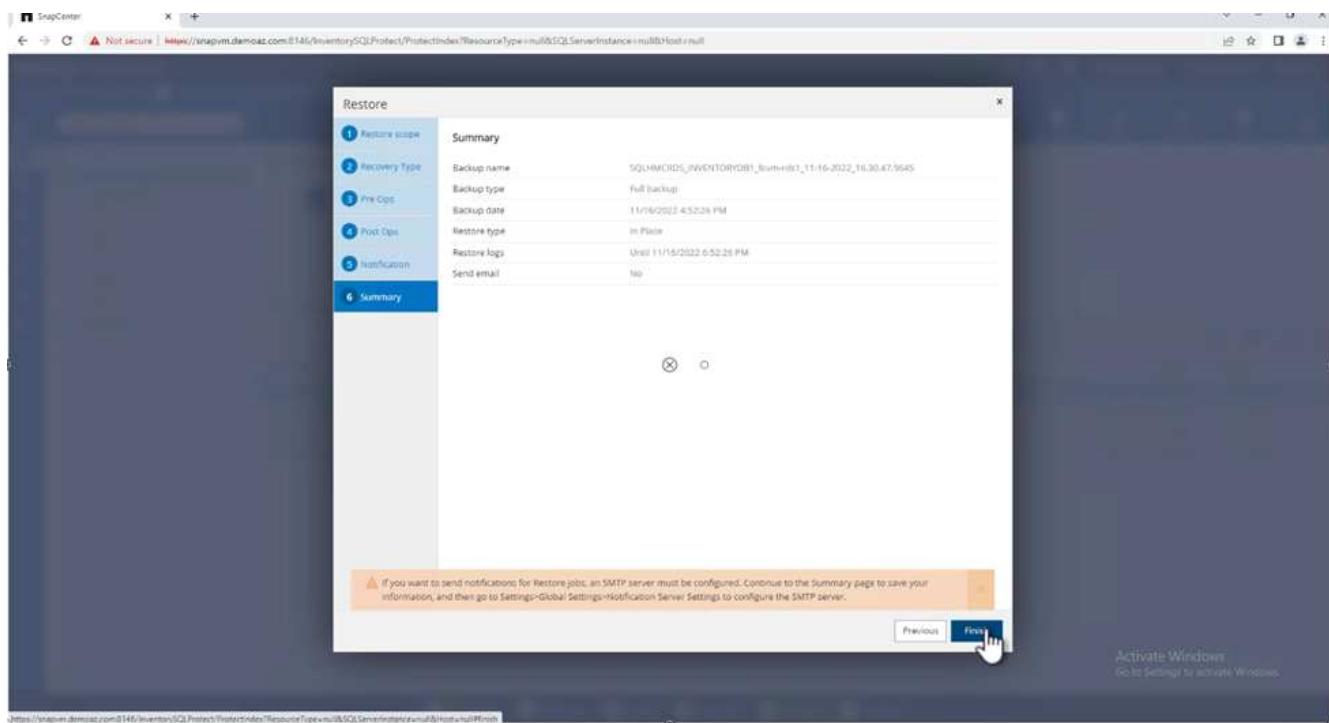
1. Select the option **Operational, but unavailable for restoring additional transaction logs**. Click **Next**.



2. Provide the email settings. Click **Next**.



3. On the **Summary** page, click **Finish**.



Monitoring the restore progress

1. From the **Monitoring** tab, click the restore job details to view the progress of the restore job.

Screenshot of the NetApp SnapCenter Jobs page. The left sidebar shows navigation options: Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area displays a table of jobs with columns: ID, Status, Name, Start date, End date, and Owner. The table lists numerous backup and restore operations for a resource group named 'SQLHMCRD\$INVENTORYDB\$'. The 'Owner' column consistently shows 'Administrator'. A cursor is hovering over the 'Download Log' button in the top right corner of the interface.

2. Restore the job details.

Screenshot of the 'Job Details' dialog box for job 157. The dialog title is 'Restore 'SQLHMCRD\$INVENTORYDB\$''. It displays a hierarchical tree of tasks: 'Restore 'SQLHMCRD\$INVENTORYDB\$'', '(job 157) Tail log backup of 'SQLHMCRD\$INVENTORYDB\$'', 'FQVM-RD\$1.Demoaz.com', 'Preparing for Backup', 'Creating SQL Backup', 'Finalizing Backup', and 'Send EMS Messages'. At the bottom, a note says 'Task Name: Send EMS Messages Start Time: 11/16/2022 11:18:54 PM End Time: 11/16/2022 11:18:54 PM'. Buttons at the bottom right include 'View Logs', 'Cancel job', and 'Close'. A cursor is pointing at the 'Close' button. A watermark for 'Activate Windows' is visible in the background.

3. Return to SQL Server host > database > table are present.

```

SELECT TOP 1000 [Id], [Author_name], [country]
FROM [INVENTORYDB1].[dbo].[tblAuthors]

```

	Author_name	country
1	Author -1	Country -1name
2	Author -2	Country -2name
3	Author -3	Country -3name
4	Author -4	Country -4name
5	Author -5	Country -5name
6	Author -6	Country -6name
7	Author -7	Country -7name
8	Author -8	Country -8name
9	Author -9	Country -9name
10	Author -10	Country -10name
11	Author -11	Country -11name
12	Author -12	Country -12name

Where to find additional information

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

- TR-4714: Best Practices Guide for Microsoft SQL Server using NetApp SnapCenter

<https://www.netapp.com/pdf.html?item=/media/12400-tr4714pdf.pdf>

- Requirements for restoring a database

https://docs.netapp.com/us-en/snapcenter-45/protect-scsql/concept_requirements_for_restoring_a_database.html

- Understanding cloned database lifecycles

<https://library.netapp.com/ecmdocs/ECMP1217281/html/GUID-4631AFF4-64FE-4190-931E-690FCADA5963.html>

TR-4467: SAP with Microsoft SQL Server on Windows - Best practices using NetApp Clustered Data ONTAP and SnapCenter

Marco Schoen, NetApp

TR-4467 provides customers and partners with best practices for deploying clustered NetApp Data ONTAP in support of SAP Business Suite solutions running in a Microsoft SQL Server on Windows environment.

[TR-4467: SAP with Microsoft SQL Server on Windows - Best practices using NetApp Clustered Data ONTAP and SnapCenter](#)

Modernizing your Microsoft SQL Server environment

Optimize operations and unleash the power of your data - on the premises or in the cloud.

TR-4764: Best practices for Microsoft SQL Server with NetApp EF-Series

Mitch Blackburn, Pat Sinthusan, NetApp

This best practices guide is intended to help storage administrators and database administrators successfully deploy Microsoft SQL Server on NetApp EF-Series storage.

[TR-4764: Best practices for Microsoft SQL Server with NetApp EF-Series](#)

Open Source Databases

TR-4956: Automated PostgreSQL High Availability Deployment and Disaster Recovery in AWS FSx/EC2

Allen Cao, Niyaz Mohamed, NetApp

Purpose

PostgreSQL is a widely used open-source database that is ranked number four among the top ten most popular database engines by [DB-Engines](#). On one hand, PostgreSQL derives its popularity from its license-free, open-source model while still possessing sophisticated features. On the other hand, because it is open sourced, there is shortage of detailed guidance on production-grade database deployment in the area of high availability and disaster recovery (HA/DR), particularly in the public cloud. In general, it can be difficult to set up a typical PostgreSQL HA/DR system with hot and warm standby, streaming replication, and so on. Testing the HA/DR environment by promoting the standby site and then switching back to the primary can be disruptive to production. There are well documented performance issues on the primary when read workloads are deployed on streaming hot standby.

In this documentation, we demonstrate how you can do away with an application-level PostgreSQL streaming HA/DR solution and build a PostgreSQL HA/DR solution based on AWS FSx ONTAP storage and EC2 compute instances using storage-level replication. The solution creates a simpler and comparable system and delivers equivalent results when compared with traditional PostgreSQL application-level streaming replication for HA/DR.

This solution is built on proven and mature NetApp SnapMirror storage-level replication technology that is available in AWS-native FSX ONTAP cloud storage for PostgreSQL HA/DR. It is simple to implement with an automation toolkit provided by the NetApp Solutions team. It provides similar functionality while eliminating the complexity and performance drag on the primary site with the application-level streaming-based HA/DR solution. The solution can be easily deployed and tested without affecting the active primary site.

This solution addresses the following use cases:

- Production grade HA/DR deployment for PostgreSQL in the public AWS cloud
- Testing and validating a PostgreSQL workload in the public AWS cloud
- Testing and validating a PostgreSQL HA/DR strategy based on NetApp SnapMirror replication technology

Audience

This solution is intended for the following people:

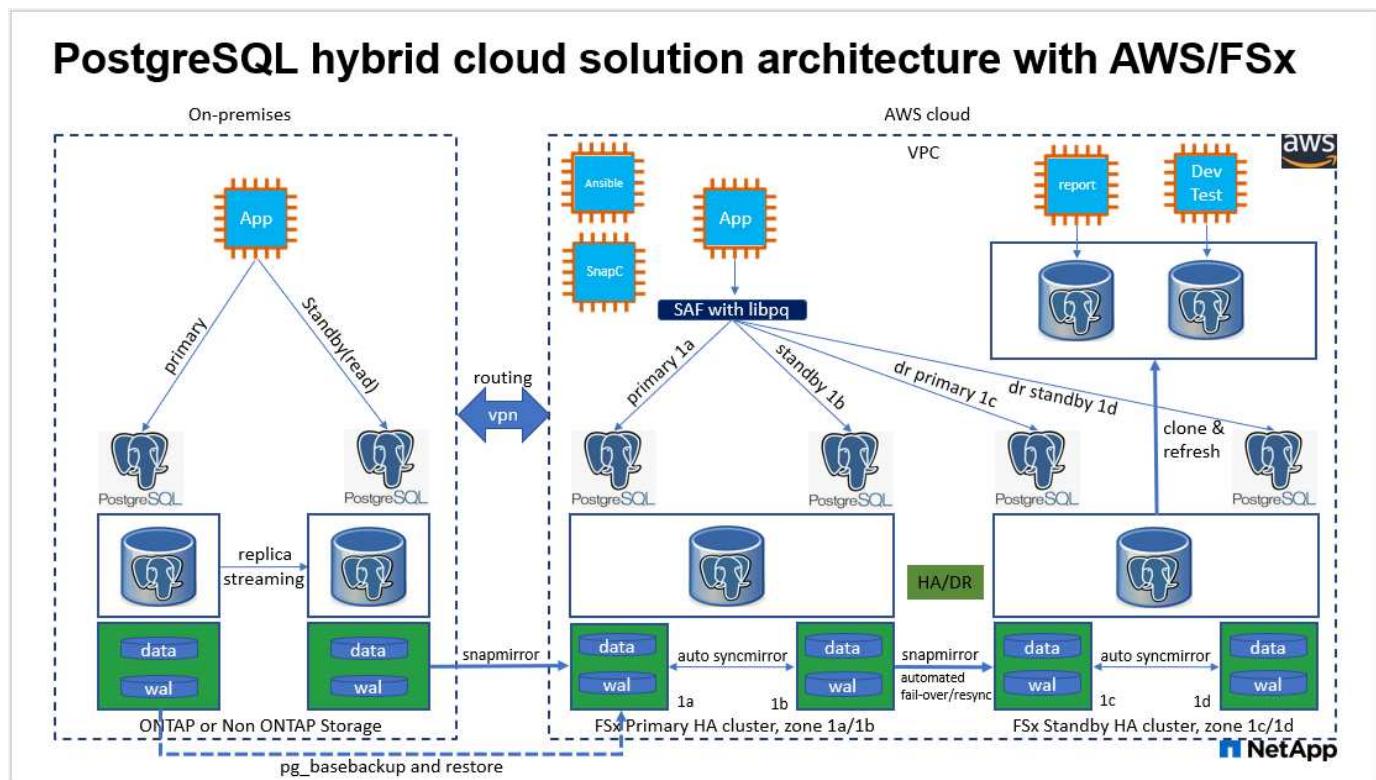
- The DBA who is interested in deploying PostgreSQL with HA/DR in the public AWS cloud.

- The database solution architect who is interested in testing PostgreSQL workloads in the public AWS cloud.
- The storage administrator who is interested in deploying and managing PostgreSQL instances deployed to AWS FSx storage.
- The application owner who is interested in standing up a PostgreSQL environment 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	Two FSx HA pairs in the same VPC and availability zone as primary and standby HA clusters
EC2 instance for compute	t2.xlarge/4vCPU/16G	Two EC2 T2 xlarge as primary and standby compute instances
Ansible controller	on-prem Centos VM/4vCPU/8G	A VM to host Ansible automation controller either on-premise or in the cloud
Software		
RedHat Linux	RHEL-8.6.0_HVM-20220503-x86_64-2-Hourly2-GP2	Deployed RedHat subscription for testing

Centos Linux	CentOS Linux release 8.2.2004 (Core)	Hosting Ansible controller deployed in on-premises lab
PostgreSQL	Version 14.5	Automation pulls the latest available version of PostgreSQL from the postgresql.ora yum repo
Ansible	Version 2.10.3	Prerequisites for required collections and libraries installed with requirements playbook

Key factors for deployment consideration

- **PostgreSQL database backup, restore, and recovery.** A PostgreSQL database supports a number of backup methods, such as a logical backup using pg_dump, a physical online backup with pg_basebackup or a lower-level OS backup command, and storage-level-consistent snapshots. This solution uses NetApp consistency-group snapshots for PostgreSQL database data and WAL volumes backup, restore, and recovery at the standby site. The NetApp consistency-group volume snapshots sequence I/O as it is written to storage and protect the integrity of database data files.
- **EC2 compute instances.** In these tests and validations, we used the AWS EC2 t2.xlarge instance type for the PostgreSQL database compute instance. NetApp recommends using an M5 type EC2 instance as the compute instance for PostgreSQL in deployment because it is optimized for database workloads. The standby compute instance should always be deployed in the same zone as the passive (standby) file system deployed for the FSx HA cluster.
- **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. A disaster-recovery standby HA pair for business continuity can be set up in a different region if a specific distance is required between the primary and standby. An FSx HA cluster is always provisioned in a HA pair that is sync mirrored in a pair of active-passive file systems to provide storage-level redundancy.
- **PostgreSQL data and log placement.** Typical PostgreSQL deployments share the same root directory or volumes for data and log files. In our tests and validations, we have separated PostgreSQL data and logs into two separate volumes for performance. A soft link is used in the data directory to point to the log directory or volume that hosts PostgreSQL WAL logs and archived WAL logs.
- **PostgreSQL service startup delay timer.** This solution uses NFS mounted volumes to store the PostgreSQL database file and WAL log files. During a database host reboot, PostgreSQL service might try to start while the volume is not mounted. This results in database service startup failure. A 10 to 15 seconds timer delay is needed for the PostgreSQL database to start up correctly.
- **RPO/RTO for business continuity.** FSx data replication from primary to standby for DR is based on ASYNC, which means that the RPO depends on the frequency of Snapshot backups and SnapMirror replication. A higher frequency of Snapshot copy and SnapMirror replication reduces the RPO. Therefore, there is a balance between potential data loss in the event of a disaster and incremental storage cost. We have determined that Snapshot copy and SnapMirror replication can be implemented in as low as 5 minute intervals for RPO, and PostgreSQL can generally be recovered at the DR standby site in under a minute for the RTO.
- **Database backup.** After a PostgreSQL database is implemented or migrated into AWS FSx storage from an on-premises data center, the data is auto-sync mirrored in the FSx HA pair for protection. Data is further protected with a replicated standby site in case of a disaster. For longer-term backup retention or data protection, NetApp recommends using the built-in PostgreSQL pg_basebackup utility to run a full database backup that can be ported to S3 blob storage.

Solution Deployment

The deployment of this solution can be completed automatically using the NetApp Ansible-based automation toolkit by following the detailed instructions outlined below.

1. Read the instructions in the automation toolkit README.md [na_postgresql_aws_deploy_hadr](#).
2. Watch the following video walk through.
► https://docs.netapp.com/us-en/netapp-solutions/media/aws_postgres_fsx_ec2_deploy_hadr.mp4 (video)
3. Configure the required parameters files (hosts, host_vars/host_name.yml, fsx_vars.yml) by entering user-specific parameters into the template in the relevant sections. Then use the copy button to copy files to the Ansible controller host.

Prerequisites for automated 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 PostgreSQL DB server at the primary and one at the standby DR site. For compute redundancy at the primary and standby DR sites, deploy two additional EC2 Linux instances as standby PostgreSQL DB servers. 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 two FSx ONTAP storage HA clusters to host the PostgreSQL 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. Build a Centos Linux VM to host the Ansible controller. The Ansible controller can be located either on-premises or in the AWS cloud. If it is located on-premises, you must have SSH connectivity to the VPC, EC2 Linux instances, and FSx storage clusters.
5. Set up the Ansible controller as described in the section "Set up the Ansible Control Node for CLI deployments on RHEL/CentOS" from the resource [Getting Started with NetApp solution automation](#).
6. Clone a copy of the automation toolkit from the public NetApp GitHub site.

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

7. From the toolkit root directory, execute the prerequisite playbooks to install the required collections and libraries for the Ansible controller.

```
ansible-playbook -i hosts requirements.yml
```

```
ansible-galaxy collection install -r collections/requirements.yml  
--force --force-with-deps
```

8. Retrieve the required EC2 FSx instance parameters for the DB host variables file `host_vars/*` and the global variables file `fsx_vars.yml` configuration.

Configure the hosts file

Input the primary FSx ONTAP cluster management IP and EC2 instances hosts names into the hosts file.

```
# Primary FSx cluster management IP address
[fsx_ontap]
172.30.15.33
```

```
# Primary PostgreSQL DB server at primary site where database is
initialized at deployment time
[postgresql]
pgsql_01p ansible_ssh_private_key_file=pgsql_01p.pem
```

```
# Primary PostgreSQL DB server at standby site where postgresql service is
installed but disabled at deployment
# Standby DB server at primary site, to setup this server comment out
other servers in [dr_postgresql]
# Standby DB server at standby site, to setup this server comment out
other servers in [dr_postgresql]
[dr_postgresql] --
pgsql_01s ansible_ssh_private_key_file=pgsql_01s.pem
#pgsql_01ps ansible_ssh_private_key_file=pgsql_01ps.pem
#pgsql_01ss ansible_ssh_private_key_file=pgsql_01ss.pem
```

Configure the `host_name.yml` file in the `host_vars` folder

Enter the appropriate parameters for your system into the blue underlined fields, and then copy and paste the entries into the `host_name.yml` file in the Ansible controller `host_vars` folder.

```
<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;
right: 0;
}
button {
transition-duration: 0.4s;
```

```

background-color: white;
color: #1563a3;
border: 2px solid #1563a3;
}
button:hover {
background-color: #1563a3;
color: white;
}
#more_datastores_nfs {
display: block;
}
#more_datastores_nfs_button {
display: none;
}

```

</style>

```

<div class="listingblock"><div class="content"><div><button id="copy-
button1" onclick="CopyClassText1()">Copy</button></div><pre><code><div
class="CopyMeClass1" id="CopyMeID1">
#####
##### Host Variables Configuration #####
#####

# Add your AWS EC2 instance IP address for the respective PostgreSQL
server host
ansible_host: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>10.61.180.15</i></span>

# "{{groups.postgresql[0]}}" represents first PostgreSQL DB server as
defined in PostgreSQL hosts group [postgresql]. For concurrent multiple
PostgreSQL DB servers deployment, [0] will be incremented for each
additional DB server. For example, "{{groups.postgresql[1]}}" represents
DB server 2, "{{groups.postgresql[2]}}" represents DB server 3 ... As a
good practice and the default, two volumes are allocated to a PostgreSQL
DB server with corresponding /pgdata, /pglogs mount points, which store
PostgreSQL data, and PostgreSQL log files respectively. The number and
naming of DB volumes allocated to a DB server must match with what is
defined in global fsx_vars.yml file by src_db_vols, src_archivelog_vols
parameters, which dictates how many volumes are to be created for each DB
server. agr_name is agr1 by default. Do not change. lif address is the
NFS IP address for the SVM where PostgreSQL server is expected to mount
its database volumes. Primary site servers from primary SVM and standby
servers from standby SVM.

host_datastores_nfs:
- {vol_name: "<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-

```

```

decoration:underline;"/><i>{{groups.postgresql[0]}}_pgdata</i></span>&quot
, aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr1</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>100</i></span>
- {vol_name: &quot<span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.postgresql[0]}}_pglogs</i></span>&quot
, aggr_name: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr1</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.200</i></span>,
size: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>100</i></span>}

# Add swap space to EC2 instance, that is equal to size of RAM up to 16G
max. Determine the number of blocks by dividing swap size in MB by 128.
swap_blocks: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>128</i></span>

# Postgresql user configurable parameters
pgsql_port: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>5432</i></span>
buffer_cache: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>8192MB</i></span>
archive_mode: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>"on"</i></span>
max_wal_size: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>5GB</i></span>
client_address: <span <div contenteditable="true" style="color:#004EFF;
font-weight:bold; font-style:italic; text-decoration:underline; text-
decoration:underline;"><i>172.30.15.0/24</i></span>

</div></code></pre></div></div>
<script>

```

```

function CopyClassText1() {
    var textToCopy = document.getElementById("CopyMeID1");
    var currentRange;
    if(document.getSelection().rangeCount > 0)
    {
        currentRange = document.getSelection().getRangeAt(0);
        window.getSelection().removeRange(currentRange);
    }
    else
    {
        currentRange = false;
    }
    var CopyRange = document.createRange();
    CopyRange.selectNode(textToCopy);
    window.getSelection().addRange(CopyRange);
    document.getElementById("more_datastores_nfs").style.display = "none";
    var command = document.execCommand("copy");
    if (command)
    {
        document.getElementById("copy-button1").innerHTML = "Copied!";
        setTimeout(revert_copy, 3000);
    }
    window.getSelection().removeRange(CopyRange);
    if(currentRange)
    {
        window.getSelection().addRange(currentRange);
    }
}
function revert_copy() {
    document.getElementById("copy-button1").innerHTML = "Copy";
    document.getElementById("more_datastores_nfs").style.display =
"block";
}

function datastoredropdown() {
    document.getElementById("more_datastores_nfs").style.display = "none";
    document.getElementById("more_datastores_nfs_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_datastores_nfs");
    while (x < 100) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
}

```

```

myHTML += '<a id="more_datastores_nfs">How many extra NFS volumes do
you wish to add?</a><select name="number_of_extra_datastores_nfs"
id="number_of_extra_datastores_nfs">' + buildup + '</select>';
wrapper.innerHTML = myHTML;
}
function adddatastorevolumes() {
    var y =
document.getElementById("number_of_extra_datastores_nfs").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_datastores_nfs");
    while (j < y) {
        j++;
        myHTML += ' - {vol_name: <span <div contenteditable="true"
style="color:#004EFF; font-weight:bold; font-style:italic; text-
decoration:underline;"><i>{{groups.oracle[0]}}_u01</i></span>,
aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>aggr01_node02</i></span>, lif: <span <div
contenteditable="true" style="color:#004EFF; font-weight:bold; font-
style:italic; text-decoration:underline;"><i>172.21.94.201</i></span>,
size: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-
decoration:underline;"><i>25</i></span>}<br>';
    }
    wrapper.innerHTML = myHTML;
    document.getElementById("select_more_datastores_nfs").style.display =
"none";
    document.getElementById("more_datastores_nfs_button").style.display =
"none";
}

</script>

```

Configure the global `fsx_vars.yml` file in the `vars` folder

Input the appropriate parameters for your system into the blue underlined fields, and then copy and paste the entries into the `fsx_vars.yml` file at the Ansible controller host.

```

<style>
div {
position: relative;
}
div button {
position: absolute;
top: 0;

```

```

right: 0;
}
button {
  transition-duration: 0.4s;
  background-color: white;
  color: #1563a3;
  border: 2px solid #1563a3;
}
button:hover {
  background-color: #1563a3;
  color: white;
}
#more_storage_vlans {
  display: block;
}
#more_storage_vlans_button {
  display: none;
}
#more_nfs_volumes {
  display: block;
}
#more_nfs_volumes_button {
  display: none;
}

```

</style>

```

<div class="listingblock"><div class="content"><div><button id="copy-
button" onclick="CopyClassText()">Copy</button></div><pre><code><div
class="CopyMeClass" id="CopyMeID">
#####
##### PostgreSQL HADR global user configuration variables #####
##### Consolidate all variables from FSx, Linux, and postgresql #####
#####
##### Ontap env specific config variables #####
#####

#####
# Variables for SnapMirror Peering
#####
#Passphrase for cluster peering authentication
passphrase: <span <div contenteditable="true" style="color:#004EFF; font-
weight:bold; font-style:italic; text-

```

```

decoration:underline;"/><i>xxxxxxxx</i></span>

#Please enter destination or standby FSx cluster name
dst_cluster_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>FsxId0cf8e0bccb14805e8</i></span>

#Please enter destination or standby FSx cluster management IP
dst_cluster_ip: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>172.30.15.90</i></span>

#Please enter destination or standby FSx cluster inter-cluster IP
dst_inter_ip: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>172.30.15.13</i></span>

#Please enter destination or standby SVM name to create mirror relationship
dst_vserver: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>dr</i></span>

#Please enter destination or standby SVM management IP
dst_vserver_mgmt_lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>172.30.15.88</i></span>

#Please enter destination or standby SVM NFS lif
dst_nfs_lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>172.30.15.88</i></span>

#Please enter source or primary FSx cluster name
src_cluster_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>FsxId0cf8e0bccb14805e8</i></span>

#Please enter source or primary FSx cluster management IP
src_cluster_ip: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"><i>172.30.15.20</i></span>

#Please enter source or primary FSx cluster inter-cluster IP
src_inter_ip: <span <div contenteditable="true" style="color:#004EFF;

```

```

font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>172.30.15.5</i></span>

#Please enter source or primary SVM name to create mirror relationship
src_vserver: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>prod</i></span>

#Please enter source or primary SVM management IP
src_vserver_mgmt_lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline; text-decoration:underline;"/><i>172.30.15.115</i></span>

#####
#####
#
# Variable for PostgreSQL Volumes, lif - source or primary FSx NFS lif address
#####
#####
#####

src_db_vols:
- {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.postgresql[0]}}_pgdata</i></span>", aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>aggr1</i></span>, lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>172.21.94.200</i></span>, size: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>100</i></span>}"}

src_archivelog_vols:
- {vol_name: ""<span <div contenteditable='true' style='color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;'><i>{{groups.postgresql[0]}}_pglogs</i></span>", aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>aggr1</i></span>, lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>172.21.94.200</i></span>, size: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>100</i></span>}"}

```

```

#Names of the Nodes in the ONTAP Cluster
nfs_export_policy: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>default</i></span>

#####
#####
### Linux env specific config variables ###
#####
#####
#####

#NFS Mount points for PostgreSQL DB volumes
mount_points:
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/pgdata</i></span>
  - <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>/pglogs</i></span>

#RedHat subscription username and password
redhat_sub_username: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxxxx</i></span>
redhat_sub_password: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"><i>xxxxx</i></span>

#####
#####
### DB env specific install and config variables ###
#####
#####
#The latest version of PostgreSQL RPM is pulled/installed and config file is deployed from a preconfigured template
#Recovery type and point: default as all logs and promote and leave all PITR parameters blank

</div></code></pre></div></div>
<script>
function CopyClassText() {
  var textToCopy = document.getElementById("CopyMeID");
  var currentRange;
  if(document.getSelection().rangeCount > 0)
  {
    currentRange = document.getSelection().getRangeAt(0);
    window.getSelection().removeRange(currentRange);
  }
}

```

```

else
{
    currentRange = false;
}
var CopyRange = document.createRange();
CopyRange.selectNode(textToCopy);
window.getSelection().addRange(CopyRange);
document.getElementById("more_storage_vlans").style.display = "none";
document.getElementById("more_nfs_volumes").style.display = "none";
var command = document.execCommand("copy");
if (command)
{
    document.getElementById("copy-button").innerHTML = "Copied!";
    setTimeout(revert_copy, 3000);
}
window.getSelection().removeRange(CopyRange);
if(currentRange)
{
    window.getSelection().addRange(currentRange);
}
}

function revert_copy() {
    document.getElementById("copy-button").innerHTML = "Copy";
    document.getElementById("more_storage_vlans").style.display =
"block";
    document.getElementById("more_nfs_volumes").style.display = "block";
}

function storagevlandropdown() {
    document.getElementById("more_storage_vlans").style.display = "none";
    document.getElementById("more_storage_vlans_button").style.display =
"block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_storage_vlans");
    while (x < 10) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_storage_vlans_info">How many extra VLANs do you
    wish to add?</a><select name="number_of_extra_storage_vlans"
    id="number_of_extra_storage_vlans">' + buildup + '</select>';
    wrapper.innerHTML = myHTML;
}

function addstoragevlans() {
    var y =

```

```

document.getElementById("number_of_extra_storage_vlans").value;
var j=0;
var myHTML = '';
var wrapper = document.getElementById("extra_storage_vlans");
while (j < y) {
    j++;
    myHTML += ' - {vlan_id: " + i + ", name: " + infra_NFS + ", protocol: " + NFS + "}";
}
wrapper.innerHTML = myHTML;
document.getElementById("select_more_storage_vlans").style.display = "none";
document.getElementById("more_storage_vlans_button").style.display = "none";
}

function nfsvolumesdropdown() {
    document.getElementById("more_nfs_volumes").style.display = "none";
    document.getElementById("more_nfs_volumes_button").style.display = "block";
    var x=1;
    var myHTML = '';
    var buildup = '';
    var wrapper = document.getElementById("select_more_nfs_volumes");
    while (x < 100) {
        buildup += '<option value="' + x + '">' + x + '</option>';
        x++;
    }
    myHTML += '<a id="more_nfs_volumes_info">How many extra NFS volumes do you wish to add?</a><select name="number_of_extra_nfs_volumes" id="number_of_extra_nfs_volumes">' + buildup + '</select>';
    wrapper.innerHTML = myHTML;
}

function addnfsvolumes() {
    var y = document.getElementById("number_of_extra_nfs_volumes").value;
    var j=0;
    var myHTML = '';
    var wrapper = document.getElementById("extra_nfs_volumes");
    while (j < y) {
        j++;
        myHTML += ' - {vol_name: " + vol_name + ", ';
}

```

```

style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>rtpora04_u01</i></span>, aggr_name: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>aggr01_node02</i></span>, lif: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>172.21.94.201</i></span>, size: <span <div contenteditable="true" style="color:#004EFF; font-weight:bold; font-style:italic; text-decoration:underline;"/><i>25</i></span>}<br>';
}
wrapper.innerHTML = myHTML;
document.getElementById("select_more_nfs_volumes").style.display =
"none";
document.getElementById("more_nfs_volumes_button").style.display =
"none";
}

</script>

```

PostgreSQL deployment and HA/DR setup

The following tasks deploy the PostgreSQL DB server service and initialize the database at the primary site on the primary EC2 DB server host. A standby primary EC2 DB server host is then set up at the standby site. Finally, DB volume replication is set up from the primary-site FSx cluster to the standby-site FSx cluster for disaster recovery.

1. Create DB volumes on the primary FSx cluster, and set up postgresql on the primary EC2 instance host.

```
ansible-playbook -i hosts postgresql_deploy.yml -u ec2-user --private
-key psql_01p.pem -e @vars/fsx_vars.yml
```

2. Set up the standby DR EC2 instance host.

```
ansible-playbook -i hosts postgresql_standby_setup.yml -u ec2-user
--private-key psql_01s.pem -e @vars/fsx_vars.yml
```

3. Set up FSx ONTAP cluster peering and database volume replication.

```
ansible-playbook -i hosts fsx_replication_setup.yml -e
@vars/fsx_vars.yml
```

4. Consolidate the previous steps into a single-step PostgreSQL deployment and HA/DR setup.

```
ansible-playbook -i hosts postgresql_hadr_setup.yml -u ec2-user -e @vars/fsx_vars.yml
```

5. For setting up a standby PostgreSQL DB host at either the primary or standby sites, comment out all other servers in the hosts file [dr_postgresql] section and then execute the postgresql_standby_setup.yml playbook with the respective target host (such as psql_01ps or standby EC2 compute instance at primary site). Make sure that a host parameters file such as psql_01ps.yml is configured under the host_vars directory.

```
[dr_postgresql] --  
#psql_01s ansible_ssh_private_key_file=psql_01s.pem  
psql_01ps ansible_ssh_private_key_file=psql_01ps.pem  
#psql_01ss ansible_ssh_private_key_file=psql_01ss.pem
```

```
ansible-playbook -i hosts postgresql_standby_setup.yml -u ec2-user  
--private-key psql_01ps.pem -e @vars/fsx_vars.yml
```

PostgreSQL database snapshot backup and replication to standby site

PostgreSQL database snapshot backup and replication to the standby site can be controlled and executed on the Ansible controller with a user-defined interval. We have validated that the interval can be as low as 5 minutes. Therefore, in the case of failure at the primary site, there is 5 minutes of potential data loss if failure occurs right before the next scheduled snapshot backup.

```
*/15 * * * * /home/admin/na_postgresql_aws_deploy_hadr/data_log_snap.sh
```

Failover to Standby Site for DR

For testing the PostgreSQL HA/DR system as a DR exercise, execute failover and PostgreSQL database recovery on the primary standby EC2 DB instance on standby site by executing following playbook. In an actually DR scenario, execute the same for an actually failover to DR site.

```
ansible-playbook -i hosts postgresql_failover.yml -u ec2-user --private  
-key psql_01s.pem -e @vars/fsx_vars.yml
```

Resync Replicated DB volumes after Failover Test

Run resync after the failover test to reestablish database-volume SnapMirror replication.

```
ansible-playbook -i hosts postgresql_standby_resync.yml -u ec2-user  
--private-key psql_01s.pem -e @vars/fsx_vars.yml
```

Failover from primary EC2 DB server to standby EC2 DB server due to EC2 compute instance failure

NetApp recommends running manual failover or using well-established OS cluster-ware that might require a license.

Where to find additional information

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

- Amazon FSx for NetApp ONTAP

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

- Amazon EC2

https://aws.amazon.com/pm/ec2/?trk=36c6da98-7b20-48fa-8225-4784bcd9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIIsAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixFxnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

- NetApp Solution Automation

<https://docs.netapp.com/us-en/netapp-solutions/automation/introduction.html>

SnapCenter for databases

TR-4964: Oracle Database backup, restore and clone with SnapCenter Services

Allen Cao, Niyaz Mohamed, NetApp

Purpose

SnapCenter Services is the SaaS version of the classic SnapCenter database management UI tool that is available through the NetApp BlueXP cloud management console. It is an integral part of the NetApp cloud-backup, data-protection offering for databases such as Oracle and HANA running on NetApp cloud storage. This SaaS-based service simplifies traditional SnapCenter standalone server deployment that generally requires a Windows server operating in a Windows domain environment.

In this documentation, we demonstrate how you can set up SnapCenter Services to backup, restore, and clone Oracle databases deployed to Amazon FSx for ONTAP storage and EC2 compute instances. Although it is much easier to set up and use, SnapCenter Services deliver key functionalities that are available in the legacy SnapCenter UI tool.

This solution addresses the following use cases:

- Database backup with snapshots for Oracle databases hosted in Amazon FSx for ONTAP
- Oracle database recovery in the case of a failure
- Fast and storage-efficient cloning of primary databases for a dev/test environment or other use cases

Audience

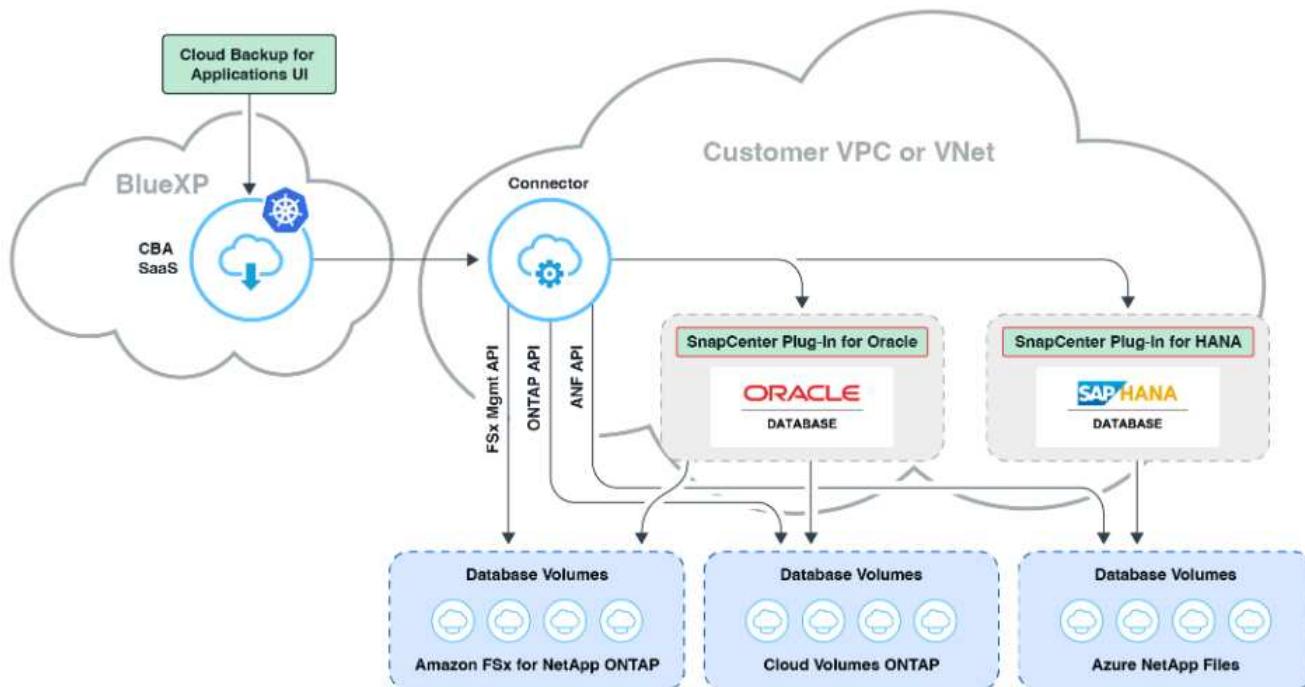
This solution is intended for the following audiences:

- The DBA who manages Oracle databases running on Amazon FSx for ONTAP storage
- The solution architect who is interested in testing Oracle database backup, restore, and clone in the public AWS cloud
- The storage administrator who supports and manages the Amazon FSx for ONTAP storage
- The application owner who owns applications that are deployed to Amazon FSx for ONTAP storage

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



This image provides a detailed picture of Cloud Backup for Application within the BlueXP console, including the UI, the connector, and the resources it manages.

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 large EC2 instances, one as primary DB server and the other as 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

- **Connector to be deployed in the same VPC as database and FSx.** When possible, the connector should be deployed in the same AWS VPC, which enables connectivity to the FSx storage and the EC2 compute instance.
- **An AWS IAM policy created for SnapCenter connector.** The policy in JSON format is available in the detailed SnapCenter service documentation. When you launch connector deployment with the BlueXP console, you are prompted to set up the prerequisites. The policy should be assigned to the AWS user account that owns the connector.
- **The AWS account access key and the SSH key pair created in the AWS account.** The SSH key pair is assigned to the ec2-user for logging into the connector host and then deploying a database plug-in to the EC2 DB server host. The access key grants permission for provisioning the required connector.
- **A credential added to the BlueXP console setting.** To add Amazon FSx for ONTAP to the BlueXP working environment, a credential that grants permissions to access Amazon FSx for ONTAP from the BlueXP console is set up in the BlueXP console setting.
- **SnapCenter plug-in deployed to the EC2 database instance host.** SnapCenter services make API calls that are executed by the SnapCenter plug-in on the EC2 database instance host. You must deploy it before setting up the services.

Solution deployment

There is extensive NetApp documentation with a broader scope to help you protect your cloud-native application data. The goal of this documentation is to provide step-by-step procedures that cover SnapCenter Service deployment with the BlueXP console to protect your Oracle database deployed to Amazon FSx for ONTAP and an EC2 compute instance. This document fills in certain details that might be missing from more general instructions.

To get started, complete the following steps:

- Read the general instructions [Protect your cloud native applications data](#) and the sections related to Oracle and Amazon FSx for ONTAP.
- Watch the following video walkthrough.

► <https://docs.netapp.com/us-en/netapp-solutions/media/oracle-aws-fsx-part4c-bkup-restore->

Prerequisites for SnapCenter service deployment

Deployment requires the following prerequisites.

1. A primary Oracle database server on an EC2 instance with an Oracle database fully deployed and running.
2. A Amazon FSx for ONTAP cluster deployed in AWS that is hosting the database above.
3. An optional database server on an EC2 instance that can be used for testing the cloning of an Oracle database to an alternative host for the purpose of supporting a dev/test workload or any use cases that requires a full data set of production Oracle database.
4. If you need help to meet the above prerequisites for Oracle database deployment on Amazon FSx for ONTAP and EC2 compute instance, see [Oracle Database Deployment and Protection in AWS FSx/EC2 with iSCSI/ASM](#).

Onboarding to BlueXP preparation

1. Use the link [NetApp BlueXP](#) to sign up for BlueXP console access.
2. To set up BlueXP to manage AWS cloud resources such as Amazon FSx for ONTAP, you should already have an AWS account set up. You can then log into your AWS account to create an IAM policy for granting SnapCenter service access to an AWS account to use for connector deployment.

The screenshot shows the AWS Identity and Access Management (IAM) console. The left sidebar is collapsed, showing options like Dashboard, Access management, Policies, and Access reports. The main area is titled "Summary" under "Policies > snapcenter". It displays the following details:

- Policy ARN:** arn:aws:iam::541696183547:policy/snapcenter
- Description:** Policy to grant snapcenter service permission to create connector in AWS.

The "Permissions" tab is selected, showing the JSON policy document:

```

1 {  
2   "Version": "2012-10-17",  
3   "Statement": [  
4     {  
5       "Effect": "Allow",  
6       "Action": [  
7         "iam:CreateRole",  
8         "iam:DeleteRole",  
9         "iam:PutRolePolicy",  
10        "iam:CreateInstanceProfile",  
11        "iam:DeleteRolePolicy",  
12        "iam:AddRoleToInstanceProfile",  
13        "iam:RemoveRoleFromInstanceProfile",  
14        "iam:DeleteInstanceProfile",  
15        "iam:PassRole",  
16        "iam>ListRoles",  
17        "ec2:DescribeInstanceStatus",  
18        "ec2:RunInstances",  
19        "ec2:ModifyInstanceAttribute",  
20        "ec2>CreateSecurityGroup",  
21        "ec2>DeleteSecurityGroup",  
22        "ec2:DescribeSecurityGroups",  
23        "ec2:RevokeSecurityGroupEgress",  
24        "ec2:AuthorizeSecurityGroupEgress",  
25        "ec2:AuthorizeSecurityGroupIngress",  
26        "ec2:RevokeSecurityGroupIngress",  
27        "ec2>CreateNetworkInterface",  
28        "ec2:DescribeNetworkInterface"
      ]  
6     }  
3   ]  
1 }

```

The policy should be configured with a JSON string that is available when connector provisioning is launched and you are prompted as a reminder that an IAM policy has been created and granted to an AWS account that is used for connector deployment.

3. You also need the AWS VPC, a key and secrets for your AWS account, an SSH key for EC2 access, a security group, and so on ready for connector provisioning.

Deploy a connector for SnapCenter services

1. Log into the BlueXP console. For a shared account, it is a best practice to create an individual workspace by clicking **Account** > **Manage Account** > **Workspace** to add a new workspace.

Manage Account: Automation-team

Overview Members Workspaces BlueXP Connector X

Manage the BlueXP connector Workspaces

+ Add New Workspace

Database	 
Database-2	 
sufians-k8	 
Workspace-1	 

2. Click **Add a Connector** to launch the connector provisioning workflow.

The screenshot shows the NetApp Cloud Manager interface. At the top, there are navigation links for Account (Automation-team), Workspace (new-workspace), and Connector (N/A). The main header includes a bell icon, gear icon, and help icon. Below the header, a sidebar on the left features various icons for cloud services like AWS, Azure, GCP, and StorageGRID. The main content area has tabs for Backup & Restore, Restore, Applications, Virtual Machines, Kubernetes, and Job Monitoring. The 'Backup & Restore' tab is selected and highlighted in blue. The central part of the screen displays the 'Backup & Restore' section with the title 'Fully integrated data protection for ONTAP anywhere'. It includes a detailed description of Cloud Backup's benefits, a call-to-action button 'Add a Connector', and three promotional cards at the bottom: 'Simple & intuitive' (with a hand icon), 'Hybrid Multicloud' (with a cloud icon), and 'Unmatched Efficiency' (with a dollar sign icon).

Backup & Restore

Fully integrated data protection for ONTAP anywhere

Cloud Backup dramatically reduces the complexity of backing up critical structured and unstructured data across your ONTAP hybrid cloud environments to cost-effective object storage. All you need to do is select the source, the target and the protection policy and you're protected.

To start your Backup & Restore experience, please deploy our connector

Add a Connector

Simple & intuitive

No backup or cloud expertise required. Simply click the button above and follow the instructions

Hybrid Multicloud

Backup from On-premises or Cloud Volumes ONTAP to AWS, Azure, GCP or StorageGRID

Unmatched Efficiency

Combines incremental, block-level operation with storage efficiencies to reduce time and costs

3. Choose your cloud provider (in this case, **Amazon Web Services**).

Add Connector X

Provider

Choose the cloud provider where you want to run the Connector:



Microsoft Azure



Amazon Web Services



Google Cloud Platform

Continue Back

4. Skip the **Permission**, **Authentication**, and **Networking** steps if you already have them set up in your AWS account. If not, you must configure these before proceeding. From here, you could also retrieve the permissions for the AWS policy that is referenced in the previous section "[Onboarding to BlueXP preparation.](#)"

Add Connector - AWS

X

Deploying a Connector

The Connector is a crucial component for the day-to-day use of Cloud Manager. It's used to connect Cloud Manager's services to your hybrid-cloud environments. The Connector can then manage the resources and processes within your public cloud environment.

Before you begin the deployment process, ensure that you have completed the required preparations. This guide will enable you to focus on the minimum requirements for Connector installation.

Permissions

Set up an IAM role with the required permissions

Authentication

Choose between two AWS authentication methods: AWS keys or assuming an IAM role

Networking

Obtain details about the VPC and subnet in which the Connector will reside

[Skip to Deployment](#)

[Previous](#)

[Continue](#)



5. Enter your AWS account authentication access key and secret key.

Add Connector - AWS

[More Information](#)

X

[1 AWS Credentials](#)

[2 Details](#)

[3 Network](#)

[4 Security Group](#)

[5 Review](#)

AWS Authentication

Region

us-east-1 | US East (N. Virginia)

Select the Authentication Method:

Assume Role

AWS Keys

AWS Access Key

AKIA6JRXA6ZGVF5HMO3

AWS Secret Key

.....

Want to launch an instance without AWS Credentials? ▾

[Previous](#)

[Next](#)



6. Name the connector instance and select **Create Role** under **Details**.

The screenshot shows the 'Add Connector - AWS' wizard in progress, specifically the 'Details' step (step 2). The top navigation bar includes 'More Information' and a close button. Below the navigation, five steps are listed: 1. AWS Credentials (selected), 2. Details (current step), 3. Network, 4. Security Group, and 5. Review.

Connector Instance Name: SnapCenterSvs

Connector Role: Create Role (selected)

Role Name: Cloud-Manager-Operator-VZzSSP9-SnapCenter

AWS Managed Encryption: Enabled (Master Key: aws/ebs (default))

Buttons: Previous, Next, and a blue circular icon with a white square symbol.

7. Configure networking with the proper VPC, subnet, and SSH key pair for EC2 access.

Add BlueXP Connector - AWS

More Information X

AWS Credentials Details Network Security Group Review

Network

Connectivity

VPC:

Subnet:

Key Pair:

Public IP:

Proxy Configuration (Optional)

HTTP Proxy:

Define Credentials for this Proxy

Upload a root certificate

Notice: Ensure that the subnet has internet connectivity through a NAT device or proxy server so that the Connector can communicate with AWS services.

Previous Next



8. Set the security group for the connector.

Add BlueXP Connector - AWS

More Information X

AWS Credentials Details Network Security Group Review

Security Group

The security group must allow inbound HTTP, HTTPS and SSH access.

