Databases

NetApp Solutions

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TR-4986: Simplified, Automated Oracle Deployment on Amazon FSx ONTAP with iSCSI

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for automated Oracle deployment and protection in Amazon FSx ONTAP as primary database storage with iSCSI protocol and Oracle database configured in standalone ReStart using Oracle asm as volume manager.

Purpose

Amazon FSx for NetApp ONTAP is a storage service that allows you to launch and run fully managed NetApp ONTAP file systems in the AWS Cloud. It provides the familiar features, performance, capabilities, and APIs of NetApp file systems with the agility, scalability, and simplicity of a fully managed AWS service. It empowers you to run the most demanding database workload, such as Oracle, in the AWS cloud with peace of mind.

This documentation demonstrates the simplified deployment of Oracle databases in an Amazon FSx ONTAP file system using Ansible automation. The Oracle database is deployed in a standalone ReStart configuration with iSCSI protocol for data access and Oracle ASM for database storage disks management. It also provides information on Oracle database backup, restore, and clone using the NetApp SnapCenter UI tool for storage-efficient database operation in AWS Cloud.

This solution addresses the following use cases:

- Automated Oracle database deployment on Amazon FSx ONTAP file system
- Oracle database backup and restore on Amazon FSx ONTAP file system using NetApp SnapCenter tool
- Oracle database clone for dev/test or other use cases on Amazon FSx ONTAP file system using NetApp SnapCenter tool

Audience

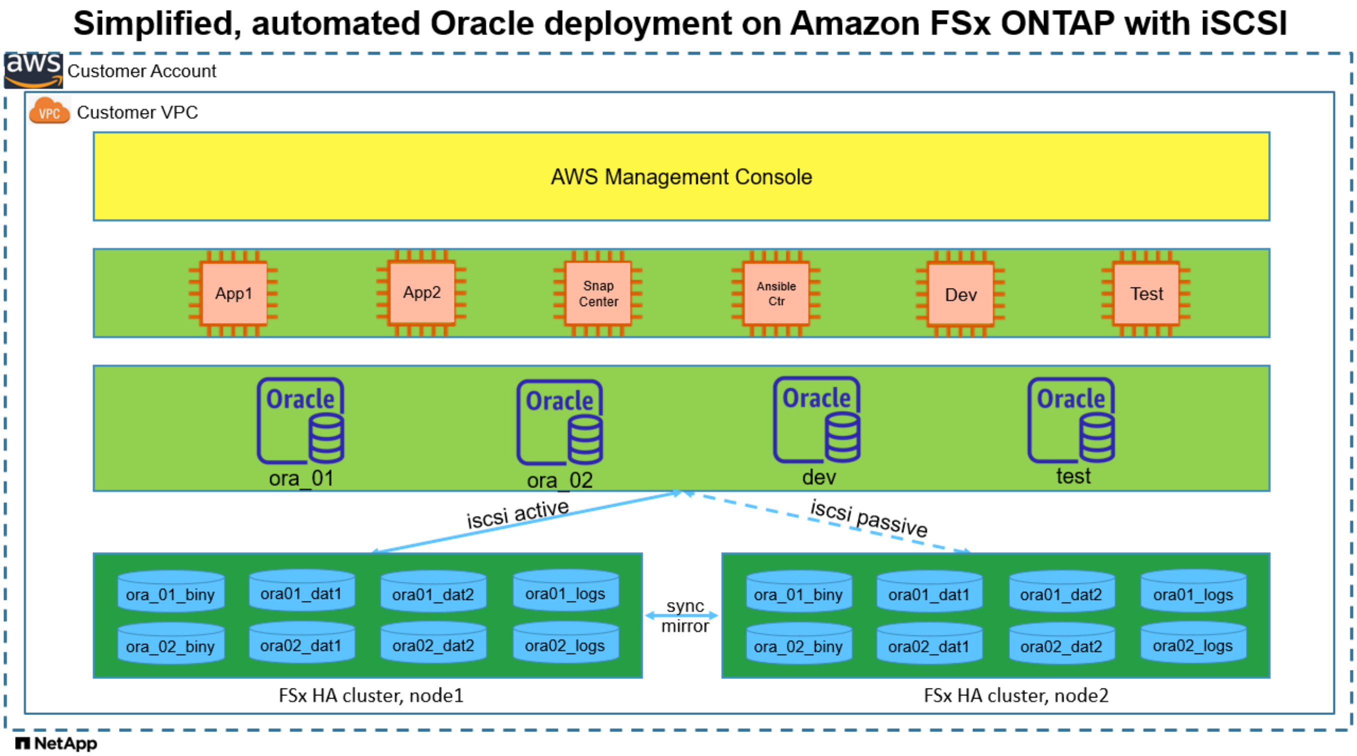
This solution is intended for the following people:

- A DBA who would like to deploy Oracle on Amazon FSx ONTAP file system.
- A database solution architect who would like to test Oracle workloads on Amazon FSx ONTAP file system.
- A storage administrator who would like to deploy and manage an Oracle database on Amazon FSx ONTAP file system.
- An application owner who would like to stand up an Oracle database on Amazon FSx ONTAP file system.

Solution test and validation environment

The testing and validation of this solution were performed in a lab setting that might not match the final deployment environment. See the section Key factors for deployment consideration for more information.

Architecture



Hardware and software components

	Hardware	
Amazon 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 for concurrent deployment
	Software	
RedHat Linux	RHEL-8.6, 4.18.0-372.9.1.el8.x86_64 kernel	Deployed RedHat subscription for testing
Windows Server	2022 Standard, 10.0.20348 Build 20348	Hosting SnapCenter server
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 Server	Version 4.9P1	Workgroup deployment

Open JDK	Version java-1.8.0-openjdk.x86_64	SnapCenter plugin requirement on DB VMs

Oracle database configuration in the lab environment

Server	Database	DB Storage
ora_01	NTAP1(NTAP1_PDB1,NTAP1_PDB2,NTAP1_PDB3)	iSCSI luns on Amazon FSx ONTAP file system
ora_02	NTAP2(NTAP2_PDB1,NTAP2_PDB2,NTAP2_PDB3)	iSCSI luns on Amazon FSx ONTAP file system

Key factors for deployment consideration

- **Oracle database storage layout.** In this automated Oracle deployment, we provision four database volumes to host Oracle binary, data, and logs by default. A single lun in a volume allocates to Oracle binary. We then create two ASM disk groups from data and logs luns. Within the +DATA asm disk group, we provision two data volumes with two luns in a volume. Within the +LOGS asm disk group, we create two luns in a log volume. Multiple luns laid out within an ONTAP volume provides better performance in general.
- **Multiple DB servers deployment.** The automation solution can deploy an Oracle container database to multiple DB servers in a single Ansible playbook run. Regardless of the number of DB servers, the playbook execution remains the same. You can deploy multiple container databases to a single EC2 instance with different database instance IDs (Oracle SID). But ensure there is sufficient memory on the host to support deployed databases.
- **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 the right EC2 compute instance that meets both application and iSCSI traffic-throughput requirements. Also, AWS EC2 generally limits each TCP flow to 5 Gbps. Each iSCSI path provides 5 Gbps (625 MBps) of bandwidth, and multiple iSCSI connections may be required to support higher throughput requirements.
- **Oracle ASM redundancy level to use for each Oracle ASM disk group that you create.** Because the Amazon FSx ONTAP is HA enabled for data protection at the cluster disk 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 SnapCenter software suite for database backup, restore, and cloning with a user-friendly UI interface. NetApp recommends implementing such a management tool to achieve fast (under a minute) SnapShot backup, quick (minutes) database restore, and database clone.

Solution deployment

The following sections provide step-by-step procedures for automated Oracle 19c deployment and protection on Amazon FSx ONTAP file system with directly mounted database luns via iSCSI to EC2 instance VM in a single node Restart configuration with Oracle ASM as database volume manager.

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, deploy EC2 Linux instances as Oracle DB servers. Enable SSH private/public key authentication for ec2-user. See the architecture diagram in the previous section for details about the environment setup. Also review the User Guide for Linux instances for more information.
3. From the AWS FSx console, provision an Amazon FSx ONTAP file system that meets the requirements. Review 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. The template can be easily revised for your own deployment requirements.

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

5. Provision an EC2 Linux instance as the Ansible controller node with the latest version of Ansible and Git installed. Refer to the following link for details: Getting Started with NetApp solution automation in section -
   `Setup the Ansible Control Node for CLI deployments on RHEL / CentOS` or
   `Setup the Ansible Control Node for CLI deployments on Ubuntu / Debian`.
6. Provision a Windows server to run the NetApp SnapCenter UI tool with the latest version. Refer to the following link for details: Install the SnapCenter Server
7. Clone a copy of the NetApp Oracle deployment automation toolkit for iSCSI.

   ```
   git clone https://bitbucket.ngage.netapp.com/scm/ns-
   bb/na_oracle_deploy_iscsi.git
   ```

8. Stage following Oracle 19c installation files on EC2 instances /tmp/archive directory.

   ```
   installer_archives:
     - "LINUX.X64_193000_grid_home.zip"
     - "p34762026_190000_Linux-x86-64.zip"
     - "LINUX.X64_193000_db_home.zip"
     - "p34765931_190000_Linux-x86-64.zip"
     - "p6880880_190000_Linux-x86-64.zip"
   ```

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

9. Watch the following video:

Simplified and automated Oracle deployment on Amazon FSx ONTAP with iSCSI

Automation parameter files

Ansible playbook executes database installation and configuration tasks with predefined parameters. For this Oracle automation solution, there are three user-defined parameter files that need user input before playbook execution.

- hosts - define targets that the automation playbook is running against.
- vars/vars.yml - the global variable file that defines variables that apply to all targets.
- host_vars/host_name.yml - the local variable file that defines variables that apply only to a named target. In our use case, these are the Oracle DB servers.

In addition to these user-defined variable files, there are several default variable files that contain default parameters that do not require change unless necessary. The following sections show how to configure the user-defined variable files.

Parameter files configuration

1. Ansible target `hosts` file configuration:

```
# Enter Amazon FSx ONTAP management IP address
[ontap]
172.16.9.32

# Enter name for ec2 instance (not default IP address naming) to be
deployed one by one, follow by ec2 instance IP address, and ssh
private key of ec2-user for the instance.
[oracle]
ora_01 ansible_host=10.61.180.21 ansible_ssh_private_key_file
=ora_01.pem
ora_02 ansible_host=10.61.180.23 ansible_ssh_private_key_file
=ora_02.pem
```

2. Global `vars/vars.yml` file configuration

```
####################################################################
#########################################
######                 Oracle 19c deployment global user
configurable variables                        ######
######                 Consolidate all variables from ONTAP, linux
and oracle                          ######
####################################################################
#########################################

####################################################################
#########################################
######                 ONTAP env specific config variables
######
####################################################################
#########################################

# Enter the supported ONTAP platform: on-prem, aws-fsx.
ontap_platform: aws-fsx

# Enter ONTAP cluster management user credentials
username: "fsxadmin"
password: "xxxxxxxx"

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

```
####################################################################
#########################################

# Enter RHEL subscription to enable repo
redhat_sub_username: xxxxxxxx
redhat_sub_password: "xxxxxxxx"


####################################################################
#########################################
###                   Oracle DB env specific config variables
###
####################################################################
#########################################

# Enter Database domain name
db_domain: solutions.netapp.com

# Enter initial password for all required Oracle passwords. Change
them after installation.
initial_pwd_all: xxxxxxxx
```

3. Local DB server `host_vars/host_name.yml` configuration such as ora_01.yml, ora_02.yml …

```
# User configurable Oracle host specific parameters

# Enter container database SID. By default, a container DB is
created with 3 PDBs within the CDB
oracle_sid: NTAP1

# Enter database shared memory size or SGA. CDB is created with SGA
at 75% of memory_limit, MB. The grand total of SGA should not exceed
75% available RAM on node.
memory_limit: 8192
```

Playbook execution

There are a total of six playbooks in the automation toolkit. Each performs different task blocks and serves different purposes.

```
0-all_playbook.yml - execute playbooks from 1-4 in one playbook run.
1-ansible_requirements.yml - set up Ansible controller with required
libs and collections.
2-linux_config.yml - execute Linux kernel configuration on Oracle DB
servers.
3-ontap_config.yml - configure ONTAP svm/volumes/luns for Oracle
database and grant DB server access to luns.
4-oracle_config.yml - install and configure Oracle on DB servers for
grid infrastructure and create a container database.
5-destroy.yml - optional to undo the environment to dismantle all.
```

There are three options to run the playbooks with the following commands.

1. Execute all deployment playbooks in one combined run.

   ```
   ansible-playbook -i hosts 0-all_playbook.yml -u ec2-user -e
   @vars/vars.yml
   ```

2. Execute playbooks one at a time with the number sequence from 1-4.

   ```
   ansible-playbook -i hosts 1-ansible_requirements.yml -u ec2-user -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 2-linux_config.yml -u ec2-user -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 3-ontap_config.yml -u ec2-user -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 4-oracle_config.yml -u ec2-user -e
   @vars/vars.yml
   ```

3. Execute 0-all_playbook.yml with a tag.

```
ansible-playbook -i hosts 0-all_playbook.yml -u ec2-user -e
@vars/vars.yml -t ansible_requirements
```

```
ansible-playbook -i hosts 0-all_playbook.yml -u ec2-user -e
@vars/vars.yml -t linux_config
```

```
ansible-playbook -i hosts 0-all_playbook.yml -u ec2-user -e
@vars/vars.yml -t ontap_config
```

```
ansible-playbook -i hosts 0-all_playbook.yml -u ec2-user -e
@vars/vars.yml -t oracle_config
```

4. Undo the environment

```
ansible-playbook -i hosts 5-destroy.yml -u ec2-user -e
@vars/vars.yml
```

Post execution validation

After the playbook run, login to the Oracle DB server as oracle user to validate that Oracle grid infrastructure and database are created successfully. Following is an example of Oracle database validation on host ora_01.

1. Validate Oracle container database on EC2 instance

```
[admin@ansiblectl na_oracle_deploy_iscsi]$ ssh -i ora_01.pem ec2-
user@172.30.15.40
Last login: Fri Dec  8 17:14:21 2023 from 10.61.180.18
[ec2-user@ip-172-30-15-40 ~]$ uname -a
Linux ip-172-30-15-40.ec2.internal 4.18.0-372.9.1.el8.x86_64 #1 SMP
Fri Apr 15 22:12:19 EDT 2022 x86_64 x86_64 x86_64 GNU/Linux

[ec2-user@ip-172-30-15-40 ~]$ sudo su
[root@ip-172-30-15-40 ec2-user]# su - oracle
Last login: Fri Dec  8 16:25:52 UTC 2023 on pts/0
[oracle@ip-172-30-15-40 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Dec 8 18:18:20 2023
Version 19.18.0.0.0

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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, log_mode from v$database;

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
NTAP1     READ WRITE           ARCHIVELOG

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP1_PDB1                     READ WRITE NO
         4 NTAP1_PDB2                     READ WRITE NO
         5 NTAP1_PDB3                     READ WRITE NO
SQL> select name from v$datafile;

NAME
```

```
--------------------------------------------------------------------------------
------------
+DATA/NTAP1/DATAFILE/system.257.1155055419
+DATA/NTAP1/DATAFILE/sysaux.258.1155055463
+DATA/NTAP1/DATAFILE/undotbs1.259.1155055489
+DATA/NTAP1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/system.266.115
5056241
+DATA/NTAP1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/sysaux.267.115
5056241
+DATA/NTAP1/DATAFILE/users.260.1155055489
+DATA/NTAP1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/undotbs1.268.1
155056241
+DATA/NTAP1/0C03AAFA7C6FD2E5E063280F1EACFBE0/DATAFILE/system.272.115
5057059
+DATA/NTAP1/0C03AAFA7C6FD2E5E063280F1EACFBE0/DATAFILE/sysaux.273.115
5057059
+DATA/NTAP1/0C03AAFA7C6FD2E5E063280F1EACFBE0/DATAFILE/undotbs1.271.1
155057059
+DATA/NTAP1/0C03AAFA7C6FD2E5E063280F1EACFBE0/DATAFILE/users.275.1155
057075

NAME
--------------------------------------------------------------------------------
------------
+DATA/NTAP1/0C03AC0089ACD352E063280F1EAC12BD/DATAFILE/system.277.115
5057075
+DATA/NTAP1/0C03AC0089ACD352E063280F1EAC12BD/DATAFILE/sysaux.278.115
5057075
+DATA/NTAP1/0C03AC0089ACD352E063280F1EAC12BD/DATAFILE/undotbs1.276.1
155057075
+DATA/NTAP1/0C03AC0089ACD352E063280F1EAC12BD/DATAFILE/users.280.1155
057091
+DATA/NTAP1/0C03ACEABA54D386E063280F1EACE573/DATAFILE/system.282.115
5057091
+DATA/NTAP1/0C03ACEABA54D386E063280F1EACE573/DATAFILE/sysaux.283.115
5057091
+DATA/NTAP1/0C03ACEABA54D386E063280F1EACE573/DATAFILE/undotbs1.281.1
155057091
+DATA/NTAP1/0C03ACEABA54D386E063280F1EACE573/DATAFILE/users.285.1155
057105

19 rows selected.

SQL> select name from v$controlfile;

NAME
```

```
--------------------------------------------------------------------
------------
+DATA/NTAP1/CONTROLFILE/current.261.1155055529
+LOGS/NTAP1/CONTROLFILE/current.256.1155055529

SQL> select member from v$logfile;

MEMBER
--------------------------------------------------------------------
------------
+DATA/NTAP1/ONLINELOG/group_3.264.1155055531
+LOGS/NTAP1/ONLINELOG/group_3.259.1155055539
+DATA/NTAP1/ONLINELOG/group_2.263.1155055531
+LOGS/NTAP1/ONLINELOG/group_2.257.1155055539
+DATA/NTAP1/ONLINELOG/group_1.262.1155055531
+LOGS/NTAP1/ONLINELOG/group_1.258.1155055539

6 rows selected.

SQL> exit
Disconnected from Oracle Database 19c Enterprise Edition Release
19.0.0.0.0 - Production
Version 19.18.0.0.0
```

2. Validate Oracle listener.

```
[oracle@ip-172-30-15-40 ~]$ lsnrctl status listener

LSNRCTL for Linux: Version 19.0.0.0.0 - Production on 08-DEC-2023
18:20:24

Copyright (c) 1991, 2022, Oracle.  All rights reserved.

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=TCP)(HOST=ip-172-30-
15-40.ec2.internal)(PORT=1521)))
STATUS of the LISTENER
------------------------
Alias                     LISTENER
Version                   TNSLSNR for Linux: Version 19.0.0.0.0 -
Production
Start Date                08-DEC-2023 16:26:09
Uptime                    0 days 1 hr. 54 min. 14 sec
Trace Level               off
Security                  ON: Local OS Authentication
SNMP                      OFF
Listener Parameter File
```

```
/u01/app/oracle/product/19.0.0/grid/network/admin/listener.ora
Listener Log File         /u01/app/oracle/diag/tnslsnr/ip-172-30-15-
40/listener/alert/log.xml
Listening Endpoints Summary...
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=ip-172-30-15-
40.ec2.internal)(PORT=1521)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=EXTPROC1521)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcps)(HOST=ip-172-30-15-
40.ec2.internal)(PORT=5500))(Security=(my_wallet_directory=/u01/app/
oracle/product/19.0.0/NTAP1/admin/NTAP1/xdb_wallet))(Presentation=HT
TP)(Session=RAW))
Services Summary...
Service "+ASM" has 1 instance(s).
  Instance "+ASM", status READY, has 1 handler(s) for this
service...
Service "+ASM_DATA" has 1 instance(s).
  Instance "+ASM", status READY, has 1 handler(s) for this
service...
Service "+ASM_LOGS" has 1 instance(s).
  Instance "+ASM", status READY, has 1 handler(s) for this
service...
Service "0c03aafa7c6fd2e5e063280f1eacfbe0.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "0c03ac0089acd352e063280f1eac12bd.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "0c03aceaba54d386e063280f1eace573.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "NTAP1.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "NTAP1XDB.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap1_pdb1.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap1_pdb2.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap1_pdb3.solutions.netapp.com" has 1 instance(s).
```

```
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
The command completed successfully
```

3. Validate the grid infrastructure and resources created.

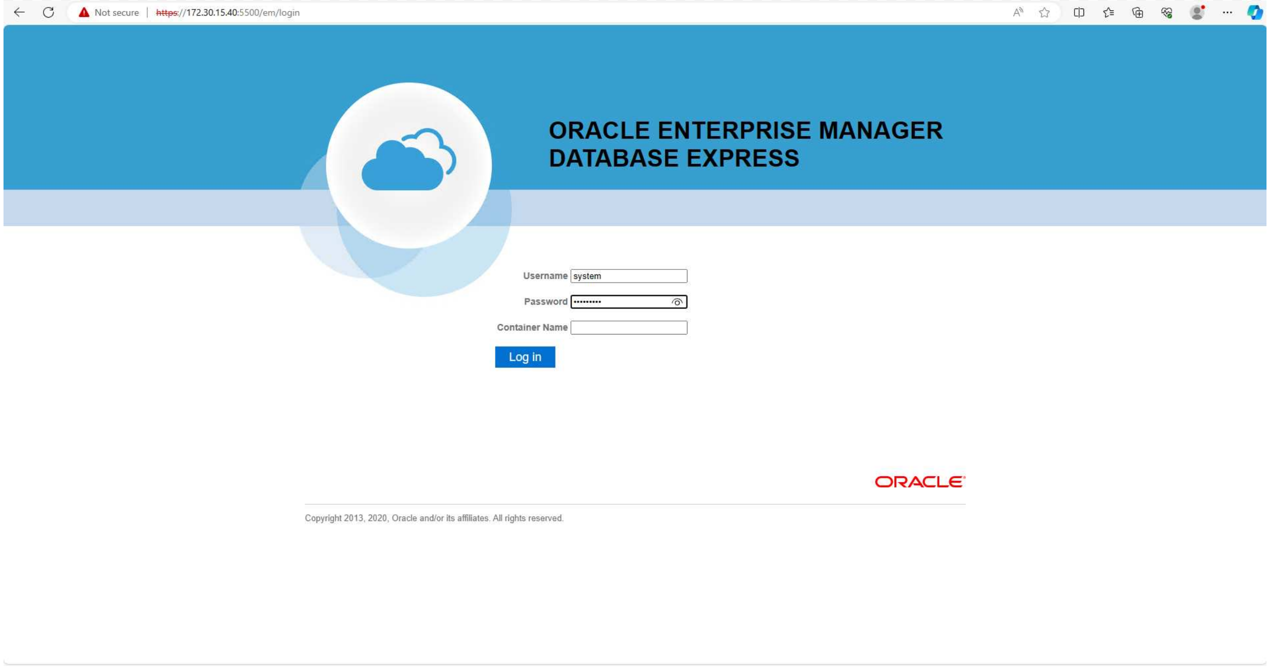
```
[oracle@ip-172-30-15-40 ~]$ asm
[oracle@ip-172-30-15-40 ~]$ crsctl check has
CRS-4638: Oracle High Availability Services is online
[oracle@ip-172-30-15-40 ~]$ crsctl stat res -t
--------------------------------------------------------------------
------------
Name           Target  State        Server                   State
details
--------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------
------------
ora.DATA.dg
               ONLINE  ONLINE       ip-172-30-15-40          STABLE
ora.LISTENER.lsnr
               ONLINE  ONLINE       ip-172-30-15-40          STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ip-172-30-15-40          STABLE
ora.asm
               ONLINE  ONLINE       ip-172-30-15-40
Started,STABLE
ora.ons
               OFFLINE OFFLINE      ip-172-30-15-40          STABLE
--------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------
------------
ora.cssd
      1        ONLINE  ONLINE       ip-172-30-15-40          STABLE
ora.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.driver.afd
      1        ONLINE  ONLINE       ip-172-30-15-40          STABLE
ora.evmd
      1        ONLINE  ONLINE       ip-172-30-15-40          STABLE
ora.ntap1.db
      1        ONLINE  ONLINE       ip-172-30-15-40
```

```
Open,HOME=/u01/app/o

racle/product/19.0.0

/NTAP1,STABLE
--------------------------------------------------------------------
------------
```

4. Validate Oracle ASM.

```
[oracle@ip-172-30-15-40 ~]$ 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  4194304
163840   155376                0          155376              0
N  DATA/
MOUNTED  EXTERN  N         512             512   4096  4194304
81920    80972                0           80972              0
N  LOGS/
ASMCMD> lsdsk
Path
AFD:ORA_01_DAT1_01
AFD:ORA_01_DAT1_03
AFD:ORA_01_DAT2_02
AFD:ORA_01_DAT2_04
AFD:ORA_01_LOGS_01
AFD:ORA_01_LOGS_02
ASMCMD> afd_state
ASMCMD-9526: The AFD state is 'LOADED' and filtering is 'ENABLED' on
host 'ip-172-30-15-40.ec2.internal'
ASMCMD> exit
```

5. Login to Oracle Enterprise Manager Express to validate database.

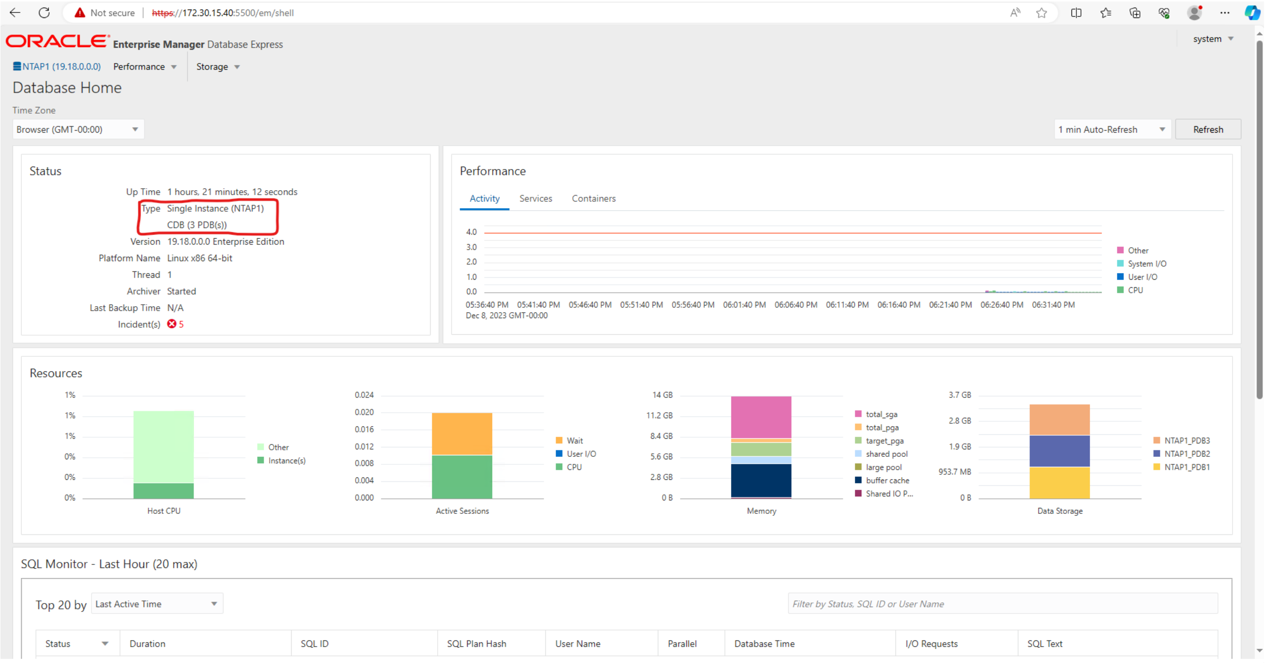


Not secure | https://172.30.15.40:5500/em/login
ORACLE ENTERPRISE MANAGER
DATABASE EXPRESS
Log in
ORACLE
Copyright 2013, 2020, Oracle and/or its affiliates. All rights reserved.

Username: system

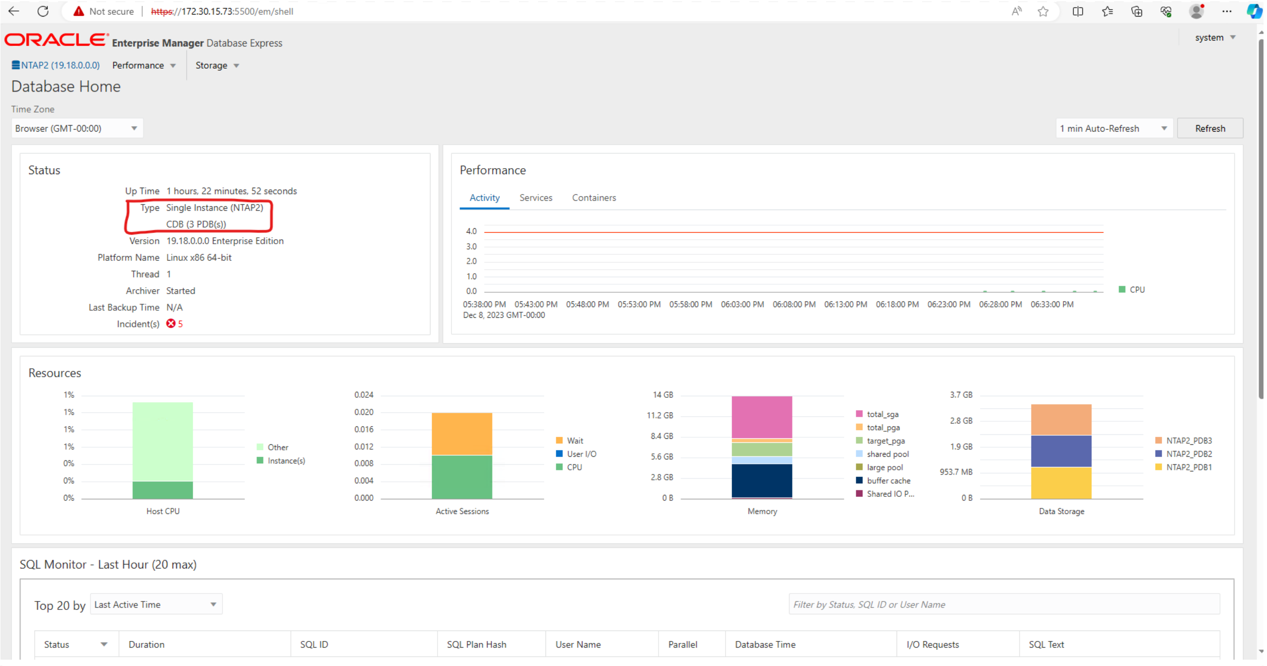
Password: •••••••••

Container Name:



Status

Up Time	1 hours, 21 minutes, 12 seconds
Type	Single Instance (NTAP1)
	CDB (3 PDB(s))
Version	19.18.0.0.0 Enterprise Edition
Platform Name	Linux x86 64-bit
Thread	1
Archiver	Started
Last Backup Time	N/A
Incident(s)	✖ 5



Status

Up Time 1 hours, 22 minutes, 52 seconds
Type Single Instance (NTAP2)
CDB (3 PDB(s))
Version 19.18.0.0.0 Enterprise Edition
Platform Name Linux x86 64-bit
Thread 1
Archiver Started
Last Backup Time N/A
Incident(s) ✖ 5

Oracle backup, restore, and clone with SnapCenter

Refer to TR-4979 Simplified, self-managed Oracle in VMware Cloud on AWS with guest-mounted FSx ONTAP section `Oracle backup, restore, and clone with SnapCenter` for details on setting up SnapCenter and executing the database backup, restore, and clone workflows.

Where to find additional information

To learn more about the information 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-8225-4784bced9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIsAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixF-xnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

- 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

- Use Red Hat Enterprise Linux 8.2 with ONTAP

  https://docs.netapp.com/us-en/ontap-sanhost/hu_rhel_82.html#all-san-array-configurations

TR-4979: Simplified, Self-managed Oracle in VMware Cloud on AWS with guest-mounted FSx ONTAP

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for Oracle deployment and protection in VMware Cloud in AWS with FSx ONTAP as primary database storage and Oracle database configured in standalone ReStart using asm as volume manager.

Purpose

Enterprises have been running Oracle on VMware in private data centers for decades. VMware Cloud (VMC) on AWS provides a push-button solution to bring VMware’s enterprise-class Software-Defined Data Center (SDDC) software to the AWS Cloud’s dedicated, elastic, bare-metal infrastructure. AWS FSx ONTAP offers premium storage to VMC SDDC and a data fabric that enables customers to run business-critical applications such as Oracle across vSphere®-based private, public, and hybrid cloud environments, with optimized access to AWS services. Whether it is an existing or new Oracle workload, VMC on AWS provides a familiar, simplified, and self-managed Oracle environment on VMware with all the benefits of AWS cloud while deferring all platform management and optimization to VMware.

This documentation demonstrates the deployment and protection of an Oracle database in a VMC environment with Amazon FSx ONTAP as primary database storage. Oracle database can be deployed to VMC on FSx storage as direct VM guest-mounted LUNs or NFS-mounted VMware VMDK datastore disks. This technical report focuses on Oracle database deployment as direct guest-mounted FSx storage to VMs in the VMC cluster with the iSCSI protocol and Oracle ASM. We also demonstrate how to use the NetApp SnapCenter UI tool to backup, restore, and clone an Oracle database for dev/test or other use cases for storage-efficient database operation in the VMC on AWS.

This solution addresses the following use cases:

- Oracle database deployment in VMC on AWS with Amazon FSx ONTAP as primary database storage
- Oracle database backup and restore in VMC on AWS using NetApp SnapCenter tool
- Oracle database clone for dev/test or other use cases in VMC on AWS using NetApp SnapCenter tool

Audience

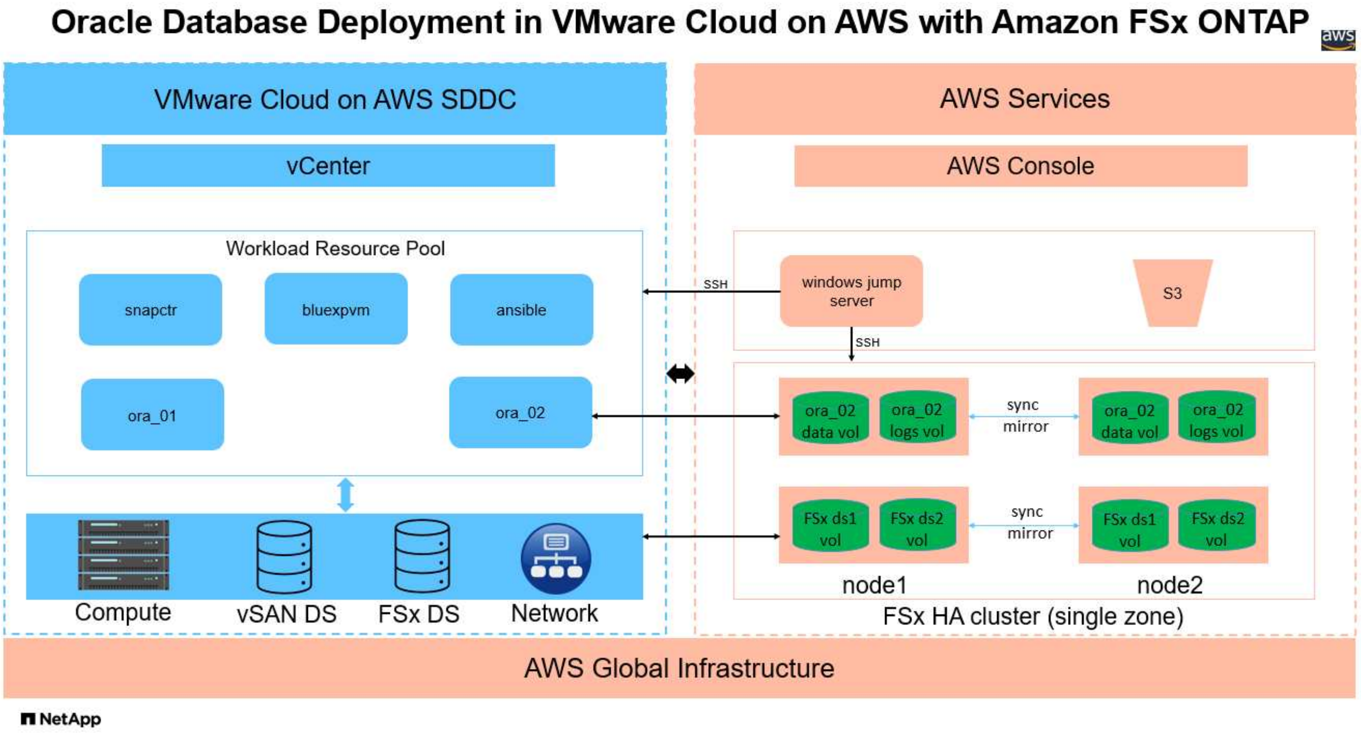
This solution is intended for the following people:

- A DBA who would like to deploy Oracle in VMC on AWS with Amazon FSx ONTAP
- A database solution architect who would like to test Oracle workloads in VMC on the AWS cloud
- A storage administrator who would like to deploy and manage an Oracle database deployed to VMC on AWS with Amazon FSx ONTAP
- An application owner who would like to stand up an Oracle database in VMC on the AWS cloud

Solution test and validation environment

The testing and validation of this solution was performed in a lab environment with VMC on AWS that might not match the final deployment environment. For more information, see the section Key factors for deployment consideration.

Architecture



Hardware and software components

	Hardware	
FSx ONTAP storage	Current version offered by AWS	One FSx ONTAP HA cluster in the same VPC and availability zone as VMC
VMC SDDC cluster	Amazon EC2 i3.metal single node/Intel Xeon E5-2686 CPU,36 cores/512G RAM	10.37 TB vSAN storage
	Software	
RedHat Linux	RHEL-8.6, 4.18.0-372.9.1.el8.x86_64 kernel	Deployed RedHat subscription for testing
Windows Server	2022 Standard, 10.0.20348 Build 20348	Hosting SnapCenter server
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 Server	Version 4.9P1	Workgroup deployment
BlueXP backup and recovery for VMs	Release 1.0	Deployed as an ova vSphere plugin VM
VMware vSphere	Version 8.0.1.00300	VMware Tools, Version: 11365 - Linux, 12352 - Windows
Open JDK	Version java-1.8.0-openjdk.x86_64	SnapCenter plugin requirement on DB VMs

Oracle database configuration in VMC on AWS

Server	Database	DB Storage
ora_01	cdb1(cdb1_pdb1,cdb1_pdb2,cdb1_pdb3)	VMDK datastore on FSx ONTAP
ora_01	cdb2(cdb2_pdb)	VMDK datastore on FSx ONTAP
ora_02	cdb3(cdb3_pdb1,cdb3_pdb2,cdb3_pdb3)	Direct guest mounted FSx ONTAP
ora_02	cdb4(cdb4_pdb)	Direct guest mounted FSx ONTAP

Key factors for deployment consideration

- **FSx to VMC connectivity.** When you deploy your SDDC on VMware Cloud on AWS, it is created within an AWS account and a VPC dedicated to your organization and managed by VMware. You must also connect the SDDC to an AWS account belonging to you, called the customer AWS account. This connection allows your SDDC to access AWS services belonging to your customer account. FSx for ONTAP is an AWS service deployed in your customer account. Once the VMC SDDC is connected to your customer account, FSx storage is available to VMs in VMC SDDC for direct guest mount.
- **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. NetApp also recommends deploying FSx for NetApp ONTAP and VMware Cloud on AWS in the same availability zone to achieve better performance and avoid data transfer charges between availability zones.
- **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 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 log volume. In general, multiple LUNs laid out within an Amazon FSx for ONTAP volume provide better performance.

- **iSCSI configuration.** The database VMs in VMC SDDC connect to FSx storage with the iSCSI protocol. It is important to gauge the Oracle database peak I/O throughput requirement by carefully analyzing the Oracle AWR report to determine the 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 ONTAP 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 SnapCenter software suite for database backup, restore, and cloning with a user-friendly UI interface. NetApp recommends implementing such a management tool to achieve fast (under a minute) SnapShot backup, quick (minutes) database restore, and database clone.

Solution deployment

The following sections provide step-by-step procedures for Oracle 19c deployment in VMC on AWS with directly mounted FSx ONTAP storage to DB VM in a single node Restart configuration with Oracle ASM as database volume manager.

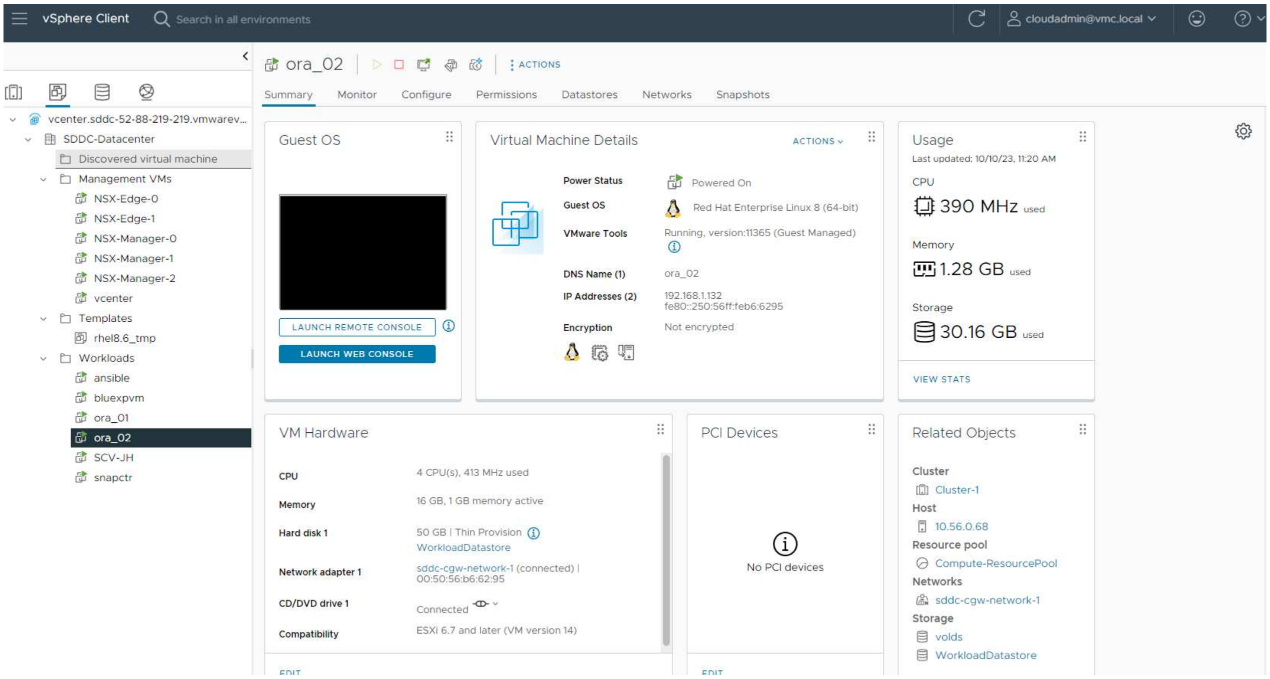
Prerequisites for deployment

Deployment requires the following prerequisites.

1. A software-defined data center (SDDC) using VMware Cloud on AWS has been created. For detailed instruction on how to create an SDDC in VMC, please refer to VMware documentation Getting Started With VMware Cloud on AWS
2. An AWS account has been set up, and the necessary VPC and network segments have been created within your AWS account. The AWS account is linked to your VMC SDDC.
3. From the AWS EC2 console, deploying an 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. The above step can be performed using the following Terraform automation toolkit, which creates an EC2 instance as a jump host for SDDC in VMC access via SSH and an FSx file system. Review instructions carefully and change the variables to suit your environment before execution.

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

5. Build VMs in VMware SDDC on AWS for hosting your Oracle environment to be deployed in VMC. In our demonstration, we have built two Linux VMs as Oracle DB servers, one Windows server for the SnapCenter server, and one optional Linux server as an Ansible controller for automated Oracle installation or configuration if desired. Following is a snapshot of the lab environment for the solution validation.



Power Status: Powered On
Guest OS: Red Hat Enterprise Linux 8 (64-bit)
VMware Tools: Running, version:11365 (Guest Managed)
DNS Name (1): ora_02
IP Addresses (2): 192.168.1.132 fe80::250:56ff:feb6:6295
Encryption: Not encrypted

Last updated: 10/10/23, 11:20 AM
CPU: 390 MHz used
Memory: 1.28 GB used
Storage: 30.16 GB used

CPU: 4 CPU(s), 413 MHz used
Memory: 16 GB, 1 GB memory active
Hard disk 1: 50 GB | Thin Provision WorkloadDatastore
Network adapter 1: sddc-cgw-network-1 (connected) | 00:50:56:b6:62:95
CD/DVD drive 1: Connected
Compatibility: ESXi 6.7 and later (VM version 14)

No PCI devices

Cluster: Cluster-1
Host: 10.56.0.68
Resource pool: Compute-ResourcePool
Networks: sddc-cgw-network-1
Storage: vols
WorkloadDatastore

6. Optionally, NetApp also provides several automation toolkits to run Oracle deployment and configuration when applicable. Refer to DB Automation Toolkits for more information.

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

DB VM kernel configuration

With the prerequisites provisioned, login to the Oracle VM as an admin user via SSH and sudo to the root user to configure the Linux kernel for Oracle installation. Oracle install files can be staged in an AWS S3 bucket and transferred into the VM.

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 DB VM.

   ```
   [admin@ora_02 ~]$ ls -l /tmp/archive/
   total 10539364
   -rw-rw-r--. 1 admin  admin         19112 Oct  4 17:04 compat-
   libcap1-1.10-7.el7.x86_64.rpm
   -rw-rw-r--. 1 admin  admin    3059705302 Oct  4 17:10
   LINUX.X64_193000_db_home.zip
   -rw-rw-r--. 1 admin  admin    2889184573 Oct  4 17:11
   LINUX.X64_193000_grid_home.zip
   -rw-rw-r--. 1 admin  admin        589145 Oct  4 17:04
   netapp_linux_unified_host_utilities-7-1.x86_64.rpm
   -rw-rw-r--. 1 admin  admin         31828 Oct  4 17:04 oracle-
   database-preinstall-19c-1.0-2.el8.x86_64.rpm
   -rw-rw-r--. 1 admin  admin    2872741741 Oct  4 17:12
   p34762026_190000_Linux-x86-64.zip
   -rw-rw-r--. 1 admin  admin    1843577895 Oct  4 17:13
   p34765931_190000_Linux-x86-64.zip
   -rw-rw-r--. 1 admin  admin     124347218 Oct  4 17:13
   p6880880_190000_Linux-x86-64.zip
   -rw-rw-r--. 1 admin  admin        257136 Oct  4 17:04
   policycoreutils-python-utils-2.9-9.el8.noarch.rpm
   [admin@ora_02 ~]$
   ```

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`.

```
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
```

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

```
vi /etc/rc.local
```

```
  # 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
```

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

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

14. Add the following lines to `limit.conf` to set the file descriptor limit and stack size.

```
vi /etc/security/limits.conf
```

```
*                hard    nofile          65536
*                soft    stack           10240
```

15. Add swap space to DB VM if there is no swap space configured with 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.
16. Change `node.session.timeo.replacement_timeout` in the `iscsi.conf` configuration file from 120 to 5 seconds.

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

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

```
systemctl enable iscsid
```

```
systemctl start iscsid
```

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

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

19. Add the asm groups for asm management user (oracle).

```
groupadd asmadmin
```

```
groupadd asmdba
```

```
groupadd asmoper
```

20. Modify the oracle user to add asm groups as secondary groups (the oracle user should have been created after Oracle preinstall RPM installation).

```
usermod -a -G asmadmin oracle
```

```
usermod -a -G asmdba oracle
```

```
usermod -a -G asmoper oracle
```

21. Stop and disable the Linux firewall if it is active.

```
systemctl stop firewalld
```

```
systemctl disable firewalld
```

22. Enable password-less sudo for admin user by uncommenting `# %wheel ALL=(ALL) NOPASSWD: ALL` line in /etc/sudoers file. Change the file permission to make the edit.

```
chmod 640 /etc/sudoers
```

```
vi /etc/sudoers
```

```
chmod 440 /etc/sudoers
```

23. Reboot the EC2 instance.

Provision and map FSx ONTAP LUNs to the DB VM

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

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

```
ssh fsxadmin@10.49.0.74
```

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

```
vol create -volume ora_02_biny -aggregate aggr1 -size 50G -state
online  -type RW -snapshot-policy none -tiering-policy snapshot-only
```

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

```
vol create -volume ora_02_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_02_logs -aggregate aggr1 -size 100G -state
online  -type RW -snapshot-policy none -tiering-policy snapshot-only
```

5. Validate the volumes created.

```
vol show ora*
```

Output from the command:

```
FsxId0c00cec8dad373fd1::> vol show ora*
Vserver   Volume       Aggregate    State      Type       Size
Available Used%
--------- ------------ ------------ ---------- ---- ----------
---------- -----
nim       ora_02_biny  aggr1        online     RW         50GB
22.98GB   51%
nim       ora_02_data  aggr1        online     RW        100GB
18.53GB   80%
nim       ora_02_logs  aggr1        online     RW         50GB
7.98GB   83%
```

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

   ```
   lun create -path /vol/ora_02_biny/ora_02_biny_01 -size 40G -ostype
   linux
   ```

7. Create data LUNs within the database data volume.

   ```
   lun create -path /vol/ora_02_data/ora_02_data_01 -size 20G -ostype
   linux
   ```

   ```
   lun create -path /vol/ora_02_data/ora_02_data_02 -size 20G -ostype
   linux
   ```

   ```
   lun create -path /vol/ora_02_data/ora_02_data_03 -size 20G -ostype
   linux
   ```

   ```
   lun create -path /vol/ora_02_data/ora_02_data_04 -size 20G -ostype
   linux
   ```

8. Create log LUNs within the database logs volume.

   ```
   lun create -path /vol/ora_02_logs/ora_02_logs_01 -size 40G -ostype
   linux
   ```

   ```
   lun create -path /vol/ora_02_logs/ora_02_logs_02 -size 40G -ostype
   linux
   ```

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

   ```
   igroup create -igroup ora_02 -protocol iscsi -ostype linux
   -initiator iqn.1994-05.com.redhat:f65fed7641c2
   ```

10. Map the LUNs to the igroup created above. Increment the LUN ID sequentially for each additional LUN.

```
lun map -path /vol/ora_02_biny/ora_02_biny_01 -igroup ora_02
-vserver svm_ora -lun-id 0
lun map -path /vol/ora_02_data/ora_02_data_01 -igroup ora_02
-vserver svm_ora -lun-id 1
lun map -path /vol/ora_02_data/ora_02_data_02 -igroup ora_02
-vserver svm_ora -lun-id 2
lun map -path /vol/ora_02_data/ora_02_data_03 -igroup ora_02
-vserver svm_ora -lun-id 3
lun map -path /vol/ora_02_data/ora_02_data_04 -igroup ora_02
-vserver svm_ora -lun-id 4
lun map -path /vol/ora_02_logs/ora_02_logs_01 -igroup ora_02
-vserver svm_ora -lun-id 5
lun map -path /vol/ora_02_logs/ora_02_logs_02 -igroup ora_02
-vserver svm_ora -lun-id 6
```

11. Validate the LUN mapping.

```
mapping show
```

This is expected to return:

```
FsxId0c00cec8dad373fd1::> mapping show
  (lun mapping show)
Vserver    Path                                      Igroup   LUN ID
Protocol
---------- ---------------------------------------  -------  ------
--------
nim        /vol/ora_02_biny/ora_02_u01_01            ora_02        0
iscsi
nim        /vol/ora_02_data/ora_02_u02_01            ora_02        1
iscsi
nim        /vol/ora_02_data/ora_02_u02_02            ora_02        2
iscsi
nim        /vol/ora_02_data/ora_02_u02_03            ora_02        3
iscsi
nim        /vol/ora_02_data/ora_02_u02_04            ora_02        4
iscsi
nim        /vol/ora_02_logs/ora_02_u03_01            ora_02        5
iscsi
nim        /vol/ora_02_logs/ora_02_u03_02            ora_02        6
iscsi
```

DB VM storage configuration

Now, import and set up the FSx ONTAP storage for the Oracle grid infrastructure and database installation on the VMC database VM.

1. Login to the DB VM via SSH as the admin user using Putty from Windows jump server.
2. Discover the FSx iSCSI endpoints using either SVM iSCSI IP address. Change to your environment-specific portal address.

```
sudo iscsiadm iscsiadm --mode discovery --op update --type
sendtargets --portal 10.49.0.12
```

3. Establish iSCSI sessions by logging into each target.

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

The expected output from the command is:

```
[ec2-user@ip-172-30-15-58 ~]$ sudo iscsiadm --mode node -l all
Logging in to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
10.49.0.12,3260]
Logging in to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
10.49.0.186,3260]
Login to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
10.49.0.12,3260] successful.
Login to [iface: default, target: iqn.1992-
08.com.netapp:sn.1f795e65c74911edb785affbf0a2b26e:vs.3, portal:
10.49.0.186,3260] successful.
```

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

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

Return the iSCSI sessions.

```
[ec2-user@ip-172-30-15-58 ~]$ sudo iscsiadm --mode session
tcp: [1] 10.49.0.186:3260,1028 iqn.1992-
08.com.netapp:sn.545a38bf06ac11ee8503e395ab90d704:vs.3 (non-flash)
tcp: [2] 10.49.0.12:3260,1029 iqn.1992-
08.com.netapp:sn.545a38bf06ac11ee8503e395ab90d704: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.

```
[admin@ora_02 ~]$ sudo sanlun lun show
controller(7mode/E-Series)/
device          host                  lun
vserver(cDOT/FlashRay)        lun-pathname
filename        adapter    protocol   size    product
---------------------------------------------------------------------
------------------------------------------------------------
nim                           /vol/ora_02_logs/ora_02_u03_02
/dev/sdo        host34     iSCSI      20g     cDOT
nim                           /vol/ora_02_logs/ora_02_u03_01
/dev/sdn        host34     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_04
/dev/sdm        host34     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_03
/dev/sdl        host34     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_02
/dev/sdk        host34     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_01
/dev/sdj        host34     iSCSI      20g     cDOT
nim                           /vol/ora_02_biny/ora_02_u01_01
/dev/sdi        host34     iSCSI      40g     cDOT
nim                           /vol/ora_02_logs/ora_02_u03_02
/dev/sdh        host33     iSCSI      20g     cDOT
nim                           /vol/ora_02_logs/ora_02_u03_01
/dev/sdg        host33     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_04
/dev/sdf        host33     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_03
/dev/sde        host33     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_02
/dev/sdd        host33     iSCSI      20g     cDOT
nim                           /vol/ora_02_data/ora_02_u02_01
/dev/sdc        host33     iSCSI      20g     cDOT
nim                           /vol/ora_02_biny/ora_02_u01_01
/dev/sdb        host33     iSCSI      40g     cDOT
```

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

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

Add following entries:

```
defaults {
    find_multipaths yes
    user_friendly_names yes
}

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

7. Start the multipath service.

```
sudo systemctl start multipathd
```

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

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

8. Log into the FSx ONTAP cluster as the fsxadmin user via SSH to retrieve the serial-hex number for each LUN starting with 6c574xxx…, the HEX number starts with 3600a0980, which is the 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_02_biny/ora_02_biny_01 6c574235472455534e68512d
svm_ora /vol/ora_02_data/ora_02_data_01 6c574235472455534e685141
svm_ora /vol/ora_02_data/ora_02_data_02 6c574235472455534e685142
svm_ora /vol/ora_02_data/ora_02_data_03 6c574235472455534e685143
svm_ora /vol/ora_02_data/ora_02_data_04 6c574235472455534e685144
svm_ora /vol/ora_02_logs/ora_02_logs_01 6c574235472455534e685145
svm_ora /vol/ora_02_logs/ora_02_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_02_biny_01
        }
        multipath {
                wwid            3600a09806c574235472455534e685141
                alias           ora_02_data_01
        }
        multipath {
                wwid            3600a09806c574235472455534e685142
                alias           ora_02_data_02
        }
        multipath {
                wwid            3600a09806c574235472455534e685143
                alias           ora_02_data_03
        }
        multipath {
                wwid            3600a09806c574235472455534e685144
                alias           ora_02_data_04
        }
        multipath {
                wwid            3600a09806c574235472455534e685145
                alias           ora_02_logs_01
        }
        multipath {
                wwid            3600a09806c574235472455534e685146
                alias           ora_02_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_02_biny_01 -> ../dm-
0
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_02_data_01 -> ../dm-
1
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_02_data_02 -> ../dm-
2
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_02_data_03 -> ../dm-
3
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_02_data_04 -> ../dm-
4
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_02_logs_01 -> ../dm-
5
lrwxrwxrwx 1 root root       7 Mar 21 20:41 ora_02_logs_02 -> ../dm-
6
```

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

```
sudo fdisk /dev/mapper/ora_02_biny_01
```

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

```
sudo mkfs.xfs /dev/mapper/ora_02_biny_01p1
```

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

```
sudo mkdir /u01
```

```
sudo mount -t xfs /dev/mapper/ora_02_biny_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 UUI of the binary LUN.

```
sudo blkid /dev/mapper/ora_02_biny_01p1
```

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

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

    Add the following line.

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

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 DB VM as the admin user via SSH and enable password authentication by uncommenting `PasswordAuthentication yes` and then commenting out `PasswordAuthentication no`.

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

2. Restart the sshd service.

   ```
   sudo systemctl restart sshd
   ```

3. Reset the Oracle user password.

   ```
   sudo passwd oracle
   ```

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

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

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

5. Change the directory permission setting.

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

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

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

   ```
   cd /u01/app/oracle/product/19.0.0/grid
   ```

7. Unzip the grid installation files.

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

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

```
rm -rf OPatch
```

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

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

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

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

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

```
INVENTORY_LOCATION=/u01/app/oraInventory
oracle.install.option=HA_CONFIG
ORACLE_BASE=/u01/app/oracle
oracle.install.asm.OSDBA=asmdba
oracle.install.asm.OSOPER=asmoper
oracle.install.asm.OSASM=asmadmin
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_02_data_01,/dev/mapper/ora_02_data_02,/dev/mapper/ora_02_data_03,/dev/mapper/ora_02_data_04
oracle.install.asm.diskGroup.diskDiscoveryString=/dev/mapper/*
oracle.install.asm.monitorPassword="SetPWD"
oracle.install.asm.configureAFD=true
```

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

```
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/
```

```
export ORACLE_BASE=/tmp
```

```
cd /u01/app/oracle/product/19.0.0/grid/bin
```

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

    ```
     ./asmcmd afd_label DATA01 /dev/mapper/ora_02_data_01 --init
    ```

    ```
     ./asmcmd afd_label DATA02 /dev/mapper/ora_02_data_02 --init
    ```

    ```
     ./asmcmd afd_label DATA03 /dev/mapper/ora_02_data_03 --init
    ```

    ```
     ./asmcmd afd_label DATA04 /dev/mapper/ora_02_data_04 --init
    ```

    ```
     ./asmcmd afd_label LOGS01 /dev/mapper/ora_02_logs_01 --init
    ```

    ```
     ./asmcmd afd_label LOGS02 /dev/mapper/ora_02_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 -q /tmp/archive/p34762026_190000_Linux-x86-64.zip -d
    /tmp/archive
    ```

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
    ```

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
```

```
[oracle@ora_02 grid]$ bin/crsctl stat res -t
--------------------------------------------------------------------
------------
Name           Target  State        Server                   State
details
--------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------
------------
ora.DATA.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.LISTENER.lsnr
               ONLINE  INTERMEDIATE ora_02                   Not All
Endpoints Re

gistered,STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.asm
               ONLINE  ONLINE       ora_02
Started,STABLE
ora.ons
               OFFLINE OFFLINE      ora_02                   STABLE
--------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------
------------
ora.cssd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.driver.afd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.evmd
      1        ONLINE  ONLINE       ora_02                   STABLE
--------------------------------------------------------------------
------------
```

23. Valiate ASM filter driver status.

```
[oracle@ora_02 grid]$ export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/grid
[oracle@ora_02 grid]$ export ORACLE_SID=+ASM
[oracle@ora_02 grid]$ export PATH=$PATH:$ORACLE_HOME/bin
[oracle@ora_02 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  4194304
81920    81780                0           81780              0
N  DATA/
MOUNTED  EXTERN  N         512             512   4096  4194304
40960    40852                0           40852              0
N  LOGS/
ASMCMD> afd_state
ASMCMD-9526: The AFD state is 'LOADED' and filtering is 'ENABLED' on
host 'ora_02'
ASMCMD> exit
[oracle@ora_02 grid]$
```

24. Validate HA service status.

```
[oracle@ora_02 bin]$ ./crsctl check has
CRS-4638: Oracle High Availability Services is online
```

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 the directory to it.

   ```
   mkdir /u01/app/oracle/product/19.0.0/cdb3
   ```

   ```
   cd /u01/app/oracle/product/19.0.0/cdb3
   ```

3. Unzip the Oracle DB installation files.

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

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

   ```
   rm -rf OPatch
   ```

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

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

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

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

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

   ```
   unzip -q /tmp/archive/p34765931_190000_Linux-x86-64.zip -d
   /tmp/archive
   ```

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/cdb3
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 cdb3 home /u01/app/oracle/product/19.0.0/cdb3, 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=cdb3.demo.netapp.com
sid=cdb3
createAsContainerDatabase=true
numberOfPDBs=3
pdbName=cdb3_pdb
useLocalUndoForPDBs=true
pdbAdminPassword="yourPWD"
templateName=General_Purpose.dbc
sysPassword="yourPWD"
systemPassword="yourPWD"
dbsnmpPassword="yourPWD"
datafileDestination=+DATA
recoveryAreaDestination=+LOGS
storageType=ASM
diskGroupName=DATA
characterSet=AL32UTF8
nationalCharacterSet=AL16UTF16
listeners=LISTENER
databaseType=MULTIPURPOSE
automaticMemoryManagement=false
totalMemory=8192
```

12. As oracle user, launch 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/cdb3.
Database Information:
Global Database Name:cdb3.vmc.netapp.com
System Identifier(SID):cdb3
Look at the log file "/u01/app/oracle/cfgtoollogs/dbca/cdb3/cdb3.log"
for further details.
```

1. Repeat the same procedures from step 2 to create a container database cdb4 in a separate ORACLE_HOME /u01/app/oracle/product/19.0.0/cdb4 with a single PDB.
2. As Oracle user, validate Oracle Restart HA services after DB creation that all databases (cdb3, cdb4) are registered with HA services.

   ```
   /u01/app/oracle/product/19.0.0/grid/crsctl stat res -t
   ```

   output:

   ```
   [oracle@ora_02 bin]$ ./crsctl stat res -t
   --------------------------------------------------------------------
   ------------
   Name           Target  State        Server                      State
   ```

```
details
--------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------
------------
ora.DATA.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.LISTENER.lsnr
               ONLINE  INTERMEDIATE ora_02                   Not All
Endpoints Re

gistered,STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.asm
               ONLINE  ONLINE       ora_02
Started,STABLE
ora.ons
               OFFLINE OFFLINE      ora_02                   STABLE
--------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------
------------
ora.cdb3.db
      1        ONLINE  ONLINE       ora_02
Open,HOME=/u01/app/o

racle/product/19.0.0

/cdb3,STABLE
ora.cdb4.db
      1        ONLINE  ONLINE       ora_02
Open,HOME=/u01/app/o

racle/product/19.0.0

/cdb4,STABLE
ora.cssd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.driver.afd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.evmd
```

```
      1        ONLINE  ONLINE       ora_02                       STABLE
--------------------------------------------------------------------
------------
```

3. Set the Oracle user `.bash_profile`.

```
vi ~/.bash_profile
```

Add following entries:

```
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/db3
export ORACLE_SID=db3
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'
alias cdb3='export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/cdb3;export
ORACLE_SID=cdb3;export PATH=$PATH:$ORACLE_HOME/bin'
alias cdb4='export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/cdb4;export
ORACLE_SID=cdb4;export PATH=$PATH:$ORACLE_HOME/bin'
```

4. Validate the CDB/PDB created for cdb3.

```
cdb3
```

```
[oracle@ora_02 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Mon Oct 9 08:19:20 2023
Version 19.18.0.0.0

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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
--------- --------------------
CDB3      READ WRITE

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 CDB3_PDB1                      READ WRITE NO
         4 CDB3_PDB2                      READ WRITE NO
         5 CDB3_PDB3                      READ WRITE NO
SQL>

SQL> select name from v$datafile;

NAME
--------------------------------------------------------------------
------------
+DATA/CDB3/DATAFILE/system.257.1149420273
+DATA/CDB3/DATAFILE/sysaux.258.1149420317
+DATA/CDB3/DATAFILE/undotbs1.259.1149420343
+DATA/CDB3/86B637B62FE07A65E053F706E80A27CA/DATAFILE/system.266.1149
421085
+DATA/CDB3/86B637B62FE07A65E053F706E80A27CA/DATAFILE/sysaux.267.1149
421085
+DATA/CDB3/DATAFILE/users.260.1149420343
+DATA/CDB3/86B637B62FE07A65E053F706E80A27CA/DATAFILE/undotbs1.268.11
49421085
+DATA/CDB3/06FB206DF15ADEE8E065025056B66295/DATAFILE/system.272.1149
422017
+DATA/CDB3/06FB206DF15ADEE8E065025056B66295/DATAFILE/sysaux.273.1149
422017
+DATA/CDB3/06FB206DF15ADEE8E065025056B66295/DATAFILE/undotbs1.271.11
49422017
+DATA/CDB3/06FB206DF15ADEE8E065025056B66295/DATAFILE/users.275.11494
22033

NAME
--------------------------------------------------------------------
------------
+DATA/CDB3/06FB21766256DF9AE065025056B66295/DATAFILE/system.277.1149
422033
+DATA/CDB3/06FB21766256DF9AE065025056B66295/DATAFILE/sysaux.278.1149
422033
+DATA/CDB3/06FB21766256DF9AE065025056B66295/DATAFILE/undotbs1.276.11
```

```
49422033
+DATA/CDB3/06FB21766256DF9AE065025056B66295/DATAFILE/users.280.11494
22049
+DATA/CDB3/06FB22629AC1DFD7E065025056B66295/DATAFILE/system.282.1149
422049
+DATA/CDB3/06FB22629AC1DFD7E065025056B66295/DATAFILE/sysaux.283.1149
422049
+DATA/CDB3/06FB22629AC1DFD7E065025056B66295/DATAFILE/undotbs1.281.11
49422049
+DATA/CDB3/06FB22629AC1DFD7E065025056B66295/DATAFILE/users.285.11494
22063

19 rows selected.

SQL>
```

5. Validate the CDB/PDB created for cdb4.

```
cdb4
```

```
[oracle@ora_02 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Mon Oct 9 08:20:26 2023
Version 19.18.0.0.0

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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
--------- --------------------
CDB4      READ WRITE

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 CDB4_PDB                       READ WRITE NO
SQL>

SQL> select name from v$datafile;

NAME
--------------------------------------------------------------------
------------
+DATA/CDB4/DATAFILE/system.286.1149424943
+DATA/CDB4/DATAFILE/sysaux.287.1149424989
+DATA/CDB4/DATAFILE/undotbs1.288.1149425015
+DATA/CDB4/86B637B62FE07A65E053F706E80A27CA/DATAFILE/system.295.1149
425765
+DATA/CDB4/86B637B62FE07A65E053F706E80A27CA/DATAFILE/sysaux.296.1149
425765
+DATA/CDB4/DATAFILE/users.289.1149425015
+DATA/CDB4/86B637B62FE07A65E053F706E80A27CA/DATAFILE/undotbs1.297.11
49425765
+DATA/CDB4/06FC3070D5E12C23E065025056B66295/DATAFILE/system.301.1149
426581
+DATA/CDB4/06FC3070D5E12C23E065025056B66295/DATAFILE/sysaux.302.1149
426581
+DATA/CDB4/06FC3070D5E12C23E065025056B66295/DATAFILE/undotbs1.300.11
49426581
+DATA/CDB4/06FC3070D5E12C23E065025056B66295/DATAFILE/users.304.11494
26597

11 rows selected.
```

6. Login to each cdb as sysdba with sqlplus and set the DB recovery destination size to the +LOGS disk group size for both cdbs.

```
alter system set db_recovery_file_dest_size = 40G scope=both;
```

7. Login to each cdb as sysdba with sqlplus and enable archive log mode with following command sets in sequence.

```
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 storage and a VMC DB VM. If desired, NetApp recommends relocating the Oracle control file and online log files to the +LOGS disk group.

Oracle backup, restore, and clone with SnapCenter

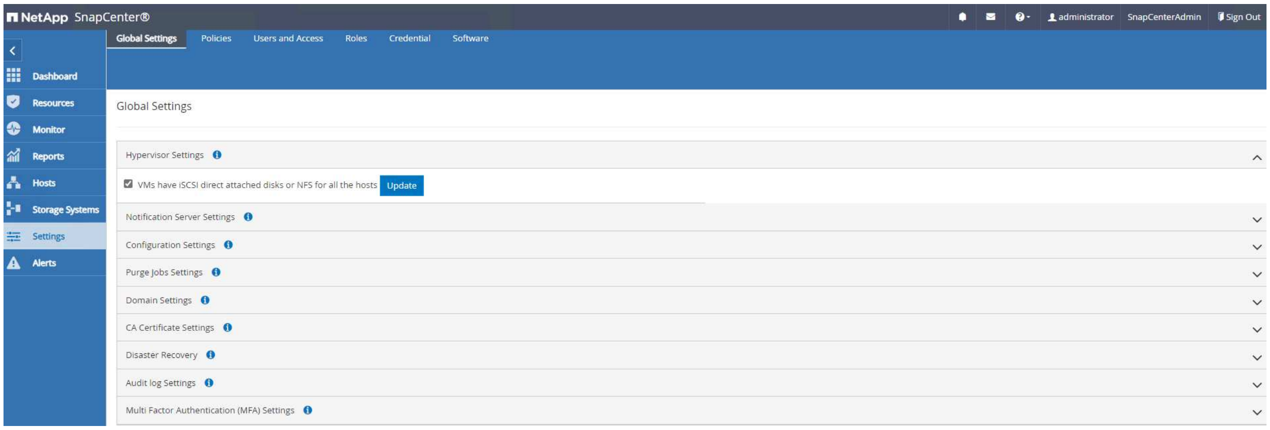
SnapCenter Setup

SnapCenter relies on a host-side plug-in on database VM to perform application-aware data protection management activities. For detailed information on NetApp SnapCenter plugin for Oracle, refer to this documentation What can you do with the Plug-in for Oracle Database. The following provides high level steps to setup SnapCenter for Oracle database backup, recovery, and clone.

1. Download the latest version of SnapCenter software from NetApp support site: NetApp Support Downloads.
2. As administrator, install latest java JDK from Get Java for desktop applications on SnapCenter server Windows host.

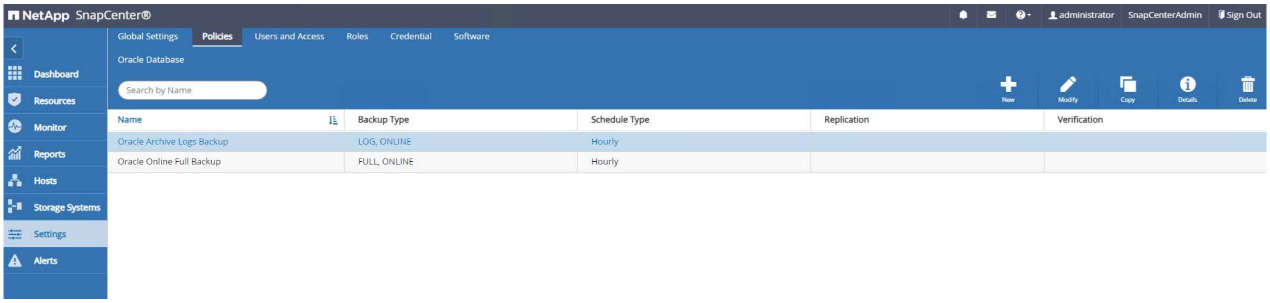
   > If Windows server is deployed in a domain environment, add a domain user to SnapCenter server local administrators group and run SnapCenter installation with the domain user.

3. Login to SnapCenter UI via HTTPS port 8846 as installation user to configure SnapCenter for Oracle.
4. Update `Hypervisor Settings` in global settings.



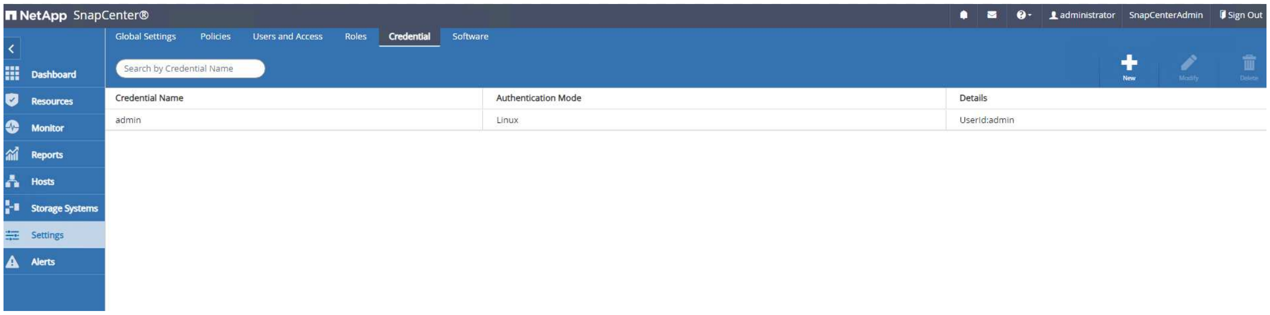
☑ VMs have iSCSI direct attached disks or NFS for all the hosts

5. Create Oracle database backup policies. Ideally, create a separate archive log backup policy to allow more frequent backup interval to minimize data loss in the event of a failure.



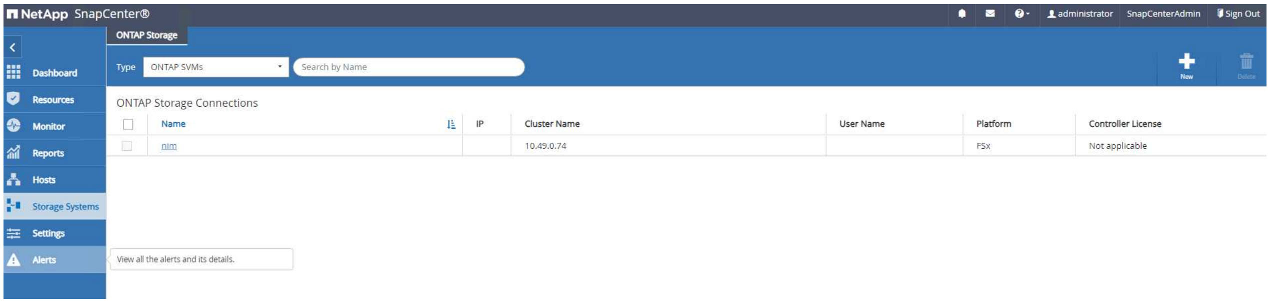
Name	Backup Type	Schedule Type	Replication	Verification
Oracle Archive Logs Backup	LOG, ONLINE	Hourly		
Oracle Online Full Backup	FULL, ONLINE	Hourly		

6. Add database server `Credential` for SnapCenter access to DB VM. The credential should have sudo privilege on a Linux VM or administrator privilege on a Windows VM.



Credential Name	Authentication Mode	Details
admin	Linux	UserId:admin

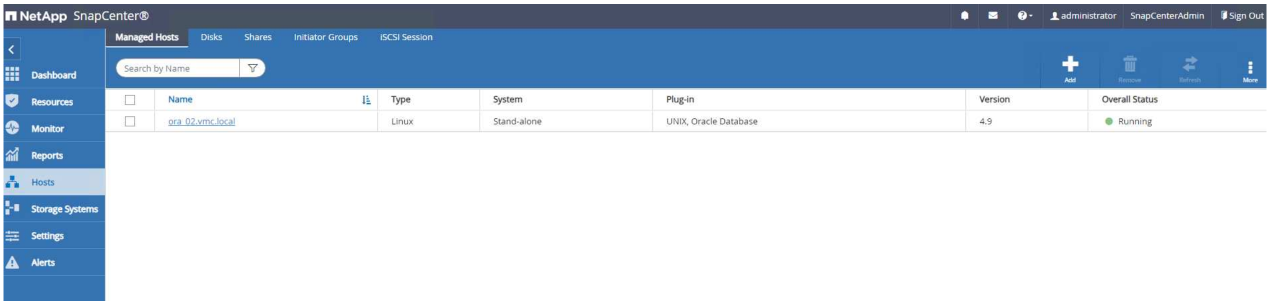
7. Add FSx ONTAP storage cluster to `Storage Systems` with cluster management IP and authenticated via fsxadmin user ID.



ONTAP Storage Connections

☐	Name	IP	Cluster Name	User Name	Platform	Controller License
☐	nim		10.49.0.74		FSx	Not applicable

8. Add Oracle database VM in VMC to `Hosts` with server credential created in previous step 6.



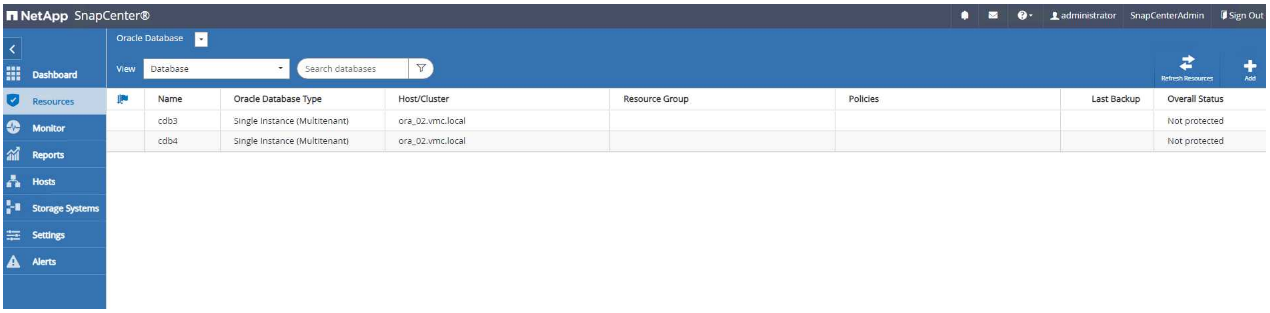
☐	Name	Type	System	Plug-in	Version	Overall Status
☐	ora_02.vmc.local	Linux	Stand-alone	UNIX, Oracle Database	4.9	● Running

Ensure that the SnapCenter server name can be resolved to the IP address from the DB VM and DB VM name can be resolved to the IP address from the SnapCenter server.

Database backup

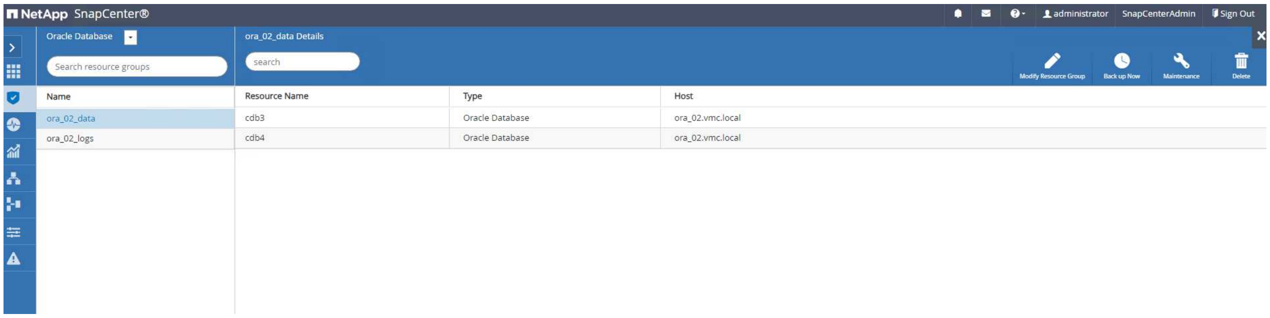
SnapCenter leverages FSx ONTAP volume snapshot for much quicker database backup, restore, or clone compared with traditional RMAN based methodology. The snapshots are application-consistent as the database is put in Oracle backup mode before a snapshot.

1. From the `Resources` tab, any databases on the VM are auto-discovered after the VM is added to SnapCenter. Initially, the database status shows as `Not protected`.



Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb3	Single Instance (Multitenant)	ora_02.vmc.local				Not protected
cdb4	Single Instance (Multitenant)	ora_02.vmc.local				Not protected

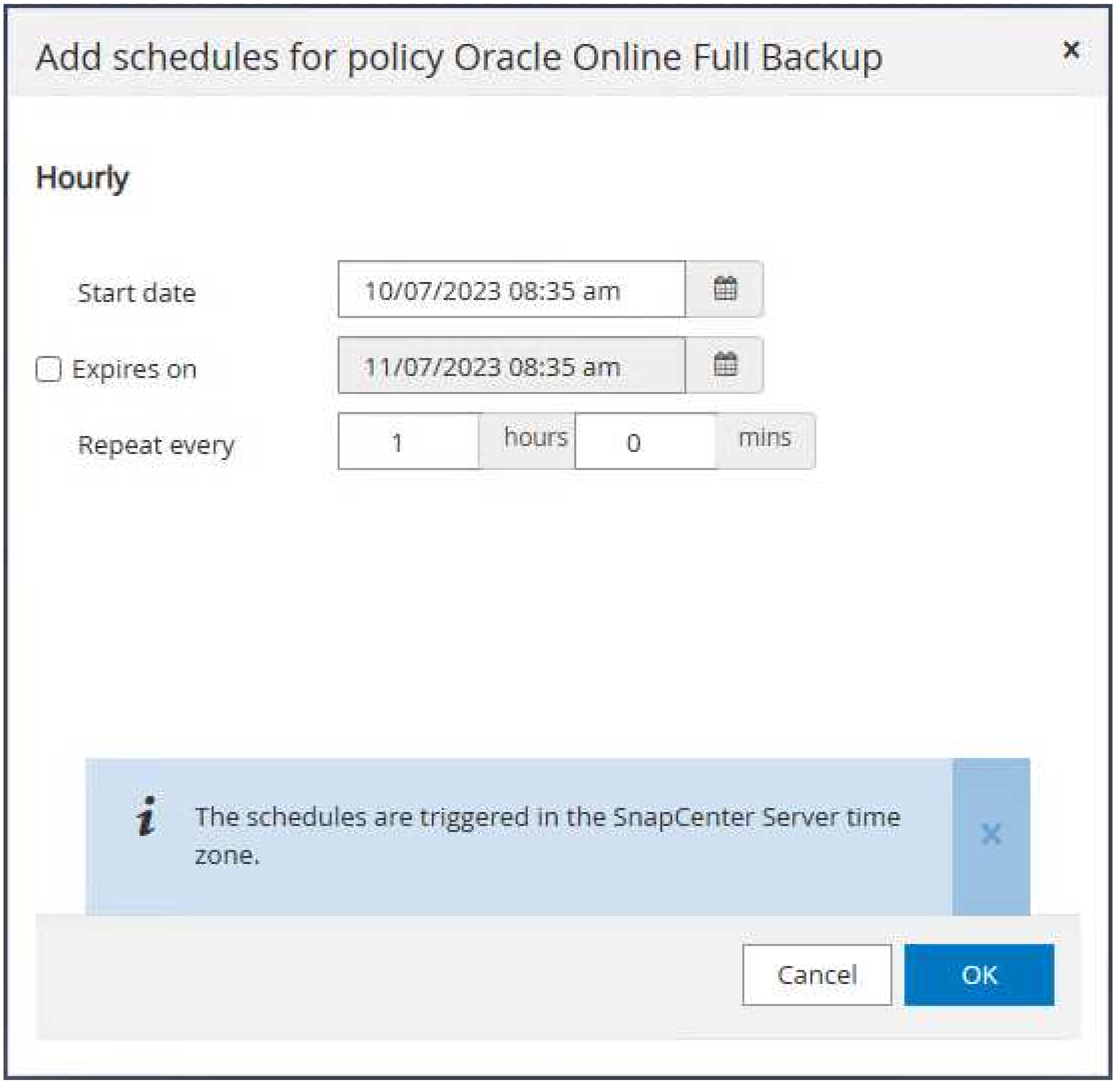
2. Create a resources group to backup the database in a logical grouping such as by DB VM etc. In this example, we created an ora_02_data group to do a full online database backup for all databases on VM ora_02. Resources group ora_02_log performs the backup of archived logs only on the VM. Creating a resources group also defines a schedule to execute the backup.



Name
ora_02_data
ora_02_logs

Resource Name	Type	Host
cdb3	Oracle Database	ora_02.vmc.local
cdb4	Oracle Database	ora_02.vmc.local

3. Resources group backup can also be triggered manually by clicking on `Back up Now` and executing the backup with the policy defined in the resources group.



Add schedules for policy Oracle Online Full Backup

Hourly

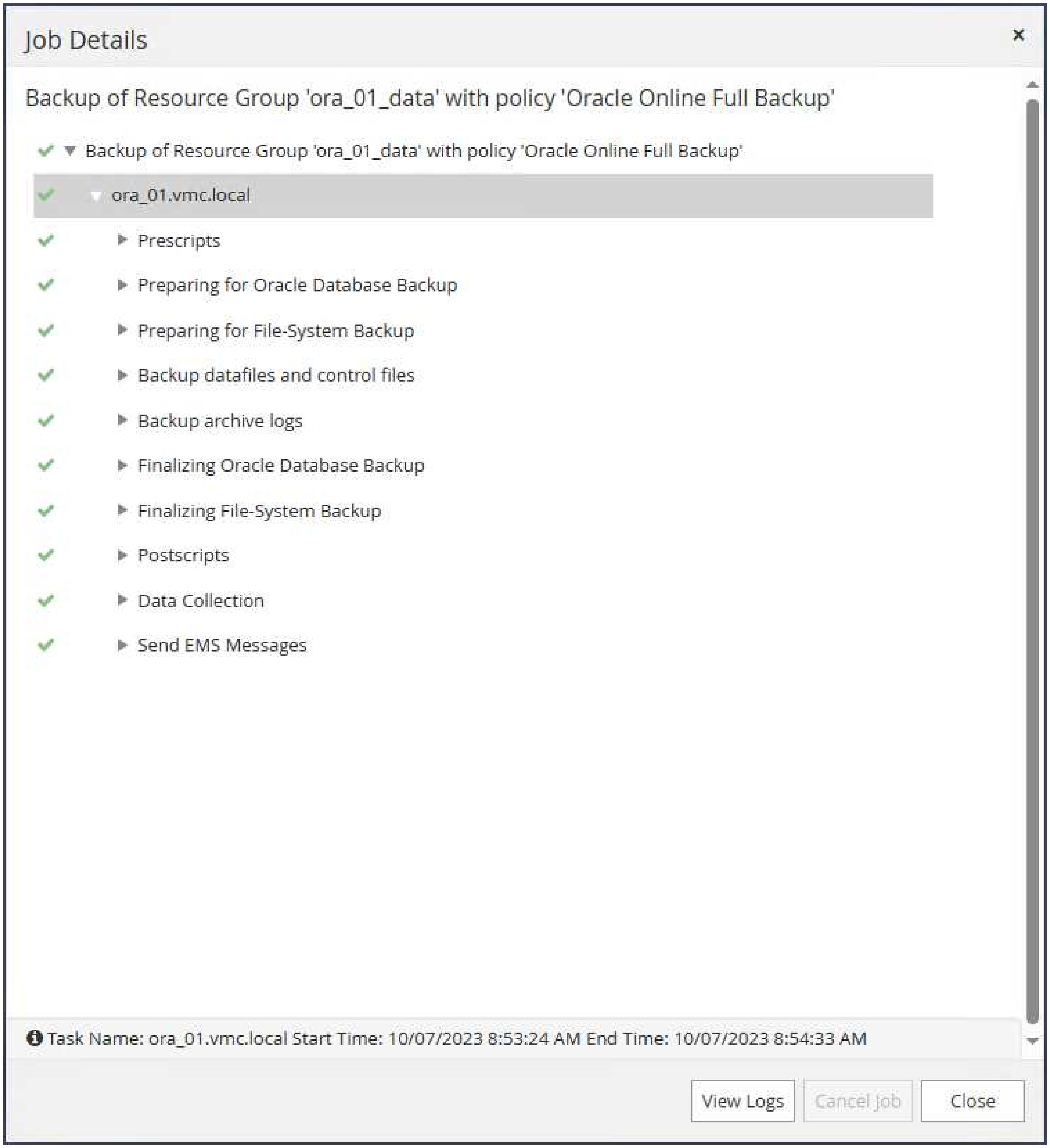
Start date: 10/07/2023 08:35 am

☐ Expires on: 11/07/2023 08:35 am

Repeat every: 1 hours 0 mins

The schedules are triggered in the SnapCenter Server time zone.

4. The backup job can be monitored at the `Monitor` tab by clicking on the running job.

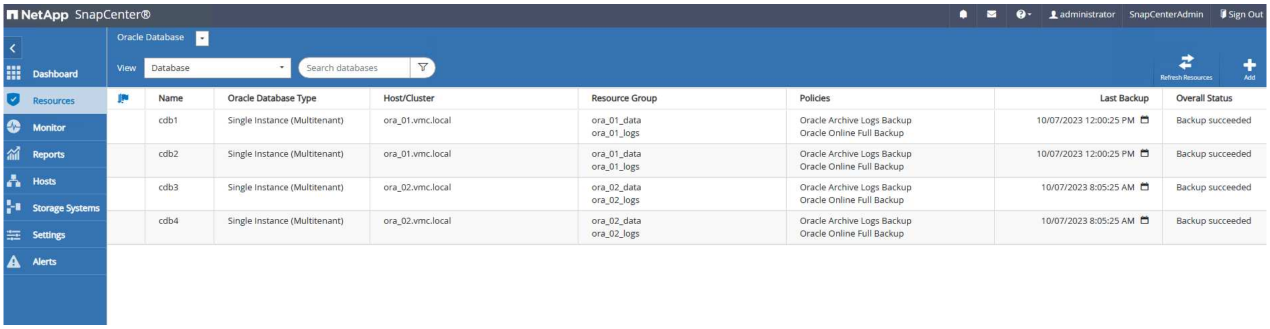


Backup of Resource Group 'ora_01_data' with policy 'Oracle Online Full Backup'

- ✓ ▼ Backup of Resource Group 'ora_01_data' with policy 'Oracle Online Full Backup'
  - ✓ ▼ ora_01.vmc.local
    - ✓ ▶ Prescripts
    - ✓ ▶ Preparing for Oracle Database Backup
    - ✓ ▶ Preparing for File-System Backup
    - ✓ ▶ Backup datafiles and control files
    - ✓ ▶ Backup archive logs
    - ✓ ▶ Finalizing Oracle Database Backup
    - ✓ ▶ Finalizing File-System Backup
    - ✓ ▶ Postscripts
    - ✓ ▶ Data Collection
    - ✓ ▶ Send EMS Messages

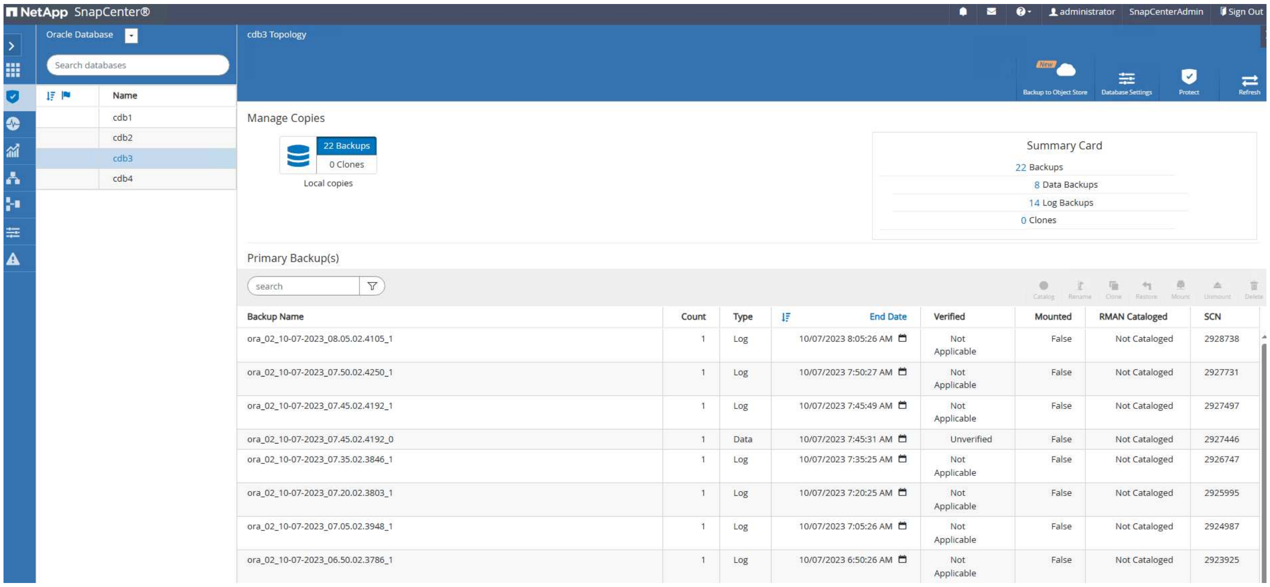
Task Name: ora_01.vmc.local Start Time: 10/07/2023 8:53:24 AM End Time: 10/07/2023 8:54:33 AM

5. After a successful backup, the database status shows the job status and the most recent backup time.



Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb1	Single Instance (Multitenant)	ora_01.vmc.local	ora_01_data ora_01_logs	Oracle Archive Logs Backup Oracle Online Full Backup	10/07/2023 12:00:25 PM	Backup succeeded
cdb2	Single Instance (Multitenant)	ora_01.vmc.local	ora_01_data ora_01_logs	Oracle Archive Logs Backup Oracle Online Full Backup	10/07/2023 12:00:25 PM	Backup succeeded
cdb3	Single Instance (Multitenant)	ora_02.vmc.local	ora_02_data ora_02_logs	Oracle Archive Logs Backup Oracle Online Full Backup	10/07/2023 8:05:25 AM	Backup succeeded
cdb4	Single Instance (Multitenant)	ora_02.vmc.local	ora_02_data ora_02_logs	Oracle Archive Logs Backup Oracle Online Full Backup	10/07/2023 8:05:25 AM	Backup succeeded

6. Click on database to review the backup sets for each database.



Summary Card

22 Backups

8 Data Backups

14 Log Backups

0 Clones

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ora_02_10-07-2023_08.05.02.4105_1	1	Log	10/07/2023 8:05:26 AM	Not Applicable	False	Not Cataloged	2928738
ora_02_10-07-2023_07.50.02.4250_1	1	Log	10/07/2023 7:50:27 AM	Not Applicable	False	Not Cataloged	2927731
ora_02_10-07-2023_07.45.02.4192_1	1	Log	10/07/2023 7:45:49 AM	Not Applicable	False	Not Cataloged	2927497
ora_02_10-07-2023_07.45.02.4192_0	1	Data	10/07/2023 7:45:31 AM	Unverified	False	Not Cataloged	2927446
ora_02_10-07-2023_07.35.02.3846_1	1	Log	10/07/2023 7:35:25 AM	Not Applicable	False	Not Cataloged	2926747
ora_02_10-07-2023_07.20.02.3803_1	1	Log	10/07/2023 7:20:25 AM	Not Applicable	False	Not Cataloged	2925995
ora_02_10-07-2023_07.05.02.3948_1	1	Log	10/07/2023 7:05:26 AM	Not Applicable	False	Not Cataloged	2924987
ora_02_10-07-2023_06.50.02.3786_1	1	Log	10/07/2023 6:50:26 AM	Not Applicable	False	Not Cataloged	2923925

Database recovery

SnapCenter provides a number of restore and recovery options for Oracle databases from snapshot backup. In this example, we demonstrate a point in time restoration to recover a dropped table by mistake. On VM ora_02, two databases cdb3, cdb4 share the same +DATA and +LOGS disk groups. Database restoration for one database does not impact the availability of the other database.

1. First, create a test table and insert a row into table to validate a point in time recovery.

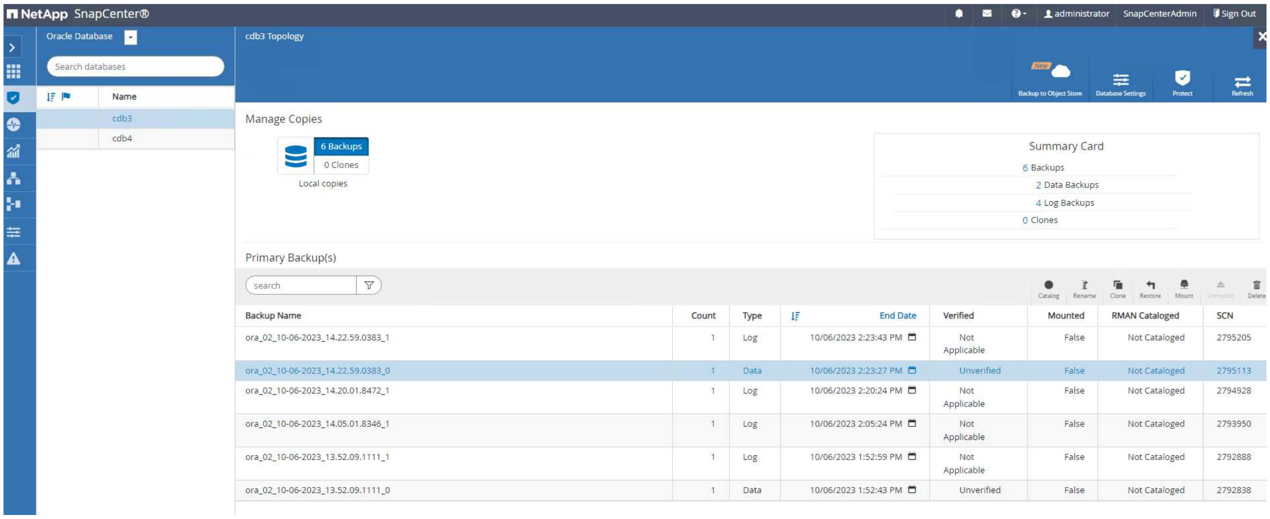
```
[oracle@ora_02 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Oct 6 14:15:21 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
--------- --------------------
CDB3      READ WRITE

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 CDB3_PDB1                      READ WRITE NO
         4 CDB3_PDB2                      READ WRITE NO
         5 CDB3_PDB3                      READ WRITE NO
SQL>


SQL> alter session set container=cdb3_pdb1;

Session altered.

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

Table created.
```

```
SQL> insert into test values(1, sysdate, 'test oracle recovery on
guest mounted fsx storage to VMC guest vm ora_02');

1 row created.

SQL> commit;

Commit complete.

SQL> select * from test;

        ID
----------
DT
---------------------------------------------------------------------
-------
EVENT
---------------------------------------------------------------------
------------
         1
06-OCT-23 03.18.24.000000 PM
test oracle recovery on guest mounted fsx storage to VMC guest vm
ora_02


SQL> select current_timestamp from dual;

CURRENT_TIMESTAMP
---------------------------------------------------------------------
-------
06-OCT-23 03.18.53.996678 PM -07:00
```

2. We run a manual snapshot backup from SnapCenter. Then drop the table.

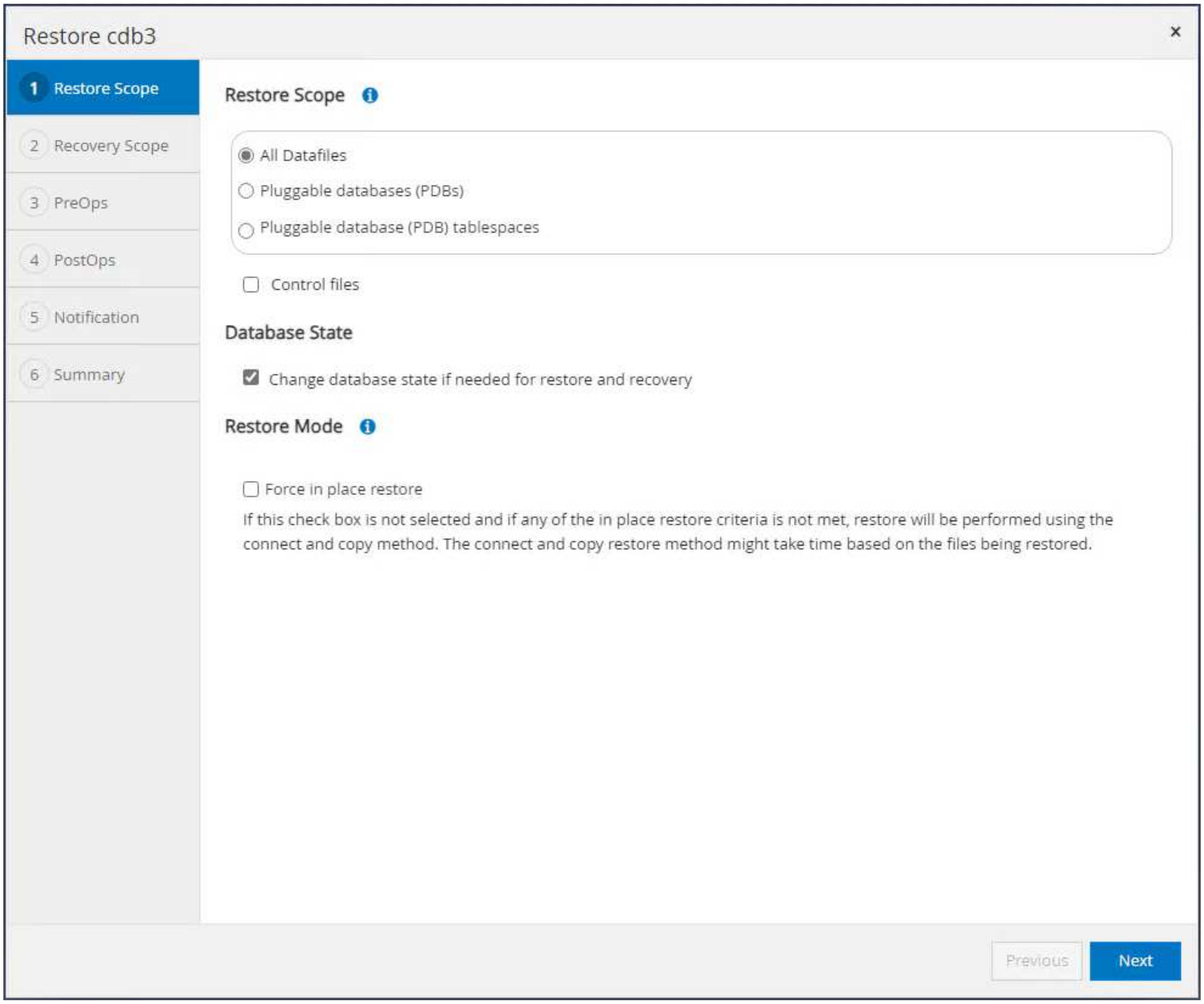
```
SQL> drop table test;

Table dropped.

SQL> commit;

Commit complete.

SQL> select current_timestamp from dual;

CURRENT_TIMESTAMP
---------------------------------------------------------------------
-------
06-OCT-23 03.26.30.169456 PM -07:00

SQL> select * from test;
select * from test
              *
ERROR at line 1:
ORA-00942: table or view does not exist
```

3. From backup set created from last step, take a note of the SCN number of log backup. Click on `Restore` to launch restore-recover workflow.



Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ora_02_10-06-2023_14.22.59.0383_1	1	Log	10/06/2023 2:23:43 PM	Not Applicable	False	Not Cataloged	2795205
ora_02_10-06-2023_14.22.59.0383_0	1	Data	10/06/2023 2:23:27 PM	Unverified	False	Not Cataloged	2795113
ora_02_10-06-2023_14.20.01.8472_1	1	Log	10/06/2023 2:20:24 PM	Not Applicable	False	Not Cataloged	2794928
ora_02_10-06-2023_14.05.01.8346_1	1	Log	10/06/2023 2:05:24 PM	Not Applicable	False	Not Cataloged	2793950
ora_02_10-06-2023_13.52.09.1111_1	1	Log	10/06/2023 1:52:59 PM	Not Applicable	False	Not Cataloged	2792888
ora_02_10-06-2023_13.52.09.1111_0	1	Data	10/06/2023 1:52:43 PM	Unverified	False	Not Cataloged	2792838

4. Choose restore scope.



Restore Scope

● All Datafiles
○ Pluggable databases (PDBs)
○ Pluggable database (PDB) tablespaces

☐ Control files

Database State

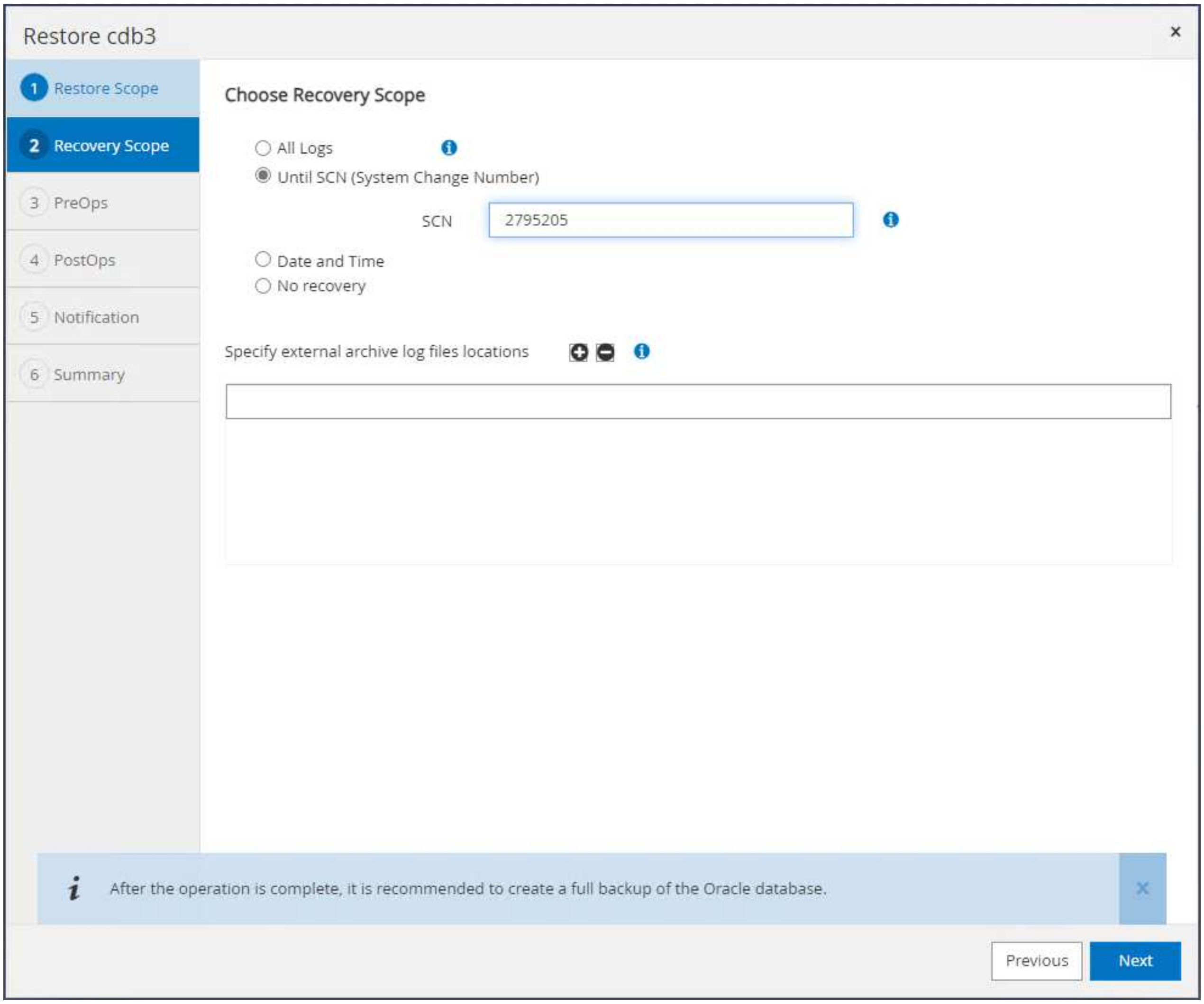
☑ Change database state if needed for restore and recovery

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.

5. Choose recovery scope up to the log SCN from last full database backup.



Choose Recovery Scope

○ All Logs

● Until SCN (System Change Number)

SCN 2795205

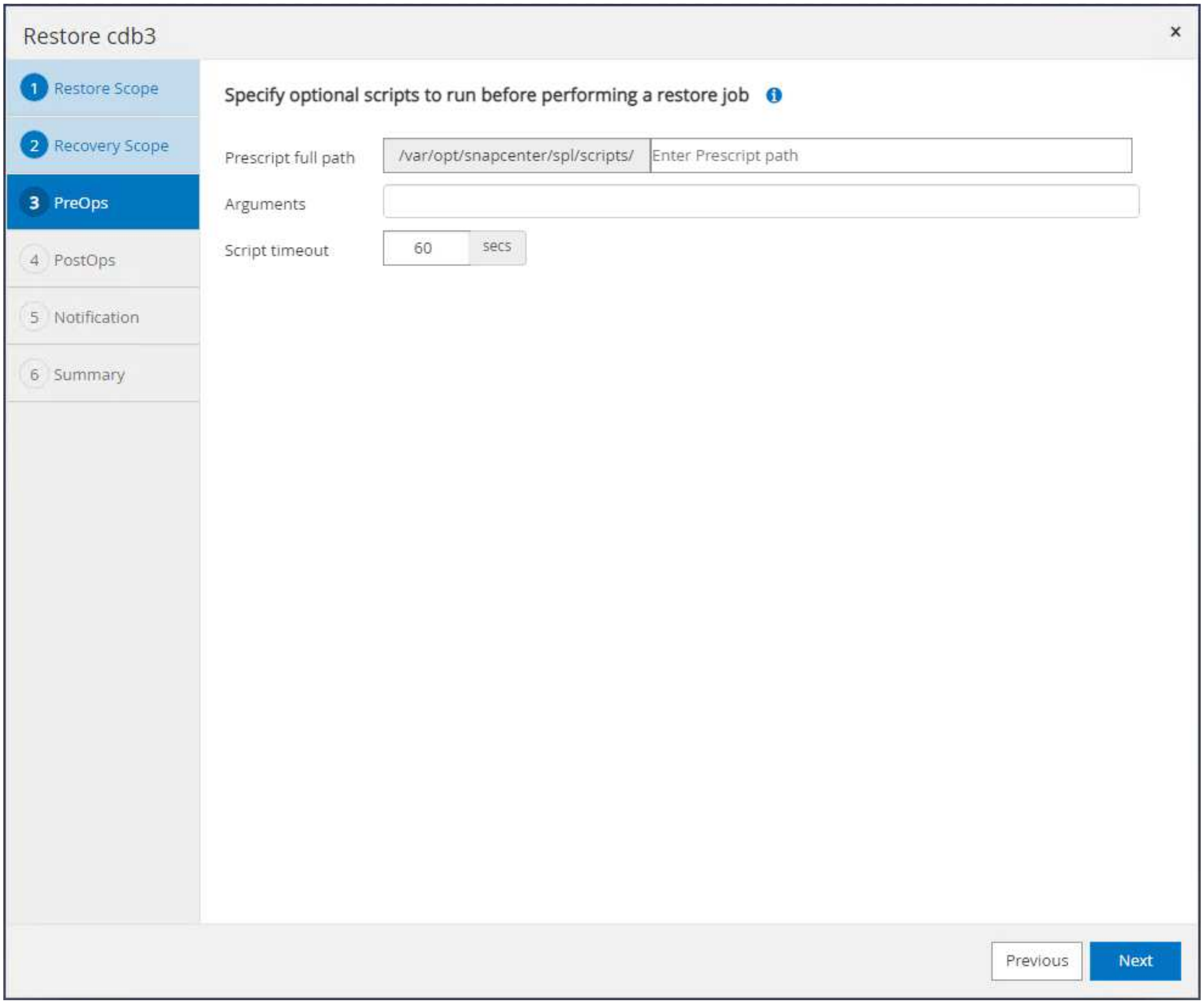
○ Date and Time

○ No recovery

Specify external archive log files locations

After the operation is complete, it is recommended to create a full backup of the Oracle database.

6. Specify any optional pre-scripts to run.



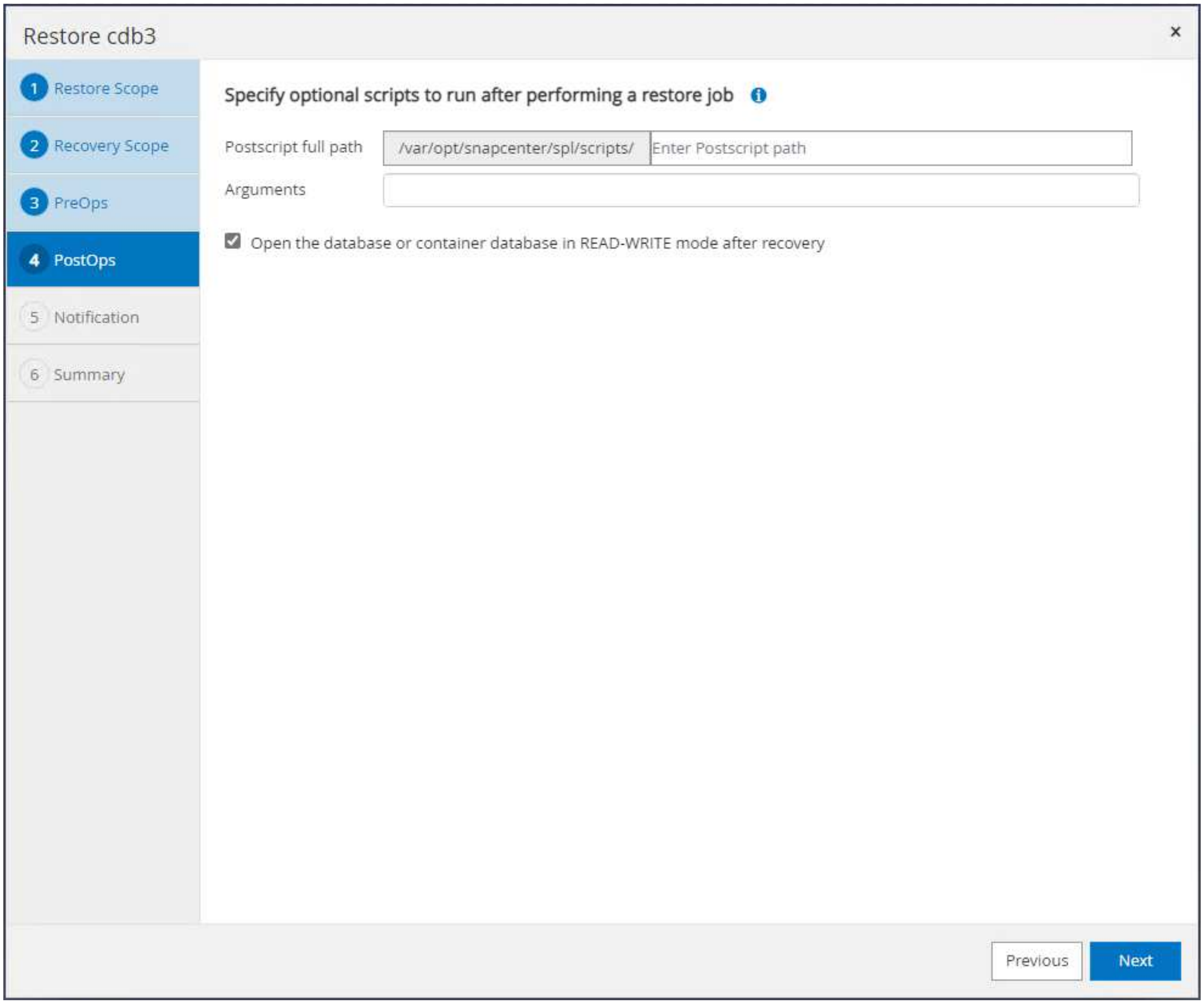
Specify optional scripts to run before performing a restore job

Prescript full path /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Arguments

Script timeout 60 secs

7. Specify any optional after-script to run.



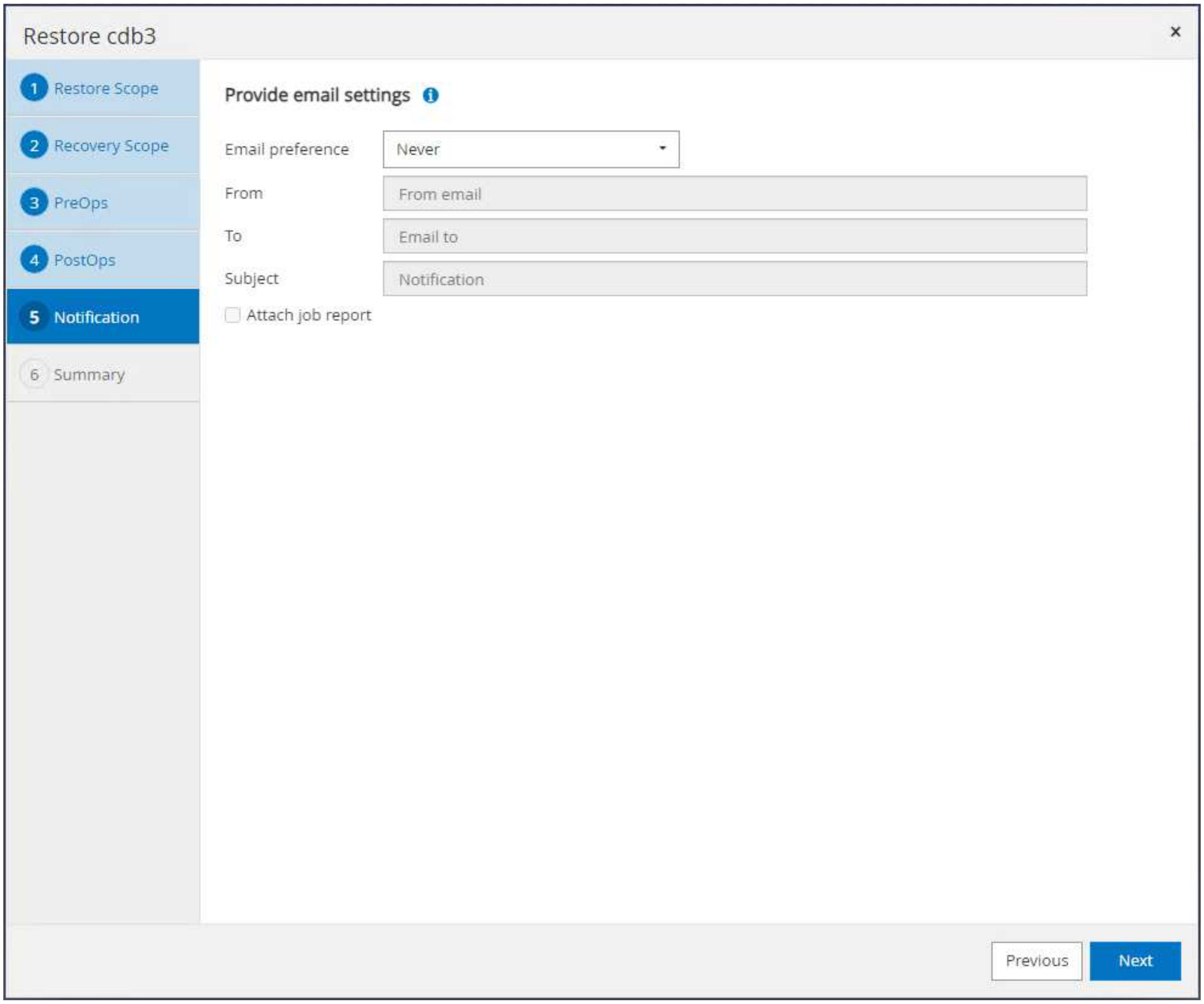
Specify optional scripts to run after performing a restore job

Postscript full path /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Arguments

☑ Open the database or container database in READ-WRITE mode after recovery

8. Send a job report if desired.



Provide email settings

Email preference: Never

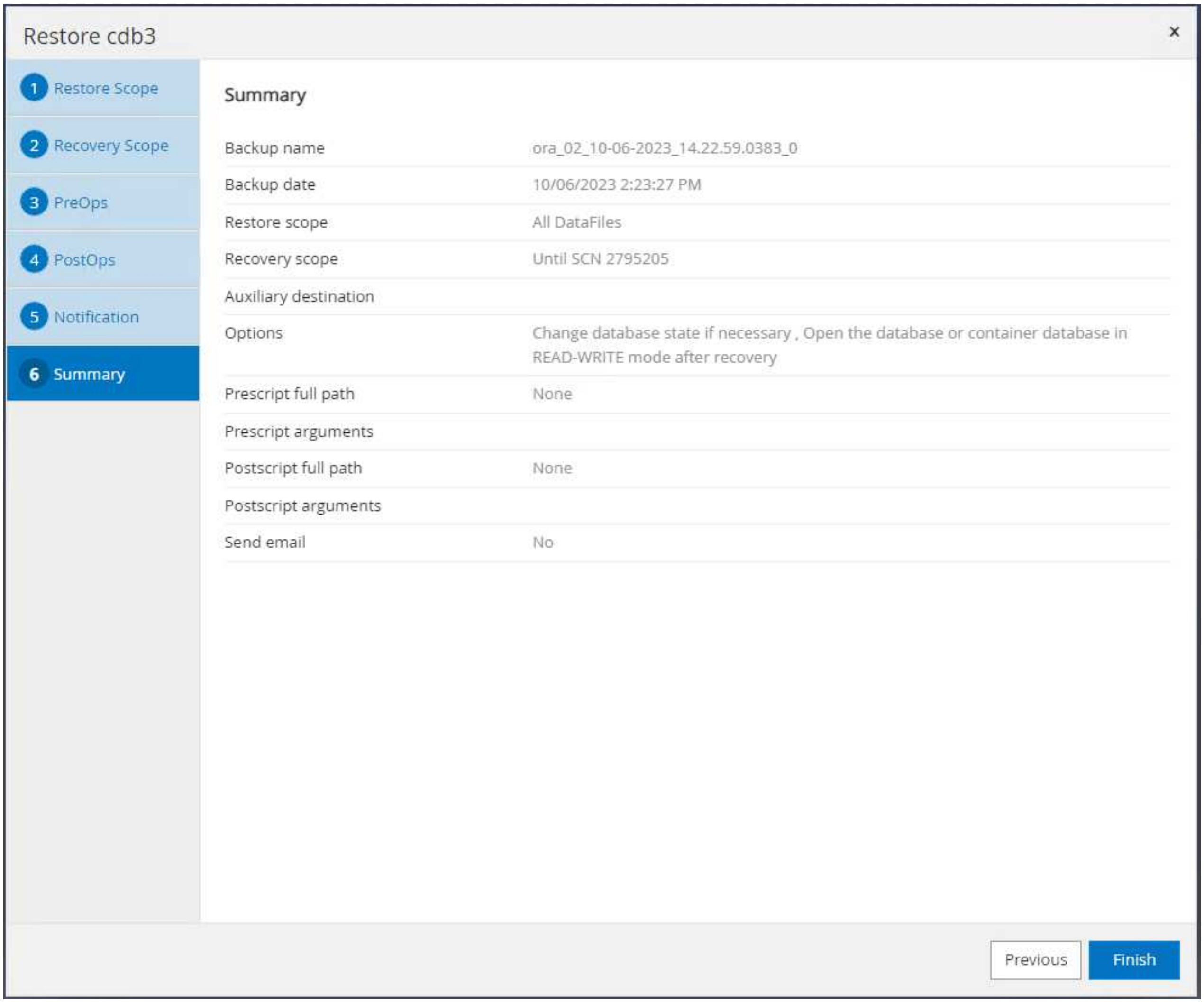
From: From email

To: Email to

Subject: Notification

☐ Attach job report

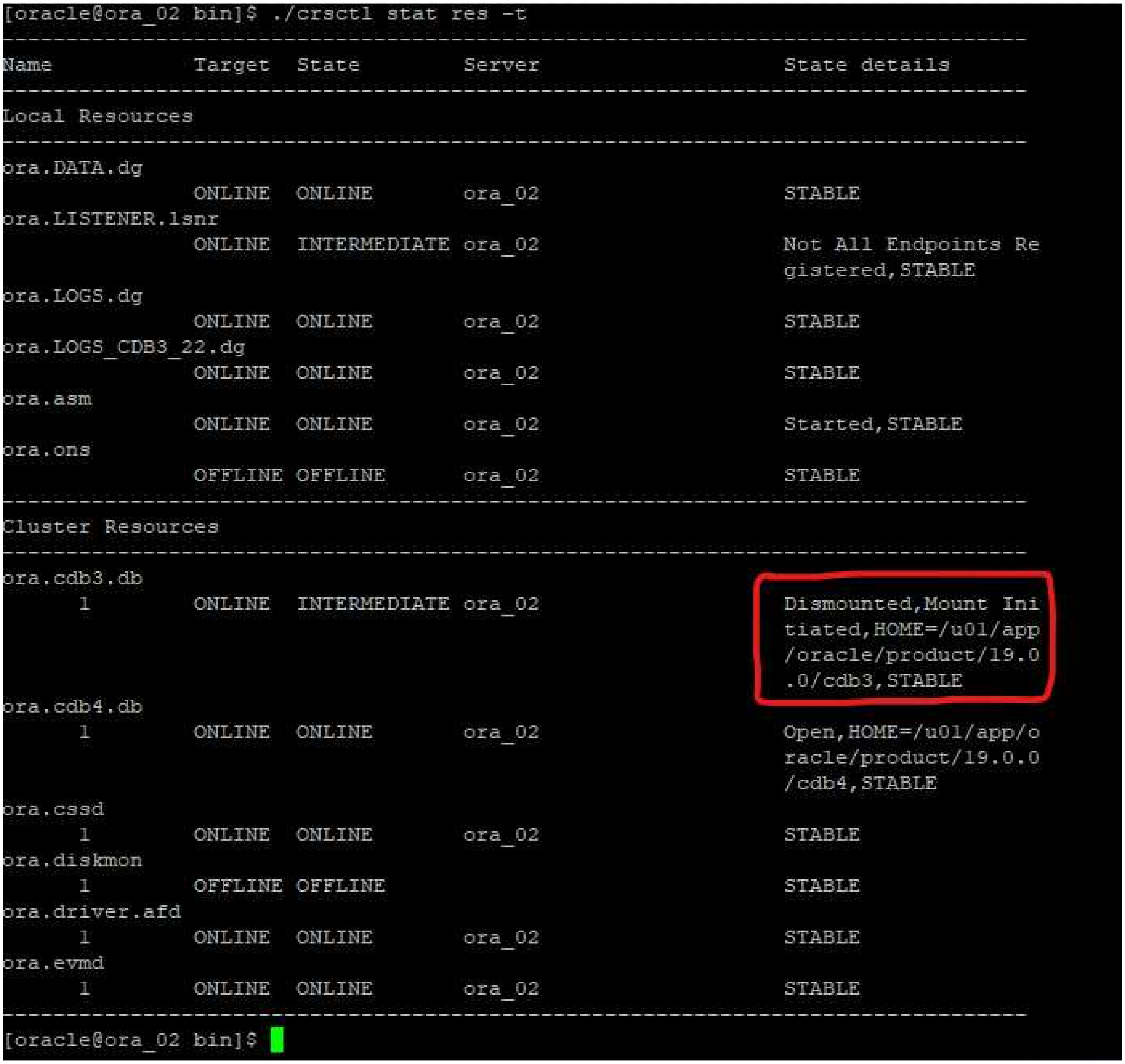
9. Review the summary and click on `Finish` to launch the restoration and recovery.



Summary

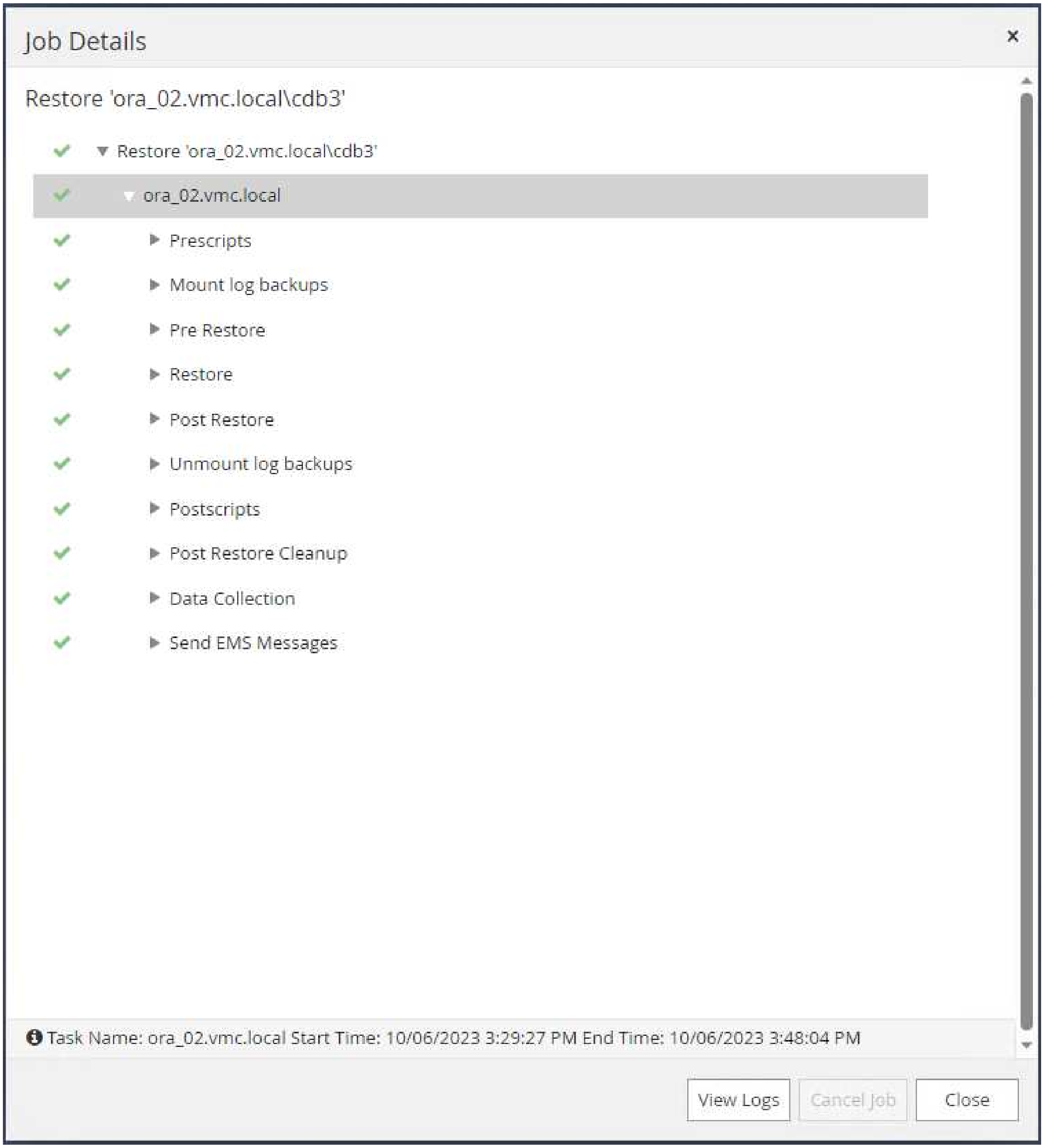
Backup name	ora_02_10-06-2023_14.22.59.0383_0
Backup date	10/06/2023 2:23:27 PM
Restore scope	All DataFiles
Recovery scope	Until SCN 2795205
Auxiliary destination	
Options	Change database state if necessary , Open the database or container database in READ-WRITE mode after recovery
Prescript full path	None
Prescript arguments	
Postscript full path	None
Postscript arguments	
Send email	No

10. From Oracle Restart grid control, we observe that while cdb3 is under restoration and recovery cdb4 is online and available.



```
[oracle@ora_02 bin]$ ./crsctl stat res -t
--------------------------------------------------------------------------------
Name           Target  State        Server                   State details
--------------------------------------------------------------------------------
Local Resources
--------------------------------------------------------------------------------
ora.DATA.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.LISTENER.lsnr
               ONLINE  INTERMEDIATE ora_02                   Not All Endpoints Re
                                                             gistered,STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.LOGS_CDB3_22.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.asm
               ONLINE  ONLINE       ora_02                   Started,STABLE
ora.ons
               OFFLINE OFFLINE      ora_02                   STABLE
--------------------------------------------------------------------------------
Cluster Resources
--------------------------------------------------------------------------------
ora.cdb3.db
      1        ONLINE  INTERMEDIATE ora_02                   Dismounted,Mount Ini
                                                             tiated,HOME=/u01/app
                                                             /oracle/product/19.0
                                                             .0/cdb3,STABLE
ora.cdb4.db
      1        ONLINE  ONLINE       ora_02                   Open,HOME=/u01/app/o
                                                             racle/product/19.0.0
                                                             /cdb4,STABLE
ora.cssd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.driver.afd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.evmd
      1        ONLINE  ONLINE       ora_02                   STABLE
--------------------------------------------------------------------------------
[oracle@ora_02 bin]$
```

11. From `Monitor` tab, open the job to review the details.



Restore 'ora_02.vmc.local\cdb3'

- ✓ Restore 'ora_02.vmc.local\cdb3'
  - ✓ ora_02.vmc.local
    - ✓ Prescripts
    - ✓ Mount log backups
    - ✓ Pre Restore
    - ✓ Restore
    - ✓ Post Restore
    - ✓ Unmount log backups
    - ✓ Postscripts
    - ✓ Post Restore Cleanup
    - ✓ Data Collection
    - ✓ Send EMS Messages

Task Name: ora_02.vmc.local Start Time: 10/06/2023 3:29:27 PM End Time: 10/06/2023 3:48:04 PM

12. From DB VM ora_02, validate the dropped table is recovered after a successful recovery.

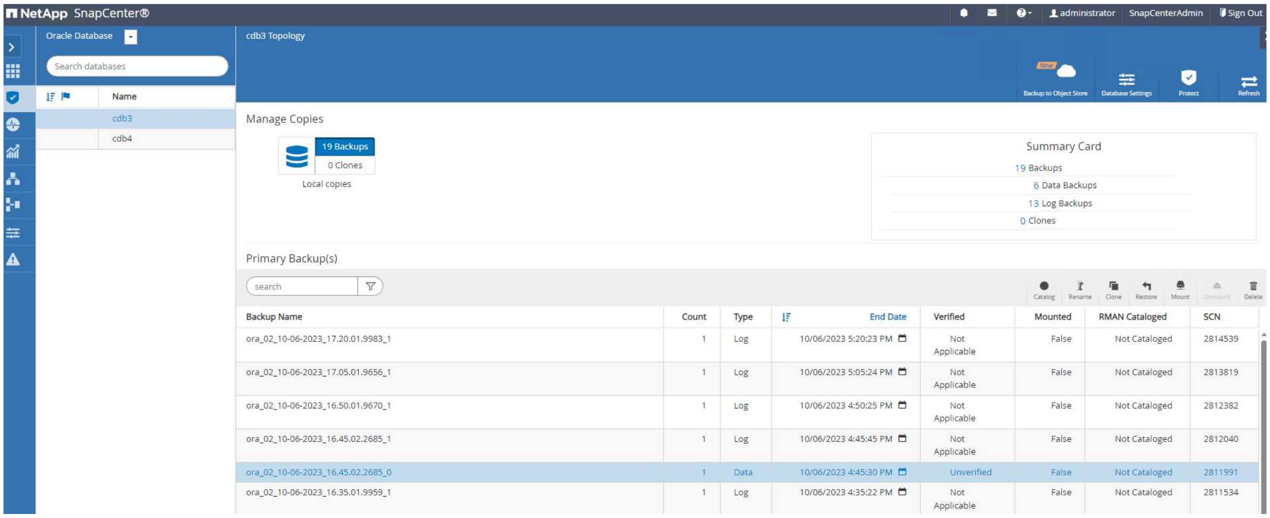
```
[oracle@ora_02 bin]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Oct 6 17:01:28 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
--------- --------------------
CDB3      READ WRITE

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 CDB3_PDB1                      READ WRITE NO
         4 CDB3_PDB2                      READ WRITE NO
         5 CDB3_PDB3                      READ WRITE NO
SQL> alter session set container=CDB3_PDB1;

Session altered.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
06-OCT-23 03.18.24.000000 PM
test oracle recovery on guest mounted fsx storage to VMC guest vm
ora_02


SQL> select current_timestamp from dual;

CURRENT_TIMESTAMP
--------------------------------------------------------------------
-------
06-OCT-23 05.02.20.382702 PM -07:00

SQL>
```

Database clone

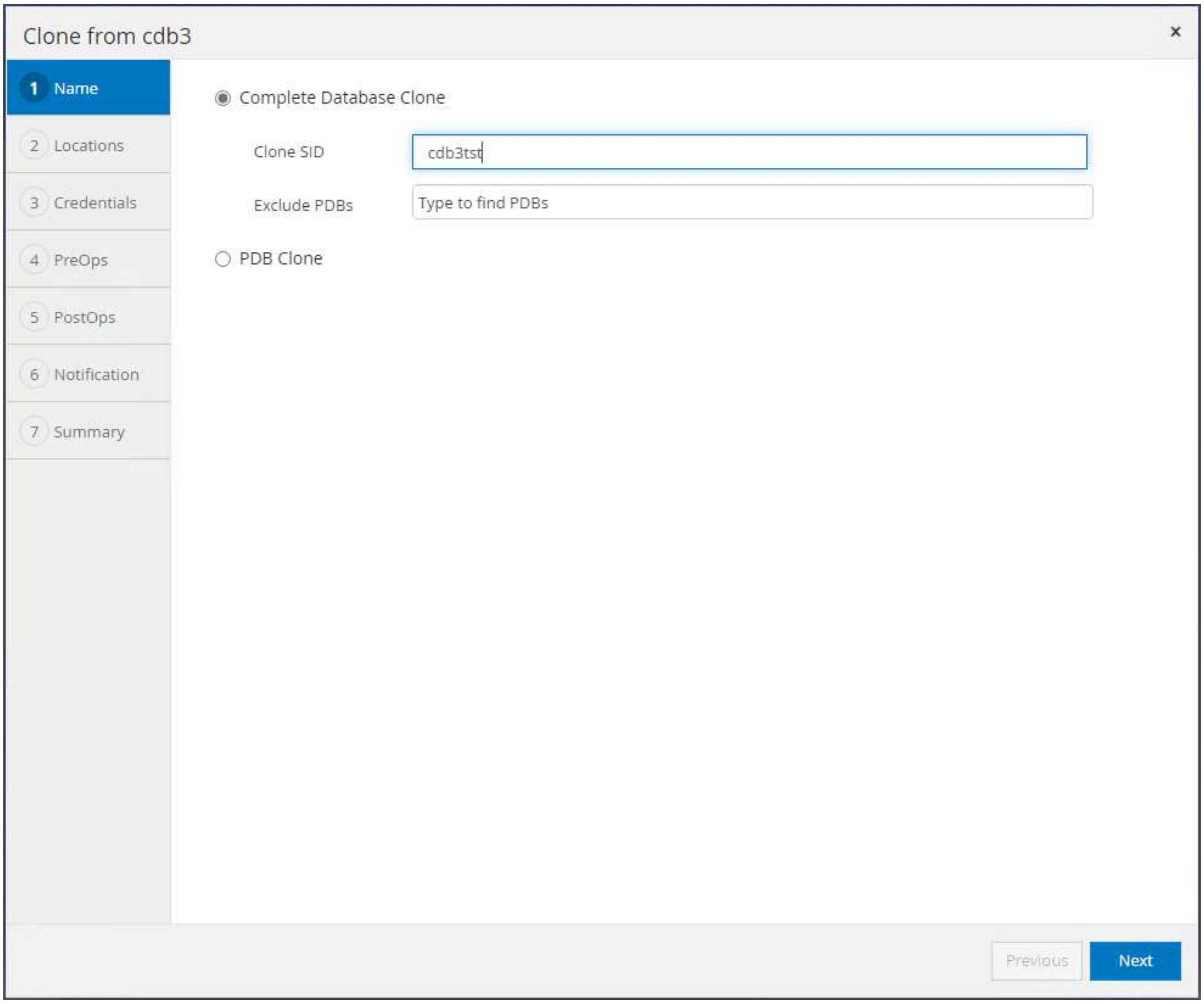
In this example, the same backup sets is used to clone a database on the same VM in a different ORACLE_HOME. The procedures are equally applicable to clone a database from the backup to separate VM in VMC if needed.

1. Open the database cdb3 backup list. From a data backup of choice, click on `Clone` button to launch database clone workflow.



Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ora_02_10-06-2023_17.20.01.9983_1	1	Log	10/06/2023 5:20:23 PM	Not Applicable	False	Not Cataloged	2814539
ora_02_10-06-2023_17.05.01.9656_1	1	Log	10/06/2023 5:05:24 PM	Not Applicable	False	Not Cataloged	2813819
ora_02_10-06-2023_16.50.01.9670_1	1	Log	10/06/2023 4:50:25 PM	Not Applicable	False	Not Cataloged	2812382
ora_02_10-06-2023_16.45.02.2685_1	1	Log	10/06/2023 4:45:45 PM	Not Applicable	False	Not Cataloged	2812040
ora_02_10-06-2023_16.45.02.2685_0	1	Data	10/06/2023 4:45:30 PM	Unverified	False	Not Cataloged	2811991
ora_02_10-06-2023_16.35.01.9959_1	1	Log	10/06/2023 4:35:22 PM	Not Applicable	False	Not Cataloged	2811534

2. Name the clone database SID.



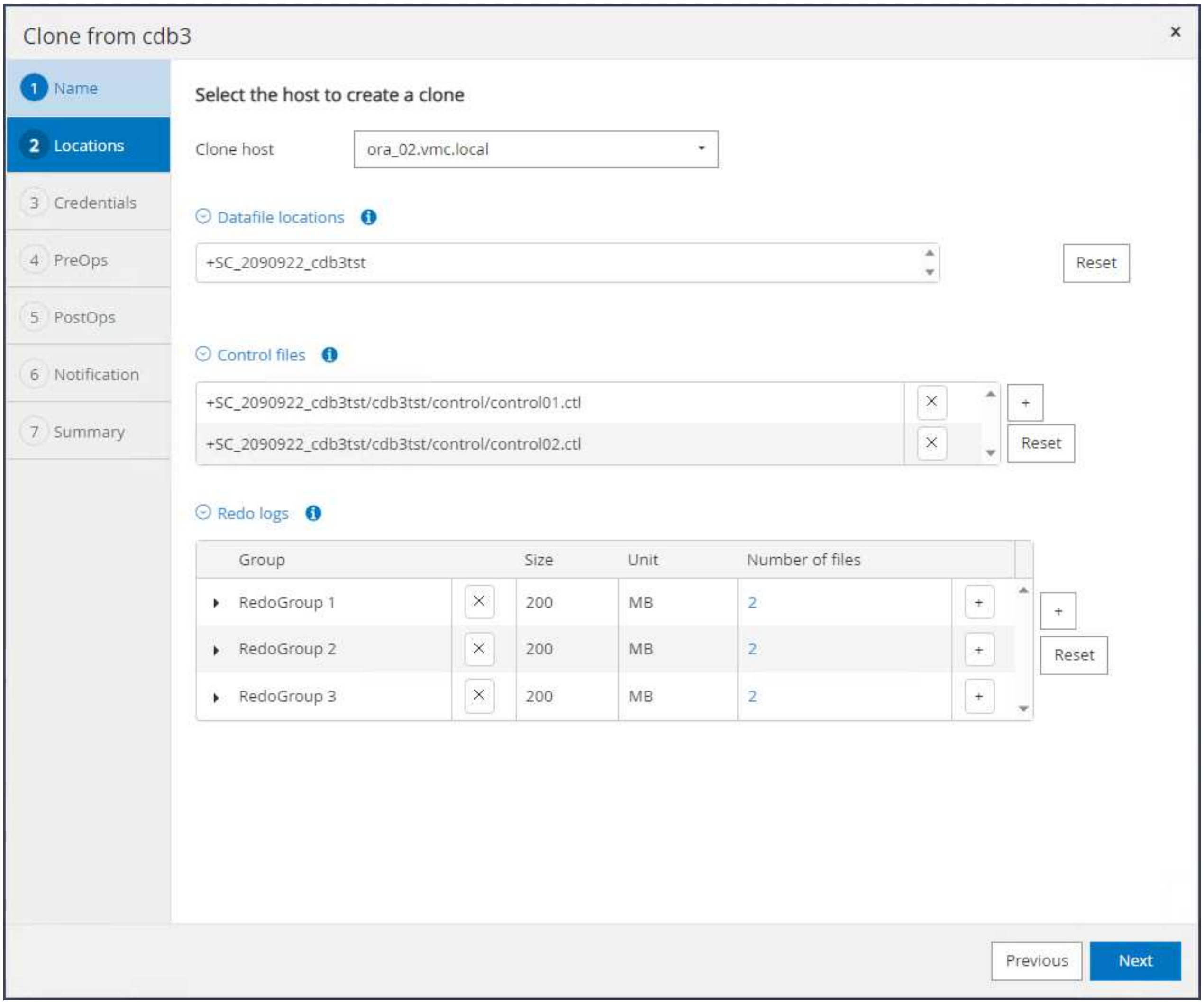
● Complete Database Clone

Clone SID: cdb3tst

Exclude PDBs: Type to find PDBs

○ PDB Clone

3. Select a VM in VMC as the target database host. Identical Oracle version should have been installed and configured on the host.



Select the host to create a clone

Clone host: ora_02.vmc.local

Datafile locations

+SC_2090922_cdb3tst

Control files

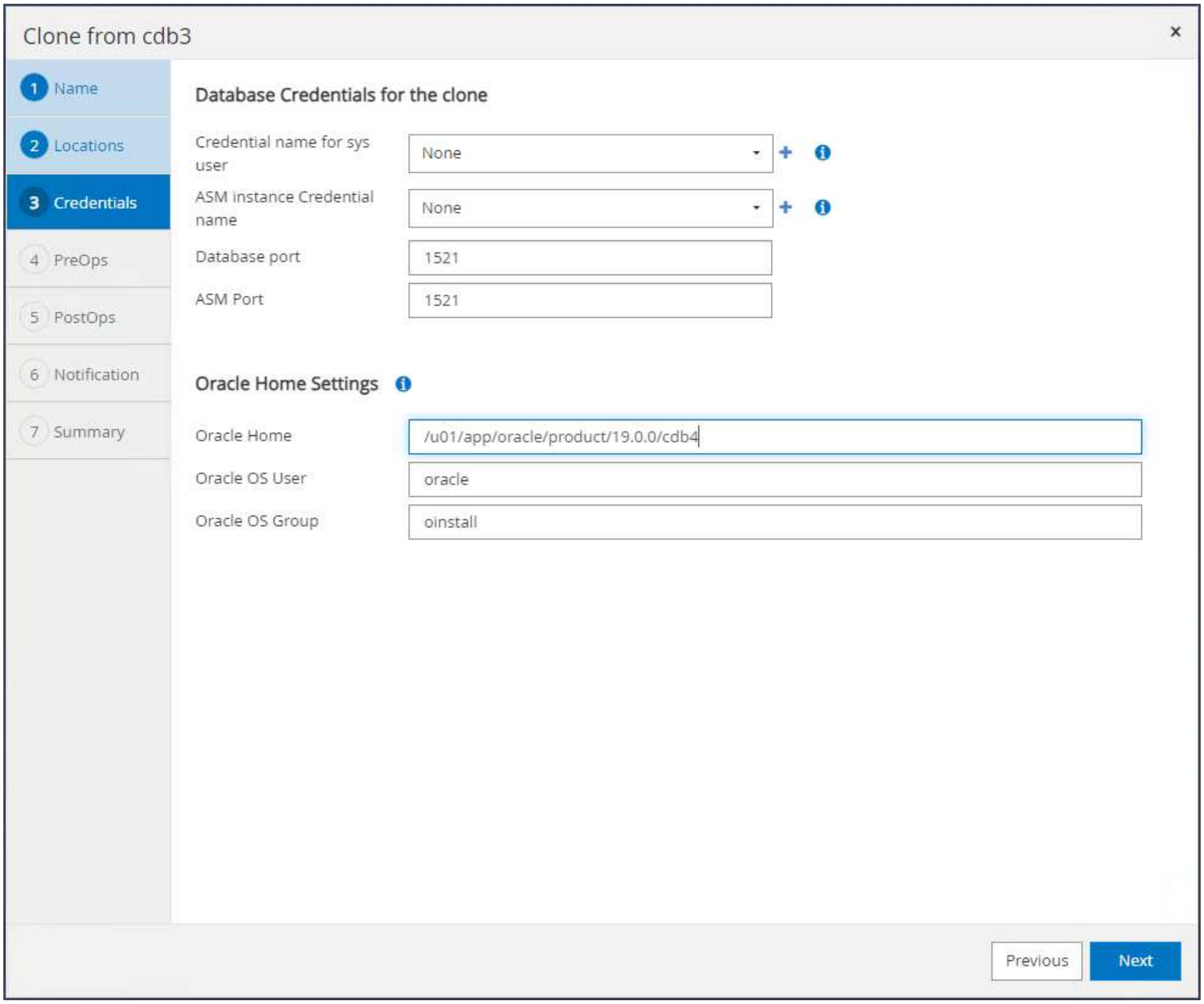
+SC_2090922_cdb3tst/cdb3tst/control/control01.ctl

+SC_2090922_cdb3tst/cdb3tst/control/control02.ctl

Redo logs

Group	Size	Unit	Number of files
RedoGroup 1	200	MB	2
RedoGroup 2	200	MB	2
RedoGroup 3	200	MB	2

4. Select the proper ORACLE_HOME, user and group on the target host. Keep credential at default.



Database Credentials for the clone

Credential name for sys user: None

ASM instance Credential name: None

Database port: 1521

ASM Port: 1521

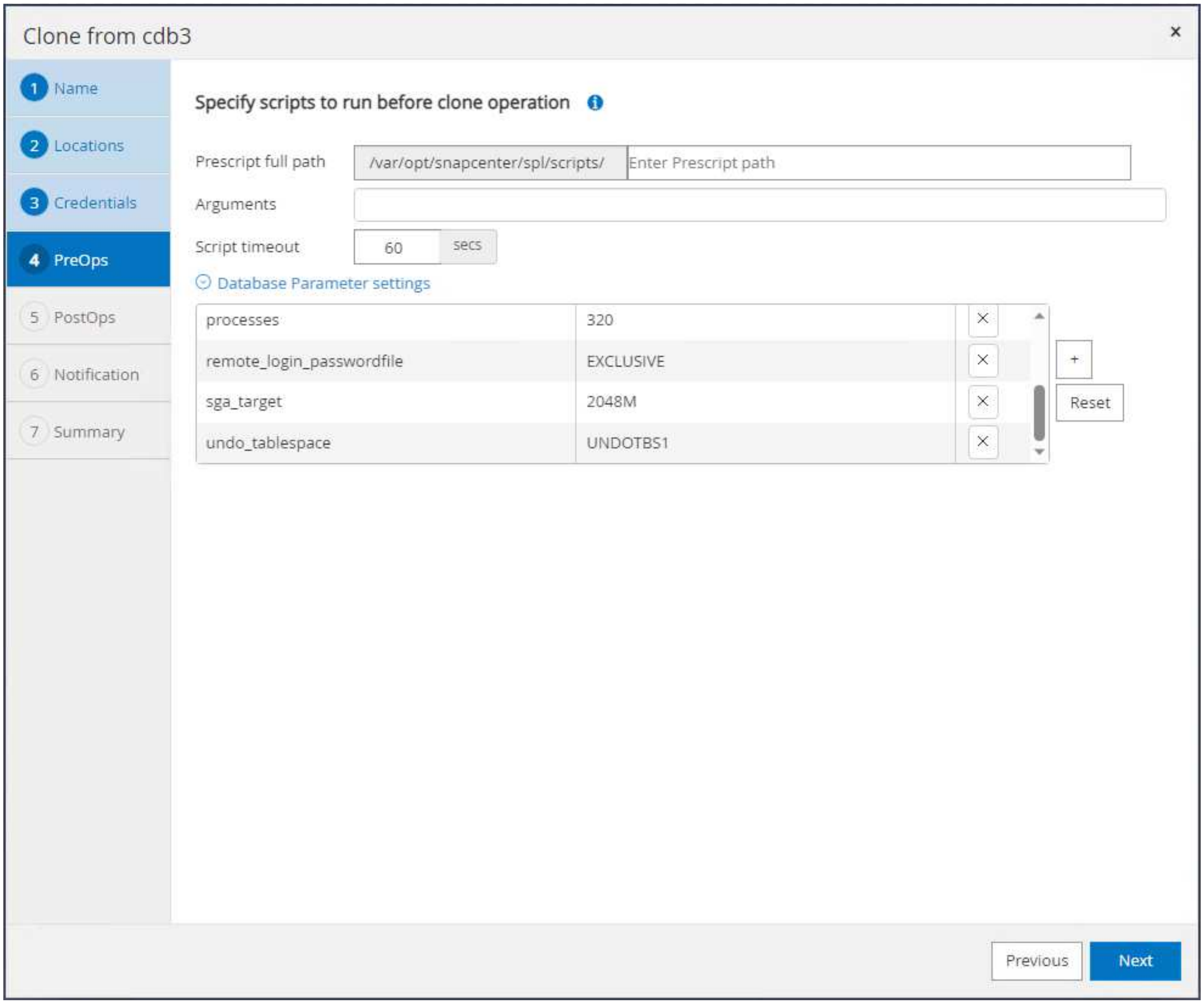
Oracle Home Settings

Oracle Home: /u01/app/oracle/product/19.0.0/cdb4

Oracle OS User: oracle

Oracle OS Group: oinstall

5. Change clone database parameters to meet configuration or resources requirements for the clone database.



Specify scripts to run before clone operation

Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

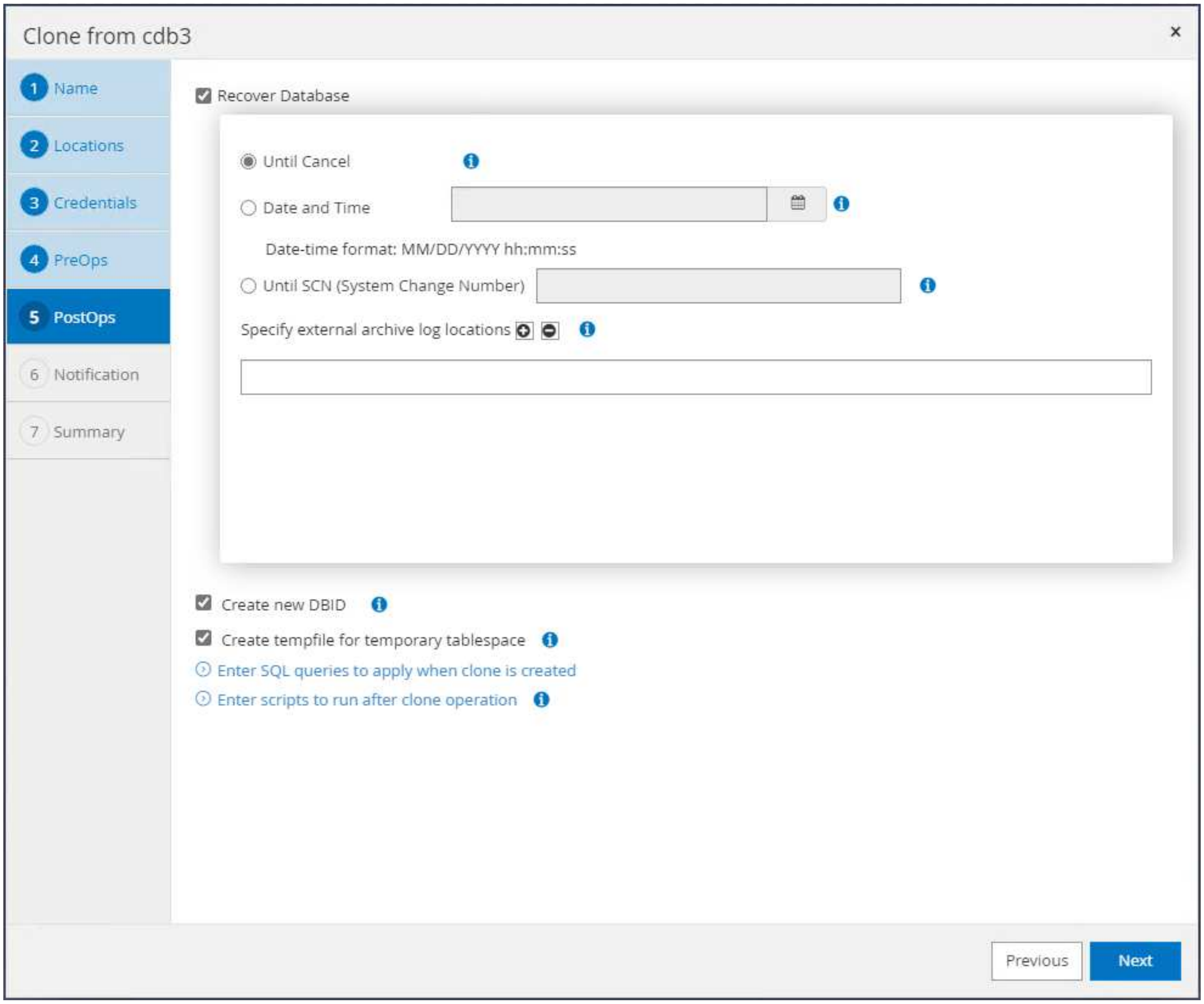
Arguments:

Script timeout: 60 secs

Database Parameter settings

processes	320
remote_login_passwordfile	EXCLUSIVE
sga_target	2048M
undo_tablespace	UNDOTBS1

6. Choose recovery scope. `Until Cancel` recovers the clone up to last available log file in the backup set.



☑ Recover Database

● Until Cancel

○ Date and Time

Date-time format: MM/DD/YYYY hh:mm:ss

○ Until SCN (System Change Number)

Specify external archive log locations

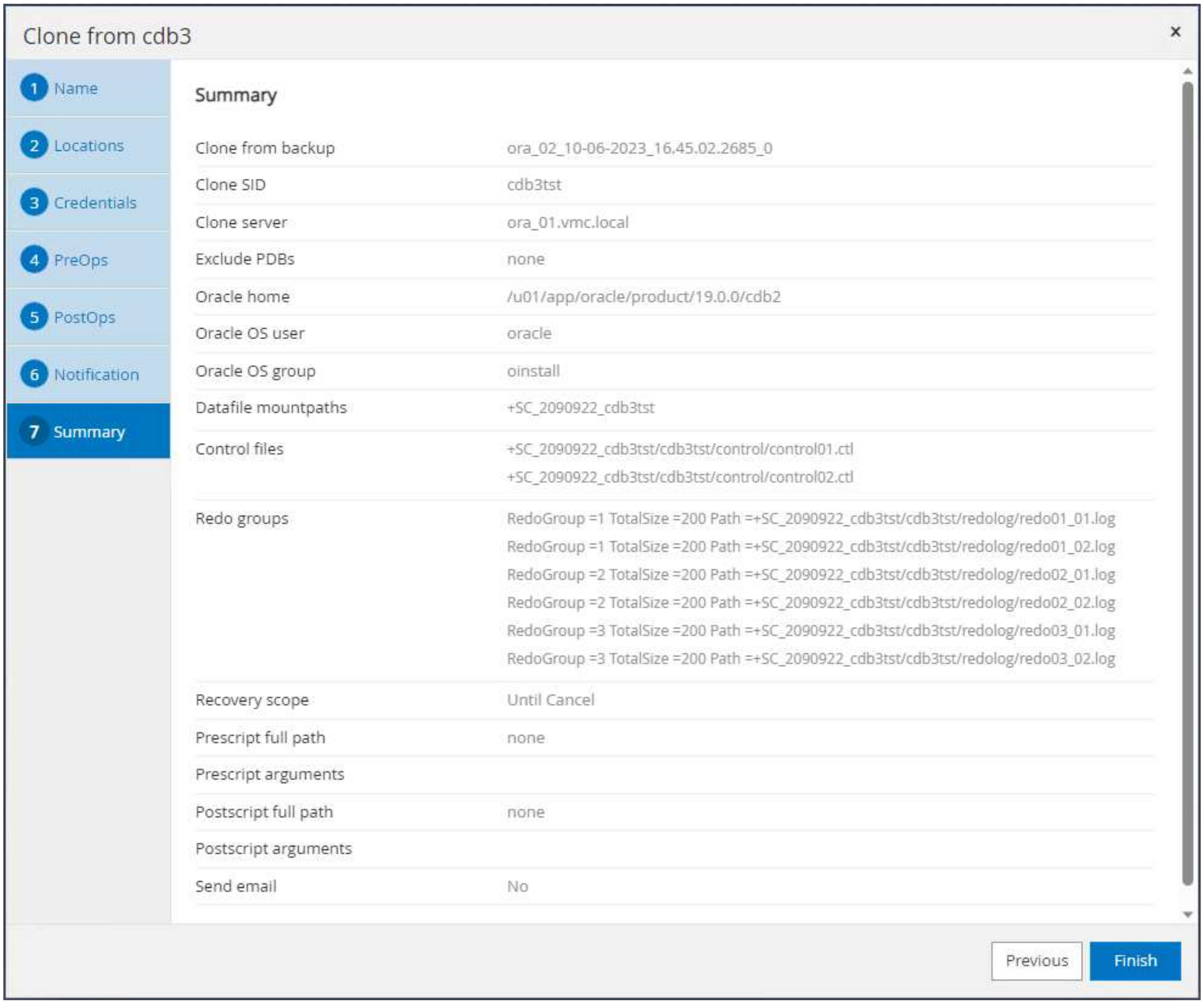
☑ Create new DBID

☑ Create tempfile for temporary tablespace

Enter SQL queries to apply when clone is created

Enter scripts to run after clone operation

7. Review the summary and launch the clone job.



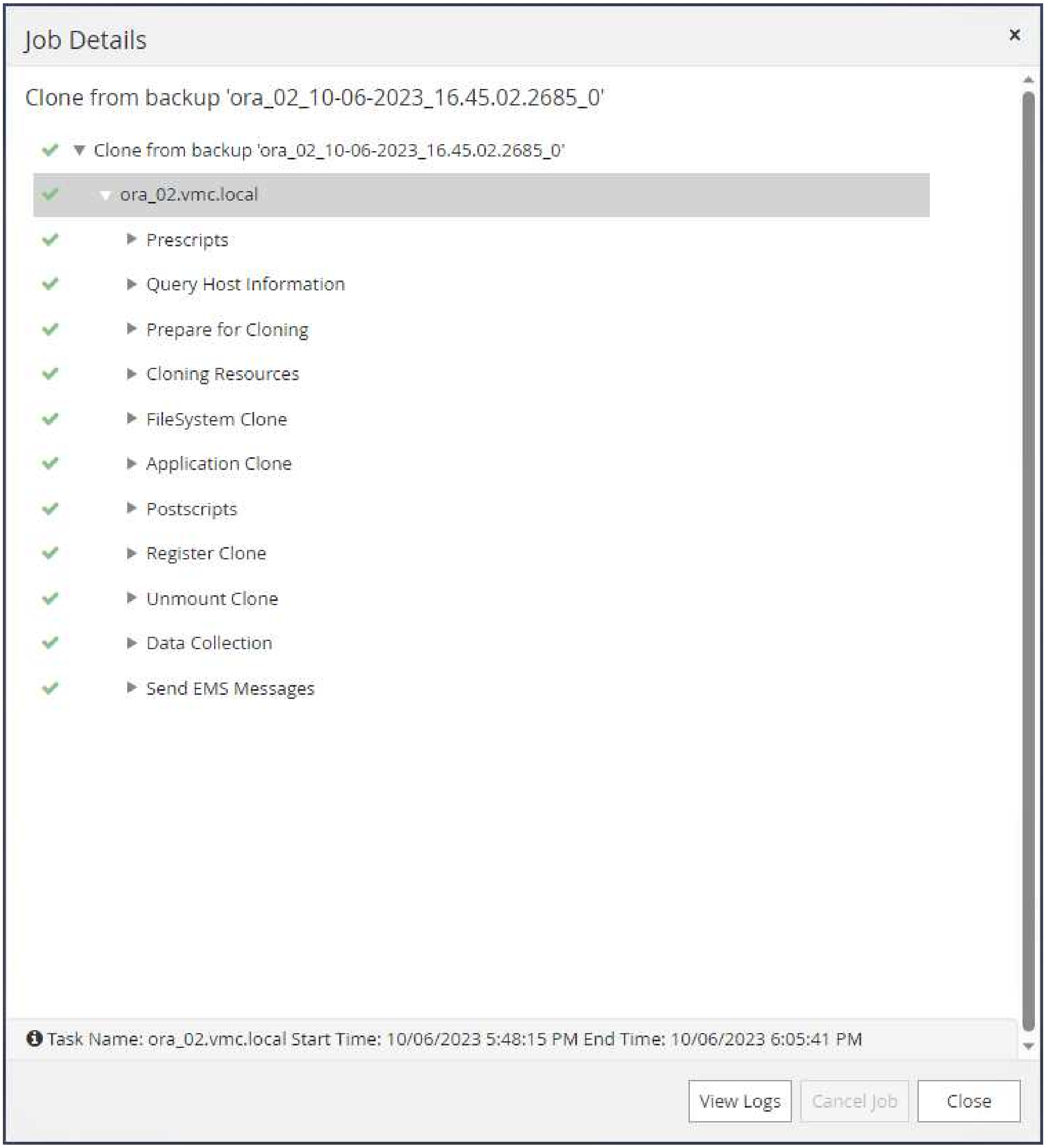
Summary

Clone from backup	ora_02_10-06-2023_16.45.02.2685_0
Clone SID	cdb3tst
Clone server	ora_01.vmc.local
Exclude PDBs	none
Oracle home	/u01/app/oracle/product/19.0.0/cdb2
Oracle OS user	oracle
Oracle OS group	oinstall
Datafile mountpaths	+SC_2090922_cdb3tst
Control files	+SC_2090922_cdb3tst/cdb3tst/control/control01.ctl +SC_2090922_cdb3tst/cdb3tst/control/control02.ctl

Redo groups	RedoGroup =1 TotalSize =200 Path =+SC_2090922_cdb3tst/cdb3tst/redolog/redo01_01.log
	RedoGroup =1 TotalSize =200 Path =+SC_2090922_cdb3tst/cdb3tst/redolog/redo01_02.log
	RedoGroup =2 TotalSize =200 Path =+SC_2090922_cdb3tst/cdb3tst/redolog/redo02_01.log
	RedoGroup =2 TotalSize =200 Path =+SC_2090922_cdb3tst/cdb3tst/redolog/redo02_02.log
	RedoGroup =3 TotalSize =200 Path =+SC_2090922_cdb3tst/cdb3tst/redolog/redo03_01.log
	RedoGroup =3 TotalSize =200 Path =+SC_2090922_cdb3tst/cdb3tst/redolog/redo03_02.log

Recovery scope	Until Cancel
Prescript full path	none
Prescript arguments	
Postscript full path	none
Postscript arguments	
Send email	No

8. Monitor the clone job execution from `Monitor` tab.

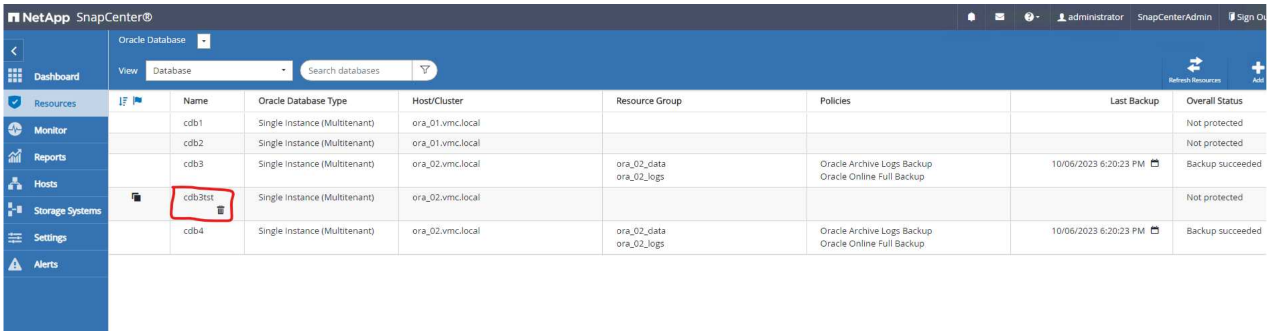


Clone from backup 'ora_02_10-06-2023_16.45.02.2685_0'

- ✓ Clone from backup 'ora_02_10-06-2023_16.45.02.2685_0'
  - ✓ ora_02.vmc.local
    - ✓ 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: ora_02.vmc.local Start Time: 10/06/2023 5:48:15 PM End Time: 10/06/2023 6:05:41 PM

9. Cloned database is immediately registered in SnapCenter.



View: Database

Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb1	Single Instance (Multitenant)	ora_01.vmc.local				Not protected
cdb2	Single Instance (Multitenant)	ora_01.vmc.local				Not protected
cdb3	Single Instance (Multitenant)	ora_02.vmc.local	ora_02_data ora_02_logs	Oracle Archive Logs Backup Oracle Online Full Backup	10/06/2023 6:20:23 PM	Backup succeeded
cdb3tst	Single Instance (Multitenant)	ora_02.vmc.local				Not protected
cdb4	Single Instance (Multitenant)	ora_02.vmc.local	ora_02_data ora_02_logs	Oracle Archive Logs Backup Oracle Online Full Backup	10/06/2023 6:20:23 PM	Backup succeeded

10. From DB VM ora_02, the cloned database is also registered in Oracle Restart grid control and the dropped test table is recovered in the cloned database cdb3tst as shown below.

```
[oracle@ora_02 ~]$ /u01/app/oracle/product/19.0.0/grid/bin/crsctl
stat res -t
--------------------------------------------------------------------
------------
Name           Target  State        Server                   State
details
--------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------
------------
ora.DATA.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.LISTENER.lsnr
               ONLINE  INTERMEDIATE ora_02                   Not All
Endpoints Re

gistered,STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.SC_2090922_CDB3TST.dg
               ONLINE  ONLINE       ora_02                   STABLE
ora.asm
               ONLINE  ONLINE       ora_02
Started,STABLE
ora.ons
               OFFLINE OFFLINE      ora_02                   STABLE
--------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------
------------
ora.cdb3.db
      1        ONLINE  ONLINE       ora_02
Open,HOME=/u01/app/o

racle/product/19.0.0

/cdb3,STABLE
ora.cdb3tst.db
      1        ONLINE  ONLINE       ora_02
Open,HOME=/u01/app/o
```

```
racle/product/19.0.0

/cdb4,STABLE
ora.cdb4.db
      1        ONLINE  ONLINE       ora_02
Open,HOME=/u01/app/o

racle/product/19.0.0

/cdb4,STABLE
ora.cssd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.driver.afd
      1        ONLINE  ONLINE       ora_02                   STABLE
ora.evmd
      1        ONLINE  ONLINE       ora_02                   STABLE
--------------------------------------------------------------------
------------

[oracle@ora_02 ~]$ export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/cdb4
[oracle@ora_02 ~]$ export ORACLE_SID=cdb3tst
[oracle@ora_02 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Sat Oct 7 08:04:51 2023
Version 19.18.0.0.0

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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
--------- --------------------
CDB3TST   READ WRITE

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
```

```
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 CDB3_PDB1                      READ WRITE NO
         4 CDB3_PDB2                      READ WRITE NO
         5 CDB3_PDB3                      READ WRITE NO
SQL> alter session set container=CDB3_PDB1;

Session altered.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
06-OCT-23 03.18.24.000000 PM
test oracle recovery on guest mounted fsx storage to VMC guest vm
ora_02
```

```
SQL>
```

This completes the demonstration of SnapCenter backup, restore, and clone of Oracle database in VMC SDDC on AWS.

Where to find additional information

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

- VMware Cloud on AWS Documentation

  https://docs.vmware.com/en/VMware-Cloud-on-AWS/index.html

- 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/

TR-4981: Oracle Active Data Guard Cost Reduction with Amazon FSx ONTAP

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for configuring Oracle Data Guard using AWS FSx ONTAP as standby site Oracle database storage to reduce licensing and operational cost of Oracle Data Guard HA/DR solution in AWS.

Purpose

Oracle Data Guard ensures high availability, data protection, and disaster recovery for enterprise data in a primary database and standby database replication configuration. Oracle Active Data Guard empowers users to access standby databases while data replication is active from the primary database to standby databases. Data Guard is a feature of Oracle Database Enterprise Edition. It does not require separate licensing. On the other hand, Active Data Guard is an Oracle Database Enterprise Edition Option therefore requires separate licensing. Multiple standby databases can receive data replication from a primary database in the Active Data Guard setup. However, each additional standby database requires an Active Data Guard license and extra storage as the size of primary database. The operational costs add up quickly.

If you are keen on cutting back cost of your Oracle database operation and are planning to set up an Active Data Guard in AWS, you should consider an alternative. Instead of Active Data Guard, use Data Guard to replicate from primary database to a single physical standby database on Amazon FSx ONTAP storage. Subsequently, multiple copies of this standby database can be cloned and opened for read/write access to serve many other use cases such as reporting, development, test etc. The net results effectively deliver functionalities of Active Data Guard while eliminating Active Data Guard license and extra storage cost for each additional standby database. In this documentation, we demonstrate how to setup an Oracle Data Guard with your existing primary database in AWS and place physical standby database on Amazon FSx ONTAP storage. The standby database is backed up via snapshot and cloned for read/write access for use cases as desired.

This solution addresses the following use cases:

- Oracle Data Guard between a primary database on any storage in AWS to standby database on Amazon FSx ONTAP storage.
- Clone the standby database while closed for data replication to serve use cases such as reporting, dev, test, etc.

Audience

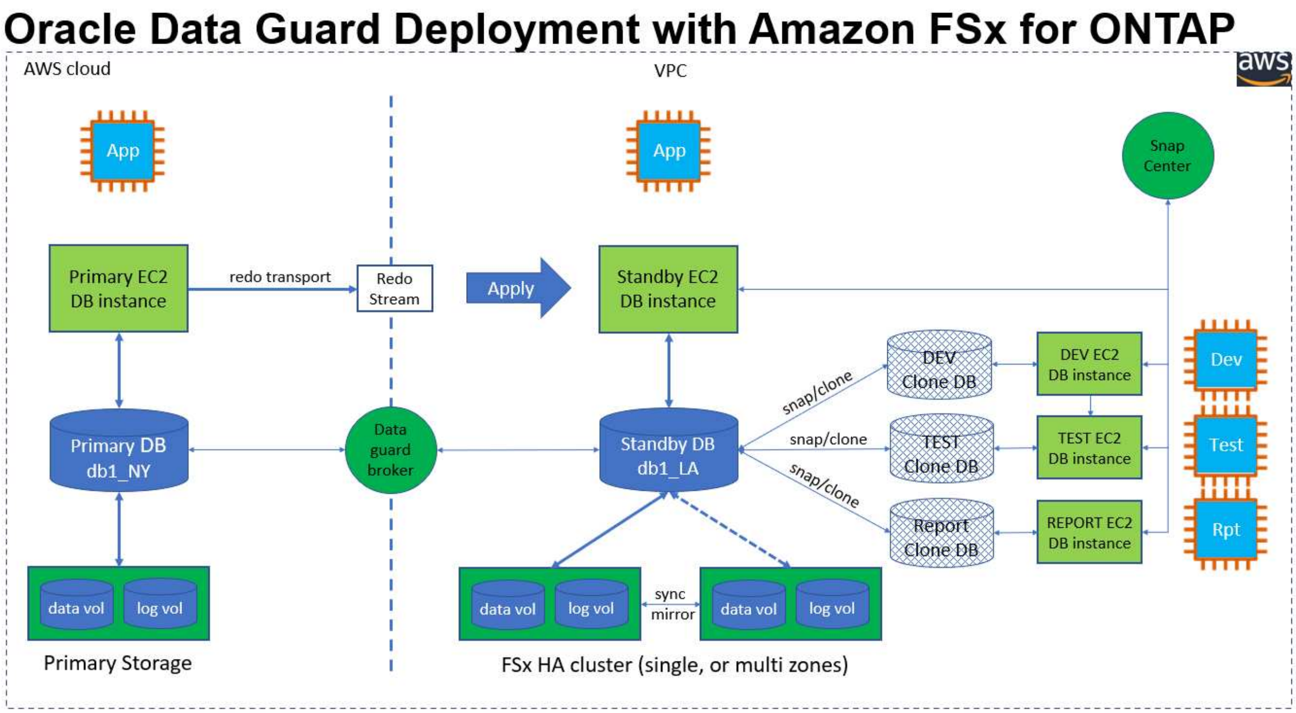
This solution is intended for the following people:

- A DBA who set up Oracle Active Data Guard in AWS for high availability, data protection, and disaster recovery.
- A database solution architect interested in Oracle Active Data Guard configuration in the AWS cloud.
- A storage administrator who manages AWS FSx ONTAP storage that supports Oracle Data Guard.
- An application owner who like to stand up Oracle Data Guard in AWS FSx/EC2 environment.

Solution test and validation environment

The testing and validation of this solution was performed in an AWS FSx ONTAP and EC2 lab environment that might not match the final deployment environment. For more information, see the section Key factors for deployment consideration.

Architecture



Hardware and software components

	Hardware	
FSx ONTAP storage	Current version offered by AWS	One FSx HA cluster in the same VPC and availability zone
EC2 instance for compute	t2.xlarge/4vCPU/16G	Three EC2 T2 xlarge EC2 instances, one as primary DB server, one as standby DB server, and the third 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

Oracle Data Guard configuration with hypothetical NY to LA DR setup

Database	DB_UNIQUE_NAME	Oracle Net Service Name
Primary	db1_NY	db1_NY.demo.netapp.com
Physical Standby	db1_LA	db1_LA.demo.netapp.com

Key factors for deployment consideration

- **How Oracle Standby Database FlexClone Works.** AWS FSx ONTAP FlexClone provides shared copies of the same standby database volumes that are writable. The copies of the volumes are actually pointers that link back to original data blocks until a new write initiates on the clone. ONTAP then allocates new storage blocks for the new writes. Any read IOs are serviced by original data blocks under active replication. Thus, the clone are very storage efficient that can be used for many other use cases with minimal and incremental new storage allocation for new write IOs. This provides tremendous storage cost saving by substantially reducing Active Data Guard storage footprint. NetApp recommends to minimize FlexClone activities in the event of database switching over from primary storage to standby FSx storage in order to maintain Oracle performance at high level.
- **Oracle Software Requirements.** In general, a physical standby database must have the same Database Home version as the primary database including Patch Set Exceptions (PSEs), Critical Patch Updates (CPUs), and Patch Set Updates (PSUs), unless an Oracle Data Guard Standby-First Patch Apply process is in progress (as described in My Oracle Support note 1265700.1 at support.oracle.com
- **Standby Database Directory Structure Considerations.** If possible, the data files, log files, and control files on the primary and standby systems should have the same names and path names and use Optimal Flexible Architecture (OFA) naming conventions. The archival directories on the standby database should also be identical between sites, including size and structure. This strategy allows other operations such as backups, switchovers, and failovers to execute the same set of steps, reducing the maintenance complexity.
- **Force Logging Mode.** To protect against unlogged direct writes in the primary database that cannot be propagated to the standby database, turn on FORCE LOGGING at the primary database before performing data file backups for standby creation.
- **Database Storage Management.** For operational simplicity, Oracle recommends that when you set up Oracle Automatic Storage Management (Oracle ASM) and Oracle Managed Files (OMF) in an Oracle Data Guard configuration that you set it up symmetrically on the primary and standby database(s).
- **EC2 compute instances.** In these tests and validations, we used an AWS EC2 t2.xlarge instance as the Oracle database compute instance. NetApp recommends using a M5 type EC2 instance as the compute instance for Oracle in production deployment because it is optimized for database workload. 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 cluster is alway provisioned in a HA pair that is sync mirrored in a pair of active-passive file systems to provide storage-level redundancy. Multi-zone deployment further enhances high availability in the event of failure in a single AWS zone.
- **FSx storage cluster sizing.** An Amazon FSx for ONTAP storage file system provides up to 160,000 raw

SSD IOPS, up to 4GBps throughput, and a maximum of 192TiB capacity. However, you can size the cluster in terms of provisioned IOPS, throughput, and the storage limit (minimum 1,024 GiB) based on your actually requirements at the time of deployment. The capacity can be adjusted dynamically on the fly without affecting application availability.

Solution deployment

It is assumed that you already have your primary Oracle database deployed in AWS EC2 environment within a VPC as the starting point for setting up Data Guard. The primary database is deployed using Oracle ASM for storage management. Two ASM disk groups - +DATA and +LOGS are created for Oracle data files, log files, and control file etc. For details on Oracle deployment in AWS with ASM, please refer to following technical reports for help.

- Oracle Database Deployment on EC2 and FSx Best Practices
- Oracle Database Deployment and Protection in AWS FSx/EC2 with iSCSI/ASM
- Oracle 19c in Standalone Restart on AWS FSx/EC2 with NFS/ASM

Your primary Oracle database can be running either on an FSx ONTAP or any other storage of choices within the AWS EC2 ecosystem. The following section provides step-by-step deployment procedures for setting up Oracle Data Guard between a primary EC2 DB instance with ASM storage to a standby EC2 DB instance with ASM storage.

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 need to deploy minimum three EC2 Linux instances, one as the primary Oracle DB instance, one as standby Oracle DB instance, and an clone target DB instance for reporting, dev, and test etc. See the architecture diagram in the previous section for more details about the environment setup. Also review the AWS User Guide for Linux instances for more information.
3. From the AWS EC2 console, deploy Amazon FSx for ONTAP storage HA clusters to host Oracle volumes that stores the Oracle standby database. 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. The template can be easily revised for your own deployment requirements.