Assign a security group: Create a new security group Select an existing security group

Security Group Name	Description
default	default VPC security group

1 Security Group

Previous Next



9. Review the summary page and click **Add** to start connector creation. It generally takes about 10 mins to complete deployment. Once completed, the connector instance appears in the AWS EC2 dashboard.

The screenshot shows the 'Review' step of the 'Add BlueXP Connector - AWS' wizard. The configuration details listed are:

Review	
Code for Terraform Automation	
BlueXP Connector Name	aws-snapctr-us-east
AWS Access Key	AKIAJ4H43ZT56IWWR3TI
Region	us-east-1
VPC	vpc-0b522d5e982a50ceb - 172.30.15.0/25
Subnet	172.30.15.0/25 priv-subnet-01
Key Pair	sufi_new
Public IP	Use subnet settings (Disable)
Proxy	None
Security Group	default

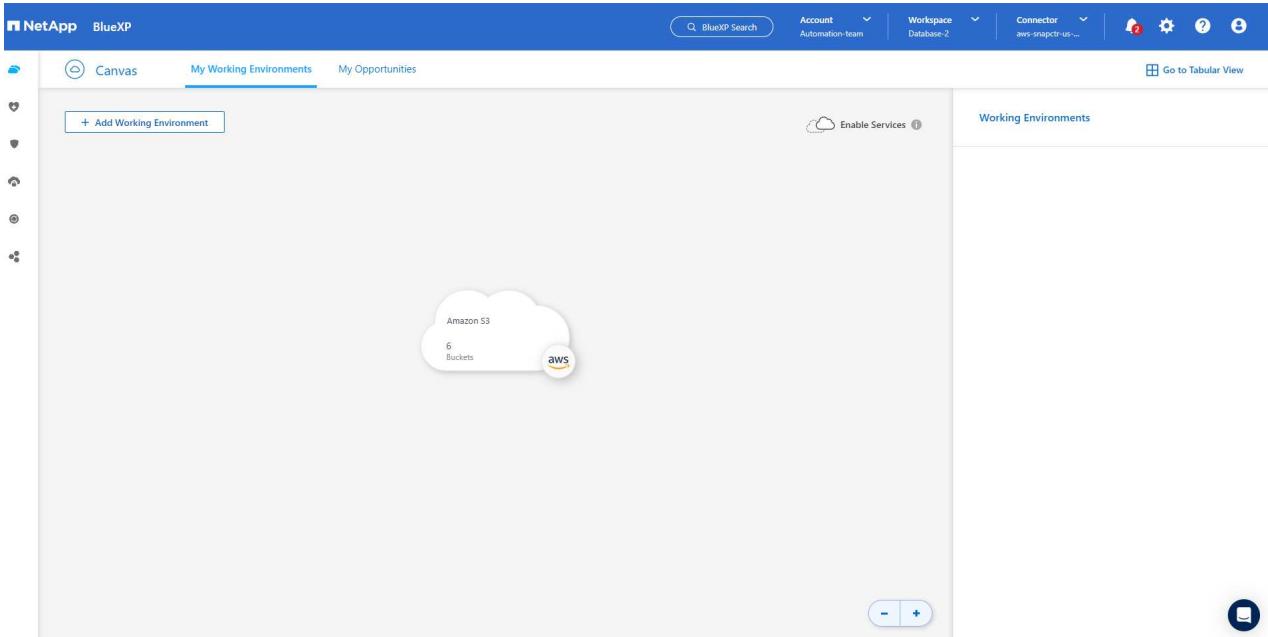
At the bottom of the screen, there are two buttons: 'Previous' and 'Add'. A help icon is located in the bottom right corner.

10. After the connector is deployed, log into the connector EC2 host as the ec2-user with an SSH key to install the SnapCenter plug-in following these instructions: [Deploy the plug-in using script and add host from UI using manual option](#).

SnapCenter services setup

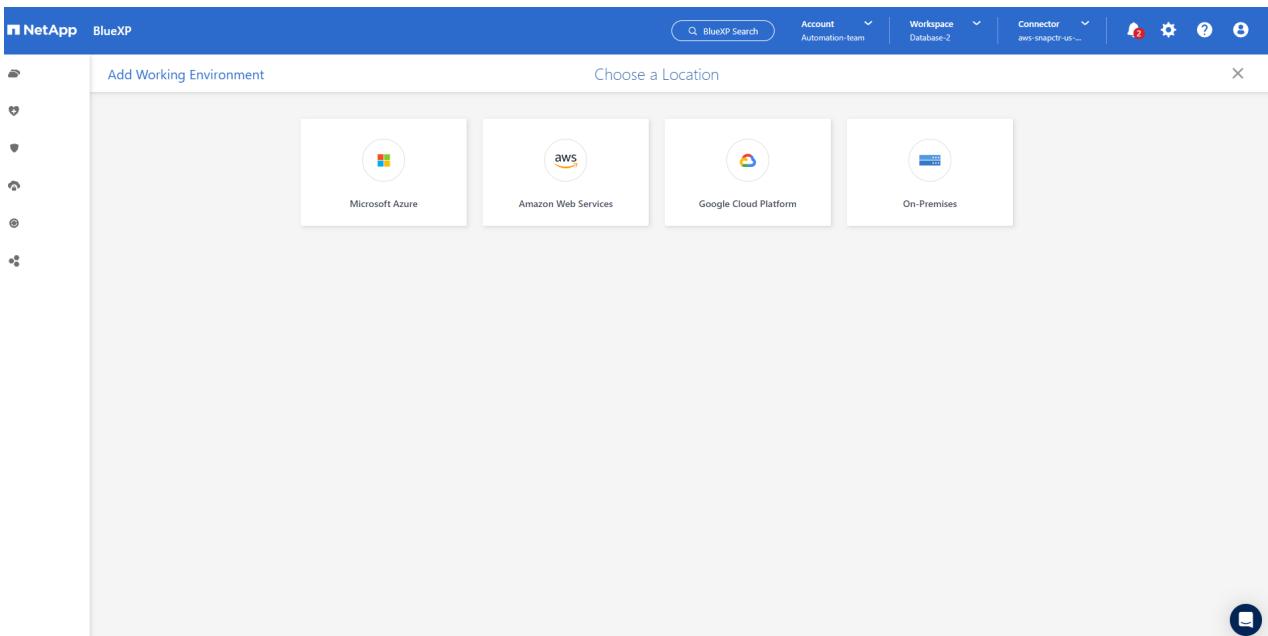
With the connector deployed, SnapCenter services can now be set up with the following procedure:

1. From **My Working Environment** click **Add working Environment** to discover FSx deployed in AWS.



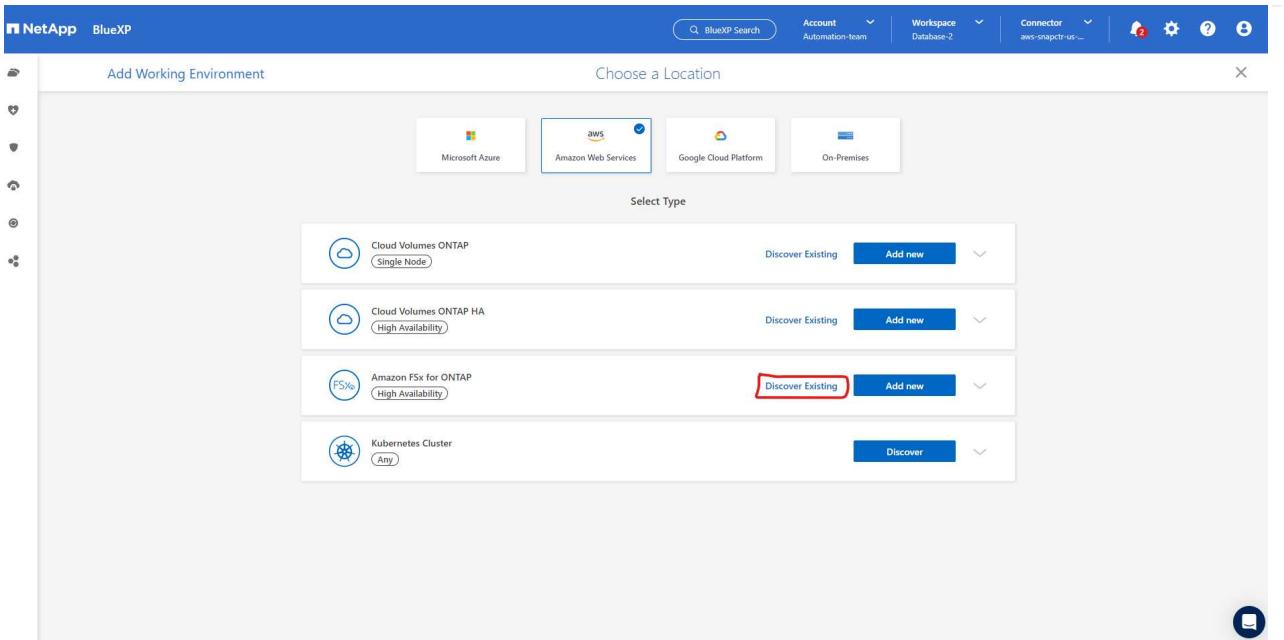
The screenshot shows the NetApp BlueXP web interface. At the top, there's a blue header bar with the NetApp logo and "BlueXP". On the right side of the header are account, workspace, and connector dropdowns, along with various icons for search, settings, and help. Below the header, there are three tabs: "Canvas" (disabled), "My Working Environments" (selected, indicated by a blue underline), and "My Opportunities". In the main content area, there's a large white space with a central cloud icon labeled "Amazon S3" and "6 Buckets". To the right of this icon is a small "aws" logo. At the bottom right of the main area are two circular buttons with minus and plus signs. On the far right, there's a sidebar titled "Working Environments" which is currently empty. At the very bottom right of the screen is a small blue circular icon with a white speech bubble symbol.

2. Choose **Amazon Web Services** as the location.

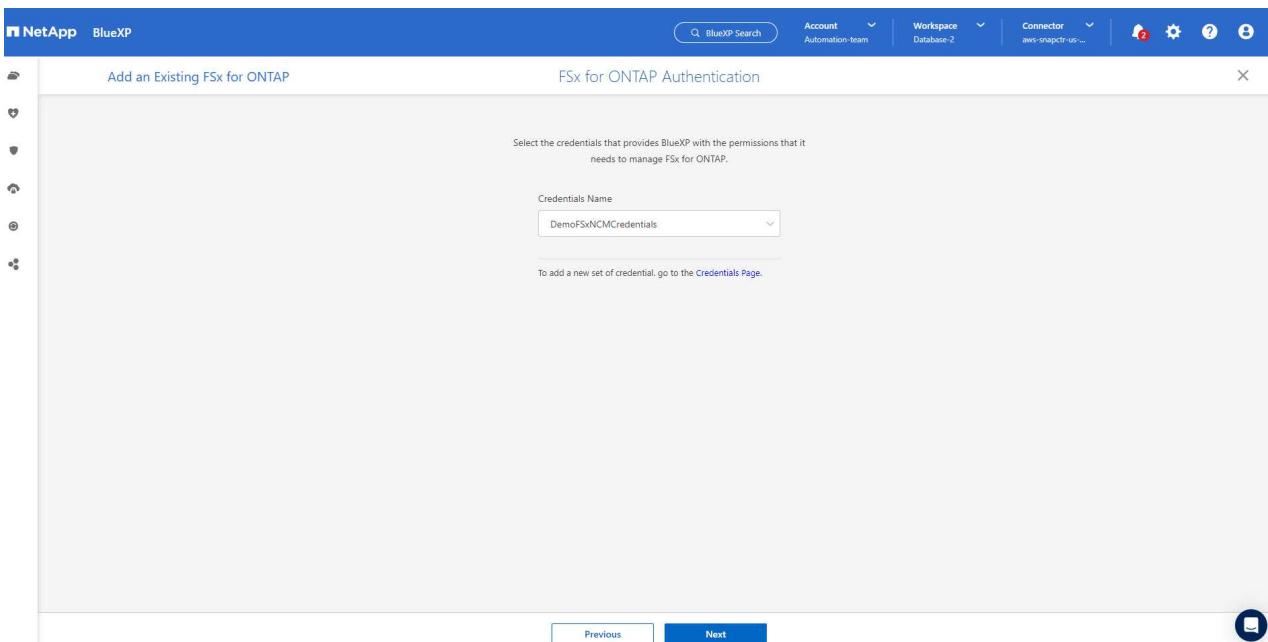


The screenshot shows a modal dialog box titled "Add Working Environment" with the sub-section "Choose a Location". The dialog has a blue header bar with the NetApp logo and "BlueXP". On the right side of the header are account, workspace, and connector dropdowns, along with various icons for search, settings, and help. The main content area contains four square buttons, each representing a different location type: "Microsoft Azure" (with a Microsoft logo icon), "Amazon Web Services" (with an AWS logo icon, which is highlighted with a light gray background), "Google Cloud Platform" (with a Google logo icon), and "On-Premises" (with a server icon). At the bottom right of the dialog is a small blue circular icon with a white speech bubble symbol.

3. Click **Discover Existing** next to **Amazon FSx for ONTAP**.



4. Select the credentials that provides BlueXP with the permissions that it needs to manage FSx for ONTAP. If you have not added credentials, you can add it from the **Settings** menu at the top right corner of the BlueXP console.



5. Choose the AWS region where Amazon FSx for ONTAP is deployed, select the FSx cluster that is hosting the Oracle database and click Add.

Add an Existing FSx for ONTAP

Select FSx for ONTAP

Choose an AWS region and then select the working environment that you want to add

Region: us-east-1 | US East (N. Virginia)

Name	File System ID	VPC ID	Subnet ID	Management Address	Deployment modal	Tags
fsx_01	fs-02ad7bf3476b741df	vpc-0b522d5e982a...	subnet-04f5fe7073ff5...	management.fs-02ad7bf3476b741df.fsx.us-east...	Single Availability Zone	(4)

Previous Add

6. The discovered Amazon FSx for ONTAP instance now appears in the working environment.

Canvas My Working Environments My Opportunities

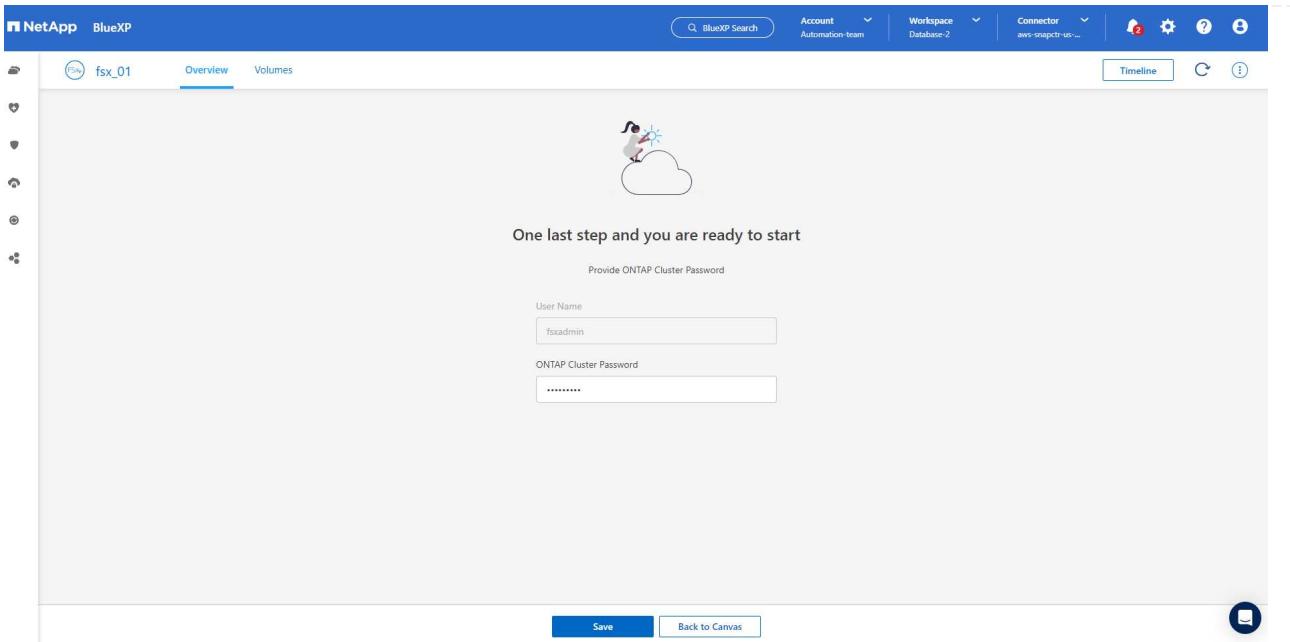
+ Add Working Environment

Enable Services

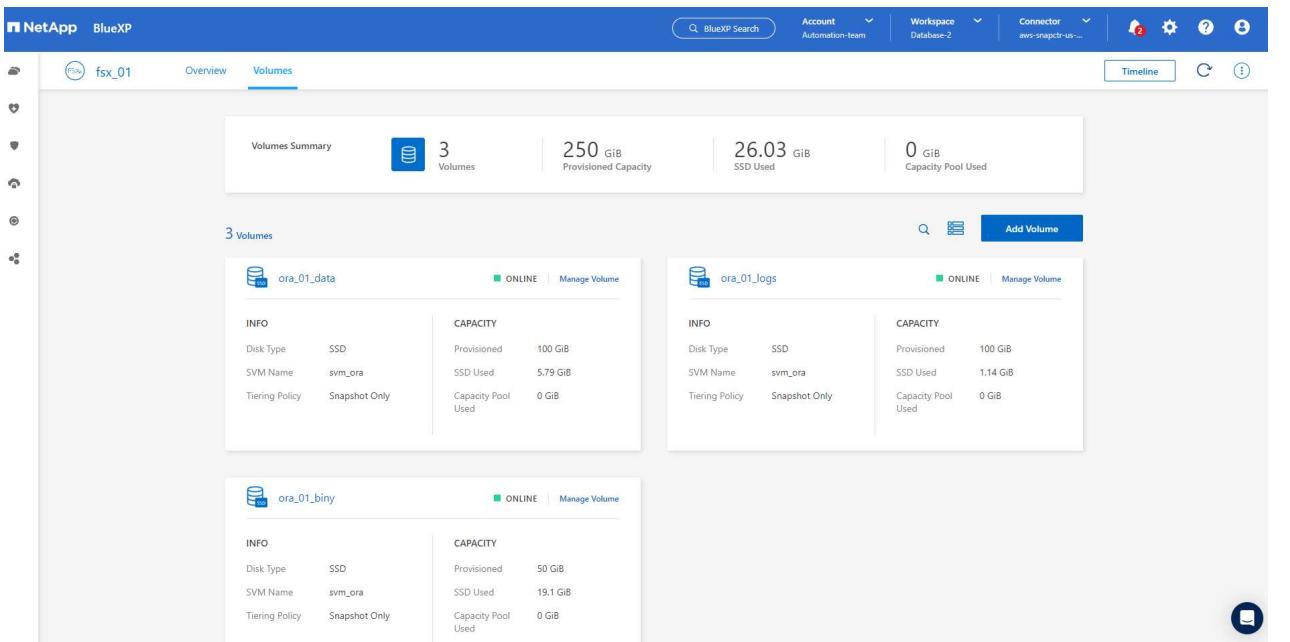
Working Environments

1 FSx for ONTAP (High-Availability)
250 GiB Provisioned Capacity

7. You can log into the FSx cluster with your fsxadmin account credentials.



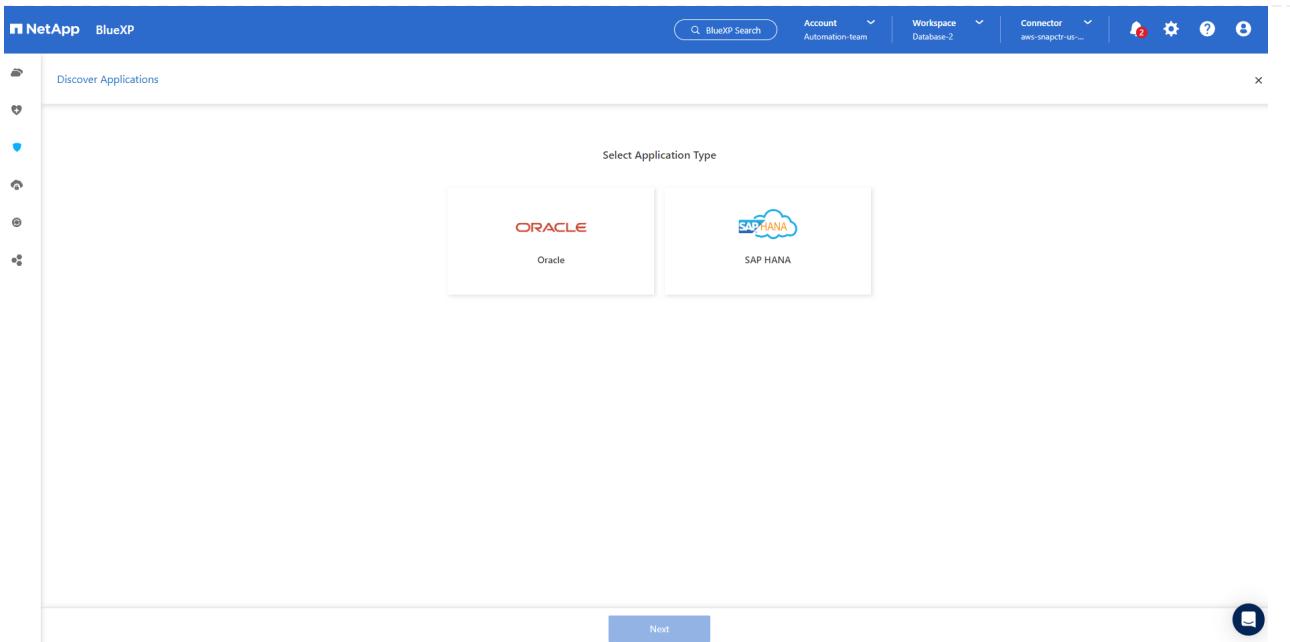
8. After you log into Amazon FSx for ONTAP, review your database storage information (such as database volumes).



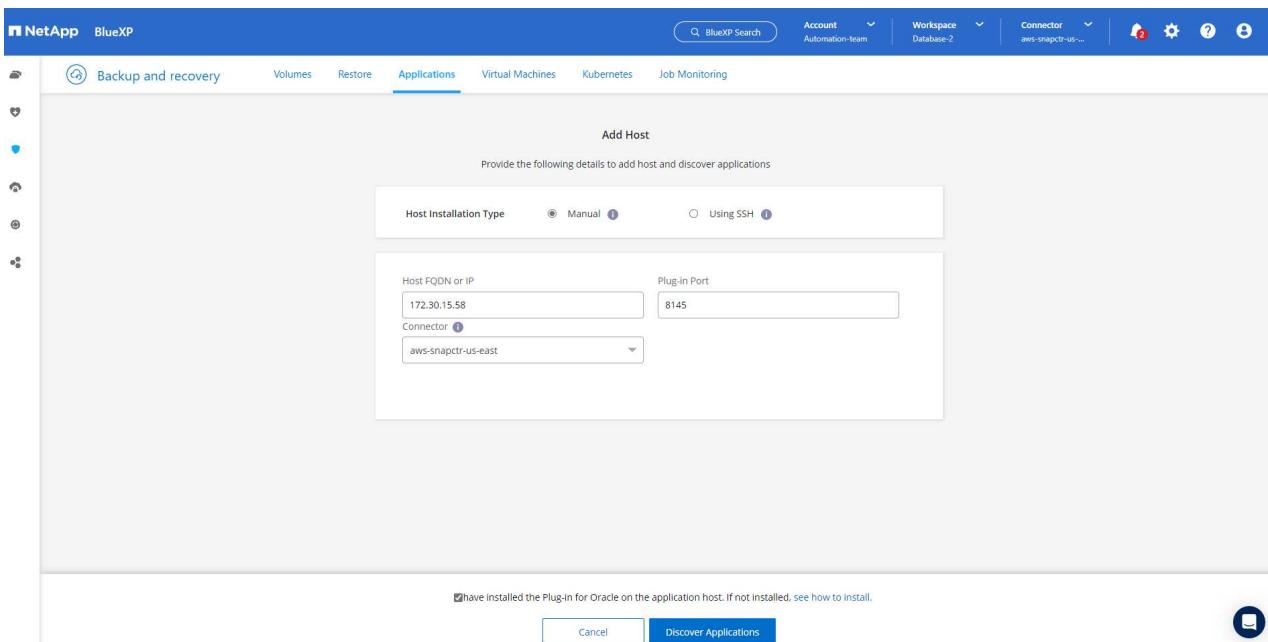
9. From the left-hand sidebar of the console, hover your mouse over the protection icon, and then click **Protection > Applications** to open the Applications launch page. Click **Discover Applications**.

10. Select **Cloud Native** as the application source type.

11. Choose **Oracle** for the application type.



12. Provide the Oracle EC2 instance host details to add a host. Check the box to confirm that the plug-in for Oracle on the host has been installed, because you deploy the plug-in after the connector is provisioned.



13. Discover the Oracle EC2 host and add it to **Applications**, and any databases on the host are discovered and displayed on the page as well. The database **Protection Status** shows as **Unprotected**.

The screenshot shows the NetApp BlueXP web interface. At the top, there are navigation tabs: Backup and recovery, Volumes, Restore, Applications (which is selected), Virtual Machines, Kubernetes, and Job Monitoring. The top right includes search, account, workspace, connector, and notification icons. Below the tabs, there's a sidebar with various icons. The main content area has dropdown filters for 'Cloud Native' and 'Oracle'. It displays three counts: 1 Hosts, 1 ORACLE, and 0 Clones. A summary box shows 'Application Protection' with 0 Protected and 1 Unprotected. Below this is a table titled '1 Databases' with one entry: db1, Host Name 172.30.15.58, Policy Name (empty), Protection Status Unprotected, and a three-dot menu icon. The bottom of the table shows '1 - 1 of 1' and navigation arrows.

This completes the initial setup of SnapCenter services for Oracle. The next three sections of this document describe Oracle database backup, restore, and clone operations.

Oracle database backup

- Click the three dots next to the database **Protection Status**, and then click **Policies** to view the default preloaded database protection policies that can be applied to protect your Oracle databases.

The screenshot shows the NetApp BlueXP interface with the Applications tab selected. In the top right, there's a tooltip for 'Protection Status' which indicates 0 Protected and 1 Unprotected. Below this, a table lists one database named 'db1' with its host name as '172.30.15.58'. The protection status for this database is marked as 'Unprotected'.

- You can also create your own policy with a customized backup frequency and backup data-retention window.

The screenshot shows the NetApp BlueXP interface with the Policies section for Oracle selected. It lists four existing policies:

- Oracle Full Backup for Bronze**: FullBackup. Details: Daily: Repeats Every 1 Day, Keeps 14 copies; Weekly: Repeats Every Fri, Keeps 4 copies; Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov.
- Oracle Full Backup for Gold**: FullBackup. Details: Hourly: Repeats Every 6 Hrs, Keeps 16 copies; Daily: Repeats Every 1 Day, Keeps 30 copies; Weekly: Repeats Every Fri, Keeps 4 copies; Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov.
- Oracle Full Backup for Silver**: FullBackup. Details: Hourly: Repeats Every 12 Hrs, Keeps 6 copies; Daily: Repeats Every 1 Day, Keeps 14 copies; Weekly: Repeats Every Fri, Keeps 4 copies; Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov.
- my_full_bkup**: FullBackup. Details: Hourly: Repeats Every 1 Hr, Keeps 3 Days.

- When you are happy with the policy configuration, you can then assign your policy of choice to protect the database.

The screenshot shows the NetApp BlueXP web interface. The top navigation bar includes 'Backup and recovery', 'Volumes', 'Restore', 'Applications' (which is selected), 'Virtual Machines', 'Kubernetes', and 'Job Monitoring'. The search bar says 'BlueXP Search' and the account dropdown says 'Account Automation-team'. The workspace dropdown says 'Workspace Database-2' and the connector dropdown says 'Connector aws-snapcrus...'. On the left sidebar, there are icons for Cloud Native, Oracle, and other services. The main content area shows 'Cloud Native' and 'Oracle' filters. It displays '1 Hosts', '1 ORACLE', and '0 Clone'. An 'Application Protection' summary shows '0 Protected' and '1 Unprotected'. Below this, a table lists '1 Databases' with one entry: 'db1' at '172.30.15.58' with 'Protection Status' as 'Unprotected'. A context menu for 'db1' includes 'View Details' and 'Assign Policy' (which is highlighted with a red box). There are also navigation buttons for '1 > >>'.

4. Choose the policy to assign to the database.

The screenshot shows the 'Assign Policy' dialog. The title is 'Assign Policy' with the sub-instruction 'Assign a policy to start taking backups of the database "db1"'. It shows a table of '4 Policies':

Policy Name	Backup Type	Schedules
Oracle Full Backup for Bronze	FullBackup	Daily: Repeats Every 1 Day, Keeps 14 copies Weekly: Repeats Every Fri, Keeps 4 copies Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, C
Oracle Full Backup for Gold	FullBackup	Hourly: Repeats Every 6 Hrs, Keeps 16 copies Daily: Repeats Every 1 Day, Keeps 30 copies Weekly: Repeats Every Fri, Keeps 4 copies Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, C
Oracle Full Backup for Silver	FullBackup	Hourly: Repeats Every 12 Hrs, Keeps 6 copies Daily: Repeats Every 1 Day, Keeps 14 copies Weekly: Repeats Every Fri, Keeps 4 copies Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, C
my_full_bkup	FullBackup	Hourly: Repeats Every 1 Hr, Keeps 3 Days

The 'my_full_bkup' policy is selected (indicated by a checked checkbox). At the bottom are 'Cancel' and 'Assign' buttons.

5. After the policy is applied, the database protection status changed to **Protected** with a green check mark.

The screenshot shows the NetApp BlueXP web interface. At the top, there are tabs for Backup and recovery, Volumes, Restore, Applications (which is selected), Virtual Machines, Kubernetes, and Job Monitoring. The left sidebar has icons for Cloud Native, Oracle, and other services. In the main area, there are summary counts: 1 Hosts, 1 Oracle, and 0 Clones. An Application Protection section shows 1 Protected and 0 Unprotected. Below this is a table for Databases:

Name	Host Name	Policy Name	Protection Status
db1	172.30.15.58	my_full_bkup	Protected

At the bottom right of the table, there is a page navigation bar showing "1 - 1 of 1".

6. The database backup runs on a predefined schedule. You can also run a one-off on-demand backup as shown below.

The screenshot shows the same NetApp BlueXP interface as above, but with a context menu open over the "db1" database row in the table. The menu options are: View Details, On-Demand Backup (which is highlighted with a red underline), Assign Policy, and Un-assign Policy.

7. The database backups details can be viewed by clicking **View Details** from the menu list. This includes the backup name, backup type, SCN, and backup date. A backup set covers a snapshot for both data volume and log volume. A log volume snapshot takes place right after a database volume snapshot. You can apply a filter if you are looking for a particular backup in a long list.

The screenshot shows the NetApp BlueXP interface. The top navigation bar includes 'NetApp BlueXP' logo, 'BlueXP Search' search bar, 'Account Automation-team', 'Workspace Database-2', 'Connector aws-snapctr-us...', and several icons for notifications, settings, and help.

The main menu has tabs: 'Backup and recovery' (selected), 'Volumes', 'Restore', 'Applications' (selected), 'Virtual Machines', 'Kubernetes', and 'Job Monitoring'. Below the tabs, a breadcrumb path shows 'Applications > Database Details'.

The 'Database Details' section displays information for database 'db1':

db1	Protected Protection	Oracle Full Backup for Gold Policy Names	Database Type
172.30.15.58	FSx Host Storage	Unreachable Database Version	bKed8yv2T19BJ0V5QyqvA... Agent Id
- Clones	- Parent Database		

Below this, a section titled '8 Backups' shows a list of backups:

Backup Name	Backup Type	SCN	Backup Date	Action
Oracle_Full_Backup_for_Gold_Weekly_db1_2023_03_24_19_12_18_60900_1	Log	2589354	Mar 24, 2023, 3:12:34 pm	Delete
Oracle_Full_Backup_for_Gold_Weekly_db1_2023_03_24_19_11_51_51476_0	Data	2589306	Mar 24, 2023, 3:12:18 pm	...
Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_18_10_31_71953_1	Log	2586621	Mar 24, 2023, 2:10:45 pm	Delete
Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_18_10_03_70535_0	Data	2586557	Mar 24, 2023, 2:10:31 pm	...

Oracle database restore and recovery

- For a database restore, choose the right backup, either by the SCN or backup time. Click the three dots from the database data backup, and then click **Restore** to initiate database restore and recovery.

The screenshot shows the 'Database Details' section for a database named 'db1'. It displays various configuration details such as Protection, Host Name, Host Storage, and Database Type. Below this, a table lists four backups, each with columns for Backup Name, Backup Type, SCN, and Backup Date. The third backup in the list has a context menu open, with the 'Restore' option highlighted by a red box.

- Choose your restore setting. If you are sure that nothing has changed in the physical database structure after the backup (such as the addition of a data file or a disk group), you can use the **Force in place restore** option, which is generally faster. Otherwise, do not check this box.

The screenshot shows the 'Restore Settings' dialog for restoring database 'db1'. Under 'Restore Scope', the 'All Data Files' radio button is selected. The 'Force in place restore' checkbox is checked. Under 'Recovery Scope', the 'All Logs' radio button is selected. The 'Archive Log Files Locations' field is set to '/mnt/log_location001'. The 'Next' button is visible at the bottom of the dialog.

- Review and start database restore and recovery.

Restore "db1"

Review

Backup Name	Oracle_Full_Backup_for_Gold_Weekly_db1_2023_03_24_19_11_51_51476_0
Restore Scope	All Data Files
Recovery Scope	All Logs
Force In Place Restore	Yes
Open Database or Container Database In READ-WRITE Mode After Recovery	

Previous Restore

- From the Job Monitoring tab, you can view the status of the restore job as well as any details while it is running.

Backup and recovery Volumes Restore Applications Virtual Machines Kubernetes Job Monitoring

Job Monitoring Last Updated March 24 2023, 15:25:33

Advanced Search & Filtering Timeframe: Last 24 Hours

Jobs(30)

Job ID	Type	Resource Name	Status	Job Name	Start Time
1fdca0bd-a9c8-45aa...	--	--	Success	Restore for Oracle Database db1 ...	Mar 24 2023, 3:16:28 pr
f6f4fe2d-3040-497f...	--	--	Success	Backup of db1 oracle database o...	Mar 24 2023, 3:11:51 pr
5e3299f5-29db-4dcc...	--	--	Success	Backup of db1 oracle database o...	Mar 24 2023, 2:10:03 pr
6da5e51e-1a79-4e7e...	--	--	Success	Initialize FullBackup backup of po...	Mar 24 2023, 2:10:01 pr

The screenshot shows the NetApp BlueXP web interface. At the top, there are navigation links for Backup and recovery, Volumes, Restore, Applications, Virtual Machines, Kubernetes, and Job Monitoring. The Job Monitoring link is underlined, indicating it is the active page. The main content area displays "Job Details" for a specific job. The job ID is listed as 1fdca0bd-a9c8-45aa-9d7a-05a07cb291f4. Below this, a table titled "Sub-Jobs(6)" lists six sub-jobs with columns for Job Name, Job ID, Start Time, End Time, Duration, and a plus sign icon for adding more. The sub-jobs are:

Job Name	Job ID	Start Time	End Time	Duration
Restore for Oracle Database db1 using backup ...	1fdca0bd-a9c8-45aa-9d7a-05a07cb291f4	Mar 24 2023, 3:16:28 pm	Mar 24 2023, 3:23:33 pm	7 Minutes
Post Restore Cleanup	2096a8e4-889d-4b2a-9...	Mar 24 2023, 3:23:18 pm	Mar 24 2023, 3:23:32 pm	14 Seconds
Post Restore	fb7b1171-9f6f-4228-9e...	Mar 24 2023, 3:20:06 pm	Mar 24 2023, 3:23:19 pm	3 Minutes
Restore	0f4580d0-6598-458b-a7...	Mar 24 2023, 3:17:49 pm	Mar 24 2023, 3:20:07 pm	2 Minutes

Oracle database clone

To clone a database, launch the clone workflow from the same database backup details page.

1. Select the right database backup copy, click the three dots to view the menu, and choose the **Clone** option.

The screenshot shows the 'Database Details' section of the NetApp BlueXP interface. It displays information for a database named 'db1'. Below this, a table lists two backups: 'Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_34_41_30491_1' (Log type) and 'Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_34_07_26748_0' (Data type). For the second backup, a context menu is open with options: 'Restore', 'Delete', and 'Clone'. The 'Clone' option is circled in red.

2. Select the **Basic** option if you don't need to change any cloned database parameters.

The screenshot shows the 'Create Clone' wizard. At the top, there are two tabs: 'Clone Details' (selected) and 'Review'. Below this, a section titled 'Select Clone Options' offers two choices: 'Basic' (selected) and 'Specification file'. The 'Basic' section contains fields for 'Clone Host' (set to '172.30.15.58'), 'Clone SID' ('db1clone'), 'Clone Naming Scheme' ('Auto-generated'), and 'Oracle Home' ('/u01/app/oracle/product/19.0.0/db1'). There are also sections for 'Database Credentials' and 'ASM Credentials', each with a 'Add Credential' button. At the bottom of the screen are 'Cancel' and 'Next' buttons.

3. Alternatively, select **Specification file**, which gives you the option of downloading the current init file, making changes, and then uploading it back to the job.

Clone Database of "db1"

Create Clone

Provide following details to create a clone from the database backup "Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_34_07_26748_0"

Select Clone Options

Basic Specification file

(i) Generate specification file to modify input parameters and use for clone. [Download File](#)

Specification File: db1_3_24_2023_10_14_spec.json [Browse](#)

Clone Host: 172.30.15.58

Clone SID: db1clone

Database Credentials: *Optional* [Add Credential](#)

ASM Credentials: *Optional* [Add Credential](#)

Cancel Next

4. Review and launch the job.

Clone Database of "db1"

Review

General		Database parameters
Backup Name:	Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_34_07_26748_0	
Clone SID:	db1clone	
Clone Host:	172.30.15.58	
Datafile locations:	DATA_db1clone	
Control files:	+DATA_db1clone/db1clone/control/control01.ctf	
Redo logs:	RedoGroup = 1 TotalSize = 1024 Path = +DATA_db1clone/db1clone/reredo/reredo01_01.log RedoGroup = 2 TotalSize = 1024 Path = +DATA_db1clone/db1clone/reredo/reredo02_01.log RedoGroup = 3 TotalSize = 1024 Path = +DATA_db1clone/db1clone/reredo/reredo03_01.log	
Recovery scope:	Until cancel using selected backup's archive logs	

Previous Clone

5. Monitor the cloning job status from the **Job Monitoring** tab.

The screenshot shows the NetApp BlueXP interface with the 'Job Monitoring' tab selected. A specific job is being tracked, with its ID visible in the URL. The interface displays the 'Job Details' section, which includes a table of sub-jobs. The sub-jobs listed are:

Job Name	Job ID	Start Time	End Time	Duration
Cloning Oracle Database db1 as db1clone on h...	cd30abaf-fbe2-4052-a6db-4bf965a8d29b	Mar 24 2023, 1:30:36 pm	--	--
Running pre scripts	5ff152c1-853a-4ec6-a4f...	Mar 24 2023, 1:30:41 pm	Mar 24 2023, 1:30:41 pm	0 Second
Validating clone request	f93a6cc44-2eb2-4c5e-9f...	Mar 24 2023, 1:30:35 pm	Mar 24 2023, 1:30:42 pm	7 Seconds

6. Validate the cloned database on the EC2 instance host.

```
# Multiple entries with the same $ORACLE_SID are not allowed.
#
#+ASM:/u01/app/oracle/product/19.0.0/grid:N
db1:/u01/app/oracle/product/19.0.0/db1:N
# SnapCenter Plug-in for Oracle Database generated entry (DO NOT REMOVE THIS LINE)
db1clone:/u01/app/oracle/product/19.0.0/db1:N
[oracle@ip-172-30-15-58 ~]$ crsctl stat res -t
-----
Name          Target   State        Server           State details
-----
Local Resources
-----
ora.DATA.dg    ONLINE   ONLINE      ip-172-30-15-58      STABLE
ora.DATA_DB1CLONE.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.LOGS_SCO_2748138658.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       1        ONLINE   ONLINE      ip-172-30-15-58      STABLE
ora.db1.db      1        ONLINE   ONLINE      ip-172-30-15-58      Open,HOME=/u01/app/o
racle/product/19.0.0
/db1,STABLE
ora.db1clone.db
    1        ONLINE   ONLINE      ip-172-30-15-58      Open,HOME=/u01/app/o
racle/product/19.0.0
/db1,STABLE
ora.diskmon     1        OFFLINE  OFFLINE     STABLE
ora.driver.afd  1        ONLINE   ONLINE      ip-172-30-15-58      STABLE
ora.evmd        1        ONLINE   ONLINE      ip-172-30-15-58      STABLE
-----
[oracle@ip-172-30-15-58 ~]$
```

```

[oracle@ip-172-30-15-58 ~]$ export ORACLE_HOME=/u01/app/oracle/product/19.0.0/db1
[oracle@ip-172-30-15-58 ~]$ export ORACLE_SID=db1clone
[oracle@ip-172-30-15-58 ~]$ export PATH=$ORACLE_HOME/bin:$PATH
[oracle@ip-172-30-15-58 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Mar 24 18:32:21 2023
Version 19.18.0.0.0

Copyright (c) 1982, 2022, Oracle. All rights reserved.

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.18.0.0.0

SQL> select name, open_mode from v$database;

NAME      OPEN_MODE
----- -----
DB1CLONE  READ WRITE

SQL>

```

Additional information

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

- Set up and administer BlueXP

<https://docs.netapp.com/us-en/cloud-manager-setup-admin/index.html>

- Cloud Backup documentation

<https://docs.netapp.com/us-en/cloud-manager-backup-restore/index.html>

- Amazon FSx for NetApp ONTAP

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

- Amazon EC2

https://aws.amazon.com/pm/ec2/?trk=36c6da98-7b20-48fa-8225-4784bcd9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIIsAJzSrdqwQrghn6l71jiWzSeaT9Uh1-vY-VfhJixFxnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

Hybrid Cloud Database Solutions with SnapCenter

TR-4908: Hybrid Cloud Database Solutions with SnapCenter Overview

Alan Cao, Felix Melligan, NetApp

This solution provides NetApp field and customers with instructions and guidance for configuring, operating, and migrating databases to a hybrid cloud environment using the NetApp SnapCenter GUI-based tool and the NetApp storage service CVO in public clouds for the following use cases:

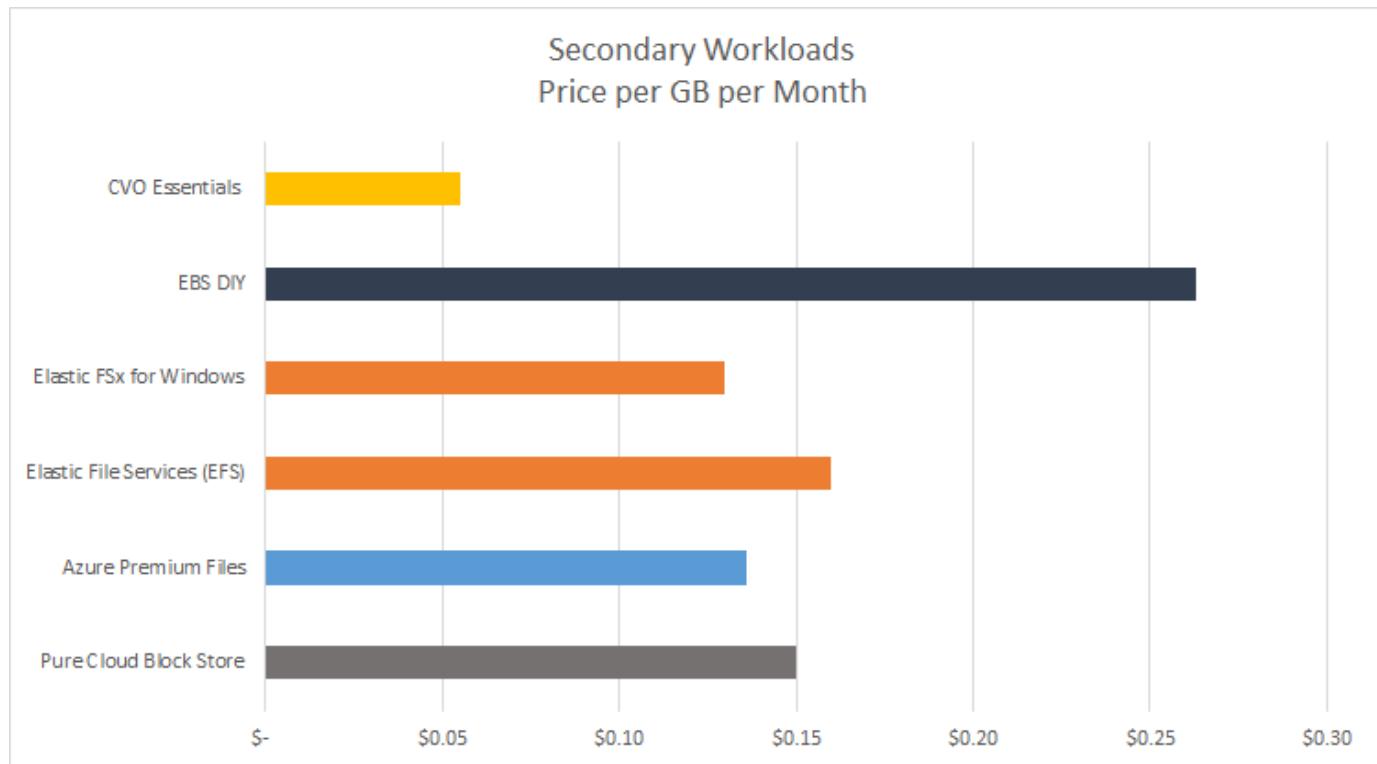
- Database dev/test operations in the hybrid cloud
- Database disaster recovery in the hybrid cloud

Today, many enterprise databases still reside in private corporate data centers for performance, security, and/or other reasons. This hybrid cloud database solution enables enterprises to operate their primary databases on site while using a public cloud for dev/test database operations as well as for disaster recovery to reduce licensing and operational costs.

Many enterprise databases, such as Oracle, SQL Server, SAP HANA, and so on, carry high licensing and operational costs. Many customers pay a one-time license fee as well as annual support costs based on the number of compute cores in their database environment, whether the cores are used for development, testing, production, or disaster recovery. Many of those environments might not be fully utilized throughout the application lifecycle.

The solutions provide an option for customers to potentially reduce their licensable cores count by moving their database environments devoted to development, testing, or disaster recovery to the cloud. By using public-cloud scale, redundancy, high availability, and a consumption-based billing model, the cost saving for licensing and operation can be substantial, while not sacrificing any application usability or availability.

Beyond potential database license-cost savings, the NetApp capacity-based CVO license model allows customers to save storage costs on a per-GB basis while empowering them with high level of database manageability that is not available from competing storage services. The following chart shows a storage cost comparison of popular storage services available in the public cloud.



This solution demonstrates that, by using the SnapCenter GUI-based software tool and NetApp SnapMirror technology, hybrid cloud database operations can be easily setup, implemented, and operated.

The following videos demonstrate SnapCenter in action:

- [Backup of an Oracle database across a Hybrid Cloud using SnapCenter](#)

- SnapCenter- Clone DEV/TEST to AWS Cloud for an Oracle database

Notably, although the illustrations throughout this document show CVO as a target storage instance in the public cloud, the solution is also fully validated for the new release of the FSx ONTAP storage engine for AWS.