```
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.

Prepare the primary database for Data Guard

In this demonstration, we have setup a primary Oracle database called db1 on the primary EC2 DB instance with two ASM disk groups in standalone Restart configuration with data files in ASM disk group +DATA and flash recovery area in ASM disk group +LOGS. Following illustrates the detailed procedures for setting up primary database for Data Guard. All steps should be executed as database owner - oracle user.

1. Primary database db1 configuration on primary EC2 DB instance ip-172-30-15-45. The ASM disk groups can be on any type of storage within EC2 ecosystem.

```
[oracle@ip-172-30-15-45 ~]$ cat /etc/oratab

# This file is used by ORACLE utilities.  It is created by root.sh
# and updated by either Database Configuration Assistant while
creating
# a database or ASM Configuration Assistant while creating ASM
instance.

# A colon, ':', is used as the field terminator.  A new line
terminates
# the entry.  Lines beginning with a pound sign, '#', are comments.
#
# Entries are of the form:
#   $ORACLE_SID:$ORACLE_HOME:<N|Y>:
#
# The first and second fields are the system identifier and home
# directory of the database respectively.  The third field indicates
# to the dbstart utility that the database should , "Y", or should
not,
# "N", be brought up at system boot time.
#
# 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

[oracle@ip-172-30-15-45 ~]$
/u01/app/oracle/product/19.0.0/grid/bin/crsctl stat res -t
--------------------------------------------------------------------
------------
Name           Target  State        Server                  State
details
--------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------
```

```
------------
ora.DATA.dg
               ONLINE  ONLINE       ip-172-30-15-45          STABLE
ora.LISTENER.lsnr
               ONLINE  ONLINE       ip-172-30-15-45          STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ip-172-30-15-45          STABLE
ora.asm
               ONLINE  ONLINE       ip-172-30-15-45
Started,STABLE
ora.ons
               OFFLINE OFFLINE      ip-172-30-15-45          STABLE
--------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------
------------
ora.cssd
      1        ONLINE  ONLINE       ip-172-30-15-45          STABLE
ora.db1.db
      1        ONLINE  ONLINE       ip-172-30-15-45
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-172-30-15-45          STABLE
ora.evmd
      1        ONLINE  ONLINE       ip-172-30-15-45          STABLE
--------------------------------------------------------------------
------------
```

2. From sqlplus, enable forced logging on primary.

```
alter database force logging;
```

3. From sqlplus, enable flashback on primary. Flashback allows easy reinstate primary database as a standby after a failover.

```
alter database flashback on;
```

4. Configure redo transport authentication using Oracle password file - create a pwd file on the primary using orapwd utility if not set and copy over to standby database $ORACLE_HOME/dbs directory.
5. Create standby redo logs on the primary DB with same size as current online log file. Log groups are one more than online log file groups. The primary database can then quickly transition to the standby role and begin receiving redo data, if necessary.

```
alter database add standby logfile thread 1 size 200M;
```

```
Validate after standby logs addition:

SQL> select group#, type, member from v$logfile;

    GROUP# TYPE    MEMBER
---------- -------
------------------------------------------------------------
         3 ONLINE  +DATA/DB1/ONLINELOG/group_3.264.1145821513
         2 ONLINE  +DATA/DB1/ONLINELOG/group_2.263.1145821513
         1 ONLINE  +DATA/DB1/ONLINELOG/group_1.262.1145821513
         4 STANDBY +DATA/DB1/ONLINELOG/group_4.286.1146082751
         4 STANDBY +LOGS/DB1/ONLINELOG/group_4.258.1146082753
         5 STANDBY +DATA/DB1/ONLINELOG/group_5.287.1146082819
         5 STANDBY +LOGS/DB1/ONLINELOG/group_5.260.1146082821
         6 STANDBY +DATA/DB1/ONLINELOG/group_6.288.1146082825
         6 STANDBY +LOGS/DB1/ONLINELOG/group_6.261.1146082827
         7 STANDBY +DATA/DB1/ONLINELOG/group_7.289.1146082835
         7 STANDBY +LOGS/DB1/ONLINELOG/group_7.262.1146082835

11 rows selected.
```

6. From sqlplus, create a pfile from spfile for editing.

```
create pfile='/home/oracle/initdb1.ora' from spfile;
```

7. Revise the pfile and add following parameters.

```
DB_NAME=db1
DB_UNIQUE_NAME=db1_NY
LOG_ARCHIVE_CONFIG='DG_CONFIG=(db1_NY,db1_LA)'
LOG_ARCHIVE_DEST_1='LOCATION=USE_DB_RECOVERY_FILE_DEST
VALID_FOR=(ALL_LOGFILES,ALL_ROLES) DB_UNIQUE_NAME=db1_NY'
LOG_ARCHIVE_DEST_2='SERVICE=db1_LA ASYNC
VALID_FOR=(ONLINE_LOGFILES,PRIMARY_ROLE) DB_UNIQUE_NAME=db1_LA'
REMOTE_LOGIN_PASSWORDFILE=EXCLUSIVE
FAL_SERVER=db1_LA
STANDBY_FILE_MANAGEMENT=AUTO
```

8. From sqlplus, create spfile in ASM +DATA directory from revised pfile in /home/oracle directory.

```
create spfile='+DATA' from pfile='/home/oracle/initdb1.ora';
```

9. Locate the newly created spfile under +DATA disk group(using asmcmd utility if necessary). Use srvctl to modify grid to start database from new spfile as shown below.

```
[oracle@ip-172-30-15-45 db1]$ srvctl config database -d db1
Database unique name: db1
Database name: db1
Oracle home: /u01/app/oracle/product/19.0.0/db1
Oracle user: oracle
Spfile: +DATA/DB1/PARAMETERFILE/spfile.270.1145822903
Password file:
Domain: demo.netapp.com
Start options: open
Stop options: immediate
Database role: PRIMARY
Management policy: AUTOMATIC
Disk Groups: DATA
Services:
OSDBA group:
OSOPER group:
Database instance: db1
[oracle@ip-172-30-15-45 db1]$ srvctl modify database -d db1 -spfile
+DATA/DB1/PARAMETERFILE/spfiledb1.ora
[oracle@ip-172-30-15-45 db1]$ srvctl config database -d db1
Database unique name: db1
Database name: db1
Oracle home: /u01/app/oracle/product/19.0.0/db1
Oracle user: oracle
Spfile: +DATA/DB1/PARAMETERFILE/spfiledb1.ora
Password file:
Domain: demo.netapp.com
Start options: open
Stop options: immediate
Database role: PRIMARY
Management policy: AUTOMATIC
Disk Groups: DATA
Services:
OSDBA group:
OSOPER group:
Database instance: db1
```

10. Modify tnsnames.ora to add db_unique_name for name resolution.

```
# tnsnames.ora Network Configuration File:
/u01/app/oracle/product/19.0.0/db1/network/admin/tnsnames.ora
# Generated by Oracle configuration tools.

db1_NY =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
45.ec2.internal)(PORT = 1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SID = db1)
    )
  )

db1_LA =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
67.ec2.internal)(PORT = 1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SID = db1)
    )
  )

LISTENER_DB1 =
  (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
45.ec2.internal)(PORT = 1521))
```

11. Add data guard service name db1_NY_DGMGRL.demo.netapp for primary database to listener.ora file.

```
#Backup file is  /u01/app/oracle/crsdata/ip-172-30-15-
45/output/listener.ora.bak.ip-172-30-15-45.oracle line added by Agent
# listener.ora Network Configuration File:
/u01/app/oracle/product/19.0.0/grid/network/admin/listener.ora
# Generated by Oracle configuration tools.

LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
45.ec2.internal)(PORT = 1521))
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1521))
    )
  )

SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (GLOBAL_DBNAME = db1_NY_DGMGRL.demo.netapp.com)
      (ORACLE_HOME = /u01/app/oracle/product/19.0.0/db1)
      (SID_NAME = db1)
    )
  )

ENABLE_GLOBAL_DYNAMIC_ENDPOINT_LISTENER=ON              # line added by
Agent
VALID_NODE_CHECKING_REGISTRATION_LISTENER=ON            # line added by
Agent
```

1. Shutdown and restart database with srvctl and validate that data guard parameters are now active.

   ```
   srvctl stop database -d db1
   ```

   ```
   srvctl start database -d db1
   ```

This completes primary database setup for Data Guard.

Prepare standby database and activate Data Guard

Oracle Data Guard requires OS kernel configuration and Oracle software stacks including patch sets on standby EC2 DB instance to match with primary EC2 DB instance. For easy management and simplicity, the standby EC2 DB instance database storage configuration ideally should match with the primary EC2 DB instance as well, such as the name, number and size of ASM disk groups. Following are detail procedures for setting up the standby EC2 DB instance for Data Guard. All commands should be executed as oracle owner user id.

1. First, review the configuration of the primary database on primary EC2 instance. In this demonstration, we have setup a primary Oracle database called db1 on the primary EC2 DB instance with two ASM disk groups +DATA and +LOGS in standalone Restart configuration. The primary ASM disk groups may be on any type of storage within EC2 ecosystem.
2. Follow procedures in documentation TR-4965: Oracle Database Deployment and Protection in AWS FSx/EC2 with iSCSI/ASM to install and configure grid and Oracle on standby EC2 DB instance to match with primary database. The database storage should be provisioned and allocated to standby EC2 DB instance from FSx ONTAP with same storage capacity as primary EC2 DB instance.

   > Stop at step 10 in `Oracle database installation` section. The standby database will be instantiated from primary database using dbca database duplication function.

3. Once Oracle software is installed and configured, from standby $ORACLE_HOME dbs directory, copy oracle password from primary database.

   ```
   scp
   oracle@172.30.15.45:/u01/app/oracle/product/19.0.0/db1/dbs/orapwdb1
   .
   ```

4. Create tnsnames.ora file with following entries.

```
# tnsnames.ora Network Configuration File:
/u01/app/oracle/product/19.0.0/db1/network/admin/tnsnames.ora
# Generated by Oracle configuration tools.

db1_NY =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
45.ec2.internal)(PORT = 1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SID = db1)
    )
  )

db1_LA =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
67.ec2.internal)(PORT = 1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SID = db1)
    )
  )
```

5. Add DB data guard service name to listener.ora file.

```
#Backup file is  /u01/app/oracle/crsdata/ip-172-30-15-
67/output/listener.ora.bak.ip-172-30-15-67.oracle line added by
Agent
# listener.ora Network Configuration File:
/u01/app/oracle/product/19.0.0/grid/network/admin/listener.ora
# Generated by Oracle configuration tools.

LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = TCP)(HOST = ip-172-30-15-
67.ec2.internal)(PORT = 1521))
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1521))
    )
  )

SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (GLOBAL_DBNAME = db1_LA_DGMGRL.demo.netapp.com)
      (ORACLE_HOME = /u01/app/oracle/product/19.0.0/db1)
      (SID_NAME = db1)
    )
  )

ENABLE_GLOBAL_DYNAMIC_ENDPOINT_LISTENER=ON              # line added
by Agent
VALID_NODE_CHECKING_REGISTRATION_LISTENER=ON            # line added
by Agent
```

6. Set oracle home and path.

```
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/db1
```

```
export PATH=$PATH:$ORACLE_HOME/bin
```

7. Use dbca to instantiate standby database from primary database db1.

```
[oracle@ip-172-30-15-67 bin]$ dbca -silent -createDuplicateDB
-gdbName db1 -primaryDBConnectionString ip-172-30-15-
45.ec2.internal:1521/db1_NY.demo.netapp.com -sid db1 -initParams
fal_server=db1_NY -createAsStandby -dbUniqueName db1_LA
Enter SYS user password:

Prepare for db operation
22% complete
Listener config step
44% complete
Auxiliary instance creation
67% complete
RMAN duplicate
89% complete
Post duplicate database operations
100% complete

Look at the log file
"/u01/app/oracle/cfgtoollogs/dbca/db1_LA/db1_LA.log" for further
details.
```

8. Validate duplicated standby database. Newly duplicated standby database open in READ ONLY mode initially.

```
[oracle@ip-172-30-15-67 bin]$ export ORACLE_SID=db1
[oracle@ip-172-30-15-67 bin]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Wed Aug 30 18:25:46
2023
Version 19.18.0.0.0

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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
--------- --------------------
DB1       READ ONLY
```

```
SQL> show parameter name

NAME                                 TYPE        VALUE
------------------------------------ -----------
------------------------------
cdb_cluster_name                     string
cell_offloadgroup_name               string
db_file_name_convert                 string
db_name                              string      db1
db_unique_name                       string      db1_LA
global_names                         boolean     FALSE
instance_name                        string      db1
lock_name_space                      string
log_file_name_convert                string
pdb_file_name_convert                string
processor_group_name                 string

NAME                                 TYPE        VALUE
------------------------------------ -----------
------------------------------
service_names                        string
db1_LA.demo.netapp.com
SQL>
SQL> show parameter log_archive_config

NAME                                 TYPE        VALUE
------------------------------------ -----------
------------------------------
log_archive_config                   string
DG_CONFIG=(db1_NY,db1_LA)
SQL> show parameter fal_server

NAME                                 TYPE        VALUE
------------------------------------ -----------
------------------------------
fal_server                           string      db1_NY

SQL> select name from v$datafile;

NAME
--------------------------------------------------------------------
------------
+DATA/DB1_LA/DATAFILE/system.261.1146248215
+DATA/DB1_LA/DATAFILE/sysaux.262.1146248231
+DATA/DB1_LA/DATAFILE/undotbs1.263.1146248247
+DATA/DB1_LA/03C5C01A66EE9797E0632D0F1EAC5F59/DATAFILE/system.264.11
```

```
46248253
+DATA/DB1_LA/03C5C01A66EE9797E0632D0F1EAC5F59/DATAFILE/sysaux.265.11
46248261
+DATA/DB1_LA/DATAFILE/users.266.1146248267
+DATA/DB1_LA/03C5C01A66EE9797E0632D0F1EAC5F59/DATAFILE/undotbs1.267.
1146248269
+DATA/DB1_LA/03C5EFD07C41A1FAE0632D0F1EAC9BD8/DATAFILE/system.268.11
46248271
+DATA/DB1_LA/03C5EFD07C41A1FAE0632D0F1EAC9BD8/DATAFILE/sysaux.269.11
46248279
+DATA/DB1_LA/03C5EFD07C41A1FAE0632D0F1EAC9BD8/DATAFILE/undotbs1.270.
1146248285
+DATA/DB1_LA/03C5EFD07C41A1FAE0632D0F1EAC9BD8/DATAFILE/users.271.114
6248293

NAME
--------------------------------------------------------------------
------------
+DATA/DB1_LA/03C5F0DDF35CA2B6E0632D0F1EAC8B6B/DATAFILE/system.272.11
46248295
+DATA/DB1_LA/03C5F0DDF35CA2B6E0632D0F1EAC8B6B/DATAFILE/sysaux.273.11
46248301
+DATA/DB1_LA/03C5F0DDF35CA2B6E0632D0F1EAC8B6B/DATAFILE/undotbs1.274.
1146248309
+DATA/DB1_LA/03C5F0DDF35CA2B6E0632D0F1EAC8B6B/DATAFILE/users.275.114
6248315
+DATA/DB1_LA/03C5F1C9B142A2F1E0632D0F1EACF21A/DATAFILE/system.276.11
46248317
+DATA/DB1_LA/03C5F1C9B142A2F1E0632D0F1EACF21A/DATAFILE/sysaux.277.11
46248323
+DATA/DB1_LA/03C5F1C9B142A2F1E0632D0F1EACF21A/DATAFILE/undotbs1.278.
1146248331
+DATA/DB1_LA/03C5F1C9B142A2F1E0632D0F1EACF21A/DATAFILE/users.279.114
6248337

19 rows selected.

SQL> select name from v$controlfile;

NAME
--------------------------------------------------------------------
------------
+DATA/DB1_LA/CONTROLFILE/current.260.1146248209
+LOGS/DB1_LA/CONTROLFILE/current.257.1146248209

SQL> select name from v$tempfile;
```

```
NAME
--------------------------------------------------------------------
------------
+DATA/DB1_LA/TEMPFILE/temp.287.1146248371
+DATA/DB1_LA/03C5C01A66EE9797E0632D0F1EAC5F59/TEMPFILE/temp.288.1146
248375
+DATA/DB1_LA/03C5EFD07C41A1FAE0632D0F1EAC9BD8/TEMPFILE/temp.290.1146
248463
+DATA/DB1_LA/03C5F0DDF35CA2B6E0632D0F1EAC8B6B/TEMPFILE/temp.291.1146
248463
+DATA/DB1_LA/03C5F1C9B142A2F1E0632D0F1EACF21A/TEMPFILE/temp.292.1146
248463

SQL> select group#, type, member from v$logfile order by 2, 1;

    GROUP# TYPE    MEMBER
---------- -------
------------------------------------------------------------
         1 ONLINE  +LOGS/DB1_LA/ONLINELOG/group_1.259.1146248349
         1 ONLINE  +DATA/DB1_LA/ONLINELOG/group_1.280.1146248347
         2 ONLINE  +DATA/DB1_LA/ONLINELOG/group_2.281.1146248351
         2 ONLINE  +LOGS/DB1_LA/ONLINELOG/group_2.258.1146248353
         3 ONLINE  +DATA/DB1_LA/ONLINELOG/group_3.282.1146248355
         3 ONLINE  +LOGS/DB1_LA/ONLINELOG/group_3.260.1146248355
         4 STANDBY +DATA/DB1_LA/ONLINELOG/group_4.283.1146248357
         4 STANDBY +LOGS/DB1_LA/ONLINELOG/group_4.261.1146248359
         5 STANDBY +DATA/DB1_LA/ONLINELOG/group_5.284.1146248361
         5 STANDBY +LOGS/DB1_LA/ONLINELOG/group_5.262.1146248363
         6 STANDBY +LOGS/DB1_LA/ONLINELOG/group_6.263.1146248365
         6 STANDBY +DATA/DB1_LA/ONLINELOG/group_6.285.1146248365
         7 STANDBY +LOGS/DB1_LA/ONLINELOG/group_7.264.1146248369
         7 STANDBY +DATA/DB1_LA/ONLINELOG/group_7.286.1146248367

14 rows selected.

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

```
NAME      OPEN_MODE
--------- --------------------
DB1       READ ONLY
```

9. Restart standby database in `mount` stage and execute following command to activate standby database managed recovery.

```
alter database recover managed standby database disconnect from
session;
```

```
SQL> shutdown immediate;
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> startup mount;
ORACLE instance started.

Total System Global Area 8053062944 bytes
Fixed Size                  9182496 bytes
Variable Size            1291845632 bytes
Database Buffers         6744440832 bytes
Redo Buffers                7593984 bytes
Database mounted.
SQL> alter database recover managed standby database disconnect from
session;

Database altered.
```

10. Validate the standby database recovery status. Notice the `recovery logmerger` in `APPLYING_LOG` action.

```
SQL> SELECT ROLE, THREAD#, SEQUENCE#, ACTION FROM
V$DATAGUARD_PROCESS;

ROLE                        THREAD#  SEQUENCE# ACTION
------------------------ ---------- ---------- ------------
recovery apply slave              0          0 IDLE
recovery apply slave              0          0 IDLE
recovery apply slave              0          0 IDLE
recovery apply slave              0          0 IDLE
recovery logmerger                1         30 APPLYING_LOG
RFS ping                          1         30 IDLE
RFS async                         1         30 IDLE
archive redo                      0          0 IDLE
archive redo                      0          0 IDLE
archive redo                      0          0 IDLE
gap manager                       0          0 IDLE

ROLE                        THREAD#  SEQUENCE# ACTION
------------------------ ---------- ---------- ------------
managed recovery                  0          0 IDLE
redo transport monitor            0          0 IDLE
log writer                        0          0 IDLE
archive local                     0          0 IDLE
redo transport timer              0          0 IDLE

16 rows selected.

SQL>
```

This completes the Data Guard protection setup for db1 from primary to standby with managed standby recovery enabled.

Setup Data Guard Broker

Oracle Data Guard broker is a distributed management framework that automates and centralizes the creation, maintenance, and monitoring of Oracle Data Guard configurations. Following section demonstrate how to setup Data Guard Broker to manage Data Guard environment.

1. Start data guard broker on both primary and standby databases with following command via sqlplus.

   ```
   alter system set dg_broker_start=true scope=both;
   ```

2. From primary database, connect to Data Guard Borker as SYSDBA.

   ```
   [oracle@ip-172-30-15-45 db1]$ dgmgrl sys@db1_NY
   DGMGRL for Linux: Release 19.0.0.0.0 - Production on Wed Aug 30
   19:34:14 2023
   Version 19.18.0.0.0

   Copyright (c) 1982, 2019, Oracle and/or its affiliates.  All rights
   reserved.

   Welcome to DGMGRL, type "help" for information.
   Password:
   Connected to "db1_NY"
   Connected as SYSDBA.
   ```

3. Create and enable Data Guard Broker configuration.

```
DGMGRL> create configuration dg_config as primary database is db1_NY
connect identifier is db1_NY;
Configuration "dg_config" created with primary database "db1_ny"
DGMGRL> add database db1_LA as connect identifier is db1_LA;
Database "db1_la" added
DGMGRL> enable configuration;
Enabled.
DGMGRL> show configuration;

Configuration - dg_config

  Protection Mode: MaxPerformance
  Members:
  db1_ny - Primary database
    db1_la - Physical standby database

Fast-Start Failover:  Disabled

Configuration Status:
SUCCESS   (status updated 28 seconds ago)
```

4. Validate database status within Data Guard Broker management framework.

```
DGMGRL> show database db1_ny;

Database - db1_ny

  Role:               PRIMARY
  Intended State:     TRANSPORT-ON
  Instance(s):
    db1

Database Status:
SUCCESS

DGMGRL> show database db1_la;

Database - db1_la

  Role:               PHYSICAL STANDBY
  Intended State:     APPLY-ON
  Transport Lag:      0 seconds (computed 1 second ago)
  Apply Lag:          0 seconds (computed 1 second ago)
  Average Apply Rate: 2.00 KByte/s
  Real Time Query:    OFF
  Instance(s):
    db1

Database Status:
SUCCESS

DGMGRL>
```

In the event of a failure, Data Guard Broker can be used to failover primary database to standby instantaniouly.

Clone standby databse for other use cases

The key benefit of staging standby database on AWS FSx ONTAP in Data Guard is that it can be FlexCloned to serve many other use cases with minimal additional storage investment. In the following section, we demonstrate how to snapshot and clone the mounted and under recovery standby database volumes on FSx ONTAP for other purposes, such as DEV, TEST, REPORT, etc., using the NetApp SnapCenter tool.

Following are high level procedures to clone a READ/WRITE database from the managed physical standby database in Data Guard using SnapCenter. For detail instructions on how to setup and configure SnapCenter, please refer to Hybrid Cloud Database Solutions with SnapCenter relavant Oracle sections.

1. We begin with creating a test table and inserting a row into the test table on primary database. We will then validate if the transaction traverse down to standby and finally the clone.

```
[oracle@ip-172-30-15-45 db1]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Thu Aug 31 16:35:53
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> alter session set container=db1_pdb1;

Session altered.

SQL> create table test(
  2  id integer,
  3  dt timestamp,
  4  event varchar(100));

Table created.

SQL> insert into test values(1, sysdate, 'a test transaction on
primary database db1 and ec2 db host: ip-172-30-15-
45.ec2.internal');

1 row created.

SQL> commit;

Commit complete.
```

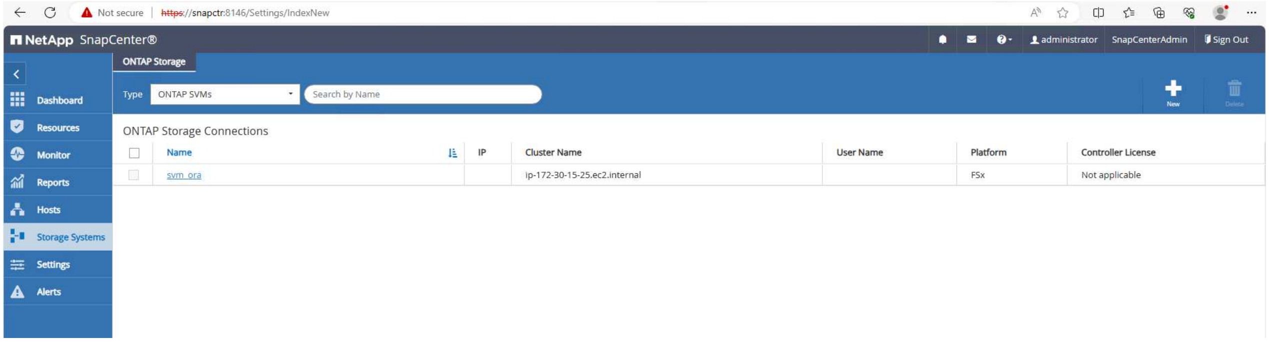
```
SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
31-AUG-23 04.49.29.000000 PM
a test transaction on primary database db1 and ec2 db host: ip-172-
30-15-45.ec2.
internal

SQL> select instance_name, host_name from v$instance;

INSTANCE_NAME
----------------
HOST_NAME
----------------------------------------------------------------
db1
ip-172-30-15-45.ec2.internal
```

2. Add FSx storage cluster to `Storage Systems` in SnapCenter with FSx cluster management IP and fsxadmin credential.



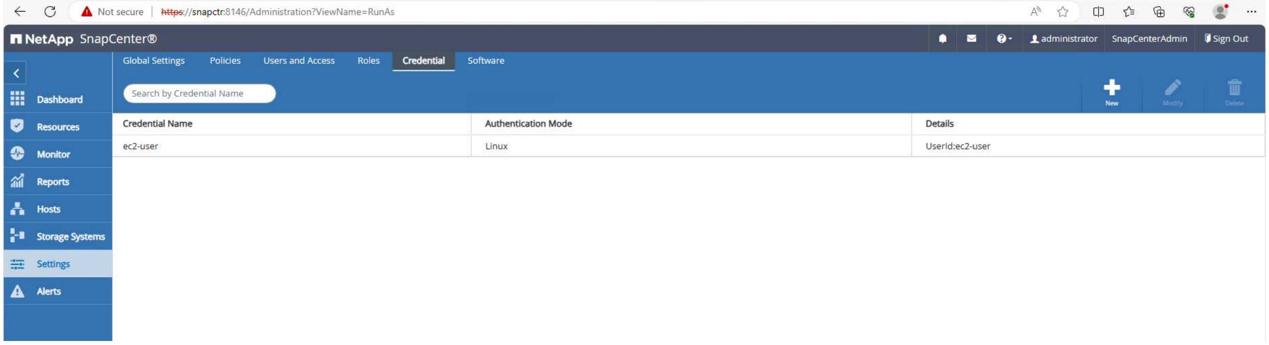
Type: ONTAP SVMs

Search by Name

ONTAP Storage Connections

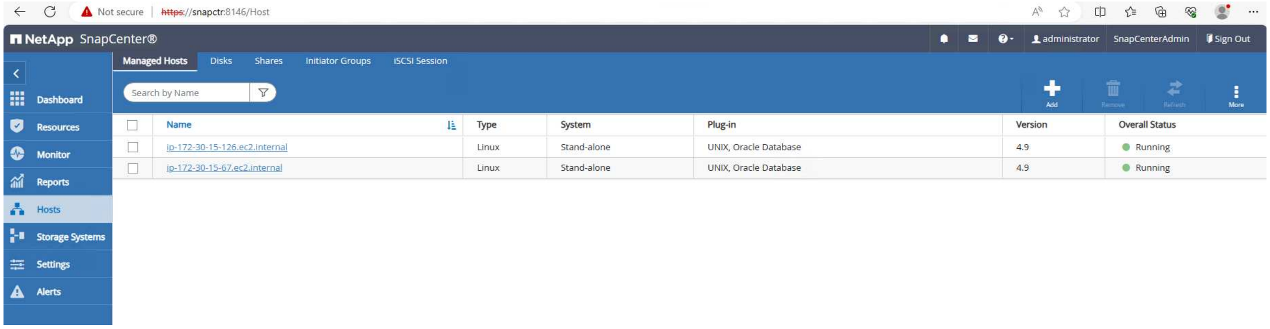
☐	Name	IP	Cluster Name	User Name	Platform	Controller License
☐	svm_ora		ip-172-30-15-25.ec2.internal		FSx	Not applicable

3. Add AWS ec2-user to `Credential` in `Settings`.



Credential Name	Authentication Mode	Details
ec2-user	Linux	UserId:ec2-user

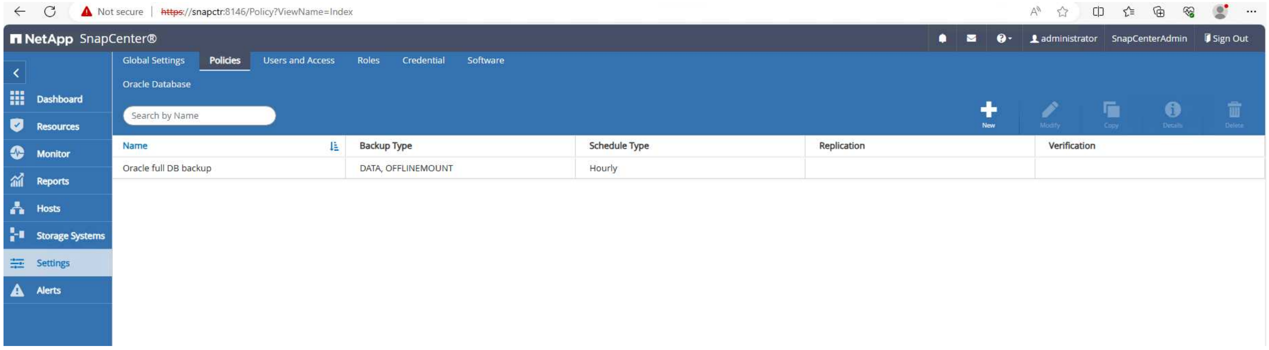
4. Add standby EC2 DB instance and clone EC2 DB instance to `Hosts`.



☐	Name	Type	System	Plug-in	Version	Overall Status
☐	ip-172-30-15-126.ec2.internal	Linux	Stand-alone	UNIX, Oracle Database	4.9	● Running
☐	ip-172-30-15-67.ec2.internal	Linux	Stand-alone	UNIX, Oracle Database	4.9	● Running

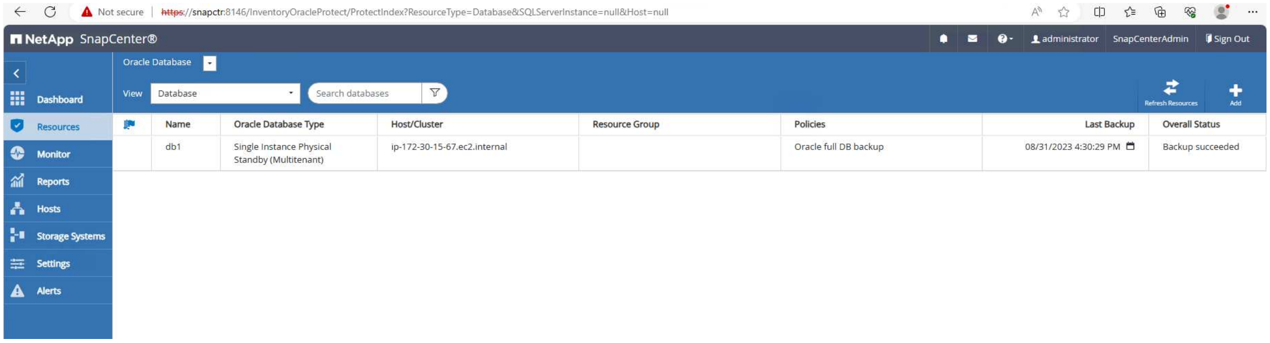
> The clone EC2 DB instance should have similar Oracle software stacks installed and configured. In our test case, the grid infrastructure and Oracle 19C installed and configured but no database created.

5. Create a backup policy that is tailored for offline/mount full database backup.



Name	Backup Type	Schedule Type	Replication	Verification
Oracle full DB backup	DATA, OFFLINEMOUNT	Hourly		

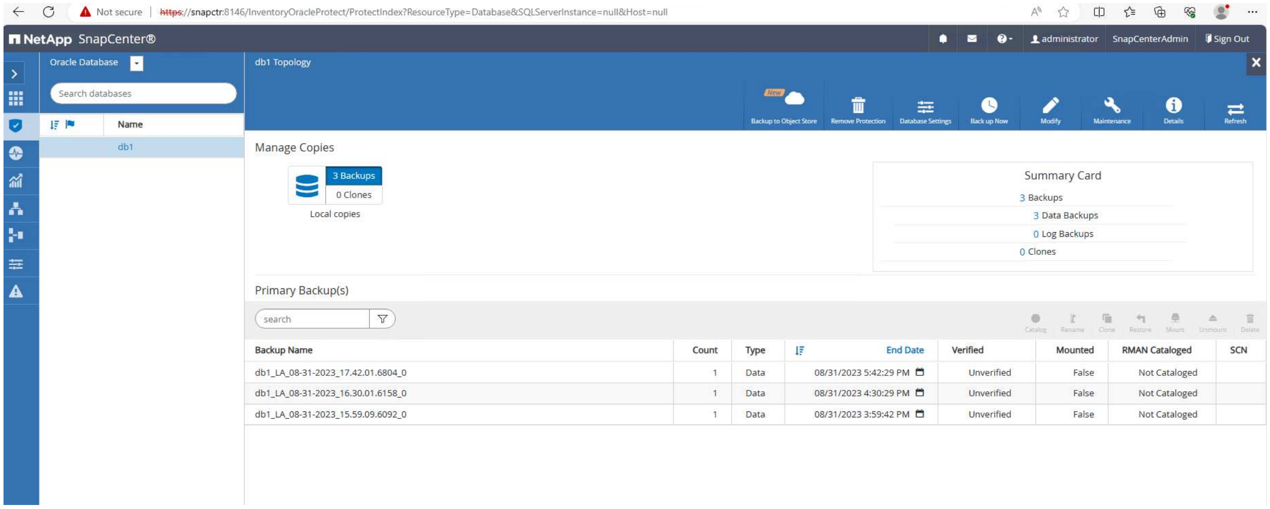
6. Apply backup policy to protect standby database in `Resources` tab.



	Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
	db1	Single Instance Physical Standby (Multitenant)	ip-172-30-15-67.ec2.internal		Oracle full DB backup	08/31/2023 4:30:29 PM	Backup succeeded

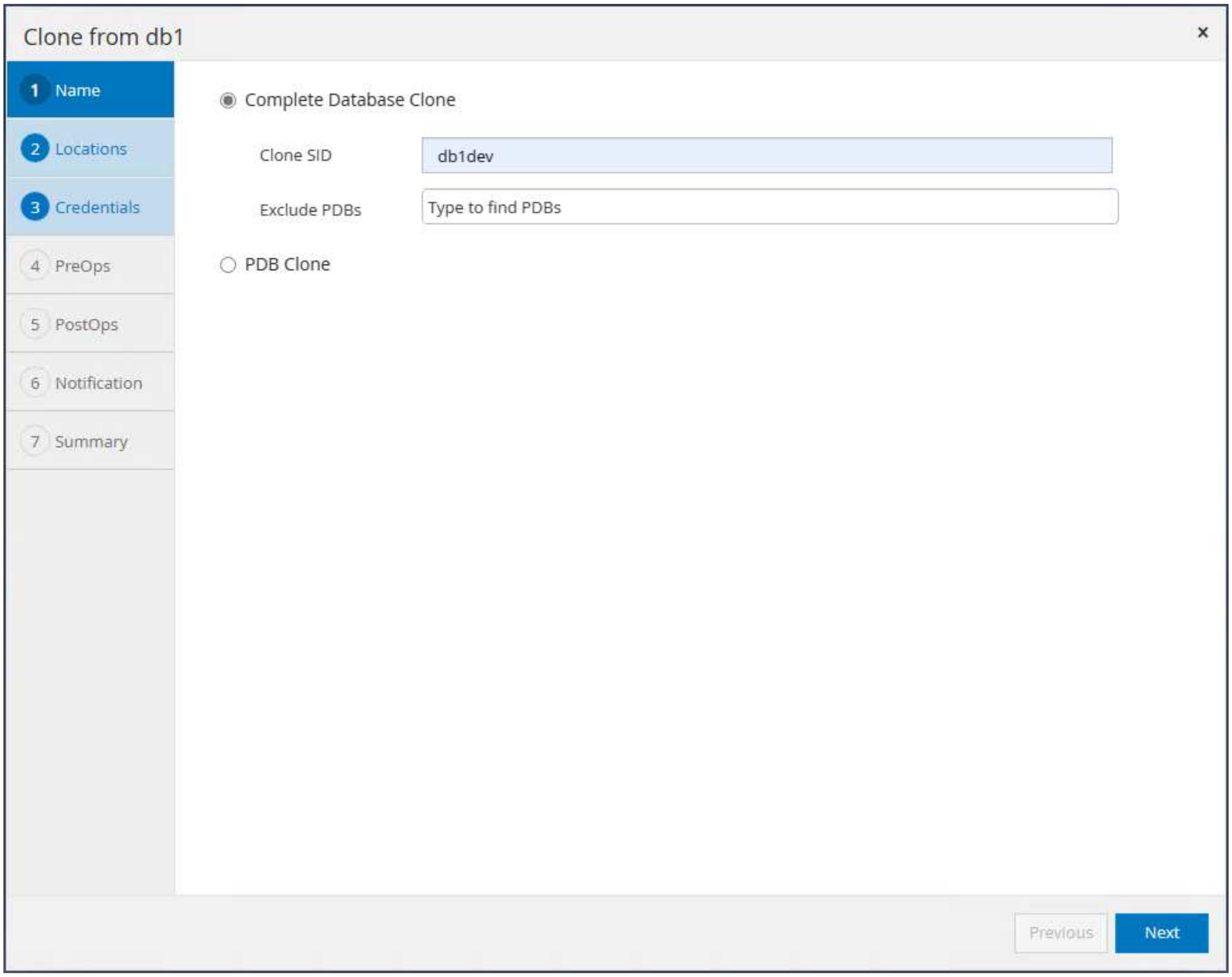
7. Click on database name to open the database backups page. Select a backup to be used for

database clone and click on `Clone` button to launch clone workflow.



Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
db1_LA_08-31-2023_17.42.01.6804_0	1	Data	08/31/2023 5:42:29 PM	Unverified	False	Not Cataloged	
db1_LA_08-31-2023_16.30.01.6158_0	1	Data	08/31/2023 4:30:29 PM	Unverified	False	Not Cataloged	
db1_LA_08-31-2023_15.59.09.6092_0	1	Data	08/31/2023 3:59:42 PM	Unverified	False	Not Cataloged	

8. Select `Complete Database Clone` and name the clone instance SID.



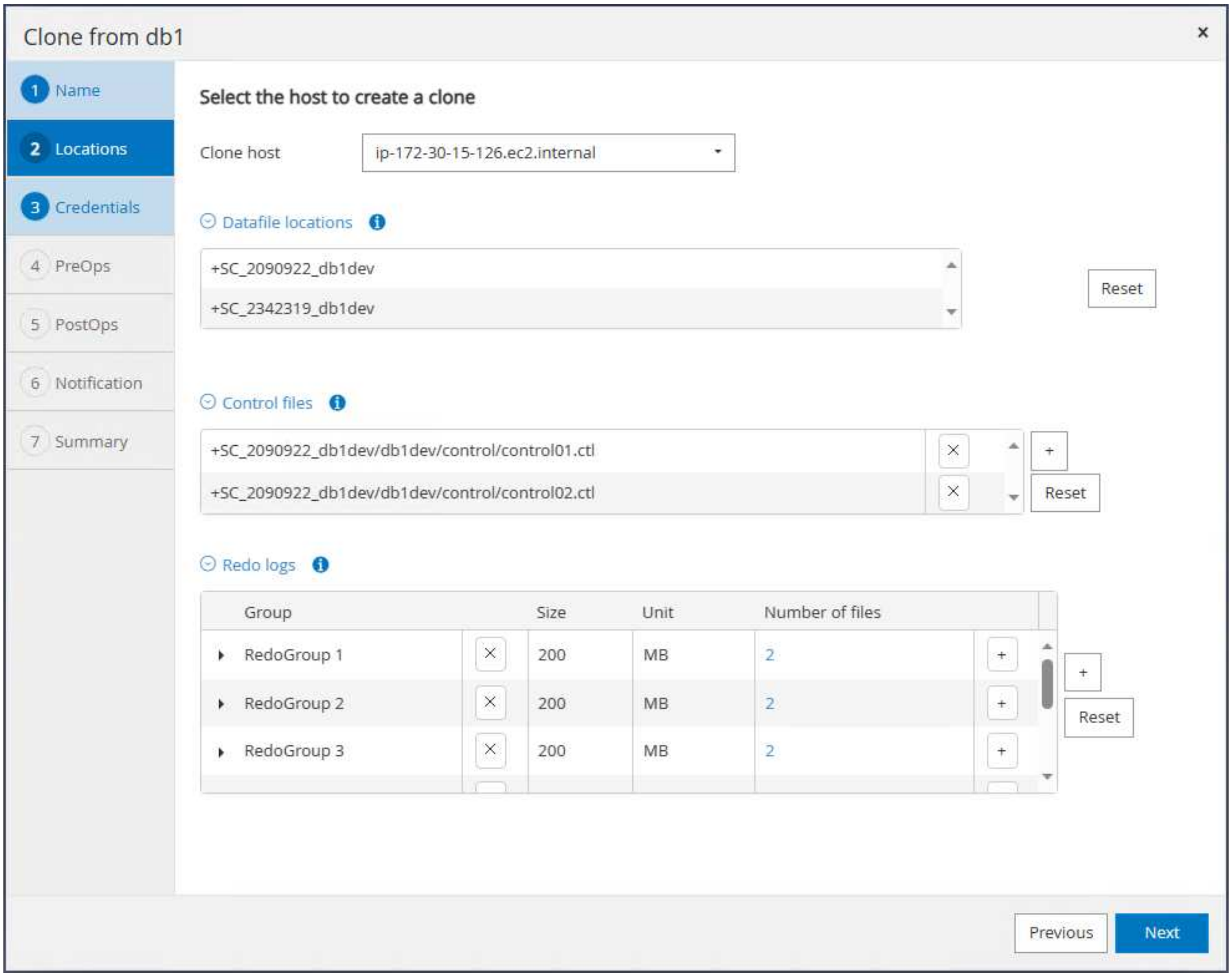
● Complete Database Clone

Clone SID: db1dev

Exclude PDBs: Type to find PDBs

○ PDB Clone

9. Select the clone host, which hosts the cloned database from standby DB. Accept the default for data files, control files, and redo logs. Two ASM disk groups will be created on the clone host that are corresponding to the disk groups on standby database.



Select the host to create a clone

Clone host: ip-172-30-15-126.ec2.internal

Datafile locations

- +SC_2090922_db1dev
- +SC_2342319_db1dev

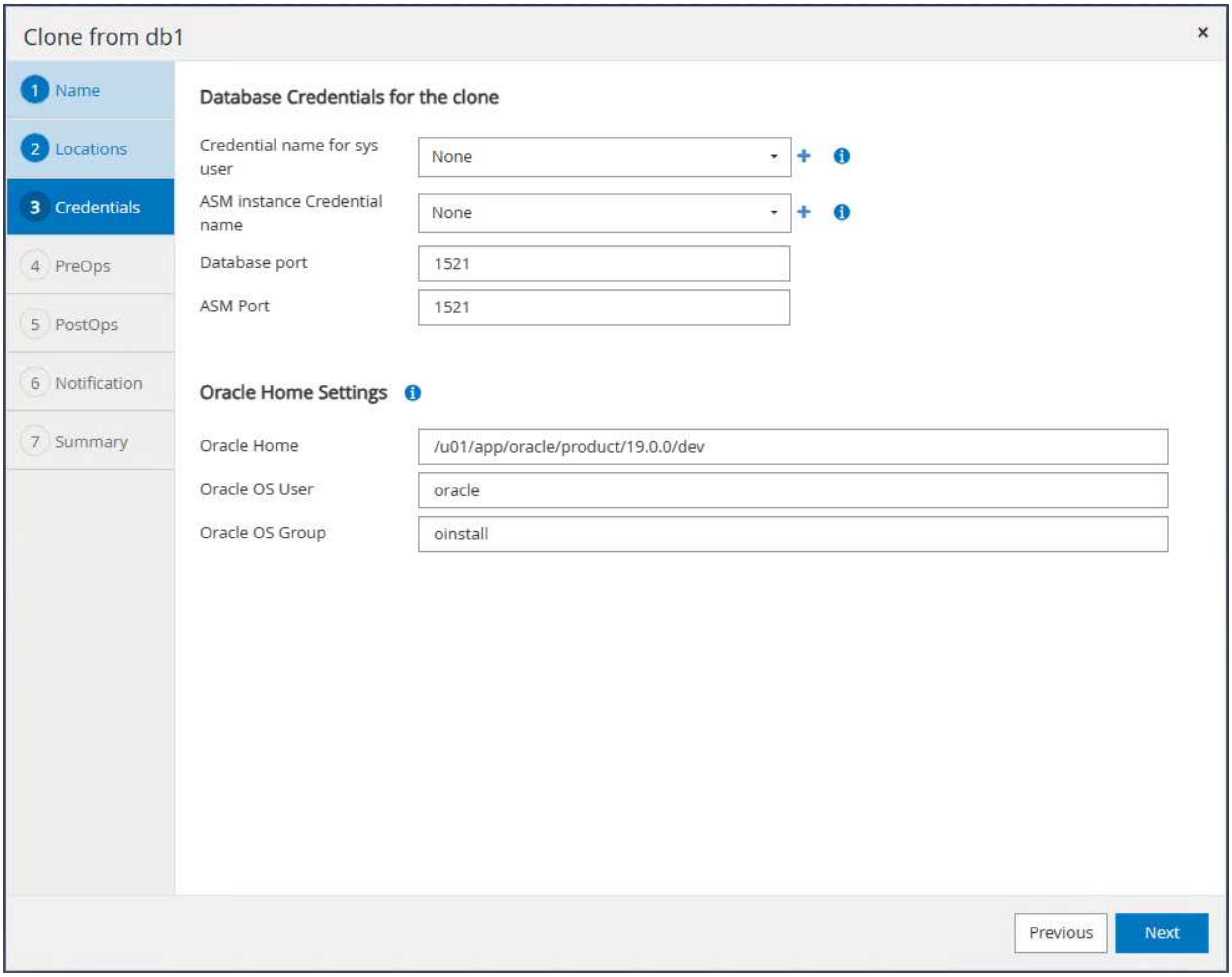
Control files

- +SC_2090922_db1dev/db1dev/control/control01.ctl
- +SC_2090922_db1dev/db1dev/control/control02.ctl

Redo logs

Group	Size	Unit	Number of files
RedoGroup 1	200	MB	2
RedoGroup 2	200	MB	2
RedoGroup 3	200	MB	2

10. No database credentials are needed for OS based authentication. Match Oracle home setting with what is configured on the clone EC2 database instance.



Database Credentials for the clone

Credential name for sys user: None

ASM instance Credential name: None

Database port: 1521

ASM Port: 1521

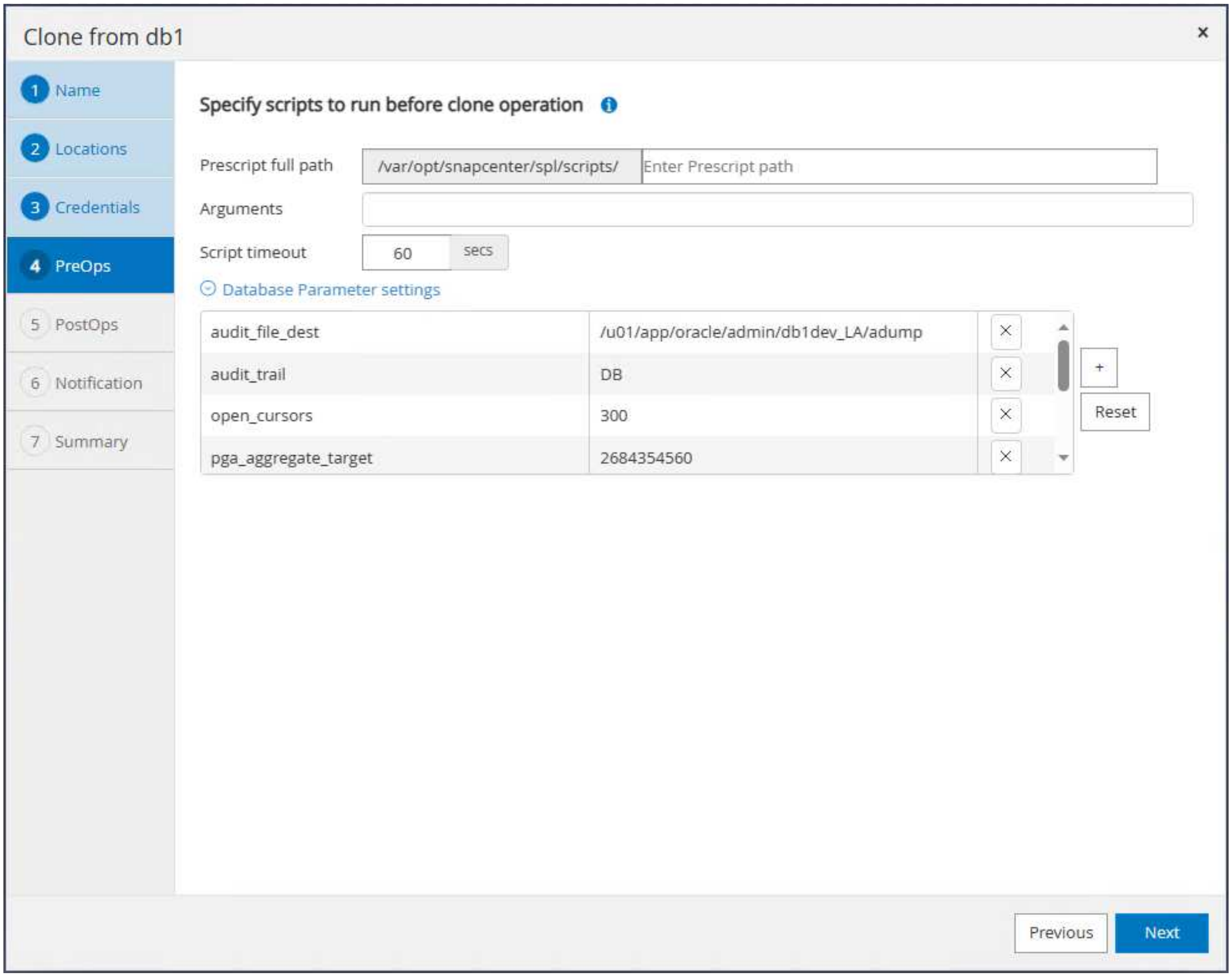
Oracle Home Settings

Oracle Home: /u01/app/oracle/product/19.0.0/dev

Oracle OS User: oracle

Oracle OS Group: oinstall

11. Change clone database parameters if needed and specify scripts to run before cloen if any.



Specify scripts to run before clone operation

Prescript full path /var/opt/snapcenter/spl/scripts/ Enter Prescript path

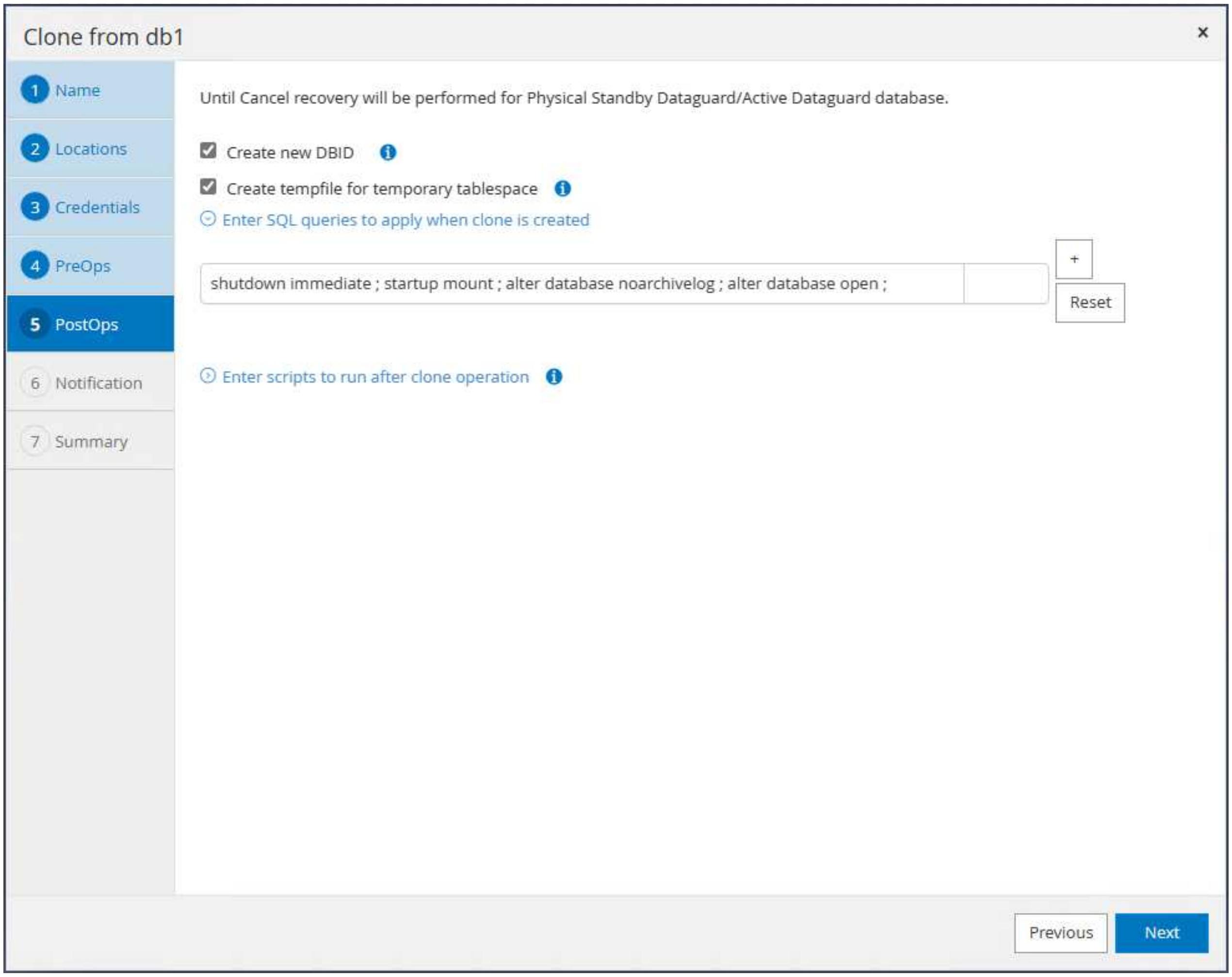
Arguments

Script timeout 60 secs

Database Parameter settings

audit_file_dest	/u01/app/oracle/admin/db1dev_LA/adump
audit_trail	DB
open_cursors	300
pga_aggregate_target	2684354560

12. Enter SQL to run after clone. In the demo, we executed commands to turn off database archive mode for a dev/test/report database.



Until Cancel recovery will be performed for Physical Standby Dataguard/Active Dataguard database.

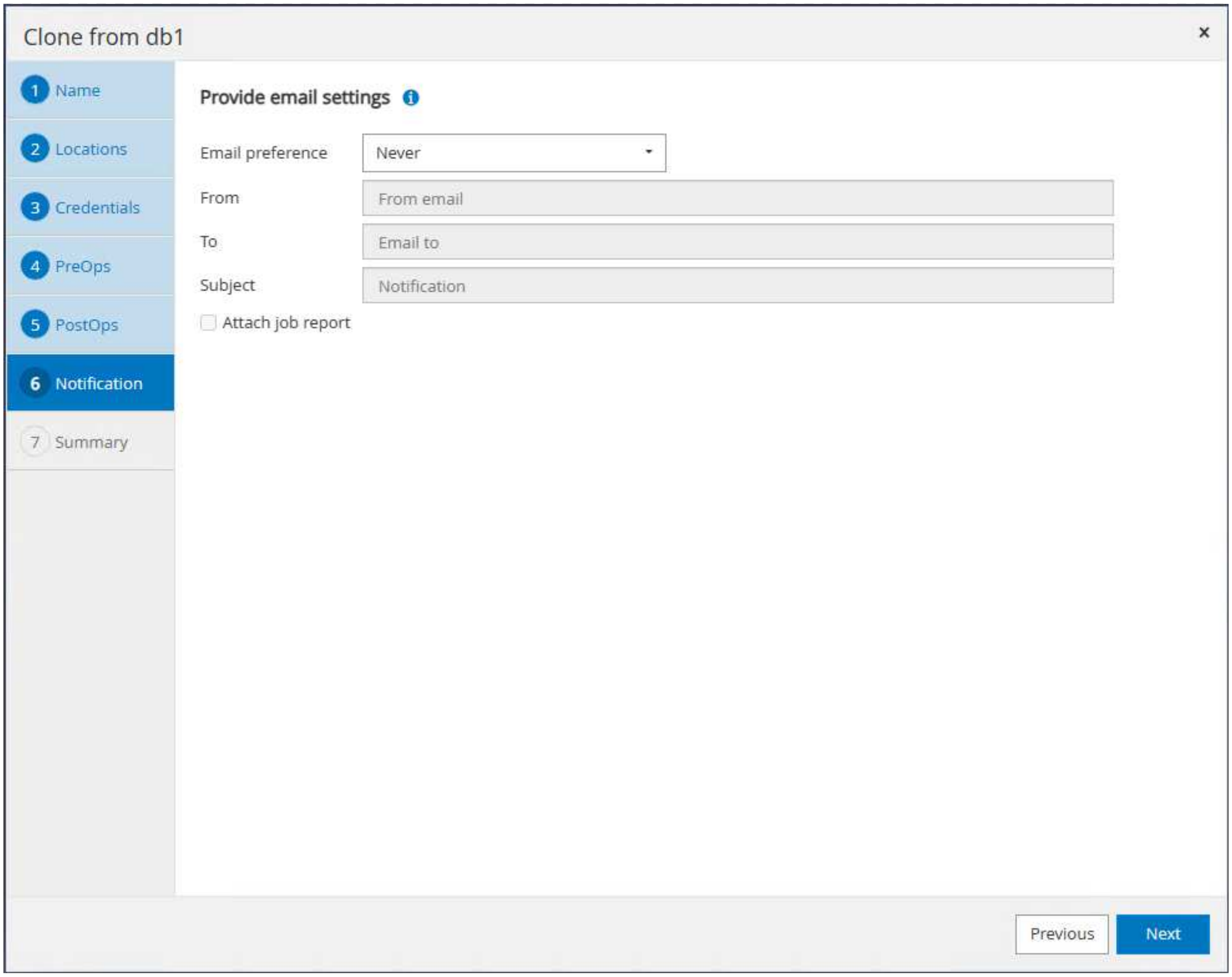
☑ Create new DBID

☑ Create tempfile for temporary tablespace

Enter SQL queries to apply when clone is created

```
shutdown immediate ; startup mount ; alter database noarchivelog ; alter database open ;
```

13. Configure email notification if desired.



Provide email settings

Email preference: Never

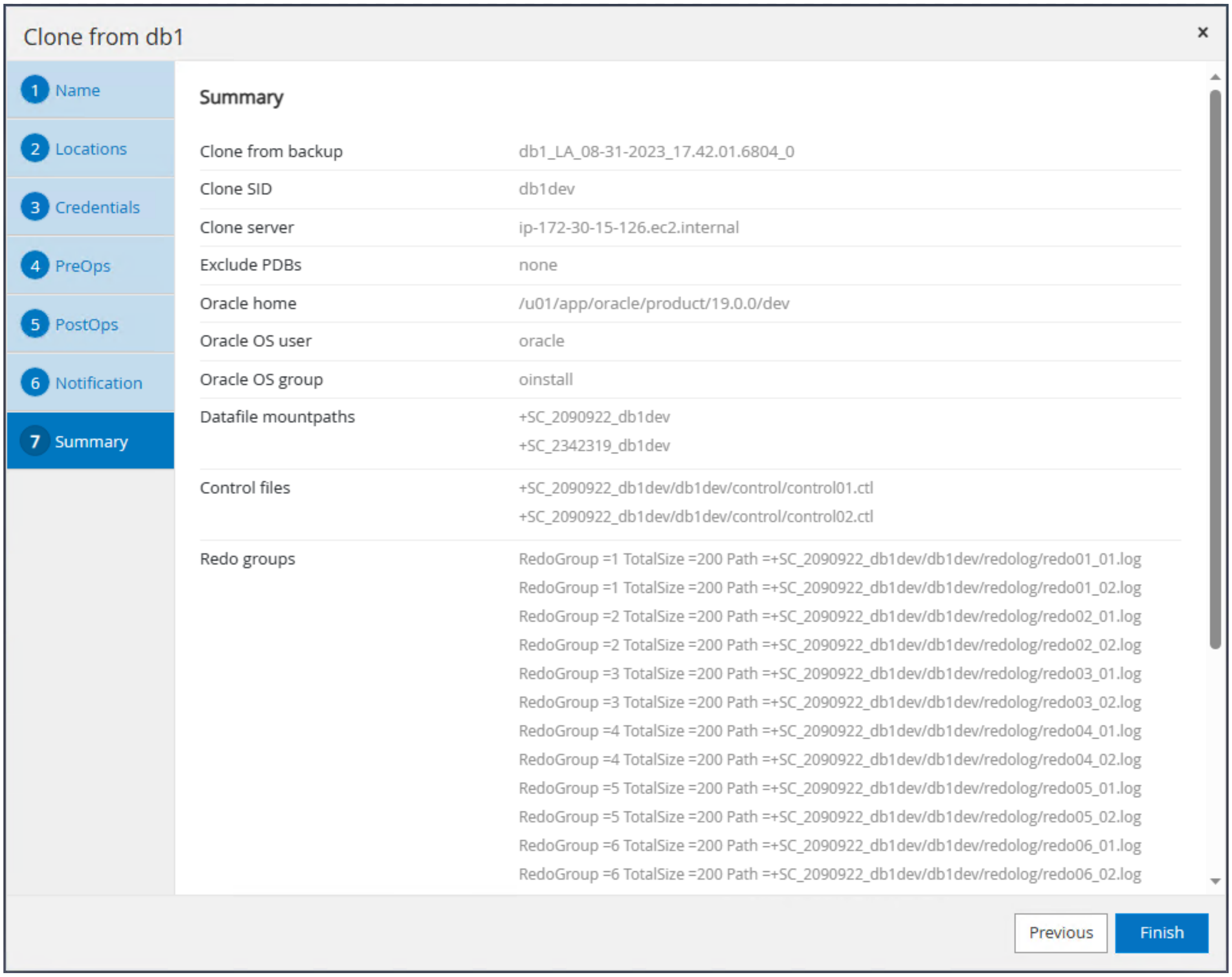
From: From email

To: Email to

Subject: Notification

☐ Attach job report

14. Review the summary, click `Finish` to start the clone.

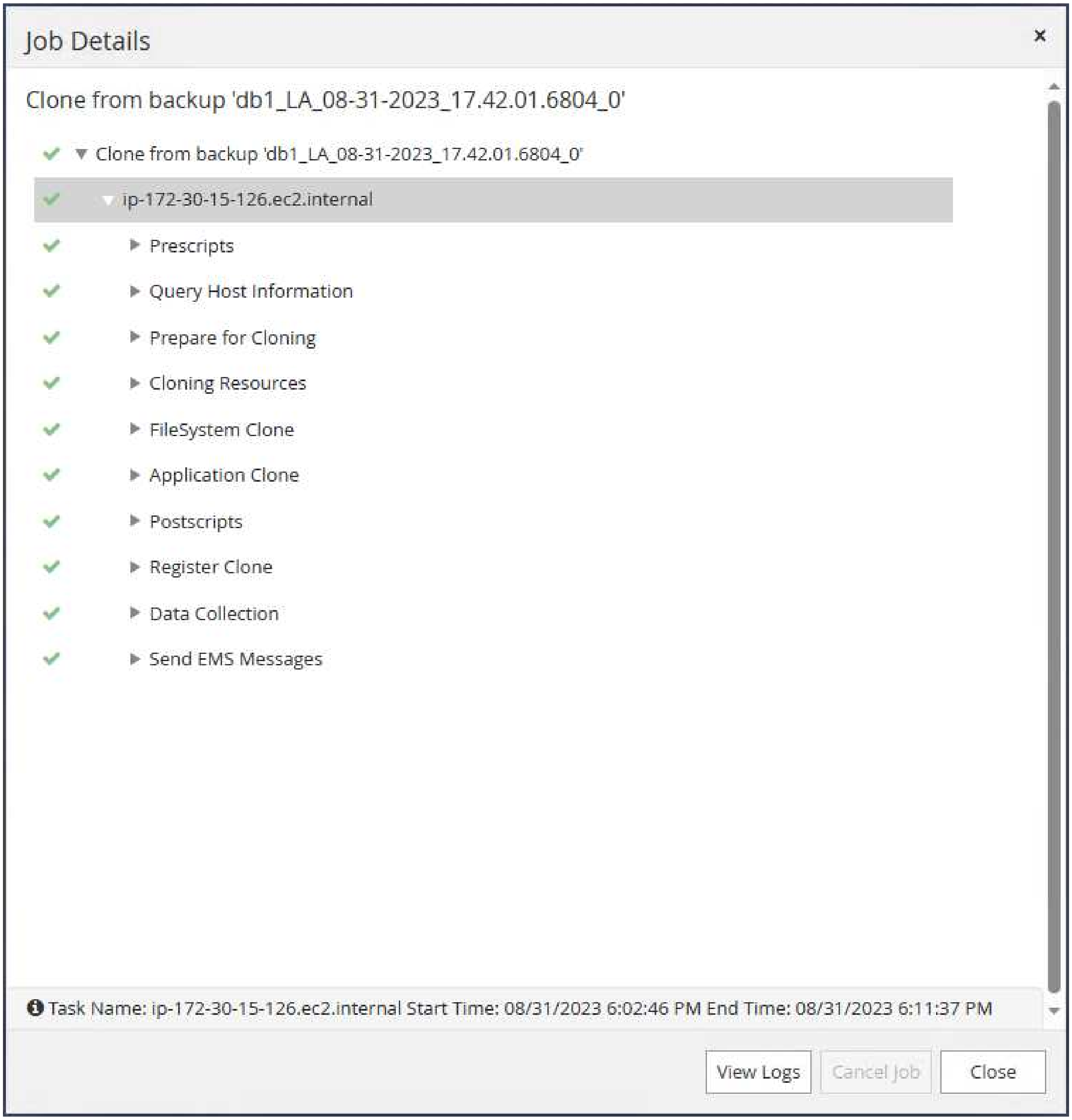


Summary

Clone from backup	db1_LA_08-31-2023_17.42.01.6804_0
Clone SID	db1dev
Clone server	ip-172-30-15-126.ec2.internal
Exclude PDBs	none
Oracle home	/u01/app/oracle/product/19.0.0/dev
Oracle OS user	oracle
Oracle OS group	oinstall
Datafile mountpaths	+SC_2090922_db1dev +SC_2342319_db1dev
Control files	+SC_2090922_db1dev/db1dev/control/control01.ctl +SC_2090922_db1dev/db1dev/control/control02.ctl

Redo groups	RedoGroup =1 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo01_01.log
	RedoGroup =1 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo01_02.log
	RedoGroup =2 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo02_01.log
	RedoGroup =2 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo02_02.log
	RedoGroup =3 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo03_01.log
	RedoGroup =3 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo03_02.log
	RedoGroup =4 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo04_01.log
	RedoGroup =4 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo04_02.log
	RedoGroup =5 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo05_01.log
	RedoGroup =5 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo05_02.log
	RedoGroup =6 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo06_01.log
	RedoGroup =6 TotalSize =200 Path =+SC_2090922_db1dev/db1dev/redolog/redo06_02.log

15. Monitor clone job in `Monitor` tab. We observed that it took around 8 minutes to clone a database about 300GB in database volume size.

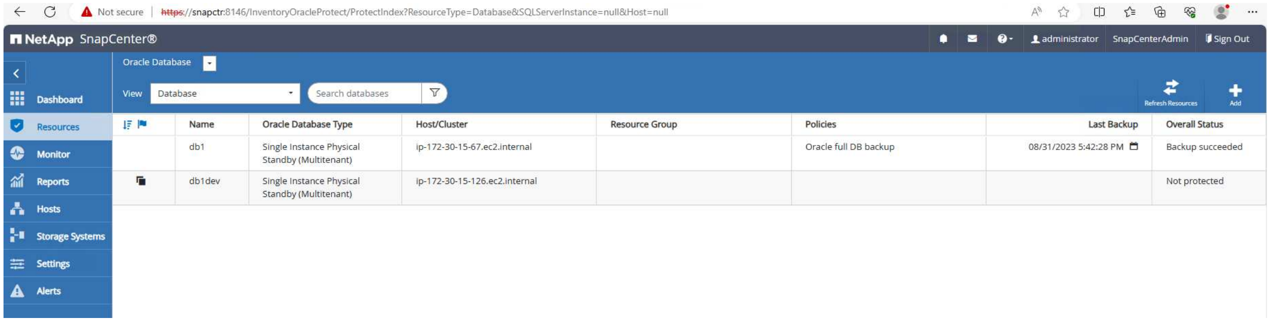


Clone from backup 'db1_LA_08-31-2023_17.42.01.6804_0'

- ✓ Clone from backup 'db1_LA_08-31-2023_17.42.01.6804_0'
  - ✓ ip-172-30-15-126.ec2.internal
    - ✓ Prescripts
    - ✓ Query Host Information
    - ✓ Prepare for Cloning
    - ✓ Cloning Resources
    - ✓ FileSystem Clone
    - ✓ Application Clone
    - ✓ Postscripts
    - ✓ Register Clone
    - ✓ Data Collection
    - ✓ Send EMS Messages

Task Name: ip-172-30-15-126.ec2.internal Start Time: 08/31/2023 6:02:46 PM End Time: 08/31/2023 6:11:37 PM

16. Validate the clone database from SnapCenter, which is immediately registered in `Resources` tab right after clone operation.



	Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
	db1	Single Instance Physical Standby (Multitenant)	ip-172-30-15-67.ec2.internal		Oracle full DB backup	08/31/2023 5:42:28 PM	Backup succeeded
	db1dev	Single Instance Physical Standby (Multitenant)	ip-172-30-15-126.ec2.internal				Not protected

17. Query the clone database from clone EC2 instance. We validated that test transaction that occurred in primary database had traversed down to clone database.

```
[oracle@ip-172-30-15-126 ~]$ export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/dev
[oracle@ip-172-30-15-126 ~]$ export ORACLE_SID=db1dev
[oracle@ip-172-30-15-126 ~]$ export PATH=$PATH:$ORACLE_HOME/bin
[oracle@ip-172-30-15-126 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Wed Sep 6 16:41:41 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, log_mode from v$database;

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
DB1DEV    READ WRITE           NOARCHIVELOG

SQL> select instance_name, host_name from v$instance;

INSTANCE_NAME
----------------
HOST_NAME
----------------------------------------------------------------
db1dev
ip-172-30-15-126.ec2.internal

SQL> alter session set container=db1_pdb1;

Session altered.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
```

```
         1
31-AUG-23 04.49.29.000000 PM
a test transaction on primary database db1 and ec2 db host: ip-172-
30-15-45.ec2.
internal


SQL>
```

This completes the clone and validation of a new Oracle database from standby database in Data Guard on FSx storage for DEV, TEST, REPORT or any other use cases. Multiple Oracle databases can be cloned off the same standby database in Data Guard.

Where to find additional information

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

- Data Guard Concepts and Administration

  https://docs.oracle.com/en/database/oracle/oracle-database/19/sbydb/index.html#Oracle%C2%AE-Data-Guard

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

  Introduction

- Amazon FSx for NetApp ONTAP

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

- Amazon EC2

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

TR-4973: Quick Recovery and Clone of Oracle VLDB with Incremental Merge on AWS FSx ONTAP

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for quick recovery and clone of Oracle VLDB deployed to AWS EC2 compute instance with NFS mount on FSx ONTAP to staging a standby data file copy to be incrementally merged constantly via RMAN.

Purpose

Recovering a Very Large Database (VLDB) in Oracle using the Oracle Recovery Manager (RMAN) backup tool can be a highly challenging task. The database restoration process from backup media in the event of a failure can be time-consuming, delaying the database recovery and potentially impacting your Service Level

Agreement (SLA) significantly. However, starting from version 10g, Oracle introduced a RMAN feature that allows users to create staged image copies of the Oracle database data files on additional disk storage located on the DB server host. These image copies can be incrementally updated using RMAN on a daily basis. In the case of a failure, the Database Administrator (DBA) can swiftly switch the Oracle database from the failed media to the image copy, eliminating the need for a complete database media restore. The result is a greatly improved SLA, albeit at the cost of doubling the required database storage.

If you are keen on SLA for your VLDB and contemplating moving the Oracle database to a public cloud such as AWS, you could set up a similar database protection structure using resources such as AWS FSx ONTAP for staging your standby database image copy. In this documentation, we demonstrate how to provision and export an NFS file system from AWS FSx ONTAP to be mounted on an Oracle database server for staging a standby database copy for quick recovery in the event of a primary storage failure.

Better yet, we also show how you could leverage NetApp FlexClone to create a copy of the same staging NFS file system for other use cases such as standing up a dev/test Oracle environment with this same standby database image copy without additional storage investment.

This solution addresses the following use cases:

- An Oracle VLDB image copy incremental merge via RMAN on NFS mount point off AWS FSx ONTAP storage.
- Quick recovery of an Oracle VLDB by switching to database image copy on FSx ONTAP storage in the event of failure.
- Clone FSx ONTAP NFS file system volume storing an Oracle VLDB image copy to be used for standing up another database instance for other use cases.

Audience

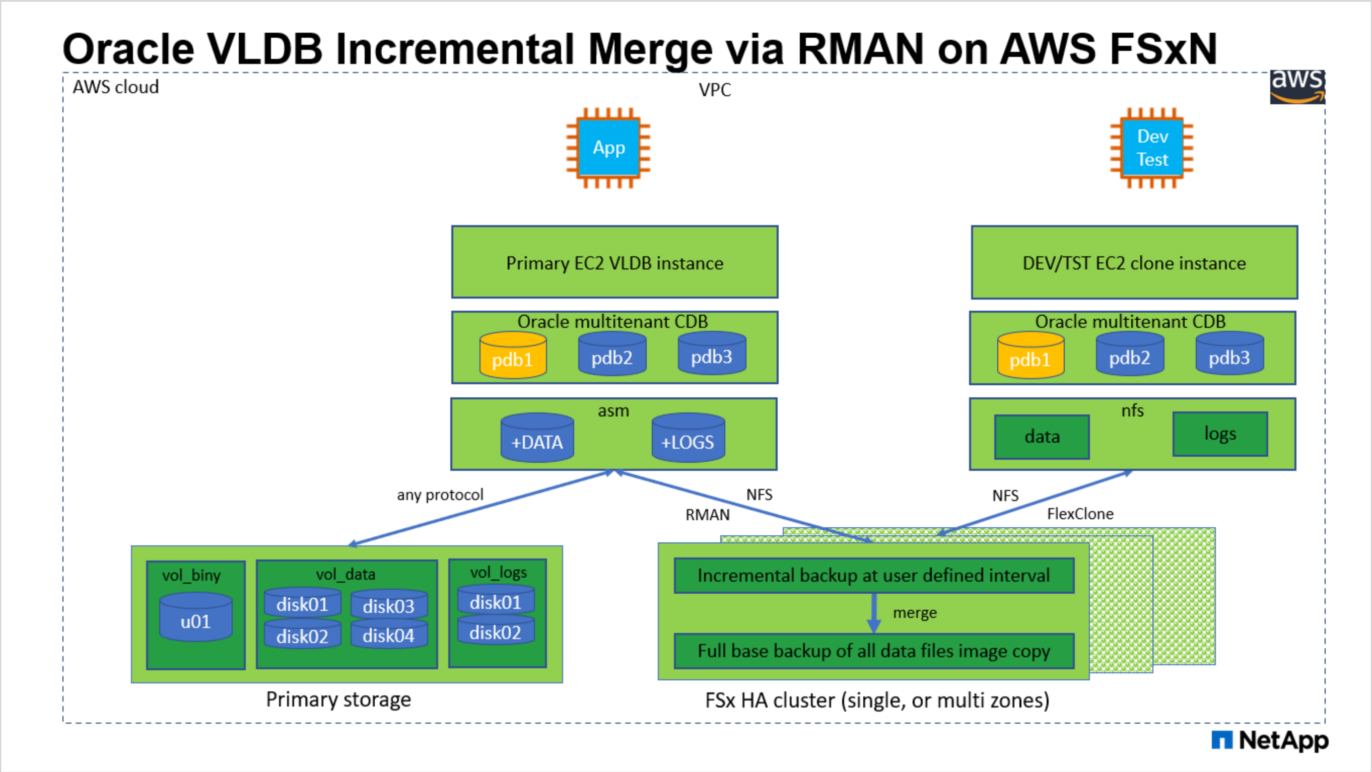
This solution is intended for the following people:

- A DBA who set up Oracle VLDB image copy incremental merge via RMAN in AWS for faster database recovery.
- A database solution architect who tests Oracle workloads in the AWS public cloud.
- A storage administrator who manages Oracle databases deployed to AWS FSx ONTAP storage.
- An application owner who would like to stand up Oracle databases in AWS FSx/EC2 environment.

Solution test and validation environment

The testing and validation of this solution was performed in an AWS FSx ONTAP and EC2 environment that might not match the final deployment environment. For more information, see the section Key factors for deployment consideration.

Architecture


Oracle VLDB Incremental Merge via RMAN on AWS FSxN
AWS cloud
VPC
aws
App
Dev Test
Primary EC2 VLDB instance
DEV/TST EC2 clone instance
Oracle multitenant CDB
pdb1
pdb2
pdb3
asm
+DATA
+LOGS
nfs
data
logs
any protocol
NFS
RMAN
NFS
FlexClone
vol_biny
u01
vol_data
disk01
disk03
disk02
disk04
vol_logs
disk01
disk02
Incremental backup at user defined interval
merge
Full base backup of all data files image copy
Primary storage
FSx HA cluster (single, or multi zones)
NetApp

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

Key factors for deployment consideration

- **Oracle VLDB storage layout for RMAN incremental merge.** In our tests and validations, the NFS volume for Oracle incremental backup and merge is allocated from a single FSx file system, which has 4GBps throughput, 160,000 raw SSD IOPS, and 192TiB capacity limit. For deployment over the thresholds, multiple FSx file systems can be concatenated in parallel with multiple NFS mount points to provide higher capacity.

- **Oracle recoverability using RMAN incremental merge.** The RMAN incremental backup and merge is generally executed at user defined frequency based on your RTO and RPO objectives. If there are total loss of primary data storage and/or archived logs, the data loss can occur. The Oracle database can be recovered up to last incremental backup that is available from FSx database backup image copy. To minimize the data loss, Oracle flash recovery area can be setup on FSx NFS mount point and archived logs are backed up to FSx NFS mount along with database image copy.
- **Running Oracle VLDB off FSx NFS file system.** Unlike other bulk storage for database backup, AWS FSx ONTAP is a cloud enabled production grade storage that delivers high level of performance and storage efficiency. Once Oracle VLDB switches over from primary storage to image copy on FSx ONTAP NFS file system, database performance can be maintained at high level while the primary storage failure is addressed. You can take comfort to know that user application experience does not suffer as the result of primary storage failure.
- **FlexClone Oracle VLDB image copy of NFS volume for other use cases.** AWS FSx ONTAP FlexClone provides shared copies of the same NFS data volume that are writable. Thus, they can be used for many other use cases while still maintaining the integrity of staging Oracle VLDB image copy even when Oracle database is switched over. This provides tremendous storage cost saving by substantially reducing VLDB storage footprint. NetApp recommends to minimize FlexClone activities in the event of database switching over from primary storage to database image copy in order to maintain Oracle performance at high level.
- **EC2 compute instances.** In these tests and validations, we used an AWS EC2 t2.xlarge instance as 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 workload. You need to size the EC2 instance appropriately for the number of vCPUs and the amount of RAM based on actual workload requirements.
- **FSx storage HA clusters single- or multi-zone deployment.** In these tests and validations, we deployed an FSx HA cluster in a single AWS availability zone. For production deployment, NetApp recommends deploying an FSx HA pair in two different availability zones. An FSx HA cluster is alway provisioned in a HA pair that is sync mirrored in a pair of active-passive file systems to provide storage-level redundancy. Multi-zone deployment further enhances high availability in the event of failure in a single AWS zone.
- **FSx storage cluster sizing.** An Amazon FSx for ONTAP storage file system provides up to 160,000 raw SSD IOPS, up to 4GBps throughput, and a maximum of 192TiB capacity. However, you can size the cluster in terms of provisioned IOPS, throughput, and the storage limit (minimum 1,024 GiB) based on your actually requirements at the time of deployment. The capacity can be adjusted dynamically on the fly without affecting application availability.
- **dNFS configuration.** dNFS is built into Oracle kernel and is known to dramatically increase Oracle database performance when Oracle is deployed to NFS storage. dNFS is packaged into Oracle binary but is not turned on by default. It should be turned on for any Oracle database deployment on NFS. For multiple FSx file systems deployment for a VLDB, dNFS multi-path to different FSx NFS file systems should be properly configured.

Solution deployment

It is assumed that you already have your Oracle VLDB deployed in AWS EC2 environment within a VPC. If you need help on Oracle deployment in AWS, please refer to following technical reports for help.

- Oracle Database Deployment on EC2 and FSx Best Practices
- Oracle Database Deployment and Protection in AWS FSx/EC2 with iSCSI/ASM
- Oracle 19c in Standalone Restart on AWS FSx/EC2 with NFS/ASM

Your Oracle VLDB can be running either on a FSx ONTAP or any other storage of choices within the AWS EC2 ecosystem. The following section provides step-by-step deployment procedures for setting up RMAN incremental merge to an image copy of an Oracle VLDB that is staging in an NFS mount off AWS FSx ONTAP storage.

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 NFS volumes that stores the Oracle database standby image copy. 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. The template can be easily revised for your own deployment requirements.

   ```
   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.

Provision and export NFS volume to be mounted to EC2 DB instance host

In this demonstration, we will show how to provision an NFS volume from the command line by login to an FSx cluster via ssh as fsxadmin user through FSx cluster management IP. Alternatively, the volume can be allocated using the AWS FSx console as well. Repeat the procedures on other FSx file systems if more than one FSx file system are set up to accommodate the size of the database.

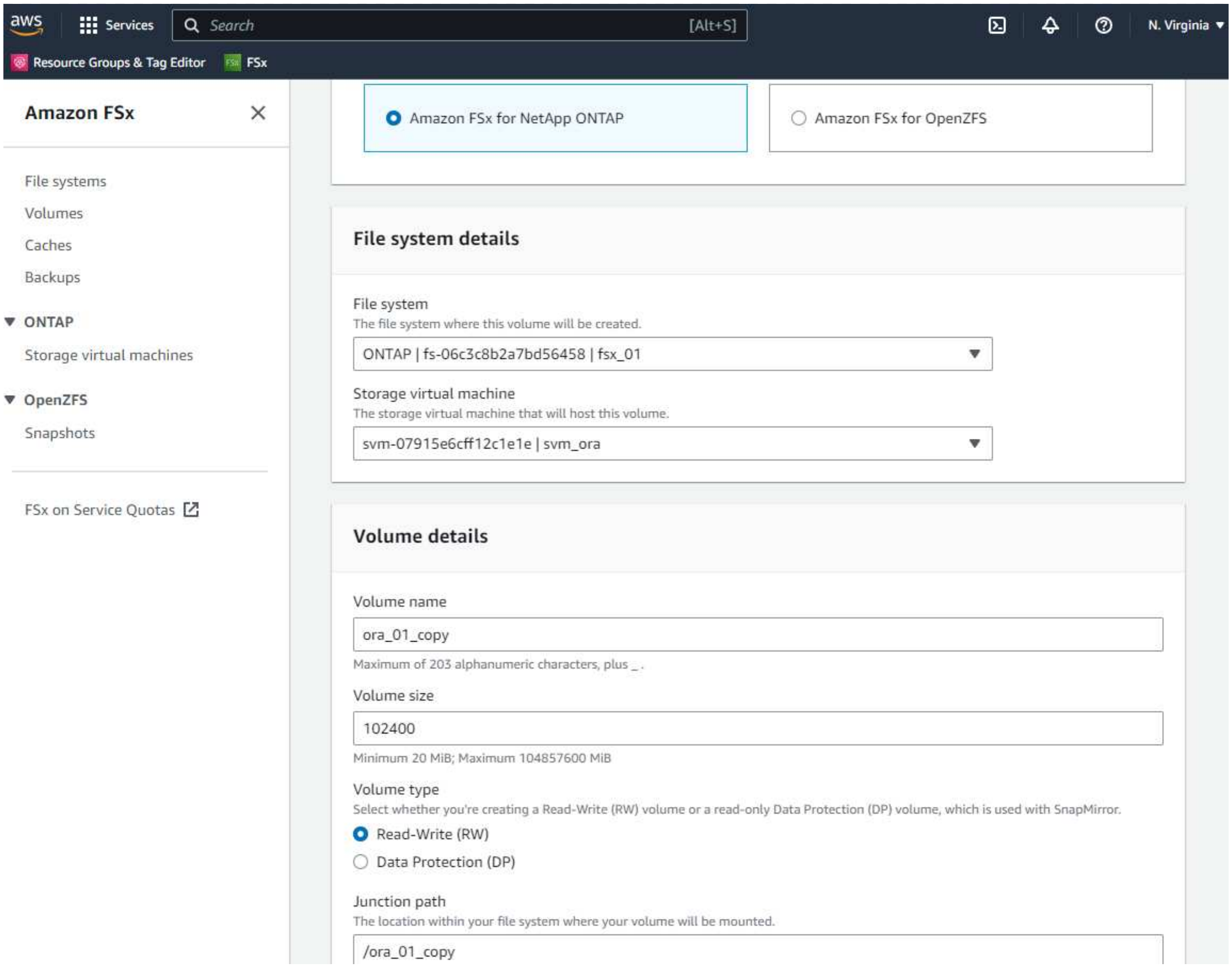
1. First, provision NFS volume via CLI by logging to the FSx cluster through SSH as the fsxadmin user. Change to your FSx cluster management IP address, which can be retrieved from AWS FSx ONTAP UI console.

   ```
   ssh fsxadmin@172.30.15.53
   ```

2. Create NFS volume the same size as your primary storage for storing primary Oracle VLDB database data files image copy.

   ```
   vol create -volume ora_01_copy -aggregate aggr1 -size 100G -state
   online -type RW -junction-path /ora_01_copy -snapshot-policy none
   -tiering-policy snapshot-only
   ```

3. Alternatively, the volume can be provisioned from AWS FSx console UI with options: storage efficiency `Enabled`, security style `Unix` , Snapshot policy `None`, and Storage tiering `Snapshot Only` as show below.



● Amazon FSx for NetApp ONTAP
○ Amazon FSx for OpenZFS

File system details

File system
The file system where this volume will be created.
ONTAP | fs-06c3c8b2a7bd56458 | fsx_01

Storage virtual machine
The storage virtual machine that will host this volume.
svm-07915e6cff12c1e1e | svm_ora

Volume details

Volume name
ora_01_copy
Maximum of 203 alphanumeric characters, plus _ .

Volume size
102400
Minimum 20 MiB; Maximum 104857600 MiB

Volume type
Select whether you're creating a Read-Write (RW) volume or a read-only Data Protection (DP) volume, which is used with SnapMirror.
● Read-Write (RW)
○ Data Protection (DP)

Junction path
The location within your file system where your volume will be mounted.
/ora_01_copy

4. Create a customized snapshot policy for oracle database with a daily schedule and 30 days retention. You should adjust the policy to fit your specific needs in terms of snapshot frequency and retention window.

   ```
   snapshot policy create -policy oracle -enabled true -schedule1 daily
   -count1 30
   ```

   Apply policy to provisioned NFS volume for RMAN incremental backup and merge.

   ```
   vol modify -volume ora_01_copy -snapshot-policy oracle
   ```

5. Login to EC2 instance as ec2-user and create a directory /nfsfsxn. Create additional mount point directories for additional FSx file systems.

   ```
   sudo mkdir /nfsfsxn
   ```

6. Mount the FSx ONTAP NFS volume to EC2 DB instance host. Change to your FSx virtual server NFS lif address. The NFS lif address can be retrieved from FSx ONTAP UI console.

```
sudo mount 172.30.15.19:/ora_01_copy /nfsfsxn -o
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
tr
```

7. Change mount point ownership to oracle:oisntall, change to your oracle user name and primary group as necessary.

```
sudo chown oracle:oinstall /nfsfsxn
```

Setup Oracle RMAN incremental merge to image copy on FSx

RMAN incremental merge update the staging database data files image copy continuously at every incremental backup/merge interval. The image copy of database backup will be as up to date as the frequency you execute the incremental backup/merge. So, take into consideration of database performance, your RTO and RPO objectives when deciding the frequency of RMAN incremental backup and merge.

1. Login to primary DB server EC2 instance as oracle user
2. Create an oracopy directory under mount point /nfsfsxn to store oracle data files image copies and archlog directory for Oracle flash recovery area.

   ```
   mkdir /nfsfsxn/oracopy
   ```

   ```
   mkdir /nfsfsxn/archlog
   ```

3. Login to Oracle database via sqlplus, enable block change tracking for faster incremental backup and change Oracle flash recovery area to FSxN mount if it is currently on primary storage. This allows the RMAN default control file/spfile autobackup and archived logs to be backed up to FSxN NFS mount for recovery.

   ```
   sqlplus / as sysdba
   ```

   From sqlplus prompt, execute following command.

   ```
   alter database enable block change tracking using file
   '/nfsfsxn/oracopy/bct_db1.ctf'
   ```

   ```
   alter system set db_recovery_file_dest='/nfsfsxn/archlog/'
   scope=both;
   ```

4. Create a RMAN backup and incremental merge script. The script allocates multiple channels for parallel RMAN backup and merge. First execution would generate the initial full baseline image copy. In a complete run, it first purges obsolete backups that are outside of retention window to keep staging area clean. It then switches current log file before merge and backup. The incremental backup follows the merge so that the database image copy is trailing current database state by one backup/merge cycle. The merge and backup order can be reversed for quicker recovery at user’s preference. The RMAN script can be integrated into a simple shell script to be executed from crontab on the primary DB server. Ensure control file autobackup is on in RMAN setting.

```
vi /home/oracle/rman_bkup_merge.cmd

Add following lines:

RUN
{
  allocate channel c1 device type disk format '/nfsfsxn/oracopy/%U';
  allocate channel c2 device type disk format '/nfsfsxn/oracopy/%U';
  allocate channel c3 device type disk format '/nfsfsxn/oracopy/%U';
  allocate channel c4 device type disk format '/nfsfsxn/oracopy/%U';
  delete obsolete;
  sql 'alter system archive log current';
  recover copy of database with tag 'OraCopyBKUPonFSxN_level_0';
  backup incremental level 1 copies=1 for recover of copy with tag
'OraCopyBKUPonFSxN_level_0' database;
}
```

5. At EC2 DB server, login to RMAN locally as oracle user with or without RMAN catalog. In this demonstration, we are not connecting to a RMAN catalog.

```
rman target / nocatalog;

output:

[oracle@ip-172-30-15-99 ~]$ rman target / nocatalog;

Recovery Manager: Release 19.0.0.0.0 - Production on Wed May 24
17:44:49 2023
Version 19.18.0.0.0

Copyright (c) 1982, 2019, Oracle and/or its affiliates.  All rights
reserved.

connected to target database: DB1 (DBID=1730530050)
using target database control file instead of recovery catalog

RMAN>
```

6. From RMAN prompt, execute the script. First execution creates a baseline database image copy and subsequent executions merge and update the baseline image copy incrementally. The following is how to execute the script and the typical output. Set the number of channels to match the CPU cores on the host.

```
RMAN> @/home/oracle/rman_bkup_merge.cmd
RMAN> RUN
2> {
3>   allocate channel c1 device type disk format
'/nfsfsxn/oracopy/%U';
4>   allocate channel c2 device type disk format
'/nfsfsxn/oracopy/%U';
5>   allocate channel c3 device type disk format
'/nfsfsxn/oracopy/%U';
6>   allocate channel c4 device type disk format
'/nfsfsxn/oracopy/%U';
7>   delete obsolete;
8>   sql 'alter system archive log current';
9>   recover copy of database with tag 'OraCopyBKUPonFSxN_level_0';
10>  backup incremental level 1 copies=1 for recover of copy with
tag 'OraCopyBKUPonFSxN_level_0' database;
11> }

allocated channel: c1
channel c1: SID=411 device type=DISK

allocated channel: c2
channel c2: SID=146 device type=DISK

allocated channel: c3
channel c3: SID=402 device type=DISK

allocated channel: c4
channel c4: SID=37 device type=DISK

Starting recover at 17-MAY-23
no copy of datafile 1 found to recover
no copy of datafile 3 found to recover
no copy of datafile 4 found to recover
no copy of datafile 5 found to recover
no copy of datafile 6 found to recover
no copy of datafile 7 found to recover
.
.
Finished recover at 17-MAY-23

Starting backup at 17-MAY-23
channel c1: starting incremental level 1 datafile backup set
channel c1: specifying datafile(s) in backup set
input datafile file number=00022
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.287.113
7018311
```

```
input datafile file number=00026
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.291.113
7018481
input datafile file number=00030
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.295.113
7018787
input datafile file number=00011
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/undotbs1.27
1.1136668041
input datafile file number=00035
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.300.113
7019181
channel c1: starting piece 1 at 17-MAY-23
channel c2: starting incremental level 1 datafile backup set
channel c2: specifying datafile(s) in backup set
input datafile file number=00023
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.288.113
7018359
input datafile file number=00027
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.292.113
7018523
input datafile file number=00031
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.296.113
7018837
input datafile file number=00009
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/system.272.
1136668041
input datafile file number=00034
name=+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.299.113
7019117
.
.
Finished backup at 17-MAY-23

Starting Control File and SPFILE Autobackup at 17-MAY-23
piece
handle=+LOGS/DB1/AUTOBACKUP/2023_05_17/s_1137095435.367.1137095435
comment=NONE
Finished Control File and SPFILE Autobackup at 17-MAY-23
released channel: c1
released channel: c2
released channel: c3
released channel: c4
```

```
RMAN> **end-of-file**
```

7. List database image copy after backup to observe that a database image copy has been created in FSx ONTAP NFS mount point.

```
RMAN> list copy of database tag 'OraCopyBKUPonFSxN_level_0';

List of Datafile Copies
=======================

Key     File S Completion Time Ckp SCN    Ckp Time        Sparse
------- ---- - --------------- ---------- --------------- ------
19      1    A 17-MAY-23       3009819    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-1_0h1sd7ae
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

20      3    A 17-MAY-23       3009826    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-3_0i1sd7at
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

21      4    A 17-MAY-23       3009830    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-4_0j1sd7b4
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

27      5    A 17-MAY-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-5_0p1sd7cf
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

26      6    A 17-MAY-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-6_0o1sd7c8
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

34      7    A 17-MAY-23       3009907    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
7_101sd7dl
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

33      8    A 17-MAY-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-8_0v1sd7di
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

28      9    A 17-MAY-23       3009871    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-9_0q1sd7cm
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

22      10   A 17-MAY-23       3009849    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-10_0k1sd7bb
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

25      11   A 17-MAY-23       3009862    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-11_0n1sd7c1
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

35      12   A 17-MAY-23       3009909    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
12_111sd7dm
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

29      13   A 17-MAY-23       3009876    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-13_0r1sd7ct
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

23      14   A 17-MAY-23       3009854    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-14_0l1sd7bi
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

31      15   A 17-MAY-23       3009900    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-15_0t1sd7db
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

36      16   A 17-MAY-23       3009911    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
```

```
16_121sd7dn
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

30      17   A 17-MAY-23       3009895    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-17_0s1sd7d4
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

24      18   A 17-MAY-23       3009858    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-18_0m1sd7bq
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

32      19   A 17-MAY-23       3009903    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-19_0u1sd7de
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

37      20   A 17-MAY-23       3009914    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
20_131sd7do
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

4       21   A 17-MAY-23       3009019    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
21_021sd6pv
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

5       22   A 17-MAY-23       3009419    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
22_031sd6r2
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

6       23   A 17-MAY-23       3009460    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
23_041sd6s5
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1
```

```
7       24   A 17-MAY-23       3009473    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
24_051sd6t9
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

8       25   A 17-MAY-23       3009502    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
25_061sd6uc
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

9       26   A 17-MAY-23       3009548    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
26_071sd6vf
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

10      27   A 17-MAY-23       3009576    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
27_081sd70i
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

11      28   A 17-MAY-23       3009590    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
28_091sd71l
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

12      29   A 17-MAY-23       3009619    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
29_0a1sd72o
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

13      30   A 17-MAY-23       3009648    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
30_0b1sd73r
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

14      31   A 17-MAY-23       3009671    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
31_0c1sd74u
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

15      32   A 17-MAY-23       3009729    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
32_0d1sd762
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

16      33   A 17-MAY-23       3009743    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
33_0e1sd775
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

17      34   A 17-MAY-23       3009771    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
34_0f1sd788
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

18      35   A 17-MAY-23       3009805    17-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
35_0g1sd79b
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1


RMAN>
```

8. Report schema from Oracle RMAN command prompt to observe that current active database data files are in primary storage ASM +DATA disk group.

```
RMAN> report schema;

Report of database schema for database with db_unique_name DB1

List of Permanent Datafiles
===========================
File Size(MB) Tablespace           RB segs Datafile Name
---- -------- -------------------- ------- ------------------------
1    1060     SYSTEM               YES
+DATA/DB1/DATAFILE/system.257.1136666315
3    810      SYSAUX               NO
+DATA/DB1/DATAFILE/sysaux.258.1136666361
4    675      UNDOTBS1             YES
+DATA/DB1/DATAFILE/undotbs1.259.1136666385
```

```
5    400      PDB$SEED:SYSTEM      NO
+DATA/DB1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/system.266.11366
67165
6    460      PDB$SEED:SYSAUX      NO
+DATA/DB1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/sysaux.267.11366
67165
7    5        USERS                NO
+DATA/DB1/DATAFILE/users.260.1136666387
8    230      PDB$SEED:UNDOTBS1    NO
+DATA/DB1/86B637B62FE07A65E053F706E80A27CA/DATAFILE/undotbs1.268.113
6667165
9    400      DB1_PDB1:SYSTEM      YES
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/system.272.11366
68041
10   490      DB1_PDB1:SYSAUX      NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/sysaux.273.11366
68041
11   465      DB1_PDB1:UNDOTBS1    YES
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/undotbs1.271.113
6668041
12   5        DB1_PDB1:USERS       NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/users.275.113666
8057
13   400      DB1_PDB2:SYSTEM      YES
+DATA/DB1/FB867EA89ECF81C0E053630F1EACB901/DATAFILE/system.277.11366
68057
14   470      DB1_PDB2:SYSAUX      NO
+DATA/DB1/FB867EA89ECF81C0E053630F1EACB901/DATAFILE/sysaux.278.11366
68057
15   235      DB1_PDB2:UNDOTBS1    YES
+DATA/DB1/FB867EA89ECF81C0E053630F1EACB901/DATAFILE/undotbs1.276.113
6668057
16   5        DB1_PDB2:USERS       NO
+DATA/DB1/FB867EA89ECF81C0E053630F1EACB901/DATAFILE/users.280.113666
8071
17   400      DB1_PDB3:SYSTEM      YES
+DATA/DB1/FB867F8A4D4F821CE053630F1EAC69CC/DATAFILE/system.282.11366
68073
18   470      DB1_PDB3:SYSAUX      NO
+DATA/DB1/FB867F8A4D4F821CE053630F1EAC69CC/DATAFILE/sysaux.283.11366
68073
19   235      DB1_PDB3:UNDOTBS1    YES
+DATA/DB1/FB867F8A4D4F821CE053630F1EAC69CC/DATAFILE/undotbs1.281.113
6668073
20   5        DB1_PDB3:USERS       NO
+DATA/DB1/FB867F8A4D4F821CE053630F1EAC69CC/DATAFILE/users.285.113666
```

```
8087
21   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.286.11370182
39
22   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.287.11370183
11
23   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.288.11370183
59
24   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.289.11370184
05
25   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.290.11370184
43
26   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.291.11370184
81
27   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.292.11370185
23
28   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.293.11370187
07
29   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.294.11370187
45
30   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.295.11370187
87
31   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.296.11370188
37
32   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.297.11370189
35
33   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.298.11370190
77
34   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.299.11370191
17
35   4096     DB1_PDB1:SOE          NO
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/DATAFILE/soe.300.11370191
81
```

```
List of Temporary Files
=======================
File Size(MB) Tablespace           Maxsize(MB) Tempfile Name
---- -------- -------------------- ----------- --------------------
1    123      TEMP                 32767
+DATA/DB1/TEMPFILE/temp.265.1136666447
2    123      PDB$SEED:TEMP        32767
+DATA/DB1/FB864A929AEB79B9E053630F1EAC7046/TEMPFILE/temp.269.1136667
185
3    10240    DB1_PDB1:TEMP        32767
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/TEMPFILE/temp.274.1136668
051
4    123      DB1_PDB2:TEMP        32767
+DATA/DB1/FB867EA89ECF81C0E053630F1EACB901/TEMPFILE/temp.279.1136668
067
5    123      DB1_PDB3:TEMP        32767
+DATA/DB1/FB867F8A4D4F821CE053630F1EAC69CC/TEMPFILE/temp.284.1136668
081

RMAN>
```

9. Validate database image copy from OS NFS mount point.

```
[oracle@ip-172-30-15-99 ~]$ ls -l /nfsfsxn/oracopy/
total 70585148
-rw-r----- 1 oracle asm 4294975488 May 17 18:09 data_D-DB1_I-
1730530050_TS-SOE_FNO-21_021sd6pv
-rw-r----- 1 oracle asm 4294975488 May 17 18:10 data_D-DB1_I-
1730530050_TS-SOE_FNO-22_031sd6r2
-rw-r----- 1 oracle asm 4294975488 May 17 18:10 data_D-DB1_I-
1730530050_TS-SOE_FNO-23_041sd6s5
-rw-r----- 1 oracle asm 4294975488 May 17 18:11 data_D-DB1_I-
1730530050_TS-SOE_FNO-24_051sd6t9
-rw-r----- 1 oracle asm 4294975488 May 17 18:11 data_D-DB1_I-
1730530050_TS-SOE_FNO-25_061sd6uc
-rw-r----- 1 oracle asm 4294975488 May 17 18:12 data_D-DB1_I-
1730530050_TS-SOE_FNO-26_071sd6vf
-rw-r----- 1 oracle asm 4294975488 May 17 18:13 data_D-DB1_I-
1730530050_TS-SOE_FNO-27_081sd70i
-rw-r----- 1 oracle asm 4294975488 May 17 18:13 data_D-DB1_I-
1730530050_TS-SOE_FNO-28_091sd71l
-rw-r----- 1 oracle asm 4294975488 May 17 18:14 data_D-DB1_I-
1730530050_TS-SOE_FNO-29_0a1sd72o
-rw-r----- 1 oracle asm 4294975488 May 17 18:14 data_D-DB1_I-
```

```
1730530050_TS-SOE_FNO-30_0b1sd73r
-rw-r----- 1 oracle asm 4294975488 May 17 18:15 data_D-DB1_I-
1730530050_TS-SOE_FNO-31_0c1sd74u
-rw-r----- 1 oracle asm 4294975488 May 17 18:16 data_D-DB1_I-
1730530050_TS-SOE_FNO-32_0d1sd762
-rw-r----- 1 oracle asm 4294975488 May 17 18:16 data_D-DB1_I-
1730530050_TS-SOE_FNO-33_0e1sd775
-rw-r----- 1 oracle asm 4294975488 May 17 18:17 data_D-DB1_I-
1730530050_TS-SOE_FNO-34_0f1sd788
-rw-r----- 1 oracle asm 4294975488 May 17 18:17 data_D-DB1_I-
1730530050_TS-SOE_FNO-35_0g1sd79b
-rw-r----- 1 oracle asm  513810432 May 17 18:18 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-10_0k1sd7bb
-rw-r----- 1 oracle asm  492838912 May 17 18:18 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-14_0l1sd7bi
-rw-r----- 1 oracle asm  492838912 May 17 18:18 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-18_0m1sd7bq
-rw-r----- 1 oracle asm  849354752 May 17 18:18 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-3_0i1sd7at
-rw-r----- 1 oracle asm  482353152 May 17 18:18 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-6_0o1sd7c8
-rw-r----- 1 oracle asm 1111498752 May 17 18:18 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-1_0h1sd7ae
-rw-r----- 1 oracle asm  419438592 May 17 18:19 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-13_0r1sd7ct
-rw-r----- 1 oracle asm  419438592 May 17 18:19 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-17_0s1sd7d4
-rw-r----- 1 oracle asm  419438592 May 17 18:19 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-5_0p1sd7cf
-rw-r----- 1 oracle asm  419438592 May 17 18:19 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-9_0q1sd7cm
-rw-r----- 1 oracle asm  487596032 May 17 18:18 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-11_0n1sd7c1
-rw-r----- 1 oracle asm  246423552 May 17 18:19 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-15_0t1sd7db
-rw-r----- 1 oracle asm  246423552 May 17 18:19 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-19_0u1sd7de
-rw-r----- 1 oracle asm  707796992 May 17 18:18 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-4_0j1sd7b4
-rw-r----- 1 oracle asm  241180672 May 17 18:19 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-8_0v1sd7di
-rw-r----- 1 oracle asm    5251072 May 17 18:19 data_D-DB1_I-
1730530050_TS-USERS_FNO-12_111sd7dm
-rw-r----- 1 oracle asm    5251072 May 17 18:19 data_D-DB1_I-
1730530050_TS-USERS_FNO-16_121sd7dn
-rw-r----- 1 oracle asm    5251072 May 17 18:19 data_D-DB1_I-
```

```
1730530050_TS-USERS_FNO-20_131sd7do
-rw-r----- 1 oracle asm    5251072 May 17 18:19 data_D-DB1_I-
1730530050_TS-USERS_FNO-7_101sd7dl
```

This completes the setup of Oracle database standby image copy backup and merge.

Switch Oracle DB to image copy for quick recovery

In the event of a failure due to primary storage issue such as data loss or corruption, database can be quickly switched over to image copy on FSx ONTAP NFS mount and recovered to current state without database restore. Eliminating media restoration speeds up the database recovery tremendously for a VLDB. This use case assumes that the database host instance is intact and database control file, archived and current logs are all available for recovery.

1. Login to EC2 DB server host as oracle user and create a test table before switch over.

```
[ec2-user@ip-172-30-15-99 ~]$ sudo su
[root@ip-172-30-15-99 ec2-user]# su - oracle
Last login: Thu May 18 14:22:34 UTC 2023
[oracle@ip-172-30-15-99 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Thu May 18 14:30:36
2023
Version 19.18.0.0.0

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Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 -
Production
Version 19.18.0.0.0

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> alter session set container=db1_pdb1;

Session altered.

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

Table created.

SQL> insert into test values(1, sysdate, 'test oracle incremental
merge switch to copy');

1 row created.
```

```
SQL> commit;

Commit complete.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
18-MAY-23 02.35.37.000000 PM
test oracle incremental merge switch to copy


SQL>
```

2. Simulate a failure by shutdown abort database, then start up oracle in mount stage.

```
SQL> shutdown abort;
ORACLE instance shut down.
SQL> startup mount;
ORACLE instance started.

Total System Global Area 1.2885E+10 bytes
Fixed Size                  9177880 bytes
Variable Size            1778384896 bytes
Database Buffers         1.1073E+10 bytes
Redo Buffers               24375296 bytes
Database mounted.
SQL>
```

3. As oracle user, connect to Oracle database via RMAN to switch database to copy.

```
RMAN> switch database to copy;

datafile 1 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-1_0h1sd7ae"
datafile 3 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-3_0i1sd7at"
```

```
datafile 4 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-4_0j1sd7b4"
datafile 5 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-5_0p1sd7cf"
datafile 6 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-6_0o1sd7c8"
datafile 7 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-USERS_FNO-7_101sd7dl"
datafile 8 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-8_0v1sd7di"
datafile 9 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-9_0q1sd7cm"
datafile 10 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-10_0k1sd7bb"
datafile 11 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-11_0n1sd7c1"
datafile 12 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-12_111sd7dm"
datafile 13 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-13_0r1sd7ct"
datafile 14 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-14_0l1sd7bi"
datafile 15 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-15_0t1sd7db"
datafile 16 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-16_121sd7dn"
datafile 17 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-17_0s1sd7d4"
datafile 18 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-18_0m1sd7bq"
datafile 19 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-19_0u1sd7de"
datafile 20 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-20_131sd7do"
datafile 21 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-21_021sd6pv"
datafile 22 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-22_031sd6r2"
datafile 23 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-23_041sd6s5"
datafile 24 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-24_051sd6t9"
datafile 25 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-25_061sd6uc"
datafile 26 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-26_071sd6vf"
```

```
datafile 27 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-27_081sd70i"
datafile 28 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-28_091sd71l"
datafile 29 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-29_0a1sd72o"
datafile 30 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-30_0b1sd73r"
datafile 31 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-31_0c1sd74u"
datafile 32 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-32_0d1sd762"
datafile 33 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-33_0e1sd775"
datafile 34 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-34_0f1sd788"
datafile 35 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-35_0g1sd79b"
```

4. Recover and open database to bring it up to current from last incremental backup.

```
RMAN> recover database;

Starting recover at 18-MAY-23
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=392 device type=DISK
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00009: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-9_0q1sd7cm
destination for restore of datafile 00023: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-23_041sd6s5
destination for restore of datafile 00027: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-27_081sd70i
destination for restore of datafile 00031: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-31_0c1sd74u
destination for restore of datafile 00034: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-34_0f1sd788
channel ORA_DISK_1: reading from backup piece
/nfsfsxn/oracopy/321sfous_98_1_1
channel ORA_DISK_1: piece handle=/nfsfsxn/oracopy/321sfous_98_1_1
tag=ORACOPYBKUPONFSXN_LEVEL_0
channel ORA_DISK_1: restored backup piece 1
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00010: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-10_0k1sd7bb
destination for restore of datafile 00021: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-21_021sd6pv
destination for restore of datafile 00025: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-25_061sd6uc
.
.
.
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00016: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-16_121sd7dn
channel ORA_DISK_1: reading from backup piece
/nfsfsxn/oracopy/3i1sfov0_114_1_1
channel ORA_DISK_1: piece handle=/nfsfsxn/oracopy/3i1sfov0_114_1_1
tag=ORACOPYBKUPONFSXN_LEVEL_0
channel ORA_DISK_1: restored backup piece 1
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00020: /nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-20_131sd7do
channel ORA_DISK_1: reading from backup piece
/nfsfsxn/oracopy/3j1sfov0_115_1_1
channel ORA_DISK_1: piece handle=/nfsfsxn/oracopy/3j1sfov0_115_1_1
tag=ORACOPYBKUPONFSXN_LEVEL_0
channel ORA_DISK_1: restored backup piece 1
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01

starting media recovery
media recovery complete, elapsed time: 00:00:01

Finished recover at 18-MAY-23

RMAN> alter database open;

Statement processed

RMAN>
```

5. Check database structure from sqlplus after recovery to observe that all database data files with exception of control, temp, and current log files are now switched over to copy on FSx ONTAP NFS file system.

```
SQL> select name from v$datafile
  2  union
  3  select name from v$tempfile
  4  union
  5  select name from v$controlfile
  6  union
  7  select member from v$logfile;

NAME
--------------------------------------------------------------------------------
+DATA/DB1/CONTROLFILE/current.261.1136666435
+DATA/DB1/FB864A929AEB79B9E053630F1EAC7046/TEMPFILE/temp.269.1136667
185
+DATA/DB1/FB867DA8C68C816EE053630F1EAC2BCF/TEMPFILE/temp.274.1136668
051
+DATA/DB1/FB867EA89ECF81C0E053630F1EACB901/TEMPFILE/temp.279.1136668
067
+DATA/DB1/FB867F8A4D4F821CE053630F1EAC69CC/TEMPFILE/temp.284.1136668
081
+DATA/DB1/ONLINELOG/group_1.262.1136666437
+DATA/DB1/ONLINELOG/group_2.263.1136666437
+DATA/DB1/ONLINELOG/group_3.264.1136666437
+DATA/DB1/TEMPFILE/temp.265.1136666447
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-21_021sd6pv
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-22_031sd6r2

NAME
--------------------------------------------------------------------------------
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-23_041sd6s5
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-24_051sd6t9
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-25_061sd6uc
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-26_071sd6vf
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-27_081sd70i
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-28_091sd71l
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-29_0a1sd72o
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-30_0b1sd73r
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-31_0c1sd74u
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-32_0d1sd762
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-33_0e1sd775
```

```
NAME
--------------------------------------------------------------------
------------
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-34_0f1sd788
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-35_0g1sd79b
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-10_0k1sd7bb
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-14_0l1sd7bi
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-18_0m1sd7bq
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-3_0i1sd7at
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-6_0o1sd7c8
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-13_0r1sd7ct
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-17_0s1sd7d4
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-1_0h1sd7ae
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-5_0p1sd7cf

NAME
--------------------------------------------------------------------
------------
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-9_0q1sd7cm
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-11_0n1sd7c1
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-15_0t1sd7db
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-19_0u1sd7de
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-4_0j1sd7b4
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-8_0v1sd7di
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-12_111sd7dm
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-16_121sd7dn
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-20_131sd7do
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-7_101sd7dl

43 rows selected.

SQL>
```

6. From SQL plus, check the content of test table we have inserted before the switch over to copy

```
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> alter session set container=db1_pdb1;

Session altered.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
18-MAY-23 02.35.37.000000 PM
test oracle incremental merge switch to copy


SQL>
```

7. You could run the Oracle database in FSx NFS mount for an extended period without a performance penalty because FSx ONTAP is redundant production-grade storage that delivers high performance. When the primary storage issue is fixed, you can swing back to it by reversing the incremental backup merge processes with minimal downtime.

Oracle DB recovery from image copy to different EC2 DB instance host

In a failure when both primary storage and EC2 DB instance host are lost, the recovery can not be conducted from the original server. Fortunately, you still have an Oracle database backup image copy on the redundant FSxN NFS file system. You could quickly provision another identical EC2 DB instance and easily mount the image copy of your VLDB to the new EC2 DB host via NFS to run recovery. In this section, we will demonstrate the step-by-step procedures for doing so.

1. Insert a row to test table we have created previously for Oracle database restoring to alternative host validation.

```
[oracle@ip-172-30-15-99 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Tue May 30 17:21:05
2023
Version 19.18.0.0.0

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Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 -
Production
Version 19.18.0.0.0

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> alter session set container=db1_pdb1;

Session altered.


SQL> insert into test values(2, sysdate, 'test recovery on a new EC2
instance host with image copy on FSxN');

1 row created.

SQL> commit;

Commit complete.

SQL> select * from test;
```

```
        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
18-MAY-23 02.35.37.000000 PM
test oracle incremental merge switch to copy

         2
30-MAY-23 05.23.11.000000 PM
test recovery on a new EC2 instance host with image copy on FSxN


SQL>
```

2. As oracle user, run RMAN incremental backup and merge to flush the transaction to backup set on FSxN NFS mount.

```
[oracle@ip-172-30-15-99 ~]$ rman target / nocatalog

Recovery Manager: Release 19.0.0.0.0 - Production on Tue May 30
17:26:03 2023
Version 19.18.0.0.0

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reserved.

connected to target database: DB1 (DBID=1730530050)
using target database control file instead of recovery catalog

RMAN> @rman_bkup_merge.cmd
```

3. Shutdown primary EC2 DB instance host to simulate a total failure of storage and DB server host.
4. Privison a new EC2 DB instance host ora_02 with same OS and version via AWS EC2 console. Configure OS kernal with same patches as primary EC2 DB server host, Oracle preinstall RPM, and add swap space to the host as well. Install same version and patches of Oracle as in primary EC2 DB server host with software only option. These tasks can be automated with NetApp automation toolkit as available from below links.

   Toolkit: na_oracle19c_deploy
   Documentation: Automated Deployment of Oracle19c for ONTAP on NFS

5. Configure oracle environment similiarly to primary EC2 DB instance host ora_01, such as oratab, oraInst.loc, and oracle user .bash_profile. It is a good practice to backup those files to FSxN NFS mount point.
6. The Oracle database backup image copy on FSxN NFS mount is stored on a FSx cluster that spans AWS availability zones for redundancy, high avilability, and high performance. The NFS file system can be easily mounted to a new server as far as the networking is reachable. The following procedures mount the image copy of an Oracle VLDB backup to newly provsioned EC2 DB instance host for recovery.

   As ec2-user, create the mount point.

   ```
   sudo mkdir /nfsfsxn
   ```

   As ec2-user, mount the NFS volume that stored Oracle VLDB backup image copy.

   ```
   sudo mount 172.30.15.19:/ora_01_copy /nfsfsxn -o
   rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
   tr
   ```

7. Validate the Oracle database backup image copy on FSxN NFS mount point.

   ```
   [ec2-user@ip-172-30-15-124 ~]$ ls -ltr /nfsfsxn/oracopy
   total 78940700
   -rw-r-----. 1 oracle 54331  482353152 May 26 18:45 data_D-DB1_I-
   1730530050_TS-SYSAUX_FNO-6_4m1t508t
   -rw-r-----. 1 oracle 54331  419438592 May 26 18:45 data_D-DB1_I-
   1730530050_TS-SYSTEM_FNO-5_4q1t509n
   -rw-r-----. 1 oracle 54331  241180672 May 26 18:45 data_D-DB1_I-
   1730530050_TS-UNDOTBS1_FNO-8_4t1t50a6
   -rw-r-----. 1 oracle 54331     450560 May 30 15:29 6b1tf6b8_203_1_1
   -rw-r-----. 1 oracle 54331     663552 May 30 15:29 6c1tf6b8_204_1_1
   -rw-r-----. 1 oracle 54331     122880 May 30 15:29 6d1tf6b8_205_1_1
   -rw-r-----. 1 oracle 54331     507904 May 30 15:29 6e1tf6b8_206_1_1
   -rw-r-----. 1 oracle 54331    4259840 May 30 15:29 6f1tf6b9_207_1_1
   -rw-r-----. 1 oracle 54331    9060352 May 30 15:29 6h1tf6b9_209_1_1
   -rw-r-----. 1 oracle 54331     442368 May 30 15:29 6i1tf6b9_210_1_1
   -rw-r-----. 1 oracle 54331     475136 May 30 15:29 6j1tf6bb_211_1_1
   -rw-r-----. 1 oracle 54331   48660480 May 30 15:29 6g1tf6b9_208_1_1
   -rw-r-----. 1 oracle 54331     589824 May 30 15:29 6l1tf6bb_213_1_1
   -rw-r-----. 1 oracle 54331     606208 May 30 15:29 6m1tf6bb_214_1_1
   -rw-r-----. 1 oracle 54331     368640 May 30 15:29 6o1tf6bb_216_1_1
   -rw-r-----. 1 oracle 54331     368640 May 30 15:29 6p1tf6bc_217_1_1
   -rw-r-----. 1 oracle 54331      57344 May 30 15:29 6r1tf6bc_219_1_1
   -rw-r-----. 1 oracle 54331      57344 May 30 15:29 6s1tf6bc_220_1_1
   -rw-r-----. 1 oracle 54331      57344 May 30 15:29 6t1tf6bc_221_1_1
   ```

```
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-23_3q1t4ut3
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-21_3o1t4ut2
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-27_461t4vt7
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-25_3s1t4v1a
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-22_3p1t4ut3
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-31_4a1t5015
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-29_481t4vt7
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-34_4d1t5058
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-26_451t4vt7
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-24_3r1t4ut3
-rw-r-----. 1 oracle 54331  555753472 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-10_4i1t5083
-rw-r-----. 1 oracle 54331  429924352 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-9_4n1t509m
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-30_491t5014
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-28_471t4vt7
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-35_4e1t5059
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-32_4b1t501u
-rw-r-----. 1 oracle 54331  487596032 May 30 17:26 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-11_4l1t508t
-rw-r-----. 1 oracle 54331 4294975488 May 30 17:26 data_D-DB1_I-
1730530050_TS-SOE_FNO-33_4c1t501v
-rw-r-----. 1 oracle 54331    5251072 May 30 17:26 data_D-DB1_I-
1730530050_TS-USERS_FNO-12_4v1t50aa
-rw-r-----. 1 oracle 54331 1121984512 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-1_4f1t506m
-rw-r-----. 1 oracle 54331  707796992 May 30 17:26 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-4_4h1t5083
-rw-r-----. 1 oracle 54331  534781952 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-14_4j1t508s
-rw-r-----. 1 oracle 54331  429924352 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-13_4o1t509m
```

```
-rw-r-----. 1 oracle 54331  429924352 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-17_4p1t509m
-rw-r-----. 1 oracle 54331  534781952 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-18_4k1t508t
-rw-r-----. 1 oracle 54331 1027612672 May 30 17:26 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-3_4g1t506m
-rw-r-----. 1 oracle 54331    5251072 May 30 17:26 data_D-DB1_I-
1730530050_TS-USERS_FNO-7_4u1t50a6
-rw-r-----. 1 oracle 54331  246423552 May 30 17:26 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-15_4r1t50a6
-rw-r-----. 1 oracle 54331    5251072 May 30 17:26 data_D-DB1_I-
1730530050_TS-USERS_FNO-16_501t50ad
-rw-r-----. 1 oracle 54331  246423552 May 30 17:26 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-19_4s1t50a6
-rw-r-----. 1 oracle 54331    5251072 May 30 17:26 data_D-DB1_I-
1730530050_TS-USERS_FNO-20_511t50ad
-rw-r-----. 1 oracle 54331 2318712832 May 30 17:32 721tfd6b_226_1_1
-rw-r-----. 1 oracle 54331 1813143552 May 30 17:33 701tfd6a_224_1_1
-rw-r-----. 1 oracle 54331     966656 May 30 17:33 731tfdic_227_1_1
-rw-r-----. 1 oracle 54331    5980160 May 30 17:33 751tfdij_229_1_1
-rw-r-----. 1 oracle 54331     458752 May 30 17:33 761tfdin_230_1_1
-rw-r-----. 1 oracle 54331     458752 May 30 17:33 771tfdiq_231_1_1
-rw-r-----. 1 oracle 54331   11091968 May 30 17:33 741tfdij_228_1_1
-rw-r-----. 1 oracle 54331     401408 May 30 17:33 791tfdit_233_1_1
-rw-r-----. 1 oracle 54331 2070708224 May 30 17:33 6v1tfd6a_223_1_1
-rw-r-----. 1 oracle 54331     376832 May 30 17:33 7a1tfdit_234_1_1
-rw-r-----. 1 oracle 54331 1874903040 May 30 17:33 711tfd6b_225_1_1
-rw-r-----. 1 oracle 54331     303104 May 30 17:33 7c1tfdiu_236_1_1
-rw-r-----. 1 oracle 54331     319488 May 30 17:33 7d1tfdiv_237_1_1
-rw-r-----. 1 oracle 54331      57344 May 30 17:33 7f1tfdiv_239_1_1
-rw-r-----. 1 oracle 54331      57344 May 30 17:33 7g1tfdiv_240_1_1
-rw-r-----. 1 oracle 54331      57344 May 30 17:33 7h1tfdiv_241_1_1
-rw-r--r--. 1 oracle 54331      12720 May 30 17:33 db1_ctl.sql
-rw-r-----. 1 oracle 54331   11600384 May 30 17:54 bct_db1.ctf
```

8. Verify the available Oracle archived logs on the FSxN NFS mount for recovery and note the last log file log sequency number. In this case, it is 175. Our recovery point is up to log sequency number 176.

```
 [ec2-user@ip-172-30-15-124 ~]$ ls -ltr
/nfsfsxn/archlog/DB1/archivelog/2023_05_30
total 5714400
-r--r-----. 1 oracle 54331    321024 May 30 14:59
o1_mf_1_140__003t9mvn_.arc
-r--r-----. 1 oracle 54331  48996352 May 30 15:29
o1_mf_1_141__01t9qf6r_.arc
-r--r-----. 1 oracle 54331 167477248 May 30 15:44
```

```
o1_mf_1_142__02n3x2qb_.arc
-r--r-----. 1 oracle 54331 165684736 May 30 15:46
o1_mf_1_143__02rotwyb_.arc
-r--r-----. 1 oracle 54331 165636608 May 30 15:49
o1_mf_1_144__02x563wh_.arc
-r--r-----. 1 oracle 54331 168408064 May 30 15:51
o1_mf_1_145__031kg2co_.arc
-r--r-----. 1 oracle 54331 169446400 May 30 15:54
o1_mf_1_146__035xpcdt_.arc
-r--r-----. 1 oracle 54331 167595520 May 30 15:56
o1_mf_1_147__03bds8qf_.arc
-r--r-----. 1 oracle 54331 169270272 May 30 15:59
o1_mf_1_148__03gyt7rx_.arc
-r--r-----. 1 oracle 54331 170712576 May 30 16:01
o1_mf_1_149__03mfxl7v_.arc
-r--r-----. 1 oracle 54331 170744832 May 30 16:04
o1_mf_1_150__03qzz0ty_.arc
-r--r-----. 1 oracle 54331 169380864 May 30 16:06
o1_mf_1_151__03wgxdry_.arc
-r--r-----. 1 oracle 54331 169833984 May 30 16:09
o1_mf_1_152__040y85v3_.arc
-r--r-----. 1 oracle 54331 165134336 May 30 16:20
o1_mf_1_153__04ox946w_.arc
-r--r-----. 1 oracle 54331 169929216 May 30 16:22
o1_mf_1_154__04rbv7n8_.arc
-r--r-----. 1 oracle 54331 171903488 May 30 16:23
o1_mf_1_155__04tv1yvn_.arc
-r--r-----. 1 oracle 54331 179061248 May 30 16:25
o1_mf_1_156__04xgfjtl_.arc
-r--r-----. 1 oracle 54331 173593088 May 30 16:26
o1_mf_1_157__04zyg8hw_.arc
-r--r-----. 1 oracle 54331 175999488 May 30 16:27
o1_mf_1_158__052gp9mt_.arc
-r--r-----. 1 oracle 54331 179092992 May 30 16:29
o1_mf_1_159__0551wk7s_.arc
-r--r-----. 1 oracle 54331 175524352 May 30 16:30
o1_mf_1_160__057l46my_.arc
-r--r-----. 1 oracle 54331 173949440 May 30 16:32
o1_mf_1_161__05b2dmwp_.arc
-r--r-----. 1 oracle 54331 184166912 May 30 16:33
o1_mf_1_162__05drbj8n_.arc
-r--r-----. 1 oracle 54331 173026816 May 30 16:35
o1_mf_1_163__05h8lm1h_.arc
-r--r-----. 1 oracle 54331 174286336 May 30 16:36
o1_mf_1_164__05krsqmh_.arc
-r--r-----. 1 oracle 54331 166092288 May 30 16:37
```

```
o1_mf_1_165__05n378pw_.arc
-r--r-----. 1 oracle 54331 177640960 May 30 16:39
o1_mf_1_166__05pmg74l_.arc
-r--r-----. 1 oracle 54331 173972992 May 30 16:40
o1_mf_1_167__05s3o01r_.arc
-r--r-----. 1 oracle 54331 178474496 May 30 16:41
o1_mf_1_168__05vmwt34_.arc
-r--r-----. 1 oracle 54331 177694208 May 30 16:43
o1_mf_1_169__05y45qdd_.arc
-r--r-----. 1 oracle 54331 170814976 May 30 16:44
o1_mf_1_170__060kgh33_.arc
-r--r-----. 1 oracle 54331 177325056 May 30 16:46
o1_mf_1_171__0631tvgv_.arc
-r--r-----. 1 oracle 54331 164455424 May 30 16:47
o1_mf_1_172__065d94fq_.arc
-r--r-----. 1 oracle 54331 178252288 May 30 16:48
o1_mf_1_173__067wnwy8_.arc
-r--r-----. 1 oracle 54331 170579456 May 30 16:50
o1_mf_1_174__06b9zdh8_.arc
-r--r-----. 1 oracle 54331  93928960 May 30 17:26
o1_mf_1_175__08c7jc2b_.arc
[ec2-user@ip-172-30-15-124 ~]$
```

9. As oracle user, set ORACLE_HOME variable to current Oracle installation on new EC2 instance DB host ora_02, ORACLE_SID to primary Oracle instance SID. In this case, it is db1.
10. As oracle user, create a generic Oracle init file in $ORACLE_HOME/dbs directory with proper admin directories configured. Most importantly, have Oracle `flash recovery area` point to FSxN NFS mount path as defined in primary Oracle VLDB instance. `flash recovery area` configuration is demonstrated in section `Setup Oracle RMAN incremental merge to image copy on FSx`. Set the Oracle control file to FSx ONTAP NFS file system.

    ```
    vi $ORACLE_HOME/dbs/initdb1.ora
    ```

    With following example entries:

```
*.audit_file_dest='/u01/app/oracle/admin/db1/adump'
*.audit_trail='db'
*.compatible='19.0.0'
*.control_files=('/nfsfsxn/oracopy/db1.ctl')
*.db_block_size=8192
*.db_create_file_dest='/nfsfsxn/oracopy/'
*.db_domain='demo.netapp.com'
*.db_name='db1'
*.db_recovery_file_dest_size=85899345920
*.db_recovery_file_dest='/nfsfsxn/archlog/'
*.diagnostic_dest='/u01/app/oracle'
*.dispatchers='(PROTOCOL=TCP) (SERVICE=db1XDB)'
*.enable_pluggable_database=true
*.local_listener='LISTENER'
*.nls_language='AMERICAN'
*.nls_territory='AMERICA'
*.open_cursors=300
*.pga_aggregate_target=1024m
*.processes=320
*.remote_login_passwordfile='EXCLUSIVE'
*.sga_target=10240m
*.undo_tablespace='UNDOTBS1'
```

The above init file should be replaced by restored backup init file from primary Oracle DB server in the case of discrepancy.

11. As oracle user, launch RMAN to run Oracle recovery on a new EC2 DB instance host.

```
[oracle@ip-172-30-15-124 dbs]$ rman target / nocatalog;

Recovery Manager: Release 19.0.0.0.0 - Production on Wed May 31
00:56:07 2023
Version 19.18.0.0.0

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reserved.

connected to target database (not started)

RMAN> startup nomount;

Oracle instance started

Total System Global Area   12884900632 bytes

Fixed Size                     9177880 bytes
Variable Size               1778384896 bytes
Database Buffers           11072962560 bytes
Redo Buffers                  24375296 bytes
```

12. Set database ID. The database ID can be retrieved from Oracle file name of image copy on FSx NFS mount point.

```
RMAN> set dbid = 1730530050;

executing command: SET DBID
```

13. Restore controlfile from autobackup. If Oracle controlfile and spfile autobackup is enabled, they are backed up in every incremental backup and merge cycle. The latest backup will be restored if multiple copies are available.

```
RMAN> restore controlfile from autobackup;

Starting restore at 31-MAY-23
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=2 device type=DISK

recovery area destination: /nfsfsxn/archlog
database name (or database unique name) used for search: DB1
channel ORA_DISK_1: AUTOBACKUP
/nfsfsxn/archlog/DB1/autobackup/2023_05_30/o1_mf_s_1138210401__08qlx
rrr_.bkp found in the recovery area
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230531
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230530
channel ORA_DISK_1: restoring control file from AUTOBACKUP
/nfsfsxn/archlog/DB1/autobackup/2023_05_30/o1_mf_s_1138210401__08qlx
rrr_.bkp
channel ORA_DISK_1: control file restore from AUTOBACKUP complete
output file name=/nfsfsxn/oracopy/db1.ctl
Finished restore at 31-MAY-23
```

14. Restore init file from spfile to a /tmp folder for updating parameter file later to match with primary DB instance.

```
RMAN> restore spfile to pfile '/tmp/archive/initdb1.ora' from
autobackup;

Starting restore at 31-MAY-23
using channel ORA_DISK_1

recovery area destination: /nfsfsxn/archlog
database name (or database unique name) used for search: DB1
channel ORA_DISK_1: AUTOBACKUP
/nfsfsxn/archlog/DB1/autobackup/2023_05_30/o1_mf_s_1138210401__08qlx
rrr_.bkp found in the recovery area
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230531
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230530
channel ORA_DISK_1: restoring spfile from AUTOBACKUP
/nfsfsxn/archlog/DB1/autobackup/2023_05_30/o1_mf_s_1138210401__08qlx
rrr_.bkp
channel ORA_DISK_1: SPFILE restore from AUTOBACKUP complete
Finished restore at 31-MAY-23
```

15. Mount control file and validate the database backup image copy.

```
RMAN> alter database mount;

released channel: ORA_DISK_1
Statement processed

RMAN> list copy of database tag 'OraCopyBKUPonFSxN_level_0';

List of Datafile Copies
=======================

Key     File S Completion Time Ckp SCN    Ckp Time        Sparse
------- ---- - --------------- ---------- --------------- ------
316     1    A 30-MAY-23       4120170    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-1_4f1t506m
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

322     3    A 30-MAY-23       4120175    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-3_4g1t506m
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

317     4    A 30-MAY-23       4120179    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-4_4h1t5083
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

221     5    A 26-MAY-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-5_4q1t509n
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

216     6    A 26-MAY-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-6_4m1t508t
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

323     7    A 30-MAY-23       4120207    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
7_4u1t50a6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

227     8    A 26-MAY-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-8_4t1t50a6
```

```
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

308     9    A 30-MAY-23       4120158    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-9_4n1t509m
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

307     10   A 30-MAY-23       4120166    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-10_4i1t5083
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

313     11   A 30-MAY-23       4120154    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-11_4l1t508t
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

315     12   A 30-MAY-23       4120162    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
12_4v1t50aa
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

319     13   A 30-MAY-23       4120191    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-13_4o1t509m
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

318     14   A 30-MAY-23       4120183    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-14_4j1t508s
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

324     15   A 30-MAY-23       4120199    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-15_4r1t50a6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

325     16   A 30-MAY-23       4120211    30-MAY-23       NO
```

```
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
16_501t50ad
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

320     17   A 30-MAY-23       4120195    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-17_4p1t509m
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

321     18   A 30-MAY-23       4120187    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-18_4k1t508t
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

326     19   A 30-MAY-23       4120203    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-19_4s1t50a6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

327     20   A 30-MAY-23       4120216    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
20_511t50ad
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

298     21   A 30-MAY-23       4120166    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
21_3o1t4ut2
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

302     22   A 30-MAY-23       4120154    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
22_3p1t4ut3
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

297     23   A 30-MAY-23       4120158    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
23_3q1t4ut3
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1
```

```
306     24   A 30-MAY-23       4120162    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
24_3r1t4ut3
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

300     25   A 30-MAY-23       4120166    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
25_3s1t4v1a
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

305     26   A 30-MAY-23       4120154    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
26_451t4vt7
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

299     27   A 30-MAY-23       4120158    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
27_461t4vt7
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

310     28   A 30-MAY-23       4120162    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
28_471t4vt7
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

303     29   A 30-MAY-23       4120166    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
29_481t4vt7
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

309     30   A 30-MAY-23       4120154    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
30_491t5014
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

301     31   A 30-MAY-23       4120158    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
31_4a1t5015
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

312     32   A 30-MAY-23       4120162    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
32_4b1t501u
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

314     33   A 30-MAY-23       4120162    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
33_4c1t501v
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

304     34   A 30-MAY-23       4120158    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
34_4d1t5058
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

311     35   A 30-MAY-23       4120154    30-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
35_4e1t5059
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1
```

16. Switch database to copy to run recovery without database restore.

```
RMAN> switch database to copy;

Starting implicit crosscheck backup at 31-MAY-23
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=11 device type=DISK
Crosschecked 33 objects
Finished implicit crosscheck backup at 31-MAY-23

Starting implicit crosscheck copy at 31-MAY-23
using channel ORA_DISK_1
Crosschecked 68 objects
Finished implicit crosscheck copy at 31-MAY-23

searching for all files in the recovery area
cataloging files...
cataloging done

List of Cataloged Files
```

```
=======================
File Name:
/nfsfsxn/archlog/DB1/autobackup/2023_05_30/o1_mf_s_1138210401__08qlx
rrr_.bkp

datafile 1 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-1_4f1t506m"
datafile 3 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-3_4g1t506m"
datafile 4 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-4_4h1t5083"
datafile 5 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-5_4q1t509n"
datafile 6 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-6_4m1t508t"
datafile 7 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-USERS_FNO-7_4u1t50a6"
datafile 8 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-8_4t1t50a6"
datafile 9 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-9_4n1t509m"
datafile 10 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-10_4i1t5083"
datafile 11 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-11_4l1t508t"
datafile 12 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-12_4v1t50aa"
datafile 13 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-13_4o1t509m"
datafile 14 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-14_4j1t508s"
datafile 15 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-15_4r1t50a6"
datafile 16 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-16_501t50ad"
datafile 17 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-17_4p1t509m"
datafile 18 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-18_4k1t508t"
datafile 19 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-19_4s1t50a6"
datafile 20 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-20_511t50ad"
datafile 21 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-21_3o1t4ut2"
datafile 22 switched to datafile copy "/nfsfsxn/oracopy/data_D-
```

```
DB1_I-1730530050_TS-SOE_FNO-22_3p1t4ut3"
datafile 23 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-23_3q1t4ut3"
datafile 24 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-24_3r1t4ut3"
datafile 25 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-25_3s1t4v1a"
datafile 26 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-26_451t4vt7"
datafile 27 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-27_461t4vt7"
datafile 28 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-28_471t4vt7"
datafile 29 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-29_481t4vt7"
datafile 30 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-30_491t5014"
datafile 31 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-31_4a1t5015"
datafile 32 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-32_4b1t501u"
datafile 33 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-33_4c1t501v"
datafile 34 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-34_4d1t5058"
datafile 35 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-35_4e1t5059"
```

17. Run Oracle recovery up to last available archive log in flash recovery area.

```
RMAN> run {
2> set until sequence=176;
3> recover database;
4> }

executing command: SET until clause

Starting recover at 31-MAY-23
using channel ORA_DISK_1

starting media recovery

archived log for thread 1 with sequence 142 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_142__02n3x2qb_.ar
```

```
c
archived log for thread 1 with sequence 143 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_143__02rotwyb_.ar
c
archived log for thread 1 with sequence 144 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_144__02x563wh_.ar
c
archived log for thread 1 with sequence 145 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_145__031kg2co_.ar
c
archived log for thread 1 with sequence 146 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_146__035xpcdt_.ar
c
archived log for thread 1 with sequence 147 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_147__03bds8qf_.ar
c
archived log for thread 1 with sequence 148 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_148__03gyt7rx_.ar
c
archived log for thread 1 with sequence 149 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_149__03mfxl7v_.ar
c
archived log for thread 1 with sequence 150 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_150__03qzz0ty_.ar
c
archived log for thread 1 with sequence 151 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_151__03wgxdry_.ar
c
archived log for thread 1 with sequence 152 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_152__040y85v3_.ar
c
archived log for thread 1 with sequence 153 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_153__04ox946w_.ar
c
archived log for thread 1 with sequence 154 is already on disk as
```

```
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_154__04rbv7n8_.ar
c
archived log for thread 1 with sequence 155 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_155__04tv1yvn_.ar
c
archived log for thread 1 with sequence 156 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_156__04xgfjtl_.ar
c
archived log for thread 1 with sequence 157 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_157__04zyg8hw_.ar
c
archived log for thread 1 with sequence 158 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_158__052gp9mt_.ar
c
archived log for thread 1 with sequence 159 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_159__0551wk7s_.ar
c
archived log for thread 1 with sequence 160 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_160__057l46my_.ar
c
archived log for thread 1 with sequence 161 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_161__05b2dmwp_.ar
c
archived log for thread 1 with sequence 162 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_162__05drbj8n_.ar
c
archived log for thread 1 with sequence 163 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_163__05h8lm1h_.ar
c
archived log for thread 1 with sequence 164 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_164__05krsqmh_.ar
c
archived log for thread 1 with sequence 165 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_165__05n378pw_.ar
```

```
c
archived log for thread 1 with sequence 166 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_166__05pmg74l_.ar
c
archived log for thread 1 with sequence 167 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_167__05s3o01r_.ar
c
archived log for thread 1 with sequence 168 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_168__05vmwt34_.ar
c
archived log for thread 1 with sequence 169 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_169__05y45qdd_.ar
c
archived log for thread 1 with sequence 170 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_170__060kgh33_.ar
c
archived log for thread 1 with sequence 171 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_171__0631tvgv_.ar
c
archived log for thread 1 with sequence 172 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_172__065d94fq_.ar
c
archived log for thread 1 with sequence 173 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_173__067wnwy8_.ar
c
archived log for thread 1 with sequence 174 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_174__06b9zdh8_.ar
c
archived log for thread 1 with sequence 175 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_175__08c7jc2b_.ar
c
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_142__02n3x2q
b_.arc thread=1 sequence=142
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_143__02rotwy
```

```
b_.arc thread=1 sequence=143
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_144__02x563w
h_.arc thread=1 sequence=144
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_145__031kg2c
o_.arc thread=1 sequence=145
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_146__035xpcd
t_.arc thread=1 sequence=146
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_147__03bds8q
f_.arc thread=1 sequence=147
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_148__03gyt7r
x_.arc thread=1 sequence=148
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_149__03mfxl7
v_.arc thread=1 sequence=149
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_150__03qzz0t
y_.arc thread=1 sequence=150
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_151__03wgxdr
y_.arc thread=1 sequence=151
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_152__040y85v
3_.arc thread=1 sequence=152
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_153__04ox946
w_.arc thread=1 sequence=153
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_154__04rbv7n
8_.arc thread=1 sequence=154
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_155__04tv1yv
n_.arc thread=1 sequence=155
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_156__04xgfjt
l_.arc thread=1 sequence=156
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_157__04zyg8h
w_.arc thread=1 sequence=157
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_158__052gp9m
t_.arc thread=1 sequence=158
```

```
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_159__0551wk7
s_.arc thread=1 sequence=159
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_160__057l46m
y_.arc thread=1 sequence=160
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_161__05b2dmw
p_.arc thread=1 sequence=161
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_162__05drbj8
n_.arc thread=1 sequence=162
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_163__05h8lm1
h_.arc thread=1 sequence=163
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_164__05krsqm
h_.arc thread=1 sequence=164
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_165__05n378p
w_.arc thread=1 sequence=165
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_166__05pmg74
l_.arc thread=1 sequence=166
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_167__05s3o01
r_.arc thread=1 sequence=167
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_168__05vmwt3
4_.arc thread=1 sequence=168
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_169__05y45qd
d_.arc thread=1 sequence=169
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_170__060kgh3
3_.arc thread=1 sequence=170
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_171__0631tvg
v_.arc thread=1 sequence=171
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_172__065d94f
q_.arc thread=1 sequence=172
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_173__067wnwy
8_.arc thread=1 sequence=173
archived log file
```

```
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_174__06b9zdh
8_.arc thread=1 sequence=174
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_05_30/o1_mf_1_175__08c7jc2
b_.arc thread=1 sequence=175
media recovery complete, elapsed time: 00:48:34
Finished recover at 31-MAY-23
```

> For faster recovery, enable parallel sessions with recovery_parallelism parameter or specify degree of parallel in recovery command for database recovery: `RECOVER DATABASE PARALLEL (DEGREE d INSTANCES DEFAULT);`. In general, degrees of parallelism should be equal to number of CPU cores on the host.

18. Exit RMAN, login to Oracle as oracle user via sqlplus to open database and reset log after an incomplete recovery.

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

NAME      OPEN_MODE
--------- --------------------
DB1       MOUNTED

SQL> select member from v$logfile;

MEMBER
--------------------------------------------------------------------
------------
+DATA/DB1/ONLINELOG/group_3.264.1136666437
+DATA/DB1/ONLINELOG/group_2.263.1136666437
+DATA/DB1/ONLINELOG/group_1.262.1136666437

SQL> alter database rename file
'+DATA/DB1/ONLINELOG/group_1.262.1136666437' to
'/nfsfsxn/oracopy/redo01.log';

Database altered.

SQL> alter database rename file
'+DATA/DB1/ONLINELOG/group_2.263.1136666437' to
'/nfsfsxn/oracopy/redo02.log';

Database altered.

SQL> alter database rename file
'+DATA/DB1/ONLINELOG/group_3.264.1136666437' to
'/nfsfsxn/oracopy/redo03.log';

Database altered.

SQL> alter database open resetlogs;

Database altered.
```

19. Validate the database restored to new host that has the row we have inserted before primary database failure.

```
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> alter session set container=db1_pdb1;

Session altered.

SQL> select * from test;

        ID DT
EVENT
----------
--------------------------------------------------------------------
-------
--------------------------------------------------------------------
--------------------------------
         1 18-MAY-23 02.35.37.000000 PM
test oracle incremental merge switch to copy
         2 30-MAY-23 05.23.11.000000 PM
test recovery on a new EC2 instance host with image copy on FSxN
```

20. Other post recovery tasks

```
Add FSxN NFS mount to fstab so that the NFS file system will be
mounted when EC2 instance host rebooted.

As EC2 user, vi /etc/fstab and add following entry:

172.30.15.19:/ora_01_copy       /nfsfsxn        nfs
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
tr  0       0

Update the Oracle init file from primary databse init file backup
that is restored to /tmp/archive and create spfile as needed.
```

This completes the Oracle VLDB database recovery from backup image copy on FSxN NFS file system to a new EC2 DB instance host.

Clone Oracle standby image copy for other use cases

Another benefit of using AWS FSx ONTAP for staging Oracle VLDB image copy is that it can be FlexCloned to serve many other purposes with minimal additional storage investment. In the following use case, we demonstrate how to snapshot and clone the staging NFS volume on FSx ONTAP for other Oracle use cases such as DEV, UAT, etc.

1. We begin with inserting a row into the same test table we have created before.

```
 SQL> insert into test values (3, sysdate, 'test clone on a new EC2
instance host with image copy on FSxN');

1 row created.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
18-MAY-23 02.35.37.000000 PM
test oracle incremental merge switch to copy

         2
30-MAY-23 05.23.11.000000 PM
test recovery on a new EC2 instance host with image copy on FSxN

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------

         3
05-JUN-23 03.19.46.000000 PM
test clone on a new EC2 instance host with image copy on FSxN


SQL>
```

2. Take a RMAN backup and merge to FSx ONTAP database image copy so that the transaction will be captured in the backup set on FSx NFS mount but not merged into copy until cloned database is recovered.

   ```
   RMAN> @/home/oracle/rman_bkup_merge.cmd
   ```

3. Login to FSx cluster via ssh as fsxadmin user to observe the snapshots created by scheduled backup policy - oracle and take an one-off snapshot so that it will include the transaction we commited in step 1.

```
FsxId06c3c8b2a7bd56458::> vol snapshot create -vserver svm_ora
-volume ora_01_copy -snapshot one-off.2023-06-05-1137 -foreground
true

FsxId06c3c8b2a7bd56458::> snapshot show

---Blocks---
Vserver  Volume   Snapshot                                  Size
Total% Used%
-------- -------- ------------------------------------- --------
------ -----
svm_ora  ora_01_copy
                  daily.2023-06-02_0010                   3.59GB
2%    5%
                  daily.2023-06-03_0010                   1.10GB
1%    1%
                  daily.2023-06-04_0010                    608KB
0%    0%
                  daily.2023-06-05_0010                   3.81GB
2%    5%
                  one-off.2023-06-05-1137                  168KB
0%    0%
         svm_ora_root
                  weekly.2023-05-28_0015                  1.86MB
0%   78%
                  daily.2023-06-04_0010                    152KB
0%   22%
                  weekly.2023-06-04_0015                  1.24MB
0%   70%
                  daily.2023-06-05_0010                    196KB
0%   27%
                  hourly.2023-06-05_1005                   156KB
0%   22%
                  hourly.2023-06-05_1105                   156KB
0%   22%
                  hourly.2023-06-05_1205                   156KB
0%   22%
                  hourly.2023-06-05_1305                   156KB
0%   22%
                  hourly.2023-06-05_1405                  1.87MB
0%   78%
                  hourly.2023-06-05_1505                   148KB
0%   22%
15 entries were displayed.
```

4. Clone from the one-off snapshot to be used for standing up a new DB1 clone instance on an alternative EC2 Oracle host. You have the option to clone from any available daily snapshots for volume ora_01_copy.

```
FsxId06c3c8b2a7bd56458::> vol clone create -flexclone db1_20230605of
-type RW -parent-vserver svm_ora -parent-volume ora_01_copy
-junction-path /db1_20230605of -junction-active true -parent
-snapshot one-off.2023-06-05-1137
[Job 464] Job succeeded: Successful

FsxId06c3c8b2a7bd56458::>

FsxId06c3c8b2a7bd56458::> vol show db1*
Vserver   Volume       Aggregate    State      Type       Size
Available Used%
--------- ------------ ------------ ---------- ---- ----------
---------- -----
svm_ora   db1_20230605of
                       aggr1        online     RW        200GB
116.6GB   38%

FsxId06c3c8b2a7bd56458::>
```

5. Turn off snapshot policy for the cloned volume as it inherits parent volume snapshot policy unless you want to protect the cloned volume, then leave it alone.

```
FsxId06c3c8b2a7bd56458::> vol modify -volume db1_20230605of
-snapshot-policy none

Warning: You are changing the Snapshot policy on volume
"db1_20230605of" to "none". Snapshot copies on this volume that do
not match any of the prefixes of the new Snapshot policy will not be
deleted. However, when the new Snapshot policy
         takes effect, depending on the new retention count, any
existing Snapshot copies that continue to use the same prefixes
might be deleted. See the 'volume modify' man page for more
information.
Do you want to continue? {y|n}: y
Volume modify successful on volume db1_20230605of of Vserver
svm_ora.

FsxId06c3c8b2a7bd56458::>
```

6. Login to a new EC2 Linux instance with Oracle software pre-installed with same version and patch level as your primary Oracle EC2 instance and mount the cloned volume.

```
[ec2-user@ip-172-30-15-124 ~]$ sudo mkdir /nfsfsxn
[ec2-user@ip-172-30-15-124 ~]$ sudo mount -t nfs
172.30.15.19:/db1_20230605of /nfsfsxn -o
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
tr
```

7. Validate the database incremental backup sets, image copy, and available archived logs on FSx NFS mount.

```
[ec2-user@ip-172-30-15-124 ~]$ ls -ltr /nfsfsxn/oracopy
total 79450332
-rw-r----- 1 oracle 54331  482353152 Jun  1 19:02 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-6_891tkrhr
-rw-r----- 1 oracle 54331  419438592 Jun  1 19:03 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-5_8d1tkril
-rw-r----- 1 oracle 54331  241180672 Jun  1 19:03 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-8_8g1tkrj7
-rw-r----- 1 oracle 54331  912506880 Jun  1 20:21 8n1tkvv2_279_1_1
-rw-r----- 1 oracle 54331     925696 Jun  1 20:21 8q1tl05i_282_1_1
-rw-r----- 1 oracle 54331 1169014784 Jun  1 20:21 8p1tkvv2_281_1_1
-rw-r----- 1 oracle 54331    6455296 Jun  1 20:21 8r1tl05m_283_1_1
-rw-r----- 1 oracle 54331     139264 Jun  1 20:21 8t1tl05t_285_1_1
-rw-r----- 1 oracle 54331    3514368 Jun  1 20:21 8s1tl05t_284_1_1
-rw-r----- 1 oracle 54331     139264 Jun  1 20:21 8u1tl060_286_1_1
-rw-r----- 1 oracle 54331     425984 Jun  1 20:21 901tl062_288_1_1
-rw-r----- 1 oracle 54331     344064 Jun  1 20:21 911tl062_289_1_1
-rw-r----- 1 oracle 54331     245760 Jun  1 20:21 931tl063_291_1_1
-rw-r----- 1 oracle 54331     237568 Jun  1 20:21 941tl064_292_1_1
-rw-r----- 1 oracle 54331      57344 Jun  1 20:21 961tl065_294_1_1
-rw-r----- 1 oracle 54331      57344 Jun  1 20:21 971tl066_295_1_1
-rw-r----- 1 oracle 54331      57344 Jun  1 20:21 981tl067_296_1_1
-rw-r----- 1 oracle 54331 1040760832 Jun  1 20:23 8m1tkvv2_278_1_1
-rw-r----- 1 oracle 54331  932847616 Jun  1 20:24 8o1tkvv2_280_1_1
-rw-r----- 1 oracle 54331 1121984512 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-1_821tkrb8
-rw-r----- 1 oracle 54331 1027612672 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-3_831tkrd9
-rw-r----- 1 oracle 54331  429924352 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-9_8a1tkrhr
-rw-r----- 1 oracle 54331  707796992 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-4_851tkrgf
-rw-r----- 1 oracle 54331  534781952 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-14_871tkrhr
-rw-r----- 1 oracle 54331  534781952 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-18_881tkrhr
```

```
-rw-r----- 1 oracle 54331  429924352 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-13_8b1tkril
-rw-r----- 1 oracle 54331  429924352 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-17_8c1tkril
-rw-r----- 1 oracle 54331  246423552 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-15_8e1tkril
-rw-r----- 1 oracle 54331  246423552 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-19_8f1tkrj4
-rw-r----- 1 oracle 54331    5251072 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-USERS_FNO-7_8h1tkrj9
-rw-r----- 1 oracle 54331    5251072 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-USERS_FNO-16_8j1tkrja
-rw-r----- 1 oracle 54331    5251072 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-USERS_FNO-20_8k1tkrjb
-rw-r----- 1 oracle 54331    5251072 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-USERS_FNO-12_8i1tkrj9
-rw-r----- 1 oracle 54331  555753472 Jun  5 15:21 data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-10_861tkrgo
-rw-r----- 1 oracle 54331  796925952 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-11_841tkrf2
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-21_7j1tkqk6
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-34_801tkram
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-29_7r1tkr32
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-25_7n1tkqrh
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-31_7t1tkr3i
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-33_7v1tkra6
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-23_7l1tkqk6
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-27_7p1tkqrq
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-35_811tkrap
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-32_7u1tkr42
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-22_7k1tkqk6
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-24_7m1tkqk6
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-28_7q1tkqs1
```

```
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-30_7s1tkr3a
-rw-r----- 1 oracle 54331 4294975488 Jun  5 15:22 data_D-DB1_I-
1730530050_TS-SOE_FNO-26_7o1tkqrj
-rw-r----- 1 oracle 54331 1241432064 Jun  5 15:30 9d1tv06n_301_1_1
-rw-r----- 1 oracle 54331 1019805696 Jun  5 15:31 9a1tv06m_298_1_1
-rw-r----- 1 oracle 54331    4612096 Jun  5 15:31 9e1tv0ld_302_1_1
-rw-r----- 1 oracle 54331  967163904 Jun  5 15:31 9b1tv06n_299_1_1
-rw-r----- 1 oracle 54331   31563776 Jun  5 15:31 9g1tv0lt_304_1_1
-rw-r----- 1 oracle 54331     319488 Jun  5 15:31 9h1tv0lt_305_1_1
-rw-r----- 1 oracle 54331     335872 Jun  5 15:31 9i1tv0m0_306_1_1
-rw-r----- 1 oracle 54331     565248 Jun  5 15:31 9k1tv0m1_308_1_1
-rw-r----- 1 oracle 54331     581632 Jun  5 15:31 9l1tv0m5_309_1_1
-rw-r----- 1 oracle 54331   54345728 Jun  5 15:31 9f1tv0lt_303_1_1
-rw-r----- 1 oracle 54331     368640 Jun  5 15:31 9n1tv0m5_311_1_1
-rw-r----- 1 oracle 54331     385024 Jun  5 15:31 9o1tv0m6_312_1_1
-rw-r----- 1 oracle 54331  985858048 Jun  5 15:31 9c1tv06n_300_1_1
-rw-r----- 1 oracle 54331      57344 Jun  5 15:31 9q1tv0m7_314_1_1
-rw-r----- 1 oracle 54331      57344 Jun  5 15:31 9r1tv0m8_315_1_1
-rw-r----- 1 oracle 54331      57344 Jun  5 15:31 9s1tv0m9_316_1_1
-rw-r--r-- 1 oracle 54331      12720 Jun  5 15:31 db1_ctl.sql
-rw-r----- 1 oracle 54331   11600384 Jun  5 15:48 bct_db1.ctf
[ec2-user@ip-172-30-15-124 ~]$

[oracle@ip-172-30-15-124 ~]$ ls -l
/nfsfsxn/archlog/DB1/archivelog/2023_06_05
total 2008864
-rw-r----- 1 oracle 54331    729088 Jun  5 14:38
o1_mf_1_190_l7vwvvt9_.arc
-rw-r----- 1 oracle 54331 166651904 Jun  5 14:44
o1_mf_1_191_l7vx6vmg_.arc
-rw-r----- 1 oracle 54331 167406080 Jun  5 14:47
o1_mf_1_192_l7vxctms_.arc
-rw-r----- 1 oracle 54331 166868992 Jun  5 14:49
o1_mf_1_193_l7vxjjps_.arc
-rw-r----- 1 oracle 54331 166087168 Jun  5 14:52
o1_mf_1_194_l7vxnxrh_.arc
-rw-r----- 1 oracle 54331 175210496 Jun  5 14:54
o1_mf_1_195_l7vxswv5_.arc
-rw-r----- 1 oracle 54331 167078400 Jun  5 14:57
o1_mf_1_196_l7vxylwp_.arc
-rw-r----- 1 oracle 54331 169701888 Jun  5 14:59
o1_mf_1_197_l7vy3cyw_.arc
-rw-r----- 1 oracle 54331 167845376 Jun  5 15:02
o1_mf_1_198_l7vy8245_.arc
-rw-r----- 1 oracle 54331 170763776 Jun  5 15:05
```

```
o1_mf_1_199_l7vydv4c_.arc
-rw-r----- 1 oracle 54331 193853440 Jun  5 15:07
o1_mf_1_200_l7vykf23_.arc
-rw-r----- 1 oracle 54331 165523968 Jun  5 15:09
o1_mf_1_201_l7vyp1dh_.arc
-rw-r----- 1 oracle 54331 161117184 Jun  5 15:12
o1_mf_1_202_l7vyvrm5_.arc
-rw-r----- 1 oracle 54331  10098176 Jun  5 15:21
o1_mf_1_203_l7vzdfwm_.arc
```

8. The recovery processes now are similar to previous use case of recovery to a new EC2 DB instance after a failure - set oracle environment (oratab, $ORACLE_HOME, $ORACLE_SID) to match with primary production instance, create an init file including db_recovery_file_dest_size and db_recovery_file_dest that point to flash recovery directory on FSx NFS mount. Then, lanuch RMAN to run recovery. Following are command steps and output.

```
[oracle@ip-172-30-15-124 dbs]$ rman target / nocatalog

Recovery Manager: Release 19.0.0.0.0 - Production on Wed Jun 7
14:44:33 2023
Version 19.18.0.0.0

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reserved.

connected to target database (not started)

RMAN> startup nomount;

Oracle instance started

Total System Global Area   10737418000 bytes

Fixed Size                     9174800 bytes
Variable Size               1577058304 bytes
Database Buffers            9126805504 bytes
Redo Buffers                  24379392 bytes

RMAN> set dbid = 1730530050;

executing command: SET DBID

RMAN> restore controlfile from autobackup;

Starting restore at 07-JUN-23
allocated channel: ORA_DISK_1
```

```
channel ORA_DISK_1: SID=2 device type=DISK

recovery area destination: /nfsfsxn/archlog/
database name (or database unique name) used for search: DB1
channel ORA_DISK_1: AUTOBACKUP
/nfsfsxn/archlog/DB1/autobackup/2023_06_05/o1_mf_s_1138721482_l7vzyb
vq_.bkp found in the recovery area
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230607
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230606
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20230605
channel ORA_DISK_1: restoring control file from AUTOBACKUP
/nfsfsxn/archlog/DB1/autobackup/2023_06_05/o1_mf_s_1138721482_l7vzyb
vq_.bkp
channel ORA_DISK_1: control file restore from AUTOBACKUP complete
output file name=/nfsfsxn/oracopy/db1.ctl
Finished restore at 07-JUN-23

RMAN> alter database mount;

released channel: ORA_DISK_1
Statement processed

RMAN> list incarnation;


List of Database Incarnations
DB Key  Inc Key DB Name  DB ID            STATUS  Reset SCN  Reset
Time
------- ------- -------- ---------------- --- ---------- ----------
1       1       DB1      1730530050       PARENT  1          17-APR-
19
2       2       DB1      1730530050       CURRENT 1920977    12-MAY-
23

RMAN> list copy of database tag 'OraCopyBKUPonFSxN_level_0';

List of Datafile Copies
=======================

Key     File S Completion Time Ckp SCN    Ckp Time        Sparse
------- ---- - --------------- ---------- --------------- ------
362     1    A 05-JUN-23       8319160    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-1_821tkrb8
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

363     3    A 05-JUN-23       8319165    01-JUN-23       NO
```

```
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-3_831tkrd9
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

365     4    A 05-JUN-23       8319171    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-4_851tkrgf
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

355     5    A 01-JUN-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-5_8d1tkril
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

349     6    A 01-JUN-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-6_891tkrhr
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

372     7    A 05-JUN-23       8319201    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
7_8h1tkrj9
        Tag: ORACOPYBKUPONFSXN_LEVEL_0

361     8    A 01-JUN-23       2383520    12-MAY-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-8_8g1tkrj7
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

364     9    A 05-JUN-23       8318717    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-9_8a1tkrhr
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

376     10   A 05-JUN-23       8318714    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-10_861tkrgo
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

377     11   A 05-JUN-23       8318720    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
```

```
UNDOTBS1_FNO-11_841tkrf2
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

375     12   A 05-JUN-23       8318719    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
12_8i1tkrj9
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

368     13   A 05-JUN-23       8319184    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-13_8b1tkril
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

366     14   A 05-JUN-23       8319175    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-14_871tkrhr
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

370     15   A 05-JUN-23       8319193    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-15_8e1tkril
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

373     16   A 05-JUN-23       8319206    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
16_8j1tkrja
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 4, PDB Name: DB1_PDB2

369     17   A 05-JUN-23       8319188    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSTEM_FNO-17_8c1tkril
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

367     18   A 05-JUN-23       8319180    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
SYSAUX_FNO-18_881tkrhr
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3
```

```
371     19   A 05-JUN-23       8319197    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-19_8f1tkrj4
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

374     20   A 05-JUN-23       8319210    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
20_8k1tkrjb
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 5, PDB Name: DB1_PDB3

378     21   A 05-JUN-23       8318720    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
21_7j1tkqk6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

388     22   A 05-JUN-23       8318714    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
22_7k1tkqk6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

384     23   A 05-JUN-23       8318717    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
23_7l1tkqk6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

389     24   A 05-JUN-23       8318719    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
24_7m1tkqk6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

381     25   A 05-JUN-23       8318720    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
25_7n1tkqrh
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

392     26   A 05-JUN-23       8318714    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
26_7o1tkqrj
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

385     27   A 05-JUN-23       8318717    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
27_7p1tkqrq
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

390     28   A 05-JUN-23       8318719    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
28_7q1tkqs1
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

380     29   A 05-JUN-23       8318720    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
29_7r1tkr32
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

391     30   A 05-JUN-23       8318714    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
30_7s1tkr3a
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

382     31   A 05-JUN-23       8318717    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
31_7t1tkr3i
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

387     32   A 05-JUN-23       8318719    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
32_7u1tkr42
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

383     33   A 05-JUN-23       8318719    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
33_7v1tkra6
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

379     34   A 05-JUN-23       8318717    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
```

```
34_801tkram
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

386     35   A 05-JUN-23       8318714    01-JUN-23       NO
        Name: /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
35_811tkrap
        Tag: ORACOPYBKUPONFSXN_LEVEL_0
        Container ID: 3, PDB Name: DB1_PDB1

RMAN> switch database to copy;

datafile 1 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-1_821tkrb8"
datafile 3 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-3_831tkrd9"
datafile 4 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-4_851tkrgf"
datafile 5 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-5_8d1tkril"
datafile 6 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSAUX_FNO-6_891tkrhr"
datafile 7 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-USERS_FNO-7_8h1tkrj9"
datafile 8 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-UNDOTBS1_FNO-8_8g1tkrj7"
datafile 9 switched to datafile copy "/nfsfsxn/oracopy/data_D-DB1_I-
1730530050_TS-SYSTEM_FNO-9_8a1tkrhr"
datafile 10 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-10_861tkrgo"
datafile 11 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-11_841tkrf2"
datafile 12 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-12_8i1tkrj9"
datafile 13 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-13_8b1tkril"
datafile 14 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-14_871tkrhr"
datafile 15 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-15_8e1tkril"
datafile 16 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-16_8j1tkrja"
datafile 17 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSTEM_FNO-17_8c1tkril"
datafile 18 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SYSAUX_FNO-18_881tkrhr"
```

```
datafile 19 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-UNDOTBS1_FNO-19_8f1tkrj4"
datafile 20 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-USERS_FNO-20_8k1tkrjb"
datafile 21 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-21_7j1tkqk6"
datafile 22 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-22_7k1tkqk6"
datafile 23 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-23_7l1tkqk6"
datafile 24 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-24_7m1tkqk6"
datafile 25 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-25_7n1tkqrh"
datafile 26 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-26_7o1tkqrj"
datafile 27 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-27_7p1tkqrq"
datafile 28 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-28_7q1tkqs1"
datafile 29 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-29_7r1tkr32"
datafile 30 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-30_7s1tkr3a"
datafile 31 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-31_7t1tkr3i"
datafile 32 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-32_7u1tkr42"
datafile 33 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-33_7v1tkra6"
datafile 34 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-34_801tkram"
datafile 35 switched to datafile copy "/nfsfsxn/oracopy/data_D-
DB1_I-1730530050_TS-SOE_FNO-35_811tkrap"

RMAN> run {
2> set until sequence 204;
3> recover database;
4> }

executing command: SET until clause

Starting recover at 07-JUN-23
using channel ORA_DISK_1

starting media recovery
```

```
archived log for thread 1 with sequence 190 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_190_l7vwvvt9_.arc
archived log for thread 1 with sequence 191 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_191_l7vx6vmg_.arc
archived log for thread 1 with sequence 192 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_192_l7vxctms_.arc
archived log for thread 1 with sequence 193 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_193_l7vxjjps_.arc
archived log for thread 1 with sequence 194 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_194_l7vxnxrh_.arc
archived log for thread 1 with sequence 195 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_195_l7vxswv5_.arc
archived log for thread 1 with sequence 196 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_196_l7vxylwp_.arc
archived log for thread 1 with sequence 197 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_197_l7vy3cyw_.arc
archived log for thread 1 with sequence 198 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_198_l7vy8245_.arc
archived log for thread 1 with sequence 199 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_199_l7vydv4c_.arc
archived log for thread 1 with sequence 200 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_200_l7vykf23_.arc
archived log for thread 1 with sequence 201 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_201_l7vyp1dh_.arc
archived log for thread 1 with sequence 202 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_202_l7vyvrm5_.arc
archived log for thread 1 with sequence 203 is already on disk as
file
/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_203_l7vzdfwm_.arc
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_190_l7vwvvt9
_.arc thread=1 sequence=190
archived log file
```

```
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_191_l7vx6vmg
_.arc thread=1 sequence=191
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_192_l7vxctms
_.arc thread=1 sequence=192
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_193_l7vxjjps
_.arc thread=1 sequence=193
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_194_l7vxnxrh
_.arc thread=1 sequence=194
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_195_l7vxswv5
_.arc thread=1 sequence=195
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_196_l7vxylwp
_.arc thread=1 sequence=196
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_197_l7vy3cyw
_.arc thread=1 sequence=197
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_198_l7vy8245
_.arc thread=1 sequence=198
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_199_l7vydv4c
_.arc thread=1 sequence=199
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_200_l7vykf23
_.arc thread=1 sequence=200
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_201_l7vyp1dh
_.arc thread=1 sequence=201
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_202_l7vyvrm5
_.arc thread=1 sequence=202
archived log file
name=/nfsfsxn/archlog/DB1/archivelog/2023_06_05/o1_mf_1_203_l7vzdfwm
_.arc thread=1 sequence=203
media recovery complete, elapsed time: 00:19:30
Finished recover at 07-JUN-23

RMAN> exit

Recovery Manager complete.
[oracle@ip-172-30-15-124 dbs]$ sqlplus / as sysdba
```

```
SQL*Plus: Release 19.0.0.0.0 - Production on Wed Jun 7 15:58:12 2023
Version 19.18.0.0.0

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Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 -
Production
Version 19.18.0.0.0

SQL> select member from v$logfile;

MEMBER
--------------------------------------------------------------------
------------
+DATA/DB1/ONLINELOG/group_3.264.1136666437
+DATA/DB1/ONLINELOG/group_2.263.1136666437
+DATA/DB1/ONLINELOG/group_1.262.1136666437

SQL> alter database rename file
'+DATA/DB1/ONLINELOG/group_1.262.1136666437' to
'/nfsfsxn/oracopy/redo01.log';

Database altered.

SQL> alter database rename file
'+DATA/DB1/ONLINELOG/group_2.263.1136666437' to
'/nfsfsxn/oracopy/redo02.log';

Database altered.

SQL> alter database rename file
'+DATA/DB1/ONLINELOG/group_3.264.1136666437' to
'/nfsfsxn/oracopy/redo03.log';

Database altered.

SQL> alter database noarchivelog;

Database altered.

SQL> alter database open resetlogs;

Database altered.