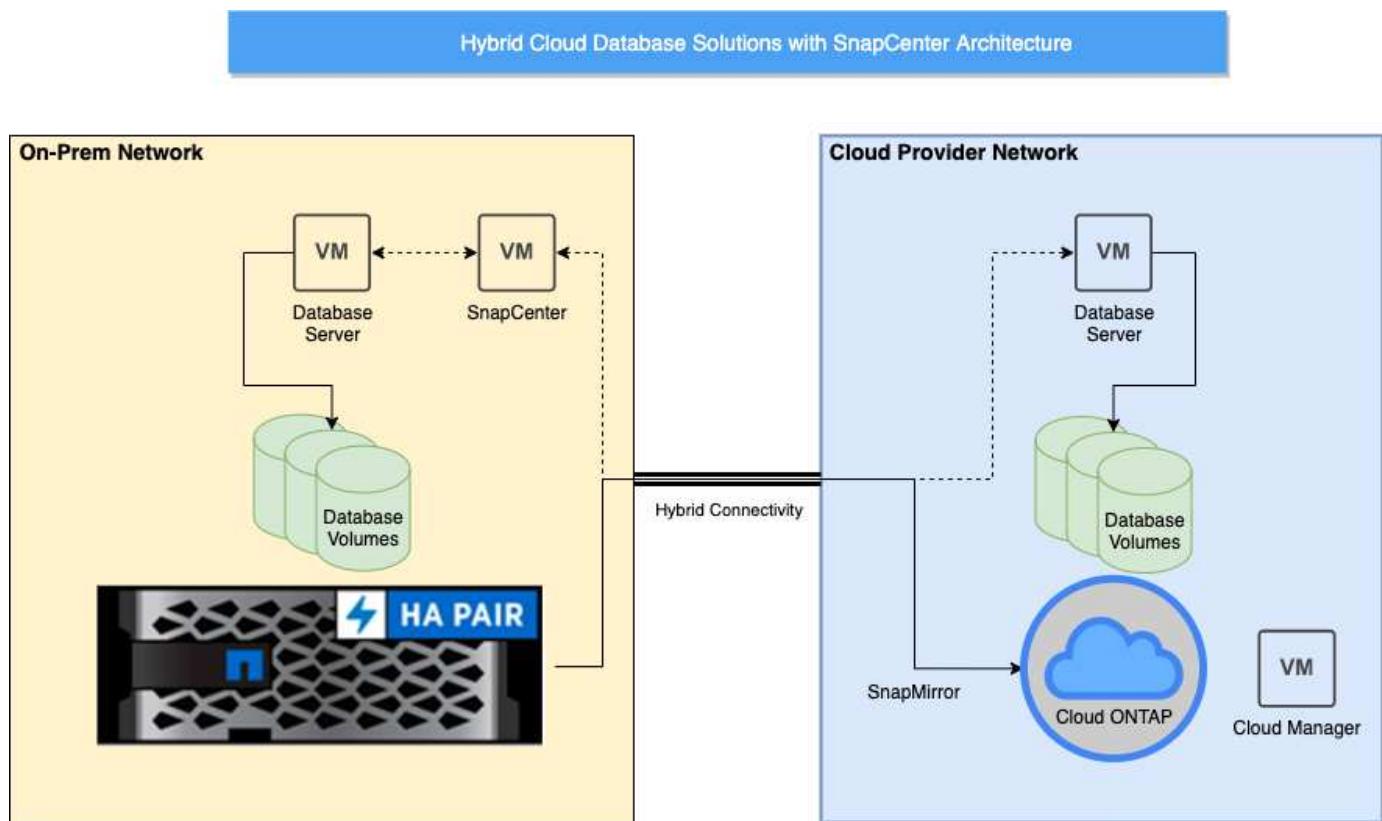
To test drive the solution and use cases for yourself, a NetApp Lab-on-Demand SL10680 can be requested at following xref:./databases/ [TL_AWS_004 HCoD: AWS - NW,SnapCenter\(OnPrem\)](#).

[Next: Solutions architecture.](#)

Solution Architecture

[Previous: Introduction.](#)

The following architecture diagram illustrates a typical implementation of enterprise database operation in a hybrid cloud for dev/test and disaster recovery operations.



In normal business operations, synchronized database volumes in the cloud can be cloned and mounted to dev/test database instances for applications development or testing. In the event of a failure, the synchronized database volumes in the cloud can then be activated for disaster recovery.

[Next: Solutions requirements.](#)

SnapCenter Requirements

[Previous: Solutions architecture.](#)

This solution is designed in a hybrid cloud setting to support on-premises production databases that can burst to all of the popular public clouds for dev/test and disaster

recovery operations.

This solution supports all databases that are currently supported by SnapCenter, although only Oracle and SQL Server databases are demonstrated here. This solution is validated with virtualized database workloads, although bare-metal workloads are also supported.

We assume that production database servers are hosted on-premises with DB volumes presented to DB hosts from a ONTAP storage cluster. SnapCenter software is installed on-premises for database backup and data replication to the cloud. An Ansible controller is recommended but not required for database deployment automation or OS kernel and DB configuration syncing with a standby DR instance or dev/test instances in the public cloud.

Requirements

Environment	Requirements
On-premises	<p>Any databases and versions supported by SnapCenter</p> <p>SnapCenter v4.4 or higher</p> <p>Ansible v2.09 or higher</p> <p>ONTAP cluster 9.x</p> <p>Intercluster LIFs configured</p> <p>Connectivity from on-premises to a cloud VPC (VPN, interconnect, and so on)</p> <p>Networking ports open</p> <ul style="list-style-type: none">- ssh 22- tcp 8145, 8146, 10000, 11104, 11105
Cloud - AWS	<p>Cloud Manager Connector</p> <p>Cloud Volumes ONTAP</p> <p>Matching DB OS EC2 instances to On-prem</p>
Cloud - Azure	<p>Cloud Manager Connector</p> <p>Cloud Volumes ONTAP</p> <p>Matching DB OS Azure Virtual Machines to On-prem</p>
Cloud - GCP	<p>Cloud Manager Connector</p> <p>Cloud Volumes ONTAP</p> <p>Matching DB OS Google Compute Engine instances to on-premises</p>

[Next: Prerequisites configuration.](#)

Prerequisites configuration

[Previous: Solutions requirements.](#)

Certain prerequisites must be configured both on-premises and in the cloud before the execution of hybrid cloud database workloads. The following section provides a high-level summary of this process, and the following links provide further information about necessary system configuration.

On premises

- SnapCenter installation and configuration
- On-premises database server storage configuration
- Licensing requirements
- Networking and security
- Automation

Public cloud

- A NetApp Cloud Central login
- Network access from a web browser to several endpoints
- A network location for a connector
- Cloud provider permissions
- Networking for individual services

Important considerations:

1. Where to deploy the Cloud Manager Connector?
2. Cloud Volume ONTAP sizing and architecture
3. Single node or high availability?

The following links provide further details:

[On Premises](#)

[Public Cloud](#)

[Next: Prerequisites on-premises.](#)

Prerequisites on-premises

[Previous: Prerequisites configuration.](#)

The following tasks must be completed on-premises to prepare the SnapCenter hybrid-cloud database workload environment.

SnapCenter installation and configuration

The NetApp SnapCenter tool is a Windows-based application that typically runs in a Windows domain environment, although workgroup deployment is also possible. It is based on a multilayered architecture that includes a centralized management server (the SnapCenter server) and a SnapCenter plug-in on the database server hosts for database workloads. Here are a few key considerations for hybrid-cloud deployment.

- **Single instance or HA deployment.** HA deployment provides redundancy in the case of a single SnapCenter instance server failure.
- **Name resolution.** DNS must be configured on the SnapCenter server to resolve all database hosts as well as on the storage SVM for forward and reverse lookup. DNS must also be configured on database servers to resolve the SnapCenter server and the storage SVM for both forward and reverse lookup.

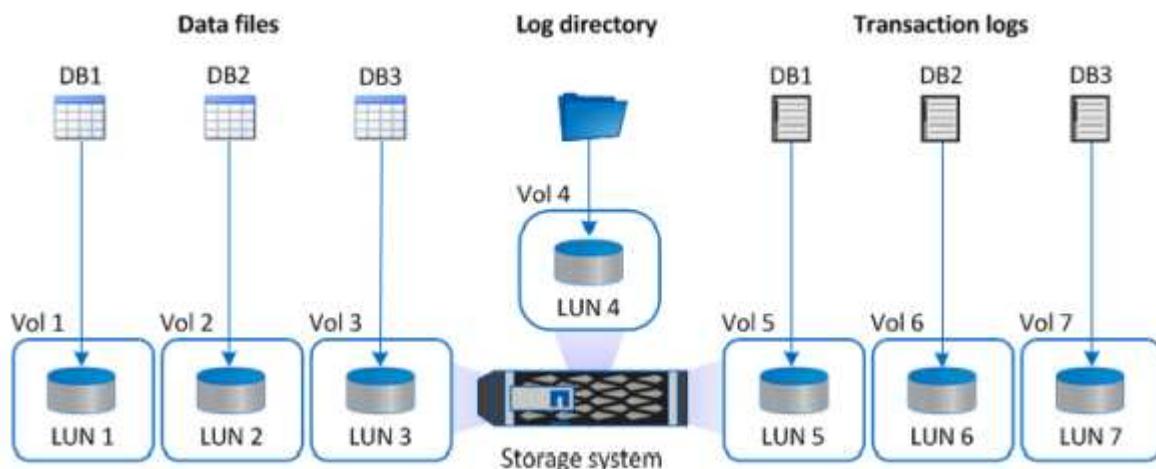
- **Role-based access control (RBAC) configuration.** For mixed database workloads, you might want to use RBAC to segregate management responsibility for different DB platform such as an admin for Oracle database or an admin for SQL Server. Necessary permissions must be granted for the DB admin user.
- **Enable policy-based backup strategy.** To enforce backup consistency and reliability.
- **Open necessary network ports on the firewall.** For the on-premises SnapCenter server to communicate with agents installed in the cloud DB host.
- **Ports must be open to allow SnapMirror traffic between on-prem and public cloud.** The SnapCenter server relies on ONTAP SnapMirror to replicate onsite Snapshot backups to cloud CVO storage SVMs.

After careful pre-installation planning and consideration, click this [SnapCenter installation workflow](#) for details of SnapCenter installation and configuration.

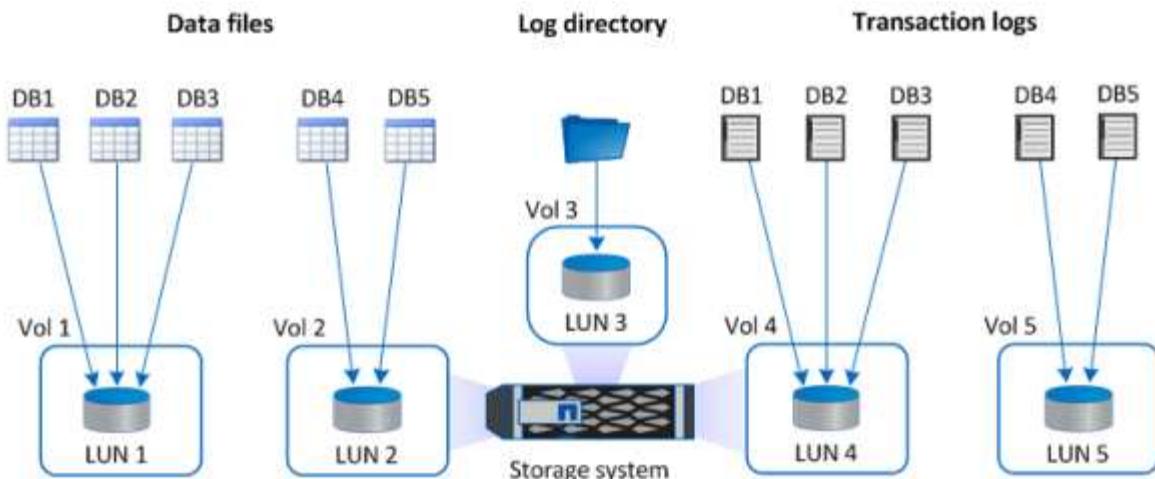
On-premises database server storage configuration

Storage performance plays an important role in the overall performance of databases and applications. A well-designed storage layout can not only improve DB performance but also make it easy to manage database backup and recovery. Several factors should be considered when defining your storage layout, including the size of the database, the rate of expected data change for the database, and the frequency with which you perform backups.

Directly attaching storage LUNs to the guest VM by either NFS or iSCSI for virtualized database workloads generally provides better performance than storage allocated via VMDK. NetApp recommends the storage layout for a large SQL Server database on LUNs depicted in the following figure.



The following figure shows the NetApp recommended storage layout for small or medium SQL Server database on LUNs.



The Log directory is dedicated to SnapCenter to perform transaction log rollup for database recovery. For an extra large database, multiple LUNs can be allocated to a volume for better performance.

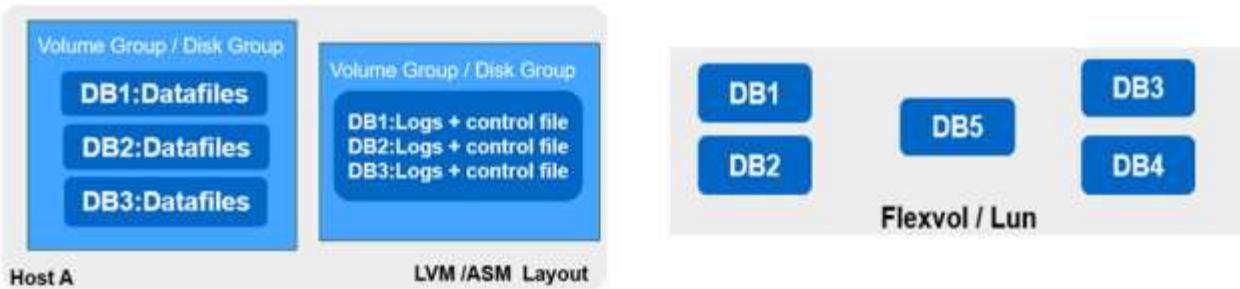
For Oracle database workloads, SnapCenter supports database environments backed by ONTAP storage that are mounted to the host as either physical or virtual devices. You can host the entire database on a single or multiple storage devices based on the criticality of the environment. Typically, customers isolate data files on dedicated storage from all other files such as control files, redo files, and archive log files. This helps administrators to quickly restore (ONTAP single-file SnapRestore) or clone a large critical database (petabyte scale) using Snapshot technology within few seconds to minutes.



For mission critical workloads that are sensitive to latency, a dedicated storage volume should be deployed to different types of Oracle files to achieve the best latency possible. For a large database, multiple LUNs (NetApp recommends up to eight) per volume should be allocated to data files.



For smaller Oracle databases, SnapCenter supports shared storage layouts in which you can host multiple databases or part of a database on the same storage volume or LUN. As an example of this layout, you can host data files for all the databases on a +DATA ASM disk group or a volume group. The remainder of the files (redo, archive log, and control files) can be hosted on another dedicated disk group or volume group (LVM). Such a deployment scenario is illustrated below.



To facilitate the relocation of Oracle databases, the Oracle binary should be installed on a separate LUN that is included in the regular backup policy. This ensures that in the case of database relocation to a new server host, the Oracle stack can be started for recovery without any potential issues due to an out-of-sync Oracle binary.

Licensing requirements

SnapCenter is licensed software from NetApp. It is generally included in an on-premises ONTAP license. However, for hybrid cloud deployment, a cloud license for SnapCenter is also required to add CVO to SnapCenter as a target data replication destination. Please review following links for SnapCenter standard capacity-based license for details:

[SnapCenter standard capacity-based licenses](#)

Networking and security

In a hybrid database operation that requires an on-premises production database that is burstable to cloud for dev/test and disaster recovery, networking and security is important factor to consider when setting up the environment and connecting to the public cloud from an on-premises data center.

Public clouds typically use a virtual private cloud (VPC) to isolate different users within a public-cloud platform. Within an individual VPC, security is controlled using measures such as security groups that are configurable based on user needs for the lockdown of a VPC.

The connectivity from the on-premises data center to the VPC can be secured through a VPN tunnel. On the VPN gateway, security can be hardened using NAT and firewall rules that block attempts to establish network connections from hosts on the internet to hosts inside the corporate data center.

For networking and security considerations, review the relevant inbound and outbound CVO rules for your public cloud of choice:

- [Security group rules for CVO - AWS](#)
- [Security group rules for CVO - Azure](#)
- [Firewall rules for CVO - GCP](#)

Using Ansible automation to sync DB instances between on-premises and the cloud - optional

To simplify management of a hybrid-cloud database environment, NetApp highly recommends but does not require that you deploy an Ansible controller to automate some management tasks, such as keeping compute instances on-premises and in the cloud in sync. This is particular important because an out-of-sync compute instance in the cloud might render the recovered database in the cloud error prone because of missing kernel packages and other issues.

The automation capability of an Ansible controller can also be used to augment SnapCenter for certain tasks, such as breaking up the SnapMirror instance to activate the DR data copy for production.

Follow these instruction to set up your Ansible control node for RedHat or CentOS machines: [RedHat/CentOS Ansible Controller Setup](#).

Follow these instruction to set up your Ansible control node for Ubuntu or Debian machines: [Ubuntu/Debian Ansible Controller Setup](#).

Next: Public cloud.

Prerequisites for the public cloud

Previous: [Prerequisites on-premises](#).

Before we install the Cloud Manager connector and Cloud Volumes ONTAP and configure SnapMirror, we must perform some preparation for our cloud environment. This page describes the work that needs to be done as well as the considerations when deploying Cloud Volumes ONTAP.

Cloud Manager and Cloud Volumes ONTAP deployment prerequisites checklist

- A NetApp Cloud Central login
- Network access from a web browser to several endpoints
- A network location for a Connector
- Cloud provider permissions
- Networking for individual services

For more information about what you need to get started, visit our [cloud documentation](#).

Considerations

1. What is a Cloud Manager connector?

In most cases, a Cloud Central account admin must deploy a connector in your cloud or on-premises network. The connector enables Cloud Manager to manage resources and processes within your public cloud environment.

For more information about Connectors, visit our [cloud documentation](#).

2. Cloud Volumes ONTAP sizing and architecture

When deploying Cloud Volumes ONTAP, you are given the choice of either a predefined package or the creation of your own configuration. Although many of these values can be changed later on nondisruptively, there are some key decisions that need to be made before deployment based on the workloads to be deployed in the cloud.

Each cloud provider has different options for deployment and almost every workload has its own unique properties. NetApp has a [CVO sizing tool](#) that can help size deployments correctly based on capacity and performance, but it has been built around some basic concepts which are worth considering:

- Capacity required
- Network capability of the cloud virtual machine
- Performance characteristics of cloud storage

The key is to plan for a configuration that not only satisfies the current capacity and performance requirements, but also looks at future growth. This is generally known as capacity headroom and performance headroom.

If you would like further information, read the documentation about planning correctly for [AWS](#), [Azure](#), and [GCP](#).

3. Single node or high availability?

In all clouds, there is the option to deploy CVO in either a single node or in a clustered high availability pair with two nodes. Depending on the use case, you might wish to deploy a single node to save costs or an HA pair to provide further availability and redundancy.

For a DR use case or spinning up temporary storage for development and testing, single nodes are common since the impact of a sudden zonal or infrastructure outage is lower. However, for any production use case, when the data is in only a single location, or when the dataset must have more redundancy and availability, high availability is recommended.

For further information about the architecture of each cloud's version of high availability, visit the documentation for [AWS](#), [Azure](#) and [GCP](#).

[Next: Getting started overview.](#)

Getting started overview

[Previous: Prerequisites for the public cloud.](#)

This section provides a summary of the tasks that must be completed to meet the prerequisite requirements as outlined in previous section. The following section provide a high level tasks list for both on-premises and public cloud operations. The detailed processes and procedures can be accessed by clicking on the relevant links.

On-premises

- Setup database admin user in SnapCenter
- SnapCenter plugin installation prerequisites
- SnapCenter host plugin installation
- DB resource discovery
- Setup storage cluster peering and DB volume replication
- Add CVO database storage SVM to SnapCenter
- Setup database backup policy in SnapCenter
- Implement backup policy to protect database
- Validate backup

AWS public cloud

- Pre-flight check
- Steps to deploy Cloud Manager and Cloud Volumes ONTAP in AWS
- Deploy EC2 compute instance for database workload

Click the following links for details:

Getting started on premises

Previous: Getting started overview.

On Premises

1. Setup database admin user in SnapCenter

The NetApp SnapCenter tool uses role-based access control (RBAC) to manage user resources access and permission grants, and SnapCenter installation creates prepopulated roles. You can also create custom roles based on your needs or applications. It makes sense to have a dedicated admin user ID for each database platform supported by SnapCenter for database backup, restoration, and/or disaster recovery. You can also use a single ID to manage all databases. In our test cases and demonstration, we created a dedicated admin user for both Oracle and SQL Server, respectively.

Certain SnapCenter resources can only be provisioned with the SnapCenterAdmin role. Resources can then be assigned to other user IDs for access.

In a pre-installed and configured on-premises SnapCenter environment, the following tasks might have already have been completed. If not, the following steps create a database admin user:

1. Add the admin user to Windows Active Directory.
2. Log into SnapCenter using an ID granted with the SnapCenterAdmin role.
3. Navigate to the Access tab under Settings and Users, and click Add to add a new user. The new user ID is linked to the admin user created in Windows Active Directory in step 1. . Assign the proper role to the user as needed. Assign resources to the admin user as applicable.

	Name	Type	Roles	Domain
<input type="checkbox"/>	administrator	User	SnapCenterAdmin	demo
<input type="checkbox"/>	oradba	User	App Backup and Clone Admin	demo
<input type="checkbox"/>	soldba	User	App Backup and Clone Admin	demo

2. SnapCenter plugin installation prerequisites

SnapCenter performs backup, restore, clone, and other functions by using a plugin agent running on the DB hosts. It connects to the database host and database via credentials configured under the Setting and Credentials tab for plugin installation and other management functions. There are specific privilege requirements based on the target host type, such as Linux or Windows, as well as the type of database.

DB hosts credentials must be configured before SnapCenter plugin installation. Generally, you want to use an administrator user accounts on the DB host as your host connection credentials for plugin installation. You can also grant the same user ID for database access using OS-based authentication. On the other hand, you can also employ database authentication with different database user IDs for DB management access. If you decide to use OS-based authentication, the OS admin user ID must be granted DB access. For Windows domain-based SQL Server installation, a domain admin account can be used to manage all SQL Servers

within the domain.

Windows host for SQL server:

1. If you are using Windows credentials for authentication, you must set up your credential before installing plugins.
2. If you are using a SQL Server instance for authentication, you must add the credentials after installing plugins.
3. If you have enabled SQL authentication while setting up the credentials, the discovered instance or database is shown with a red lock icon. If the lock icon appears, you must specify the instance or database credentials to successfully add the instance or database to a resource group.
4. You must assign the credential to a RBAC user without sysadmin access when the following conditions are met:
 - The credential is assigned to a SQL instance.
 - The SQL instance or host is assigned to an RBAC user.
 - The RBAC DB admin user must have both the resource group and backup privileges.

Unix host for Oracle:

1. You must have enabled the password-based SSH connection for the root or non-root user by editing sshd.conf and restarting the sshd service. Password-based SSH authentication on AWS instance is turned off by default.
2. Configure the sudo privileges for the non-root user to install and start the plugin process. After installing the plugin, the processes run as an effective root user.
3. Create credentials with the Linux authentication mode for the install user.
4. You must install Java 1.8.x (64-bit) on your Linux host.
5. Installation of the Oracle database plugin also installs the SnapCenter plugin for Unix.

3. SnapCenter host plugin installation



Before attempting to install SnapCenter plugins on cloud DB server instances, make sure that all configuration steps have been completed as listed in the relevant cloud section for compute instance deployment.

The following steps illustrate how a database host is added to SnapCenter while a SnapCenter plugin is installed on the host. The procedure applies to adding both on-premises hosts and cloud hosts. The following demonstration adds a Windows or a Linux host residing in AWS.

Configure SnapCenter VMware global settings

Navigate to Settings > Global Settings. Select "VMs have iSCSI direct attached disks or NFS for all the hosts" under Hypervisor Settings and click Update.

Add Windows host and installation of plugin on the host

1. Log into SnapCenter with a user ID with SnapCenterAdmin privileges.
2. Click the Hosts tab from the left-hand menu, and then click Add to open the Add Host workflow.
3. Choose Windows for Host Type; the Host Name can be either a host name or an IP address. The host name must be resolved to the correct host IP address from the SnapCenter host. Choose the host credentials created in step 2. Choose Microsoft Windows and Microsoft SQL Server as the plugin packages to be installed.

4. After the plugin is installed on a Windows host, its Overall Status is shown as "Configure log directory."

Name	Type	System	Plug-in	Version	Overall Status
rhel2.demo.netapp.com	Linux	Stand-alone	UNIX, Oracle Database	4.5	Running
sql1.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Running
sql1-standby.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Configure log directory

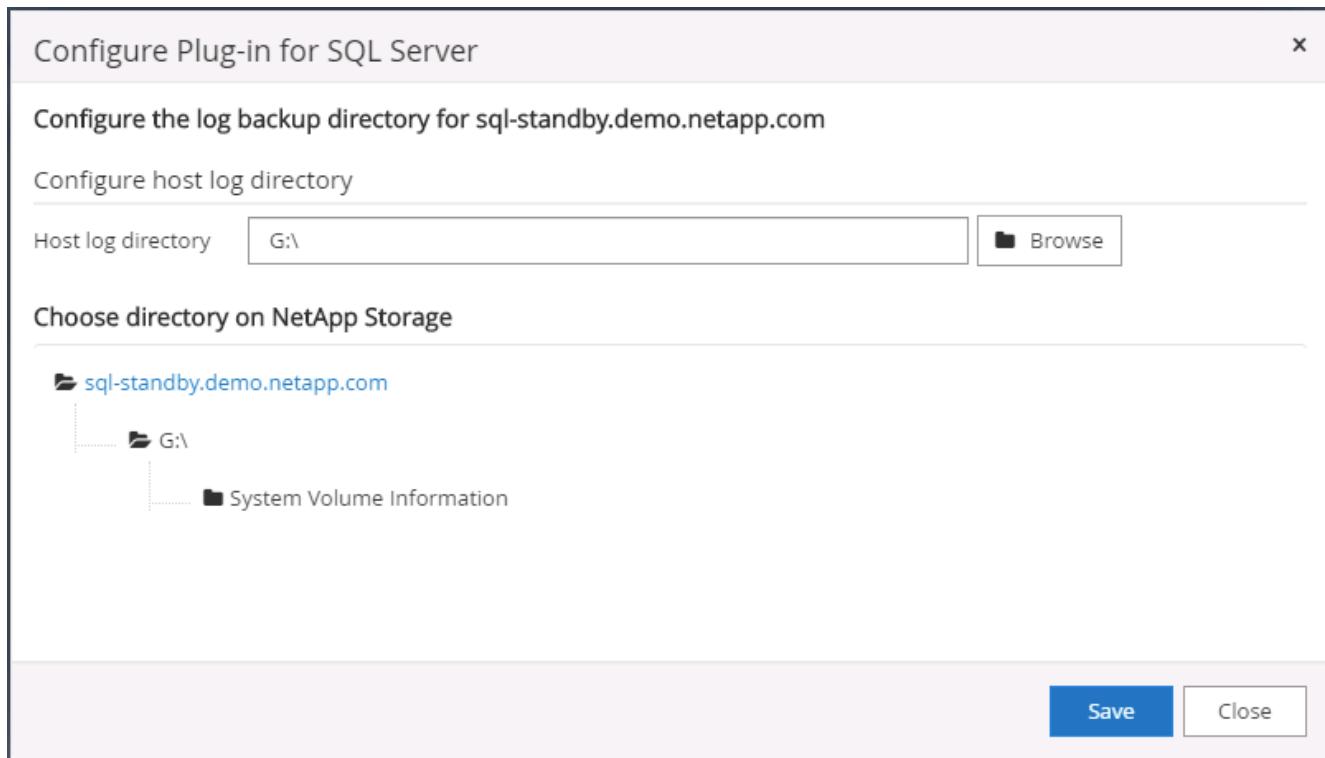
5. Click the Host Name to open the SQL Server log directory configuration.

The screenshot shows the NetApp SnapCenter interface. On the left, there's a sidebar with icons for hosts, storage, and logs. The main area has a title bar "NetApp SnapCenter®" and tabs for "Managed Hosts" and "Storage". Under "Managed Hosts", there's a search bar "Search by Name" and a list of hosts: "Name" (checkbox), "rhel2.demo.netapp.com" (checkbox), "sql1.demo.netapp.com" (checkbox), and "sql-standby.demo.netapp.com" (checkbox, selected). To the right, the "Host Details" panel shows: Host Name: sql-standby.demo.netapp.com, Host IP: 10.221.2.56, Overall Status: "Configure log directory" (orange), Host Type: Windows, System: Stand-alone, Credentials: Domain Admin (checkbox), and Plug-ins: "SnapCenter Plug-ins package 4.5.0.6123 for Windows" (checkboxes for Microsoft Windows and Microsoft SQL Server, with "Remove" and "Configure log directory" options). At the bottom are "Submit", "Cancel", and "Reset" buttons.

6. Click "Configure log directory" to open "Configure Plug-in for SQL Server."

The screenshot shows the "Configure Plug-in for SQL Server" dialog box. The title is "Configure Plug-in for SQL Server" with a close button. The main heading is "Configure the log backup directory for sql-standby.demo.netapp.com". Below it, a section titled "Configure host log directory" has a "Host log directory" label and a "dedicated disk directory path" input field with a "Browse" button. At the bottom right are "Save" and "Close" buttons.

7. Click Browse to discover NetApp storage so that a log directory can be set; SnapCenter uses this log directory to roll up the SQL server transaction log files. Then click Save.



For NetApp storage provisioned to a DB host to be discovered, the storage (on-prem or CVO) must be added to SnapCenter, as illustrated in step 6 for CVO as an example.

- After the log directory is configured, the Windows host plugin Overall Status is changed to Running.

Name	Type	System	Plug-in	Version	Overall Status
rhel2.demo.netapp.com	Linux	Stand-alone	UNIX, Oracle Database	4.5	Running
sql1.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Running
sql-standby.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Running

- To assign the host to the database management user ID, navigate to the Access tab under Settings and Users, click the database management user ID (in our case the sqldba that the host needs to be assigned to), and click Save to complete host resource assignment.

Name	Type	Roles	Domain
administrator	User	SnapCenterAdmin	demo
oradba	User	App Backup and Clone Admin	demo
sqldba	User	App Backup and Clone Admin	demo

Assign Assets

Asset Type: Host

search

<input type="checkbox"/>	Asset Name	
<input type="checkbox"/>	rhel2.demo.netapp.com	
<input type="checkbox"/>	sql1.demo.netapp.com	
<input checked="" type="checkbox"/>	sql-standby.demo.netapp.com	

Save **Close**

Add Unix host and installation of plugin on the host

1. Log into SnapCenter with a user ID with SnapCenterAdmin privileges.
2. Click the Hosts tab from left-hand menu, and click Add to open the Add Host workflow.
3. Choose Linux as the Host Type. The Host Name can be either the host name or an IP address. However, the host name must be resolved to correct host IP address from SnapCenter host. Choose host credentials created in step 2. The host credentials require sudo privileges. Check Oracle Database as the plug-in to be installed, which installs both Oracle and Linux host plugins.

Add Host

Host Type: Linux

Host Name: ora-standby

Credentials: admin

Select Plug-ins to Install SnapCenter Plug-ins Package 4.5 for Linux

Oracle Database
 SAP HANA

[More Options](#) : Port, Install Path, Custom Plug-ins...

Submit **Cancel**

4. Click More Options and select "Skip preinstall checks." You are prompted to confirm the skipping of the preinstall check. Click Yes and then Save.

More Options

Port	8145	<i></i>
Installation Path	/opt/NetApp/snapcenter	<i></i>
<input checked="" type="checkbox"/> Skip preinstall checks <input checked="" type="checkbox"/> Add all hosts in the oracle RAC		
Custom Plug-ins		
Choose a File <input type="button" value="Browse"/> <input type="button" value="Upload"/> <div style="border: 1px solid #ccc; padding: 5px; height: 40px; margin-top: 10px;">No plug-ins found.</div>		
<input type="button" value="Save"/>		<input type="button" value="Cancel"/>

5. Click Submit to start the plugin installation. You are prompted to Confirm Fingerprint as shown below.

Confirm Fingerprint

Authenticity of the host cannot be determined

Host name	<i></i>	Fingerprint	Valid
ora-standby.demo.netapp.com	<i></i>	ssh-rsa 3072 5C:02:EF:6B:63:54:59:10:84:DF:4D:6B:AB:FB:61:67	

6. SnapCenter performs host validation and registration, and then the plugin is installed on the Linux host. The status is changed from Installing Plugin to Running.

Name	Type	System	Plug-in	Version	Overall Status
ora-standby.demo.netapp.com	Linux	Stand-alone	UNIX, Oracle Database	4.5	Running
rhel2.demo.netapp.com	Linux	Stand-alone	UNIX, Oracle Database	4.5	Running
sql1.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Running
sql-standby.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	Running

7. Assign the newly added host to the proper database management user ID (in our case, oradba).

User Name: oradba
Domain: demo
Roles: App Backup and Clone Admin

Asset Name	Type	Asset Type
10.0.0.1	DataOntapCluster	Storage Connection
192.168.0.101	DataOntapCluster	Storage Connection
admin		Credentials
Linux Admin		Credentials
Oracle Archive Log Backup		Policy
Oracle Full Online Backup		Policy
rhel2.demo.netapp.com		host

Asset Type: Host

Asset Name
<input checked="" type="checkbox"/> ora-standby.demo.netapp.com
<input type="checkbox"/> rhel2.demo.netapp.com
<input type="checkbox"/> sql1.demo.netapp.com
<input type="checkbox"/> sql-standby.demo.netapp.com

Save Close

4. Database resource discovery

With successful plugin installation, the database resources on the host can be immediately discovered. Click the Resources tab in the left-hand menu. Depending on the type of database platform, a number of views are available, such as the database, resources group, and so on. You might need to click the Refresh Resources tab if the resources on the host are not discovered and displayed.

Oracle Database

Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com				Not protected

When the database is initially discovered, the Overall Status is shown as "Not protected." The previous screenshot shows an Oracle database not protected yet by a backup policy.

When a backup configuration or policy is set up and a backup has been executed, the Overall Status for the database shows the backup status as "Backup succeeded" and the timestamp of the last backup. The following screenshot shows the backup status of a SQL Server user database.

Name	Instance	Host	Last Backup	Overall Status	Type
master	sql1	sql1.demo.netapp.com		Not available for backup	System database
model	sql1	sql1.demo.netapp.com		Not available for backup	System database
msdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tempdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tpcc	sql1	sql1.demo.netapp.com	09/14/2021 2:35:07 PM	Backup succeeded	User database

If database access credentials are not properly set up, a red lock button indicates that the database is not accessible. For example, if Windows credentials do not have sysadmin access to a database instance, then database credentials must be reconfigured to unlock the red lock.

Name	Host	Resource Groups	Policies	State	Type
sql-standby	sql-standby.demo.netapp.com			Running	Standalone ()
sql1	sql1.demo.netapp.com			Running	Standalone (15.0.2000)

The Microsoft SQL Server or Windows credentials are necessary to unlock the selected instance. Click Refresh Resources to run a discovery with the associated Auth.

Name	Host	Resource Groups	Policies	State	Type
sql-standby	sql-standby.demo.netapp.com	None	None	Not available for backup. DB is not on NetApp storage, auto-close is enabled or in recovery mode.	Standalone ()
sql1	sql1.demo.netapp.com				Standalone (15.0.2000)

After the appropriate credentials are configured either at the Windows level or the database level, the red lock disappears and SQL Server Type information is gathered and reviewed.

Name	Host	Resource Groups	Policies	State	Type
sql1	sql1.demo.netapp.com			Running	Standalone (15.0.2000)
sql-standby	sql-standby.demo.netapp.com			Running	Standalone (15.0.2000)

5. Setup storage cluster peering and DB volumes replication

To protect your on-premises database data using a public cloud as the target destination, on-premises ONTAP cluster database volumes are replicated to the cloud CVO using NetApp SnapMirror technology. The replicated target volumes can then be cloned for DEV/OPS or disaster recovery. The following high-level steps enable you to set up cluster peering and DB volumes replication.

1. Configure intercluster LIFs for cluster peering on both the on-premises cluster and the CVO cluster instance. This step can be performed with ONTAP System Manager. A default CVO deployment has inter-cluster LIFs configured automatically.

On-premises cluster:

The screenshot shows the ONTAP System Manager interface with the 'NETWORK' tab selected. In the 'IPspaces' section, there are two entries: 'Cluster' (Broadcast Domains Cluster) and 'Default' (Storage VMs, svm_onPrem, Broadcast Domains Default). In the 'Broadcast Domains' section, there are two entries: 'Cluster' (9000 MTU, IPspace: Cluster) and 'Default' (1500 MTU, IPspace: Default, onPrem-01 e0a e0b e0c e0d e0e e0f e0g e0h e0g-100 e0e-200 e0f-201). The 'Network Interfaces' section lists three interfaces: 'onPrem-01_IC' (Status: green, Storage VM: Default, Address: 192.168.0.113, Current Node: onPrem-01, Current Port: e0b, Type: Intercluster), 'onPrem-01_mgmt1' (Status: green, Storage VM: Default, Address: 192.168.0.111, Current Node: onPrem-01, Current Port: e0c, Type: Cluster/Node Mgmt), and 'cluster_mgmt' (Status: green, Storage VM: Default, Address: 192.168.0.101, Current Node: onPrem-01, Current Port: e0a, Type: Cluster/Node Mgmt).

Target CVO cluster:

The screenshot shows the ONTAP System Manager interface with the 'NETWORK' tab selected. In the 'IPspaces' section, there are two entries: 'Cluster' (Broadcast Domains Cluster) and 'Default' (Storage VMs, svm_hybridcvo, Broadcast Domains Default). In the 'Broadcast Domains' section, there are two entries: 'Cluster' (9000 MTU, IPspace: Cluster, hybridcvo-01 e0b, hybridcvo-02 e0b) and 'Default' (9001 MTU, IPspace: Default, hybridcvo-01 e0a, hybridcvo-02 e0a). The 'Network Interfaces' section lists five interfaces: 'hybridcvo-02_mgmt1' (Status: green, Storage VM: Default, Address: 10.221.2.104, Current Node: hybridcvo-02, Current Port: e0a, Type: Cluster/Node Mgmt), 'inter_1' (Status: green, Storage VM: Default, Address: 10.221.1.180, Current Node: hybridcvo-01, Current Port: e0a, Type: Intercluster, Cluster/Node Mgmt), 'inter_2' (Status: green, Storage VM: Default, Address: 10.221.2.250, Current Node: hybridcvo-02, Current Port: e0a, Type: Intercluster, Cluster/Node Mgmt), 'iscsi_1' (Status: green, Storage VM: svm_hybridcvo, Address: 10.221.1.5, Current Node: hybridcvo-01, Current Port: e0a, Protocols: iSCSI, Type: Data), and 'iscsi_2' (Status: green, Storage VM: svm_hybridcvo, Address: 10.221.2.168, Current Node: hybridcvo-02, Current Port: e0a, Protocols: iSCSI, Type: Data). The 'inter_1' and 'inter_2' interfaces are highlighted with a red oval.

2. With the intercluster LIFs configured, cluster peering and volume replication can be set up by using drag-and-drop in NetApp Cloud Manager. See "[Getting Started - AWS Public Cloud](#)" for details.

Alternatively, cluster peering and DB volume replication can be performed by using ONTAP System Manager as follows:

3. Log into ONTAP System Manager. Navigate to Cluster > Settings and click Peer Cluster to set up cluster peering with the CVO instance in the cloud.

The screenshot shows the ONTAP System Manager interface. The left sidebar is collapsed. The main area displays the 'Intercluster Settings' section. Under 'Cluster Peers', there is a 'Peer Cluster' entry with a red box around it, and options to 'Generate Passphrase' and 'Manage Cluster Peers'. Below this is the 'UI Settings' section, which includes 'LOG LEVEL' set to 'DEBUG' and 'INACTIVITY TIMEOUT' set to '30 minutes'. The 'Cluster' tab in the sidebar is selected.

4. Go to the Volumes tab. Select the database volume to be replicated and click Protect.

The screenshot shows the ONTAP System Manager interface with the 'Volumes' tab selected in the sidebar. A volume named 'rhel2_u03' is selected, indicated by a checked checkbox. The 'Protect' button, located at the top of the volume list, is highlighted with a red box. To the right of the volume list, detailed information about 'rhel2_u03' is displayed, including its status as 'Online', type as 'FlexVol', and various performance metrics like capacity and latency.

5. Set the protection policy to Asynchronous. Select the destination cluster and storage SVM.

The screenshot shows the 'Protect Volumes' dialog in the ONTAP System Manager. The 'PROTECTION POLICY' dropdown is set to 'Asynchronous'. Under 'Source', 'CLUSTER' is 'onPrem' and 'SELECTED VOLUMES' is 'rhel2_u03'. Under 'Destination', 'CLUSTER' is 'hybridcvo' and 'STORAGE VM' is 'svm_hybridcvo'. The 'Destination Settings' section shows a 'VOLUME NAME' field with a prefix 'vol_' and a suffix '_dest'. In the 'Configuration Details' section, the 'Initialize relationship' checkbox is checked.

- Validate that the volume is synced between the source and target and that the replication relationship is healthy.

Source	Destination	Protection Policy	Relationship Health	Relationship Status	Lag
svm_onPrem:rhel2_u03	svm_hybridcvo:rhel2_u03_dr	MirrorAllSnapshots	Healthy	Mirrored	12 seconds

6. Add CVO database storage SVM to SnapCenter

- Log into SnapCenter with a user ID with SnapCenterAdmin privileges.
- Click the Storage System tab from the menu, and then click New to add a CVO storage SVM that hosts replicated target database volumes to SnapCenter. Enter the cluster management IP in the Storage System field, and enter the appropriate username and password.

- Click More Options to open additional storage configuration options. In the Platform field, select Cloud Volumes ONTAP, check Secondary, and then click Save.

Platform	Cloud Volumes ON TM	<input checked="" type="checkbox"/> Secondary
Protocol	HTTPS	
Port	443	
Timeout	60	seconds
<input type="checkbox"/> Preferred IP		
<input type="button" value="Save"/> <input type="button" value="Cancel"/>		

- Assign the storage systems to SnapCenter database management user IDs as shown in [3. SnapCenter host plugin installation](#).

Name	IP	Cluster Name	User Name	Platform	Controller License
svm_hybridcvo	10.0.0.1			CVO	X
svm_onPrem	192.168.0.101			CVO	✓

7. Setup database backup policy in SnapCenter

The following procedures demonstrates how to create a full database or log file backup policy. The policy can then be implemented to protect databases resources. The recovery point objective (RPO) or recovery time objective (RTO) dictates the frequency of database and/or log backups.

Create a full database backup policy for Oracle

1. Log into SnapCenter as a database management user ID, click Settings, and then click Policies.

The screenshot shows the NetApp SnapCenter interface. The left sidebar has links for Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings (which is selected), and Alerts. The main area is titled 'Policies' and shows 'Oracle Database'. A search bar says 'Search by Name'. Below is a table with columns: Name, Backup Type, Schedule Type, Replication, and Verification. Two policies are listed:

Name	Backup Type	Schedule Type	Replication	Verification
Oracle Archive Log Backup	LOG, ONLINE	Hourly	SnapMirror	
Oracle Full Online Backup	FULL, ONLINE	Daily	SnapMirror	

Action buttons at the top right include New, Modify, Copy, Details, and Delete.

2. Click New to launch a new backup policy creation workflow or choose an existing policy for modification.

The dialog box is titled 'Modify Oracle Database Backup Policy' with a close button 'x' in the top right. On the left is a vertical navigation bar with steps 1 through 7: 1. Name, 2. Backup Type, 3. Retention, 4. Replication, 5. Script, 6. Verification, 7. Summary. Step 1 is highlighted in blue. The main area is titled 'Provide a policy name' and contains two fields: 'Policy name' with the value 'Oracle Full Online Backup' and 'Details' with the value 'Backup all data and log files'. There is an information icon 'i' next to the details field. At the bottom right are 'Previous' and 'Next' buttons.

3. Select the backup type and schedule frequency.

Modify Oracle Database Backup Policy

1 Name

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Select Oracle database backup options

Choose backup type

Online backup

Datafiles, control files, and archive logs

Datafiles and control files

Archive logs

Offline backup i

Mount

Shutdown

Save state of PDBs i

Choose schedule frequency

Select how often you want the schedules to occur in the policy. The specific times are set at backup job creation enabling you to stagger your start times.

On demand

Hourly

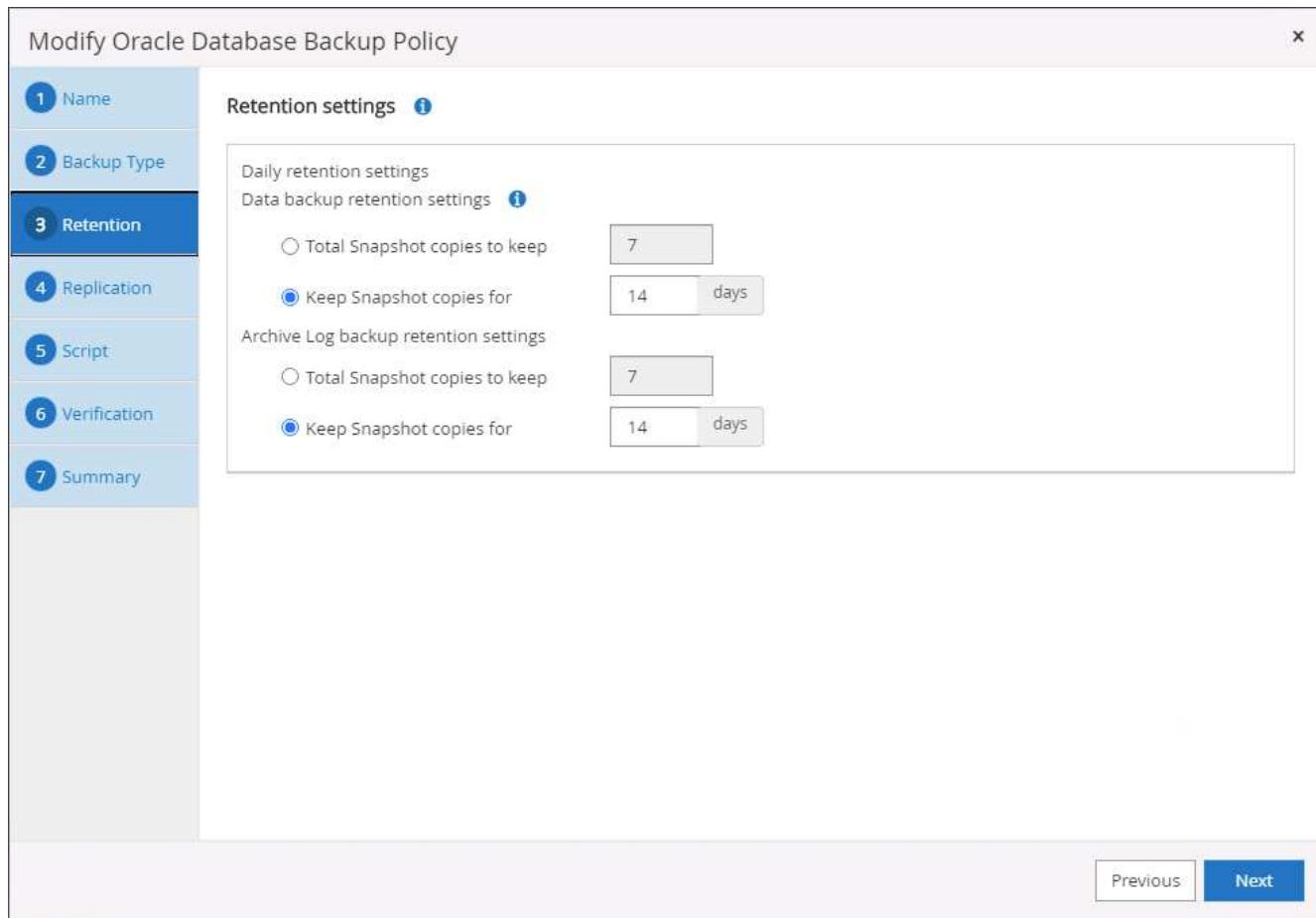
Daily

Previous

Next

This screenshot shows the 'Modify Oracle Database Backup Policy' wizard, specifically Step 2: Backup Type. The left sidebar lists steps 1 through 7. The main area is titled 'Select Oracle database backup options'. Under 'Choose backup type', 'Online backup' and 'Datafiles, control files, and archive logs' are selected. Under 'Choose schedule frequency', 'Daily' is selected. At the bottom right are 'Previous' and 'Next' buttons.

4. Set the backup retention setting. This defines how many full database backup copies to keep.



5. Select the secondary replication options to push local primary snapshots backups to be replicated to a secondary location in cloud.

Modify Oracle Database Backup Policy x

1 Name

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Select secondary replication options i

Update SnapMirror after creating a local Snapshot copy.

Update SnapVault after creating a local Snapshot copy.

Secondary policy label Daily i

Error retry count 3 i

Previous Next

6. Specify any optional script to run before and after a backup run.

Modify Oracle Database Backup Policy X

Specify optional scripts to run before and after performing a backup job

1 Name	Prescript full path <input type="text" value="/var/opt/snapcenter/spl/scripts/"/> Enter Prescript path	
2 Backup Type	Prescript arguments <input type="text"/>	
3 Retention	Postscript full path <input type="text" value="/var/opt/snapcenter/spl/scripts/"/> Enter Postscript path	
4 Replication	Postscript arguments <input type="text"/>	
5 Script	Script timeout 60	secs
6 Verification		
7 Summary		

Previous **Next**

7. Run backup verification if desired.

Modify Oracle Database Backup Policy X

1 Name Select the options to run backup verification

2 Backup Type Run Verifications for following backup schedules

Select how often you want the schedules to occur in the policy. The specific verification times are set at backup job creation enabling you to stagger your verification start times.

Daily

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Verification script commands

Script timeout	60	secs
Prescript full path	/var/opt/snapcenter/spl/scripts/	Enter Prescript path
Prescript arguments	Choose optional arguments...	
Postscript full path	/var/opt/snapcenter/spl/scripts/	Enter Postscript path
Postscript arguments	Choose optional arguments...	

[Previous](#) [Next](#)

8. Summary.

Modify Oracle Database Backup Policy

1 Name	Summary
2 Backup Type	Policy name: Oracle Full Online Backup Details: Backup all data and log files
3 Retention	Backup type: Online backup
4 Replication	Schedule type: Daily RMAN catalog backup: Disabled
5 Script	Archive log pruning: None On demand data backup retention: None
6 Verification	On demand archive log backup retention: None Hourly data backup retention: None Hourly archive log backup retention: None
7 Summary	Daily data backup retention: Delete Snapshot copies older than : 14 days Daily archive log backup retention: Delete Snapshot copies older than : 14 days Weekly data backup retention: None Weekly archive log backup retention: None Monthly data backup retention: None Monthly archive log backup retention: None Replication: SnapMirror enabled , Secondary policy label: Daily , Error retry count: 3

[Previous](#) [Finish](#)

Create a database log backup policy for Oracle

1. Log into SnapCenter with a database management user ID, click Settings, and then click Policies.
2. Click New to launch a new backup policy creation workflow, or choose an existing policy for modification.

New Oracle Database Backup Policy X

1 Name

Provide a policy name

Policy name i

Details

2 Backup Type

3 Retention

4 Replication

5 Script

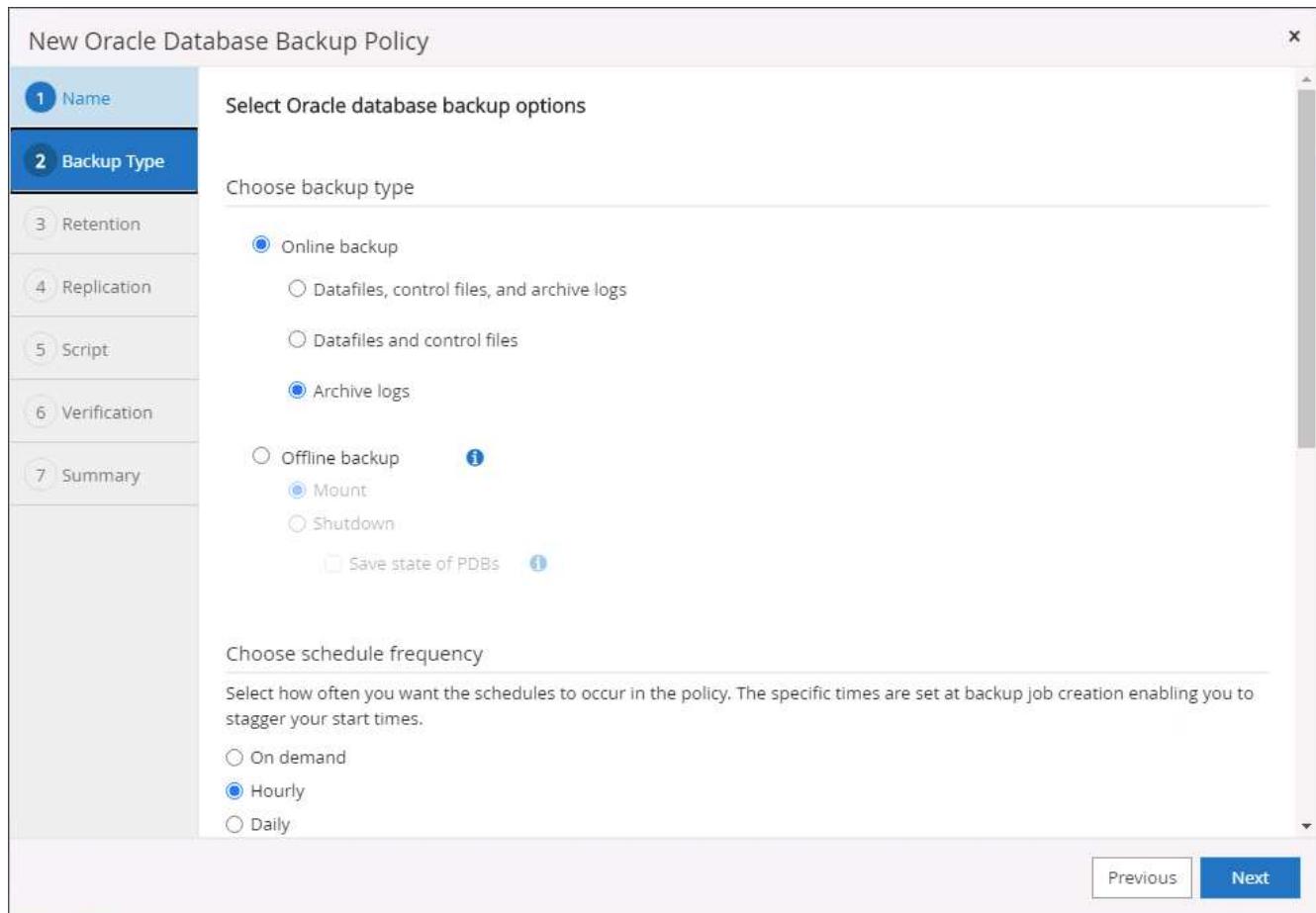
6 Verification

7 Summary

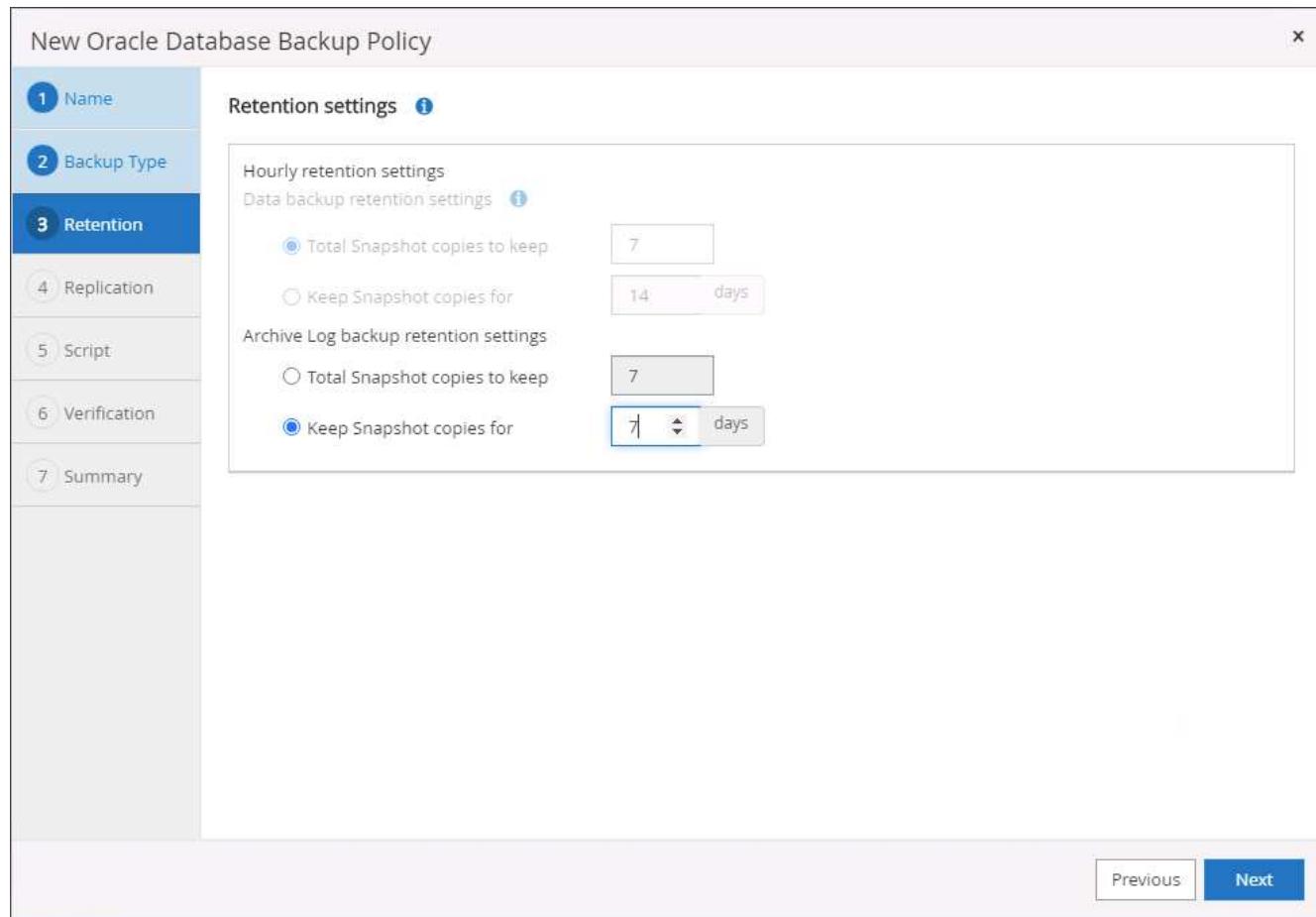
Previous Next

The screenshot shows the 'New Oracle Database Backup Policy' wizard. The 'Name' step is active, with the policy name set to 'Oracle Archive Log Backup' and details indicating it's for 'Backup Oracle archive logs'. The sidebar lists steps 2 through 7: Backup Type, Retention, Replication, Script, Verification, and Summary. The bottom right has 'Previous' and 'Next' buttons.

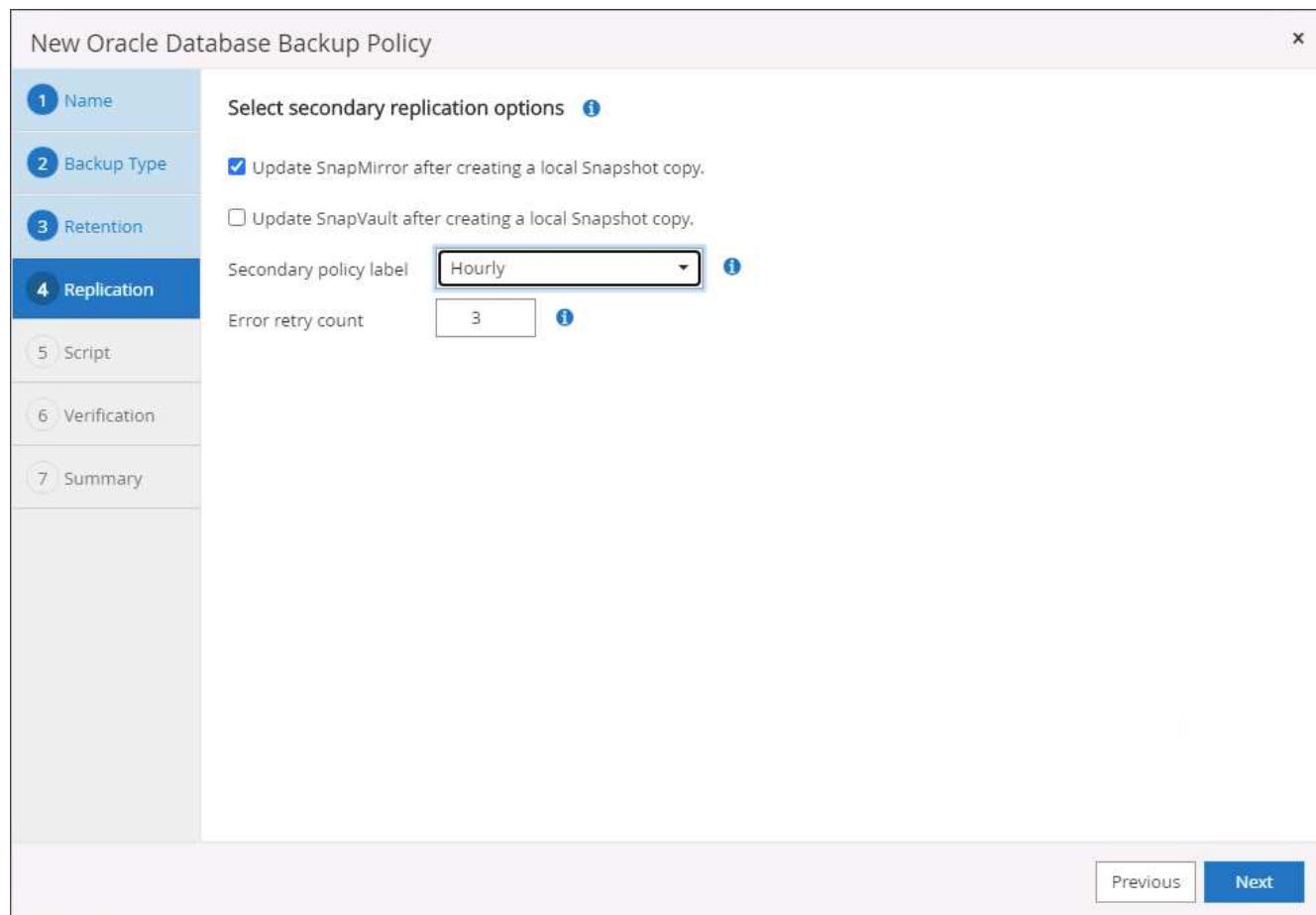
3. Select the backup type and schedule frequency.



4. Set the log retention period.



5. Enable replication to a secondary location in the public cloud.



6. Specify any optional scripts to run before and after log backup.

New Oracle Database Backup Policy X

1 Name

Specify optional scripts to run before and after performing a backup job

2 Backup Type

Prescript full path Enter Prescript path

3 Retention

Prescript arguments

4 Replication

Postscript full path Enter Postscript path

5 Script

Postscript arguments

Script timeout secs

6 Verification

7 Summary

Previous Next

7. Specify any backup verification scripts.

New Oracle Database Backup Policy X

1 Name Select the options to run backup verification

2 Backup Type Run Verifications for following backup schedules

3 Retention Select how often you want the schedules to occur in the policy. The specific verification times are set at backup job creation enabling you to stagger your verification start times.

4 Replication

5 Script

6 Verification Verification script commands

Script timeout 60 secs

Prescript full path /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Prescript arguments Choose optional arguments...

Postscript full path /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Postscript arguments Choose optional arguments...

[Previous](#) [Next](#)

8. Summary.

New Oracle Database Backup Policy

1 Name	Summary
2 Backup Type	Policy name: Oracle Archive Log Backup Details: Backup Oracle archive logs
3 Retention	Backup type: Online backup
4 Replication	Schedule type: Hourly RMAN catalog backup: Disabled
5 Script	Archive log pruning: None
6 Verification	On demand data backup retention: None On demand archive log backup retention: None
7 Summary	Hourly data backup retention: None Hourly archive log backup retention: Delete Snapshot copies older than : 7 days Daily data backup retention: None Daily archive log backup retention: None Weekly data backup retention: None Weekly archive log backup retention: None Monthly data backup retention: None Monthly archive log backup retention: None Replication: SnapMirror enabled , Secondary policy label: Hourly , Error retry count: 3

[Previous](#) [Finish](#)

Create a full database backup policy for SQL

1. Log into SnapCenter with a database management user ID, click Settings, and then click Policies.

The screenshot shows the NetApp SnapCenter interface. On the left is a navigation sidebar with icons for Dashboard, Resources, Monitor, Reports, Hosts, Storage Systems, Settings (which is selected), and Alerts. The main content area has a header with 'Policies' and 'Credential' tabs, and a dropdown for 'Microsoft SQL Server'. Below this is a search bar labeled 'Search by Name'. The main table has columns for 'Name', 'Backup Type', 'Schedule Type', 'Replication', and 'Verification'. A message at the bottom of the table says 'There is no match for your search or data is not available.' To the right of the table are buttons for 'New', 'Modify', 'Copy', 'Details', and 'Delete'.

2. Click New to launch a new backup policy creation workflow, or choose an existing policy for modification.

New SQL Server Backup Policy

1 Name

Provide a policy name

Policy name: SQL Server Full Backup i

Details: Backup all data and log files

2 Backup Type

3 Retention

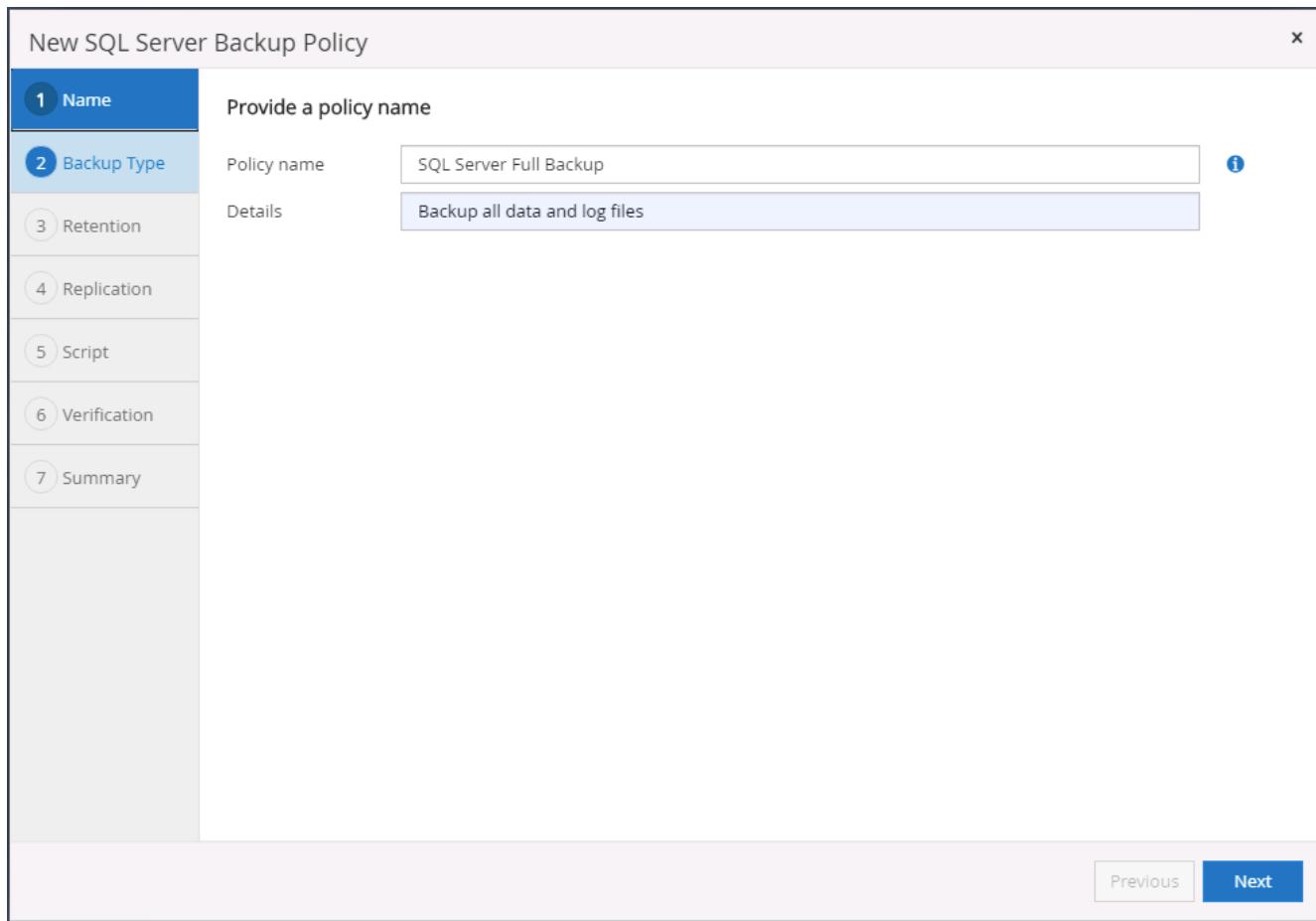
4 Replication

5 Script

6 Verification

7 Summary

Previous Next



3. Define the backup option and schedule frequency. For SQL Server configured with an availability group, a preferred backup replica can be set.

New SQL Server Backup Policy X

1 Name

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Select SQL server backup options

Choose backup type

Full backup and log backup

Full backup

Log backup

Copy only backup i

Maximum databases backed up per Snapshot copy: 100 i

Availability Group Settings ▼

Schedule frequency

Select how often you want the schedules to occur in the policy. The specific times are set at backup job creation enabling you to stagger your start times.

On demand

Hourly

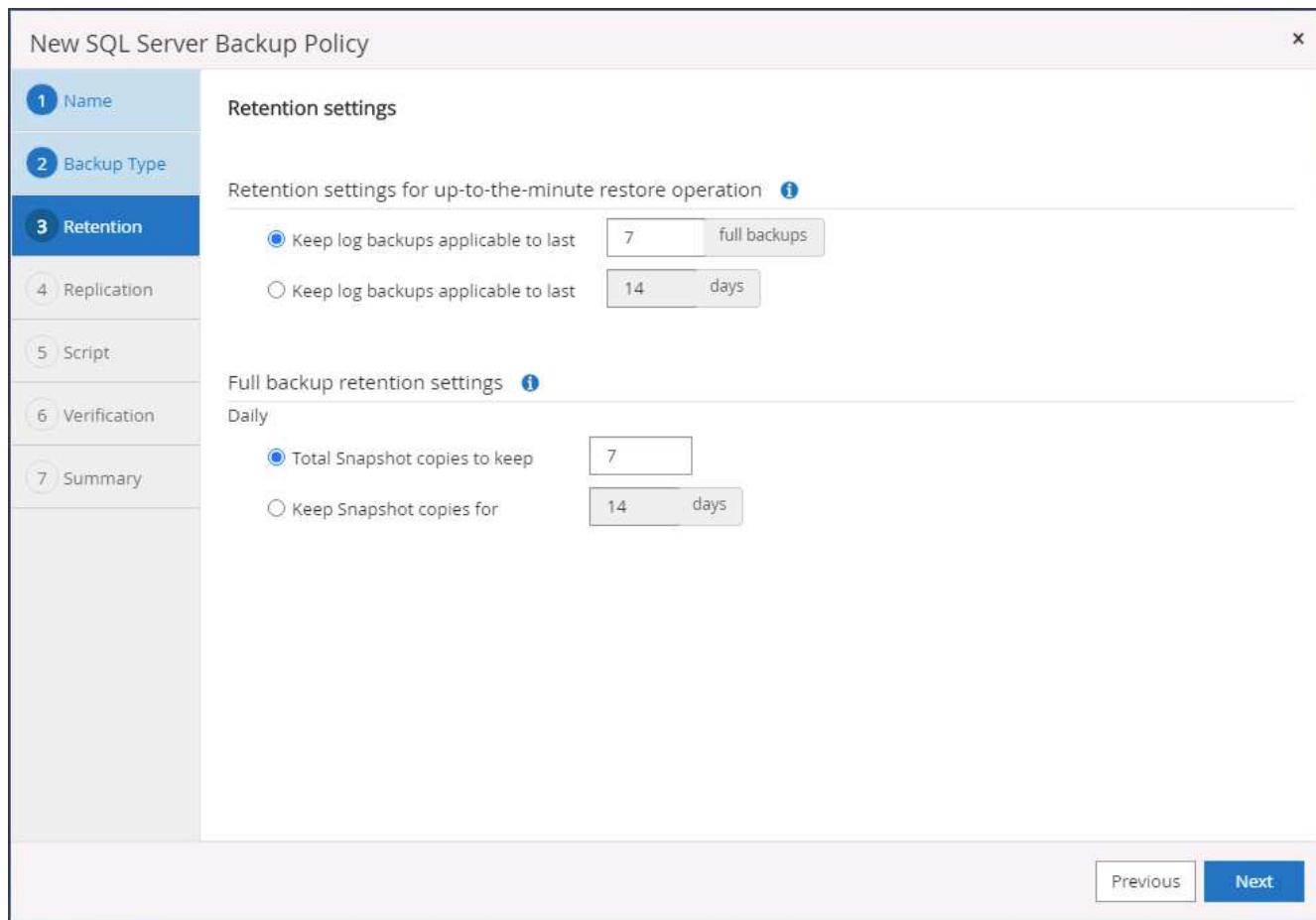
Daily

Weekly

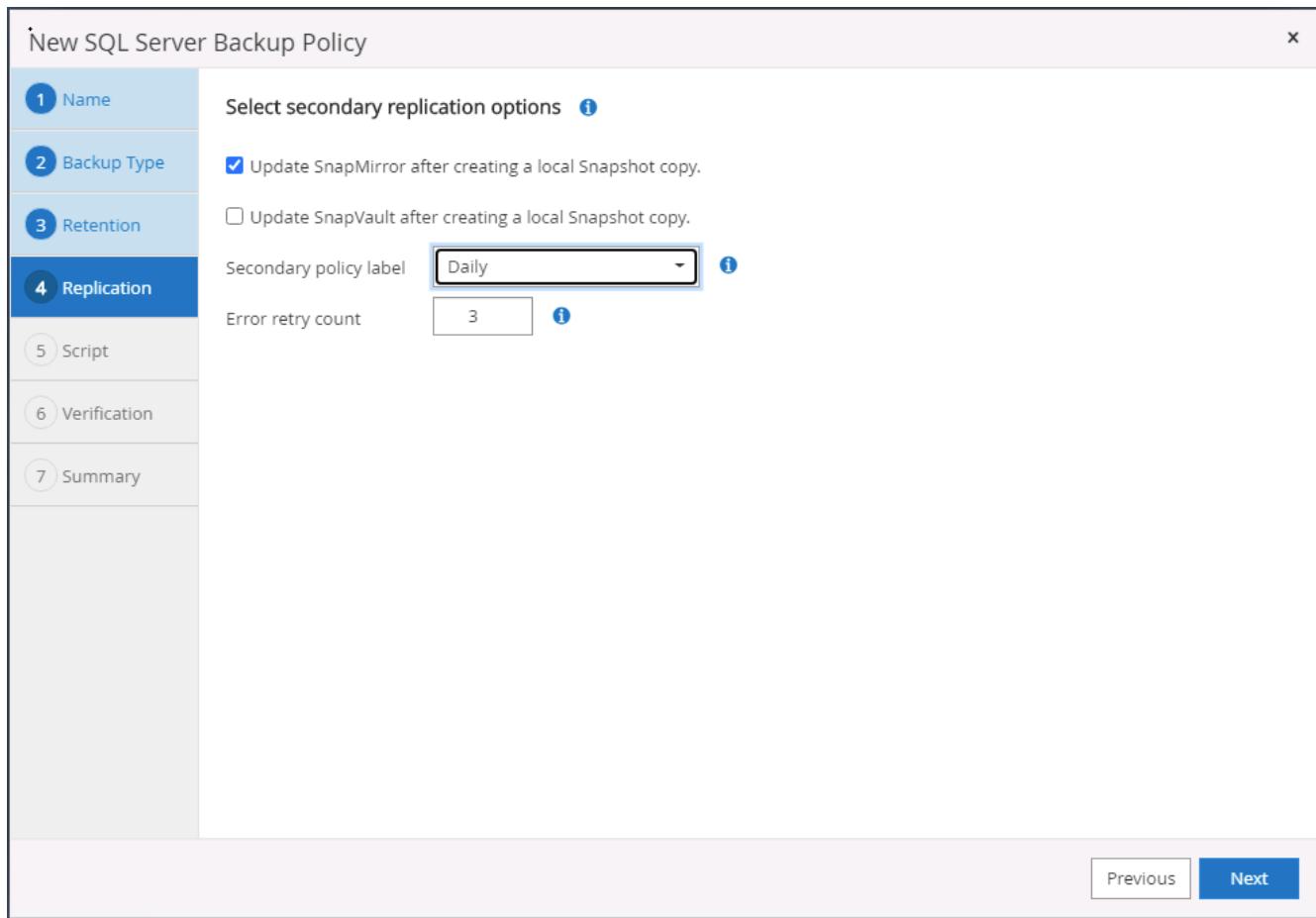
Monthly

Previous Next

4. Set the backup retention period.



5. Enable backup copy replication to a secondary location in cloud.



6. Specify any optional scripts to run before or after a backup job.

New SQL Server Backup Policy X

1 Name Specify optional scripts to run before performing a backup job

2 Backup Type Prescript full path

3 Retention Prescript arguments Choose optional arguments...

4 Replication Specify optional scripts to run after performing a backup job

5 Script Postscript full path
Postscript arguments Choose optional arguments...

6 Verification Script timeout 60 secs

7 Summary

Previous Next

7. Specify the options to run backup verification.

New SQL Server Backup Policy

1 Name

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Select the options to run backup verification

Run verifications for the following backup schedules

Select how often you want the schedules to occur in the policy. The specific verification times are set at backup job creation enabling you to stagger your verification start times.

Daily

Database consistency checks options

Limit the integrity structure to physical structure of the database (PHYSICAL_ONLY)

Suppress all information message (NO_INFOMSGS)

Display all reported error messages per object (ALL_ERRORMSGGS)

Do not check non-clustered indexes (NOINDEX)

Limit the checks and obtain the locks instead of using an internal database Snapshot copy (TABLOCK)

Log backup

Verify log backup. i

Verification script settings

Script timeout secs

Previous Next

8. Summary.

New SQL Server Backup Policy X

1 Name	Summary
2 Backup Type	Policy name: SQL Server Full Backup
3 Retention	Details: Backup all data and log files
4 Replication	Backup type: Full backup and log backup
5 Script	Availability group settings: Backup only on preferred backup replica
6 Verification	Schedule Type: Daily UTM retention: Total backup copies to retain : 7 Daily Full backup retention: Total backup copies to retain : 7 Replication: SnapMirror enabled , Secondary policy label: Daily , Error retry count: 3
7 Summary	Backup prescript settings: undefined Prescript arguments: Backup postscript settings: undefined Postscript arguments: Verification for backup schedule type: none Verification prescript settings: undefined Prescript arguments: Verification postscript settings: undefined Postscript arguments:
Previous Finish	

Create a database log backup policy for SQL.

1. Log into SnapCenter with a database management user ID, click Settings > Policies, and then New to launch a new policy creation workflow.

New SQL Server Backup Policy

1 Name

Provide a policy name

Policy name: SQL Server Log Backup

Details: Backup SQL server log

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Previous Next

The screenshot shows the 'New SQL Server Backup Policy' wizard. The 'Name' tab is active. The 'Policy name' field is set to 'SQL Server Log Backup'. The 'Details' field contains the text 'Backup SQL server log'. The sidebar on the left lists other tabs: 'Backup Type', 'Retention', 'Replication', 'Script', 'Verification', and 'Summary'. At the bottom right are 'Previous' and 'Next' buttons.

- Define the log backup option and schedule frequency. For SQL Server configured with a availability group, a preferred backup replica can be set.

New SQL Server Backup Policy X

1 Name

2 Backup Type

3 Retention

4 Replication

5 Script

6 Verification

7 Summary

Select SQL server backup options

Choose backup type

Full backup and log backup
 Full backup
 Log backup
 Copy only backup i

Maximum databases backed up per Snapshot copy: 100 i

Availability Group Settings ▼

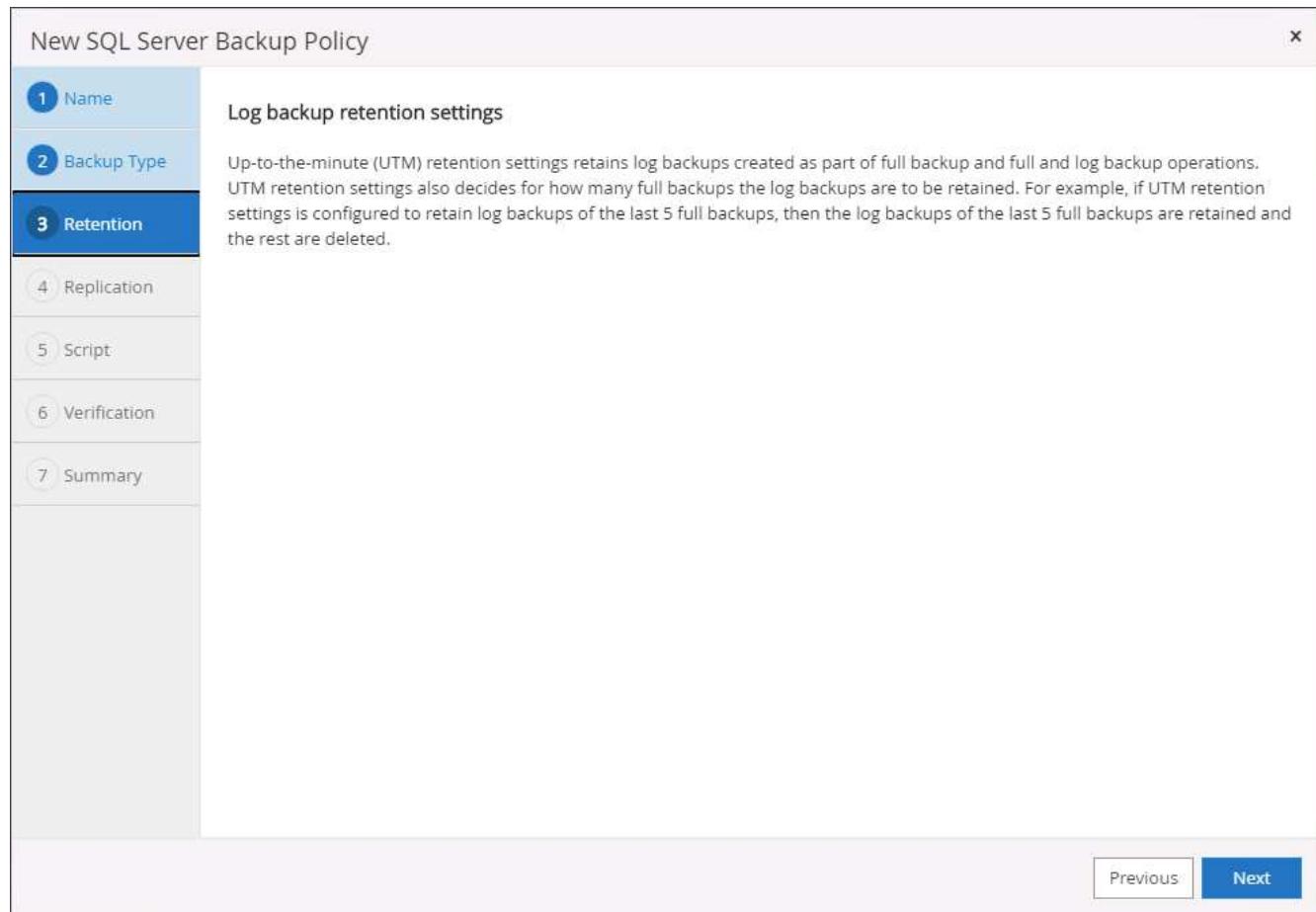
Schedule frequency

Select how often you want the schedules to occur in the policy. The specific times are set at backup job creation enabling you to stagger your start times.

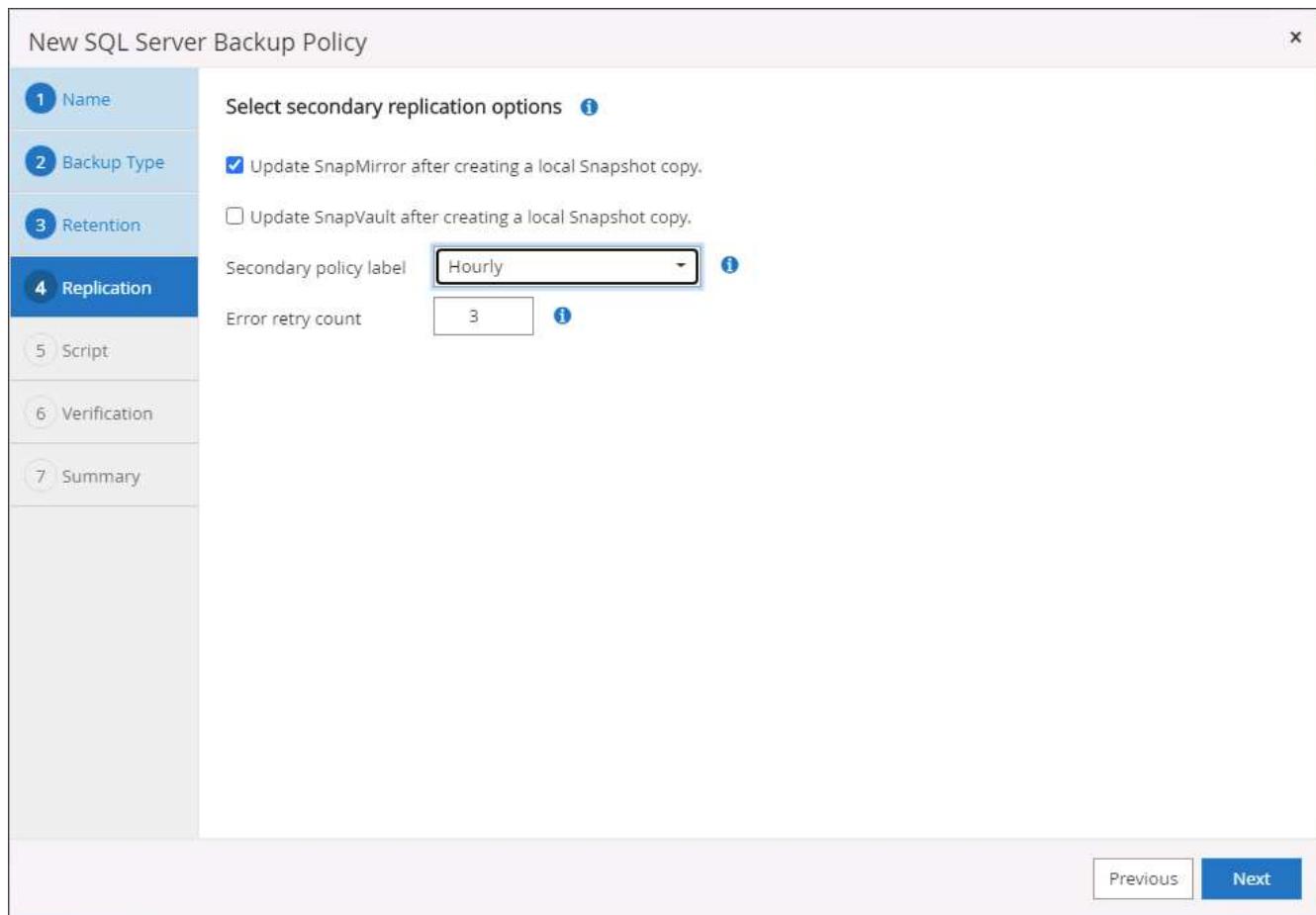
On demand
 Hourly
 Daily
 Weekly
 Monthly

Previous Next

3. SQL server data backup policy defines the log backup retention; accept the defaults here.



4. Enable log backup replication to secondary in the cloud.



5. Specify any optional scripts to run before or after a backup job.

New SQL Server Backup Policy X

1 Name

Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments Choose optional arguments...

2 Backup Type

3 Retention

4 Replication

5 Script

Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments Choose optional arguments...

Script timeout 60 secs

6 Verification

7 Summary

Previous Next

6. Summary.

New SQL Server Backup Policy

Step	Setting
1 Name	Policy name: SQL Server Log Backup
2 Backup Type	Details: Backup SQL server log Backup type: Log transaction backup
3 Retention	Availability group settings: Backup only on preferred backup replica
4 Replication	Schedule Type: Hourly
5 Script	Replication: SnapMirror enabled, Secondary policy label: Hourly, Error retry count: 3
6 Verification	Backup prescript settings: undefined Prescript arguments: Backup postscript settings: undefined Postscript arguments:
7 Summary	Verification for backup schedule type: none Verification prescript settings: undefined Prescript arguments: Verification postscript settings: undefined Postscript arguments:

[Previous](#) [Finish](#)

8. Implement backup policy to protect database

SnapCenter uses a resource group to backup a database in a logical grouping of database resources, such as multiple databases hosted on a server, a database sharing the same storage volumes, multiple databases supporting a business application, and so on. Protecting a single database creates a resource group of its own. The following procedures demonstrate how to implement a backup policy created in section 7 to protect Oracle and SQL Server databases.

Create a resource group for full backup of Oracle

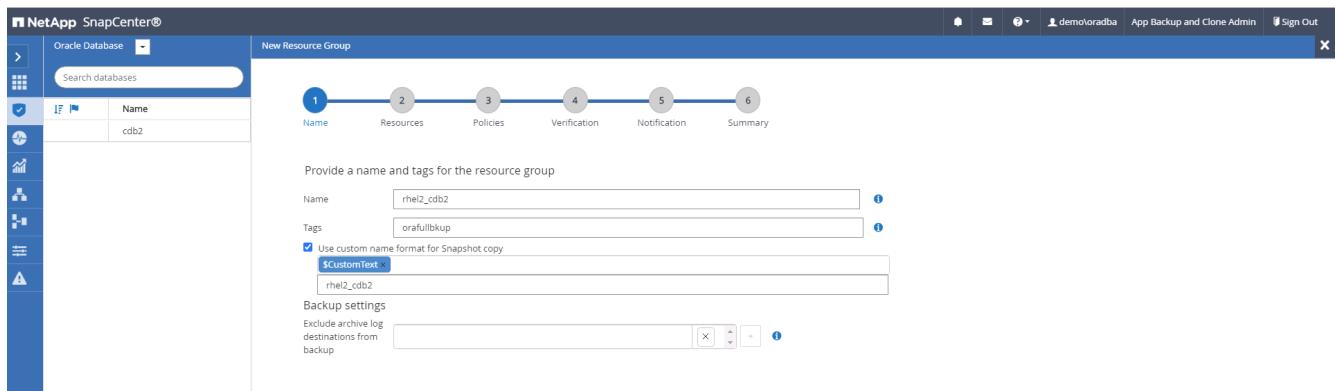
1. Log into SnapCenter with a database management user ID, and navigate to the Resources tab. In the View drop-down list, choose either Database or Resource Group to launch the resource group creation workflow.

The screenshot shows the NetApp SnapCenter interface. The top navigation bar includes links for Dashboard, Oracle Database, demotoradb, App Backup and Clone Admin, and Sign Out. The left sidebar has links for Resources, Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main content area is titled "Oracle Database" and shows a table with one row:

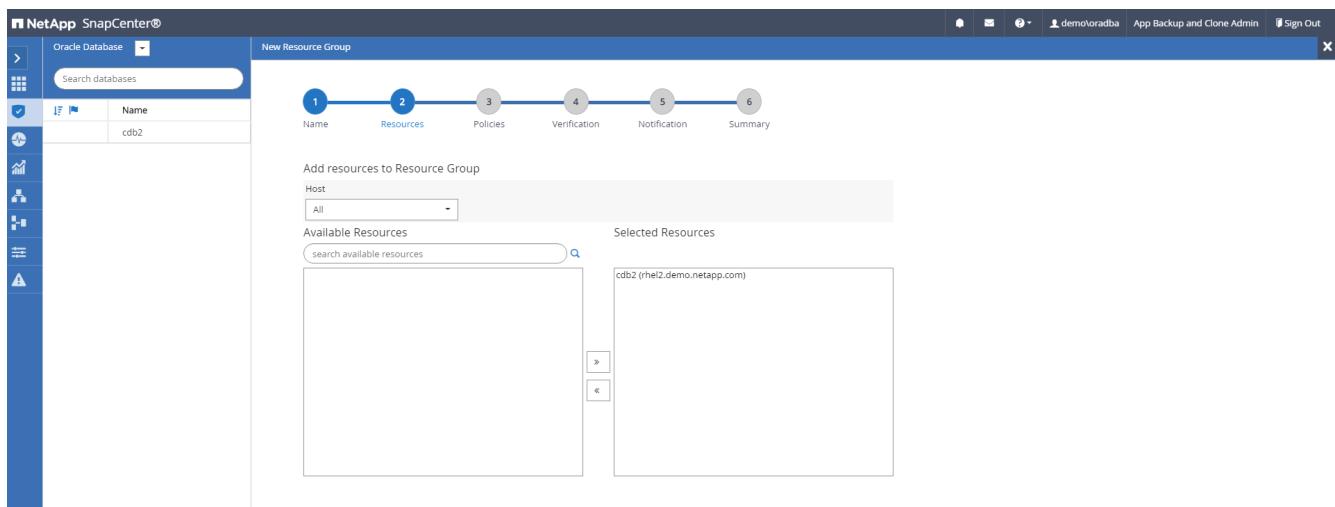
Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com				Not protected

Buttons at the bottom right include Refresh Resources and New Resource Group.

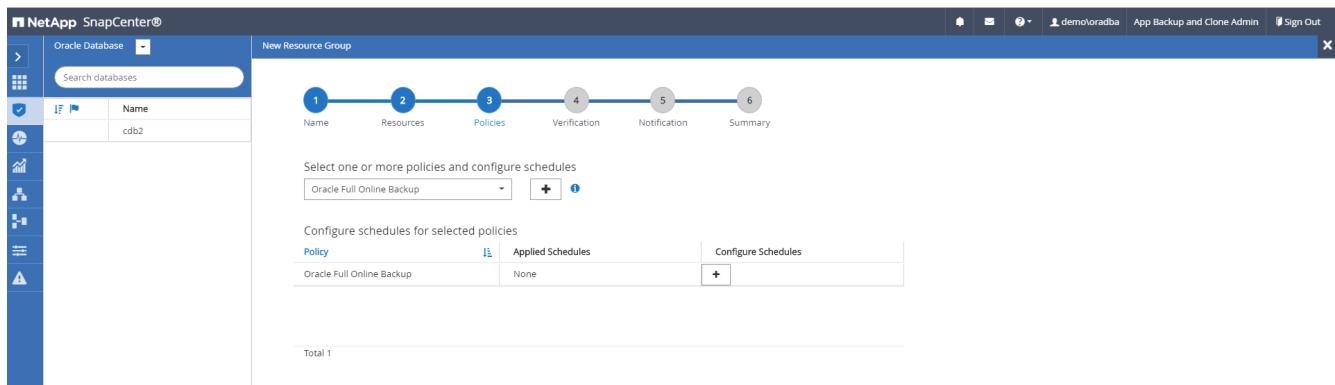
2. Provide a name and tags for the resource group. You can define a naming format for the Snapshot copy and bypass the redundant archive log destination if configured.