SQL> set lin 200;
SQL> select name from v$datafile
  2  union
  3  select name from v$controlfile
  4  union
  5  select name from v$tempfile
  6  union
  7  select member from v$logfile;

NAME
--------------------------------------------------------------------
--------------------
/nfsfsxn/oracopy/DB1/FB864A929AEB79B9E053630F1EAC7046/datafile/o1_mf
_temp_l81bhz6g_.tmp
/nfsfsxn/oracopy/DB1/FB867DA8C68C816EE053630F1EAC2BCF/datafile/o1_mf
_temp_l81bj16t_.tmp
/nfsfsxn/oracopy/DB1/FB867EA89ECF81C0E053630F1EACB901/datafile/o1_mf
_temp_l81bj135_.tmp
/nfsfsxn/oracopy/DB1/FB867F8A4D4F821CE053630F1EAC69CC/datafile/o1_mf
_temp_l81bj13g_.tmp
/nfsfsxn/oracopy/DB1/datafile/o1_mf_temp_l81bhwjg_.tmp
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-21_7j1tkqk6
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-22_7k1tkqk6
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-23_7l1tkqk6
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-24_7m1tkqk6
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-25_7n1tkqrh
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-26_7o1tkqrj

NAME
--------------------------------------------------------------------
--------------------
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-27_7p1tkqrq
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-28_7q1tkqs1
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-29_7r1tkr32
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-30_7s1tkr3a
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-31_7t1tkr3i
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-32_7u1tkr42
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-33_7v1tkra6
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-34_801tkram
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-35_811tkrap
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-10_861tkrgo
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-14_871tkrhr

NAME
--------------------------------------------------------------------
--------------------
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-18_881tkrhr
```

```
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-3_831tkrd9
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-6_891tkrhr
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-13_8b1tkril
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-17_8c1tkril
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-1_821tkrb8
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-5_8d1tkril
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-9_8a1tkrhr
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-11_841tkrf2
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-15_8e1tkril
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-19_8f1tkrj4

NAME
--------------------------------------------------------------------
---------------------
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-4_851tkrgf
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-UNDOTBS1_FNO-8_8g1tkrj7
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-12_8i1tkrj9
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-16_8j1tkrja
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-20_8k1tkrjb
/nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-7_8h1tkrj9
/nfsfsxn/oracopy/db1.ctl
/nfsfsxn/oracopy/redo01.log
/nfsfsxn/oracopy/redo02.log
/nfsfsxn/oracopy/redo03.log

43 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> alter session set container=db1_pdb1;

Session altered.

SQL> select * from test;

        ID DT
EVENT
----------
--------------------------------------------------------------------
-------
```

```
----------------------------------------------------------------
         1 18-MAY-23 02.35.37.000000 PM
test oracle incremental merge switch to copy
         2 30-MAY-23 05.23.11.000000 PM
test recovery on a new EC2 instance host with image copy on FSxN
         3 05-JUN-23 03.19.46.000000 PM
test clone on a new EC2 instance host with image copy on FSxN

SQL>
```

9. Rename the cloned database instance and change database ID with Oracle nid utility. The database instance state needs to be in `mount` to execute the command.

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

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
DB1       READ WRITE           NOARCHIVELOG

SQL> shutdown immediate;
Database closed.
Database dismounted.
ORACLE instance shut down.

SQL> startup mount;
ORACLE instance started.

Total System Global Area 1.0737E+10 bytes
Fixed Size                  9174800 bytes
Variable Size            1577058304 bytes
Database Buffers         9126805504 bytes
Redo Buffers               24379392 bytes
Database mounted.
SQL> exit
Disconnected from Oracle Database 19c Enterprise Edition Release
19.0.0.0.0 - Production
Version 19.18.0.0.0
[oracle@ip-172-30-15-124 dbs]$ nid target=/ dbname=db1tst

DBNEWID: Release 19.0.0.0.0 - Production on Wed Jun 7 16:15:14 2023

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reserved.

Connected to database DB1 (DBID=1730530050)
Connected to server version 19.18.0

Control Files in database:
    /nfsfsxn/oracopy/db1.ctl

Change database ID and database name DB1 to DB1TST? (Y/[N]) => Y

Proceeding with operation
Changing database ID from 1730530050 to 3054879890
Changing database name from DB1 to DB1TST
    Control File /nfsfsxn/oracopy/db1.ctl - modified
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-
1_821tkrb - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-
3_831tkrd - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-4_851tkrg - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-
5_8d1tkri - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-
6_891tkrh - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
7_8h1tkrj - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-8_8g1tkrj - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-
9_8a1tkrh - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-
10_861tkrg - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-11_841tkrf - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
12_8i1tkrj - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-
13_8b1tkri - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-
14_871tkrh - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
UNDOTBS1_FNO-15_8e1tkri - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
16_8j1tkrj - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSTEM_FNO-
17_8c1tkri - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SYSAUX_FNO-
18_881tkrh - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-
```

```
UNDOTBS1_FNO-19_8f1tkrj - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-USERS_FNO-
20_8k1tkrj - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
21_7j1tkqk - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
22_7k1tkqk - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
23_7l1tkqk - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
24_7m1tkqk - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
25_7n1tkqr - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
26_7o1tkqr - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
27_7p1tkqr - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
28_7q1tkqs - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
29_7r1tkr3 - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
30_7s1tkr3 - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
31_7t1tkr3 - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
32_7u1tkr4 - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
33_7v1tkra - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
34_801tkra - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/data_D-DB1_I-1730530050_TS-SOE_FNO-
35_811tkra - dbid changed, wrote new name
    Datafile /nfsfsxn/oracopy/DB1/datafile/o1_mf_temp_l81bhwjg_.tm -
dbid changed, wrote new name
    Datafile
/nfsfsxn/oracopy/DB1/FB864A929AEB79B9E053630F1EAC7046/datafile/o1_mf
_temp_l81bhz6g_.tm - dbid changed, wrote new name
    Datafile
/nfsfsxn/oracopy/DB1/FB867DA8C68C816EE053630F1EAC2BCF/datafile/o1_mf
_temp_l81bj16t_.tm - dbid changed, wrote new name
    Datafile
/nfsfsxn/oracopy/DB1/FB867EA89ECF81C0E053630F1EACB901/datafile/o1_mf
_temp_l81bj135_.tm - dbid changed, wrote new name
    Datafile
/nfsfsxn/oracopy/DB1/FB867F8A4D4F821CE053630F1EAC69CC/datafile/o1_mf
```

```
_temp_l81bj13g_.tm - dbid changed, wrote new name
    Control File /nfsfsxn/oracopy/db1.ctl - dbid changed, wrote new
name
    Instance shut down

Database name changed to DB1TST.
Modify parameter file and generate a new password file before
restarting.
Database ID for database DB1TST changed to 3054879890.
All previous backups and archived redo logs for this database are
unusable.
Database is not aware of previous backups and archived logs in
Recovery Area.
Database has been shutdown, open database with RESETLOGS option.
Succesfully changed database name and ID.
DBNEWID - Completed succesfully.
```

10. Change Oracle database environment configuration to new database name or instance ID in oratab, init file, and create necessary admin directories that match with new instance ID. Then, start the instance with resetlogs option.

```
SQL> startup mount;
ORACLE instance started.

Total System Global Area 1.0737E+10 bytes
Fixed Size                  9174800 bytes
Variable Size            1577058304 bytes
Database Buffers         9126805504 bytes
Redo Buffers               24379392 bytes
Database mounted.
SQL> alter database open resetlogs;

Database altered.

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

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
DB1TST    READ WRITE           NOARCHIVELOG

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 DB1_PDB1                       MOUNTED
         4 DB1_PDB2                       MOUNTED
         5 DB1_PDB3                       MOUNTED
SQL> alter pluggable database all open;

Pluggable database altered.

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>
```

This completes the clone of a new Oracle instance from staging database copy on FSx NFS mount for DEV, UAT, or any other use cases. Multiple Oracle instances can be cloned off the same staging image copy.

> If you run into error `RMAN-06571: datafile 1 does not have recoverable copy` when switching the database to copy, check database incarnation that matches with primary production DB. If needed, reset the incarnation to match with primary with RMAN command `reset database to incarnation n;`.

Where to find additional information

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

- RMAN: Merged Incremental Backup Strategies (Doc ID 745798.1)

  https://support.oracle.com/knowledge/Oracle%20Database%20Products/745798_1.html

- RMAN Backup and Recovery User's Guide

  https://docs.oracle.com/en/database/oracle/oracle-database/19/bradv/getting-started-rman.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-8225-4784bced9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIsAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixF-xnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

TR-4974: Oracle 19c in Standalone Restart on AWS FSx/EC2 with NFS/ASM

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for Oracle database deployment and protection in AWS FSx ONTAP storage and EC2 compute instance with NFS protocol and Oracle database configured in standalone ReStart using asm as volume manager.

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.

Oracle ASM is generally deployed in FC, iSCSI storage protocols and luns as raw storage devices. However, ASM on NFS protocol and NFS file system is also supported configuration by Oracle. In this documentation, we demonstrate how to deploy an Oracle 19c database with the NFS 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 NFS/ASM
- Testing and validating an Oracle workload in the public AWS cloud with NFS/ASM
- Testing and validating Oracle database Restart functionalities deployed in AWS

Audience

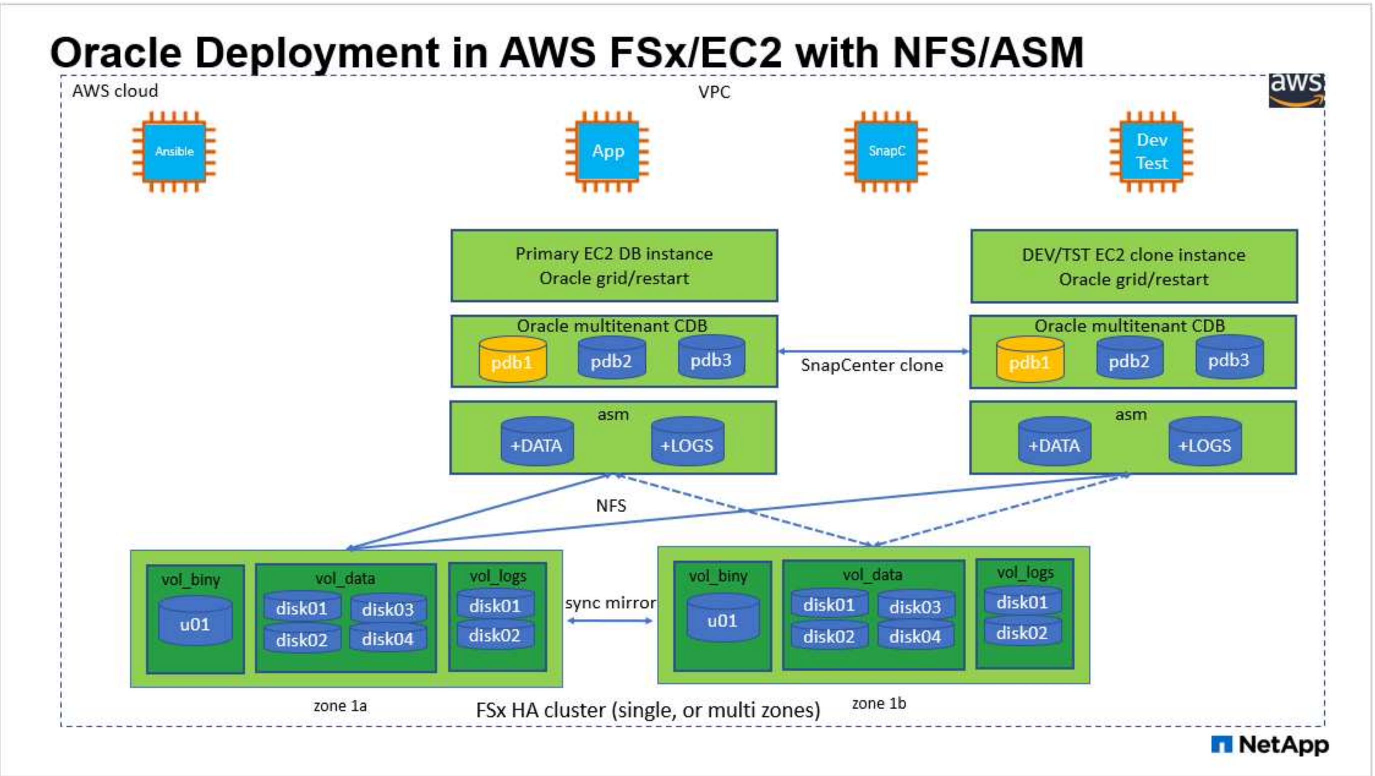
This solution is intended for the following people:

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

Solution test and validation environment

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

Architecture



Hardware and software components

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

Key factors for deployment consideration

- **EC2 compute instances.** In these tests and validations, we used an AWS EC2 t2.xlarge instance type for the Oracle database compute instance. NetApp recommends using an M5 type EC2 instance as the compute instance for Oracle in production deployment because it is optimized for database workloads. You need to size the EC2 instance appropriately for the number of vCPUs and the amount of RAM based on actual workload requirements.
- **FSx storage HA clusters single- or multi-zone deployment.** In these tests and validations, we deployed an FSx HA cluster in a single AWS availability zone. For production deployment, NetApp recommends deploying an FSx HA pair in two different availability zones. An FSx HA cluster is alway provisioned in a HA pair that is sync mirrored in a pair of active-passive file systems to provide storage-level redundancy. Multi-zone deployment further enhances high availability in the event of failure in a single AWS zone.
- **FSx storage cluster sizing.** An Amazon FSx for ONTAP storage file system provides up to 160,000 raw SSD IOPS, up to 4GBps throughput, and a maximum of 192TiB capacity. However, you can size the cluster in terms of provisioned IOPS, throughput, and the storage limit (minimum 1,024 GiB) based on your actually requirements at the time of deployment. The capacity can be adjusted dynamically on the fly without affecting application availability.
- **Oracle data and logs layout.** In our tests and validations, we deployed two ASM disk groups for data and logs respectively. Within the +DATA asm disk group, we provisioned four disks in a data NFS file system mount point. Within the +LOGS asm disk group, we provisioned two disks in a logs NFS file system mount point. For large database deployment, ASM disk groups can be built to span multiple FSx file systems with ASM NFS disks distributed through multiple NFS mount points anchored on FSx file systems. This particular setup is designed to meet database throughput over 4GBps throughput and 160,000 raw SSD IOPS requirement.
- **dNFS configuration.** dNFS is built into Oracle kernel and is known to dramatically increase Oracle

database performance when Oracle is deployed to NFS storage. dNFS is packaged into Oracle binary but is not turned on by default. It should be turned on for any Oracle database deployment on NFS. For multiple FSx file systems deployment for large database, dNFS multi-path should be 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 `ONLY` use External Redundancy, which means that the option does not allow Oracle ASM to mirror the contents of the disk group. This is particularly important as NFS for Oracle database data storage requires HARD NFS mount option which is NOT desirable for mirroring ASM contents on the Oracle level.
- **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 nfs-utils.

```
yum install nfs-utils
```

9. 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
```

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

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

11. 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"
```

12. 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.
13. Add the ASM group to be used for the asm sysasm group

```
groupadd asm
```

14. 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
```

15. Reboot the EC2 instance.

Provision and export NFS volumes to be mounted to EC2 instance host

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

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

   ```
   ssh fsxadmin@172.30.15.53
   ```

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

   ```
   vol create -volume ora_01_biny -aggregate aggr1 -size 50G -state
   online  -type RW -junction-path /ora_01_biny -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 -junction-path /ora_01_data -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 -junction-path /ora_01_logs -snapshot-policy none
   -tiering-policy snapshot-only
   ```

5. Validate the DB volumes created.

   ```
   vol show
   ```

   This is expected to return:

```
FsxId02ad7bf3476b741df::> vol show
  (vol show)
FsxId06c3c8b2a7bd56458::> vol show
Vserver   Volume       Aggregate    State      Type       Size
Available Used%
--------- ------------ ------------ ---------- ---- ----------
---------- -----
svm_ora   ora_01_biny  aggr1        online     RW         50GB
47.50GB    0%
svm_ora   ora_01_data  aggr1        online     RW        100GB
95.00GB    0%
svm_ora   ora_01_logs  aggr1        online     RW        100GB
95.00GB    0%
svm_ora   svm_ora_root aggr1        online     RW          1GB
972.1MB    0%
4 entries were displayed.
```

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. Create /u01 directory to mount Oracle binary file system

   ```
   sudo mkdir /u01
   ```

3. Mount the binary volume to `/u01`, changed to your FSx NFS lif IP address. If you deployed FSx cluster via NetApp automation toolkit, FSx virtual storage server NFS lif IP address will be listed in the output at the end of resources provision execution. Otherwise, it can be retrieved from AWS FSx console UI.

   ```
   sudo mount -t nfs 172.30.15.19:/ora_01_biny /u01 -o
   rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536
   ```

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

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

5. Create /oradata directory to mount Oracle data file system

   ```
   sudo mkdir /oradata
   ```

6. Mount the data volume to `/oradata`, changed to your FSx NFS lif IP address

   ```
   sudo mount -t nfs 172.30.15.19:/ora_01_data /oradata -o
   rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536
   ```

7. Change `/oradata` mount point ownership to the Oracle user and it's associated primary group.

   ```
   sudo chown oracle:oinstall /oradata
   ```

8. Create /oralogs directory to mount Oracle logs file system

   ```
   sudo mkdir /oralogs
   ```

9. Mount the log volume to `/oralogs`, changed to your FSx NFS lif IP address

   ```
   sudo mount -t nfs 172.30.15.19:/ora_01_logs /oralogs -o
   rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536
   ```

10. Change `/oralogs` mount point ownership to the Oracle user and it's associated primary group.

    ```
    sudo chown oracle:oinstall /oralogs
    ```

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

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

    Add the following line.

    ```
    172.30.15.19:/ora_01_biny       /u01            nfs
    rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536   0
    0
    172.30.15.19:/ora_01_data       /oradata        nfs
    rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536   0
    0
    172.30.15.19:/ora_01_logs       /oralogs        nfs
    rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536   0
    0
    ```

12. sudo to oracle user, create asm folders to store asm disk files

    ```
    sudo su
    su - oracle
    mkdir /oradata/asm
    mkdir /oralogs/asm
    ```

13. As the oracle user, create asm data disk files, change the count to match to the disk size with block size.

```
dd if=/dev/zero of=/oradata/asm/nfs_data_disk01 bs=1M count=20480
oflag=direct
dd if=/dev/zero of=/oradata/asm/nfs_data_disk02 bs=1M count=20480
oflag=direct
dd if=/dev/zero of=/oradata/asm/nfs_data_disk03 bs=1M count=20480
oflag=direct
dd if=/dev/zero of=/oradata/asm/nfs_data_disk04 bs=1M count=20480
oflag=direct
```

14. As the root user, change data disk file permission to 640

```
chmod 640 /oradata/asm/*
```

15. AS the oracle user, create asm logs disk files, change to count to match to the disk size with block size.

```
dd if=/dev/zero of=/oralogs/asm/nfs_logs_disk01 bs=1M count=40960
oflag=direct
dd if=/dev/zero of=/oralogs/asm/nfs_logs_disk02 bs=1M count=40960
oflag=direct
```

16. As the root user, change logs disk file permission to 640

```
chmod 640 /oralogs/asm/*
```

17. 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 infomation:

```
INVENTORY_LOCATION=/u01/app/oraInventory
oracle.install.option=HA_CONFIG
ORACLE_BASE=/u01/app/oracle
oracle.install.asm.OSDBA=dba
oracle.install.asm.OSOPER=oper
oracle.install.asm.OSASM=asm
oracle.install.asm.SYSASMPassword="SetPWD"
oracle.install.asm.diskGroup.name=DATA
oracle.install.asm.diskGroup.redundancy=EXTERNAL
oracle.install.asm.diskGroup.AUSize=4
oracle.install.asm.diskGroup.disks=/oradata/asm/*,/oralogs/asm/*
oracle.install.asm.diskGroup.diskDiscoveryString=/oradata/asm/nfs_da
ta_disk01,/oradata/asm/nfs_data_disk02,/oradata/asm/nfs_data_disk03,
/oradata/asm/nfs_data_disk04
oracle.install.asm.monitorPassword="SetPWD"
oracle.install.asm.configureAFD=false
```

12. Log into the EC2 instance as the root user.
13. 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
```

14. 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
```

15. 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.

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

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

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

17. 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
```

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

```
bin/asmca -silent -sysAsmPassword 'yourPWD' -asmsnmpPassword
'yourPWD' -createDiskGroup -diskGroupName LOGS -disk
'/oralogs/asm/nfs_logs_disk*' -redundancy EXTERNAL -au_size 4
```

19. 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
```

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 sofware-only installation.

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

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

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

ⓘ Set the total memory based on available memory in EC2 instance host. Oracle allocates 75% of `totalMemory` to DB instance SGA or buffer cache.

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
      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.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.evmd
      1        ONLINE  ONLINE       ip-172-30-15-58          STABLE
--------------------------------------------------------------------
------------
[oracle@ip-172-30-15-58 db1]$
```

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.

```
. ~/.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. As oracle user, change to Oracle database home directory /u01/app/oracle/product/19.0.0/db1 and Enable dNFS

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

mkdir rdbms/lib/odm

cp lib/libnfsodm19.so rdbms/lib/odm/
```

18. Configure oranfstab file in ORACLE_HOME

```
vi $ORACLE_HOME/dbs/oranfstab

add following entries:

server: fsx_01
local: 172.30.15.58 path: 172.30.15.19
nfs_version: nfsv3
export: /ora_01_biny mount: /u01
export: /ora_01_data mount: /oradata
export: /ora_01_logs mount: /oralogs
```

19. As oracle user, login to database from sqlplus and set the DB recovery size and location to the +LOGS disk group.

```
. ~/.bash_profile

sqlplus / as sysdba

alter system set db_recovery_file_dest_size = 80G scope=both;

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

20. Enable archive log mode and reboot Oracle DB instance

```
shutdown immediate;

startup mount;

alter database archivelog;

alter database open;

alter system switch logfile;
```

21. Validate DB log mode and dNFS after instance reboot

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

NAME      LOG_MODE
--------- ------------
DB1       ARCHIVELOG

SQL> select svrname, dirname from v$dnfs_servers;

SVRNAME
--------------------------------------------------------------------
------------
DIRNAME
--------------------------------------------------------------------
------------
fsx_01
/ora_01_data

fsx_01
/ora_01_biny

fsx_01
/ora_01_logs
```

22. Validate Oracle ASM

```
[oracle@ip-172-30-15-58 db1]$ asm
[oracle@ip-172-30-15-58 db1]$ sqlplus / as sysasm

SQL*Plus: Release 19.0.0.0.0 - Production on Tue May 9 20:39:39 2023
Version 19.18.0.0.0

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Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 -
Production
Version 19.18.0.0.0

SQL> set lin 200
SQL> col path form a30
SQL> select name, path, header_status, mount_status, state from
v$asm_disk;

NAME                           PATH
```

```
HEADER_STATU MOUNT_S STATE
------------------------------ ------------------------------
------------ ------- --------
DATA_0002                      /oradata/asm/nfs_data_disk01   MEMBER
CACHED  NORMAL
DATA_0000                      /oradata/asm/nfs_data_disk02   MEMBER
CACHED  NORMAL
DATA_0001                      /oradata/asm/nfs_data_disk03   MEMBER
CACHED  NORMAL
DATA_0003                      /oradata/asm/nfs_data_disk04   MEMBER
CACHED  NORMAL
LOGS_0000                      /oralogs/asm/nfs_logs_disk01   MEMBER
CACHED  NORMAL
LOGS_0001                      /oralogs/asm/nfs_logs_disk02   MEMBER
CACHED  NORMAL

6 rows selected.


SQL> select name, state, ALLOCATION_UNIT_SIZE, TOTAL_MB, FREE_MB
from v$asm_diskgroup;

NAME                           STATE       ALLOCATION_UNIT_SIZE
TOTAL_MB    FREE_MB
------------------------------ ----------- --------------------
---------- ----------
DATA                           MOUNTED                  4194304
81920      73536
LOGS                           MOUNTED                  4194304
81920      81640

This completes Oracle 19c version 19.18 Restart deployment on an
Amazon FSx for ONTAP and EC2 compute instance with NFS/ASM. 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

At this moment, Oracle database with NFS and ASM storage option is only supported by traditional SnapCenter Server UI tool See Hybrid Cloud Database Solutions with SnapCenter for details on Oracle database backup, restore, and clone with NetApp SnapCenter UI tool.

Where to find additional information

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

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

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

- Installing and Configuring Oracle Database Using Response Files

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

- Amazon FSx for NetApp ONTAP

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

- Amazon EC2

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

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

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for Oracle database deployment and protection in AWS FSx ONTAP storage and EC2 compute instance with iSCSI protocol and Oracle database configured in standalone ReStart using asm as volume manager.

Purpose

ASM (Automatic Storage Management) is a popular Oracle storage volume manager 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 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 Oracle database deployment. However, as the name implies, when Oracle deployed in Restart mode, failed Oracle services restarted automatically by grid infrastructure or after a host reboot without user intervention, which provides a certain degree of high availability or HA functionality.

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

This solution addresses the following use cases:

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

Audience

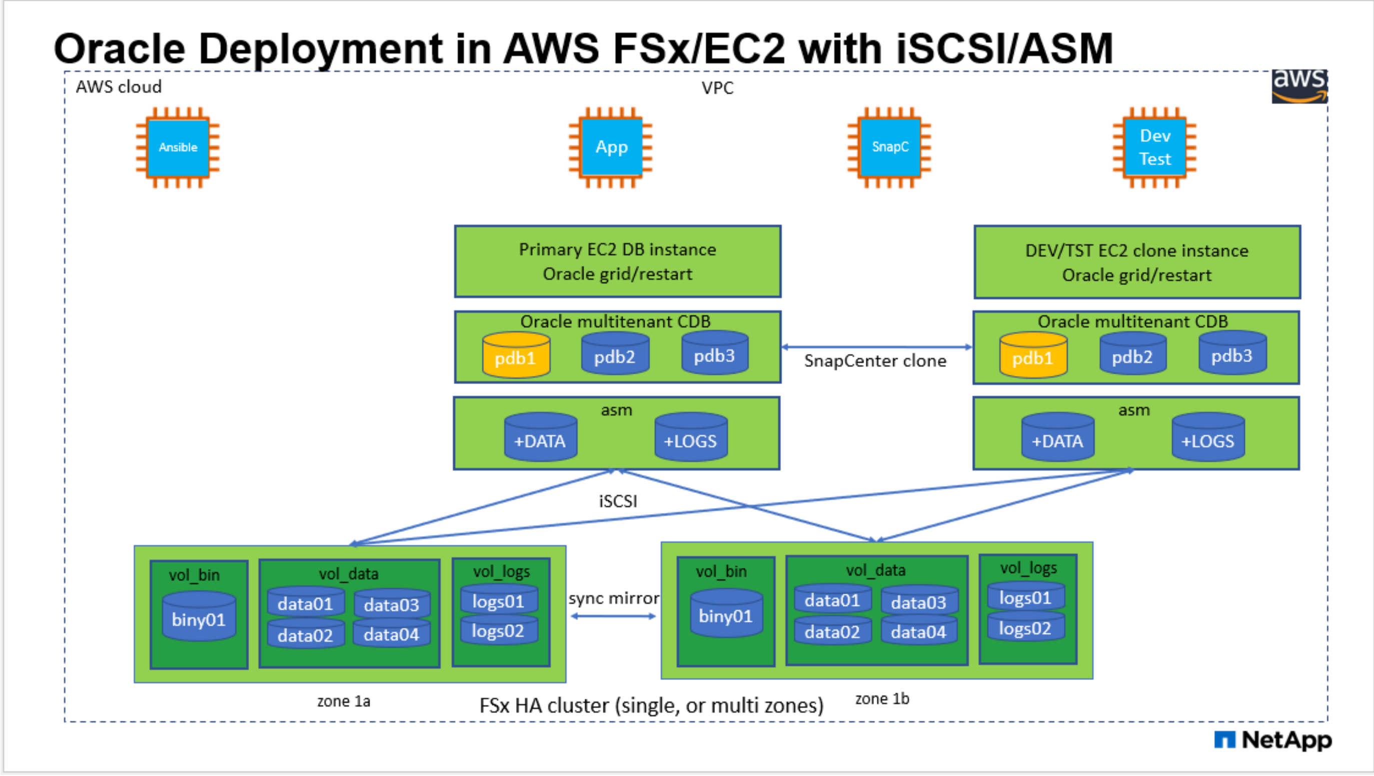
This solution is intended for the following people:

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

Solution test and validation environment

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

Architecture



Hardware and software components

	Hardware	
FSx ONTAP storage	Current version offered by AWS	One FSx HA cluster in the same VPC and availability zone

EC2 instance for compute	t2.xlarge/4vCPU/16G	Two EC2 T2 xlarge EC2 instances, one as primary DB server and the other as a clone DB server
	Software	
RedHat Linux	RHEL-8.6.0_HVM-20220503-x86_64-2-Hourly2-GP2	Deployed RedHat subscription for testing
Oracle Grid Infrastructure	Version 19.18	Applied RU patch p34762026_190000_Linux-x86-64.zip
Oracle Database	Version 19.18	Applied RU patch p34765931_190000_Linux-x86-64.zip
Oracle OPatch	Version 12.2.0.1.36	Latest patch p6880880_190000_Linux-x86-64.zip
SnapCenter Service	Version	v2.3.1.2324

Key factors for deployment consideration

- **EC2 compute instances.** In these tests and validations, we used an AWS EC2 t2.xlarge instance type for the Oracle database compute instance. NetApp recommends using an M5 type EC2 instance as the compute instance for Oracle in production deployment because it is optimized for database workloads. You need to size the EC2 instance appropriately for the number of vCPUs and the amount of RAM based on actual workload requirements.
- **FSx storage HA clusters single- or multi-zone deployment.** In these tests and validations, we deployed an FSx HA cluster in a single AWS availability zone. For production deployment, NetApp recommends deploying an FSx HA pair in two different availability zones. An FSx HA cluster is alway provisioned in a HA pair that is sync mirrored in a pair of active-passive file systems to provide storage-level redundancy. Multi-zone deployment further enhances high availability in the event of failure in a single AWS zone.
- **FSx storage cluster sizing.** An Amazon FSx for ONTAP storage file system provides up to 160,000 raw SSD IOPS, up to 4GBps throughput, and a maximum of 192TiB capacity. However, you can size the cluster in terms of provisioned IOPS, throughput, and the storage limit (minimum 1,024 GiB) based on your actually requirements at the time of deployment. The capacity can be adjusted dynamically on the fly without affecting application availability.
- **Oracle data and logs layout.** In our tests and validations, we deployed two ASM disk groups for data and logs respectively. Within the +DATA asm disk group, we provisioned four LUNs in a data volume. Within the +LOGS asm disk group, we provisioned two LUNs in a logs volume. In general, multiple LUNs laid out within an Amazon FSx for ONTAP volume provides better performance.
- **iSCSI configuration.** The EC2 instance database server connects to FSx storage with the iSCSI protocol. EC2 instances generally deploy with a single network interface or ENI. The single NIC interface carries both iSCSI and application traffic. It is important to gauge the Oracle database 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.timeo.replacement_timeout` in the `iscsi.conf` configuration file from 120 to 5 seconds.

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

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

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

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

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

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

```
groupadd asm
```

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

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

20. Stop and disable Linux firewall if it is active.

```
systemctl stop firewalld
systemctl disable firewalld
```

21. Reboot the EC2 instance.

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

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

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

   ```
   ssh fsxadmin@172.30.15.53
   ```

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

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

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

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

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

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

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

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

6. Create data LUNs within the database data volume.

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

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

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

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

7. Create log LUNs within the database logs volume.

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

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

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

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

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

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

10. Validate the LUN mapping.

```
mapping show
```

This is expected to return:

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

Database storage configuration

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

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

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

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

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

3. Establish iSCSI sessions by logging into each target.

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

The expected output from the command is:

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

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

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

Return the iSCSI sessions.

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

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

```
sudo sanlun lun show
```

This will return a list of Oracle LUNs from FSx.

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

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

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

```
sudo vi /etc/multipath.conf

defaults {
    find_multipaths yes
    user_friendly_names yes
}

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

7. Start the multipath service.

   ```
   sudo systemctl start multipathd
   ```

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

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

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

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

and return as follow:

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

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

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

with following entries:

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

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

    ```
    sudo systemctl restart multipathd
    ```

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

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

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

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

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

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

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

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

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

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

15. Find the UUI of the binary LUN.

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

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

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

Add the following line.

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

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

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

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

Include following entries:

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

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

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

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

```
udevadm trigger
```

20. As the root user, reload multipathd.

```
systemctl restart multipathd
```

21. Reboot the EC2 instance host.

Oracle grid infrastructure installation

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

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

2. Restart the sshd service.

   ```
   sudo systemctl restart sshd
   ```

3. Reset the Oracle user password.

   ```
   sudo passwd oracle
   ```

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

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

5. Change the directory permission setting.

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

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

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

7. Unzip the grid installation files.

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

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

   ```
   rm -rf OPatch
   ```

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

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

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

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

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

```
INVENTORY_LOCATION=/u01/app/oraInventory
oracle.install.option=HA_CONFIG
ORACLE_BASE=/u01/app/oracle
oracle.install.asm.OSDBA=dba
oracle.install.asm.OSOPER=oper
oracle.install.asm.OSASM=asm
oracle.install.asm.SYSASMPassword="SetPWD"
oracle.install.asm.diskGroup.name=DATA
oracle.install.asm.diskGroup.redundancy=EXTERNAL
oracle.install.asm.diskGroup.AUSize=4
oracle.install.asm.diskGroup.disks=/dev/mapper/ora_01_data_01,/dev/mapper/ora_01_data_02,/dev/mapper/ora_01_data_03,/dev/mapper/ora_01_data_04
oracle.install.asm.diskGroup.diskDiscoveryString=/dev/mapper/*
oracle.install.asm.monitorPassword="SetPWD"
oracle.install.asm.configureAFD=true
```

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

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

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

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

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

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

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

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

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

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

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

15. Unset `$ORACLE_BASE`.

```
unset ORACLE_BASE
```

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

```
unzip /tmp/archive/p34762026_190000_Linux-x86-64.zip -d /tmp/archive
```

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

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

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

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

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

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

19. As root user, reload the multipathd.

```
systemctl restart multipathd
```

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

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

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

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

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

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

23. Valiate ASM filter driver status.

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

Oracle database installation

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

```
unset ORACLE_HOME
unset ORACLE_SID
```

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

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

3. Unzip the Oracle DB installation files.

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

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

```
rm -rf OPatch
```

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Name            Target  State        Server                   State
details

Local Resources

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

Cluster Resources

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

14. Set the Oracle user `.bash_profile`.

```
vi ~/.bash_profile
```

15. Add following entries:

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

16. Validate the CDB/PDB created.

```
/home/oracle/.bash_profile

sqlplus / as sysdba
```

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

NAME      OPEN_MODE

DB1       READ WRITE

SQL> select name from v$datafile;

NAME

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

NAME

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

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

19 rows selected.

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED

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

17. Set the DB recovery destination size to the +LOGS disk group size.

```
alter system set db_recovery_file_dest_size = 80G 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

Refer to TR-4986: Simplified, Automated Oracle Deployment on Amazon FSx ONTAP with iSCSI for details.

Oracle Database backup, restore, and clone with SnapCenter Service

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

Where to find additional information

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

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

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

- Installing and Configuring Oracle Database Using Response Files

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

- Amazon FSx for NetApp ONTAP

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

- Amazon EC2

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

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:

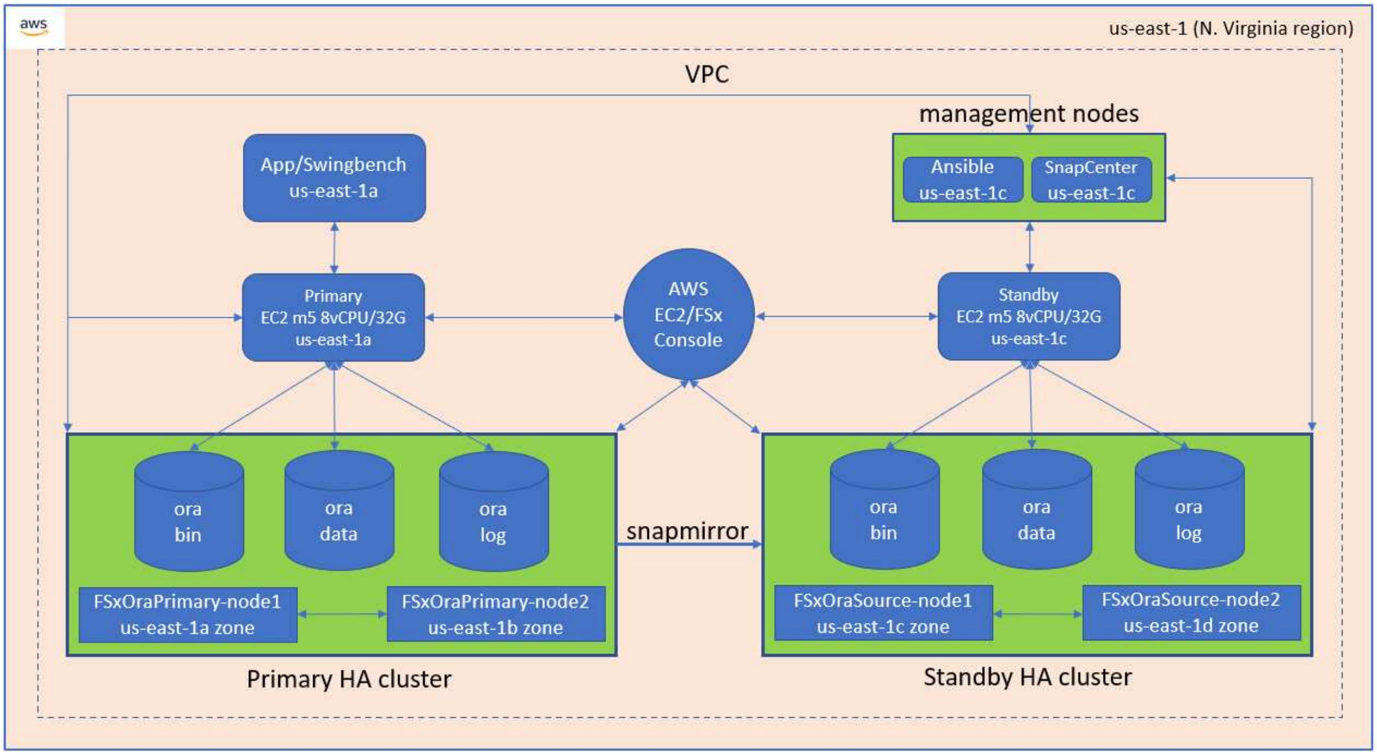
Modernize your Oracle database with hybrid cloud in AWS and FSx ONTAP, Part1 - Use case and solution architecture

Solution architecture

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.

Factors to consider for Oracle database deployment

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

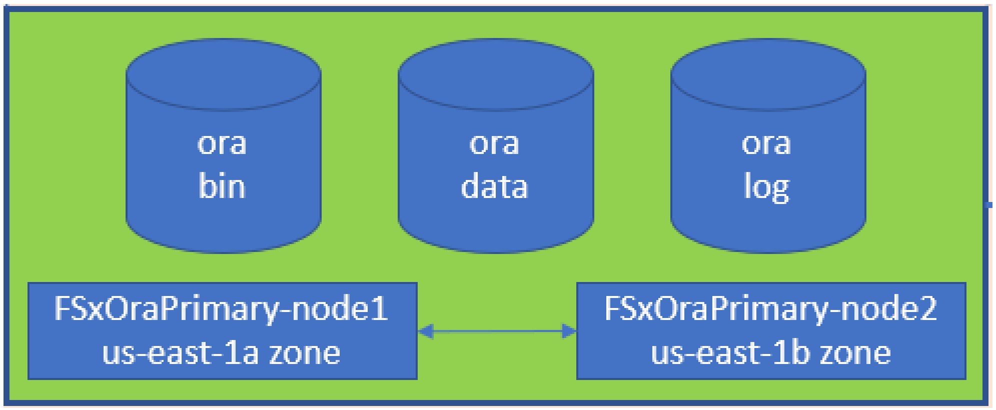
Selecting the right VM size is important for optimal performance of a relational database in a public cloud. For better performance, NetApp recommends using an EC2 M5 Series instance for Oracle deployment, which is optimized for database workloads. The same instance type is also used to power a RDS instance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

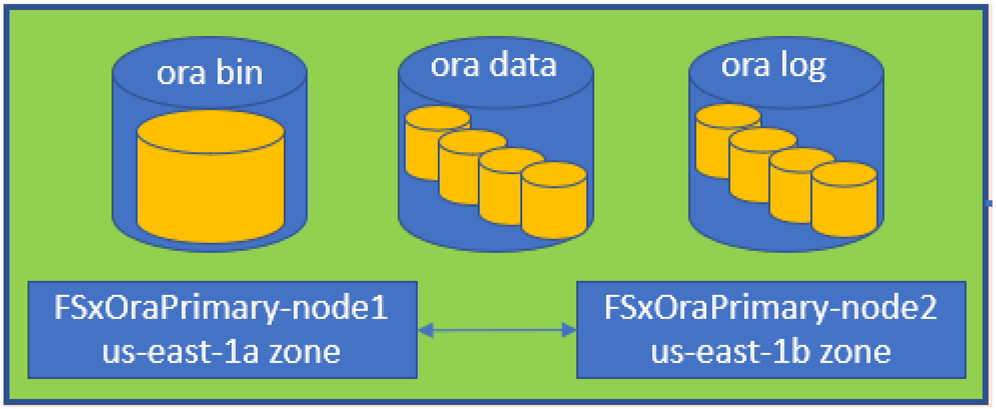
Storage layout and settings

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, 2045 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. dNFS is supported with NFSv3 with all versions of Oracle. NFSv4 is supported with all OS's that follow the NFSv4 standard. dNFS support for NFSv4 requires Oracle 12.1.0.2 or higher. NFSv4.1 requires specific OS support. Consult the NetApp Interoperability Matrix Tool (IMT) for supported OS's. dNFS support for NFSv4.1 requires Oracle version 19.3.0.0 or higher.

Automated Oracle deployment using the NetApp automation toolkit automatically configures dNFS on NFSv3.

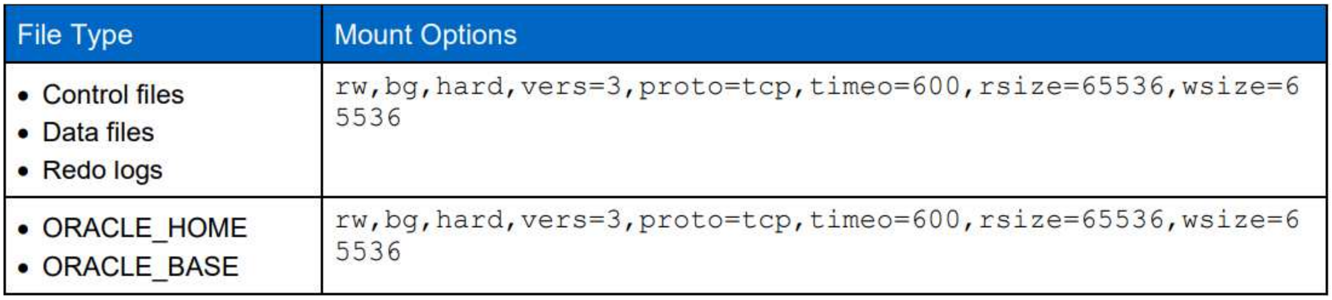
Other factors to consider:

- 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	`rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536`
• ORACLE_HOME • ORACLE_BASE	`rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536`

Before using dNFS, verify that the patches described in Oracle Doc 1495104.1 are installed. The NetApp Support matrix for NFSv3 and NFSv4 do not include specific operating systems. All OSs that obey the RFC are supported. When searching the online IMT for NFSv3 or NFSv4 support, do not select a specific OS because no matches will be displayed. All OSs are implicitly supported by the general policy.

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.

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

This section describes the deployment procedures of deploying Oracle RDS custom database with FSx storage.

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:

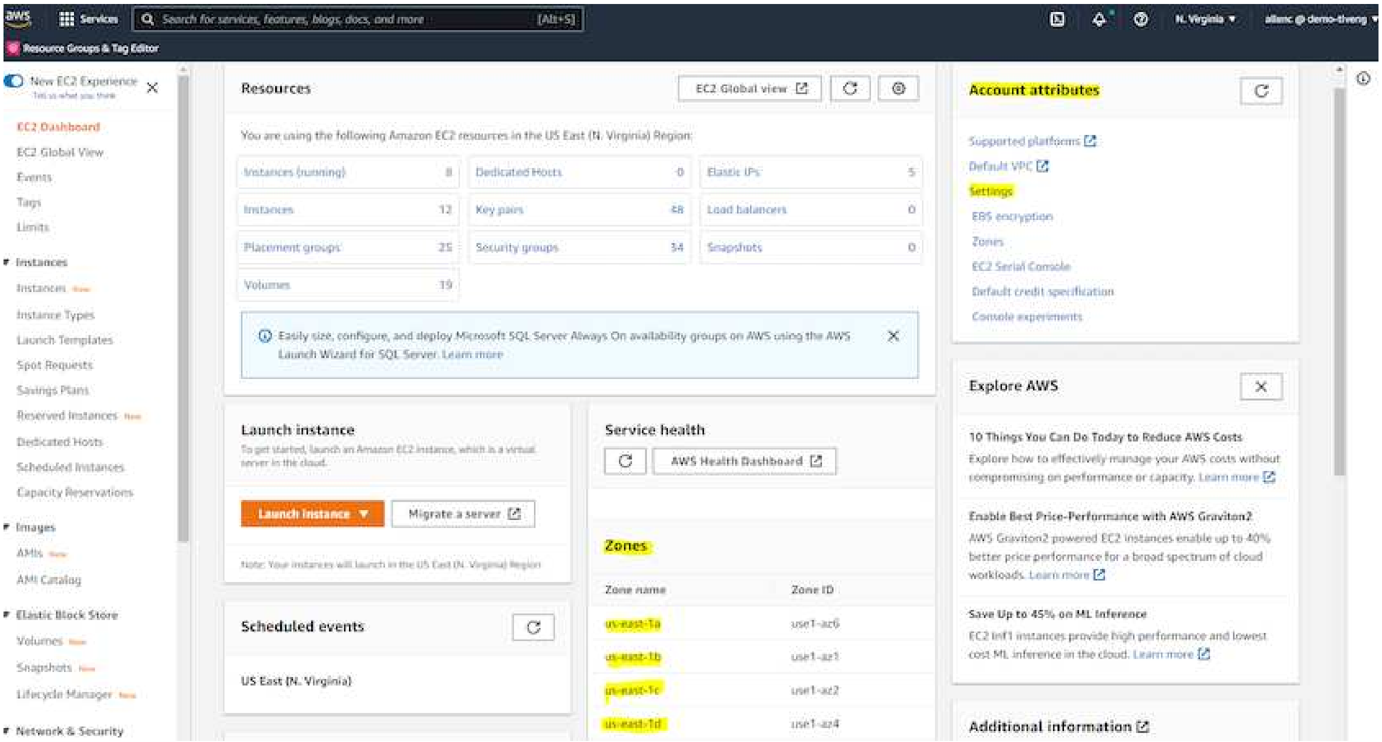
- Set up to use Amazon EC2

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.



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

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				

Easily size, configure, and deploy Microsoft SQL Server Always On availability groups on AWS using the AWS Launch Wizard for SQL Server. Learn more

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

Note: Your instances will launch in the US East (N. Virginia) Region

US East (N. Virginia)

Zones

Zone name	Zone ID
us-east-1a	use1-az6
us-east-1b	use1-az1
us-east-1c	use1-az2
us-east-1d	use1-az4

10 Things You Can Do Today to Reduce AWS Costs
Explore how to effectively manage your AWS costs without compromising on performance or capacity. Learn more

Enable Best Price-Performance with AWS Graviton2
AWS Graviton2 powered EC2 instances enable up to 40% better price performance for a broad spectrum of cloud workloads. Learn more

Save Up to 45% on ML Inference
EC2 Inf1 instances provide high performance and lowest cost ML inference in the cloud. Learn more

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.

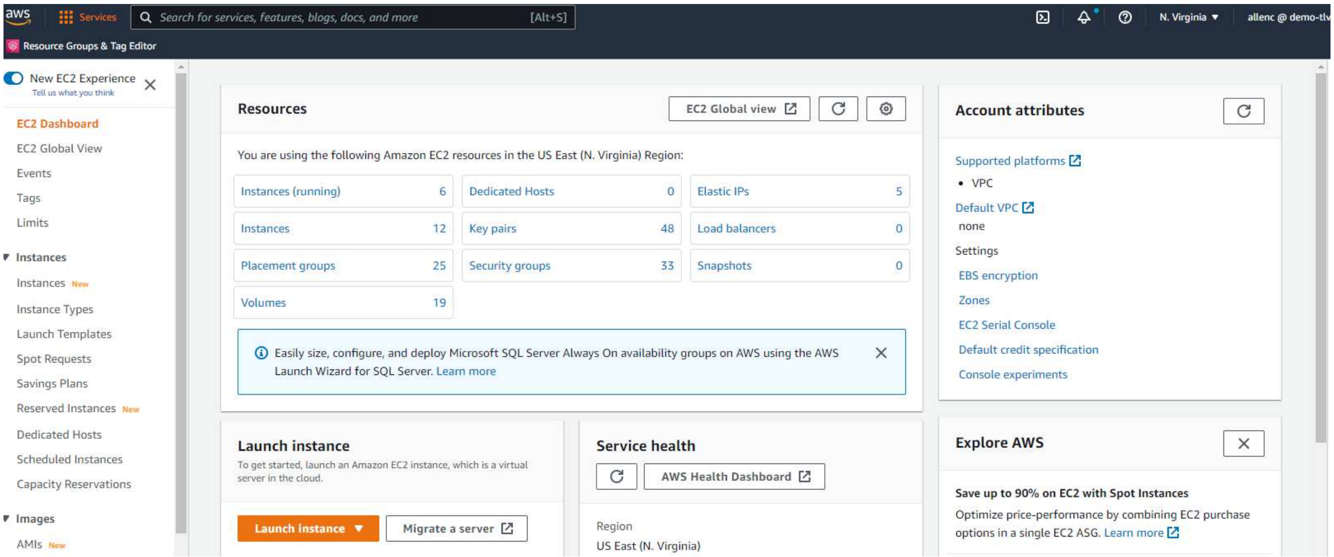
Key topics:

- 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.



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				

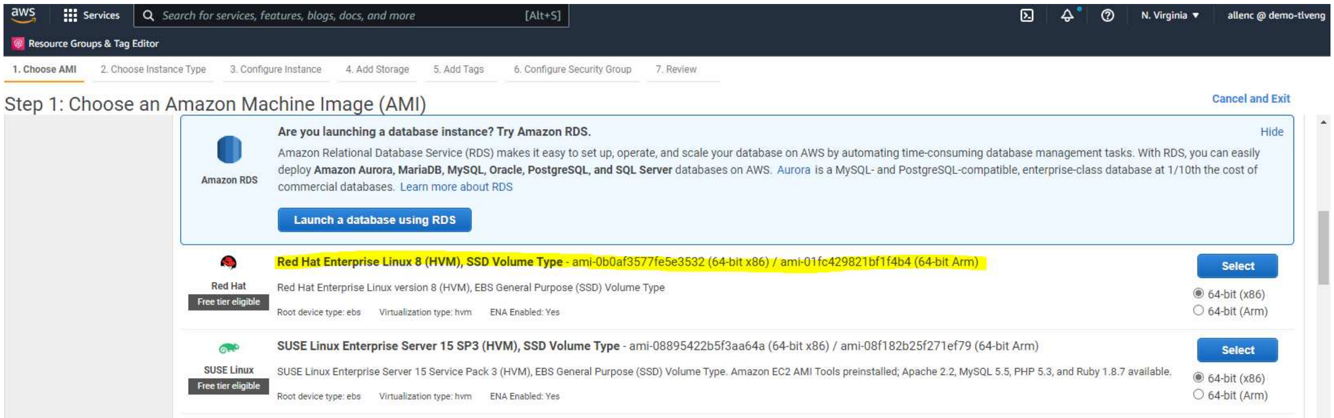
Easily size, configure, and deploy Microsoft SQL Server Always On availability groups on AWS using the AWS Launch Wizard for SQL Server. Learn more

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

Region
US East (N. Virginia)

Save up to 90% on EC2 with Spot Instances
Optimize price-performance by combining EC2 purchase options in a single EC2 ASG. Learn more

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



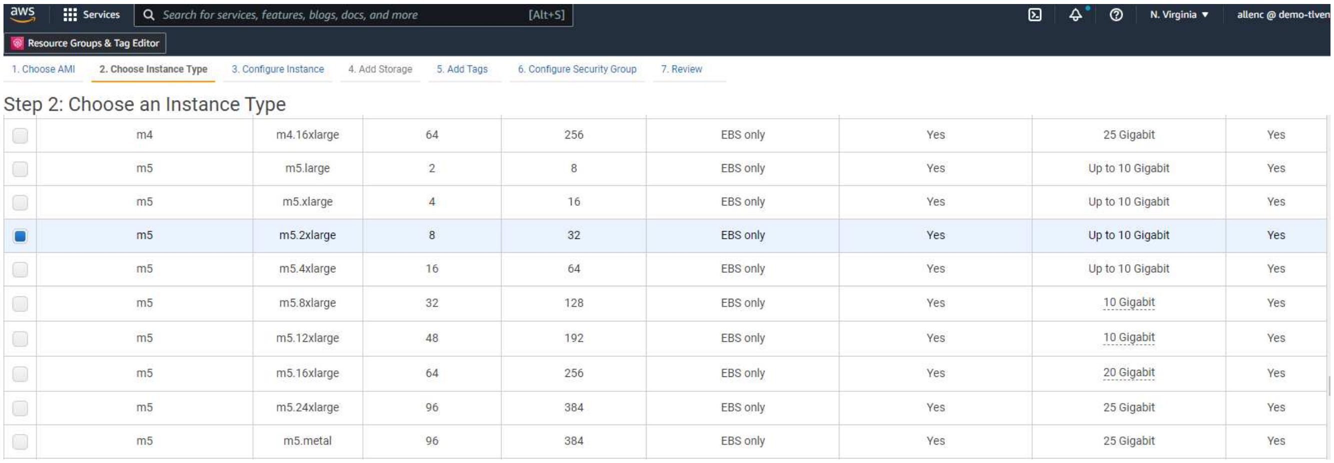
Step 1: Choose an Amazon Machine Image (AMI)

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 Enterprise Linux 8 (HVM), SSD Volume Type - ami-0b0af3577fe5e3532 (64-bit x86) / ami-01fc429821bf1f4b4 (64-bit Arm)
Red Hat Enterprise Linux version 8 (HVM), EBS General Purpose (SSD) Volume Type
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
● 64-bit (x86)
○ 64-bit (Arm)

SUSE Linux Enterprise Server 15 SP3 (HVM), SSD Volume Type - ami-08895422b5f3aa64a (64-bit x86) / ami-08f182b25f271ef79 (64-bit Arm)
SUSE Linux Enterprise Server 15 Service Pack 3 (HVM), EBS General Purpose (SSD) Volume Type. Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.5, PHP 5.3, and Ruby 1.8.7 available.
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
● 64-bit (x86)
○ 64-bit (Arm)

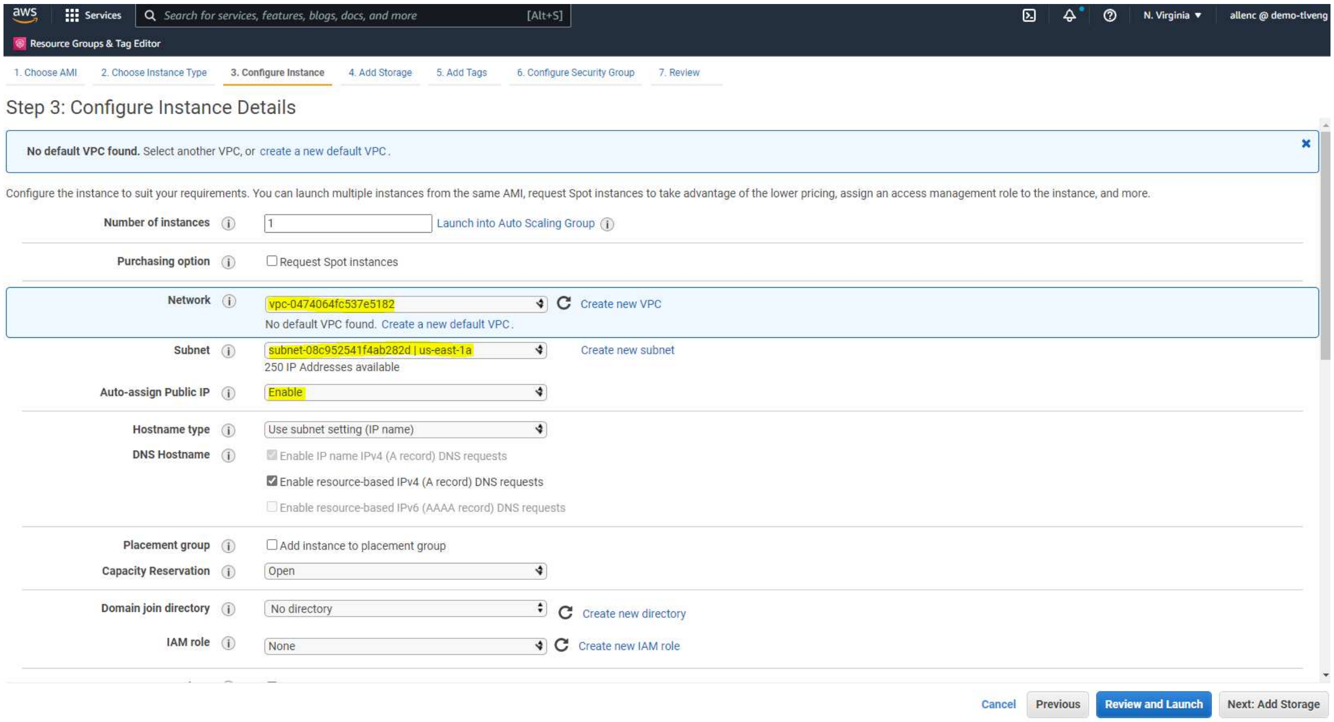
3. In Step 2, select an m5 instance type with the appropriate CPU and memory allocation based on your Oracle database workload. Click "Next: Configure Instance Details."



Step 2: Choose an Instance Type

☐	m4	m4.16xlarge	64	256	EBS only	Yes	25 Gigabit	Yes
☐	m5	m5.large	2	8	EBS only	Yes	Up to 10 Gigabit	Yes
☐	m5	m5.xlarge	4	16	EBS only	Yes	Up to 10 Gigabit	Yes
■	m5	m5.2xlarge	8	32	EBS only	Yes	Up to 10 Gigabit	Yes
☐	m5	m5.4xlarge	16	64	EBS only	Yes	Up to 10 Gigabit	Yes
☐	m5	m5.8xlarge	32	128	EBS only	Yes	10 Gigabit	Yes
☐	m5	m5.12xlarge	48	192	EBS only	Yes	10 Gigabit	Yes
☐	m5	m5.16xlarge	64	256	EBS only	Yes	20 Gigabit	Yes
☐	m5	m5.24xlarge	96	384	EBS only	Yes	25 Gigabit	Yes
☐	m5	m5.metal	96	384	EBS only	Yes	25 Gigabit	Yes

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



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 vpc-0474064fc537e5182

No default VPC found. Create a new default VPC.

Subnet subnet-08c952541f4ab282d | us-east-1a

250 IP Addresses available

Auto-assign Public IP Enable

Hostname type Use subnet setting (IP name)

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

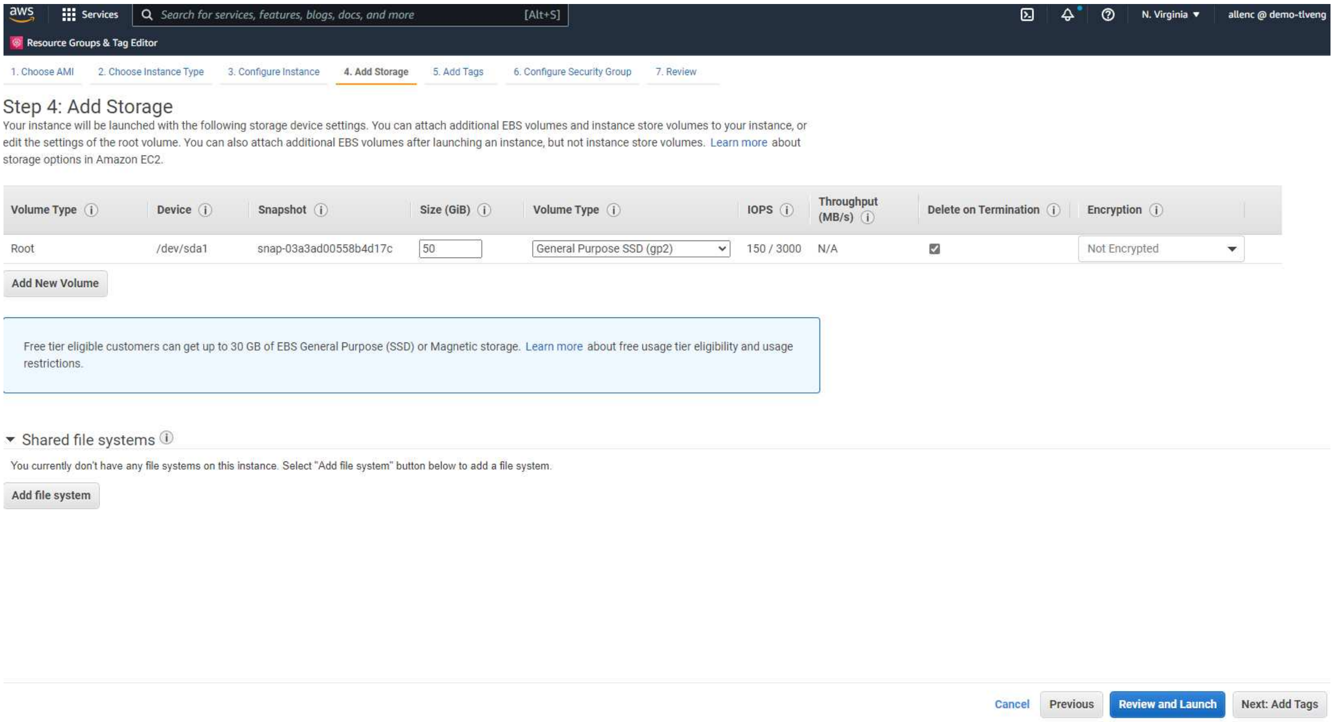
Placement group ☐ Add instance to placement group

Capacity Reservation Open

Domain join directory No directory

IAM role None

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.



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.

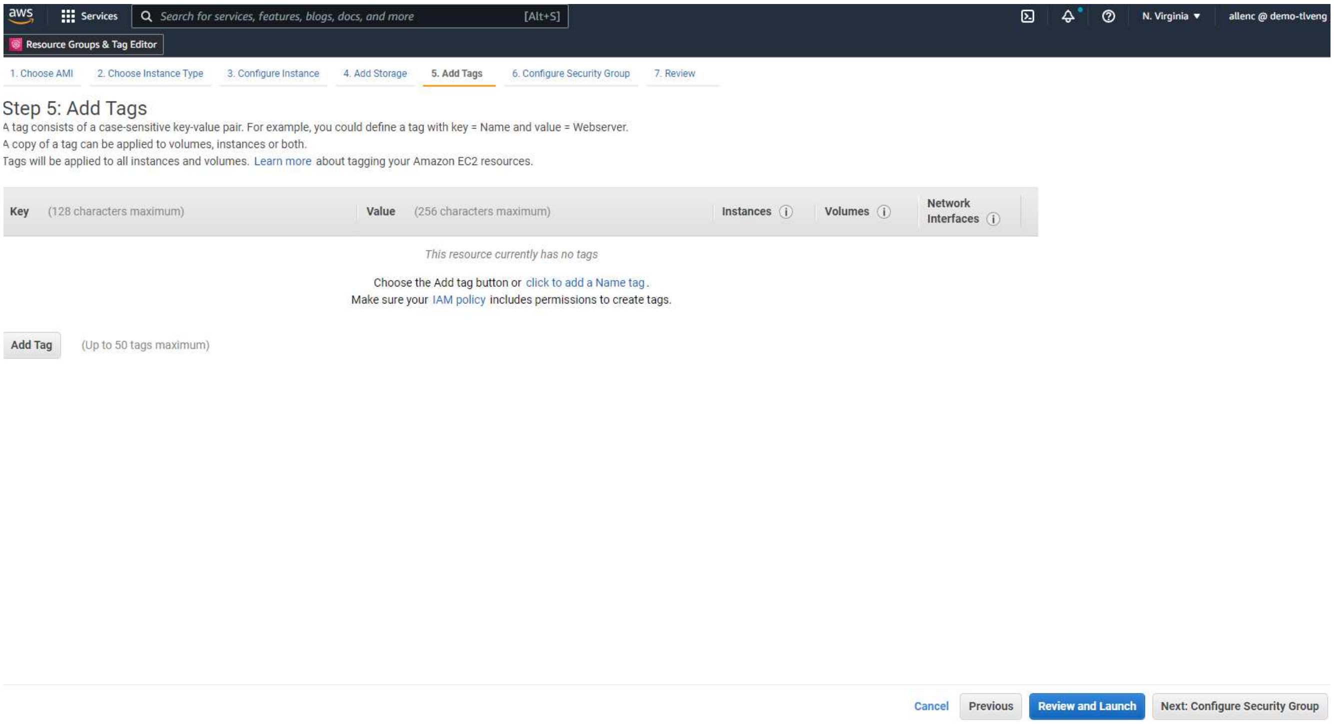
Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/sda1	snap-03a3ad00558b4d17c	50	General Purpose SSD (gp2)	150 / 3000	N/A	☑	Not Encrypted

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.

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.

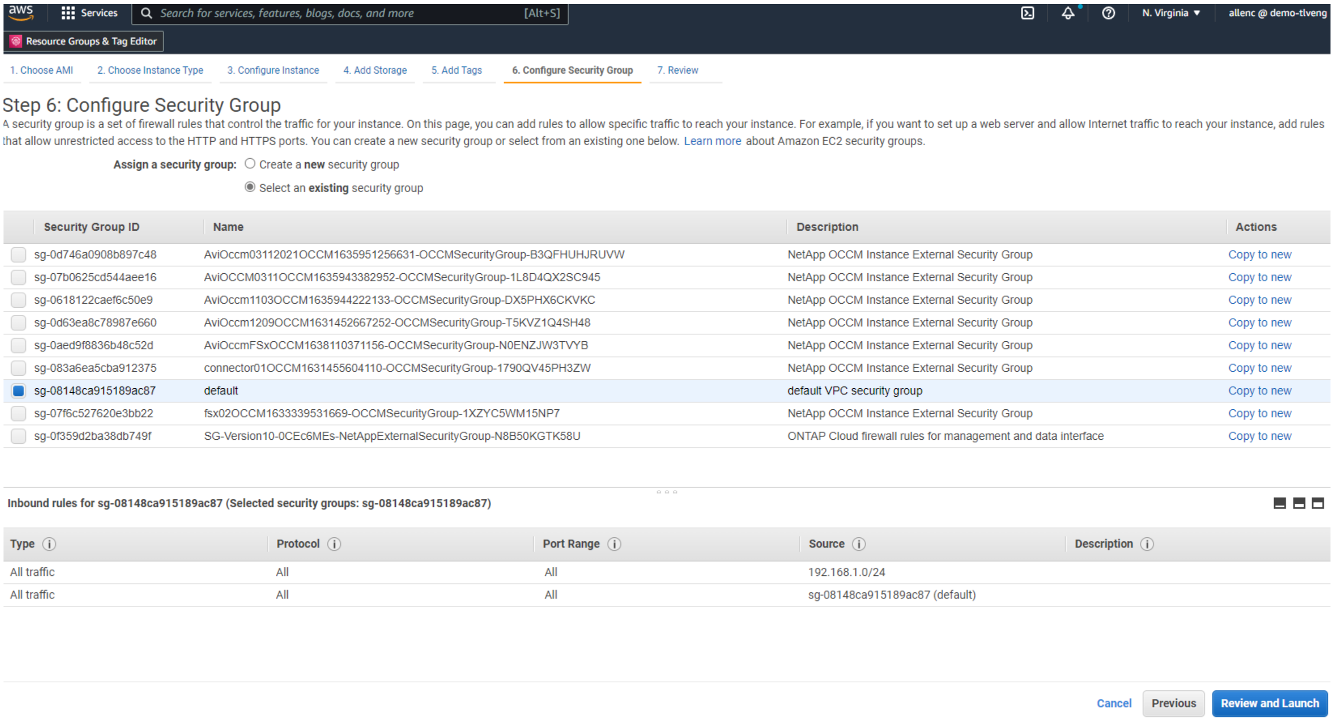
Key (128 characters maximum)	Value (256 characters maximum)	Instances	Volumes	Network Interfaces

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.

(Up to 50 tags maximum)

7. 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.

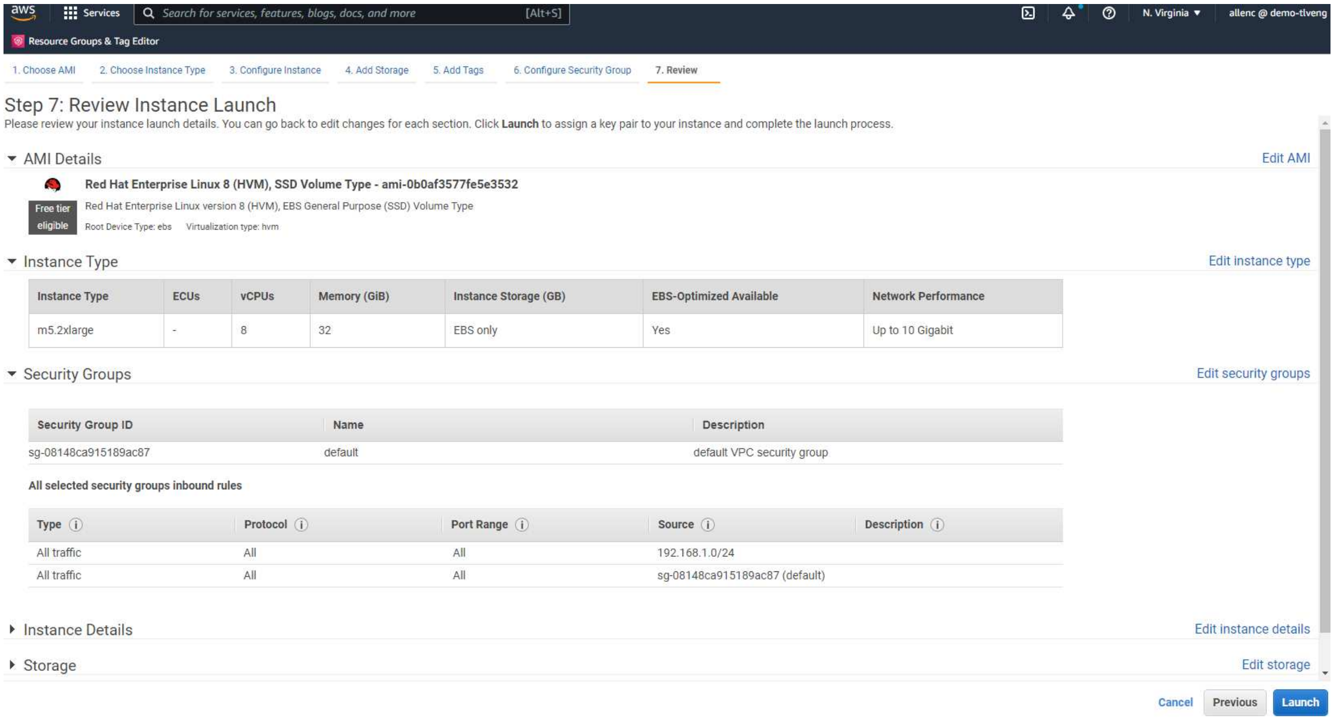
Assign a security group: ○ Create a **new** security group
● Select an **existing** security group

	Security Group ID	Name	Description	Actions
☐	sg-0d746a0908b897c48	AviOccm03112021OCCM1635951256631-OCCMSecurityGroup-B3QFHUHJRUVW	NetApp OCCM Instance External Security Group	Copy to new
☐	sg-07b0625cd544aee16	AviOCCM0311OCCM1635943382952-OCCMSecurityGroup-1L8D4QX2SC945	NetApp OCCM Instance External Security Group	Copy to new
☐	sg-0618122caef6c50e9	AviOccm1103OCCM1635944222133-OCCMSecurityGroup-DX5PHX6CKVKC	NetApp OCCM Instance External Security Group	Copy to new
☐	sg-0d63ea8c78987e660	AviOccm1209OCCM1631452667252-OCCMSecurityGroup-T5KVZ1Q4SH48	NetApp OCCM Instance External Security Group	Copy to new
☐	sg-0aed9f8836b48c52d	AviOccmFSxOCCM1638110371156-OCCMSecurityGroup-N0ENZJW3TVYB	NetApp OCCM Instance External Security Group	Copy to new
☐	sg-083a6ea5cba912375	connector01OCCM1631455604110-OCCMSecurityGroup-1790QV45PH3ZW	NetApp OCCM Instance External Security Group	Copy to new
☑	sg-08148ca915189ac87	default	default VPC security group	Copy to new
☐	sg-07f6c527620e3bb22	fsx02OCCM1633339531669-OCCMSecurityGroup-1XZYC5WM15NP7	NetApp OCCM Instance External Security Group	Copy to new
☐	sg-0f359d2ba38db749f	SG-Version10-0CEc6MEs-NetAppExternalSecurityGroup-N8B50KGTK58U	ONTAP Cloud firewall rules for management and data interface	Copy to new

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

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

8. 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.



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

Root Device Type: ebs Virtualization type: hvm

▾ 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

▾ Security Groups

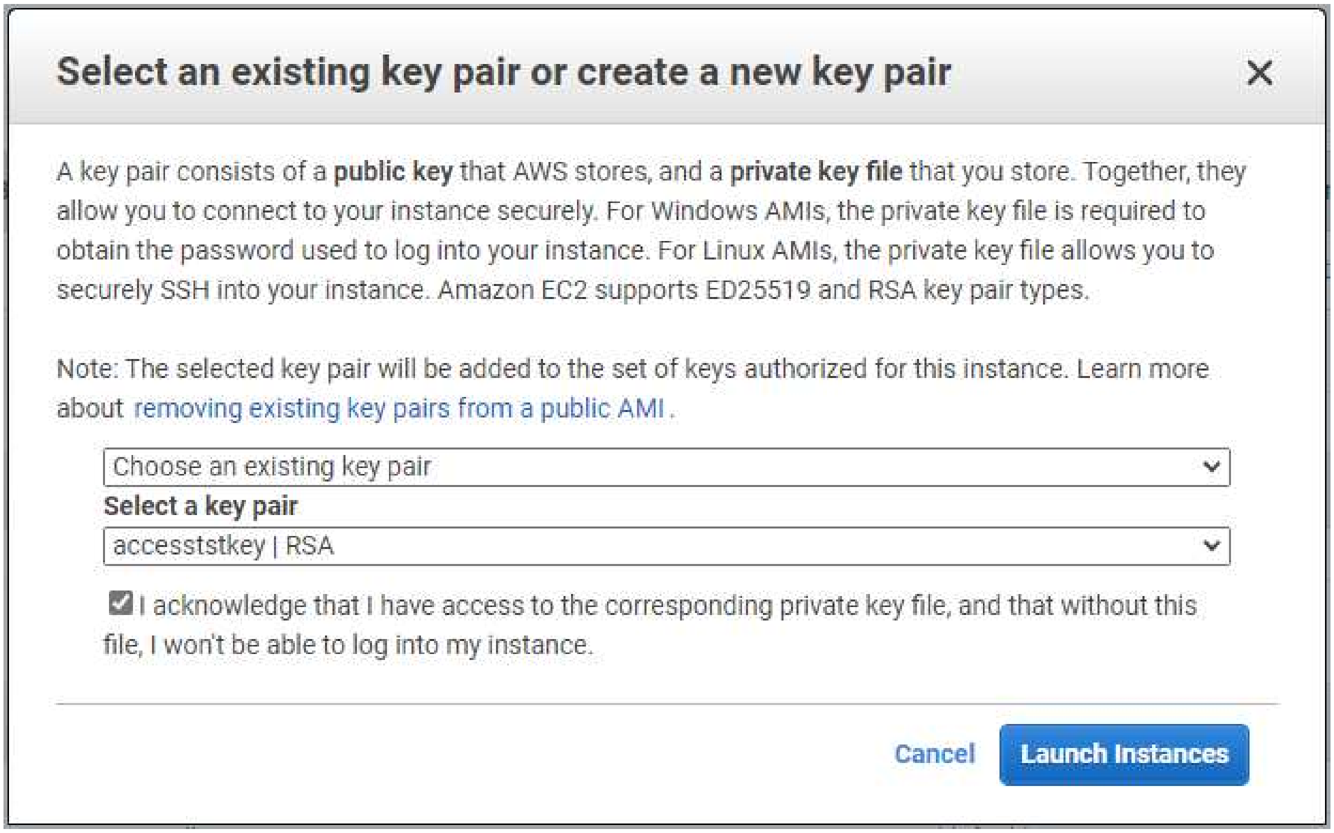
Security Group ID	Name	Description
sg-08148ca915189ac87	default	default VPC security group

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)	

▸ Instance Details

▸ Storage



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.

9. 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.

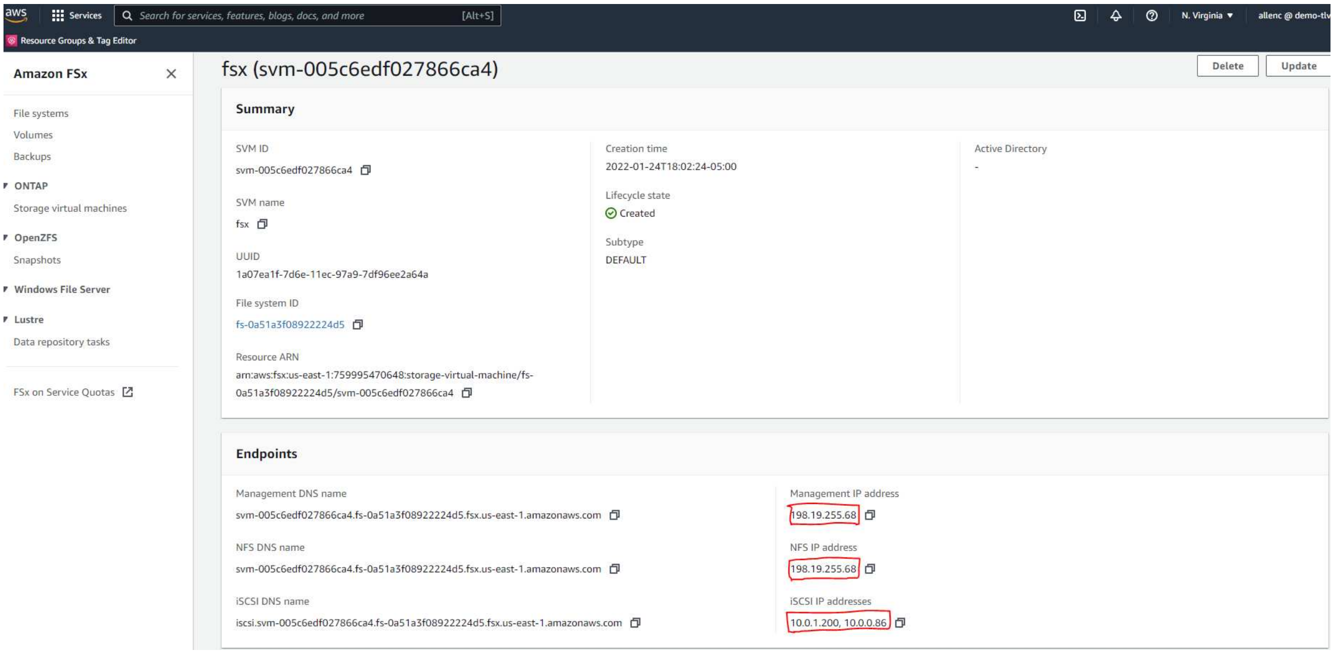
Creating FSx for ONTAP file systems

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.



fsx (svm-005c6edf027866ca4)

Summary

SVM ID: svm-005c6edf027866ca4

SVM name: fsx

UUID: 1a07ea1f-7d6e-11ec-97a9-7df96ee2a64a

File system ID: fs-0a51a3f08922224d5

Resource ARN: arn:aws:fsx:us-east-1:759995470648:storage-virtual-machine/fs-0a51a3f08922224d5/svm-005c6edf027866ca4

Creation time: 2022-01-24T18:02:24-05:00

Lifecycle state: Created

Subtype: DEFAULT

Active Directory: -

Endpoints

Management DNS name: svm-005c6edf027866ca4.fs-0a51a3f08922224d5.fsx.us-east-1.amazonaws.com

NFS DNS name: svm-005c6edf027866ca4.fs-0a51a3f08922224d5.fsx.us-east-1.amazonaws.com

iSCSI DNS name: iscsi.svm-005c6edf027866ca4.fs-0a51a3f08922224d5.fsx.us-east-1.amazonaws.com

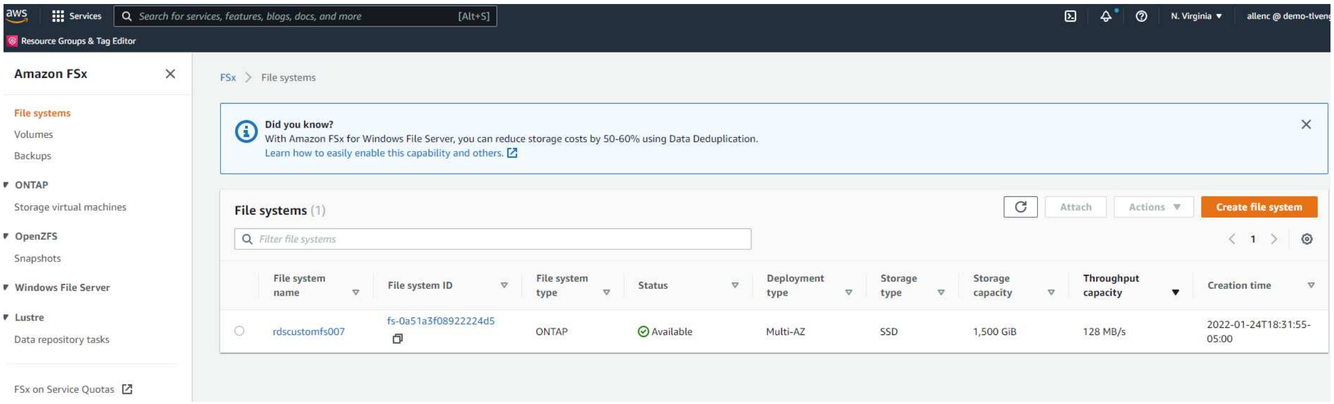
Management IP address: 198.19.255.68

NFS IP address: 198.19.255.68

iSCSI IP addresses: 10.0.1.200, 10.0.0.86

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.

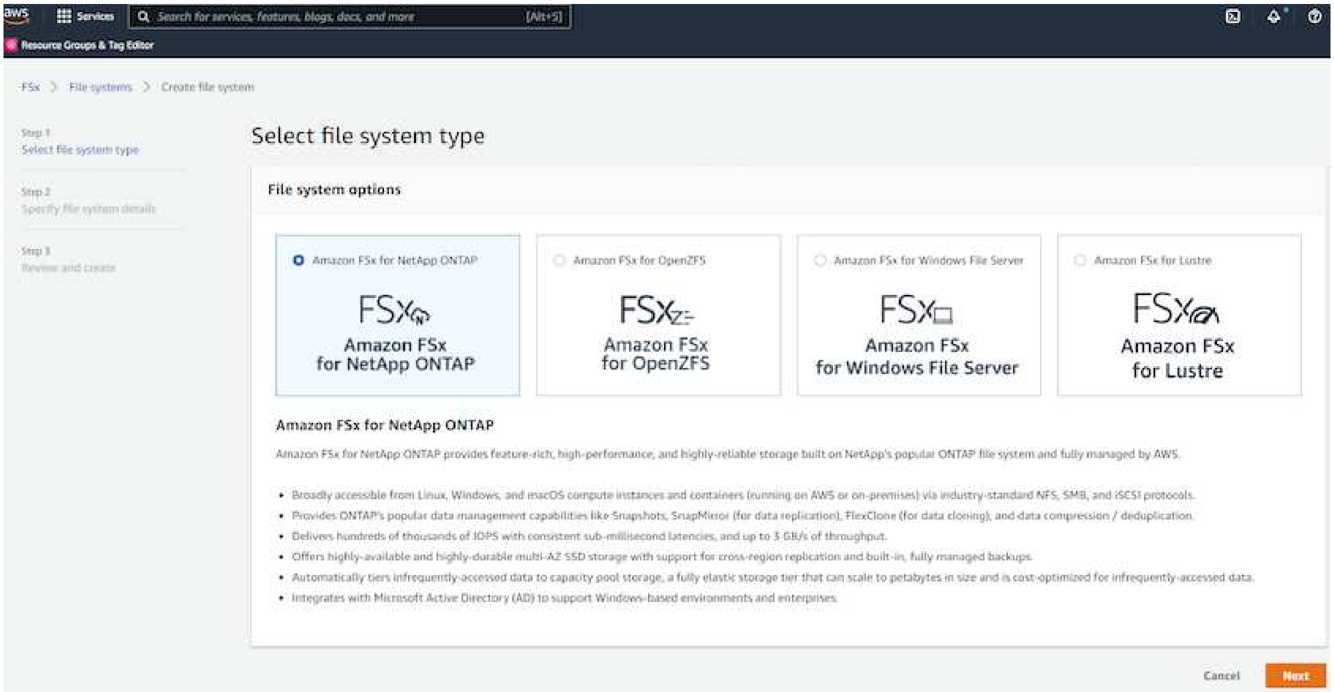


Did you know?
With Amazon FSx for Windows File Server, you can reduce storage costs by 50-60% using Data Deduplication.
Learn how to easily enable this capability and others.

File systems (1)

	File system name	File system ID	File system type	Status	Deployment type	Storage type	Storage capacity	Throughput capacity	Creation time
○	rdscustomfs007	fs-0a51a3f08922224d5	ONTAP	Available	Multi-AZ	SSD	1,500 GiB	128 MB/s	2022-01-24T18:31:55-05:00

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

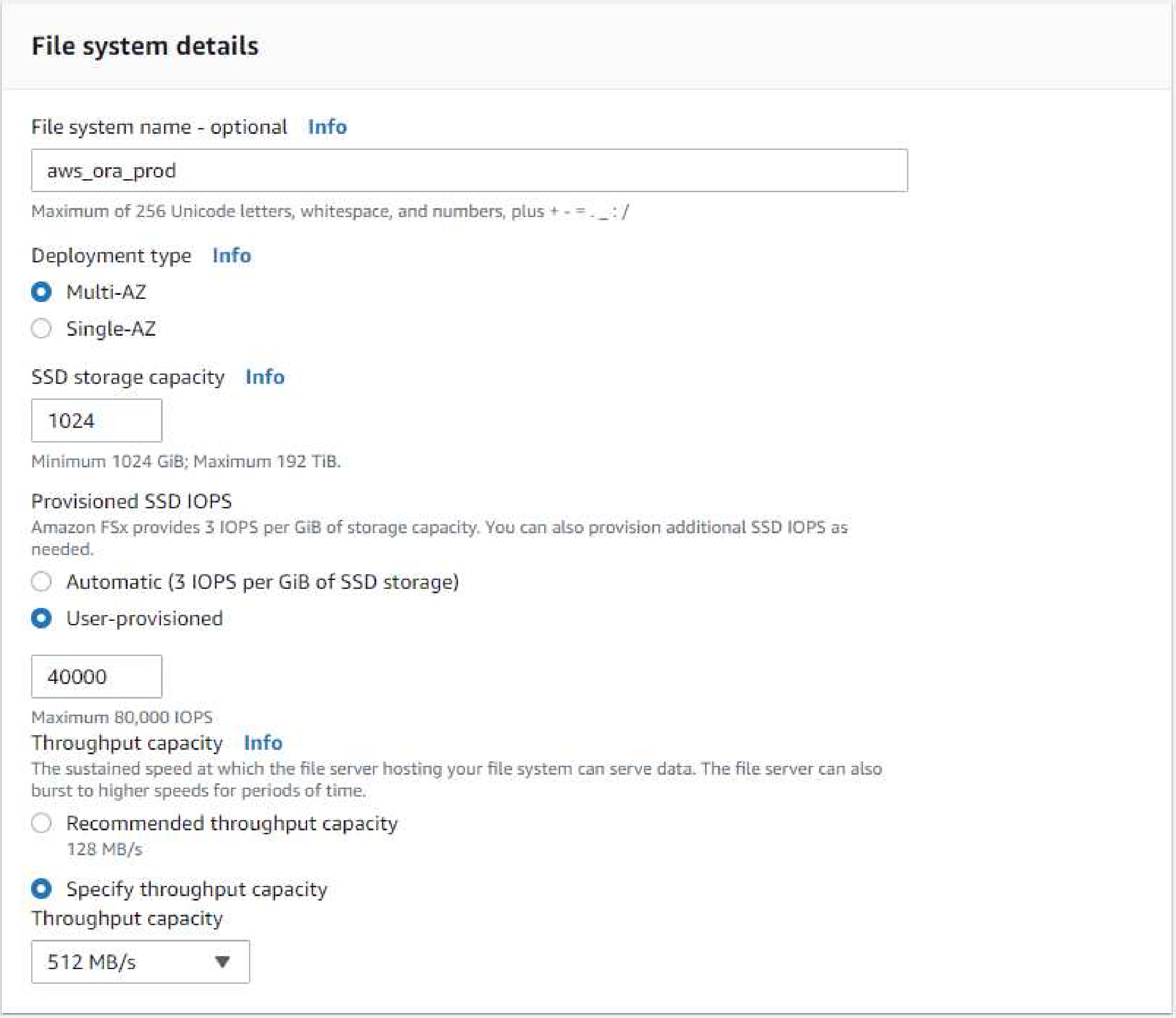

Services
Search for services, features, blogs, docs, and more
[Alt+S]
Resource Groups & Tag Editor
FSx > File systems > Create file system
Step 1
Select file system type
Step 2
Specify file system details
Step 3
Review and create
Select file system type
File system options
● Amazon FSx for NetApp ONTAP
Amazon FSx for NetApp ONTAP
○ Amazon FSx for OpenZFS
Amazon FSx for OpenZFS
○ Amazon FSx for Windows File Server
Amazon FSx for Windows File Server
○ Amazon FSx for Lustre
Amazon FSx for Lustre
Cancel
Next

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.

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.

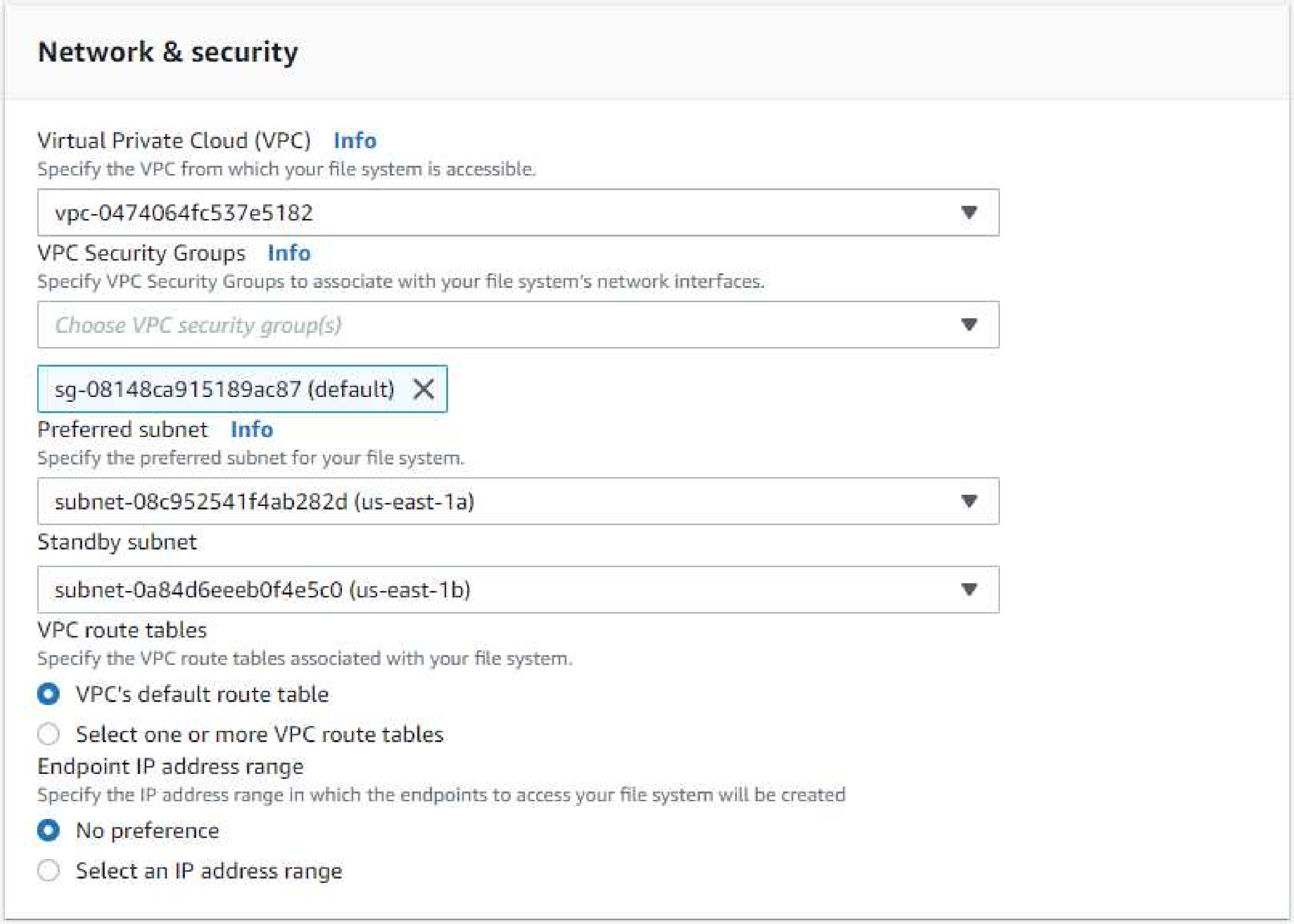
○ Recommended throughput capacity
128 MB/s

● 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)

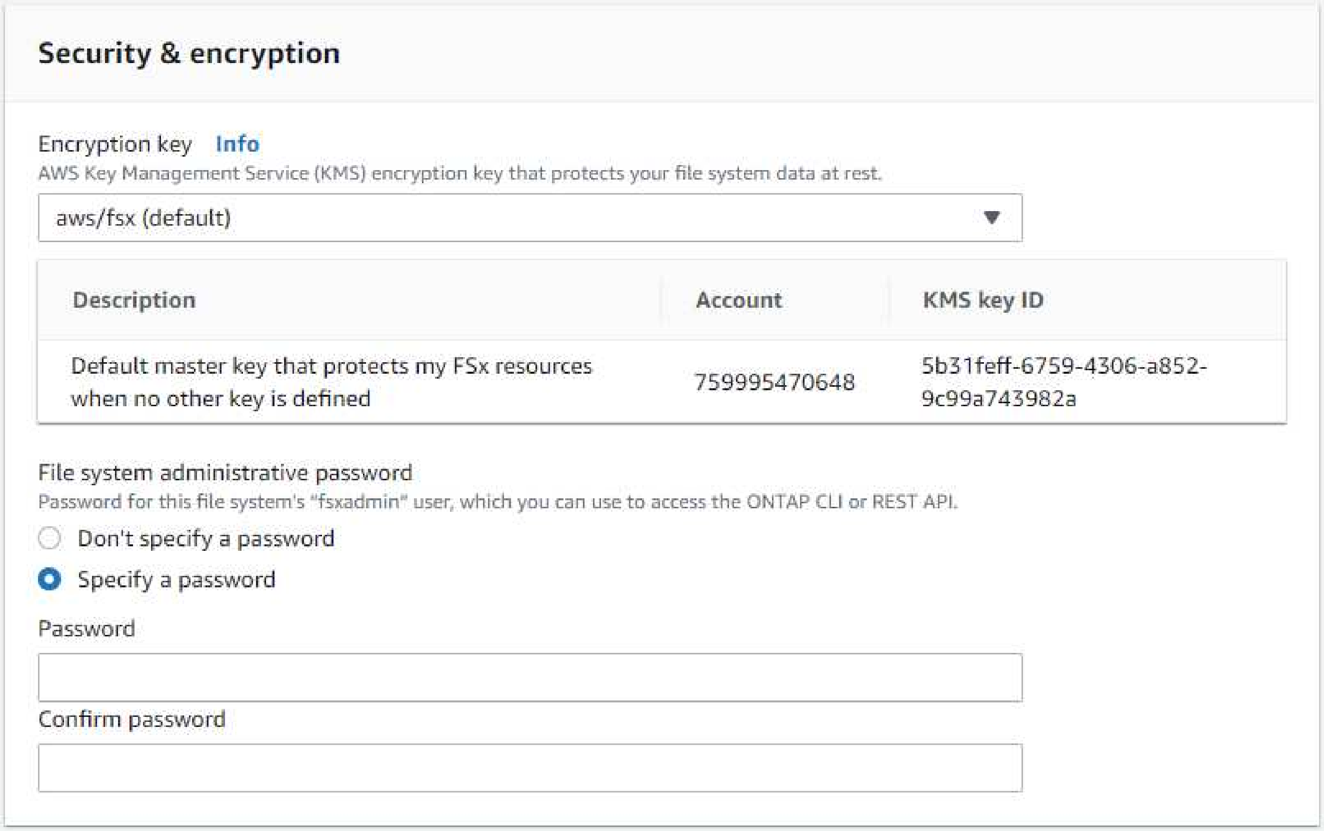
Preferred subnet Info
Specify the preferred subnet for your file system.
subnet-08c952541f4ab282d (us-east-1a)

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)

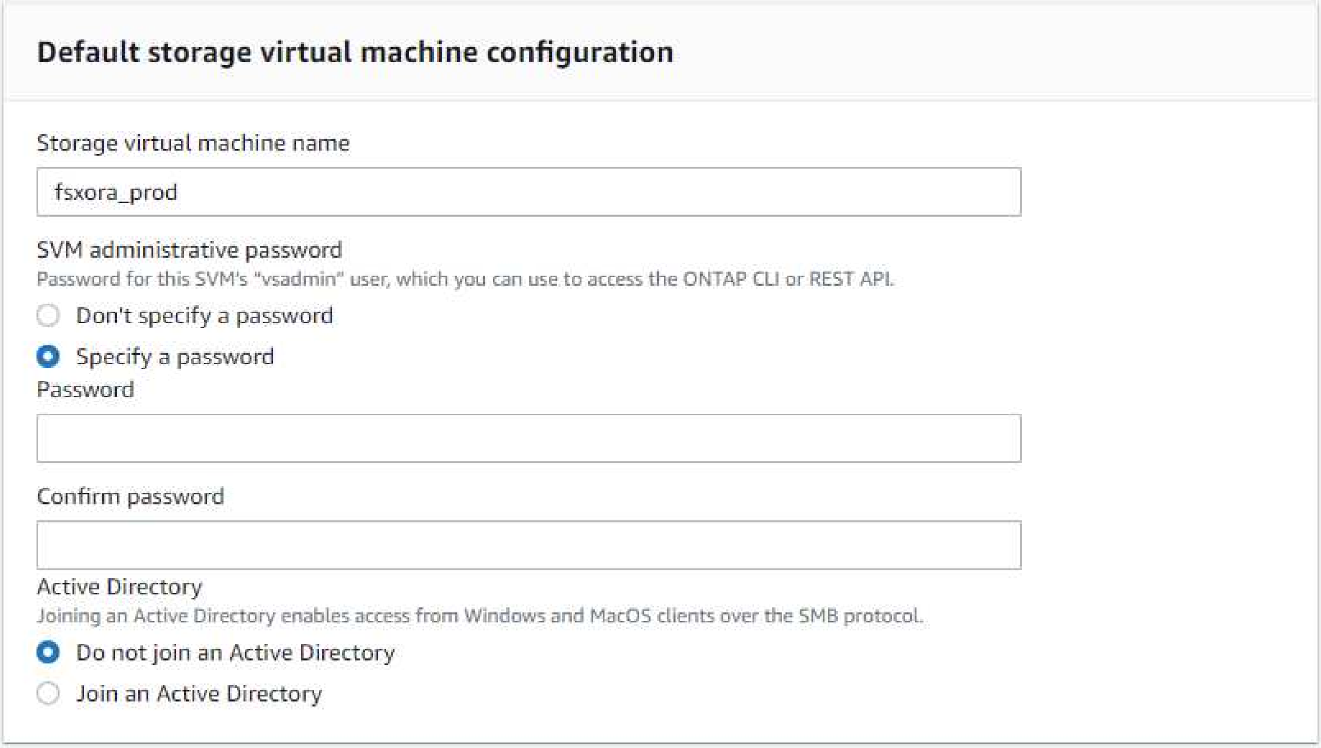
Description	Account	KMS key ID
Default master key that protects my FSx resources when no other key is defined	759995470648	5b31feff-6759-4306-a852-9c99a743982a

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

fsxora_prod

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

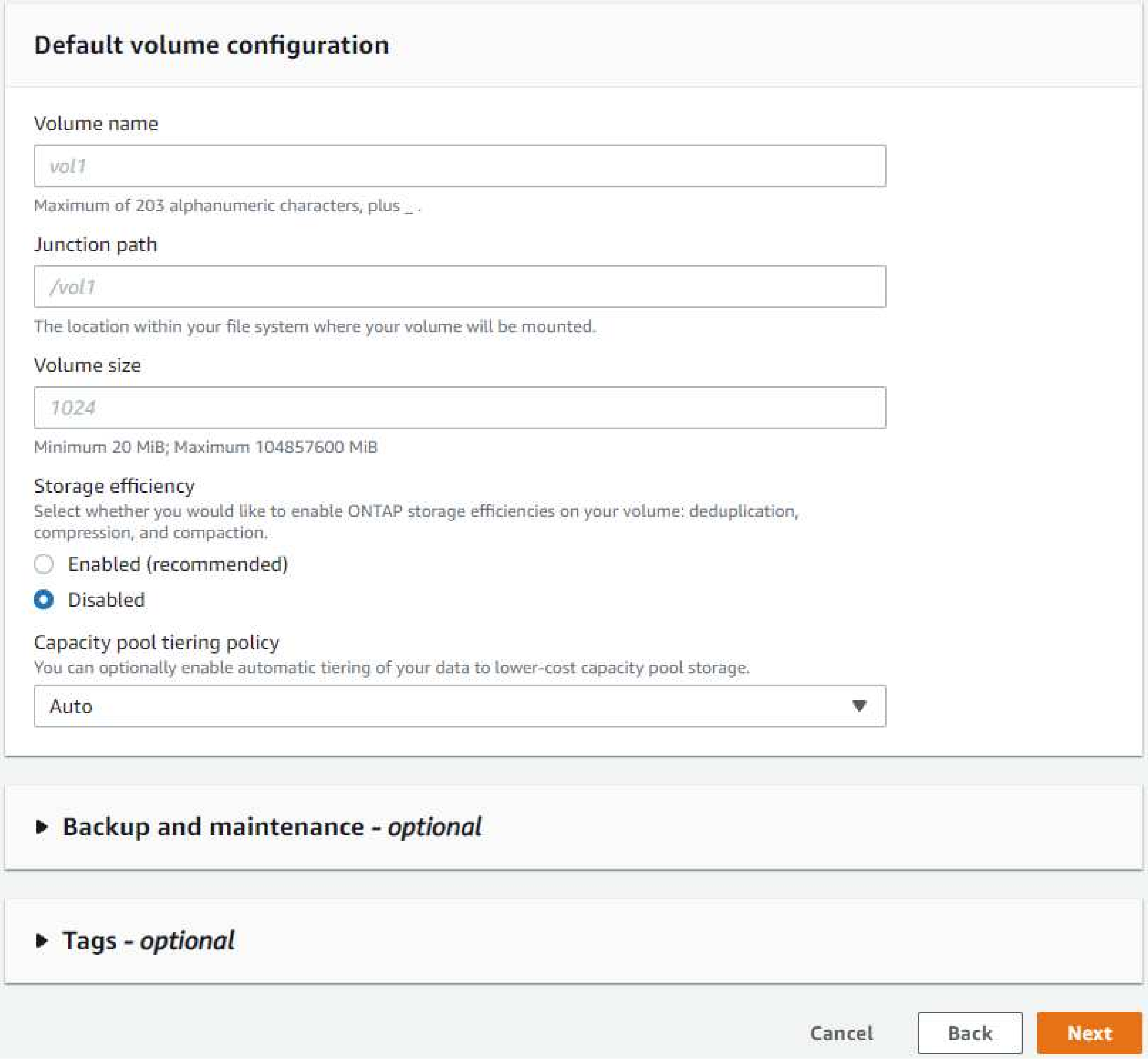
Active Directory

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)

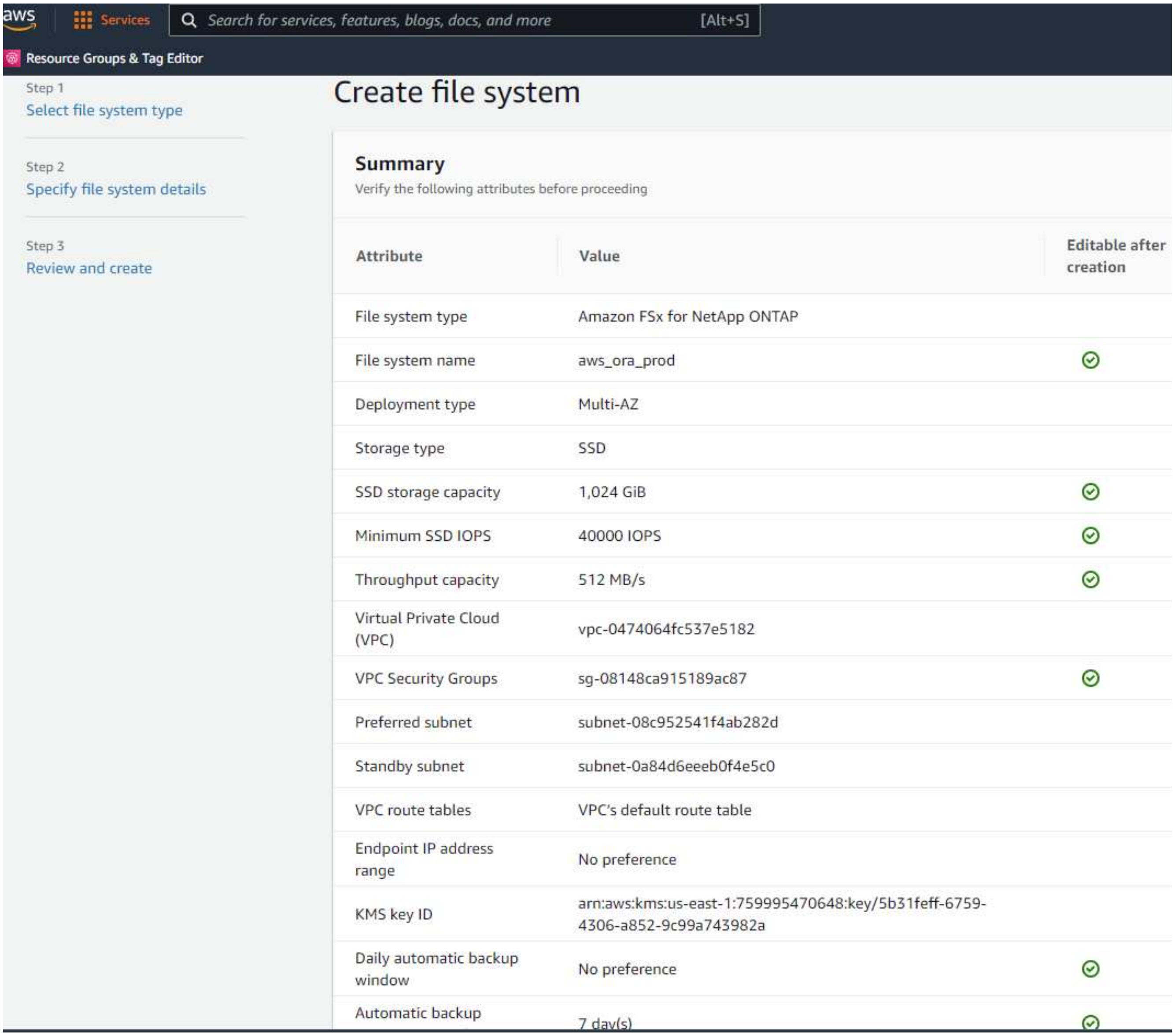
● Disabled

Capacity pool tiering policy

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

Auto

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


aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Resource Groups & Tag Editor
Step 1
Select file system type
Step 2
Specify file system details
Step 3
Review and create

Create file system

Summary

Verify the following attributes before proceeding

Attribute	Value	Editable after creation
File system type	Amazon FSx for NetApp ONTAP	
File system name	aws_ora_prod	✓
Deployment type	Multi-AZ	
Storage type	SSD	
SSD storage capacity	1,024 GiB	✓
Minimum SSD IOPS	40000 IOPS	✓
Throughput capacity	512 MB/s	✓
Virtual Private Cloud (VPC)	vpc-0474064fc537e5182	
VPC Security Groups	sg-08148ca915189ac87	✓
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	✓
Automatic backup	7 day(s)	✓

Provisioning of database volumes for Oracle database

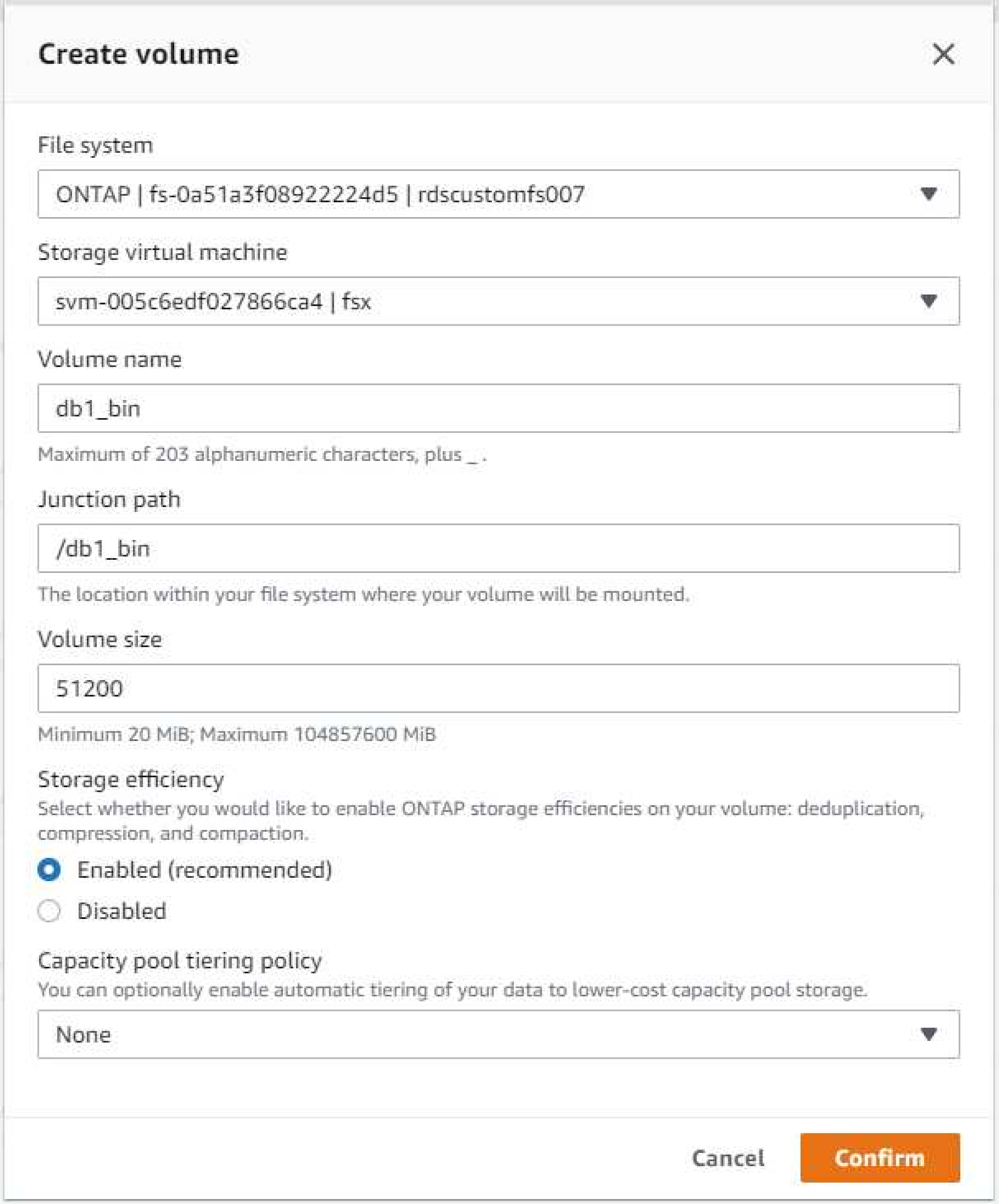
See Managing FSx for ONTAP volumes - creating a volume for details.

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

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.

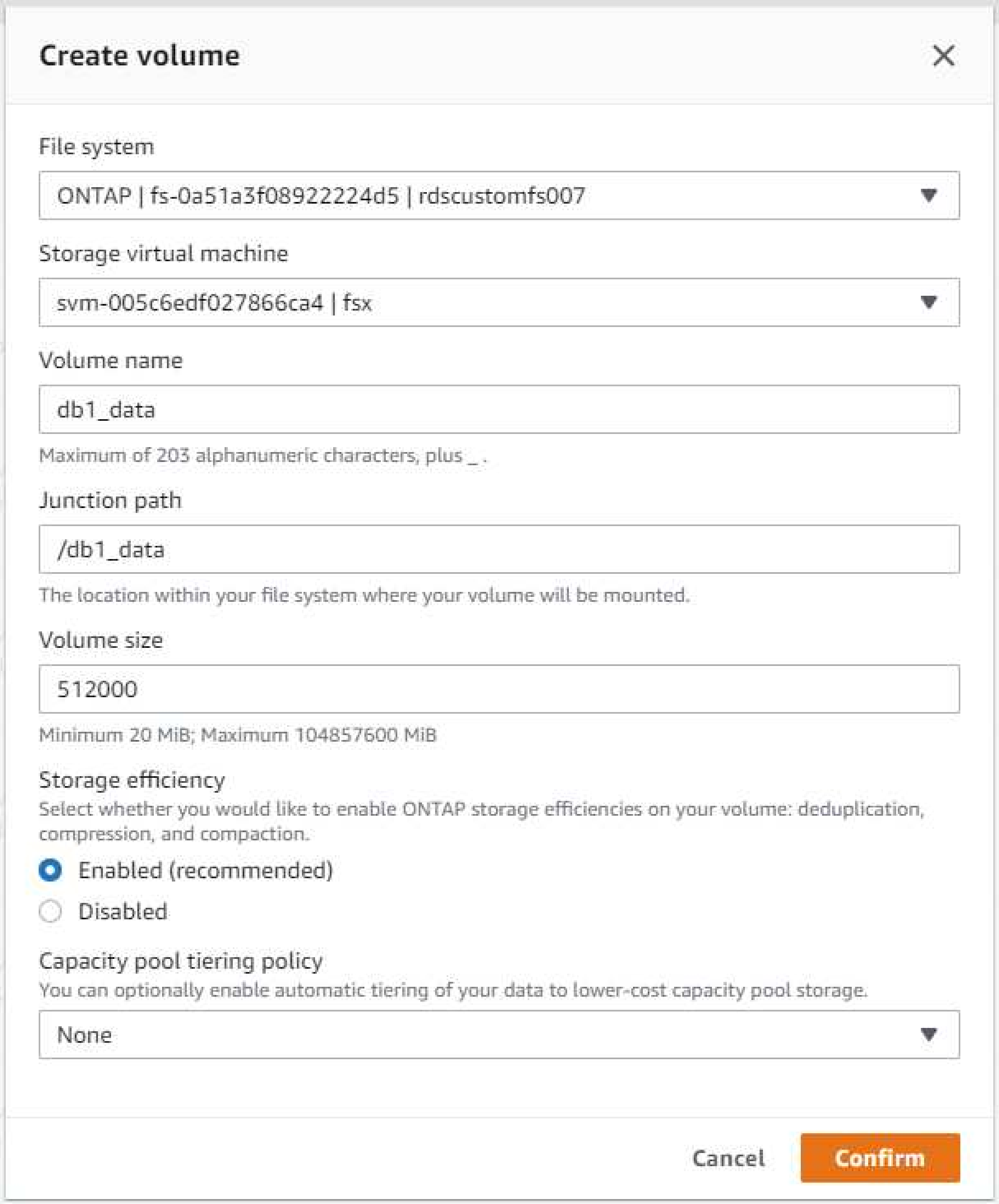
● Enabled (recommended)

○ Disabled

Capacity pool tiering policy

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

None



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.

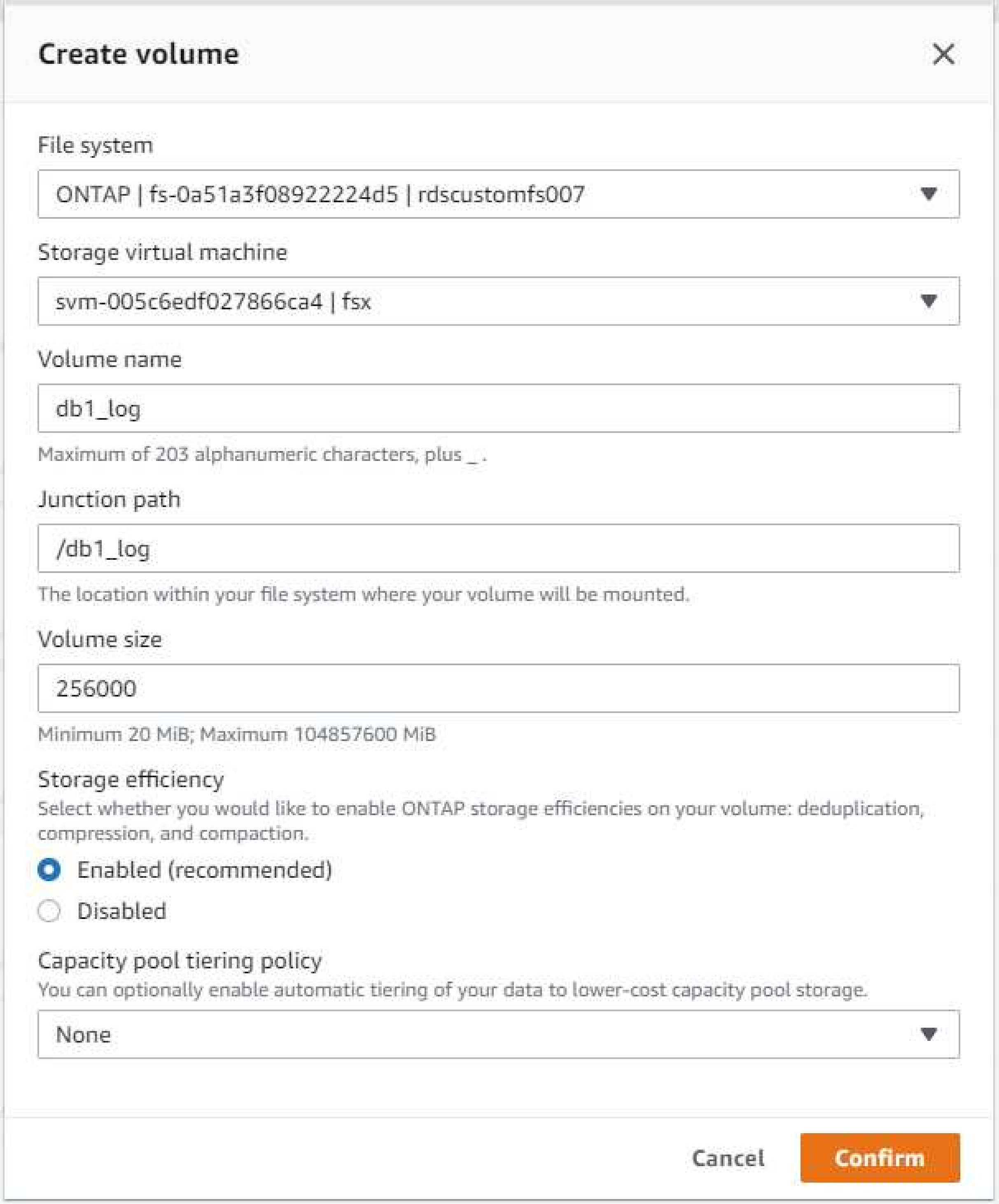
● Enabled (recommended)

○ Disabled

Capacity pool tiering policy

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

None



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

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 `accessstkey.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 accessstkey.pem -e @vars/fsx_vars.yml -t requirements_config
   ```

   ```
   ansible-playbook -i hosts rds_preclone_config.yml -u ec2-user --private
   -key accessstkey.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.

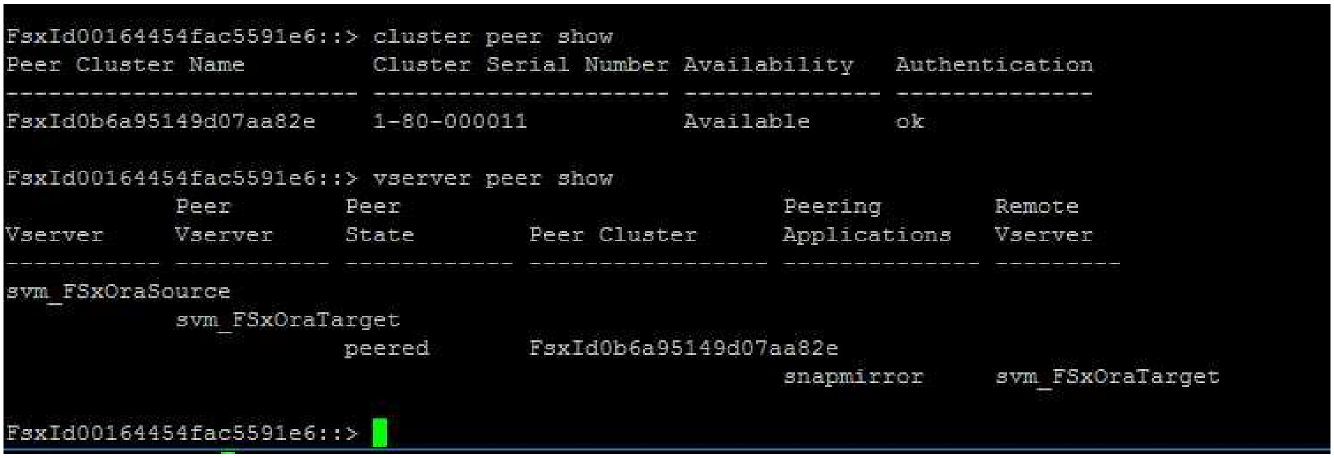
1. Setup primary and standby cluster peering. Log into the primary cluster as the fsxadmin user and execute the following command. This reciprocal create process executes the create command on both the primary cluster and the standby cluster. Replace `standby_cluster_name` with the appropriate name for 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_FSxOraSource
            svm_FSxOraTarget
                        peered       FsxId0b6a95149d07aa82e
                                                       snapmirror     svm_FSxOraTarget

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.

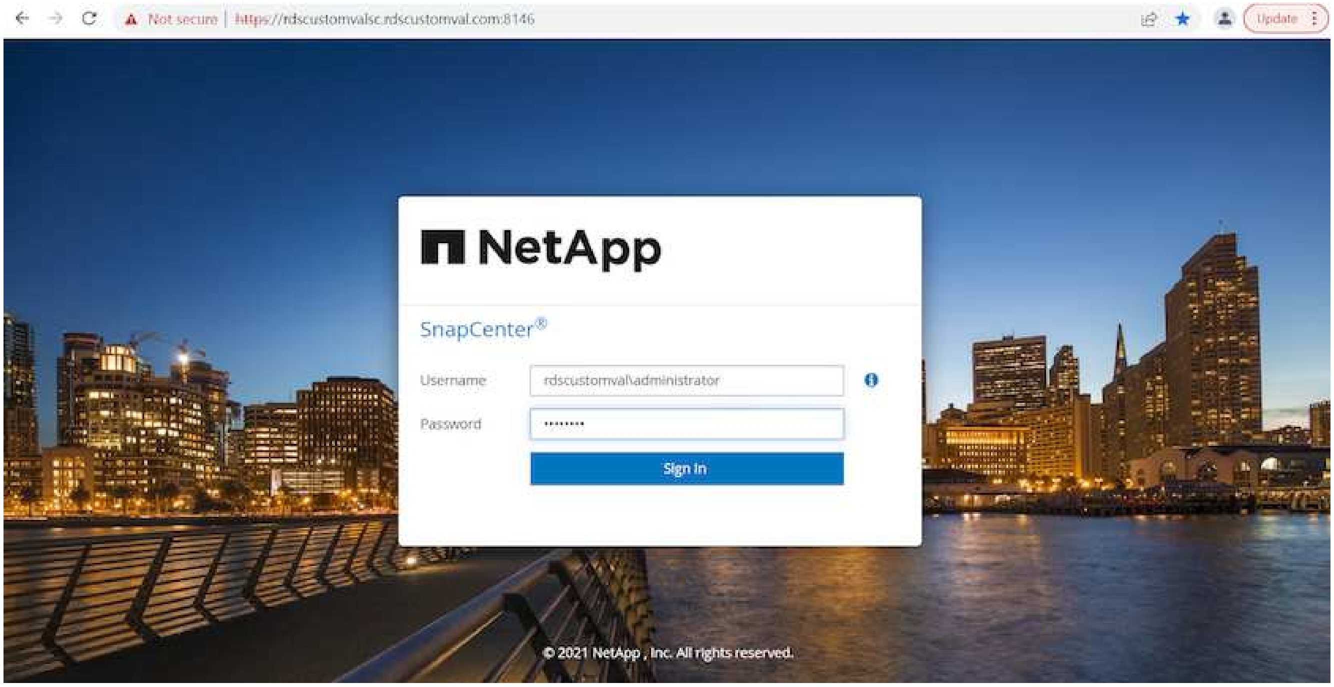
SnapCenter Deployment

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

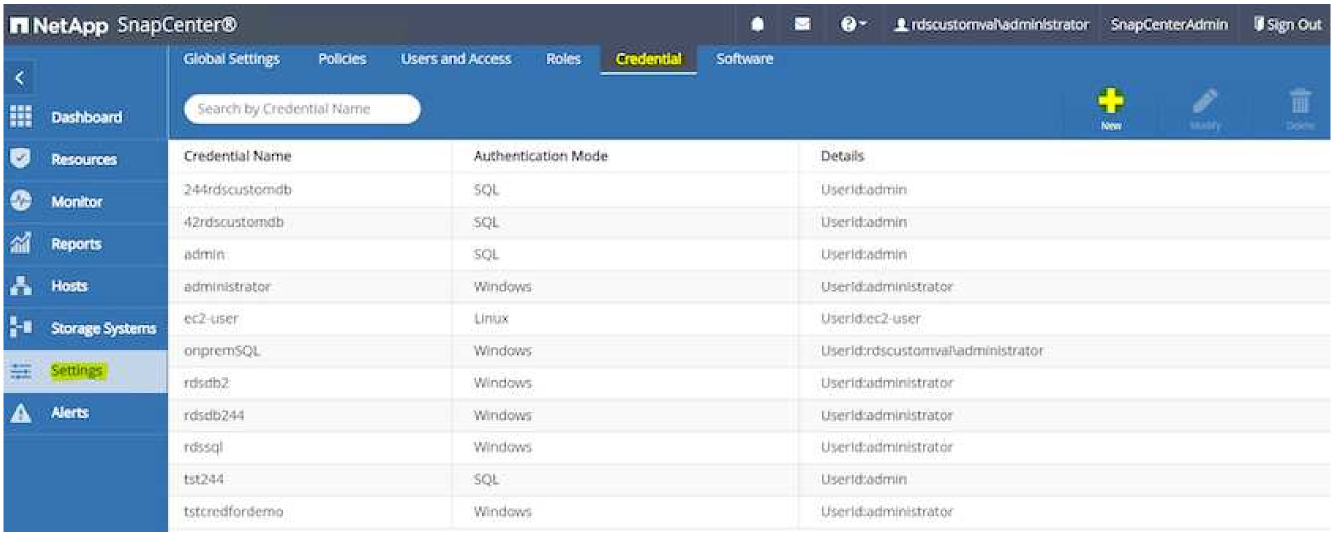
1. After automated SnapCenter installation, log into SnapCenter as an administrative user for the Window host on which the SnapCenter server is installed.


Not secure | https://rdscustomvalsc.rdscustomval.com:8146
Update
NetApp
SnapCenter®
Sign In
© 2021 NetApp , Inc. All rights reserved.

Username: rdscustomval\administrator

Password: ••••••••

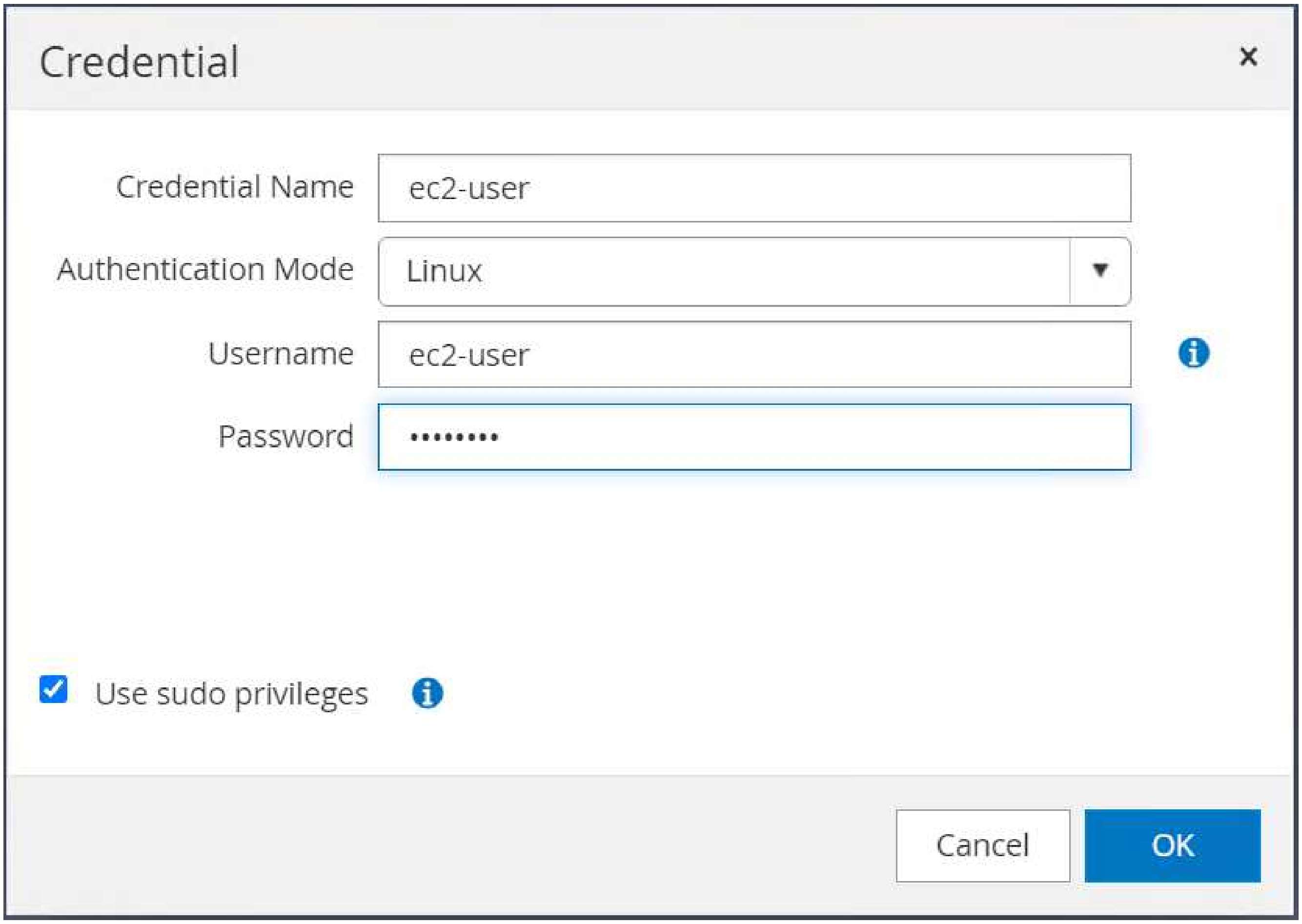
2. From the left-side menu, click Settings, and then Credential and New to add ec2-user credentials for SnapCenter plugin installation.



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

3. Reset the ec2-user password and enable password SSH authentication by editing the `/etc/ssh/sshd_config` file on the EC2 instance host.

4. Verify that the "Use sudo privileges" checkbox is selected. You just reset the ec2-user password in the previous step.



Credential Name: ec2-user

Authentication Mode: Linux

Username: ec2-user

Password: ••••••••

☑ Use sudo privileges

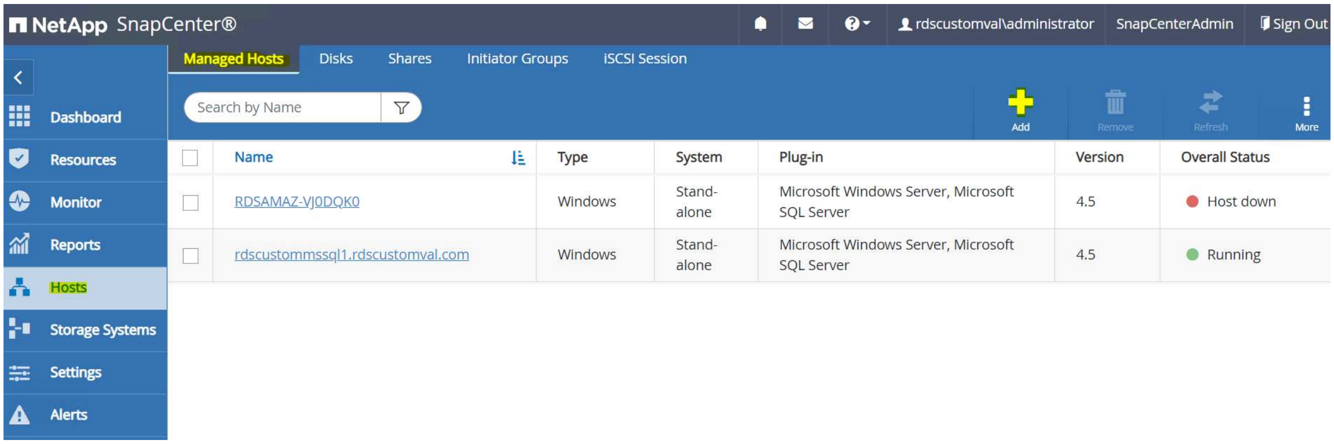
5. Add the SnapCenter server name and the IP address to the EC2 instance host file for name resolution.

```
[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`.

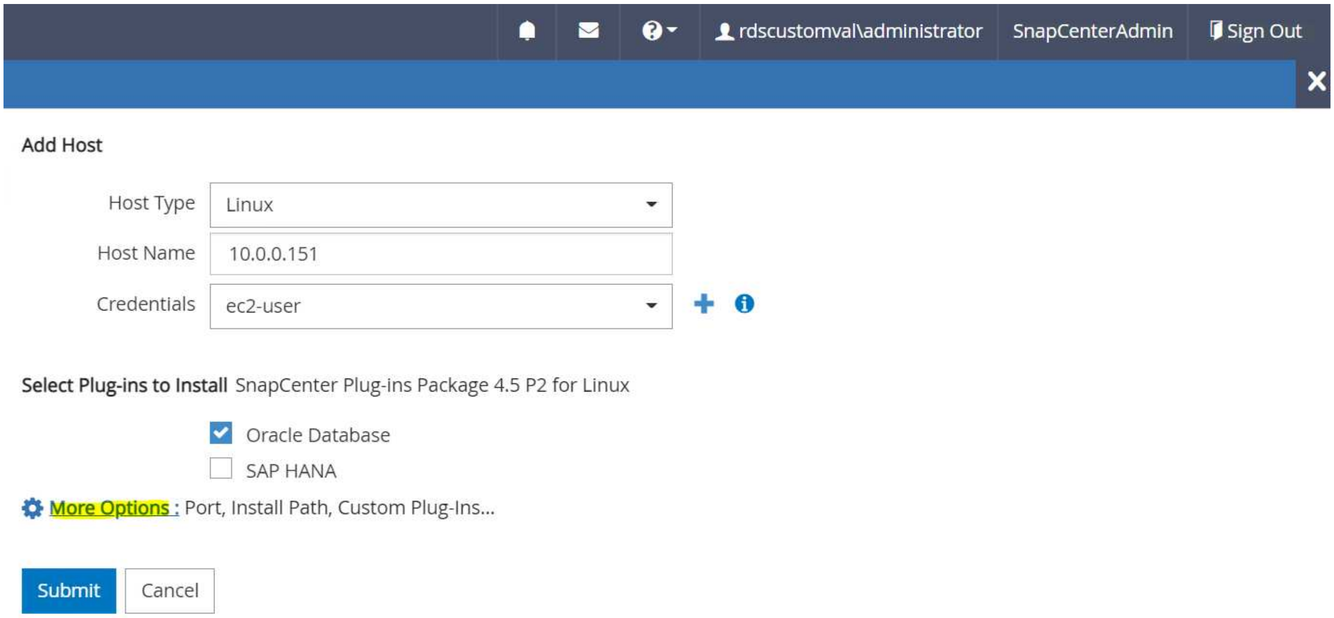
```
10.0.0.151      ip-10-0-0-151.ec2.internal
```

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



☐	Name	Type	System	Plug-in	Version	Overall Status
☐	RDSAMAZ-VJ0DQK0	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	● Host down
☐	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.



Add Host

Host Type: Linux

Host Name: 10.0.0.151

Credentials: ec2-user

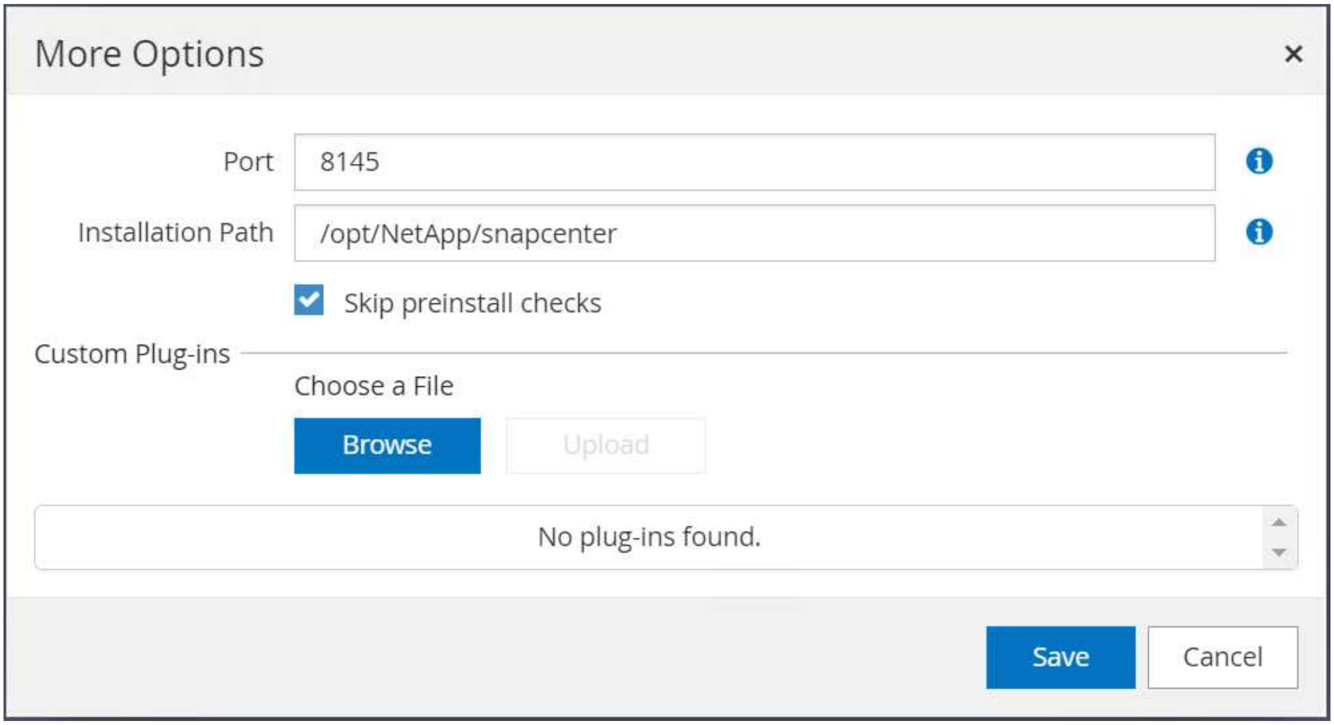
Select Plug-ins to Install: SnapCenter Plug-ins Package 4.5 P2 for Linux

☑ Oracle Database

☐ SAP HANA

More Options : Port, Install Path, Custom Plug-Ins...

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

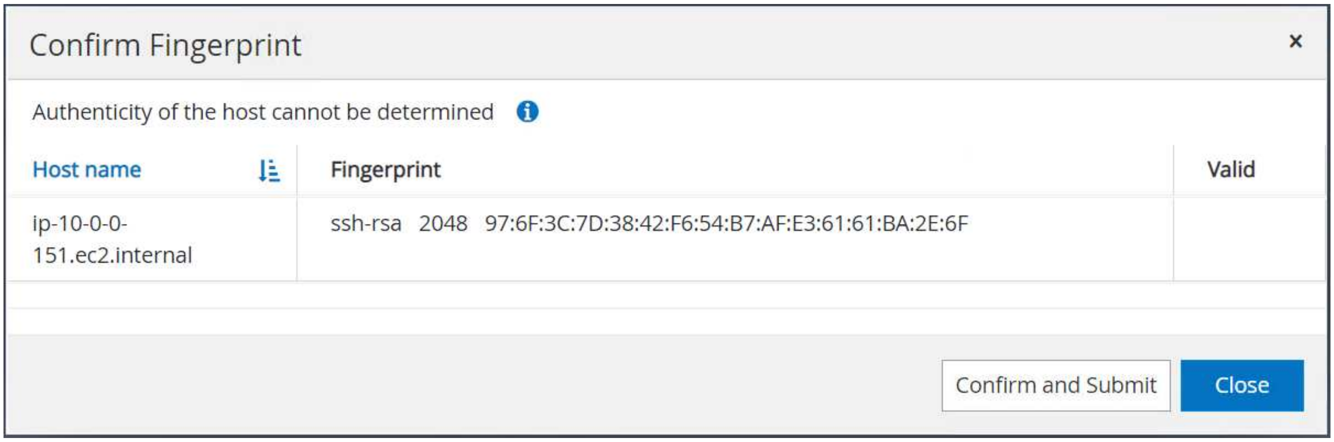


Port 8145

Installation Path /opt/NetApp/snapcenter

☑ Skip preinstall checks

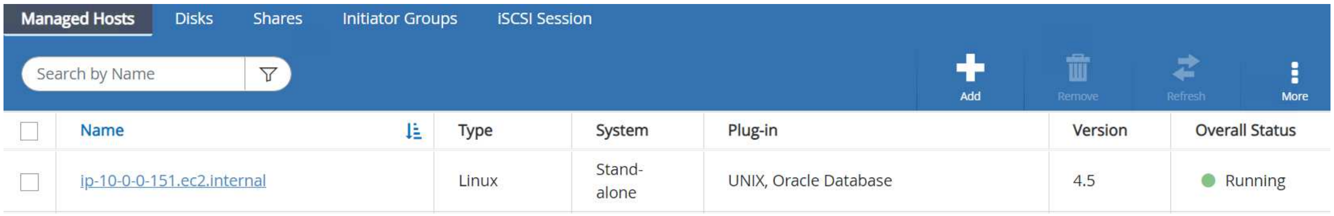
You are prompted with Confirm Fingerprint, and then click Confirm and Submit.



Authenticity of the host cannot be determined

Host name	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.



☐	Name	Type	System	Plug-in	Version	Overall Status
☐	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.

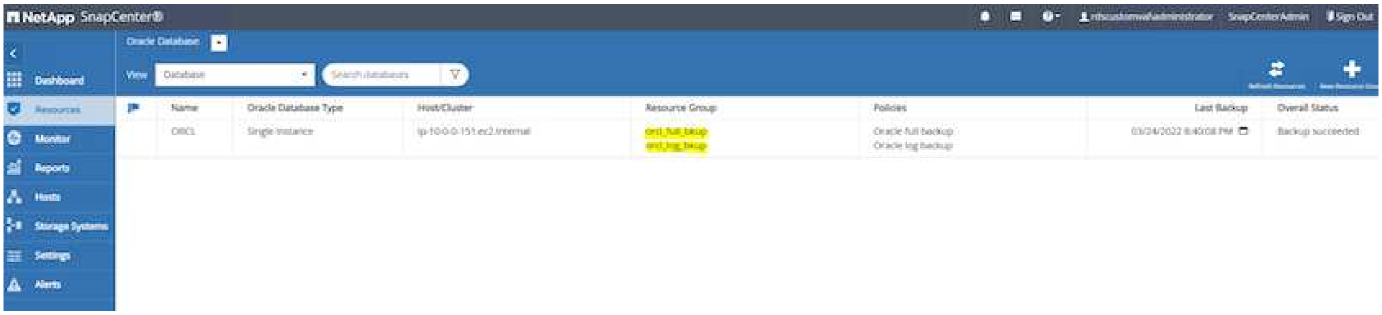
> You can enable Oracle archive log pruning in the backup policy to control log-archive space. Check "Update SnapMirror after creating a local Snapshot copy" in "Select secondary replication option" as you need to replicate to a standby location for HA or DR.

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.



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

EC2 and FSx Oracle database management

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.

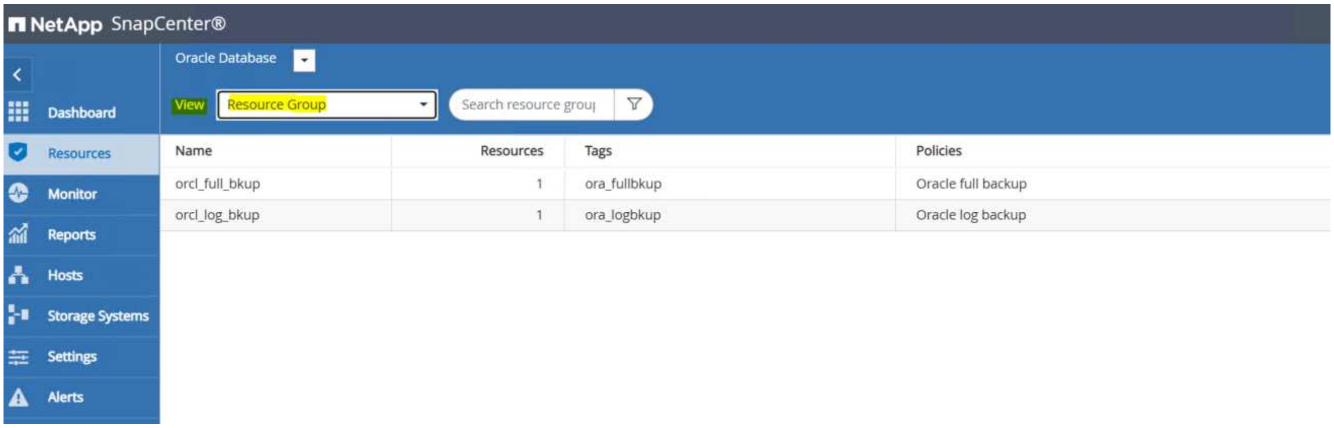
Taking a snapshot

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

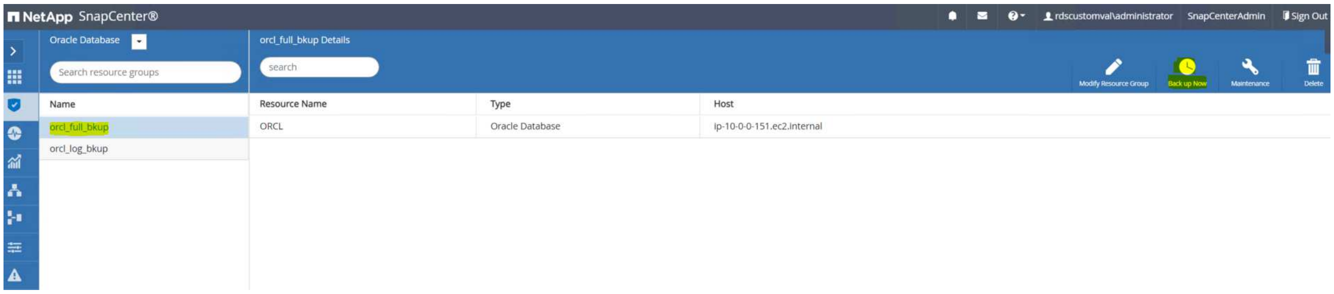
A full database snapshot includes all Oracle files, including data files, control files, and archive log files.

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
orcl_full_bkup	1	ora_fullbkup	Oracle full backup
orcl_log_bkup	1	ora_logbkup	Oracle log backup

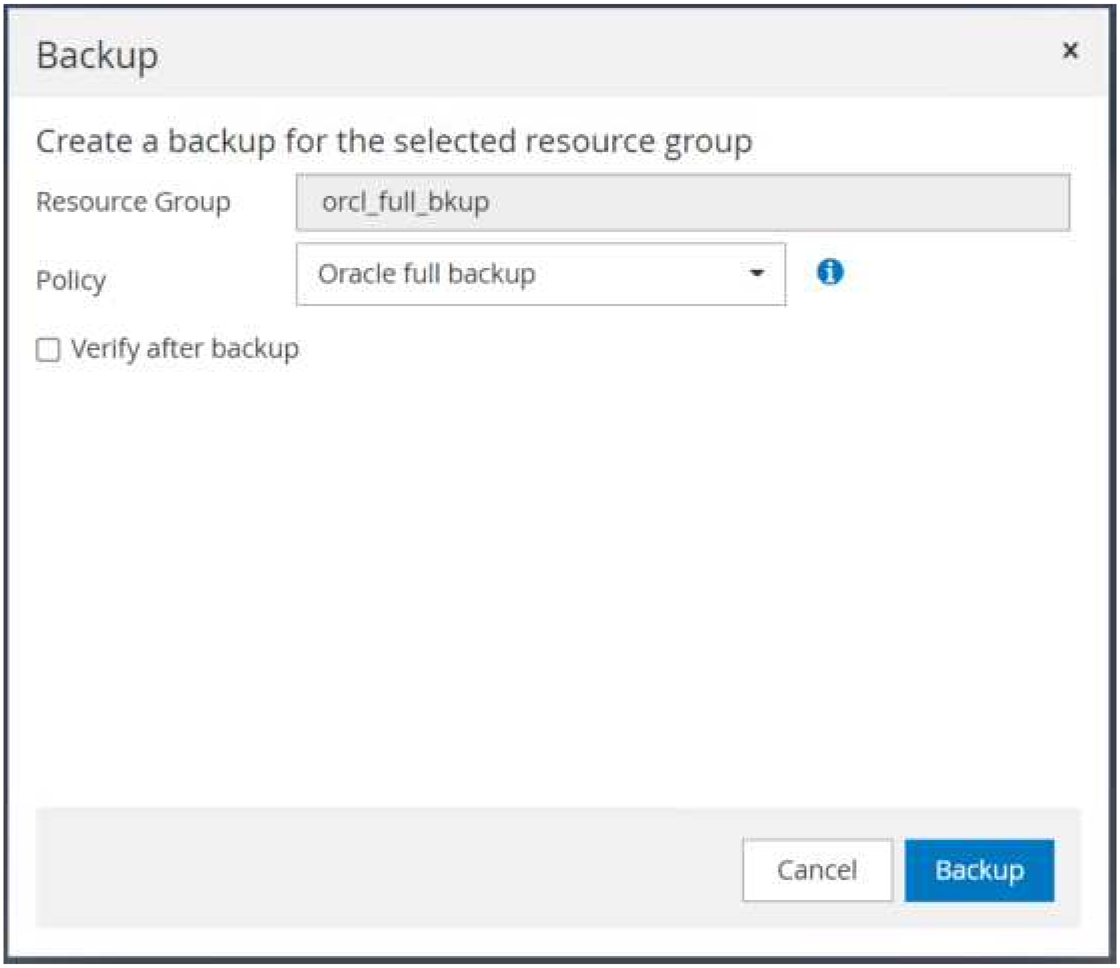
2. Click the full backup resource name, and then click the Backup Now icon to initiate an add-hoc backup.



Name
orcl_full_bkup
orcl_log_bkup

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

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



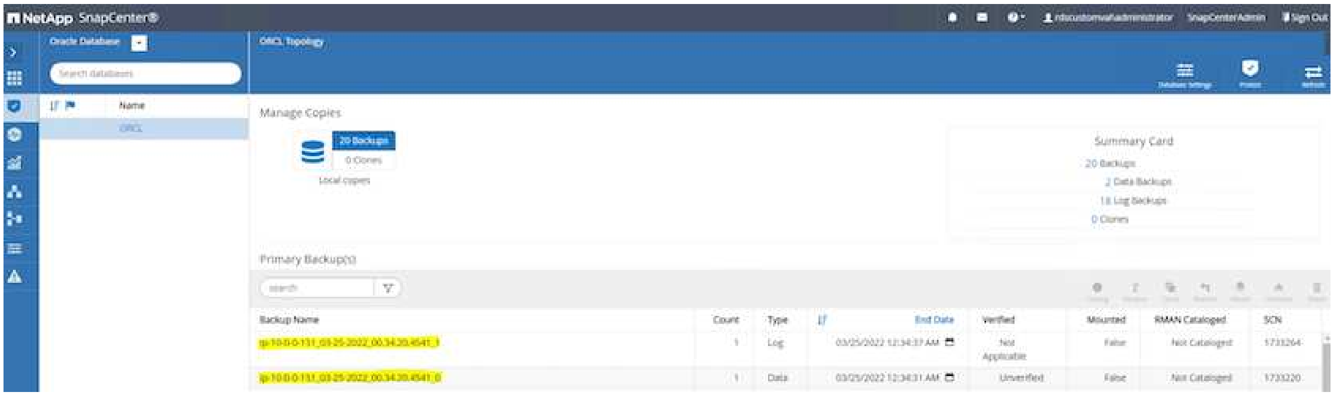
Create a backup for the selected resource group

Resource Group: orcl_full_bkup

Policy: Oracle full backup

☐ Verify after 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.



Summary Card
20 Backups
2 Data Backups
18 Log Backups
0 Clones

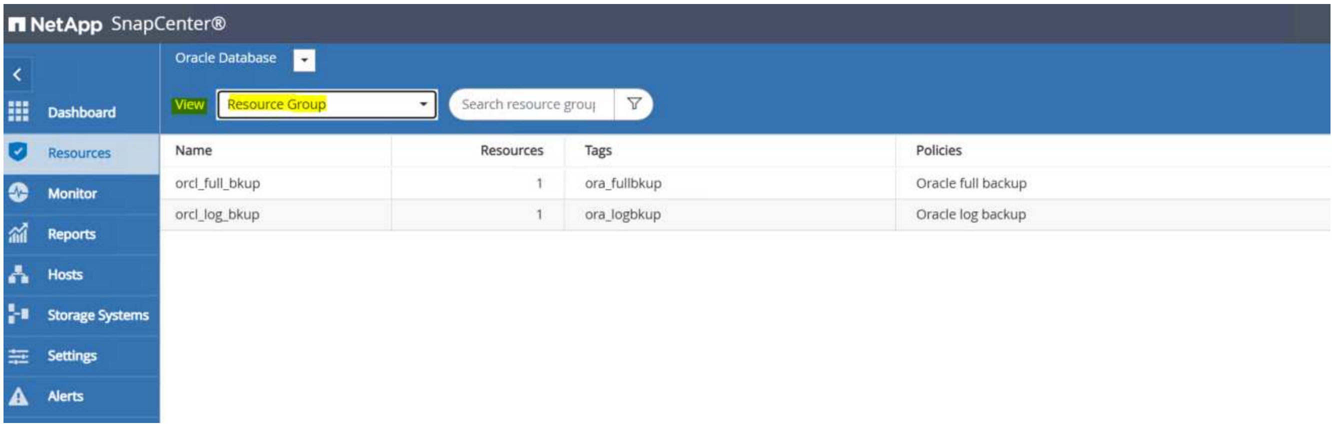
Primary Backup(s)

Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-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
ip-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

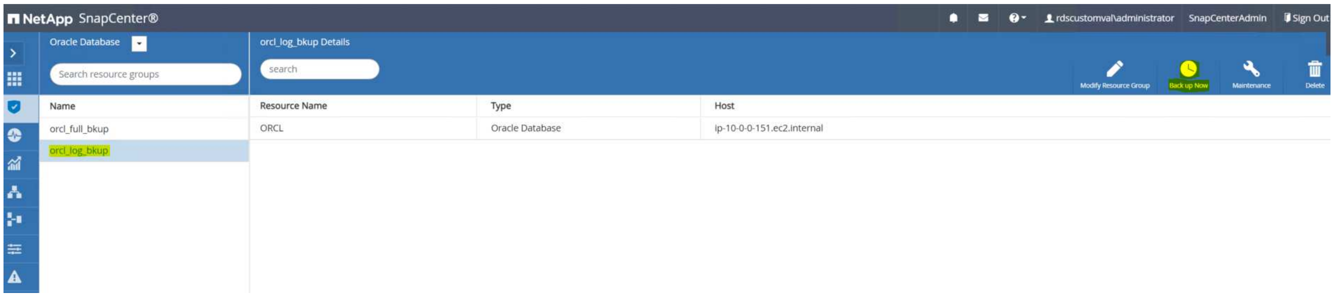
An archive log snapshot is only taken for the Oracle archive log volume.

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.



Name	Resources	Tags	Policies
orcl_full_bkup	1	ora_fullbkup	Oracle full backup
orcl_log_bkup	1	ora_logbkup	Oracle log backup

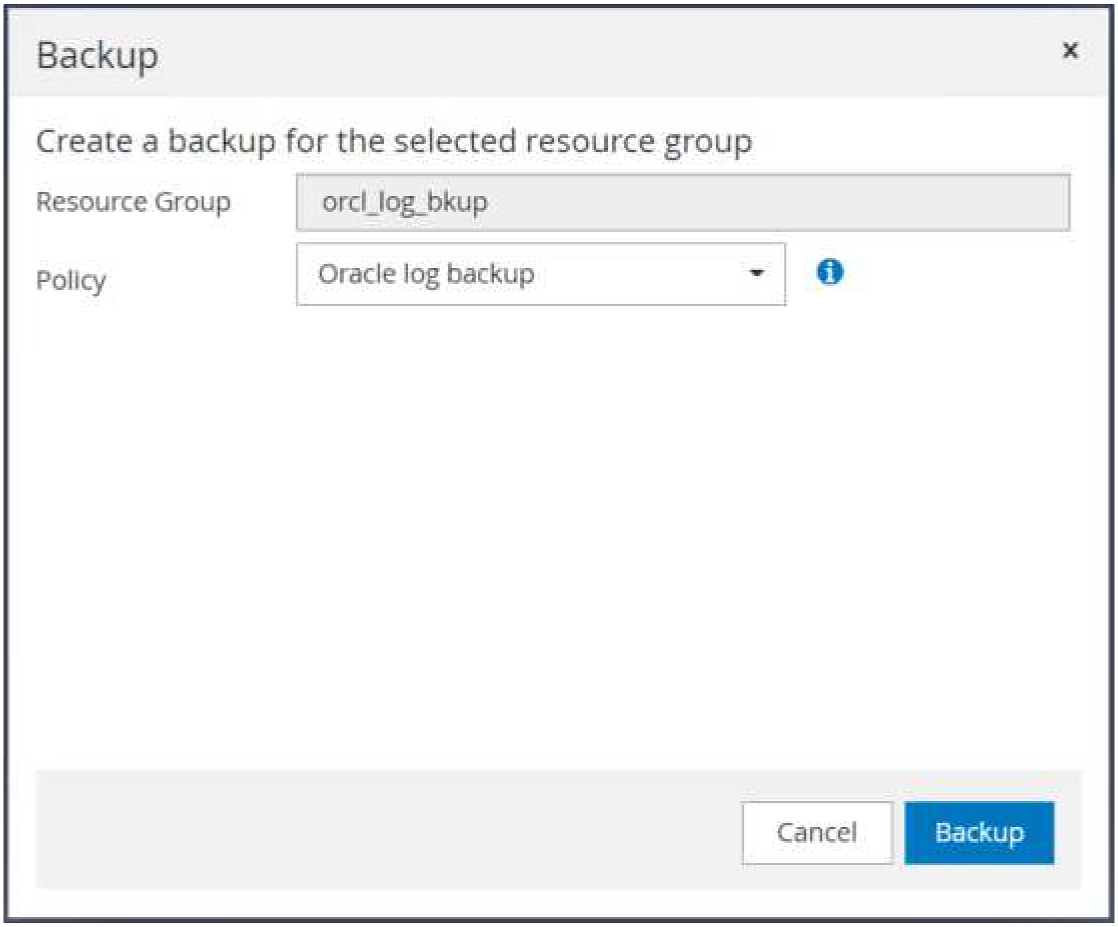
2. Click the log backup resource name, and then click the Backup Now icon to initiate an add-hoc backup for archive logs.



Name
orcl_full_bkup
orcl_log_bkup

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

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

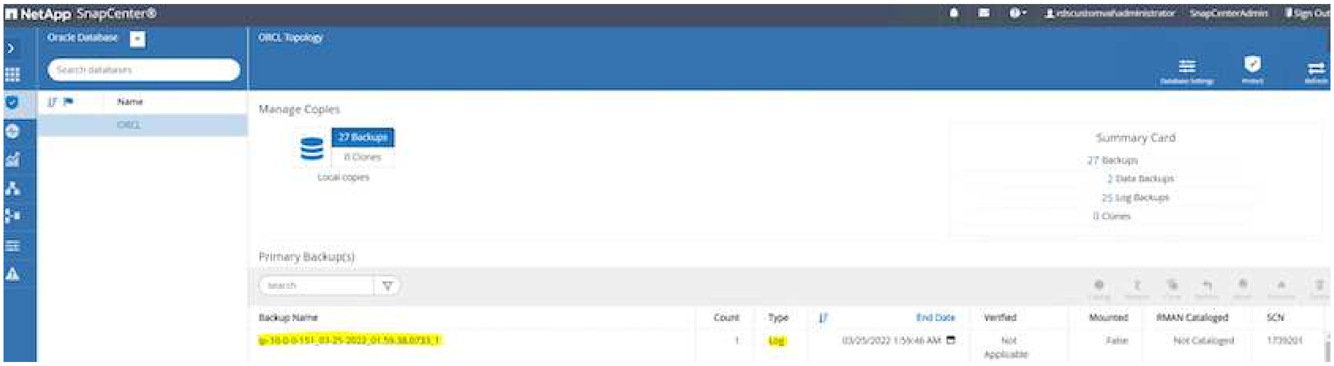


Create a backup for the selected resource group

Resource Group: orcl_log_bkup

Policy: Oracle log backup

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.

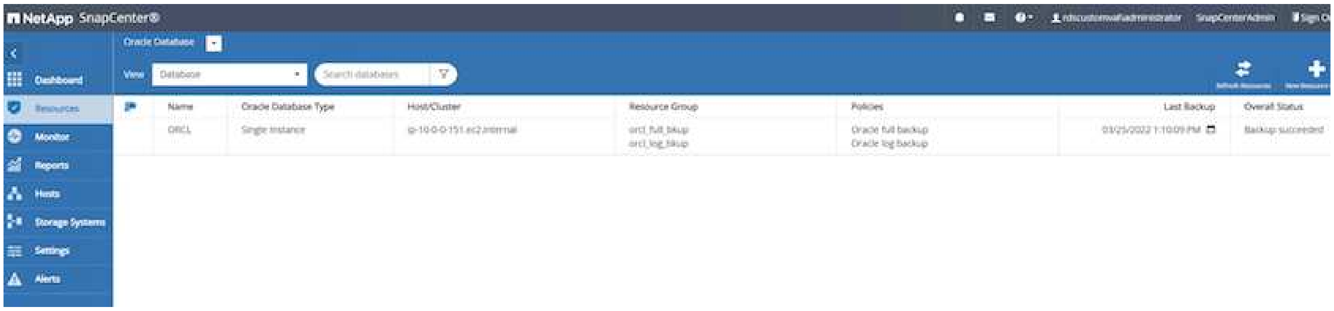


Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_01.59.38.0733_1	1	Log	03/25/2022 1:59:46 AM	Not Applicable	False	Not Cataloged	1739201

Restoring to a point in time

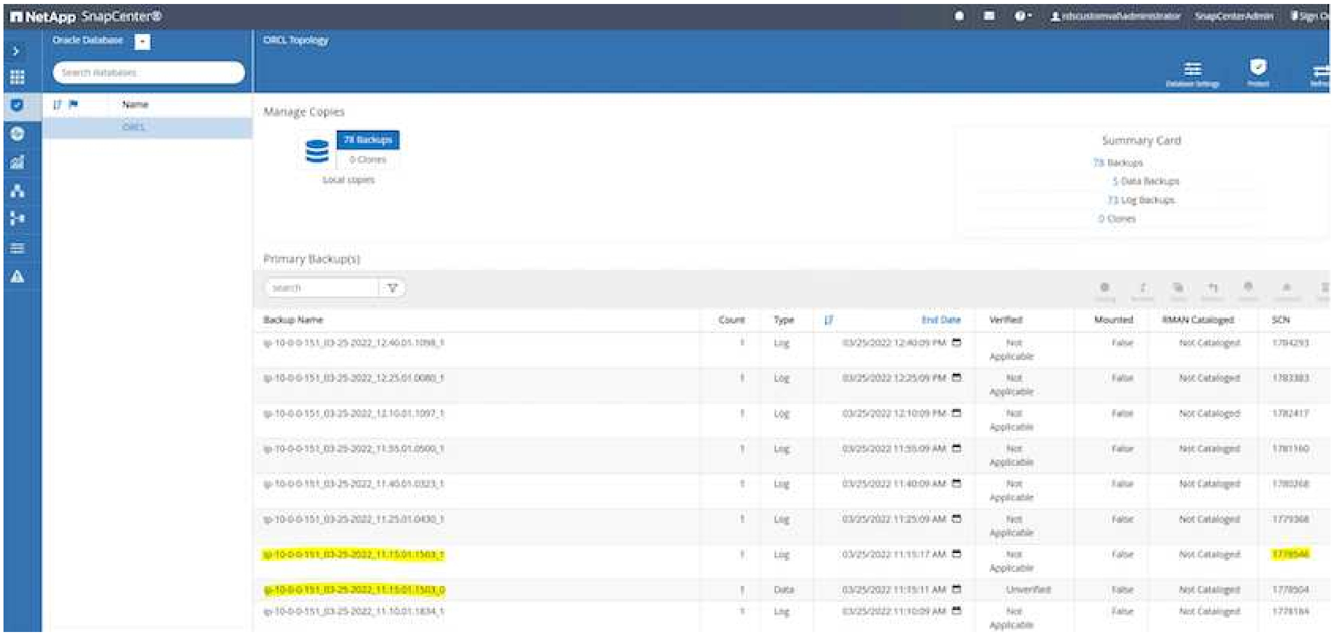
SnapCenter-based restore to a point in time is executed on the same EC2 instance host. Complete the following steps to perform the restore:

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



Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
ORCL	Single Instance	ip-10-0-0-151.ec2.internal	orcl_full_bkup orcl_log_bkup	Oracle full backup Oracle log backup	03/25/2022 1:10:09 PM	Backup succeeded

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.



Manage Copies

Summary Card

78 Backups

5 Data Backups

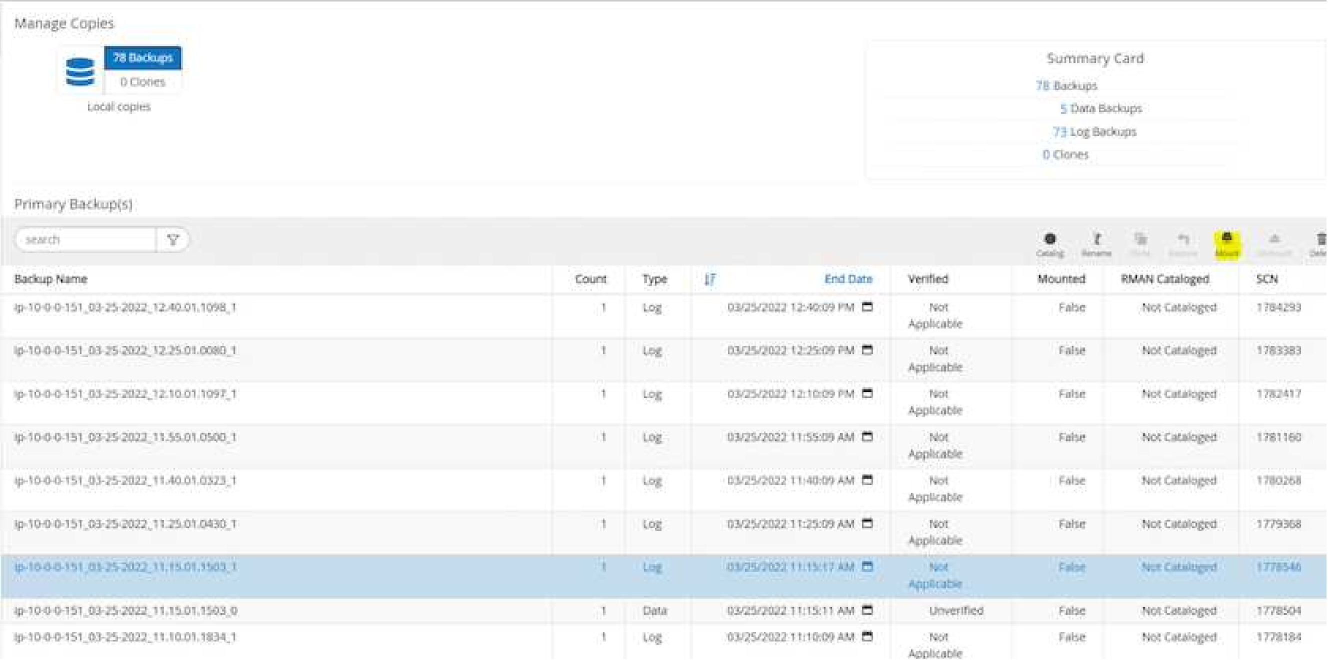
73 Log Backups

0 Clones

Primary Backup(s)

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.



Manage Copies

Summary Card

78 Backups

5 Data Backups

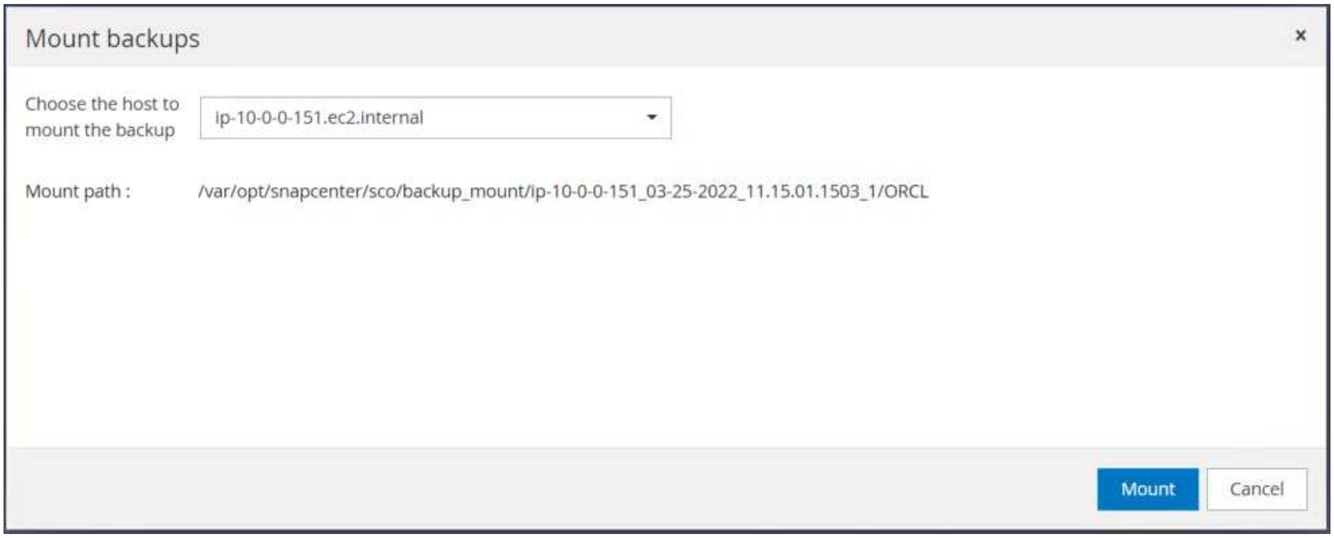
73 Log Backups

0 Clones

Primary Backup(s)

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

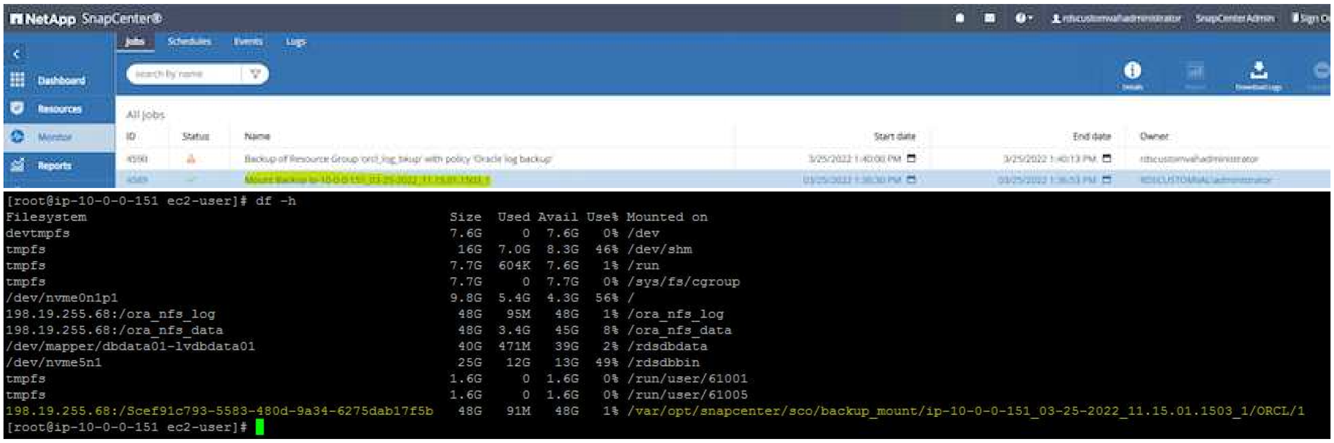
4. Choose the primary EC2 instance to mount the log volume.