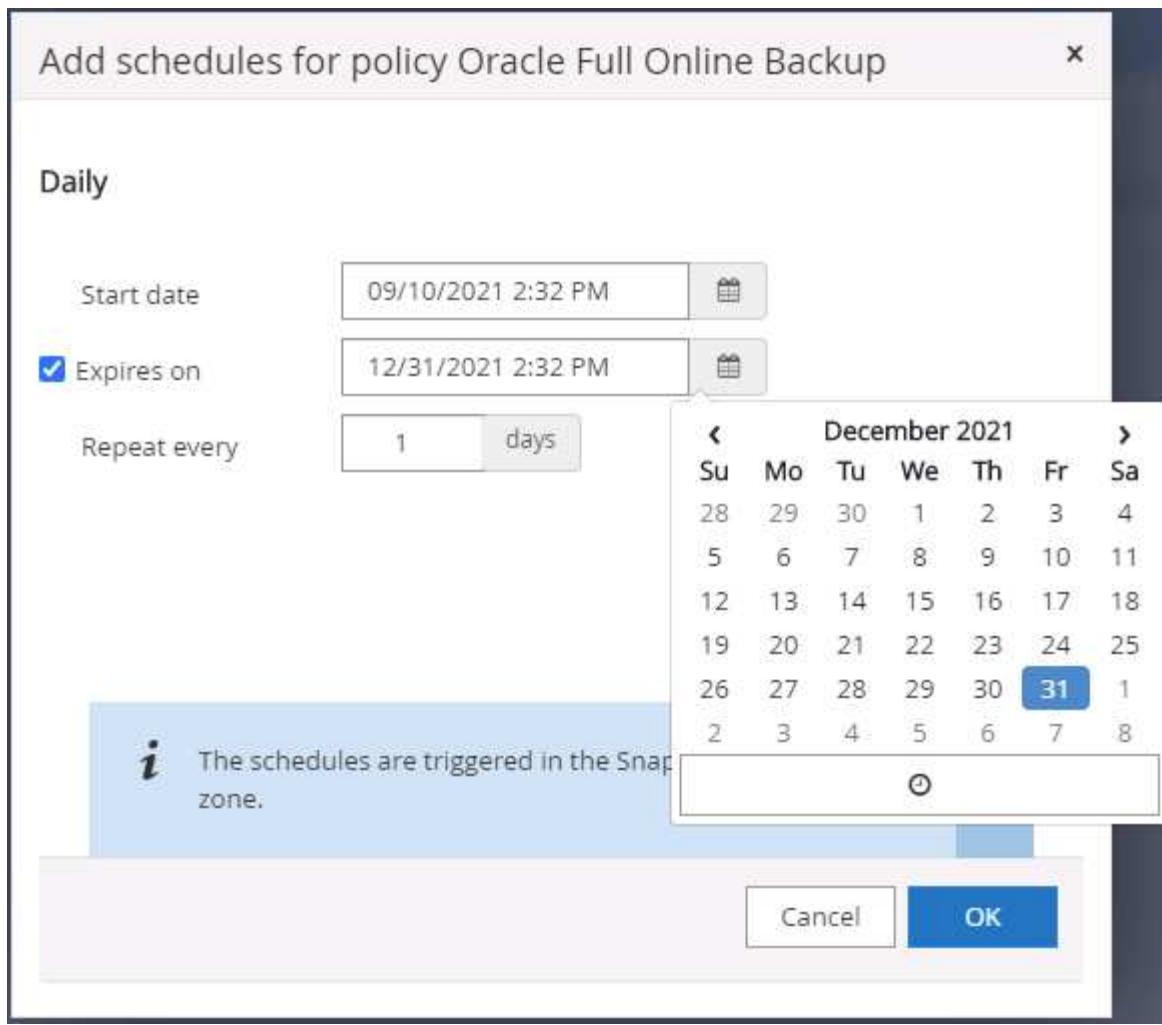
3. Add database resources to the resource group.



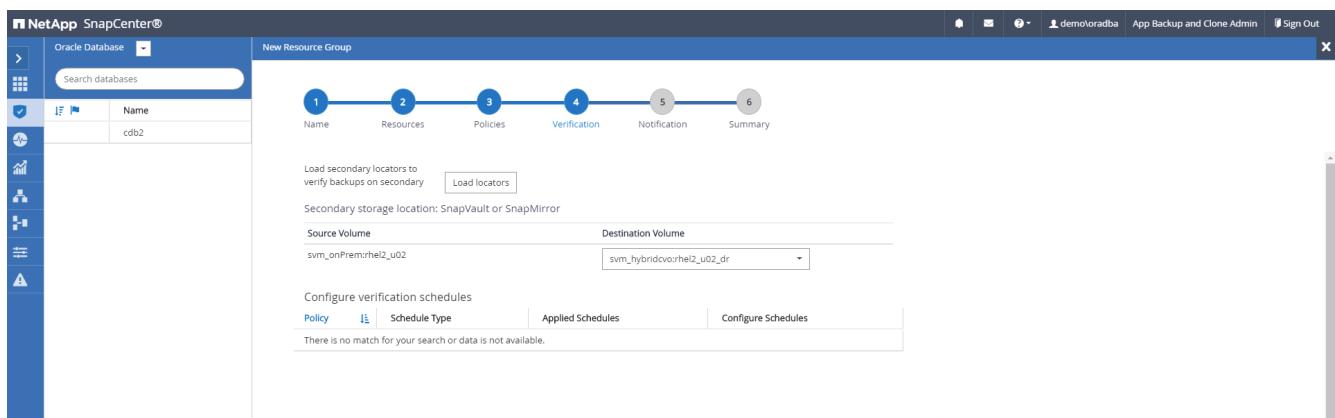
4. Select a full backup policy created in section 7 from the drop-down list.



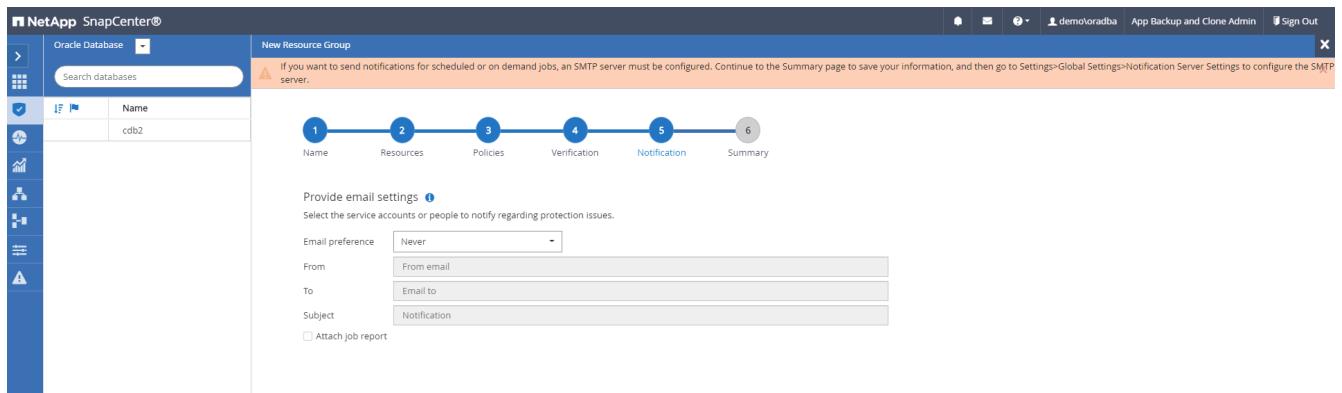
5. Click the (+) sign to configure the desired backup schedule.



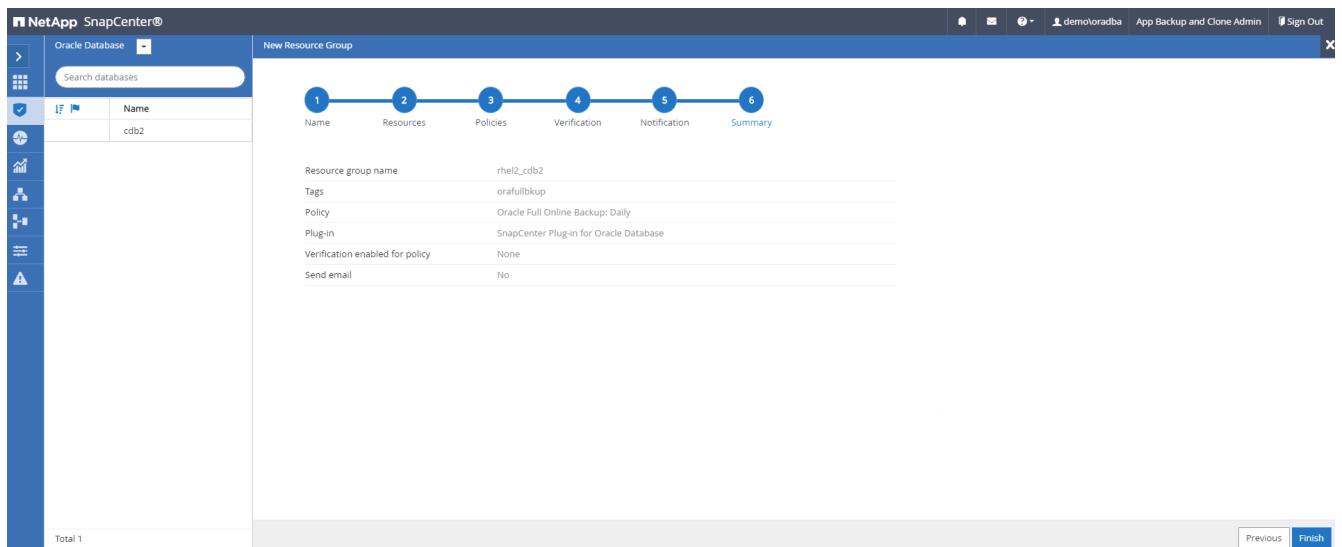
6. Click Load Locators to load the source and destination volume.



7. Configure the SMTP server for email notification if desired.

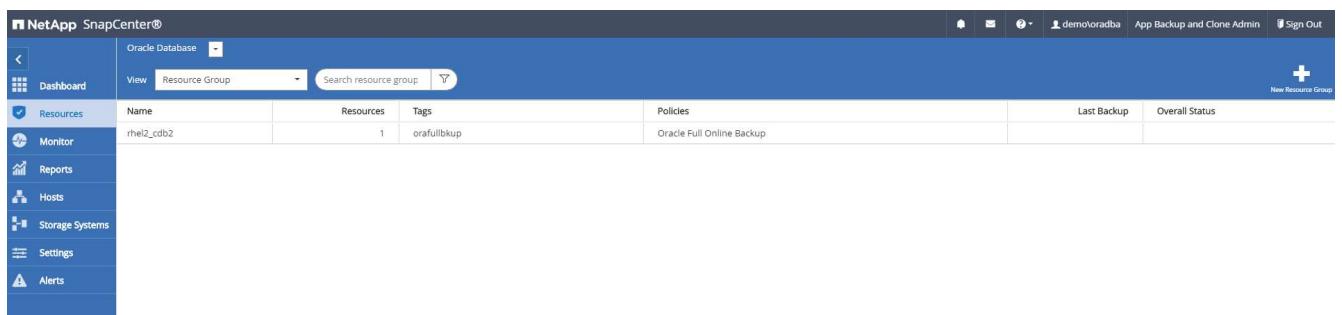


8. Summary.

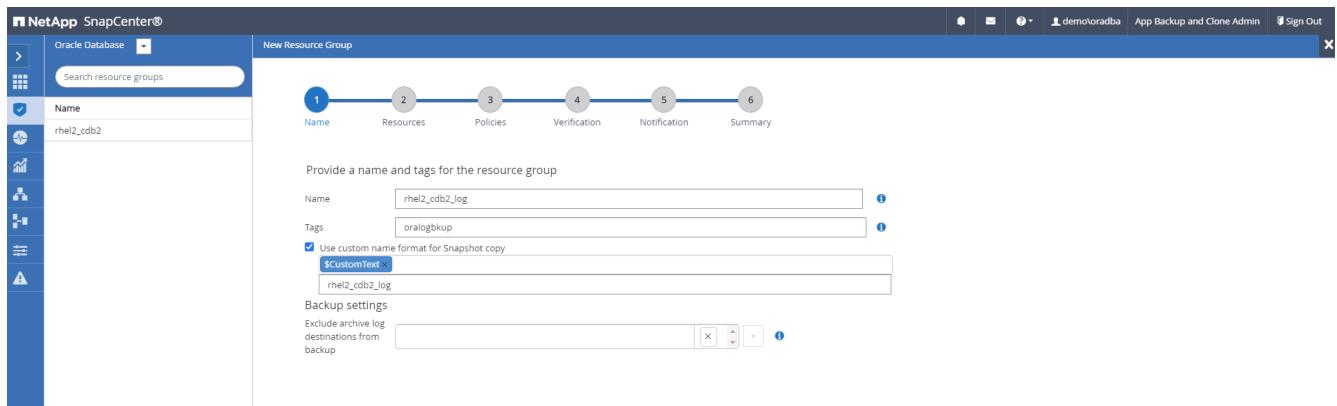


Create a resource group for log backup of Oracle

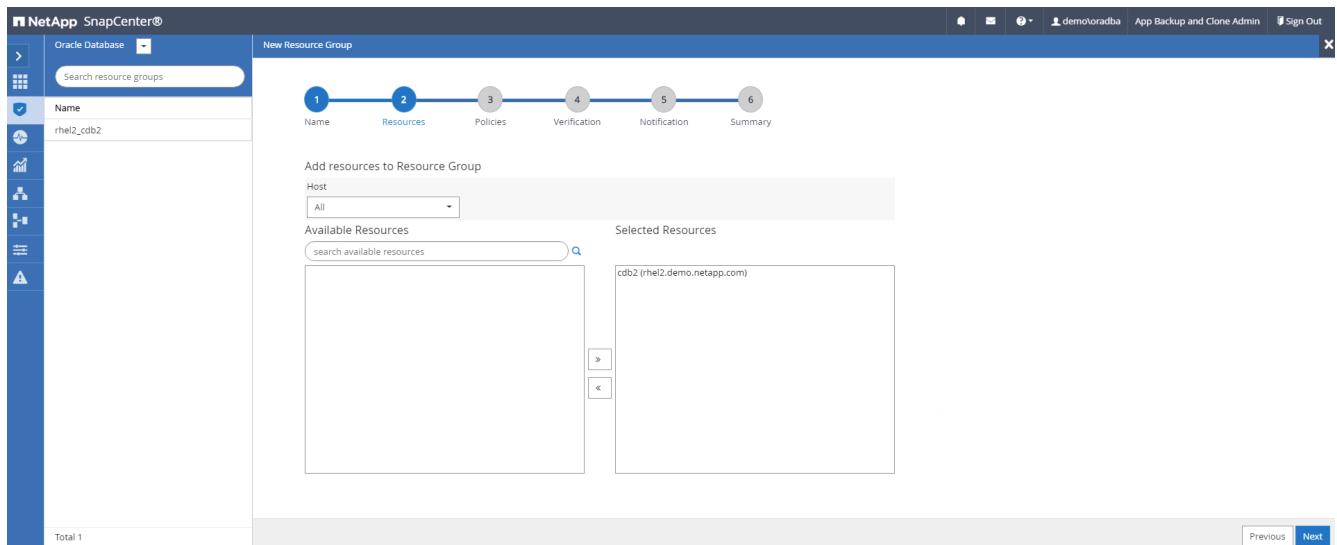
1. Log into SnapCenter with a database management user ID, and navigate to the Resources tab. In the View drop-down list, choose either Database or Resource Group to launch the resource group creation workflow.



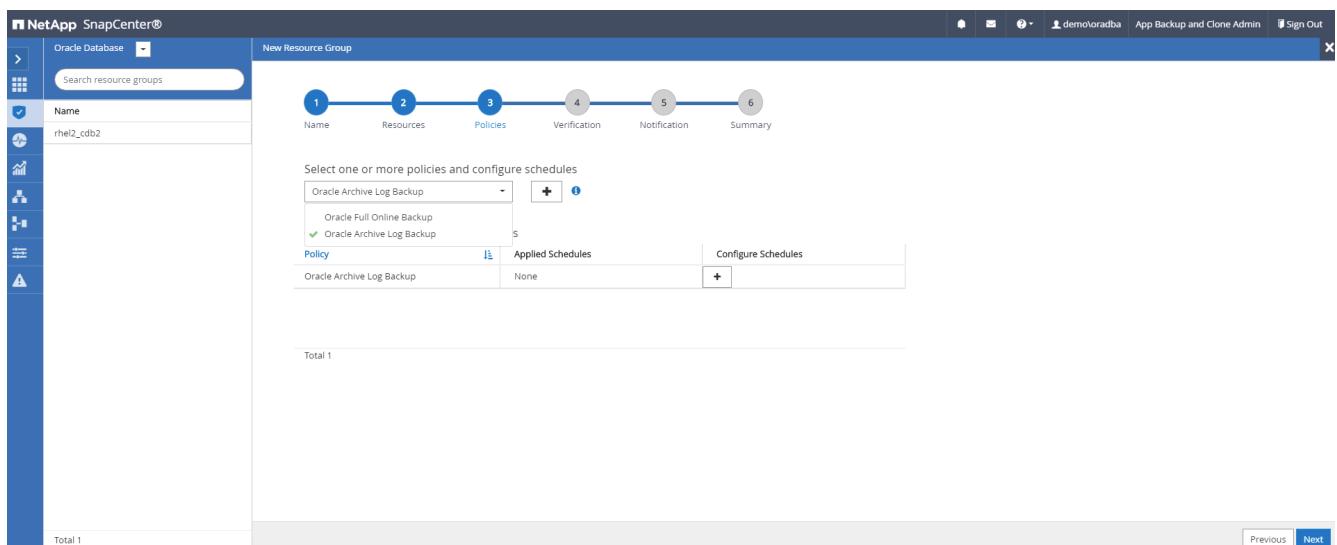
2. Provide a name and tags for the resource group. You can define a naming format for the Snapshot copy and bypass the redundant archive log destination if configured.



3. Add database resources to the resource group.



4. Select a log backup policy created in section 7 from the drop-down list.



5. Click on the (+) sign to configure the desired backup schedule.

Add schedules for policy Oracle Archive Log Backup x

Hourly

Start date

Expires on

Repeat every hours mins

i The schedules are triggered in the SnapCenter Server time zone. X

Cancel OK

6. If backup verification is configured, it displays here.

NetApp SnapCenter®

Oracle Database

New Resource Group

Name

Search resource groups

1 Name 2 Resources 3 Policies 4 Verification 5 Notification 6 Summary

Configure verification schedules

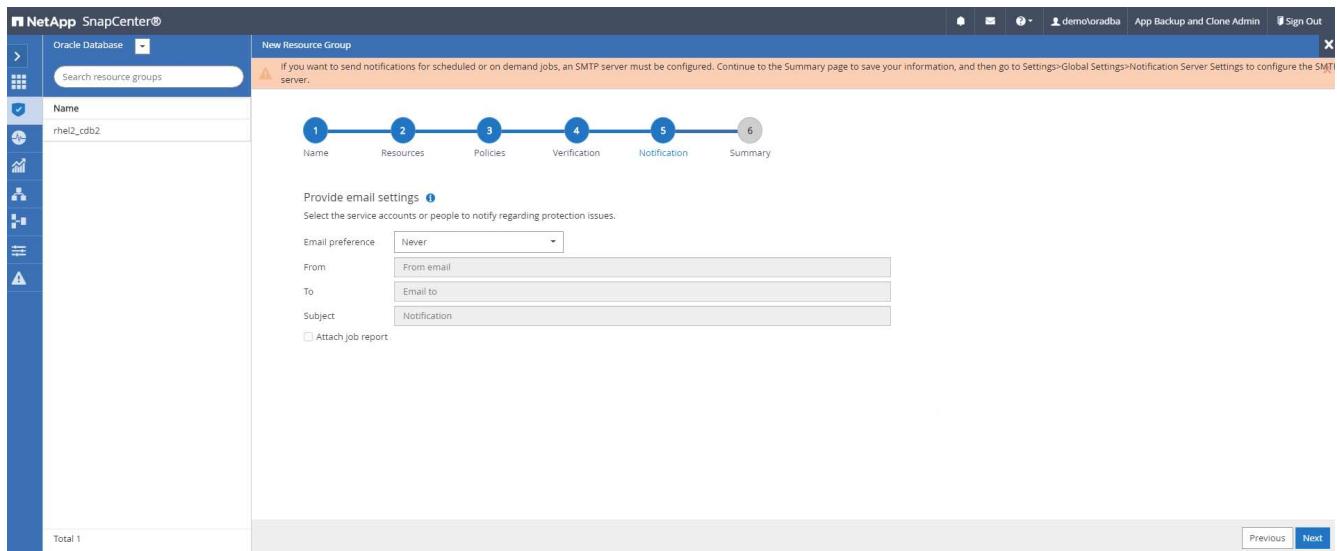
Policy Schedule Type Applied Schedules Configure Schedules

There is no match for your search or data is not available.

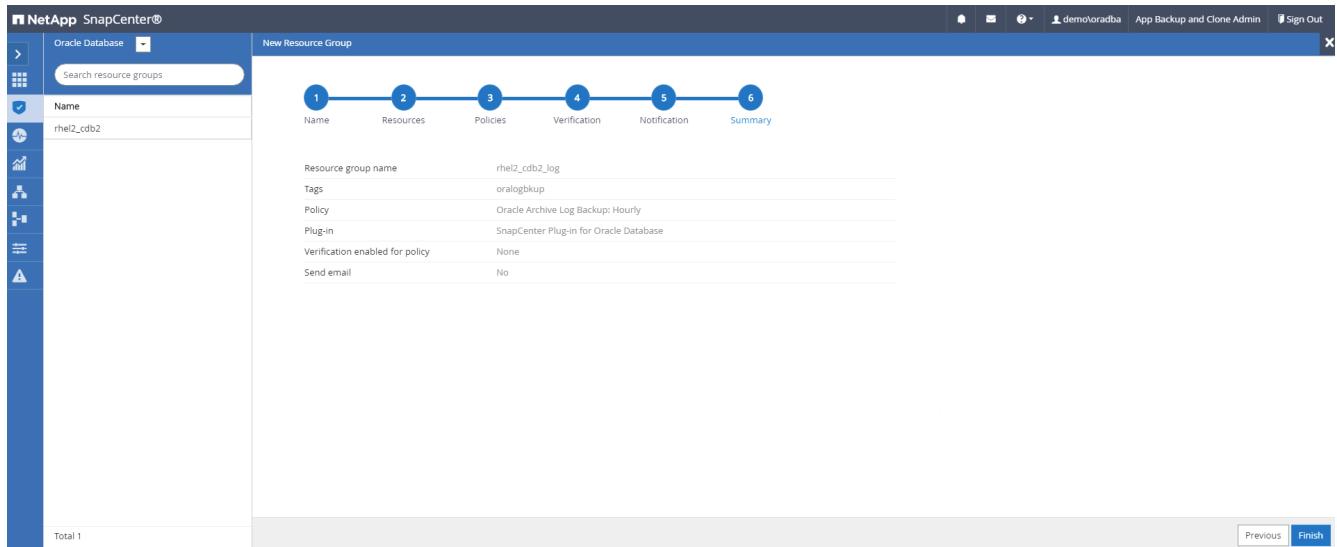
Total 0

Previous Next

7. Configure an SMTP server for email notification if desired.

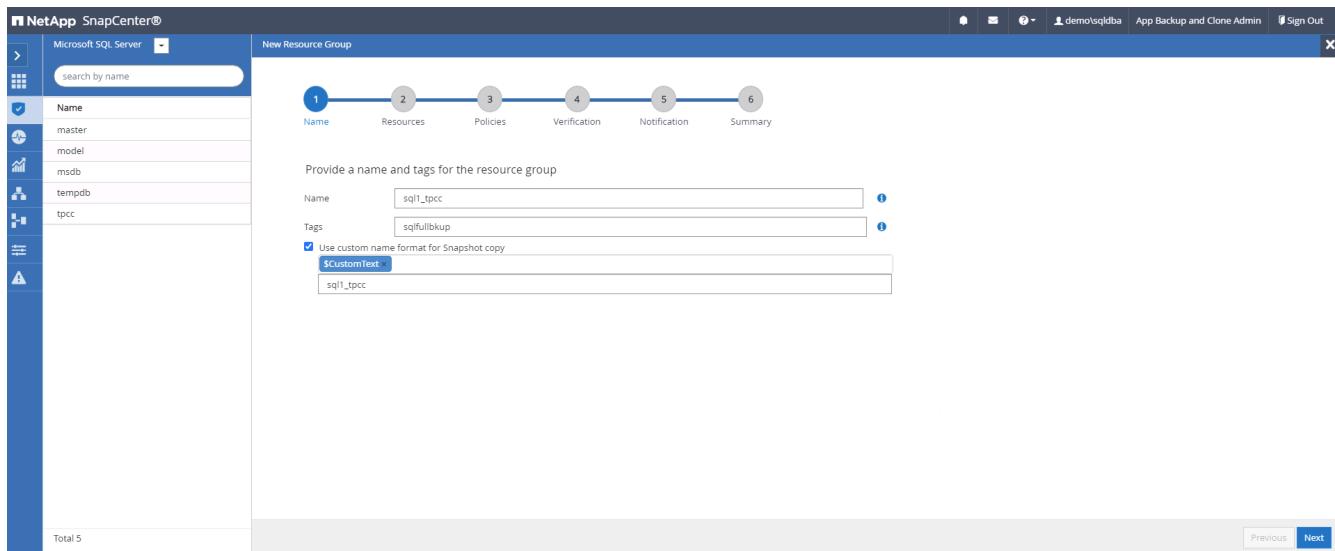


8. Summary.

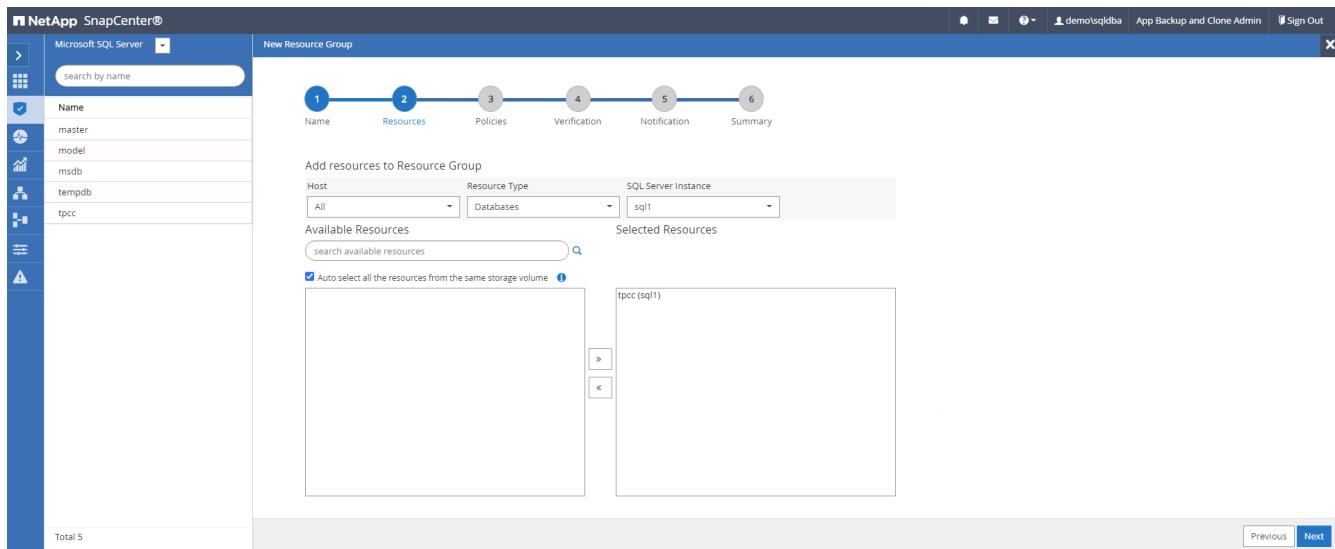


Create a resource group for full backup of SQL Server

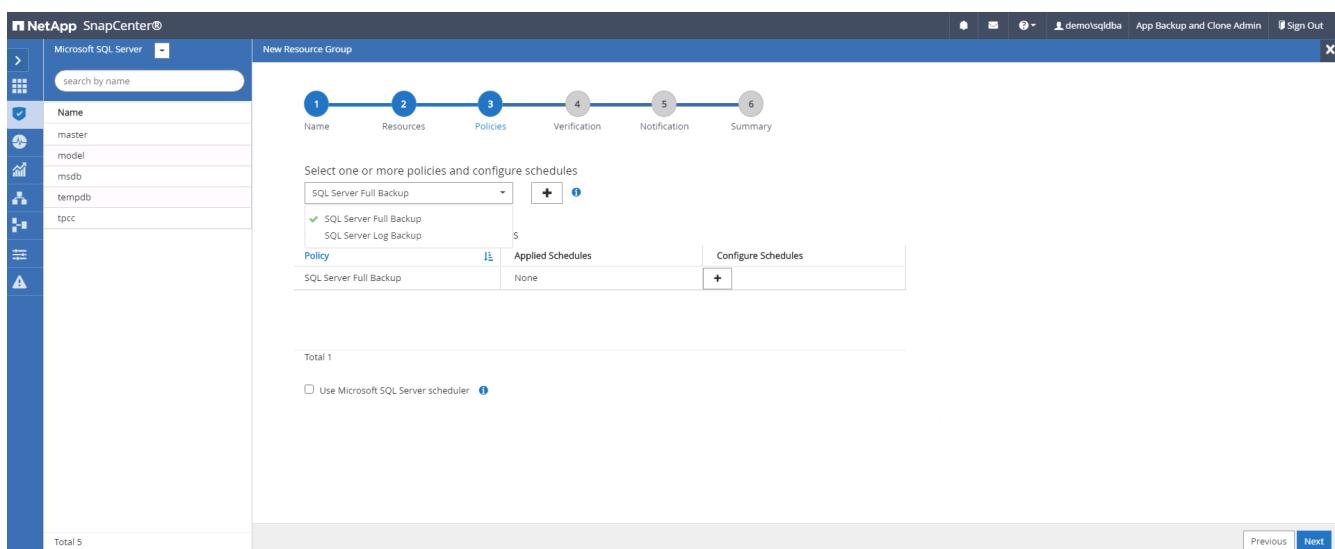
1. Log into SnapCenter with a database management user ID, and navigate to the Resources tab. In the View drop-down list, choose either a Database or Resource Group to launch the resource group creation workflow. Provide a name and tags for the resource group. You can define a naming format for the Snapshot copy.



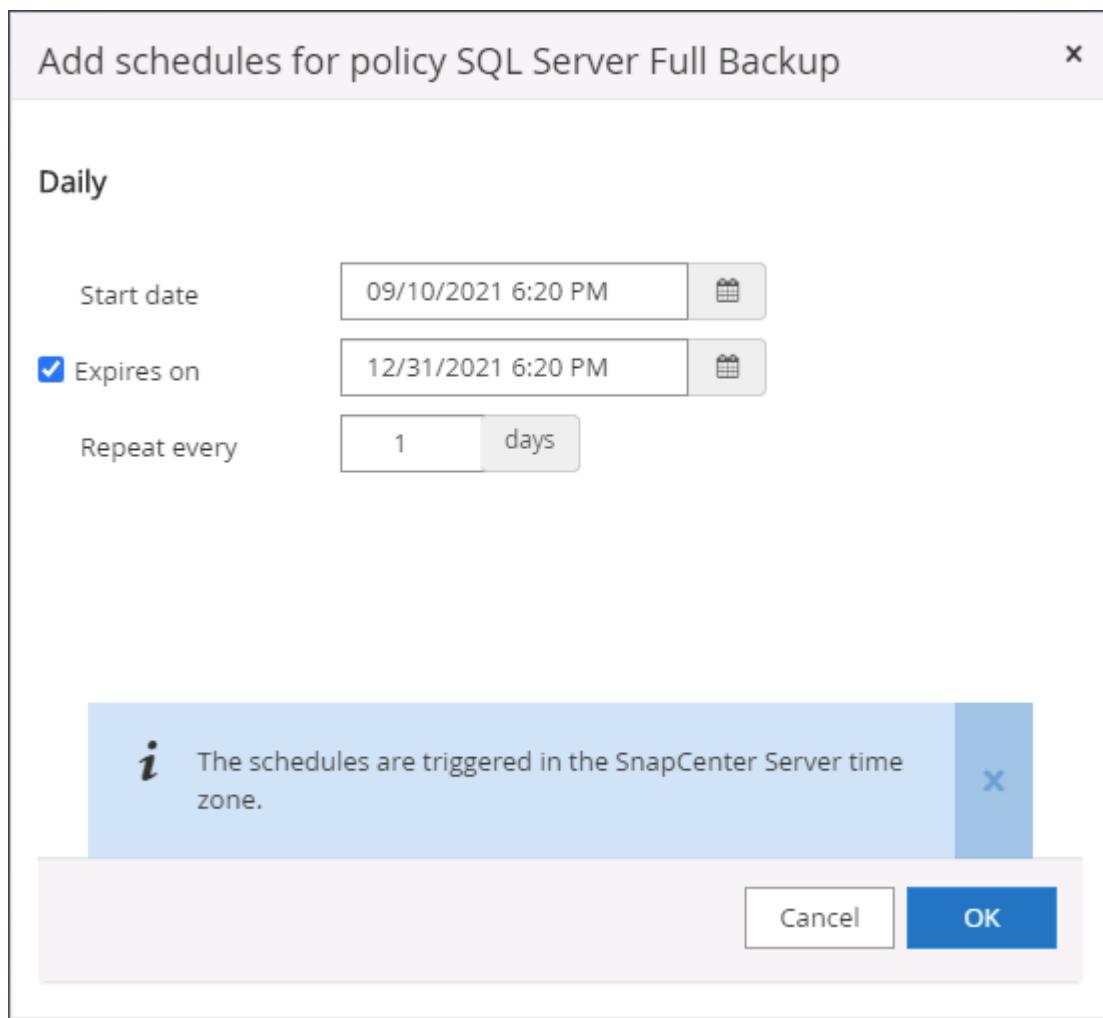
2. Select the database resources to be backed up.



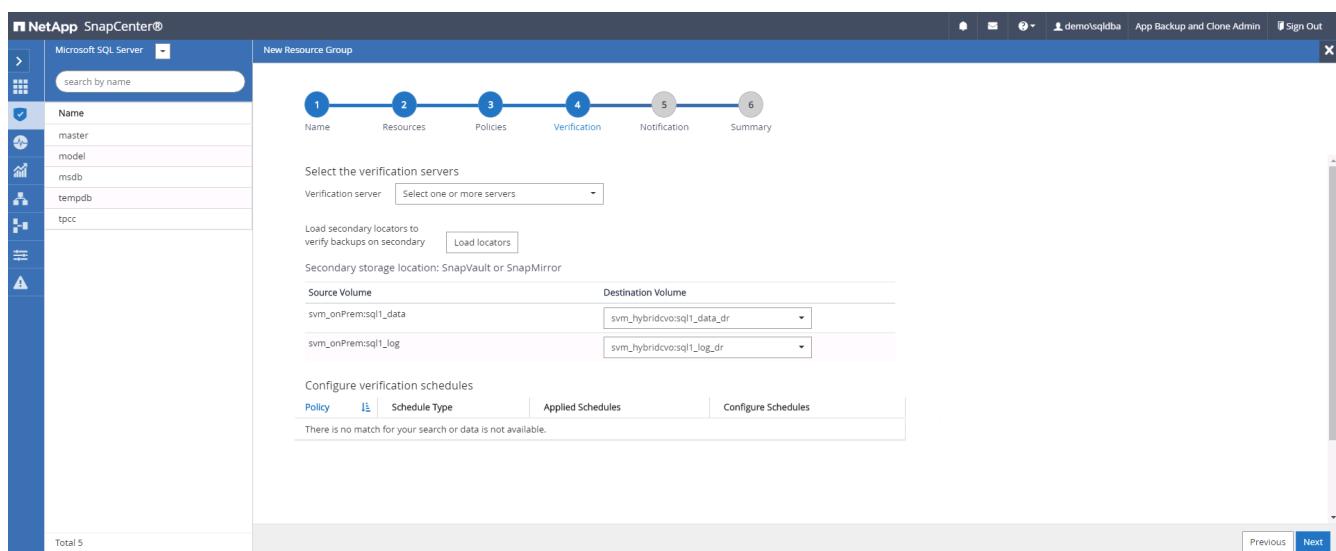
3. Select a full SQL backup policy created in section 7.



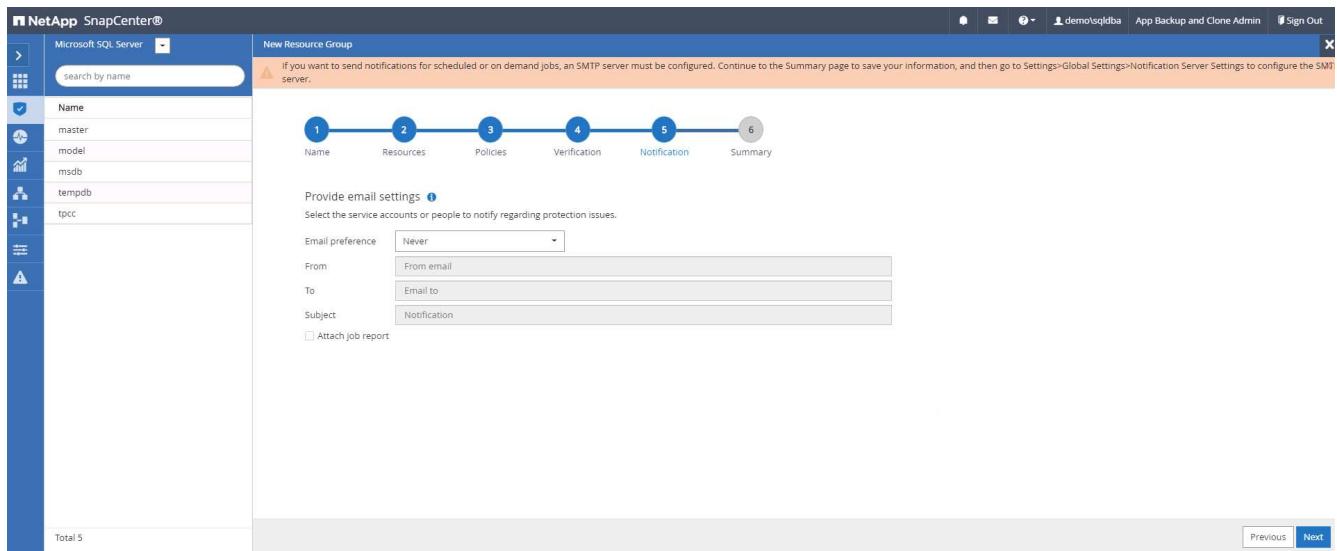
- Add exact timing for backups as well as the frequency.



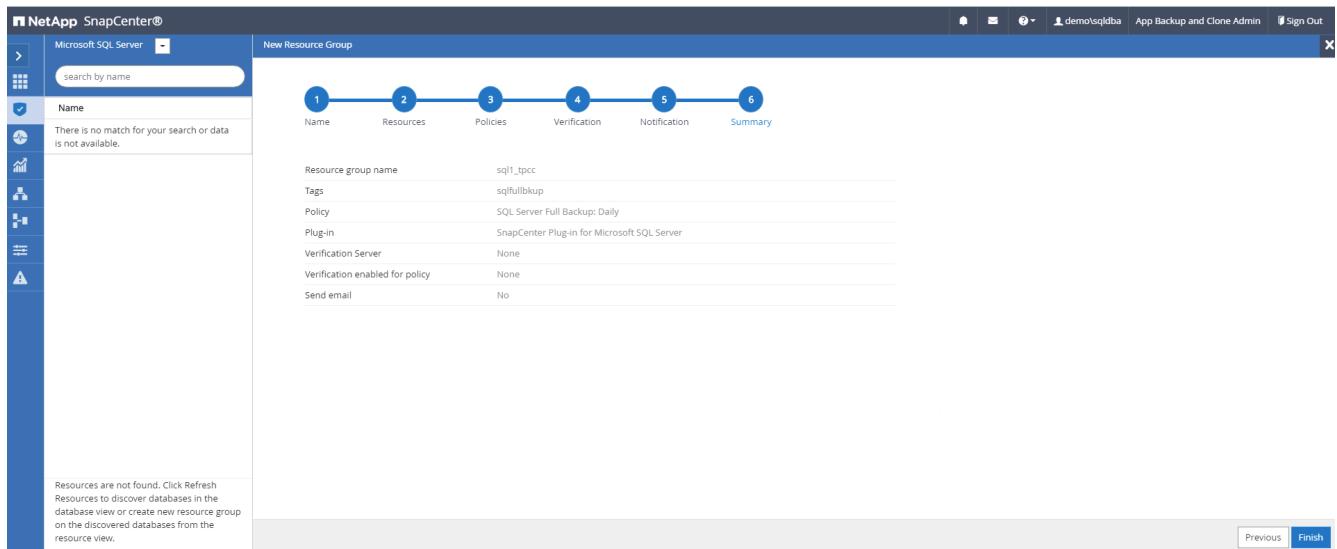
- Choose the verification server for the backup on secondary if backup verification is to be performed. Click Load Locator to populate the secondary storage location.



- Configure the SMTP server for email notification if desired.

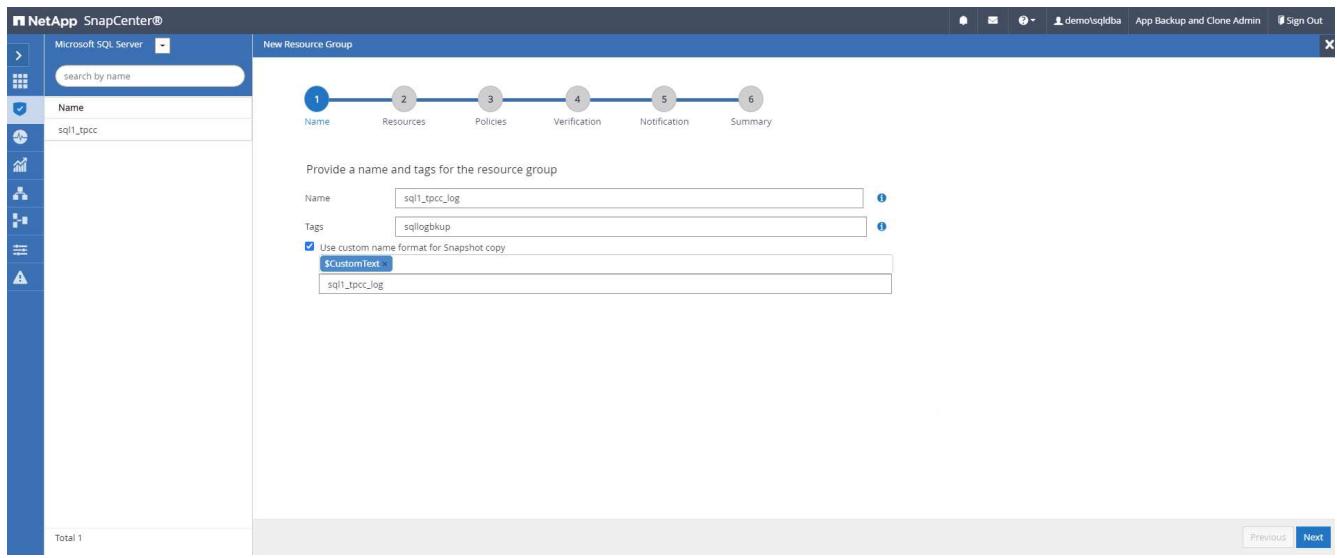


7. Summary.

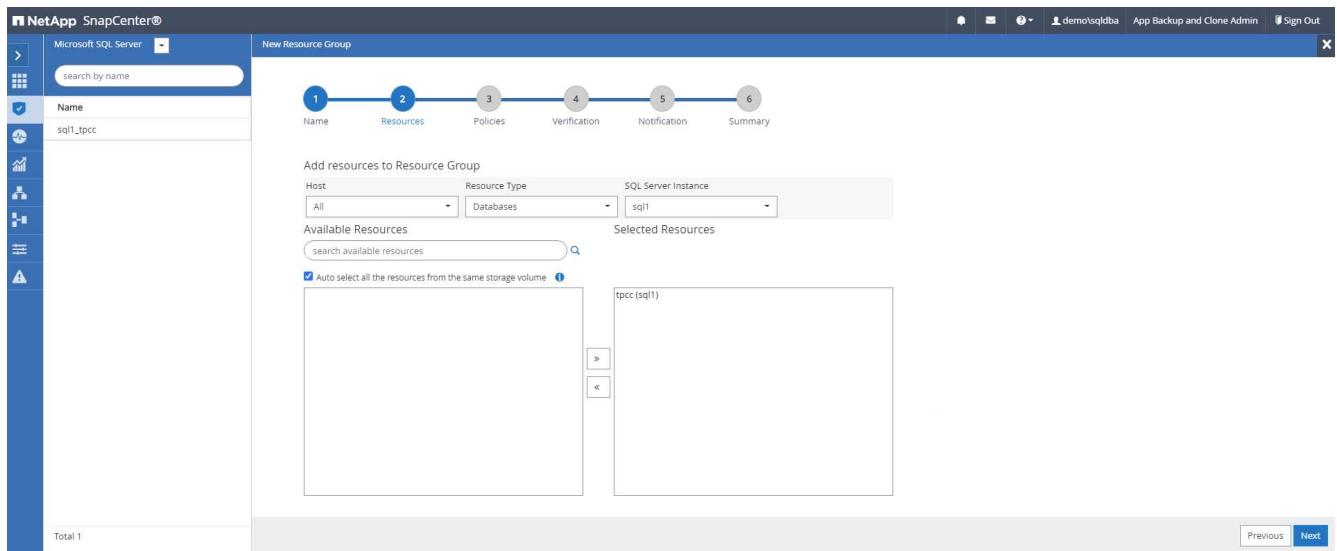


Create a resource group for log backup of SQL Server

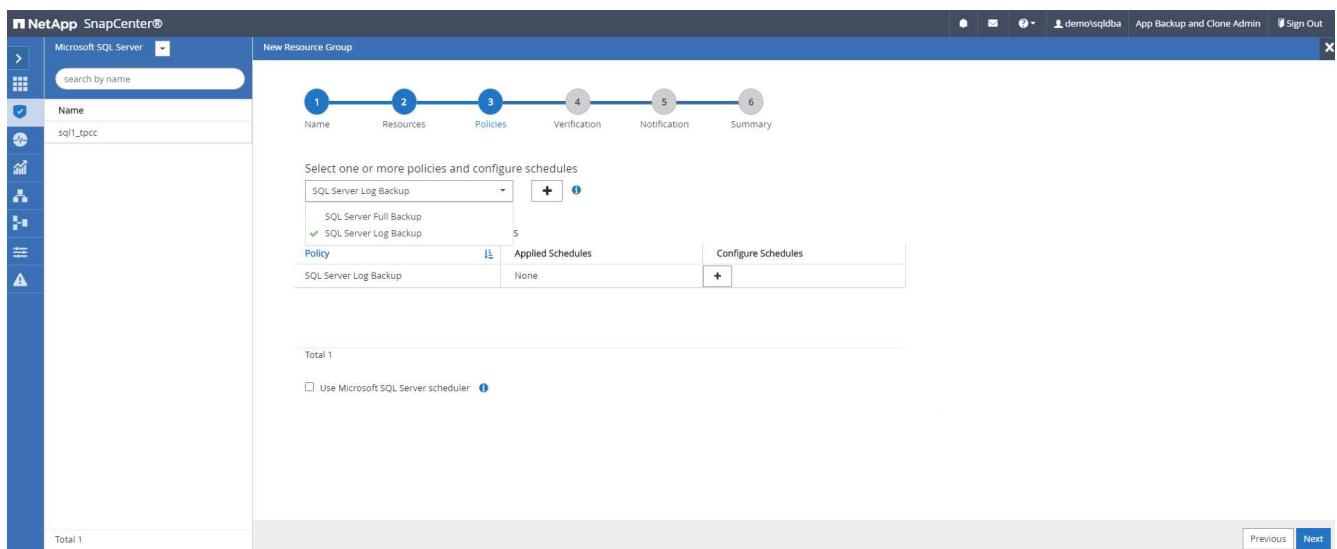
1. Log into SnapCenter with a database management user ID, and navigate to the Resources tab. In the View drop-down list, choose either a Database or Resource Group to launch the resource group creation workflow. Provide the name and tags for the resource group. You can define a naming format for the Snapshot copy.