Choose the host to mount the backup: ip-10-0-0-151.ec2.internal

Mount path : /var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_11.15.01.1503_1/ORCL

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



All jobs

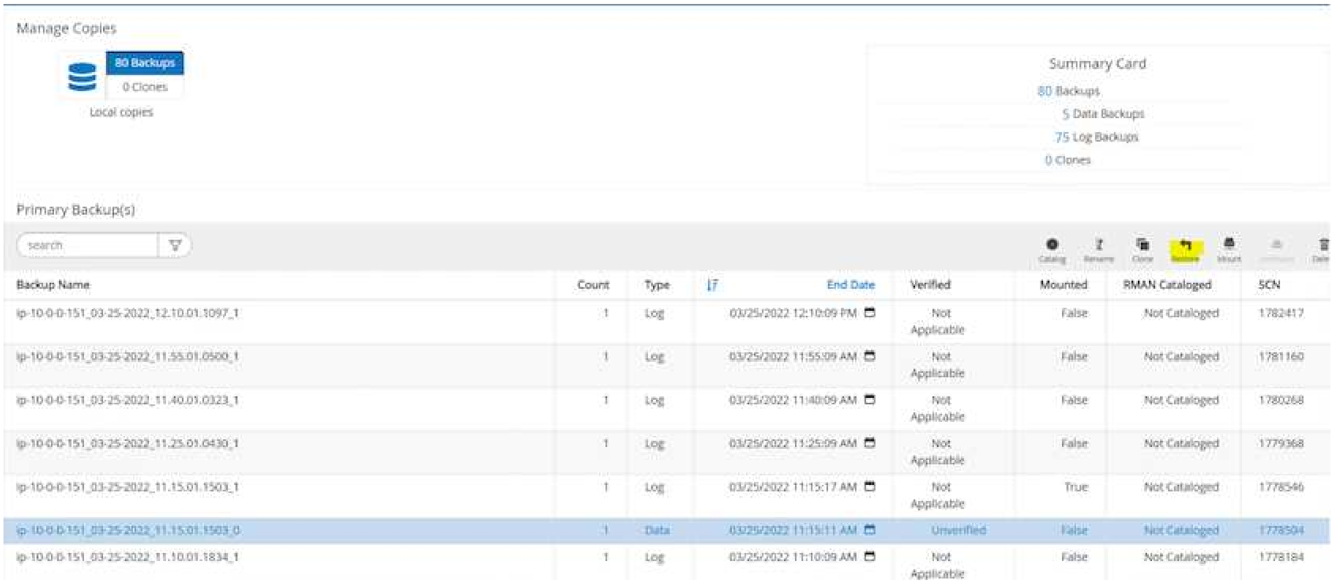
ID	Status	Name	Start date	End date	Owner
4590	⚠	Backup of Resource Group 'orcl_log_bkup' with policy 'Oracle log backup'	3/25/2022 1:40:00 PM	3/25/2022 1:40:13 PM	rdscustomval\administrator
4589	✓	Mount Backup ip-10-0-0-151_03-25-2022_11.15.01.1503_1	03/25/2022 1:36:30 PM	03/25/2022 1:36:53 PM	RDSCUSTOMVAL\administrator

```
[root@ip-10-0-0-151 ec2-user]# df -h
Filesystem                                           Size  Used Avail Use% Mounted on
devtmpfs                                             7.6G     0  7.6G   0% /dev
tmpfs                                                 16G  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/dbdata01-lvdbdata01                       40G  471M   39G   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/1
[root@ip-10-0-0-151 ec2-user]#
```

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

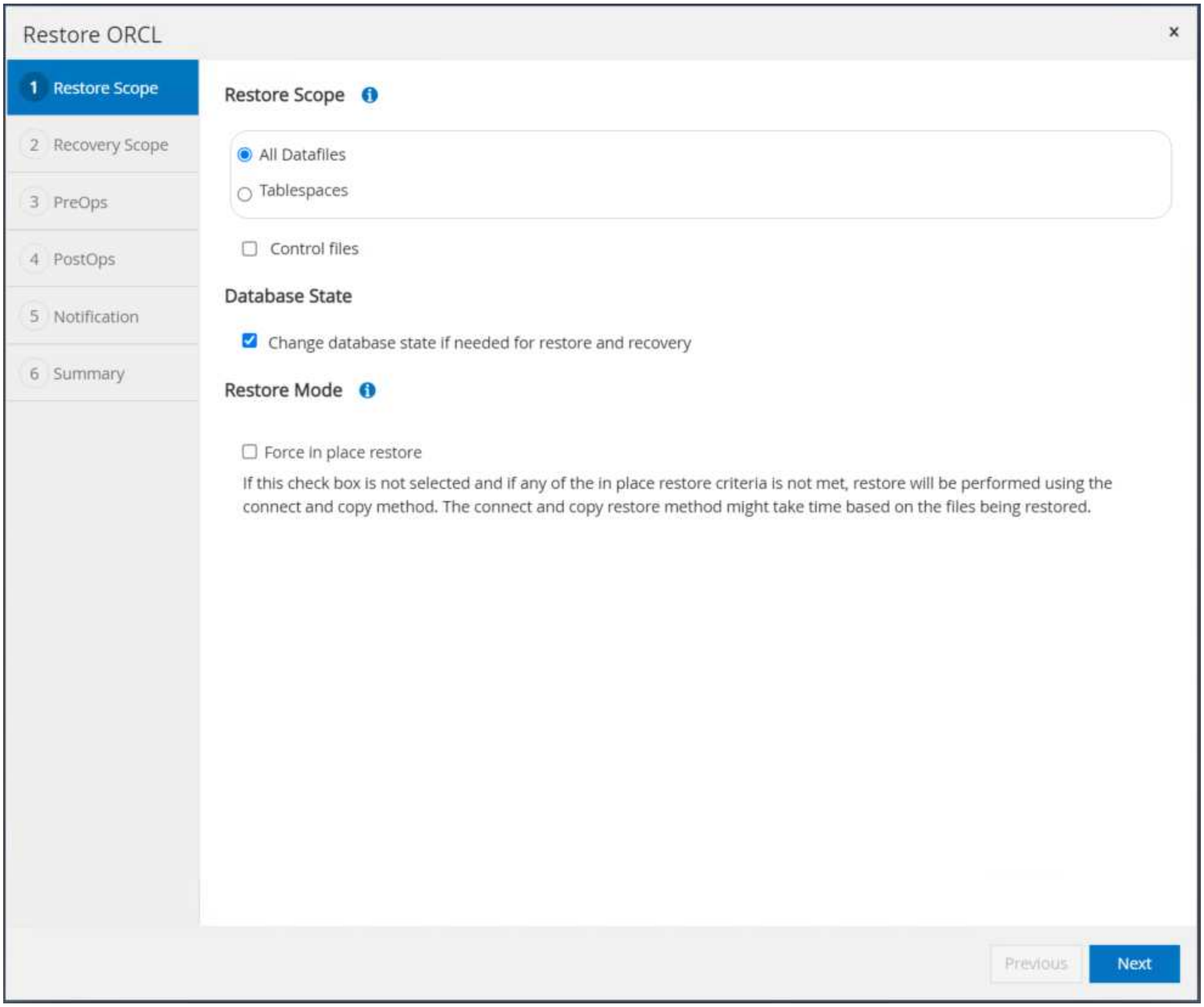
```
[ec2-user@ip-10-0-0-151 ~]$ cp /var/opt/snapcenter/sco/backup_mount/ip-
10-0-0-151_03-25-2022_11.15.01.1503_1/ORCL/1/db/ORCL_A/arch/*.arc
/ora_nfs_log/db/ORCL_A/arch/
```

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.



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 Scope

● All Datafiles

○ Tablespaces

☐ Control files

Database State

☑ Change database state if needed for restore and recovery

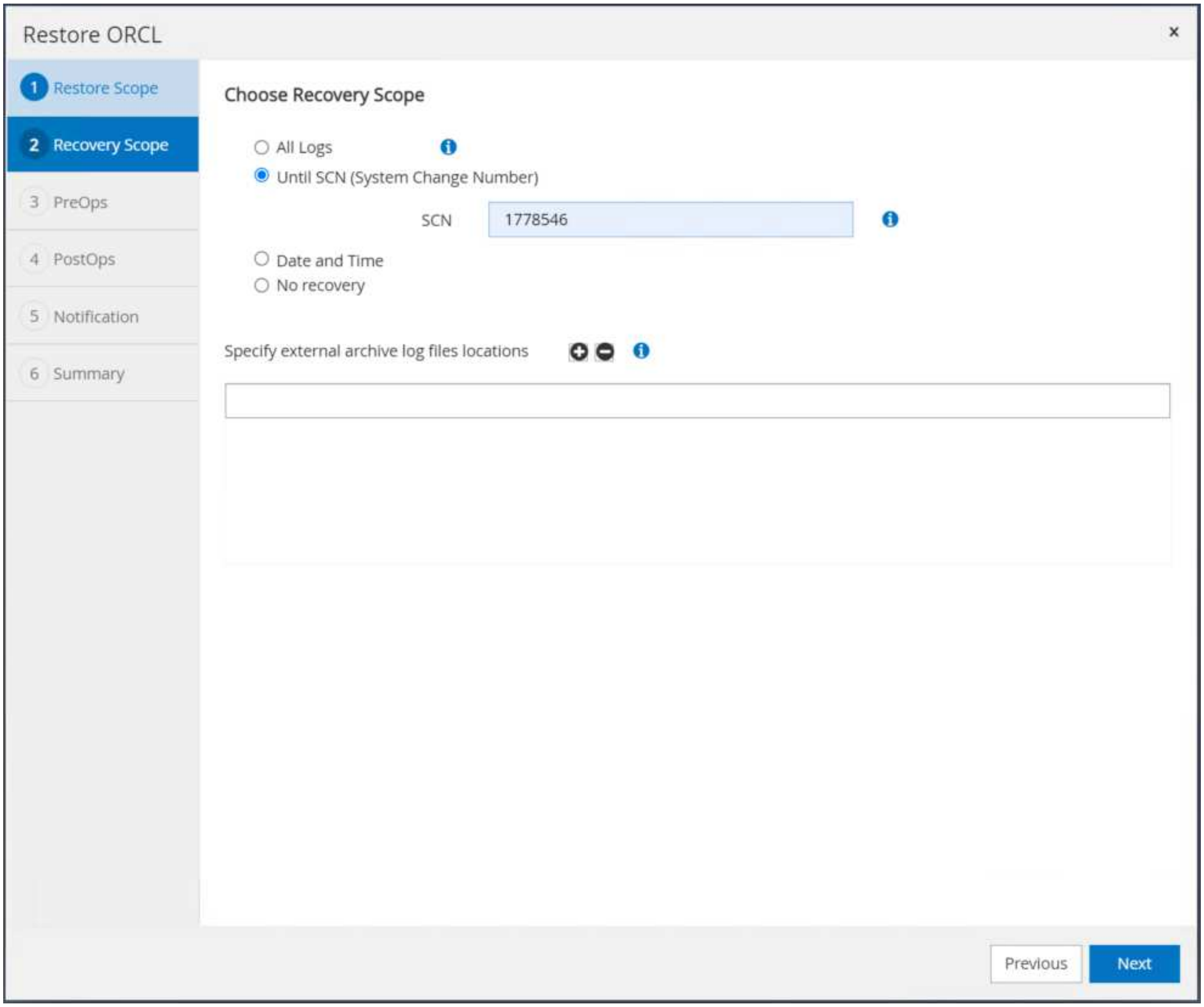
Restore Mode

☐ 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.

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.

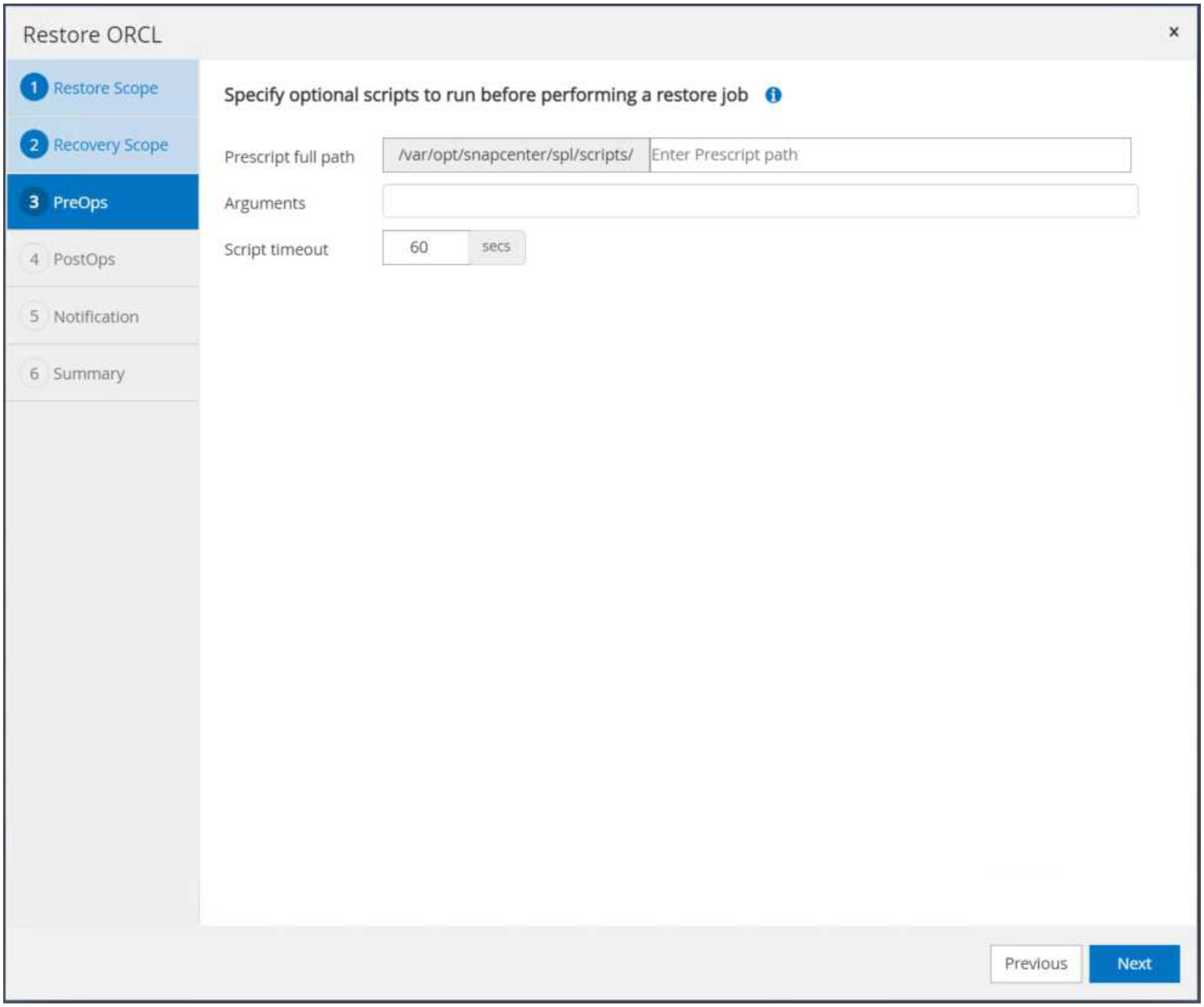


Choose Recovery Scope

○ All Logs
● Until SCN (System Change Number)
SCN 1778546
○ Date and Time
○ No recovery

Specify external archive log files locations

10. Specify an optional prescript to run if necessary.



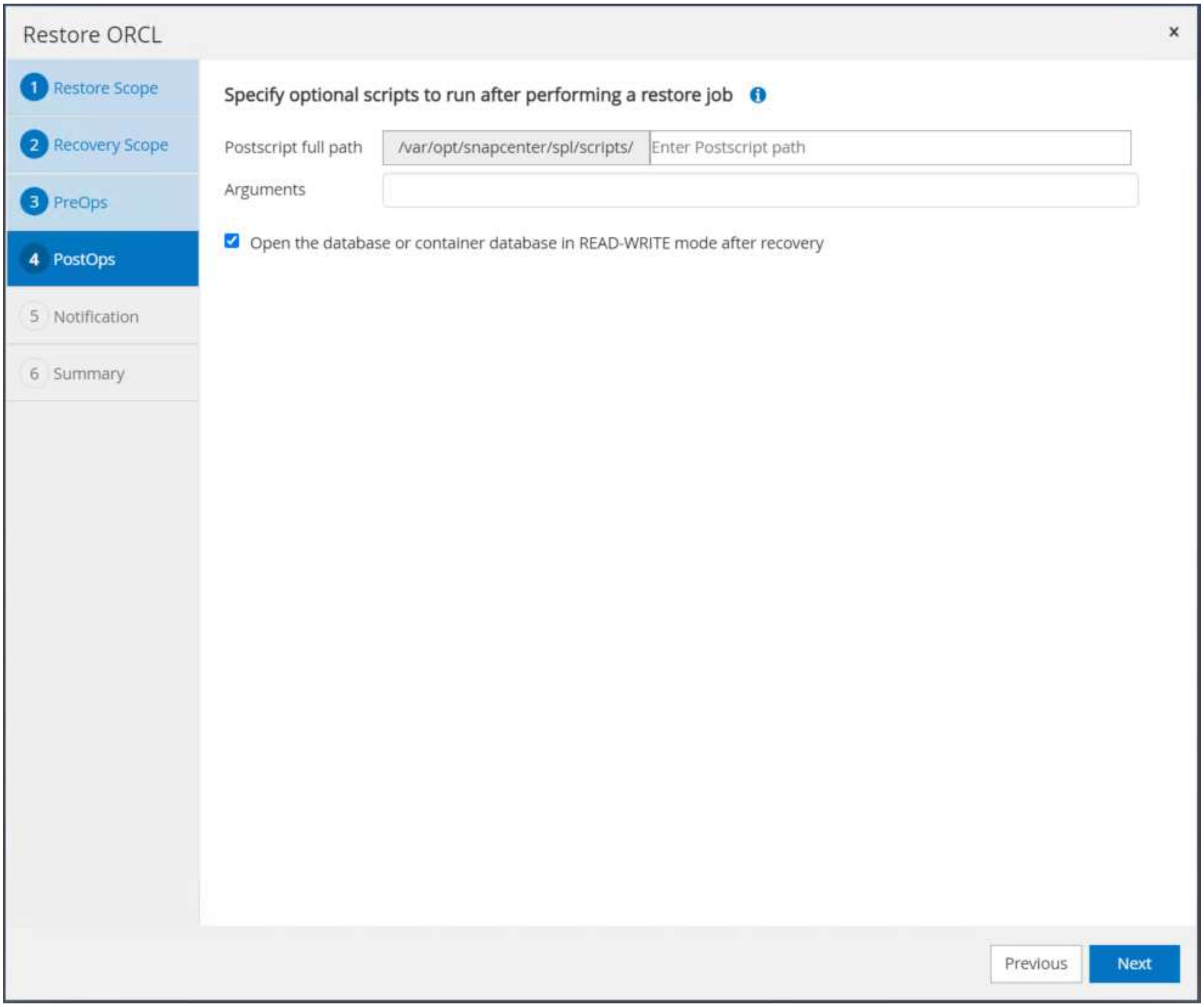
Specify optional scripts to run before performing a restore job

Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Arguments:

Script timeout: 60 secs

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



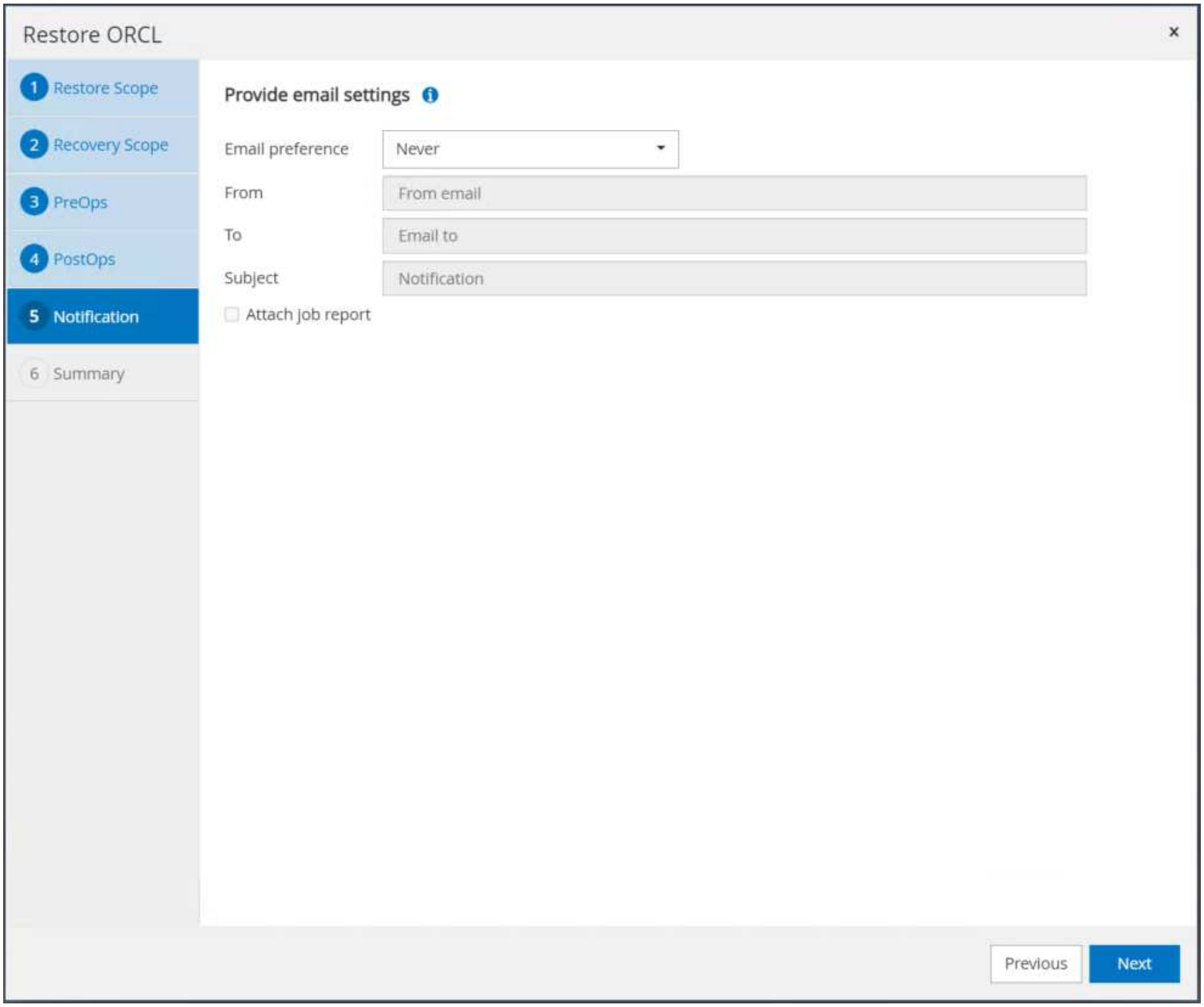
Specify optional scripts to run after performing a restore job

Postscript full path /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Arguments

☑ Open the database or container database in READ-WRITE mode after recovery

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



Provide email settings

Email preference: Never

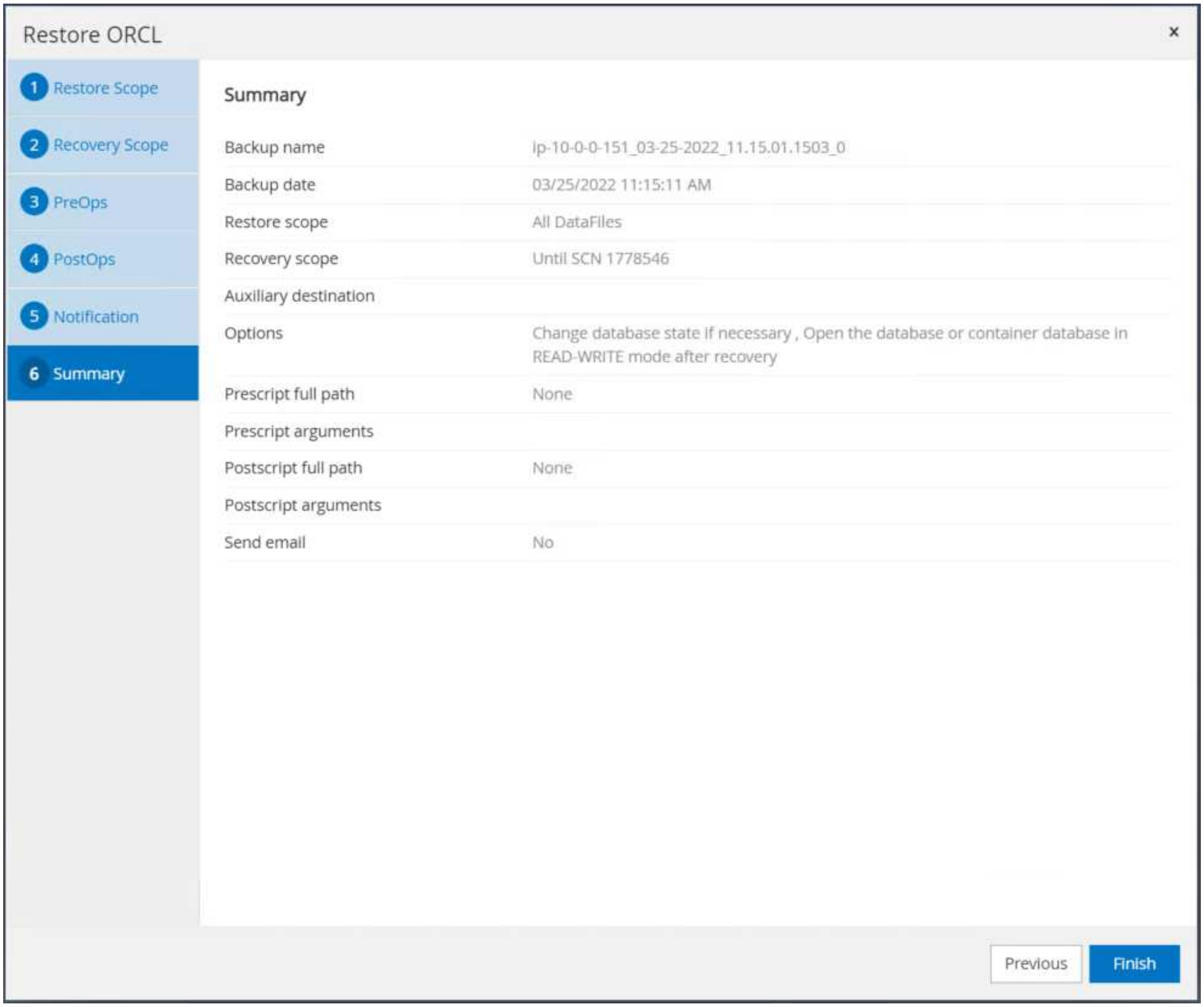
From: From email

To: Email to

Subject: Notification

☐ Attach job report

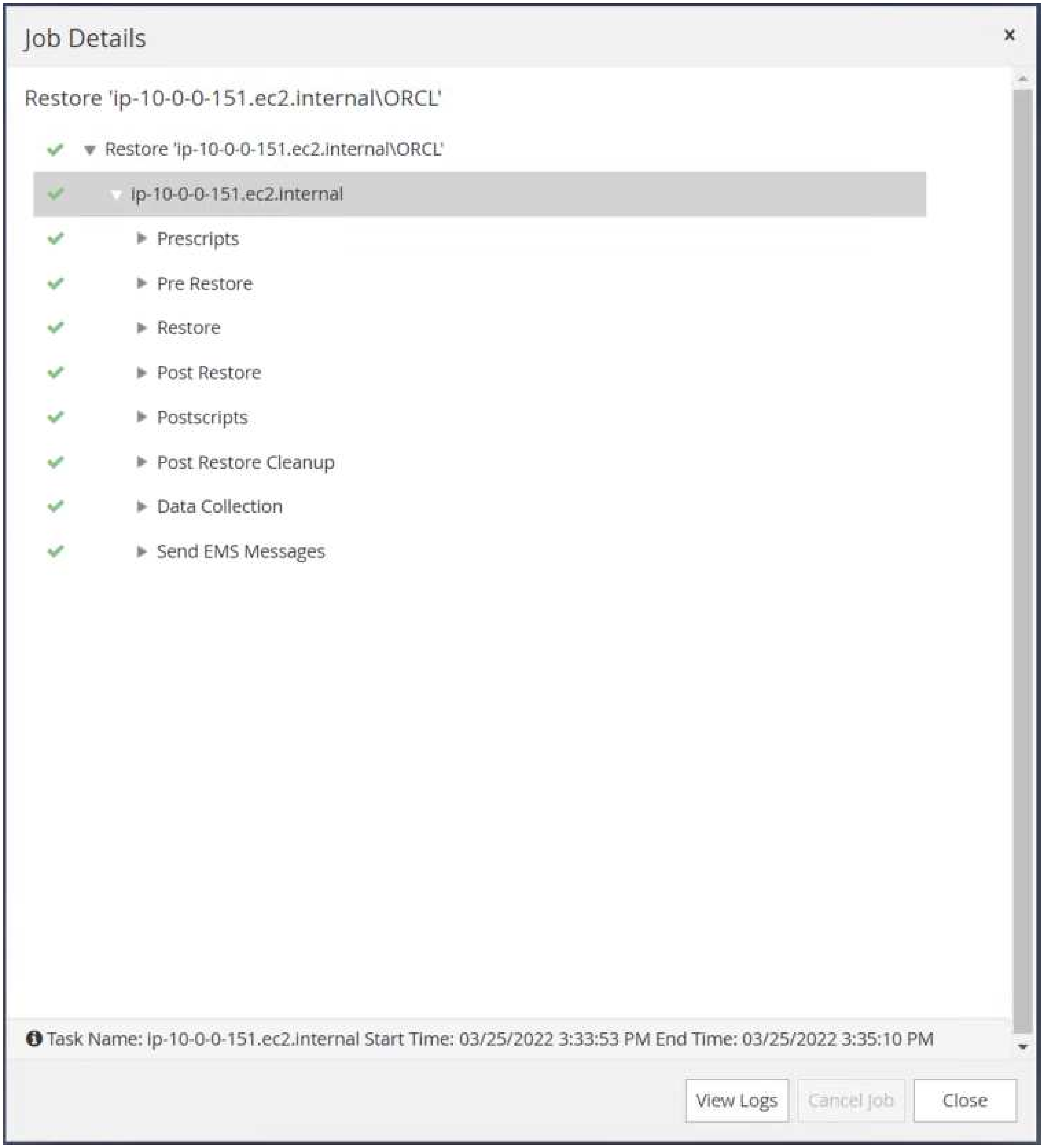
13. Restore the job summary. Click finish to launch the restore job.



Summary

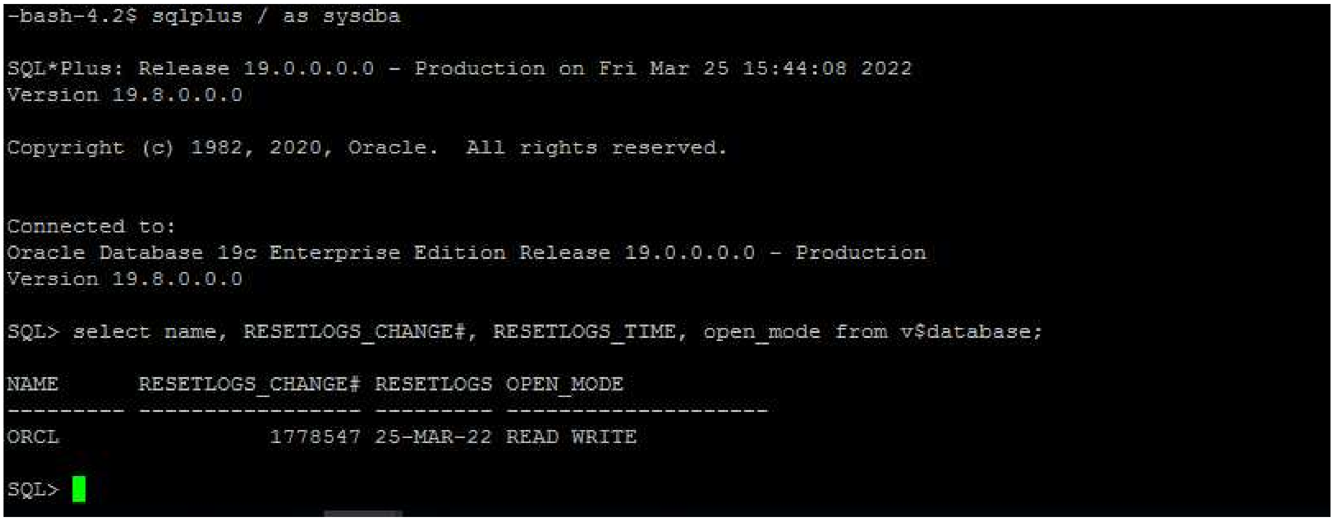
Backup name	ip-10-0-0-151_03-25-2022_11.15.01.1503_0
Backup date	03/25/2022 11:15:11 AM
Restore scope	All DataFiles
Recovery scope	Until SCN 1778546
Auxiliary destination	
Options	Change database state if necessary , Open the database or container database in READ-WRITE mode after recovery
Prescript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

14. Validate the restore from SnapCenter.



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

15. Validate the restore from the EC2 instance host.



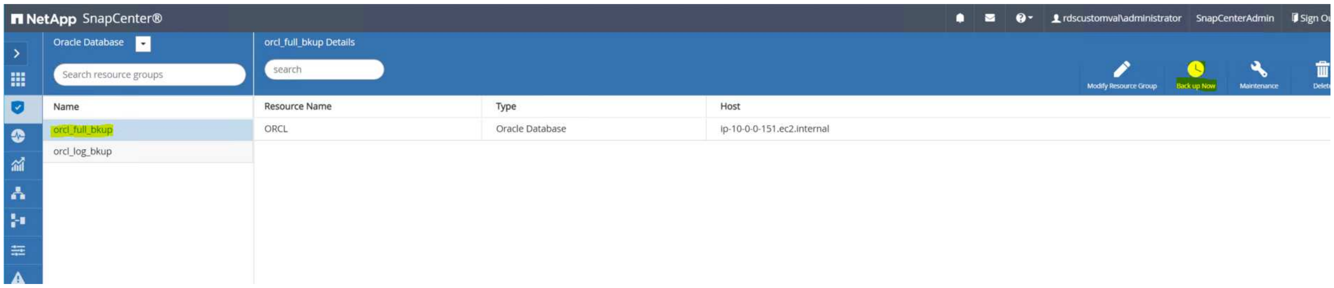
```
-bash-4.2$ sqlplus / as sysdba

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.

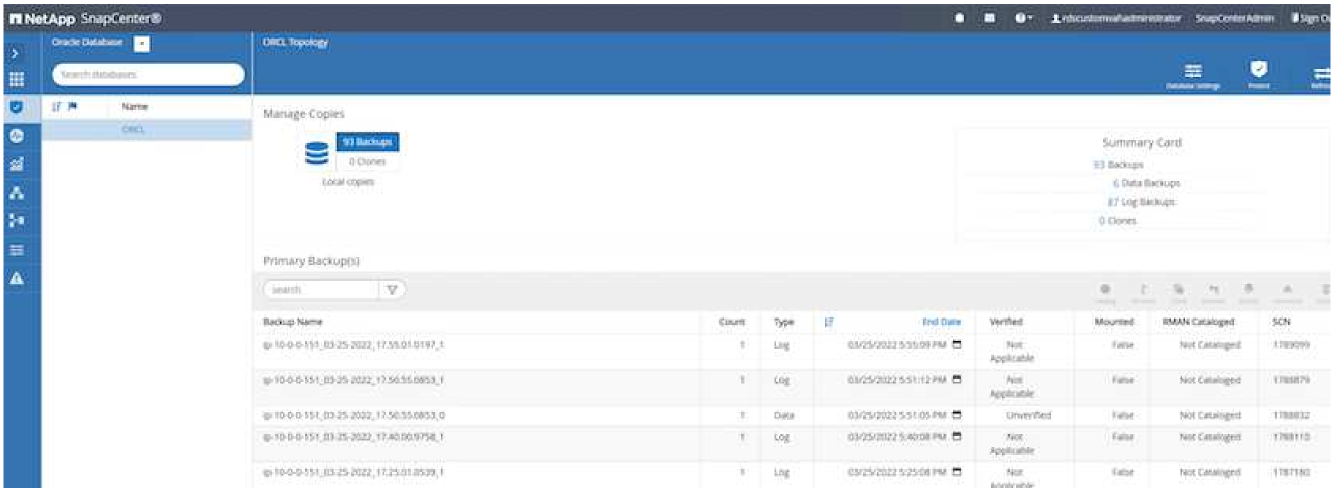
1. Take a full snapshot backup of the primary database from SnapCenter using the full backup resource group.



Name
orcl_full_bkup
orcl_log_bkup

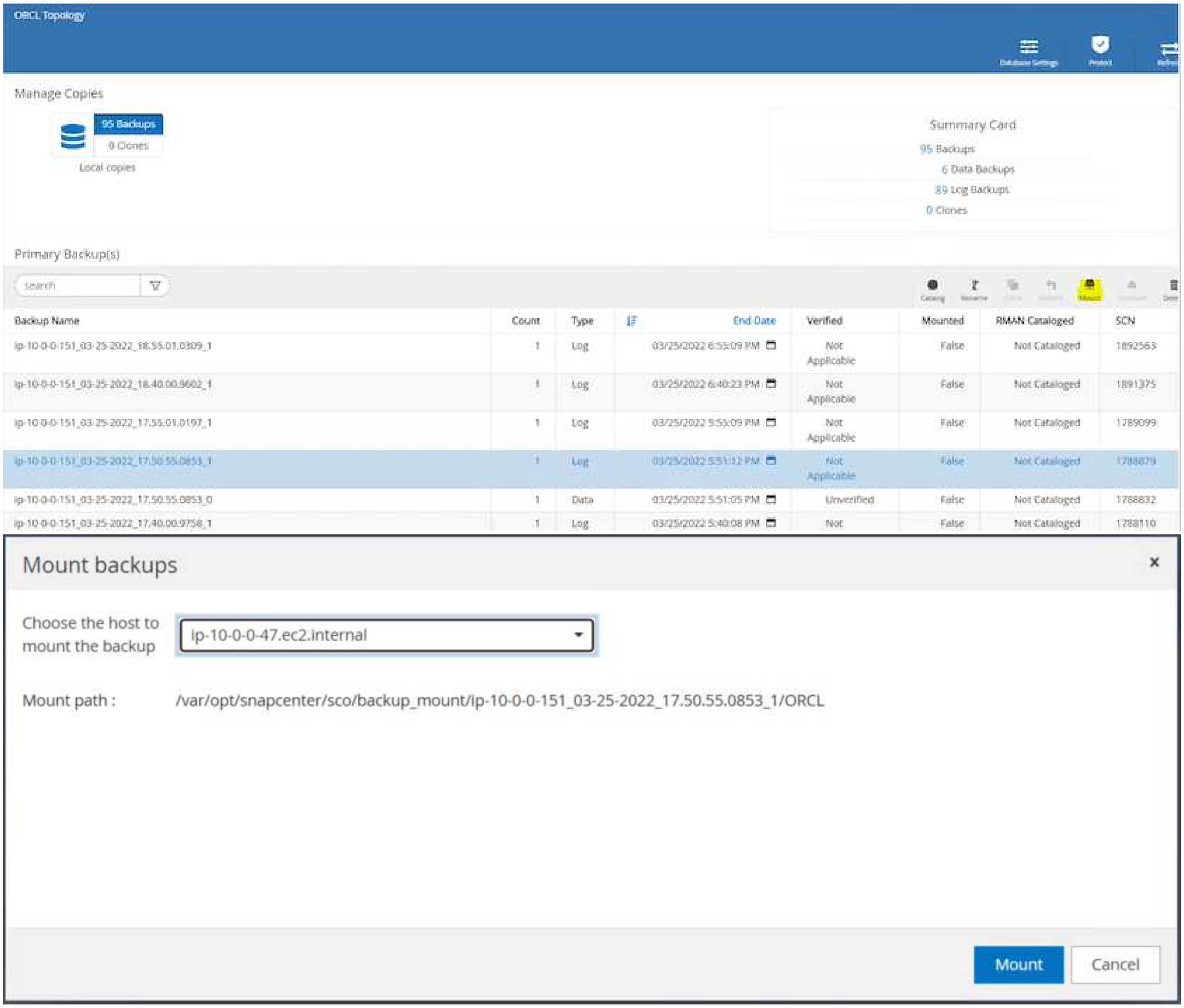
Resource Name	Type	Host
ORCL	Oracle Database	ip-10-0-0-151.ec2.internal

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.



Backup Name	Count	Type	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	[illegible]
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	[illegible]
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	[illegible]
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	[illegible]
ip-10-0-0-151_03-25-2022_17.25.01.0539_1	1	Log	03/25/2022 5:25:08 PM	Not Applicable	False	Not Cataloged	[illegible]

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

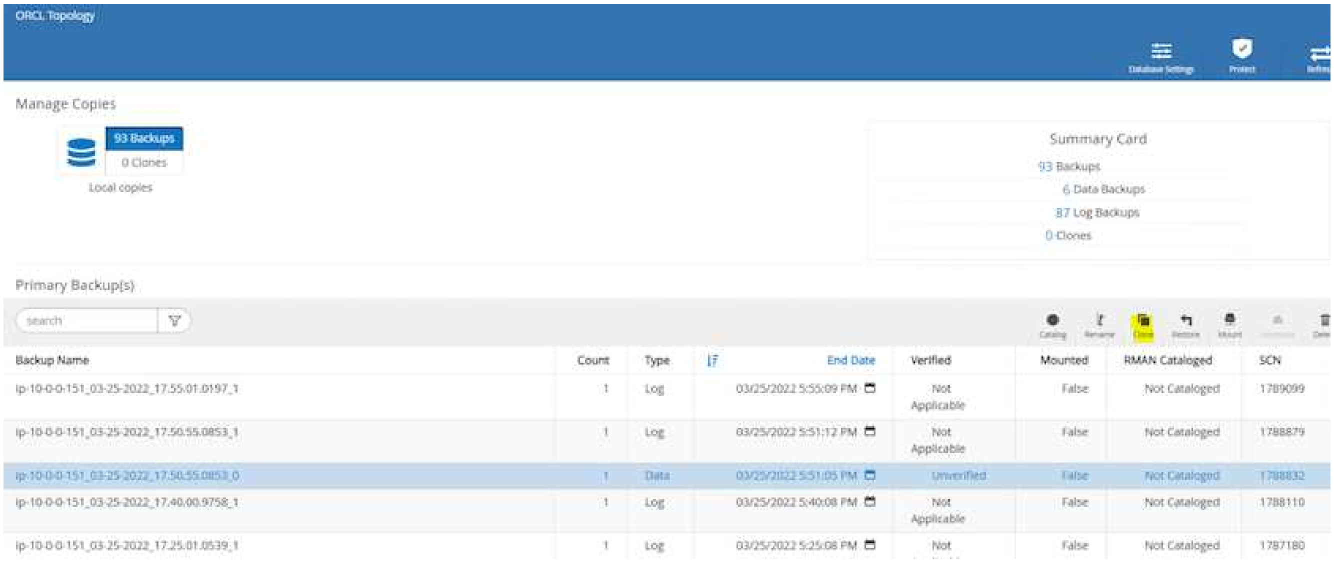


Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_18.55.01.0309_1	1	Log	03/25/2022 6:55:09 PM	Not Applicable	False	Not Cataloged	1892563
ip-10-0-0-151_03-25-2022_18.40.00.9602_1	1	Log	03/25/2022 6:40:23 PM	Not Applicable	False	Not Cataloged	1891375
ip-10-0-0-151_03-25-2022_17.55.01.0197_1	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

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

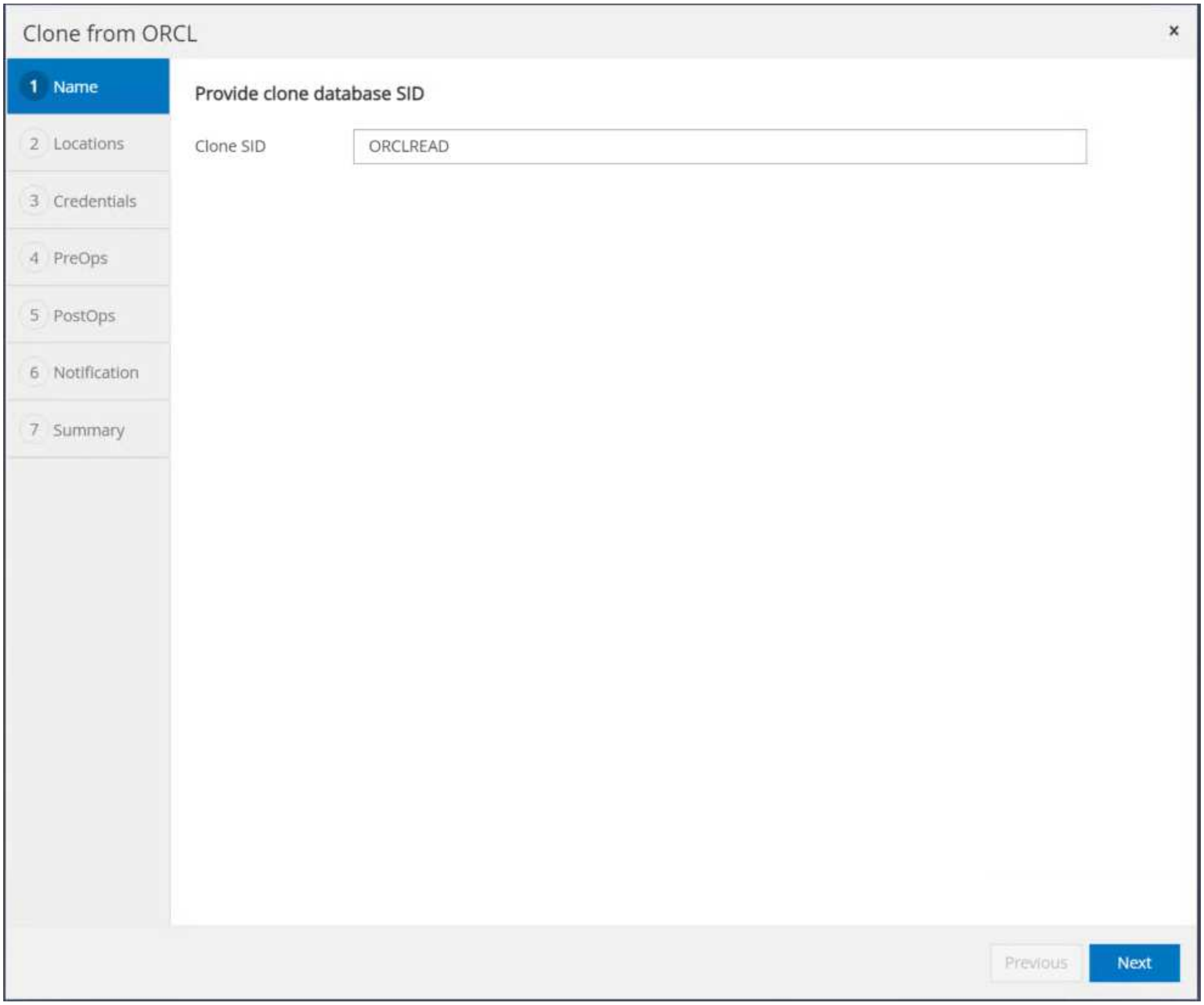
Mount path : /var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_17.50.55.0853_1/ORCL

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



Backup Name	Count	Type	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

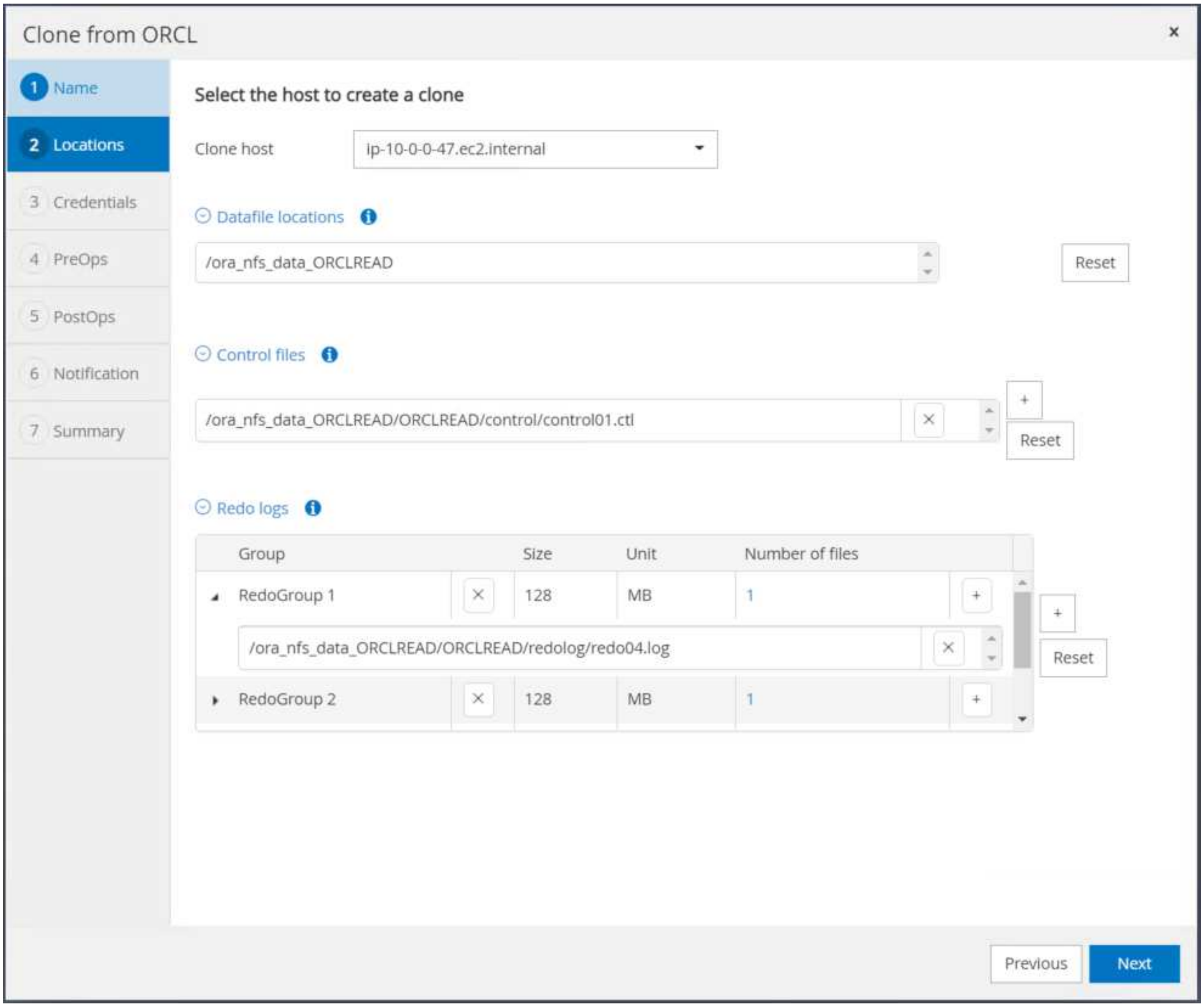
5. Change the replica copy name so that it is different from the primary database name. Click Next.



Provide clone database SID

Clone SID: ORCLREAD

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



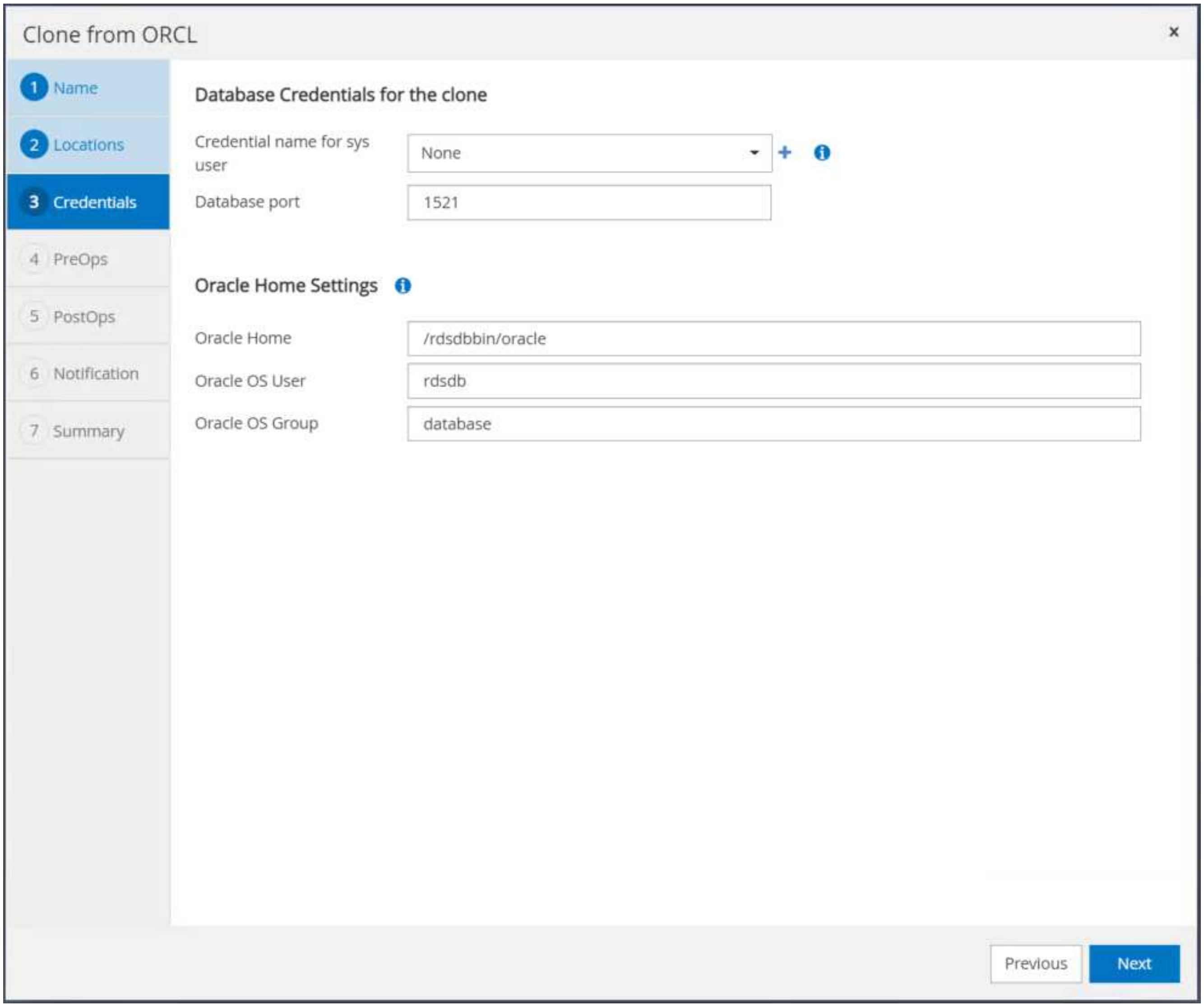
Clone host: ip-10-0-0-47.ec2.internal

Datafile locations: /ora_nfs_data_ORCLREAD

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

Group	Size	Unit	Number of files
RedoGroup 1	128	MB	1
/ora_nfs_data_ORCLREAD/ORCLREAD/redolog/redo04.log			
RedoGroup 2	128	MB	1

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



Database Credentials for the clone

Credential name for sys user: None

Database port: 1521

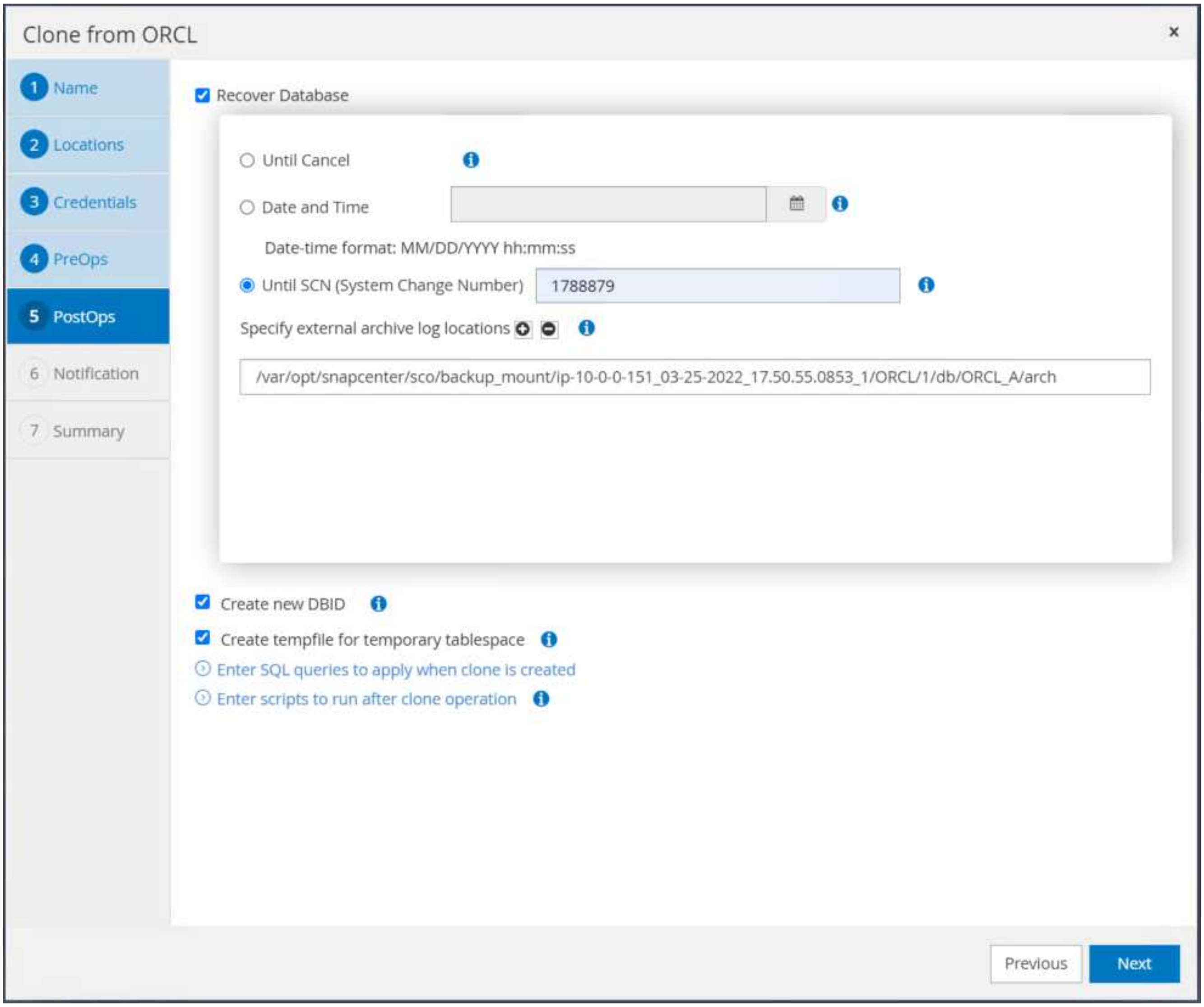
Oracle Home Settings

Oracle Home: /rdsdbbin/oracle

Oracle OS User: rdsdb

Oracle OS Group: database

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



☑ Recover Database

○ Until Cancel

○ Date and Time

Date-time format: MM/DD/YYYY hh:mm:ss

● Until SCN (System Change Number) 1788879

Specify external archive log locations

/var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_17.50.55.0853_1/ORCL/1/db/ORCL_A/arch

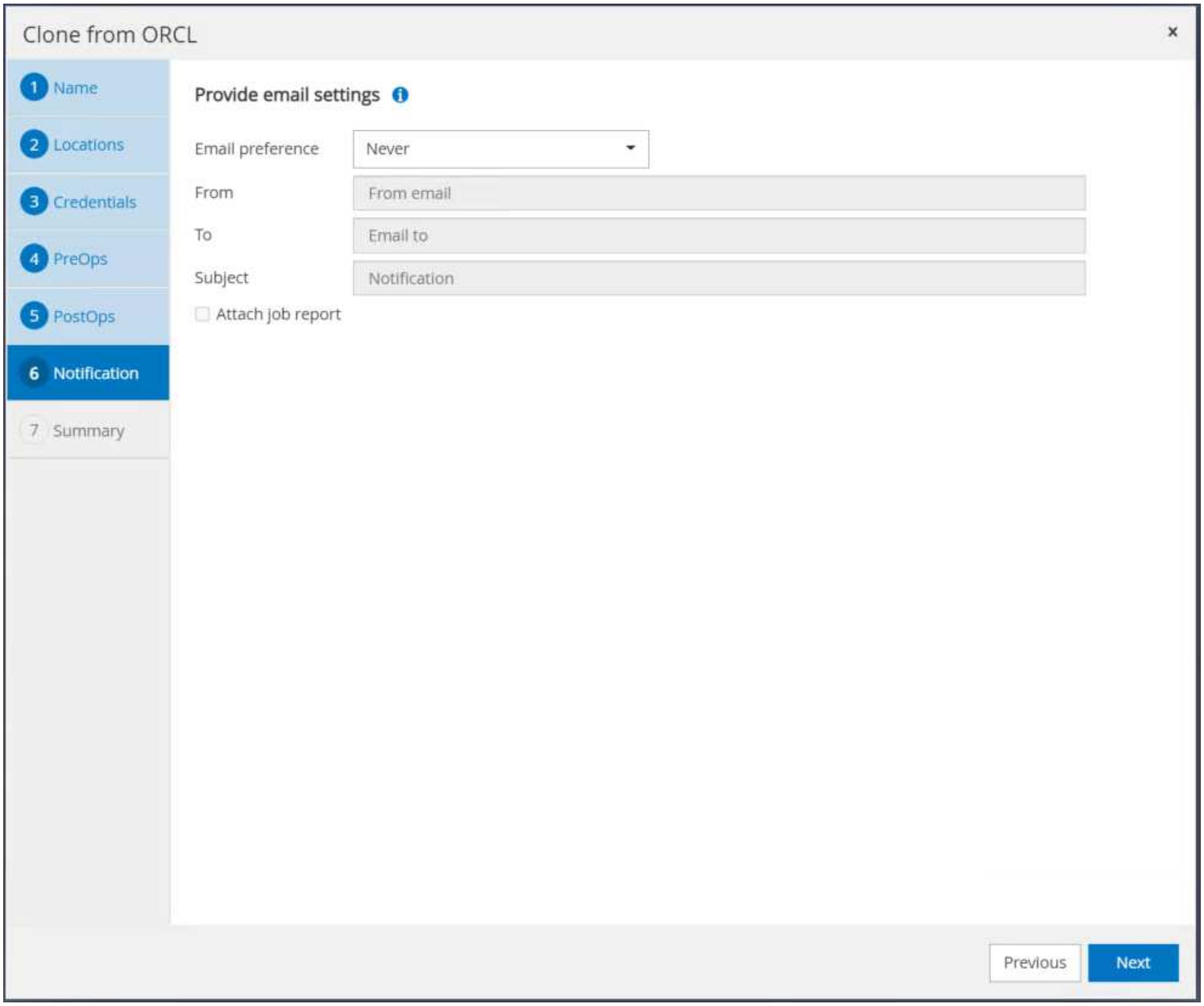
☑ Create new DBID

☑ Create tempfile for temporary tablespace

Enter SQL queries to apply when clone is created

Enter scripts to run after clone operation

9. Send the SMTP email settings if needed.



Provide email settings

Email preference: Never

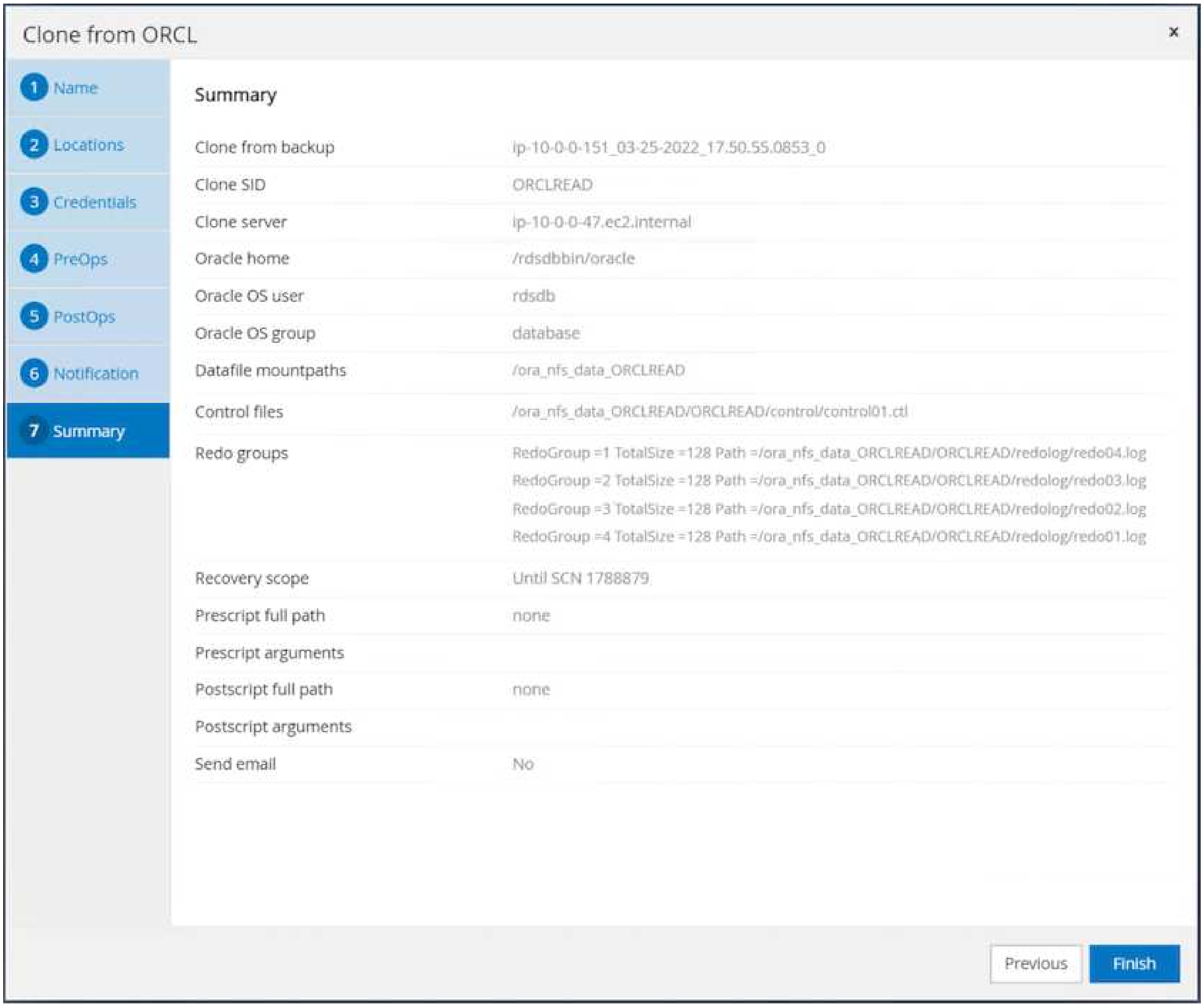
From: From email

To: Email to

Subject: Notification

☐ Attach job report

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



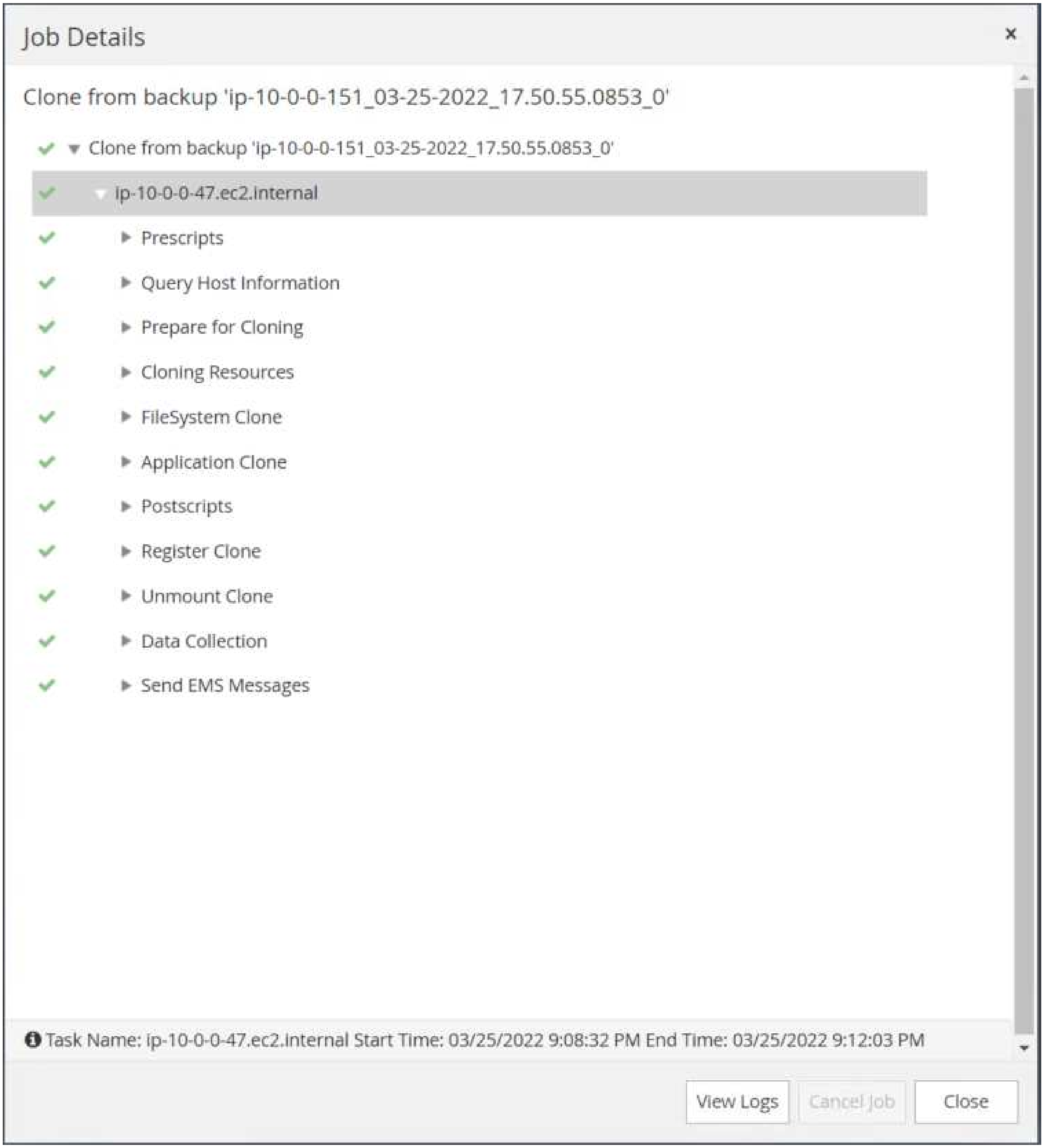
Summary

Clone from backup	ip-10-0-0-151_03-25-2022_17.50.55.0853_0
Clone SID	ORCLREAD
Clone server	ip-10-0-0-47.ec2.internal
Oracle home	/rdsdbbin/oracle
Oracle OS user	rdsdb
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

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

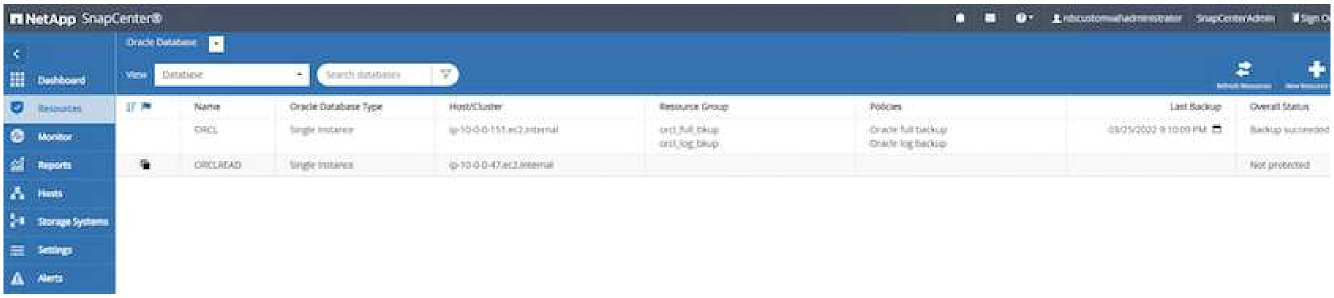


Clone from backup 'ip-10-0-0-151_03-25-2022_17.50.55.0853_0'

- ✓ 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

The cloned database is registered in SnapCenter immediately.



Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
ORCL	Single Instance	ip-10-0-0-151.ec2.internal	orcl_full_bkup orcl_log_bkup	Oracle full backup Oracle log backup	03/25/2022 9:10:09 PM	Backup succeeded
ORCLREAD	Single Instance	ip-10-0-0-47.ec2.internal				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.

Database migration from on-prem to public cloud

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.

Migrate on-prem Oracle DB to AWS

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
```

Azure Cloud

TR-4990: Quick Recovery of Oracle VLDB with Incremental Merge on ANF

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for quick recovery of Oracle VLDB deployed to Azure VM compute instance with NFS mount on Azure NetApp Files capacity pool to stage a standby database copy that is incrementally merged constantly via RMAN.

Purpose

Recovering a Very Large Database (VLDB) in Oracle using the Oracle Recovery Manager (RMAN) backup tool can be a highly challenging task. The database restoration process from backup media in the event of a failure can be time-consuming, delaying the database recovery and potentially impacting your Service Level Agreement (SLA) significantly. However, starting from version 10g, Oracle introduced a RMAN feature that allows users to create staged image copies of the Oracle database data files on additional disk storage located on the DB server host. These image copies can be incrementally updated using RMAN on a daily basis. In the case of a failure, the Database Administrator (DBA) can swiftly switch the Oracle database from the failed media to the image copy, eliminating the need for a complete database media restore. The result is a greatly improved SLA, albeit at the cost of doubling the required database storage.

If you are keen on SLA for your VLDB and contemplating moving the Oracle database to a public cloud such as Azure, you could set up a similar database protection structure using resources such as Microsoft Azure NetApp Files (ANF) for staging your standby database image copy. In this documentation, we demonstrate how to provision and export an NFS file system from ANF capacity pool to be mounted on an Oracle database server for staging a standby database copy for quick recovery in the event of a primary storage failure.

This solution addresses the following use cases:

- An Oracle VLDB image copy incremental merge via RMAN on NFS mount point off Microsoft ANF capacity pool storage.
- Quick recovery of an Oracle VLDB in the event of a failure on the same Azure database server VM.
- Quick recovery of an Oracle VLDB in the event of a failure on a standby Azure database server VM.

Audience

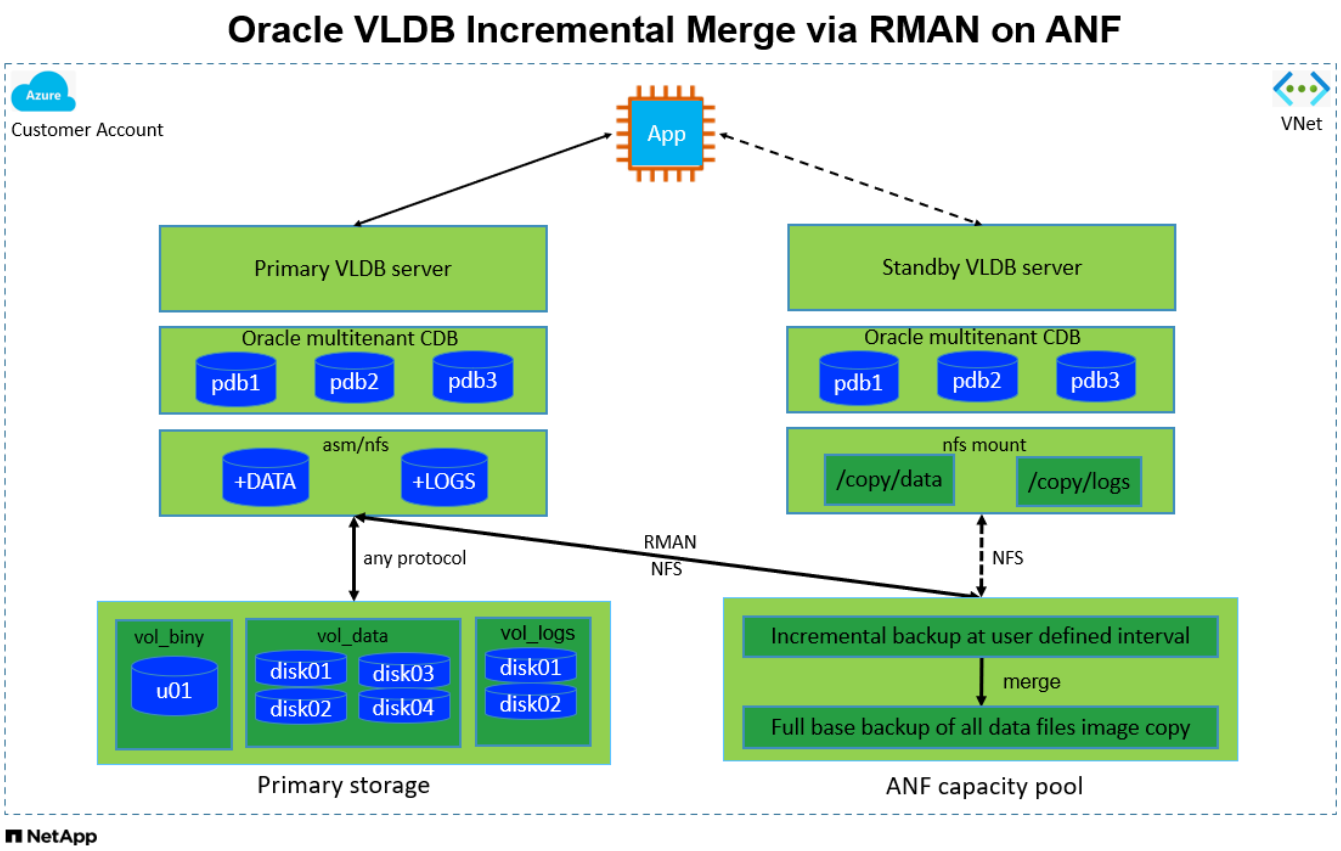
This solution is intended for the following people:

- A DBA who sets up Oracle VLDB image copy incremental merge via RMAN in Azure for faster database recovery.
- A database solution architect who tests Oracle workloads in the Azure public cloud.
- A storage administrator who manages Oracle databases deployed to ANF capacity pool storage.
- An application owner who would like to stand up Oracle databases in Azure cloud environment.

Solution test and validation environment

The testing and validation of this solution was performed in a Microsoft ANF capacity pool storage and Azure VM compute 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	
ANF storage	Current version offered by Microsoft	2 TiB ANF capacity pool storage with Premium service level
Azure VM for DB server	Standard_B4ms - 4 vCPUs, 16GiB	2 VMs, one as primary DB server and the other as a standby
	Software	
RedHat Linux	RHEL Linux 8.6 (LVM) - x64 Gen2	Deployed RedHat subscription for testing
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
NFS	Version 3.0	Oracle dNFS enabled

Key factors for deployment consideration

- **Oracle VLDB storage layout for RMAN incremental merge.** In our tests and validations, the NFS volume for Oracle incremental backup and merge is allocated from a single ANF capacity pool, which has 100 TiB per volume, and 1000 TiB total capacity limit. For deployment over the thresholds, multiple volumes, and ANF capacity pools can be concatenated in parallel with multiple NFS mount points to provide higher capacity.

- **Oracle recoverability using RMAN incremental merge.** The RMAN incremental backup and merge is generally executed at user defined frequency based on your RTO and RPO objectives. If there are total loss of primary data storage and/or archived logs, the data loss can occur. The Oracle database can be recovered up to last incremental backup that is available from ANF database backup image copy. To minimize the data loss, Oracle flash recovery area can be setup on ANF NFS mount point and archived logs are backed up to ANF NFS mount along with database image copy.
- **Running Oracle VLDB off ANF NFS file system.** Unlike other bulk storage for database backup, Microsoft ANF is a cloud enabled production grade storage that delivers high level of performance and storage efficiency. Once Oracle VLDB switches over from primary storage to image copy on ANF NFS file system, database performance can be maintained at high level while the primary storage failure is addressed. You can take comfort to know that user application experience does not suffer as the result of primary storage failure.
- **Azure compute instances.** In these tests and validations, we used Standard_B4ms Azure VMs as the Oracle database servers. There are other Azure VMs that may be optimized and better suited for database workload. You also need to size the Azure VM appropriately for the number of vCPUs and the amount of RAM based on actual workload requirements.
- **ANF capacity pool service level.** ANF capacity pool offers three service level: Standard, Premium, Ultra. By default, an auto QoS applies to a volume created within a capacity pool, which restricts the throughput on the volume. The throughput on a volume can be manually adjusted based on the size of capacity pool and service level.
- **dNFS configuration.** dNFS is built into Oracle kernel and is known to dramatically increase Oracle database performance when Oracle is deployed to NFS storage. dNFS is packaged into Oracle binary but is not turned on by default. It should be turned on for any Oracle database deployment on NFS. For multiple ANF capacity pools deployment for a VLDB, dNFS multi-paths to different ANF capacity pools storage should be properly configured.

Solution deployment

It is assumed that you already have your Oracle VLDB deployed in Azure cloud environment within a VNet. If you need help on Oracle deployment in Azure, please refer to following technical reports for help.

- Simplified, Automated Oracle Deployment on Azure NetApp Files with NFS
- Oracle Database Deployment and Protection on Azure NetApp Files

Your Oracle VLDB can be running either on an ANF storage or any other storage of choices within the Azure cloud ecosystem. The following section provides step-by-step deployment procedures for setting up RMAN incremental merge to an image copy of an Oracle VLDB that is staging in an NFS mount off ANF storage.

Prerequisites for deployment

Deployment requires the following prerequisites.

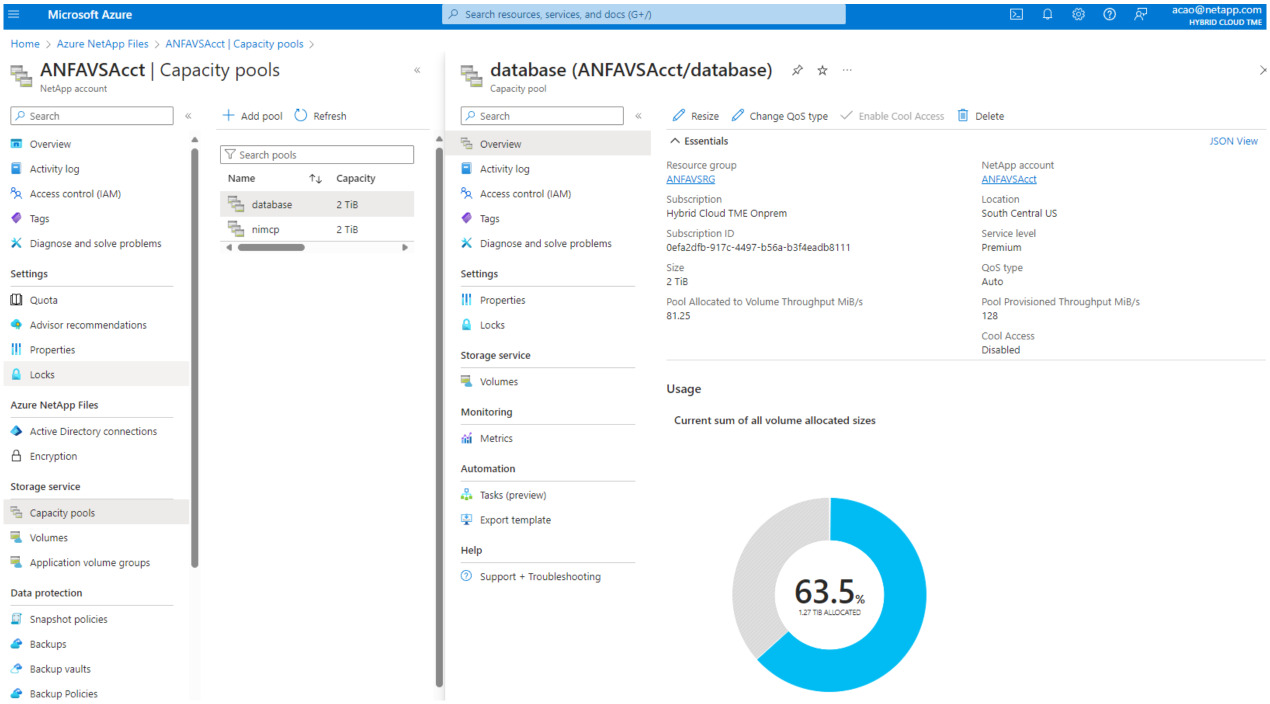
1. An Azure account has been set up, and the necessary Azure VNet and network segments have been created within your Azure account.
2. From the Azure portal console, you must deploy two Azure VM instances, one as the primary Oracle DB server and an optional standby DB server. See the architecture diagram in the previous section for more details about the environment setup. Also review the Azure Virtual Machine series for more information.
3. From the Azure portal console, deploy ANF storage to host the NFS volumes that stores the Oracle database standby image copy. If you are not familiar with the deployment of ANF, see the documentation Quickstart: Set up Azure NetApp Files and create an NFS volume for step-by-step instructions.

Ensure that you have allocated at least 128G in Azure VM root volume in order to have sufficient space to stage Oracle installation files.

Provision and export NFS volume to be mounted on primary Oracle VLDB server

In this section, we show provisioning an NFS volume from an ANF capacity pool via Azure portal console. Repeat the procedures on other ANF capacity pools if more than one ANF capacity pools are set up to accommodate the size of the database.

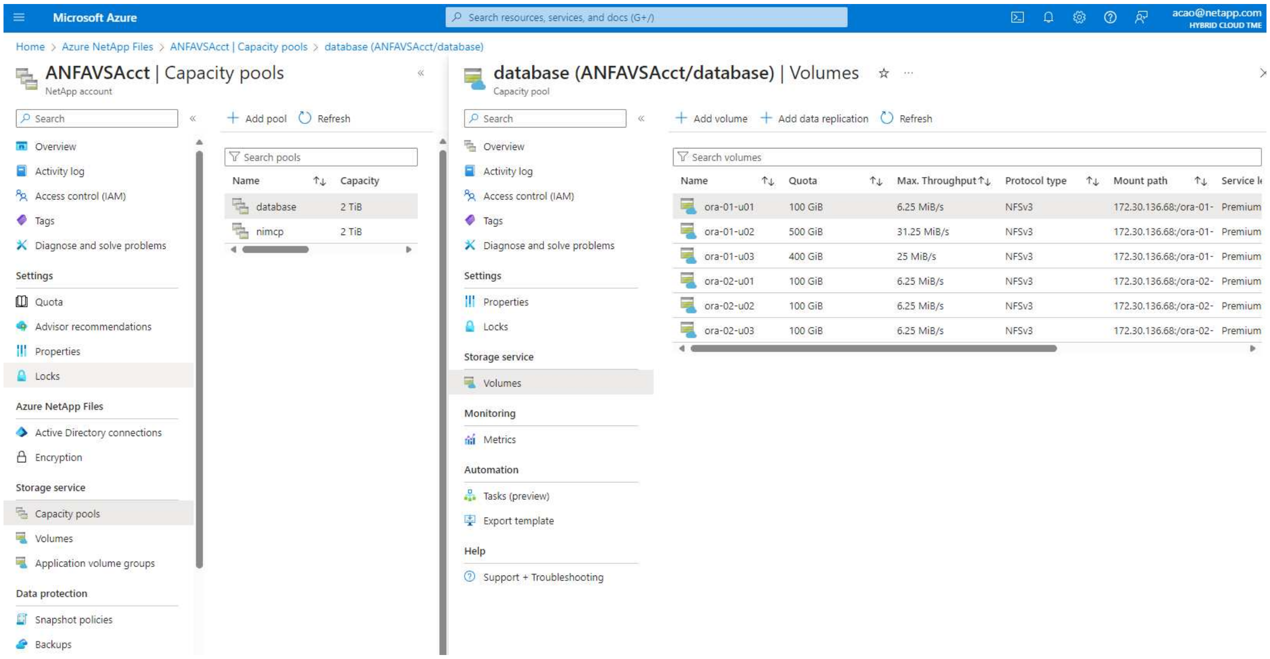
1. First, from Azure portal console, navigating to ANF capacity pool that is used to stage Oracle VLDB image copy.



Name	Capacity
database	2 TiB
nimcp	2 TiB

Resource group: ANFAVSRG
Subscription: Hybrid Cloud TME Onprem
Subscription ID: 0efa2dfb-917c-4497-b56a-b3f4eadb8111
Size: 2 TiB
Pool Allocated to Volume Throughput MiB/s: 81.25
NetApp account: ANFAVSAcct
Location: South Central US
Service level: Premium
QoS type: Auto
Pool Provisioned Throughput MiB/s: 128
Cool Access: Disabled

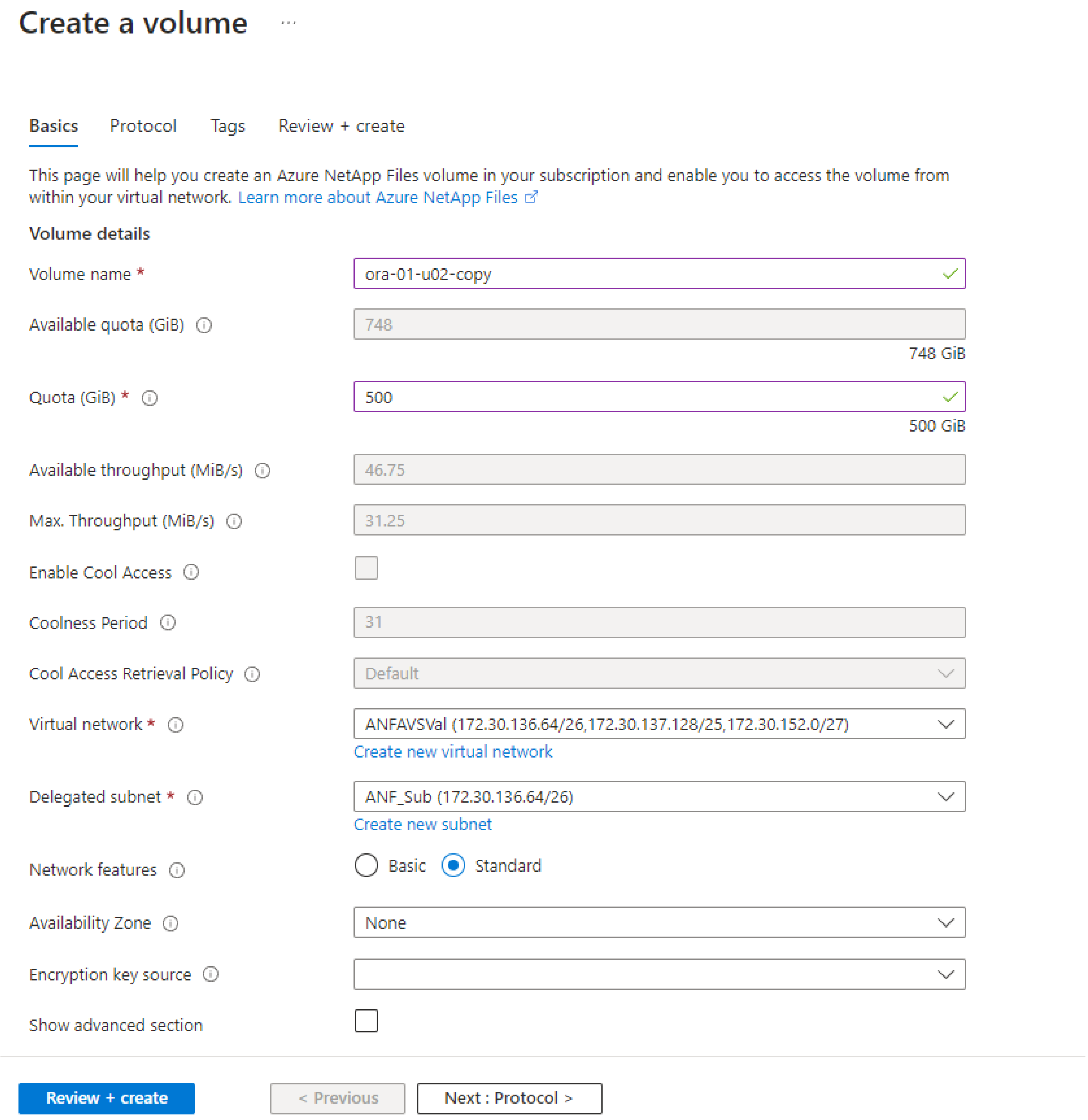
2. From selected capacity pool - `database`, click `Volumes` and then, `Add volume` to launch add-volume workflow.



Name	Capacity
database	2 TiB
nimcp	2 TiB

Name	Quota	Max. Throughput	Protocol type	Mount path	Service l
ora-01-u01	100 GiB	6.25 MiB/s	NFSv3	172.30.136.68:/ora-01-	Premium
ora-01-u02	500 GiB	31.25 MiB/s	NFSv3	172.30.136.68:/ora-01-	Premium
ora-01-u03	400 GiB	25 MiB/s	NFSv3	172.30.136.68:/ora-01-	Premium
ora-02-u01	100 GiB	6.25 MiB/s	NFSv3	172.30.136.68:/ora-02-	Premium
ora-02-u02	100 GiB	6.25 MiB/s	NFSv3	172.30.136.68:/ora-02-	Premium
ora-02-u03	100 GiB	6.25 MiB/s	NFSv3	172.30.136.68:/ora-02-	Premium

3. Fill in `Volume name`, `Quota`, `Virtual network`, and `Delegated subnet` to move to `Protocol` page.



This page will help you create an Azure NetApp Files volume in your subscription and enable you to access the volume from within your virtual network. Learn more about Azure NetApp Files

Volume details

Volume name * : ora-01-u02-copy

Available quota (GiB): 748 (748 GiB)

Quota (GiB) * : 500 (500 GiB)

Available throughput (MiB/s): 46.75

Max. Throughput (MiB/s): 31.25

Enable Cool Access: ☐

Coolness Period: 31

Cool Access Retrieval Policy: Default

Virtual network * : ANFAVSVal (172.30.136.64/26,172.30.137.128/25,172.30.152.0/27)

Create new virtual network

Delegated subnet * : ANF_Sub (172.30.136.64/26)

Create new subnet

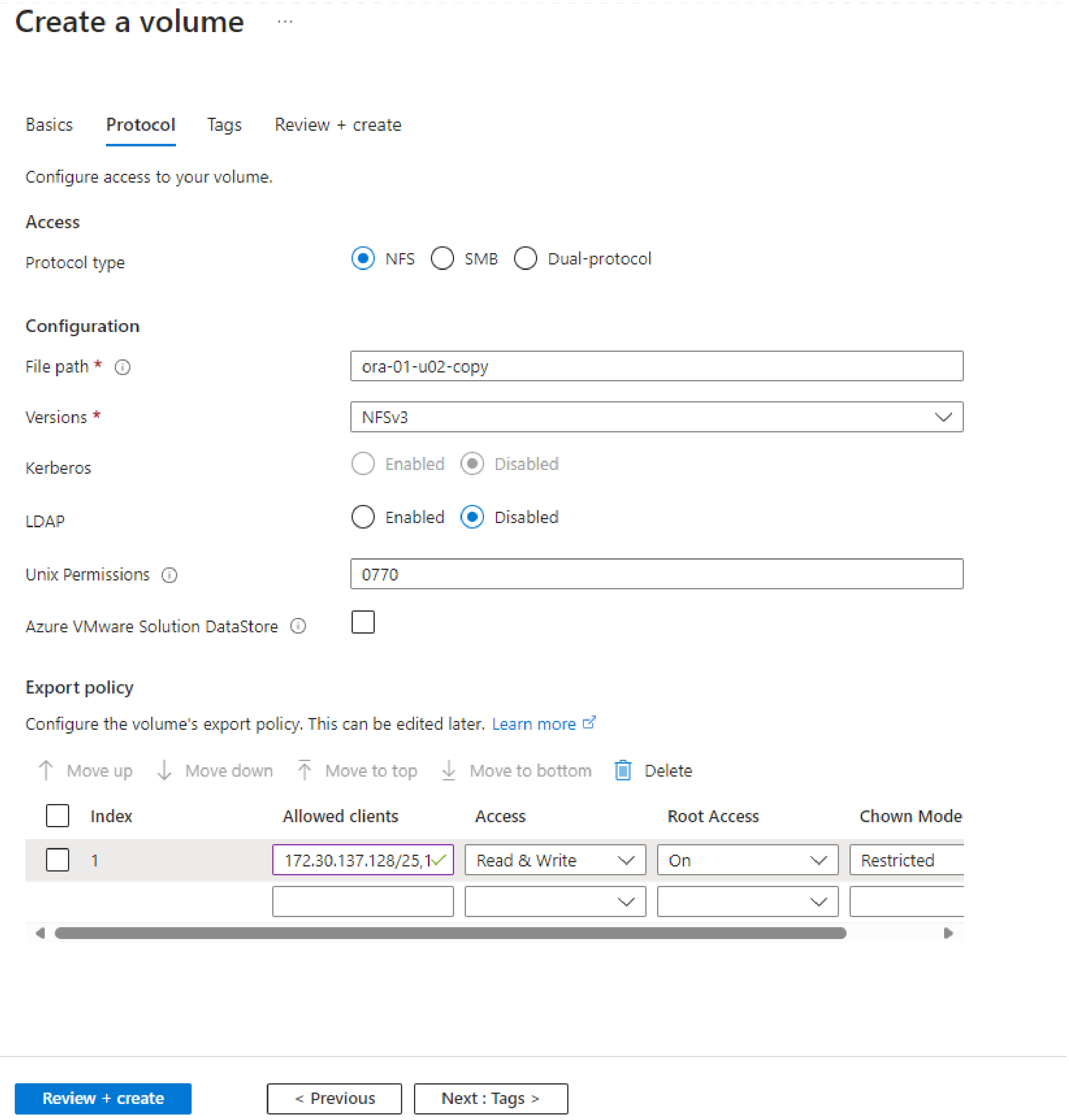
Network features: ○ Basic ● Standard

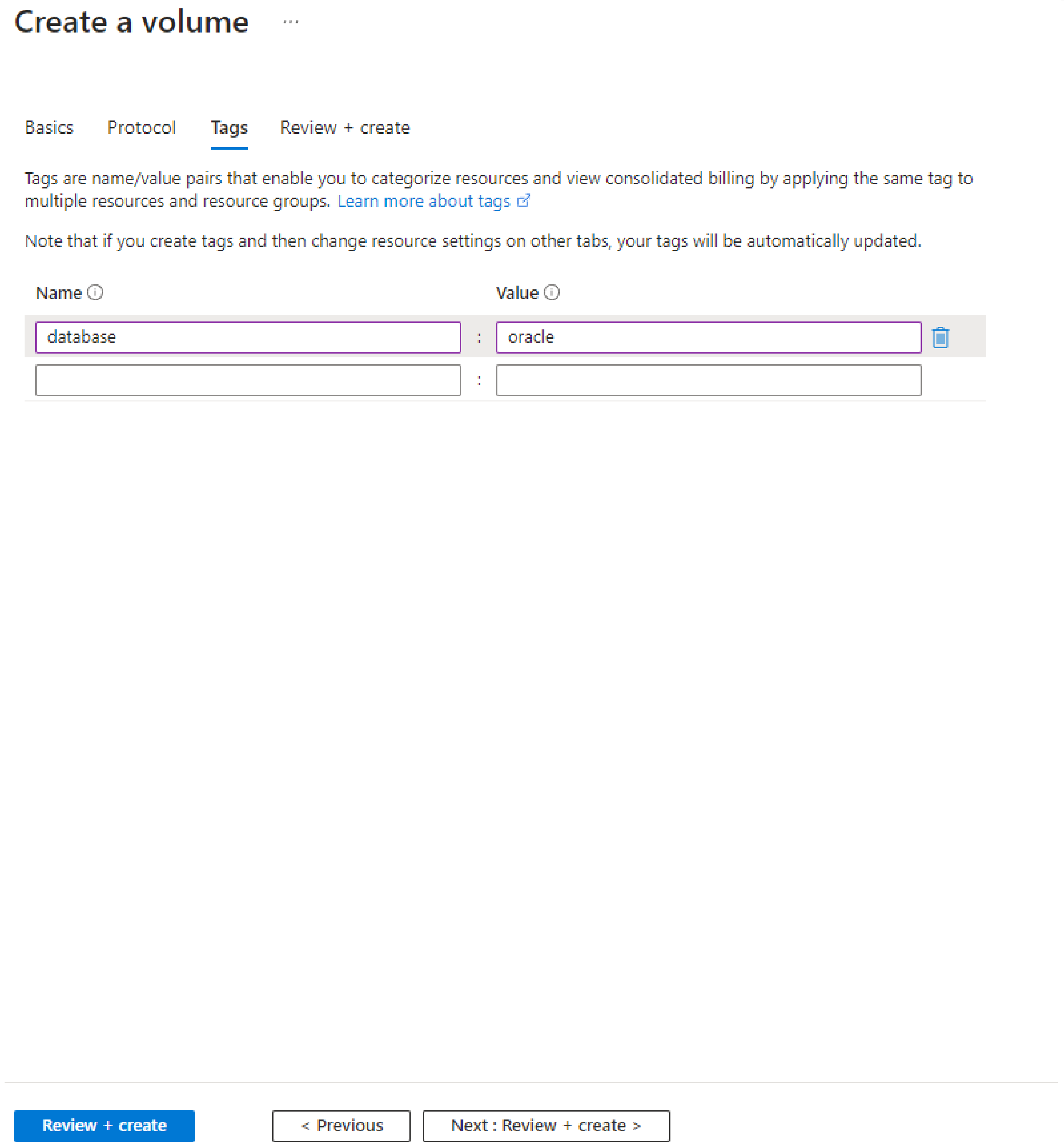
Availability Zone: None

Encryption key source:

Show advanced section: ☐

4. Take a note of the file path, enter allowed clients CIDR range, and enable `Root Access` for the volume.



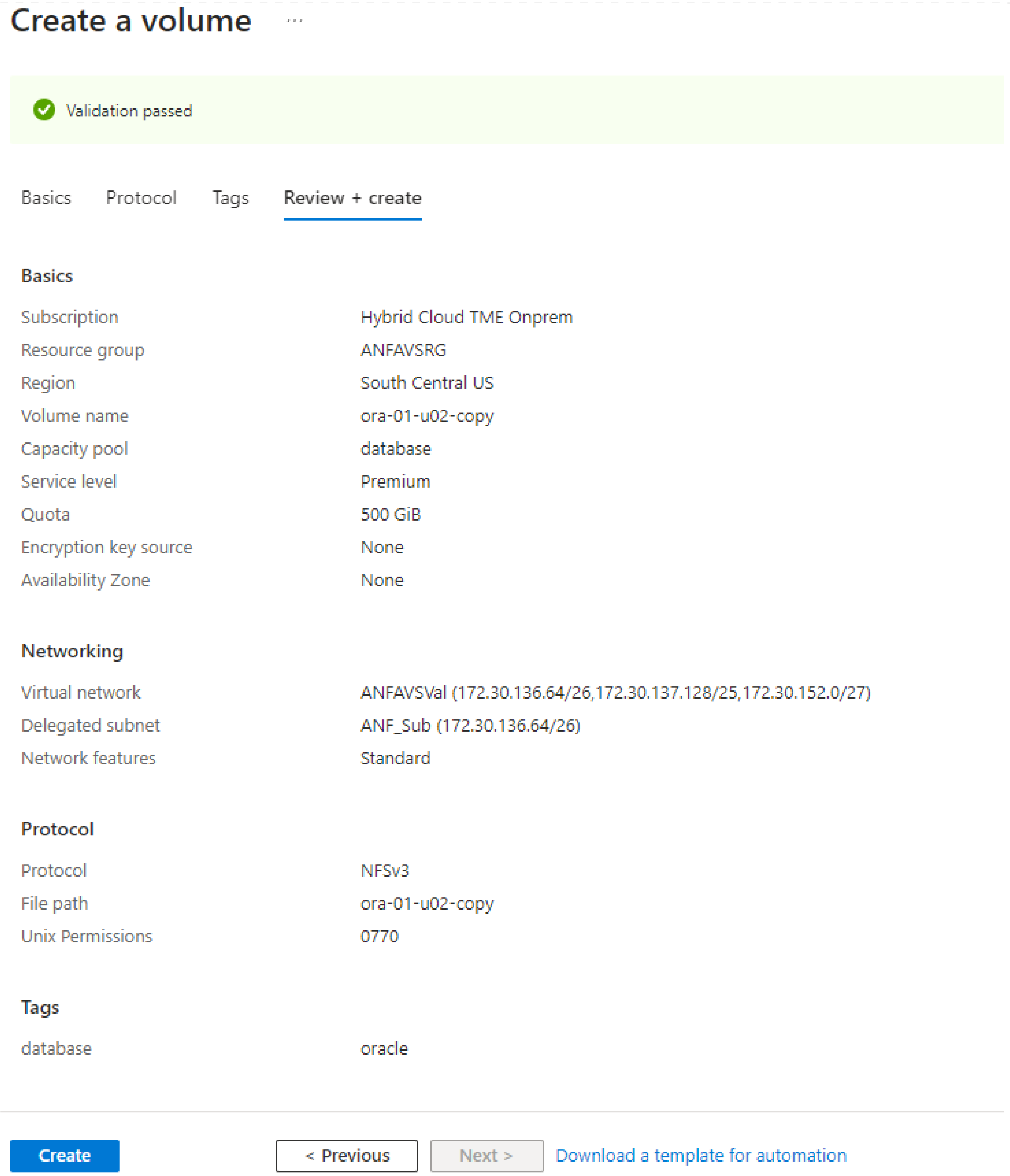


Tags are name/value pairs that enable you to categorize resources and view consolidated billing by applying the same tag to multiple resources and resource groups. Learn more about tags

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

Name		Value
database	:	oracle
	:	

6. Review and create the volume.



Create a volume

Validation passed

Basics

Subscription	Hybrid Cloud TME Onprem
Resource group	ANFAVSRG
Region	South Central US
Volume name	ora-01-u02-copy
Capacity pool	database
Service level	Premium
Quota	500 GiB
Encryption key source	None
Availability Zone	None

Networking

Virtual network	ANFAVSVal (172.30.136.64/26,172.30.137.128/25,172.30.152.0/27)
Delegated subnet	ANF_Sub (172.30.136.64/26)
Network features	Standard

Protocol

Protocol	NFSv3
File path	ora-01-u02-copy
Unix Permissions	0770

Tags

database	oracle

7. Login to primary Oracle VLDB server as a user with sudo privilege and mount the NFS volume exported from ANF storage. Change to your ANF NFS server IP address and file path as necessary. The ANF NFS server IP address can be retrieved from ANF volume console page.

```
sudo mkdir /nfsanf
sudo mount 172.30.136.68:/ora-01-u02-copy /nfsanf -o
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
tr
```

8. Change mount point ownership to oracle:oisntall, change to your oracle user name and primary group as necessary.

```
sudo chown oracle:oinstall /nfsanf
```

Setup Oracle RMAN incremental merge to image copy on ANF

RMAN incremental merge update the staging database data files image copy continuously at every incremental backup/merge interval. The image copy of database backup will be as up to date as the frequency you execute the incremental backup/merge. So, take into consideration of database performance, your RTO and RPO objectives when deciding the frequency of RMAN incremental backup and merge.

1. Login to primary Oracle VLDB server as oracle user.
2. Create an oracopy directory under mount point /nfsanf to store oracle data files image copies and archlog directory for Oracle flash recovery area.

   ```
   mkdir /nfsanf/oracopy
   ```

   ```
   mkdir /nfsanf/archlog
   ```

3. Login to Oracle database via sqlplus, enable block change tracking for faster incremental backup and change Oracle flash recovery area to ANF NFS mount if it is currently on primary storage. This allows the RMAN default control file/spfile autobackup and archived logs to be backed up to ANF NFS mount for recovery.

   ```
   sqlplus / as sysdba
   ```

   From sqlplus prompt, execute following command.

   ```
   alter database enable block change tracking using file
   '/nfsanf/oracopy/bct_ntap1.ctf'
   ```

   ```
   alter system set db_recovery_file_dest='/nfsanf/archlog/'
   scope=both;
   ```

   Expected output:

```
[oracle@ora-01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Wed Mar 20 16:44:21
2024
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> alter database enable block change tracking using file
'/nfsanf/oracopy/bct_ntap1.ctf';

Database altered.

SQL> alter system set db_recovery_file_dest='/nfsanf/archlog/'
scope=both;

System altered.

SQL>
```

4. Create a RMAN backup and incremental merge script. The script allocates multiple channels for parallel RMAN backup and merge. First execution would generate the initial full baseline image copy. In a complete run, it first purges obsolete backups that are outside of retention window to keep staging area clean. It then switches current log file before merge and backup. The incremental backup follows the merge so that the database image copy is trailing current database state by one backup/merge cycle. The merge and backup order can be reversed for quicker recovery at user’s preference. The RMAN script can be integrated into a simple shell script to be executed from crontab on the primary DB server. Ensure control file autobackup is on in RMAN setting.

```
vi /home/oracle/rman_bkup_merge.cmd

Add following lines:

RUN
{
  allocate channel c1 device type disk format '/nfsanf/oracopy/%U';
  allocate channel c2 device type disk format '/nfsanf/oracopy/%U';
  allocate channel c3 device type disk format '/nfsanf/oracopy/%U';
  allocate channel c4 device type disk format '/nfsanf/oracopy/%U';
  delete obsolete;
  sql 'alter system archive log current';
  recover copy of database with tag 'OraCopyBKUPonANF_level_0';
  backup incremental level 1 copies=1 for recover of copy with tag
'OraCopyBKUPonANF_level_0' database;
}
```

5. At the primary Oracle VLDB server, login to RMAN locally as oracle user with or without RMAN catalog. In this demonstration, we are not connecting to a RMAN catalog.

```
rman target / nocatalog;

output:

[oracle@ora-01 ~]$ rman target / nocatalog

Recovery Manager: Release 19.0.0.0.0 - Production on Wed Mar 20
16:54:24 2024
Version 19.18.0.0.0

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reserved.

connected to target database: NTAP1 (DBID=2441823937)
using target database control file instead of recovery catalog
```

6. From RMAN prompt, execute the script. First execution creates a baseline database image copy and subsequent executions merge and update the baseline image copy incrementally. The following is how to execute the script and the typical output. Set the number of channels to match the CPU cores on the host.

```
RMAN> @/home/oracle/rman_bkup_merge.cmd

RMAN> RUN
```

```
2> {
3>   allocate channel c1 device type disk format
'/nfsanf/oracopy/%U';
4>   allocate channel c2 device type disk format
'/nfsanf/oracopy/%U';
5>   allocate channel c3 device type disk format
'/nfsanf/oracopy/%U';
6>   allocate channel c4 device type disk format
'/nfsanf/oracopy/%U';
7>   delete obsolete;
8>   sql 'alter system archive log current';
9>   recover copy of database with tag 'OraCopyBKUPonANF_level_0';
10>   backup incremental level 1 copies=1 for recover of copy with
tag 'OraCopyBKUPonANF_level_0' database;
11> }
allocated channel: c1
channel c1: SID=142 device type=DISK

allocated channel: c2
channel c2: SID=277 device type=DISK

allocated channel: c3
channel c3: SID=414 device type=DISK

allocated channel: c4
channel c4: SID=28 device type=DISK

RMAN retention policy will be applied to the command
RMAN retention policy is set to redundancy 1
Deleting the following obsolete backups and copies:
Type                 Key    Completion Time    Filename/Handle
-------------------- ------ ------------------ --------------------
Backup Set           1      18-MAR-24
  Backup Piece       1      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163958359__04h19dg
r_.bkp
Backup Set           2      18-MAR-24
  Backup Piece       2      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163961675__07l1m2l
g_.bkp
Backup Set           3      18-MAR-24
  Backup Piece       3      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163962888__08p6y7l
x_.bkp
Backup Set           4      18-MAR-24
  Backup Piece       4      18-MAR-24
```

```
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163963796__09k8g1m
4_.bkp
Backup Set           5      18-MAR-24
  Backup Piece       5      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163964697__0bd3tqg
3_.bkp
Backup Set           6      18-MAR-24
  Backup Piece       6      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163965895__0chx6mz
t_.bkp
Backup Set           7      18-MAR-24
  Backup Piece       7      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163966806__0dbyx34
4_.bkp
Backup Set           8      18-MAR-24
  Backup Piece       8      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163968012__0fgvg80
5_.bkp
Backup Set           9      18-MAR-24
  Backup Piece       9      18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163968919__0g9x5t1
v_.bkp
Backup Set           10     18-MAR-24
  Backup Piece       10     18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163969821__0h4rfdz
j_.bkp
Backup Set           11     18-MAR-24
  Backup Piece       11     18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163971026__0j8o4wk
8_.bkp
Backup Set           12     18-MAR-24
  Backup Piece       12     18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163971931__0k3pnn2
o_.bkp
Backup Set           13     18-MAR-24
  Backup Piece       13     18-MAR-24
/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163972835__0kyg92t
1_.bkp
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163963796__
09k8g1m4_.bkp RECID=4 STAMP=1163963804
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163962888__
08p6y7lx_.bkp RECID=3 STAMP=1163962897
```

```
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163961675__
07l1m2lg_.bkp RECID=2 STAMP=1163961683
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163958359__
04h19dgr_.bkp RECID=1 STAMP=1163958361
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163964697__
0bd3tqg3_.bkp RECID=5 STAMP=1163964705
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163965895__
0chx6mzt_.bkp RECID=6 STAMP=1163965906
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163966806__
0dbyx344_.bkp RECID=7 STAMP=1163966814
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163968012__
0fgvg805_.bkp RECID=8 STAMP=1163968018
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163968919__
0g9x5t1v_.bkp RECID=9 STAMP=1163968926
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163969821__
0h4rfdzj_.bkp RECID=10 STAMP=1163969827
Deleted 3 objects

deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163971026__
0j8o4wk8_.bkp RECID=11 STAMP=1163971032
Deleted 3 objects

deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163971931__
0k3pnn2o_.bkp RECID=12 STAMP=1163971938
Deleted 3 objects
```

```
deleted backup piece
backup piece
handle=/u03/orareco/NTAP1/autobackup/2024_03_18/o1_mf_s_1163972835__
0kyg92t1_.bkp RECID=13 STAMP=1163972837
Deleted 4 objects


sql statement: alter system archive log current

Starting recover at 20-MAR-24
no copy of datafile 1 found to recover
no copy of datafile 3 found to recover
no copy of datafile 4 found to recover
.
.
no copy of datafile 31 found to recover
no copy of datafile 32 found to recover
Finished recover at 20-MAR-24

Starting backup at 20-MAR-24
no parent backup or copy of datafile 1 found
no parent backup or copy of datafile 3 found
no parent backup or copy of datafile 4 found
.
.
no parent backup or copy of datafile 19 found
no parent backup or copy of datafile 20 found
channel c1: starting datafile copy
input datafile file number=00021
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_01.dbf
channel c2: starting datafile copy
input datafile file number=00022
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_02.dbf
channel c3: starting datafile copy
input datafile file number=00023
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_03.dbf
channel c4: starting datafile copy
input datafile file number=00024
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_04.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-22_0g2m6brl tag=ORACOPYBKUPONANF_LEVEL_0 RECID=4
STAMP=1164132108
channel c2: datafile copy complete, elapsed time: 01:06:39
channel c2: starting datafile copy
input datafile file number=00025
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_05.dbf
```

```
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-24_0i2m6brl tag=ORACOPYBKUPONANF_LEVEL_0 RECID=5
STAMP=1164132121
channel c4: datafile copy complete, elapsed time: 01:06:45
channel c4: starting datafile copy
input datafile file number=00026
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_06.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-23_0h2m6brl tag=ORACOPYBKUPONANF_LEVEL_0 RECID=6
STAMP=1164132198
channel c3: datafile copy complete, elapsed time: 01:08:05
channel c3: starting datafile copy
input datafile file number=00027
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_07.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-21_0f2m6brl tag=ORACOPYBKUPONANF_LEVEL_0 RECID=7
STAMP=1164132248
channel c1: datafile copy complete, elapsed time: 01:08:57
channel c1: starting datafile copy
input datafile file number=00028
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_08.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-25_0j2m6fol tag=ORACOPYBKUPONANF_LEVEL_0 RECID=9
STAMP=1164136123
channel c2: datafile copy complete, elapsed time: 01:06:46
channel c2: starting datafile copy
input datafile file number=00029
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_09.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-26_0k2m6fot tag=ORACOPYBKUPONANF_LEVEL_0 RECID=8
STAMP=1164136113
channel c4: datafile copy complete, elapsed time: 01:06:36
channel c4: starting datafile copy
input datafile file number=00030
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_10.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-27_0l2m6frc tag=ORACOPYBKUPONANF_LEVEL_0 RECID=10
STAMP=1164136293
channel c3: datafile copy complete, elapsed time: 01:08:10
channel c3: starting datafile copy
input datafile file number=00031
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_11.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-28_0m2m6fsu tag=ORACOPYBKUPONANF_LEVEL_0 RECID=11
STAMP=1164136333
channel c1: datafile copy complete, elapsed time: 01:07:52
channel c1: starting datafile copy
input datafile file number=00032
name=/u02/oradata/NTAP1/NTAP1_pdb1/soe_12.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-29_0n2m6jlr tag=ORACOPYBKUPONANF_LEVEL_0 RECID=12
STAMP=1164140082
channel c2: datafile copy complete, elapsed time: 01:06:01
channel c2: starting datafile copy
input datafile file number=00001
name=/u02/oradata/NTAP1/system01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-30_0o2m6jlr tag=ORACOPYBKUPONANF_LEVEL_0 RECID=13
STAMP=1164140190
channel c4: datafile copy complete, elapsed time: 01:07:49
channel c4: starting datafile copy
input datafile file number=00003
name=/u02/oradata/NTAP1/sysaux01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-1_0r2m6nhk tag=ORACOPYBKUPONANF_LEVEL_0 RECID=14
STAMP=1164140240
channel c2: datafile copy complete, elapsed time: 00:02:38
channel c2: starting datafile copy
input datafile file number=00004
name=/u02/oradata/NTAP1/undotbs01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-4_0t2m6nml tag=ORACOPYBKUPONANF_LEVEL_0 RECID=15
STAMP=1164140372
channel c2: datafile copy complete, elapsed time: 00:02:15
channel c2: starting datafile copy
input datafile file number=00011
name=/u02/oradata/NTAP1/NTAP1_pdb1/undotbs01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-3_0s2m6nl1 tag=ORACOPYBKUPONANF_LEVEL_0 RECID=16
STAMP=1164140377
channel c4: datafile copy complete, elapsed time: 00:03:01
channel c4: starting datafile copy
input datafile file number=00010
name=/u02/oradata/NTAP1/NTAP1_pdb1/sysaux01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SOE_FNO-32_0q2m6jsi tag=ORACOPYBKUPONANF_LEVEL_0 RECID=17
STAMP=1164140385
channel c1: datafile copy complete, elapsed time: 01:07:29
channel c1: starting datafile copy
input datafile file number=00014
name=/u02/oradata/NTAP1/NTAP1_pdb2/sysaux01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
```

```
SOE_FNO-31_0p2m6jrb tag=ORACOPYBKUPONANF_LEVEL_0 RECID=18
STAMP=1164140406
channel c3: datafile copy complete, elapsed time: 01:08:31
channel c3: starting datafile copy
input datafile file number=00018
name=/u02/oradata/NTAP1/NTAP1_pdb3/sysaux01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-10_0v2m6nqs tag=ORACOPYBKUPONANF_LEVEL_0 RECID=19
STAMP=1164140459
channel c4: datafile copy complete, elapsed time: 00:01:26
channel c4: starting datafile copy
input datafile file number=00006
name=/u02/oradata/NTAP1/pdbseed/sysaux01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-14_102m6nr3 tag=ORACOPYBKUPONANF_LEVEL_0 RECID=20
STAMP=1164140468
channel c1: datafile copy complete, elapsed time: 00:01:22
channel c1: starting datafile copy
input datafile file number=00009
name=/u02/oradata/NTAP1/NTAP1_pdb1/system01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-11_0u2m6nqs tag=ORACOPYBKUPONANF_LEVEL_0 RECID=21
STAMP=1164140471
channel c2: datafile copy complete, elapsed time: 00:01:33
channel c2: starting datafile copy
input datafile file number=00013
name=/u02/oradata/NTAP1/NTAP1_pdb2/system01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-18_112m6nrt tag=ORACOPYBKUPONANF_LEVEL_0 RECID=22
STAMP=1164140476
channel c3: datafile copy complete, elapsed time: 00:00:57
channel c3: starting datafile copy
input datafile file number=00017
name=/u02/oradata/NTAP1/NTAP1_pdb3/system01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-6_122m6nti tag=ORACOPYBKUPONANF_LEVEL_0 RECID=23
STAMP=1164140488
channel c4: datafile copy complete, elapsed time: 00:00:25
channel c4: starting datafile copy
input datafile file number=00005
name=/u02/oradata/NTAP1/pdbseed/system01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-13_142m6ntp tag=ORACOPYBKUPONANF_LEVEL_0 RECID=24
STAMP=1164140532
channel c2: datafile copy complete, elapsed time: 00:01:06
channel c2: starting datafile copy
```

```
input datafile file number=00008
name=/u02/oradata/NTAP1/pdbseed/undotbs01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-17_152m6nts tag=ORACOPYBKUPONANF_LEVEL_0 RECID=25
STAMP=1164140539
channel c3: datafile copy complete, elapsed time: 00:01:03
channel c3: starting datafile copy
input datafile file number=00015
name=/u02/oradata/NTAP1/NTAP1_pdb2/undotbs01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-9_132m6ntm tag=ORACOPYBKUPONANF_LEVEL_0 RECID=26
STAMP=1164140541
channel c1: datafile copy complete, elapsed time: 00:01:13
channel c1: starting datafile copy
input datafile file number=00019
name=/u02/oradata/NTAP1/NTAP1_pdb3/undotbs01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-5_162m6nuc tag=ORACOPYBKUPONANF_LEVEL_0 RECID=27
STAMP=1164140541
channel c4: datafile copy complete, elapsed time: 00:00:41
channel c4: starting datafile copy
input datafile file number=00007 name=/u02/oradata/NTAP1/users01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-8_172m6nvr tag=ORACOPYBKUPONANF_LEVEL_0 RECID=28
STAMP=1164140552
channel c2: datafile copy complete, elapsed time: 00:00:16
channel c2: starting datafile copy
input datafile file number=00012
name=/u02/oradata/NTAP1/NTAP1_pdb1/users01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-15_182m6nvs tag=ORACOPYBKUPONANF_LEVEL_0 RECID=30
STAMP=1164140561
channel c3: datafile copy complete, elapsed time: 00:00:24
channel c3: starting datafile copy
input datafile file number=00016
name=/u02/oradata/NTAP1/NTAP1_pdb2/users01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-7_1a2m6o01 tag=ORACOPYBKUPONANF_LEVEL_0 RECID=29
STAMP=1164140560
channel c4: datafile copy complete, elapsed time: 00:00:16
channel c4: starting datafile copy
input datafile file number=00020
name=/u02/oradata/NTAP1/NTAP1_pdb3/users01.dbf
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-19_192m6nvv tag=ORACOPYBKUPONANF_LEVEL_0 RECID=31
STAMP=1164140564
```

```
channel c1: datafile copy complete, elapsed time: 00:00:21
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-12_1b2m6o0e tag=ORACOPYBKUPONANF_LEVEL_0 RECID=32
STAMP=1164140564
channel c2: datafile copy complete, elapsed time: 00:00:02
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-16_1c2m6o0k tag=ORACOPYBKUPONANF_LEVEL_0 RECID=34
STAMP=1164140565
channel c3: datafile copy complete, elapsed time: 00:00:01
output file name=/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-20_1d2m6o0k tag=ORACOPYBKUPONANF_LEVEL_0 RECID=33
STAMP=1164140565
channel c4: datafile copy complete, elapsed time: 00:00:01
Finished backup at 20-MAR-24

Starting Control File and SPFILE Autobackup at 20-MAR-24
piece
handle=/nfsanf/archlog/NTAP1/autobackup/2024_03_20/o1_mf_s_116414056
5__5g56ypks_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 20-MAR-24
released channel: c1
released channel: c2
released channel: c3
released channel: c4

RMAN> **end-of-file**

RMAN>
```

7. List database image copy after backup to observe that a database image copy has been created in ANF NFS mount point.

```
RMAN> list copy of database tag 'OraCopyBKUPonANF_level_0';

List of Datafile Copies
=======================

Key     File S Completion Time Ckp SCN    Ckp Time        Sparse
------- ---- - --------------- ---------- --------------- ------
14      1    A 20-MAR-24       4161498    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-1_0r2m6nhk
        Tag: ORACOPYBKUPONANF_LEVEL_0

16      3    A 20-MAR-24       4161568    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
```

```
SYSAUX_FNO-3_0s2m6nl1
        Tag: ORACOPYBKUPONANF_LEVEL_0

15      4    A 20-MAR-24       4161589    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-4_0t2m6nml
        Tag: ORACOPYBKUPONANF_LEVEL_0

27      5    A 20-MAR-24       2379694    18-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-5_162m6nuc
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

23      6    A 20-MAR-24       2379694    18-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-6_122m6nti
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

29      7    A 20-MAR-24       4161872    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-7_1a2m6o01
        Tag: ORACOPYBKUPONANF_LEVEL_0

28      8    A 20-MAR-24       2379694    18-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-8_172m6nvr
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

26      9    A 20-MAR-24       4161835    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-9_132m6ntm
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

19      10   A 20-MAR-24       4161784    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-10_0v2m6nqs
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

21      11   A 20-MAR-24       4161780    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-11_0u2m6nqs
```

```
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

32      12   A 20-MAR-24       4161880    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-12_1b2m6o0e
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

24      13   A 20-MAR-24       4161838    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-13_142m6ntp
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

20      14   A 20-MAR-24       4161785    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-14_102m6nr3
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

30      15   A 20-MAR-24       4161863    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-15_182m6nvs
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

34      16   A 20-MAR-24       4161884    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-16_1c2m6o0k
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

25      17   A 20-MAR-24       4161841    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-17_152m6nts
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

22      18   A 20-MAR-24       4161810    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-18_112m6nrt
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

31      19   A 20-MAR-24       4161869    20-MAR-24       NO
```

```
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-19_192m6nvv
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

33      20   A 20-MAR-24       4161887    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-20_1d2m6o0k
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

7       21   A 20-MAR-24       4152514    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
21_0f2m6brl
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

4       22   A 20-MAR-24       4152518    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
22_0g2m6brl
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

6       23   A 20-MAR-24       4152522    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
23_0h2m6brl
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

5       24   A 20-MAR-24       4152529    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
24_0i2m6brl
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

9       25   A 20-MAR-24       4156120    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
25_0j2m6fol
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

8       26   A 20-MAR-24       4156130    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
26_0k2m6fot
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1
```

```
10      27   A 20-MAR-24       4156159    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
27_0l2m6frc
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

11      28   A 20-MAR-24       4156183    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
28_0m2m6fsu
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

12      29   A 20-MAR-24       4158795    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
29_0n2m6jlr
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

13      30   A 20-MAR-24       4158803    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
30_0o2m6jlr
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

18      31   A 20-MAR-24       4158871    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
31_0p2m6jrb
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

17      32   A 20-MAR-24       4158886    20-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
32_0q2m6jsi
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1
```

8. Report schema from Oracle RMAN command prompt to observe that current VLDB data files are on primary storage.

```
RMAN> report schema;

Report of database schema for database with db_unique_name NTAP1

List of Permanent Datafiles
===========================
File Size(MB) Tablespace           RB segs Datafile Name
```

```
---- -------- -------------------- ------- -------------------------
1    1060     SYSTEM               YES
/u02/oradata/NTAP1/system01.dbf
3    1000     SYSAUX               NO
/u02/oradata/NTAP1/sysaux01.dbf
4    695      UNDOTBS1             YES
/u02/oradata/NTAP1/undotbs01.dbf
5    400      PDB$SEED:SYSTEM      NO
/u02/oradata/NTAP1/pdbseed/system01.dbf
6    440      PDB$SEED:SYSAUX      NO
/u02/oradata/NTAP1/pdbseed/sysaux01.dbf
7    5        USERS                NO
/u02/oradata/NTAP1/users01.dbf
8    235      PDB$SEED:UNDOTBS1    NO
/u02/oradata/NTAP1/pdbseed/undotbs01.dbf
9    410      NTAP1_PDB1:SYSTEM    YES
/u02/oradata/NTAP1/NTAP1_pdb1/system01.dbf
10   520      NTAP1_PDB1:SYSAUX    NO
/u02/oradata/NTAP1/NTAP1_pdb1/sysaux01.dbf
11   580      NTAP1_PDB1:UNDOTBS1  YES
/u02/oradata/NTAP1/NTAP1_pdb1/undotbs01.dbf
12   5        NTAP1_PDB1:USERS     NO
/u02/oradata/NTAP1/NTAP1_pdb1/users01.dbf
13   410      NTAP1_PDB2:SYSTEM    YES
/u02/oradata/NTAP1/NTAP1_pdb2/system01.dbf
14   500      NTAP1_PDB2:SYSAUX    NO
/u02/oradata/NTAP1/NTAP1_pdb2/sysaux01.dbf
15   235      NTAP1_PDB2:UNDOTBS1  YES
/u02/oradata/NTAP1/NTAP1_pdb2/undotbs01.dbf
16   5        NTAP1_PDB2:USERS     NO
/u02/oradata/NTAP1/NTAP1_pdb2/users01.dbf
17   410      NTAP1_PDB3:SYSTEM    YES
/u02/oradata/NTAP1/NTAP1_pdb3/system01.dbf
18   500      NTAP1_PDB3:SYSAUX    NO
/u02/oradata/NTAP1/NTAP1_pdb3/sysaux01.dbf
19   235      NTAP1_PDB3:UNDOTBS1  YES
/u02/oradata/NTAP1/NTAP1_pdb3/undotbs01.dbf
20   5        NTAP1_PDB3:USERS     NO
/u02/oradata/NTAP1/NTAP1_pdb3/users01.dbf
21   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_01.dbf
22   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_02.dbf
23   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_03.dbf
24   31744    NTAP1_PDB1:SOE       NO
```

```
/u02/oradata/NTAP1/NTAP1_pdb1/soe_04.dbf
25   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_05.dbf
26   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_06.dbf
27   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_07.dbf
28   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_08.dbf
29   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_09.dbf
30   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_10.dbf
31   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_11.dbf
32   31744    NTAP1_PDB1:SOE       NO
/u02/oradata/NTAP1/NTAP1_pdb1/soe_12.dbf

List of Temporary Files
=======================
File Size(MB) Tablespace           Maxsize(MB) Tempfile Name
---- -------- -------------------- ----------- --------------------
1    123      TEMP                 32767
/u02/oradata/NTAP1/temp01.dbf
2    123      PDB$SEED:TEMP        32767
/u02/oradata/NTAP1/pdbseed/temp012024-03-18_16-07-32-463-PM.dbf
3    31744    NTAP1_PDB1:TEMP      32767
/u02/oradata/NTAP1/NTAP1_pdb1/temp01.dbf
4    123      NTAP1_PDB2:TEMP      32767
/u02/oradata/NTAP1/NTAP1_pdb2/temp01.dbf
5    123      NTAP1_PDB3:TEMP      32767
/u02/oradata/NTAP1/NTAP1_pdb3/temp01.dbf
6    31744    NTAP1_PDB1:TEMP      31744
/u02/oradata/NTAP1/NTAP1_pdb1/temp02.dbf

RMAN>
```

9. Validate database image copy from OS NFS mount point.

```
[oracle@ora-01 ~]$ ls -l /nfsanf/oracopy
total 399482176
-rw-r----- 1 oracle oinstall    11600384 Mar 20 21:44 bct_ntap1.ctf
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 18:03 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-21_0f2m6brl
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 18:01 data_D-
```

```
NTAP1_I-2441823937_TS-SOE_FNO-22_0g2m6brl
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 18:03 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-23_0h2m6brl
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 18:02 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-24_0i2m6brl
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 19:08 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-25_0j2m6fol
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 19:08 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-26_0k2m6fot
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 19:11 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-27_0l2m6frc
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 19:12 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-28_0m2m6fsu
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 20:14 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-29_0n2m6jlr
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 20:16 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-30_0o2m6jlr
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 20:20 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-31_0p2m6jrb
-rw-r----- 1 oracle oinstall 33286004736 Mar 20 20:19 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-32_0q2m6jsi
-rw-r----- 1 oracle oinstall   545267712 Mar 20 20:20 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-10_0v2m6nqs
-rw-r----- 1 oracle oinstall   524296192 Mar 20 20:21 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-14_102m6nr3
-rw-r----- 1 oracle oinstall   524296192 Mar 20 20:21 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-18_112m6nrt
-rw-r----- 1 oracle oinstall  1048584192 Mar 20 20:19 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-3_0s2m6nl1
-rw-r----- 1 oracle oinstall   461381632 Mar 20 20:21 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-6_122m6nti
-rw-r----- 1 oracle oinstall  1111498752 Mar 20 20:17 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-1_0r2m6nhk
-rw-r----- 1 oracle oinstall   429924352 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-13_142m6ntp
-rw-r----- 1 oracle oinstall   429924352 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-17_152m6nts
-rw-r----- 1 oracle oinstall   419438592 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-5_162m6nuc
-rw-r----- 1 oracle oinstall   429924352 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-9_132m6ntm
-rw-r----- 1 oracle oinstall   608182272 Mar 20 20:21 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-11_0u2m6nqs
-rw-r----- 1 oracle oinstall   246423552 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-15_182m6nvs
-rw-r----- 1 oracle oinstall   246423552 Mar 20 20:22 data_D-
```

```
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-19_192m6nvv
-rw-r----- 1 oracle oinstall   728768512 Mar 20 20:19 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-4_0t2m6nml
-rw-r----- 1 oracle oinstall   246423552 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-8_172m6nvr
-rw-r----- 1 oracle oinstall     5251072 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-12_1b2m6o0e
-rw-r----- 1 oracle oinstall     5251072 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-16_1c2m6o0k
-rw-r----- 1 oracle oinstall     5251072 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-20_1d2m6o0k
-rw-r----- 1 oracle oinstall     5251072 Mar 20 20:22 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-7_1a2m6o01
[oracle@ora-01 ~]$
```

This completes the setup of an Oracle VLDB standby image copy backup and merge.

Switch Oracle VLDB to image copy for quick recovery

In the event of a failure due to primary storage issue such as data loss or corruption, database can be quickly switched over to image copy on ANF NFS mount and recovered to current state without database restore. Eliminating media restoration speeds up the database recovery tremendously for a VLDB. This use case assumes that the Oracle VLDB DB server is intact and database control file, archived and current logs are all available for recovery.

1. Login to Azure primary VLDB server host as oracle user and create a test table before switch over.

```
[oracle@ora-01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Thu Mar 21 15:13:52
2024
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> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP1_PDB1                     READ WRITE NO
         4 NTAP1_PDB2                     READ WRITE NO
         5 NTAP1_PDB3                     READ WRITE NO
SQL> alter session set container=ntap1_pdb1;

Session altered.

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

Table created.

SQL> insert into test values(1, sysdate, 'test oracle incremental
merge switch to copy');

1 row created.

SQL> commit;
```

```
Commit complete.

SQL> select * from test;

        ID
----------
DT
---------------------------------------------------------------------------
-------
EVENT
---------------------------------------------------------------------------
------------
         1
21-MAR-24 03.15.03.000000 PM
test oracle incremental merge switch to copy
```

2. Simulate a failure by shutdown abort database, then start up oracle in mount stage.

```
SQL> shutdown abort;
ORACLE instance shut down.
SQL> startup mount;
ORACLE instance started.

Total System Global Area 6442449688 bytes
Fixed Size                  9177880 bytes
Variable Size            1325400064 bytes
Database Buffers         5100273664 bytes
Redo Buffers                7598080 bytes
Database mounted.
SQL> exit
```

3. As oracle user, connect to Oracle database via RMAN to switch database to copy.

```
[oracle@ora-01 ~]$ rman target / nocatalog

Recovery Manager: Release 19.0.0.0.0 - Production on Thu Mar 21
15:20:58 2024
Version 19.18.0.0.0

Copyright (c) 1982, 2019, Oracle and/or its affiliates.  All rights
reserved.

connected to target database: NTAP1 (DBID=2441823937, not open)
using target database control file instead of recovery catalog
```

```
RMAN> switch database to copy;

datafile 1 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-1_0r2m6nhk"
datafile 3 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-3_0s2m6nl1"
datafile 4 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-4_0t2m6nml"
datafile 5 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-5_162m6nuc"
datafile 6 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-6_122m6nti"
datafile 7 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-7_1a2m6o01"
datafile 8 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-8_172m6nvr"
datafile 9 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-9_132m6ntm"
datafile 10 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-10_0v2m6nqs"
datafile 11 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-11_0u2m6nqs"
datafile 12 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-12_1b2m6o0e"
datafile 13 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-13_142m6ntp"
datafile 14 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-14_102m6nr3"
datafile 15 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-15_182m6nvs"
datafile 16 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-16_1c2m6o0k"
datafile 17 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-17_152m6nts"
datafile 18 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-18_112m6nrt"
datafile 19 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-19_192m6nvv"
datafile 20 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-20_1d2m6o0k"
datafile 21 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-21_0f2m6brl"
datafile 22 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-22_0g2m6brl"
datafile 23 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-23_0h2m6brl"
```

```
datafile 24 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-24_0i2m6brl"
datafile 25 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-25_0j2m6fol"
datafile 26 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-26_0k2m6fot"
datafile 27 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-27_0l2m6frc"
datafile 28 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-28_0m2m6fsu"
datafile 29 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-29_0n2m6jlr"
datafile 30 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-30_0o2m6jlr"
datafile 31 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-31_0p2m6jrb"
datafile 32 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-32_0q2m6jsi"
```

4. Recover and open database to bring it up to current from last incremental backup.

```
RMAN> recover database;

Starting recover at 21-MAR-24
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=392 device type=DISK
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00009: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-9_0q1sd7cm
destination for restore of datafile 00023: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-23_041sd6s5
destination for restore of datafile 00027: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-27_081sd70i
destination for restore of datafile 00031: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-31_0c1sd74u
destination for restore of datafile 00034: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-34_0f1sd788
channel ORA_DISK_1: reading from backup piece
/nfsanf/oracopy/321sfous_98_1_1
channel ORA_DISK_1: piece handle=/nfsanf/oracopy/321sfous_98_1_1
tag=ORACOPYBKUPONANF_LEVEL_0
channel ORA_DISK_1: restored backup piece 1
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00010: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-10_0k1sd7bb
destination for restore of datafile 00021: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-21_021sd6pv
destination for restore of datafile 00025: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-25_061sd6uc
.
.
.
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00016: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-16_121sd7dn
channel ORA_DISK_1: reading from backup piece
/nfsanf/oracopy/3i1sfov0_114_1_1
channel ORA_DISK_1: piece handle=/nfsanf/oracopy/3i1sfov0_114_1_1
tag=ORACOPYBKUPONANF_LEVEL_0
channel ORA_DISK_1: restored backup piece 1
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup
set
destination for restore of datafile 00020: /nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-20_131sd7do
channel ORA_DISK_1: reading from backup piece
/nfsanf/oracopy/3j1sfov0_115_1_1
channel ORA_DISK_1: piece handle=/nfsanf/oracopy/3j1sfov0_115_1_1
tag=ORACOPYBKUPONANF_LEVEL_0
channel ORA_DISK_1: restored backup piece 1
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01

starting media recovery
media recovery complete, elapsed time: 00:00:01

Finished recover at 21-MAR-24

RMAN> alter database open;

Statement processed

RMAN>
```

5. Check database structure from sqlplus after recovery to observe that all VLDB data files with exception of control, temp, and current log files are now switched over to copy on ANF NFS file system.

```
SQL> select name from v$datafile
  2  union
  3  select name from v$tempfile
  4  union
  5  select name from v$controlfile
  6  union
  7* select member from v$logfile
SQL> /

NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-21_0f2m6brl
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-22_0g2m6brl
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-23_0h2m6brl
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-24_0i2m6brl
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-25_0j2m6fol
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-26_0k2m6fot
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-27_0l2m6frc
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-28_0m2m6fsu
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-29_0n2m6jlr
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-30_0o2m6jlr
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-31_0p2m6jrb

NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-32_0q2m6jsi
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-10_0v2m6nqs
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-14_102m6nr3
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-18_112m6nrt
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-3_0s2m6nl1
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-6_122m6nti
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-13_142m6ntp
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-17_152m6nts
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-1_0r2m6nhk
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-5_162m6nuc
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-9_132m6ntm

NAME
--------------------------------------------------------------------
------------
```

```
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-
11_0u2m6nqs
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-
15_182m6nvs
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-
19_192m6nvv
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-4_0t2m6nml
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-8_172m6nvr
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-12_1b2m6o0e
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-16_1c2m6o0k
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-20_1d2m6o0k
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-7_1a2m6o01
/u02/oradata/NTAP1/NTAP1_pdb1/temp01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/temp02.dbf

NAME
--------------------------------------------------------------------
------------
/u02/oradata/NTAP1/NTAP1_pdb2/temp01.dbf
/u02/oradata/NTAP1/NTAP1_pdb3/temp01.dbf
/u02/oradata/NTAP1/control01.ctl
/u02/oradata/NTAP1/pdbseed/temp012024-03-18_16-07-32-463-PM.dbf
/u02/oradata/NTAP1/temp01.dbf
/u03/orareco/NTAP1/control02.ctl
/u03/orareco/NTAP1/onlinelog/redo01.log
/u03/orareco/NTAP1/onlinelog/redo02.log
/u03/orareco/NTAP1/onlinelog/redo03.log

42 rows selected.
```

6. From SQL plus, check the content of test table we have inserted before the switch over to copy.

```
SQL> alter session set container=ntap1_pdb1;

Session altered.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
21-MAR-24 03.15.03.000000 PM
test oracle incremental merge switch to copy


SQL>
```

7. You could run the Oracle VLDB in ANF NFS mount for an extended period of time while maintaining expected performance level. When the primary storage issue is fixed, you can swing back to it by reversing the incremental backup merge processes with minimal downtime.

Oracle VLDB recovery from image copy to a standby DB server

In the event of a failure where both the primary storage and primary DB server host are lost, recovery cannot be performed from the original server. However, your Oracle database backup image copy available on the ANF NFS file system comes in handy. You can quickly recover the primary database to a standby DB server if one is available, using the backup image copy. In this section, we will demonstrate the step-by-step procedures for such recovery.

1. Insert a row to test table we have created previously for Oracle VLDB restoring to alternative host validation.

```
SQL> insert into test values(2, sysdate, 'test recovery on a new
Azure VM host with image copy on ANF');

1 row created.

SQL> commit;

Commit complete.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
21-MAR-24 03.15.03.000000 PM
test oracle incremental merge switch to copy

         2
22-MAR-24 02.22.06.000000 PM
test recovery on a new Azure VM host with image copy on ANF

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------


SQL>
```

2. As oracle user, run RMAN incremental backup and merge to flush the transaction to backup set on ANF NFS mount.

```
[oracle@ip-172-30-15-99 ~]$ rman target / nocatalog

Recovery Manager: Release 19.0.0.0.0 - Production on Tue May 30
17:26:03 2023
Version 19.18.0.0.0

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reserved.

connected to target database: NTAP1 (DBID=2441823937)
using target database control file instead of recovery catalog

RMAN> @rman_bkup_merge.cmd
```

3. Shutdown primary VLDB server host to simulate a total failure of storage and DB server host.
4. On the standby DB server ora-02 with same OS and version, OS kernal should be patched up as primary VLDB server host. Also, the same version and patches of Oracle has been installed and configured on standby DB server with software only option.
5. Configure oracle environment similiarly to primary VLDB server ora_01, such as oratab, and oracle user .bash_profile etc. It is a good practice to backup those files to ANF NFS mount point.
6. The Oracle database backup image copy on ANF NFS file system is then mounted on the standby DB server for recovery. The following procedures demonstrate the process details.

   As azureuser, create the mount point.

   ```
   sudo mkdir /nfsanf
   ```

   As azureuser, mount the NFS volume that stored Oracle VLDB backup image copy.

   ```
   sudo mount 172.30.136.68:/ora-01-u02-copy /nfsanf -o
   rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
   tr
   ```

7. Validate the Oracle database backup image copy on ANF NFS mount point.

   ```
   [oracle@ora-02 ~]$ ls -ltr /nfsanf/oracopy/
   total 400452728
   -rw-r-----. 1 oracle oinstall   461381632 Mar 21 23:47 data_D-
   NTAP1_I-2441823937_TS-SYSAUX_FNO-6_242m9oan
   -rw-r-----. 1 oracle oinstall   419438592 Mar 21 23:49 data_D-
   NTAP1_I-2441823937_TS-SYSTEM_FNO-5_282m9oem
   -rw-r-----. 1 oracle oinstall   246423552 Mar 21 23:49 data_D-
   NTAP1_I-2441823937_TS-UNDOTBS1_FNO-8_292m9oem
   ```

```
-rw-r-----. 1 oracle oinstall    21438464 Mar 22 14:35
2h2mbccv_81_1_1
-rw-r-----. 1 oracle oinstall    17956864 Mar 22 14:35
2i2mbcd0_82_1_1
-rw-r-----. 1 oracle oinstall    17956864 Mar 22 14:35
2j2mbcd1_83_1_1
-rw-r-----. 1 oracle oinstall    15245312 Mar 22 14:35
2k2mbcd3_84_1_1
-rw-r-----. 1 oracle oinstall     1638400 Mar 22 14:35
2m2mbcdn_86_1_1
-rw-r-----. 1 oracle oinstall    40042496 Mar 22 14:35
2l2mbcdn_85_1_1
-rw-r-----. 1 oracle oinstall    21856256 Mar 22 14:35
2n2mbcdo_87_1_1
-rw-r-----. 1 oracle oinstall     3710976 Mar 22 14:35
2o2mbcdv_88_1_1
-rw-r-----. 1 oracle oinstall     3416064 Mar 22 14:35
2p2mbcdv_89_1_1
-rw-r-----. 1 oracle oinstall     2596864 Mar 22 14:35
2r2mbce0_91_1_1
-rw-r-----. 1 oracle oinstall     2531328 Mar 22 14:35
2s2mbce1_92_1_1
-rw-r-----. 1 oracle oinstall     4718592 Mar 22 14:35
2v2mbce2_95_1_1
-rw-r-----. 1 oracle oinstall     4243456 Mar 22 14:35
302mbce2_96_1_1
-rw-r-----. 1 oracle oinstall       57344 Mar 22 14:35
312mbce3_97_1_1
-rw-r-----. 1 oracle oinstall       57344 Mar 22 14:35
322mbce3_98_1_1
-rw-r-----. 1 oracle oinstall       57344 Mar 22 14:35
332mbce3_99_1_1
-rw-r-----. 1 oracle oinstall   608182272 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-11_202m9o22
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-30_1q2m9k7a
-rw-r-----. 1 oracle oinstall   555753472 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-10_212m9o52
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-26_1m2m9g9j
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-27_1n2m9gcg
-rw-r-----. 1 oracle oinstall   429924352 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-9_252m9oc5
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-22_1i2m9cap
```

```
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-23_1j2m9cap
-rw-r-----. 1 oracle oinstall     5251072 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-12_2d2m9ofs
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-28_1o2m9gd4
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-31_1r2m9kfk
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-29_1p2m9ju6
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-32_1s2m9kgg
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-25_1l2m9g3u
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-24_1k2m9cap
-rw-r-----. 1 oracle oinstall 33286004736 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SOE_FNO-21_1h2m9cap
-rw-r-----. 1 oracle oinstall  1121984512 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-1_1t2m9nij
-rw-r-----. 1 oracle oinstall  1142956032 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-3_1u2m9nog
-rw-r-----. 1 oracle oinstall   728768512 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-4_1v2m9nu6
-rw-r-----. 1 oracle oinstall   534781952 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-14_222m9o53
-rw-r-----. 1 oracle oinstall   534781952 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-18_232m9oa8
-rw-r-----. 1 oracle oinstall   429924352 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-13_262m9oca
-rw-r-----. 1 oracle oinstall   246423552 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-15_2a2m9of6
-rw-r-----. 1 oracle oinstall   429924352 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-17_272m9oel
-rw-r-----. 1 oracle oinstall     5251072 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-7_2c2m9ofn
-rw-r-----. 1 oracle oinstall     5251072 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-16_2e2m9og8
-rw-r-----. 1 oracle oinstall   246423552 Mar 22 15:31 data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-19_2b2m9ofn
-rw-r-----. 1 oracle oinstall     5251072 Mar 22 15:32 data_D-
NTAP1_I-2441823937_TS-USERS_FNO-20_2f2m9og8
-rw-r-----. 1 oracle oinstall    76546048 Mar 22 15:37
362mbft5_102_1_1
-rw-r-----. 1 oracle oinstall    14671872 Mar 22 15:37
392mbg1i_105_1_1
```

```
-rw-r-----. 1 oracle oinstall    79462400 Mar 22 15:37
372mbftb_103_1_1
-rw-r-----. 1 oracle oinstall      917504 Mar 22 15:37
3a2mbg23_106_1_1
-rw-r-----. 1 oracle oinstall   428498944 Mar 22 15:37
352mbfst_101_1_1
-rw-r-----. 1 oracle oinstall    88702976 Mar 22 15:37
382mbftm_104_1_1
-rw-r-----. 1 oracle oinstall     5021696 Mar 22 15:37
3b2mbg2b_107_1_1
-rw-r-----. 1 oracle oinstall      278528 Mar 22 15:38
3c2mbg2f_108_1_1
-rw-r-----. 1 oracle oinstall      278528 Mar 22 15:38
3d2mbg2i_109_1_1
-rw-r-----. 1 oracle oinstall      425984 Mar 22 15:38
3f2mbg2m_111_1_1
-rw-r-----. 1 oracle oinstall      442368 Mar 22 15:38
3g2mbg2q_112_1_1
-rw-r-----. 1 oracle oinstall      278528 Mar 22 15:38
3j2mbg37_115_1_1
-rw-r-----. 1 oracle oinstall      270336 Mar 22 15:38
3k2mbg3a_116_1_1
-rw-r-----. 1 oracle oinstall       57344 Mar 22 15:38
3l2mbg3f_117_1_1
-rw-r-----. 1 oracle oinstall       57344 Mar 22 15:38
3n2mbg3k_119_1_1
-rw-r-----. 1 oracle oinstall       57344 Mar 22 15:38
3m2mbg3g_118_1_1
-rw-r-----. 1 oracle oinstall    11600384 Mar 22 15:52 bct_ntap1.ctf
[oracle@ora-02 ~]$
```

8. Verify the available Oracle archived logs on the ANF NFS mount for recovery and note the last log file log sequency number. In this case, it is 10. Our recovery point is up to log sequency number 11.

```
[oracle@ora-02 ~]$ ls -ltr
/nfsanf/archlog/NTAP1/archivelog/2024_03_22
total 1429548
-r--r-----. 1 oracle oinstall 176650752 Mar 22 12:00
o1_mf_1_2__9m198x6t_.arc
-r--r-----. 1 oracle oinstall  17674752 Mar 22 14:34
o1_mf_1_3__9vn701r5_.arc
-r--r-----. 1 oracle oinstall 188782080 Mar 22 15:20
o1_mf_1_4__9y6gn5co_.arc
-r--r-----. 1 oracle oinstall 183638016 Mar 22 15:21
o1_mf_1_5__9y7p68s6_.arc
-r--r-----. 1 oracle oinstall 193106944 Mar 22 15:21
o1_mf_1_6__9y8ygtss_.arc
-r--r-----. 1 oracle oinstall 179439104 Mar 22 15:22
o1_mf_1_7__9ybjdp55_.arc
-r--r-----. 1 oracle oinstall 198815232 Mar 22 15:23
o1_mf_1_8__9yctxjgy_.arc
-r--r-----. 1 oracle oinstall 185494528 Mar 22 15:24
o1_mf_1_9__9yfrj0b1_.arc
-r--r-----. 1 oracle oinstall 134470144 Mar 22 15:29
o1_mf_1_10__9yomybbc_.arc
[oracle@ora-02 ~]$
```

9. As oracle user, set ORACLE_HOME variable to current Oracle installation on standby DB server ora-02, ORACLE_SID to primary Oracle instance SID. In this case, it is NTAP1.

```
[oracle@ora-02 ~]$ export
ORACLE_HOME=/u01/app/oracle/product/19.0.0/NTAP2
[oracle@ora-02 ~]$ export ORACLE_SID=NTAP1
[oracle@ora-02 ~]$ export PATH=$PATH:$ORACLE_HOME/bin
```

10. As oracle user, create a generic Oracle init file in $ORACLE_HOME/dbs directory with proper admin directories configured. Most importantly, have Oracle `flash recovery area` point to ANF NFS mount path as defined in primary Oracle VLDB server. `flash recovery area` configuration is demonstrated in section `Setup Oracle RMAN incremental merge to image copy on ANF`. Set the Oracle control file to ANF NFS file system.

```
vi $ORACLE_HOME/dbs/initNTAP1.ora
```

With following example entries:

```
*.audit_file_dest='/u01/app/oracle/admin/NTAP1/adump'
*.audit_trail='db'
*.compatible='19.0.0'
*.control_files=('/nfsanf/oracopy/NTAP1.ctl')
*.db_block_size=8192
*.db_create_file_dest='/nfsanf/oracopy/'
*.db_domain='solutions.netapp.com'
*.db_name='NTAP1'
*.db_recovery_file_dest_size=85899345920
*.db_recovery_file_dest='/nfsanf/archlog/'
*.diagnostic_dest='/u01/app/oracle'
*.dispatchers='(PROTOCOL=TCP) (SERVICE=NTAP1XDB)'
*.enable_pluggable_database=true
*.local_listener='LISTENER'
*.nls_language='AMERICAN'
*.nls_territory='AMERICA'
*.open_cursors=300
*.pga_aggregate_target=1024m
*.processes=320
*.remote_login_passwordfile='EXCLUSIVE'
*.sga_target=10240m
*.undo_tablespace='UNDOTBS1'
```

The above init file should be replaced by restored backup init file from primary Oracle VLDB server in the case of discrepancy.

11. As oracle user, launch RMAN to run Oracle recovery on the standby DB server host. First, start the Oracle instance in `nomount` state.

```
[oracle@ora-02 ~]$ rman target / nocatalog

Recovery Manager: Release 19.0.0.0.0 - Production on Fri Mar 22
16:02:55 2024
Version 19.18.0.0.0

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reserved.

connected to target database (not started)

RMAN> startup nomount;

Oracle instance started

Total System Global Area   10737418000 bytes

Fixed Size                     9174800 bytes
Variable Size               1577058304 bytes
Database Buffers            9126805504 bytes
Redo Buffers                  24379392 bytes
```

12. Set database ID. The database ID can be retrieved from Oracle file name of image copy on ANF NFS mount point.

```
RMAN> set dbid = 2441823937;

executing command: SET DBID
```

13. Restore controlfile from autobackup. If Oracle controlfile and spfile autobackup is enabled, they are backed up in every incremental backup and merge cycle. The latest backup will be restored if multiple copies are available.

```
RMAN> restore controlfile from autobackup;

Starting restore at 22-MAR-24
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=2 device type=DISK

recovery area destination: /nfsanf/archlog/
database name (or database unique name) used for search: NTAP1
channel ORA_DISK_1: AUTOBACKUP
/nfsanf/archlog/NTAP1/autobackup/2024_03_22/o1_mf_s_1164296325__9z77
zyxb_.bkp found in the recovery area
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20240322
channel ORA_DISK_1: restoring control file from AUTOBACKUP
/nfsanf/archlog/NTAP1/autobackup/2024_03_22/o1_mf_s_1164296325__9z77
zyxb_.bkp
channel ORA_DISK_1: control file restore from AUTOBACKUP complete
output file name=/nfsanf/oracopy/NTAP1.ctl
Finished restore at 22-MAR-24
```

14. Restore init file from spfile to a /tmp folder for updating parameter file later to match with primary VLDB.

```
RMAN> restore spfile to pfile '/tmp/archive/initNTAP1.ora' from
autobackup;

Starting restore at 22-MAR-24
using channel ORA_DISK_1

recovery area destination: /nfsanf/archlog/
database name (or database unique name) used for search: NTAP1
channel ORA_DISK_1: AUTOBACKUP
/nfsanf/archlog/NTAP1/autobackup/2024_03_22/o1_mf_s_1164296325__9z77
zyxb_.bkp found in the recovery area
channel ORA_DISK_1: looking for AUTOBACKUP on day: 20240322
channel ORA_DISK_1: restoring spfile from AUTOBACKUP
/nfsanf/archlog/NTAP1/autobackup/2024_03_22/o1_mf_s_1164296325__9z77
zyxb_.bkp
channel ORA_DISK_1: SPFILE restore from AUTOBACKUP complete
Finished restore at 22-MAR-24
```

15. Mount control file and validate the database backup image copy.

```
RMAN> alter database mount;
```

```
released channel: ORA_DISK_1
Statement processed

RMAN> list copy of database tag 'ORACOPYBKUPONANF_LEVEL_0';

List of Datafile Copies
=======================

Key     File S Completion Time Ckp SCN    Ckp Time        Sparse
------- ---- - --------------- ---------- --------------- ------
82      1    A 22-MAR-24       4598427    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-1_1t2m9nij
        Tag: ORACOPYBKUPONANF_LEVEL_0

83      3    A 22-MAR-24       4598423    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-3_1u2m9nog
        Tag: ORACOPYBKUPONANF_LEVEL_0

84      4    A 22-MAR-24       4598431    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-4_1v2m9nu6
        Tag: ORACOPYBKUPONANF_LEVEL_0

58      5    A 21-MAR-24       2379694    18-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-5_282m9oem
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

52      6    A 21-MAR-24       2379694    18-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-6_242m9oan
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

90      7    A 22-MAR-24       4598462    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-7_2c2m9ofn
        Tag: ORACOPYBKUPONANF_LEVEL_0

59      8    A 21-MAR-24       2379694    18-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-8_292m9oem
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 2, PDB Name: PDB$SEED

71      9    A 22-MAR-24       4598313    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-9_252m9oc5
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

68      10   A 22-MAR-24       4598308    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-10_212m9o52
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

66      11   A 22-MAR-24       4598304    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-11_202m9o22
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

74      12   A 22-MAR-24       4598318    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-12_2d2m9ofs
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

86      13   A 22-MAR-24       4598445    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-13_262m9oca
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

85      14   A 22-MAR-24       4598437    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-14_222m9o53
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

87      15   A 22-MAR-24       4598454    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-15_2a2m9of6
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

89      16   A 22-MAR-24       4598466    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
```

```
USERS_FNO-16_2e2m9og8
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 4, PDB Name: NTAP1_PDB2

91      17   A 22-MAR-24       4598450    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSTEM_FNO-17_272m9oel
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

88      18   A 22-MAR-24       4598441    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
SYSAUX_FNO-18_232m9oa8
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

92      19   A 22-MAR-24       4598458    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
UNDOTBS1_FNO-19_2b2m9ofn
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

93      20   A 22-MAR-24       4598470    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-
USERS_FNO-20_2f2m9og8
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 5, PDB Name: NTAP1_PDB3

81      21   A 22-MAR-24       4598318    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
21_1h2m9cap
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

72      22   A 22-MAR-24       4598304    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
22_1i2m9cap
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

73      23   A 22-MAR-24       4598308    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
23_1j2m9cap
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1
```

```
80      24   A 22-MAR-24       4598313    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
24_1k2m9cap
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

79      25   A 22-MAR-24       4598318    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
25_1l2m9g3u
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

69      26   A 22-MAR-24       4598304    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
26_1m2m9g9j
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

70      27   A 22-MAR-24       4598308    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
27_1n2m9gcg
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

75      28   A 22-MAR-24       4598313    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
28_1o2m9gd4
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

77      29   A 22-MAR-24       4598318    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
29_1p2m9ju6
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

67      30   A 22-MAR-24       4598304    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
30_1q2m9k7a
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

76      31   A 22-MAR-24       4598308    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
31_1r2m9kfk
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1

78      32   A 22-MAR-24       4598313    22-MAR-24       NO
        Name: /nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-
32_1s2m9kgg
        Tag: ORACOPYBKUPONANF_LEVEL_0
        Container ID: 3, PDB Name: NTAP1_PDB1
```

16. Switch database to copy to run recovery without database restore.

```
RMAN> switch database to copy;

Starting implicit crosscheck backup at 22-MAR-24
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=12 device type=DISK
Crosschecked 33 objects
Finished implicit crosscheck backup at 22-MAR-24

Starting implicit crosscheck copy at 22-MAR-24
using channel ORA_DISK_1
Crosschecked 31 objects
Finished implicit crosscheck copy at 22-MAR-24

searching for all files in the recovery area
cataloging files...
cataloging done

List of Cataloged Files
=======================
File Name:
/nfsanf/archlog/NTAP1/autobackup/2024_03_20/o1_mf_s_1164140565__5g56
ypks_.bkp
File Name:
/nfsanf/archlog/NTAP1/autobackup/2024_03_22/o1_mf_s_1164296325__9z77
zyxb_.bkp

datafile 1 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-1_1t2m9nij"
datafile 3 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-3_1u2m9nog"
datafile 4 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-4_1v2m9nu6"
datafile 5 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-5_282m9oem"
datafile 6 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-6_242m9oan"
```

```
datafile 7 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-7_2c2m9ofn"
datafile 8 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-8_292m9oem"
datafile 9 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-9_252m9oc5"
datafile 10 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-10_212m9o52"
datafile 11 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-11_202m9o22"
datafile 12 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-12_2d2m9ofs"
datafile 13 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-13_262m9oca"
datafile 14 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-14_222m9o53"
datafile 15 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-15_2a2m9of6"
datafile 16 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-16_2e2m9og8"
datafile 17 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSTEM_FNO-17_272m9oel"
datafile 18 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SYSAUX_FNO-18_232m9oa8"
datafile 19 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-UNDOTBS1_FNO-19_2b2m9ofn"
datafile 20 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-USERS_FNO-20_2f2m9og8"
datafile 21 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-21_1h2m9cap"
datafile 22 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-22_1i2m9cap"
datafile 23 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-23_1j2m9cap"
datafile 24 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-24_1k2m9cap"
datafile 25 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-25_1l2m9g3u"
datafile 26 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-26_1m2m9g9j"
datafile 27 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-27_1n2m9gcg"
datafile 28 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-28_1o2m9gd4"
datafile 29 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-29_1p2m9ju6"
```

```
datafile 30 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-30_1q2m9k7a"
datafile 31 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-31_1r2m9kfk"
datafile 32 switched to datafile copy "/nfsanf/oracopy/data_D-
NTAP1_I-2441823937_TS-SOE_FNO-32_1s2m9kgg"
```

17. Run Oracle recovery up to last available archive log in flash recovery area.

```
RMAN> run {
2> set until sequence=11;
3> recover database;
4> }

executing command: SET until clause

Starting recover at 22-MAR-24
using channel ORA_DISK_1

starting media recovery

archived log for thread 1 with sequence 4 is already on disk as file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_4__9y6gn5co_.arc
archived log for thread 1 with sequence 5 is already on disk as file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_5__9y7p68s6_.arc
archived log for thread 1 with sequence 6 is already on disk as file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_6__9y8ygtss_.arc
archived log for thread 1 with sequence 7 is already on disk as file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_7__9ybjdp55_.arc
archived log for thread 1 with sequence 8 is already on disk as file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_8__9yctxjgy_.arc
archived log for thread 1 with sequence 9 is already on disk as file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_9__9yfrj0b1_.arc
archived log for thread 1 with sequence 10 is already on disk as
file
/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_10__9yomybbc_.ar
c
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_4__9y6gn5co
_.arc thread=1 sequence=4
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_5__9y7p68s6
_.arc thread=1 sequence=5
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_6__9y8ygtss
```

```
_.arc thread=1 sequence=6
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_7__9ybjdp55
_.arc thread=1 sequence=7
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_8__9yctxjgy
_.arc thread=1 sequence=8
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_9__9yfrj0b1
_.arc thread=1 sequence=9
archived log file
name=/nfsanf/archlog/NTAP1/archivelog/2024_03_22/o1_mf_1_10__9yomybb
c_.arc thread=1 sequence=10
media recovery complete, elapsed time: 00:01:17
Finished recover at 22-MAR-24

RMAN> exit


Recovery Manager complete.
```

ⓘ For faster recovery, enable parallel sessions with recovery_parallelism parameter or specify degree of parallel in recovery command for database recovery: `RECOVER DATABASE PARALLEL (DEGREE d INSTANCES DEFAULT);`. In general, degrees of parallelism should be equal to number of CPU cores on the host.

18. Exit RMAN, login to Oracle as oracle user via sqlplus to open database and reset log after an incomplete recovery.

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

NAME      OPEN_MODE
--------- --------------------
NTAP1     MOUNTED

SQL> select instance_name, host_name from v$instance;

INSTANCE_NAME
----------------
HOST_NAME
----------------------------------------------------------------
NTAP1
ora-02


SQL>
SQL> select member from v$logfile;

MEMBER
--------------------------------------------------------------------
------------
/u03/orareco/NTAP1/onlinelog/redo03.log
/u03/orareco/NTAP1/onlinelog/redo02.log
/u03/orareco/NTAP1/onlinelog/redo01.log

SQL> alter database rename file
'/u03/orareco/NTAP1/onlinelog/redo01.log' to
'/nfsanf/oracopy/redo01.log';

Database altered.

SQL> alter database rename file
'/u03/orareco/NTAP1/onlinelog/redo02.log' to
'/nfsanf/oracopy/redo02.log';

Database altered.

SQL> alter database rename file
'/u03/orareco/NTAP1/onlinelog/redo03.log' to
'/nfsanf/oracopy/redo03.log';

Database altered.

SQL> alter database open resetlogs;

Database altered.

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP1_PDB1                     READ WRITE NO
         4 NTAP1_PDB2                     READ WRITE NO
         5 NTAP1_PDB3                     READ WRITE NO
```

19. Validate the database structure restored to new host as well as the test row we have inserted before primary VLDB failure.

```
SQL> select name from v$datafile;
```

```
NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-1_1t2m9nij
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-3_1u2m9nog
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-4_1v2m9nu6
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-5_282m9oem
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-6_242m9oan
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-7_2c2m9ofn
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-8_292m9oem
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-9_252m9oc5
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-10_212m9o52
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-
11_202m9o22
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-12_2d2m9ofs

NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-13_262m9oca
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-14_222m9o53
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-
15_2a2m9of6
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-16_2e2m9og8
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSTEM_FNO-17_272m9oel
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SYSAUX_FNO-18_232m9oa8
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-UNDOTBS1_FNO-
19_2b2m9ofn
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-USERS_FNO-20_2f2m9og8
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-21_1h2m9cap
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-22_1i2m9cap
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-23_1j2m9cap

NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-24_1k2m9cap
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-25_1l2m9g3u
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-26_1m2m9g9j
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-27_1n2m9gcg
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-28_1o2m9gd4
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-29_1p2m9ju6
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-30_1q2m9k7a
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-31_1r2m9kfk
/nfsanf/oracopy/data_D-NTAP1_I-2441823937_TS-SOE_FNO-32_1s2m9kgg
```

```
31 rows selected.

SQL> select member from v$logfile;

MEMBER
--------------------------------------------------------------------
------------
/nfsanf/oracopy/redo03.log
/nfsanf/oracopy/redo02.log
/nfsanf/oracopy/redo01.log

SQL> select name from v$controlfile;

NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/NTAP1.ctl

SQL> alter session set container=ntap1_pdb1;

Session altered.

SQL> select * from test;

        ID
----------
DT
--------------------------------------------------------------------
-------
EVENT
--------------------------------------------------------------------
------------
         1
21-MAR-24 03.15.03.000000 PM
test oracle incremental merge switch to copy

         2
22-MAR-24 02.22.06.000000 PM
test recovery on a new Azure VM host with image copy on ANF
```

20. Drop invalid tempfiles and add new tempfiles to temp tablespaces.

```
SQL> select name from v$tempfile;

NAME
```

```
--------------------------------------------------------------------
------------
/u02/oradata/NTAP1/NTAP1_pdb1/temp01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/temp02.dbf

SQL> alter tablespace temp add tempfile
'/nfsanf/oracopy/ntap1_pdb1_temp01.dbf' size 100M;

Tablespace altered.

SQL> select name from v$tempfile;

NAME
--------------------------------------------------------------------
------------
/u02/oradata/NTAP1/NTAP1_pdb1/temp01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/temp02.dbf
/nfsanf/oracopy/ntap1_pdb1_temp01.dbf

SQL> alter database tempfile
'/u02/oradata/NTAP1/NTAP1_pdb1/temp01.dbf' offline;

Database altered.

SQL> alter database tempfile
'/u02/oradata/NTAP1/NTAP1_pdb1/temp01.dbf' drop;

Database altered.

SQL> alter database tempfile
'/u02/oradata/NTAP1/NTAP1_pdb1/temp02.dbf' offline;

Database altered.

SQL> alter database tempfile
'/u02/oradata/NTAP1/NTAP1_pdb1/temp02.dbf' drop;

Database altered.

SQL> select name from v$tempfile;

NAME
--------------------------------------------------------------------
------------
/nfsanf/oracopy/ntap1_pdb1_temp01.dbf

SQL>
```

21. Other post recovery tasks

```
- Add ANF NFS mount to fstab so that the NFS file system will be
mounted when DB server host rebooted.

        As azureuser, sudo vi /etc/fstab and add following entry:

        172.30.136.68:/ora-01-u02-copy       /nfsanf        nfs
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=262144,wsize=262144,noin
tr  0       0

- Update the Oracle init file from primary databse init file backup
that is restored to /tmp/archive and create spfile as needed.
```

This completes the Oracle VLDB database recovery from backup image copy on ANF NFS file system to a standby DB server host.

Where to find additional information

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

- RMAN: Merged Incremental Backup Strategies (Doc ID 745798.1)

  https://support.oracle.com/knowledge/Oracle%20Database%20Products/745798_1.html

- RMAN Backup and Recovery User's Guide

  https://docs.oracle.com/en/database/oracle/oracle-database/19/bradv/getting-started-rman.html

- Azure NetApp Files

  https://azure.microsoft.com/en-us/products/netapp

TR-4987: Simplified, Automated Oracle Deployment on Azure NetApp Files with NFS

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for automated Oracle deployment in Microsoft Azure NetApp Files as primary database storage with NFS protocol and Oracle database is deployed as container database with dNFS enabled.

Purpose

Running performance-intensive and latency-sensitive Oracle workloads in the cloud can be challenging. Azure NetApp Files (ANF) makes it easy for enterprise line-of-business (LOB) and storage professionals to migrate and run demanding Oracle workloads without code change. Azure NetApp Files is widely used as the underlying shared file-storage service in various scenarios, such as new deployment or migration (lift and shift) of Oracle databases from on-premises to Azure.

This documentation demonstrates the simplified deployment of Oracle databases in Azure NetApp files via NFS mounts using Ansible automation. The Oracle database deploys in a container database (CDB) and pluggable databases (PDB) configuration with Oracle dNFS protocol enabled to boost performance. Furthermore, the on-premises Oracle single instance database or PDB can be migrated into a newly deployed container database in Azure using automated PDB relocation methodology with minimal service interruption. It also provides information on fast Oracle database backup, restore, and clone with NetApp SnapCenter UI tool in Azure Cloud.

This solution addresses the following use cases:

- Automated Oracle container database deployment on Azure NetApp files
- Automated Oracle database migration between on-premisses and Azure cloud

Audience

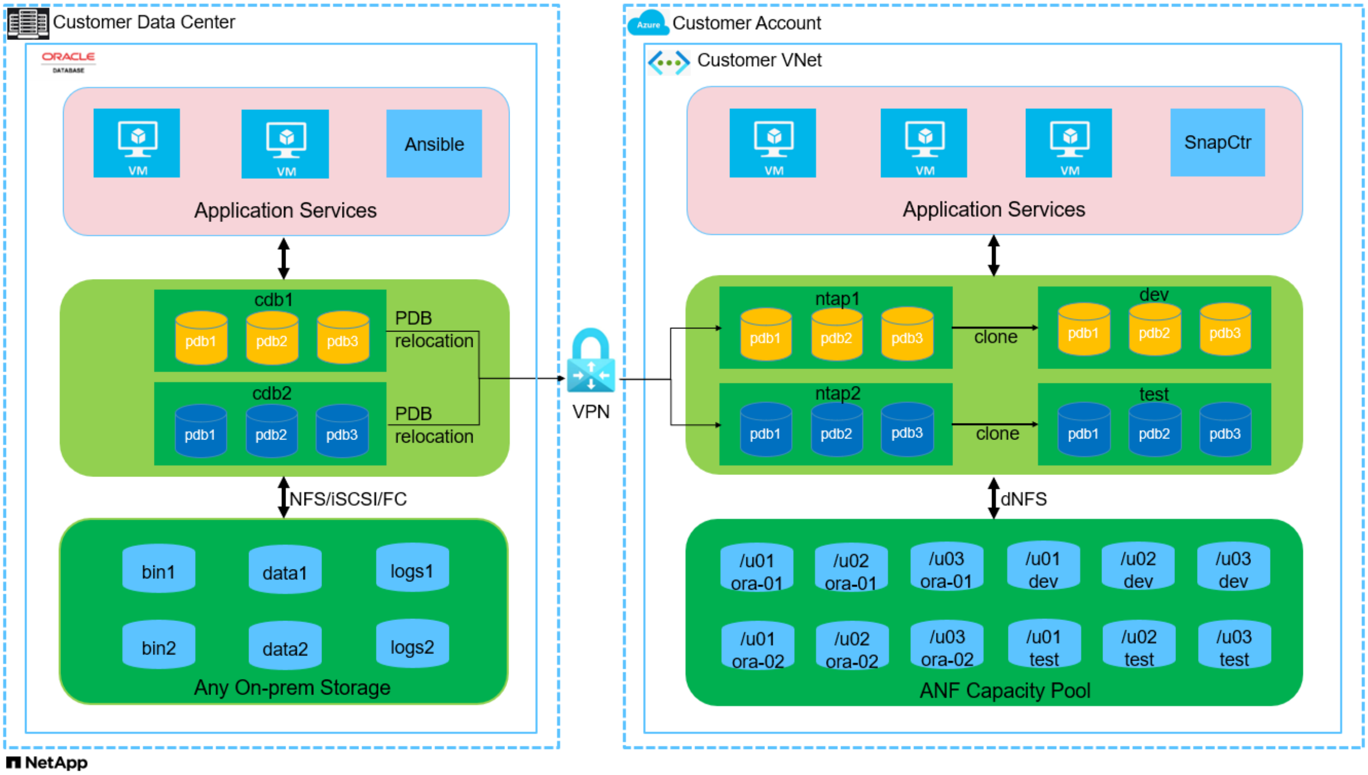
This solution is intended for the following people:

- A DBA who would like to deploy Oracle on Azure NetApp Files.
- A database solution architect who would like to test Oracle workloads on Azure NetApp Files.
- A storage administrator who would like to deploy and manage an Oracle database on Azure NetApp Files.
- An application owner who would like to stand up an Oracle database on Azure NetApp Files.

Solution test and validation environment

The testing and validation of this solution were performed in a lab setting that might not match the final deployment environment. See the section Key factors for deployment consideration for more information.

Architecture



Hardware and software components

Hardware		
Azure NetApp Files	Current offering in Azure by Microsoft	One capacity pool with Premium service level
Azure VM for DB server	Standard_B4ms - 4 vCPUs, 16GiB	Two Linux virtual machine instances for concurrent deployment
Azure VM for SnapCenter	Standard_B4ms - 4 vCPUs, 16GiB	One Windows virtual machine instance
Software		
RedHat Linux	RHEL Linux 8.6 (LVM) - x64 Gen2	Deployed RedHat subscription for testing
Windows Server	2022 DataCenter; Azure Edition Hotpatch - x64 Gen2	Hosting SnapCenter server
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 Server	Version 5.0	Workgroup deployment
Open JDK	Version java-11-openjdk	SnapCenter plugin requirement on DB VMs
NFS	Version 3.0	Oracle dNFS enabled
Ansible	core 2.16.2	Python 3.6.8

Oracle database configuration in the lab environment

Server	Database	DB Storage
ora-01	NTAP1(NTAP1_PDB1,NTAP1_PDB2,NTAP1_PDB3)	/u01, /u02, /u03 NFS mounts on ANF capacity pool
ora-02	NTAP2(NTAP2_PDB1,NTAP2_PDB2,NTAP2_PDB3)	/u01, /u02, /u03 NFS mounts on ANF capacity pool

Key factors for deployment consideration

- **Oracle database storage layout.** In this automated Oracle deployment, we provision three database volumes for each database to host Oracle binary, data, and logs by default. The volumes are mounted on Oracle DB server as /u01 - binary, /u02 - data, /u03 - logs via NFS. Dual control files are configured on /u02 and /u03 mount points for redundancy.
- **Multiple DB servers deployment.** The automation solution can deploy an Oracle container database to multiple DB servers in a single Ansible playbook run. Regardless of the number of DB servers, the playbook execution remains the same. You can deploy multiple container databases to a single VM

instance by repeating the deployment with different database instance IDs (Oracle SID). But ensure there is sufficient memory on the host to support deployed databases.

- **dNFS configuration.** 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 configures dNFS on NFSv3 by default.
- **Allocate large size volume to speed up deployment.** ANF file system IO throughput is regulated based on the size of volume. For initial deployment, allocate large size volumes can speed up the deployment. The volumes subsequently can be downsized dynamically without application impact.
- **Database backup.** NetApp provides a SnapCenter software suite for database backup, restore, and cloning with a user-friendly UI interface. NetApp recommends implementing such a management tool to achieve fast (under a minute) snapshot backup, quick (minutes) database restore, and database clone.

Solution deployment

The following sections provide step-by-step procedures for automated Oracle 19c deployment and database migration on Azure NetApp Files with directly mounted database volumes via NFS to Azure VMs.

Prerequisites for deployment

Deployment requires the following prerequisites.

1. An Azure account has been set up, and the necessary VNet and network segments have been created within your Azure account.
2. From the Azure cloud portal, deploy Azure Linux VMs as Oracle DB servers. Create an Azure NetApp Files capacity pool and database volumes for Oracle database. Enable VM SSH private/public key authentication for azureuser to DB servers. See the architecture diagram in the previous section for details about the environment setup. Also referred to Step-by-Step Oracle deployment procedures on Azure VM and Azure NetApp Files for detailed information.

   For Azure VMs deployed with local disk redundancy, ensure that you have allocated at least 128G in the VM root disk to have sufficient space to stage Oracle installation files and add OS swap file. Expand /tmplv and /rootlv OS partition accordingly. Ensure the database volume naming follows the VMname-u01, VMname-u02, and VMname-u03 convention.

   ```
   sudo lvresize -r -L +20G /dev/mapper/rootvg-rootlv
   ```

   ```
   sudo lvresize -r -L +10G /dev/mapper/rootvg-tmplv
   ```

3. From the Azure cloud portal, provision a Windows server to run the NetApp SnapCenter UI tool with the latest version. Refer to the following link for details: Install the SnapCenter Server
4. Provision a Linux VM as the Ansible controller node with the latest version of Ansible and Git installed. Refer to the following link for details: Getting Started with NetApp solution automation in section - `Setup the Ansible Control Node for CLI deployments on RHEL / CentOS` or `Setup the Ansible Control Node for CLI deployments on Ubuntu / Debian`.

   The Ansible controller node can locate either on-premisses or in Azure cloud as far as it can reach Azure DB VMs via ssh port.

5. Clone a copy of the NetApp Oracle deployment automation toolkit for NFS.

   ```
   git clone https://bitbucket.ngage.netapp.com/scm/ns-
   bb/na_oracle_deploy_nfs.git
   ```

6. Stage following Oracle 19c installation files on Azure DB VM /tmp/archive directory with 777 permission.

   ```
   installer_archives:
     - "LINUX.X64_193000_db_home.zip"
     - "p34765931_190000_Linux-x86-64.zip"
     - "p6880880_190000_Linux-x86-64.zip"
   ```

7. Watch the following video:

   Simplified and automated Oracle deployment on Azure NetApp Files with NFS

Automation parameter files

Ansible playbook executes database installation and configuration tasks with predefined parameters. For this Oracle automation solution, there are three user-defined parameter files that need user input before playbook execution.

- hosts - define targets that the automation playbook is running against.
- vars/vars.yml - the global variable file that defines variables that apply to all targets.
- host_vars/host_name.yml - the local variable file that defines variables that apply only to a named target. In our use case, these are the Oracle DB servers.

In addition to these user-defined variable files, there are several default variable files that contain default parameters that do not require change unless necessary. The following sections show how to configure the user-defined variable files.

Parameter files configuration

1. Ansible target `hosts` file configuration:

```
# Enter Oracle servers names to be deployed one by one, follow by
each Oracle server public IP address, and ssh private key of
azureuser for the server.
[oracle]
ora-01 ansible_host=10.61.180.21 ansible_ssh_private_key_file=ora-
01.pem
ora-02 ansible_host=10.61.180.23 ansible_ssh_private_key_file=ora-
02.pem
```

2. Global `vars/vars.yml` file configuration

```
####################################################################
##
###### Oracle 19c deployment user configuration variables
######
###### Consolidate all variables from ANF, linux and oracle
######
####################################################################
##

###########################################
### ANF env specific config variables   ###
###########################################

# Prerequisite to create three volumes in NetApp storage pool from
cloud dashboard with following naming convention:
# db_hostname-u01 - Oracle binary
# db_hostname-u02 - Oracle data
# db_hostname-u03 - Oracle redo
# It is important to strictly follow the name convention or the
automation will fail.

# NFS lif ip address to access database volumes in ANF storage pool
(retrievable from cloud dashboard)
nfs_lif: 172.30.136.68

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

redhat_sub_username: XXXXXXXX
redhat_sub_password: XXXXXXXX


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

# Database domain name
db_domain: solutions.netapp.com

# Set initial password for all required Oracle passwords. Change
them after installation.
initial_pwd_all: XXXXXXXX
```

3. Local DB server `host_vars/host_name.yml` configuration such as ora_01.yml, ora_02.yml …

```
# User configurable Oracle host specific parameters

# Enter container database SID. By default, a container DB is
created with 3 PDBs within the CDB
oracle_sid: NTAP1

# Enter database shared memory size or SGA. CDB is created with SGA
at 75% of memory_limit, MB. The grand total of SGA should not exceed
75% available RAM on node.
memory_limit: 8192
```

Playbook execution

There are a total of five playbooks in the automation toolkit. Each performs different task blocks and serves different purposes.

```
0-all_playbook.yml - execute playbooks from 1-4 in one playbook run.
1-ansible_requirements.yml - set up Ansible controller with required
libs and collections.
2-linux_config.yml - execute Linux kernel configuration on Oracle DB
servers.
4-oracle_config.yml - install and configure Oracle on DB servers and
create a container database.
5-destroy.yml - optional to undo the environment to dismantle all.
```

There are three options to run the playbooks with the following commands.

1. Execute all deployment playbooks in one combined run.

   ```
   ansible-playbook -i hosts 0-all_playbook.yml -u azureuser -e
   @vars/vars.yml
   ```

2. Execute playbooks one at a time with the number sequence from 1-4.

   ```
   ansible-playbook -i hosts 1-ansible_requirements.yml -u azureuser -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 2-linux_config.yml -u azureuser -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 4-oracle_config.yml -u azureuser -e
   @vars/vars.yml
   ```

3. Execute 0-all_playbook.yml with a tag.

   ```
   ansible-playbook -i hosts 0-all_playbook.yml -u azureuser -e
   @vars/vars.yml -t ansible_requirements
   ```

   ```
   ansible-playbook -i hosts 0-all_playbook.yml -u azureuser -e
   @vars/vars.yml -t linux_config
   ```

```
ansible-playbook -i hosts 0-all_playbook.yml -u azureuser -e
@vars/vars.yml -t oracle_config
```

4. Undo the environment

```
ansible-playbook -i hosts 5-destroy.yml -u azureuser -e
@vars/vars.yml
```

Post execution validation

After the playbook run, login to the Oracle DB server VM to validate that Oracle is installed and configured and a container database is created successfully. Following is an example of Oracle database validation on host ora-01.

1. Validate NFS mounts

```
[azureuser@ora-01 ~]$ cat /etc/fstab

#
# /etc/fstab
# Created by anaconda on Thu Sep 14 11:04:01 2023
#
# Accessible filesystems, by reference, are maintained under
'/dev/disk/'.
# See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for
more info.
#
# After editing this file, run 'systemctl daemon-reload' to update
systemd
# units generated from this file.
#
/dev/mapper/rootvg-rootlv /                       xfs     defaults
0 0
UUID=268633bd-f9bb-446d-9a1d-8fca4609a1e1 /boot
xfs     defaults        0 0
UUID=89D8-B037          /boot/efi               vfat
defaults,uid=0,gid=0,umask=077,shortname=winnt 0 2
/dev/mapper/rootvg-homelv /home                   xfs     defaults
0 0
/dev/mapper/rootvg-tmplv /tmp                    xfs     defaults
0 0
/dev/mapper/rootvg-usrlv /usr                    xfs     defaults
0 0
/dev/mapper/rootvg-varlv /var                    xfs     defaults
0 0
/mnt/swapfile swap swap defaults 0 0
172.30.136.68:/ora-01-u01 /u01 nfs
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536 0 0
172.30.136.68:/ora-01-u02 /u02 nfs
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536 0 0
172.30.136.68:/ora-01-u03 /u03 nfs
rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536 0 0

[azureuser@ora-01 ~]$ df -h
Filesystem                 Size  Used Avail Use% Mounted on
devtmpfs                   7.7G     0  7.7G   0% /dev
```

```
tmpfs                      7.8G     0  7.8G   0% /dev/shm
tmpfs                      7.8G  8.6M  7.7G   1% /run
tmpfs                      7.8G     0  7.8G   0% /sys/fs/cgroup
/dev/mapper/rootvg-rootlv   22G   17G  5.8G  74% /
/dev/mapper/rootvg-usrlv    10G  2.0G  8.1G  20% /usr
/dev/mapper/rootvg-varlv   8.0G  890M  7.2G  11% /var
/dev/sda1                  496M  106M  390M  22% /boot
/dev/mapper/rootvg-homelv 1014M   40M  975M   4% /home
/dev/sda15                 495M  5.9M  489M   2% /boot/efi
/dev/mapper/rootvg-tmplv    12G  8.4G  3.7G  70% /tmp
tmpfs                      1.6G     0  1.6G   0% /run/user/54321
172.30.136.68:/ora-01-u01  500G   11G  490G   3% /u01
172.30.136.68:/ora-01-u03  250G  1.2G  249G   1% /u03
172.30.136.68:/ora-01-u02  250G  7.1G  243G   3% /u02
tmpfs                      1.6G     0  1.6G   0% /run/user/1000
```

2. Validate Oracle listener

```
[azureuser@ora-01 ~]$ sudo su
[root@ora-01 azureuser]# su - oracle
Last login: Thu Feb  1 16:13:44 UTC 2024
[oracle@ora-01 ~]$ lsnrctl status listener.ntap1

LSNRCTL for Linux: Version 19.0.0.0.0 - Production on 01-FEB-2024
16:25:37

Copyright (c) 1991, 2022, Oracle.  All rights reserved.

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=TCP)(HOST=ora-
01.internal.cloudapp.net)(PORT=1521)))
STATUS of the LISTENER
------------------------
Alias                     LISTENER.NTAP1
Version                   TNSLSNR for Linux: Version 19.0.0.0.0 -
Production
Start Date                01-FEB-2024 16:13:49
Uptime                    0 days 0 hr. 11 min. 49 sec
Trace Level               off
Security                  ON: Local OS Authentication
SNMP                      OFF
Listener Parameter File
/u01/app/oracle/product/19.0.0/NTAP1/network/admin/listener.ora
Listener Log File         /u01/app/oracle/diag/tnslsnr/ora-
01/listener.ntap1/alert/log.xml
Listening Endpoints Summary...
```

```
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=ora-
01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net)(PORT=1521)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=EXTPROC1521)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcps)(HOST=ora-
01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net)(PORT=5500))(
Security=(my_wallet_directory=/u01/app/oracle/product/19.0.0/NTAP1/a
dmin/NTAP1/xdb_wallet))(Presentation=HTTP)(Session=RAW))
Services Summary...
Service "104409ac02da6352e063bb891eacf34a.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "104412c14c2c63cae063bb891eacf64d.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "1044174670ad63ffe063bb891eac6b34.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "NTAP1.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "NTAP1XDB.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap1_pdb1.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap1_pdb2.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap1_pdb3.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
The command completed successfully
```

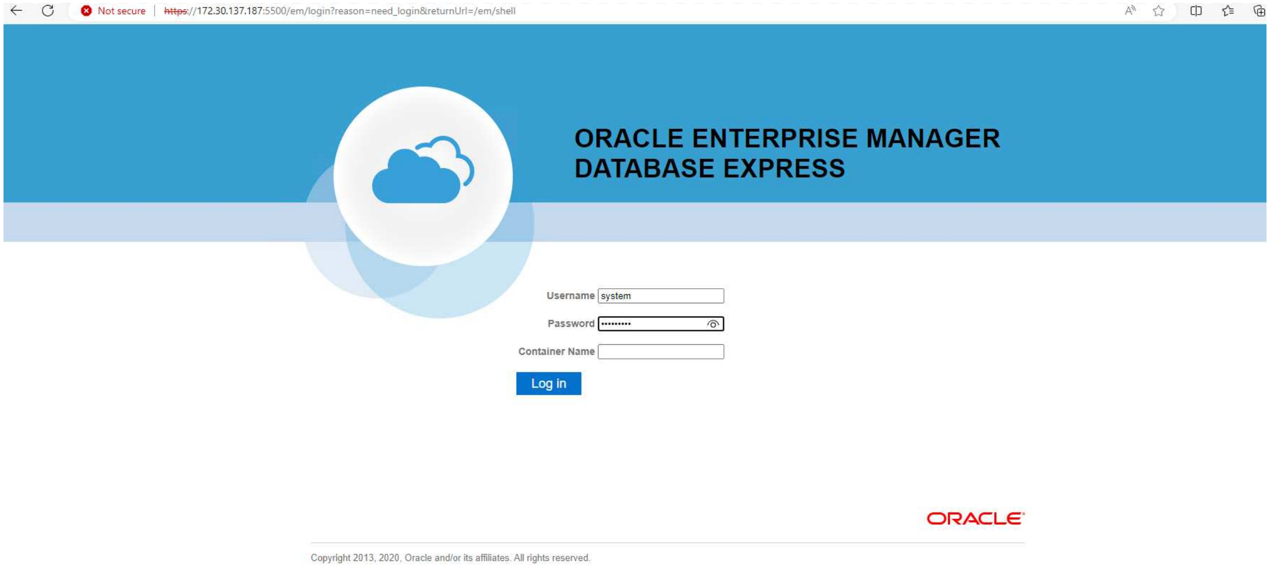
3. Validate Oracle database and dNFS

```
[oracle@ora-01 ~]$ cat /etc/oratab
#
# This file is used by ORACLE utilities.  It is created by root.sh
# and updated by either Database Configuration Assistant while
creating
# a database or ASM Configuration Assistant while creating ASM
```

```
instance.

# A colon, ':', is used as the field terminator.  A new line
terminates
# the entry.  Lines beginning with a pound sign, '#', are comments.
#
# Entries are of the form:
#   $ORACLE_SID:$ORACLE_HOME:<N|Y>:
#
# The first and second fields are the system identifier and home
# directory of the database respectively.  The third field indicates
# to the dbstart utility that the database should , "Y", or should
not,
# "N", be brought up at system boot time.
#
# Multiple entries with the same $ORACLE_SID are not allowed.
#
#
NTAP1:/u01/app/oracle/product/19.0.0/NTAP1:Y


[oracle@ora-01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Thu Feb 1 16:37:51 2024
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, log_mode from v$database;

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
NTAP1     READ WRITE           ARCHIVELOG

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP1_PDB1                     READ WRITE NO
         4 NTAP1_PDB2                     READ WRITE NO
         5 NTAP1_PDB3                     READ WRITE NO
SQL> select name from v$datafile;

NAME
--------------------------------------------------------------------
------------
/u02/oradata/NTAP1/system01.dbf
/u02/oradata/NTAP1/sysaux01.dbf
/u02/oradata/NTAP1/undotbs01.dbf
/u02/oradata/NTAP1/pdbseed/system01.dbf
/u02/oradata/NTAP1/pdbseed/sysaux01.dbf
/u02/oradata/NTAP1/users01.dbf
/u02/oradata/NTAP1/pdbseed/undotbs01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/system01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/sysaux01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/undotbs01.dbf
/u02/oradata/NTAP1/NTAP1_pdb1/users01.dbf

NAME
--------------------------------------------------------------------
------------
/u02/oradata/NTAP1/NTAP1_pdb2/system01.dbf
/u02/oradata/NTAP1/NTAP1_pdb2/sysaux01.dbf
/u02/oradata/NTAP1/NTAP1_pdb2/undotbs01.dbf
/u02/oradata/NTAP1/NTAP1_pdb2/users01.dbf
/u02/oradata/NTAP1/NTAP1_pdb3/system01.dbf
/u02/oradata/NTAP1/NTAP1_pdb3/sysaux01.dbf
/u02/oradata/NTAP1/NTAP1_pdb3/undotbs01.dbf
/u02/oradata/NTAP1/NTAP1_pdb3/users01.dbf

19 rows selected.

SQL> select name from v$controlfile;

NAME
--------------------------------------------------------------------
------------
/u02/oradata/NTAP1/control01.ctl
/u03/orareco/NTAP1/control02.ctl

SQL> select member from v$logfile;

MEMBER
--------------------------------------------------------------------
------------
/u03/orareco/NTAP1/onlinelog/redo03.log
```

```
/u03/orareco/NTAP1/onlinelog/redo02.log
/u03/orareco/NTAP1/onlinelog/redo01.log

SQL> select svrname, dirname, nfsversion from v$dnfs_servers;

SVRNAME
--------------------------------------------------------------------
------------
DIRNAME
--------------------------------------------------------------------
------------
NFSVERSION
----------------
172.30.136.68
/ora-01-u02
NFSv3.0

172.30.136.68
/ora-01-u03
NFSv3.0

SVRNAME
--------------------------------------------------------------------
------------
DIRNAME
--------------------------------------------------------------------
------------
NFSVERSION
----------------

172.30.136.68
/ora-01-u01
NFSv3.0
```

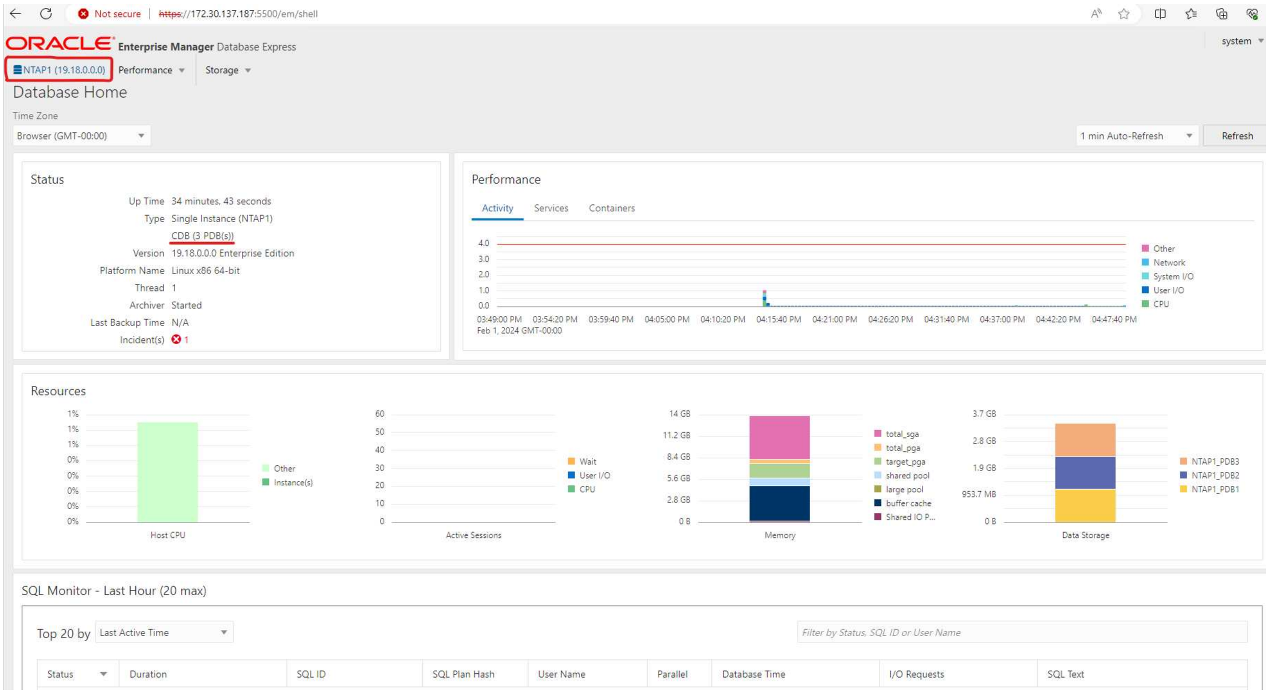
4. Login to Oracle Enterprise Manager Express to validate database.


Not secure
https://172.30.137.187:5500/em/login?reason=need_login&returnUrl=/em/shell
ORACLE ENTERPRISE MANAGER
DATABASE EXPRESS
Log in
ORACLE
Copyright 2013, 2020, Oracle and/or its affiliates. All rights reserved.

Username: system

Password: ••••••••••

Container Name:



Time Zone: Browser (GMT-00:00)

Status

Up Time: 34 minutes, 43 seconds
Type: Single Instance (NTAP1)
CDB (3 PDB(s))
Version: 19.18.0.0.0 Enterprise Edition
Platform Name: Linux x86 64-bit
Thread: 1
Archiver: Started
Last Backup Time: N/A
Incident(s): ⊗ 1

Migrate Oracle database to Azure

Oracle database migration from on-premises to the cloud is a heavy-lifting. Using the right strategy and automation can smooth the process and minimize service interruption and downtime. Follow this detailed instruction Database migration from on-premises to Azure cloud to guide your database migration journey.

Oracle backup, restore, and clone with SnapCenter

NetApp recommends SnapCenter UI tool to manage Oracle database deployed in Azure cloud. Please refer to TR-4988: Oracle Database Backup, Recovery, and Clone on ANF with SnapCenter for details.

Where to find additional information

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

- Oracle Database Backup, Recovery, and Clone on ANF with SnapCenter

  Oracle Database Backup, Recovery, and Clone on ANF with SnapCenter

- Azure NetApp Files

  https://azure.microsoft.com/en-us/products/netapp

- Deploying Oracle Direct NFS

  https://docs.oracle.com/en/database/oracle/oracle-database/19/ladbi/deploying-dnfs.html#GUID-D06079DB-8C71-4F68-A1E3-A75D7D96DCE2

- 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

Oracle Database Deployment and Protection on Azure NetApp Files

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

This best practice guide provides details of a solution for deploying and protecting Oracle database on Azure NetApp file storage and Azure VM.

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

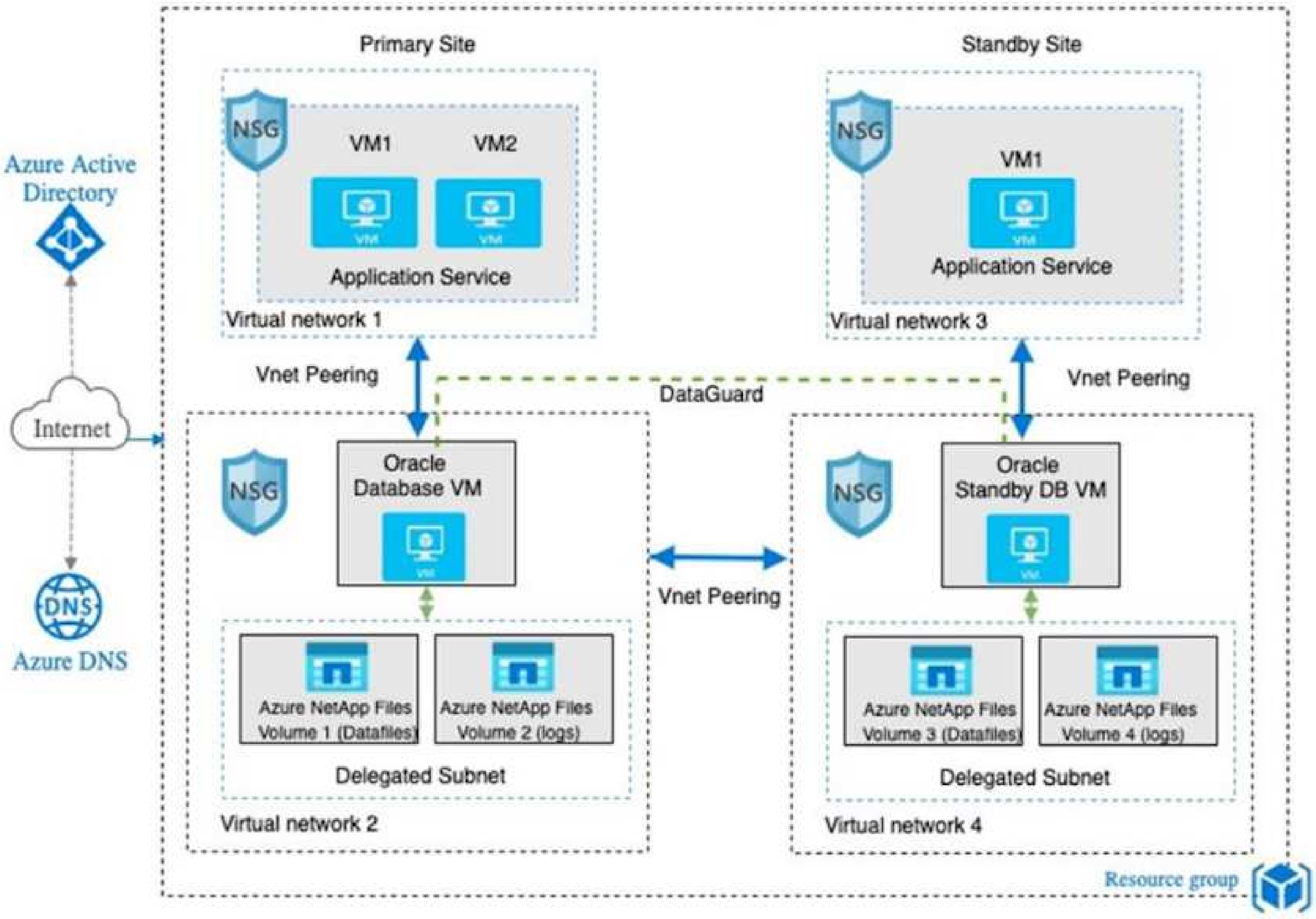
This documentation describes in detail how to deploy, configure, and protect an Oracle database with an Azure virtual machine and Azure NetApp Files storage service that delivers performance and durability similar to an on-premises system. For best-practices guidance, see TR-4780 Oracle Databases on 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.

Solution Architecture

The following architecture diagram illustrates a highly available Oracle database deployment on Azure VM instances and the Azure NetApp Files storage.

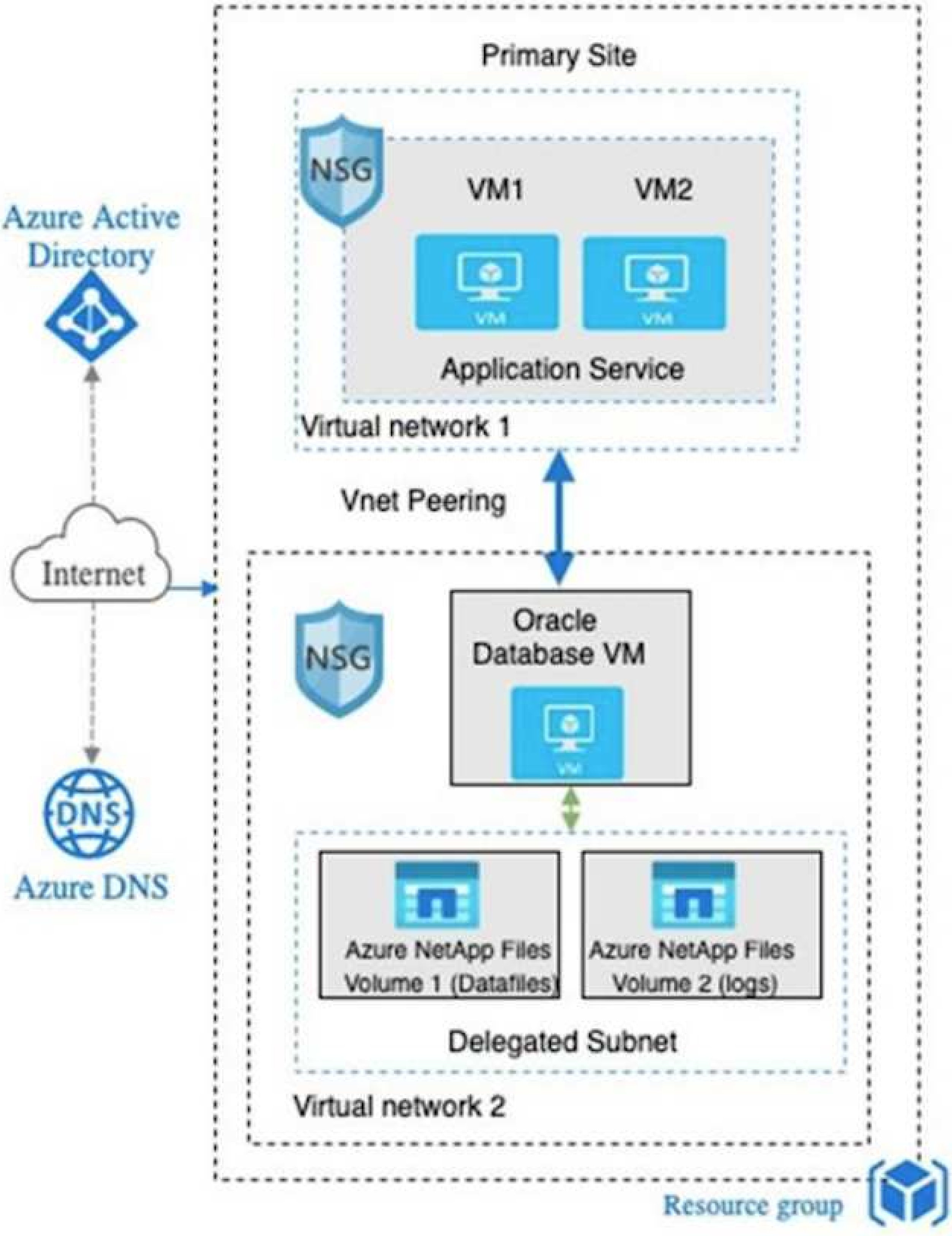
Within the environment, the Oracle compute instance is deployed via an Azure services VM console. There are multiple Azure instance types available from the console. NetApp recommends deploying a database-oriented Azure VM instance that meets your expected workload.

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.

Factors to consider for Oracle database deployment

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.

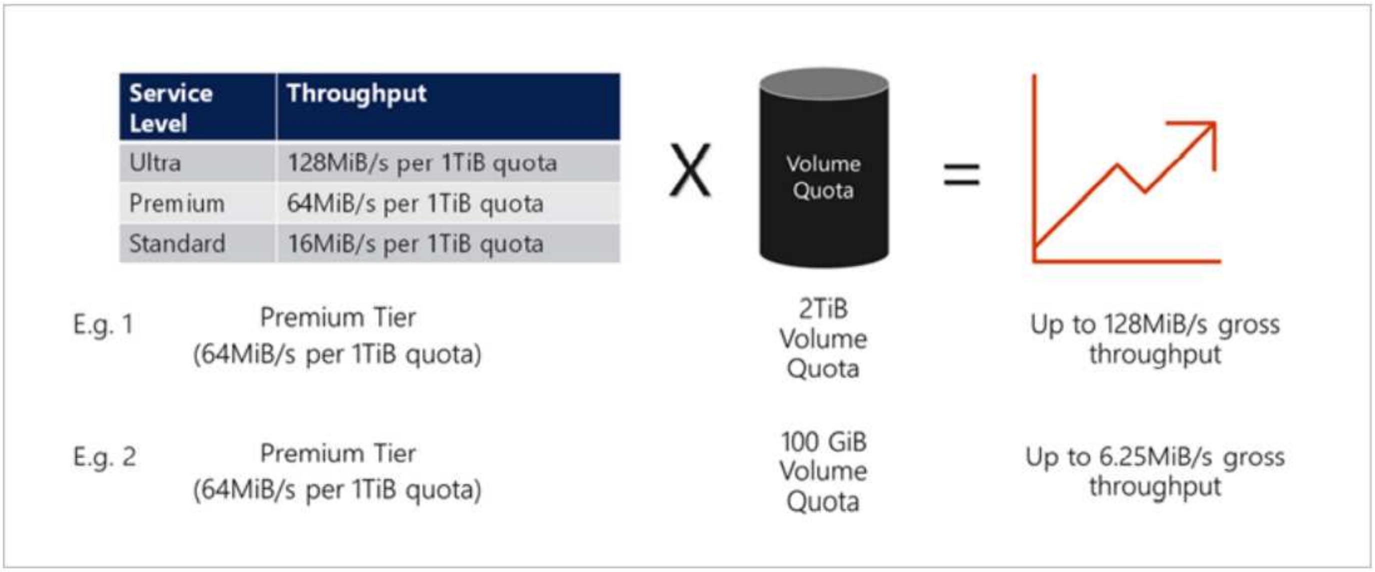
For example, a 10TiB-provisioned single-capacity pool with the premium service level provides an overall available throughput for all volumes in this capacity pool of 10x 64MBps, so 640MBps with 40,000 (16K) IOPs or 80,000 (8K) IOPs.

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.



Service Level	Throughput
Ultra	128MiB/s per 1TiB quota
Premium	64MiB/s per 1TiB quota
Standard	16MiB/s per 1TiB quota

X
Volume Quota
=
E.g. 1
Premium Tier (64MiB/s per 1TiB quota)
2TiB Volume Quota
Up to 128MiB/s gross throughput
E.g. 2
Premium Tier (64MiB/s per 1TiB quota)
100 GiB Volume Quota
Up to 6.25MiB/s gross throughput

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 (2TiB * 64MiBps). This scenario applies regardless of the capacity pool size or the actual volume consumption.

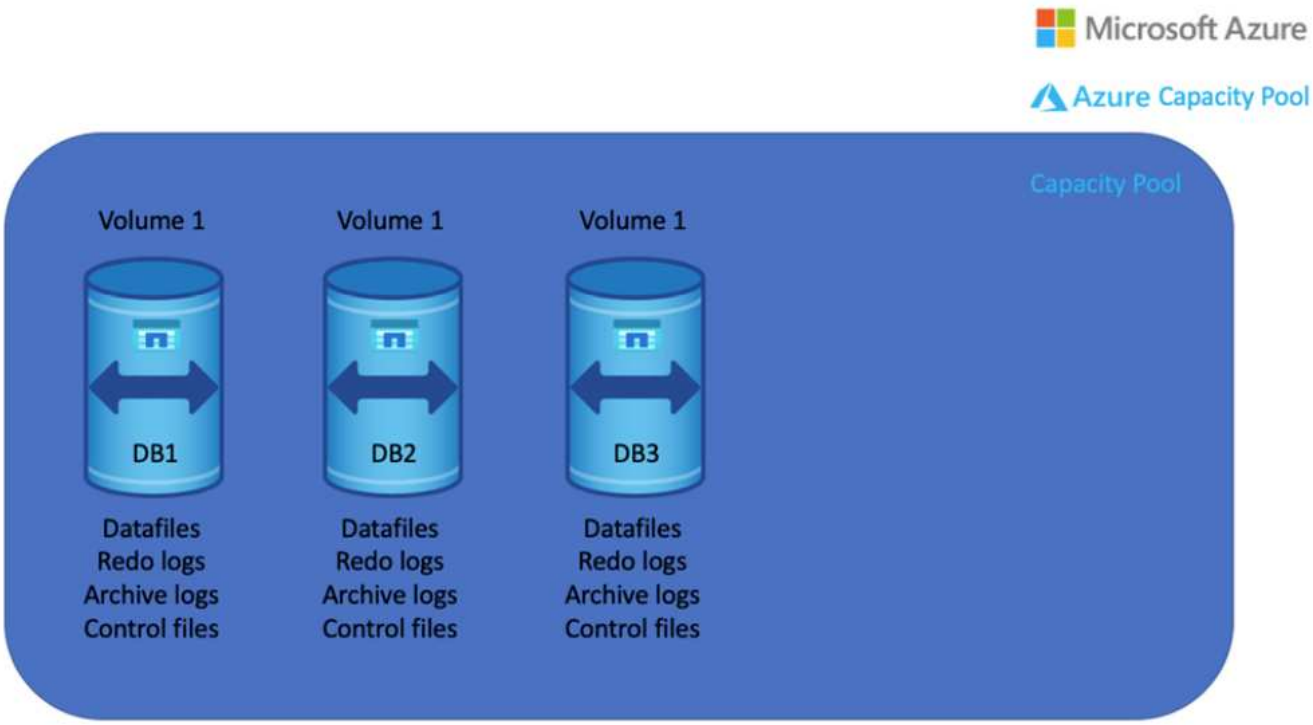
In example 2, a volume from a capacity pool with the Premium storage tier that is assigned 100GiB of quota is assigned a throughput limit of 6.25MiBps (0.09765625TiB * 64MiBps). This scenario applies regardless of the capacity pool size or the actual volume consumption.

Please note that the minimum volume size is 100GiB.

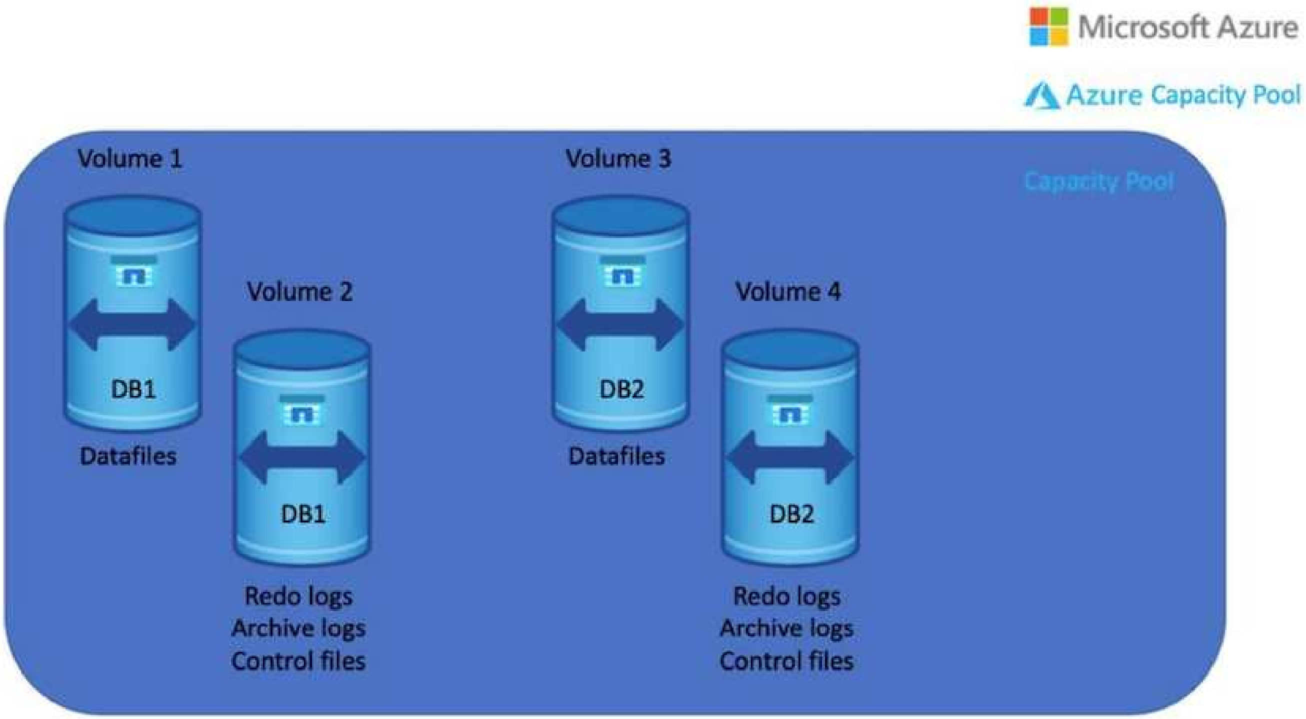
Storage layout and settings

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.

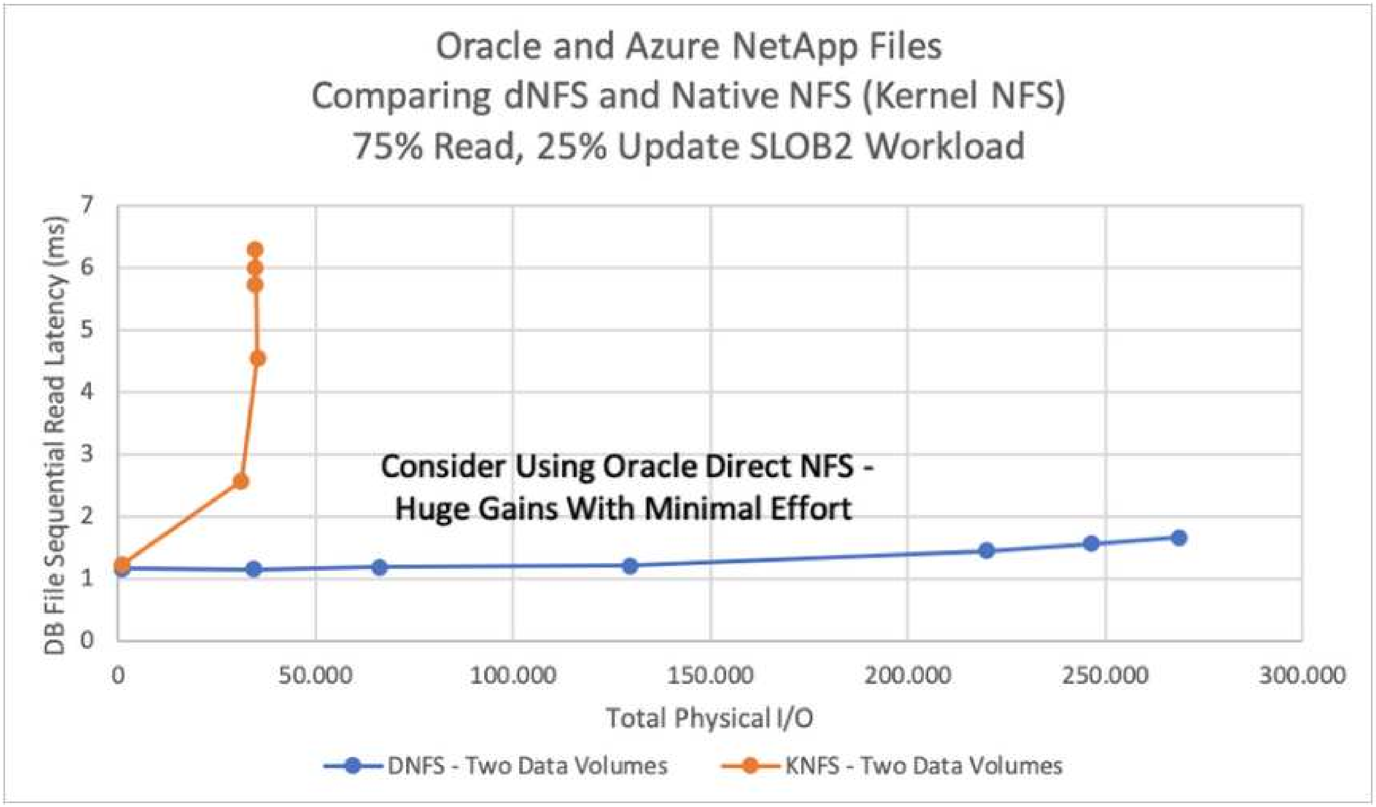


NFS configuration

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.



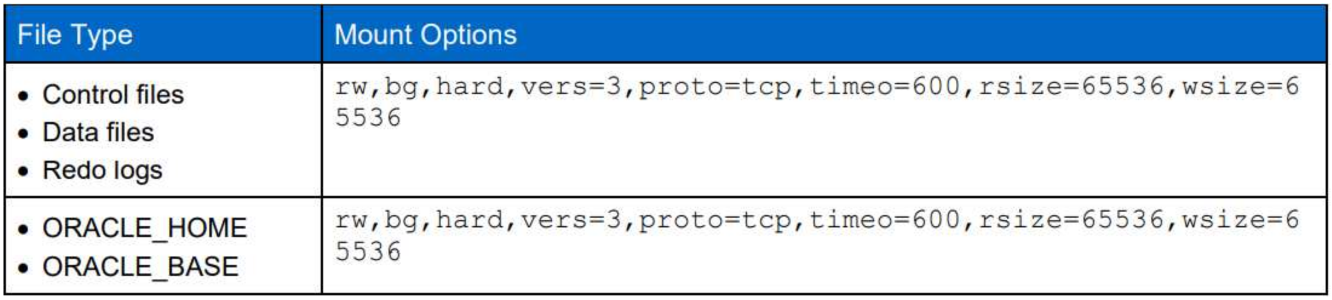
Other factors to consider:

- 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
• Control files • Data files • Redo logs	`rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536`
• ORACLE_HOME • ORACLE_BASE	`rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=65536`

> Before using dNFS, verify that the patches described in Oracle Doc 1495104.1 are installed. The NetApp Support matrix for NFSv3 and NFSv4 do not include specific operating systems. All OSs that obey the RFC are supported. When searching the online IMT for NFSv3 or NFSv4 support, do not select a specific OS because no matches will be displayed. All OSs are implicitly supported by the general policy.

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

This section describes the deployment procedures of deploying Oracle RDS custom database with FSx storage.

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

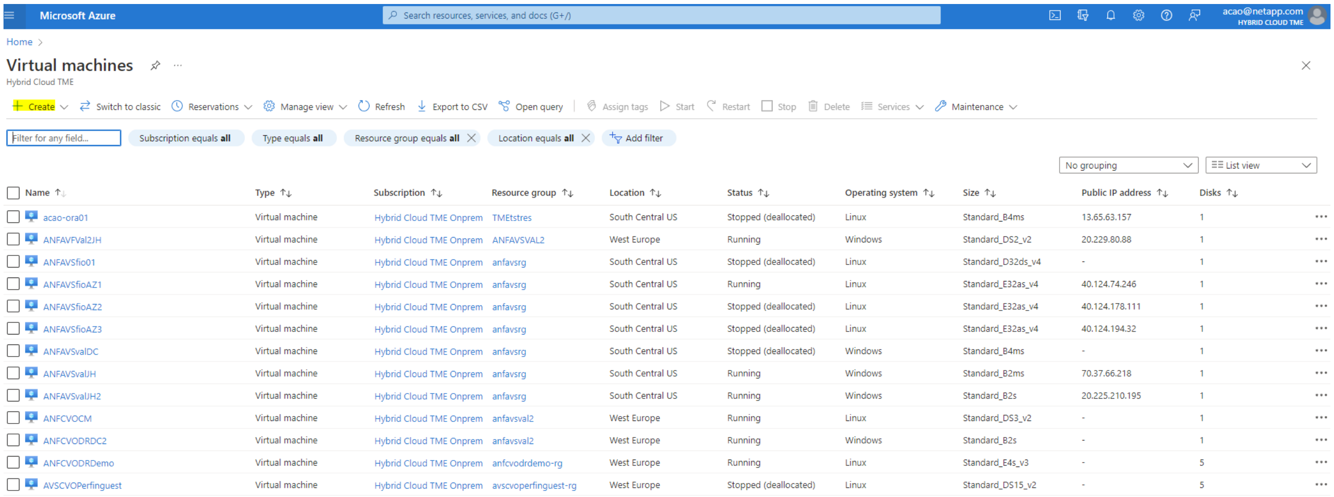
In this deployment scenario, an Azure VM OS is provisioned using regular Azure storage, but ANF volumes are provisioned to run Oracle database via NFS. First, you need to create a NetApp storage account and a capacity pool to host the storage volumes.

See Set up Azure NetApp Files and create an NFS volume to set up an ANF capacity pool.

3. Provision Azure VM for Oracle

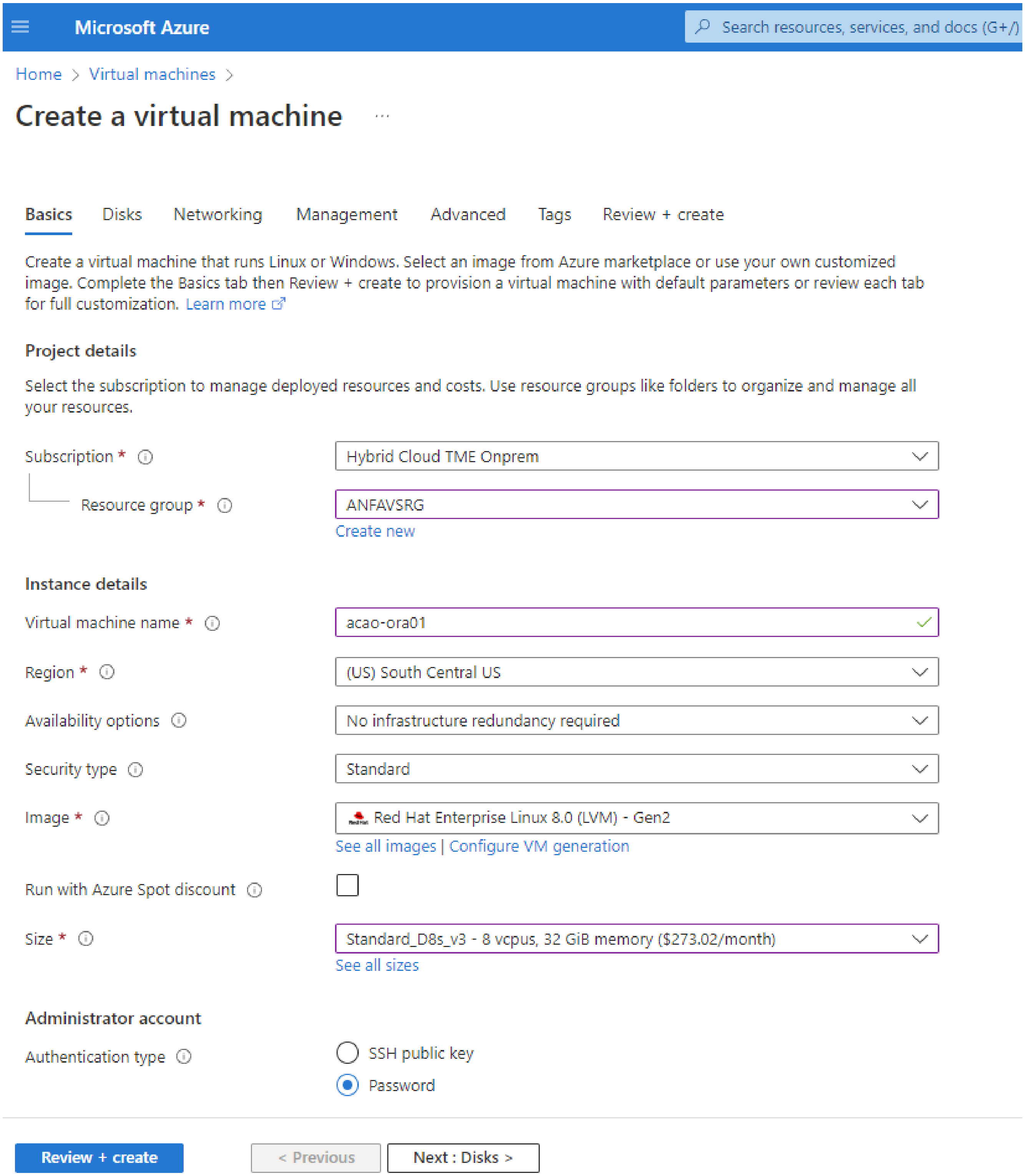
Based on your workload, determine what type of Azure VM you need and the size of the VM vCPU and RAM to deploy for Oracle. Then, from the Azure console, click the VM icon to launch the VM deployment workflow.

1. 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	TMEtstres	South Central US	Stopped (deallocated)	Linux	Standard_B4ms	13.65.63.157	1
ANFAVFVal2JH	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	anfavsrg	South Central US	Stopped (deallocated)	Linux	Standard_D32ds_v4	-	1
ANFAVSfioAZ1	Virtual machine	Hybrid Cloud TME Onprem	anfavsrg	South Central US	Running	Linux	Standard_E32as_v4	40.124.74.246	1
ANFAVSfioAZ2	Virtual machine	Hybrid Cloud TME Onprem	anfavsrg	South Central US	Stopped (deallocated)	Linux	Standard_E32as_v4	40.124.178.111	1
ANFAVSfioAZ3	Virtual machine	Hybrid Cloud TME Onprem	anfavsrg	South Central US	Stopped (deallocated)	Linux	Standard_E32as_v4	40.124.194.32	1
ANFAVSvalDC	Virtual machine	Hybrid Cloud TME Onprem	anfavsrg	South Central US	Stopped (deallocated)	Windows	Standard_B4ms	-	1
ANFAVSvalJH	Virtual machine	Hybrid Cloud TME Onprem	anfavsrg	South Central US	Running	Windows	Standard_B2ms	70.37.66.218	1
ANFAVSvalJH2	Virtual machine	Hybrid Cloud TME Onprem	anfavsrg	South Central US	Running	Windows	Standard_B2s	20.225.210.195	1
ANFCVOCM	Virtual machine	Hybrid Cloud TME Onprem	anfavsval2	West Europe	Running	Linux	Standard_DS3_v2	-	1
ANFCVODRDC2	Virtual machine	Hybrid Cloud TME Onprem	anfavsval2	West Europe	Running	Windows	Standard_B2s	-	1
ANFCVODRDemo	Virtual machine	Hybrid Cloud TME Onprem	anfcvodrdemo-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

2. 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.


Microsoft Azure
Search resources, services, and docs (G+/)
Home > Virtual machines >

Create a virtual machine ...

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

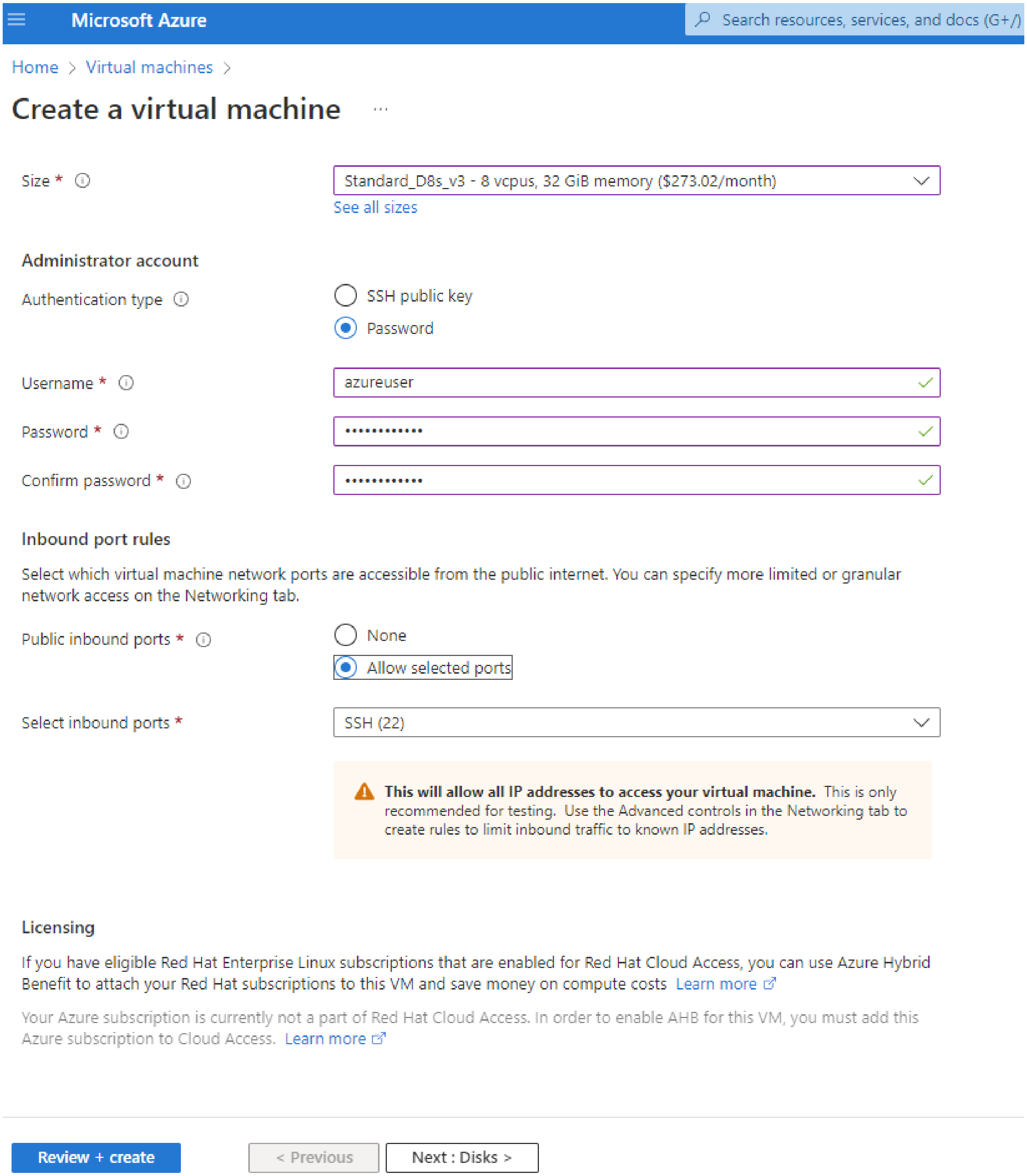
Run with Azure Spot discount : ☐

Size * : Standard_D8s_v3 - 8 vcpus, 32 GiB memory ($273.02/month)

See all sizes

Administrator account

Authentication type : ○ SSH public key ● Password


Microsoft Azure
Search resources, services, and docs (G+/)
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)

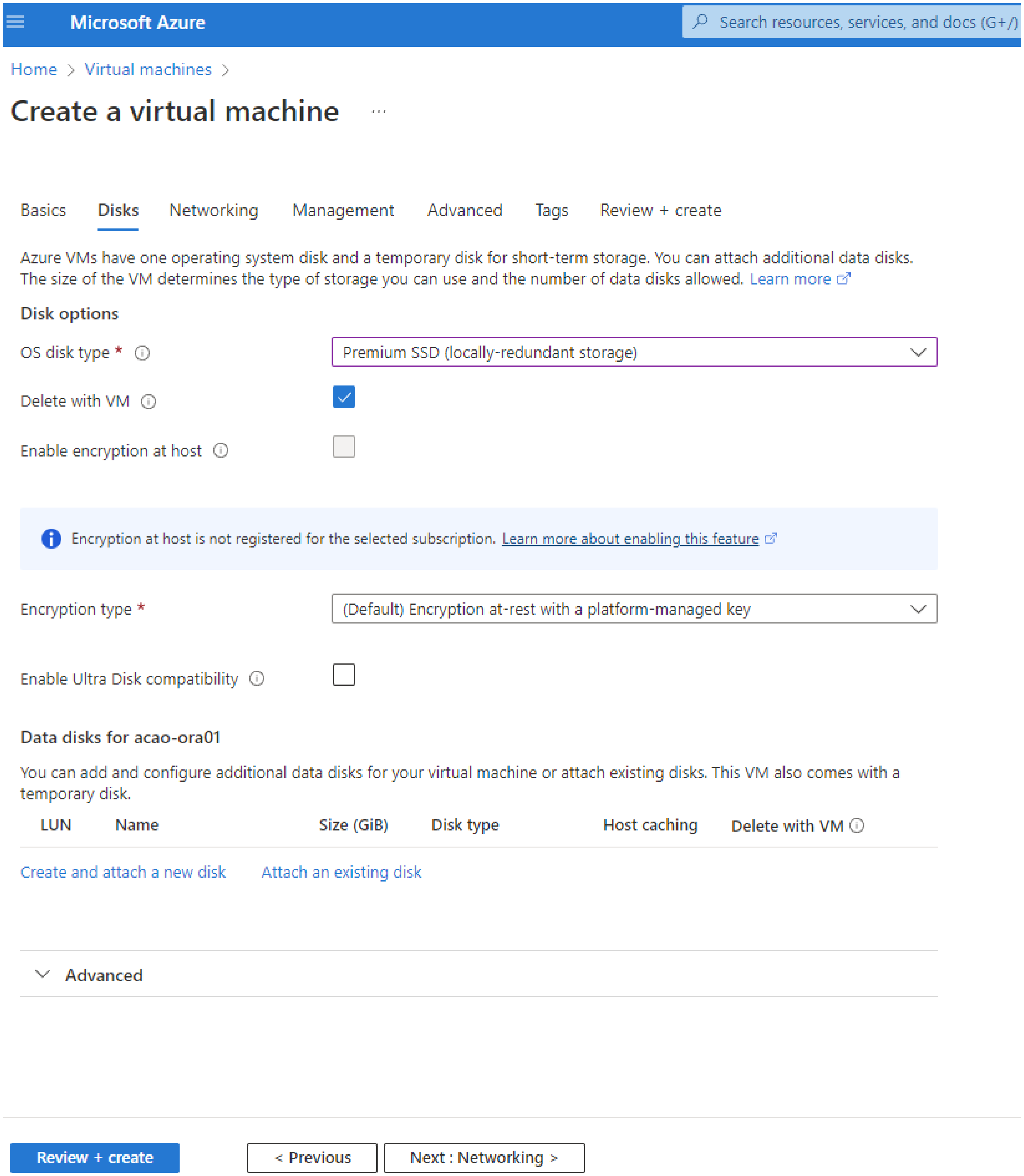
This will allow all IP addresses to access your virtual machine. This is only recommended for testing. Use the Advanced controls in the Networking tab to create rules to limit inbound traffic to known IP addresses.

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

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.



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

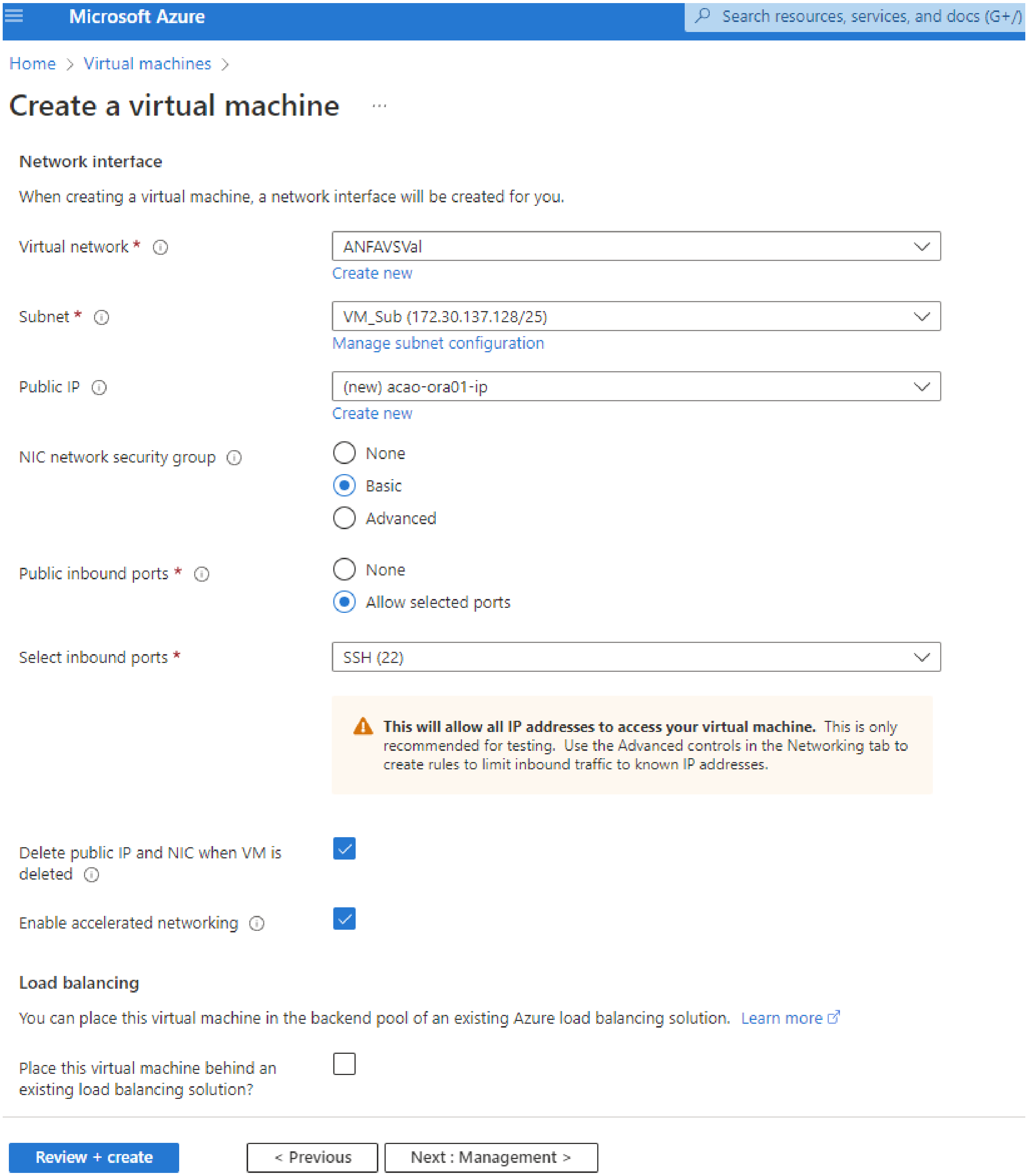
Enable Ultra Disk compatibility: ☐

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

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



Network interface

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

Virtual network * : ANFAVSVal

Subnet * : VM_Sub (172.30.137.128/25)

Public IP: (new) acao-ora01-ip

NIC network security group: ○ None ● Basic ○ Advanced

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.

Delete public IP and NIC when VM is deleted: ☑

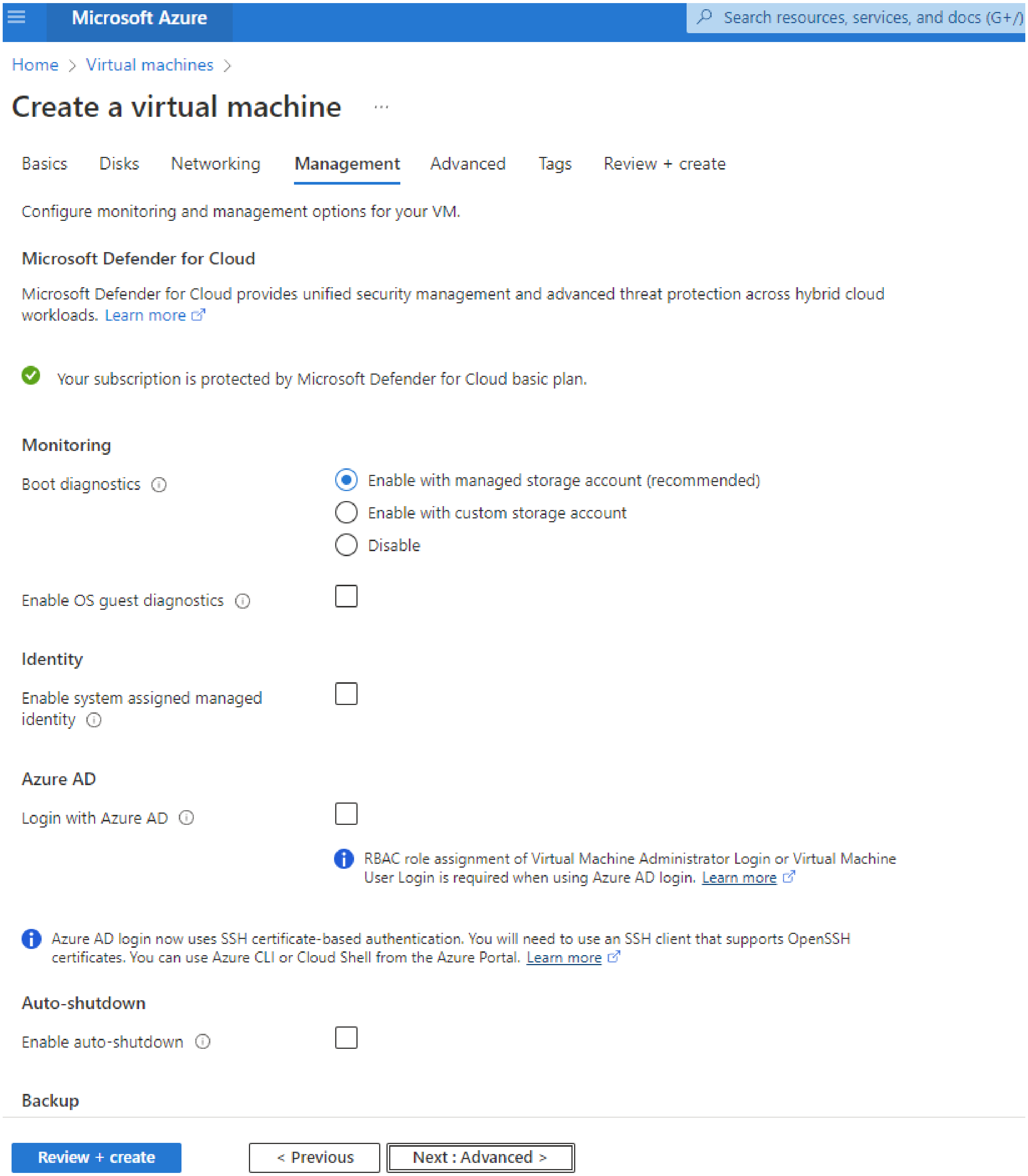
Enable accelerated networking: ☑

Load balancing

You can place this virtual machine in the backend pool of an existing Azure load balancing solution.

Place this virtual machine behind an existing load balancing solution? ☐

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



Create a virtual machine ...

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

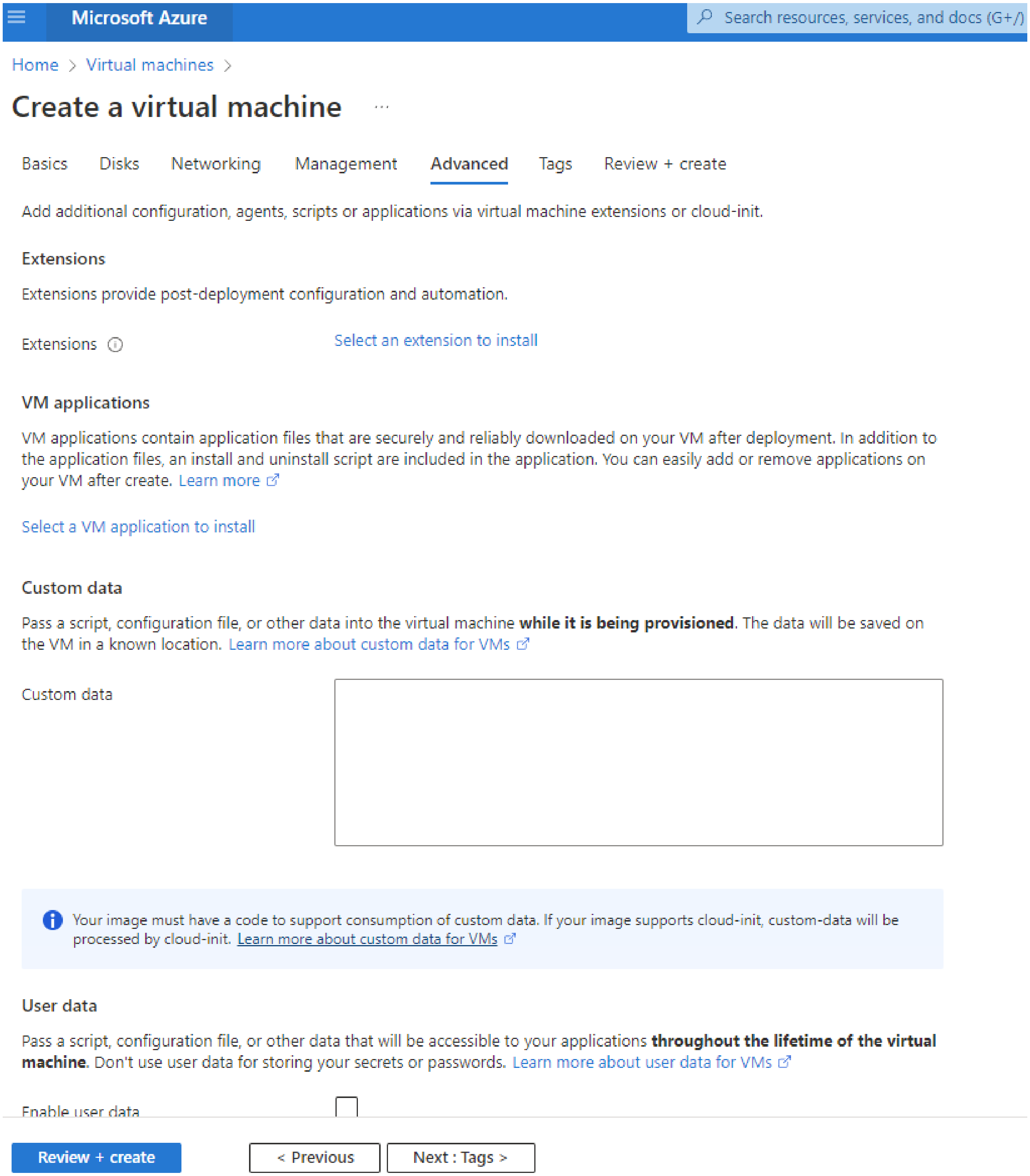
Azure AD login now uses SSH certificate-based authentication. You will need to use an SSH client that supports OpenSSH certificates. You can use Azure CLI or Cloud Shell from the Azure Portal. Learn more

Auto-shutdown

Enable auto-shutdown ☐

Backup

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.



Create a virtual machine

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

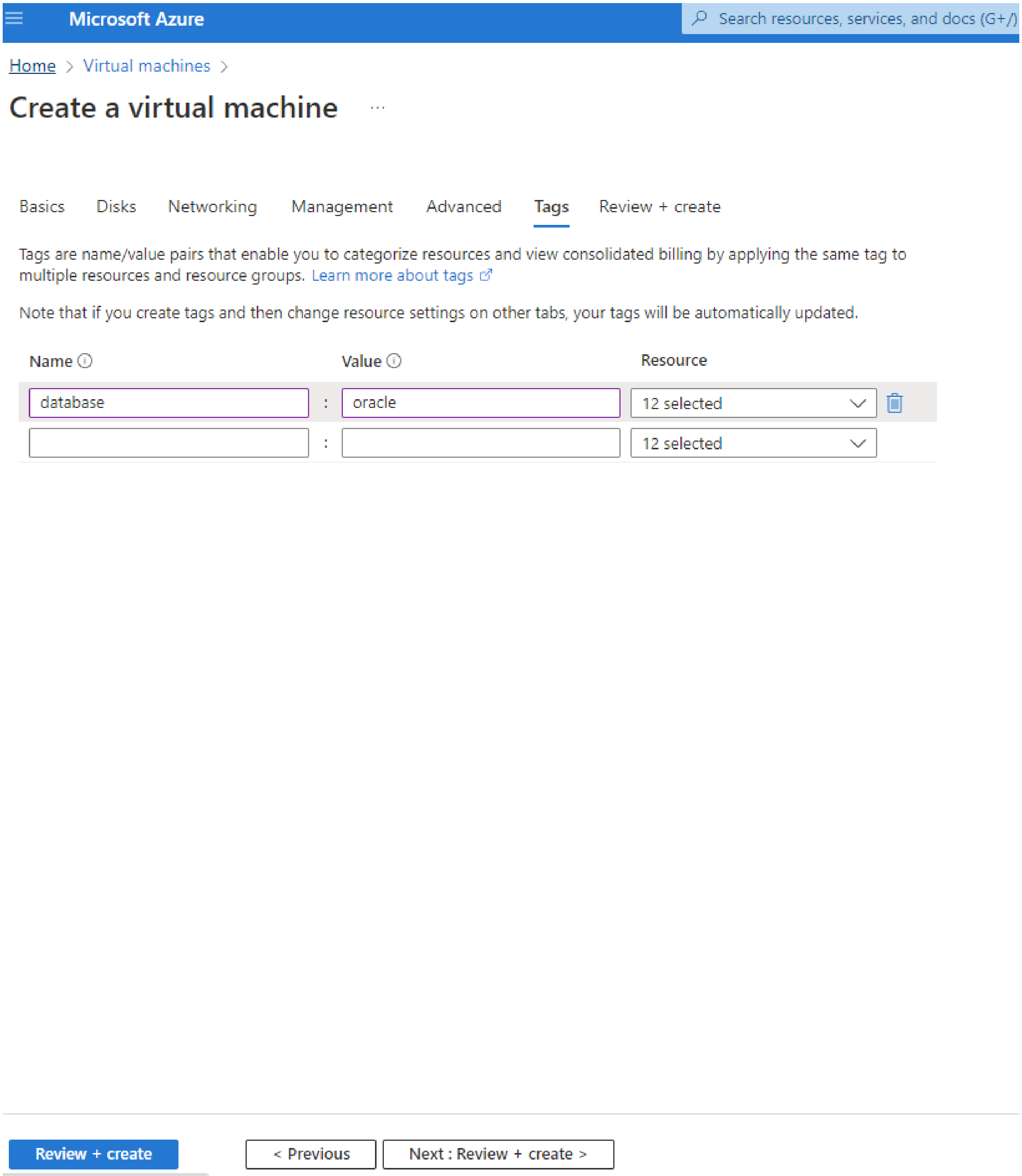
Your image must have a code to support consumption of custom data. If your image supports cloud-init, custom-data will be processed by cloud-init. Learn more about custom data for VMs

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 ☐

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



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.

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

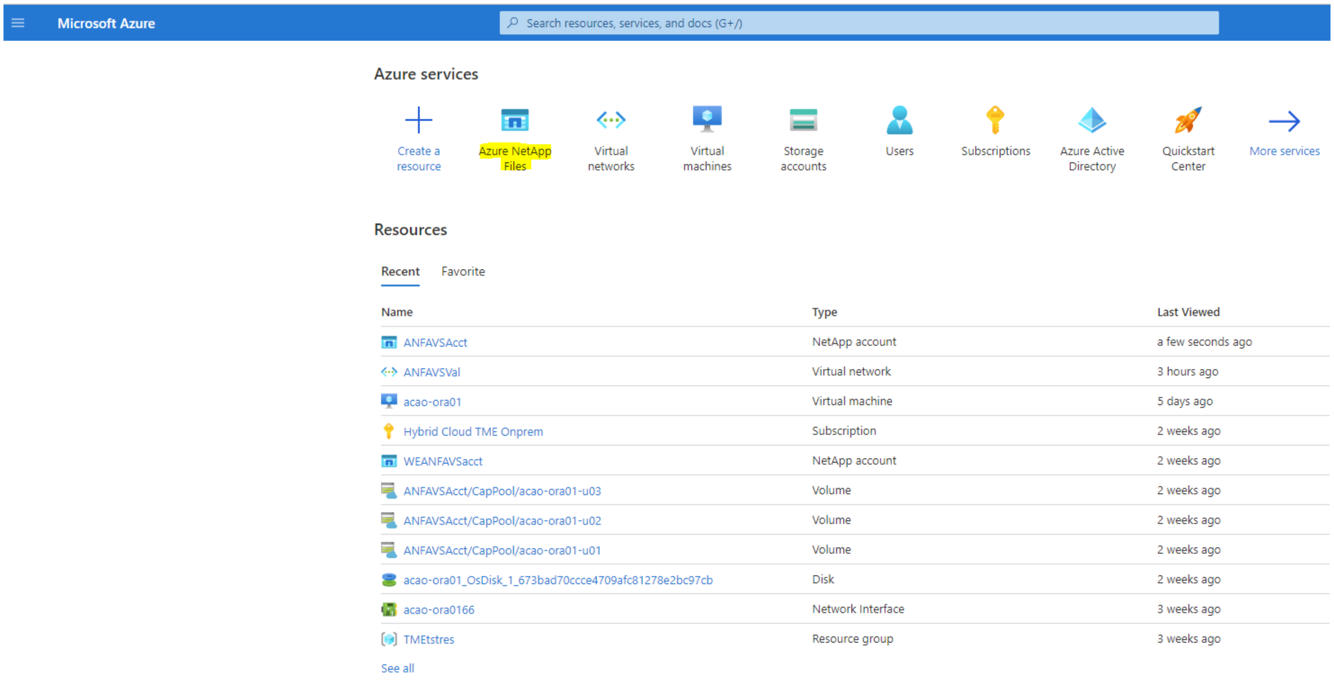
Name	Value	Resource
database	oracle	12 selected
		12 selected

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

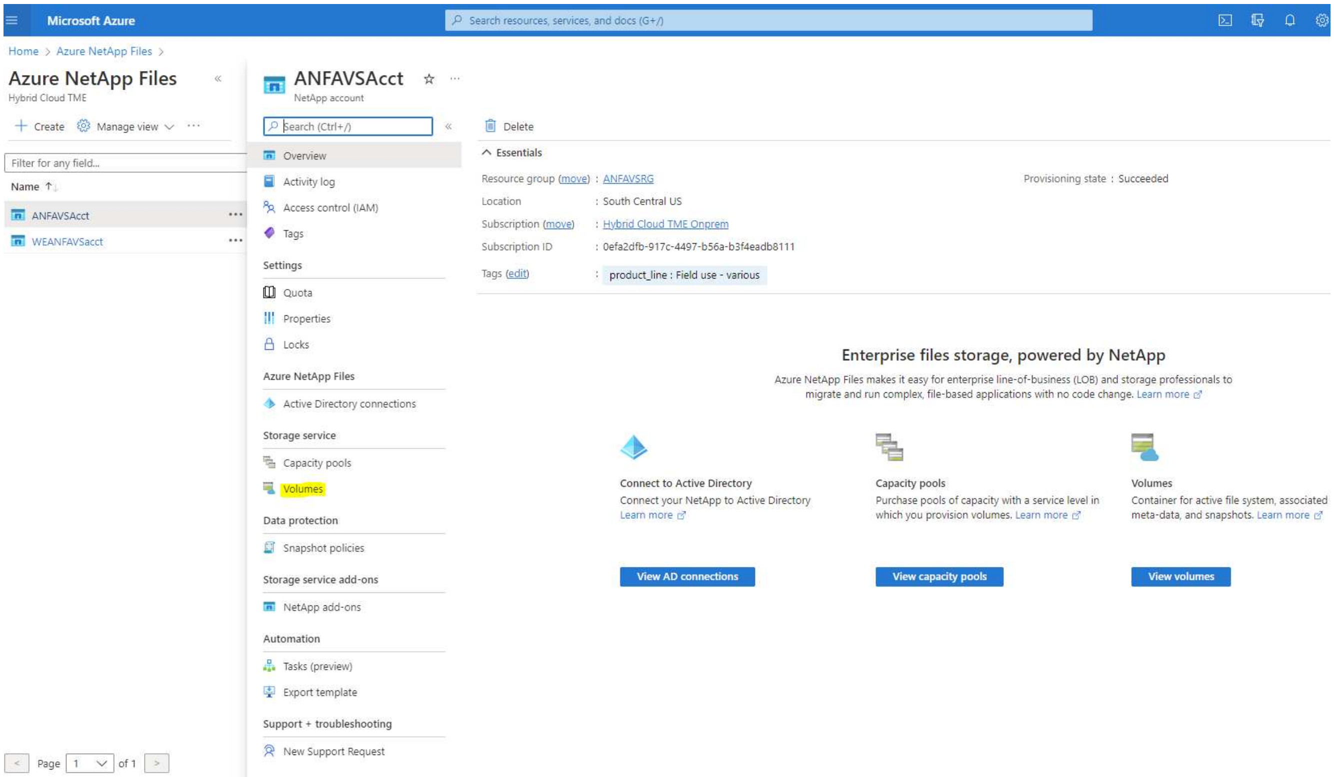
You must create three NFS volumes for an ANF capacity pool for the Oracle binary, data, and log volumes respectively.

1. 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.



Name	Type	Last Viewed
ANFAVSAcct	NetApp account	a few seconds ago
ANFAVSVal	Virtual network	3 hours ago
acao-ora01	Virtual machine	5 days ago
Hybrid Cloud TME Onprem	Subscription	2 weeks ago
WEANFAVSacct	NetApp account	2 weeks ago
ANFAVSAcct/CapPool/acao-ora01-u03	Volume	2 weeks ago
ANFAVSAcct/CapPool/acao-ora01-u02	Volume	2 weeks ago
ANFAVSAcct/CapPool/acao-ora01-u01	Volume	2 weeks ago
acao-ora01_OsDisk_1_673bad70ccce4709afc81278e2bc97cb	Disk	2 weeks ago
acao-ora0166	Network Interface	3 weeks ago
TMEtstres	Resource group	3 weeks ago

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



Resource group (move) : ANFAVSRG

Location : South Central US

Subscription (move) : Hybrid Cloud TME Onprem

Subscription ID : 0efa2dfb-917c-4497-b56a-b3f4eadb8111

Tags (edit) : product_line : Field use - various

Provisioning state : Succeeded

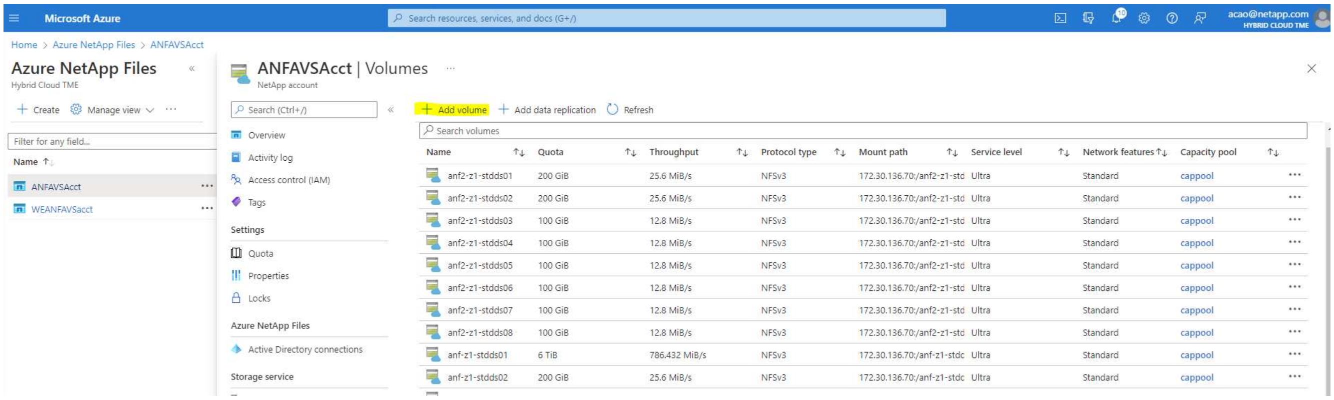
Enterprise files storage, powered by NetApp

Azure NetApp Files makes it easy for enterprise line-of-business (LOB) and storage professionals to migrate and run complex, file-based applications with no code change. Learn more

Connect to Active Directory
Connect your NetApp to Active Directory Learn more

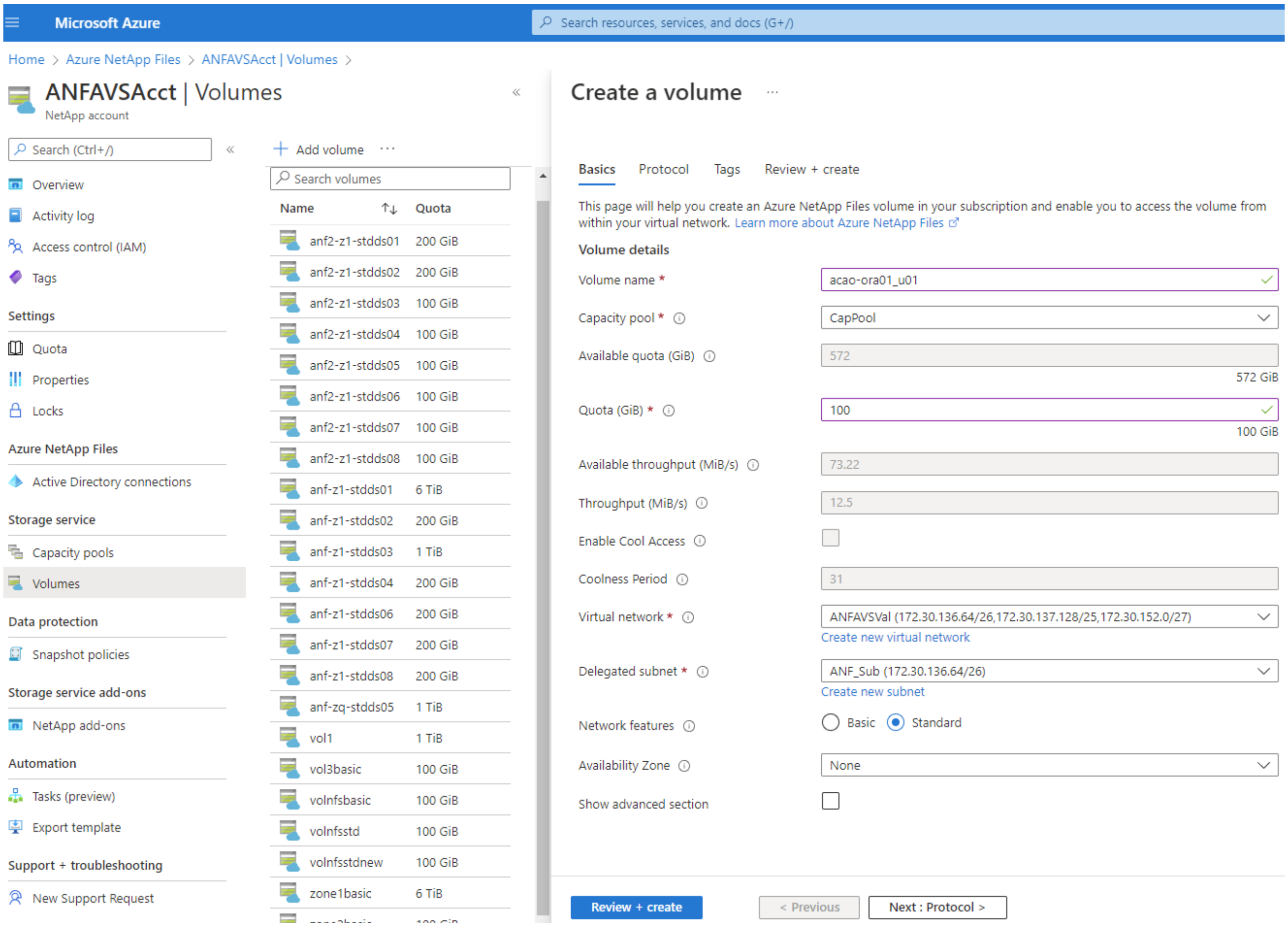
Capacity pools
Purchase pools of capacity with a service level in which you provision volumes. Learn more

Volumes
Container for active file system, associated meta-data, and snapshots. Learn more



Name	Quota	Throughput	Protocol type	Mount path	Service level	Network features	Capacity pool
anf2-z1-stdds01	200 GiB	25.6 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds02	200 GiB	25.6 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds03	100 GiB	12.8 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds04	100 GiB	12.8 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds05	100 GiB	12.8 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds06	100 GiB	12.8 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds07	100 GiB	12.8 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf2-z1-stdds08	100 GiB	12.8 MiB/s	NFSv3	172.30.136.70:/anf2-z1-std	Ultra	Standard	cappool
anf-z1-stdds01	6 TiB	786.432 MiB/s	NFSv3	172.30.136.70:/anf-z1-stdc	Ultra	Standard	cappool
anf-z1-stdds02	200 GiB	25.6 MiB/s	NFSv3	172.30.136.70:/anf-z1-stdc	Ultra	Standard	cappool

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>**.



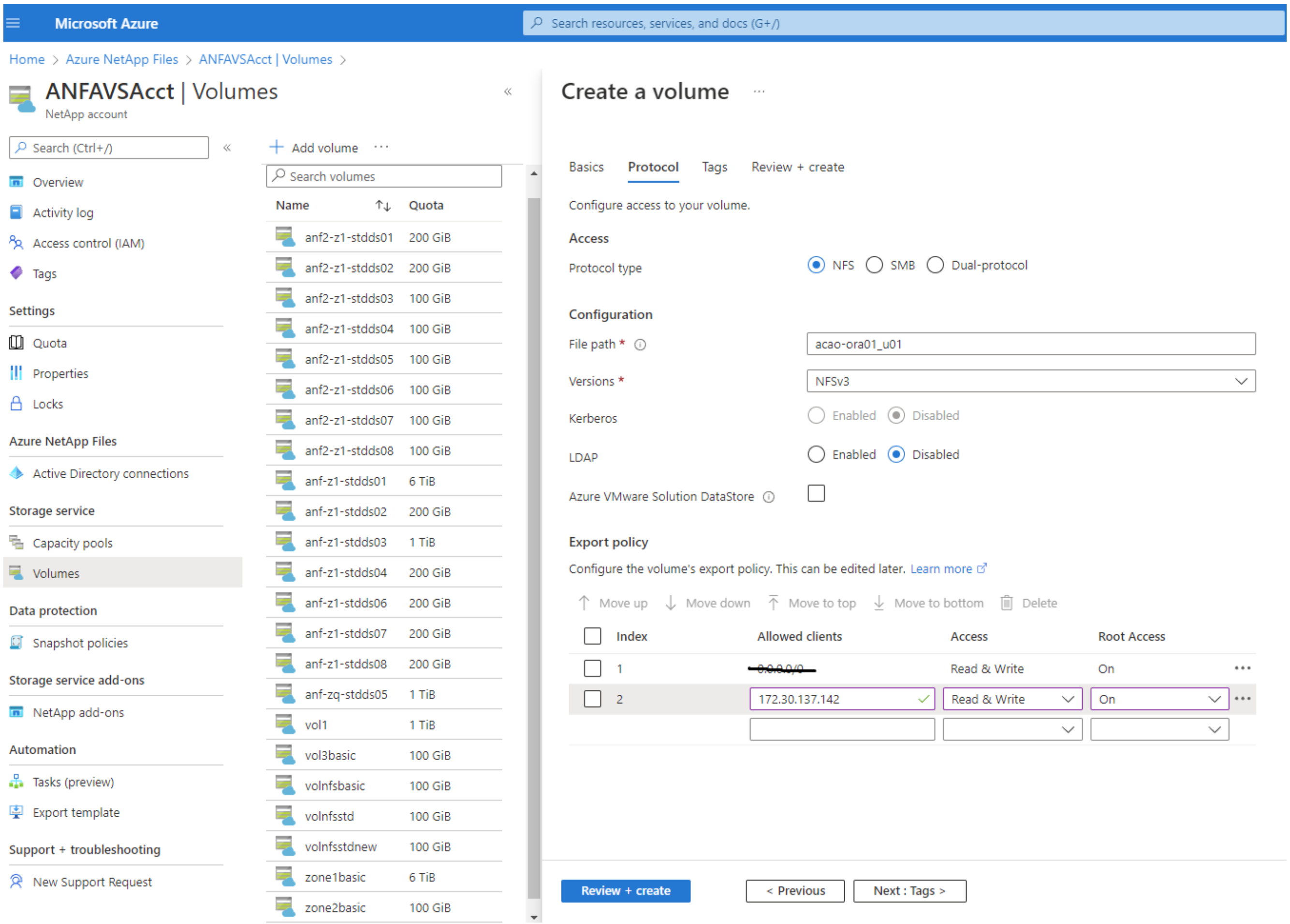
Name	Quota
anf2-z1-stdds01	200 GiB
anf2-z1-stdds02	200 GiB
anf2-z1-stdds03	100 GiB
anf2-z1-stdds04	100 GiB
anf2-z1-stdds05	100 GiB
anf2-z1-stdds06	100 GiB
anf2-z1-stdds07	100 GiB
anf2-z1-stdds08	100 GiB
anf-z1-stdds01	6 TiB
anf-z1-stdds02	200 GiB
anf-z1-stdds03	1 TiB
anf-z1-stdds04	200 GiB
anf-z1-stdds06	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

This page will help you create an Azure NetApp Files volume in your subscription and enable you to access the volume from within your virtual network. Learn more about Azure NetApp Files

Volume details

Volume name * acao-ora01_u01
Capacity pool * CapPool
Available quota (GiB) 572 (572 GiB)
Quota (GiB) * 100 (100 GiB)
Available throughput (MiB/s) 73.22
Throughput (MiB/s) 12.5
Enable Cool Access ☐
Coolness Period 31
Virtual network * ANFAVSVal (172.30.136.64/26,172.30.137.128/25,172.30.152.0/27)
Delegated subnet * ANF_Sub (172.30.136.64/26)
Network features ○ Basic ● Standard
Availability Zone None
Show advanced section ☐

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>**.



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

Configure access to your volume.

Access

Protocol type ● NFS ○ SMB ○ Dual-protocol

Configuration

File path * acao-ora01_u01

Versions * NFSv3

Kerberos ○ Enabled ● Disabled

LDAP ○ Enabled ● Disabled

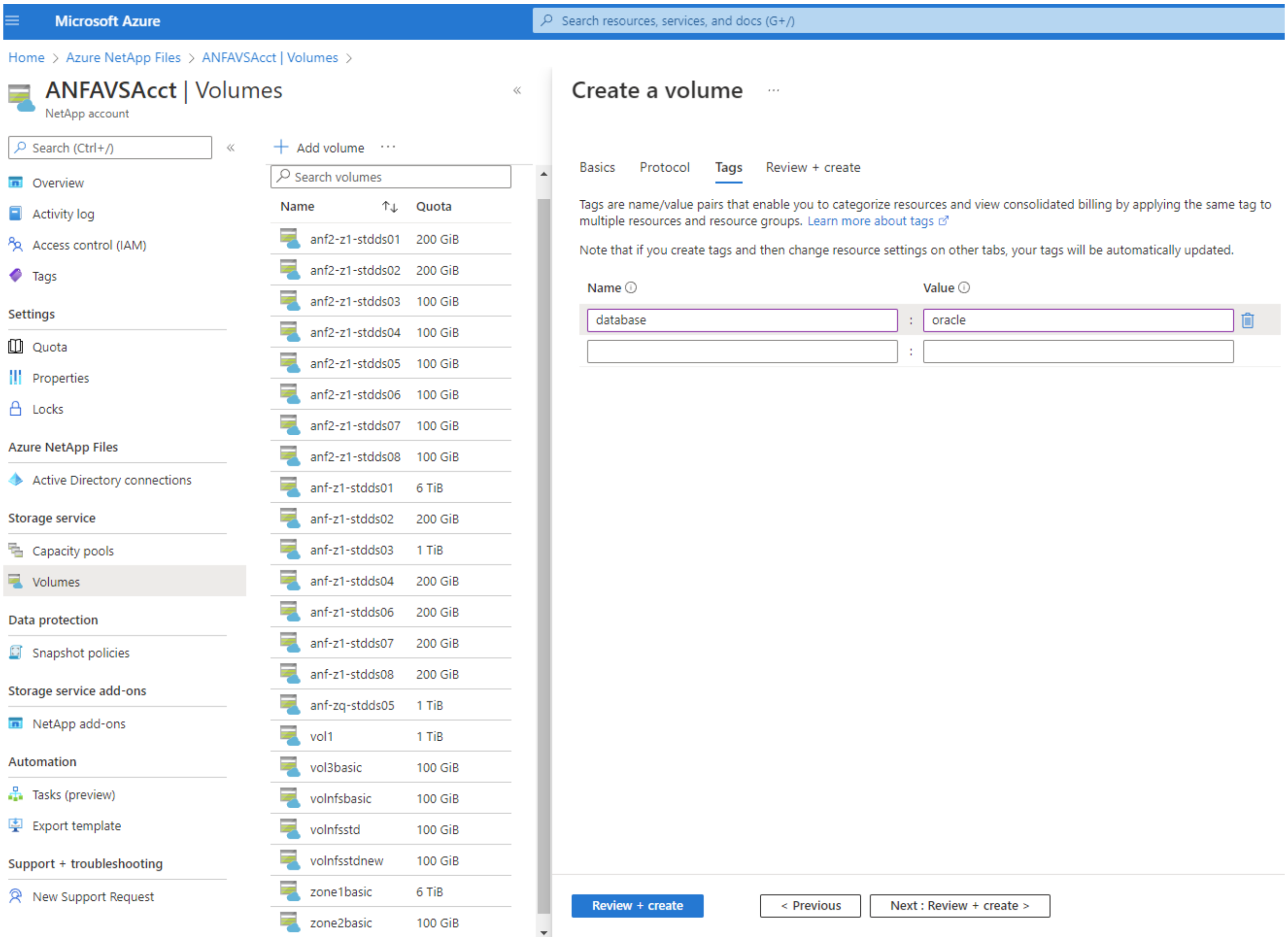
Azure VMware Solution DataStore ☐

Export policy

Configure the volume's export policy. This can be edited later. Learn more

☐	Index	Allowed clients	Access	Root Access
☐	1	~~0.0.0.0/0~~	Read & Write	On
☐	2	172.30.137.142	Read & Write	On

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



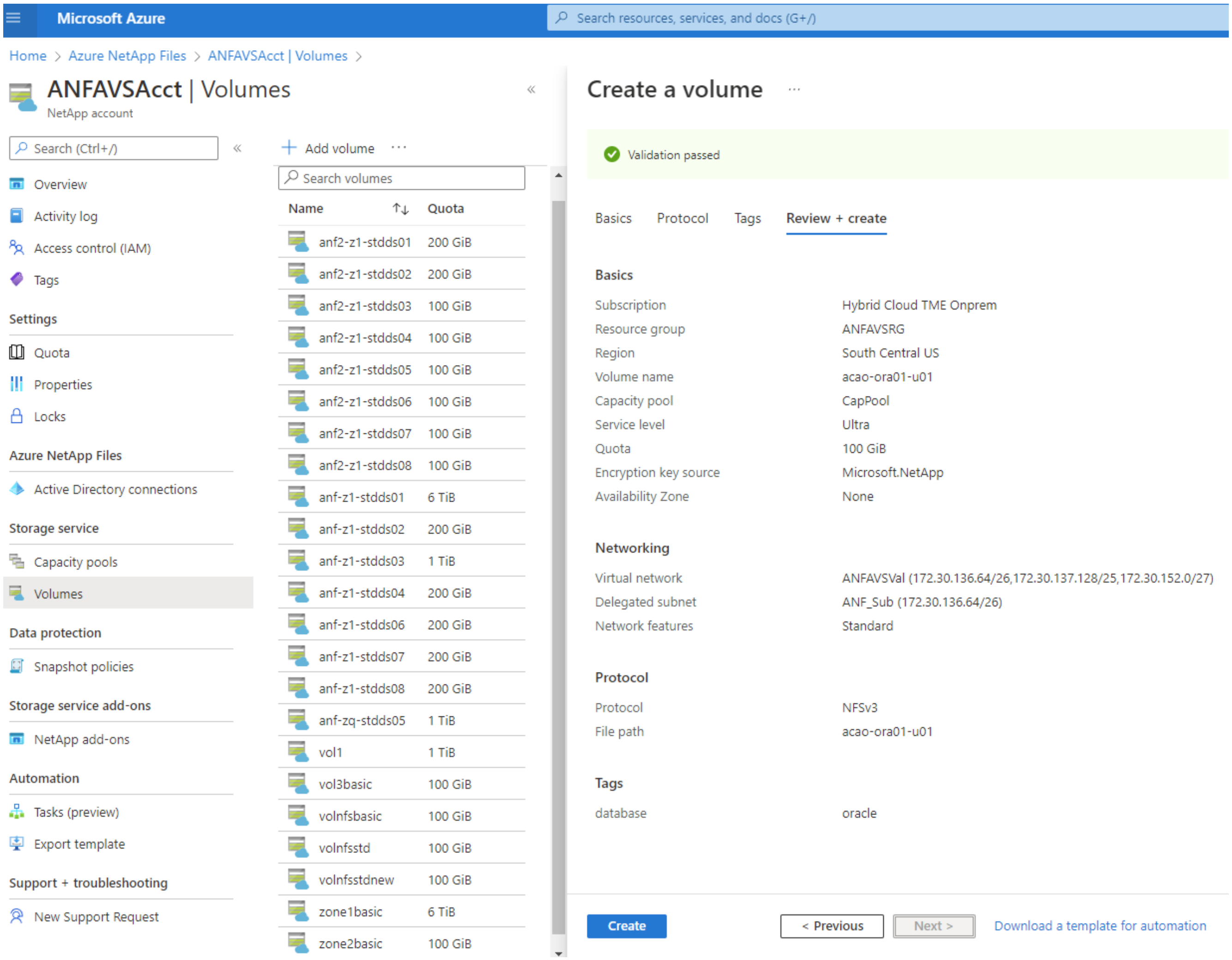
Name	Quota
anf2-z1-stdds01	200 GiB
anf2-z1-stdds02	200 GiB
anf2-z1-stdds03	100 GiB
anf2-z1-stdds04	100 GiB
anf2-z1-stdds05	100 GiB
anf2-z1-stdds06	100 GiB
anf2-z1-stdds07	100 GiB
anf2-z1-stdds08	100 GiB
anf-z1-stdds01	6 TiB
anf-z1-stdds02	200 GiB
anf-z1-stdds03	1 TiB
anf-z1-stdds04	200 GiB
anf-z1-stdds06	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

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
database	oracle

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



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

Basics

Subscription	Hybrid Cloud TME Onprem
Resource group	ANFAVSRG
Region	South Central US
Volume name	acao-ora01-u01
Capacity pool	CapPool
Service level	Ultra
Quota	100 GiB
Encryption key source	Microsoft.NetApp
Availability Zone	None

Networking

Virtual network	ANFAVSVal (172.30.136.64/26,172.30.137.128/25,172.30.152.0/27)
Delegated subnet	ANF_Sub (172.30.136.64/26)
Network features	Standard

Protocol

Protocol	NFSv3
File path	acao-ora01-u01

Tags

database	oracle

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'.
```

4. 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
```

Protect your Oracle database in Azure cloud

Allen Cao, NetApp Solutions Engineering

This section describes how to protect your Oracle database with azacsnap tool and snapshot backup, restore and snapshots tiering to Azure blob.

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
```

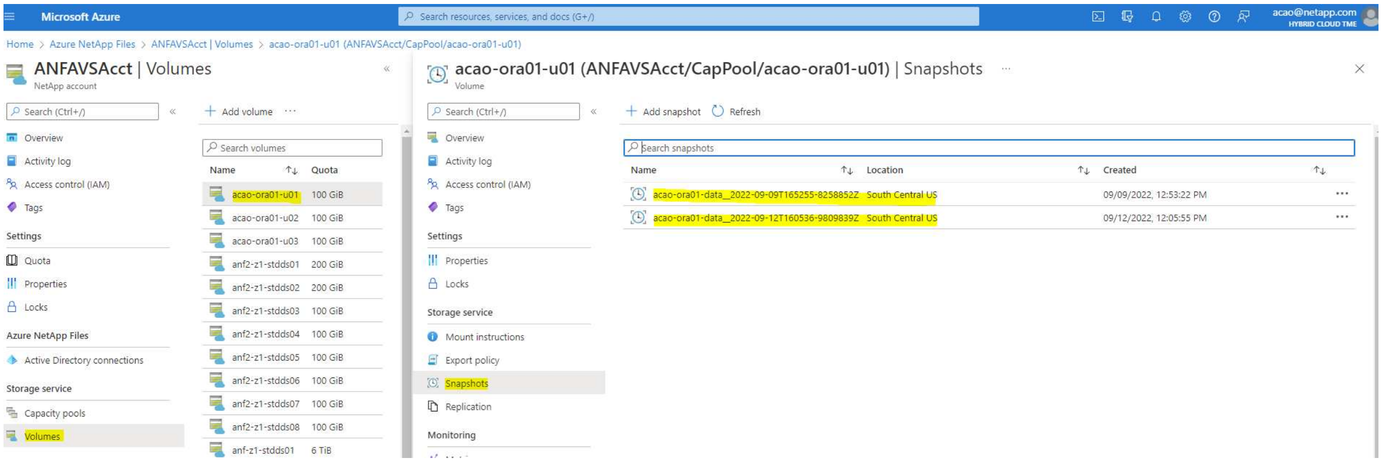
Crontab schedule:

```
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.

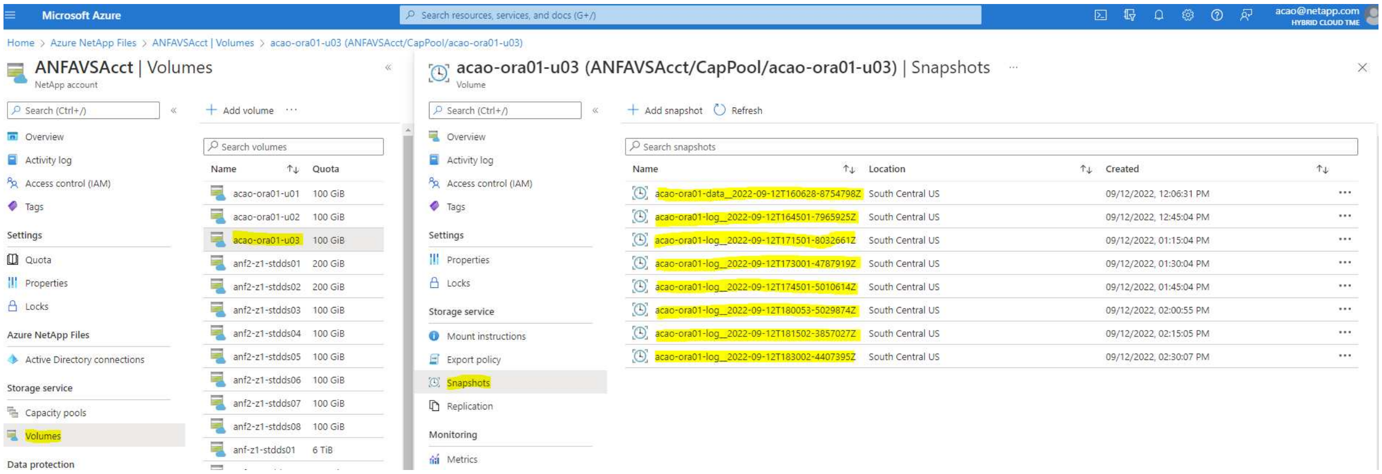
Validate the snapshots

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



Name	Quota
acao-ora01-u01	100 GiB
acao-ora01-u02	100 GiB
acao-ora01-u03	100 GiB
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

Name	Location	Created
acao-ora01-data__2022-09-09T165255-8258852Z	South Central US	09/09/2022, 12:53:22 PM
acao-ora01-data__2022-09-12T160536-9809839Z	South Central US	09/12/2022, 12:05:55 PM



Name	Quota
acao-ora01-u01	100 GiB
acao-ora01-u02	100 GiB
acao-ora01-u03	100 GiB
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

Name	Location	Created
acao-ora01-data__2022-09-12T160628-8754798Z	South Central US	09/12/2022, 12:06:31 PM
acao-ora01-log__2022-09-12T164501-7965925Z	South Central US	09/12/2022, 12:45:04 PM
acao-ora01-log__2022-09-12T171501-8032661Z	South Central US	09/12/2022, 01:15:04 PM
acao-ora01-log__2022-09-12T173001-4787919Z	South Central US	09/12/2022, 01:30:04 PM
acao-ora01-log__2022-09-12T174501-5010614Z	South Central US	09/12/2022, 01:45:04 PM
acao-ora01-log__2022-09-12T180053-5029874Z	South Central US	09/12/2022, 02:00:55 PM
acao-ora01-log__2022-09-12T181502-3857027Z	South Central US	09/12/2022, 02:15:05 PM
acao-ora01-log__2022-09-12T183002-4407395Z	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.

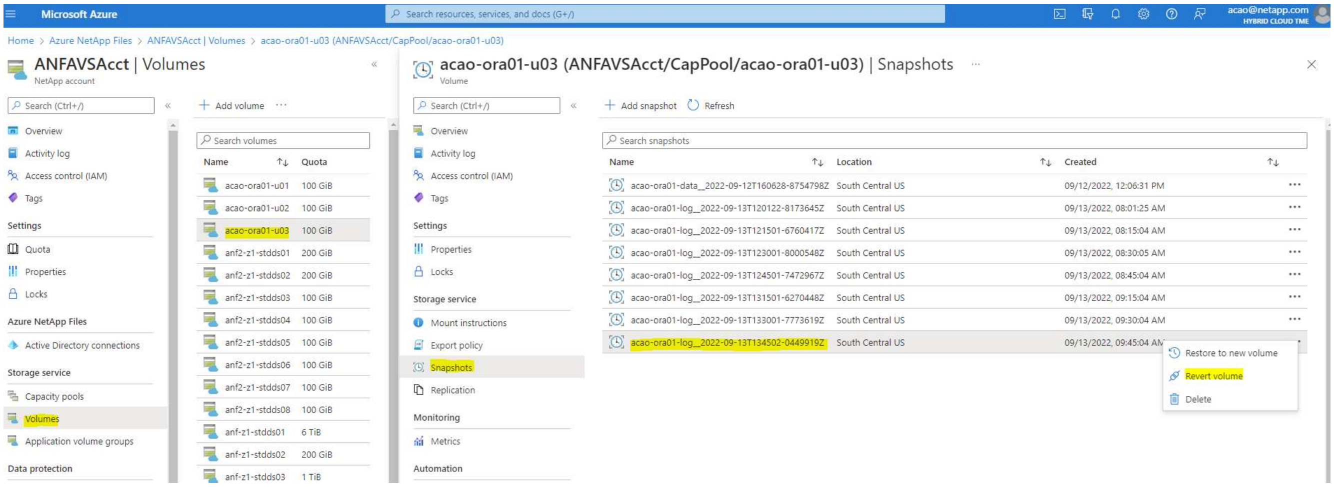
1. Create a test table in the database to be restored.

```
[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
```

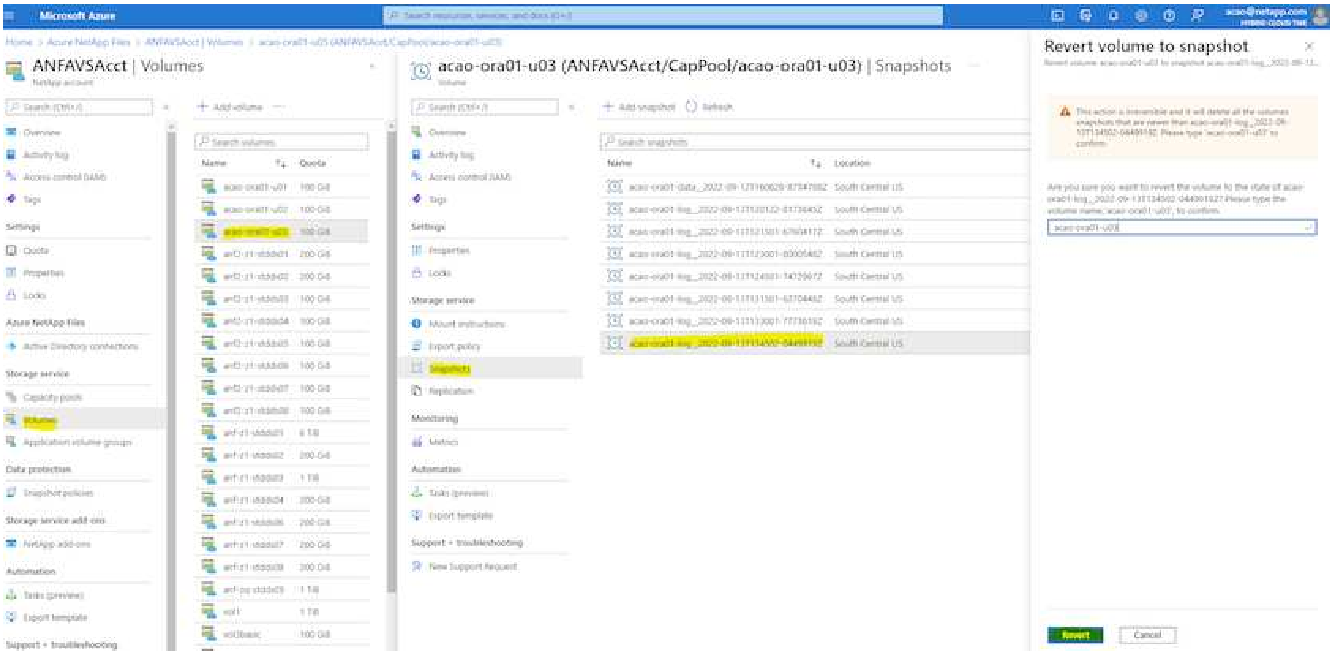
3. From the Azure NetApp Files dashboard, restore the log volume to the last available snapshot. Choose **Revert volume**.



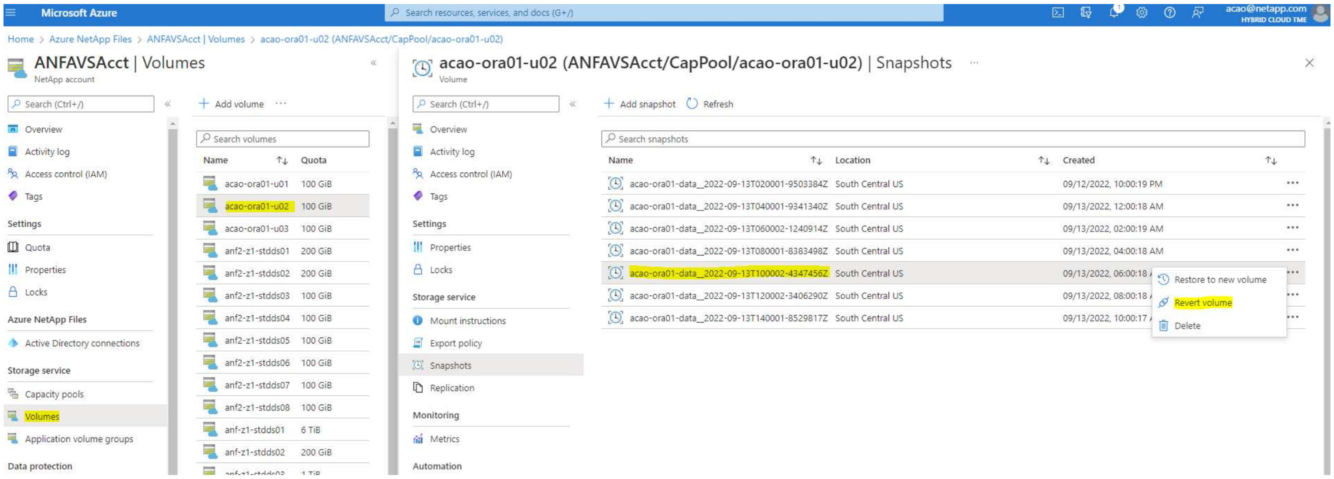
Name	Quota
acao-ora01-u01	100 GiB
acao-ora01-u02	100 GiB
acao-ora01-u03	100 GiB
anf2-z1-stdds01	200 GiB
anf2-z1-stdds02	200 GiB
anf2-z1-stdds03	100 GiB
anf2-z1-stdds04	100 GiB
anf2-z1-stdds05	100 GiB
anf2-z1-stdds06	100 GiB
anf2-z1-stdds07	100 GiB
anf2-z1-stdds08	100 GiB
anf-z1-stdds01	6 TiB
anf-z1-stdds02	200 GiB
anf-z1-stdds03	1 TiB

Name	Location	Created
acao-ora01-data__2022-09-12T160628-8754798Z	South Central US	09/12/2022, 12:06:31 PM
acao-ora01-log__2022-09-13T120122-8173645Z	South Central US	09/13/2022, 08:01:25 AM
acao-ora01-log__2022-09-13T121501-6760417Z	South Central US	09/13/2022, 08:15:04 AM
acao-ora01-log__2022-09-13T123001-8000548Z	South Central US	09/13/2022, 08:30:05 AM
acao-ora01-log__2022-09-13T124501-7472967Z	South Central US	09/13/2022, 08:45:04 AM
acao-ora01-log__2022-09-13T131501-6270448Z	South Central US	09/13/2022, 09:15:04 AM
acao-ora01-log__2022-09-13T133001-7773619Z	South Central US	09/13/2022, 09:30:04 AM
acao-ora01-log__2022-09-13T134502-0449919Z	South Central US	09/13/2022, 09:45:04 AM

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


Microsoft Azure
ANFAVSAcct | Volumes
acao-ora01-u03 (ANFAVSAcct/CapPool/acao-ora01-u03) | Snapshots
Revert volume to snapshot
Revert
Cancel

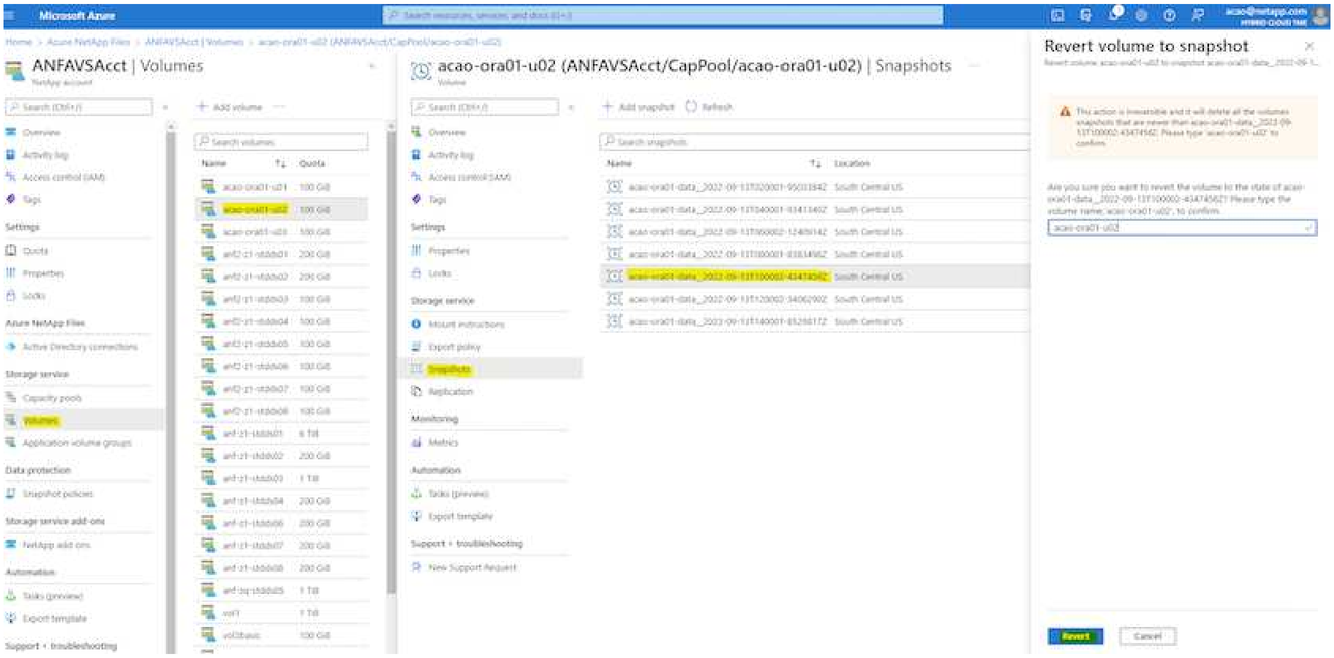
5. Repeat the same steps for the data volume, and make sure that the backup contains the table to be recovered.



Name	Quota
acao-ora01-u01	100 GiB
acao-ora01-u02	100 GiB
acao-ora01-u03	100 GiB
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

Name	Location	Created
acao-ora01-data__2022-09-13T020001-9503384Z	South Central US	09/12/2022, 10:00:19 PM
acao-ora01-data__2022-09-13T040001-9341340Z	South Central US	09/13/2022, 12:00:18 AM
acao-ora01-data__2022-09-13T060002-1240914Z	South Central US	09/13/2022, 02:00:19 AM
acao-ora01-data__2022-09-13T080001-8383498Z	South Central US	09/13/2022, 04:00:18 AM
acao-ora01-data__2022-09-13T100002-4347456Z	South Central US	09/13/2022, 06:00:18
acao-ora01-data__2022-09-13T120002-3406290Z	South Central US	09/13/2022, 08:00:18
acao-ora01-data__2022-09-13T140001-8529817Z	South Central US	09/13/2022, 10:00:17

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


Microsoft Azure
ANFAVSAcct | Volumes
acao-ora01-u02 (ANFAVSAcct/CapPool/acao-ora01-u02) | Snapshots
Revert volume to snapshot
Revert
Cancel

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__29f2lgb5_.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__29f2lgb5_.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.

Database migration from on-premises to Azure cloud

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_in_violations 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 employs PDB hot-clone technology, which allows source PDB availability while the PDB is copying over to the target. At switchover, user connections are redirected to the target PDB automatically. Thus, downtime is minimized independent of the size of the PDB.

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.

On-Premises/Hybrid Cloud

TR-4983: Simplified, Automated Oracle Deployment on NetApp ASA with iSCSI

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for automated Oracle deployment and protection in NetApp ASA array as primary database storage with iSCSI protocol and Oracle database configured in standalone ReStart using asm as volume manager.

Purpose

NetApp ASA systems deliver modern solutions to your SAN infrastructure. They simplify at scale and enable you to accelerate your business-critical applications such as databases, make sure that your data is always available (99.9999% uptime), and reduce TCO and carbon footprint. The NetApp ASA systems include A-Series models designed for the most performance-demanding applications and C-Series models optimized for cost-effective, large-capacity deployments. Together, the ASA A-Series and C-Series systems deliver exceptional performance to improve customer experience and reduce time to results, keep business-critical data available, protected, and secure, and provide more effective capacity for any workload, backed by the industry's most effective guarantee.

This documentation demonstrates the simplified deployment of Oracle databases in a SAN environment built with ASA systems using Ansible automation. The Oracle database is deployed in a standalone ReStart configuration with iSCSI protocol for data access and Oracle ASM for database disks management on the ASA storage array. It also provides information on Oracle database backup, restore, and clone using the NetApp SnapCenter UI tool for storage-efficient database operation in NetApp ASA systems.

This solution addresses the following use cases:

- Automated Oracle database deployment in NetApp ASA systems as primary database storage
- Oracle database backup and restore in NetApp ASA systems using NetApp SnapCenter tool
- Oracle database clone for dev/test or other use cases in NetApp ASA systems using NetApp SnapCenter tool

Audience

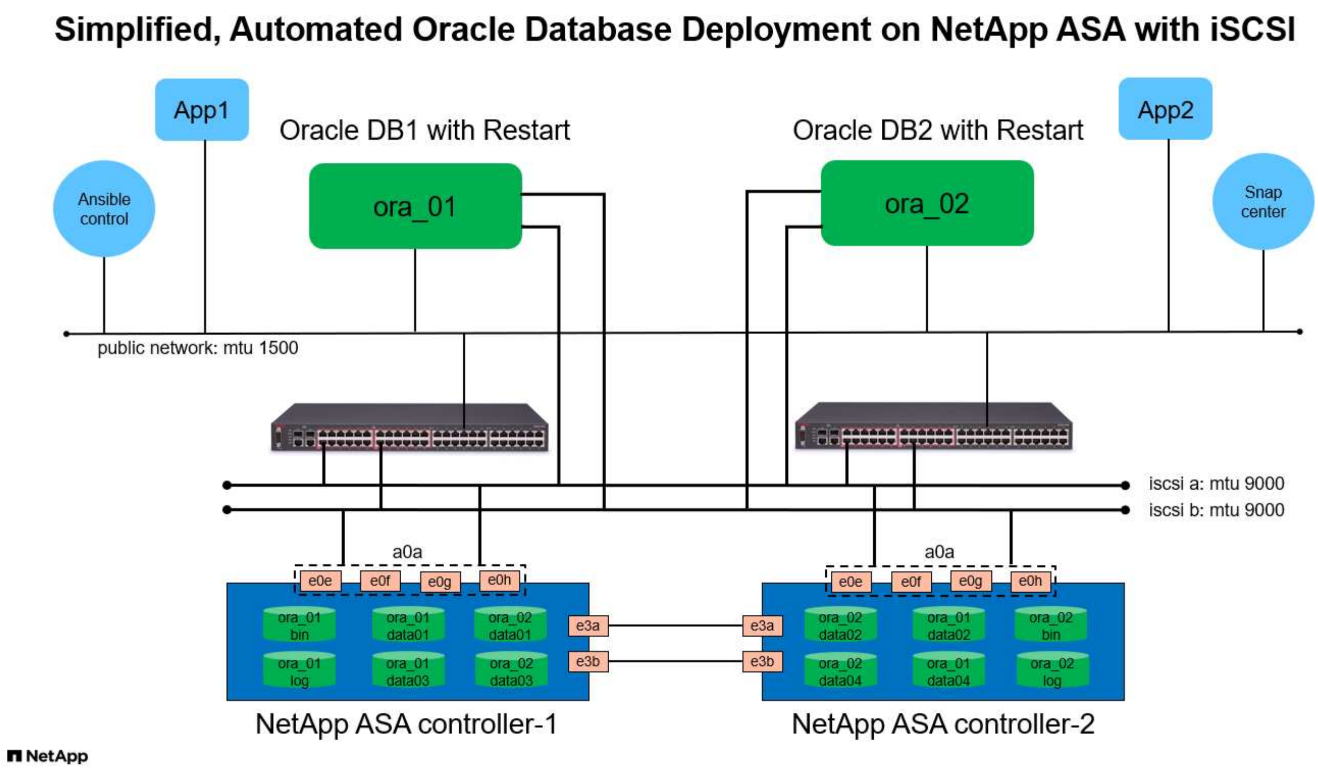
This solution is intended for the following people:

- A DBA who would like to deploy Oracle in NetApp ASA systems.
- A database solution architect who would like to test Oracle workloads in NetApp ASA systems.
- A storage administrator who would like to deploy and manage an Oracle database on NetApp ASA systems.
- An application owner who would like to stand up an Oracle database in NetApp ASA systems.

Solution test and validation environment

The testing and validation of this solution were performed in a lab setting that might not match the final deployment environment. See the section Key factors for deployment consideration for more information.

Architecture



Hardware and software components

Hardware		
NetApp ASA A400	Version 9.13.1P1	2 NS224 shelves, 48 NVMe AFF drives with total 69.3 TiB capacity
UCSB-B200-M4	Intel® Xeon® CPU E5-2690 v4 @ 2.60GHz	4-node VMware ESXi cluster
Software		
RedHat Linux	RHEL-8.6, 4.18.0-372.9.1.el8.x86_64 kernel	Deployed RedHat subscription for testing
Windows Server	2022 Standard, 10.0.20348 Build 20348	Hosting SnapCenter server
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 Server	Version 4.9P1	Workgroup deployment
VMware vSphere Hypervisor	version 6.5.0.20000	VMware Tools, Version: 11365 - Linux, 12352 - Windows

Open JDK	Version java-1.8.0-openjdk.x86_64	SnapCenter plugin requirement on DB VMs

Oracle database configuration in the lab environment

Server	Database	DB Storage
ora_01	NTAP1(NTAP1_PDB1,NTAP1_PDB2,NTAP1_PDB3)	iSCSI luns on ASA A400
ora_02	NTAP2(NTAP2_PDB1,NTAP2_PDB2,NTAP2_PDB3)	iSCSI luns on ASA A400

Key factors for deployment consideration

- **Oracle database storage layout.** In this automated Oracle deployment, we provision four database volumes to host Oracle binary, data, and logs by default. We then create two ASM disk groups from data and logs luns. Within the +DATA asm disk group, we provision two data luns in a volume on each ASA A400 cluster node. Within the +LOGS asm disk group, we create two luns in a log volume on a single ASA A400 node. Multiple luns laid out within an ONTAP volume provides better performance in general.
- **Multiple DB servers deployment.** The automation solution can deploy an Oracle container database to multiple DB servers in a single Ansible playbook run. Regardless of the number of DB servers, the playbook execution remains the same. In the event of multi-DB server deployments, the playbook builds with an algorithm to place database luns on dual controllers of ASA A400 optimally. The binary and logs luns of odd number DB server in server hosts index place on controller 1. The binary and logs luns of even number DB server in the server hosts index place on controller 2. The DB data luns evenly distributed to two controllers. Oracle ASM combines the data luns on two controllers into a single ASM disk group to fully utilize the processing power of both controllers.
- **iSCSI configuration.** The database VMs connect to ASA storage with the iSCSI protocol for storage access. You should configure dual paths on each controller node for redundancy and set up iSCSI multi-path on the DB server for multi-path storage access. Enable jumbo frame on storage network to maximize performance and throughput.
- **Oracle ASM redundancy level to use for each Oracle ASM disk group that you create.** Because the ASA A400 configures storage in RAID DP for data protection at the cluster disk 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 SnapCenter software suite for database backup, restore, and cloning with a user-friendly UI interface. NetApp recommends implementing such a management tool to achieve fast (under a minute) SnapShot backup, quick (minutes) database restore, and database clone.

Solution deployment

The following sections provide step-by-step procedures for automated Oracle 19c deployment and protection in NetApp ASA A400 with directly mounted database luns via iSCSI to DB VM in a single node Restart configuration with Oracle ASM as database volume manager.

Prerequisites for deployment

Deployment requires the following prerequisites.

1. It is assumed that the NetApp ASA storage array has been installed and configured. This includes iSCSI broadcast domain, LACP interface groups a0a on both controller nodes, iSCSI VLAN ports (a0a-<iscsi-a-vlan-id>, a0a-<iscsi-b-vlan-id>) on both controller nodes. The following link provides detailed step-by-step instructions if help is needed. Detailed guide - ASA A400
2. Provision a Linux VM as an Ansible controller node with the latest version of Ansible and Git installed. Refer to the following link for details: Getting Started with NetApp solution automation in section - `Setup the Ansible Control Node for CLI deployments on RHEL / CentOS` or `Setup the Ansible Control Node for CLI deployments on Ubuntu / Debian`.
3. Clone a copy of the NetApp Oracle deployment automation toolkit for iSCSI.

   ```
   git clone https://bitbucket.ngage.netapp.com/scm/ns-
   bb/na_oracle_deploy_iscsi.git
   ```

4. Provision a Windows server to run the NetApp SnapCenter UI tool with the latest version. Refer to the following link for details: Install the SnapCenter Server
5. Build two RHEL Oracle DB servers either bare metal or virtualized VM. Create an admin user on DB servers with sudo without password privilege and enable SSH private/public key authentication between Ansible host and Oracle DB server hosts. Stage following Oracle 19c installation files on DB servers /tmp/archive directory.

   ```
   installer_archives:
     - "LINUX.X64_193000_grid_home.zip"
     - "p34762026_190000_Linux-x86-64.zip"
     - "LINUX.X64_193000_db_home.zip"
     - "p34765931_190000_Linux-x86-64.zip"
     - "p6880880_190000_Linux-x86-64.zip"
   ```

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

6. Watch the following video:

   Simplified and automated Oracle deployment on NetApp ASA with iSCSI

Automation parameter files

Ansible playbook executes database installation and configuration tasks with predefined parameters. For this Oracle automation solution, there are three user-defined parameter files that need user input before playbook execution.

- hosts - define targets that the automation playbook is running against.
- vars/vars.yml - the global variable file that defines variables that apply to all targets.
- host_vars/host_name.yml - the local variable file that defines variables that apply only to a local target. In our use case, these are the Oracle DB servers.

In addition to these user-defined variable files, there are several default variable files that contain default parameters that do not require change unless necessary. The following sections show how the user-defined variable files are configured.

Parameter files configuration

1. Ansible target `hosts` file configuration:

```
# Enter NetApp ASA controller management IP address
[ontap]
172.16.9.32

# Enter Oracle servers names to be deployed one by one, follow by
each Oracle server public IP address, and ssh private key of admin
user for the server.
[oracle]
ora_01 ansible_host=10.61.180.21 ansible_ssh_private_key_file
=ora_01.pem
ora_02 ansible_host=10.61.180.23 ansible_ssh_private_key_file
=ora_02.pem
```

2. Global `vars/vars.yml` file configuration

```
####################################################################
#########################################
######                 Oracle 19c deployment global user
configurable variables                        ######
######                 Consolidate all variables from ONTAP, linux
and oracle                          ######
####################################################################
#########################################

####################################################################
#########################################
######                 ONTAP env specific config variables
######
####################################################################
#########################################

# Enter the supported ONTAP platform: on-prem, aws-fsx.
ontap_platform: on-prem

# Enter ONTAP cluster management user credentials
username: "xxxxxxxx"
password: "xxxxxxxx"


###### on-prem platform specific user defined variables ######

# Enter Oracle SVM iSCSI lif addresses. Each controller configures
```

```
with dual paths iscsi_a, iscsi_b for redundancy
ora_iscsi_lif_mgmt:
  - {name: '{{ svm_name }}_mgmt', address: 172.21.253.220, netmask:
255.255.255.0, vlan_name: ora_mgmt, vlan_id: 3509}

ora_iscsi_lifs_node1:
  - {name: '{{ svm_name }}_lif_1a', address: 172.21.234.221,
netmask: 255.255.255.0, vlan_name: ora_iscsi_a, vlan_id: 3490}
  - {name: '{{ svm_name }}_lif_1b', address: 172.21.235.221,
netmask: 255.255.255.0, vlan_name: ora_iscsi_b, vlan_id: 3491}
ora_iscsi_lifs_node2:
  - {name: '{{ svm_name }}_lif_2a', address: 172.21.234.223,
netmask: 255.255.255.0, vlan_name: ora_iscsi_a, vlan_id: 3490}
  - {name: '{{ svm_name }}_lif_2b', address: 172.21.235.223,
netmask: 255.255.255.0, vlan_name: ora_iscsi_b, vlan_id: 3491}


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

# Enter RHEL subscription to enable repo
redhat_sub_username: xxxxxxxx
redhat_sub_password: "xxxxxxxx"


####################################################################
#########################################
###                   Oracle DB env specific config variables
###
####################################################################
#########################################

# Enter Database domain name
db_domain: solutions.netapp.com

# Enter initial password for all required Oracle passwords. Change
them after installation.
initial_pwd_all: xxxxxxxx
```

3. Local DB server `host_vars/host_name.yml` configuration

```
# User configurable Oracle host specific parameters

# Enter container database SID. By default, a container DB is
created with 3 PDBs within the CDB
oracle_sid: NTAP1

# Enter database shared memory size or SGA. CDB is created with SGA
at 75% of memory_limit, MB. The grand total of SGA should not exceed
75% available RAM on node.
memory_limit: 8192
```

Playbook execution

There are a total of six playbooks in the automation toolkit. Each performs different task blocks and serves different purposes.

```
0-all_playbook.yml - execute playbooks from 1-4 in one playbook run.
1-ansible_requirements.yml - set up Ansible controller with required
libs and collections.
2-linux_config.yml - execute Linux kernel configuration on Oracle DB
servers.
3-ontap_config.yml - configure ONTAP svm/volumes/luns for Oracle
database and grant DB server access to luns.
4-oracle_config.yml - install and configure Oracle on DB servers for
grid infrastructure and create a container database.
5-destroy.yml - optional to undo the environment to dismantle all.
```

There are three options to run the playbooks with the following commands.

1. Execute all deployment playbooks in one combined run.

   ```
   ansible-playbook -i hosts 0-all_playbook.yml -u admin -e
   @vars/vars.yml
   ```

2. Execute playbooks one at a time with the number sequence from 1-4.

   ```
   ansible-playbook -i hosts 1-ansible_requirements.yml -u admin -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 2-linux_config.yml -u admin -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 3-ontap_config.yml -u admin -e
   @vars/vars.yml
   ```

   ```
   ansible-playbook -i hosts 4-oracle_config.yml -u admin -e
   @vars/vars.yml
   ```

3. Execute 0-all_playbook.yml with a tag.

```
ansible-playbook -i hosts 0-all_playbook.yml -u admin -e
@vars/vars.yml -t ansible_requirements
```

```
ansible-playbook -i hosts 0-all_playbook.yml -u admin -e
@vars/vars.yml -t linux_config
```

```
ansible-playbook -i hosts 0-all_playbook.yml -u admin -e
@vars/vars.yml -t ontap_config
```

```
ansible-playbook -i hosts 0-all_playbook.yml -u admin -e
@vars/vars.yml -t oracle_config
```

4. Undo the environment

```
ansible-playbook -i hosts 5-destroy.yml -u admin -e @vars/vars.yml
```

Post execution validation

After the playbook run, login to the Oracle DB server as oracle user to validate that Oracle grid infrastructure and database are created successfully. Following is an example of Oracle database validation on host ora_01.

1. Validate the grid infrastructure and resources created.

```
[oracle@ora_01 ~]$ df -h
Filesystem                      Size  Used Avail Use% Mounted on
devtmpfs                        7.7G   40K  7.7G   1% /dev
tmpfs                           7.8G  1.1G  6.7G  15% /dev/shm
tmpfs                           7.8G  312M  7.5G   4% /run
tmpfs                           7.8G     0  7.8G   0% /sys/fs/cgroup
/dev/mapper/rhel-root            44G   38G  6.8G  85% /
/dev/sda1                      1014M  258M  757M  26% /boot
tmpfs                           1.6G   12K  1.6G   1% /run/user/42
tmpfs                           1.6G  4.0K  1.6G   1% /run/user/1000
/dev/mapper/ora_01_biny_01p1    40G   21G   20G  52% /u01
[oracle@ora_01 ~]$ asm
[oracle@ora_01 ~]$ crsctl stat res -t
--------------------------------------------------------------------
------------
Name           Target  State        Server                   State
details
--------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------
------------
ora.DATA.dg
               ONLINE  ONLINE       ora_01                   STABLE
ora.LISTENER.lsnr
               ONLINE  INTERMEDIATE ora_01                   Not All
Endpoints Re

gistered,STABLE
ora.LOGS.dg
               ONLINE  ONLINE       ora_01                   STABLE
ora.asm
               ONLINE  ONLINE       ora_01
Started,STABLE
ora.ons
               OFFLINE OFFLINE      ora_01                   STABLE
--------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------
```

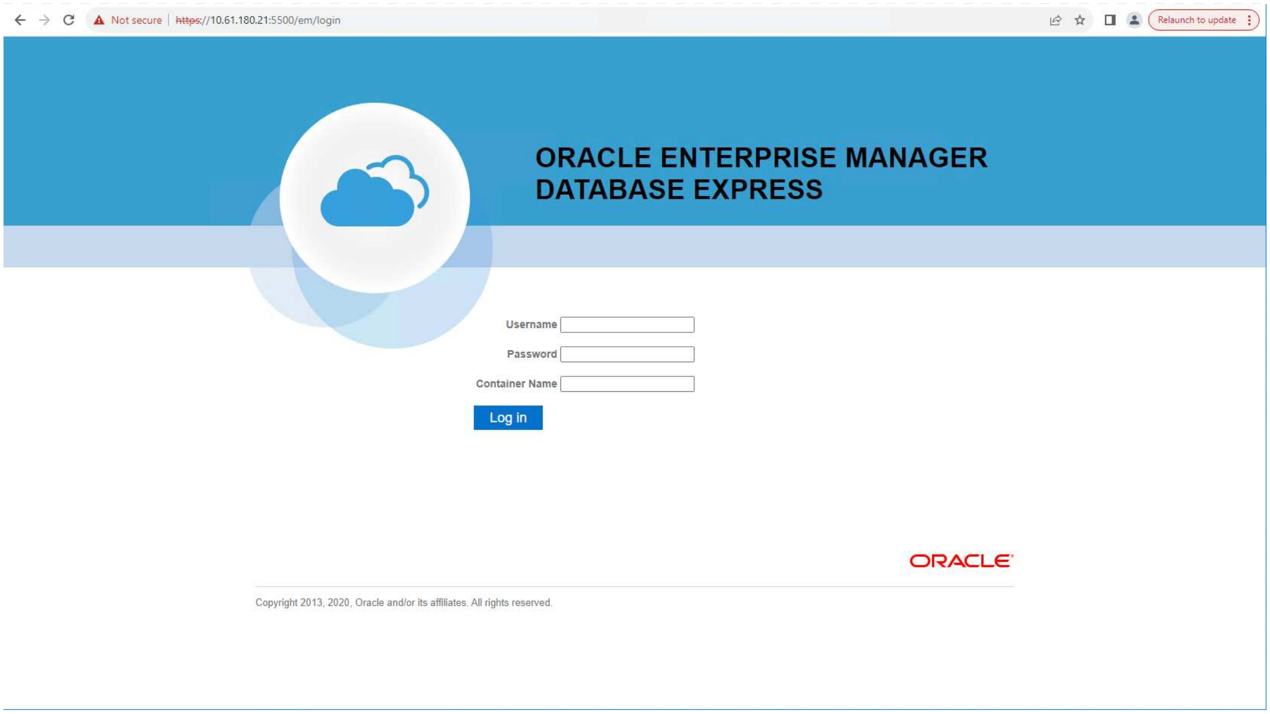
```
------------
ora.cssd
      1        ONLINE  ONLINE       ora_01                   STABLE
ora.diskmon
      1        OFFLINE OFFLINE                               STABLE
ora.driver.afd
      1        ONLINE  ONLINE       ora_01                   STABLE
ora.evmd
      1        ONLINE  ONLINE       ora_01                   STABLE
ora.ntap1.db
      1        ONLINE  ONLINE       ora_01
Open,HOME=/u01/app/o

racle/product/19.0.0

/NTAP1,STABLE
--------------------------------------------------------------------
------------
[oracle@ora_01 ~]$
```

Ignore the `Not All Endpoints Registered` in State details. This results from a conflict of manual and dynamic database registration with the listener and can be safely ignored.

2. Validate ASM filter driver is working as expected.

```
[oracle@ora_01 ~]$ 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  4194304
327680   318644                0          318644              0
N  DATA/
MOUNTED  EXTERN  N         512             512   4096  4194304
81920    78880                0           78880              0
N  LOGS/
ASMCMD> lsdsk
Path
AFD:ORA_01_DAT1_01
AFD:ORA_01_DAT1_03
AFD:ORA_01_DAT1_05
AFD:ORA_01_DAT1_07
AFD:ORA_01_DAT2_02
AFD:ORA_01_DAT2_04
AFD:ORA_01_DAT2_06
AFD:ORA_01_DAT2_08
AFD:ORA_01_LOGS_01
AFD:ORA_01_LOGS_02
ASMCMD> afd_state
ASMCMD-9526: The AFD state is 'LOADED' and filtering is 'ENABLED' on
host 'ora_01'
ASMCMD>
```

3. Login to Oracle Enterprise Manager Express to validate database.



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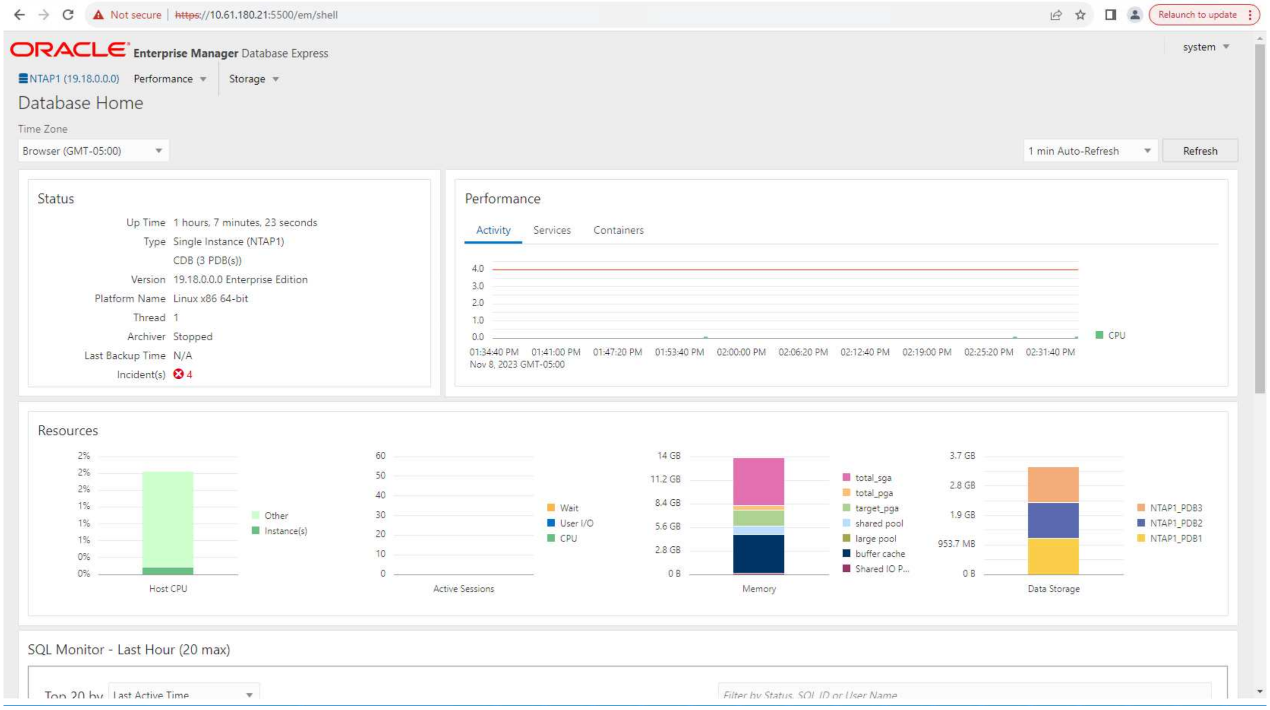
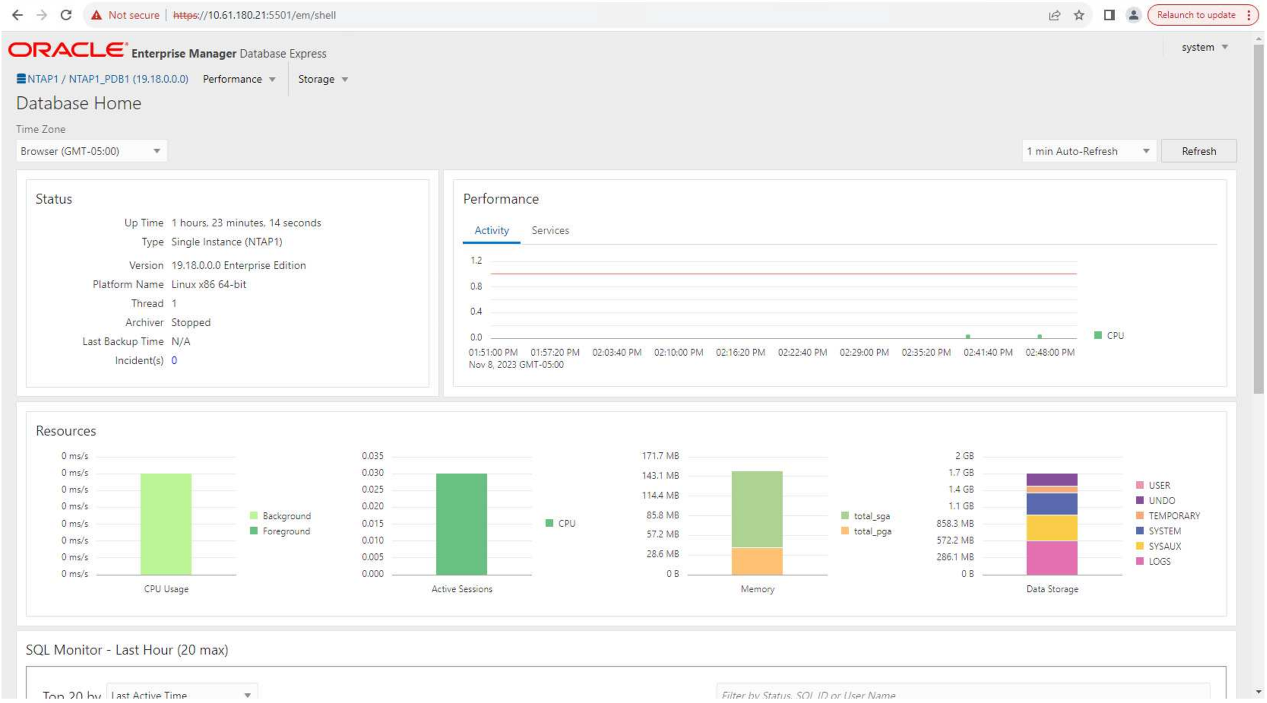


Status

Up Time 1 hours, 7 minutes, 23 seconds
Type Single Instance (NTAP1)
CDB (3 PDB(s))
Version 19.18.0.0.0 Enterprise Edition
Platform Name Linux x86 64-bit
Thread 1
Archiver Stopped
Last Backup Time N/A
Incident(s) ⊗ 4

```
Enable additional port from sqlplus for login to individual
container database or PDBs.

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP1_PDB1                     READ WRITE NO
         4 NTAP1_PDB2                     READ WRITE NO
         5 NTAP1_PDB3                     READ WRITE NO
SQL> alter session set container=NTAP1_PDB1;

Session altered.

SQL> select dbms_xdb_config.gethttpsport() from dual;

DBMS_XDB_CONFIG.GETHTTPSPORT()
------------------------------
                             0

SQL> exec DBMS_XDB_CONFIG.SETHTTPSPORT(5501);

PL/SQL procedure successfully completed.

SQL> select dbms_xdb_config.gethttpsport() from dual;

DBMS_XDB_CONFIG.GETHTTPSPORT()
------------------------------
                          5501

login to NTAP1_PDB1 from port 5501.
```



Up Time 1 hours, 23 minutes, 14 seconds
Type Single Instance (NTAP1)
Version 19.18.0.0.0 Enterprise Edition
Platform Name Linux x86 64-bit
Thread 1
Archiver Stopped
Last Backup Time N/A
Incident(s) 0

Oracle backup, restore, and clone with SnapCenter

Refer to TR-4979 Simplified, self-managed Oracle in VMware Cloud on AWS with guest-mounted FSx ONTAP section `Oracle backup, restore, and clone with SnapCenter` for details on setting up SnapCenter and executing the database backup, restore, and clone workflows.

Where to find additional information

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

- NETAPP ASA: ALL-FLASH SAN ARRAY

  https://www.netapp.com/data-storage/all-flash-san-storage-array/

- 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

- Use Red Hat Enterprise Linux 8.2 with ONTAP

  https://docs.netapp.com/us-en/ontap-sanhost/hu_rhel_82.html#all-san-array-configurations

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

Solution Overview

This page describes the Automated method for deploying Oracle19c on NetApp ONTAP storage.

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

AWX Deployment

Part 2: Variables and Running the Playbook

AWX Playbook Run

CLI Deployment

Part 1: Getting Started, Requirements, Automation Details and Ansible Control Host Setup

CLI Deployment

Part 2: Variables and Running the Playbook

CLI Playbook Run

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 is 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
ontap_config	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
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

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After you are ready, click here for detailed AWX/Tower deployment procedures or here for CLI deployment.

Step-by-step deployment procedure

This page describes the Automated method for deploying Oracle19c on NetApp ONTAP storage.

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
```

a. Paste the following content into Injector Configuration:

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

1. 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

```
######################################################################
##############      Host Variables Configuration        ##############
######################################################################

# Add your Oracle Host
ansible_host: "10.61.180.15"

# Oracle db log archive mode: true - ARCHIVELOG or false - NOARCHIVELOG
log_archive_mode: "true"

# 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: "cdb2"
pdb_num: "3"
pdb_name: "{{ oracle_sid }}_pdb"

# CDB listener port, use different listener port for additional CDB on
same host
listener_port: "1523"

# 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: "5464"

# 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: "DBEXPRESS"
em_express_port: "5501"

# {{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: "{{groups.oracle[0]}}_u01", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u02", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u03", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
```

a. Fill in all variables in the blue fields.

b. After completing variables input, click the Copy button on the form to copy all variables to be transferred to AWX or Tower.

c. Navigate back to AWX or Tower and go to Resources → Hosts, and select and open the Oracle server configuration page.

d. Under the Details tab, click edit and paste the copied variables from step 1 to the Variables field under the YAML tab.

e. Click Save.

f. 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.

```
#######################################################################
###### 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: "ontap"

#CA_signed_certificates (ONLY CHANGE to 'true' IF YOU ARE USING CA SIGNED
CERTIFICATES)
ca_signed_certs: "false"

#Names of the Nodes in the ONTAP Cluster
nodes:
 - "AFF-01"
 - "AFF-02"

#Storage VLANs
#Add additional rows for vlans as necessary
storage_vlans:
   - {vlan_id: "203", name: "infra_NFS", protocol: "NFS"}
More Storage VLANsEnter Storage VLANs details

#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: "aggr01_node01"}
  - {aggr_name: "aggr01_node02"}

#SVM name
svm_name: "ora_svm"

# SVM Management LIF Details
svm_mgmt_details:
  - {address: "172.21.91.100", netmask: "255.255.255.0", home_port: "e0M"}

# 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: "{{groups.oracle[0]}}_u01", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u02", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u03", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}

#NFS LIFs IP address and netmask

nfs_lifs_details:
  - address: "172.21.94.200" #for node-1
    netmask: "255.255.255.0"
  - address: "172.21.94.201" #for node-2
    netmask: "255.255.255.0"

#NFS client match

client_match: "172.21.94.0/24"

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

#NFS Mount points for Oracle DB volumes

mount_points:
  - "/u01"
  - "/u02"
  - "/u03"

# 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: "1234"

# RedHat subscription username and password

redhat_sub_username: "xxx"
redhat_sub_password: "xxx"

####################################################
```

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

db_domain: "your.domain.com"

# Set initial password for all required Oracle passwords. Change them
after installation.

initial_pwd_all: "netapp123"
```

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.

a. Click Next and then Launch to start the job.
b. Click View → Jobs to monitor the job output and progress.
c. 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.
d. Click Next and then Launch to start the job.
e. Click View → Jobs to monitor the job output and progress
f. After the ontap_config role has completed, run the process again for linux_config.
g. Navigate to Resources → Templates.

h. Select the desired template and then click Launch.
i. 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.
j. Click Next and then Launch to start the job.
k. Select View → Jobs to monitor the job output and progress.
l. After the linux_config role has completed, run the process again for oracle_config.
m. Go to Resources → Templates.
n. Select the desired template and then click Launch.
o. 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.
p. Click Next and then Launch to start the job.
q. 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.
3. 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

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

```
[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>

SQL> select name, log_mode from v$database;
NAME      LOG_MODE
--------- ------------
CDB2      ARCHIVELOG

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.

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

```
[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

This document details the deployment of Oracle 19c using the automation command line interface (cli).

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

[ontap]

"10.61.184.183"

#Oracle hosts

[oracle]

"rtpora01"

"rtpora02"
```

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

```
######################################################################
##############      Host Variables Configuration        ##############
######################################################################

# Add your Oracle Host
```

```
ansible_host: "10.61.180.15"

# Oracle db log archive mode: true - ARCHIVELOG or false - NOARCHIVELOG
log_archive_mode: "true"

# 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: "cdb2"
pdb_num: "3"
pdb_name: "{{ oracle_sid }}_pdb"

# CDB listener port, use different listener port for additional CDB on
same host
listener_port: "1523"

# 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: "5464"

# 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: "DBEXPRESS"
em_express_port: "5501"

# {{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: "{{groups.oracle[0]}}_u01", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u02", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u03", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
```

Edit the vars.yml file

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

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

```
#######################################################################
###### 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: "ontap"

#CA_signed_certificates (ONLY CHANGE to 'true' IF YOU ARE USING CA SIGNED
CERTIFICATES)
ca_signed_certs: "false"

#Names of the Nodes in the ONTAP Cluster
nodes:
 - "AFF-01"
 - "AFF-02"

#Storage VLANs
#Add additional rows for vlans as necessary
storage_vlans:
   - {vlan_id: "203", name: "infra_NFS", protocol: "NFS"}
More Storage VLANsEnter Storage VLANs details

#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: "aggr01_node01"}
  - {aggr_name: "aggr01_node02"}

#SVM name
```

```
svm_name: "ora_svm"

# SVM Management LIF Details
svm_mgmt_details:
  - {address: "172.21.91.100", netmask: "255.255.255.0", home_port: "e0M"}

# 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: "{{groups.oracle[0]}}_u01", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u02", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}
  - {vol_name: "{{groups.oracle[0]}}_u03", aggr_name: "aggr01_node01",
lif: "172.21.94.200", size: "25"}

#NFS LIFs IP address and netmask

nfs_lifs_details:
  - address: "172.21.94.200" #for node-1
    netmask: "255.255.255.0"
  - address: "172.21.94.201" #for node-2
    netmask: "255.255.255.0"

#NFS client match

client_match: "172.21.94.0/24"

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

#NFS Mount points for Oracle DB volumes

mount_points:
  - "/u01"
  - "/u02"
  - "/u03"

# 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: "1234"

# RedHat subscription username and password

redhat_sub_username: "xxx"
redhat_sub_password: "xxx"

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

db_domain: "your.domain.com"

# Set initial password for all required Oracle passwords. Change them
after installation.

initial_pwd_all: "netapp123"
```

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.

```
[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>

SQL> select name, log_mode from v$database;
NAME      LOG_MODE
--------- ------------
CDB2      ARCHIVELOG

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 hte Oracle listener configuration with the following command. Change to the appropriate listener port and database service name.

```
[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.

Solution Overview

This page describes the Automated method for deploying Oracle19c on NetApp ONTAP storage.

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

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.

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After you are ready, click here for detailed AWX/Tower procedures.

Step-by-step deployment procedure

This page describes the Automated Data Protection of Oracle19c on NetApp ONTAP storage.

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 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
    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 CVO Clusters, Cloud Central/Manager, AWS Access/Secret Key and Cloud Central Refresh Token.
    e. Click Save
4. Create Credential for Oracle (Source)
    a. Navigate to Resources → Credentials, and click Add.
    b. Enter the name and organization details for Oracle host
    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
5. Create Credential for Oracle Destination
    a. Navigate to Resources → Credentials, and click Add.
    b. Enter the name and organization details for the DR Oracle host
    c. Select the Machine credential type.
    d. Under Type Details, enter the Username (ec2-user or if you have changed it from default enter that), and the SSH Private Key
    e. Select the correct Privilege Escalation Method (sudo), and enter the username and password if needed.
    f. Click Save

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_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

```
# Oracle Data Protection global user configuration variables
# Ontap env specific config variables
hosts_group: "ontap"
ca_signed_certs: "false"

# Inter-cluster LIF details
src_nodes:
  - "AFF-01"
  - "AFF-02"

dst_nodes:
  - "DR-AFF-01"
  - "DR-AFF-02"

create_source_intercluster_lifs: "yes"

source_intercluster_network_port_details:
  using_dedicated_ports: "yes"
  using_ifgrp: "yes"
  using_vlans: "yes"
  failover_for_shared_individual_ports: "yes"
  ifgrp_name: "a0a"
  vlan_id: "10"
  ports:
    - "e0b"
    - "e0g"
  broadcast_domain: "NFS"
  ipspace: "Default"
  failover_group_name: "iclifs"

source_intercluster_lif_details:
  - name: "icl_1"
    address: "10.0.0.1"
    netmask: "255.255.255.0"
    home_port: "a0a-10"
    node: "AFF-01"
  - name: "icl_2"
    address: "10.0.0.2"
    netmask: "255.255.255.0"
    home_port: "a0a-10"
    node: "AFF-02"

create_destination_intercluster_lifs: "yes"
```

```
destination_intercluster_network_port_details:
  using_dedicated_ports: "yes"
  using_ifgrp: "yes"
  using_vlans: "yes"
  failover_for_shared_individual_ports: "yes"
  ifgrp_name: "a0a"
  vlan_id: "10"
  ports:
    - "e0b"
    - "e0g"
  broadcast_domain: "NFS"
  ipspace: "Default"
  failover_group_name: "iclifs"

destination_intercluster_lif_details:
  - name: "icl_1"
    address: "10.0.0.3"
    netmask: "255.255.255.0"
    home_port: "a0a-10"
    node: "DR-AFF-01"
  - name: "icl_2"
    address: "10.0.0.4"
    netmask: "255.255.255.0"
    home_port: "a0a-10"
    node: "DR-AFF-02"

# Variables for SnapMirror Peering
passphrase: "your-passphrase"

# Source & Destination List
dst_cluster_name: "dst-cluster-name"
dst_cluster_ip: "dst-cluster-ip"
dst_vserver: "dst-vserver"
dst_nfs_lif: "dst-nfs-lif"
src_cluster_name: "src-cluster-name"
src_cluster_ip: "src-cluster-ip"
src_vserver: "src-vserver"

# Variable for Oracle Volumes and SnapMirror Details
cg_snapshot_name_prefix: "oracle"
src_orabinary_vols:
  - "binary_vol"
src_db_vols:
  - "db_vol"
src_archivelog_vols:
  - "log_vol"
```

```
snapmirror_policy: "async_policy_oracle"

# Export Policy Details
export_policy_details:
  name: "nfs_export_policy"
  client_match: "0.0.0.0/0"
  ro_rule: "sys"
  rw_rule: "sys"

# Linux env specific config variables
mount_points:
  - "/u01"
  - "/u02"
  - "/u03"
hugepages_nr: "1234"
redhat_sub_username: "xxx"
redhat_sub_password: "xxx"

# DB env specific install and config variables
recovery_type: "scn"
control_files:
  - "/u02/oradata/CDB2/control01.ctl"
  - "/u03/orareco/CDB2/control02.ctl"
```

CVO

```
###########################################
### 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: "ontap"

#CA_signed_certificates (ONLY CHANGE to "true" IF YOU ARE USING CA
SIGNED CERTIFICATES)
ca_signed_certs: "false"

#Names of the Nodes in the Source ONTAP Cluster
src_nodes:
  - "AFF-01"
  - "AFF-02"

#Names of the Nodes in the Destination CVO Cluster
```

```
dst_nodes:
  - "DR-AFF-01"
  - "DR-AFF-02"

#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: "yes"

source_intercluster_network_port_details:
  using_dedicated_ports: "yes"
  using_ifgrp: "yes"
  using_vlans: "yes"
  failover_for_shared_individual_ports: "yes"
  ifgrp_name: "a0a"
  vlan_id: "10"
  ports:
    - "e0b"
    - "e0g"
  broadcast_domain: "NFS"
  ipspace: "Default"
  failover_group_name: "iclifs"

source_intercluster_lif_details:
  - name: "icl_1"
    address: "10.0.0.1"
    netmask: "255.255.255.0"
    home_port: "a0a-10"
    node: "AFF-01"
  - name: "icl_2"
    address: "10.0.0.2"
    netmask: "255.255.255.0"
    home_port: "a0a-10"
    node: "AFF-02"

############################################
### CVO Deployment Variables ###
############################################

####### Access Keys Variables ######

# Region where your CVO will be deployed.
region_deploy: "us-east-1"

########### CVO and Connector Vars ########

# AWS Managed Policy required to give permission for IAM role creation.
```

```
aws_policy: "arn:aws:iam::1234567:policy/OCCM"

# Specify your aws role name, a new role is created if one already does
not exist.
aws_role_name: "arn:aws:iam::1234567:policy/OCCM"

# Name your connector.
connector_name: "awx_connector"

# Name of the key pair generated in AWS.
key_pair: "key_pair"

# Name of the Subnet that has the range of IP addresses in your VPC.
subnet: "subnet-12345"

# ID of your AWS secuirty group that allows access to on-prem
resources.
security_group: "sg-123123123"

# You Cloud Manager Account ID.
account: "account-A23123A"

# Name of the your CVO instance
cvo_name: "test_cvo"

# ID of the VPC in AWS.
vpc: "vpc-123123123"

#######################################################################
############################
# 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: "123123123123123123123"

# For regular access with username and password, please specify "pass"
as the connector_access. For SSO users, use "refresh_token" as the
variable.
connector_access: "pass"

#######################################################################
#############################
# Variables for SnapMirror Peering
#######################################################################
```

```
##############################
passphrase: "your-passphrase"

######################################################################
##############################
# Source & Destination List
######################################################################
##############################
#Please Enter Destination Cluster Name
dst_cluster_name: "dst-cluster-name"

#Please Enter Destination Cluster (Once CVO is Created Add this
Variable to all templates)
dst_cluster_ip: "dst-cluster-ip"

#Please Enter Destination SVM to create mirror relationship
dst_vserver: "dst-vserver"

#Please Enter NFS Lif for dst vserver (Once CVO is Created Add this
Variable to all templates)
dst_nfs_lif: "dst-nfs-lif"

#Please Enter Source Cluster Name
src_cluster_name: "src-cluster-name"

#Please Enter Source Cluster
src_cluster_ip: "src-cluster-ip"

#Please Enter Source SVM
src_vserver: "src-vserver"

######################################################################
##############################
# Variable for Oracle Volumes and SnapMirror Details
######################################################################
##############################
#Please Enter Source Snapshot Prefix Name
cg_snapshot_name_prefix: "oracle"

#Please Enter Source Oracle Binary Volume(s)
src_orabinary_vols:
  - "binary_vol"
#Please Enter Source Database Volume(s)
src_db_vols:
  - "db_vol"
#Please Enter Source Archive Volume(s)
```

```
src_archivelog_vols:
  - "log_vol"
#Please Enter Destination Snapmirror Policy
snapmirror_policy: "async_policy_oracle"

#####################################################################################################
# Export Policy Details
#####################################################################################################
#Enter the destination export policy details (Once CVO is Created Add this Variable to all templates)
export_policy_details:
  name: "nfs_export_policy"
  client_match: "0.0.0.0/0"
  ro_rule: "sys"
  rw_rule: "sys"

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

#NFS Mount points for Oracle DB volumes
mount_points:
  - "/u01"
  - "/u02"
  - "/u03"

# 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: "1234"

# RedHat subscription username and password
redhat_sub_username: "xxx"
redhat_sub_password: "xxx"

####################################################
### DB env specific install and config variables ###
####################################################
#Recovery Type (leave as scn)
recovery_type: "scn"
```

```
#Oracle Control Files
control_files:
  - "/u02/oradata/CDB2/control01.ctl"
  - "/u03/orareco/CDB2/control02.ctl"
```

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 paraellel 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 sofware 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/oraInst.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-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

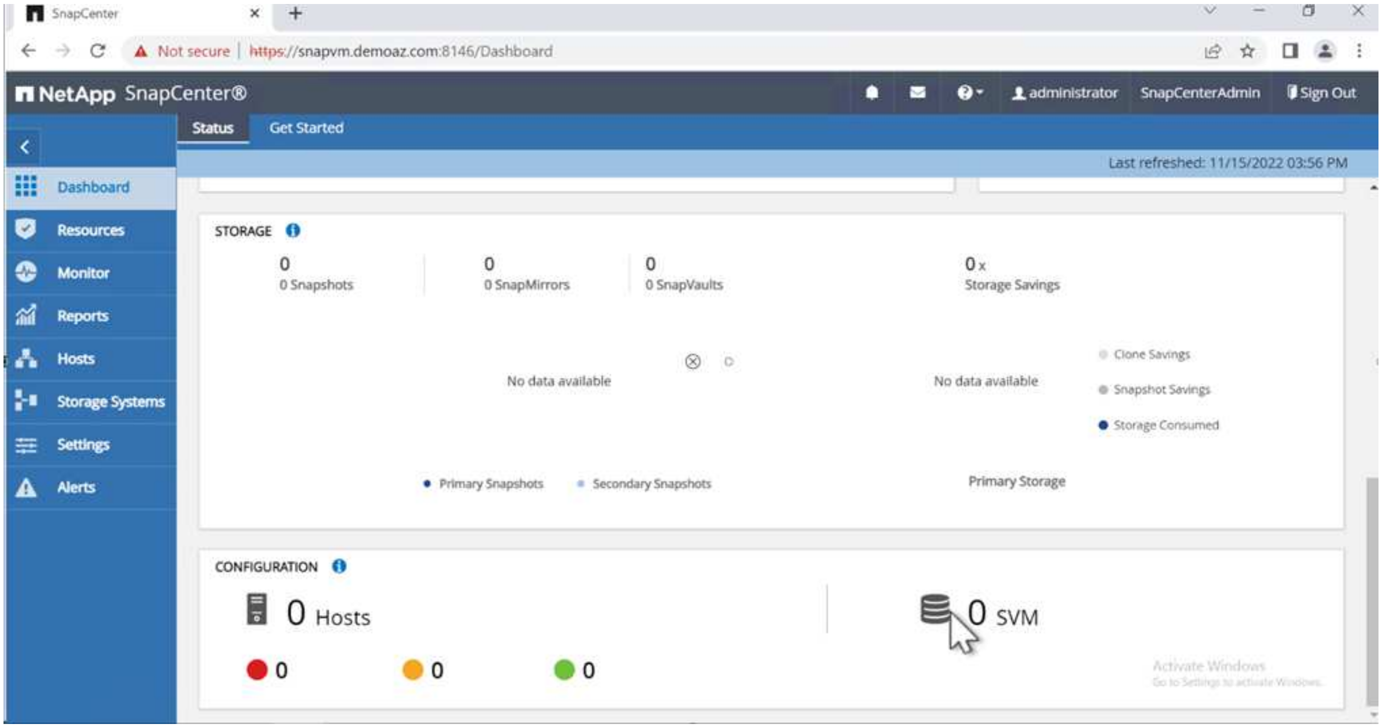
SnapCenter Configuration

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.