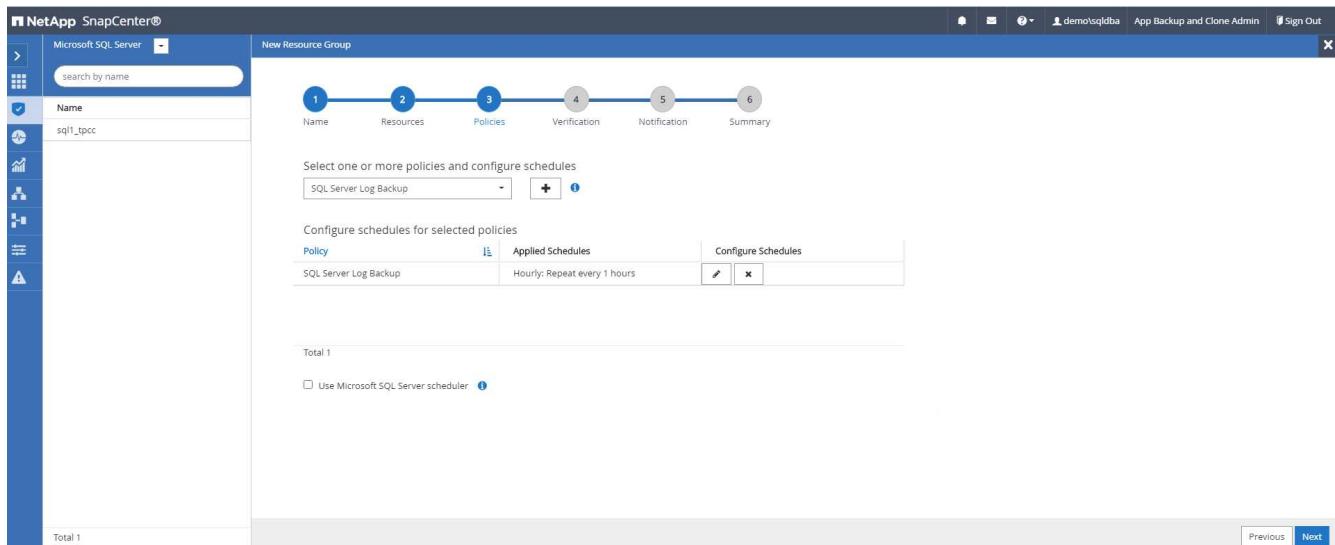
2. Select the database resources to be backed up.



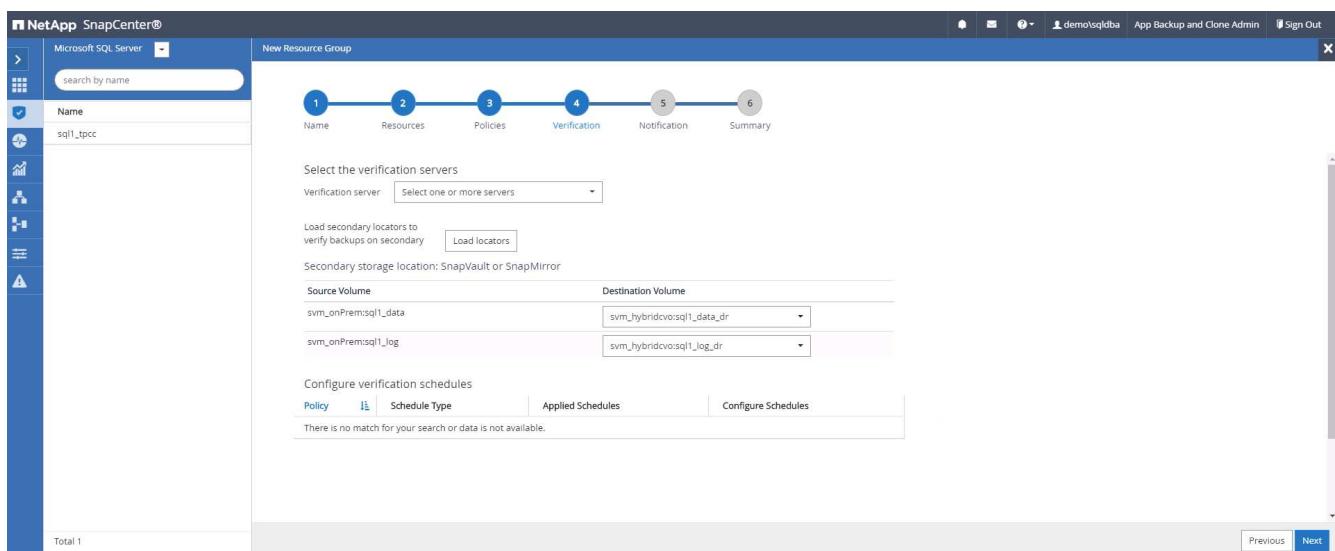
3. Select a SQL log backup policy created in section 7.



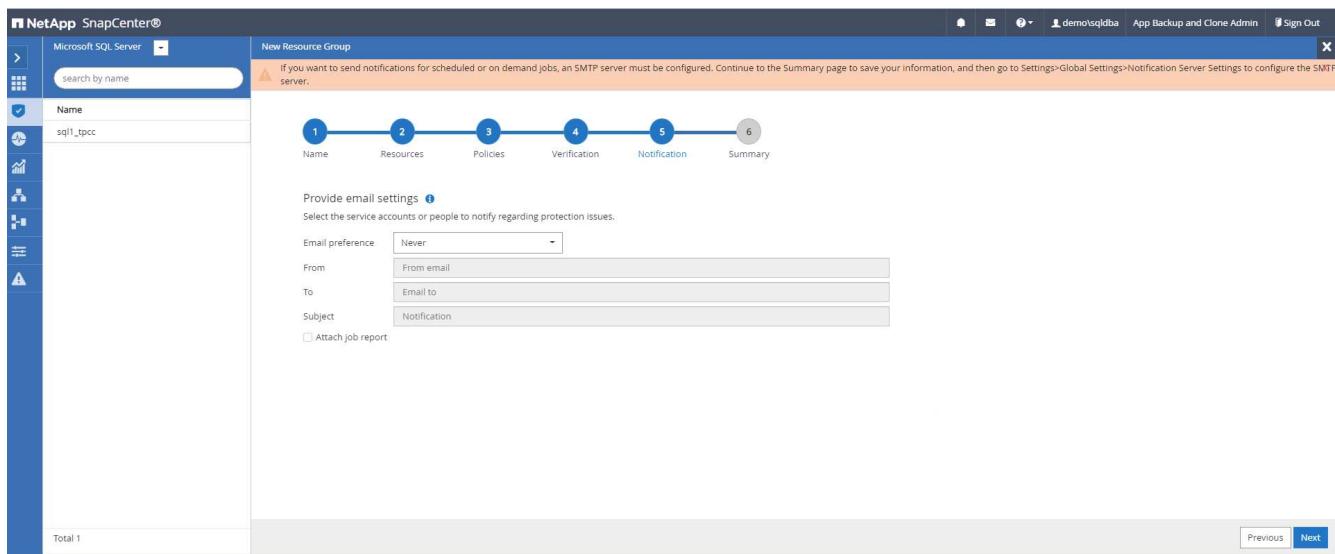
4. Add exact timing for the backup as well as the frequency.



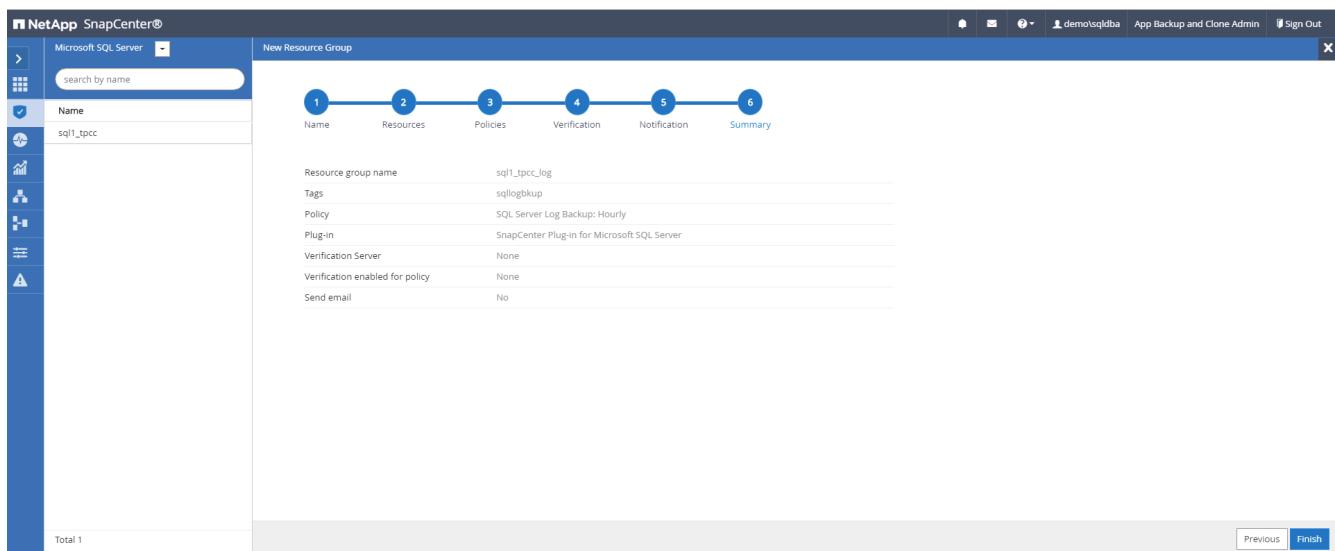
5. Choose the verification server for the backup on secondary if backup verification is to be performed. Click the Load Locator to populate the secondary storage location.



6. Configure the SMTP server for email notification if desired.



7. Summary.



9. Validate backup

After database backup resource groups are created to protect database resources, the backup jobs runs according to the predefined schedule. Check the job execution status under the Monitor tab.

Jobs		Schedules	Events	Logs								
		Dashboard	search by name									
Resources												
Monitor	ID	Status	Name									
Reports	532	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 8:35:01 PM	09/14/2021 8:37:10 PM	demo\sqldba				
Hosts	528	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 7:35:01 PM	09/14/2021 7:37:09 PM	demo\sqldba				
Storage Systems	524	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 6:35:01 PM	09/14/2021 6:37:08 PM	demo\sqldba				
Settings	521	✓	Backup of Resource Group 'sql1_tpcc' with policy 'SQL Server Full Backup'			09/14/2021 6:25:01 PM	09/14/2021 6:27:14 PM	demo\sqldba				
Alerts	517	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 5:35:01 PM	09/14/2021 5:37:09 PM	demo\sqldba				
	513	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 4:35:01 PM	09/14/2021 4:37:08 PM	demo\sqldba				
	509	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 3:35:01 PM	09/14/2021 3:37:09 PM	demo\sqldba				
	503	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'			09/14/2021 2:35:01 PM	09/14/2021 2:37:09 PM	demo\sqldba				

Go to the Resources tab, click the database name to view details of database backup, and toggle between Local copies and mirror copies to verify that Snapshot backups are replicated to a secondary location in the

public cloud.

The screenshot shows the NetApp SnapCenter interface for Oracle Database management. On the left, a sidebar lists databases: cdb2, cdb2dev, cdb2dr, cdb2dr2, and cdb2test. The main panel displays 'cdb2 Topology' with a 'Manage Copies' section showing 'Local copies' (197 Backups, 0 Clones) and 'Mirror copies' (197 Backups, 3 Clones). A 'Summary Card' on the right provides statistics: 394 Backups, 28 Data Backups, 366 Log Backups, and 3 Clones. Below these sections is a table titled 'Primary Backup(s)' listing several backups with columns for Count, Type, End Date, Verified, Mounted, RMAN Cataloged, and SCN.

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_09-23-2021_14.35.03.3242_1	1	Log	09/23/2021 2:35:45 PM	Not Applicable	False	Not Cataloged	6872761
rhel2_cdb2_09-23-2021_14.35.03.3242_0	1	Data	09/23/2021 2:35:30 PM	Unverified	False	Not Cataloged	6872715
rhel2_cdb2_09-22-2021_14.35.02.0014_1	1	Log	09/22/2021 2:35:24 PM	Not Applicable	False	Not Cataloged	6737479
rhel2_cdb2_09-22-2021_14.35.02.0014_0	1	Data	09/22/2021 2:35:14 PM	Unverified	False	Not Cataloged	6737395
rhel2_cdb2_09-21-2021_14.35.02.1884_1	1	Log	09/21/2021 2:35:35 PM	Not Available	False	Not Cataloged	6598735

At this point, database backup copies in the cloud are ready to clone to run dev/test processes or for disaster recovery in the event of a primary failure.

Next: [Getting Started with AWS public cloud](#).

Getting Started with AWS public cloud

Previous: [Getting started on-premises](#).

AWS public cloud



To make things easier to follow, we have created this document based on a deployment in AWS. However, the process is very similar for Azure and GCP.

1. Pre-flight check

Before deployment, make sure that the infrastructure is in place to allow for the deployment in the next stage. This includes the following:

- AWS account
- VPC in your region of choice
- Subnet with access to the public internet
- Permissions to add IAM roles into your AWS account
- A secret key and access key for your AWS user

2. Steps to deploy Cloud Manager and Cloud Volumes ONTAP in AWS



There are many methods for deploying Cloud Manager and Cloud Volumes ONTAP; this method is the simplest but requires the most permissions. If this method is not appropriate for your AWS environment, please consult the [NetApp Cloud Documentation](#).

Deploy the Cloud Manager connector

1. Navigate to [NetApp Cloud Central](#) and log in or sign up.



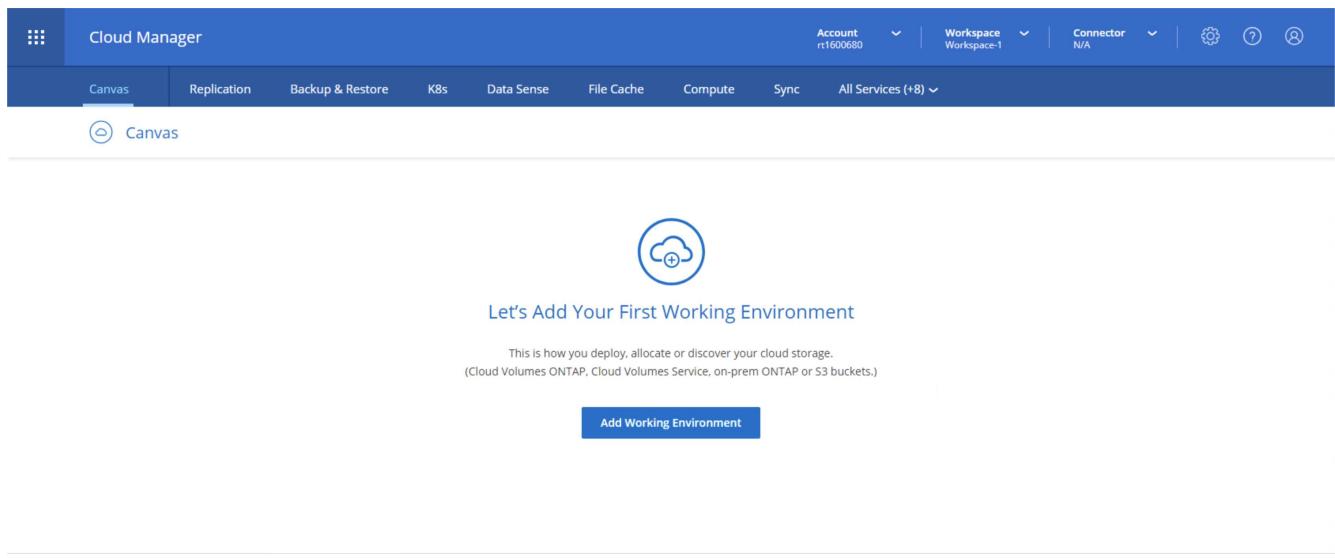
[Continue to Cloud Manager](#)

Log In to NetApp Cloud Central

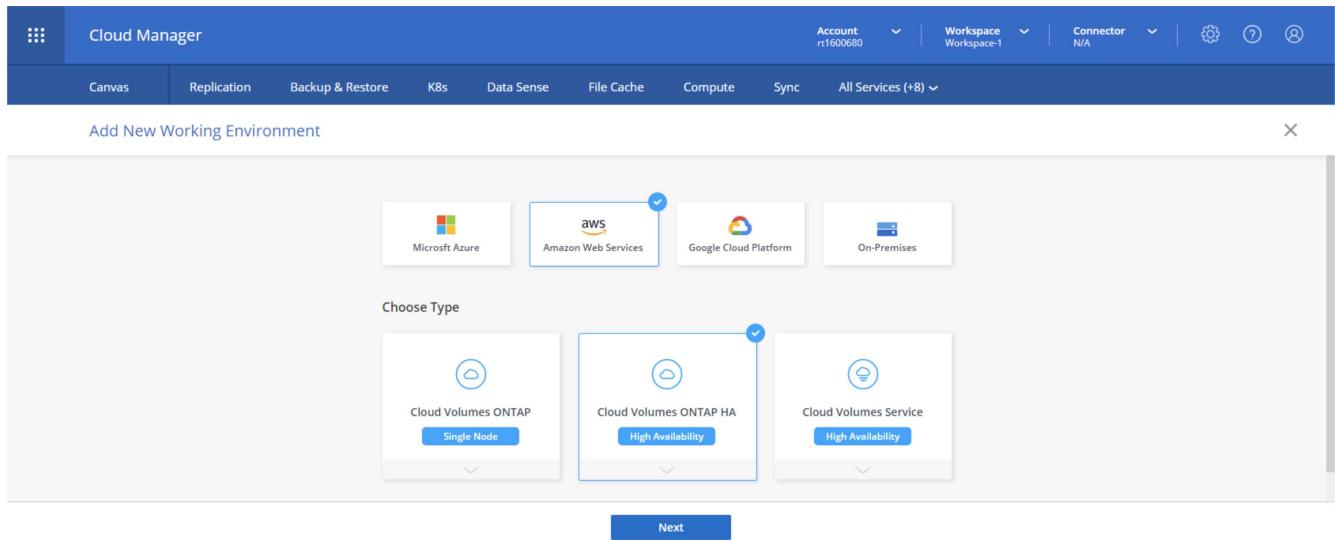
Don't have an account yet? [Sign Up](#)

[Forgot your password?](#)

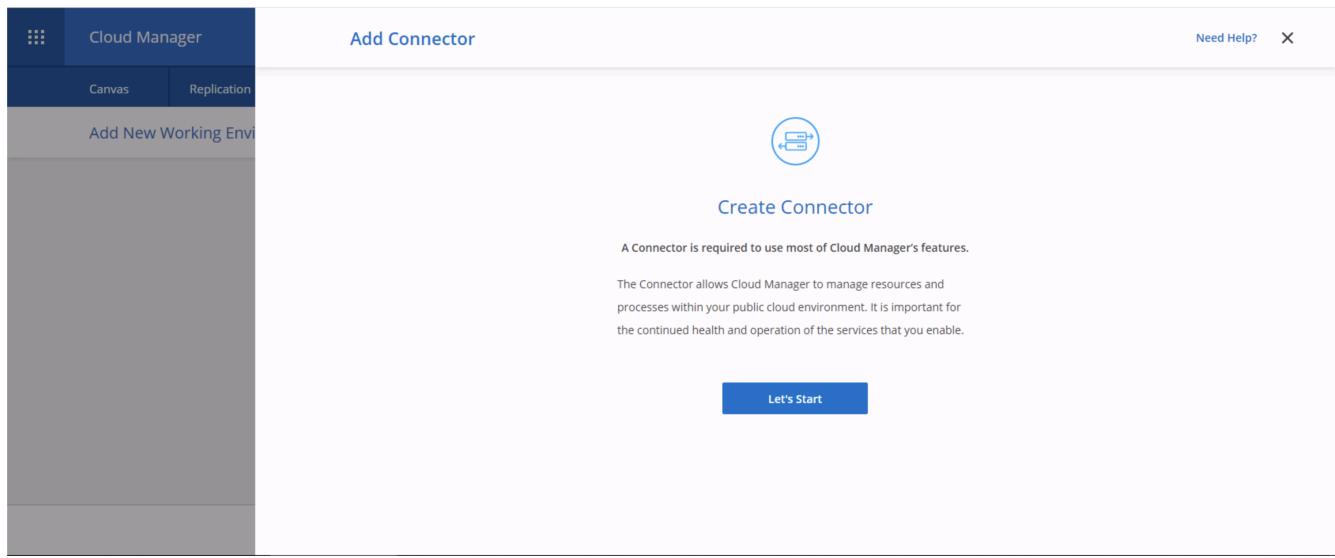
2. After you log in, you should be taken to the Canvas.



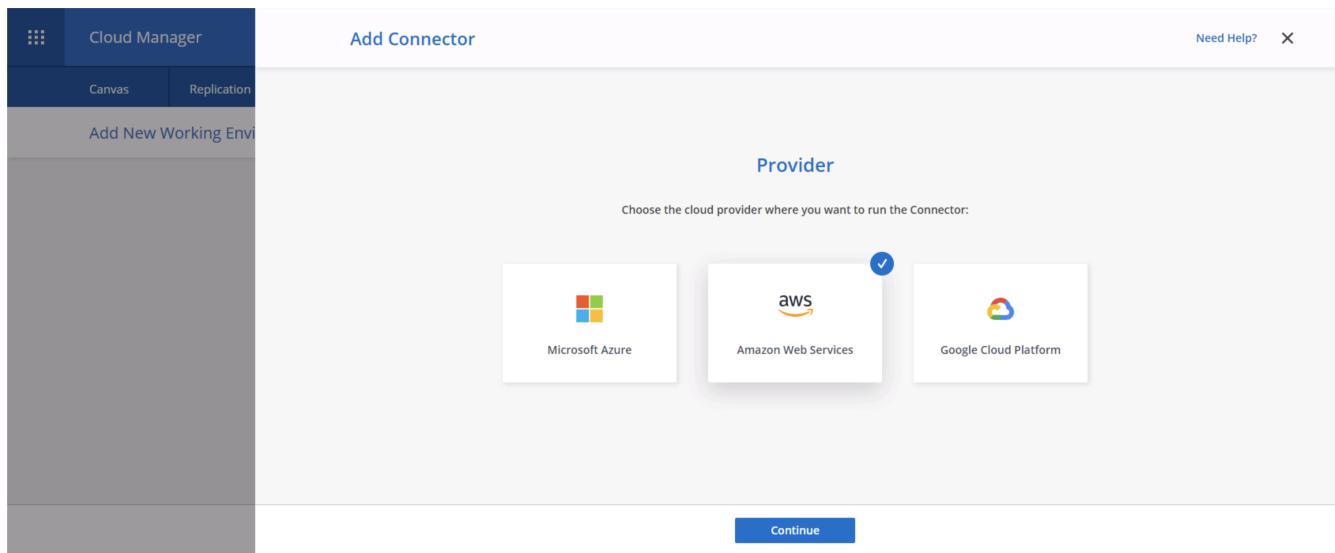
3. Click "Add Working Environment" and choose Cloud Volumes ONTAP in AWS. Here, you also choose whether you want to deploy a single node system or a high availability pair. I have chosen to deploy a high availability pair.



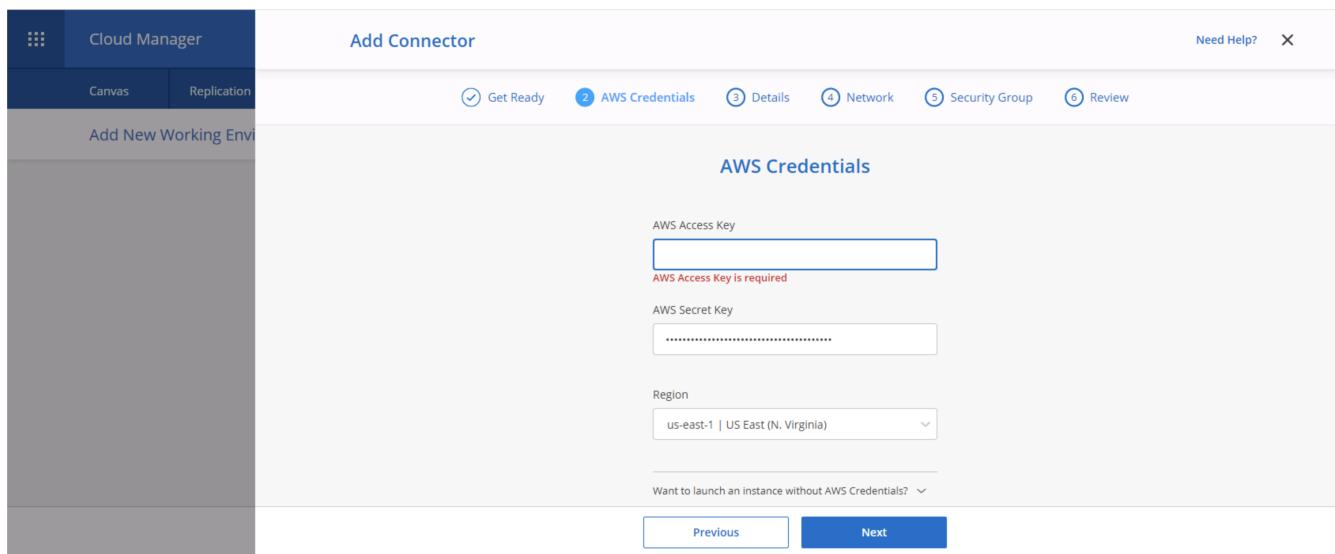
4. If no connector has been created, a pop-up appears asking you to create a connector.



5. Click Lets Start, and then choose AWS.



6. Enter your secret key and access key. Make sure that your user has the correct permissions outlined on the [NetApp policies page](#).



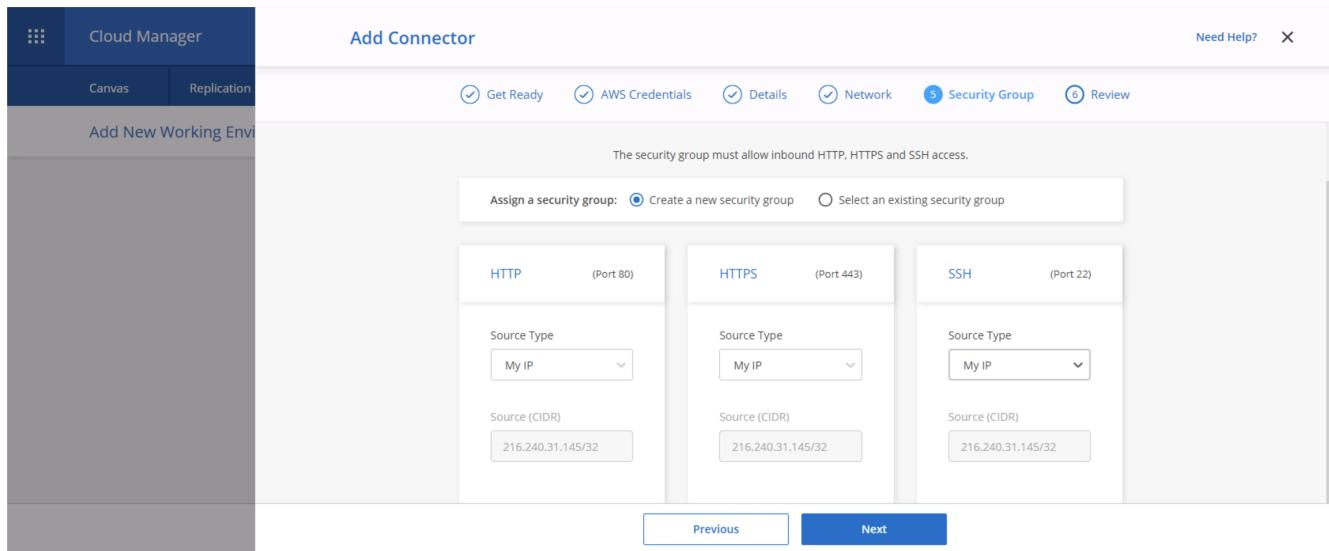
7. Give the connector a name and either use a predefined role as described on the [NetApp policies page](#) or ask Cloud Manager to create the role for you.

The screenshot shows the 'Add Connector' interface in Cloud Manager. The 'Details' step is active. A 'Connector Instance Name' field contains 'awscloudmanager'. Under 'Connector Role', the 'Create Role' option is selected, and a 'Role Name' field contains 'Cloud-Manager-Operator-IBNt24'. At the bottom are 'Previous' and 'Next' buttons.

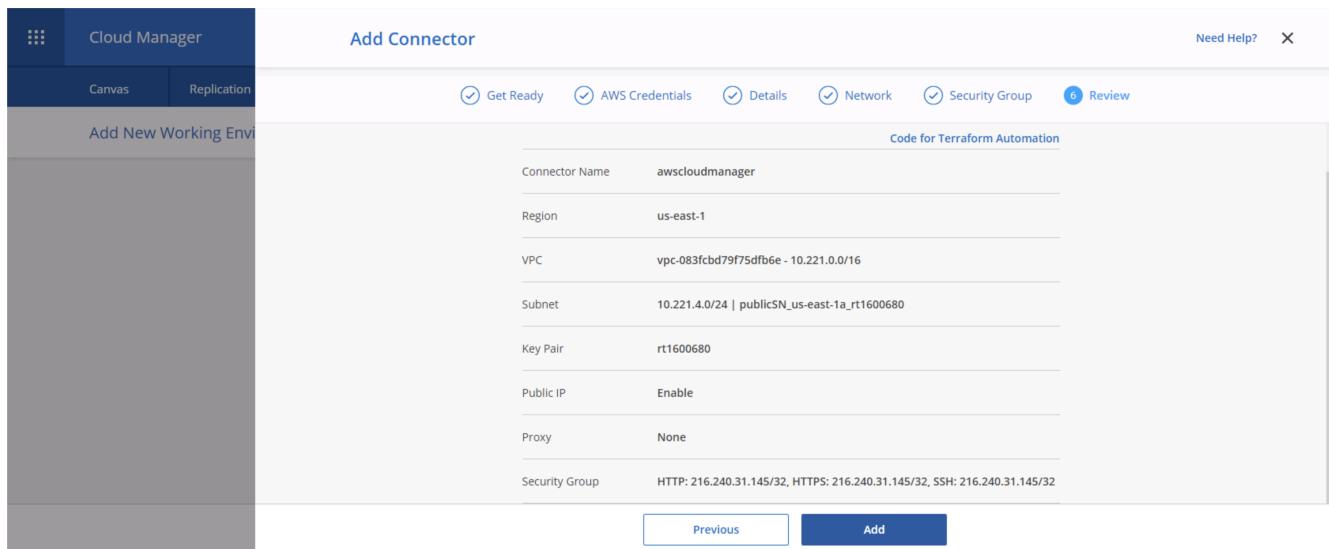
8. Give the networking information needed to deploy the connector. Verify that outbound internet access is enabled by:
- Giving the connector a public IP address
 - Giving the connector a proxy to work through
 - Giving the connector a route to the public internet through an Internet Gateway

The screenshot shows the 'Network' step of the 'Add Connector' process. It includes fields for 'VPC' (set to 'vpc-083fcbd79f75dfb6e - 10.221.0.0/16') and 'Subnet' (set to '10.221.4.0/24 | publicSN_us-east-1a_rt1600...'). There is also a section for 'Proxy Configuration (Optional)' with a placeholder 'HTTP Proxy' field. At the bottom are 'Previous' and 'Next' buttons.

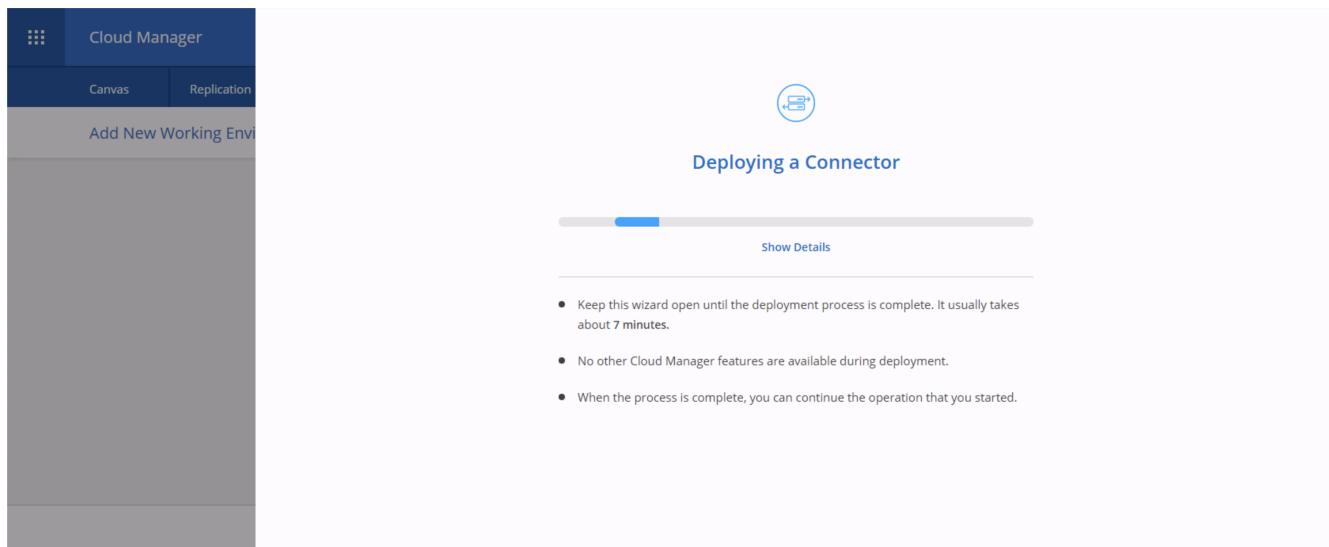
9. Provide communication with the connector via SSH, HTTP, and HTTPS by either providing a security group or creating a new security group. I have enabled access to the connector from my IP address only.



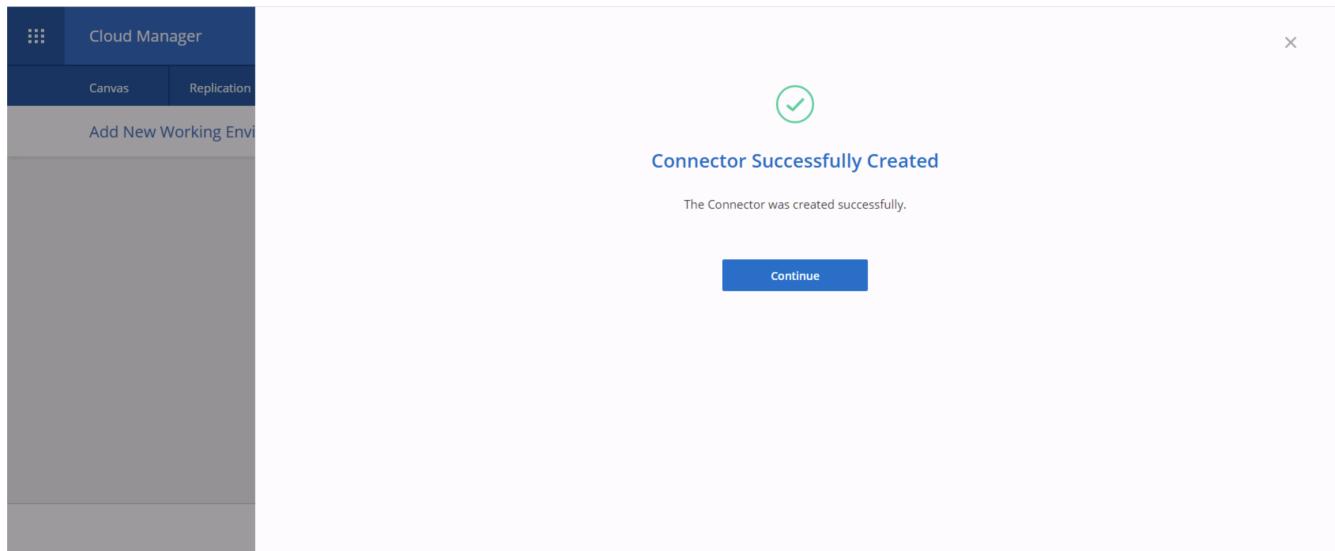
10. Review the information on the summary page and click Add to deploy the connector.



11. The connector now deploys using a cloud formation stack. You can monitor its progress from Cloud Manager or through AWS.

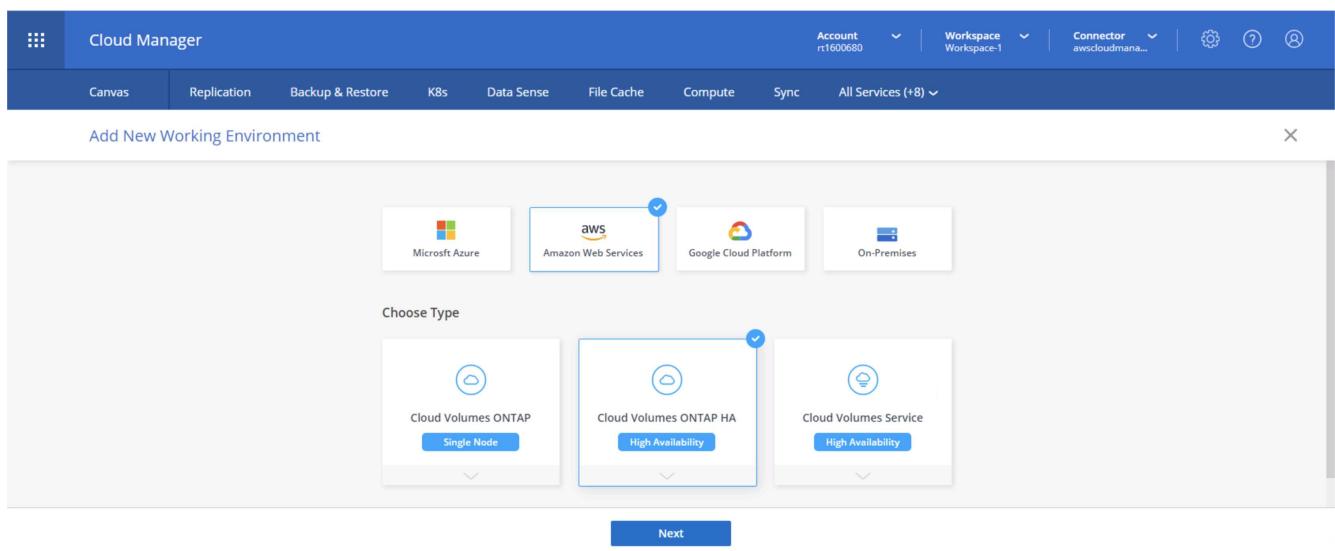


12. When the deployment is complete, a success page appears.



Deploy Cloud Volumes ONTAP

1. Select AWS and the type of deployment based on your requirements.



2. If no subscription has been assigned and you wish to purchase with PAYGO, choose Edit Credentials.

The screenshot shows the 'Cloud Manager' interface with the 'Create a New Working Environment' step selected. At the top, there are account, workspace, and connector dropdowns. Below the header, a navigation bar includes 'Canvas', 'Replication', 'Backup & Restore', 'K8s', 'Data Sense', 'File Cache', 'Compute', 'Sync', and 'All Services (+8)'. The main area displays 'Details and Credentials' for an instance profile. It shows an 'Instance Profile' section with 'Credential Name' set to '322944748816' and 'Account ID' set to 'rt1600680'. A note indicates 'No subscription is associated'. To the right, there's a 'Marketplace Subscription' section with a 'User Name' field containing 'admin'. Below this are fields for 'Password' and 'Confirm Password'. A 'Continue' button is at the bottom. The footer shows the build information: 'Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC'.

3. Choose Add Subscription.

The screenshot shows the 'Edit Credentials & Add Subscription' step. The 'Associate Subscription to Credentials' section is visible, showing 'Instance Profile | Account ID: 322944748816'. A note says 'No subscription is associated with this credential'. Below this is a 'Marketplace Subscription' section with a 'User Name' field containing 'admin'. A 'Add Subscription' button is present. At the bottom are 'Apply' and 'Cancel' buttons. The footer shows the build information: 'Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC'.

4. Choose the type of contract that you wish to subscribe to. I chose Pay-as-you-go.

The screenshot shows the 'Edit Credentials & Add Subscription' step with the 'Pay-as-you-go' contract selected. The note 'Select a subscription option and click Continue. The AWS Marketplace enables you to view pricing details and then subscribe.' is displayed. Two options are shown: 'Pay-Per-TiB - Annual Contract' and 'Pay-as-you-go'. Below this, a 'The next steps:' section lists: 1. AWS Marketplace (Subscribe and then click Set Up Your Account to configure your account.) and 2. Cloud Manager (Save your subscription and associate the Marketplace subscription with your AWS credentials.). At the bottom are 'Continue' and 'Cancel' buttons. The footer shows the build information: 'Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC'.

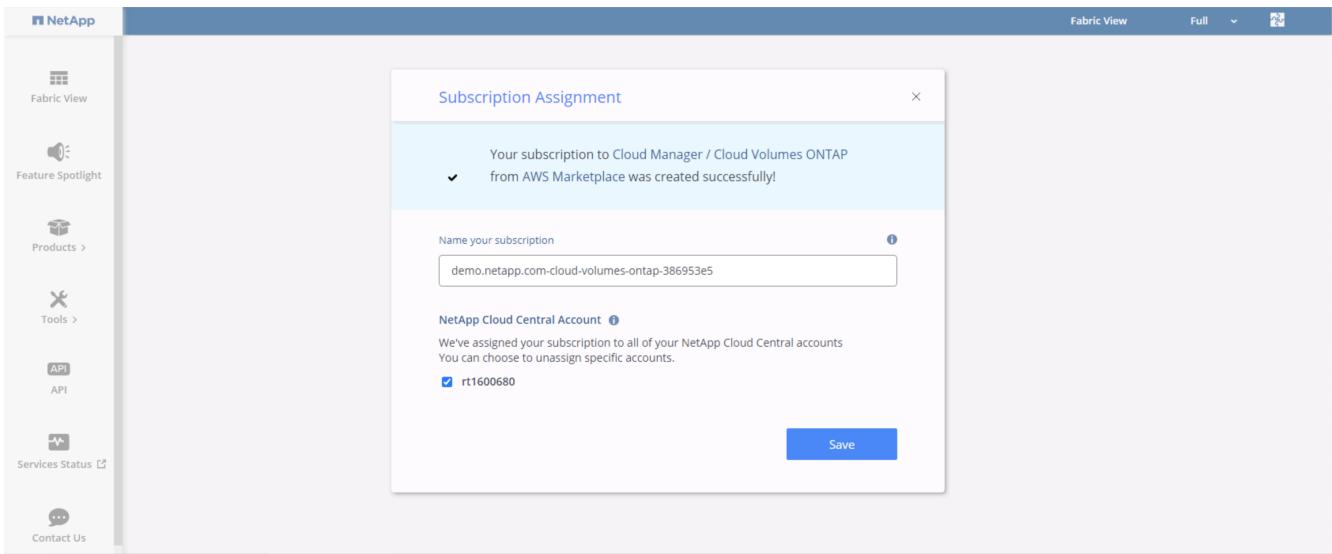
5. You are redirected to AWS; choose Continue to Subscribe.

The screenshot shows the AWS Marketplace product page for 'Cloud Manager - Deploy & Manage NetApp Cloud Data Services' by NetApp, Inc. The page includes a search bar, navigation links, and a 'Continue to Subscribe' button. The product overview section details its features, including Cloud Volumes ONTAP, Cloud Backup, Cloud Tiering, and Cloud Data Sense. A 'Highlights' box lists benefits such as streamlining deployment and centralizing management. Tabs for Overview, Pricing, Usage, Support, and Reviews are visible at the bottom.

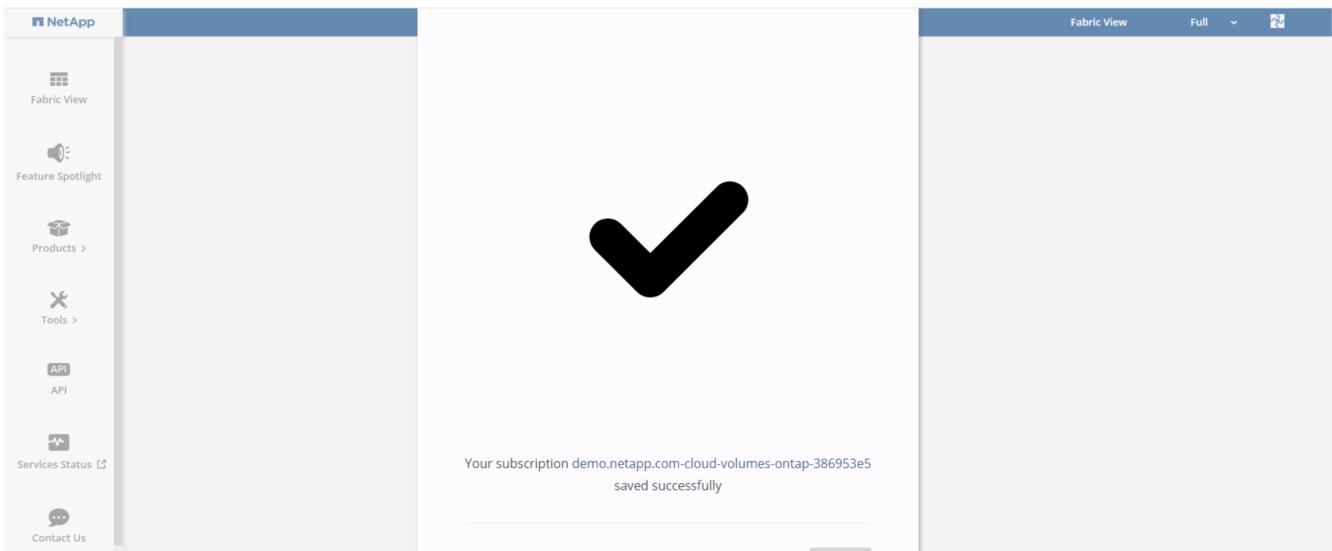
6. Subscribe and you are redirected back to NetApp Cloud Central. If you have already subscribed and don't get redirected, choose the "Click here" link.

The screenshot shows a confirmation page from the AWS Marketplace regarding a private offer for 'Cloud Manager - Deploy & Manage NetApp Cloud Data Services'. It indicates that the user is subscribed to the offer and provides details about the offer's expiration on August 1, 2022 UTC. A message box offers help for users having issues signing up. A 'Subscribe' button is present at the bottom, along with a note about agreeing to the End User License Agreement (EULA).

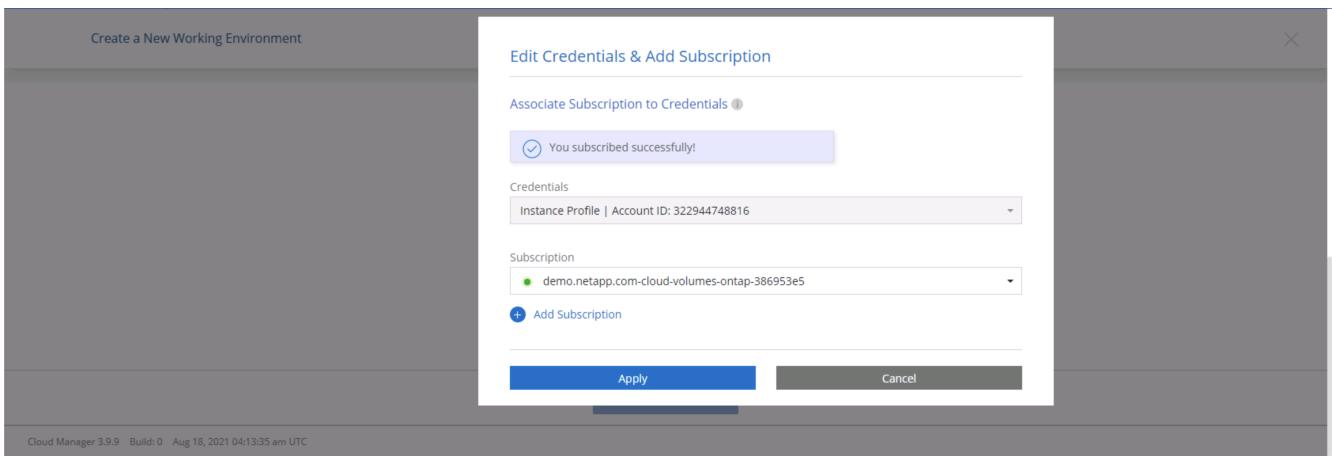
7. You are redirected to Cloud Central where you must name your subscription and assign it to your Cloud Central account.



- When successful, a check mark page appears. Navigate back to your Cloud Manager tab.