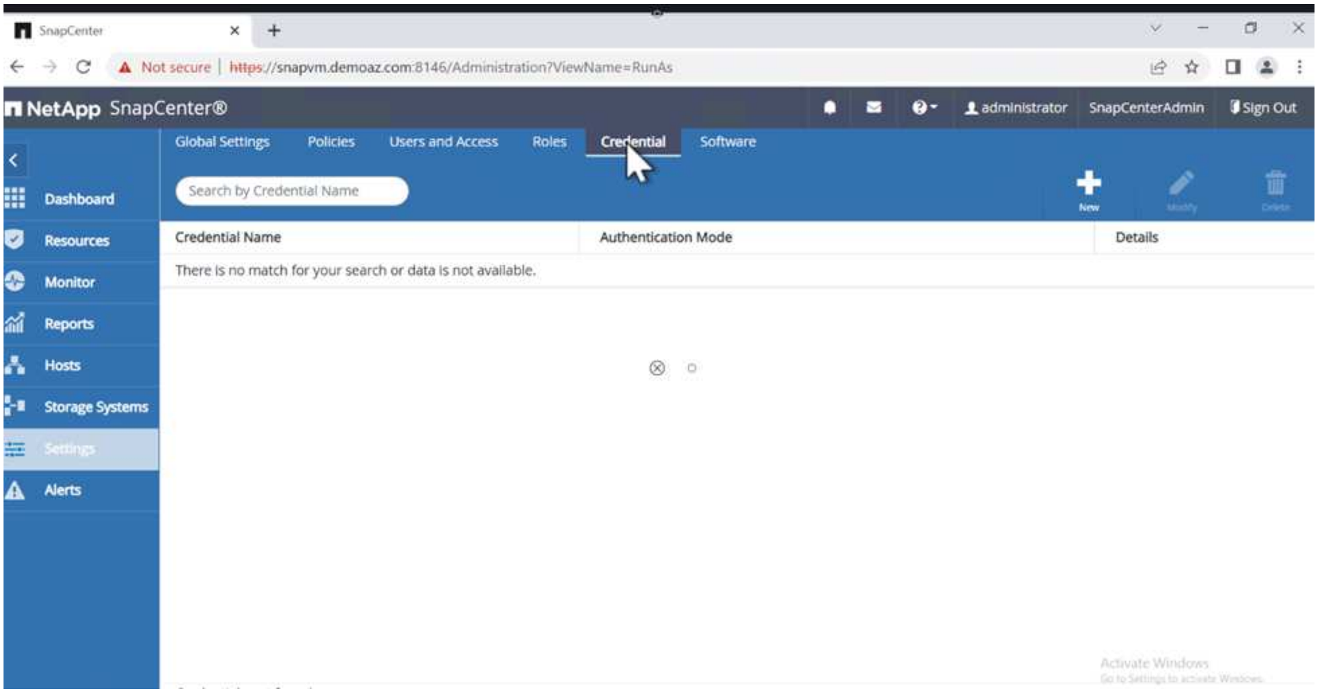


NetApp recommends using role-based access control (RBAC) to delegate data protection and management capabilities to individual users across the SnapCenter and window hosts. The user must have access to the SQL Server hosting the database. For multiple hosts, the username and password must be the same 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

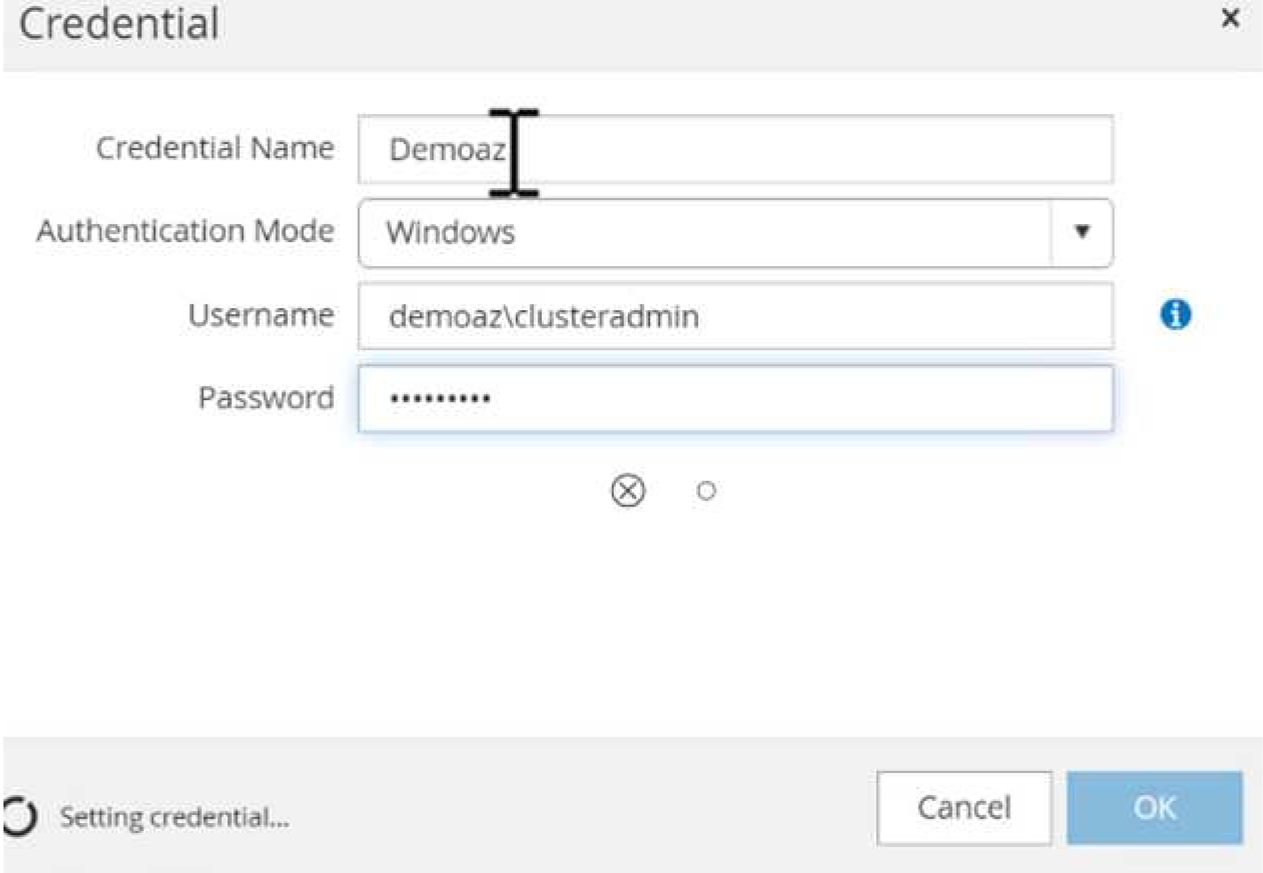
Go to **Settings**, select **Credentials**, and click (**+**).



https://snapvm.demoaz.com:8146/Administration?ViewName=RunAs

There is no match for your search or data is not available.

The new user must have administrator rights on the SQL Server host.



Credential Name: Demoaz

Authentication Mode: Windows

Username: demoaz\clusteradmin

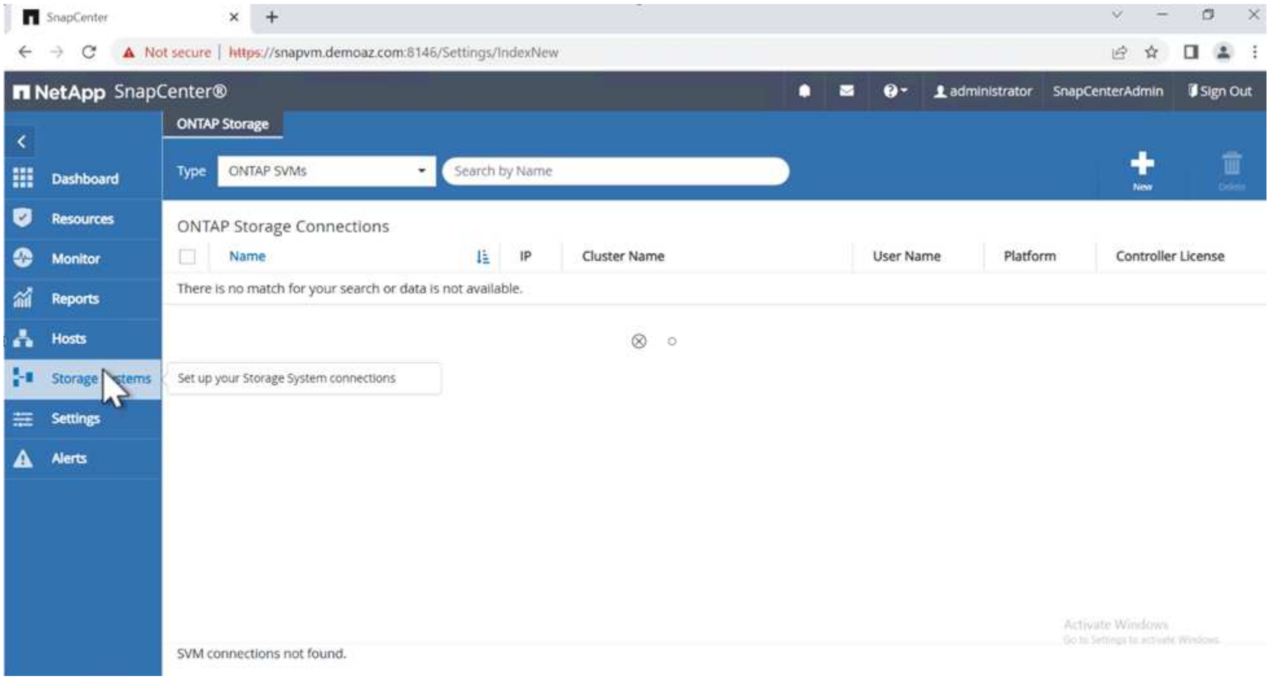
Password: ••••••••••

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.



Type: ONTAP SVMs

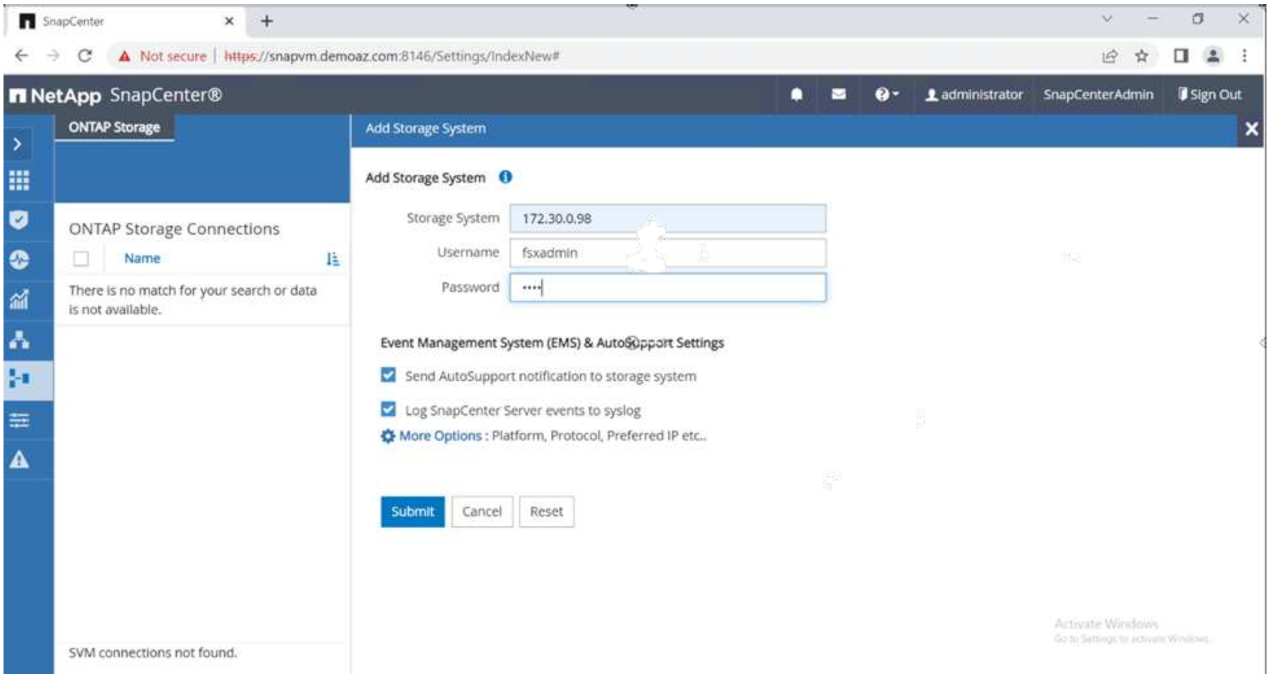
ONTAP Storage Connections

There is no match for your search or data is not available.

Set up your Storage System connections

SVM connections not found.

3. Provide the **FSx for ONTAP management** endpoint.



ONTAP Storage Connections

There is no match for your search or data is not available.

SVM connections not found.

Add Storage System

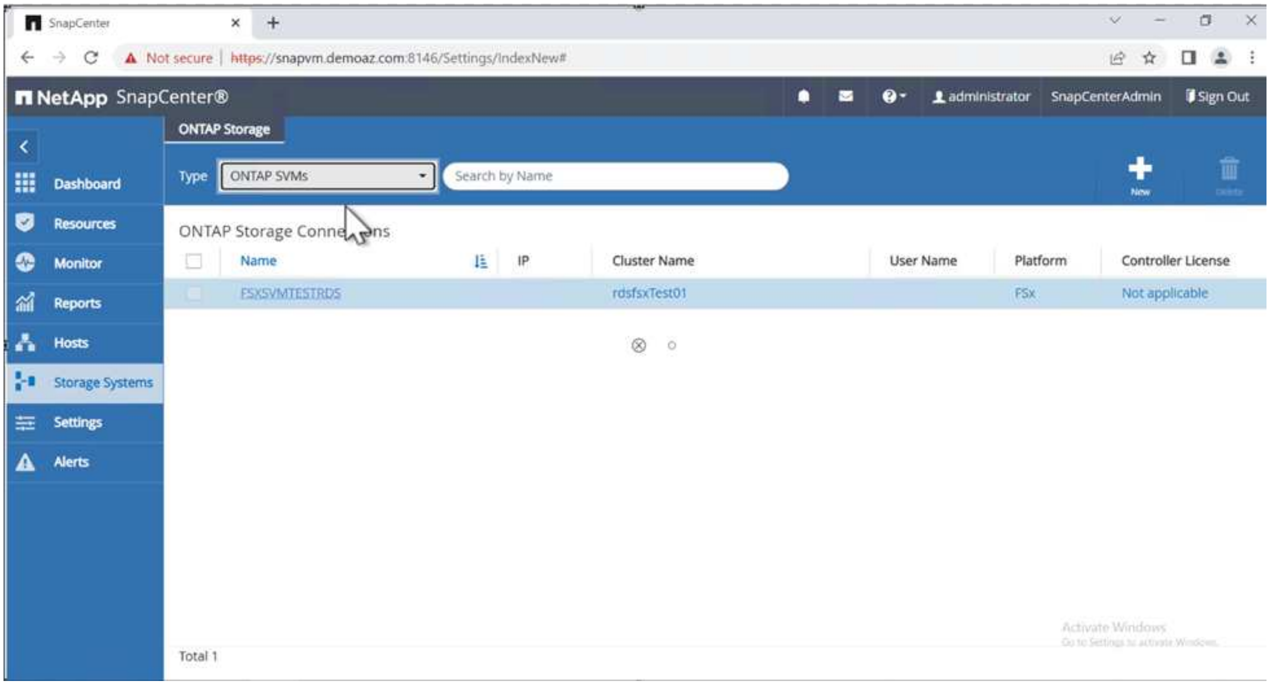
Storage System: 172.30.0.98
Username: fsxadmin
Password: ••••

Event Management System (EMS) & AutoSupport Settings

☑ Send AutoSupport notification to storage system
☑ Log SnapCenter Server events to syslog

More Options : Platform, Protocol, Preferred IP etc...

4. The SVM is now configured in SnapCenter.



ONTAP Storage

Type: ONTAP SVMs

ONTAP Storage Connections

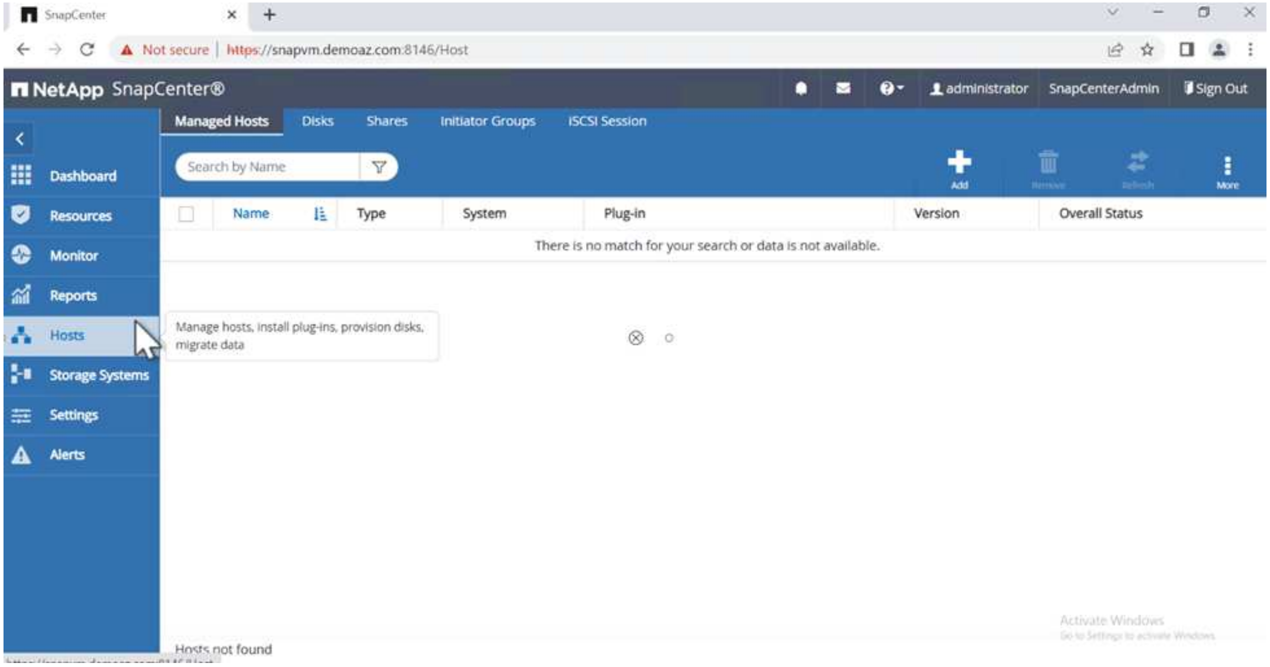
☐	Name	IP	Cluster Name	User Name	Platform	Controller License
☐	FSXSVMTESTRDS		rdsfsxTest01		FSx	Not applicable

Total 1

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.



There is no match for your search or data is not available.

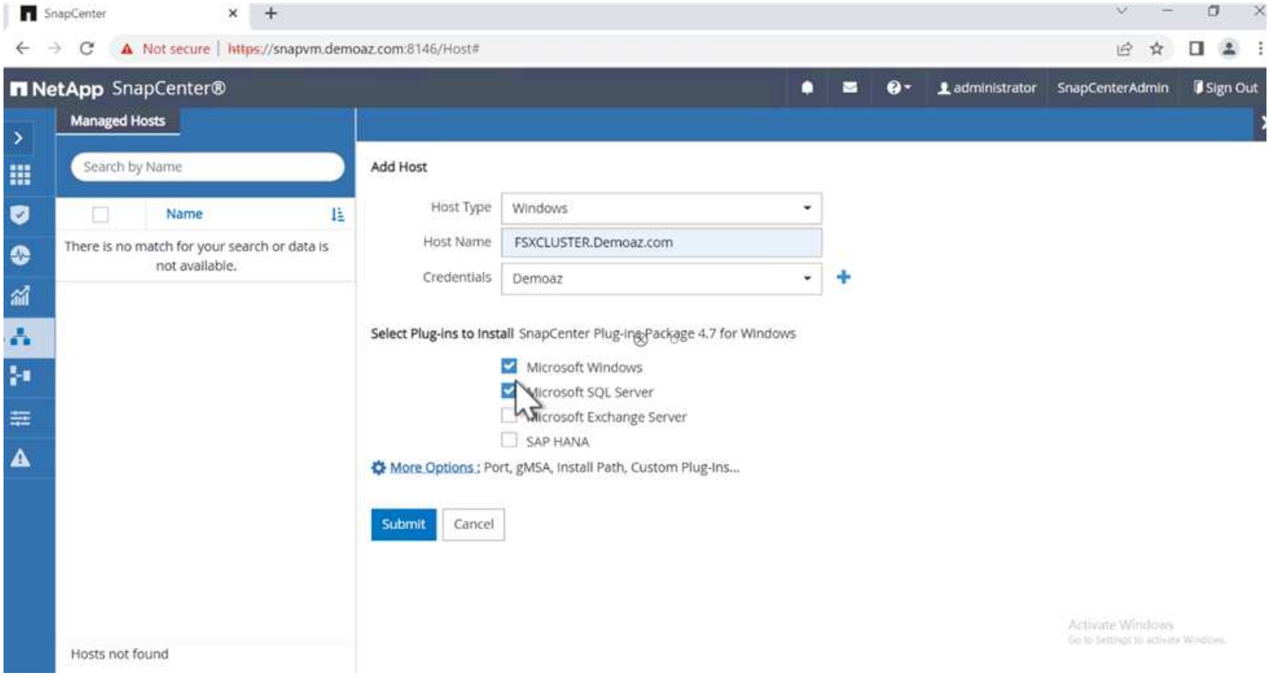
Manage hosts, install plug-ins, provision disks, migrate data

Hosts not found

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.


SnapCenter
Not secure | https://snapvm.demoaz.com:8146/Host#
NetApp SnapCenter®
administrator
SnapCenterAdmin
Sign Out
Managed Hosts
Search by Name
Name
Add Host
More Options : Port, gMSA, Install Path, Custom Plug-ins...
Submit
Cancel
Activate Windows
Go to Settings to activate Windows.

There is no match for your search or data is not available.

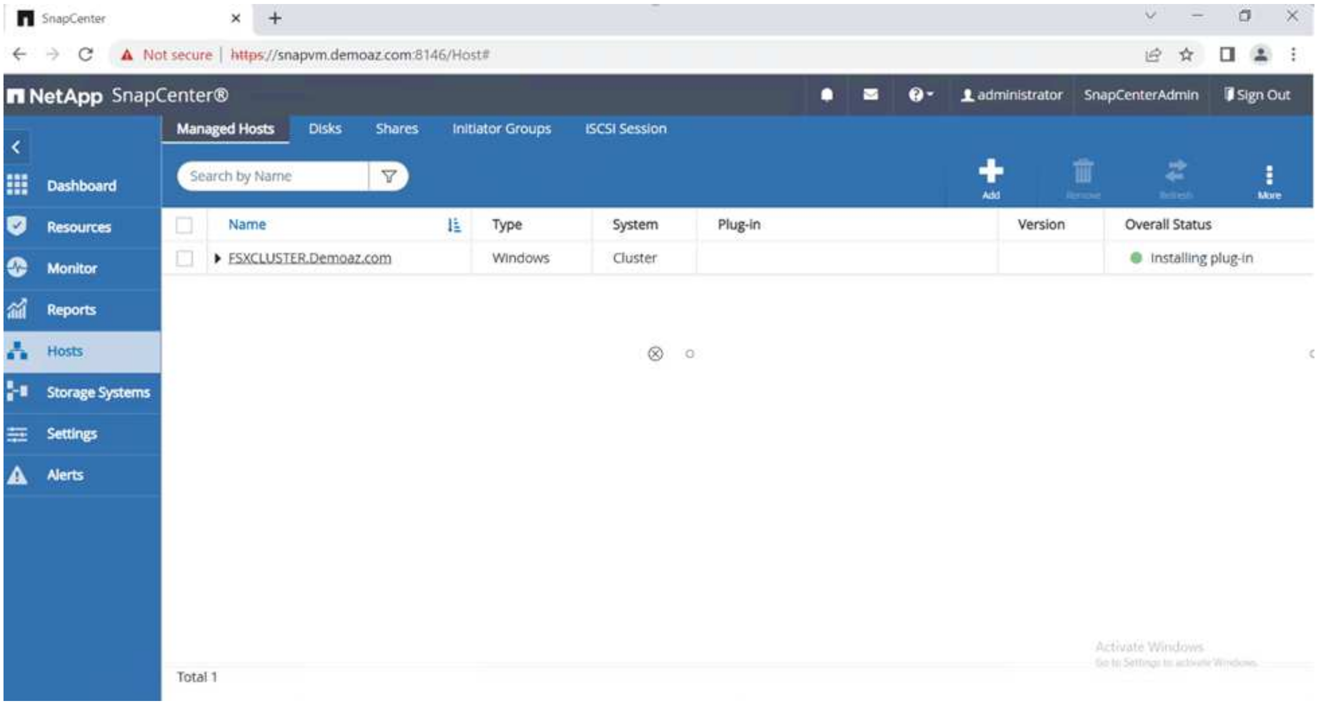
Host Type: Windows
Host Name: FSXCLUSTER.Demoaz.com
Credentials: Demoaz

Select Plug-ins to Install SnapCenter Plug-ins Package 4.7 for Windows

☑ Microsoft Windows
☑ Microsoft SQL Server
☐ Microsoft Exchange Server
☐ SAP HANA

Hosts not found

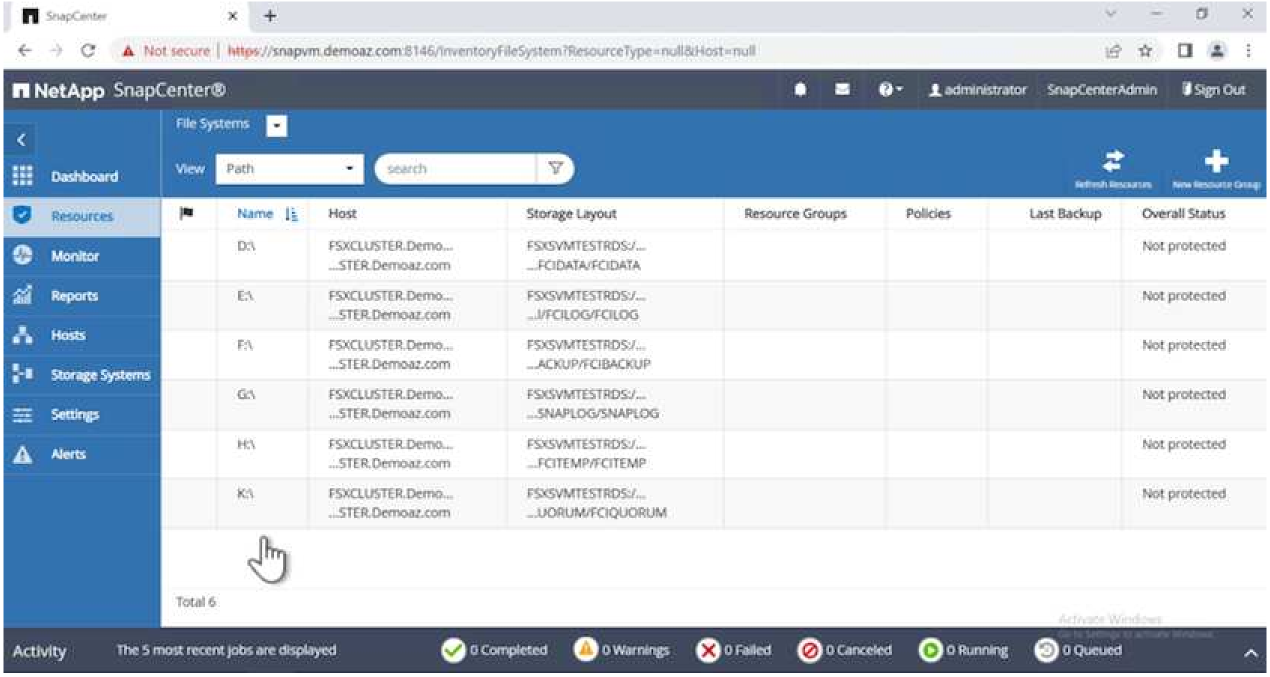
The SQL Server packages are installed.



☐	Name	Type	System	Plug-in	Version	Overall Status
☐	FSXCLUSTER.Demoaz.com	Windows	Cluster			● Installing plug-in

Total 1

1. After the installation is complete, go to the **Resource** tab to verify whether all FSx for ONTAP iSCSI volumes are present.



	Name	Host	Storage Layout	Resource Groups	Policies	Last Backup	Overall Status
	D:\	FSXCLUSTER.Demo... ...STER.Demoaz.com	FSXSVMTESTRDS:/... ...FCIDATA/FCIDATA				Not protected
	E:\	FSXCLUSTER.Demo... ...STER.Demoaz.com	FSXSVMTESTRDS:/... ...l/FCILOG/FCILOG				Not protected
	F:\	FSXCLUSTER.Demo... ...STER.Demoaz.com	FSXSVMTESTRDS:/... ...ACKUP/FCIBACKUP				Not protected
	G:\	FSXCLUSTER.Demo... ...STER.Demoaz.com	FSXSVMTESTRDS:/... ...SNAPLOG/SNAPLOG				Not protected
	H:\	FSXCLUSTER.Demo... ...STER.Demoaz.com	FSXSVMTESTRDS:/... ...FCITEMP/FCITEMP				Not protected
	K:\	FSXCLUSTER.Demo... ...STER.Demoaz.com	FSXSVMTESTRDS:/... ...UORUM/FCIQUORUM				Not protected

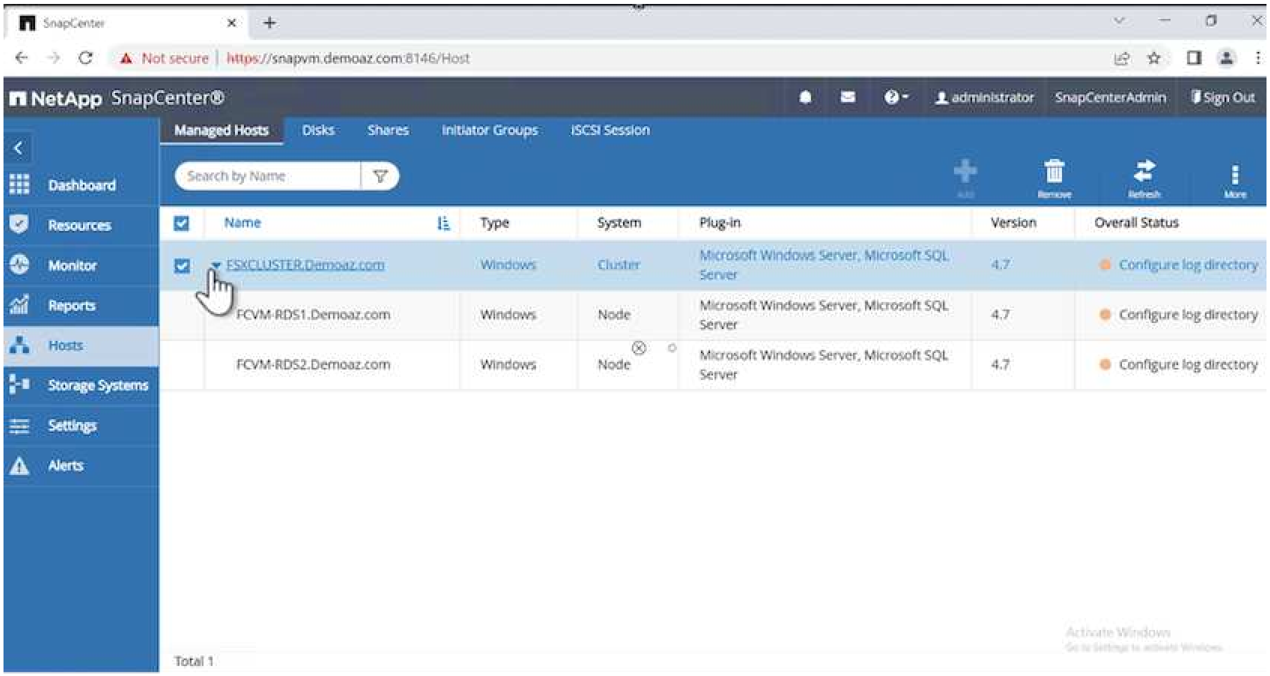
Total 6

Activity The 5 most recent jobs are displayed 0 Completed 0 Warnings 0 Failed 0 Canceled 0 Running 0 Queued

Configure log directory

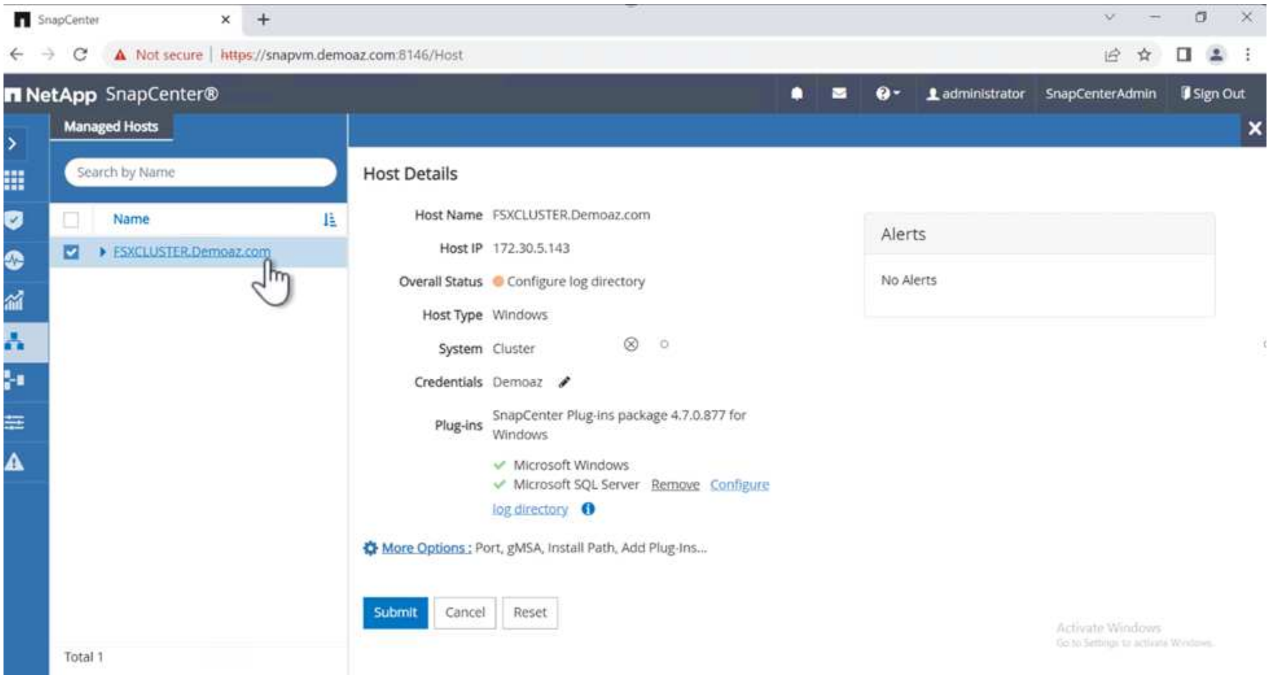
To configure a host log directory, complete the following steps:

1. Click the check box. A new tab opens.



Name	Type	System	Plug-in	Version	Overall Status
FSXCLUSTER.Demoaz.com	Windows	Cluster	Microsoft Windows Server, Microsoft SQL Server	4.7	Configure log directory
FCVM-RDS1.Demoaz.com	Windows	Node	Microsoft Windows Server, Microsoft SQL Server	4.7	Configure log directory
FCVM-RDS2.Demoaz.com	Windows	Node	Microsoft Windows Server, Microsoft SQL Server	4.7	Configure log directory

2. Click the **configure log directory** link.



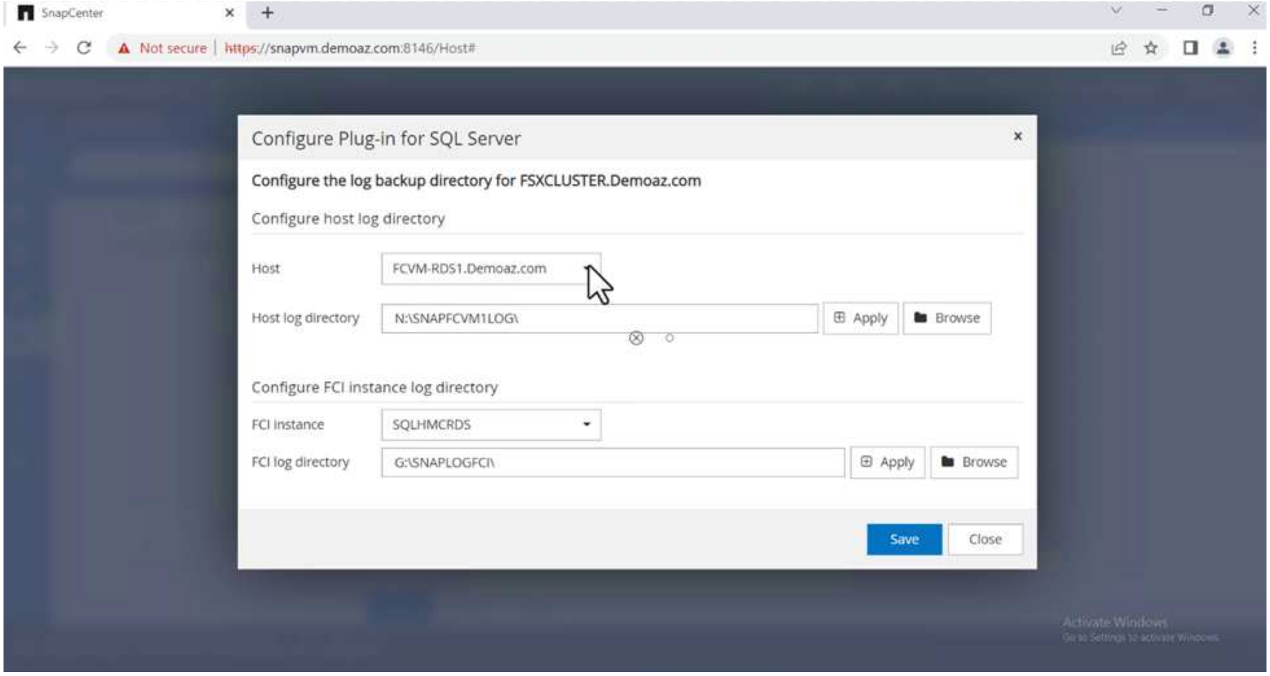
Host Details

Host Name FSXCLUSTER.Demoaz.com
Host IP 172.30.5.143
Overall Status Configure log directory
Host Type Windows
System Cluster
Credentials Demoaz
Plug-ins SnapCenter Plug-ins package 4.7.0.877 for Windows
✓ Microsoft Windows
✓ Microsoft SQL Server Remove Configure log directory

More Options : Port, gMSA, Install Path, Add Plug-Ins...

Alerts
No Alerts

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.


SnapCenter
Not secure | https://snapvm.demoaz.com:8146/Host#
Apply
Browse
Apply
Browse
Save
Close
Activate Windows
Go to Settings to activate Windows.

Configure Plug-in for SQL Server

Configure the log backup directory for FSXCLUSTER.Demoaz.com

Configure host log directory

Host: FCVM-RDS1.Demoaz.com

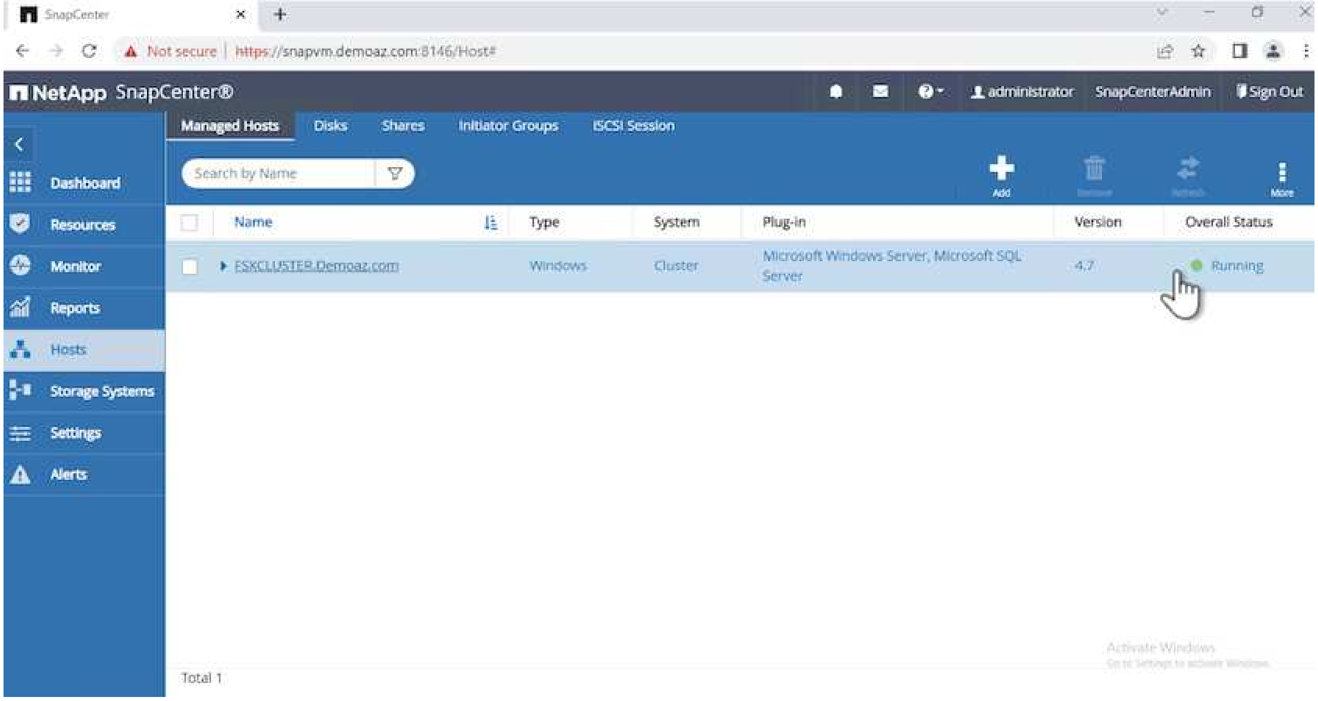
Host log directory: N:\SNAPFCVM1LOG\

Configure FCI instance log directory

FCI instance: SQLHMCRDS

FCI log directory: G:\SNAPLOGFCI\

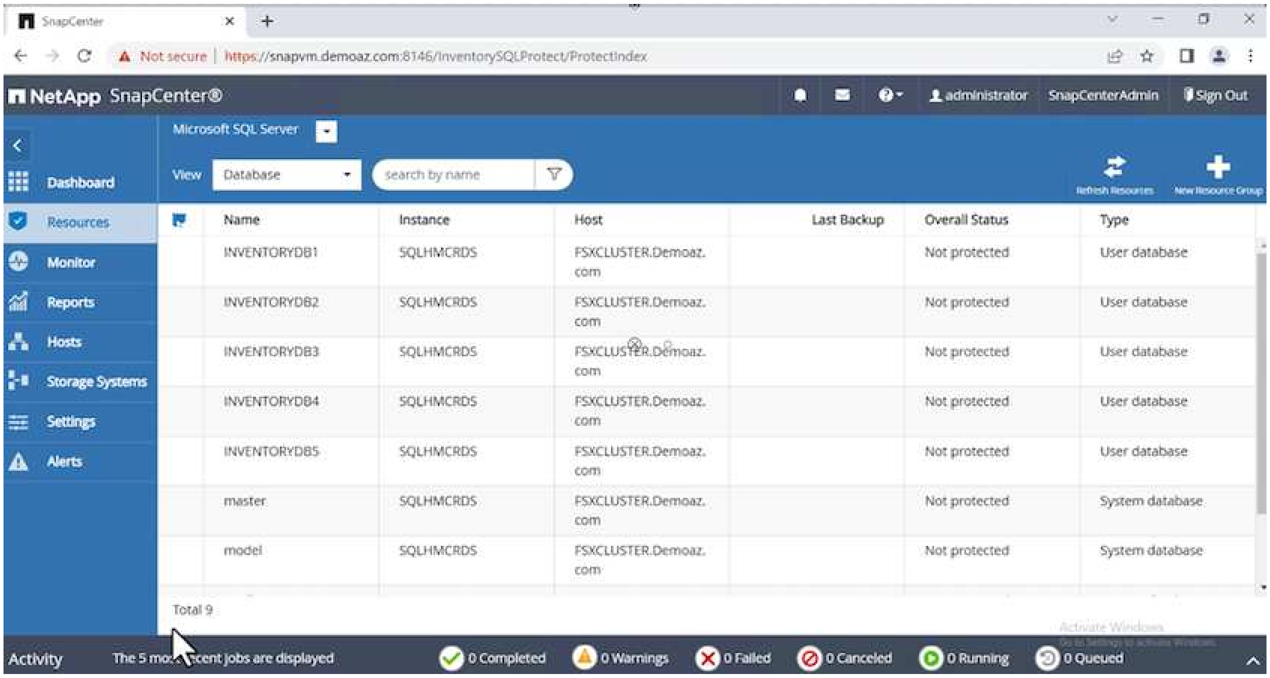
The host is now in a running state.



☐	Name	Type	System	Plug-in	Version	Overall Status
☐	FSXCLUSTER.Demoaz.com	Windows	Cluster	Microsoft Windows Server, Microsoft SQL Server	4.7	● Running

Total 1

1. From the **Resources** tab, we have all the servers and databases.



Name	Instance	Host	Last Backup	Overall Status	Type
INVENTORYDB1	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB2	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB3	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB4	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	User database
INVENTORYDB5	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	User database
master	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	System database
model	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	System database

Total 9

Configure a backup policy

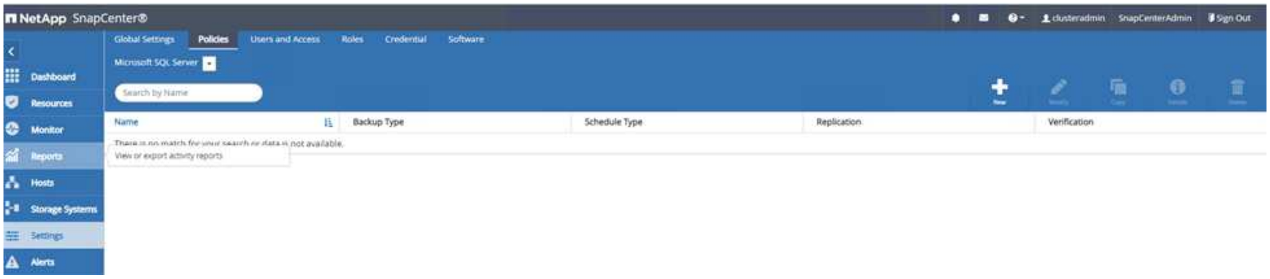
A backup policy is a set of rules that govern how to manage, schedule, and retain backup. It helps with the backup type and frequency based on your company’s SLA.

Expand the following sections to see the detailed instructions on how to complete each step.

Configure back-up operation for an FCI database

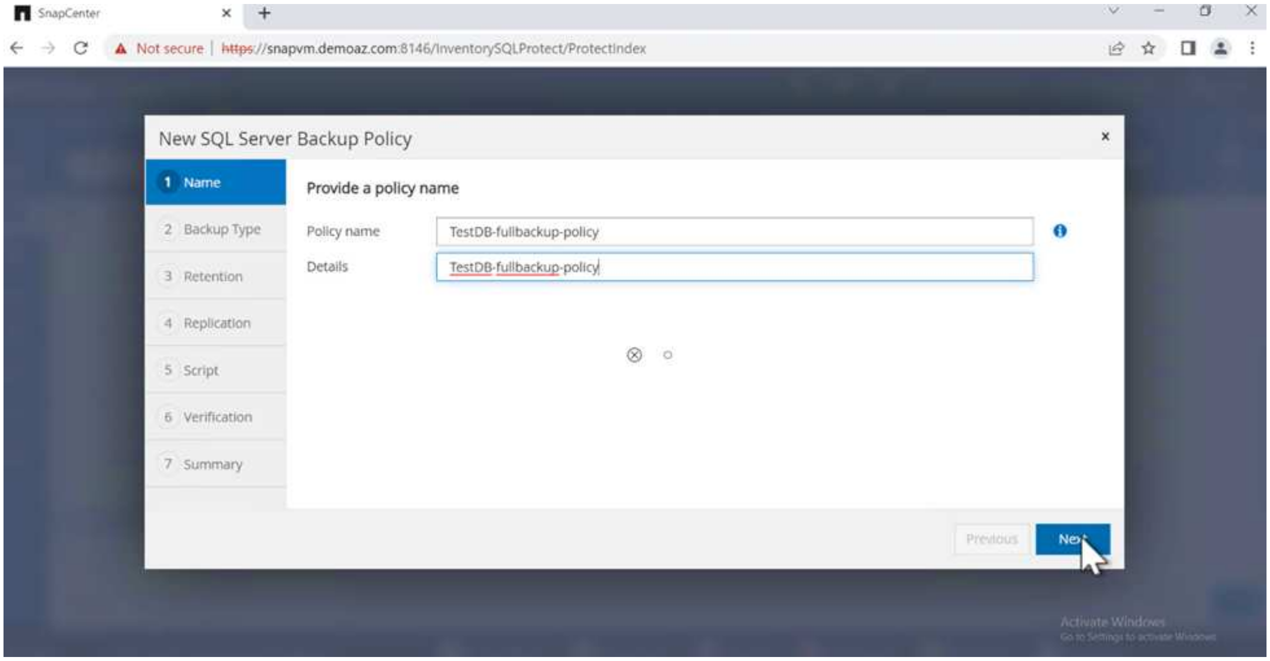
To configure a backup policy for an FCI database, complete the following steps:

1. Go to **Settings** and select **Policies** on the top left. Then click **New**.



There is no match for your search or data is not available.

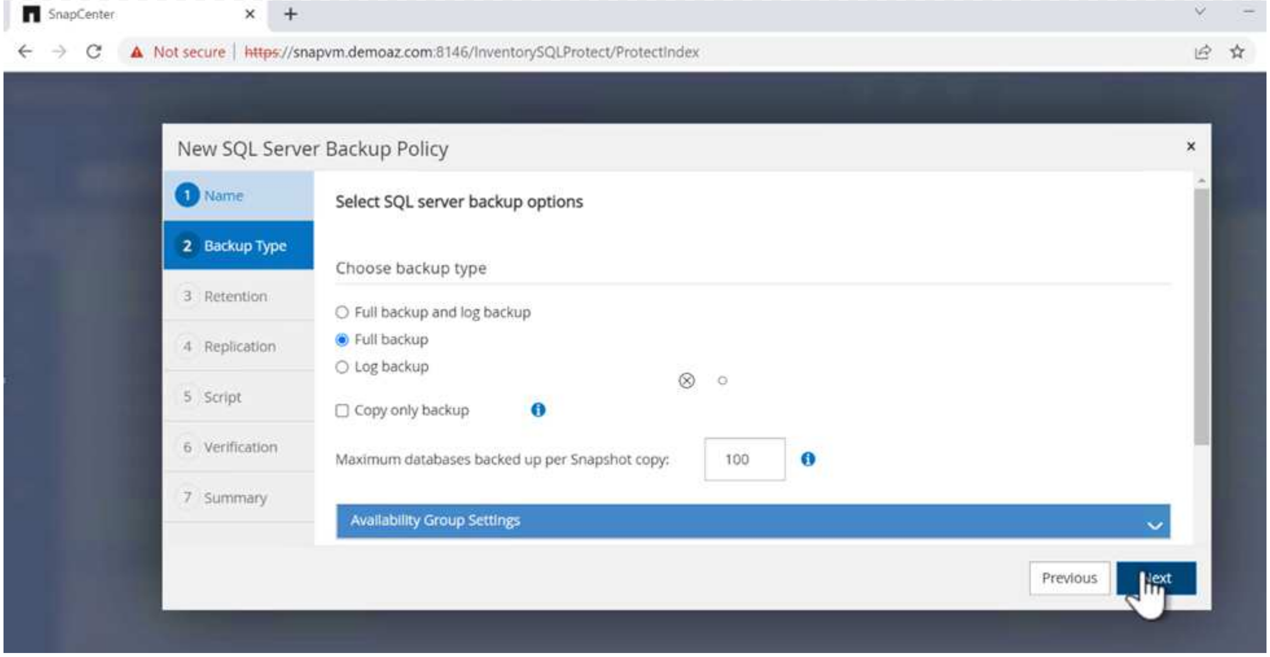
2. Enter the policy name and a description. Click **Next**.



Policy name: TestDB-fullbackup-policy

Details: TestDB-fullbackup-policy

3. Select **Full backup** as the backup type.



New SQL Server Backup Policy

Select SQL server backup options

Choose backup type

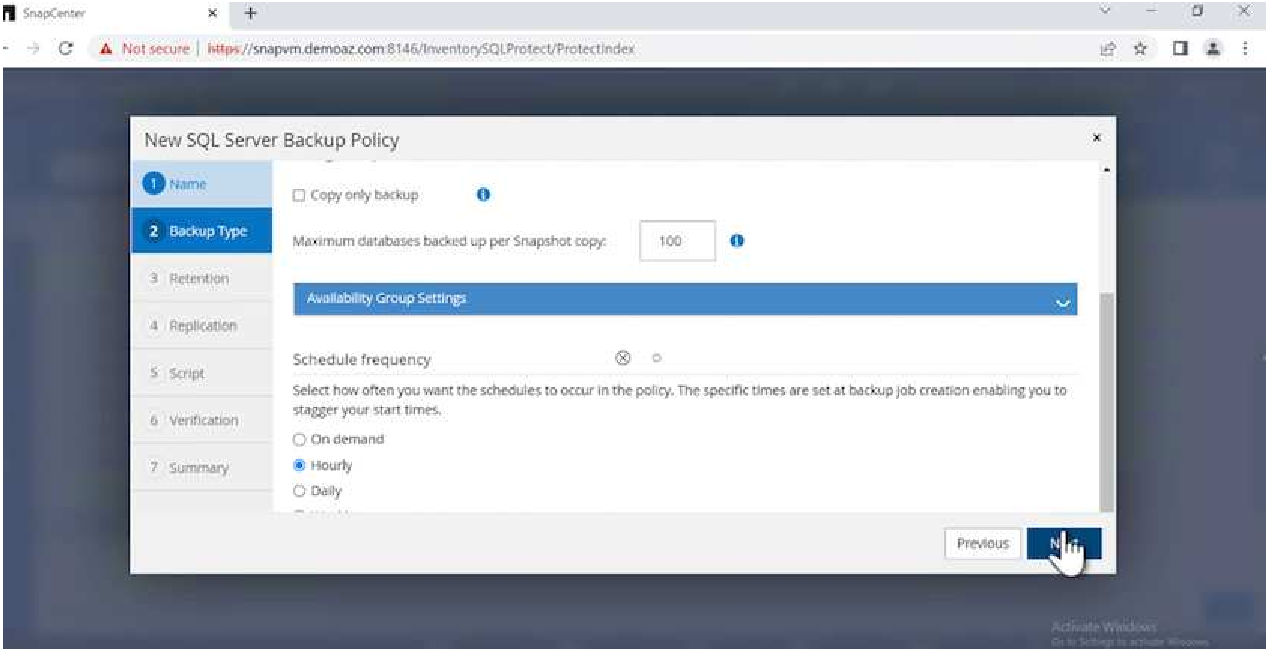
○ Full backup and log backup
● Full backup
○ Log backup

☐ Copy only backup

Maximum databases backed up per Snapshot copy: 100

Availability Group Settings

4. Select the schedule frequency (this is based on the company SLA). Click **Next**.



New SQL Server Backup Policy

☐ Copy only backup

Maximum databases backed up per Snapshot copy: 100

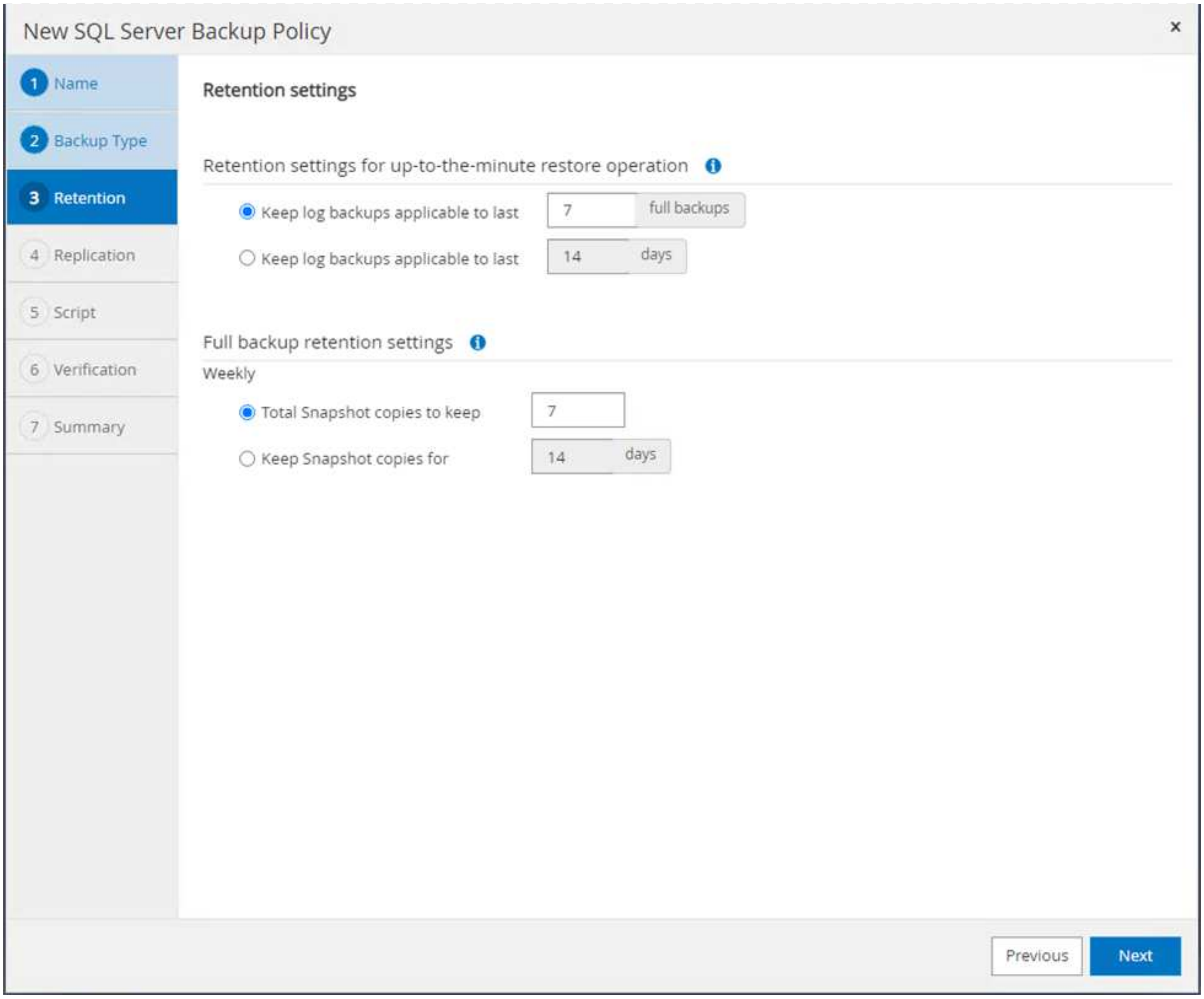
Availability Group Settings

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

5. Configure the retention settings for the backup.



Retention settings

Retention settings for up-to-the-minute restore operation

● Keep log backups applicable to last 7 full backups

○ Keep log backups applicable to last 14 days

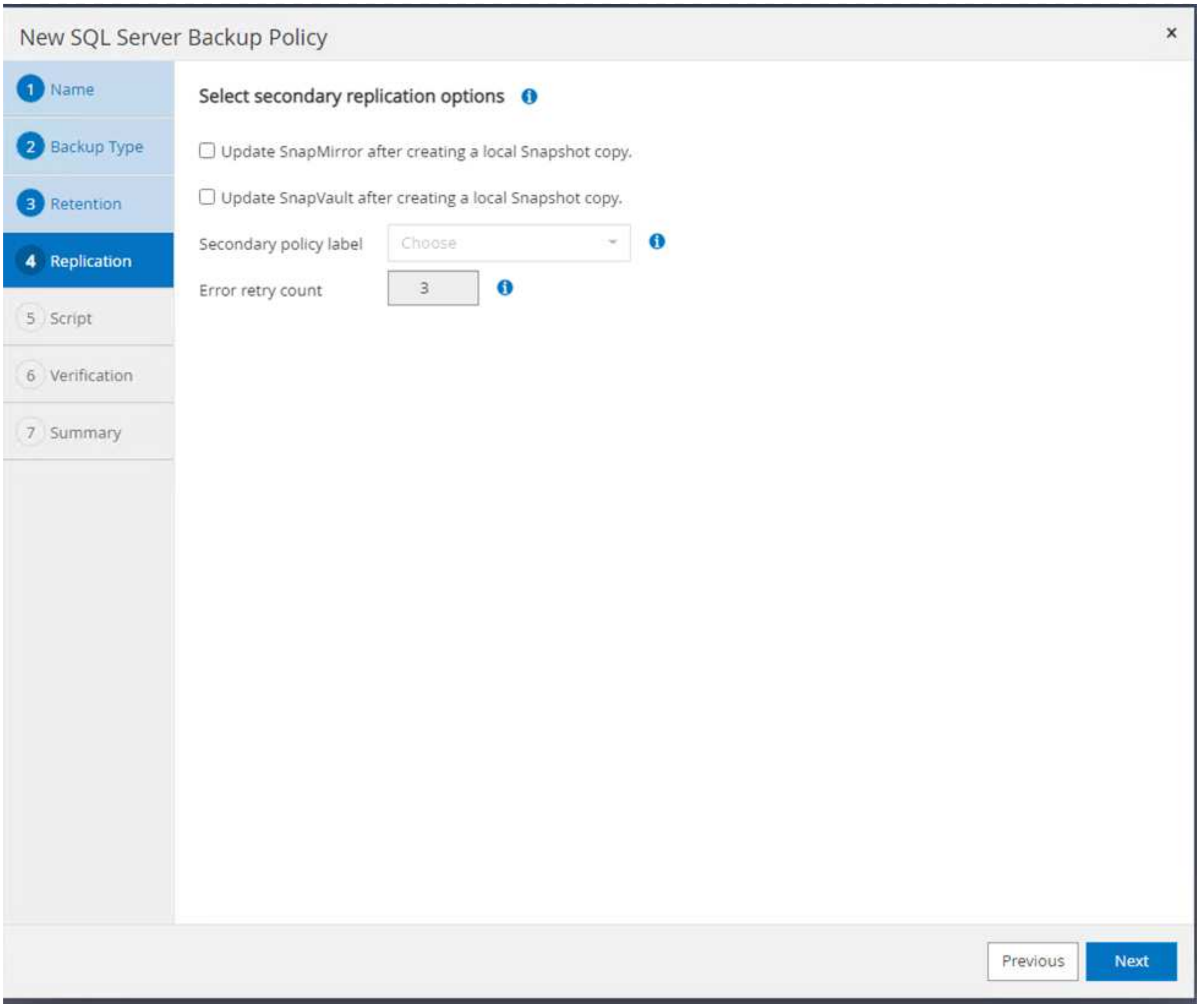
Full backup retention settings

Weekly

● Total Snapshot copies to keep 7

○ Keep Snapshot copies for 14 days

6. Configure the replication options.



Select secondary replication options

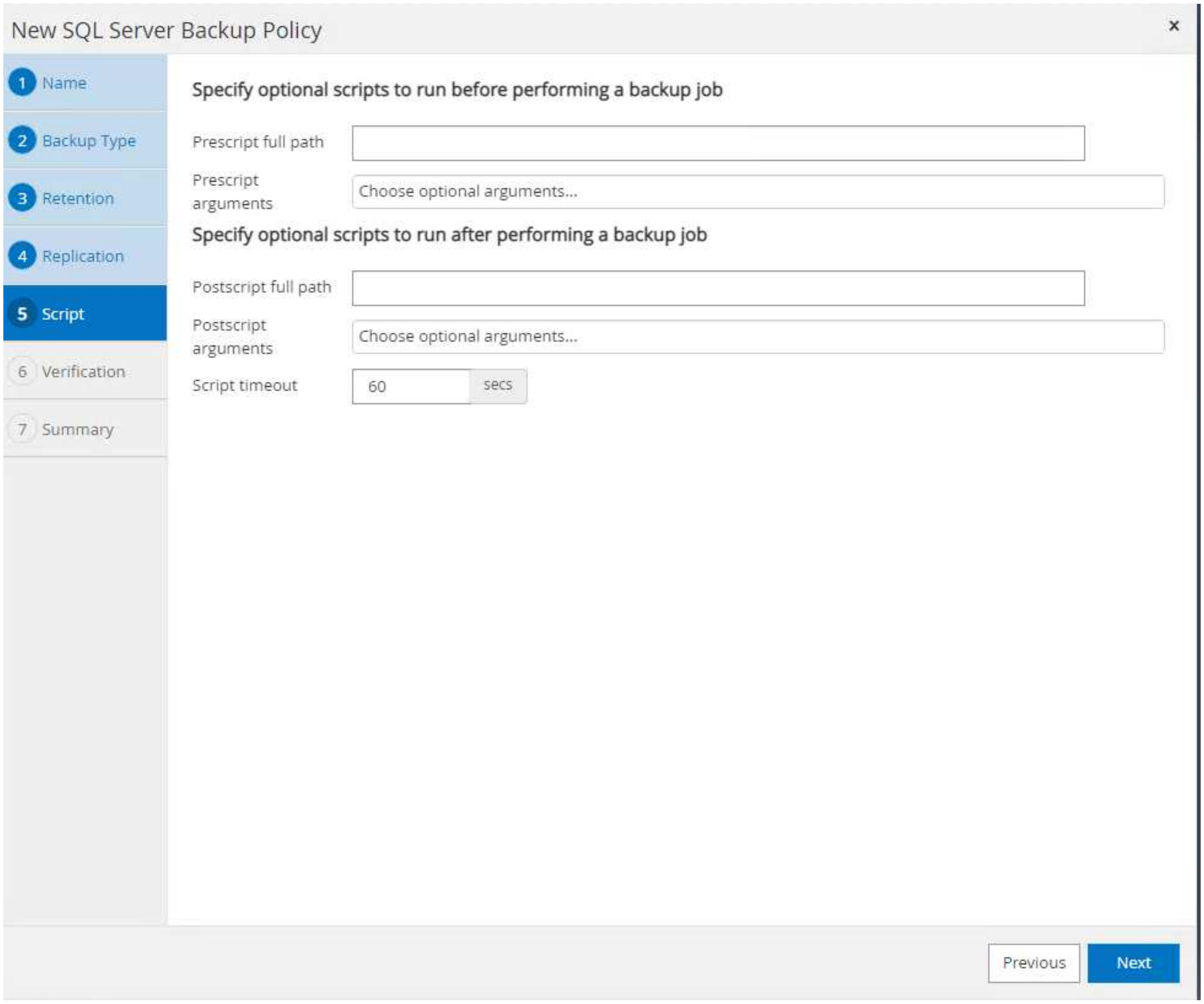
☐ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Choose

Error retry count: 3

7. Specify a run script to run before and after a backup job is run (if any).



Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments: Choose optional arguments...

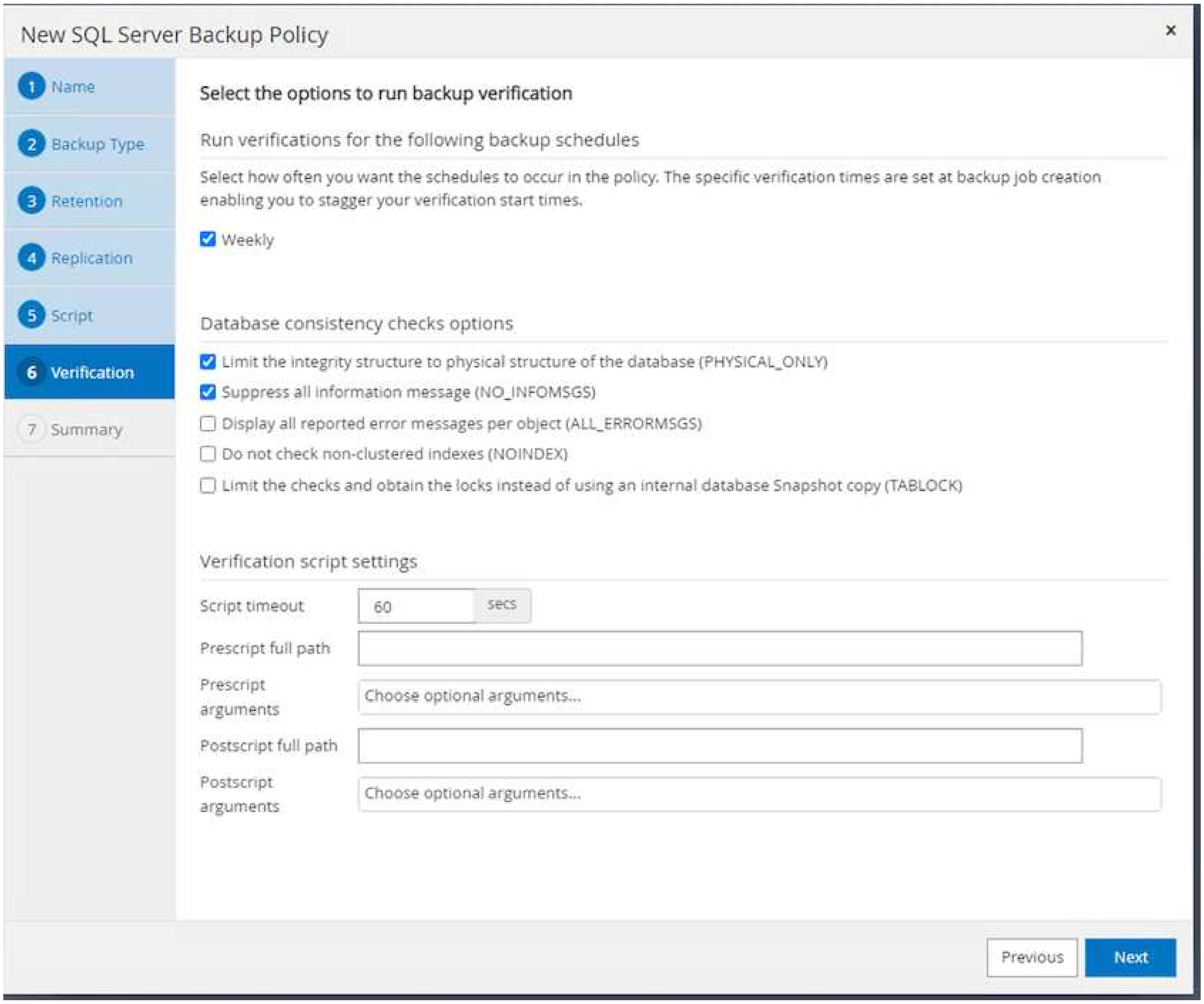
Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

8. Run verification based on the backup schedule.



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.

☑ Weekly

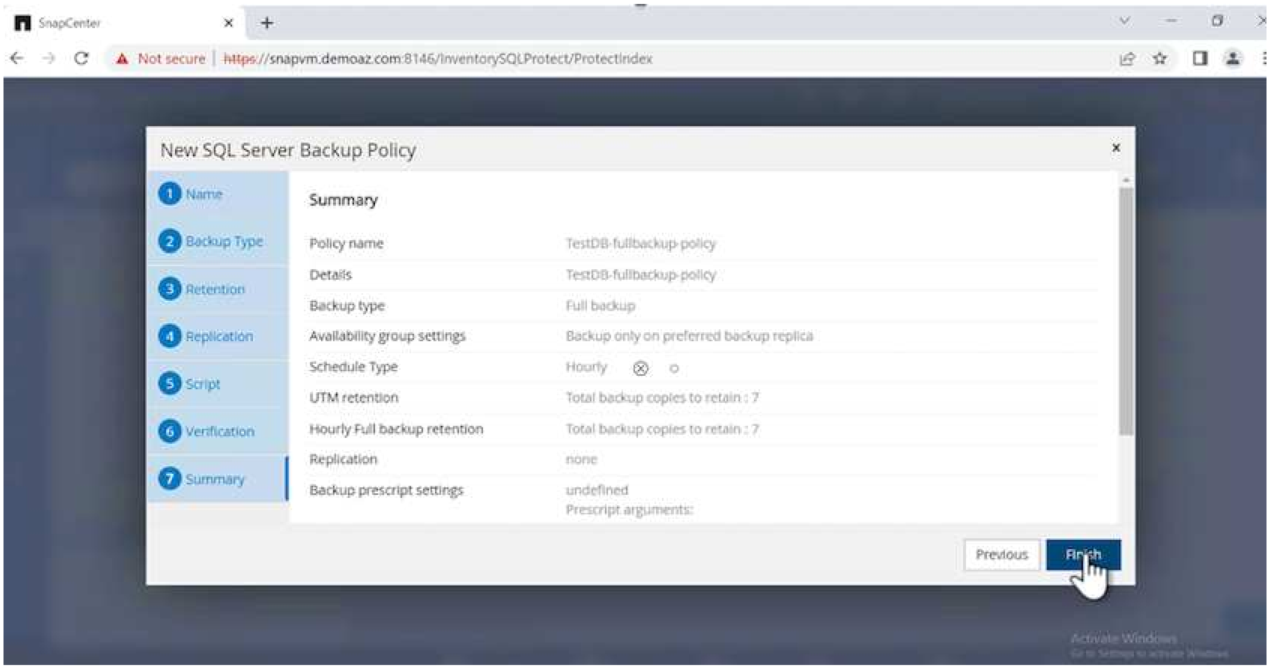
Database consistency checks options

☑ 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_ERRORMSGS)
☐ 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...

9. The **Summary** page provides details of the backup policy. Any errors can be corrected here.

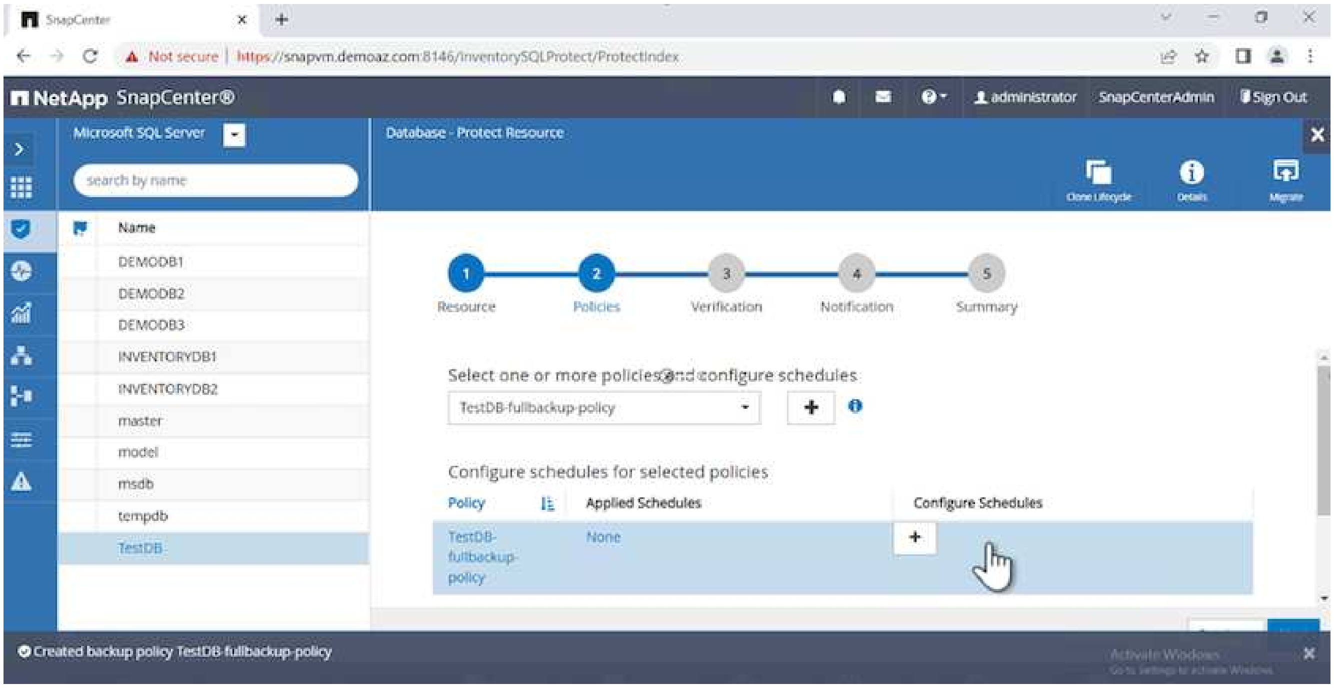


Summary

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
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:

Configure and protect MSSQL Server database

1. Set up the starting date and expiration date of the backup policy.



Select one or more policies and configure schedules

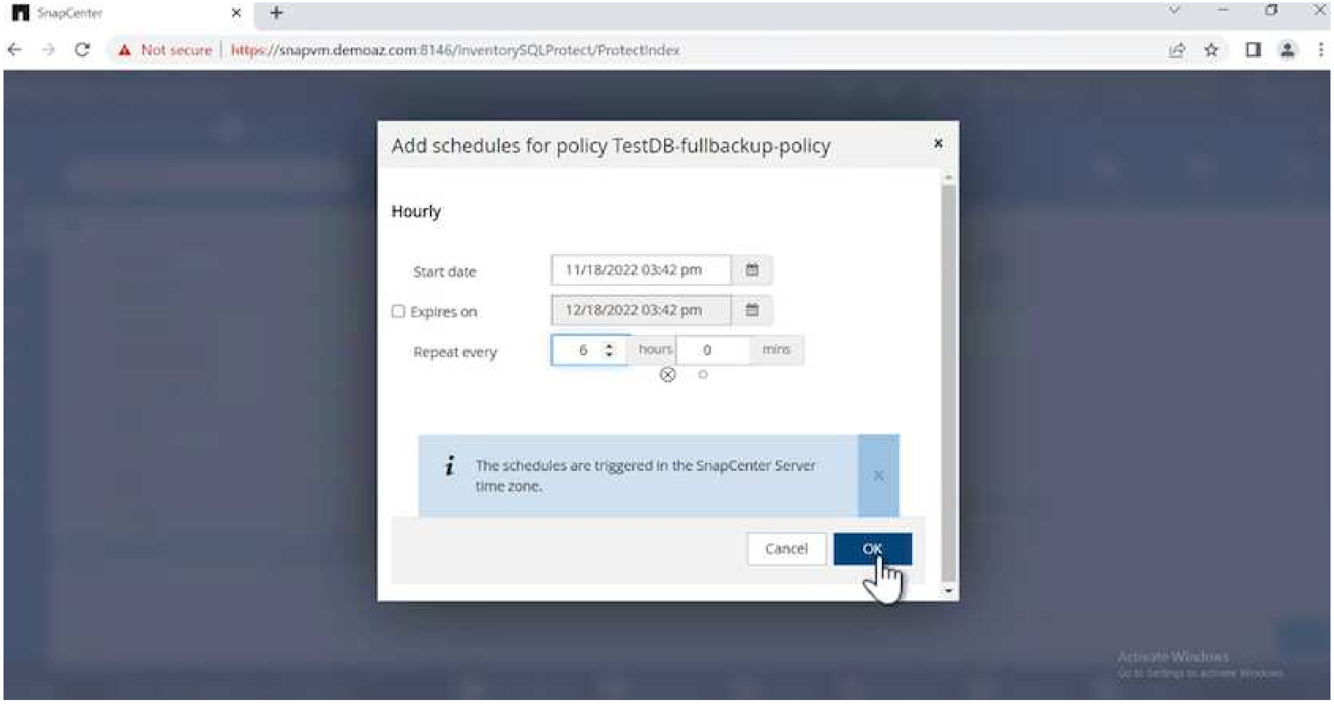
TestDB-fullbackup-policy

Configure schedules for selected policies

Policy	Applied Schedules	Configure Schedules
TestDB-fullbackup-policy	None	+

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.


SnapCenter
Not secure
https://snapvm.demoaz.com:8146/InventorySQLProtect/ProtectIndex
Cancel
OK

Add schedules for policy TestDB-fullbackup-policy

Hourly

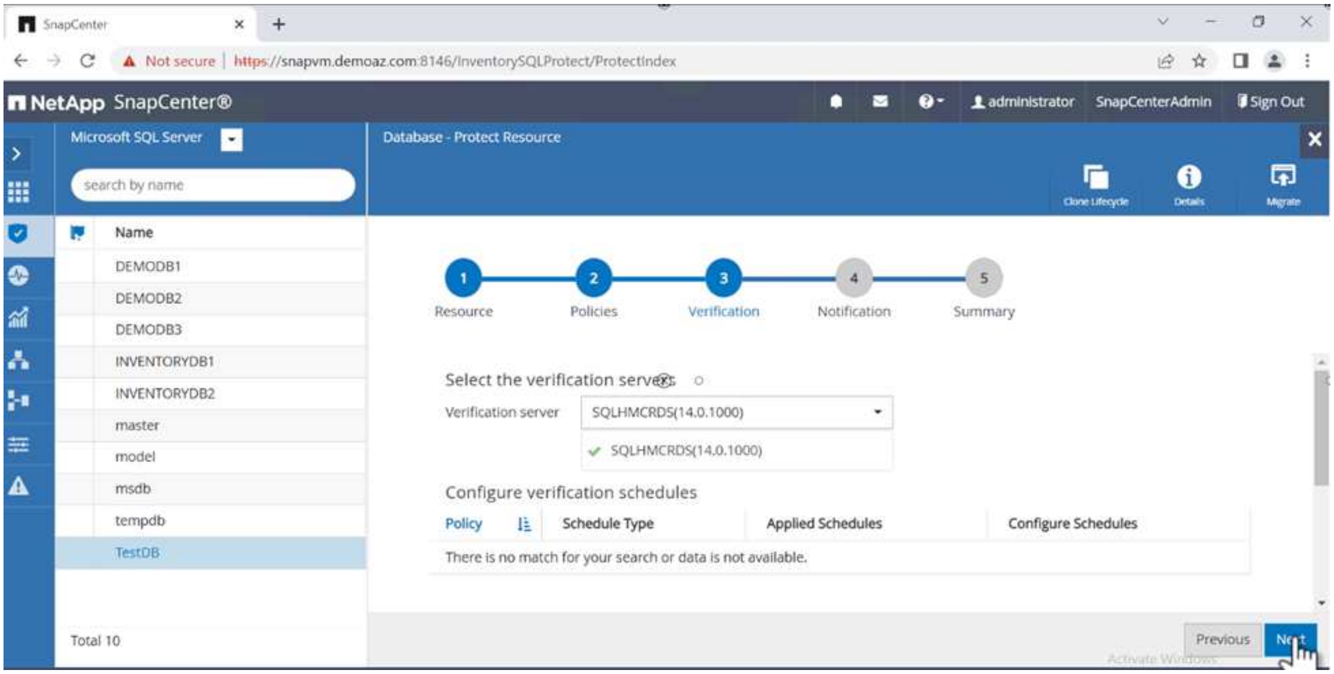
Start date: 11/18/2022 03:42 pm

☐ Expires on: 12/18/2022 03:42 pm

Repeat every: 6 hours 0 mins

The schedules are triggered in the SnapCenter Server time zone.

3. Configure the verification server. From the drop- down menu, select the server.



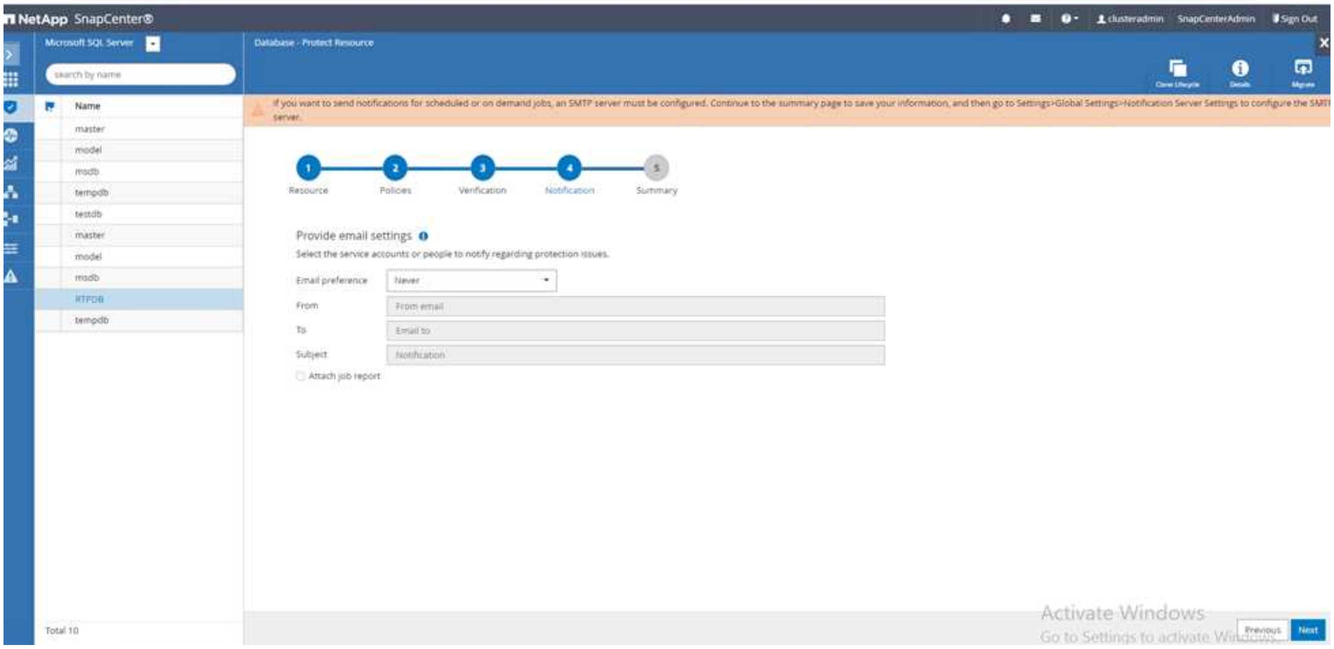
Select the verification servers

Verification server: SQLHMCRDS(14.0.1000)

Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
There is no match for your search or data is not available.			

4. Confirm the configured schedule by clicking the plus sign and confirm.
5. Provide information for email notification. Click **Next**.



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 SMT server.

Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

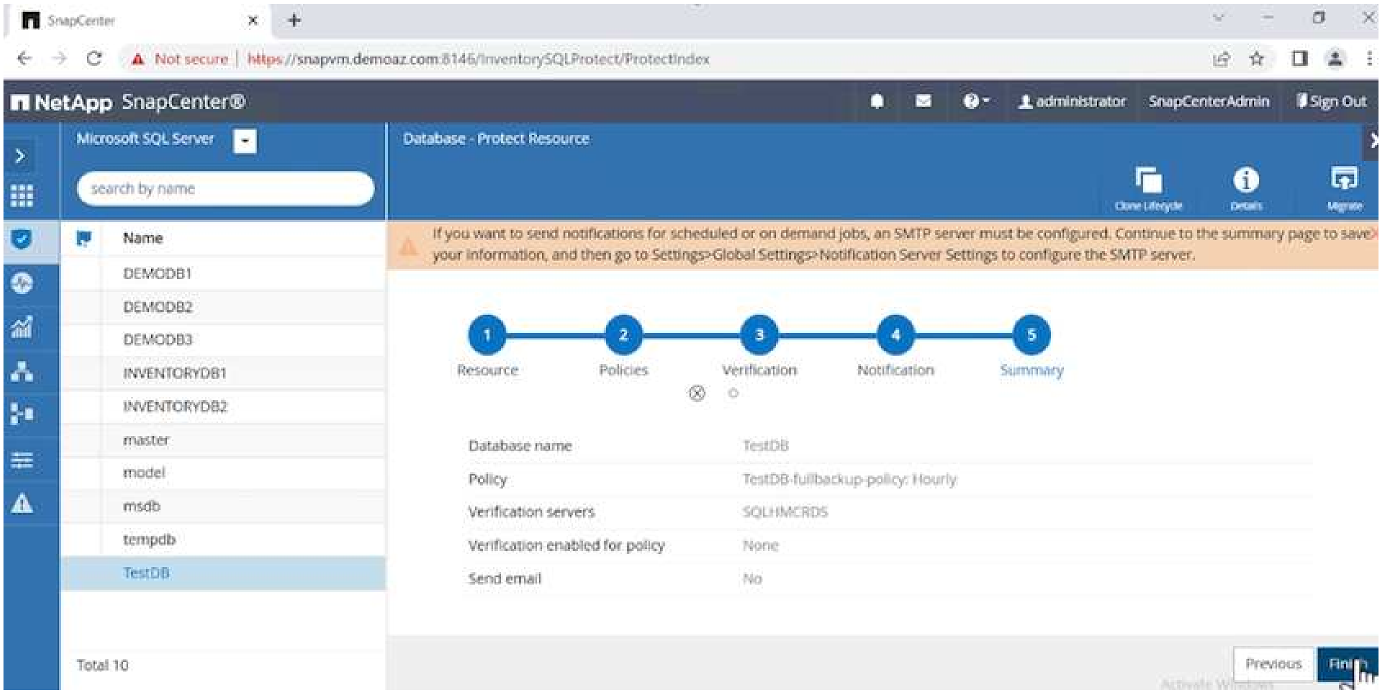
From: From email

To: Email to

Subject: Notification

☐ Attach job report

The summary of the backup policy for SQL Server database is now configured.



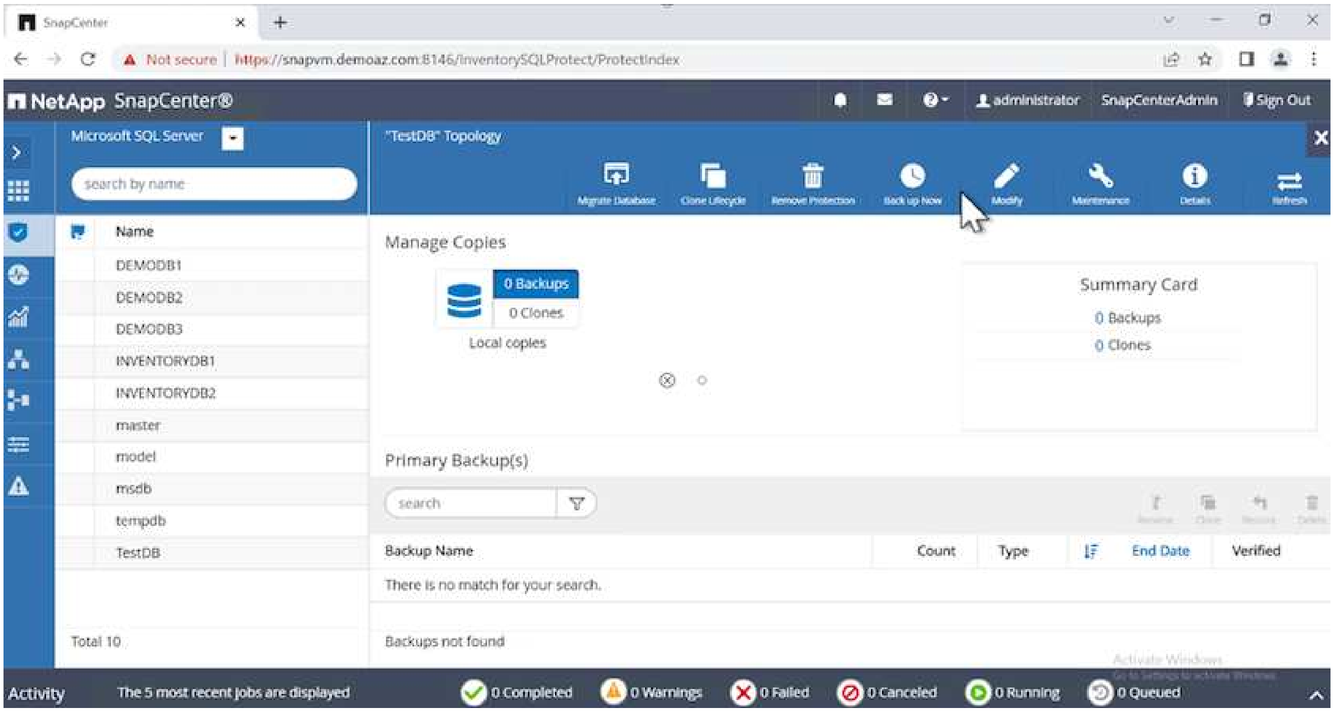
If you want to send notifications for scheduled or on demand jobs, an SMTP server must be configured. Continue to the summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

Database name TestDB
Policy TestDB-fullbackup-policy: Hourly
Verification servers SQLHMCRDS
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**.

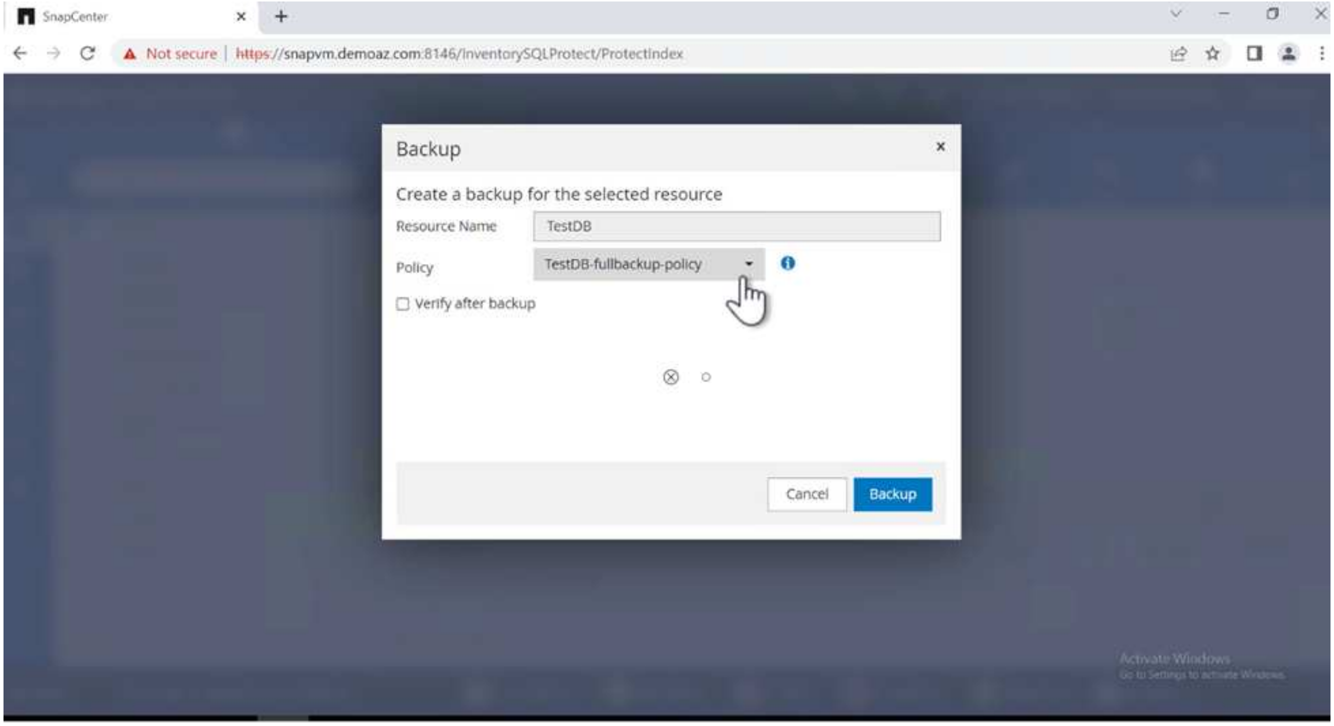


There is no match for your search.

Backups not found

The 5 most recent jobs are displayed

2. In the **Backup** dialog box, click **Backup**.


SnapCenter
Not secure | https://snapvm.demoaz.com:8146/InventorySQLProtect/ProtectIndex

Backup

Create a backup for the selected resource

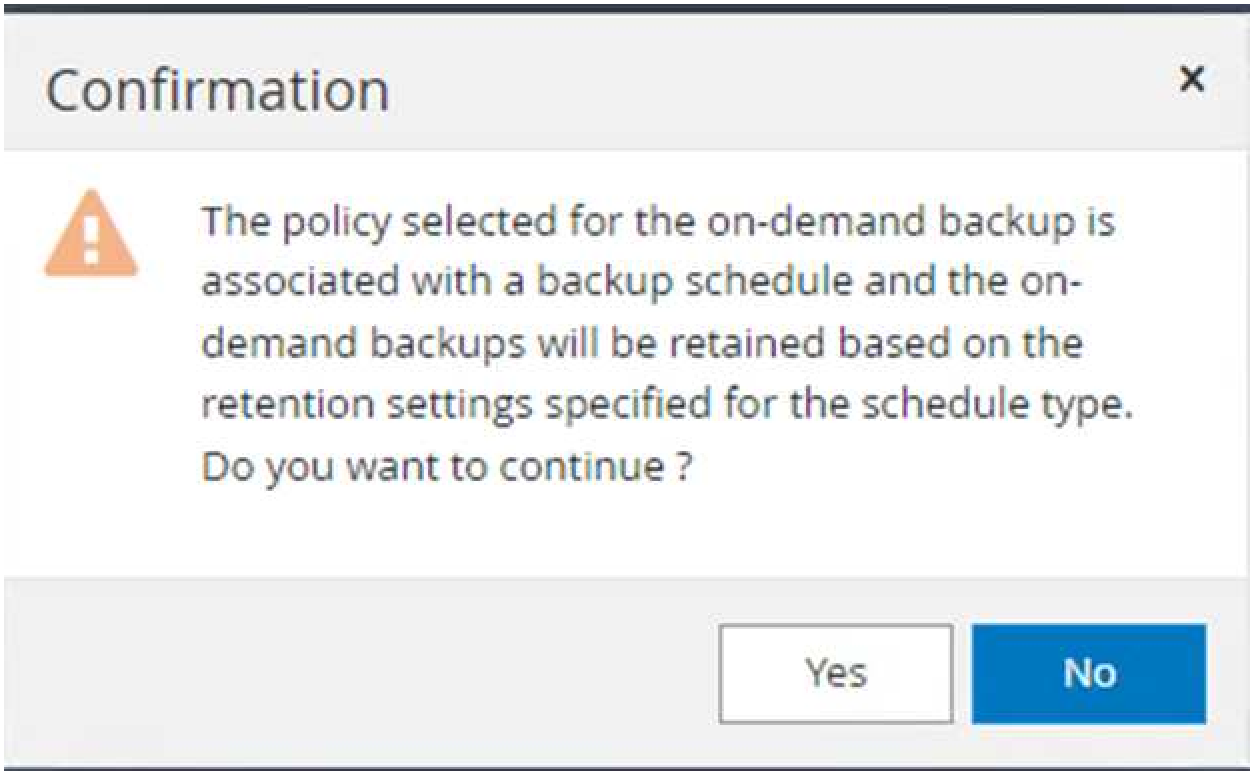
Resource Name: TestDB

Policy: TestDB-fullbackup-policy

☐ Verify after backup

Cancel
Backup
Activate Windows
Go to Settings to activate Windows.

3. A confirmation screen is displayed. Click **Yes** to confirm.

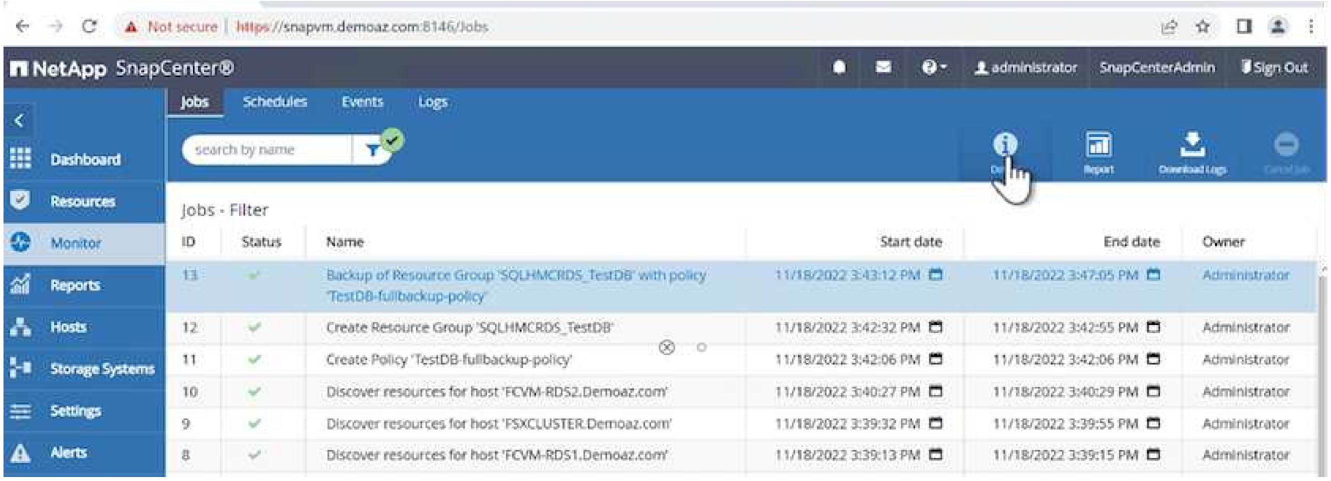


Confirmation

The policy selected for the on-demand backup is associated with a backup schedule and the on-demand backups will be retained based on the retention settings specified for the schedule type. Do you want to continue ?

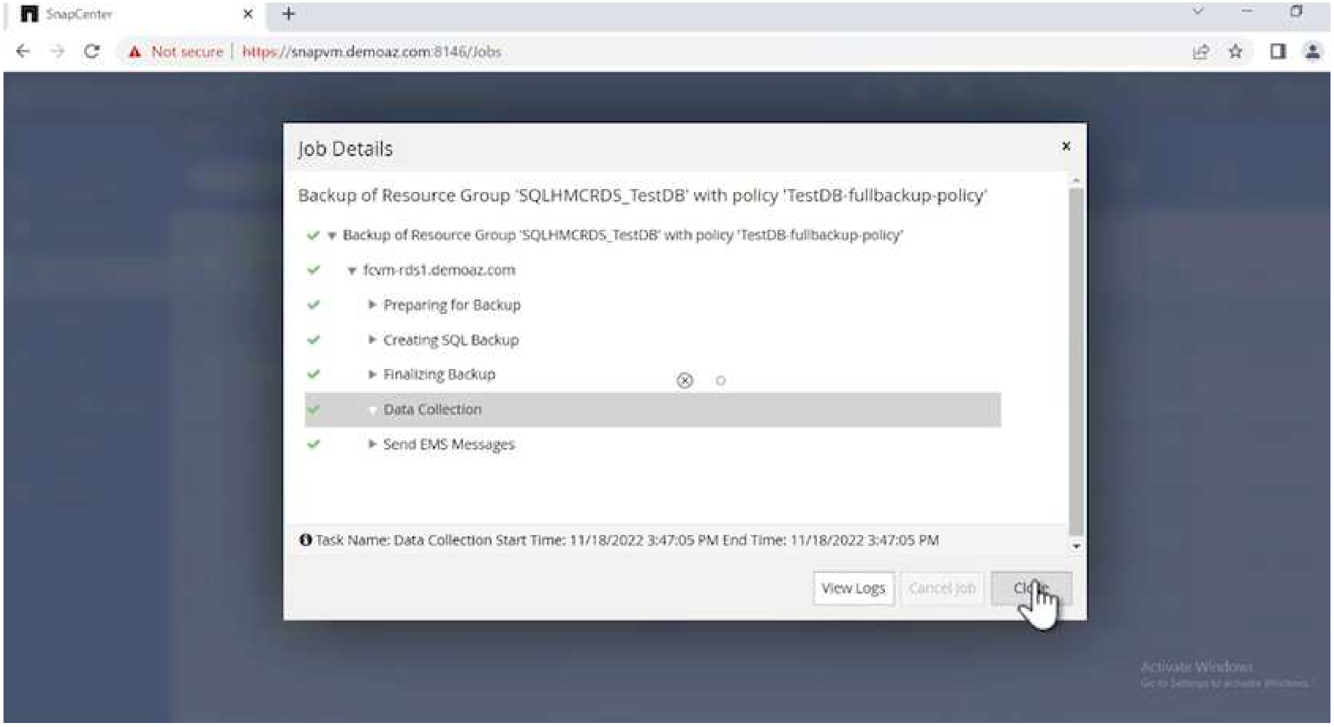
Monitor backup job

1. From the **Monitor** tab, click the job and select **Details** on the right to view the jobs.



Jobs - Filter

ID	Status	Name	Start date	End date	Owner
13	✓	Backup of Resource Group 'SQLHMCRDS_TestDB' with policy 'TestDB-fullbackup-policy'	11/18/2022 3:43:12 PM	11/18/2022 3:47:05 PM	Administrator
12	✓	Create Resource Group 'SQLHMCRDS_TestDB'	11/18/2022 3:42:32 PM	11/18/2022 3:42:55 PM	Administrator
11	✓	Create Policy 'TestDB-fullbackup-policy'	11/18/2022 3:42:06 PM	11/18/2022 3:42:06 PM	Administrator
10	✓	Discover resources for host 'FCVM-RDS2.Demoaz.com'	11/18/2022 3:40:27 PM	11/18/2022 3:40:29 PM	Administrator
9	✓	Discover resources for host 'FSXCLUSTER.Demoaz.com'	11/18/2022 3:39:32 PM	11/18/2022 3:39:55 PM	Administrator
8	✓	Discover resources for host 'FCVM-RDS1.Demoaz.com'	11/18/2022 3:39:13 PM	11/18/2022 3:39:15 PM	Administrator



Job Details

Backup of Resource Group 'SQLHMCRDS_TestDB' with policy 'TestDB-fullbackup-policy'

- ✓ ▾ Backup of Resource Group 'SQLHMCRDS_TestDB' with policy 'TestDB-fullbackup-policy'
  - ✓ ▾ fcvm-rds1.demoaz.com
    - ✓ ▸ Preparing for Backup
    - ✓ ▸ Creating SQL Backup
    - ✓ ▸ Finalizing Backup
    - ✓ Data Collection
    - ✓ ▸ Send EMS Messages

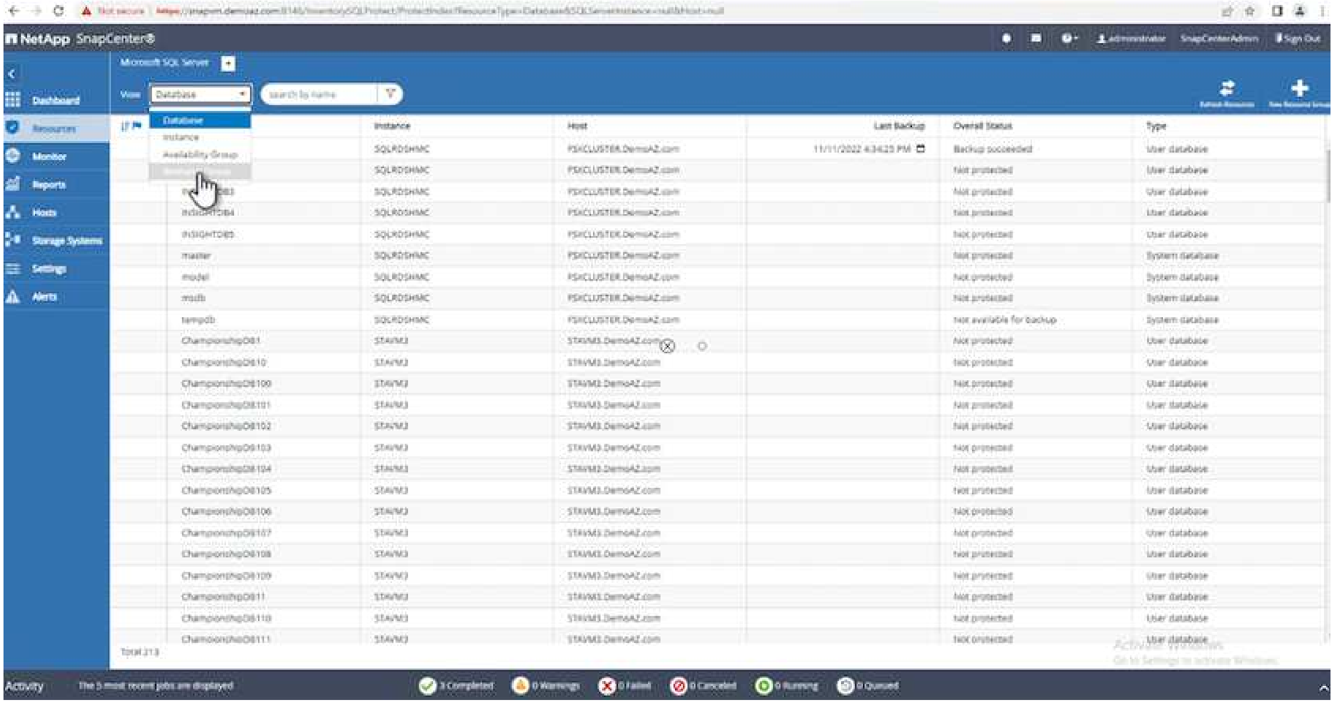
Task Name: Data Collection Start Time: 11/18/2022 3:47:05 PM End Time: 11/18/2022 3:47:05 PM

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.

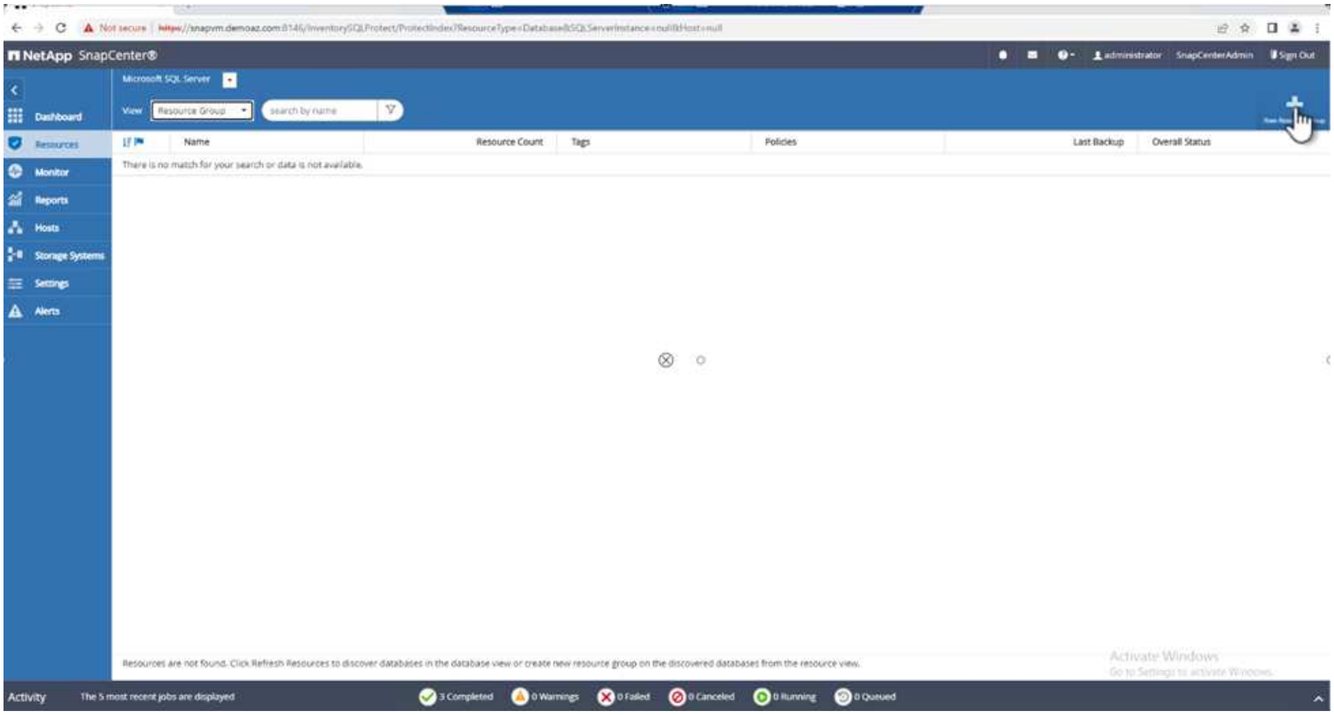


Name	Instance	Host	Last Backup	Overall Status	Type
	SQLRDSHMC	FSXCLUSTER.DemoAZ.com	11/11/2022 4:34:25 PM	Backup succeeded	User database
	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
INSIGHTDB4	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
INSIGHTDB5	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
master	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	System database
model	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	System database
msdb	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	System database
tempdb	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not available for backup	System database
ChampionshipDB1	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB10	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB100	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB101	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB102	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB103	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB104	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB105	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB106	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB107	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB108	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB109	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB11	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB110	STAVM3	STAVM3.DemoAZ.com		Not protected	User database
ChampionshipDB111	STAVM3	STAVM3.DemoAZ.com		Not protected	User database

Total 213

Activity The 5 most recent jobs are displayed 3 Completed 0 Warnings 0 Failed 0 Canceled 0 Running 0 Queued

2. Click (**+**) for a new resource group.



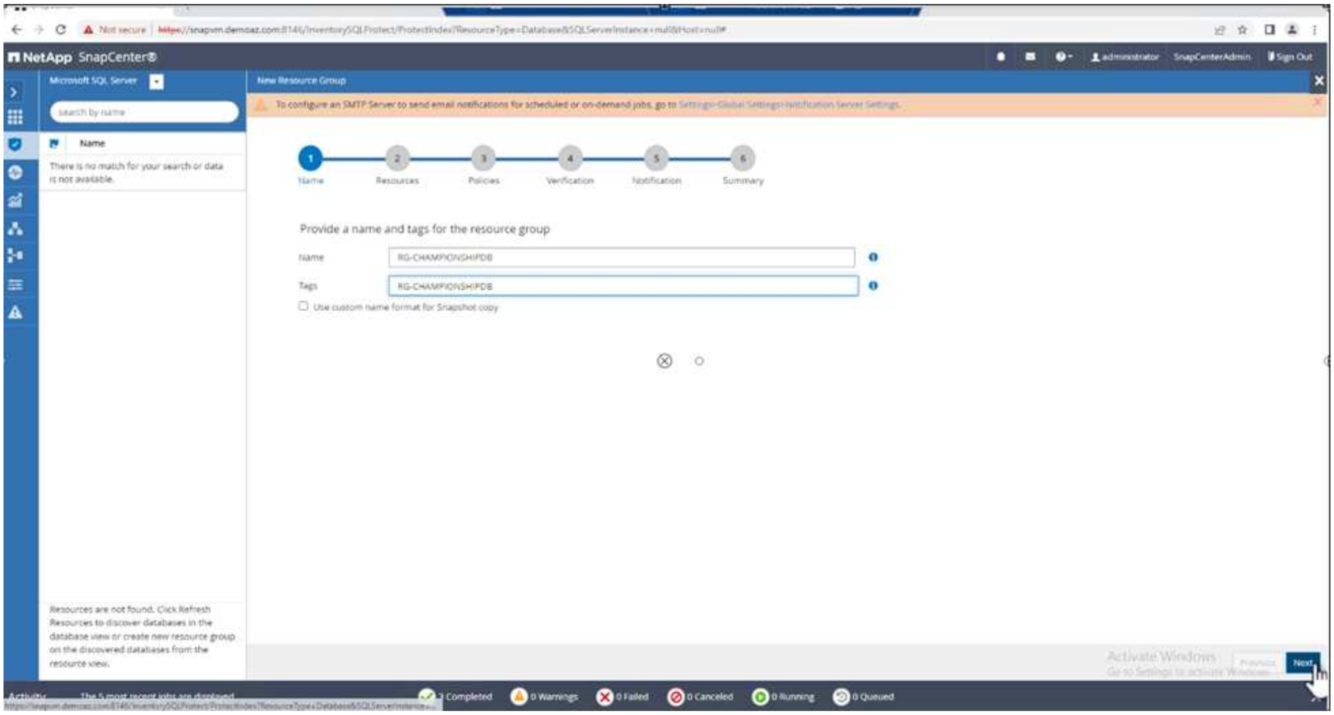
Name	Resource Count	Tags	Policies	Last Backup	Overall Status

There is no match for your search or data is not available.

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.

Activity The 5 most recent jobs are displayed 3 Completed 0 Warnings 0 Failed 0 Canceled 0 Running 0 Queued

3. Provide a name and tag. Click **Next**.



To configure an SMTP Server to send email notifications for scheduled or on-demand jobs, go to Settings>Global Settings>Notification Server Settings.

There is no match for your search or data is not available.

Provide a name and tags for the resource group

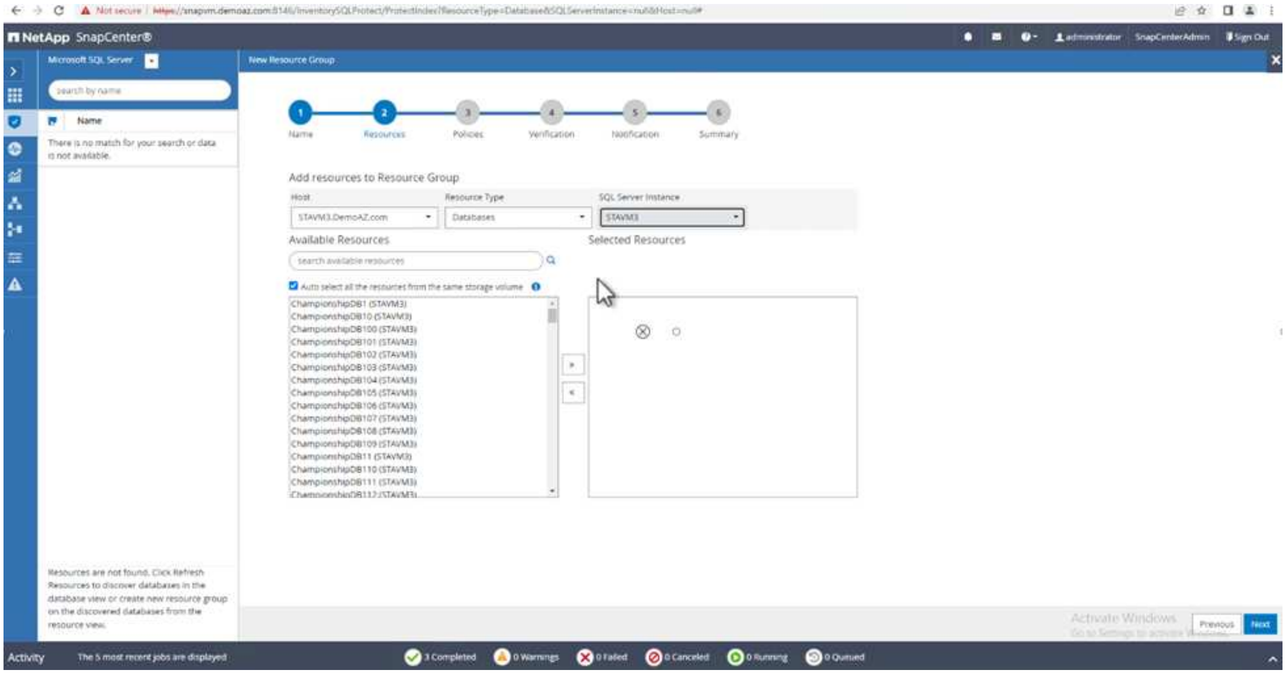
Name: RG-CHAMPIONSHIPDB

Tags: RG-CHAMPIONSHIPDB

☐ Use custom name format for Snapshot copy

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.

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.



There is no match for your search or data is not available.

Add resources to Resource Group

Host: STAVM3.DemoAZ.com

Resource Type: Databases

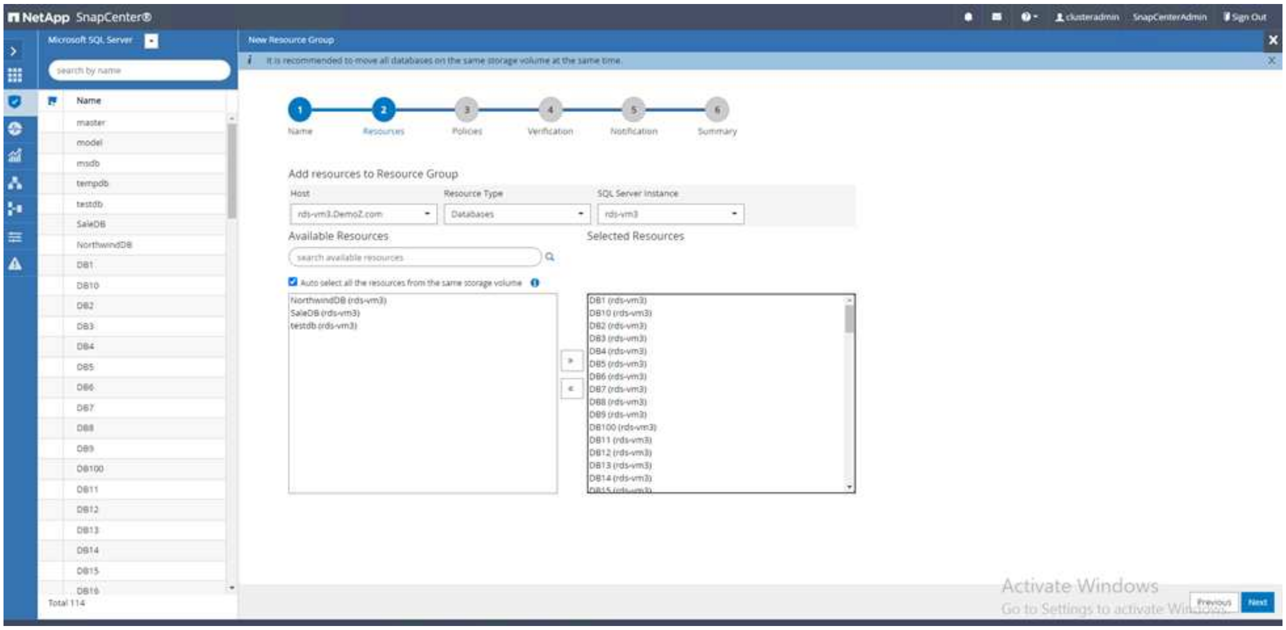
SQL Server Instance: STAVM3

☑ Auto select all the resources from the same storage volume

ChampionshipDB1 (STAVM3)
ChampionshipDB10 (STAVM3)
ChampionshipDB100 (STAVM3)
ChampionshipDB101 (STAVM3)
ChampionshipDB102 (STAVM3)
ChampionshipDB103 (STAVM3)
ChampionshipDB104 (STAVM3)
ChampionshipDB105 (STAVM3)
ChampionshipDB106 (STAVM3)
ChampionshipDB107 (STAVM3)
ChampionshipDB108 (STAVM3)
ChampionshipDB109 (STAVM3)
ChampionshipDB11 (STAVM3)
ChampionshipDB110 (STAVM3)
ChampionshipDB111 (STAVM3)
ChampionshipDB112 (STAVM3)

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 **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**.



It is recommended to move all databases on the same storage volume at the same time.

Add resources to Resource Group

Host: rds-vm3.Demo2.com
Resource Type: Databases
SQL Server Instance: rds-vm3

Available Resources

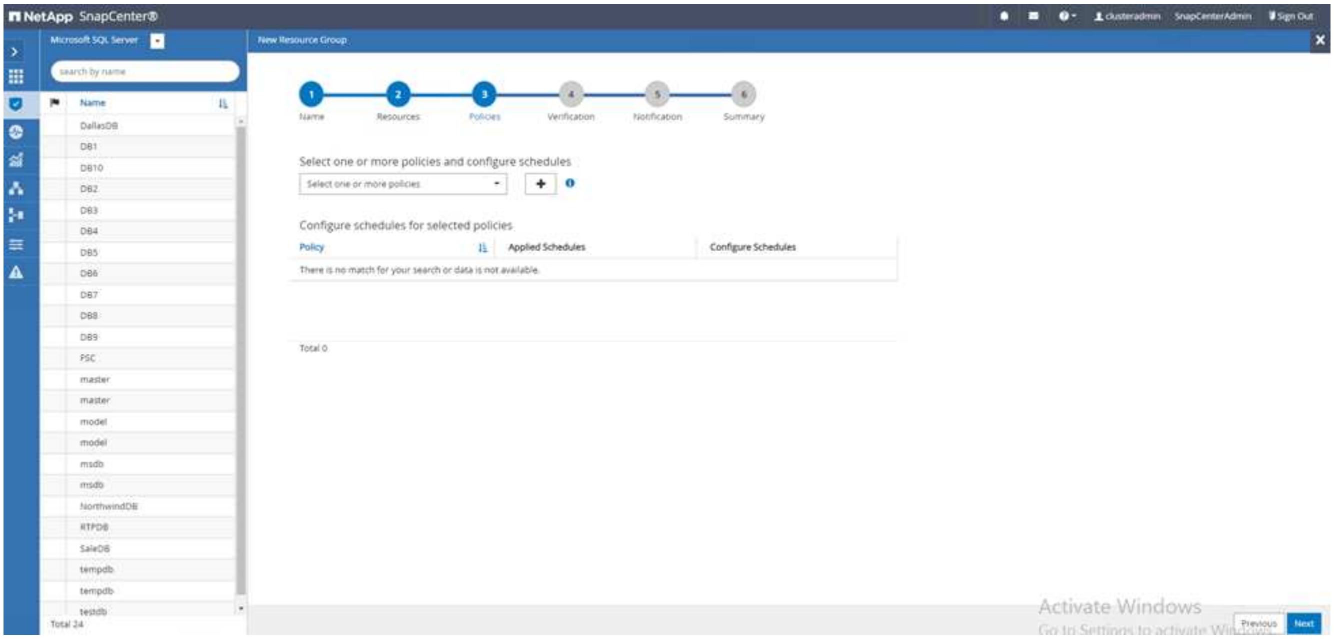
☑ Auto select all the resources from the same storage volume

NorthwindDB (rds-vm3)
SaleDB (rds-vm3)
testdb (rds-vm3)

Selected Resources

DB1 (rds-vm3)
DB10 (rds-vm3)
DB2 (rds-vm3)
DB3 (rds-vm3)
DB4 (rds-vm3)
DB5 (rds-vm3)
DB6 (rds-vm3)
DB7 (rds-vm3)
DB8 (rds-vm3)
DB9 (rds-vm3)
DB100 (rds-vm3)
DB11 (rds-vm3)
DB12 (rds-vm3)
DB13 (rds-vm3)
DB14 (rds-vm3)
DB15 (rds-vm3)

5. On the policies, click (**+**).

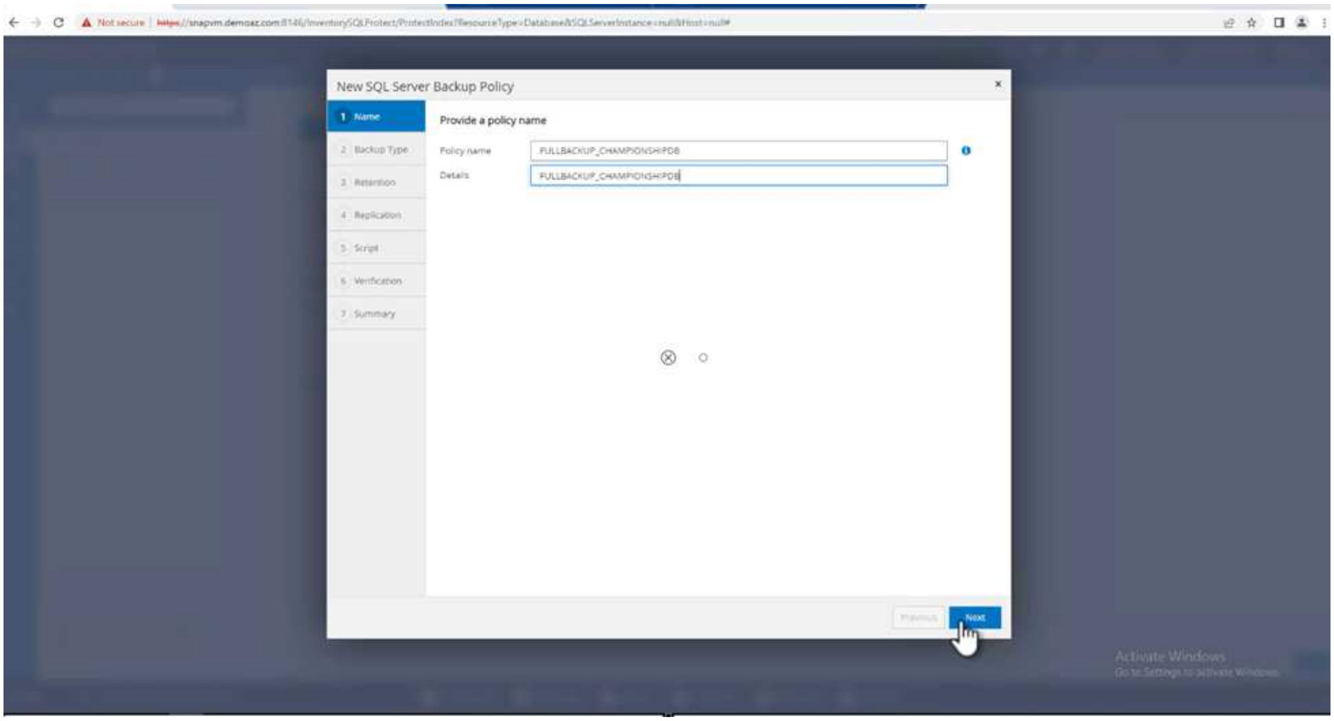


Select one or more policies and configure schedules

Configure schedules for selected policies

There is no match for your search or data is not available.

6. Enter the resource group policy name.

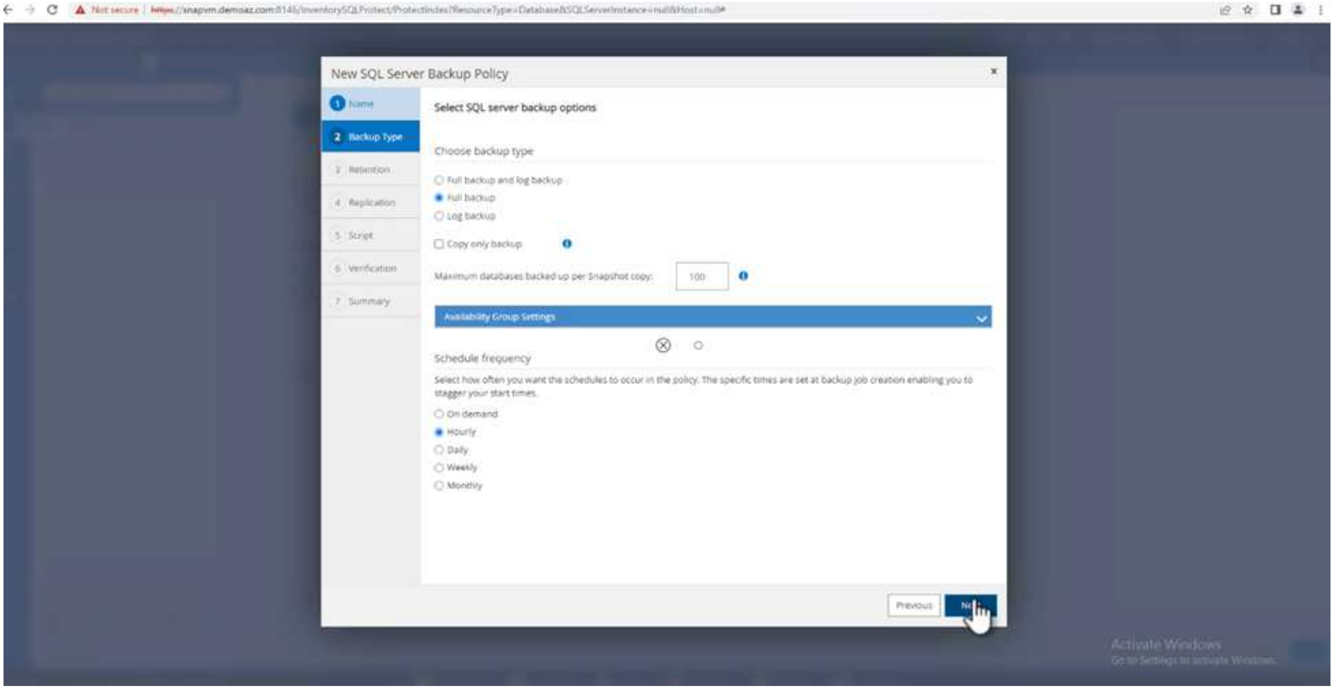


Provide a policy name

Policy name: FULLBACKUP_CHAMPIONSHIPDB

Details: FULLBACKUP_CHAMPIONSHIPDB

7. Select **Full backup** and the schedule frequency depending on your company’s SLA.



Select SQL server backup options

Choose backup type

○ Full backup and log backup
● Full backup
○ Log backup

☐ Copy only backup

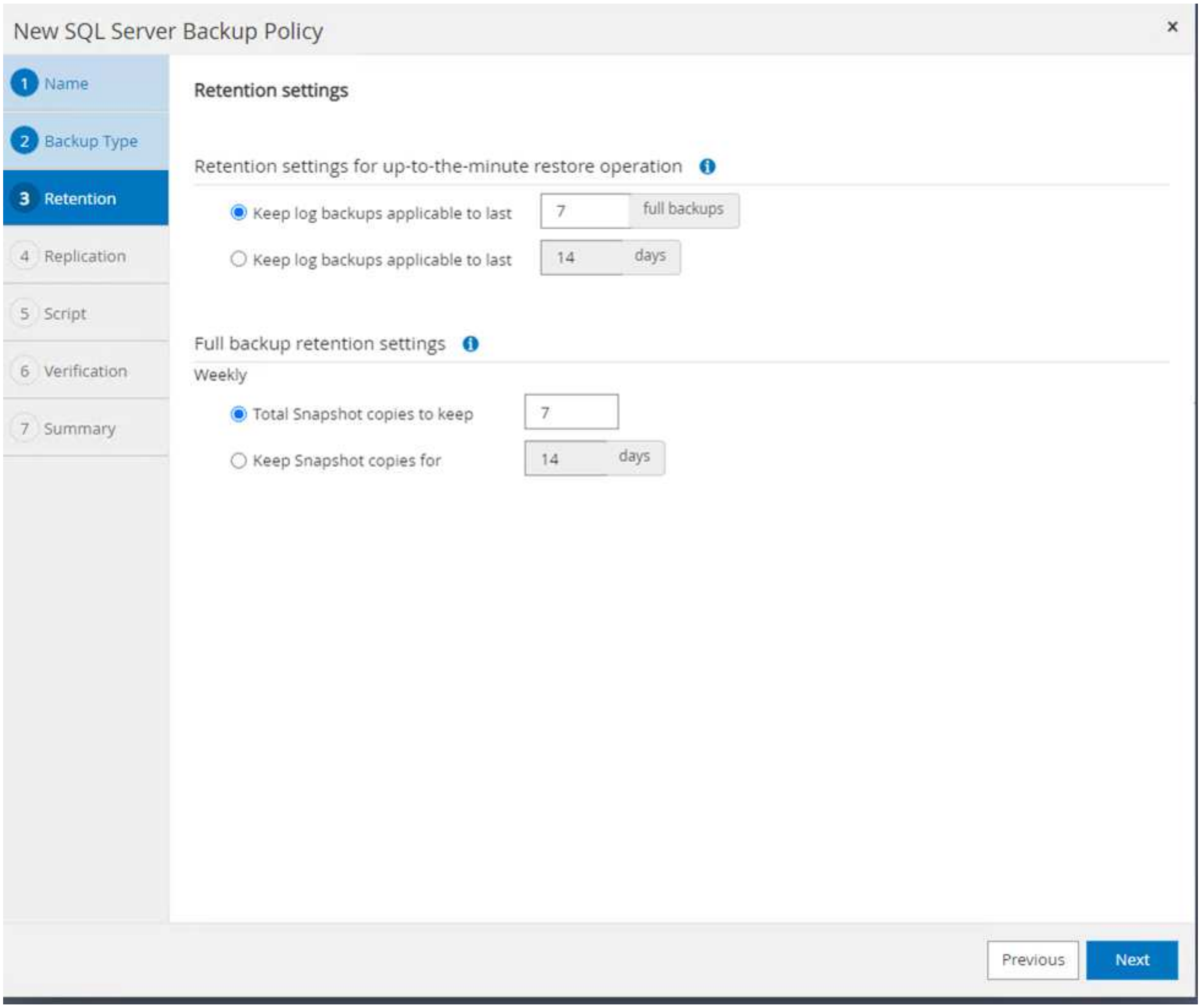
Maximum databases backed up per Snapshot copy: 100

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

8. Configure the retention settings.



Retention settings

Retention settings for up-to-the-minute restore operation

● Keep log backups applicable to last 7 full backups

○ Keep log backups applicable to last 14 days

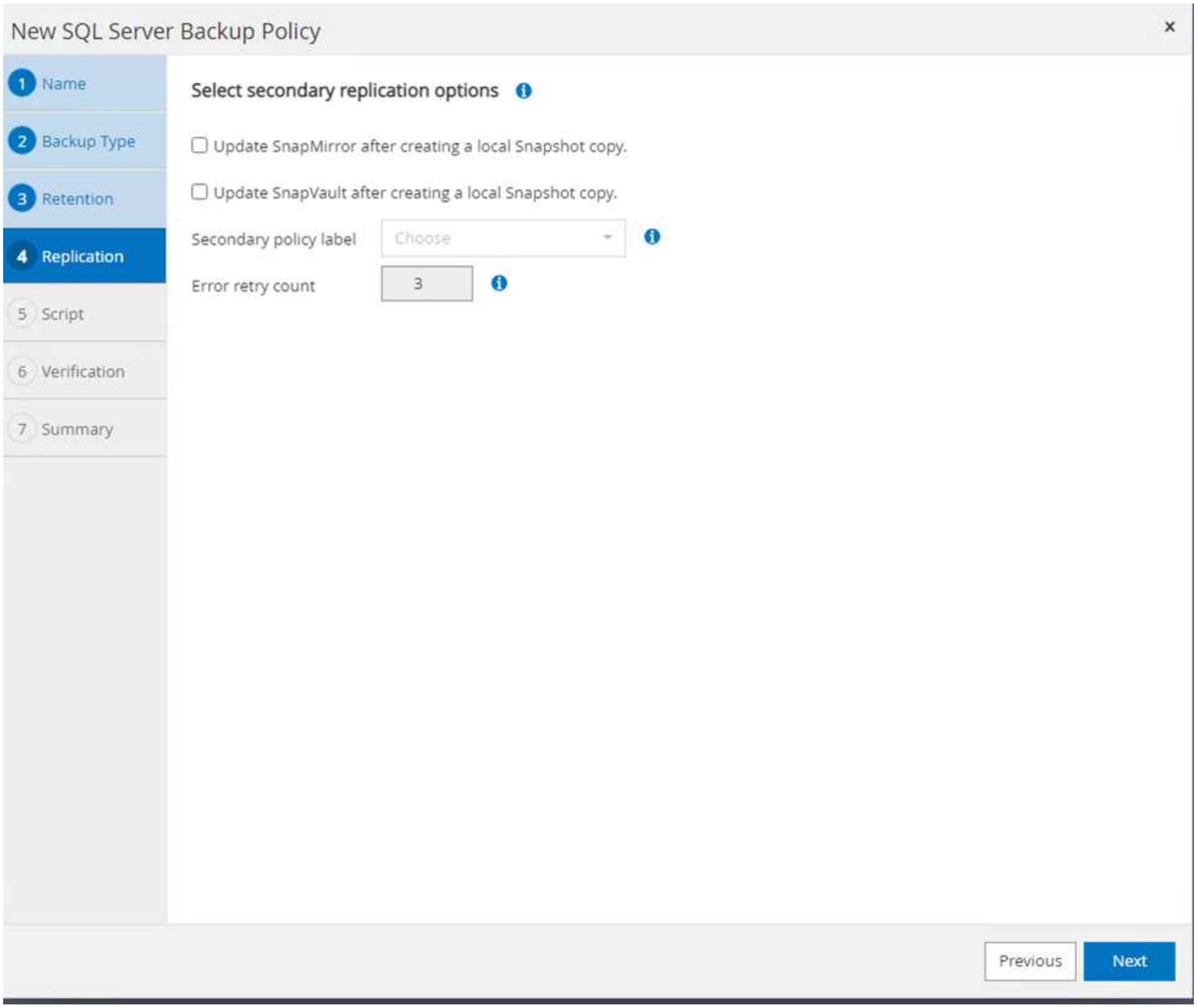
Full backup retention settings

Weekly

● Total Snapshot copies to keep 7

○ Keep Snapshot copies for 14 days

9. Configure the replication options.



Select secondary replication options

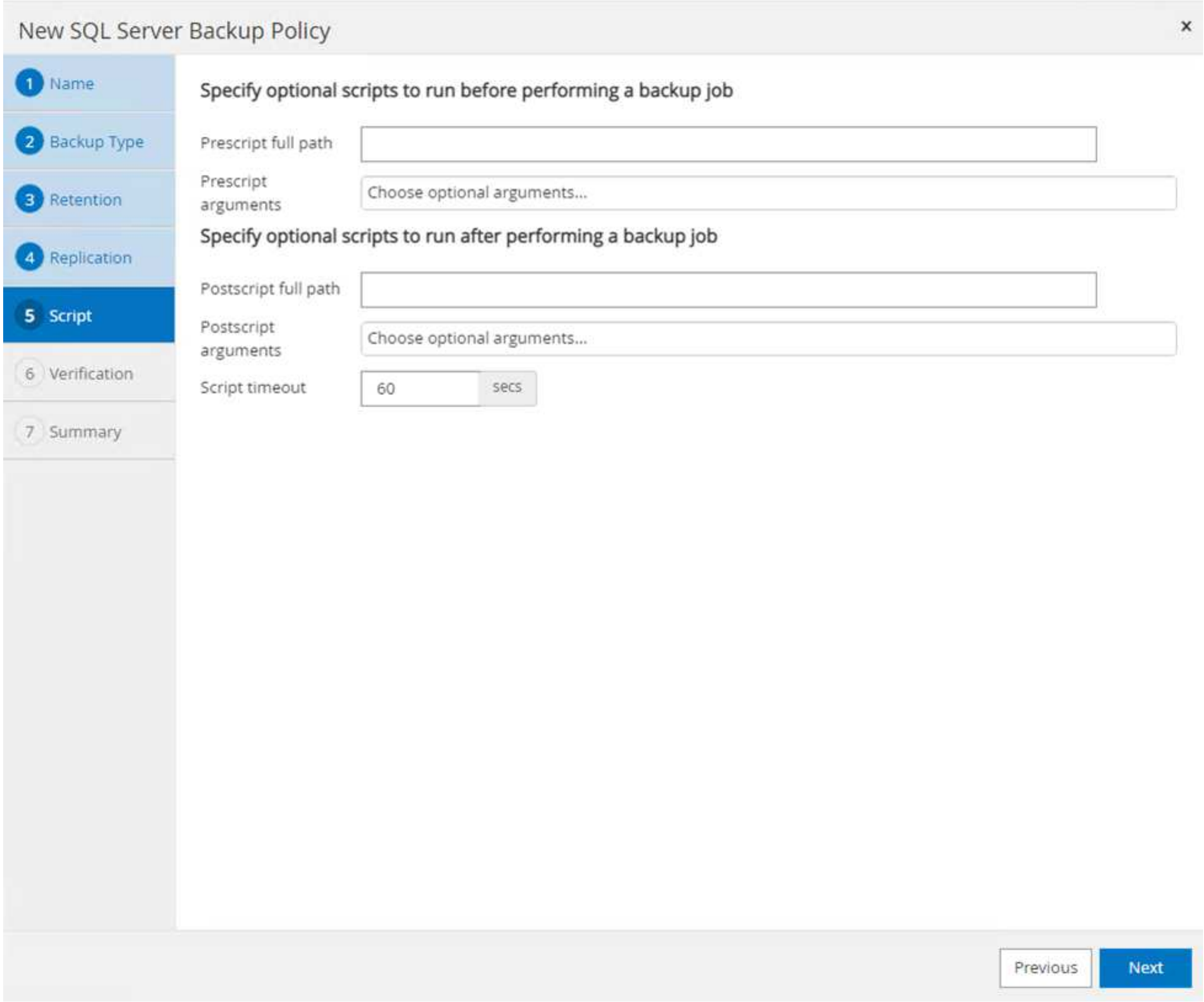
☐ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Choose

Error retry count: 3

10. Configure the scripts to run before performing a backup. Click **Next**.



Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments: Choose optional arguments...

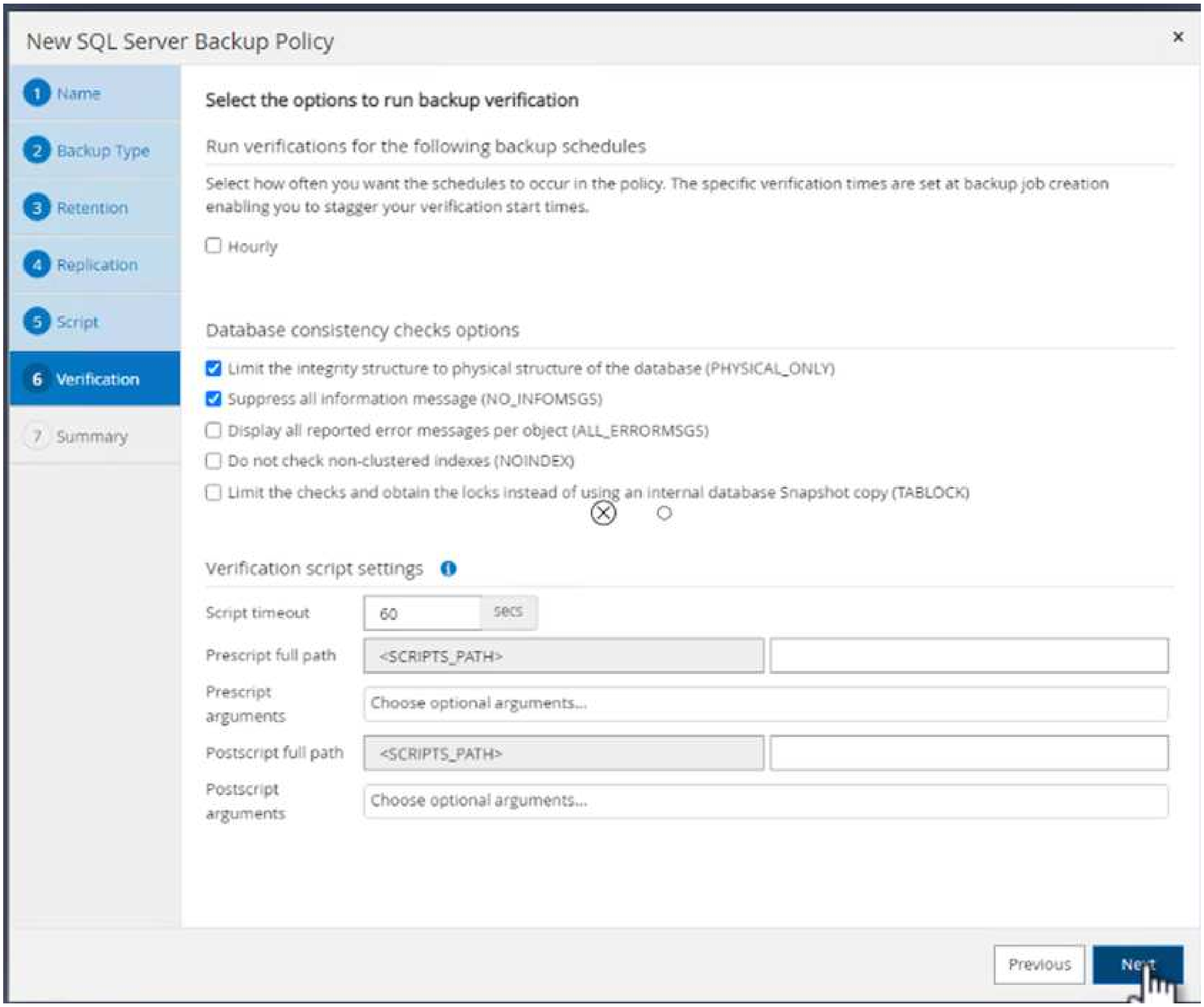
Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

11. Confirm the verification for the following backup schedules.



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.

☐ Hourly

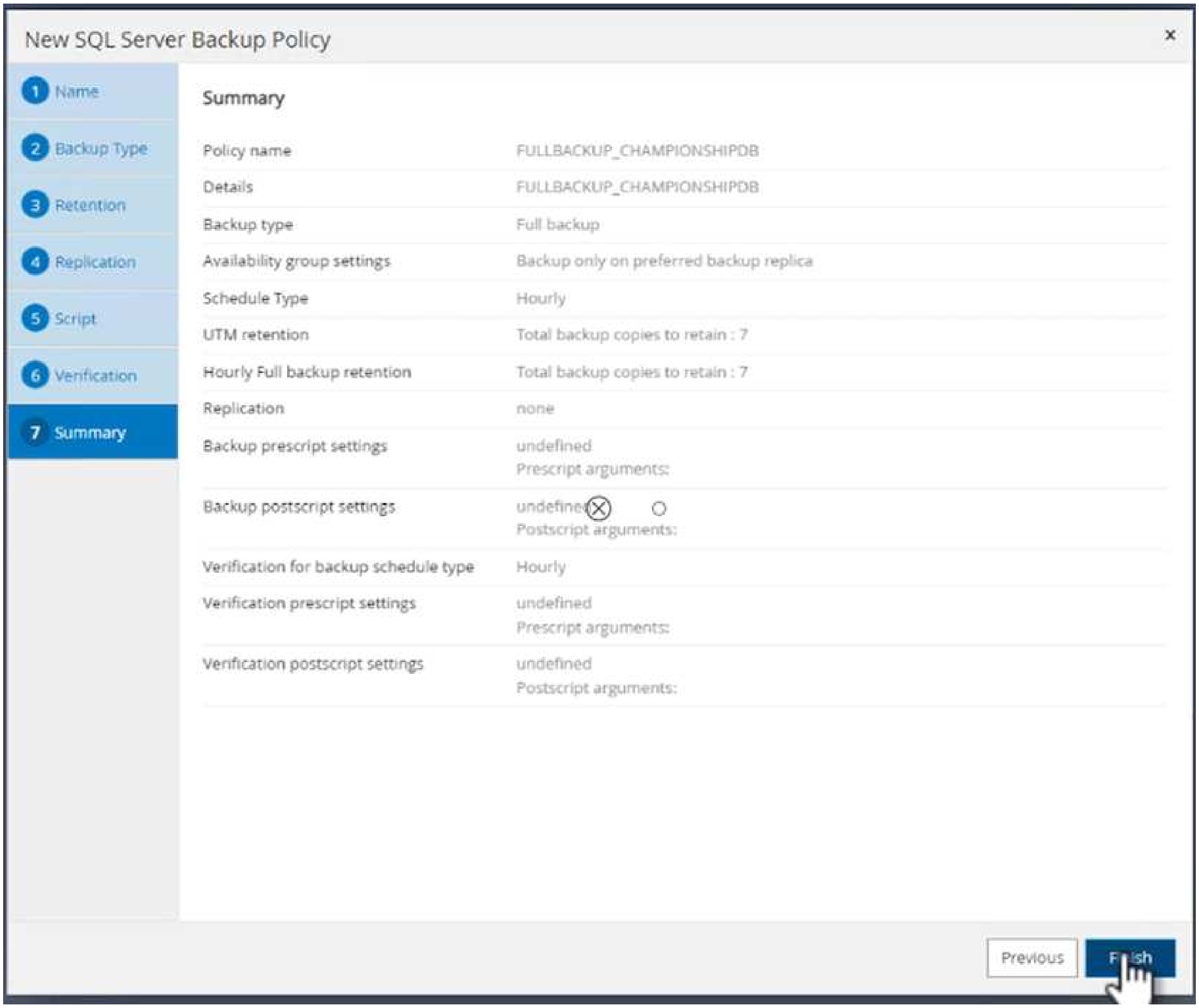
Database consistency checks options

☑ 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_ERRORMSGS)
☐ 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: <SCRIPTS_PATH>
Prescript arguments: Choose optional arguments...
Postscript full path: <SCRIPTS_PATH>
Postscript arguments: Choose optional arguments...

12. On the **Summary** page, verify the information, and click **Finish**.

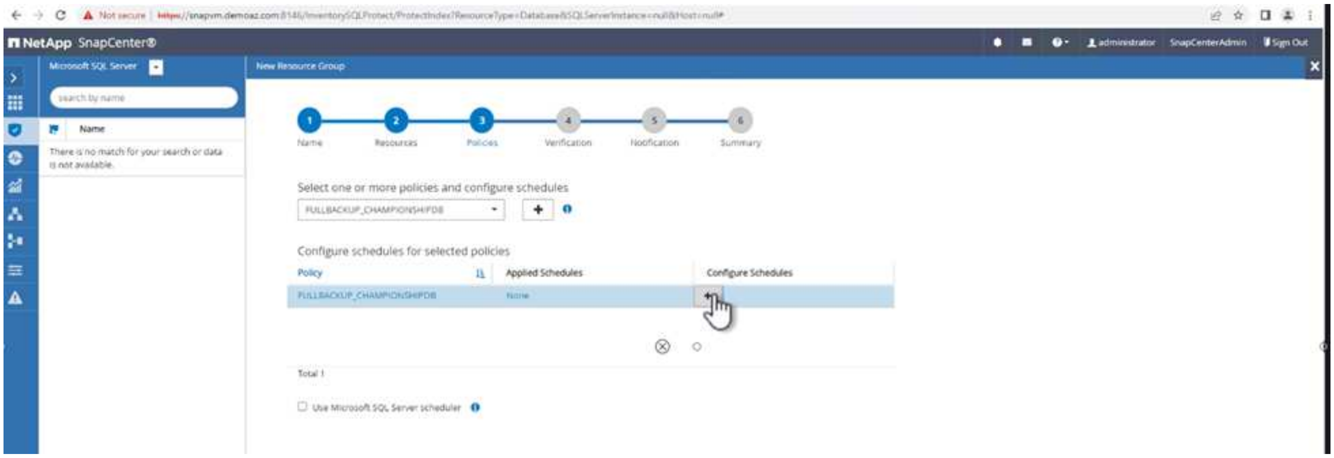


Summary

Policy name	FULLBACKUP_CHAMPIONSHIPDB
Details	FULLBACKUP_CHAMPIONSHIPDB
Backup type	Full backup
Availability group settings	Backup only on preferred backup replica
Schedule Type	Hourly
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:
Backup postscript settings	undefined Postscript arguments:
Verification for backup schedule type	Hourly
Verification prescript settings	undefined Prescript arguments:
Verification postscript settings	undefined Postscript arguments:

Configure and protect multiple SQL Server databases

1. Click the (**+**) sign to configure the start date and the expire- on date.



There is no match for your search or data is not available.

Select one or more policies and configure schedules

FULLBACKUP_CHAMPIONSHIPDB

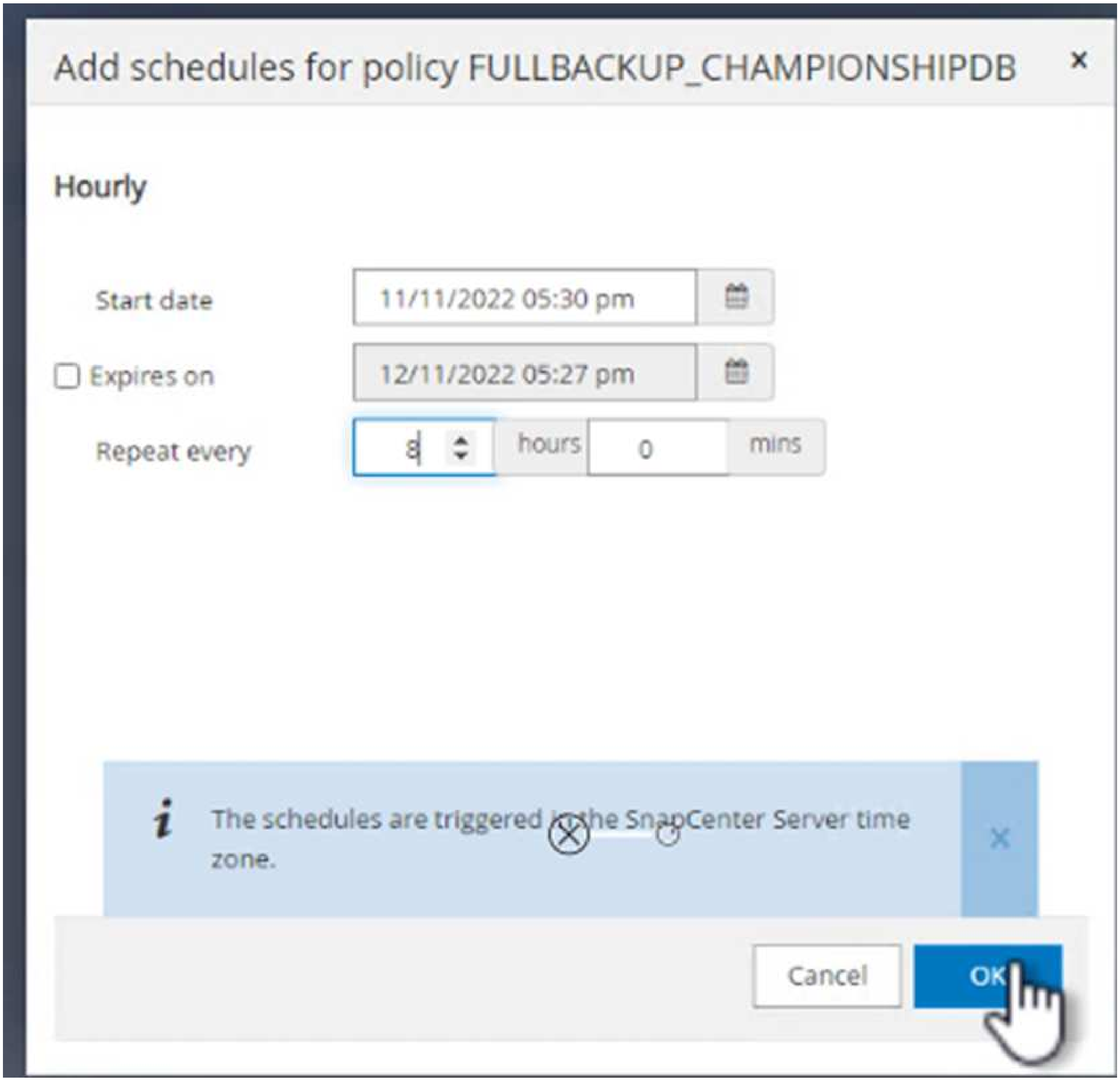
Configure schedules for selected policies

Policy	Applied Schedules	Configure Schedules
FULLBACKUP_CHAMPIONSHIPDB	None	+

Total 1

☐ Use Microsoft SQL Server scheduler

2. Set the time.



Add schedules for policy FULLBACKUP_CHAMPIONSHIPDB

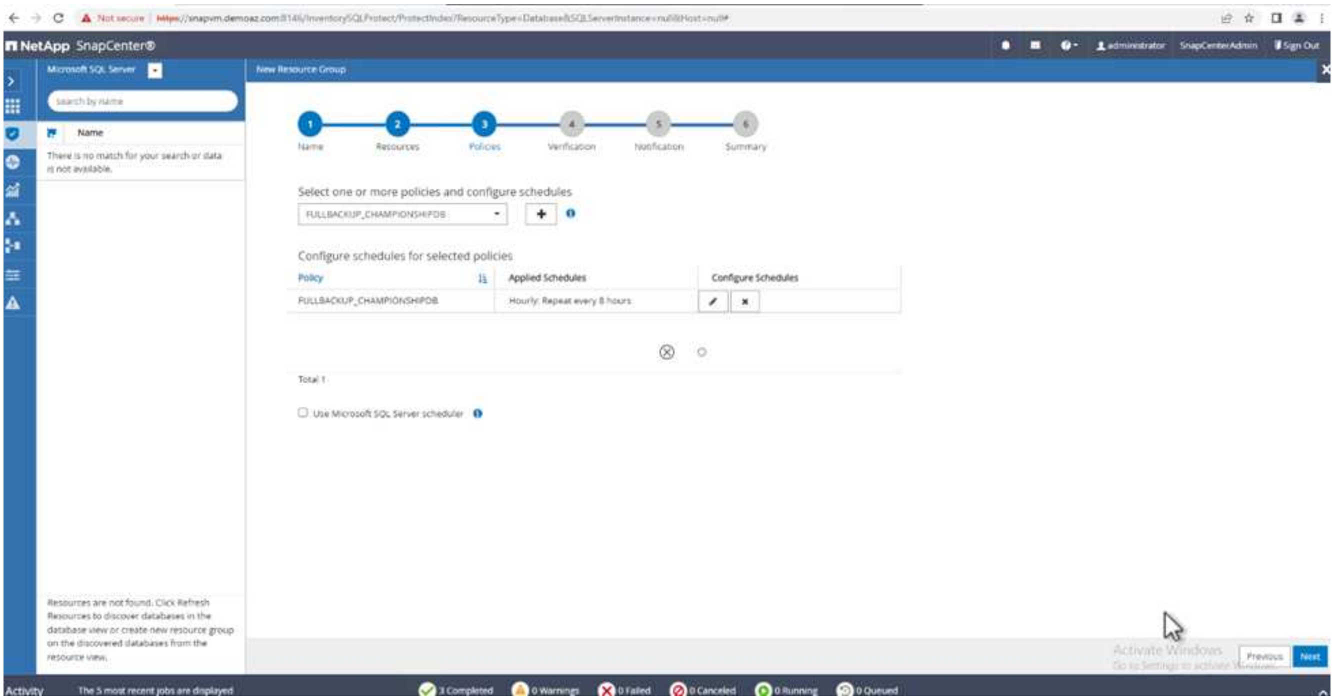
Hourly

Start date 11/11/2022 05:30 pm

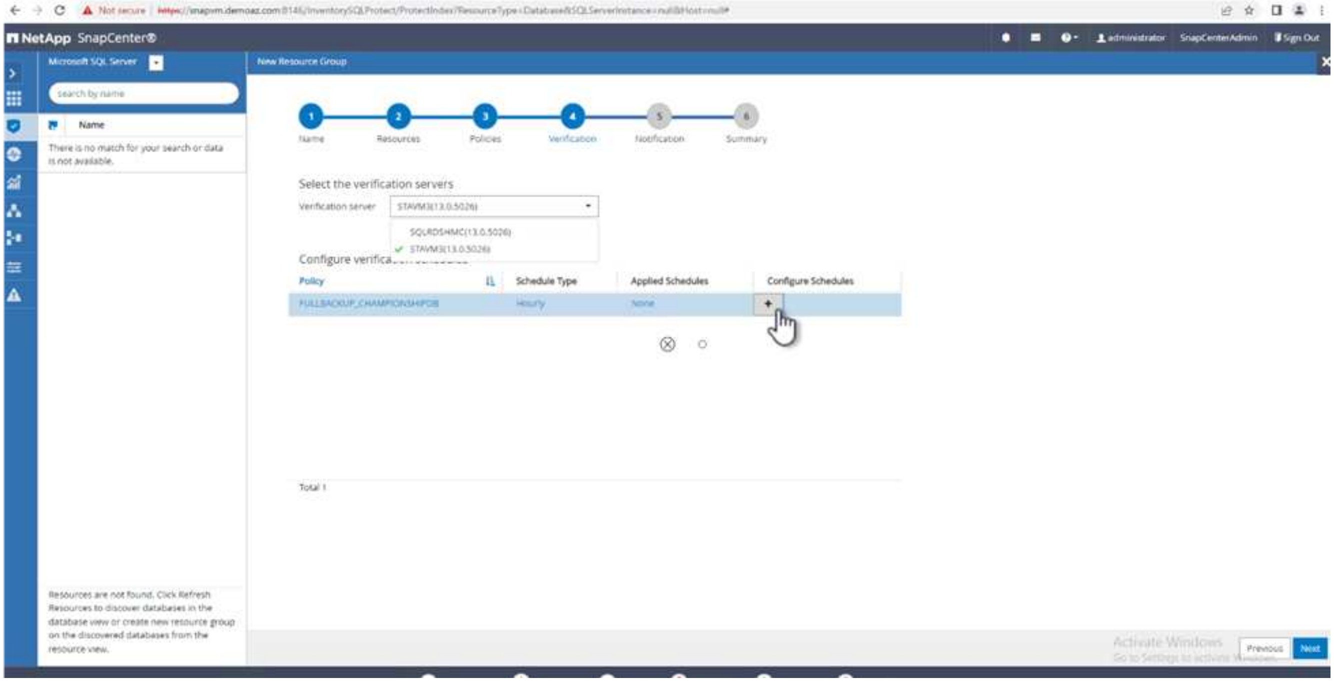
☐ Expires on 12/11/2022 05:27 pm

Repeat every 8 hours 0 mins

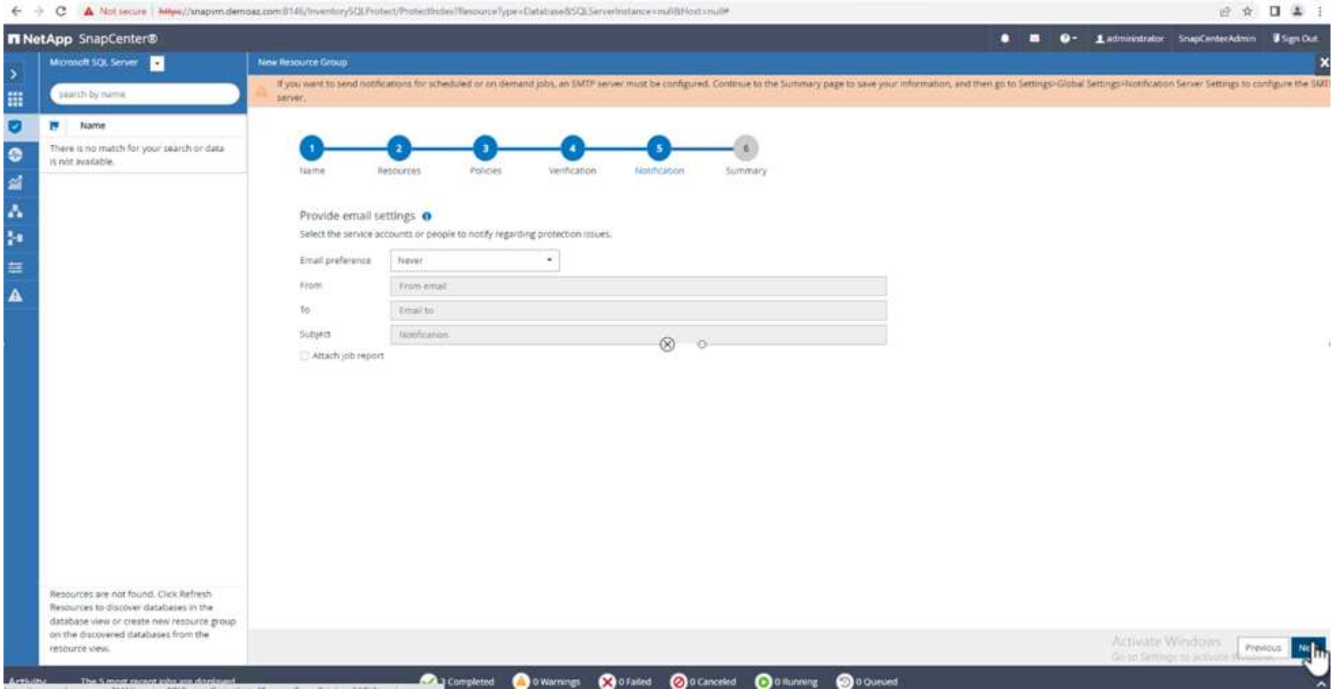
The schedules are triggered in the SnapCenter Server time zone.


NetApp SnapCenter®
Microsoft SQL Server
New Resource Group
Name
Resources
Policies
Verification
Notification
Summary
Select one or more policies and configure schedules
FULLBACKUP_CHAMPIONSHIPDB
Configure schedules for selected policies
Policy
Applied Schedules
Configure Schedules
FULLBACKUP_CHAMPIONSHIPDB
Hourly: Repeat every 8 hours
Total 1
Use Microsoft SQL Server scheduler
Previous
Next

3. From the **Verification** tab, select the server, configure the schedule, and click **Next**.



4. Configure notifications to send an email.


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 SMT server.

Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

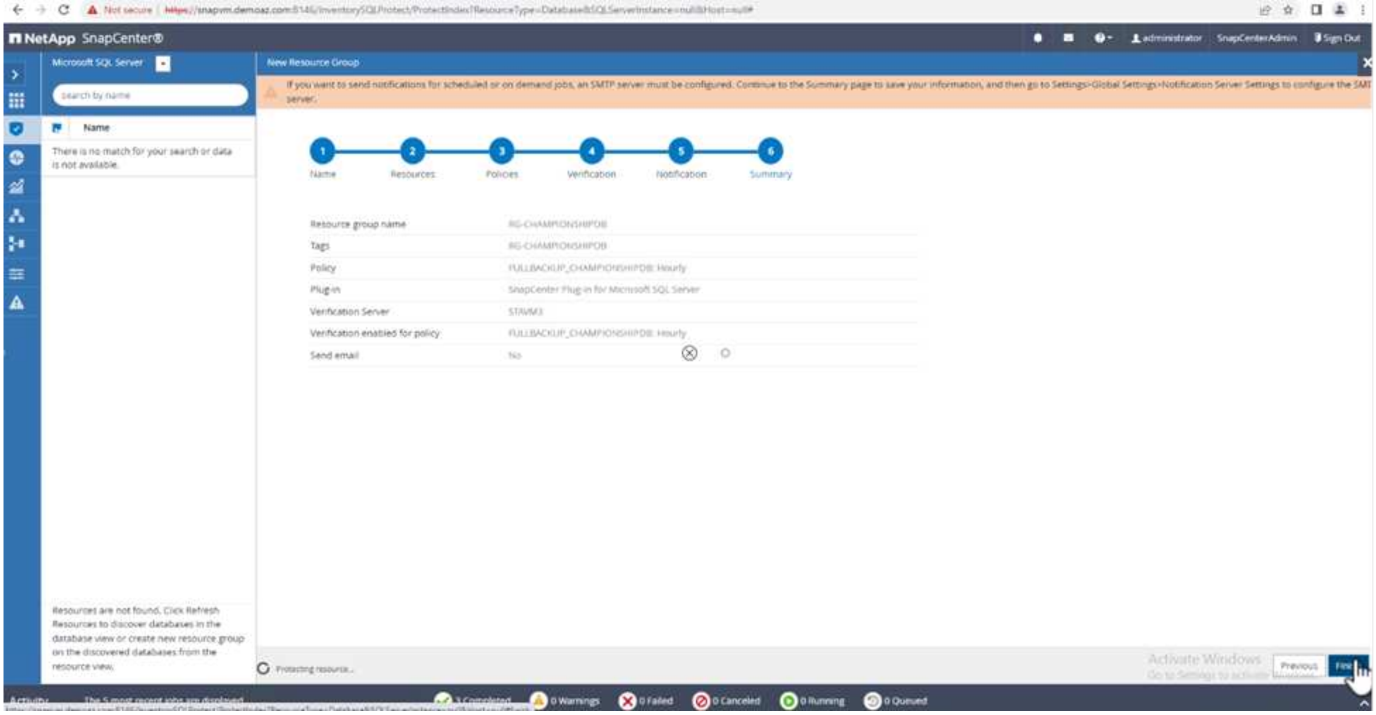
From: From email

To: Email to

Subject: Notification

☐ Attach job report

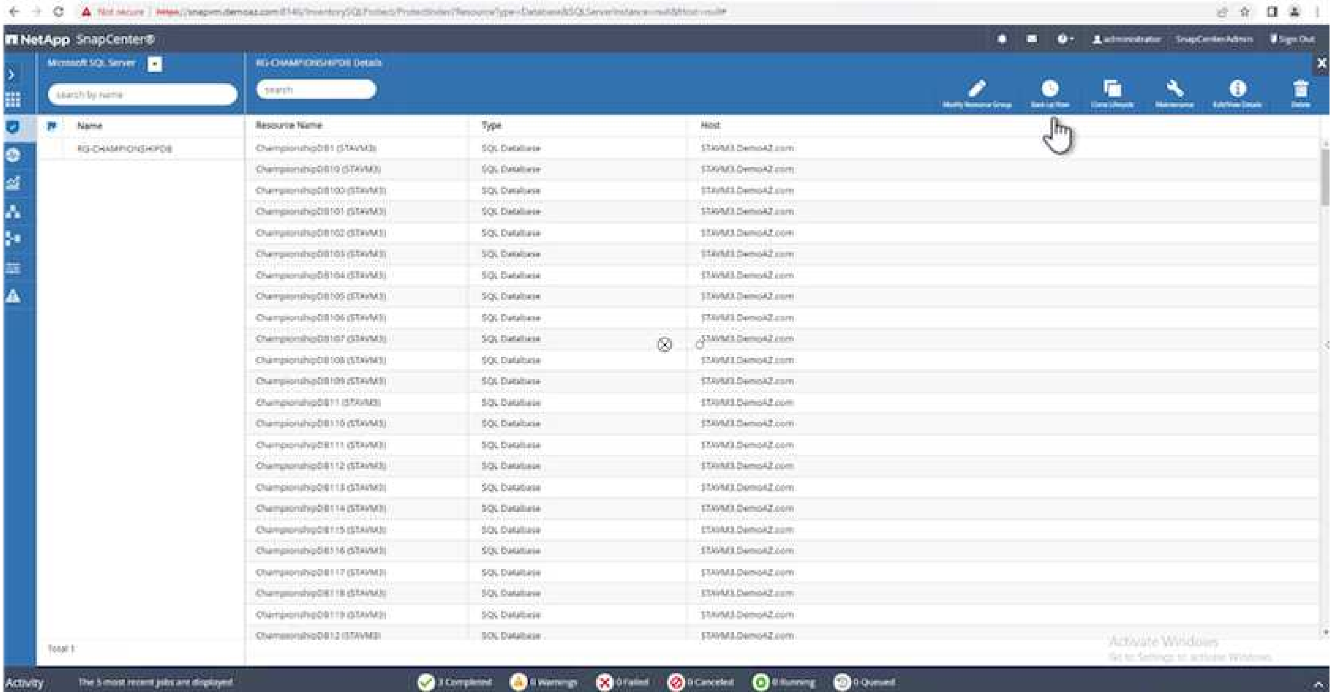
The policy is now configured for backing up multiple SQL Server databases.


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 SMT server.