- The subscription now appears in Cloud Central. Click Apply to continue.



- Enter the working environment details such as:

- Cluster name

b. Cluster password

c. AWS tags (Optional)

The screenshot shows the 'Cloud Manager' interface with the title 'Create a New Working Environment'. The 'Details and Credentials' tab is selected. On the left, there's a 'Previous Step' button and an 'Instance Profile' section with fields for '322944748816' and 'demo.netapp.com-cloud-vol...'. On the right, there's a 'Workspace' section with 'Account rt1600680', 'Workspace Workspace-1', and 'Connector awscloudman...'. Below these are 'Edit Credentials' and 'Details' sections. The 'Details' section contains a 'Working Environment Name (Cluster Name)' field with 'hybridawscvo'. The 'Credentials' section contains 'User Name' (admin), 'Password' (*****), and 'Confirm Password' (*****). A 'Continue' button is at the bottom.

11. Choose which additional services you would like to deploy. To discover more about these services, visit the [NetApp Cloud Homepage](#).

The screenshot shows the 'Cloud Manager' interface with the title 'Create a New Working Environment'. The 'Services' tab is selected. On the left, there's a 'Previous Step' button. Below it are three service options: 'Data Sense & Compliance' (with a toggle switch turned on), 'Backup to Cloud' (with a toggle switch turned on), and 'Monitoring' (with a toggle switch turned on). At the bottom is a 'Continue' button.

12. Choose whether to deploy in multiple availability zones (requires three subnets, each in a different AZ), or a single availability zone. I chose multiple AZs.

The screenshot shows the Cloud Manager interface with the title "Cloud Manager" at the top. The top navigation bar includes "Account: rt1600680", "Workspace: Workspace-1", "Connector: awscloudman...", and icons for gear, help, and refresh. Below the top bar, there are tabs for "Canvas", "Replication", "Backup & Restore", "K8s", "Data Sense", "File Cache", "Compute", "Sync", and "All Services (+8)". A sub-header "Create a New Working Environment" is followed by "HA Deployment Models". Two comparison boxes are shown: "Multiple Availability Zones" and "Single Availability Zone". Each box lists pros and cons and has a "Extended Info" link.

Multiple Availability Zones

- Provides maximum protection against AZ failures.
- Enables selection of 3 availability zones.
- An HA node serves data if its partner goes offline.

Single Availability Zone

- Protects against failures within a single AZ.
- Single availability zone. HA nodes are in a placement group, spread across distinct underlying hardware.
- An HA node serves data if its partner goes offline.

Extended Info

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

13. Choose the region, VPC, and security group for the cluster to be deployed into. In this section, you also assign the availability zones per node (and mediator) as well as the subnets that they occupy.

The screenshot shows the Cloud Manager interface with the title "Cloud Manager" at the top. The top navigation bar includes "Account: rt1600680", "Workspace: Workspace-1", "Connector: awscloudman...", and icons for gear, help, and refresh. Below the top bar, there are tabs for "Canvas", "Replication", "Backup & Restore", "K8s", "Data Sense", "File Cache", "Compute", "Sync", and "All Services (+8)". A sub-header "Create a New Working Environment" is followed by "Region & VPC". Configuration fields include "AWS Region: US East | N. Virginia", "VPC: vpc-083fcbd79f75dfb6e - 10.221.0.0/16", and "Security group: Use a generated security group". Below these are three sections for "Node 1", "Node 2", and "Mediator", each with "Availability Zone" and "Subnet" dropdowns. The "Subnet" dropdown for the "Mediator" section is highlighted. A "Continue" button is at the bottom.

AWS Region: US East | N. Virginia

VPC: vpc-083fcbd79f75dfb6e - 10.221.0.0/16

Security group: Use a generated security group

Node 1:

Availability Zone: us-east-1a

Subnet: 10.221.1.0/24

Node 2:

Availability Zone: us-east-1b

Subnet: 10.221.2.0/24

Mediator:

Availability Zone: us-east-1c

Subnet: 10.221.3.0/24

Continue

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

14. Choose the connection methods for the nodes as well as the mediator.

The screenshot shows the Cloud Manager interface with the title "Cloud Manager" at the top. The top navigation bar includes "Account: rt1600680", "Workspace: Workspace-1", "Connector: awscloudman...", and icons for gear, help, and refresh. Below the top bar, there are tabs for "Canvas", "Replication", "Backup & Restore", "K8s", "Data Sense", "File Cache", "Compute", "Sync", and "All Services (+8)". A sub-header "Create a New Working Environment" is followed by "Connectivity & SSH Authentication". Configuration fields include "Nodes: SSH Authentication Method: Password" and "Mediator: Security Group: Use a generated security group", "Key Pair Name: rt1600680", and "Internet Connection Method: Public IP address". A "Continue" button is at the bottom.

Nodes: SSH Authentication Method: Password

Mediator:

Security Group: Use a generated security group

Key Pair Name: rt1600680

Internet Connection Method: Public IP address

Continue

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC



The mediator requires communication with the AWS APIs. A public IP address is not required so long as the APIs are reachable after the mediator EC2 instance has been deployed.

1. Floating IP addresses are used to allow access to the various IP addresses that Cloud Volumes ONTAP uses, including cluster management and data serving IPs. These must be addresses that are not already routable within your network and are added to route tables in your AWS environment. These are required to enable consistent IP addresses for an HA pair during failover. More information about floating IP addresses can be found in the [NetApp Cloud Documentation](#).

The screenshot shows the 'Cloud Manager' interface with the 'Floating IPs' step selected. It includes fields for specifying floating IP addresses for cluster management, NFS/CIFS data, SVM management, and an optional floating IP address. A note explains that floating IPs can migrate between HA nodes if failures occur, and it's recommended to set up an AWS transit gateway. A 'Continue' button is at the bottom.

2. Select which route tables the floating IP addresses are added to. These route tables are used by clients to communicate with Cloud Volumes ONTAP.

The screenshot shows the 'Cloud Manager' interface with the 'Route Tables' step selected. It lists two route tables: 'private_rt_rt1600680' and 'public_rt_rt1600680'. Both are checked. A note states that selecting route tables enables client access to the HA pair. An 'Additional Information' link is available. A 'Continue' button is at the bottom.

3. Choose whether to enable AWS managed encryption or AWS KMS to encrypt the ONTAP root, boot, and data disks.

Cloud Manager

Account: rt1600680 | Workspace: Workspace-1 | Connector: awscloudman...

Canvas | Replication | Backup & Restore | K8s | Data Sense | File Cache | Compute | Sync | All Services (+8) | [Create a New Working Environment](#) | [Data Encryption](#) | [X](#)

↑ Previous Step | AWS Managed Encryption

AWS is responsible for data encryption and decryption operations. Key management is handled by AWS key management services.

Default Master Key: aws/ebs

[Continue](#)

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

4. Choose your licensing model. If you don't know which to choose, contact your NetApp representative.

Cloud Manager

Account: rt1600680 | Workspace: Workspace-1 | Connector: awscloudman...

Canvas | Replication | Backup & Restore | K8s | Data Sense | File Cache | Compute | Sync | All Services (+8) | [Create a New Working Environment](#) | [Cloud Volumes ONTAP Charging Methods & NSS Account](#) | [X](#)

↑ Previous Step | Cloud Volumes ONTAP Charging Methods

[Learn more about our charging methods](#)

Pay-As-You-Go by the hour

Bring your own license

Freemium (Up to 500GB)

NetApp Support Site Account (*Optional*)

[Learn more about NetApp Support Site \(NSS\) accounts](#)

To register this Cloud Volumes ONTAP to support, you should add NetApp Support Site Account.

Don't have a NetApp Support Site account? Select go to finish deploying this system. After it's created, use the Support Registration option to create an NSS account.

[Add Netapp Support Site Account](#)

[Continue](#)

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

5. Select which configuration best suits your use case. This is related to the sizing considerations covered in the prerequisites page.

Cloud Manager

Account: rt1600680 | Workspace: Workspace-1 | Connector: awscloudman...

Canvas | Replication | Backup & Restore | K8s | Data Sense | File Cache | Compute | Sync | All Services (+8) | [Create a New Working Environment](#) | [Preconfigured Packages](#) | [X](#)

↑ Previous Step | Select a preconfigured Cloud Volumes ONTAP system that best matches your needs, or create your own configuration. Preconfigured settings can be modified at a later time. | [Change Configuration](#)

 POC and small workloads
Up to 2TB of storage

 Database and application data production workloads
Up to 10TB of storage

 Cost effective DR
Up to 10TB of storage

 Highest performance production workloads
Up to 368TB of storage

[Continue](#)

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

6. Optionally, create a volume. This is not required, because the next steps use SnapMirror, which creates the volumes for us.

Cloud Manager

Create a New Working Environment Create Volume

↑ Previous Step Details & Protection Protocol

Volume Name: Size (GB): Volume size

Snapshot Policy: default

Access Control: Custom export policy

Custom export policy: 10.221.0.0/16

Advanced options

Continue Skip

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

7. Review the selections made and tick the boxes to verify that you understand that Cloud Manager deploys resources into your AWS environment. When ready, click Go.

Cloud Manager

Create a New Working Environment Review & Approve

↑ Previous Step hybridawsvco Show API request

AWS | us-east-1 | HA

I understand that in order to activate support, I must first register Cloud Volumes ONTAP with NetApp. [More information >](#)

I understand that Cloud Manager will allocate the appropriate AWS resources to comply with my above requirements. [More information >](#)

Overview Networking Storage

Storage System: Cloud Volumes ONTAP HA HA Deployment Model: Multiple Availability Zones

License Type: Cloud Volumes ONTAP Standard Encryption: AWS Managed

Capacity Limit: 10TB Customer Master Key: aws/ebs

Go

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

8. Cloud Volumes ONTAP now starts its deployment process. Cloud Manager uses AWS APIs and cloud formation stacks to deploy Cloud Volumes ONTAP. It then configures the system to your specifications, giving you a ready-to-go system that can be instantly utilized. The timing for this process varies depending on the selections made.

The screenshot shows the Cloud Manager Canvas interface. At the top, there are tabs for Canvas, Replication, Backup & Restore, K8s, Data Sense, File Cache, Compute, Sync, and All Services (+8). The Canvas tab is selected. In the center, there's a diagram of a hybrid cluster named 'hybridawsenv'. It consists of two clouds: one labeled 'Cloud Volumes ONTAP' with 'HA' and 'Initializing' status, and another labeled 'Amazon S3' with '1 Buckets' and '1 Region'. To the right, a section titled 'Working environments' lists '1 Cloud Volumes ONTAP (High-Availability)' and '0 B Allocated Capacity'. Below the diagram are zoom-in and zoom-out buttons.

9. You can monitor the progress by navigating to the Timeline.

The screenshot shows the Cloud Manager main dashboard. At the top, there are tabs for Canvas, Replication, Backup & Restore, K8s, Data Sense, File Cache, Compute, Sync, and All Services (+8). The Canvas tab is selected. The dashboard is divided into sections: 'Resources' (Canvas, Digital Wallet, Timeline), 'Services' (Replication, Backup & Restore, K8s, Data Sense, Compliance, Tiering, Monitoring, File Cache, Compute, Sync, SnapCenter, Active IQ), and a bottom navigation bar with a link to the Timeline at <https://cloudmanager.netapp.com/timeline>.

10. The Timeline acts as an audit of all actions performed in Cloud Manager. You can view all of the API calls that are made by Cloud Manager during setup to both AWS as well as the ONTAP cluster. This can also be effectively used to troubleshoot any issues that you face.

The screenshot shows the Cloud Manager interface with the 'Timeline' tab selected. At the top, there are filters for Time, Service, Action, Agent, Resource, User, and Status, with 'Agent (1)' currently selected. The timeline table lists three events:

Time	Action	Service	Agent	Resource	User	Status
Aug 18 2021, 9:42:32 pm	Check Connectivity	Cloud Manager	awscloudman...	hybridawscvo	Full Name	Success
Aug 18 2021, 9:42:00 pm	Create Aws Ha Working Environment	Cloud Manager	awscloudma...	hybridawscvo	Full Name	Pending
Aug 18 2021, 10:09:39 pm	Describe Operation Status					Success
Aug 19 2021, 10:00:20 pm	Describe Operation Status					Success

- After deployment is complete, the CVO cluster appears on the Canvas, which the current capacity. The ONTAP cluster in its current state is fully configured to allow a true, out-of-the-box experience.

The screenshot shows the Cloud Manager interface with the 'Canvas' tab selected. On the left, there's a cloud icon labeled 'Add Working Environment'. In the center, there are two clouds representing environments: one for 'Cloud Volumes ONTAP' (labeled 'hybridawscvo' and '1 GiB Capacity') and one for 'Amazon S3' (labeled '2 Buckets' and '1 Region'). On the right, a sidebar titled 'Working environments' lists the resources:

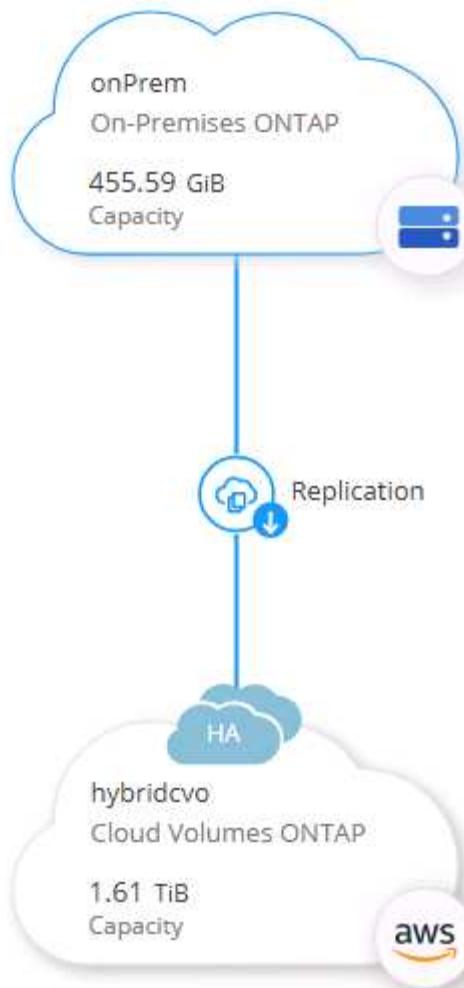
- 1 Cloud Volumes ONTAP (High-Availability)
1 GiB Allocated Capacity
- 1 Amazon S3
0 Buckets

Configure SnapMirror from on-premises to cloud

Now that you have a source ONTAP system and a destination ONTAP system deployed, you can replicate volumes containing database data into the cloud.

For a guide on compatible ONTAP versions for SnapMirror, see the [SnapMirror Compatibility Matrix](#).

- Click the source ONTAP system (on-premises) and either drag and drop it to the destination, select Replication > Enable, or select Replication > Menu > Replicate.



Select Enable.



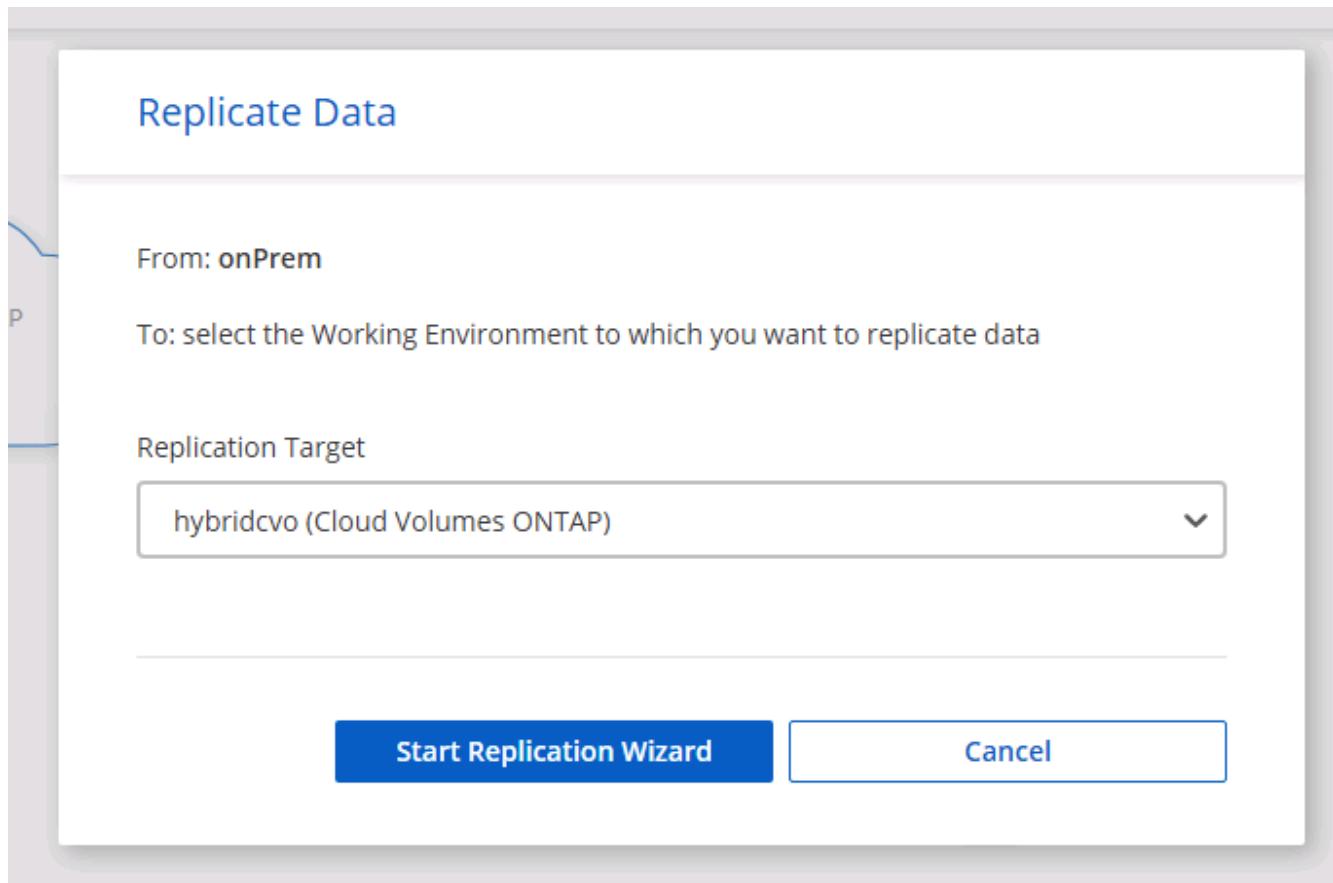
Or Options.

The screenshot shows the configuration of the 'onPrem' cluster. At the top, there is a circular icon with two servers, followed by the text 'onPrem' and a green square indicating 'On'. To the right are three blue circular icons with symbols for information, more options, and delete. Below this, the word 'DETAILS' is in bold. Under 'DETAILS', the text 'On-PremisesONTAP' is shown. In the 'SERVICES' section, there is another circular icon with a cloud and server, followed by the text 'Replication' and a green square indicating 'On'. To the right, it says '1 Replication Target' with a blue circular icon containing three dots. A horizontal line separates this from the next section.

Replicate.

This screenshot is similar to the first one but includes a dropdown menu for the 'Replication' service. The 'Replication' section is expanded, showing '1 Replication Target'. A dropdown menu is open over this section, containing two items: 'View Replications' (with a list icon) and 'Replicate' (with a circular arrow icon). The rest of the interface is identical to the first screenshot.

2. If you did not drag and drop, choose the destination cluster to replicate to.



3. Choose the volume that you'd like to replicate. We replicated the data and all log volumes.

Replication Setup				Source Volume Selection			
rhel2_u03	INFO Storage VM Name: svm_onPrem Tiering Policy: None Volume Type: RW	CAPACITY 100 GB Allocated / 7.29 GB Disk Used	ONLINE	rhel2_u03 09232119421203118	INFO Storage VM Name: svm_onPrem Tiering Policy: None Volume Type: RW	CAPACITY 100 GB Allocated / 35.83 MB Disk Used	ONLINE
sql1_data	INFO Storage VM Name: svm_onPrem Tiering Policy: None Volume Type: RW	CAPACITY 53.37 GB Allocated / 45.09 GB Disk Used	ONLINE	sql1_log	INFO Storage VM Name: svm_onPrem Tiering Policy: None Volume Type: RW	CAPACITY 21.35 GB Allocated / 18.16 GB Disk Used	ONLINE
sql1_snapctr	INFO Storage VM Name: svm_onPrem Tiering Policy: None Volume Type: RW	CAPACITY 24.87 GB Allocated / 21.23 GB Disk Used	ONLINE				
Cloud Manager 3.9.10 Build: 2 Sep 12, 2021 06:47:41 am UTC							

4. Choose the destination disk type and tiering policy. For disaster recovery, we recommend an SSD as the disk type and to maintain data tiering. Data tiering tiers the mirrored data into low-cost object storage and saves you money on local disks. When you break the relationship or clone the volume, the data uses the fast, local storage.

[↑ Previous Step](#)

Destination Disk Type



S3 Tiering

[What are storage tiers?](#) Enabled DisabledNote: If you enable S3 tiering, thin provisioning must be enabled on volumes created in this aggregate.[Continue](#)

Cloud Manager 3.9.10 Build:2 Sep 12, 2021 06:47:41 am UTC

5. Select the destination volume name: we chose [source_volume_name]_dr.

Destination Volume Name

Destination Volume Name

sql1_data_dr

Destination Aggregate

Automatically select the best aggregate ▾

6. Select the maximum transfer rate for the replication. This enables you to save bandwidth if you have a low bandwidth connection to the cloud such as a VPN.

Max Transfer Rate

You should limit the transfer rate. An unlimited rate might negatively impact the performance of other applications and it might impact your Internet performance.

Limited to:

100

MB/s

Unlimited (recommended for DR only machines)

7. Define the replication policy. We chose a Mirror, which takes the most recent dataset and replicates that into the destination volume. You could also choose a different policy based on your requirements.

Replication Policy

Default Policies

Additional Policies

Mirror

Typically used for disaster recovery

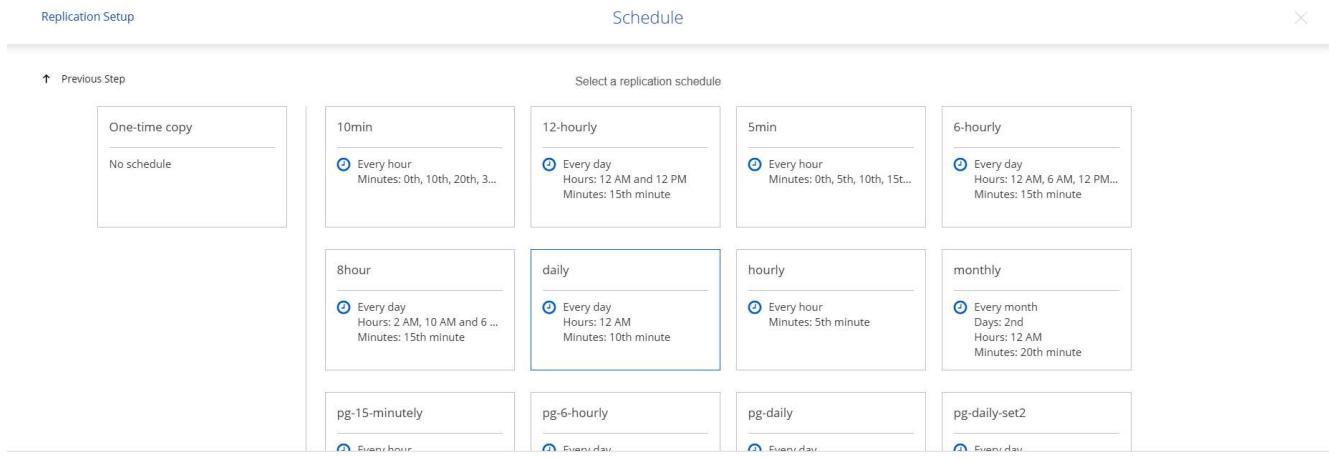
[More info](#)

Mirror and Backup (1 month retention)

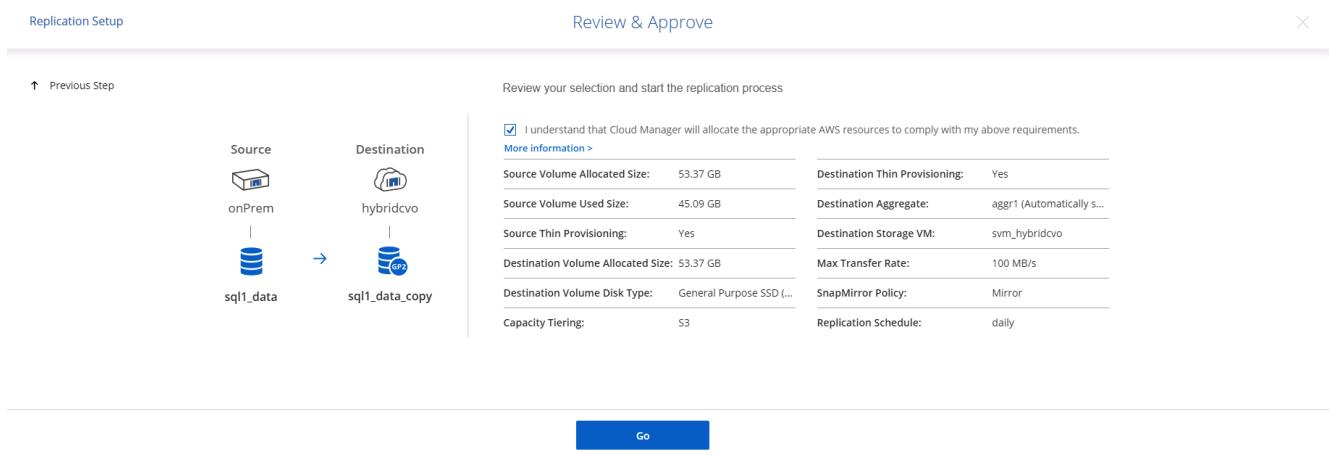
Configures disaster recovery and long-term retention of backups on the same destination volume

[More info](#)

8. Choose the schedule for triggering replication. NetApp recommends setting a "daily" schedule of for the data volume and an "hourly" schedule for the log volumes, although this can be changed based on requirements.



9. Review the information entered, click Go to trigger the cluster peer and SVM peer (if this is your first time replicating between the two clusters), and then implement and initialize the SnapMirror relationship.



10. Continue this process for data volumes and log volumes.

11. To check all of your relationships, navigate to the Replication tab inside Cloud Manager. Here you can manage your relationships and check on their status.

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer
✓	rhel2_u01 onPrem	rhel2_u01_dr hybridcvo	43 minutes 43 seconds	idle	snapmirrored	Sep 30, 2021, 12:12:50 AM 19.73 MB
✓	rhel2_u02 onPrem	rhel2_u02_dr hybridcvo	1 hour 37 minutes 59 seconds	idle	snapmirrored	Sep 30, 2021, 2:37:08 PM 239.78 MB
✓	rhel2_u03 onPrem	rhel2_u03_dr hybridcvo	16 hours 1 minute 9 seconds	idle	snapmirrored	Sep 30, 2021, 4:07:14 PM 225.37 kB
✓	sql1_data onPrem	sql1_data_dr hybridcvo	1 hour 6 minutes 50 seconds	idle	snapmirrored	Sep 30, 2021, 12:12:28 AM 24.56 kB

12. After all the volumes have been replicated, you are in a steady state and ready to move on to the disaster recovery and dev/test workflows.

3. Deploy EC2 compute instance for database workload

AWS has preconfigured EC2 compute instances for various workloads. The choice of instance type determines the number of CPU cores, memory capacity, storage type and capacity, and network performance. For the use cases, with the exception of the OS partition, the main storage to run database workload is allocated from CVO or the FSx ONTAP storage engine. Therefore, the main factors to consider are the choice of CPU cores, memory, and network performance level. Typical AWS EC2 instance types can be found here: [EC2 Instance Type](#).

Sizing the compute instance

1. Select the right instance type based on the required workload. Factors to consider include the number of business transactions to be supported, the number of concurrent users, data set sizing, and so on.
2. EC2 instance deployment can be launched through the EC2 Dashboard. The exact deployment procedures are beyond the scope of this solution. See [Amazon EC2](#) for details.

Linux instance configuration for Oracle workload

This section contain additional configuration steps after an EC2 Linux instance is deployed.

1. Add an Oracle standby instance to the DNS server for name resolution within the SnapCenter management domain.
2. Add a Linux management user ID as the SnapCenter OS credentials with sudo permissions without a password. Enable the ID with SSH password authentication on the EC2 instance. (By default, SSH password authentication and passwordless sudo is turned off on EC2 instances.)
3. Configure Oracle installation to match with on-premises Oracle installation such as OS patches, Oracle versions and patches, and so on.
4. NetApp Ansible DB automation roles can be leveraged to configure EC2 instances for database dev/test and disaster recovery use cases. The automation code can be download from the NetApp public GitHub site: [Oracle 19c Automated Deployment](#). The goal is to install and configure a database software stack on an EC2 instance to match on-premises OS and database configurations.

Windows instance configuration for SQL Server workload

This section lists additional configuration steps after an EC2 Windows instance is initially deployed.

1. Retrieve the Windows administrator password to log in to an instance via RDP.
2. Disable the Windows firewall, join the host to Windows SnapCenter domain, and add the instance to the DNS server for name resolution.
3. Provision a SnapCenter log volume to store SQL Server log files.
4. Configure iSCSI on the Windows host to mount the volume and format the disk drive.
5. Again, many of the previous tasks can be automated with the NetApp automation solution for SQL Server. Check the NetApp automation public GitHub site for newly published roles and solutions: [NetApp Automation](#).

[Next: Workflow for dev/test bursting to cloud.](#)

Workflow for dev/test bursting to cloud

[Previous: Getting Started with AWS public cloud.](#)

The agility of the public cloud, the time to value, and the cost savings are all meaningful value propositions for enterprises adopting the public cloud for database application development and testing effort. There is no better tool than SnapCenter to make this a reality. SnapCenter can not only protect your production database on-premises, but can also quickly clone a copy for application development or code testing in the public cloud while consuming very little extra storage. Following are details of the step-by-step processes for using this tool.

Clone an Oracle Database for dev/test from a replicated snapshot backup

1. Log into SnapCenter with a database management user ID for Oracle. Navigate to the Resources tab, which shows the Oracle databases being protected by SnapCenter.

Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com	rhel2_cdb2 rhel2_cdb2_log	Oracle Archive Log Backup Oracle Full Online Backup	09/17/2021 3:00:09 PM	Backup succeeded

2. Click the intended on-premises database name for the backup topology and the detailed view. If a secondary replicated location is enabled, it shows linked mirror backups.

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_log_09-17-2021_15.00.01.1317_1	1	Log	09/17/2021 3:00:10 PM	Not Applicable	False	Not Cataloged	5980203
rhel2_cdb2_09-17-2021_14.35.01.4997_1	1	Log	09/17/2021 2:35:21 PM	Not Applicable	False	Not Cataloged	5980629
rhel2_cdb2_09-17-2021_14.35.01.4997_0	1	Data	09/17/2021 2:35:12 PM	Unverified	False	Not Cataloged	5980588
rhel2_cdb2_log_09-17-2021_14.00.01.1042_1	1	Log	09/17/2021 2:00:10 PM	Not Applicable	False	Not Cataloged	5978388
rhel2_cdb2_log_09-17-2021_13.00.01.7389_1	1	Log	09/17/2021 1:00:11 PM	Not Applicable	False	Not Cataloged	5975135
rhel2_cdb2_log_09-17-2021_12.00.01.1142_1	1	Log	09/17/2021 12:00:10 PM	Not Applicable	False	Not Cataloged	5971773
rhel2_cdb2_log_09-17-2021_11.00.01.0895_1	1	Log	09/17/2021 11:00:10 AM	Not ...	False	Not Cataloged	5968474

3. Toggled to the mirrored backups view by clicking mirrored backups. The secondary mirror backup(s) is then displayed.

NetApp SnapCenter®

Oracle Database ▾

Search databases

cdb2 Topology

Manage Copies

Local copies

Mirror copies

Summary Card

368 Backups

16 Data Backups

352 Log Backups

0 Clones

Backup Name

	Count	Type	IF	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_log_09-17-2021_15.00.01.1317_1	1	Log		09/17/2021 3:00:10 PM	Not Applicable	False	Not Cataloged	5980203
rhel2_cdb2_09-17-2021_14.35.01.4997_1	1	Log		09/17/2021 2:35:21 PM	Not Applicable	False	Not Cataloged	5980629
rhel2_cdb2_09-17-2021_14.35.01.4997_0	1	Data		09/17/2021 2:35:12 PM	Unverified	False	Not Cataloged	5980588
rhel2_cdb2_log_09-17-2021_14.00.01.1042_1	1	Log		09/17/2021 2:00:10 PM	Not Applicable	False	Not Cataloged	5978388
rhel2_cdb2_log_09-17-2021_13.00.01.7389_1	1	Log		09/17/2021 1:00:11 PM	Not Applicable	False	Not Cataloged	5975135
rhel2_cdb2_log_09-17-2021_12.00.01.1142_1	1	Log		09/17/2021 12:00:10 PM	Not Applicable	False	Not Cataloged	5971773
rhel2_cdb2_log_09-17-2021_11.00.01.0895_1	1	Log		09/17/2021 11:00:10 AM	Not Applicable	False	Not Cataloged	5968474

Total 1

- Choose a mirrored secondary database backup copy to be cloned and determine a recovery point either by time and system change number or by SCN. Generally, the recovery point should be trailing the full database backup time or SCN to be cloned. After a recovery point is decided, the required log file backup must be mounted for recovery. The log file backup should be mounted to target DB server where the clone database is to be hosted.

Mount backups

Choose the host to mount the backup : ora-standby.demo.netapp.com

Mount path : /var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_09-17-2021_14.35.01.4997_1/cdb2

Secondary storage location : Snap Vault / Snap Mirror

Source Volume	Destination Volume
svm_onPrem:rhel2_u03	svm_hybridcvo:rhel2_u03_dr

Mount Cancel

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_log_09-17-2021_16.00.01.2156_1	1	Log	09/17/2021 4:00:10 PM	Not Applicable	False	Not Cataloged	5985272
rhel2_cdb2_log_09-17-2021_15.00.01.1317_1	1	Log	09/17/2021 3:00:10 PM	Not Applicable	False	Not Cataloged	5982003
rhel2_cdb2_09-17-2021_14.35.01.4997_1	1	Log	09/17/2021 2:35:21 PM	Not Applicable	True	Not Cataloged	5980629
rhel2_cdb2_09-17-2021_14.35.01.4997_0	1	Data	09/17/2021 2:35:12 PM	Unverified	False	Not Cataloged	5980588
rhel2_cdb2_log_09-17-2021_14.00.01.1042_1	1	Log	09/17/2021 2:00:10 PM	Not Applicable	False	Not Cataloged	5978388



If log pruning is enabled and the recovery point is extended beyond the last log pruning, multiple archive log backups might need to be mounted.

5. Highlight the full database backup copy to be cloned, and then click the clone button to start the DB clone Workflow.

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_log_09-17-2021_16.00.01.2156_1	1	Log	09/17/2021 4:00:10 PM	Not Applicable	False	Not Cataloged	5985272
rhel2_cdb2_log_09-17-2021_15.00.01.1317_1	1	Log	09/17/2021 3:00:10 PM	Not Applicable	False	Not Cataloged	5982003
rhel2_cdb2_09-17-2021_14.35.01.4997_1	1	Log	09/17/2021 2:35:21 PM	Not Applicable	True	Not Cataloged	5980629
rhel2_cdb2_09-17-2021_14.35.01.4997_0	1	Data	09/17/2021 2:35:12 PM	Unverified	False	Not Cataloged	5980588
rhel2_cdb2_log_09-17-2021_14.00.01.1042_1	1	Log	09/17/2021 2:00:10 PM	Not Applicable	False	Not Cataloged	5978388

6. Choose a proper clone DB SID for a complete container database or CDB clone.

Clone from cdb2

1 Name

Complete Database Clone

Clone SID: cdb2test

Exclude PDBs: Type to find PDBs

PDB Clone

Secondary storage location : Snap Vault / Snap Mirror

Data

Source Volume	Destination Volume
svm_onPrem:rhel2_u02	svm_hybridcvo:rhel2_u02_dr

Logs

Source Volume	Destination Volume
svm_onPrem:rhel2_u03	svm_hybridcvo:rhel2_u03_dr

[Previous](#) [Next](#)

7. Select the target clone host in the cloud, and datafile, control file, and redo log directories are created by the clone workflow.

Clone from cdb2

1 Name

Select the host to create a clone

Clone host

2 Locations

3 Credentials

4 PreOps

5 PostOps

6 Notification

7 Summary

Datafile locations i

/u02_cdb2test

Control files i

Path	Actions
/u02_cdb2test/cdb2test/control/control01.ctl	X + Reset
/u02_cdb2test/cdb2test/control/control02.ctl	X + Reset

Redo logs i

Group	Size	Unit	Number of files	Actions
RedoGroup 1	200	MB	1	X +
/u02_cdb2test/cdb2test/redolog redo03.log				X +
RedoGroup 2	200	MB	1	X +

8. The None credential name is used for OS-based authentication, which renders the database port irrelevant. Fill in the proper Oracle Home, Oracle OS User, and Oracle OS Group as configured in the target clone DB server.

Clone from cdb2

1 Name

2 Locations

3 Credentials

4 PreOps

5 PostOps

6 Notification

7 Summary

Database Credentials for the clone

Credential name for sys user + ?

Database port

Oracle Home Settings ?

Oracle Home

Oracle OS User

Oracle OS Group

Previous Next

The screenshot shows the Oracle Database Clone wizard interface. The left sidebar lists steps 1 through 7. Step 3, 'Credentials', is currently selected and highlighted in blue. The main panel displays 'Database Credentials for the clone' and 'Oracle Home Settings'. Under Oracle Home Settings, the Oracle Home path is set to '/u01/app/oracle/product/19800/cdb2', the Oracle OS User is 'oracle', and the Oracle OS Group is 'oinstall'. At the bottom right, there are 'Previous' and 'Next' buttons.

9. Specify the scripts to run before clone operation. More importantly, the database instance parameter can be adjusted or defined here.

Clone from cdb2

Specify scripts to run before clone operation

Prescript full path	/var/opt/snapcenter/spl/scripts/	Enter Prescript path
Arguments		
Script timeout	60	secs

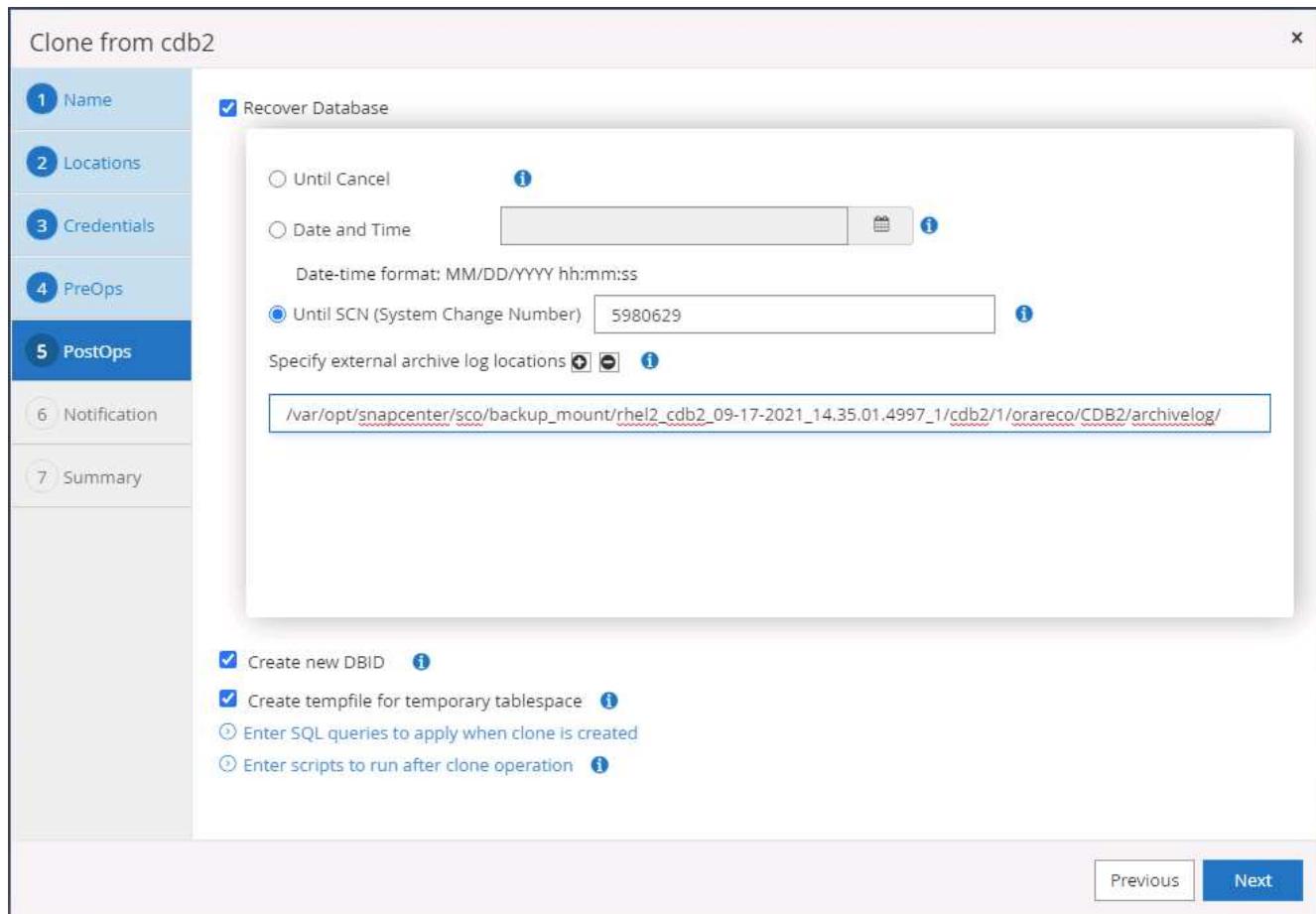
Database Parameter settings

processes	320	X
remote_login_passwordfile	EXCLUSIVE	X
sga_target	4311744512	X
undo_tablespace	UNDOTBS1	X

Buttons:

- Previous
- Next

- Specify the recovery point either by the date and time or SCN. Until Cancel recovers the database up to the available archive logs. Specify the external archive log location from the target host where the archive log volume is mounted. If target server Oracle owner is different from the on-premises production server, verify that the archive log directory is readable by the target server Oracle owner.



```
oracle@ora-standby:~$ ls /var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_09-17-2021_14.35.01.4997_1/cdb2/1/orareco/CDB2/archivelog/
2021_08_26 2021_08_28 2021_08_30 2021_09_01 2021_09_03 2021_09_05 2021_09_07 2021_09_09 2021_09_11 2021_09_13 2021_09_15 2021_09_17
2021_08_27 2021_08_29 2021_08_31 2021_09_02 2021_09_04 2021_09_06 2021_09_08 2021_09_10 2021_09_12 2021_09_14 2021_09_16
[oracle@ora-standby:~]$
```

11. Configure the SMTP server for email notification if desired.

Clone from cdb2 X

Provide email settings i

1 Name	Email preference <input type="text" value="Never"/>
2 Locations	From <input type="text" value="From email"/>
3 Credentials	To <input type="text" value="Email to"/>
4 PreOps	Subject <input type="text" value="Notification"/>
5 PostOps	<input type="checkbox"/> Attach job report
6 Notification	
7 Summary	

⚠ If you want to send notifications for Clone jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server. X

Previous Next

12. Clone summary.

Clone from cdb2

1 Name	Summary
2 Locations	Clone from backup rhel2_cdb2_09-17-2021_14.35.01.4997_0
3 Credentials	Clone SID cdb2test
4 PreOps	Clone server ora-standby.demo.netapp.com
5 PostOps	Exclude PDBs none
6 Notification	Oracle home /u01/app/oracle/product/19800/cdb2
7 Summary	Oracle OS user oracle Oracle OS group oinstall Datafile mountpaths /u02_cdb2test Control files /u02_cdb2test/cdb2test/control/control01.ctl /u02_cdb2test/cdb2test/control/control02.ctl Redo groups RedoGroup =1 TotalSize =200 Path =/u02_cdb2test/cdb2test/redolog redo03.log RedoGroup =2 TotalSize =200 Path =/u02_cdb2test/cdb2test/redolog redo02.log RedoGroup =3 TotalSize =200 Path =/u02_cdb2test/cdb2test/redolog redo01.log Recovery scope Until SCN 5980629 Prescript full path none Prescript arguments Postscript full path none Postscript arguments

[Previous](#) [Finish](#)

13. You should validate after cloning to make sure that the cloned database is operational. Some additional tasks, such as starting up the listener or turning off the DB log archive mode, can be performed on the dev/test database.

```
oracle@ora-standby:/tmp
[oracle@ora-standby tmp]$ export ORACLE_SID=cdb2test
[oracle@ora-standby tmp]$ export ORACLE_HOME=/u01/app/oracle/product/19800/cdb2
[oracle@ora-standby tmp]$ export PATH=$PATH:$ORACLE_HOME/bin
[oracle@ora-standby tmp]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Sep 17 17:49:29 2021
Version 19.3.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.3.0.0.0

SQL> select name, log_mode from v$database;
NAME      LOG_MODE
----- -----
CDB2TEST  ARCHIVELOG

SQL> select instance_name, host_name from v$instance;
INSTANCE_NAME
-----
HOST_NAME
-----
cdb2test
ora-standby.demo.netapp.com

SQL> show pdbs
CON_ID CON_NAME          OPEN MODE  RESTRICTED
----- -----
2 PDB$SEED        READ ONLY NO
3 CDB2_PDB1       READ WRITE NO
4 CDB2_PDB2       READ WRITE NO
5 CDB2_PDB3       READ WRITE NO

SQL>
```

Clone a SQL database for dev/test from a replicated Snapshot backup

1. Log into SnapCenter with a database management user ID for SQL Server. Navigate to the Resources tab, which shows the SQL Sever user databases being protected by SnapCenter and a target standby SQL instance in the public cloud.

Name	Instance	Host	Last Backup	Overall Status	Type
master	sql1	sql1.demo.netapp.com		Not available for backup	System database
model	sql1	sql1.demo.netapp.com		Not available for backup	System database
msdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tempdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tpcc	sql1	sql1.demo.netapp.com	09/16/2021 7:35:05 PM	Backup succeeded	User database
master	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
model	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
msdb	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
tempdb	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database

2. Click on the intended on-premises SQL Server user database name for the backups topology and detailed view. If a secondary replicated location is enabled, it shows linked mirror backups.

Backup Name	Count	Type	End Date	Verified
sql1_tpcc_09-16-2021_18.25.01.4024	1	Full backup	09/16/2021 6:25:05 PM	Unverified
sql1_tpcc_09-15-2021_18.25.01.4604	1	Full backup	09/15/2021 6:25:06 PM	Unverified
sql1_tpcc_09-14-2021_18.25.01.5233	1	Full backup	09/14/2021 6:25:05 PM	Unverified
sql1_tpcc_09-13-2021_18.25.01.4500	1	Full backup	09/13/2021 6:25:05 PM	Unverified
sql1_tpcc_09-12-2021_18.25.01.4016	1	Full backup	09/12/2021 6:25:05 PM	Unverified
sql1_tpcc_09-11-2021_18.25.01.3753	1	Full backup	09/11/2021 6:25:05 PM	Unverified
sql1_tpcc_09-10-2021_18.36.25.5430	1	Full backup	09/10/2021 6:36:29 PM	Unverified

3. Toggle to the Mirrored Backups view by clicking Mirrored Backups. Secondary Mirror Backup(s) are then displayed. Because SnapCenter backs up the SQL Server transaction log to a dedicated drive for recovery, only full database backups are displayed here.

Backup Name	Count	Type	End Date	Verified
sql1_tpcc_09-16-2021_18.25.01.4024	1	Full backup	09/16/2021 6:25:05 PM	Unverified
sql1_tpcc_09-15-2021_18.25.01.4604	1	Full backup	09/15/2021 6:25:06 PM	Unverified
sql1_tpcc_09-14-2021_18.25.01.5233	1	Full backup	09/14/2021 6:25:05 PM	Unverified
sql1_tpcc_09-13-2021_18.25.01.4500	1	Full backup	09/13/2021 6:25:05 PM	Unverified
sql1_tpcc_09-12-2021_18.25.01.4016	1	Full backup	09/12/2021 6:25:05 PM	Unverified
sql1_tpcc_09-11-2021_18.25.01.3753	1	Full backup	09/11/2021 6:25:05 PM	Unverified
sql1_tpcc_09-10-2021_18.36.25.5430	1	Full backup	09/10/2021 6:36:29 PM	Unverified

4. Choose a backup copy, and then click the Clone button to launch the Clone from Backup workflow.

Backup Name	Count	Type	End Date	Verified
sql1_tpcc_09-19-2021_18.25.01.4134	1	Full backup	09/19/2021 6:25:05 PM	Unverified
sql1_tpcc_09-18-2021_18.25.01.3963	1	Full backup	09/18/2021 6:25:05 PM	Unverified
sql1_tpcc_09-17-2021_18.25.01.4218	1	Full backup	09/17/2021 6:25:05 PM	Unverified
sql1_tpcc_09-16-2021_18.25.01.4024	1	Full backup	09/16/2021 6:25:05 PM	Unverified
sql1_tpcc_09-15-2021_18.25.01.4604	1	Full backup	09/15/2021 6:25:06 PM	Unverified
sql1_tpcc_09-14-2021_18.25.01.5233	1	Full backup	09/14/2021 6:25:05 PM	Unverified
sql1_tpcc_09-13-2021_18.25.01.4500	1	Full backup	09/13/2021 6:25:05 PM	Unverified

Clone from backup

1 Clone Options

Clone settings

Clone server: Choose

Clone instance: Nothing selected

Clone name: tpcc

Choose mount option

Auto assign mount point

Auto assign volume mount point under path: full file path

Secondary storage location : Snap Vault / Snap Mirror

Source Volume	Destination Volume
svm_onPrem:sql1_data	svm_hybridcvo:sql1_data_dr
svm_onPrem:sql1_log	svm_hybridcvo:sql1_log_dr

Previous **Next**

5. Select a cloud server as the target clone server, clone instance name, and clone database name. Choose either an auto-assign mount point or a user-defined mount point path.

Clone from backup x

1 Clone Options

Clone settings

Clone server	sql-standby.demo.netapp.com	i
Clone instance	sql-standby	i
Clone name	tpcc_clone	

Choose mount option

Auto assign mount point i

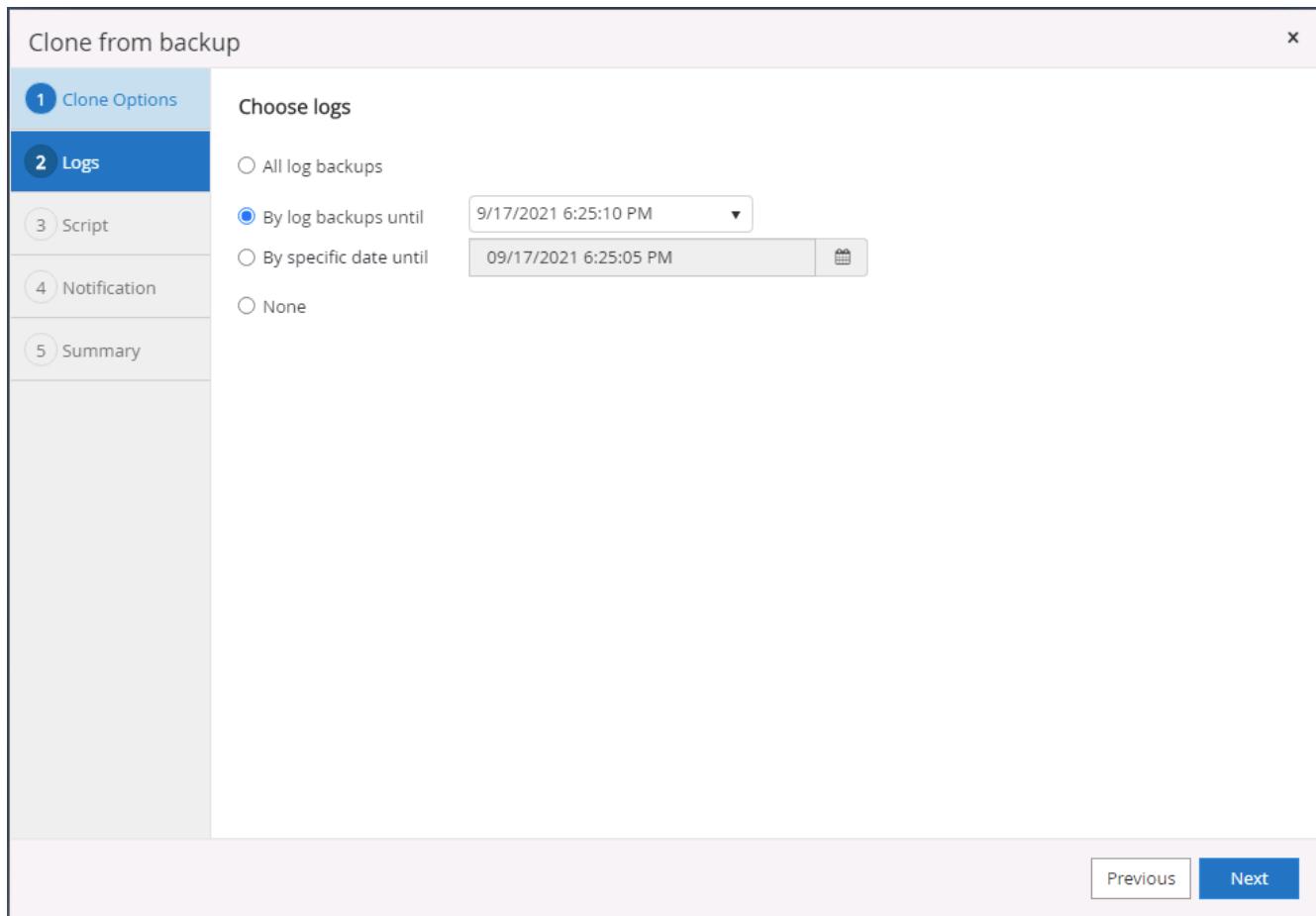
Auto assign volume mount point under path full file path i

Secondary storage location : Snap Vault / Snap Mirror

Source Volume	Destination Volume
svm_onPrem:sql1_data	svm_hybridcvo:sql1_data_dr
svm_onPrem:sql1_log	svm_hybridcvo:sql1_log_dr

Previous Next

6. Determine a recovery point either by a log backup time or by a specific date and time.



7. Specify optional scripts to run before and after the cloning operation.

Clone from backup x

1 Clone Options

2 Logs

3 Script

4 Notification

5 Summary

Specify optional scripts to run before and after performing a clone from backup job

Prescript full path

Prescript arguments Choose optional arguments...

Postscript full path

Postscript arguments Choose optional arguments...

Script timeout 60 secs

Previous Next

8. Configure an SMTP server if email notification is desired.

Clone from backup X

1 Clone Options

2 Logs

3 Script

4 Notification

5 Summary

Provide email settings i

Email preference	Never
From	From email
To	Email to
Subject	Notification

Attach Job Report

⚠ If you want to send notifications for Clone jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server. X

Previous Next

9. Clone Summary.

Clone from backup

1 Clone Options

2 Logs

3 Script

4 Notification

5 Summary

Summary	
Clone server	sql-standby.demo.netapp.com
Clone instance	sql-standby
Clone name	tpcc_dev
Mount option	Auto assign volume mount point under custom path
Prescript full path	None
Prescript arguments	
Postscript full path	None
Postscript arguments	
Send email	No

Previous **Finish**

- Monitor the job status and validate that the intended user database has been attached to a target SQL instance in the cloud clone server.

ID	Status	Name	Start date	End date	Owner
766	✓	Clone from backup 'sql1_tpcc_09-16-2021_18:25:01.4024'	09/16/2021 8:05:25 PM	09/16/2021 8:06:17 PM	demo\sqldba
763	✓	Discover resources for all hosts	09/16/2021 7:56:49 PM	09/16/2021 7:56:54 PM	demo\sqldba
761	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/16/2021 7:59:00 PM	09/16/2021 7:57:08 PM	demo\sqldba
760	⚠	Discover resources for all hosts	09/16/2021 7:19:05 PM	09/16/2021 7:19:09 PM	demo\sqldba
759	⚠	Discover resources for all hosts	09/16/2021 7:18:43 PM	09/16/2021 7:18:48 PM	demo\sqldba
756	⚠	Discover resources for all hosts	09/16/2021 6:59:51 PM	09/16/2021 6:59:56 PM	demo\sqldba
753	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/16/2021 6:35:00 PM	09/16/2021 6:37:07 PM	demo\sqldba
750	✓	Backup of Resource Group 'sql1_tpcc' with policy 'SQL Server Full Backup'	09/16/2021 6:25:01 PM	09/16/2021 6:27:14 PM	demo\sqldba
749	✓	Discover resources for host 'sql-standby.demo.netapp.com'	09/16/2021 6:19:00 PM	09/16/2021 6:19:05 PM	Demo\administrator
745	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/16/2021 5:35:00 PM	09/16/2021 5:37:08 PM	demo\sqldba

Post-clone configuration

- An Oracle production database on-premises is usually running in log archive mode. This mode is not necessary for a development or test database. To turn off log archive mode, log into the Oracle DB as sysdba, execute a log mode change command, and start the database for access.
- Configure an Oracle listener, or register the newly cloned DB with an existing listener for user access.
- For SQL Server, change the log mode from Full to Easy so that the SQL Server dev/test log file can be readily shrunk when it is filling up the log volume.

Refresh clone database

1. Drop cloned databases and clean up the cloud DB server environment. Then follow the previous procedures to clone a new DB with fresh data. It only takes few minutes to clone a new database.
2. Shutdown the clone database, run a clone refresh command by using the CLI. See the following SnapCenter documentation for details: [Refresh a clone](#).

Where to go for help?

If you need help with this solution and use cases, join the [NetApp Solution Automation community support Slack channel](#) and look for the solution-automation channel to post your questions or inquiries.

Next: [Disaster recovery workflow](#).

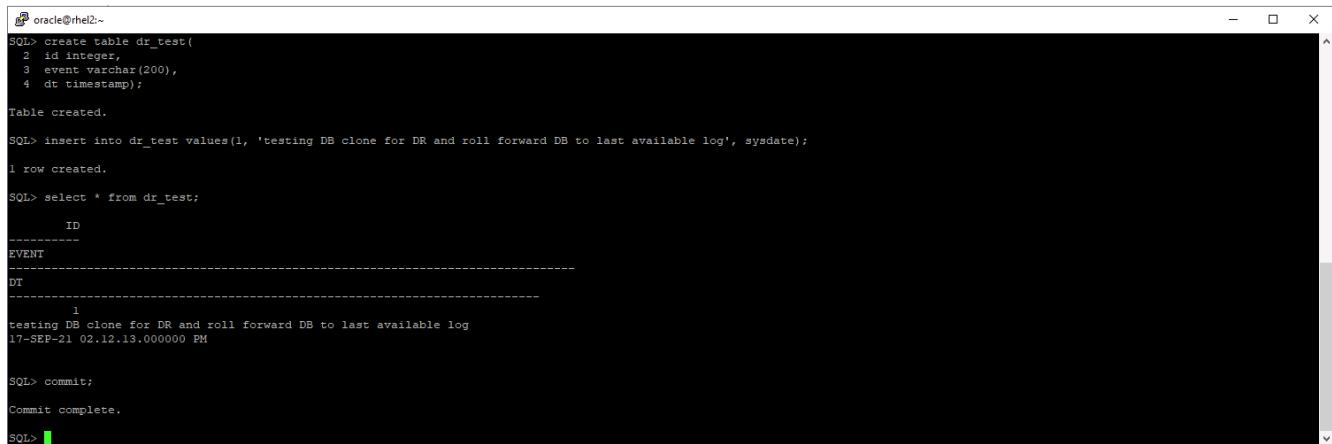
Disaster recovery workflow

Previous: [Workflow for dev/test bursting to cloud](#).

Enterprises have embraced the public cloud as a viable resource and destination for disaster recovery. SnapCenter makes this process as seamless as possible. This disaster recovery workflow is very similar to the clone workflow, but database recovery runs through the last available log that was replicated to cloud to recover all the business transactions possible. However, there are additional pre-configuration and post-configuration steps specific to disaster recovery.

Clone an on-premises Oracle production DB to cloud for DR

1. To validate that the clone recovery runs through last available log, we created a small test table and inserted a row. The test data would be recovered after a full recovery to last available log.



```
oracle@rhel2:~$ SQL> create table dr_test (
  2  id integer,
  3  event varchar(200),
  4  dt timestamp);
Table created.

SQL> insert into dr_test values(1, 'testing DB clone for DR and roll forward DB to last available log', sysdate);
1 row created.

SQL> select * from dr_test;
      ID
      --
EVENT
-----
DT
-----
      1
testing DB clone for DR and roll forward DB to last available log
17-SEP-21 02.12.13.000000 PM

SQL> commit;
Commit complete.

SQL>
```

2. Log into SnapCenter as a database management user ID for Oracle. Navigate to the Resources tab, which shows the Oracle databases being protected by SnapCenter.

The screenshot shows the NetApp SnapCenter interface. On the left, there's a sidebar with icons for Dashboard, Resources (selected), Monitor, Reports, Hosts, Storage Systems, Settings, and Alerts. The main area has a dropdown menu set to 'Oracle Database'. Below it, a search bar says 'Resource Group' and a search field contains 'rhe12_cdb2_log'. A table lists resources under 'rhe12_cdb2' and 'rhe12_cdb2_log'. The 'rhe12_cdb2_log' row has a 'Tags' column with 'orafullbkup' and a 'Policies' column with 'Oracle Full Online Backup'. The 'Last Backup' column shows '09/17/2021 2:38:16 PM' and the 'Overall Status' column shows 'Completed'. A 'New Resource Group' button is in the top right.

3. Select the Oracle log resource group and click Backup Now to manually run an Oracle log backup to flush the latest transaction to the destination in the cloud. In a real DR scenario, the last transaction recoverable depends on the database log volume replication frequency to the cloud, which in turn depends on the RTO or RPO policy of the company.

This screenshot shows the 'rhe12_cdb2_log' resource group details. The left sidebar is identical to the previous screenshot. The main area shows a table with columns: Name, Resource Name, Type, and Host. The 'rhe12_cdb2' row has 'cdb2' in Resource Name, 'Oracle Database' in Type, and 'rhe12.demo.netapp.com' in Host. There are buttons for 'Modify Resource Group', 'Backup Now', 'Maintenance', and 'Delete' at the top right.

This screenshot shows the 'Backup' dialog box. It has a title 'Backup' and a sub-instruction 'Create a backup for the selected resource group'. It displays the selected 'Resource Group' as 'rhe12_cdb2_log' and the selected 'Policy' as 'Oracle Archive Log Backup'. At the bottom, there are 'Cancel' and 'Backup' buttons.



Asynchronous SnapMirror loses data that has not made it to the cloud destination in the database log backup interval in a disaster recovery scenario. To minimize data loss, more frequent log backup can be scheduled. However there is a limit to the log backup frequency that is technically achievable.

4. Select the last log backup on the Secondary Mirror Backup(s), and mount the log backup.

The screenshot shows the NetApp SnapCenter interface for Oracle Database management. On the left, a sidebar lists databases: cdb2, cdb2dev, and cdb2test. The main pane displays 'cdb2 Topology' with a summary of 185 Backups, 0 Clones, and 2 Mirrors. Below this, the 'Secondary Mirror Backup(s)' section shows three log backups:

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_log_09-17-2021_18.20.04.1177_1	1	Log	09/17/2021 6:20:13 PM	Not Applicable	False	Not Cataloged	5994710
rhel2_cdb2_log_09-17-2021_18.00.01.2424_1	1	Log	09/17/2021 6:00:09 PM	Not Applicable	False	Not Cataloged	5992079
rhel2_cdb2_log_09-17-2021_17.00.01.1566_1	1	Log	09/17/2021 5:00:20 PM	Not Applicable	False	Not Cataloged	5988842

The dialog box is titled 'Mount backups'. It asks 'Choose the host to mount the backup' and provides a dropdown menu with 'ora-standby.demo.netapp.com'. Below this, 'Mount path' is set to '/var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_log_09-17-2021_18.20.04.1177_1/cdb2'. The 'Secondary storage location : Snap Vault / Snap Mirror' section shows 'Source Volume' as 'svm_onPrem:rhel2_u03' and 'Destination Volume' as 'svm_hybridcvo:rhel2_u03_dr'. At the bottom are 'Mount' and 'Cancel' buttons.

5. Select the last full database backup and click Clone to initiate the clone workflow.

The screenshot shows the NetApp SnapCenter interface for managing Oracle databases. The top navigation bar includes links for Database Settings, Protect, and Refresh. The main area displays the 'cdb2 Topology' for the 'cdb2' database. It shows 'Manage Copies' with 'Local copies' (185 Backups, 0 Clones) and 'Mirror copies' (185 Backups, 2 Clones). A 'Summary Card' provides a quick overview of backup statistics: 370 Backups, 16 Data Backups, 354 Log Backups, and 2 Clones. Below this, a table lists 'Secondary Mirror Backup(s)' with columns for Backup Name, Count, Type, End Date, Verified, Mounted, RMAN Cataloged, and SCN. The table contains six entries, all of which are Log type backups.

6. Select a unique clone DB ID on the host.

The screenshot shows the 'Clone from cdb2' wizard in progress. The current step is '1 Name'. The 'Complete Database Clone' option is selected. The 'Clone SID' field is populated with 'cdb2dr'. The sidebar on the left lists the following steps:

- 1 Name
- 2 Locations
- 3 Credentials
- 4 PreOps
- 5 PostOps
- 6 Notification
- 7 Summary

Secondary storage location : Snap Vault / Snap Mirror

Data

Source Volume	Destination Volume
svm_onPrem:rhel2_u02	svm_hybridcvo:rhel2_u02_dr

Logs

Source Volume	Destination Volume
svm_onPrem:rhel2_u03	svm_hybridcvo:rhel2_u03_dr

Buttons at the bottom:

- Previous
- Next

7. Provision a log volume and mount it to the target DR server for the Oracle flash recovery area and online logs.

The screenshot shows the ONTAP System Manager interface. On the left, there's a navigation sidebar with sections like DASHBOARD, STORAGE (Overview, Applications, Volumes), LUNs, Shares, Qtrees, Quotas, Storage VMs, Tiers, NETWORK, EVENTS & JOBS, PROTECTION, and HOSTS. The main area is titled 'Volumes' and lists several volumes: ora_standby_u01, rhel2_u01_dr, rhel2_u02_dr, rhel2_u02_dr09172116081193_60, rhel2_u02_dr0917211703548_63, rhel2_u03_dr, and rhel2_u03_dr09172118245747_75. A modal window titled 'Add Volume' is open, showing fields for NAME (ora_standby_u03) and CAPACITY (20 GB). There are 'More Options' and 'Save' buttons at the bottom.

```

[ec2-user@ora-standby:tmp]$ sudo mkdir /u03_cdb2dr
[ec2-user@ora-standby tmp]$ chown oracle:oinstall /u03_cdb2dr
chown: changing ownership of '/u03_cdb2dr': Operation not permitted
[ec2-user@ora-standby tmp]$ sudo chown oracle:oinstall /u03_cdb2dr
[ec2-user@ora-standby tmp]$ sudo mount -t nfs 10.221.1.6:/ora_standby_u03 /u03_cdb2dr
[ec2-user@ora-standby tmp]$ df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/tmpfs       7.6G  0    7.6G  0% /dev
tmpfs           7.6G  0    7.6G  0% /dev/shm
tmpfs           7.6G  17M  7.6G  1% /run
tmpfs           7.6G  0    7.6G  0% /sys/fs/cgroup
/dev/nvme0nlp2   10G  9.0G  1.1G  90% /
10.221.1.6:/ora_standby_u01   31G  13G  18G  42% /u01
tmpfs           1.6G  0    1.6G  0% /run/user/1000
10.221.1.6:/Sc28182452-3fa8-448c-9e4a-c5a9e465f353 100G  3.1G  97G  4% /u02_cdb2dev
tmpfs           1.6G  0    1.6G  0% /run/user/54321
10.221.1.6:/Sc39c05df8-4b00-4b3a-853c-9d6d338e5df7 100G  3.7G  97G  4% /u02_cdb2test
10.221.1.6:/Scff88ea5c-3273-475e-ad97-472b2a8dccee 100G  3.8G  97G  4% /var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_log_09-17-2021_18.20.04.1177_1/cdb2/1
10.221.1.6:/ora_standby_u03   21G  320K  20G  1% /u03_cdb2dr
[ec2-user@ora-standby tmp]$

```



The Oracle clone procedure does not create a log volume, which needs to be provisioned on the DR server before cloning.

8. Select the target clone host and location to place the data files, control files, and redo logs.

Clone from cdb2

1 Name

Select the host to create a clone

Clone host ora-standby.demo.netapp.com

2 Locations

Datafile locations /u02_cdb2dr

Control files /u02_cdb2dr/cdb2dr/control/control01.ctl
/u03_cdb2dr/cdb2dr/control/control02.ctl

Redo logs

Group	Size	Unit	Number of files
RedoGroup 1	200	MB	1
RedoGroup 2	200	MB	1

Previous Next

The screenshot shows the Oracle Database Clone wizard interface. The left sidebar lists steps 1 through 7. Step 2, 'Locations', is selected and active. The main area displays configuration for cloning a database. It includes a dropdown for 'Clone host' set to 'ora-standby.demo.netapp.com'. Under 'Datafile locations', the path '/u02_cdb2dr' is specified. In the 'Control files' section, two files are listed: '/u02_cdb2dr/cdb2dr/control/control01.ctl' and '/u03_cdb2dr/cdb2dr/control/control02.ctl'. The 'Redo logs' section contains a table with two groups: 'RedoGroup 1' and 'RedoGroup 2', each with a size of 200 MB and one log file ('redo03.log'). Navigation buttons 'Previous' and 'Next' are at the bottom right.

9. Select the credentials for the clone. Fill in the details of the Oracle home configuration on the target server.

Clone from cdb2

1 Name

2 Locations

3 Credentials

4 PreOps

5 PostOps

6 Notification

7 Summary

Database Credentials for the clone

Credential name for sys user + ?

Database port

Oracle Home Settings ?

Oracle Home

Oracle OS User

Oracle OS Group

Previous Next

The screenshot shows the Oracle Database Clone wizard interface. The left sidebar lists steps 1 through 7. Step 3, 'Credentials', is currently selected and highlighted in blue. The main panel shows 'Database Credentials for the clone' with a dropdown for 'Credential name for sys user' set to 'None' and a port of '1521'. Below that, 'Oracle Home Settings' are configured with the Oracle Home path set to '/u01/app/oracle/product/19800/cdb2', and the Oracle OS User and Group both set to 'oracle'. At the bottom right are 'Previous' and 'Next' buttons.

10. Specify the scripts to run before cloning. Database parameters can be adjusted if needed.

Clone from cdb2

Specify scripts to run before clone operation ⓘ

Prescript full path	/var/opt/snapcenter/spl/scripts/	Enter Prescript path
Arguments		
Script timeout	60	secs

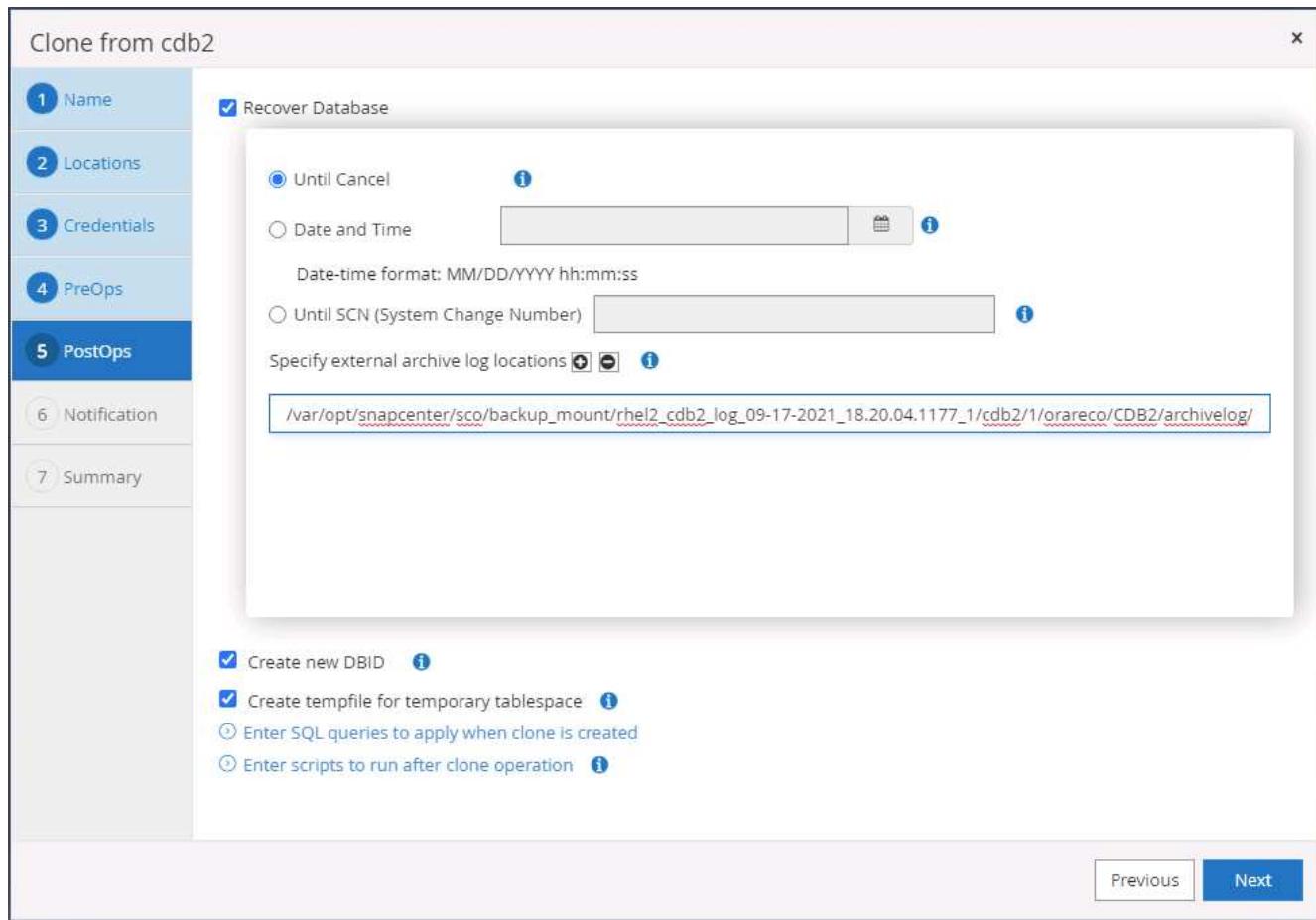
Database Parameter settings

audit_file_dest	/u01/app/oracle/admin/cdb2dr/adump	X
audit_trail	DB	X
open_cursors	300	X
pga_aggregate_target	1432354816	X

Buttons:

- Previous
- Next

- Select Until Cancel as the recovery option so that the recovery runs through all available archive logs to recoup the last transaction replicated to the secondary cloud location.



12. Configure the SMTP server for email notification if needed.

Clone from cdb2

X

1 Name

Provide email settings ⓘ

2 Locations

3 Credentials

4 PreOps

5 PostOps

6 Notification

7 Summary

Email preference: Never

From: From email

To: Email to

Subject: Notification

Attach job report

⚠ If you want to send notifications for Clone jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

Previous

Next

The screenshot shows a configuration interface for cloning a database from 'cdb2'. The left sidebar lists steps 1 through 7. Step 6, 'Notification', is currently active and highlighted in blue. The main panel displays fields for email settings: 'Email preference' (set to 'Never'), 'From' (set to 'From email'), 'To' (set to 'Email to'), and 'Subject' (set to 'Notification'). There is also an unchecked checkbox for 'Attach job report'. A prominent orange warning banner at the bottom states: '⚠ If you want to send notifications for Clone jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.' At the bottom right are 'Previous' and 'Next' navigation buttons.

13. DR clone summary.

Clone from cdb2

1 Name	Summary
2 Locations	Clone from backup rhel2_cdb2_09-17-2021_14.35.01.4997_0
3 Credentials	Clone SID cdb2dr
4 PreOps	Clone server ora-standby.demo.netapp.com
5 PostOps	Exclude PDBs none
6 Notification	Oracle home /u01/app/oracle/product/19800/cdb2
7 Summary	Oracle OS user oracle
	Oracle OS group oinstall
	Datafile mountpaths /u02_cdb2dr
	Control files /u02_cdb2dr/cdb2dr/control/control01.ctl /u03_cdb2dr/cdb2dr/control/control02.ctl
	Redo groups RedoGroup =1 TotalSize =200 Path =/u03_cdb2dr/cdb2dr/redolog/redo03.log RedoGroup =2 TotalSize =200 Path =/u03_cdb2dr/cdb2dr/redolog/redo02.log RedoGroup =3 TotalSize =200 Path =/u03_cdb2dr/cdb2dr/redolog/redo01.log
	Recovery scope Until Cancel
	Prescript full path none
	Prescript arguments
	Postscript full path none
	Postscript arguments

[Previous](#) [Finish](#)

14. Cloned DBs are registered with SnapCenter immediately after clone completion and are then available for backup protection.

NetApp SnapCenter							
		Oracle Database					
Resources		Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup
		cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com	rhel2_cdb2	Oracle Archive Log Backup Oracle Full Online Backup	09/17/2021 7:00:10 PM
		cdb2dev	Single Instance (Multitenant)	ora-standby.demo.netapp.com			Not protected
		cdb2dr	Single Instance (Multitenant)	ora-standby.demo.netapp.com			Not protected
		cdb2test	Single Instance (Multitenant)	ora-standby.demo.netapp.com			Not protected

Post DR clone validation and configuration for Oracle

1. Validate the last test transaction that has been flushed, replicated, and recovered at the DR location in the cloud.

```

oracle@ora-standby:/u01/app/oracle/product/19000/cdb2/dbs
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.3.0.0.0

SQL> set lin 200
SQL> select instance_name, host_name from v$instance;

INSTANCE_NAME      HOST_NAME
cdb2dr            ora-standby.demo.netapp.com

SQL> alter pluggable database cdb2_pdb1 open;
Pluggable database altered.

SQL> alter session set container=cdb2_pdb1;
Session altered.

SQL> select * from pdbadmin.dr_test;

ID
EVENT
DT
1
testing DB clone for DR and roll forward DB to last available log
17-SEP-21 02.12.13.000000 PM

SQL>

```

2. Configure the flash recovery area.

```

oracle@ora-standby:/u01/app/oracle/product/19000/cdb2/dbs
[oracle@ora-standby dbs]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Sep 17 22:07:11 2021
Version 19.3.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 - Production
Version 19.3.0.0.0

SQL> show parameter db_recovery_file_dest

NAME          TYPE        VALUE
db_recovery_file_dest    string
db_recovery_file_dest_size  big integer 17208M
SQL> alter system set db_recovery_file_dest='/u03_cdb2dr/cdb2dr' scope=both;

System altered.

SQL> show parameter db_recovery_file_dest

NAME          TYPE        VALUE
db_recovery_file_dest    string    /u03_cdb2dr/cdb2dr
db_recovery_file_dest_size  big integer 17208M
SQL>

```

3. Configure the Oracle listener for user access.

4. Split the cloned volume off of the replicated source volume.

5. Reverse replication from the cloud to on-premises and rebuild the failed on-premises database server.



Clone split may incur temporary storage space utilization that is much higher than normal operation. However, after the on-premises DB server is rebuilt, extra space can be released.

Clone an on-premises SQL production DB to cloud for DR

- Similarly, to validate that the SQL clone recovery ran through last available log, we created a small test table and inserted a row. The test data would be recovered after a full recovery to the last available log.

```

Administrator: Command Prompt - sqlcmd - SQLCMD
C:\Users\administrator.DEMO>sqlcmd
1> select host_name()
2> go

-----
SQL1

(1 rows affected)
1> use tpcc
2> go
Changed database context to 'tpcc'.
1> insert into snap_sync values ('test snap mirror DR for SQL', getdate())
2> go

(1 rows affected)
1> select * from snap_sync
2> go
event                                dt
test snap mirror DR for SQL          2021-09-20 14:23:04.533
(1 rows affected)
1> -

```

- Log into SnapCenter with a database management user ID for SQL Server. Navigate to the Resources tab, which shows the SQL Server protection resources group.

The screenshot shows the NetApp SnapCenter interface. The top navigation bar includes links for Microsoft SQL Server, demo/sqldba, App Backup and Clone Admin, and Sign Out. Below the navigation is a search bar labeled 'search by name' and a secondary search bar labeled 'search'. The main area displays a table of resources:

Name	Resource Name	Type	Host
sql1_tpcc	tpcc (sql1)	SQL Database	sql1.demo.netapp.com
sql1_tpcc_log			

On the far right of the table are several icons: Modify Resource Group, Back up Now, Clone Lifecycle, Maintenance, Edit/View Details, and Delete.

- Manually run a log backup to flush the last transaction to be replicated to secondary storage in the public cloud.

The screenshot shows a 'Backup' dialog box. At the top, it says 'Create a backup for the selected resource group'. Below that, there are two input fields: 'Resource Group' containing 'sql1_tpcc_log' and 'Policy' containing 'SQL Server Log Backup'. To the right of the policy dropdown is an information icon (a blue circle with a white 'i'). At the bottom right of the dialog are 'Cancel' and 'Backup' buttons, with 'Backup' being the active button.

- Select the last full SQL Server backup for the clone.

Backup Name	Count	Type	End Date	Verified
sql1_tpcc_09-19-2021_18.25.01.4134	1	Full backup	09/19/2021 6:25:05 PM	Unverified
sql1_tpcc_09-18-2021_18.25.01.3963	1	Full backup	09/18/2021 6:25:05 PM	Unverified
sql1_tpcc_09-17-2021_18.25.01.4218	1	Full backup	09/17/2021 6:25:05 PM	Unverified

5. Set the clone setting such as the Clone Server, Clone Instance, Clone Name, and mount option. The secondary storage location where cloning is performed is auto-populated.

Clone from backup

1 Clone Options

Clone settings

Clone server: sql-standby.demo.netapp.com

Clone instance: sql-standby

Clone name: tpcc_dr

Choose mount option

Auto assign mount point

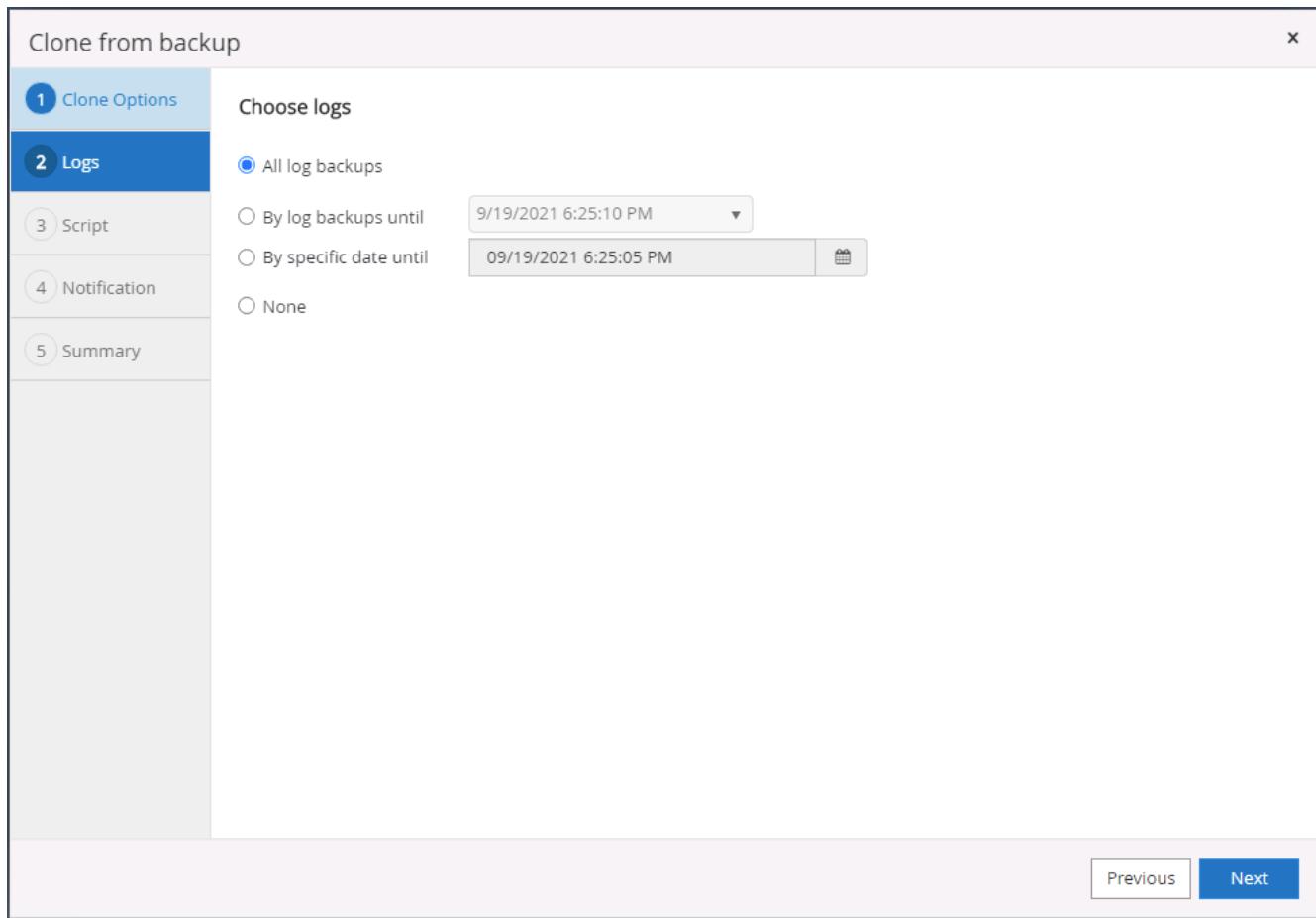
Auto assign volume mount point under path full file path

Secondary storage location : Snap Vault / Snap Mirror

Source Volume	Destination Volume
svm_onPrem:sql1_data	svm_hybridcvo:sql1_data_dr
svm_onPrem:sql1_log	svm_hybridcvo:sql1_log_dr

Next

6. Select all log backups to be applied.



7. Specify any optional scripts to run before or after cloning.

Clone from backup x

1 Clone Options

2 Logs

3 Script

4 Notification

5 Summary

Specify optional scripts to run before and after performing a clone from backup job

Prescript full path

Prescript arguments Choose optional arguments...

Postscript full path

Postscript arguments Choose optional arguments...

Script timeout 60 secs

Previous Next

8. Specify an SMTP server if email notification is desired.

Clone from backup

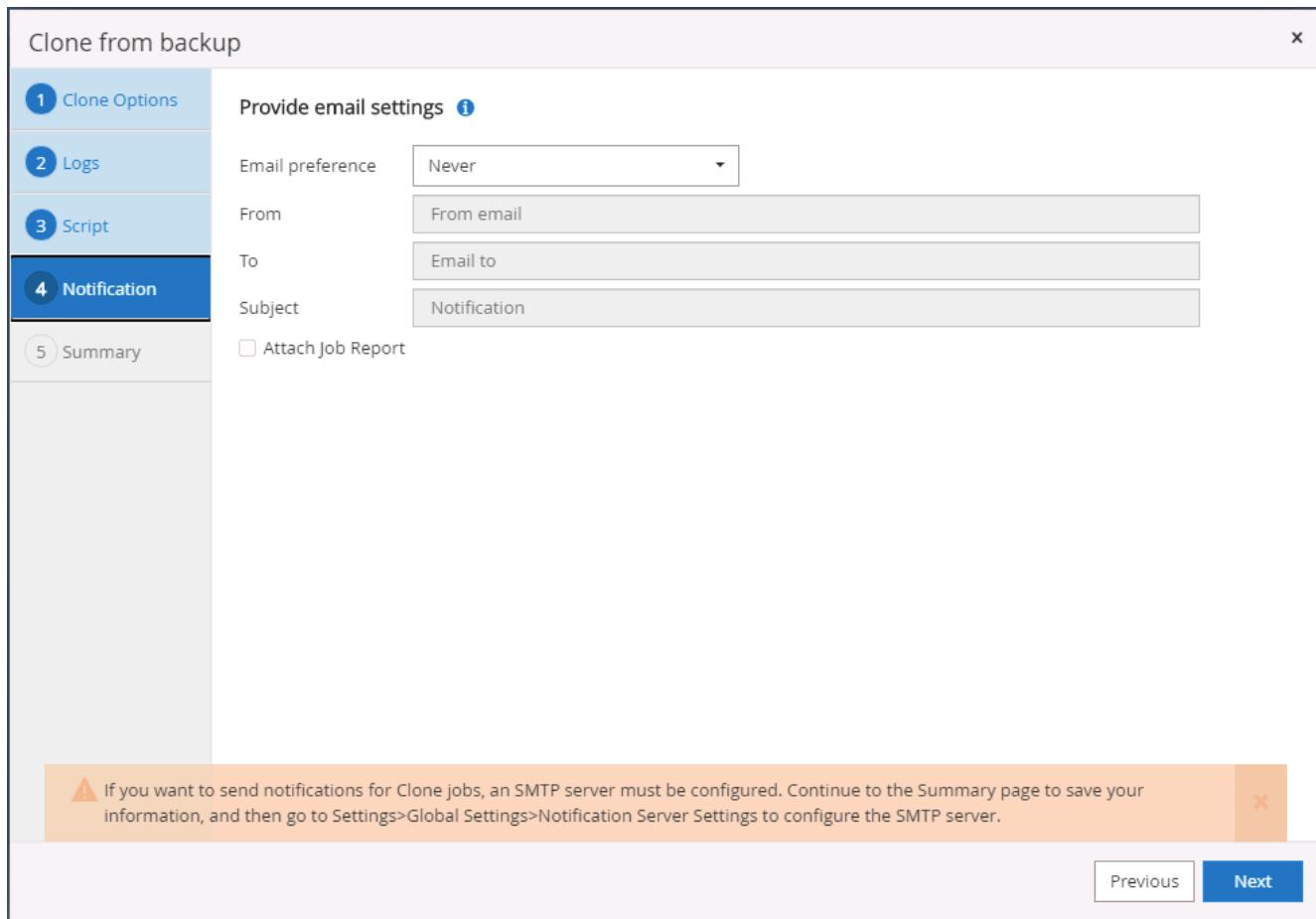
Provide email settings i

Email preference	Never
From	From email
To	Email to
Subject	Notification

Attach Job Report

⚠ If you want to send notifications for Clone jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

[Previous](#) [Next](#)



9. DR clone summary. Cloned databases are immediately registered with SnapCenter and available for backup protection.

Clone from backup

1 Clone Options

2 Logs

3 Script

4 Notification

5 Summary

Summary	
Clone server	sql-standby.demo.netapp.com
Clone instance	sql-standby
Clone name	tpcc_dr
Mount option	Auto Mount
Prescript full path	None
Prescript arguments	
Postscript full path	None
Postscript arguments	
Send email	No

Previous **Finish**

NetApp SnapCenter®

Microsoft SQL Server

View Database search by name

Dashboard Resources Monitor Reports Hosts Storage Systems Settings Alerts

Refresh Resources New Resource Group

Name	Instance	Host	Last Backup	Overall Status	Type
master	sql1	sql1.demo.netapp.com		Not available for backup	System database
model	sql1	sql1.demo.netapp.com		Not available for backup	System database
msdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tempdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tpcc	sql1	sql1.demo.netapp.com	09/22/2021 5:35:08 PM	Backup failed, Schedules on hold	User database
master	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
model	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
msdb	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
tempdb	sql-standby	sql-standby.demo.netapp.com		Not available for backup	System database
tpcc_clone	sql-standby	sql-standby.demo.netapp.com		Not protected	User database
tpcc_clev	sql-standby	sql-standby.demo.netapp.com		Not protected	User database
tpcc_dr	sql-standby	sql-standby.demo.netapp.com		Not protected	User database

Post DR clone validation and configuration for SQL

1. Monitor clone job status.

NetApp SnapCenter®

Jobs Schedules Events Logs

search by name

Dashboard Resources Monitor Reports Hosts Storage Systems Settings Alerts

Details Report Download Logs Cancel Job

ID	Status	Name	Start date	End date	Owner
1052	✓	Clone from backup 'sql1_tpcc_09-19-2021_18.25.01.4134'	09/20/2021 2:36:17 PM	09/20/2021 2:37:06 PM	demo\sqldba
1047	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/20/2021 2:35:01 PM	09/20/2021 2:37:08 PM	demo\sqldba
1045	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/20/2021 2:26:17 PM	09/20/2021 2:30:25 PM	demo\sqldba
1044	✓	Clone from backup 'sql1_tpcc_09-17-2021_18.25.01.4218'	09/20/2021 1:39:24 PM	09/20/2021 1:40:09 PM	demo\sqldba
1042	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/20/2021 1:36:01 PM	09/20/2021 1:37:08 PM	demo\sqldba
1040	✓	Backup of Resource Group 'sql1_tpcc_log' with policy 'SQL Server Log Backup'	09/20/2021 1:26:50 PM	09/20/2021 1:27:08 PM	demo\sqldba

2. Validate that last transaction has been replicated and recovered with all log file clones and recovery.

```
C:\Users\administrator.DEMO>sqlcmd
1> select host_name()
2> go
-----
SQL STANDBY
(1 rows affected)
1> use tpcc_dr
2> go
Changed database context to 'tpcc_dr'.
1> select * from snap_sync
2> go
event                                dt
test snap mirror DR for SQL          2021-09-20 14:23:04.533
(1 rows affected)
1> select getdate()
2> go
-----
2021-09-20 14:39:19.937
(1 rows affected)
1> -
```

3. Configure a new SnapCenter log directory on the DR server for SQL Server log backup.
4. Split the cloned volume off of the replicated source volume.
5. Reverse replication from the cloud to on-premises and rebuild the failed on-premises database server.

Where to go for help?

If you need help with this solution and use cases, please join the [NetApp Solution Automation community support Slack channel](#) and look for the solution-automation channel to post your questions or inquiries.

Copyright information

Copyright © 2023 NetApp, Inc. All Rights Reserved. Printed in the U.S. No part of this document covered by copyright may be reproduced in any form or by any means—graphic, electronic, or mechanical, including photocopying, recording, taping, or storage in an electronic retrieval system—with prior written permission of the copyright owner.

Software derived from copyrighted NetApp material is subject to the following license and disclaimer:

THIS SOFTWARE IS PROVIDED BY NETAPP “AS IS” AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED. IN NO EVENT SHALL NETAPP BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

NetApp reserves the right to change any products described herein at any time, and without notice. NetApp assumes no responsibility or liability arising from the use of products described herein, except as expressly agreed to in writing by NetApp. The use or purchase of this product does not convey a license under any patent rights, trademark rights, or any other intellectual property rights of NetApp.

The product described in this manual may be protected by one or more U.S. patents, foreign patents, or pending applications.

LIMITED RIGHTS LEGEND: Use, duplication, or disclosure by the government is subject to restrictions as set forth in subparagraph (b)(3) of the Rights in Technical Data -Noncommercial Items at DFARS 252.227-7013 (FEB 2014) and FAR 52.227-19 (DEC 2007).

Data contained herein pertains to a commercial product and/or commercial service (as defined in FAR 2.101) and is proprietary to NetApp, Inc. All NetApp technical data and computer software provided under this Agreement is commercial in nature and developed solely at private expense. The U.S. Government has a non-exclusive, non-transferrable, nonsublicensable, worldwide, limited irrevocable license to use the Data only in connection with and in support of the U.S. Government contract under which the Data was delivered. Except as provided herein, the Data may not be used, disclosed, reproduced, modified, performed, or displayed without the prior written approval of NetApp, Inc. United States Government license rights for the Department of Defense are limited to those rights identified in DFARS clause 252.227-7015(b) (FEB 2014).

Trademark information

NETAPP, the NETAPP logo, and the marks listed at <http://www.netapp.com/TM> are trademarks of NetApp, Inc. Other company and product names may be trademarks of their respective owners.