Resource group name	RG-CHAMPIONSHIPDB
Tags	RG-CHAMPIONSHIPDB
Policy	FULLBACKUP_CHAMPIONSHIPDB: Hourly
Plug-in	SnapCenter Plug-in for Microsoft SQL Server
Verification Server	STAVM3
Verification enabled for policy	FULLBACKUP_CHAMPIONSHIPDB: Hourly
Send email	No

Trigger on-demand backup for multiple SQL Server databases

1. From the **Resource** tab, select view. From the drop-down menu, select **Resource Group**.

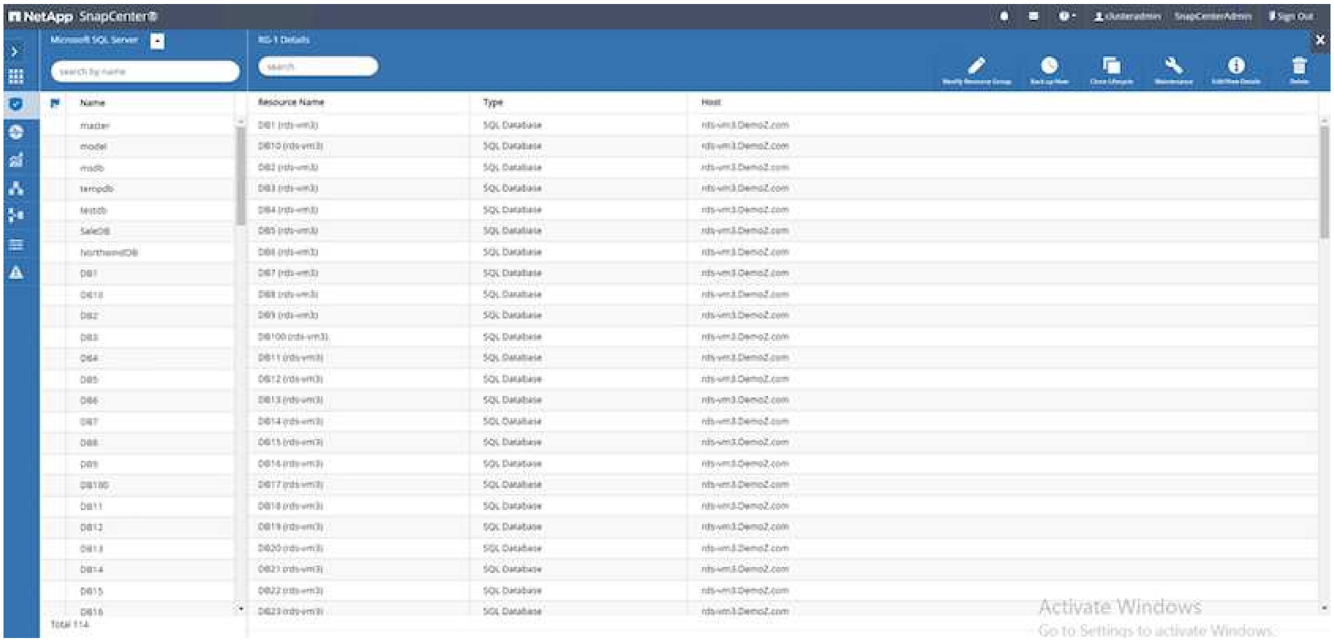


Name
RG-CHAMPIONSHIPDB

Total 1

Resource Name	Type	Host
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

2. Select the resource group name.
3. Click **Backup now** in the upper right.

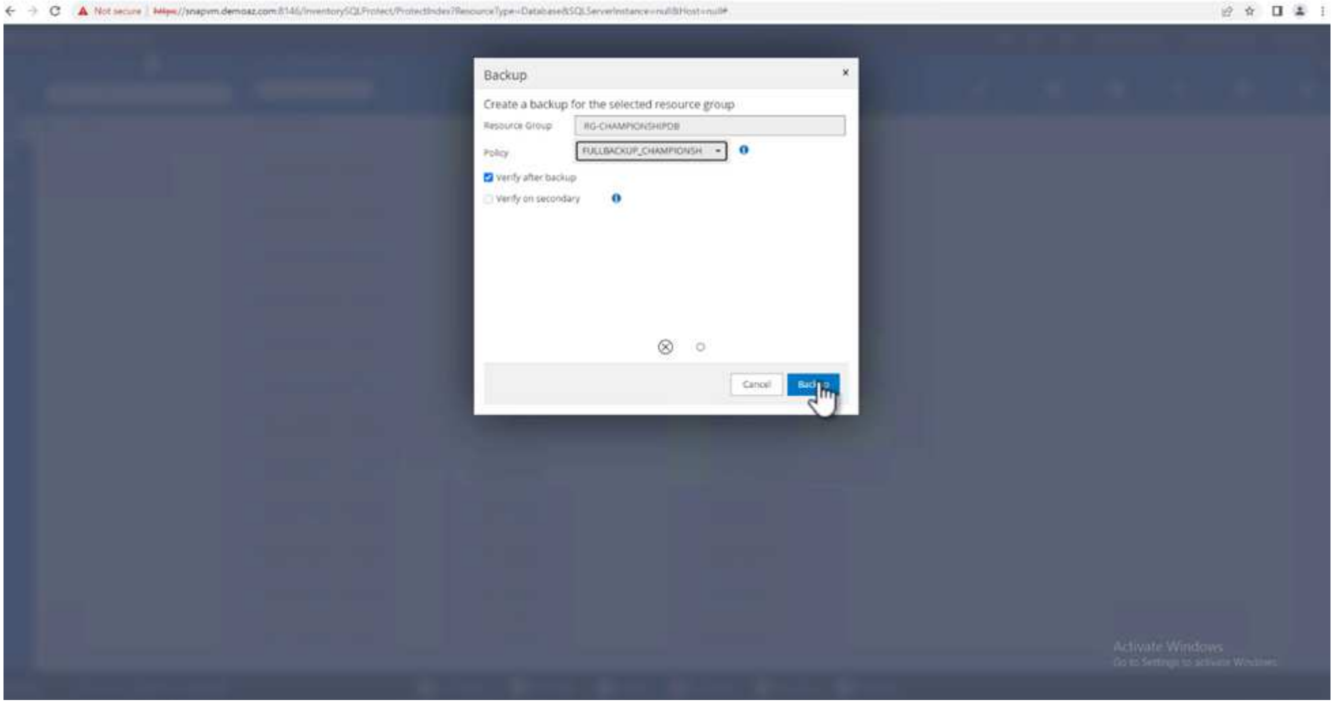


Name
master
model
msdb
tempdb
testdb
SaleDB
NorthwindDB
DB1
DB10
DB2
DB3
DB4
DB5
DB6
DB7
DB8
DB9
DB100
DB11
DB12
DB13
DB14
DB15
DB16

Total 114

Resource Name	Type	Host
DB1 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB10 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB2 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB3 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB4 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB5 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB6 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB7 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB8 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB9 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB100 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB11 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB12 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB13 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB14 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB15 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB16 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB17 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB18 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB19 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB20 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB21 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB22 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com
DB23 (rds-vm3)	SQL Database	rds-vm3.DemoZ.com

4. A new window opens. Click the **Verify after backup** checkbox and then click backup.



Backup

Create a backup for the selected resource group

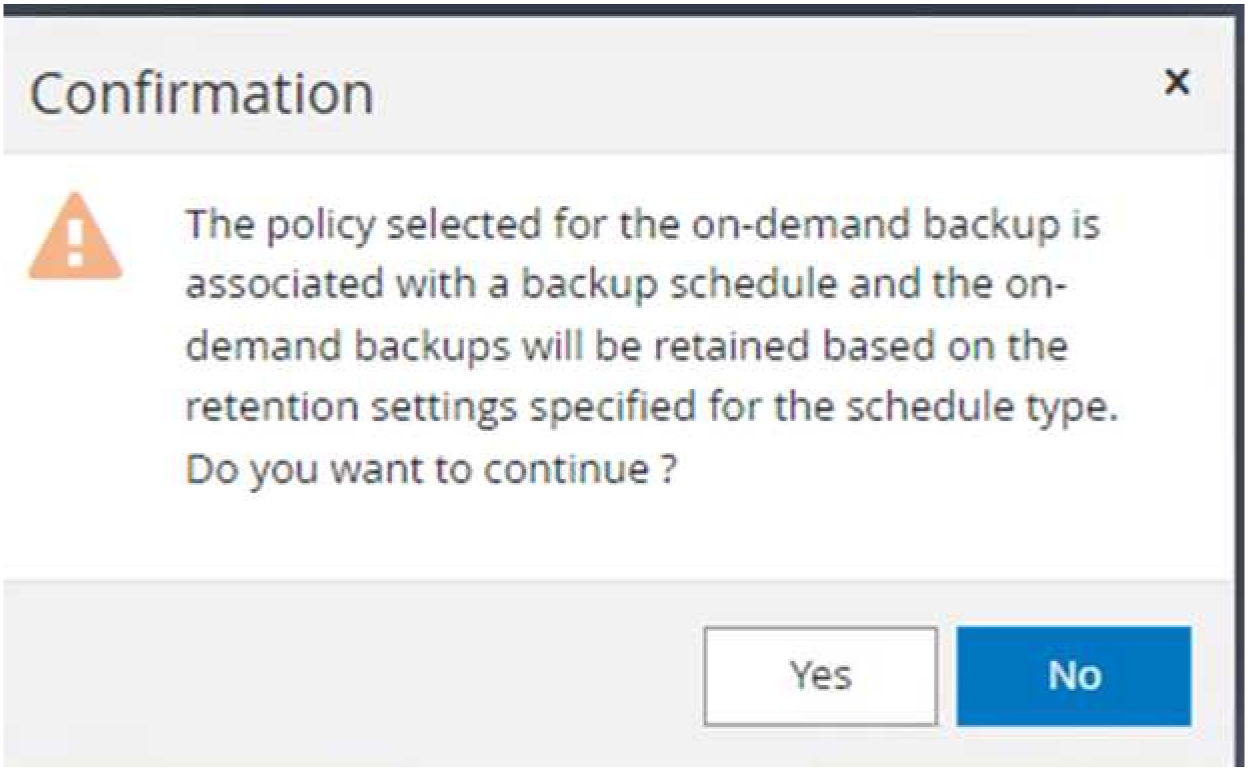
Resource Group: RG-CHAMPIONSHIPDB

Policy: FULLBACKUP_CHAMPIONSH

☑ Verify after backup

☐ Verify on secondary

5. A confirmation message is dsiplayed. Click **Yes**.

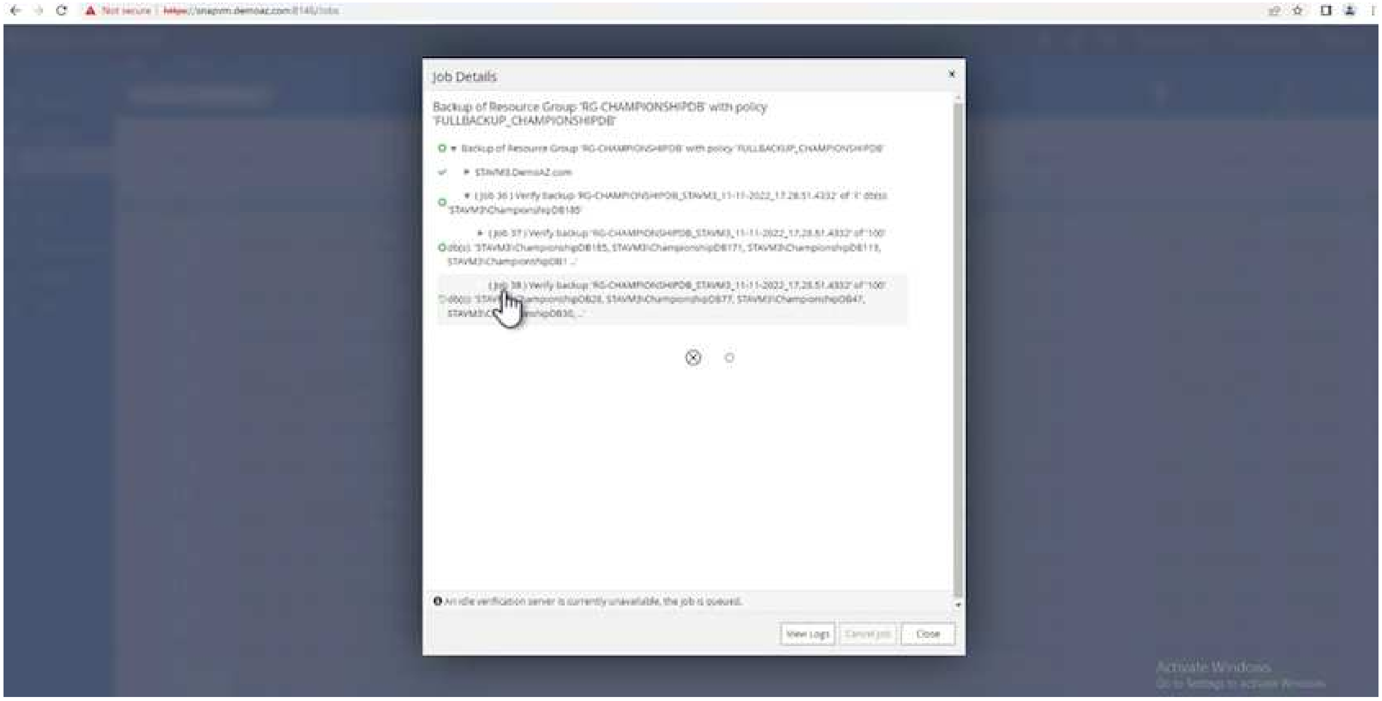


Confirmation

The policy selected for the on-demand backup is associated with a backup schedule and the on-demand backups will be retained based on the retention settings specified for the schedule type. Do you want to continue ?

Monitor multiple-database backup jobs

From the left navigation bar, click **Monitor**, select the backup job, and click **Details** to view job progress.

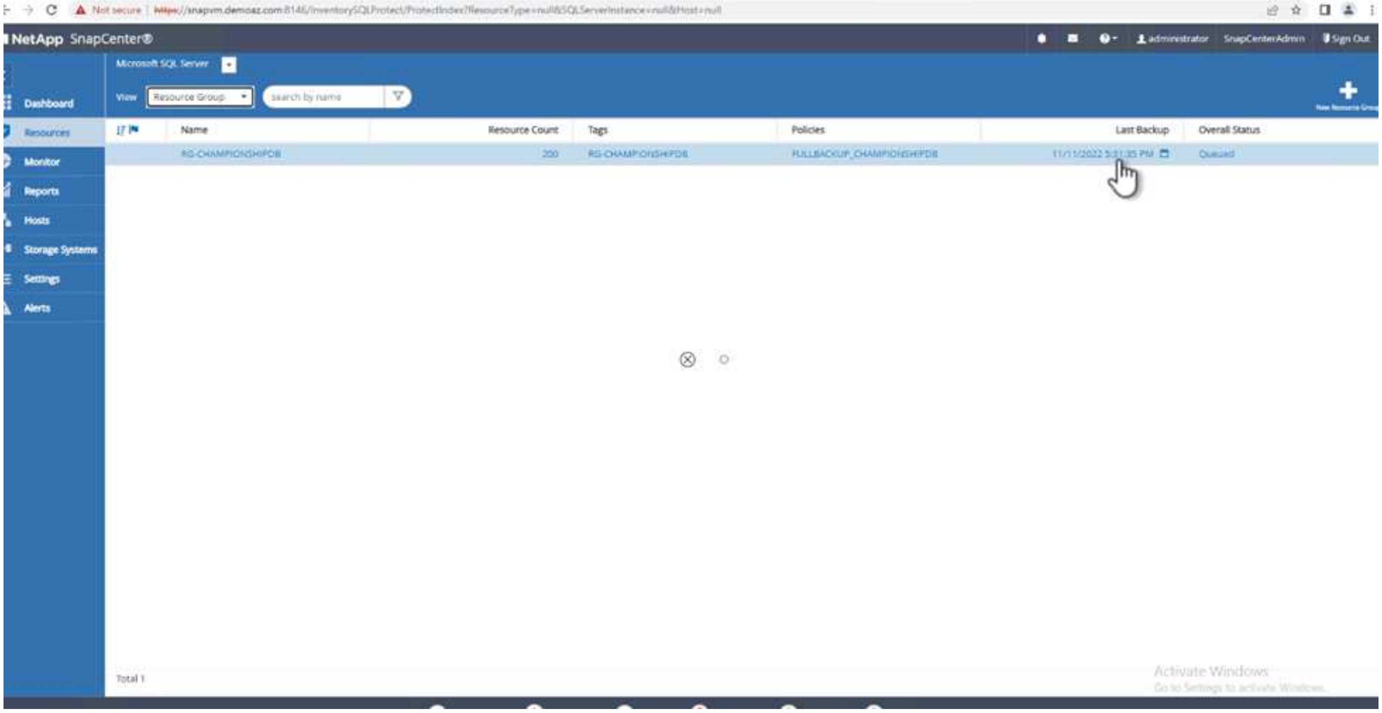


Backup of Resource Group 'RG-CHAMPIONSHIPDB' with policy 'FULLBACKUP_CHAMPIONSHIPDB'

- Backup of Resource Group 'RG-CHAMPIONSHIPDB' with policy 'FULLBACKUP_CHAMPIONSHIPDB'
  - STAVM3.DemoAZ.com

An idle verification server is currently unavailable, the job is queued.

Click the **Resource** tab to see the time it takes for the backup to be completed.



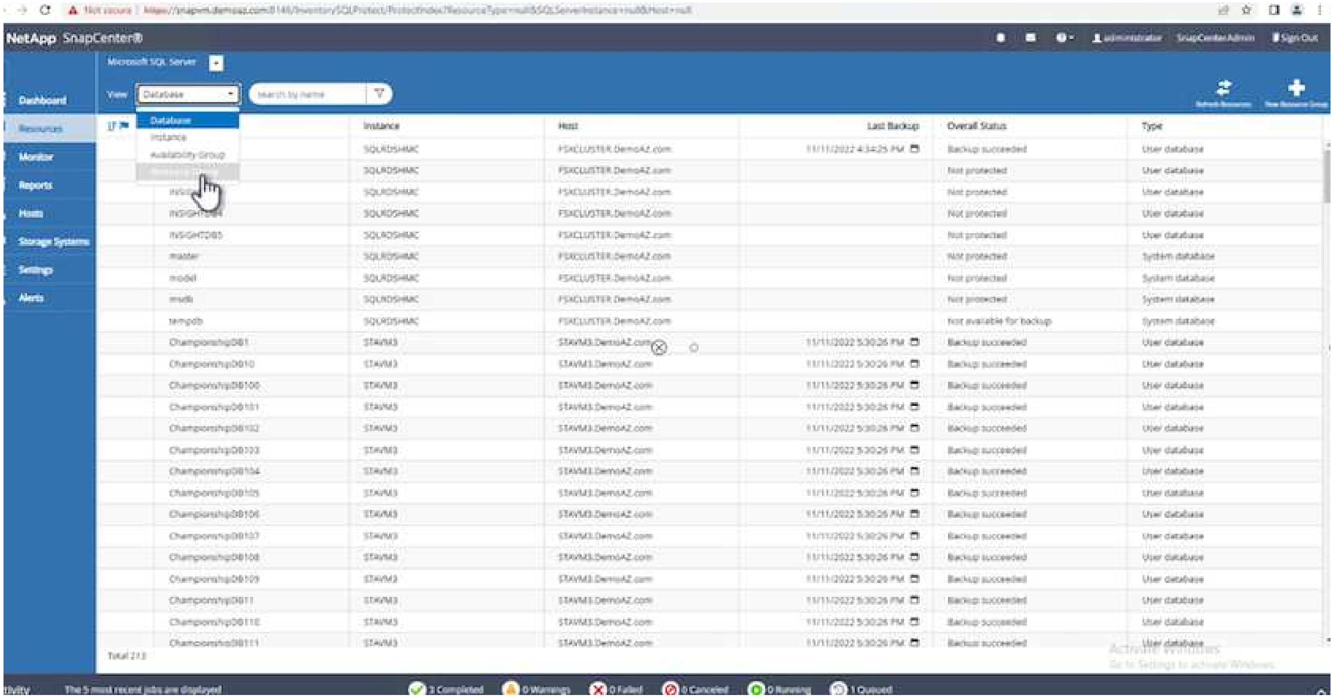
Name	Resource Count	Tags	Policies	Last Backup	Overall Status
RG-CHAMPIONSHIPDB	200	RG-CHAMPIONSHIPDB	FULLBACKUP_CHAMPIONSHIPDB	11/11/2022 5:31:35 PM	Queued

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:

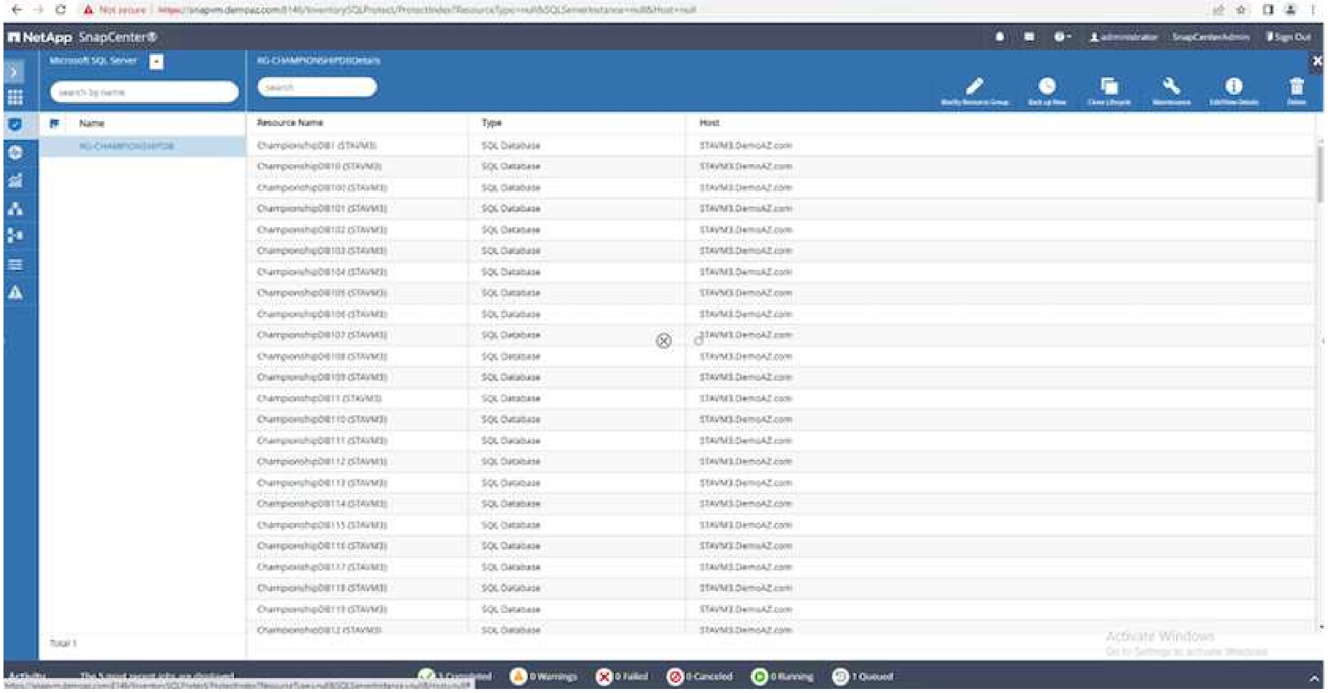
1. From the **Resources** tab, change the view menu from **Database** to **Resource group**.



Name	Instance	Host	Last Backup	Overall Status	Type
	SQLRDSHMC	FSXCLUSTER.DemoAZ.com	11/11/2022 4:34:25 PM	Backup succeeded	User database
	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
INSIG	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
INSIGHT	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
INSIGHTDB5	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	User database
master	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	System database
model	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	System database
msdb	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not protected	System database
tempdb	SQLRDSHMC	FSXCLUSTER.DemoAZ.com		Not available for backup	System database
ChampionshipDB1	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB10	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB100	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB101	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB102	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB103	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB104	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB105	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB106	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB107	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB108	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB109	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB11	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB110	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database
ChampionshipDB111	STAVM3	STAVM3.DemoAZ.com	11/11/2022 5:30:26 PM	Backup succeeded	User database

Total 213

2. Select the resource group backup policy created.
3. Select **Modify Resource Group** in the upper right.



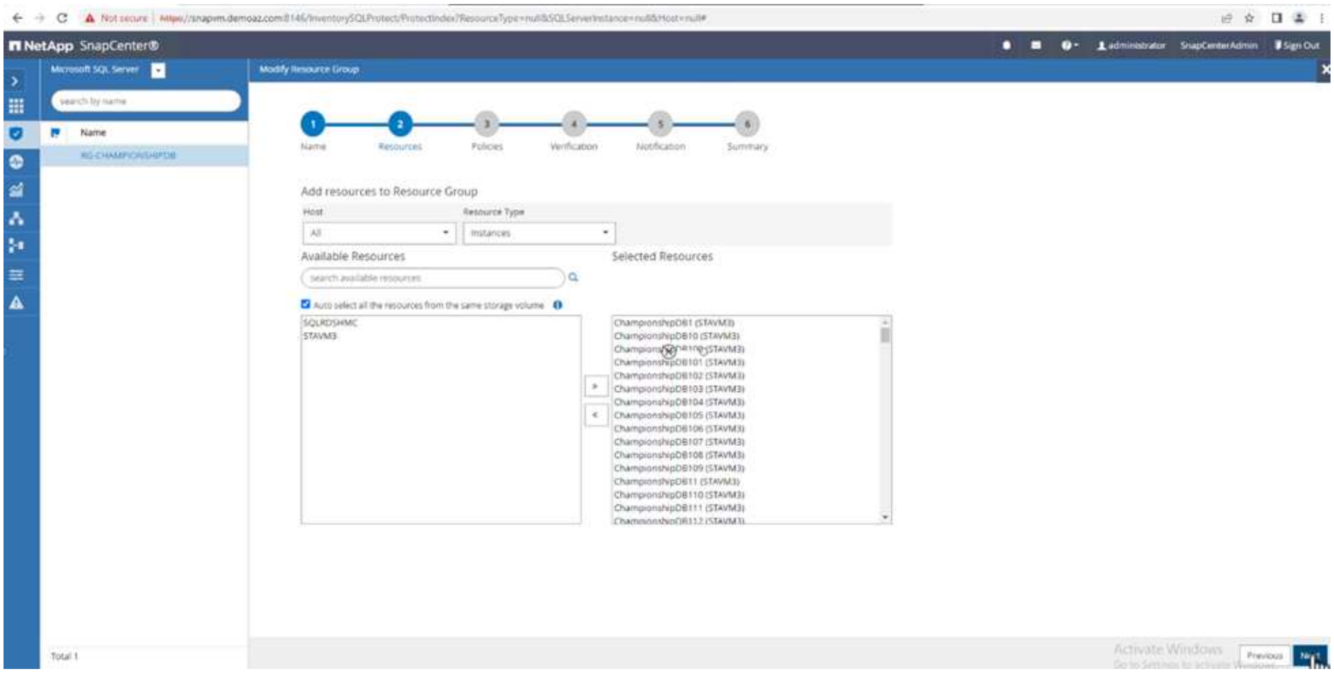
Name
RG-CHAMPIONSHIPDB

Total 1

Resource Name	Type	Host
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

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.



Add resources to Resource Group

Host: All

Resource Type: Instances

Available Resources

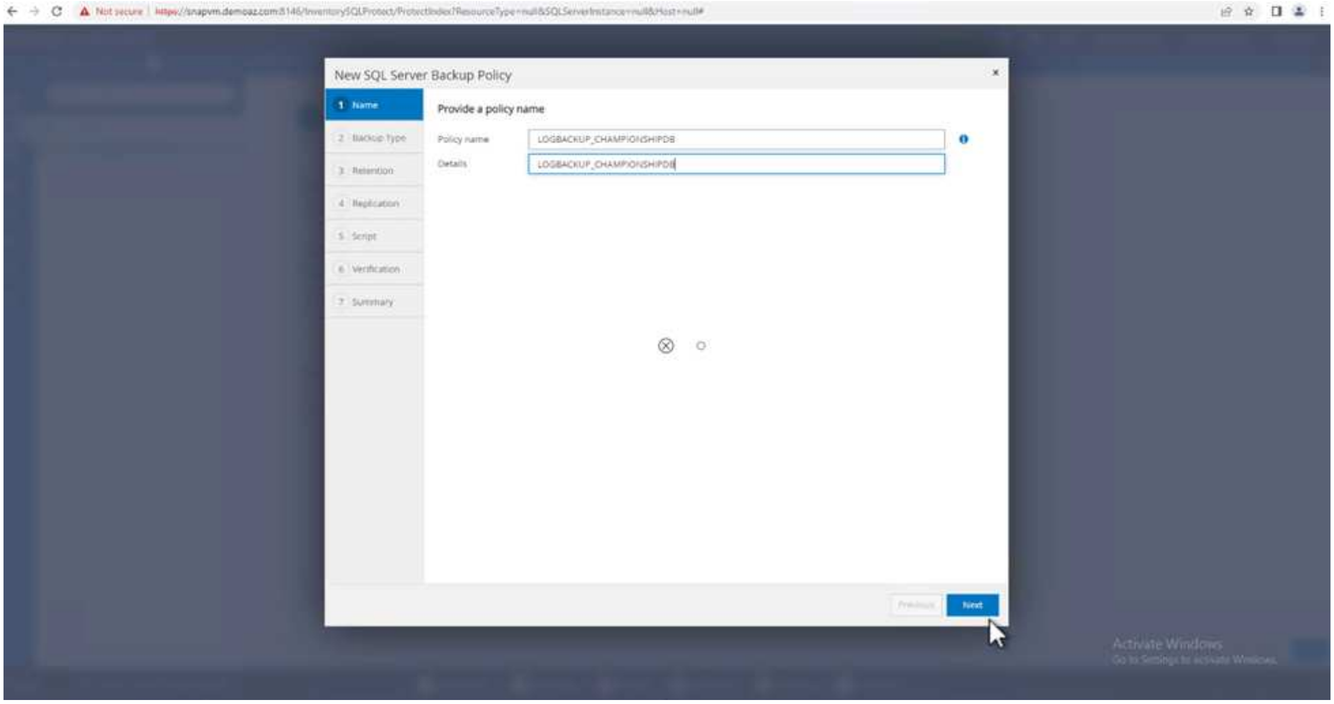
☑ Auto select all the resources from the same storage volume

SQLRDSHMC
STAVM3

Selected Resources

ChampionshipDB1 (STAVM3)
ChampionshipDB10 (STAVM3)
ChampionshipDB100 (STAVM3)
ChampionshipDB101 (STAVM3)
ChampionshipDB102 (STAVM3)
ChampionshipDB103 (STAVM3)
ChampionshipDB104 (STAVM3)
ChampionshipDB105 (STAVM3)
ChampionshipDB106 (STAVM3)
ChampionshipDB107 (STAVM3)
ChampionshipDB108 (STAVM3)
ChampionshipDB109 (STAVM3)
ChampionshipDB11 (STAVM3)
ChampionshipDB110 (STAVM3)
ChampionshipDB111 (STAVM3)
ChampionshipDB112 (STAVM3)

5. Enter the policy name.

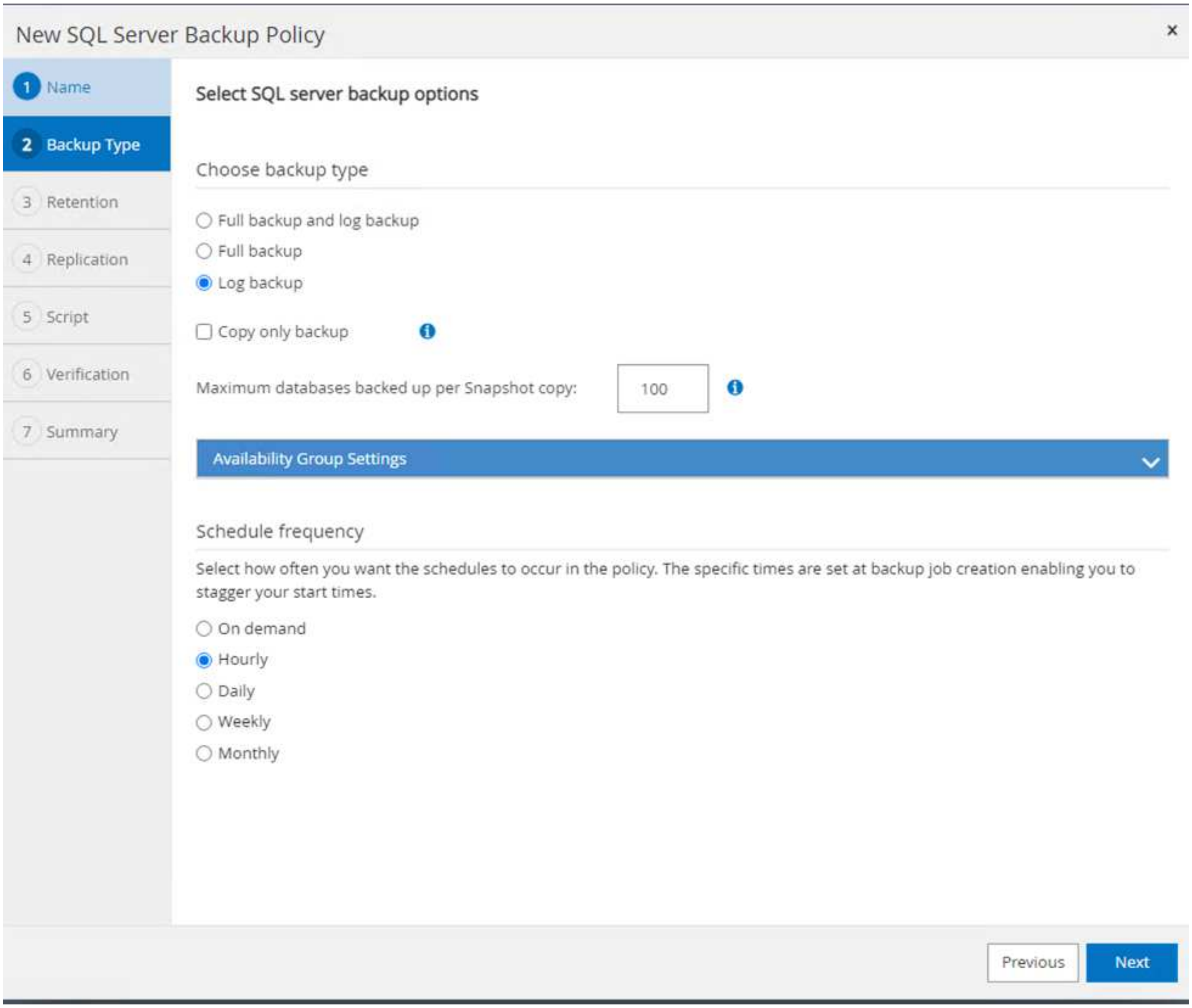


Provide a policy name

Policy name: LOGBACKUP_CHAMPIONSHIPDB

Details: LOGBACKUP_CHAMPIONSHIPDB

6. Select the SQL Server backup options.
7. Select log backup.
8. Set the schedule frequency based on your company’s RTO. Click **Next**.



Select SQL server backup options

Choose backup type

○ Full backup and log backup
○ Full backup
● Log backup

☐ Copy only backup

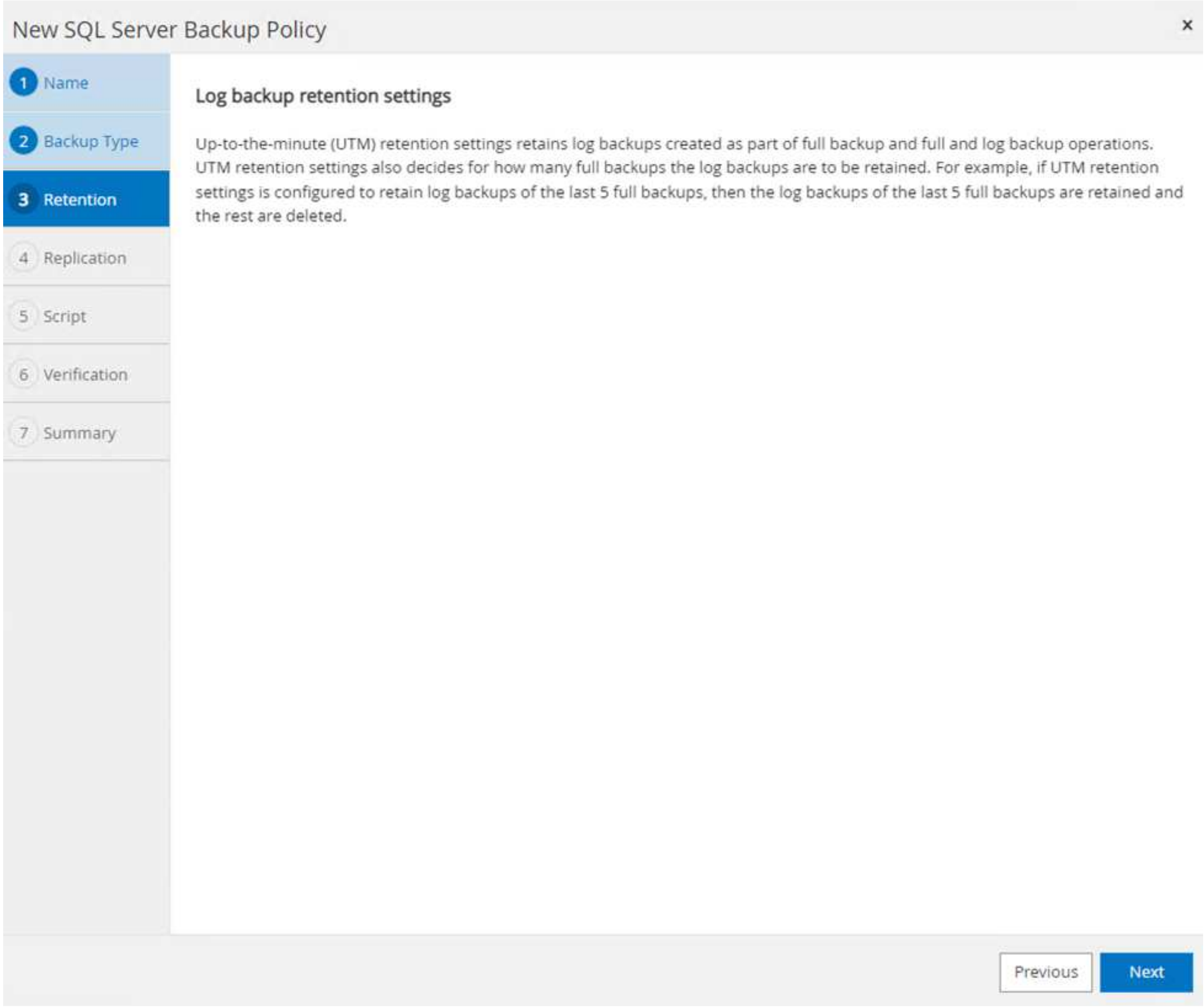
Maximum databases backed up per Snapshot copy: 100

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

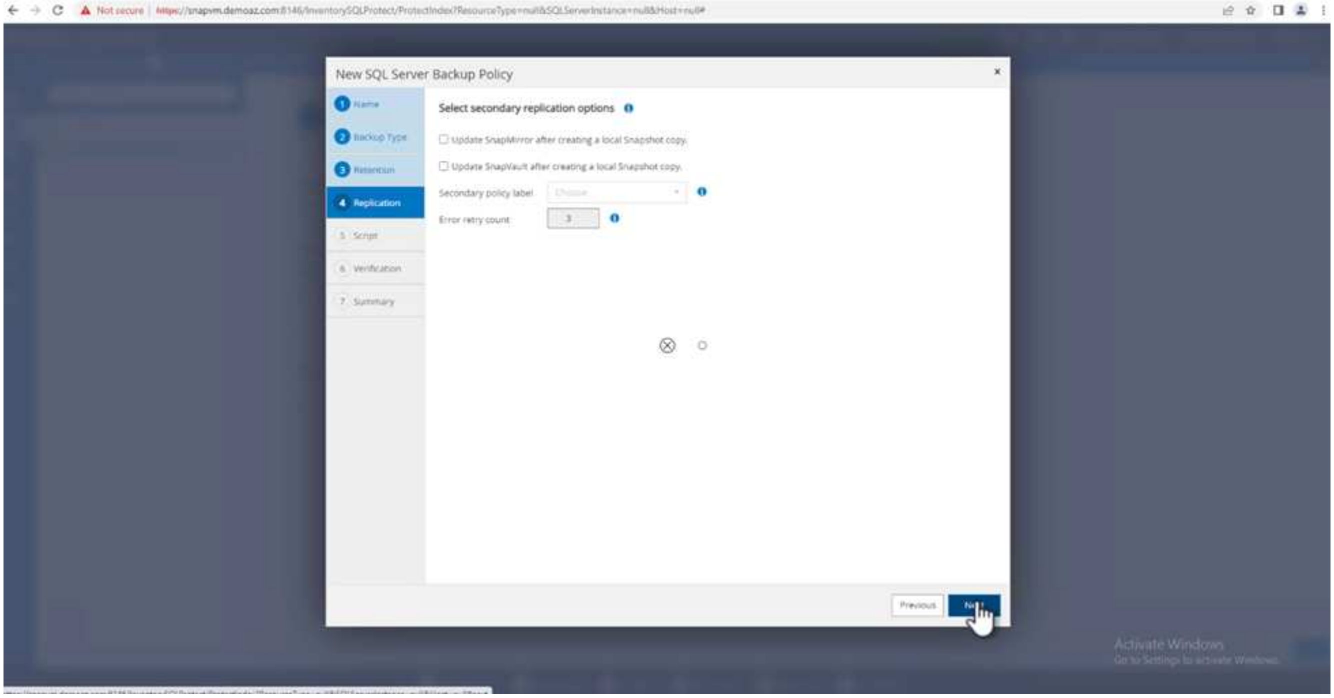
9. Configure the log backup retention settings. Click **Next**.



Log backup retention settings

Up-to-the-minute (UTM) retention settings retains log backups created as part of full backup and full and log backup operations. UTM retention settings also decides for how many full backups the log backups are to be retained. For example, if UTM retention settings is configured to retain log backups of the last 5 full backups, then the log backups of the last 5 full backups are retained and the rest are deleted.

10. (Optional) Configure the replication options.



Select secondary replication options

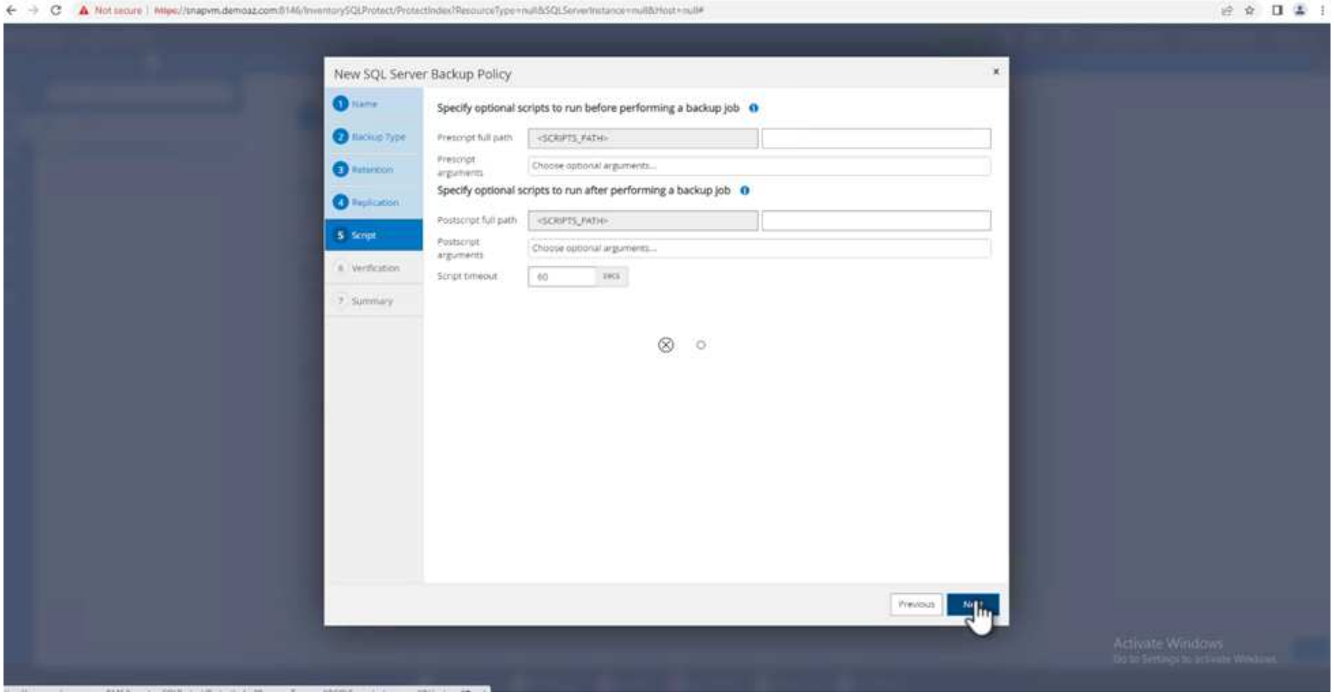
☐ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Choose

Error retry count: 3

11. (Optional) Configure any scripts to run before performing a backup job.



Specify optional scripts to run before performing a backup job

Prescript full path: <SCRIPTS_PATH>

Prescript arguments: Choose optional arguments...

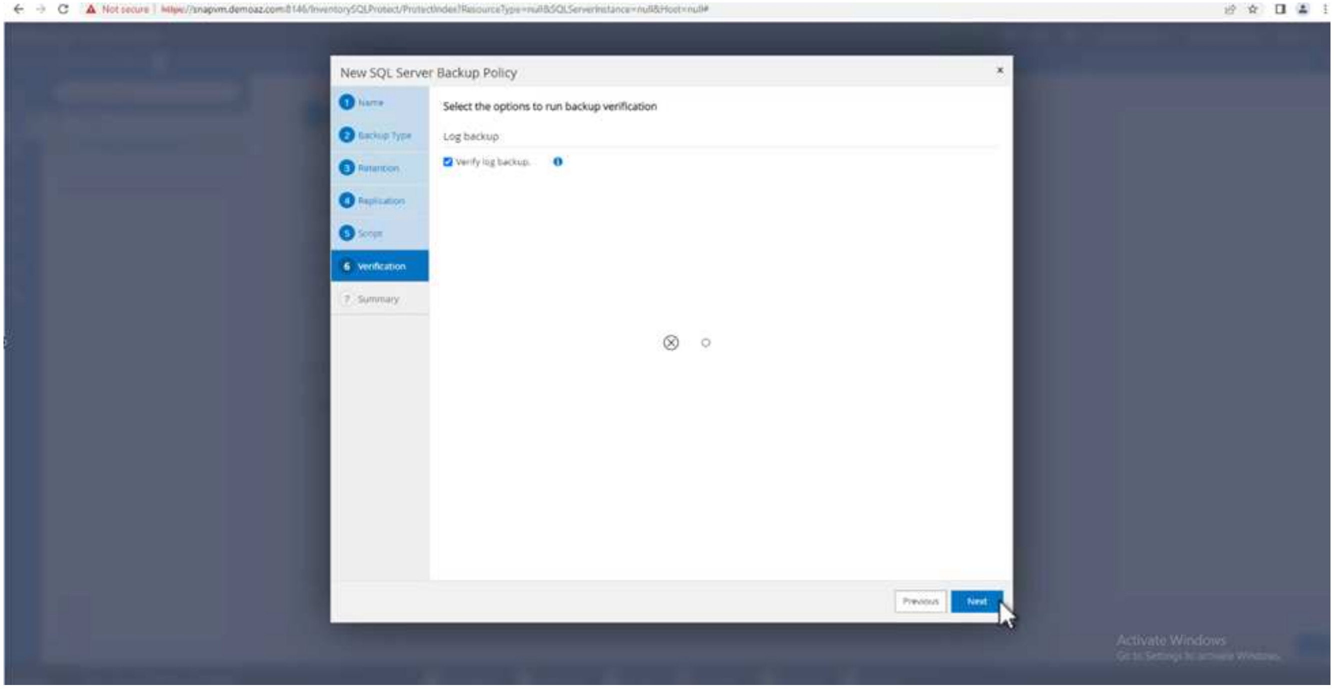
Specify optional scripts to run after performing a backup job

Postscript full path: <SCRIPTS_PATH>

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

12. (Optional) Configure backup verfication.

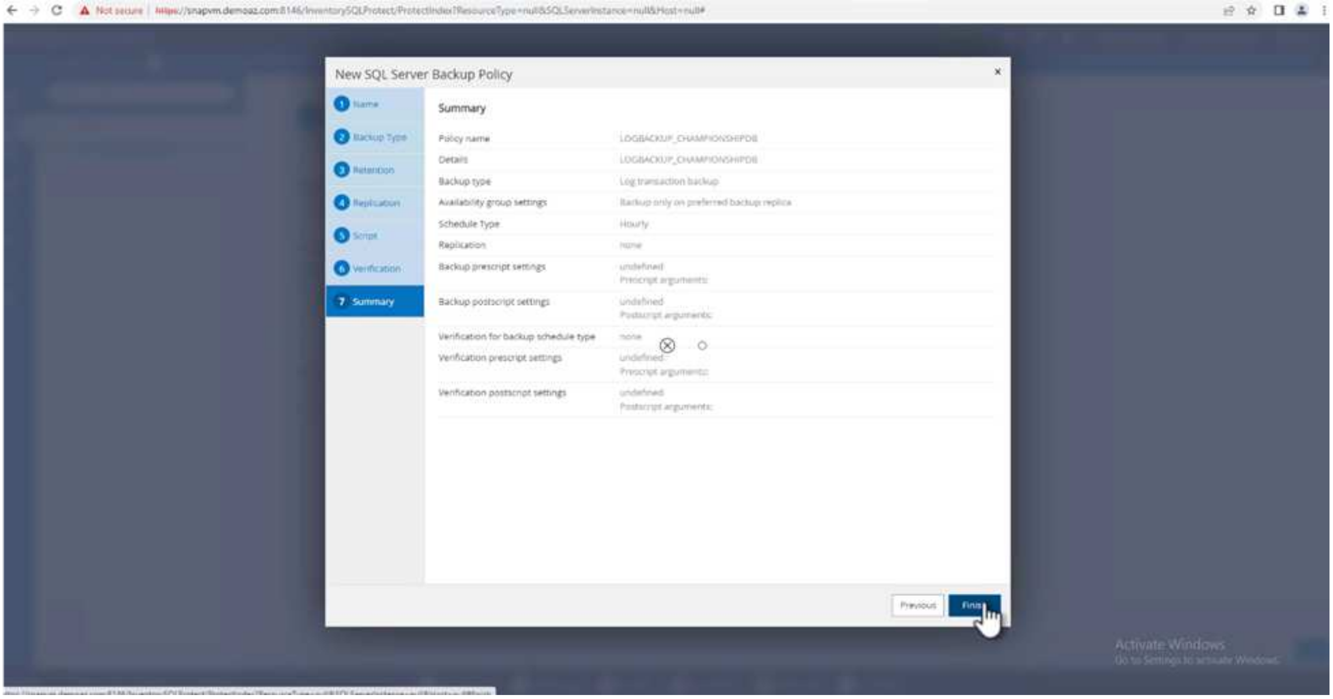


Select the options to run backup verification

Log backup

☑ Verify log backup.

13. On the **Summary** page, click **Finish**.

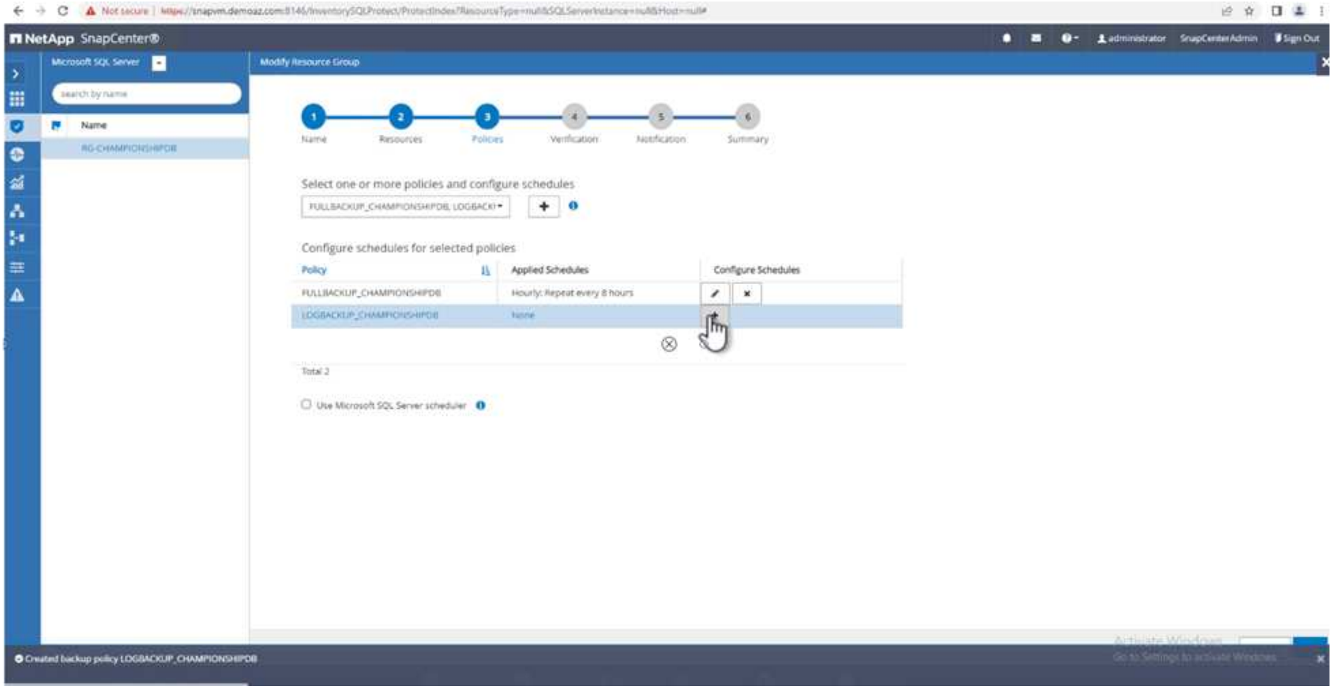


Summary

Policy name	LOGBACKUP_CHAMPIONSHIPDB
Details	LOGBACKUP_CHAMPIONSHIPDB
Backup type	Log transaction backup
Availability group settings	Backup only on preferred backup replica
Schedule Type	Hourly
Replication	none
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:

Configure and protect multiple MSSQL Server databases

1. Click the newly created transaction log backup policy.



Select one or more policies and configure schedules

FULLBACKUP_CHAMPIONSHIPDB, LOGBACKU

Configure schedules for selected policies

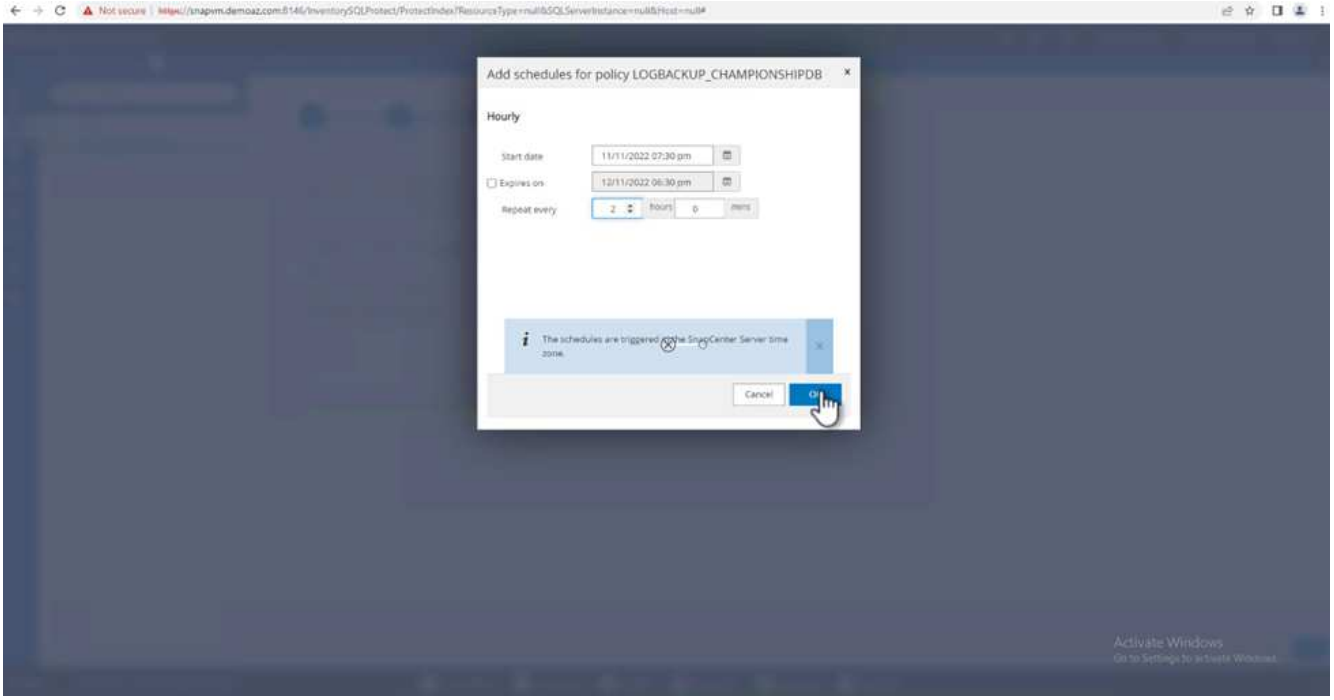
Policy	Applied Schedules	Configure Schedules
FULLBACKUP_CHAMPIONSHIPDB	Hourly: Repeat every 8 hours	
LOGBACKUP_CHAMPIONSHIPDB	None	

Total 2

☐ Use Microsoft SQL Server scheduler

Created backup policy LOGBACKUP_CHAMPIONSHIPDB

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

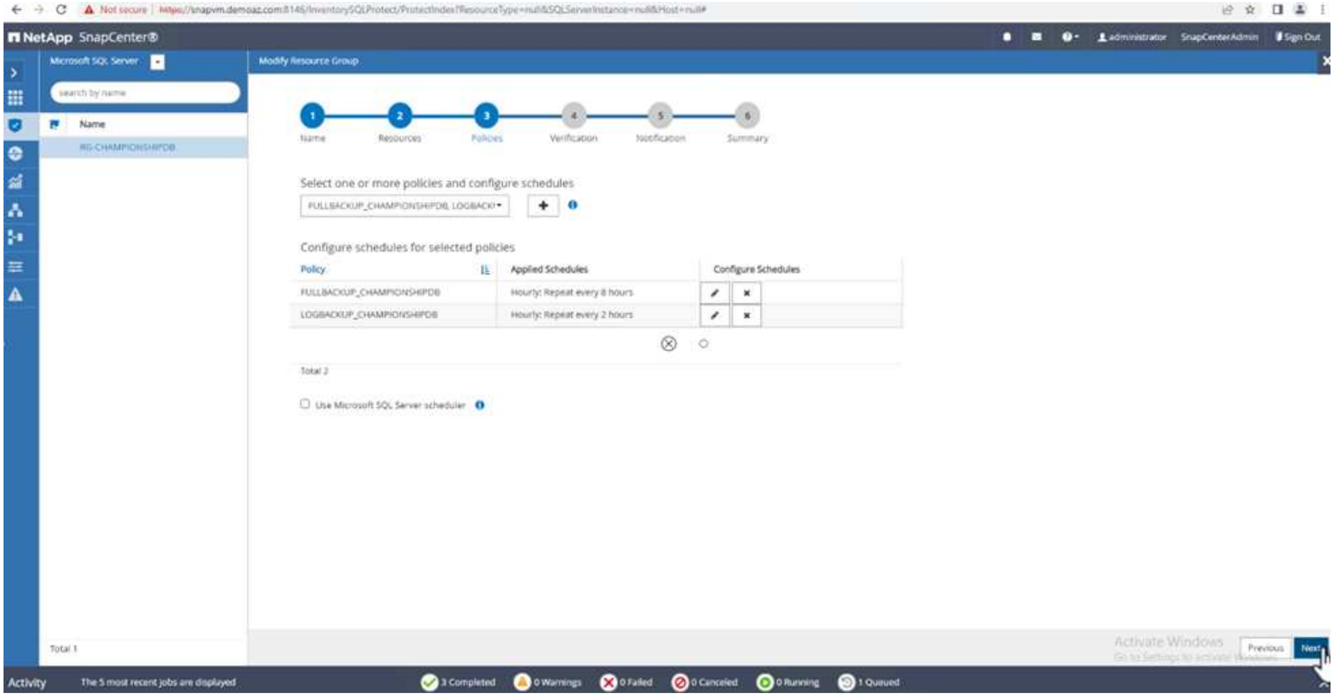
Start date 11/11/2022 07:30 pm

☐ Expires on 12/11/2022 06:30 pm

Repeat every 2 hours 0 mins

The schedules are triggered in the SnapCenter Server time zone.

4. You can see both policies. Click **Next**.



Select one or more policies and configure schedules

FULLBACKUP_CHAMPIONSHIPDB, LOGBACKU

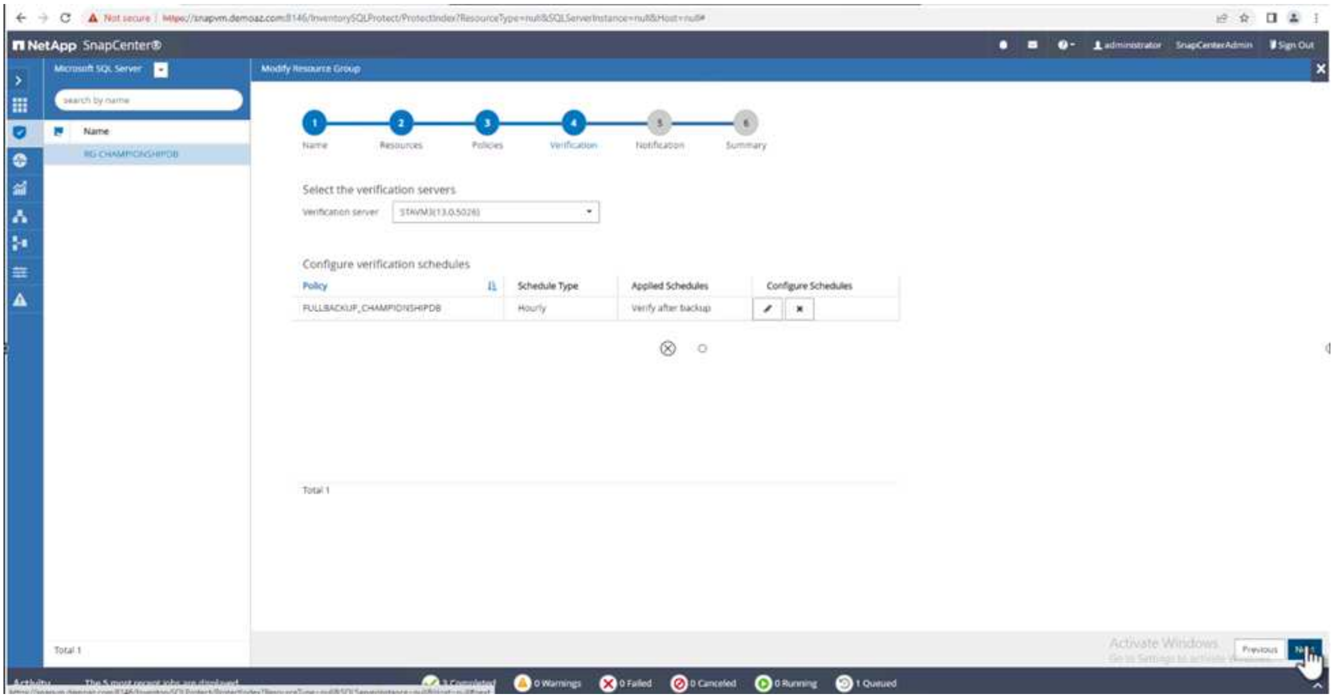
Configure schedules for selected policies

Policy	Applied Schedules	Configure Schedules
FULLBACKUP_CHAMPIONSHIPDB	Hourly: Repeat every 8 hours	
LOGBACKUP_CHAMPIONSHIPDB	Hourly: Repeat every 2 hours	

Total 2

☐ Use Microsoft SQL Server scheduler

5. Configure the verification server.



Select the verification servers

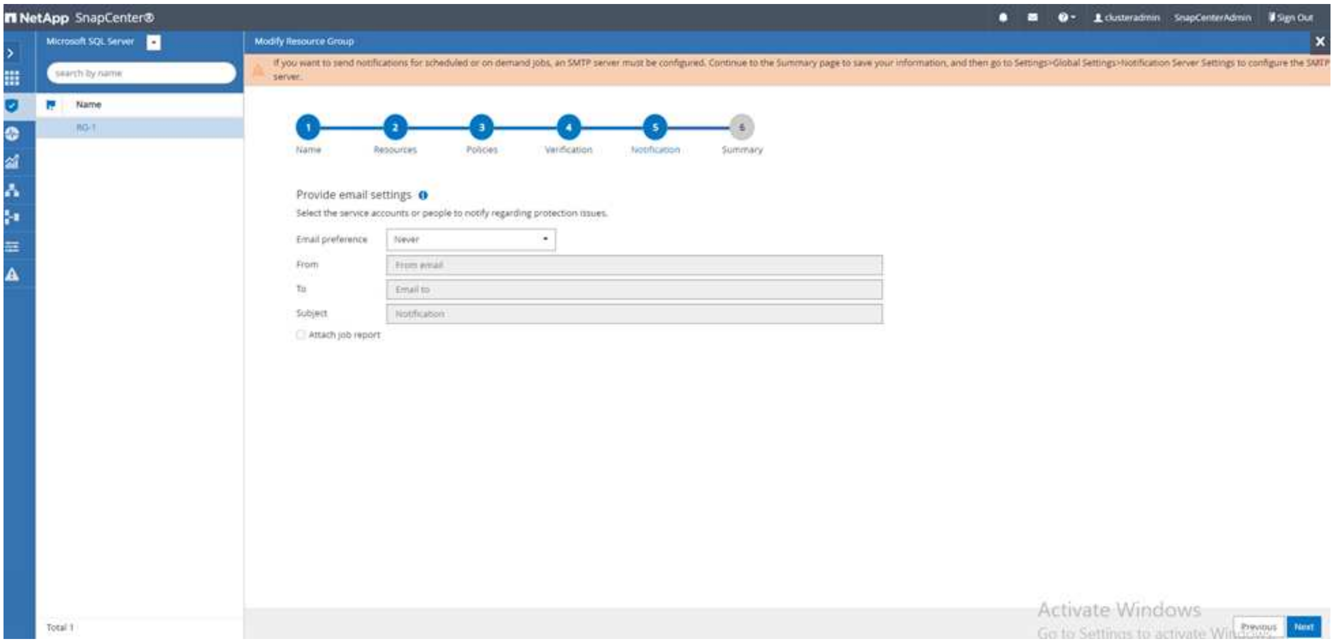
Verification server: STAVM3(13.0.5026)

Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
FULLBACKUP_CHAMPIONSHIPDB	Hourly	Verify after backup	

Total 1

6. Configure email notification.



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.

Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

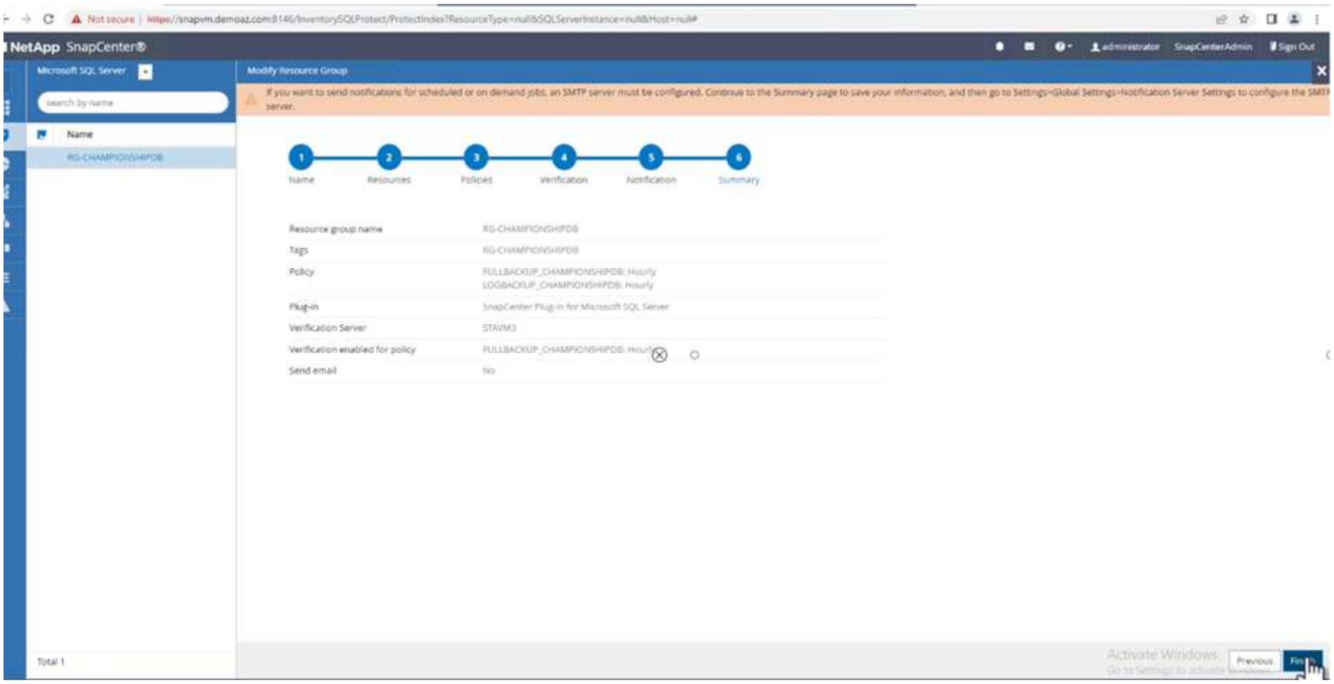
From: From email

To: Email to

Subject: Notification

☐ Attach job report

7. On the **Summary** page, click **Finish**.



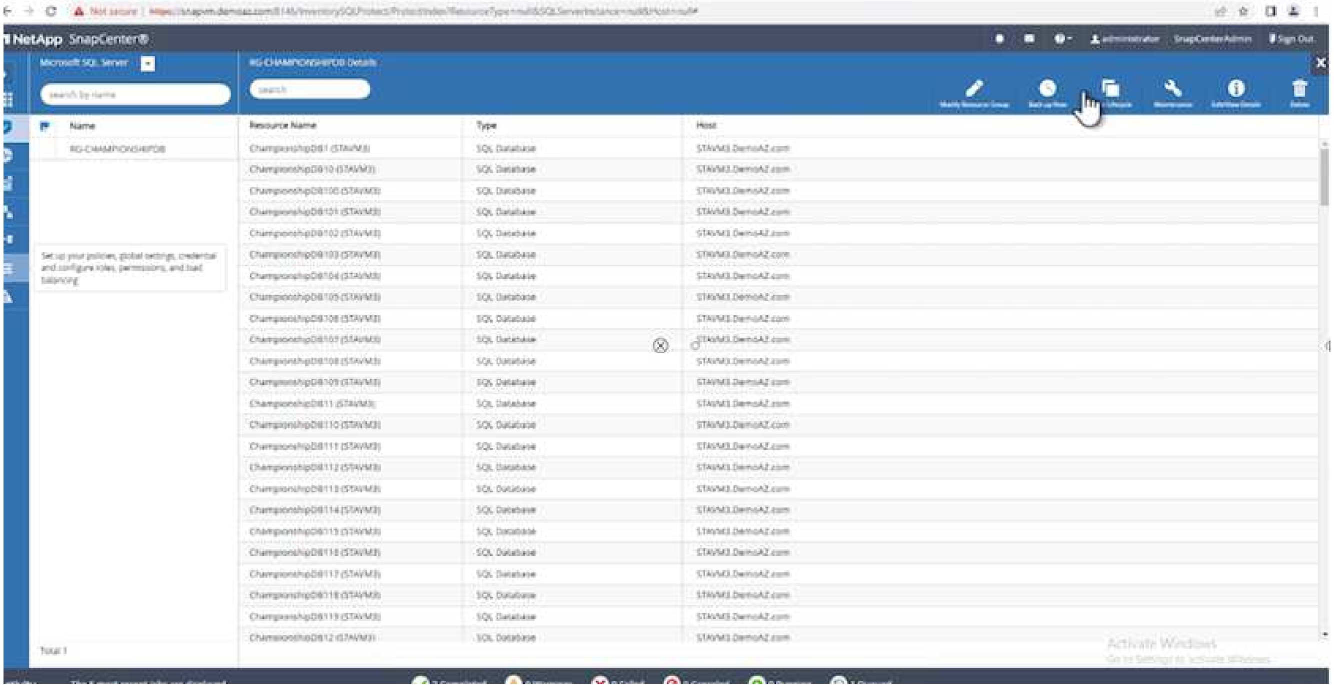
If you want to send notifications for scheduled or on demand jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

Resource group name	RG-CHAMPIONSHIPDB
Tags	RG-CHAMPIONSHIPDB
Policy	FULLBACKUP_CHAMPIONSHIPDB: Hourly LOGBACKUP_CHAMPIONSHIPDB: Hourly
Plug-in	SnapCenter Plug-in for Microsoft SQL Server
Verification Server	STAVM3
Verification enabled for policy	FULLBACKUP_CHAMPIONSHIPDB: Hourly
Send email	No

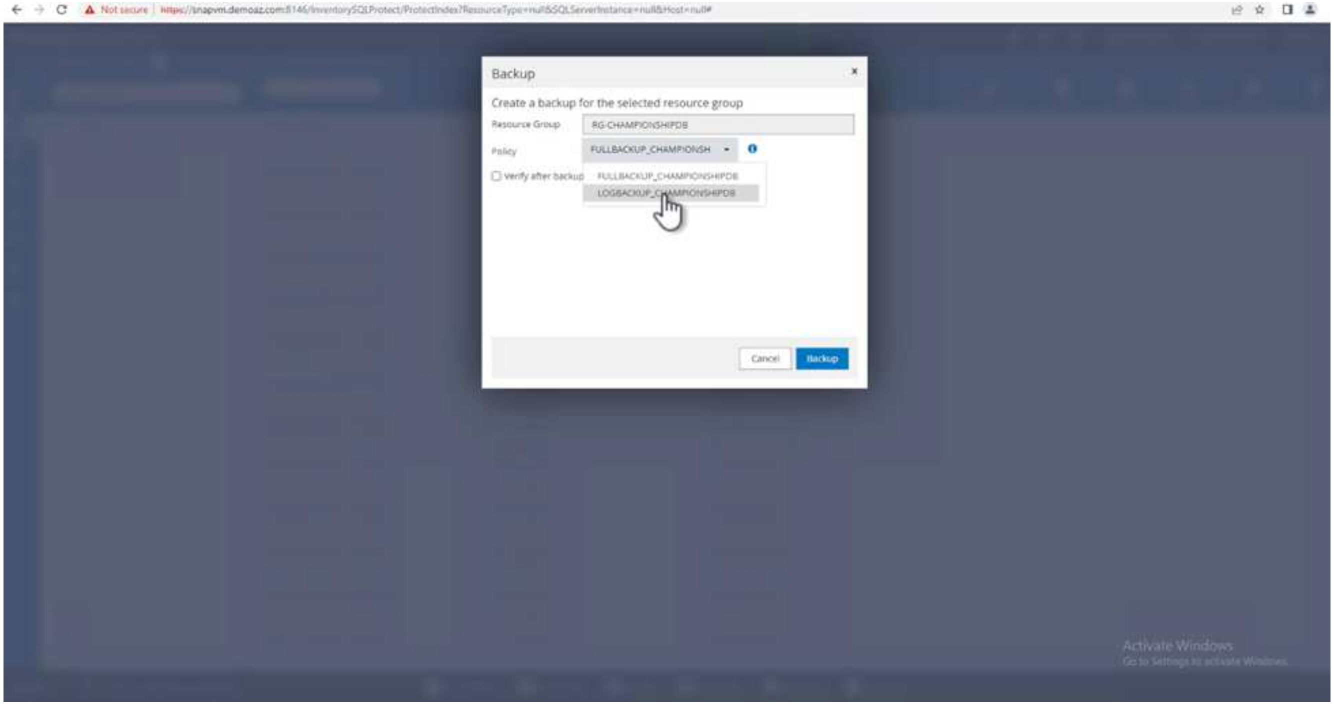
Triggering an on-demand transaction log backup for mutiple SQL Server databases

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.



2. From the pop-up on the **Policy** tab, select the drop-down menu, select the backup policy, and configure the transaction log backup.



Backup

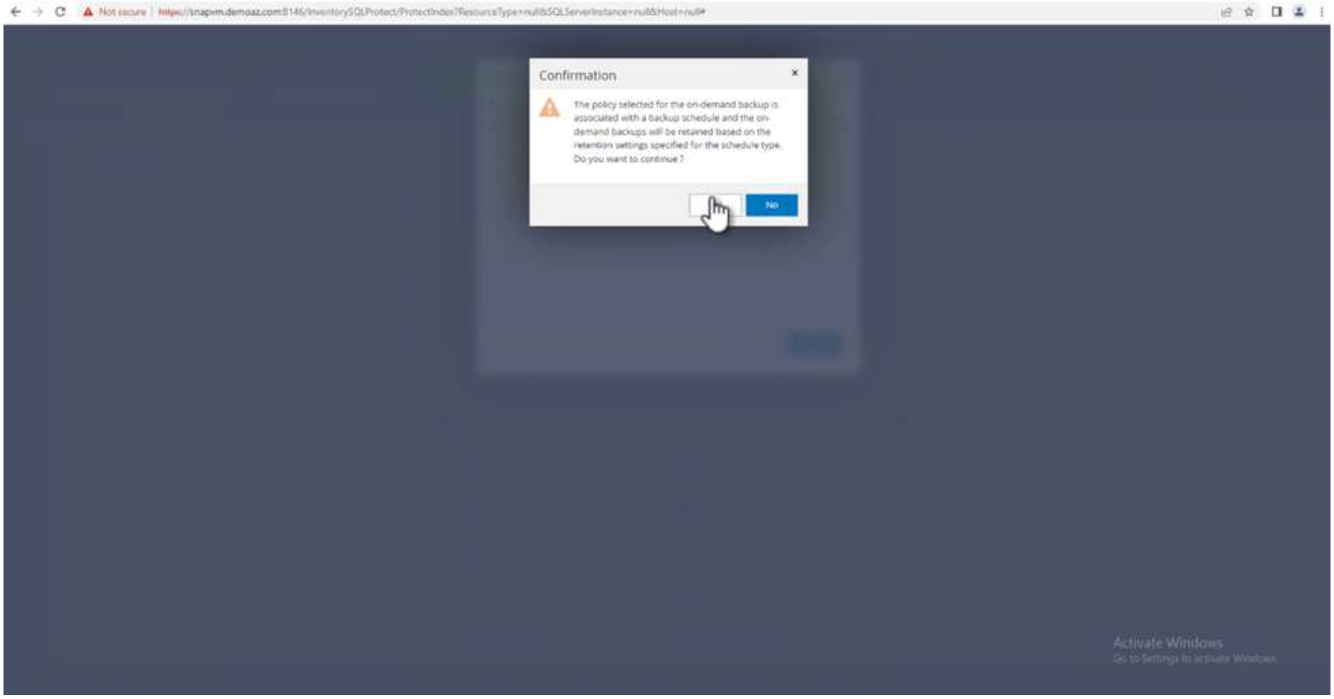
Create a backup for the selected resource group

Resource Group: RG-CHAMPIONSHIPDB

Policy: FULLBACKUP_CHAMPIONSH

☐ Verify after backup

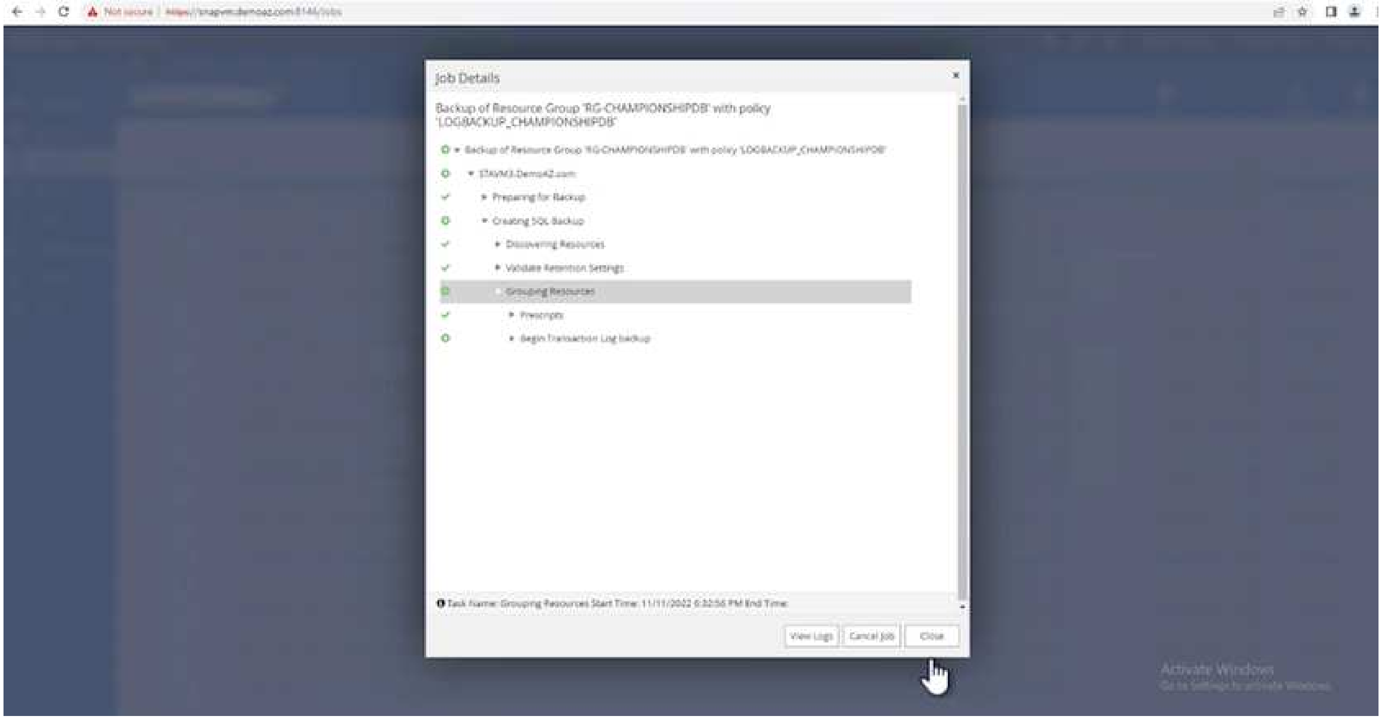
3. Click **Backup**. A new window is displayed.
4. Click **Yes** to confirm the backup policy.



The policy selected for the on-demand backup is associated with a backup schedule and the on-demand backups will be retained based on the retention settings specified for the schedule type. Do you want to continue ?

Monitoring

Move to the **Monitoring** tab and monitor the progress of the backup job.



Backup of Resource Group 'RG-CHAMPIONSHIPDB' with policy 'LOGBACKUP_CHAMPIONSHIPDB'

- Backup of Resource Group 'RG-CHAMPIONSHIPDB' with policy 'LOGBACKUP_CHAMPIONSHIPDB'
  - STAVM3.DemoAZ.com
    - Preparing for Backup
    - Creating SQL Backup
      - Discovering Resources
      - Validate Retention Settings
      - Grouping Resources
        - Prescripts
        - Begin Transaction Log backup

Task Name: Grouping Resources Start Time: 11/11/2022 6:32:56 PM End Time:

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,

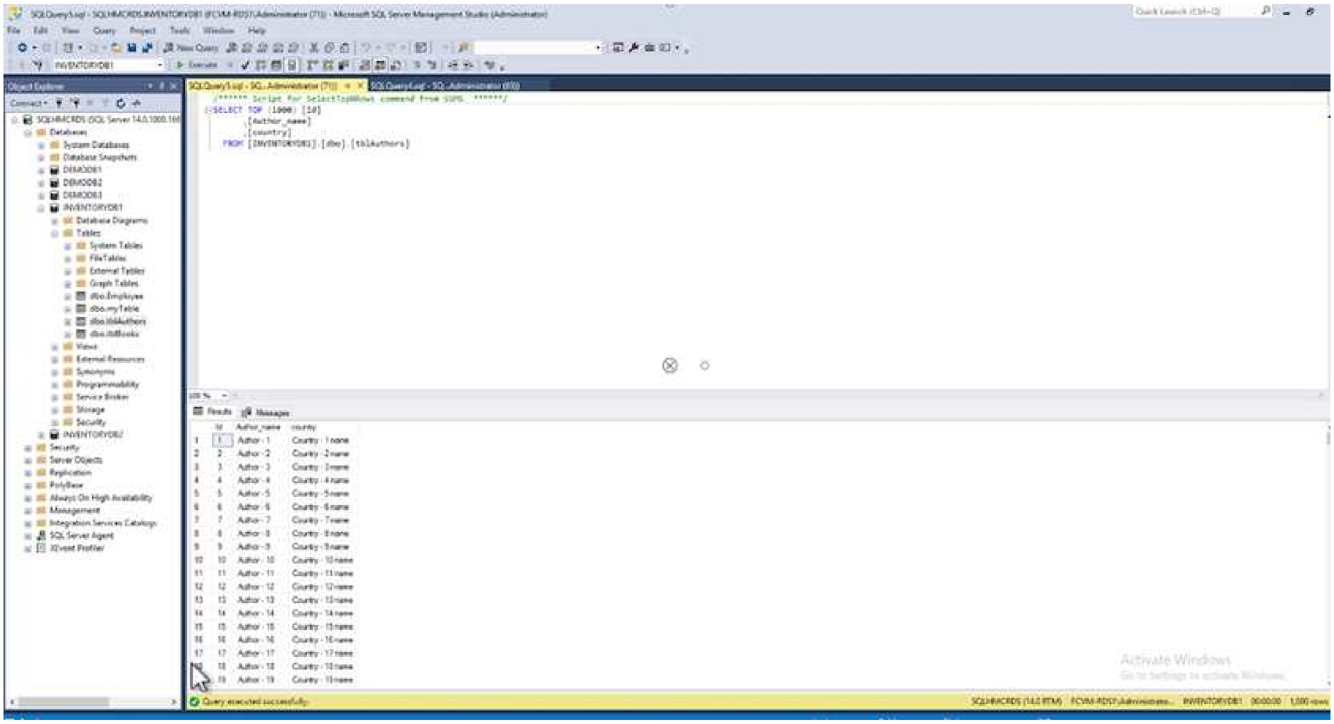
including any jobs scheduled on remote management or remote verification servers.

- 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.

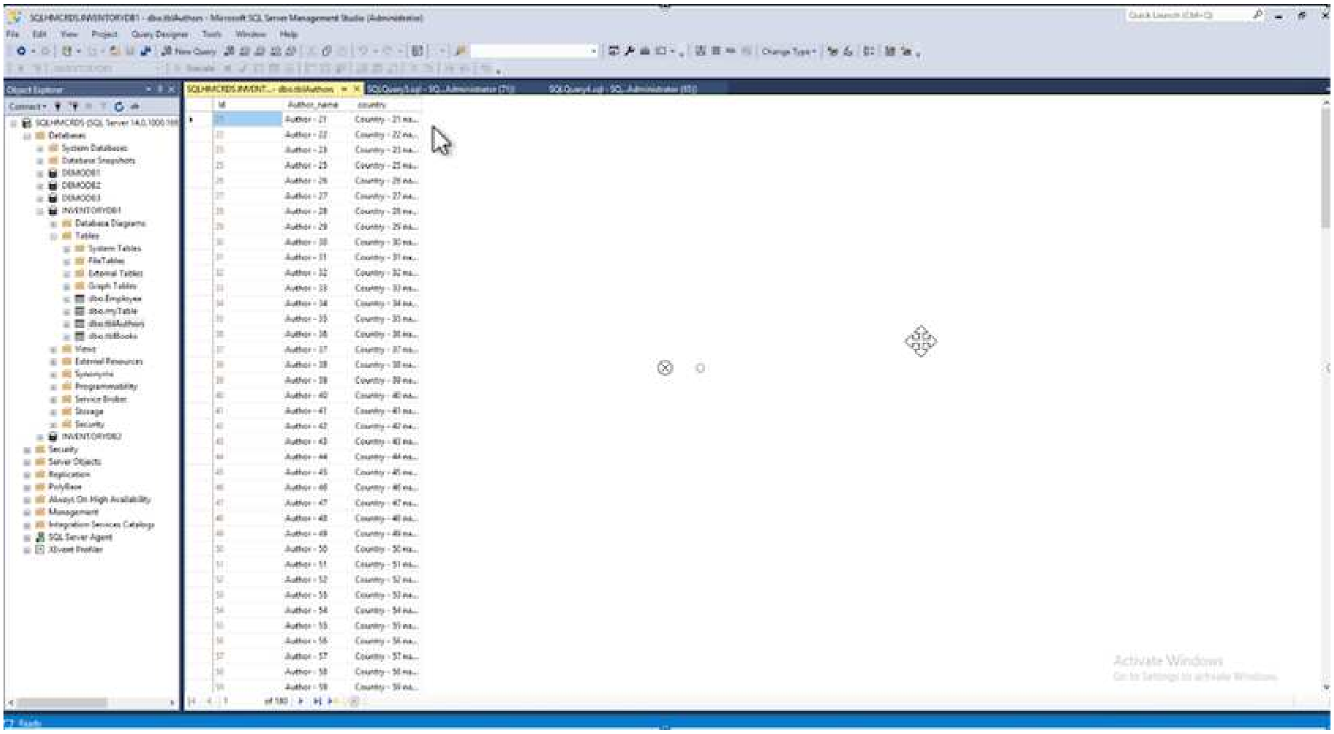


```
/****** Script for SelectTopNRows command from SSMS  ******/
SELECT TOP (1000) [Id]
      ,[Author_name]
      ,[country]
  FROM [INVENTORYDB1].[dbo].[tblAuthors]
```

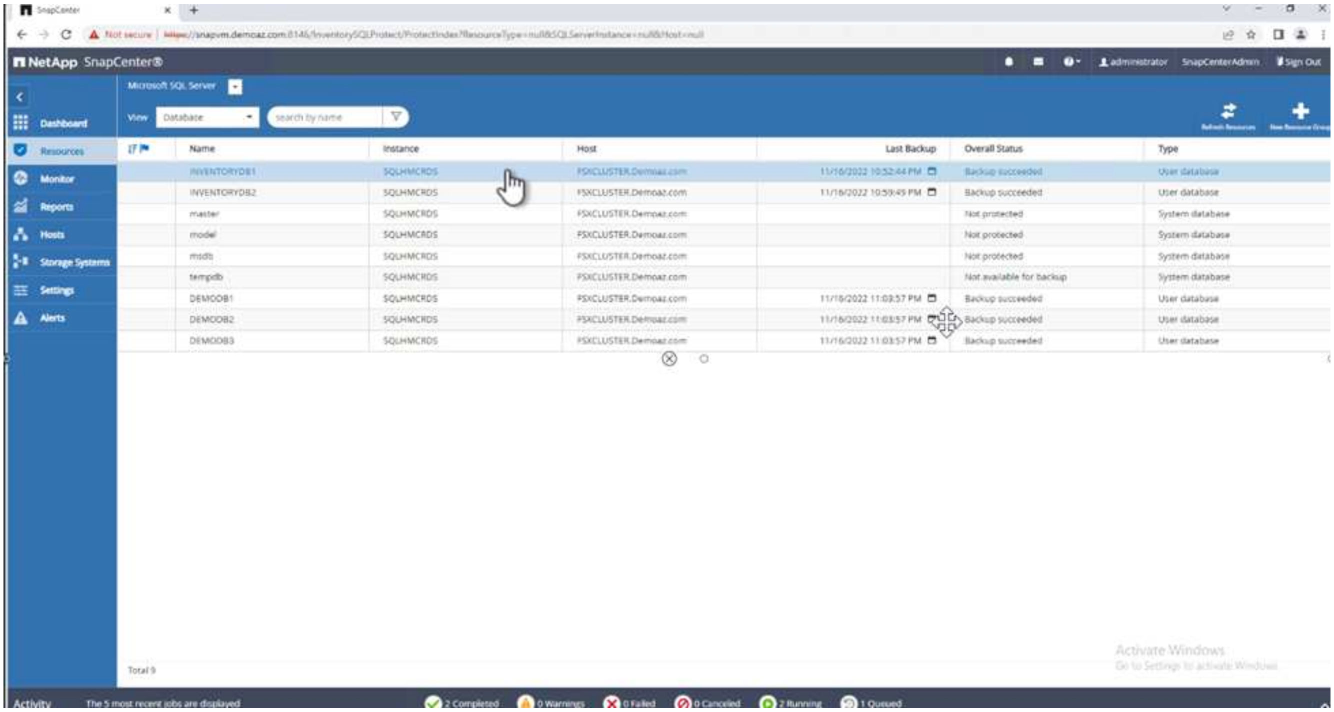
	Id	Author_name	country
1	1	Author - 1	Country - 1name
2	2	Author - 2	Country - 2name
3	3	Author - 3	Country - 3name
4	4	Author - 4	Country - 4name
5	5	Author - 5	Country - 5name
6	6	Author - 6	Country - 6name
7	7	Author - 7	Country - 7name
8	8	Author - 8	Country - 8name
9	9	Author - 9	Country - 9name
10	10	Author - 10	Country - 10name
11	11	Author - 11	Country - 11name
12	12	Author - 12	Country - 12name
13	13	Author - 13	Country - 13name
14	14	Author - 14	Country - 14name
15	15	Author - 15	Country - 15name
16	16	Author - 16	Country - 16name
17	17	Author - 17	Country - 17name
18	18	Author - 18	Country - 18name
19	19	Author - 19	Country - 19name

Query executed successfully.

The screenshot shows that 20 rows were deleted from the table.

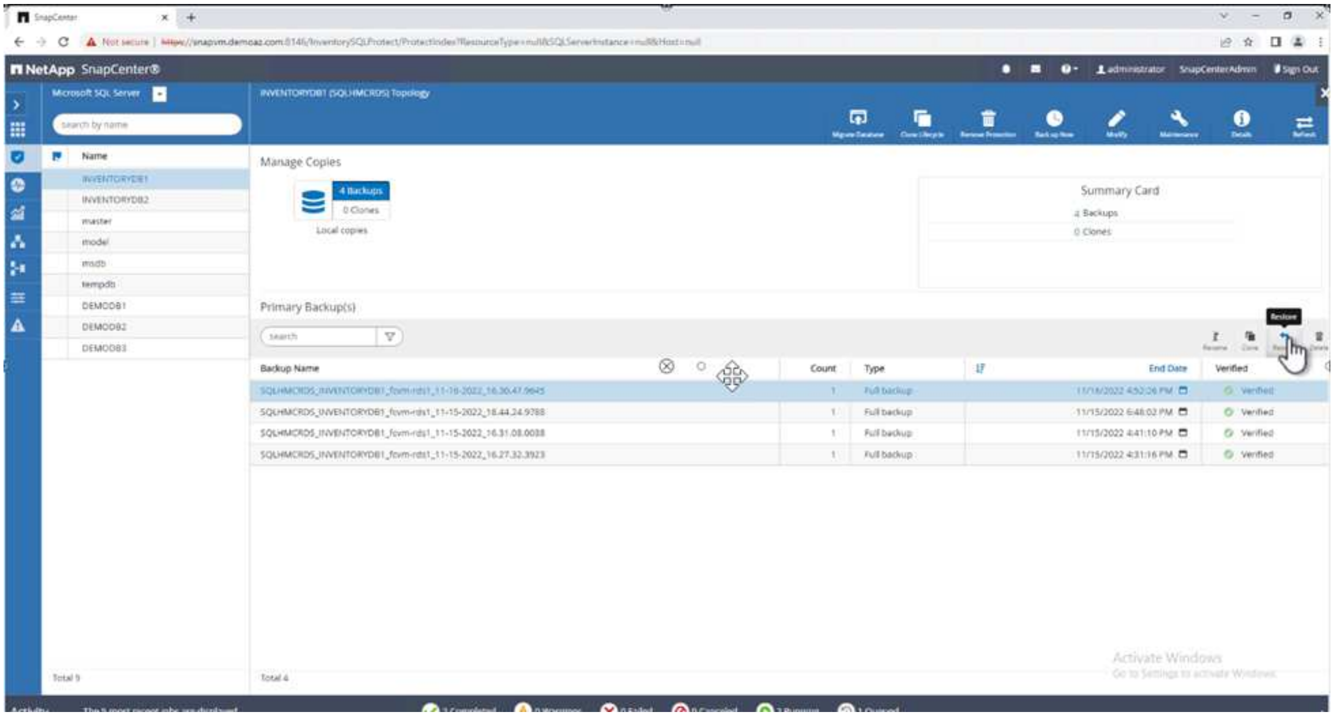


2. Log into SnapCenter Server. From the **Resources** tab, select the database.



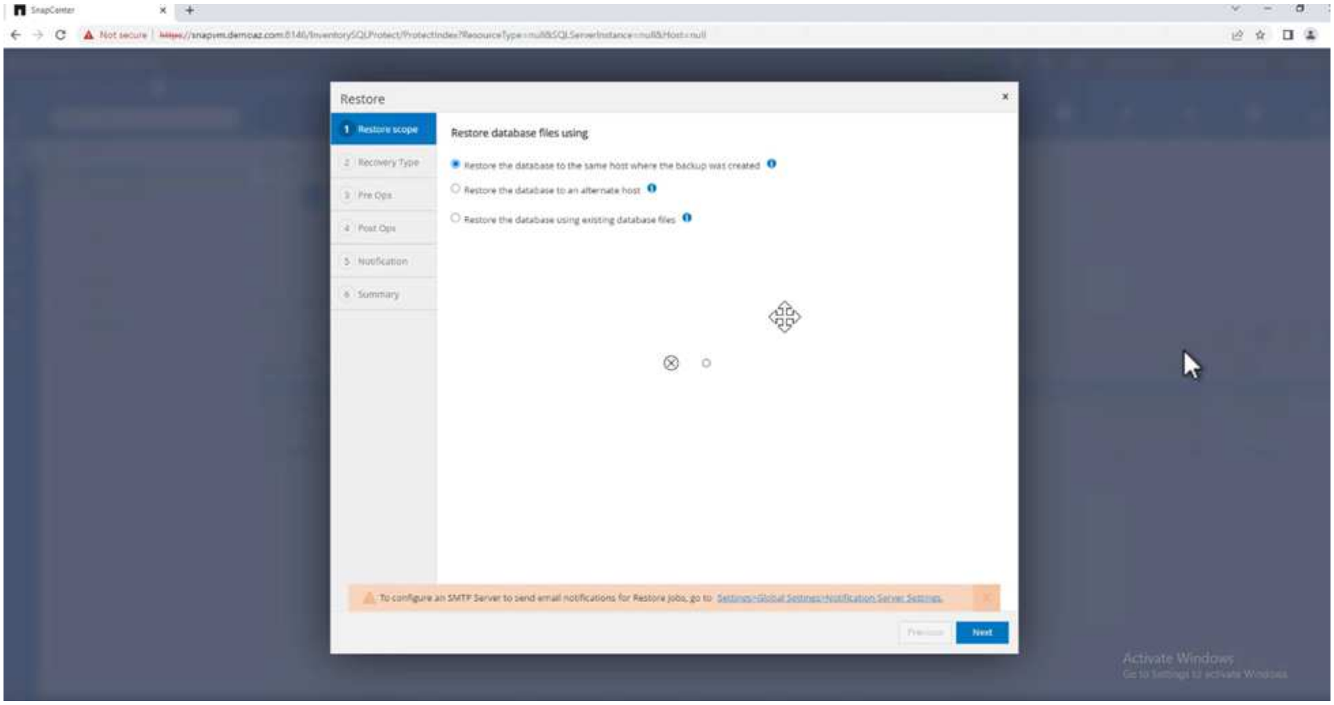
Name	Instance	Host	Last Backup	Overall Status	Type
INVENTORYDB1	SQLHMCRDS	FSXCLUSTER.Demoaz.com	11/16/2022 10:52:44 PM	Backup succeeded	User database
INVENTORYDB2	SQLHMCRDS	FSXCLUSTER.Demoaz.com	11/16/2022 10:59:45 PM	Backup succeeded	User database
master	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	System database
model	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	System database
msdb	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not protected	System database
tempdb	SQLHMCRDS	FSXCLUSTER.Demoaz.com		Not available for backup	System database
DEMODB1	SQLHMCRDS	FSXCLUSTER.Demoaz.com	11/16/2022 11:03:57 PM	Backup succeeded	User database
DEMODB2	SQLHMCRDS	FSXCLUSTER.Demoaz.com	11/16/2022 11:03:57 PM	Backup succeeded	User database
DEMODB3	SQLHMCRDS	FSXCLUSTER.Demoaz.com	11/16/2022 11:03:57 PM	Backup succeeded	User database

3. Select the most recent backup.
4. On the right, select **Restore**.



Backup Name	Count	Type	End Date	Verified
SQLHMCRDS_INVENTORYDB1_fcvm-rds1_11-16-2022_16.30.47.9645	1	Full backup	11/16/2022 4:52:26 PM	Verified
SQLHMCRDS_INVENTORYDB1_fcvm-rds1_11-15-2022_18.44.24.9788	1	Full backup	11/15/2022 6:48:02 PM	Verified
SQLHMCRDS_INVENTORYDB1_fcvm-rds1_11-15-2022_16.31.08.0038	1	Full backup	11/15/2022 4:41:10 PM	Verified
SQLHMCRDS_INVENTORYDB1_fcvm-rds1_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**.

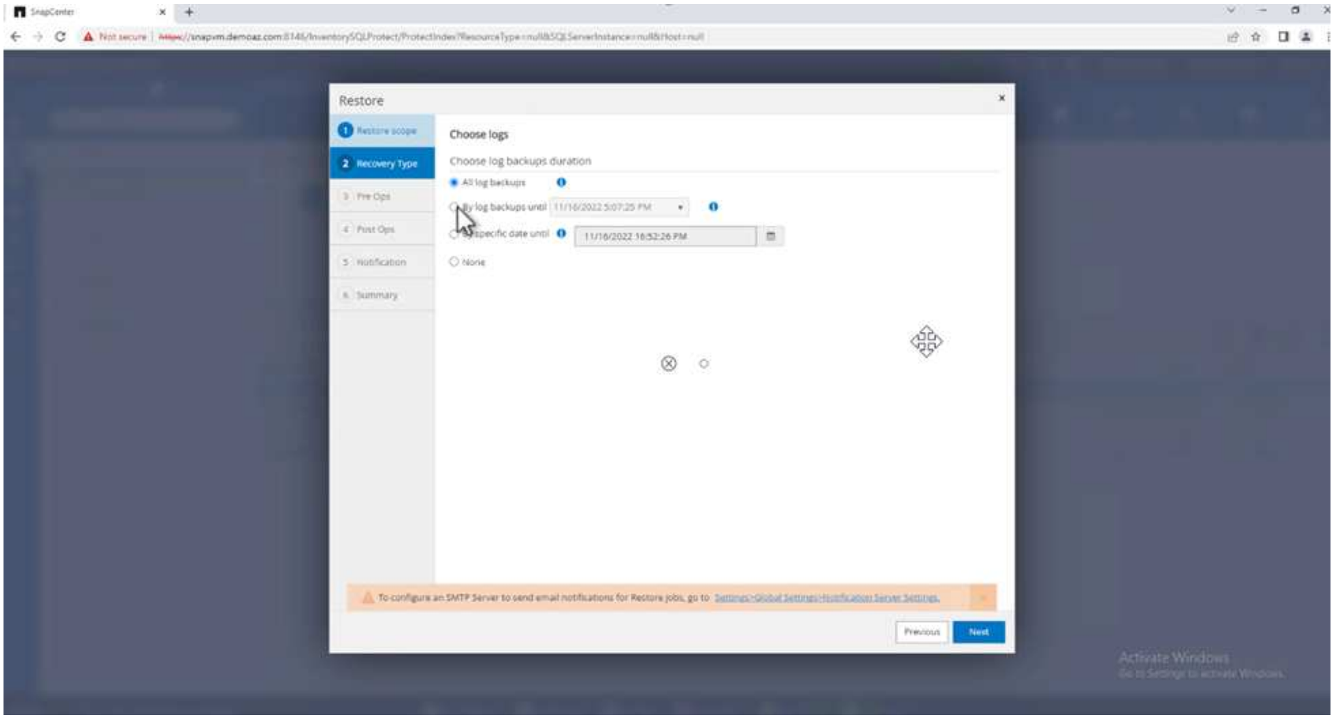


Restore database files using

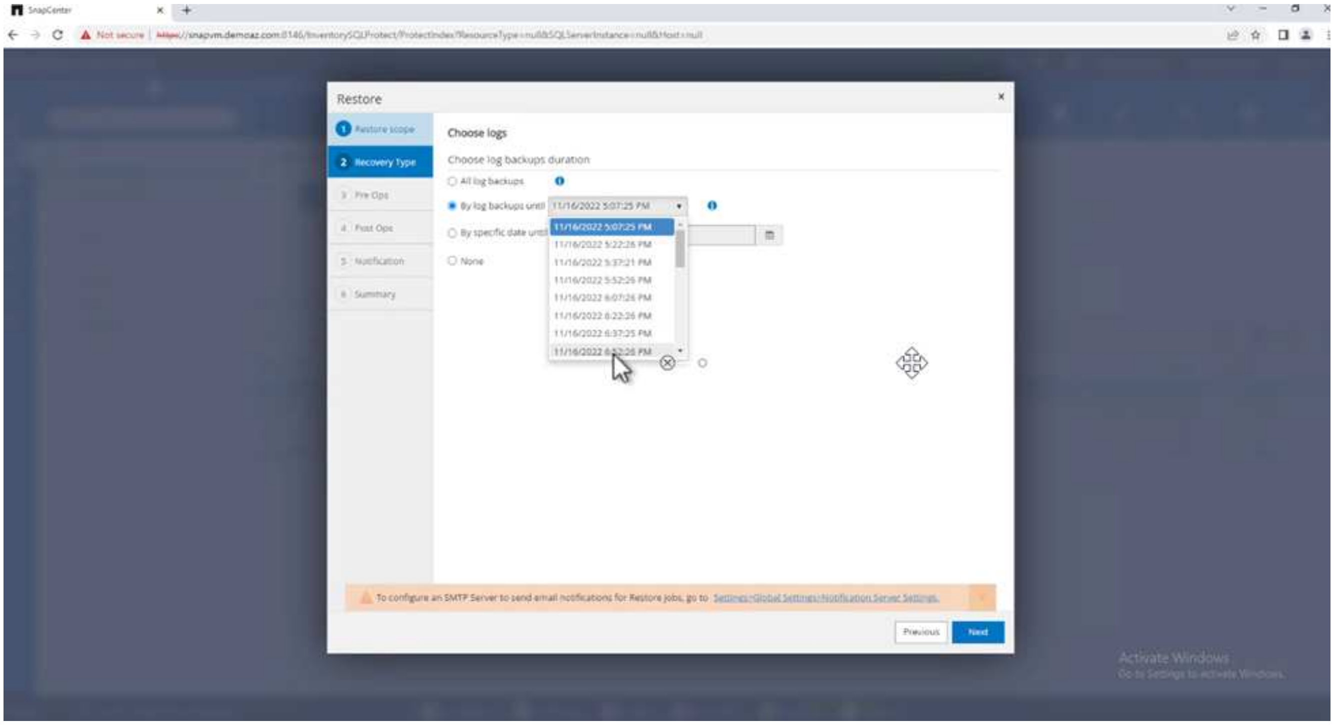
● Restore the database to the same host where the backup was created
○ Restore the database to an alternate host
○ Restore the database using existing database files

To configure an SMTP Server to send email notifications for Restore jobs, go to Settings>Global Settings>Notification Server Settings.

7. For the **Recovery type**, select **All log backups**. Click **Next**.



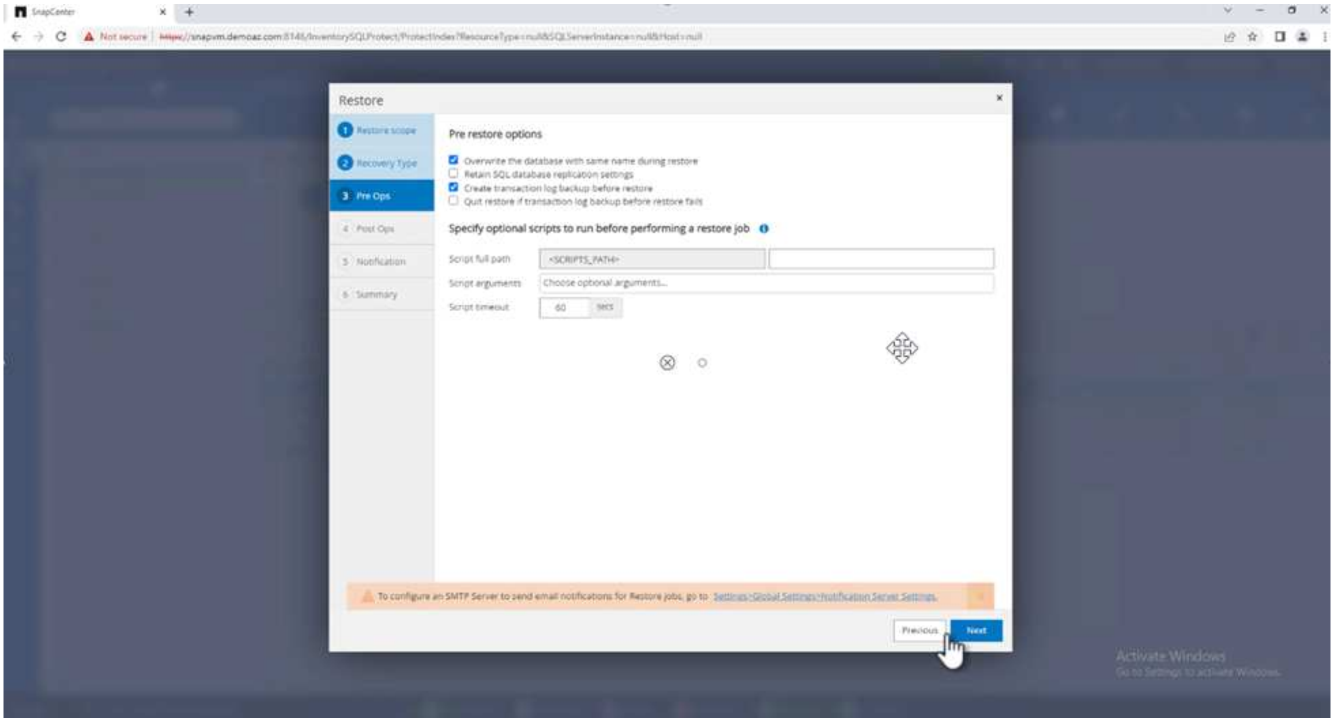
To configure an SMTP Server to send email notifications for Restore jobs, go to Settings>Global Settings>Notification Server Settings.



To configure an SMTP Server to send email notifications for Restore jobs, go to Settings>Global Settings>Notification Server Settings.

Pre- restore options:

1. Select the option **Overwrite the database with same name during restore**. Click **Next**.



Pre restore options

☑ Overwrite the database with same name during restore
☐ Retain SQL database replication settings
☑ Create transaction log backup before restore
☐ Quit restore if transaction log backup before restore fails

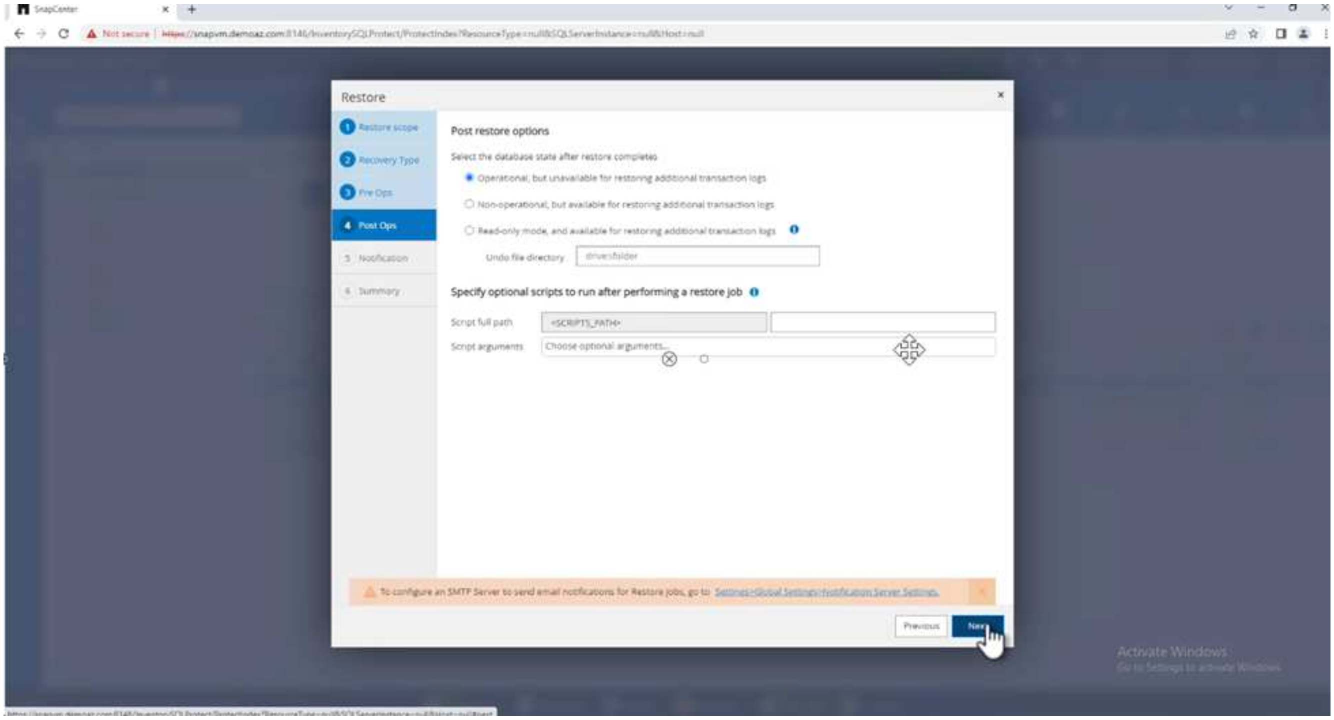
Specify optional scripts to run before performing a restore job

Script full path: <SCRIPTS_PATH>
Script arguments: Choose optional arguments...
Script timeout: 60 secs

To configure an SMTP Server to send email notifications for Restore jobs, go to Settings>Global Settings>Notification Server Settings.

Post- restore options:

1. Select the option **Operational, but unavailable for restoring additional transaction logs**. Click **Next**.



Post restore options

Select the database state after restore completes

● Operational, but unavailable for restoring additional transaction logs
○ Non-operational, but available for restoring additional transaction logs
○ Read-only mode, and available for restoring additional transaction logs

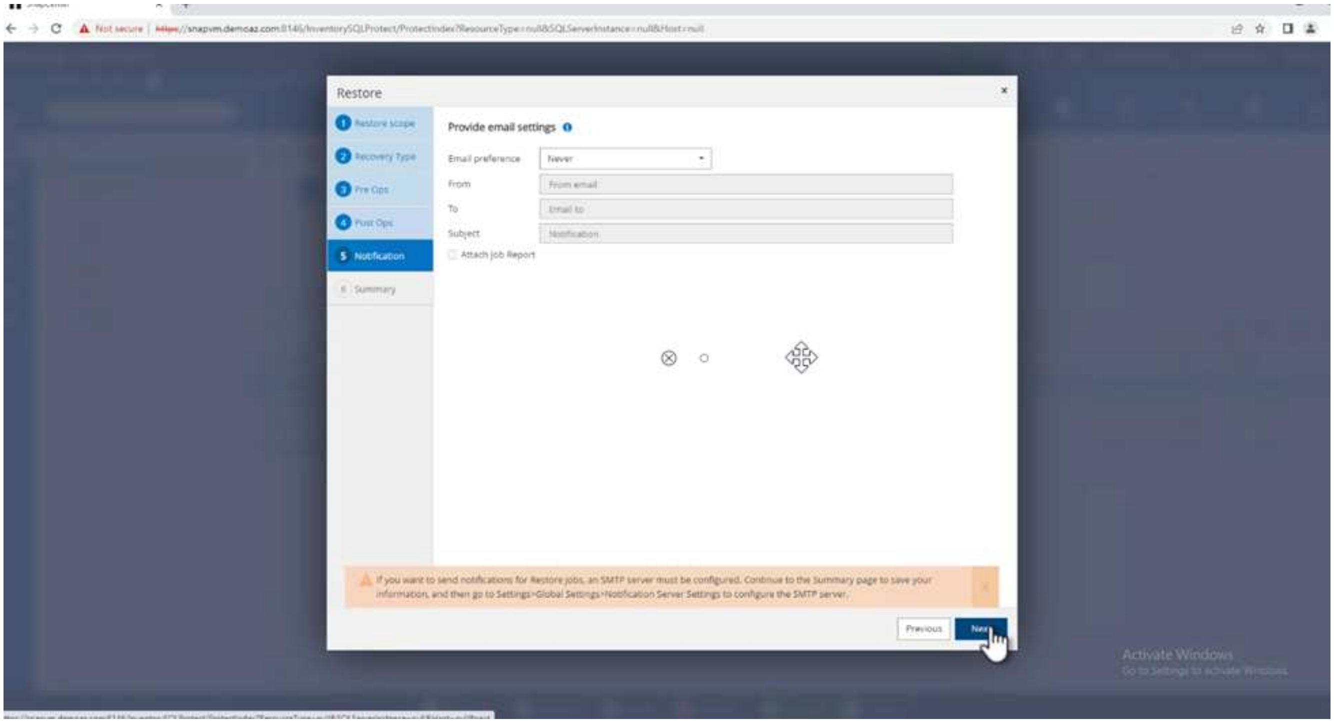
Undo file directory: drive:\folder

Specify optional scripts to run after performing a restore job

Script full path: <SCRIPTS_PATH>
Script arguments: Choose optional arguments...

To configure an SMTP Server to send email notifications for Restore jobs, go to Settings>Global Settings>Notification Server Settings.

2. Provide the email settings. Click **Next**.



Provide email settings

Email preference: Never

From: From email

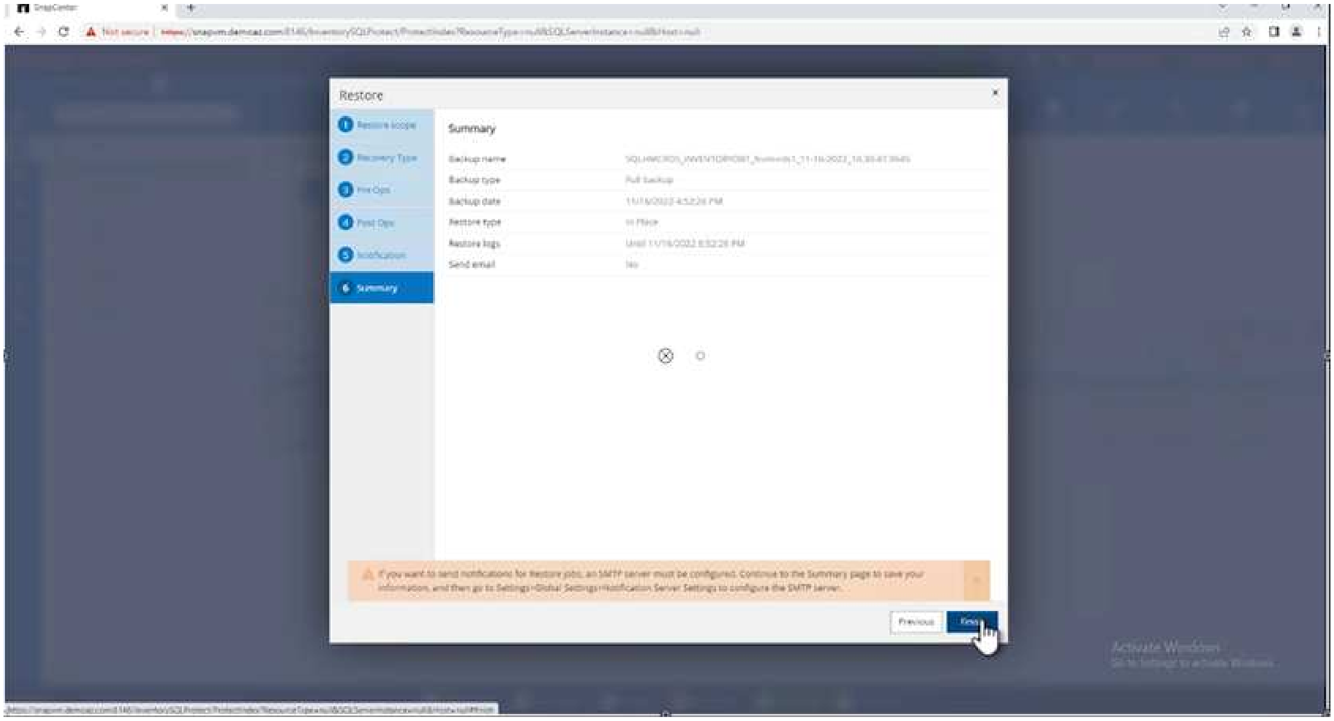
To: Email to

Subject: Notification

☐ Attach job Report

If you want to send notifications for Restore 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.

3. On the **Summary** page, click **Finish**.



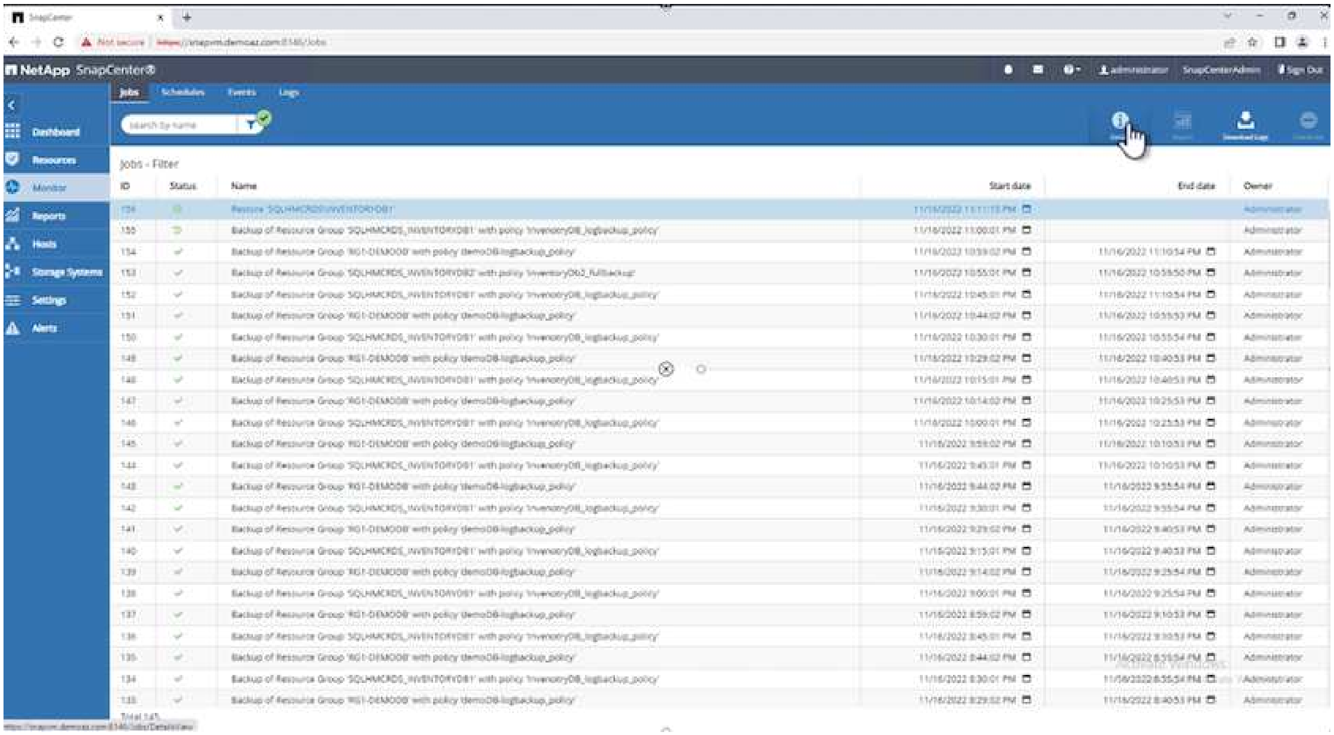
Summary

Backup name	[illegible]
Backup type	Full backup
Backup date	11/16/2022 4:52:26 PM
Restore type	In Place
Restore logs	Until 11/16/2022 8:52:26 PM
Send email	No

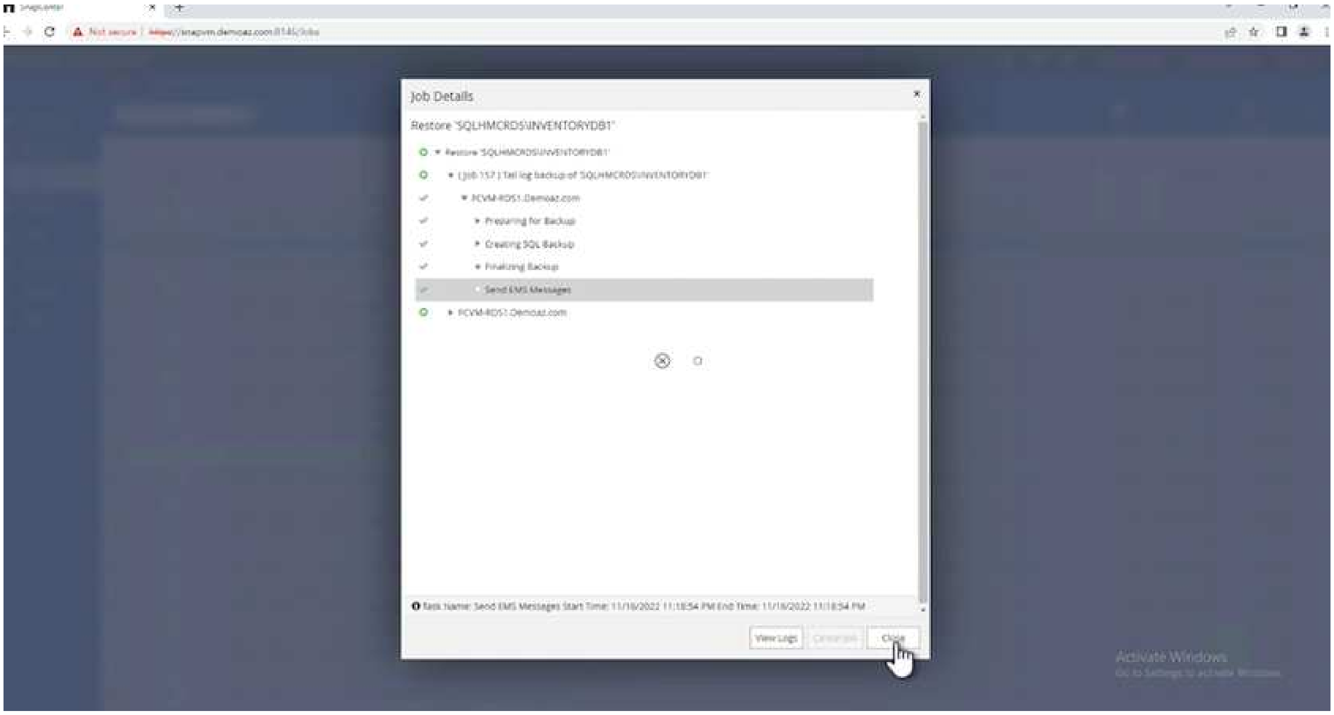
If you want to send notifications for Restore jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

Monitoring the restore progress

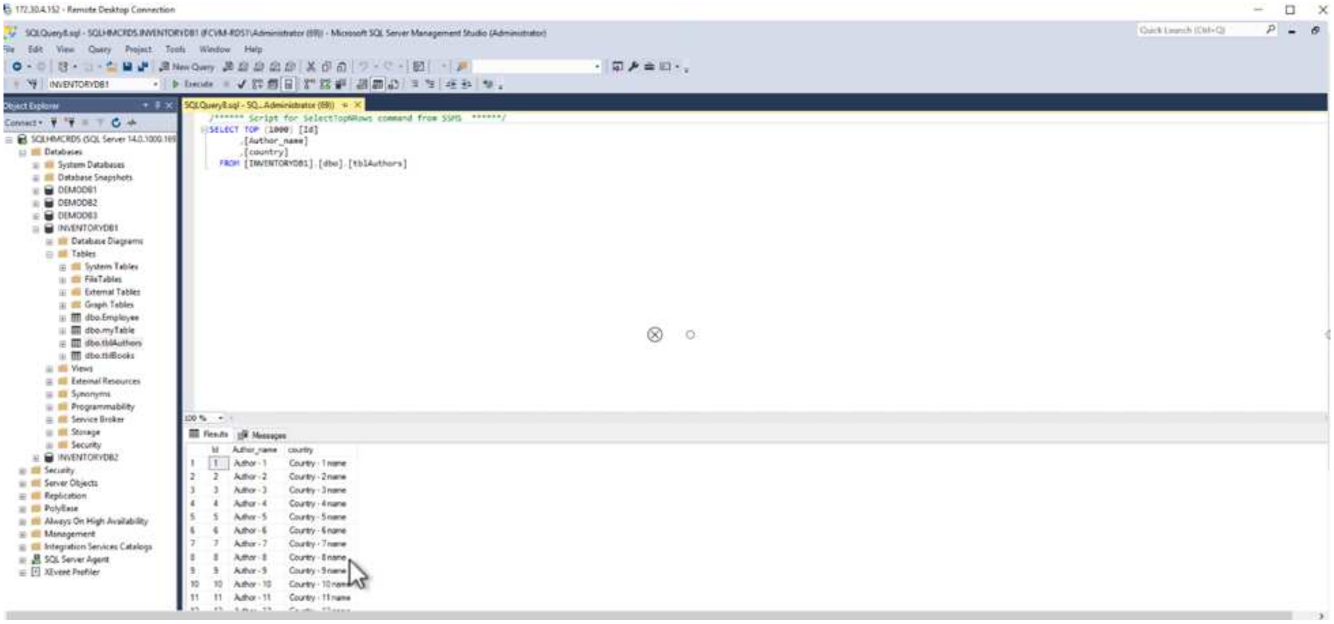
1. From the **Monitoring** tab, click the restore job details to view the progress of the restore job.



2. Restore the job details.



3. Return to SQL Server host > database > table are present.



```
/****** Script for SelectTopNRows command from SSMS  ******/
SELECT TOP (1000) [Id]
      ,[Author_name]
      ,[country]
  FROM [INVENTORYDB1].[dbo].[tblAuthors]
```

```
    Id   Author_name   country
1   1    Author - 1    Country - 1 name
2   2    Author - 2    Country - 2 name
3   3    Author - 3    Country - 3 name
4   4    Author - 4    Country - 4 name
5   5    Author - 5    Country - 5 name
6   6    Author - 6    Country - 6 name
7   7    Author - 7    Country - 7 name
8   8    Author - 8    Country - 8 name
9   9    Author - 9    Country - 9 name
10  10   Author - 10   Country - 10 name
11  11   Author - 11   Country - 11 name
```

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-4923: SQL Server on AWS EC2 using Amazon FSx for NetApp ONTAP

This solution covers the deployment of 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 todays 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

1. For optimal storage performance, provision file-system capacity to 1.35x times the size of total database usage.
2. Appropriate monitoring accompanied by an effective action plan is required when using thin provisioning to avoid application downtime.
3. Make sure to set Cloudwatch and other monitoring tool alerts so that people are contacted with enough time to react as storage is filled.

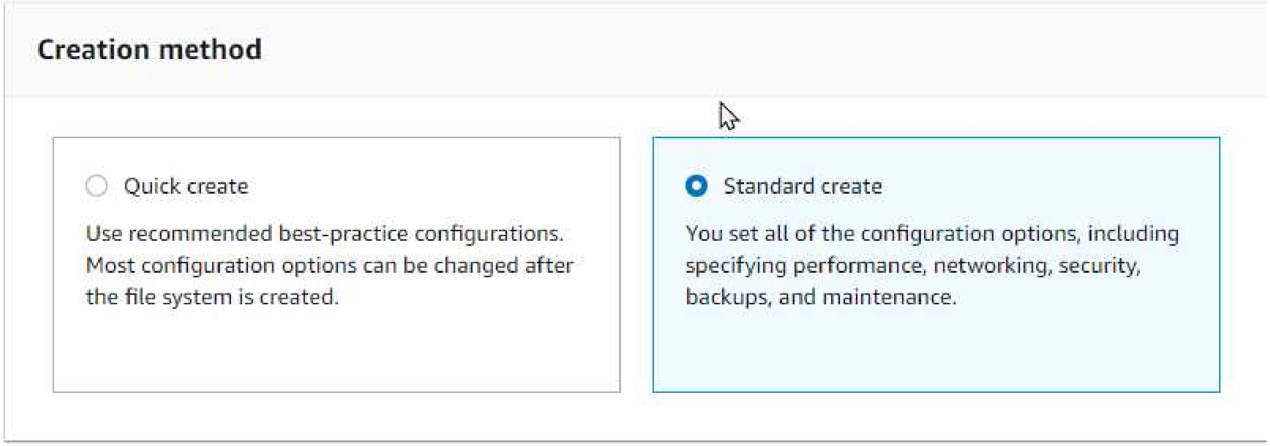
Configure Storage for SQL Server and deploy Snapcenter for Backup, Restore and clone operations

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.



Creation method

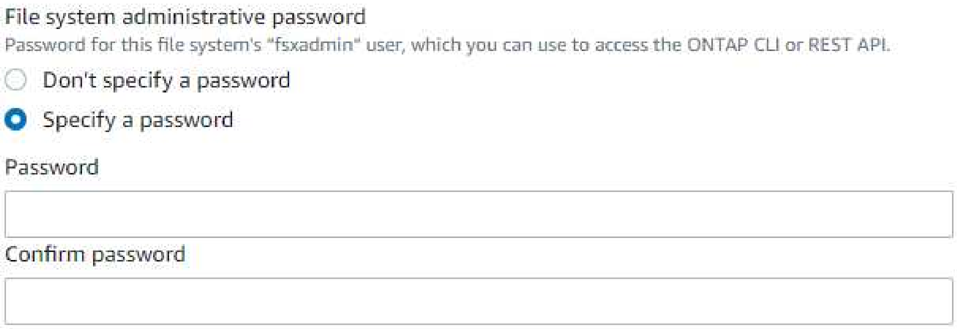
○ Quick create

Use recommended best-practice configurations. Most configuration options can be changed after the file system is created.

● Standard create

You set all of the configuration options, including specifying performance, networking, security, backups, and maintenance.

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.

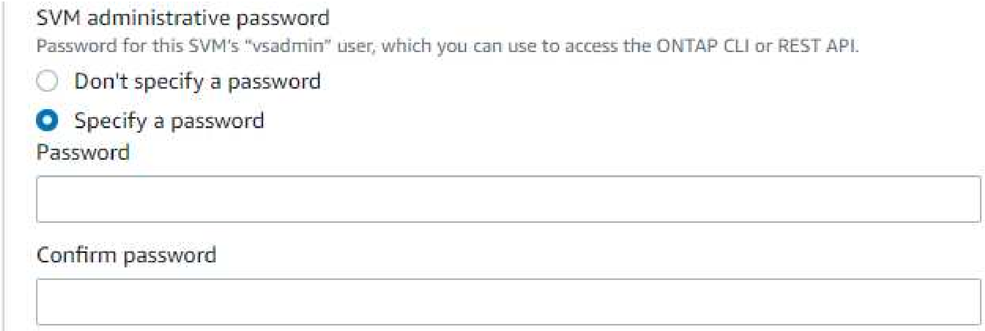
○ Don't specify a password

● 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
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.

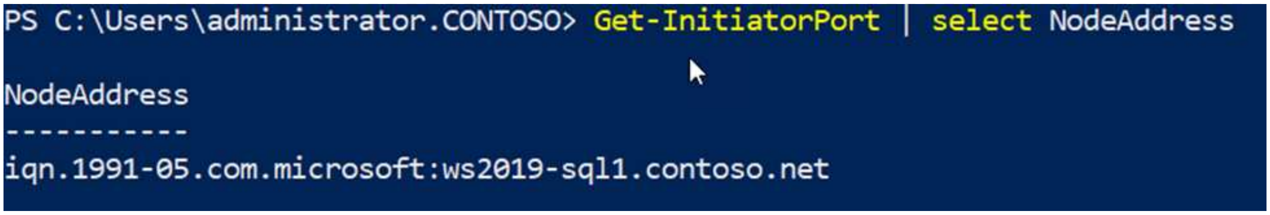
```
Start-service -Name msiscsi
Set-Service -Name msiscsi -StartupType Automatic
```

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
```



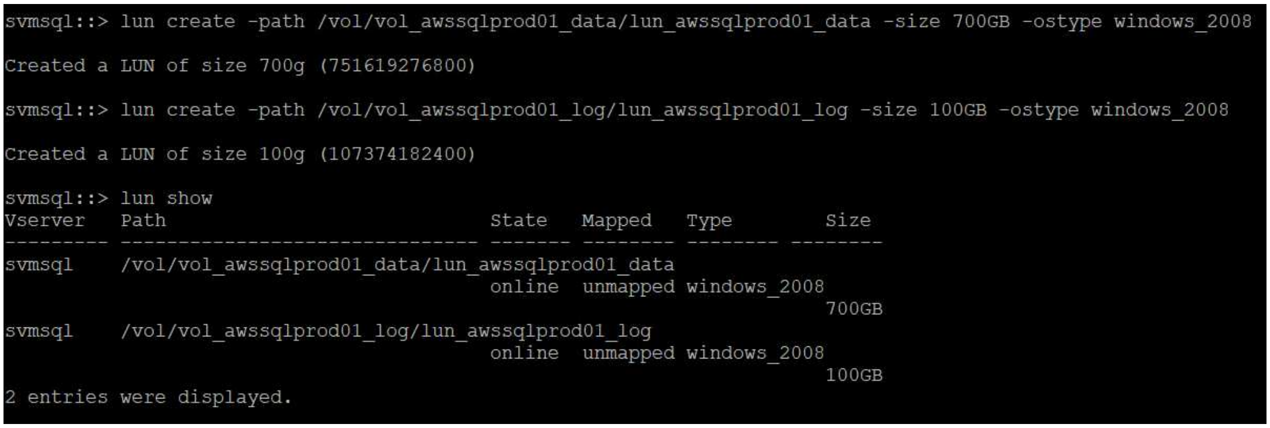
```
PS C:\Users\administrator.CONTOSO> Get-InitiatorPort | select NodeAddress

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:

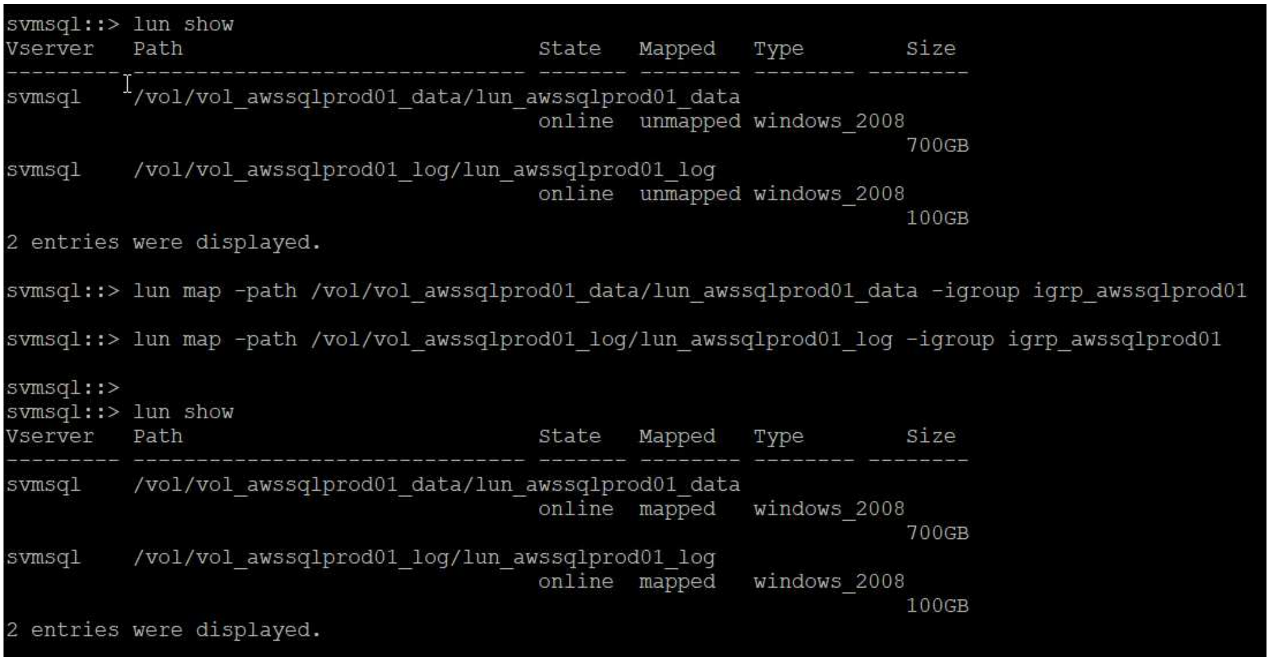
```
lun create -path /vol/vol_awssqlprod01_data/lun_awssqlprod01_data
-size 700GB -ostype windows_2008 -space-allocation enabled lun
create -path /vol/vol_awssqlprod01_log/lun_awssqlprod01_log -size
100GB -ostype windows_2008 -space-allocation enabled
```



```
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.
```

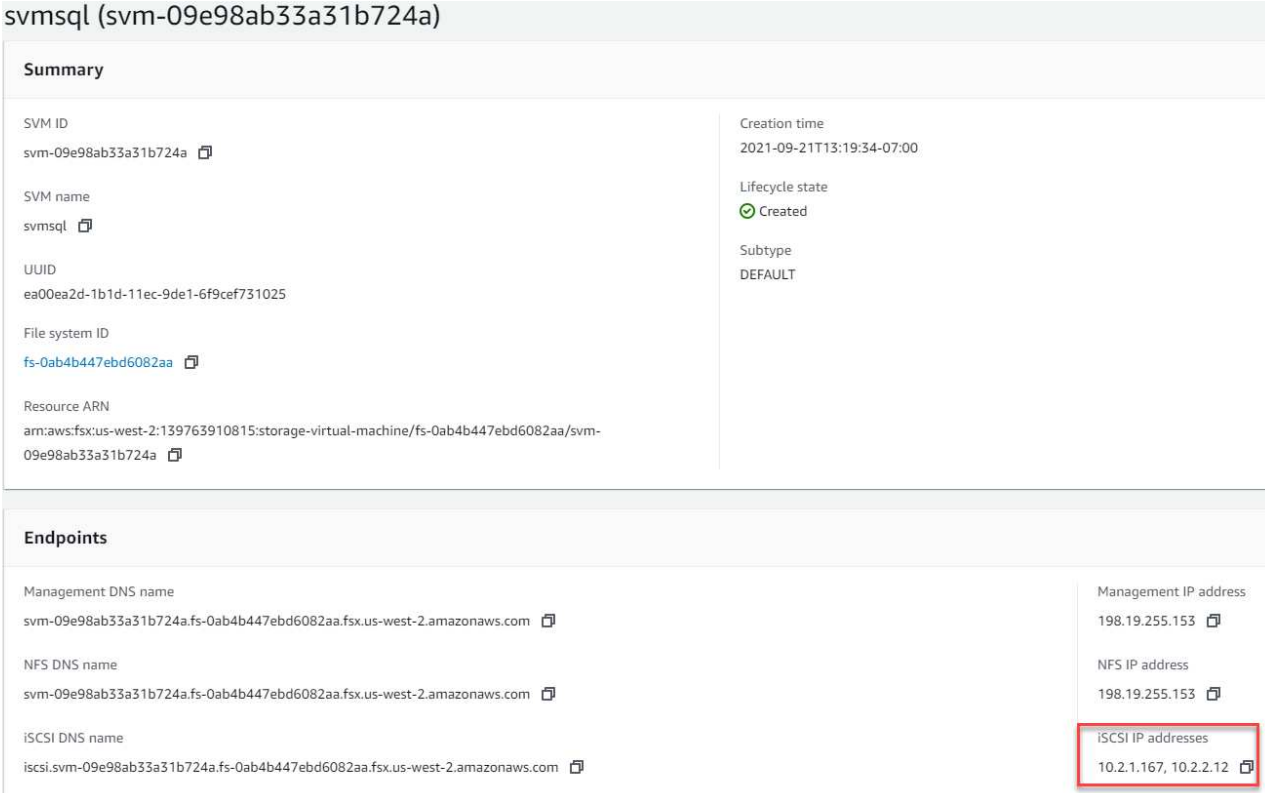
12. To achieve I/O alignment with the OS partitioning scheme, use windows_2008 as the recommended LUN type. Refer here for additional information.
13. Use the following SSH command to the map igroup to the LUNs that you just created.

```
lun show
lun map -path /vol/vol_awssqlprod01_data/lun_awssqlprod01_data
-igroup igrp_awssqlprod01lun 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
svm-09e98ab33a31b724a

SVM name
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

Creation time
2021-09-21T13:19:34-07:00

Lifecycle state
✓ Created

Subtype
DEFAULT

Endpoints

Management DNS name
svm-09e98ab33a31b724a.fs-0ab4b447ebd6082aa.fsx.us-west-2.amazonaws.com

NFS DNS name
svm-09e98ab33a31b724a.fs-0ab4b447ebd6082aa.fsx.us-west-2.amazonaws.com

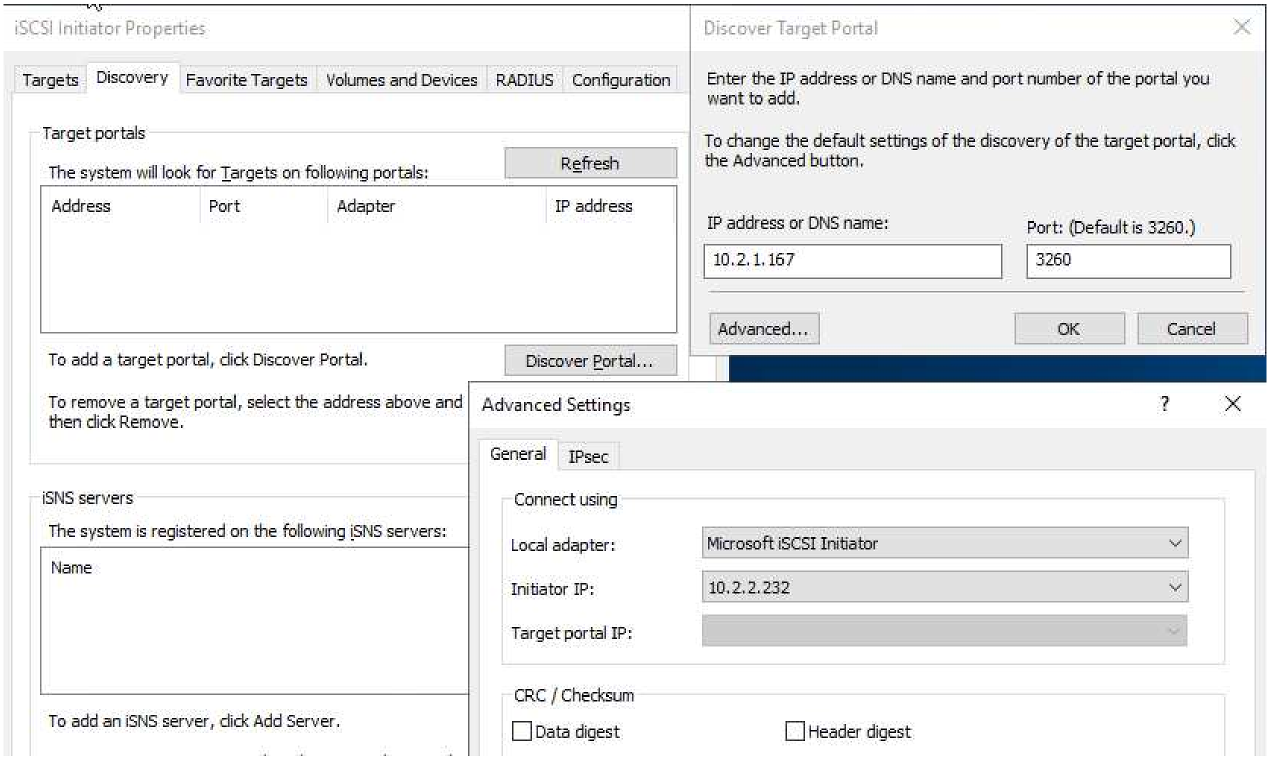
iSCSI DNS name
iscsi.svm-09e98ab33a31b724a.fs-0ab4b447ebd6082aa.fsx.us-west-2.amazonaws.com

Management IP address
198.19.255.153

NFS IP address
198.19.255.153

iSCSI IP addresses
10.2.1.167, 10.2.2.12

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 system will look for Targets on following portals:

To add a target portal, click Discover Portal.

To remove a target portal, select the address above and then click Remove.

The system is registered on the following iSNS servers:

To add an iSNS server, click Add Server.

Enter the IP address or DNS name and port number of the portal you want to add.

To change the default settings of the discovery of the target portal, click the Advanced button.

IP address or DNS name: 10.2.1.167

Port: (Default is 3260.) 3260

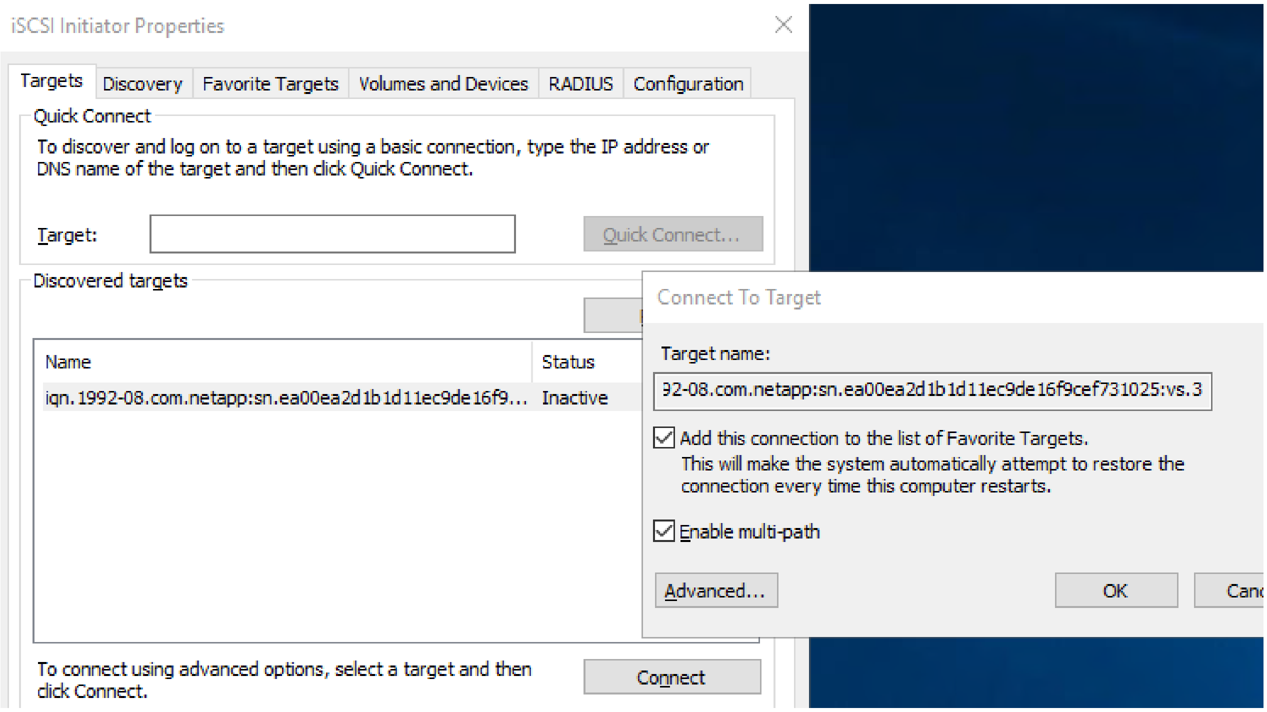
Local adapter: Microsoft iSCSI Initiator

Initiator IP: 10.2.2.232

Target portal IP:

☐ Data digest ☐ Header digest

17. Repeat step 12 for the second iSCSI IP from the SVM.
18. Select the **Targets** tab, select **Connect**, and select **Enable muti-path**.



To discover and log on to a target using a basic connection, type the IP address or DNS name of the target and then click Quick Connect.

Target:

Name	Status
iqn.1992-08.com.netapp:sn.ea00ea2d1b1d11ec9de16f9...	Inactive

To connect using advanced options, select a target and then click Connect.

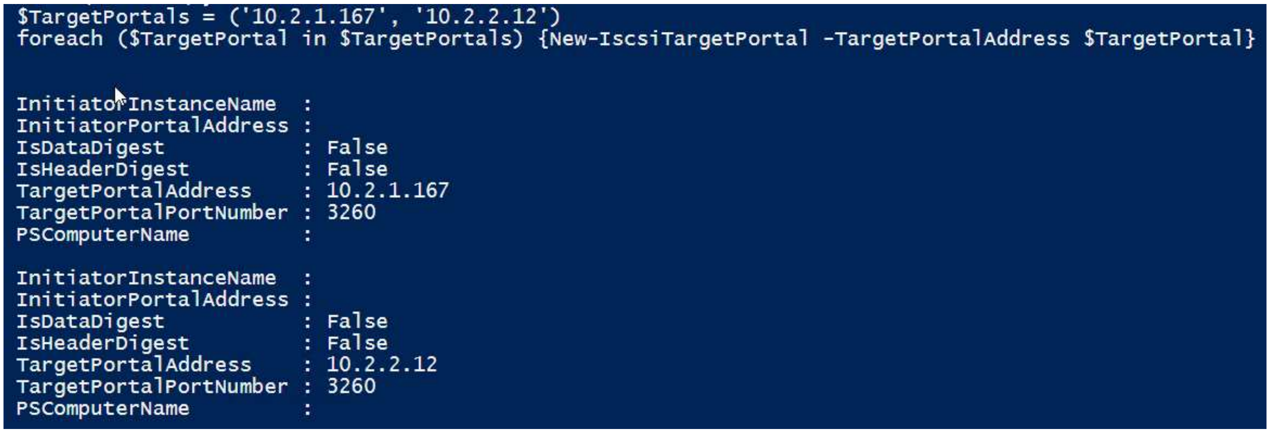
Target name: 92-08.com.netapp:sn.ea00ea2d1b1d11ec9de16f9cef731025:vs.3

☑ Add this connection to the list of Favorite Targets.
This will make the system automatically attempt to restore the connection every time this computer restarts.

☑ Enable multi-path

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}
```

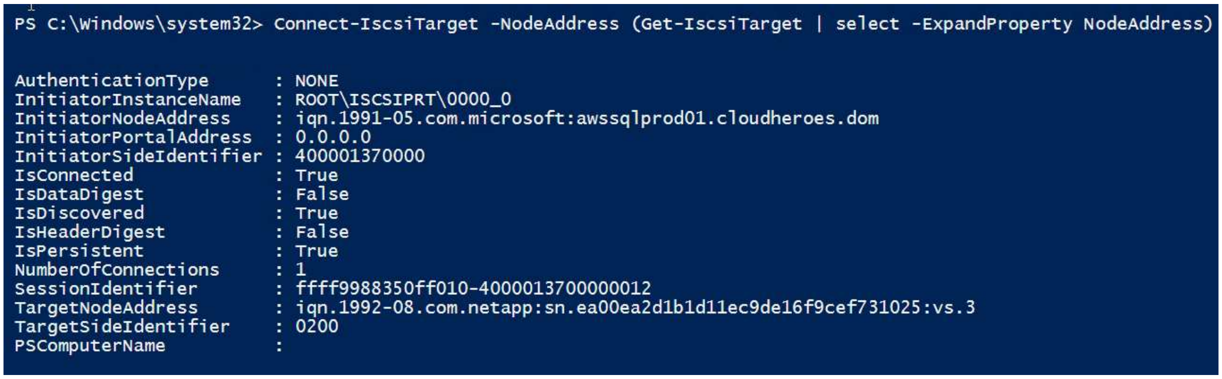


```
$TargetPortals = ('10.2.1.167', '10.2.2.12')
foreach ($TargetPortal in $TargetPortals) {New-IscsiTargetPortal -TargetPortalAddress $TargetPortal}


InitiatorInstanceName   :
InitiatorPortalAddress :
IsDataDigest           : False
IsHeaderDigest         : False
TargetPortalAddress    : 10.2.1.167
TargetPortalPortNumber : 3260
PSComputerName         :

InitiatorInstanceName   :
InitiatorPortalAddress :
IsDataDigest           : False
IsHeaderDigest         : False
TargetPortalAddress    : 10.2.2.12
TargetPortalPortNumber : 3260
PSComputerName         :
```

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
  1. Run the following PowerShell command to make sure that the iSCSI session is persisted.

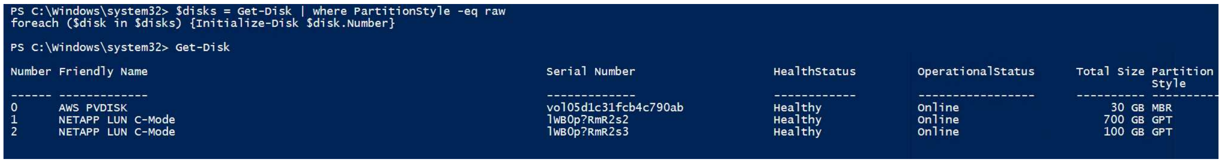
     ```
     $targets = Get-IscsiTarget
     foreach ($target in $targets)
     {
     Connect-IscsiTarget -IsMultipathEnabled $true -NodeAddress
     $target.NodeAddress -IsPersistent $true
     }
     ```

     ```
     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  : 0.0.0.0
     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
     TargetSideIdentifier    : 0200
     PSComputerName          :
     ```

  2. Initialize disks with the following PowerShell command.

```
$disks = Get-Disk | where PartitionStyle -eq raw
foreach ($disk in $disks) {Initialize-Disk $disk.Number}
```



```
PS C:\Windows\system32> $disks = Get-Disk | where PartitionStyle -eq raw
foreach ($disk in $disks) {Initialize-Disk $disk.Number}

PS C:\Windows\system32> Get-Disk

Number Friendly Name                                          Serial Number              HealthStatus         OperationalStatus      Total Size Partition
                                                                                                                                              Style
------ -------------                                          -------------              ------------         -----------------      ---------- ---------
0      AWS PVDISK                                             vol05d1c31fcb4c790ab       Healthy              Online                      30 GB MBR
1      NETAPP LUN C-Mode                                      1wB0p?RmR2s2               Healthy              Online                     700 GB GPT
2      NETAPP LUN C-Mode                                      1wB0p?RmR2s3               Healthy              Online                     100 GB GPT
```

3. 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.

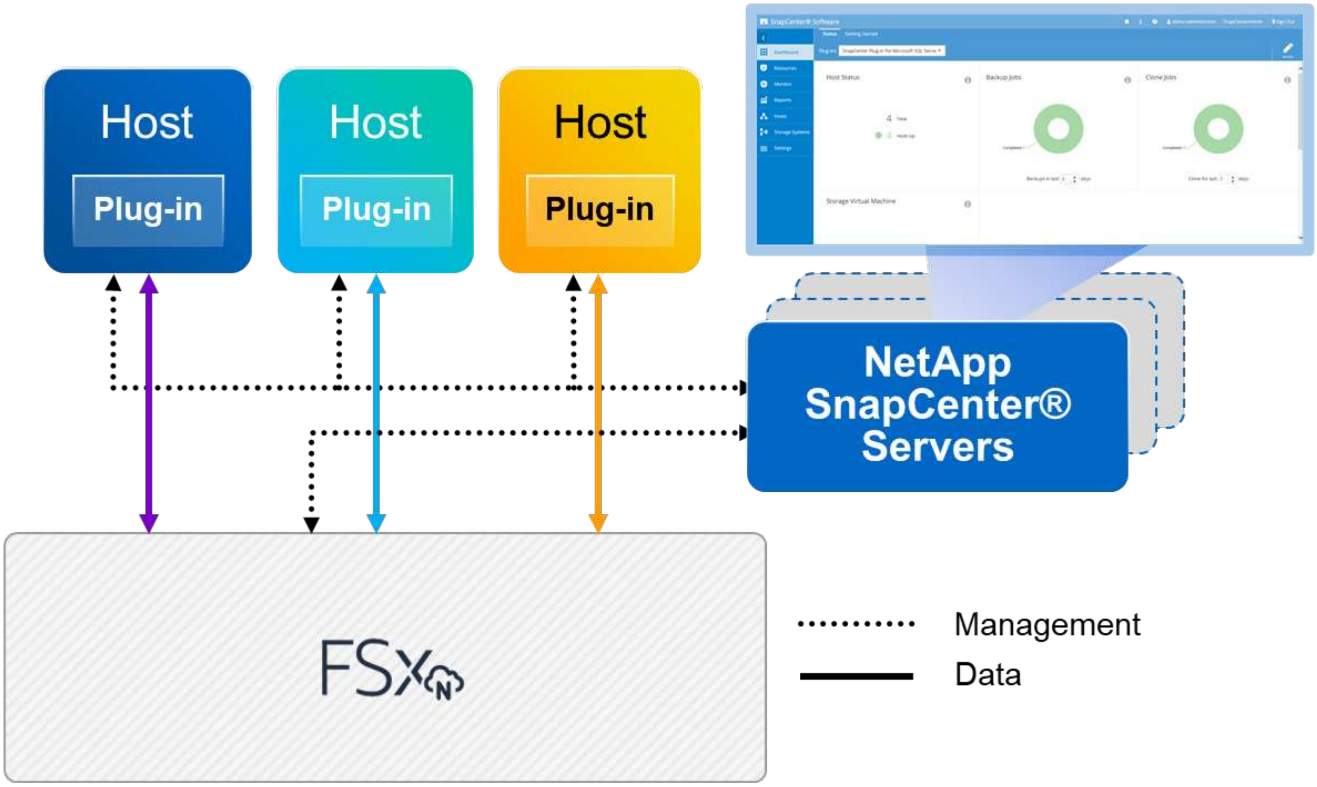
Components	Requirement
Minimum CPU count	Four cores/vCPUs
Memory	Minimum: 8GB Recommended: 32GB
Storage space	Minimum space for installation: 10GB Minimum space for repository: 10GB
Supported operating system	• Windows Server 2012 • Windows Server 2012 R2 • Windows Server 2016 • Windows Server 2019
Software packages	• .NET 4.5.2 or later • Windows Management Framework (WMF) 4.0 or later • PowerShell 4.0 or later

For detailed information, refer to space and sizing requirements.

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

1. 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.
2. 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.
3. Create separate LUNs to store full text-related files and file-streaming related files.
4. Assign separate LUNs per host to store Microsoft SQL Server log backups.
5. 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.
6. 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.

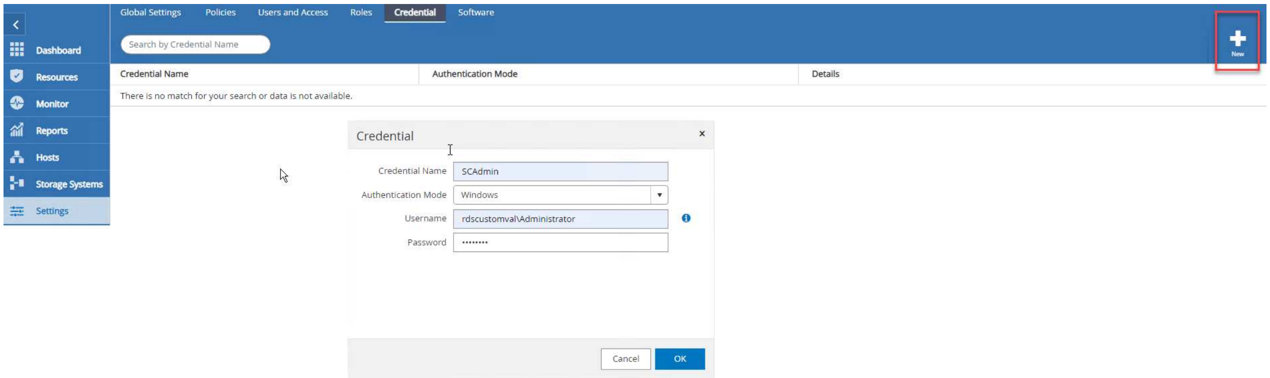
When you create a new database, Microsoft recommends specifying separate drives for the data and logs. To move files after the database is created, the database must be taken offline. For more Microsoft recommendations, see Place Data and Log Files on Separate Drives.

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.

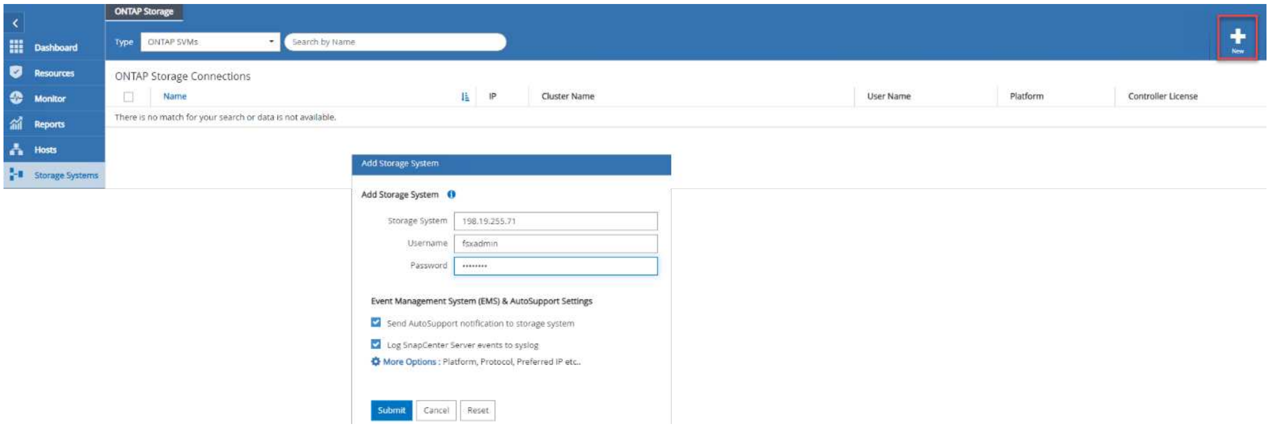


There is no match for your search or data is not available.

Credential

Credential Name: SCAdmin
Authentication Mode: Windows
Username: rdscustomval\Administrator
Password: ••••••••

2. Add the storage system by selecting Storage Systems > New and the provide the appropriate FSx for ONTAP storage information.



There is no match for your search or data is not available.

Add Storage System

Storage System: 198.19.255.71
Username: fsxadmin
Password: ••••••••

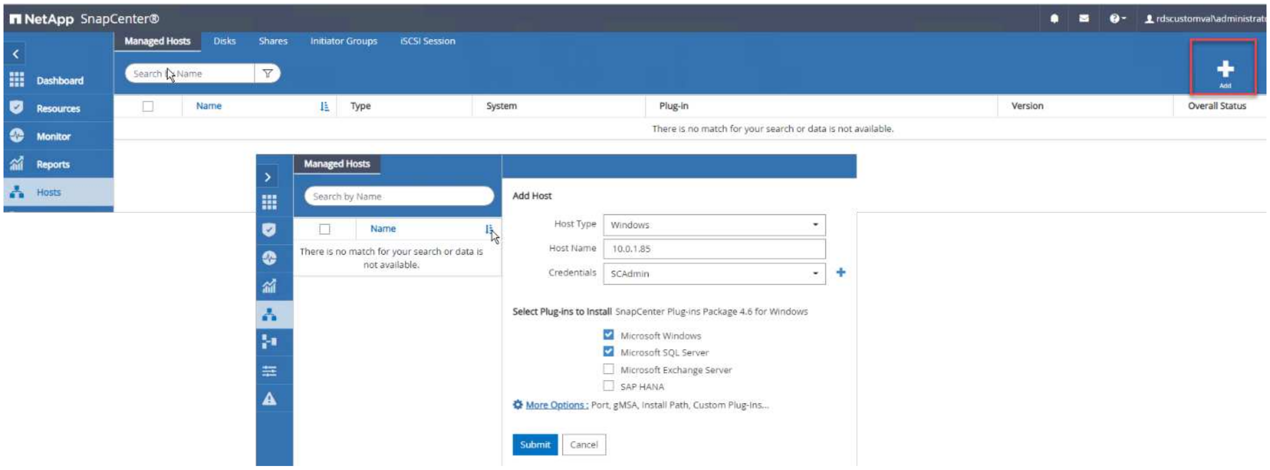
Event Management System (EMS) & AutoSupport Settings

☑ Send AutoSupport notification to storage system

☑ Log SnapCenter Server events to syslog

More Options : Platform, Protocol, Preferred IP etc..

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.



There is no match for your search or data is not available.

Add Host

Host Type: Windows
Host Name: 10.0.1.85
Credentials: SCAdmin

Select Plug-ins to Install SnapCenter Plug-ins Package 4.6 for Windows

☑ Microsoft Windows
☑ Microsoft SQL Server
☐ Microsoft Exchange Server
☐ SAP HANA

More Options : Port, gMSA, Install Path, Custom Plug-ins...

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.

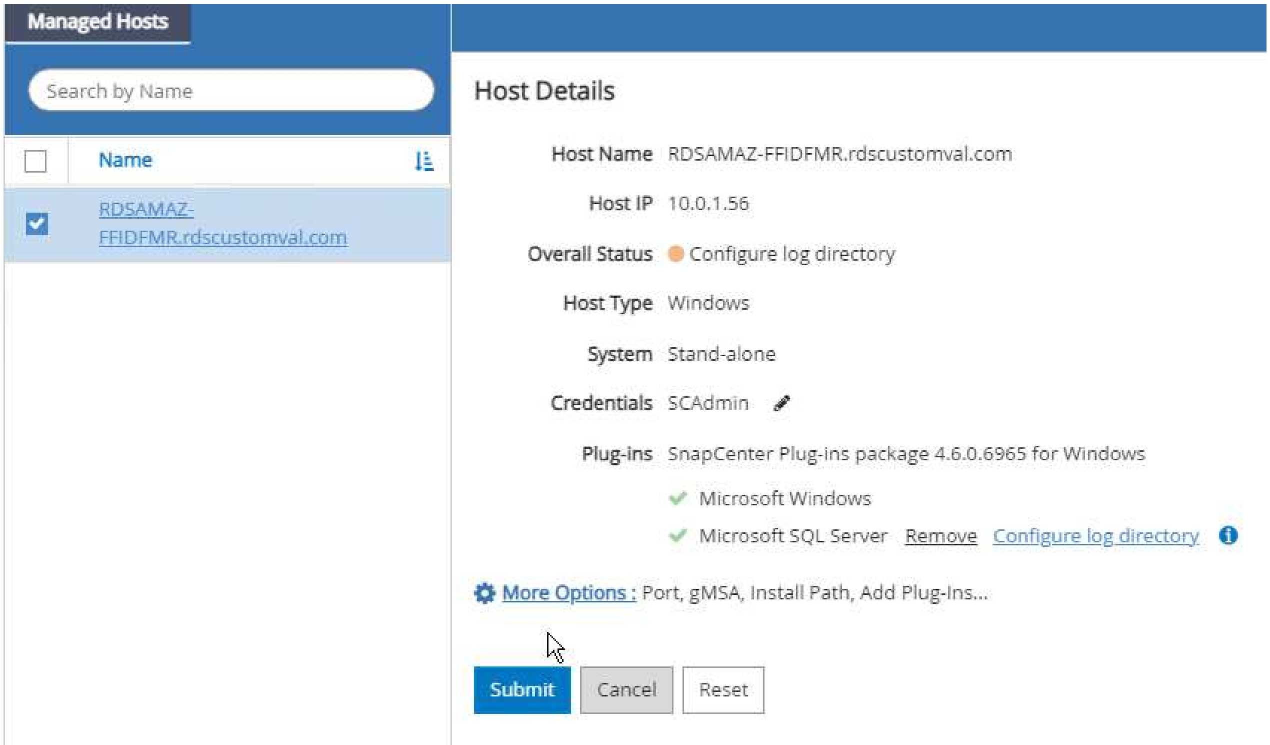
> SnapCenter uses a host log directory to store transaction log backup data. This is at the host and instance level. Each SQL Server host used by SnapCenter must have a host log directory configured to perform log backups. SnapCenter has a database repository, so metadata related to backup, restore, or cloning operations is stored in a central database repository.

The size of the host log directory is calculated as follows:

Size of host log directory = system database size + (maximum DB LDF size × daily log change rate % × (Snapshot copy retention) ÷ (1 – LUN overhead space %)

The host log directory sizing formula assumes the following:

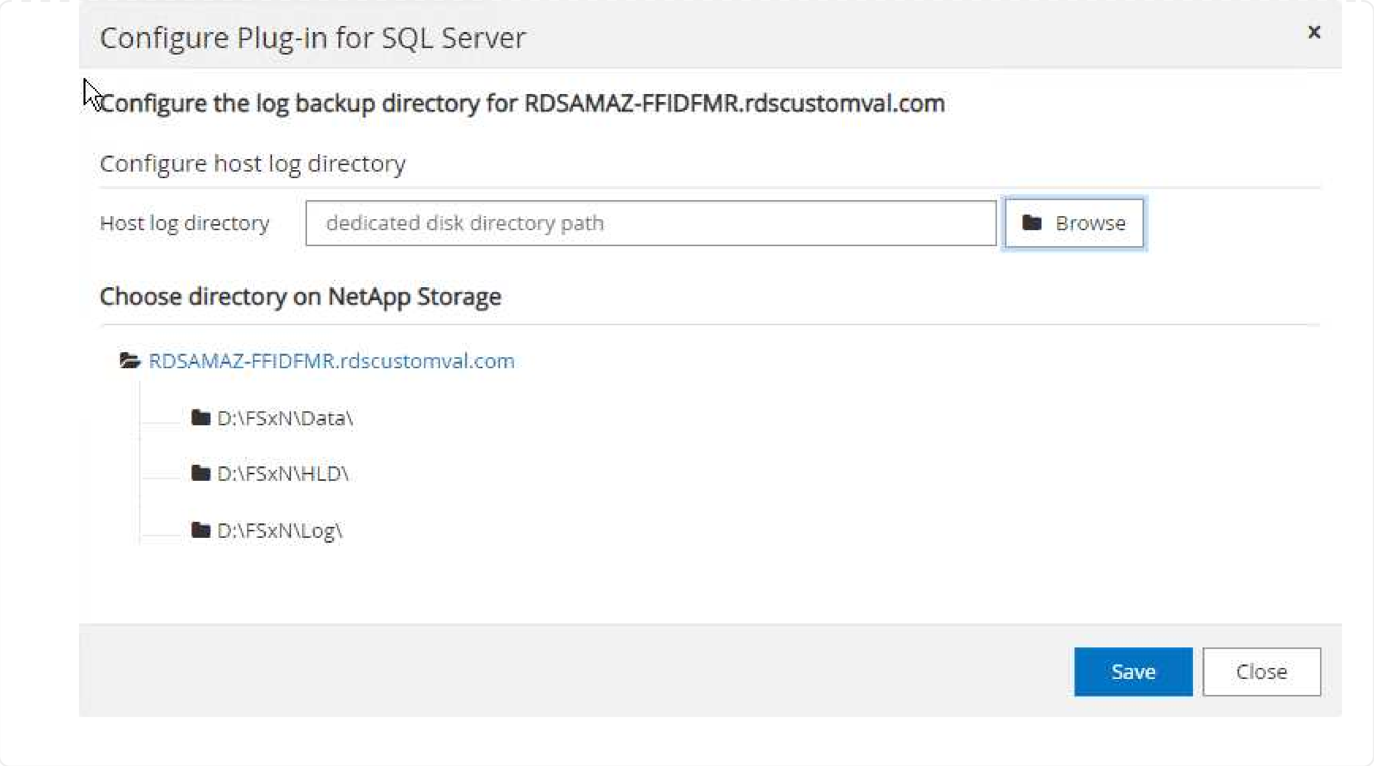
- A system database backup that does not include the tempdb database
- A 10% LUN overhead spacePlace the host log directory on a dedicated volume or LUN. The amount of data in the host log directory depends on the size of the backups and the number of days that backups are retained.



☑ RDSAMAZ-FFIDFMR.rdscustomval.com

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
More Options : Port, gMSA, Install Path, Add Plug-Ins...

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

Configure the log backup directory for RDSAMAZ-FFIDFMR.rdscustomval.com

Configure host log directory

Host log directory: dedicated disk directory path

Choose directory on NetApp Storage

- RDSAMAZ-FFIDFMR.rdscustomval.com
  - D:\FSxN\Data\
  - D:\FSxN\HLD\
  - D:\FSxN\Log\

Now you are ready to perform backup, restore and clone operations for SQL Server.

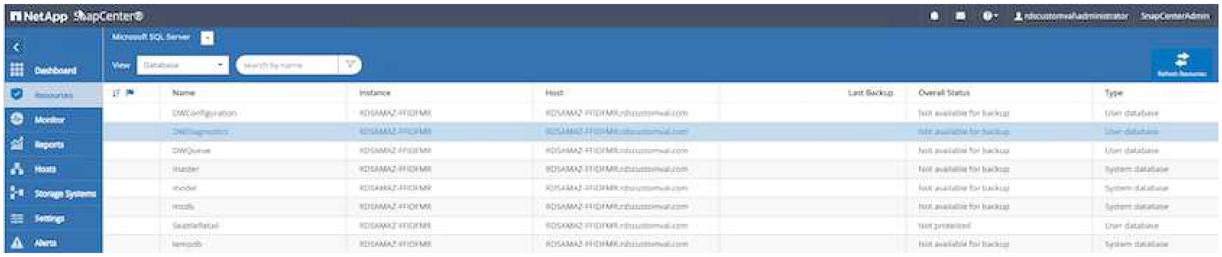
Backup database with SnapCenter

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.

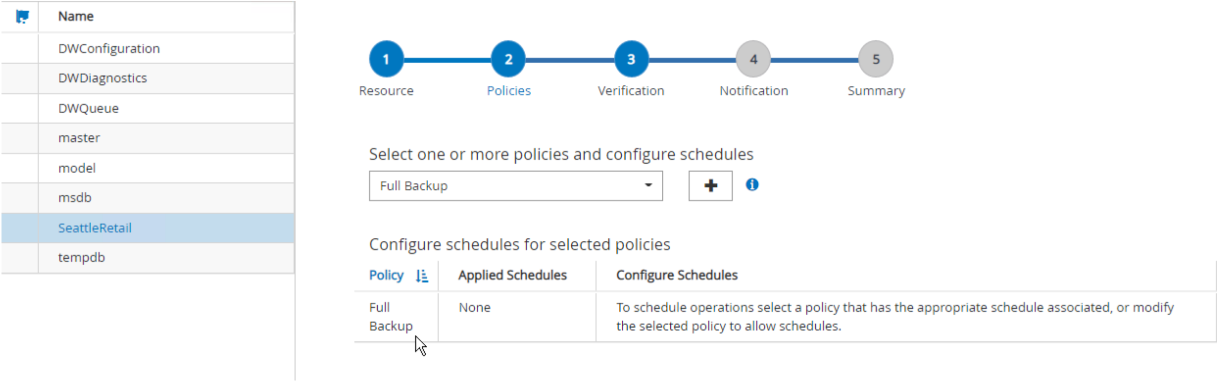
Best Practices

- 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.

1. Select **Resources**, and then select **Microsoft SQL Server *on the drop-down menu on the top left. Select *Refresh Resources**.



2. 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.



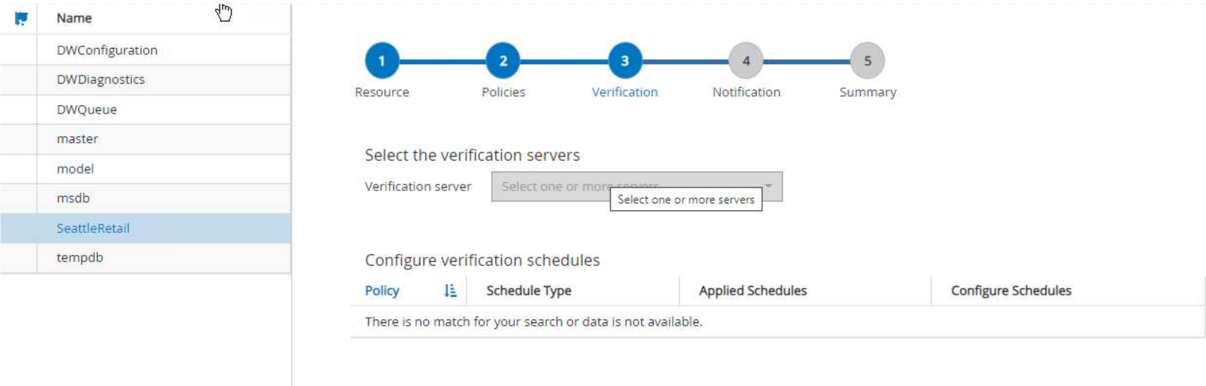
Select one or more policies and configure schedules

Full Backup

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.

3. 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**.



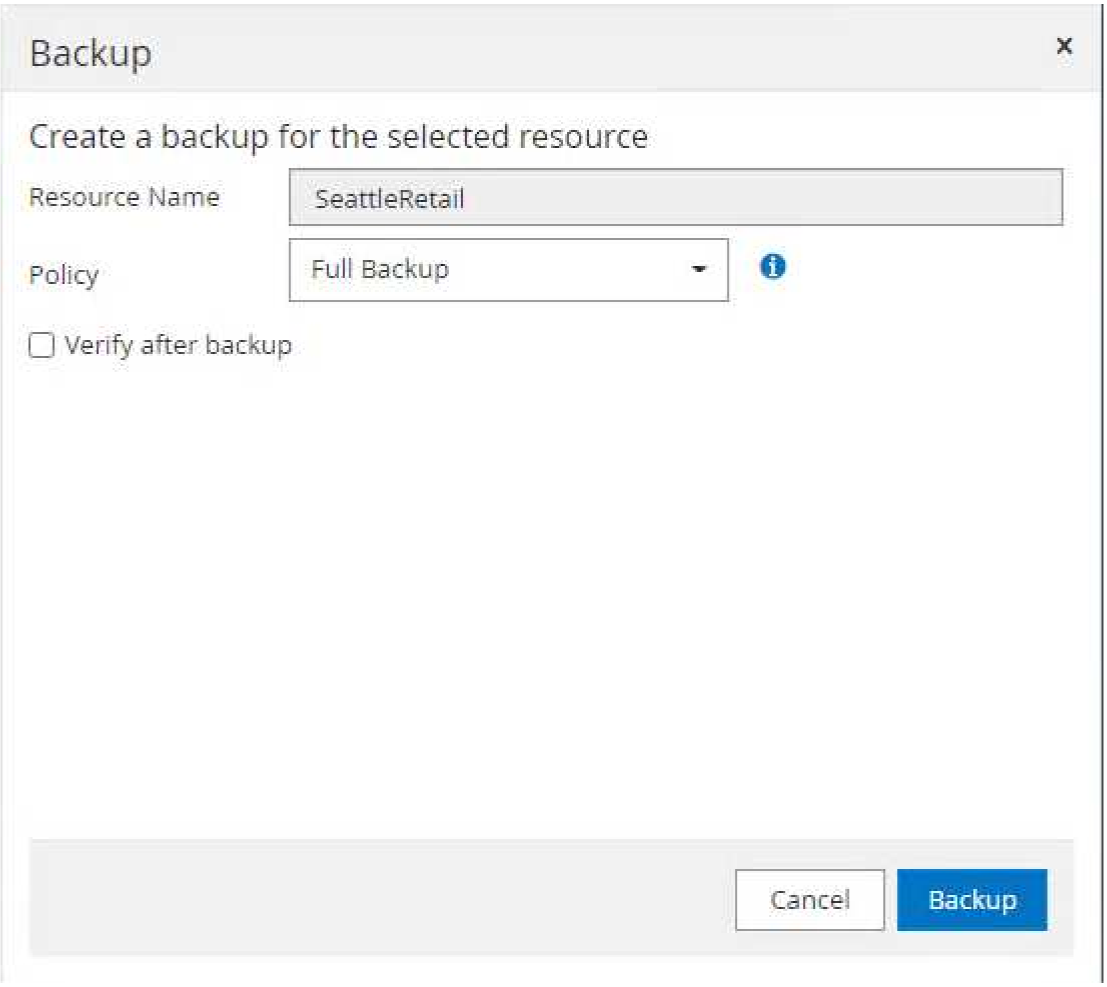
Select the verification servers

Verification server: Select one or more servers

Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
There is no match for your search or data is not available.			

4. Click **Back up Now** to test the backup. In the pop- up windows, select **Backup**.



Backup

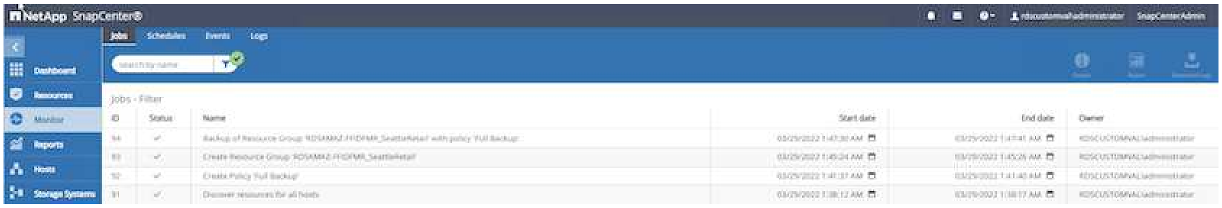
Create a backup for the selected resource

Resource Name: SeattleRetail

Policy: Full Backup

☐ Verify after 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-FH1DFMR_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-FH1DFMR_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

Best Practices

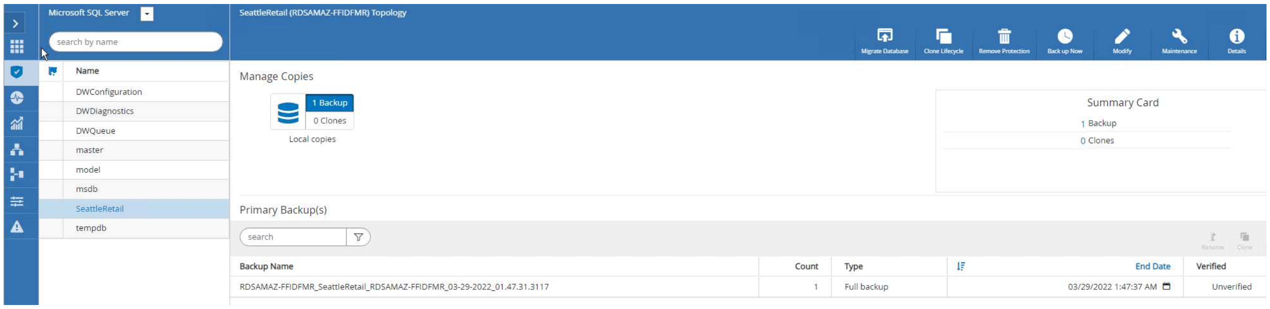
- Backup the transaction log backup from SnapCenter so that during the restoration process, SnapCenter can read all the backup files and restore in sequence automatically.
- If third party products are used for backup, select Copy backup in SnapCenter to avoid log sequence issues, and test the restore 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.

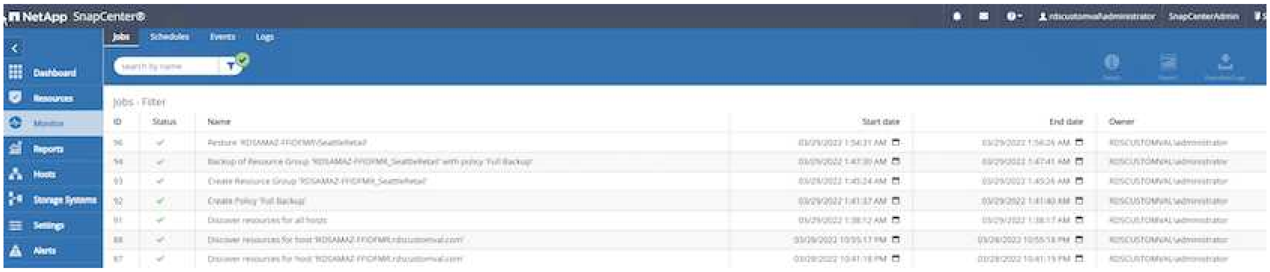
1. Select Resources and then select the database that you would like to restore.



Name
DWConfiguration
DWDiagnostics
DWQueue
master
model
msdb
SeattleRetail
tempdb

Backup Name	Count	Type	End Date	Verified
RDSAMAZ-FFIDFMR_SeattleRetail_RDSAMAZ-FFIDFMR_03-29-2022_01.47.31.3117	1	Full backup	03/29/2022 1:47:37 AM	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.



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

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. SnapCenter cannot restore transaction log backups created outside of SnapCenter.
7. When cloning FlexVol volumes, make sure that you have sufficient space for the clone metadata.

8. When restoring databases, make sure that sufficient space is available on the volume.
9. 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

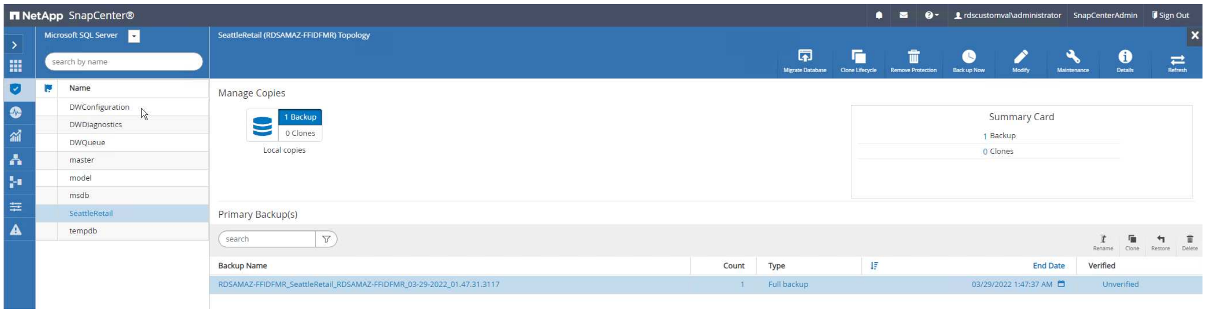
The following steps can be used to clone databases to the new database name in the same SQL server instance running on EC2:

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

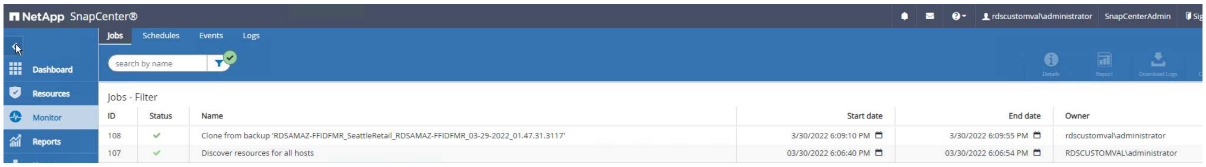
The following step are used to clone databases to the new SQL server instance running on EC2:

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.



Backup Name	Count	Type	End Date	Verified
RDSAMAZ-FFIDFMR_SeattleRetail_RDSAMAZ-FFIDFMR_03-29-2022_01.47.31.3117	1	Full backup	03/29/2022 1:47:37 AM	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.



Jobs - Filter

ID	Status	Name	Start date	End date	Owner
108	✓	Clone from backup 'RDSAMAZ-FFIDFMR_SeattleRetail_RDSAMAZ-FFIDFMR_03-29-2022_01.47.31.3117'	3/30/2022 6:09:10 PM	3/30/2022 6:09:55 PM	rdscustomval\administrator
107	✓	Discover resources for all hosts	03/30/2022 6:06:40 PM	03/30/2022 6:06:54 PM	RDSCUSTOMVAL\administrator

To learn more about this process, watch the following video:

Clone databases into the new SQL Server instance running on EC2

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/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=$fsxN.logvolsize;lunname=(
'l_'+$hostname+'_log');lunsize=$fsxN.loglunsize})
        } else {
            $volsluns
+=(@{volname=('v_'+$hostname+'_data'+[string]$i);volsize=$fsxN.datavols
ize;lunname=('l_'+$hostname+'_data'+[string]$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
    $sshcmd = 'igroup create -igroup ' + $igroup + ' -protocol iscsi
-ostype windows -initiator ' + $initport
    $ret = Invoke-SSHCommand -Command $sshcmd -SSHSession $session
    #Create vols
    Write-host 'Creating Volumes' -ForegroundColor Yellow
    foreach ($vollun in $volsluns){
        $sshcmd = 'vol create ' + $vollun.volname + ' -aggregate aggr1
-size ' + $vollun.volsize #+ ' -vserver ' + $vserver
        $return = Invoke-SSHCommand -Command $sshcmd -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 Partion 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 =
'vsadmin';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=_lDKt-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-4897: SQL Server on Azure NetApp Files - Real Deployment View

This document covers a real-time deployment of SQL Server Always On availability group (AOAG) on Azure NetApp Files leveraging Azure Virtual Machines.

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 (DevTest 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

This section describes the different issues you should consider when Azure NetApp Files with SQL Server in the cloud.

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\.

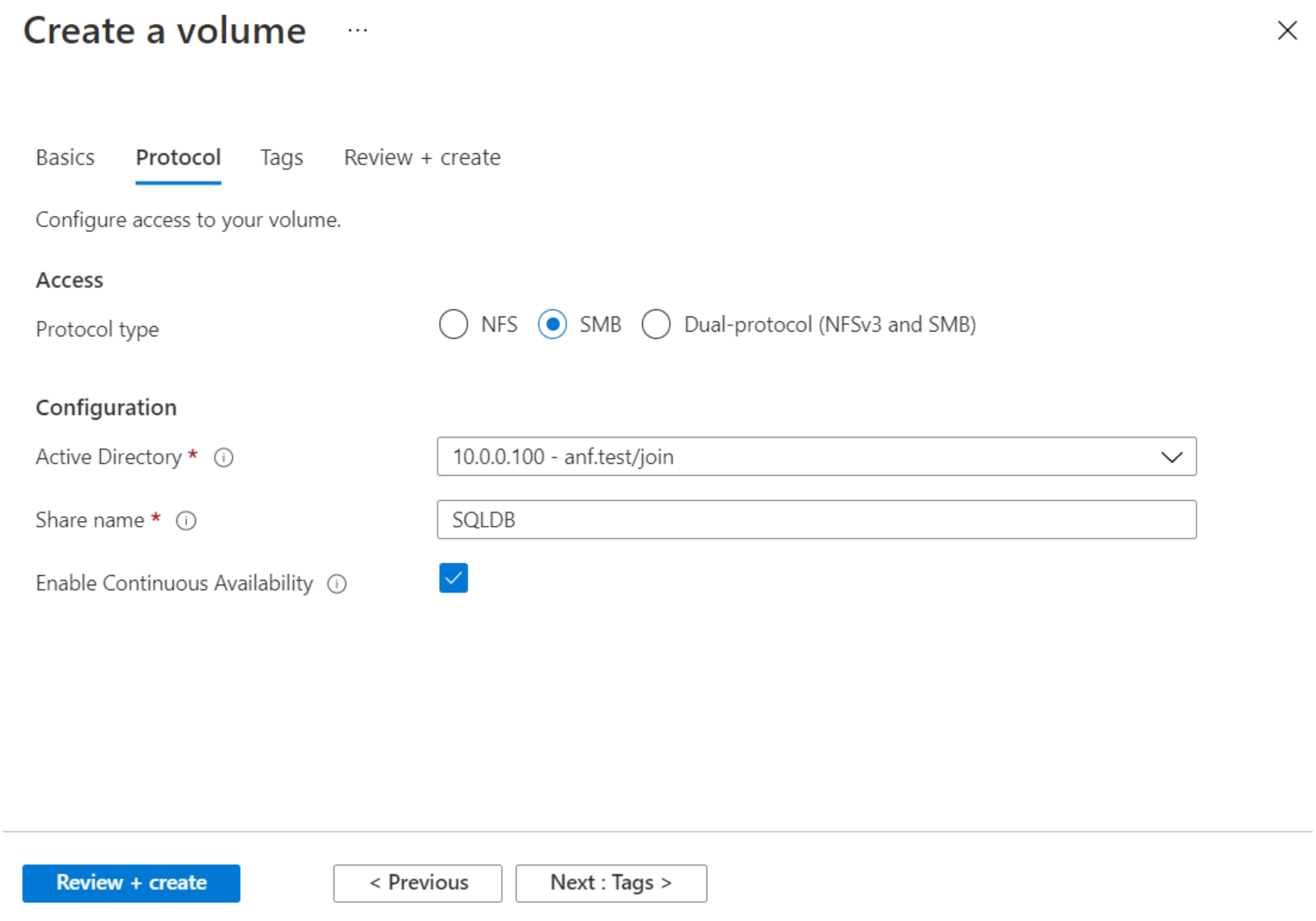
- The loopback UNC path is not supported.
- For sizing, use historic data from your on-premises environment. For OLTP workloads, match the target IOPS with performance requirements using workloads at average and peak times along with the disk reads/sec and disk writes/sec performance counters. For data 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.



Configure access to your volume.

Access

Protocol type: ○ NFS ● SMB ○ Dual-protocol (NFSv3 and SMB)

Configuration

Active Directory *: 10.0.0.100 - anf.test/join

Share name *: SQLDB

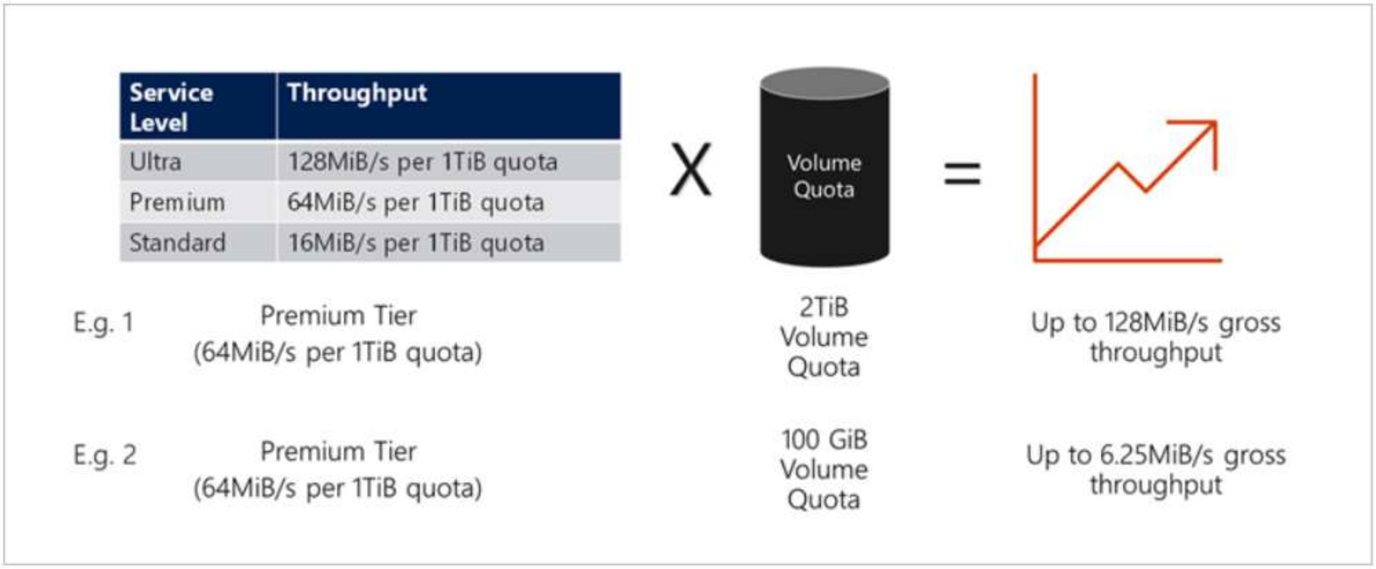
Enable Continuous Availability: ☑

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.

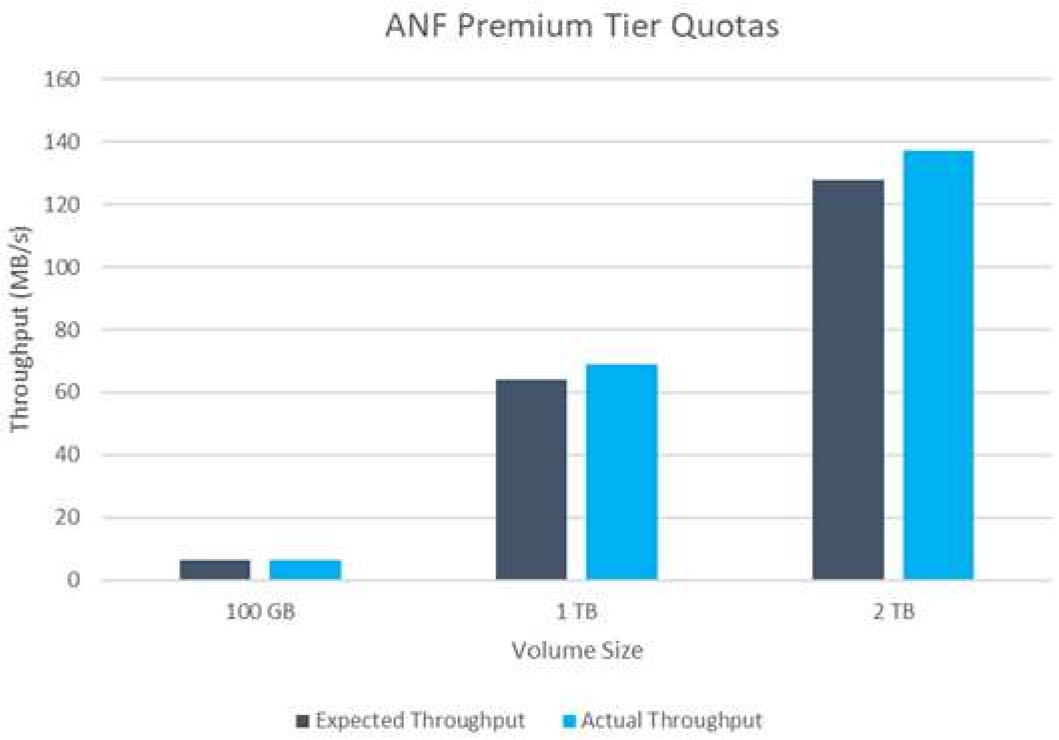


Service Level	Throughput
Ultra	128MiB/s per 1TiB quota
Premium	64MiB/s per 1TiB quota
Standard	16MiB/s per 1TiB quota

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.

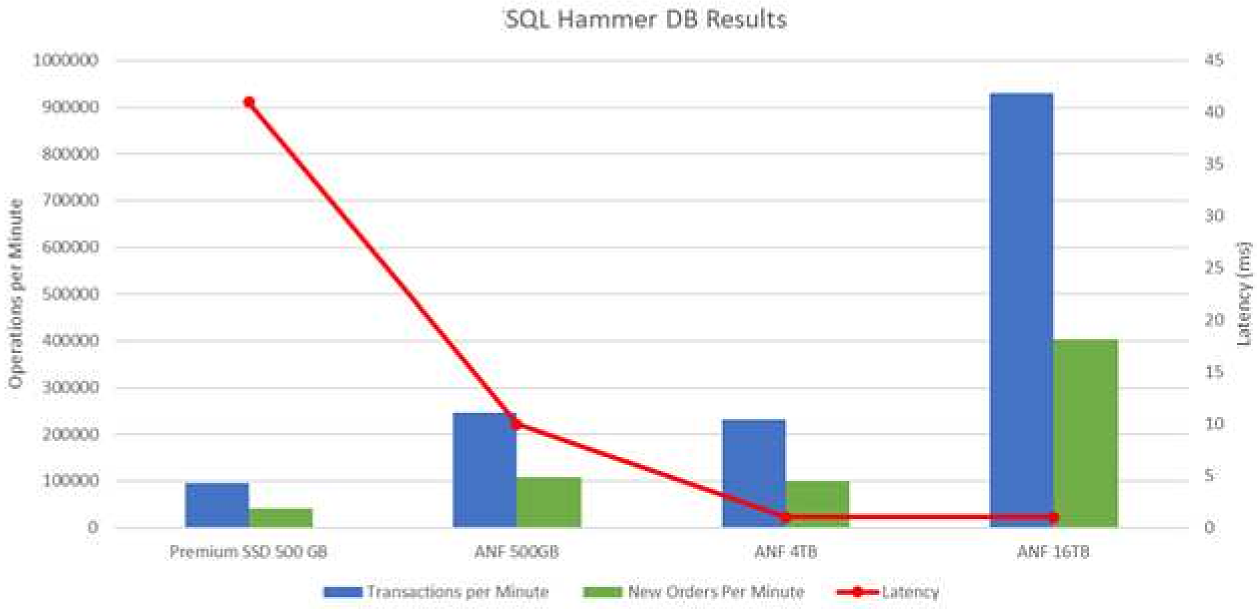
To showcase performance, a quick test was performed against a volume using premium service levels. In this test, the volume size was increased from 100GB to 2TB on the fly without any disruption to application access and zero data migration.



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.

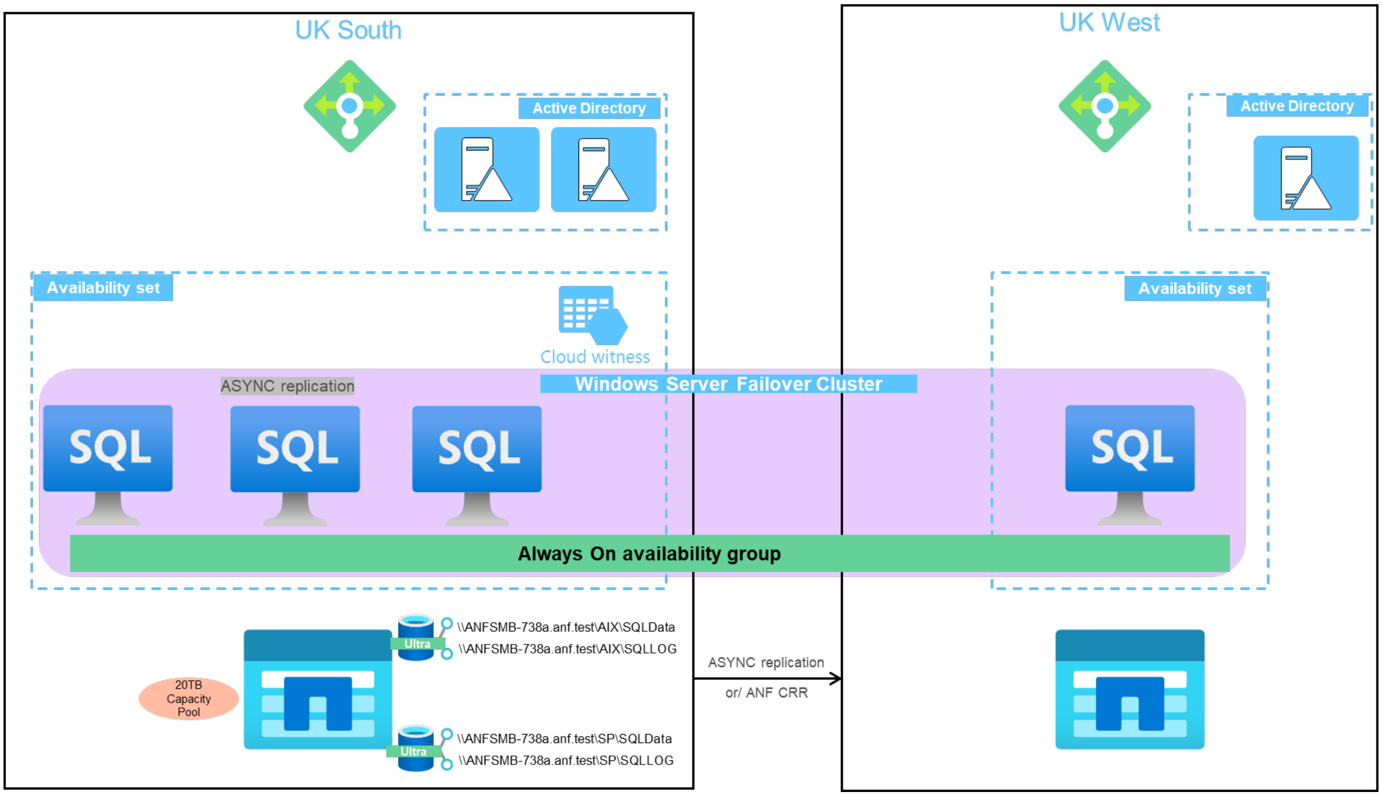
For example, consider a database that needs 250MBps for steady state operation; however, it also requires a peak throughput of 400MBps. In this case, the deployment should be performed with a 4TB volume within the Premium service level to meet the steady-state performance requirements. To handle the 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

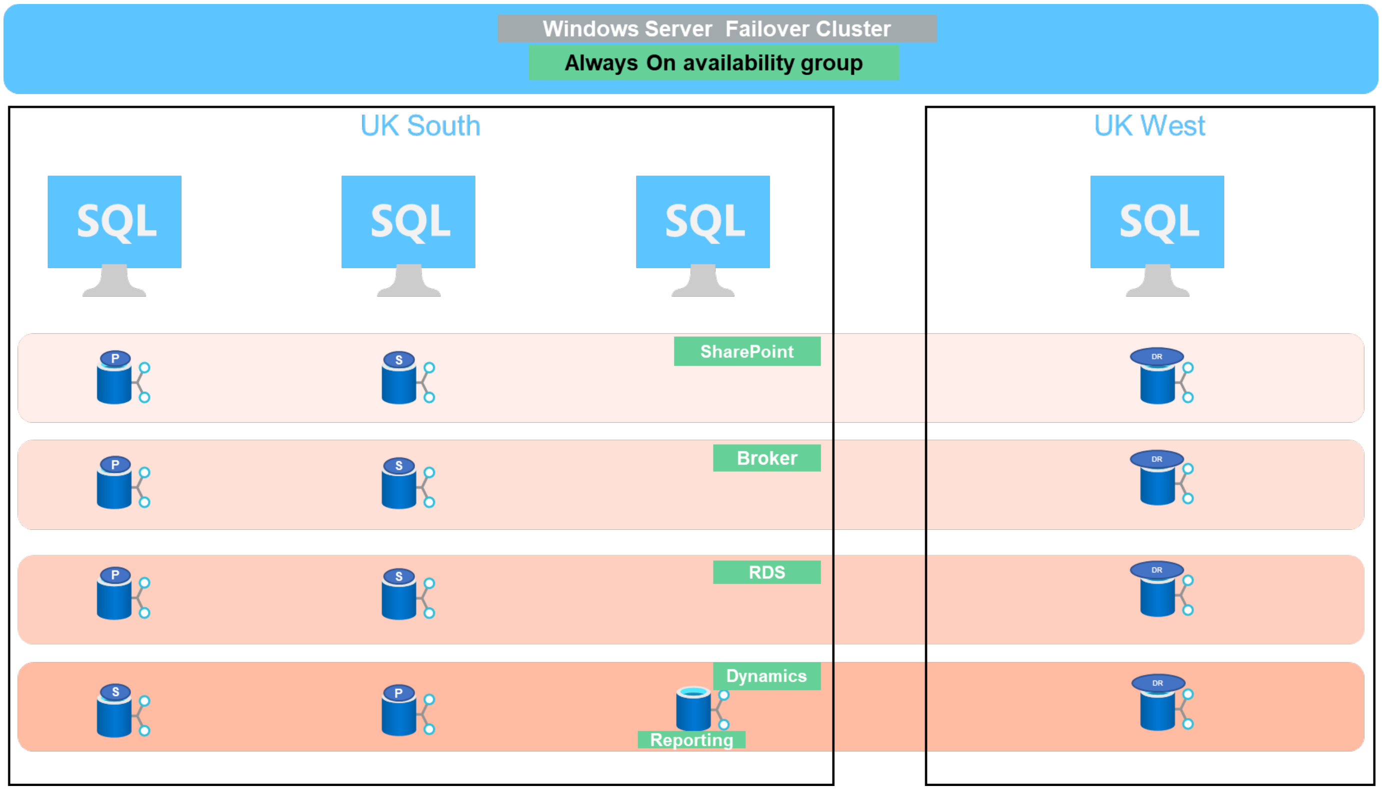
This section covers a real-time deployment of a SQL database estate in an AOAG configuration using an Azure NetApp Files SMB volume.

- 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.


UK South
Active Directory
Availability set
Cloud witness
ASYNC replication
Windows Server Failover Cluster
SQL
SQL
SQL
Always On availability group
Ultra
\\ANFSMB-738a.anf.test\AIX\SQLData
\\ANFSMB-738a.anf.test\AIX\SQLLOG
20TB
Capacity
Pool
Ultra
\\ANFSMB-738a.anf.test\SP\SQLData
\\ANFSMB-738a.anf.test\SP\SQLLOG
ASYNC replication
or/ ANF CRR
UK West
Active Directory
Availability set
SQL

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: *

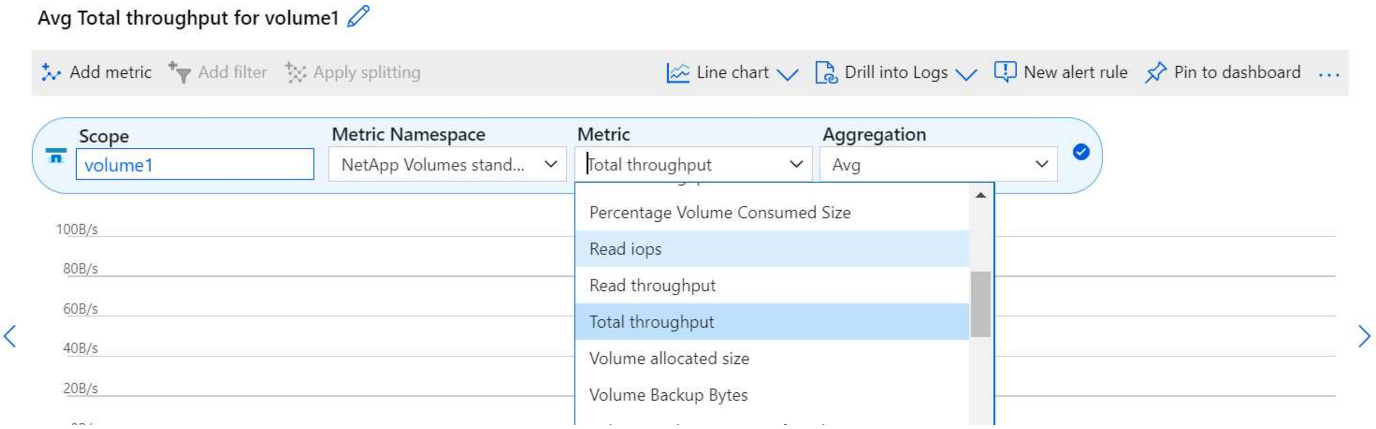
- The SCSQLAPI tool only supports the 2016 and 2017 versions of SQL Server.
- The SCSQLAPI tool only works with one database at a time.
- Isolate the files from each database by placing them onto a separate Azure NetApp Files volume.

Because of SCSQL 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.



DevTest 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 SCSQLAPI 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/azcoptst?sp=racwdl&st=2020
-10-21T18:41:35Z&se=2021-10-22T18:41:00Z&sv=2019-12
-12&sr=c&sig=ZxRUJwFlLXgHS8As7HzXJOaDXXVJ7PxxIX3ACpx56XY%%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 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-blg-fault-tolerance-high-availability-and-resilience-with-azure-netapp-files

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.

Modernizing your Microsoft SQL Server environment

TR-4590: Best practice guide for Microsoft SQL Server with ONTAP

Manohar Kulkarni and Pat Sinthusan, NetApp

This document describes best practices and offers insight into design considerations for deploying SQL Server on NetApp storage systems running NetApp ONTAP® software, with the goal of achieving effective and efficient storage deployment and end-to-end data protection and retention planning.

TR-4590: Best practices guide for Microsoft SQL Server with ONTAP

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

This solution provides overview and details for PostgreSQL database deployment and HA/DR setup, failover, resync based on NetApp SnapMirror technology built into FSx ONTAP storage offering and NetApp Ansible automation toolkit in AWS.

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

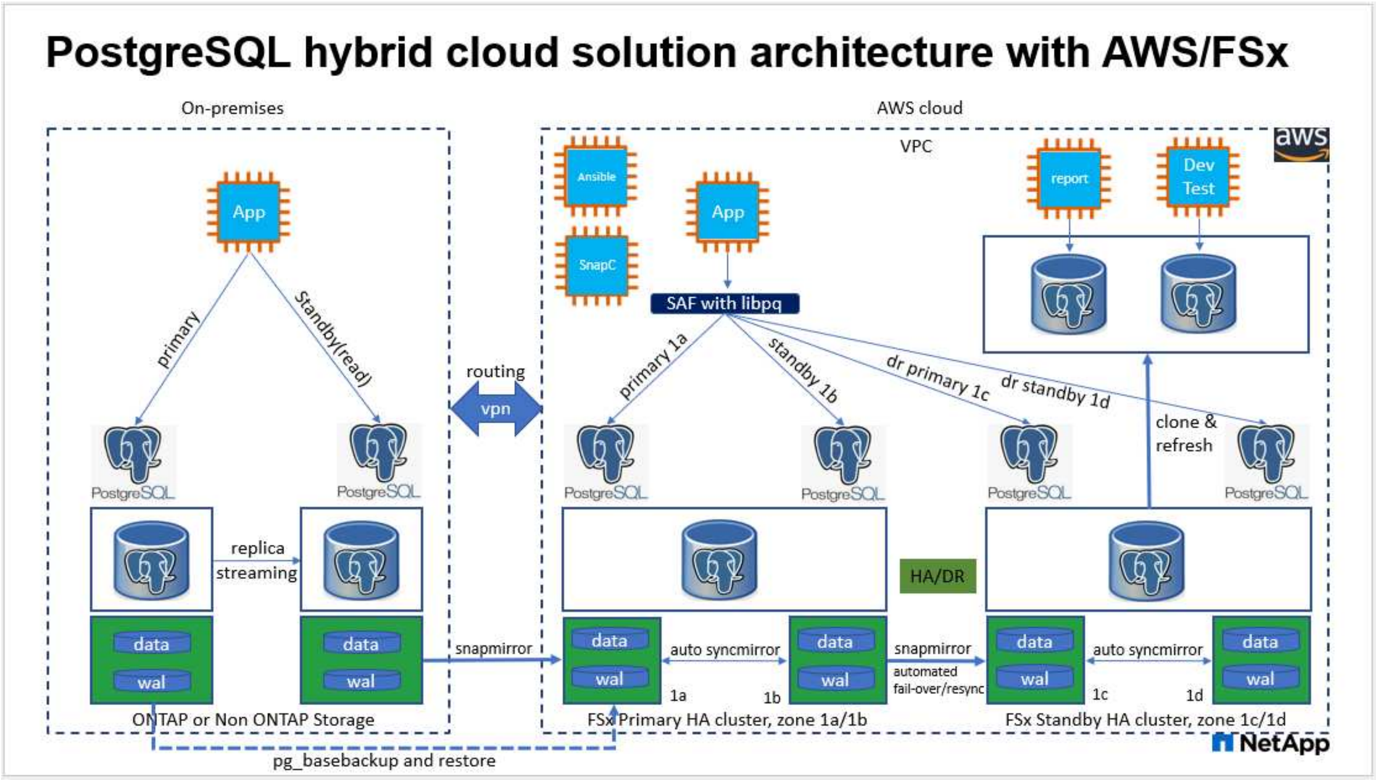
This solution is intended for the following people:

- 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. I**n 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 alway 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-premisses 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.

Automated PostgreSQL Deployment and Protection

1. 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
```

1. 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
```

1. 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]
psql_01p ansible_ssh_private_key_file=psql_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] --
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
```

Configure the host_name.yml file in the host_vars folder

```
# Add your AWS EC2 instance IP address for the respective PostgreSQL
server host
ansible_host: "10.61.180.15"

# "{{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.posgresql[1]}}" represents
DB server 2, "{{groups.posgresql[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. aggr_name is aggr1 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: "{{groups.postgresql[0]}}_pgdata", aggr_name: "aggr1", lif:
"172.21.94.200", size: "100"}
  - {vol_name: "{{groups.postgresql[0]}}_pglogs", aggr_name: "aggr1", lif:
"172.21.94.200", size: "100"}

# 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: "128"

# Postgresql user configurable parameters
psql_port: "5432"
buffer_cache: "8192MB"
archive_mode: "on"
max_wal_size: "5GB"
client_address: "172.30.15.0/24"
```

Configure the global fsx_vars.yml file in the vars folder

```
########################################################################
######   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: "xxxxxxx"

#Please enter destination or standby FSx cluster name
dst_cluster_name: "FsxId0cf8e0bccb14805e8"

#Please enter destination or standby FSx cluster management IP
dst_cluster_ip: "172.30.15.90"

#Please enter destination or standby FSx cluster inter-cluster IP
dst_inter_ip: "172.30.15.13"

#Please enter destination or standby SVM name to create mirror
relationship
dst_vserver: "dr"

#Please enter destination or standby SVM management IP
dst_vserver_mgmt_lif: "172.30.15.88"

#Please enter destination or standby SVM NFS lif
dst_nfs_lif: "172.30.15.88"

#Please enter source or primary FSx cluster name
src_cluster_name: "FsxId0cf8e0bccb14805e8"

#Please enter source or primary FSx cluster management IP
src_cluster_ip: "172.30.15.20"

#Please enter source or primary FSx cluster inter-cluster IP
src_inter_ip: "172.30.15.5"

#Please enter source or primary SVM name to create mirror relationship
src_vserver: "prod"

#Please enter source or primary SVM management IP
src_vserver_mgmt_lif: "172.30.15.115"
```

```
##########################################################################
###########################
# Variable for PostgreSQL Volumes, lif - source or primary FSx NFS lif
address
##########################################################################
###########################

src_db_vols:
  - {vol_name: "{{groups.postgresql[0]}}_pgdata", aggr_name: "aggr1", lif:
"172.21.94.200", size: "100"}

src_archivelog_vols:
  - {vol_name: "{{groups.postgresql[0]}}_pglogs", aggr_name: "aggr1", lif:
"172.21.94.200", size: "100"}

#Names of the Nodes in the ONTAP Cluster
nfs_export_policy: "default"

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

#NFS Mount points for PostgreSQL DB volumes
mount_points:
  - "/pgdata"
  - "/pglogs"

#RedHat subscription username and password
redhat_sub_username: "xxxxx"
redhat_sub_password: "xxxxx"

####################################################
### 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
```

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-8225-4784bced9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIsAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixF-xnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

- NetApp Solution Automation

Introduction

TR-4722: MySQL Database on NetApp ONTAP Best Practices

Anup Bharti, Manohar Kulkarni, Jeffrey Steiner NetApp

MySQL and its variants, including MariaDB and Percona, are widely used for many enterprise applications. These applications range from global social networking sites and massive e-commerce systems to SMB hosting systems containing thousands of database instances. This document describes the configuration requirements and provides guidance on tuning and storage configuration for deploying MySQL on NetApp® ONTAP® data management software. To determine whether the environment,configurations, and versions specified in this report support your environment, consult the Interoperability Matrix Tool (IMT).

TR-4722: MySQL Database on NetApp ONTAP Best Practices

SnapCenter for Databases

SnapCenter Oracle Clone Lifecycle Automation

Allen Cao, Niyaz Mohamed, NetApp

This solution provides an Ansible based automation toolkit for configuring Oracle database High Availability and Disaster Recovery (HA/DR) with AWS FSx ONTAP as Oracle database storage and EC2 instances as the compute instances in AWS.

Purpose

Customers love the FlexClone feature of NetApp ONTAP storage for databases with significant storage cost savings. This Ansible based toolkit automates the setup, cloning, and refreshing of cloned Oracle databases on schedule using the NetApp SnapCenter command line utilities for streamlined lifecycle management. The toolkit is applicable to Oracle databases deployed to ONTAP storage either on-premisses or public cloud and managed by NetApp SnapCenter UI tool.

This solution addresses the following use cases:

- Setup Oracle database clone-specification configuration file.
- Create and refresh clone Oracle database on user defined schedule.

Audience

This solution is intended for the following people:

- A DBA who manages Oracle databases with SnapCenter.
- A storage administrator who manages ONTAP storage with SnapCenter.
- An application owner who has access to SnapCenter UI.

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Solution deployment

Prerequisites for deployment

Deployment requires the following prerequisites.

```
Ansible controller:
  Ansible v.2.10 and higher
  ONTAP collection 21.19.1
  Python 3
  Python libraries:
    netapp-lib
    xmltodict
    jmespath
```

```
SnapCenter server:
  version 5.0
  backup policy configured
  Source database protected with a backup policy
```

```
Oracle servers:
  Source server managed by SnapCenter
  Target server managed by SnapCenter
  Target server with identical Oracle software stack as source server
installed and configured
```

Download the toolkit

```
git clone https://bitbucket.ngage.netapp.com/scm/ns-
bb/na_oracle_clone_lifecycle.git
```

Ansible target hosts file configuration

The toolkit includes a hosts file which define the targets that an Ansible playbook running against. Usually, it is the target Oracle clone hosts. Following is an example file. A host entry includes target host IP address as well as ssh key for an admin user access to the host to execute clone or refresh command.

#Oracle clone hosts

```
[clone_1]
ora_04.cie.netapp.com ansible_host=10.61.180.29
ansible_ssh_private_key_file=ora_04.pem
```

```
[clone_2]
```

```
[clone_3]
```

Global variables configuration

The Ansible playbooks take variable inputs from several variable files. Below is an example global variable file vars.yml.

```
# ONTAP specific config variables
```

```
# SnapCtr specific config variables
```

```
snapctr_usr: xxxxxxxx
snapctr_pwd: 'xxxxxxxx'
```

```
backup_policy: 'Oracle Full offline Backup'
```

```
# Linux specific config variables
```

```
# Oracle specific config variables
```

Host variables configuration

Host variables are defined in host_vars directory named as {{ host_name }}.yml. Below is an example of target Oracle host variable file ora_04.cie.netapp.com.yml that shows typical configuration.

```
# User configurable Oracle clone db host specific parameters
```

```
# Source database to clone from
source_db_sid: NTAP1
source_db_host: ora_03.cie.netapp.com
```

```
# Clone database
clone_db_sid: NTAP1DEV
```

```
snapctr_obj_id: '{{ source_db_host }}\{{ source_db_sid }}'
```

Additional clone target Oracle server configuration

Clone target Oracle server should have the same Oracle software stack as source Oracle server installed and patched. Oracle user .bash_profile has $ORACLE_BASE, and $ORACLE_HOME configured. Also, $ORACLE_HOME variable should match with source Oracle server setting. Following is an example.

```
# .bash_profile
```

```
# Get the aliases and functions
if [ -f ~/.bashrc ]; then
        . ~/.bashrc
fi
```

```
# User specific environment and startup programs
export ORACLE_BASE=/u01/app/oracle
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/NTAP1
```

Playbook execution

There are total of three playbooks to execute Oracle database clone lifecycle with SnapCenter CLI utilities.

1. Install Ansible controller prerequisites - one time only.

   ```
   ansible-playbook -i hosts ansible_requirements.yml
   ```

2. Setup clone specification file - one time only.

   ```
   ansible-playbook -i hosts clone_1_setup.yml -u admin -e
   @vars/vars.yml
   ```

3. Create and refresh clone database regularly from crontab with a shell script to call a refresh playbook.

   ```
   0 */4 * * * /home/admin/na_oracle_clone_lifecycle/clone_1_refresh.sh
   ```

For an additional clone database, create a separate clone_n_setup.yml and clone_n_refresh.yml, and clone_n_refresh.sh. Configure the Ansible target hosts and hostname.yml file in host_vars directory accordingly.

Where to find additional information

To learn more about the NetApp solution automation, review the following website NetApp Solution Automation

TR-4988: Oracle Database Backup, Recovery, and Clone on ANF with SnapCenter

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for automated Oracle deployment in Microsoft Azure NetApp Files as primary database storage with NFS protocol and Oracle database is deployed as container database with dNFS enabled. Database deployed in Azure is protected using SnapCenter UI tool for simplified database management.

Purpose

NetApp SnapCenter software is an easy-to-use enterprise platform to securely coordinate and manage data protection across applications, databases, and file systems. It simplifies backup, restore, and clone lifecycle management by offloading these tasks to application owners without sacrificing the ability to oversee and regulate activity on the storage systems. By leveraging storage-based data management, it enables increased performance and availability, as well as reduced testing and development times.

In TR-4987, Simplified, Automated Oracle Deployment on Azure NetApp Files with NFS, we demonstrate automated Oracle deployment on Azure NetApp Files (ANF)in Azure cloud. In this documentation, we showcase Oracle database protection and management on ANF in Azure cloud with a very user-friendly SnapCenter UI tool.

This solution addresses the following use cases:

- Backup and recovery of Oracle database deployed on ANF in Azure cloud with SnapCenter.
- Manage database snapshots and clone copies to accelerate application development and improve data lifecycle management.

Audience

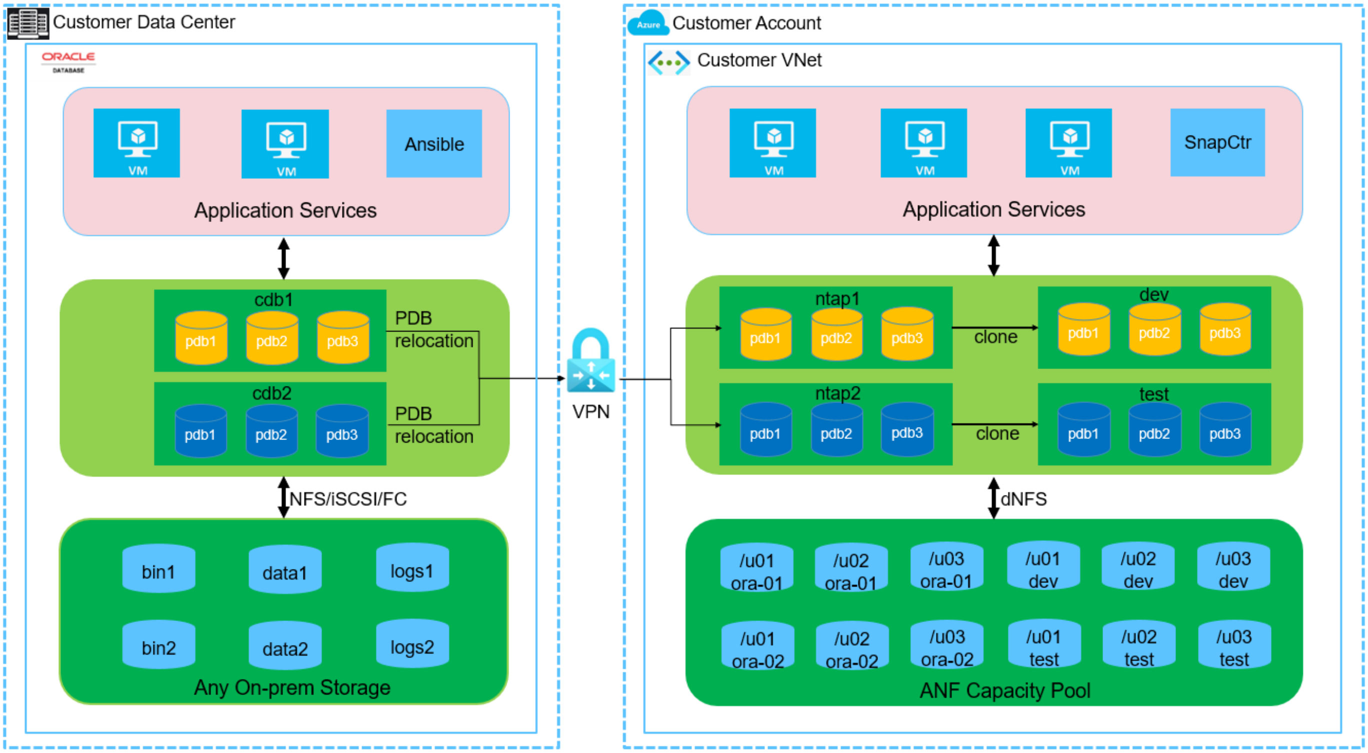
This solution is intended for the following people:

- A DBA who would like to deploy Oracle databases on Azure NetApp Files.
- A database solution architect who would like to test Oracle workloads on Azure NetApp Files.
- A storage administrator who would like to deploy and manage Oracle databases on Azure NetApp Files.
- An application owner who would like to stand up an Oracle database on Azure NetApp Files.

Solution test and validation environment

The testing and validation of this solution were performed in a lab setting that might not match the final deployment environment. See the section Key factors for deployment consideration for more information.

Architecture



Hardware and software components

Hardware		
Azure NetApp Files	Current offering in Azure by Microsoft	A capacity pool with Premium service level

Azure VM for DB server	Standard_B4ms - 4 vCPUs, 16GiB	Two Linux virtual machine instances
Azure VM for SnapCenter	Standard_B4ms - 4 vCPUs, 16GiB	One Windows virtual machine instance
	Software	
RedHat Linux	RHEL Linux 8.6 (LVM) - x64 Gen2	Deployed RedHat subscription for testing
Windows Server	2022 DataCenter; AE Hotpatch - x64 Gen2	Hosting SnapCenter server
Oracle Database	Version 19.18	Patch p34765931_190000_Linux-x86-64.zip
Oracle OPatch	Version 12.2.0.1.36	Patch p6880880_190000_Linux-x86-64.zip
SnapCenter Server	Version 5.0	Workgroup deployment
Open JDK	Version java-11-openjdk	SnapCenter plugin requirement on DB VMs
NFS	Version 3.0	Oracle dNFS enabled
Ansible	core 2.16.2	Python 3.6.8

Oracle database configuration in the lab environment

Server	Database	DB Storage
ora-01	NTAP1(NTAP1_PDB1,NTAP1_PDB2,NTAP1_PDB3)	/u01, /u02, /u03 NFS mounts on ANF capacity pool
ora-02	NTAP2(NTAP2_PDB1,NTAP2_PDB2,NTAP2_PDB3)	/u01, /u02, /u03 NFS mounts on ANF capacity pool

Key factors for deployment consideration

- **SnapCenter deployment.** SnapCenter can deploy in a Windows domain or Workgroup environment. For domain-based deployment, the domain user account should be a domain administrator account, or the domain user belongs to the local administrator's group on the SnapCenter hosting server.
- **Name resolution.** SnapCenter server needs to resolve the name to the IP address for each managed target database server host. Each target database server host must resolve the SnapCenter server name to the IP address. If a DNS server is unavailable, add naming to local host files for resolution.
- **Resource group configuration.** Resource group in SnapCenter is a logical grouping of similar resources that can be backed up together. Thus, it simplifies and reduces the number of backup jobs in a large database environment.
- **Separate full database and archive log backup.** Full database backup includes data volumes and log volumes consistent group snapshots. A frequent full database snapshot incurs higher storage consumption but improves RTO. An alternative is less frequent full database snapshots and more frequent archive logs backup, which consumes less storage and improves RPO but may extend RTO. Consider your RTO and RPO objectives when setting up the backup scheme. There is also a limit (1023) of the number of snapshot backups on a volume.

- **Privileges delegation.** Leverage role based access control that is built-in within SnapCenter UI to delegate privileges to application and database teams if desired.

Solution deployment

The following sections provide step-by-step procedures for SnapCenter deployment, configuration, and Oracle database backup, recovery, and clone on Azure NetApp Files in the Azure cloud.

Prerequisites for deployment

Deployment requires existing Oracle databases running on ANF in Azure. If not, follow the steps below to create two Oracle databases for solution validation. For details of Oracle database deployment on ANF in Azure cloud with automation, referred to TR-4987: Simplified, Automated Oracle Deployment on Azure NetApp Files with NFS

1. An Azure account has been set up, and the necessary VNet and network segments have been created within your Azure account.
2. From the Azure cloud portal, deploy Azure Linux VMs as Oracle DB servers. Create an Azure NetApp Files capacity pool and database volumes for Oracle database. Enable VM SSH private/public key authentication for azureuser to DB servers. See the architecture diagram in the previous section for details about the environment setup. Also referred to Step-by-Step Oracle deployment procedures on Azure VM and Azure NetApp Files for detailed information.

   For Azure VMs deployed with local disk redundancy, ensure that you have allocated at least 128G in the VM root disk to have sufficient space to stage Oracle installation files and add OS swap file. Expand /tmplv and /rootlv OS partition accordingly. Ensure the database volume naming follows the VMname-u01, VMname-u02, and VMname-u03 convention.

   ```
   sudo lvresize -r -L +20G /dev/mapper/rootvg-rootlv
   ```

   ```
   sudo lvresize -r -L +10G /dev/mapper/rootvg-tmplv
   ```

3. From the Azure cloud portal, provision a Windows server to run the NetApp SnapCenter UI tool with the latest version. Refer to the following link for details: Install the SnapCenter Server.
4. Provision a Linux VM as the Ansible controller node with the latest version of Ansible and Git installed. Refer to the following link for details: Getting Started with NetApp solution automation in section - `Setup the Ansible Control Node for CLI deployments on RHEL / CentOS` or `Setup the Ansible Control Node for CLI deployments on Ubuntu / Debian`.

   The Ansible controller node can locate either on-premisses or in Azure cloud as far as it can reach Azure DB VMs via ssh port.

5. Clone a copy of the NetApp Oracle deployment automation toolkit for NFS. Follow instructions in TR-4887 to execute the playbooks.

   ```
   git clone https://bitbucket.ngage.netapp.com/scm/ns-
   bb/na_oracle_deploy_nfs.git
   ```

6. Stage following Oracle 19c installation files on Azure DB VM /tmp/archive directory with 777 permission.

```
installer_archives:
  - "LINUX.X64_193000_db_home.zip"
  - "p34765931_190000_Linux-x86-64.zip"
  - "p6880880_190000_Linux-x86-64.zip"
```

7. Watch the following video:

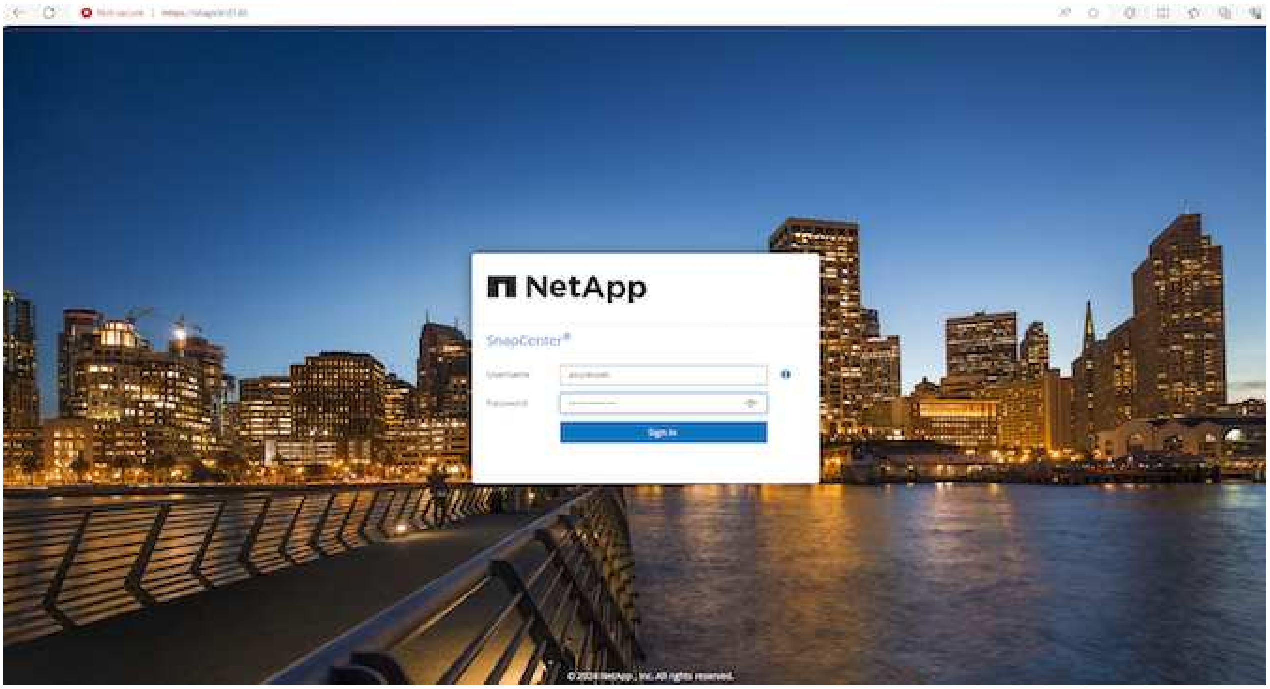
   Oracle Database Backup, Recovery, and Clone on ANF with SnapCenter

8. Review the `Get Started` online menu.

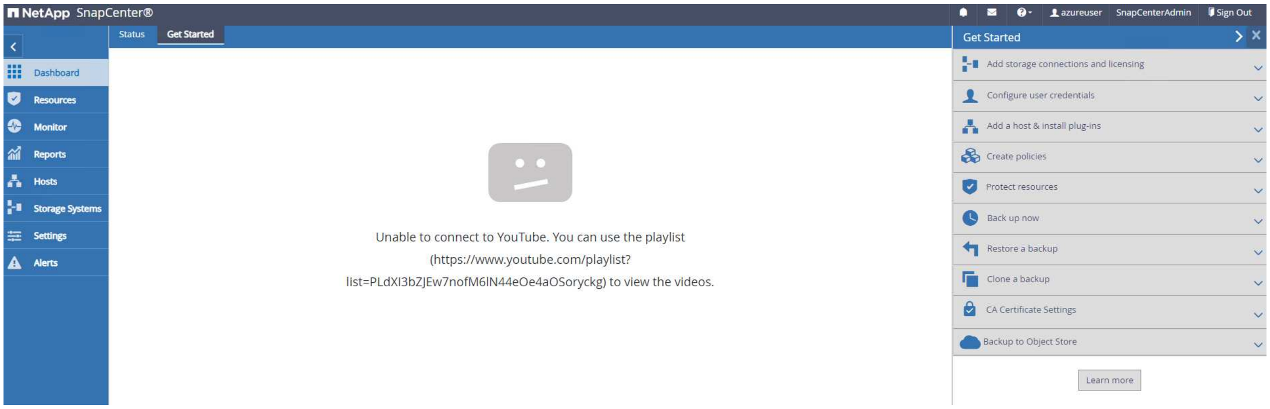
SnapCenter installation and setup

We recommend to go through online SnapCenter Software documentation before proceeding to SnapCenter installation and configuration: . Following provides a high level summary of steps for installation and setup of SnapCenter software for Oracle on Azure ANF.

1. From SnapCenter Windows server, download and install latest java JDK from Get Java for desktop applications.
2. From SnapCenter Windows server, download and install latest version (currently 5.0) of SnapCenter installation executable from NetApp support site: NetApp | Support.
3. After SnapCenter server installation, launch browser to login to SnapCenter with Windows local admin user or domain user credential via port 8146.

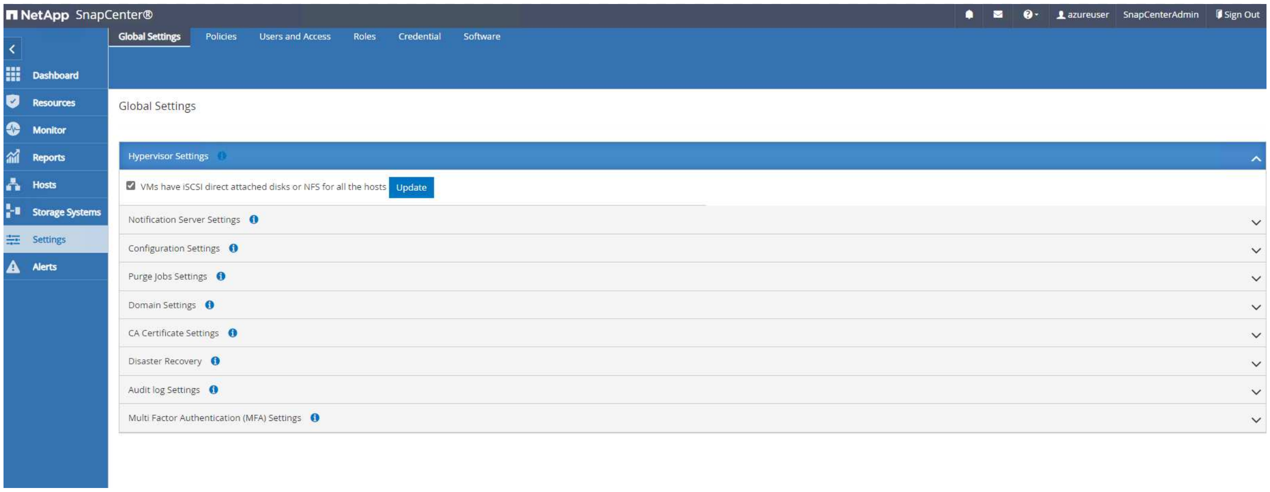


4. Review `Get Started` online menu.



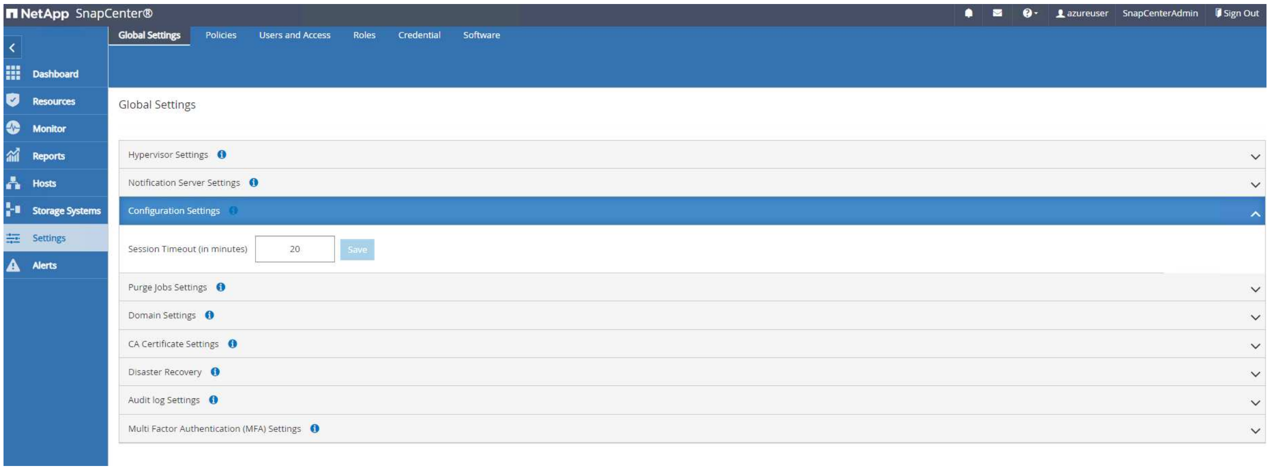
Unable to connect to YouTube. You can use the playlist (https://www.youtube.com/playlist?list=PLdXI3bZJEw7nofM6lN44eOe4aOSoryckg) to view the videos.

5. In `Settings-Global Settings`, check `Hypervisor Settings` and click on Update.



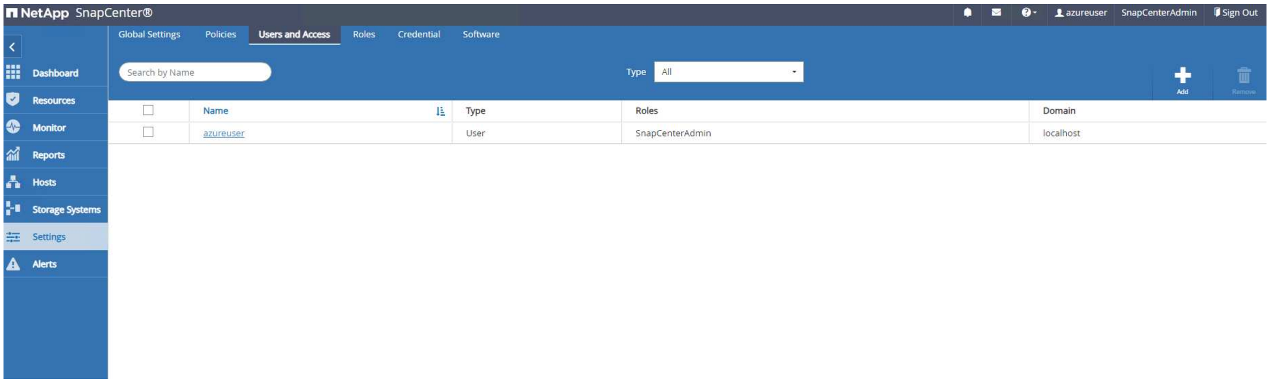
☑ VMs have iSCSI direct attached disks or NFS for all the hosts

6. If needed, adjust `Session Timeout` for SnapCenter UI to the desired interval.



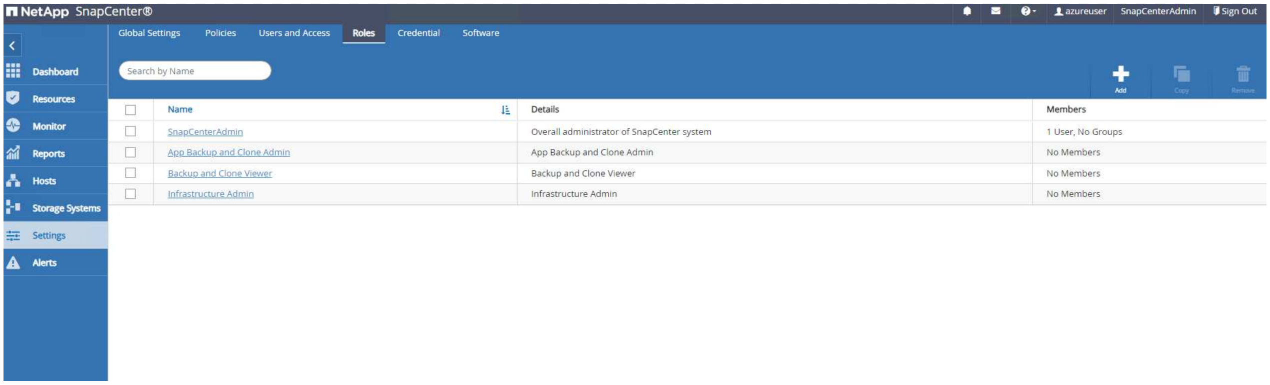
Session Timeout (in minutes): 20

7. Add additional users to SnapCenter if needed.



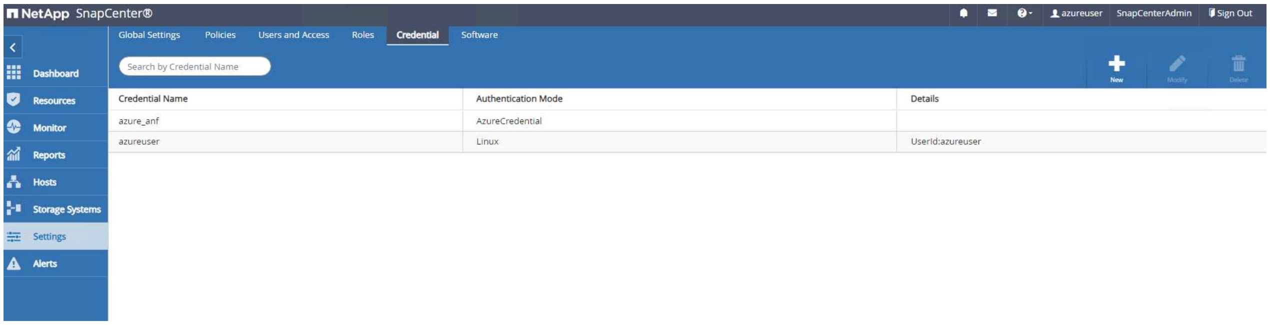
☐	Name	Type	Roles	Domain
☐	azureuser	User	SnapCenterAdmin	localhost

8. The `Roles` tab list the built-in roles that can be assigned to different SnapCenter users. Custom roles also can be created by admin user with desired privileges.

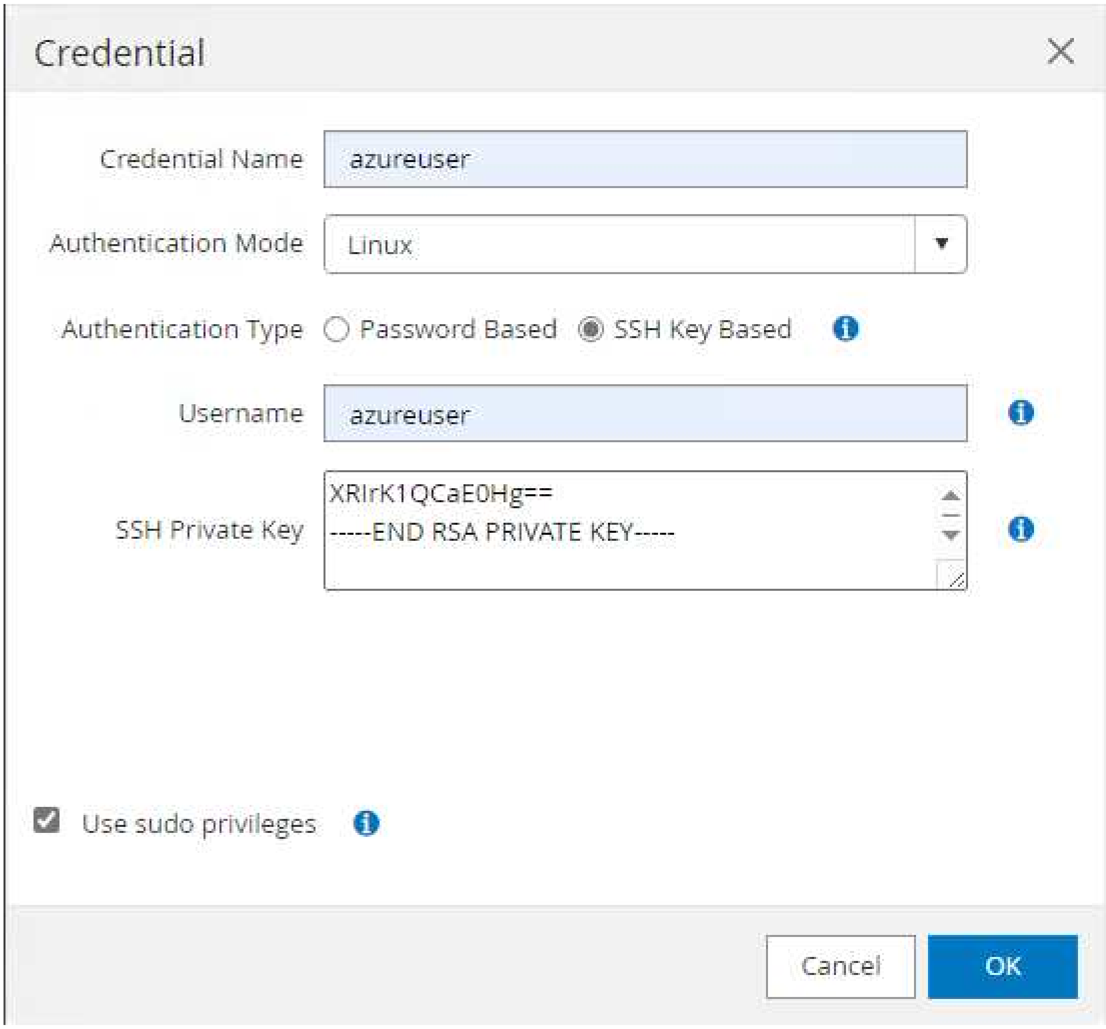


☐	Name	Details	Members
☐	SnapCenterAdmin	Overall administrator of SnapCenter system	1 User, No Groups
☐	App Backup and Clone Admin	App Backup and Clone Admin	No Members
☐	Backup and Clone Viewer	Backup and Clone Viewer	No Members
☐	Infrastructure Admin	Infrastructure Admin	No Members

9. From `Settings-Credential`, create credentials for SnapCenter management targets. In this demo use case, they are linux user for login to Azure VM and ANF credential for capacity pool access.



Credential Name	Authentication Mode	Details
azure_anf	AzureCredential	
azureuser	Linux	UserId:azureuser



Credential Name: azureuser

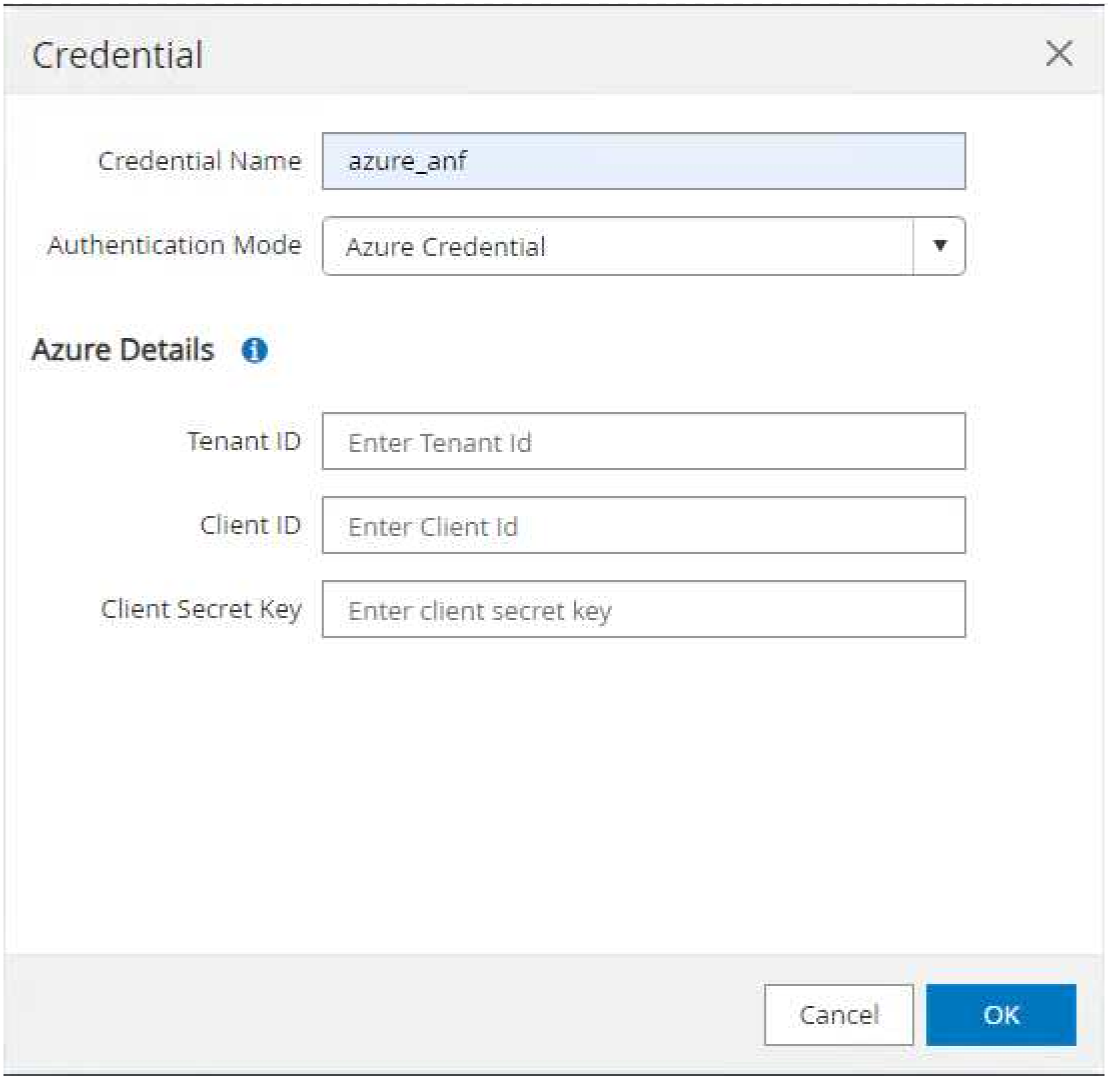
Authentication Mode: Linux

Authentication Type: ○ Password Based ● SSH Key Based

Username: azureuser

SSH Private Key: XRIrK1QCaE0Hg==
-----END RSA PRIVATE KEY-----

☑ Use sudo privileges



Credential Name: azure_anf

Authentication Mode: Azure Credential

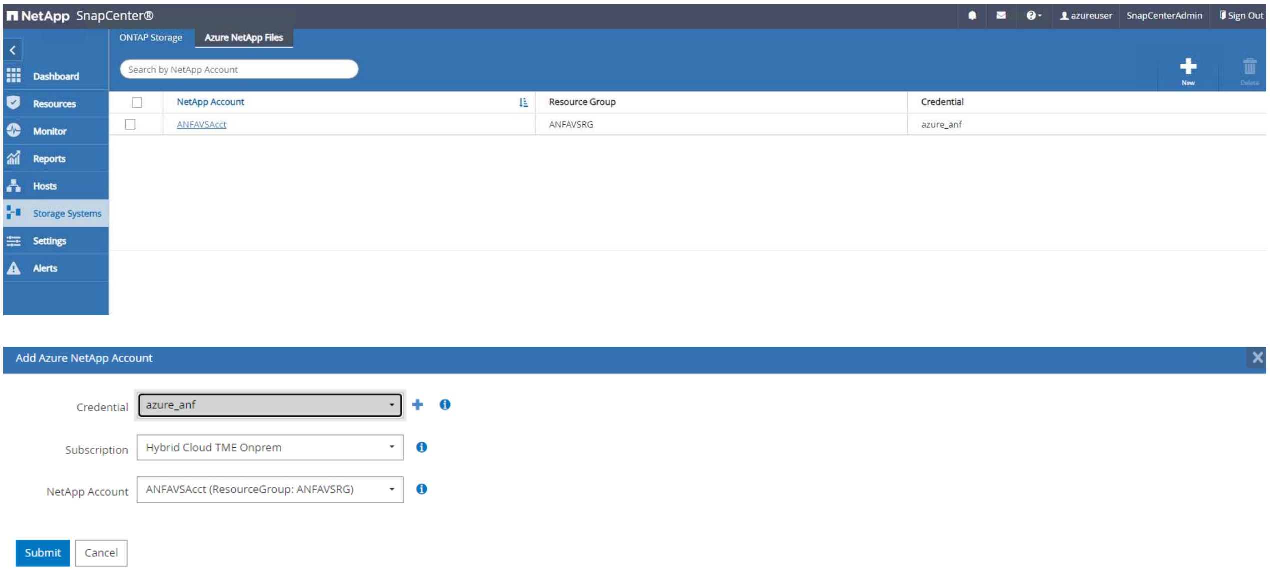
Azure Details

Tenant ID: Enter Tenant Id

Client ID: Enter Client Id

Client Secret Key: Enter client secret key

10. From `Storage Systems` tab, add `Azure NetApp Files` with credential created above.



☐	NetApp Account	Resource Group	Credential
☐	ANFAVSAcct	ANFAVSRG	azure_anf

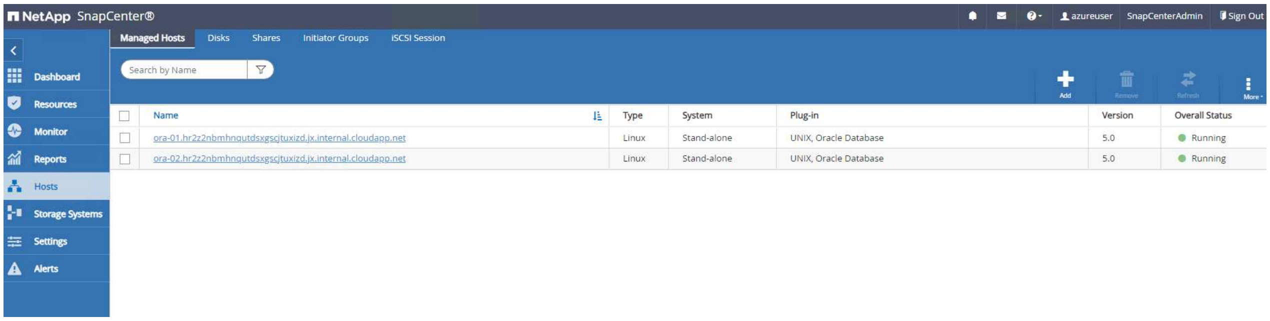
Add Azure NetApp Account

Credential: azure_anf

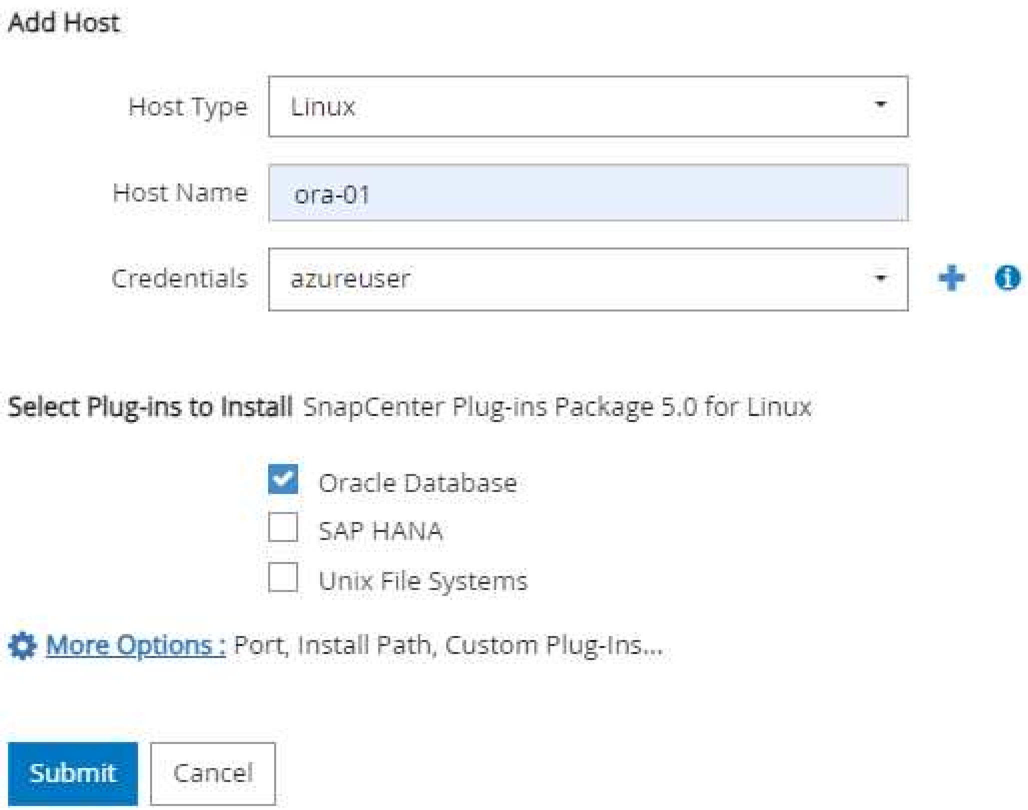
Subscription: Hybrid Cloud TME Onprem

NetApp Account: ANFAVSAcct (ResourceGroup: ANFAVSRG)

11. From `Hosts` tab, add Azure DB VMs, which installs SnapCenter plugin for Oracle on Linux.



☐	Name	Type	System	Plug-in	Version	Overall Status
☐	ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net	Linux	Stand-alone	UNIX, Oracle Database	5.0	● Running
☐	ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net	Linux	Stand-alone	UNIX, Oracle Database	5.0	● Running



Host Type: Linux

Host Name: ora-01

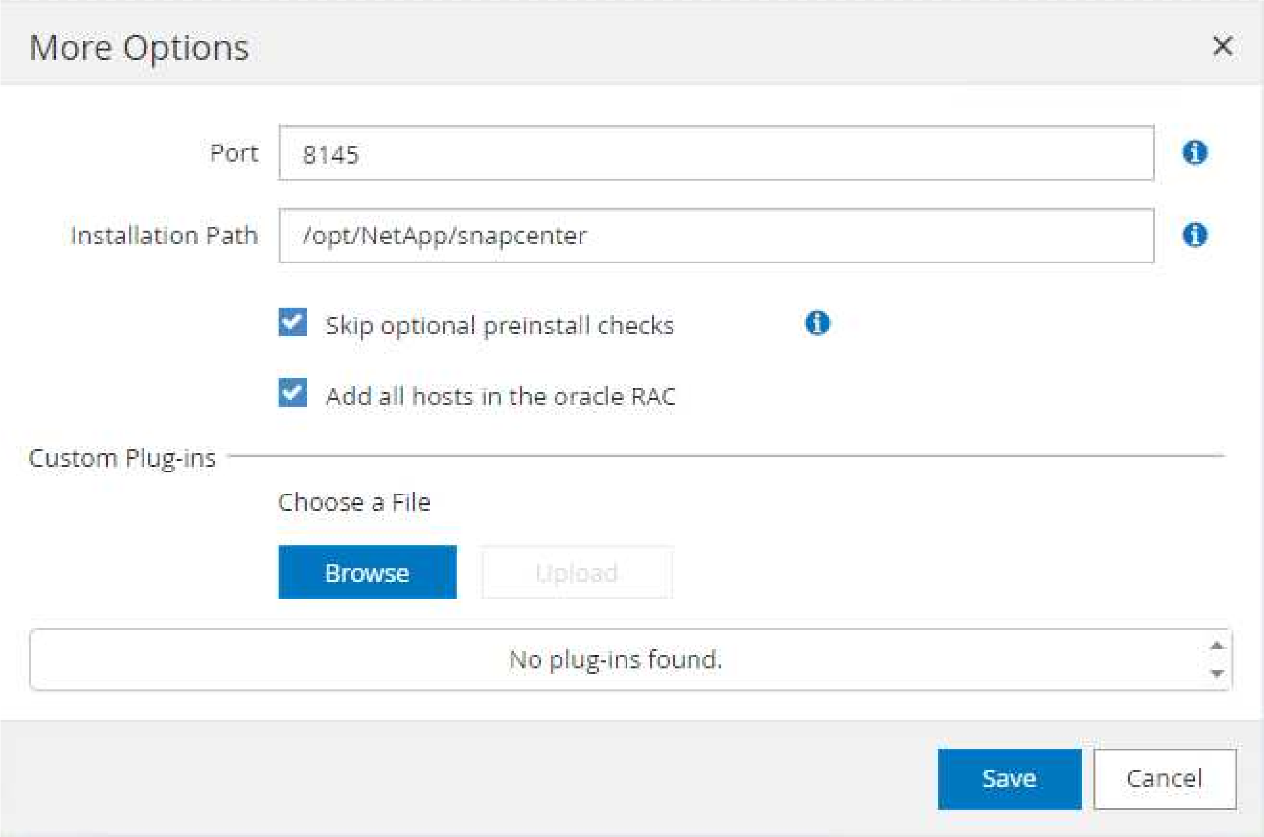
Credentials: azureuser

Select Plug-ins to Install SnapCenter Plug-ins Package 5.0 for Linux

☑ Oracle Database

☐ SAP HANA

☐ Unix File Systems



More Options

Port: 8145

Installation Path: /opt/NetApp/snapcenter

☑ Skip optional preinstall checks

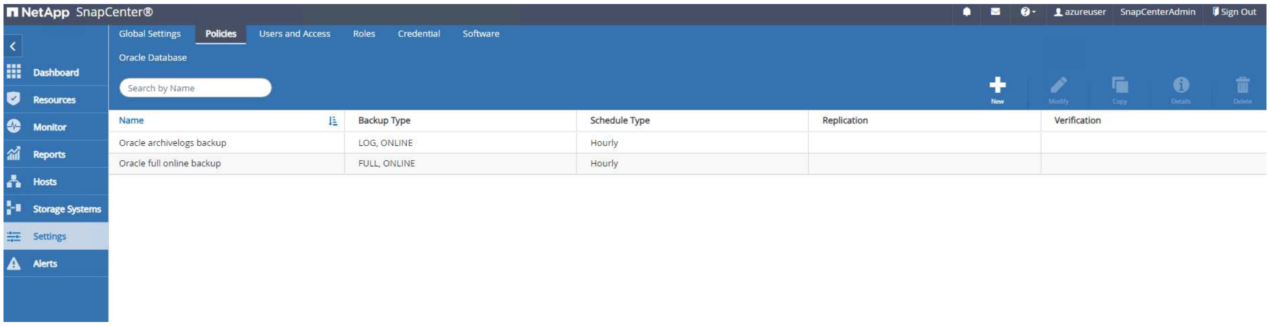
☑ Add all hosts in the oracle RAC

Custom Plug-ins

Choose a File

No plug-ins found.

12. Once host plugin is installed on DB server VM, databases on the host are auto discovered and visible in `Resources` tab. Back to `Settings-Polices`, create backup policies for full Oracle database online backup and archive logs only backup. Refer to this document Create backup policies for Oracle databases for detailed step by step procedures.



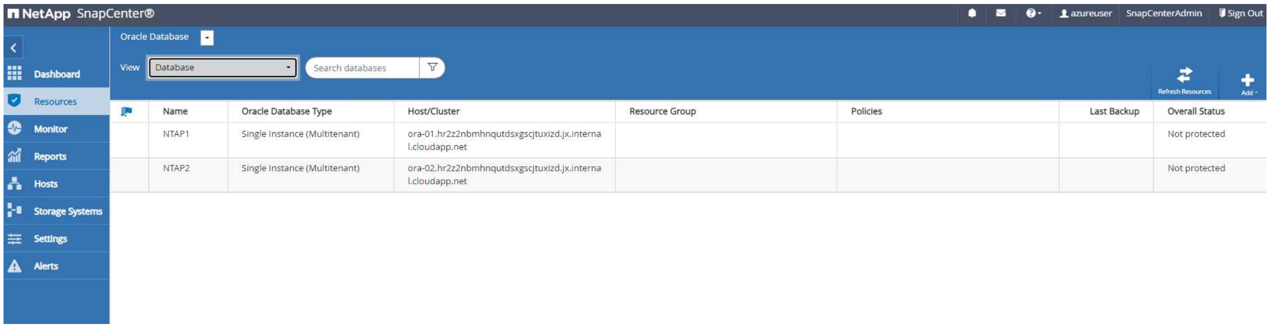
Oracle Database

Name	Backup Type	Schedule Type	Replication	Verification
Oracle archivelogs backup	LOG, ONLINE	Hourly		
Oracle full online backup	FULL, ONLINE	Hourly		

Database backup

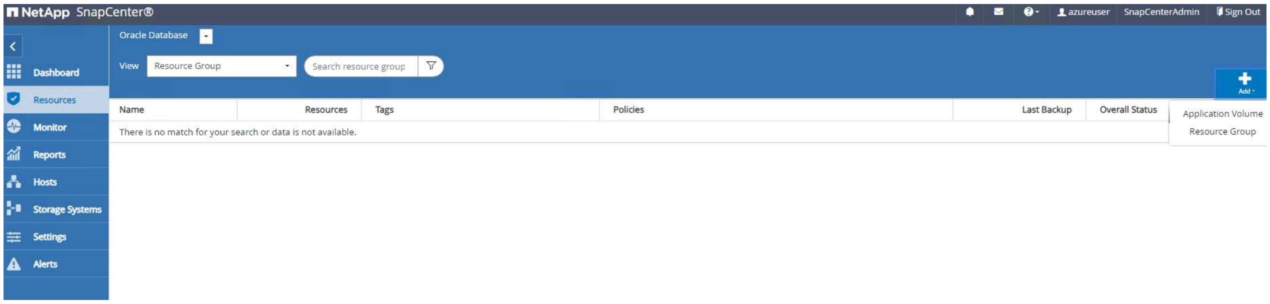
A NetApp snapshot backup creates a point-in-time image of the database volumes that you can use to restore in case of a system failure or data loss. Snapshot backups take very little time, usually less than a minute. The backup image consumes minimal storage space and incurs negligible performance overhead because it records only changes to files since the last snapshot copy was made. Following section demonstrates the implementation of snapshots for Oracle database backup in SnapCenter.

1. Navigating to `Resources` tab, which lists the databases discovered once SnapCenter plugin installed on database VM. Initially, the `Overall Status` of database shows as `Not protected`.



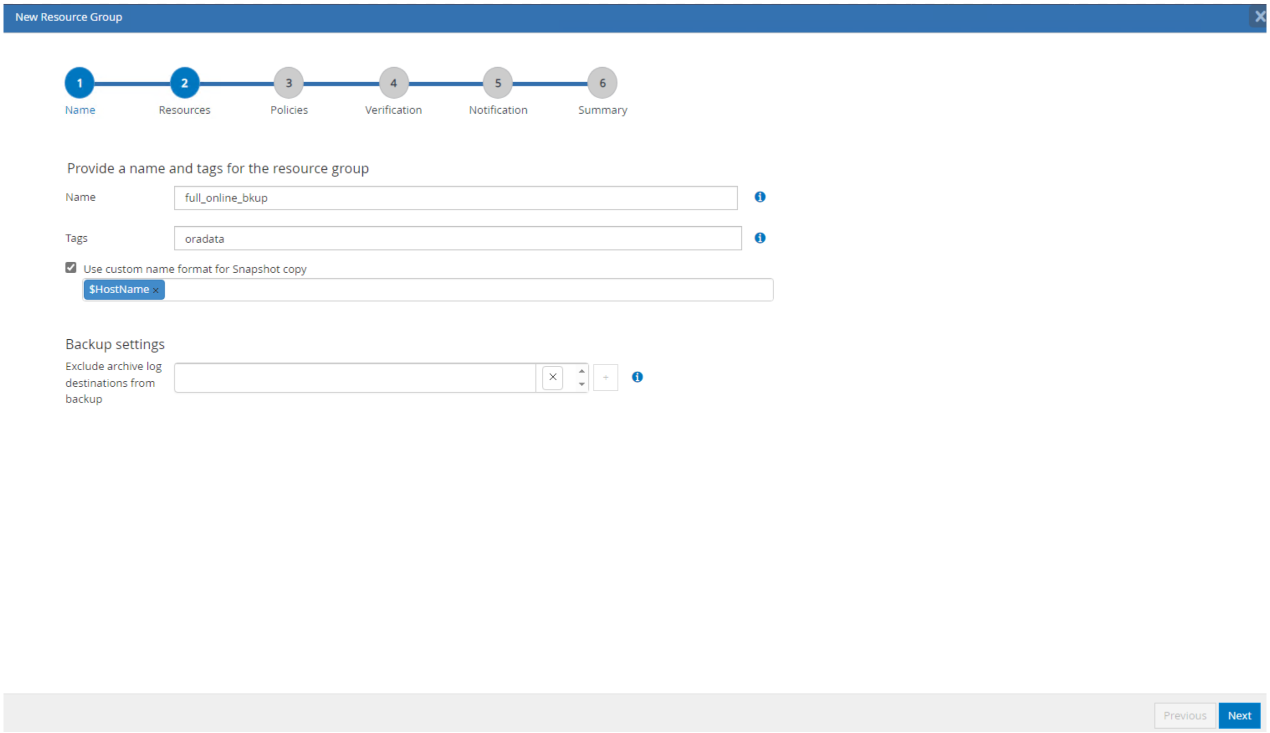
Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
NTAP1	Single Instance (Multitenant)	ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net				Not protected
NTAP2	Single Instance (Multitenant)	ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net				Not protected

2. Click on `View` drop-down to change to `Resource Group`. Click on `Add` sign on the right to add a Resource Group.



Name	Resources	Tags	Policies	Last Backup	Overall Status
There is no match for your search or data is not available.					

3. Name your resource group, tags, and any custom naming.



Provide a name and tags for the resource group

Name: full_online_bkup

Tags: oradata

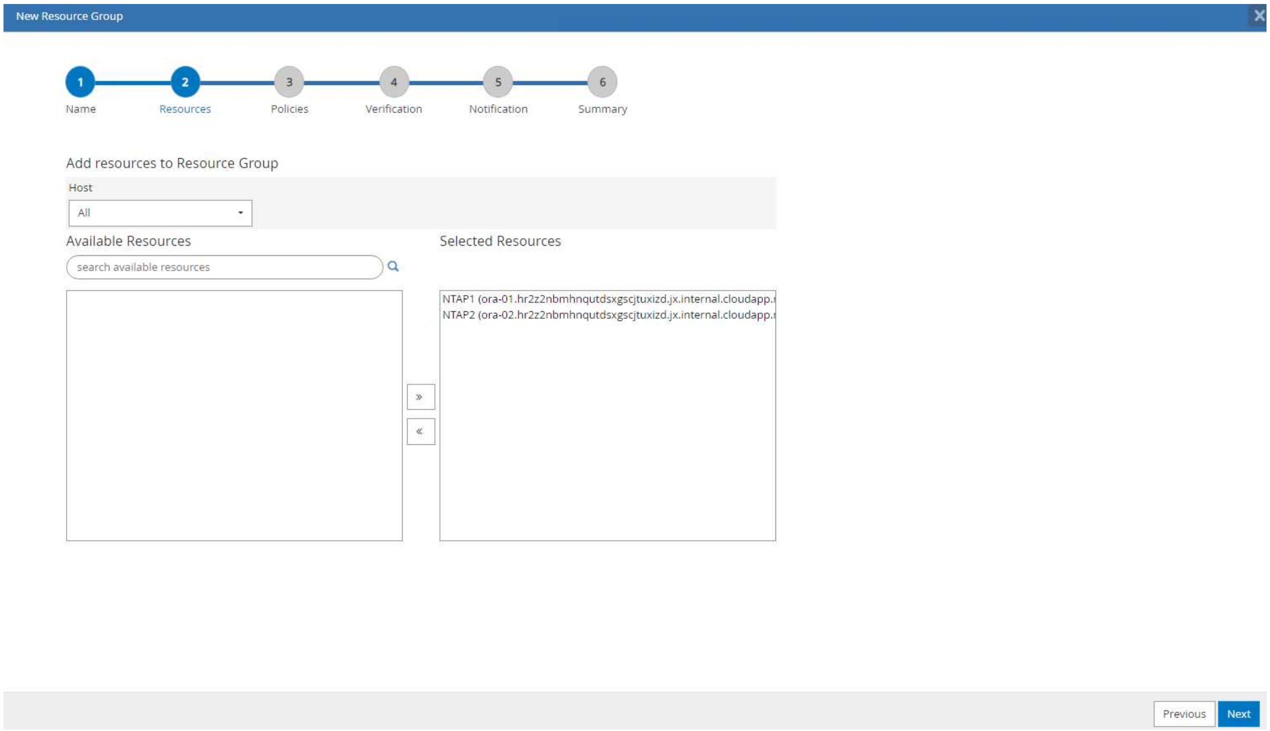
☑ Use custom name format for Snapshot copy

$HostName

Backup settings

Exclude archive log destinations from backup

4. Add resources to your `Resource Group`. Grouping of similar resources can simplify database management in a large environment.



Add resources to Resource Group

Host: All

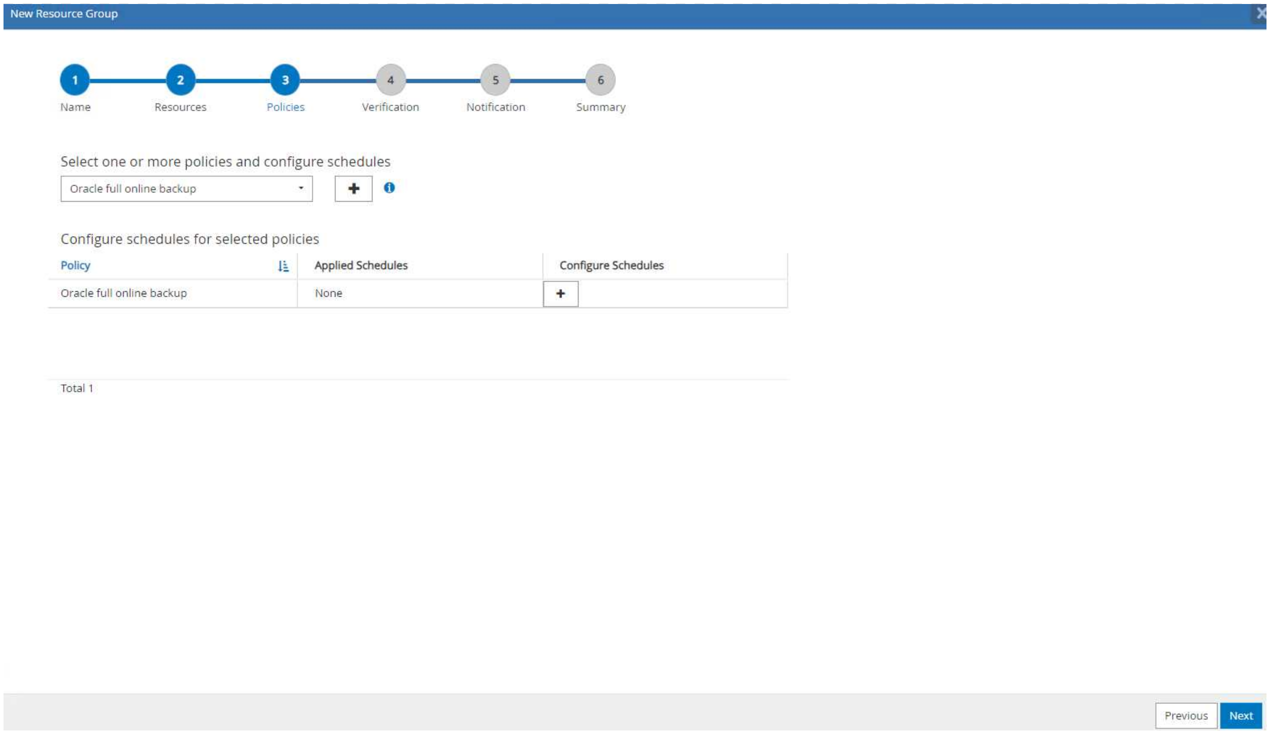
Available Resources

Selected Resources

NTAP1 (ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.

NTAP2 (ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.

5. Select the backup policy and set a schedule by click on '+' sign under `Configure Schedules`.



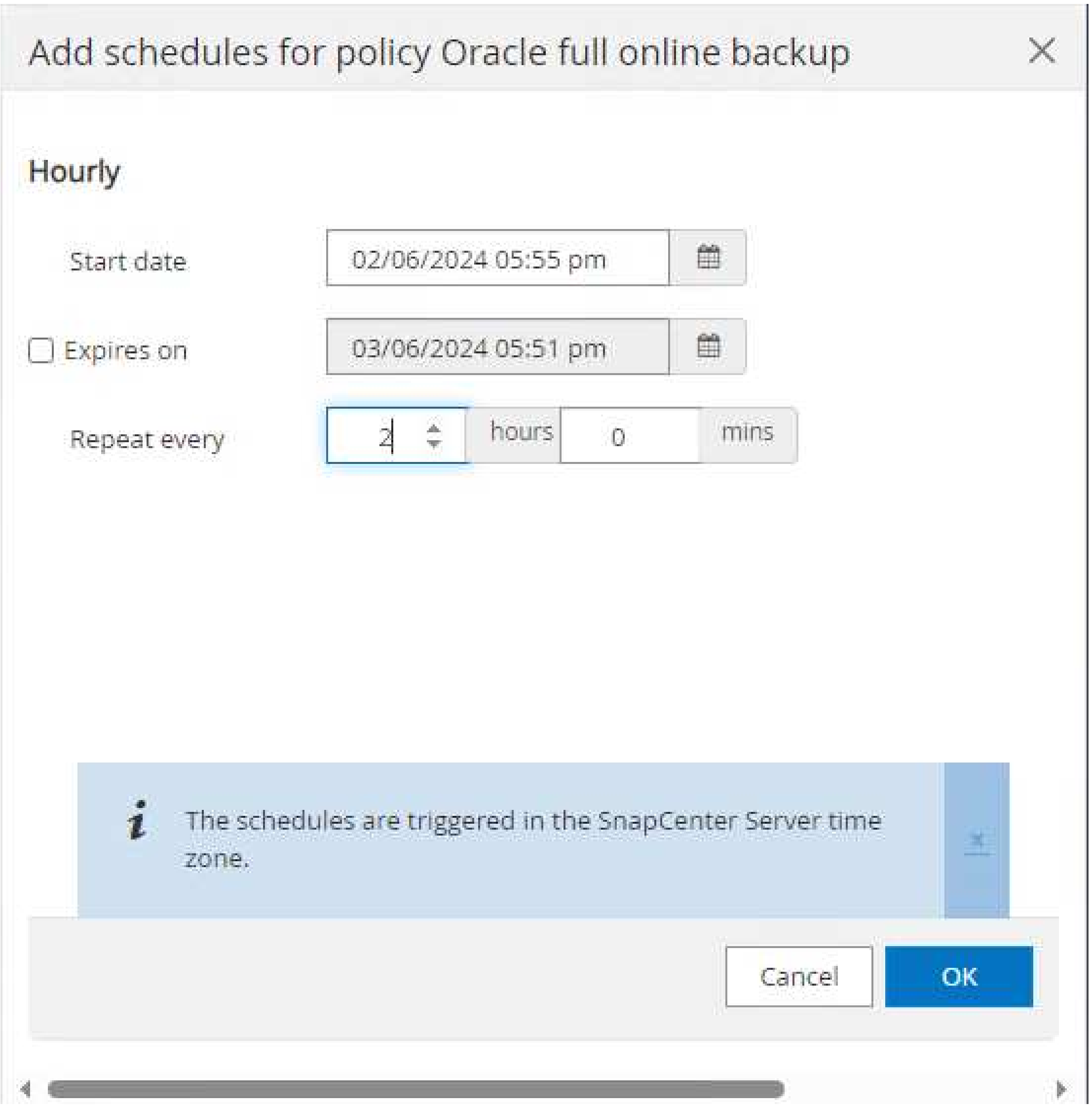
Select one or more policies and configure schedules

Oracle full online backup

Configure schedules for selected policies

Policy	Applied Schedules	Configure Schedules
Oracle full online backup	None	+

Total 1


Add schedules for policy Oracle full online backup

Hourly

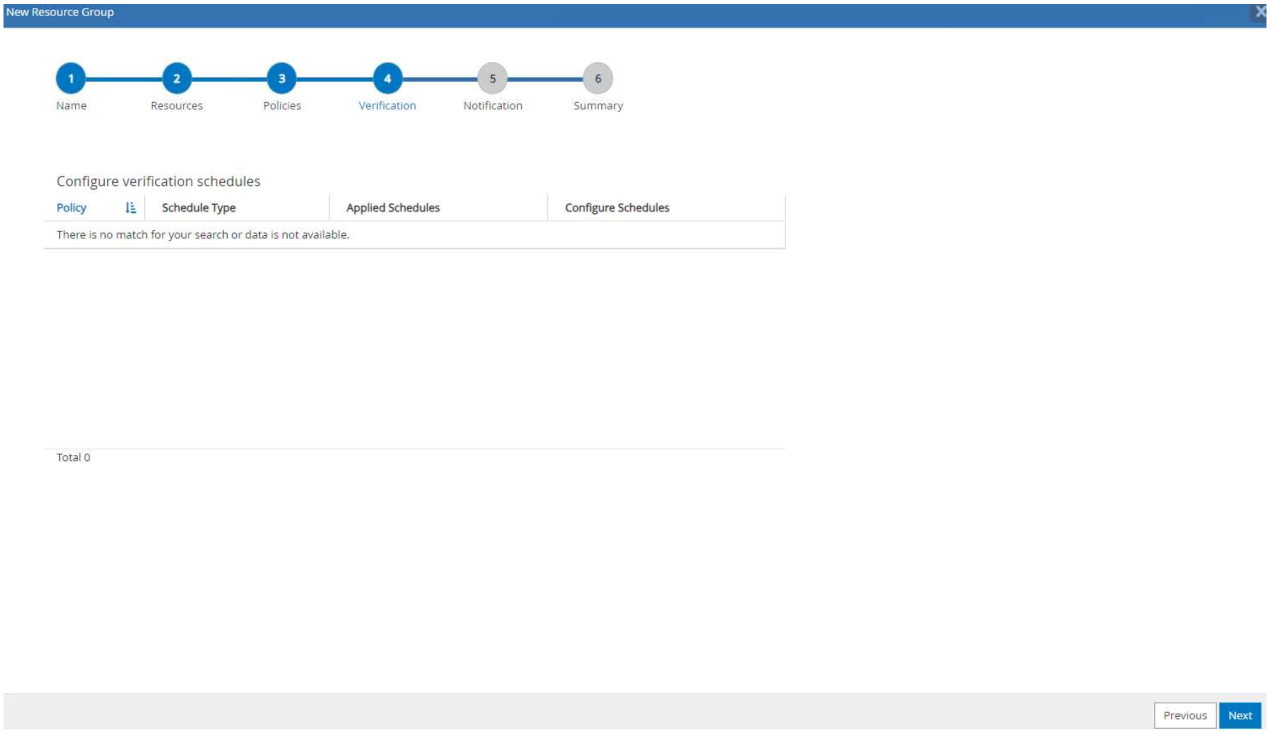
Start date: 02/06/2024 05:55 pm

☐ Expires on: 03/06/2024 05:51 pm

Repeat every: 2 hours 0 mins

The schedules are triggered in the SnapCenter Server time zone.

6. If backup verification is not configured in policy, leave verification page as is.

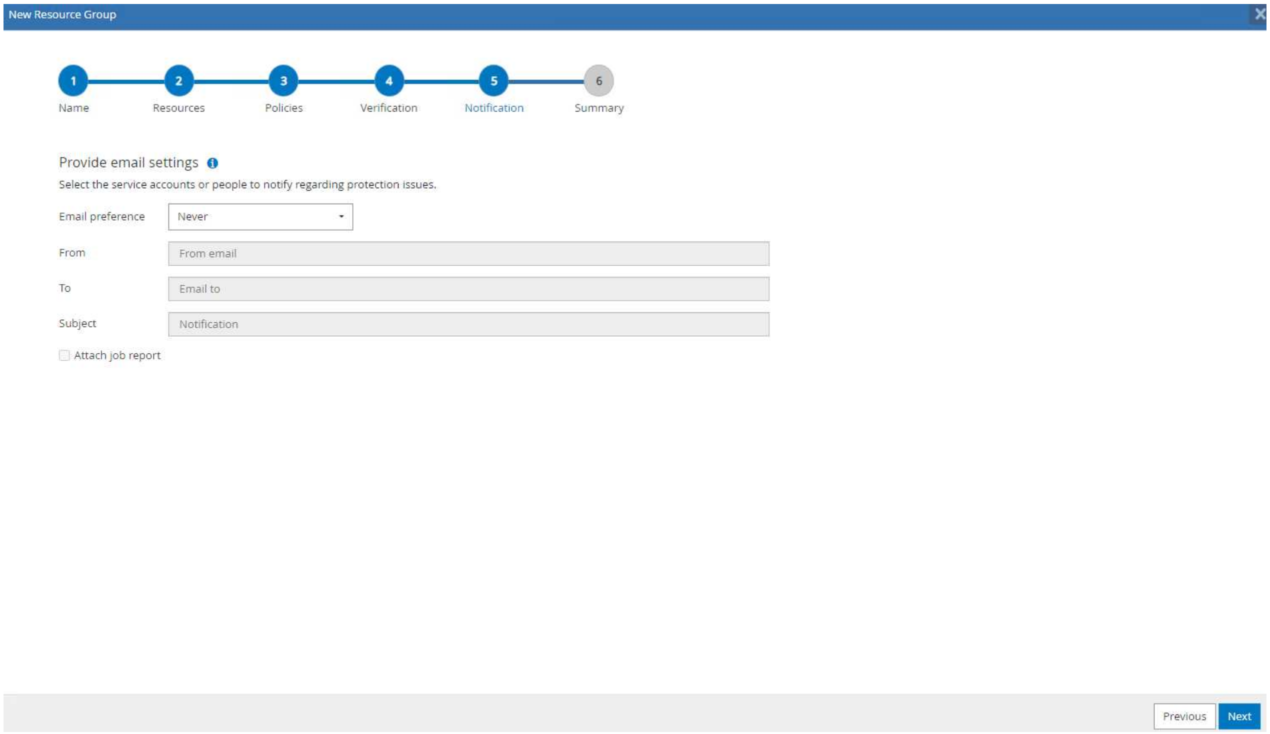


Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
There is no match for your search or data is not available.			

Total 0

7. In order to email a backup report and notification, a SMTP mail server is needed in the environment. Or leave it black if a mail server is not setup.



Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

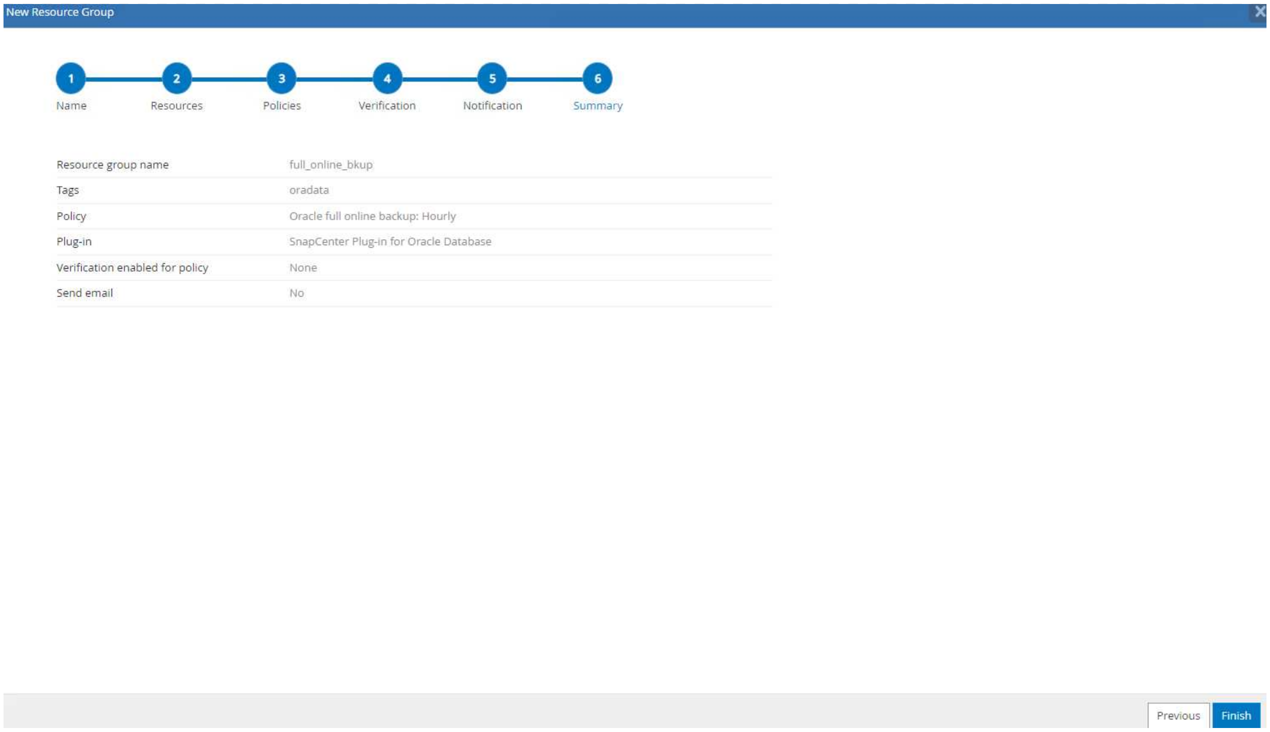
From: From email

To: Email to

Subject: Notification

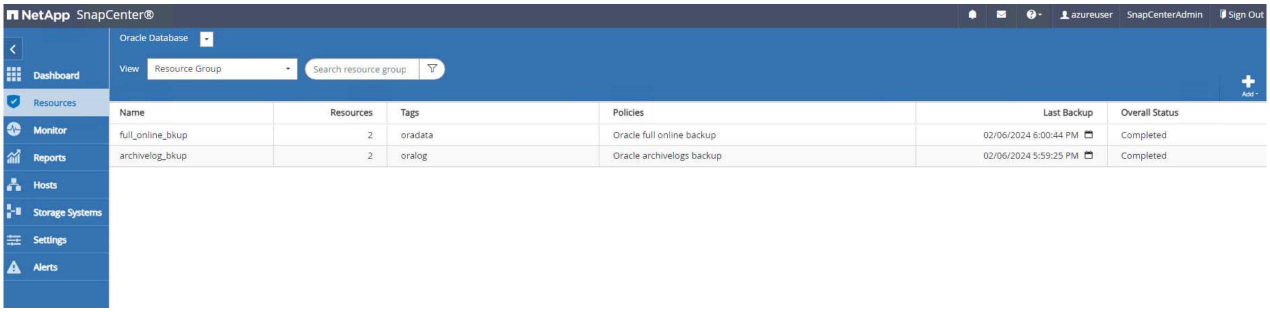
☐ Attach job report

8. Summary of new resource group.



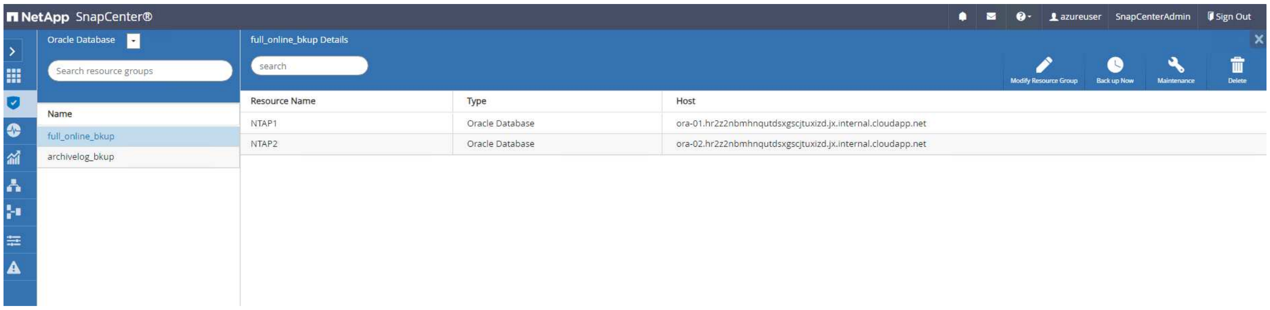
Resource group name	full_online_bkup
Tags	oradata
Policy	Oracle full online backup: Hourly
Plug-in	SnapCenter Plug-in for Oracle Database
Verification enabled for policy	None
Send email	No

9. Repeat the above procedures to create a database archive log only backup with corresponding backup policy.

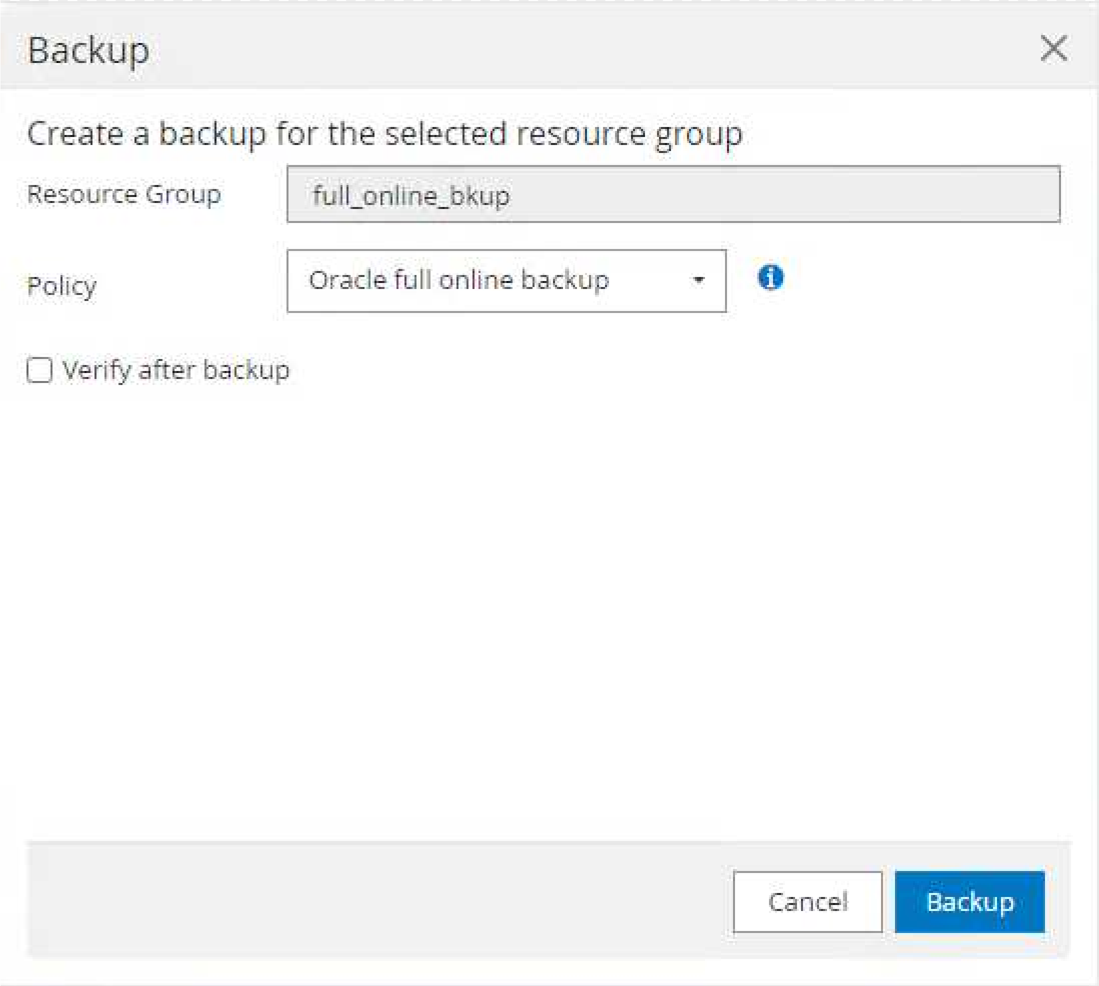


Name	Resources	Tags	Policies	Last Backup	Overall Status
full_online_bkup	2	oradata	Oracle full online backup	02/06/2024 6:00:44 PM	Completed
archivelog_bkup	2	oralog	Oracle archivelogs backup	02/06/2024 5:59:25 PM	Completed

10. Click on a resource group to reveal the resources it includes. Besides the scheduled backup job, an one-off backup can be triggered by clicking on `Backup Now`.



Resource Name	Type	Host
NTAP1	Oracle Database	ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net
NTAP2	Oracle Database	ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net



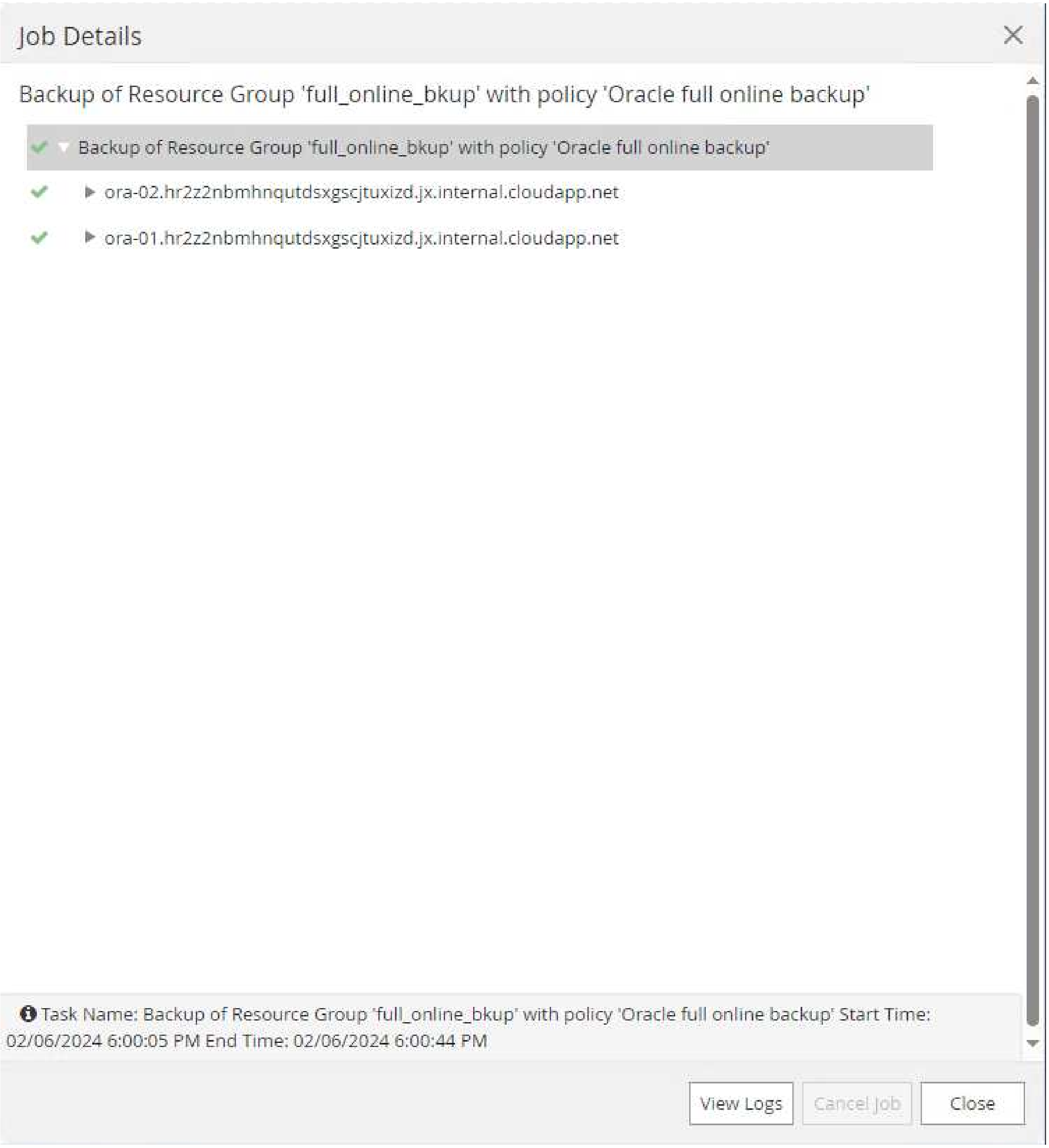
Create a backup for the selected resource group

Resource Group: full_online_bkup

Policy: Oracle full online backup

☐ Verify after backup

11. Click on the running job to open a monitoring window, which allows the operator to track the job progress in real-time.



Backup of Resource Group 'full_online_bkup' with policy 'Oracle full online backup'

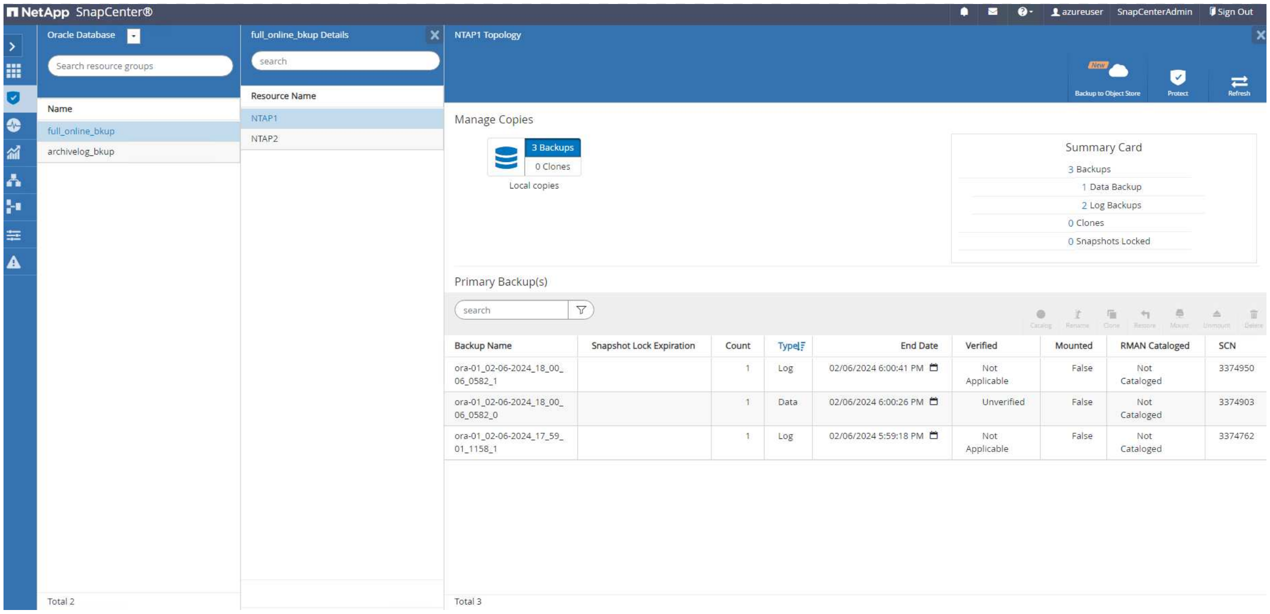
✓ Backup of Resource Group 'full_online_bkup' with policy 'Oracle full online backup'

✓ ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net

✓ ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net

Task Name: Backup of Resource Group 'full_online_bkup' with policy 'Oracle full online backup' Start Time: 02/06/2024 6:00:05 PM End Time: 02/06/2024 6:00:44 PM

12. A snapshot backup set appears under database topology once a successful backup job finishes. A full database backup set includes a snapshot of the database data volumes and a snapshot of the database log volumes. A log-only backup contains only a snapshot of the database log volumes.

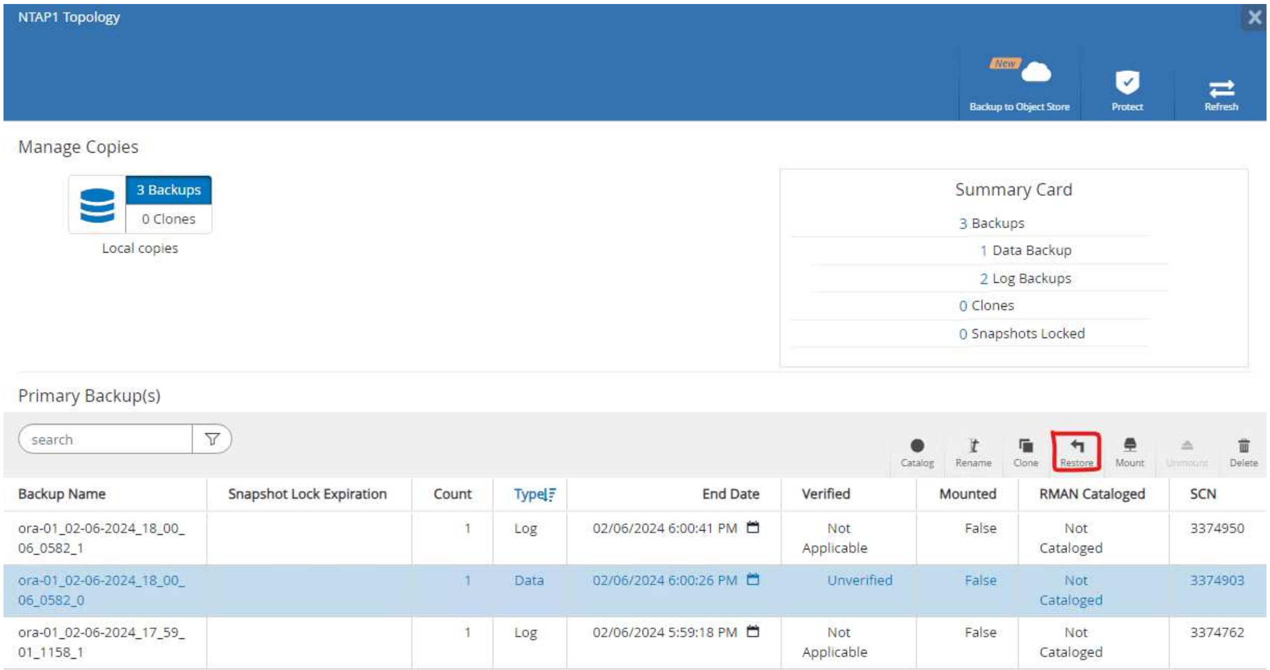


Backup Name	Snapshot Lock Expiration	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ora-01_02-06-2024_18_00_06_0582_1		1	Log	02/06/2024 6:00:41 PM	Not Applicable	False	Not Cataloged	3374950
ora-01_02-06-2024_18_00_06_0582_0		1	Data	02/06/2024 6:00:26 PM	Unverified	False	Not Cataloged	3374903
ora-01_02-06-2024_17_59_01_1158_1		1	Log	02/06/2024 5:59:18 PM	Not Applicable	False	Not Cataloged	3374762

Database recovery

Database recovery via SnapCenter restores a snapshot copy of the database volume image point-in-time. The database is then rolled forward to a desired point by SCN/timestamp or a point as allowed by available archive logs in the backup set. The following section demonstrates the workflow of database recovery with SnapCenter UI.

1. From `Resources` tab, open the database `Primary Backup(s)` page. Choose the snapshot of database data volume, then click on `Restore` button to launch database recovery workflow. Note the SCN number or timestamp in the backup sets if you like to run the recovery by Oracle SCN or timestamp.



Manage Copies

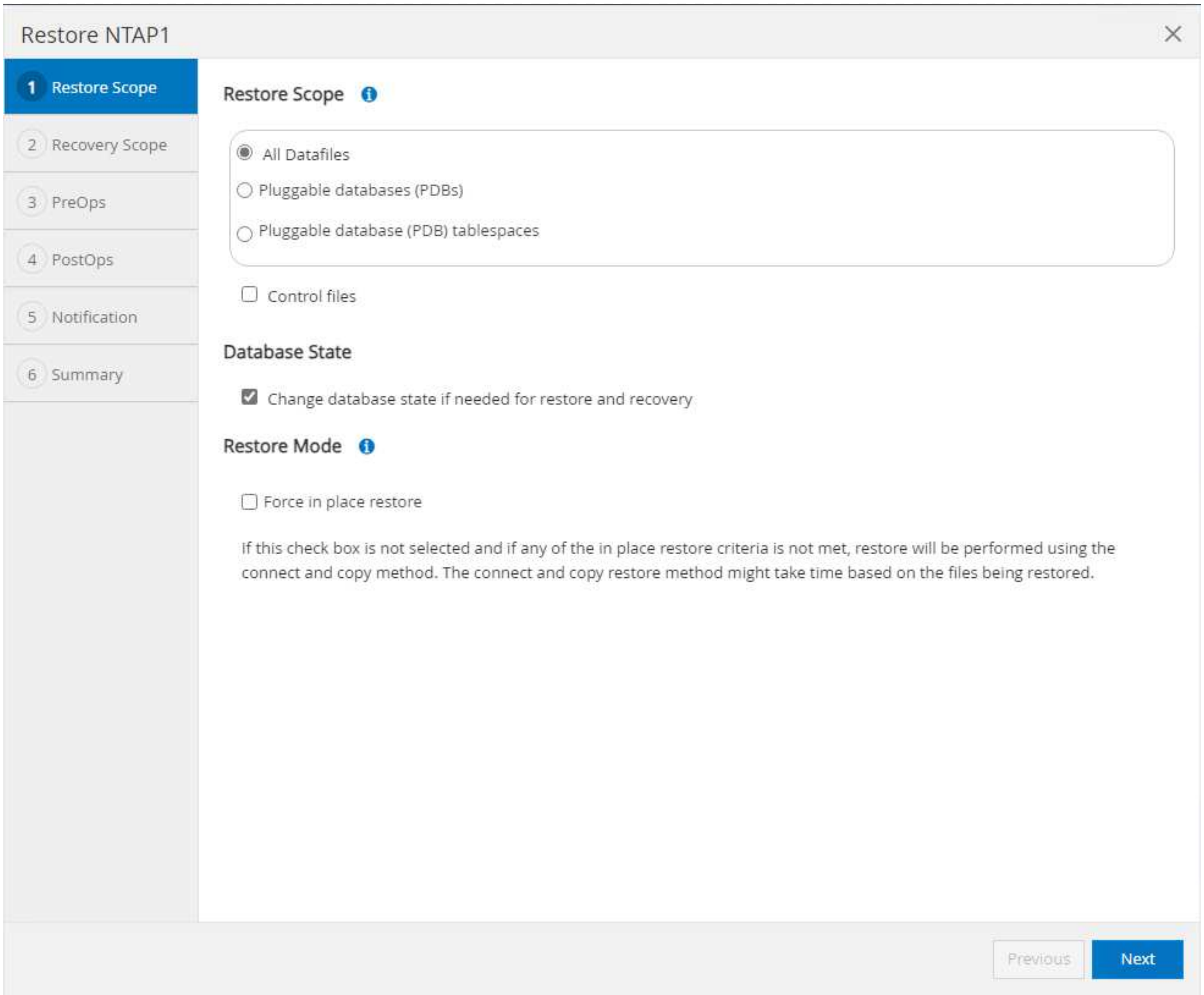
3 Backups
0 Clones
Local copies

Summary Card
3 Backups
1 Data Backup
2 Log Backups
0 Clones
0 Snapshots Locked

Primary Backup(s)

Backup Name	Snapshot Lock Expiration	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ora-01_02-06-2024_18_00_06_0582_1		1	Log	02/06/2024 6:00:41 PM	Not Applicable	False	Not Cataloged	3374950
ora-01_02-06-2024_18_00_06_0582_0		1	Data	02/06/2024 6:00:26 PM	Unverified	False	Not Cataloged	3374903
ora-01_02-06-2024_17_59_01_1158_1		1	Log	02/06/2024 5:59:18 PM	Not Applicable	False	Not Cataloged	3374762

2. Select `Restore Scope`. For a container database, SnapCenter is flexible to perform a full container database (All Datafiles), pluggable databases, or tablespaces level restore.


Restore NTAP1

Restore Scope

● All Datafiles
○ Pluggable databases (PDBs)
○ Pluggable database (PDB) tablespaces

☐ Control files

Database State

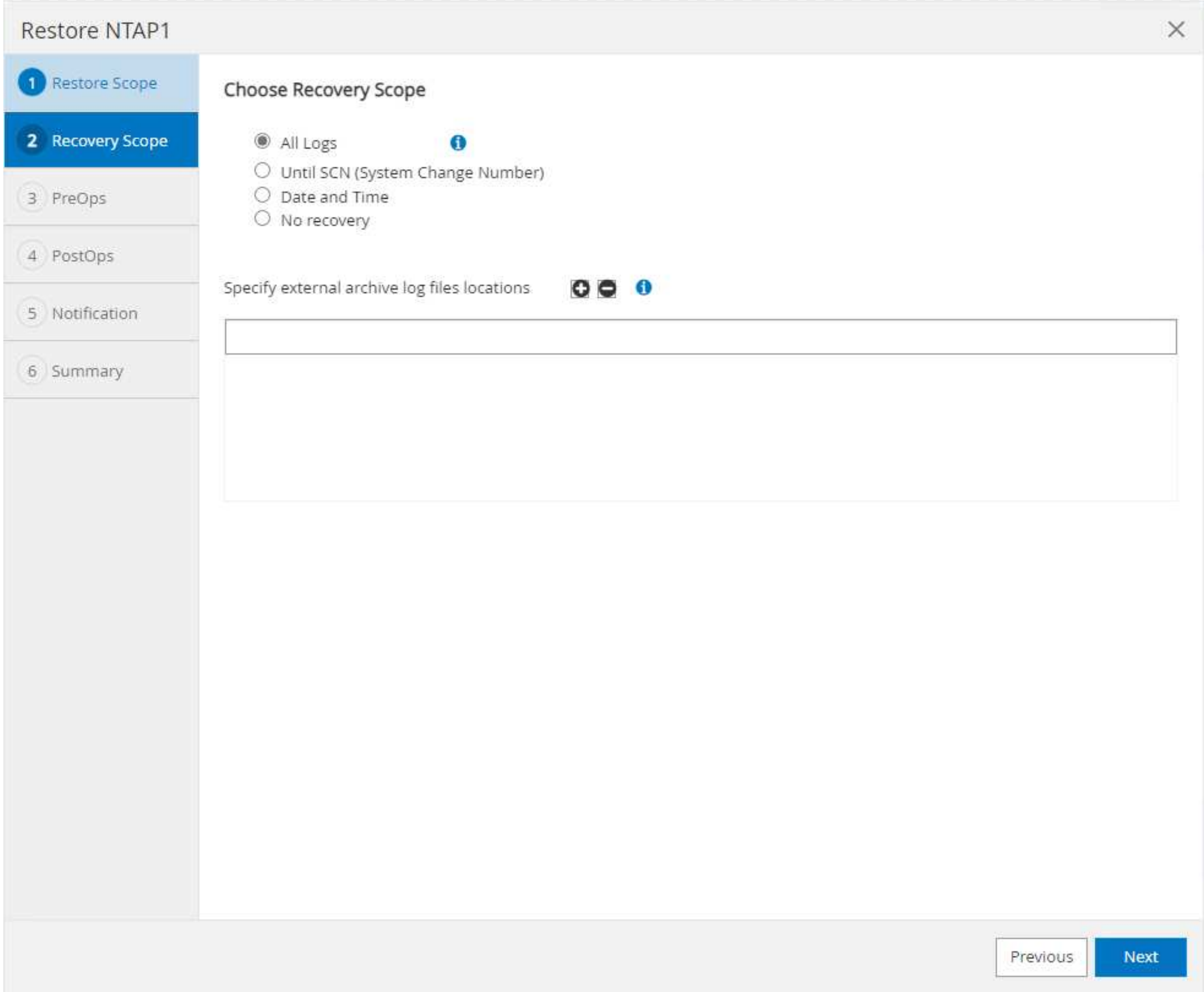
☑ Change database state if needed for restore and recovery

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.

3. Select `Recovery Scope`. `All logs` means to apply all available archive logs in the backup set. Point-in-time recovery by SCN or timestamp are also available.

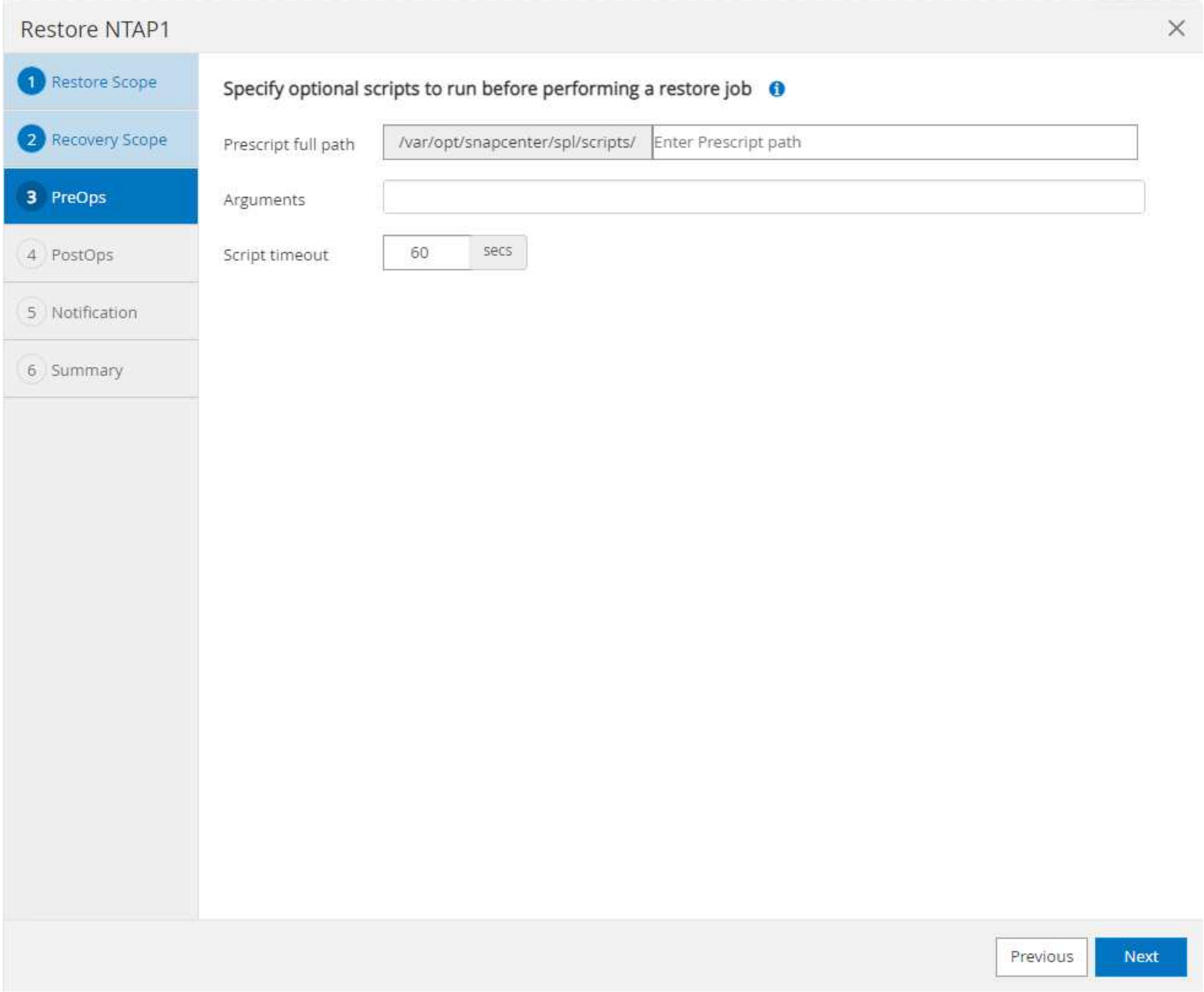


Choose Recovery Scope

● All Logs
○ Until SCN (System Change Number)
○ Date and Time
○ No recovery

Specify external archive log files locations

4. The `PreOps` allows execution of scripts against database before restore/recovery operation.



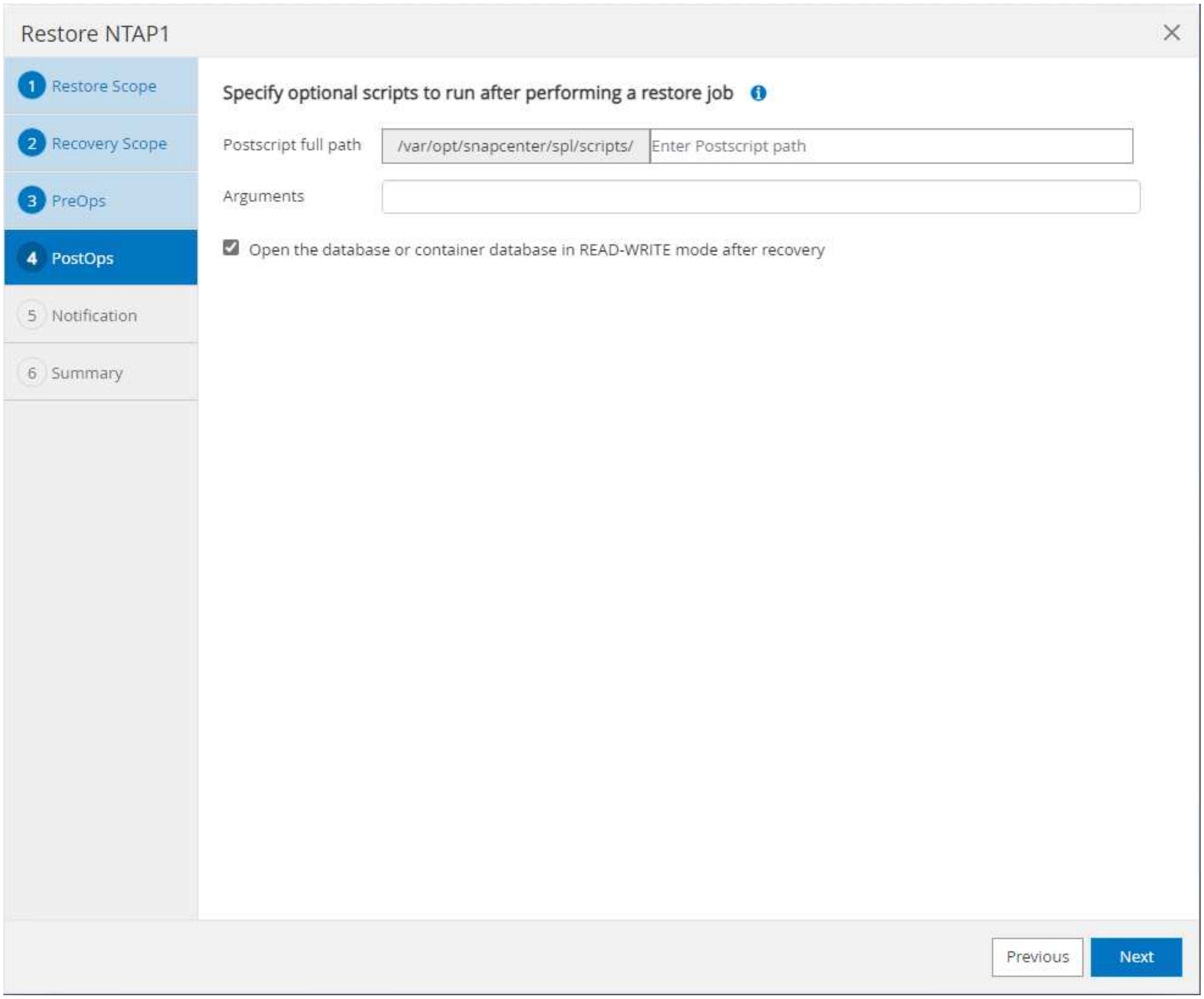
Specify optional scripts to run before performing a restore job

Prescript full path /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Arguments

Script timeout 60 secs

5. The `PostOps` allows execution of scripts against database after restore/recovery operation.



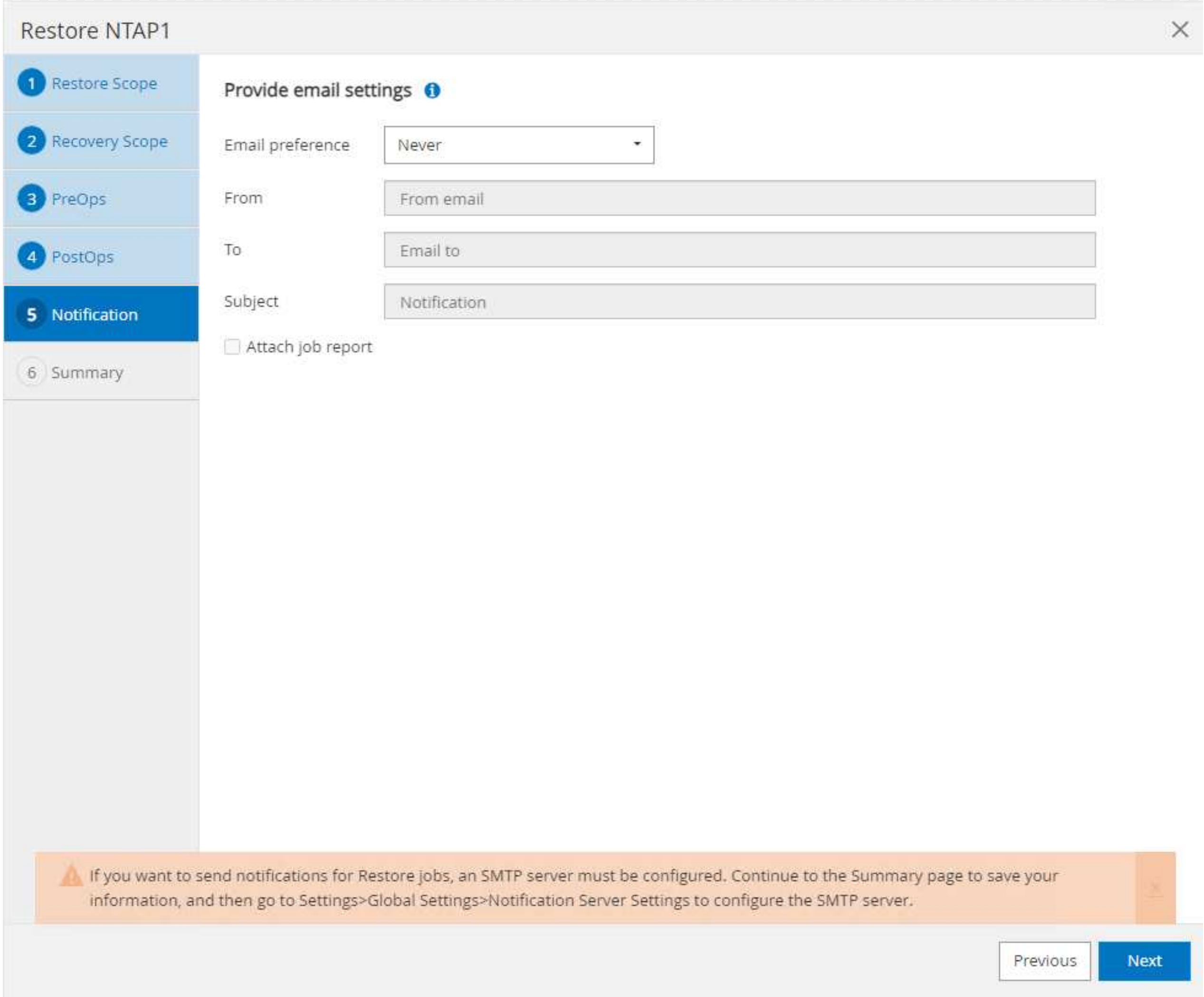
Specify optional scripts to run after performing a restore job

Postscript full path: /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Arguments

☑ Open the database or container database in READ-WRITE mode after recovery

6. Notification via email if desired.



Provide email settings

Email preference: Never

From: From email

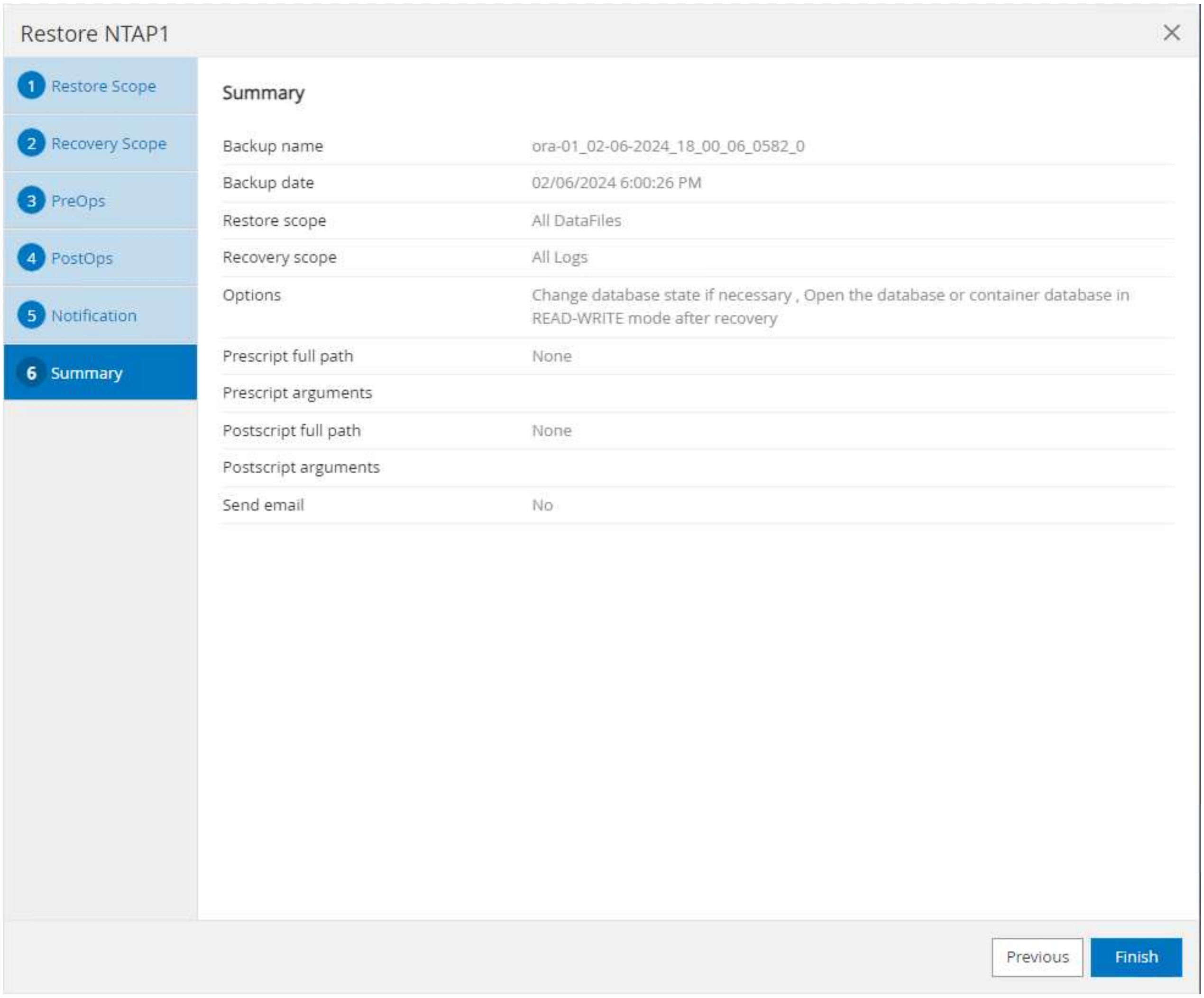
To: Email to

Subject: Notification

☐ Attach job report

If you want to send notifications for Restore 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.

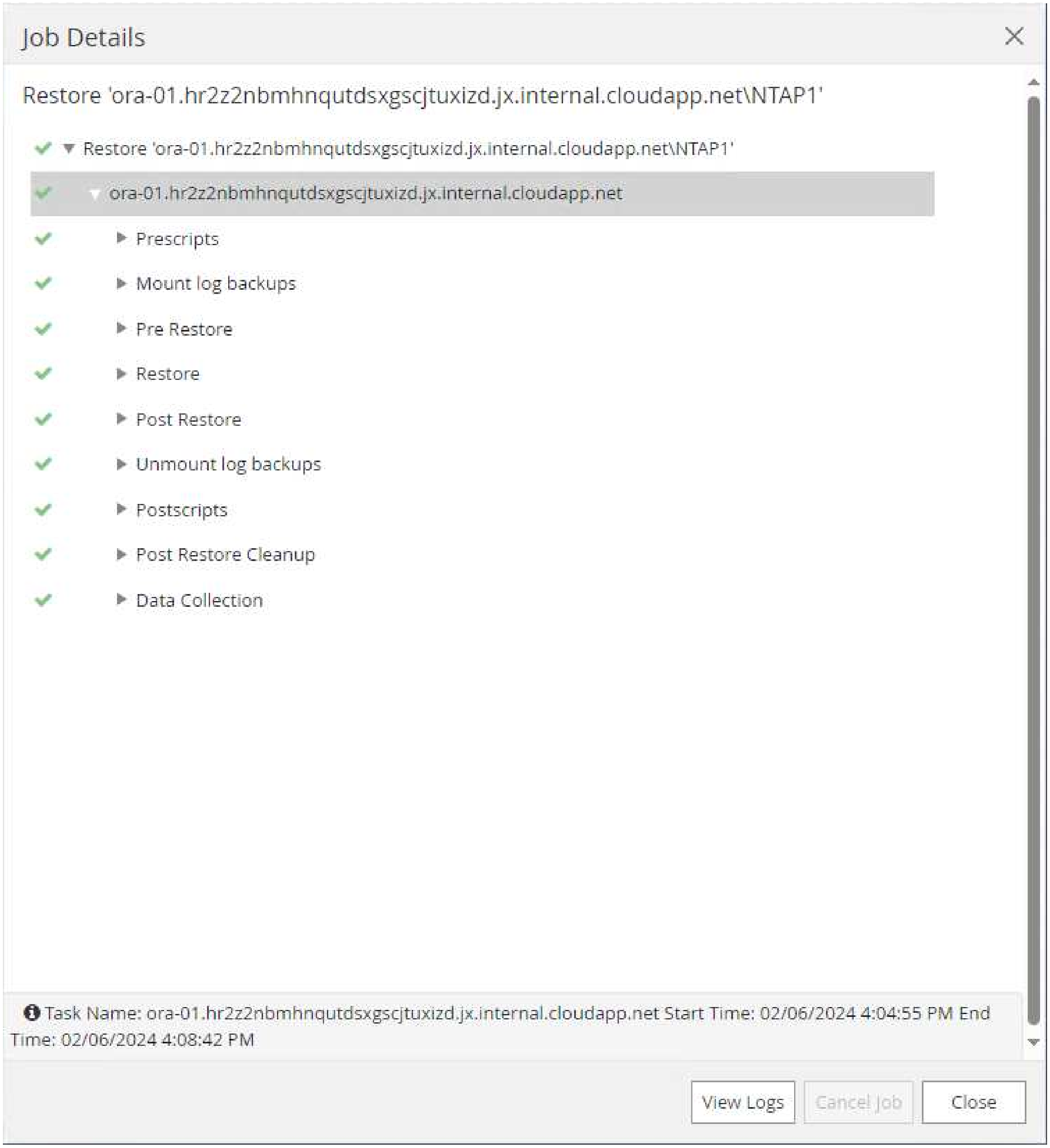
7. Restore job summary



Summary

Backup name	ora-01_02-06-2024_18_00_06_0582_0
Backup date	02/06/2024 6:00:26 PM
Restore scope	All DataFiles
Recovery scope	All Logs
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

8. Click on running job to open `Job Details` window. The job status can also be opened and viewed from the `Monitor` tab.



Job Details

Restore 'ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net\NTAP1'

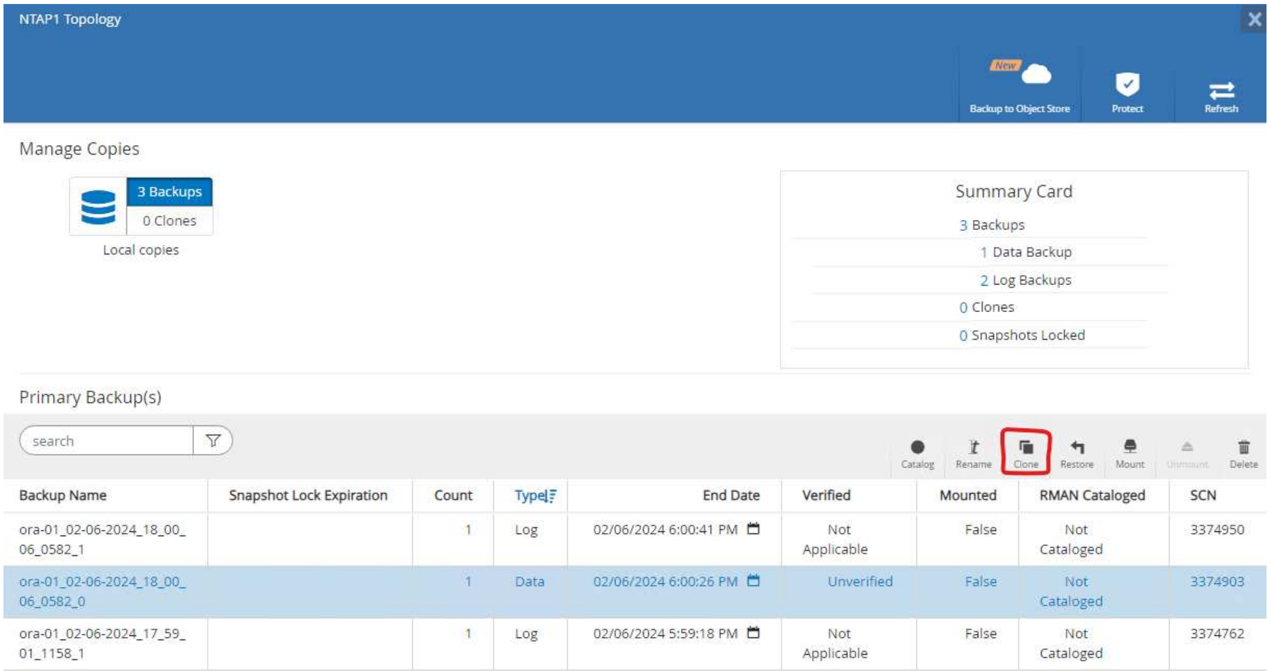
- ✓ Restore 'ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net\NTAP1'
  - ✓ ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net
    - ✓ Prescripts
    - ✓ Mount log backups
    - ✓ Pre Restore
    - ✓ Restore
    - ✓ Post Restore
    - ✓ Unmount log backups
    - ✓ Postscripts
    - ✓ Post Restore Cleanup
    - ✓ Data Collection

Task Name: ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net Start Time: 02/06/2024 4:04:55 PM End Time: 02/06/2024 4:08:42 PM

Database clone

Database clone via SnapCenter is accomplished by creating a new volume from a snapshot of a volume. The system uses the snapshot information to clone a new volume using the data on the volume when the snapshot was taken. More importantly, it is quick (a few minutes) and efficient compared with other methods to make a cloned copy of the production database to support development or testing. Thus, dramatically improve your database application lifecycle management. The following section demonstrates the workflow of database clone with SnapCenter UI.

1. From `Resources` tab, open the database `Primary Backup(s)` page. Choose the snapshot of database data volume, then click on `clone` button to launch database clone workflow.



Manage Copies

3 Backups
0 Clones
Local copies

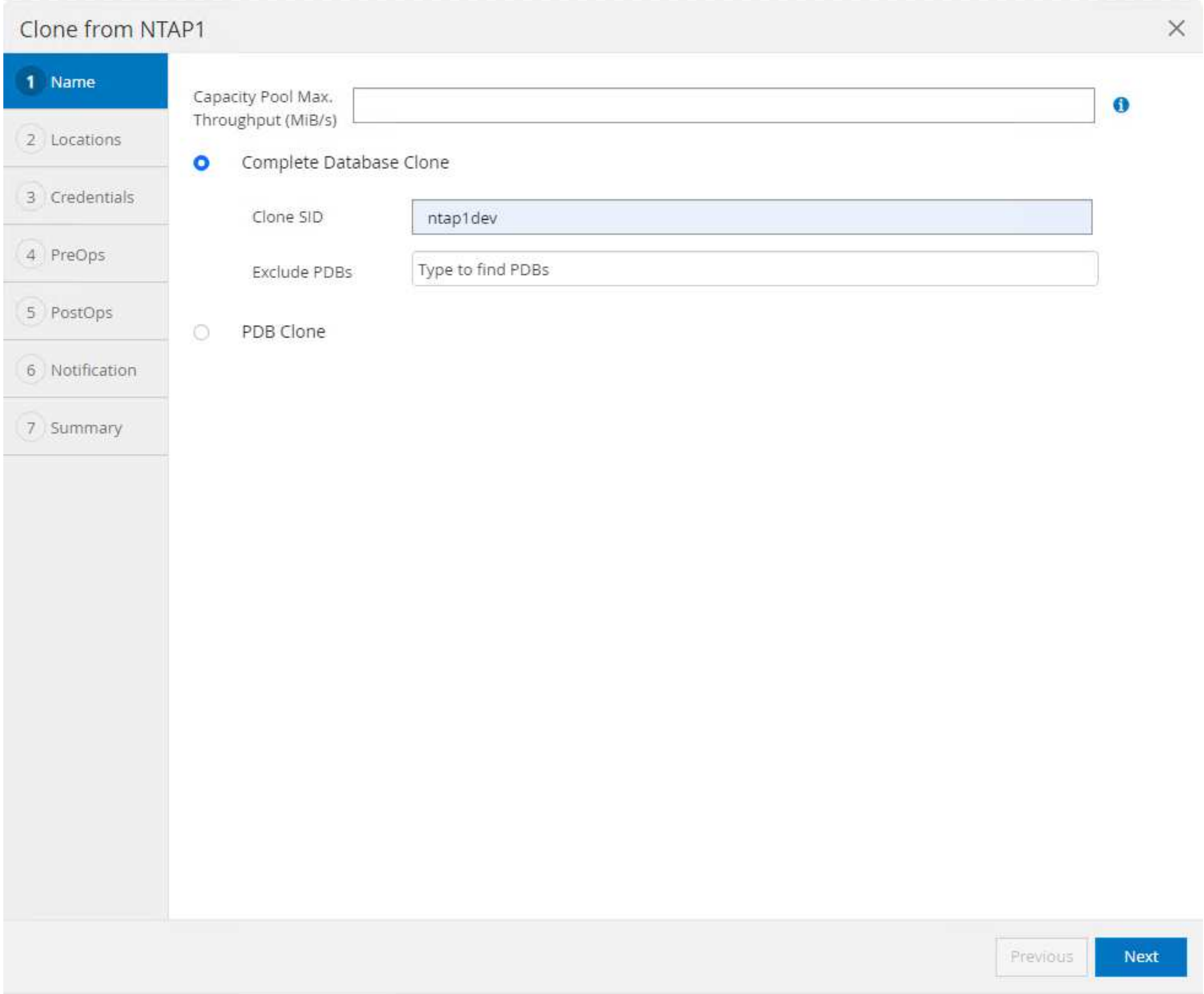
Summary Card

3 Backups
1 Data Backup
2 Log Backups
0 Clones
0 Snapshots Locked

Primary Backup(s)

Backup Name	Snapshot Lock Expiration	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
ora-01_02-06-2024_18_00_06_0582_1		1	Log	02/06/2024 6:00:41 PM	Not Applicable	False	Not Cataloged	3374950
ora-01_02-06-2024_18_00_06_0582_0		1	Data	02/06/2024 6:00:26 PM	Unverified	False	Not Cataloged	3374903
ora-01_02-06-2024_17_59_01_1158_1		1	Log	02/06/2024 5:59:18 PM	Not Applicable	False	Not Cataloged	3374762

2. Name the clone database SID. Optionally, for a container database, clone can be done at PDB level as well.



Capacity Pool Max. Throughput (MiB/s)

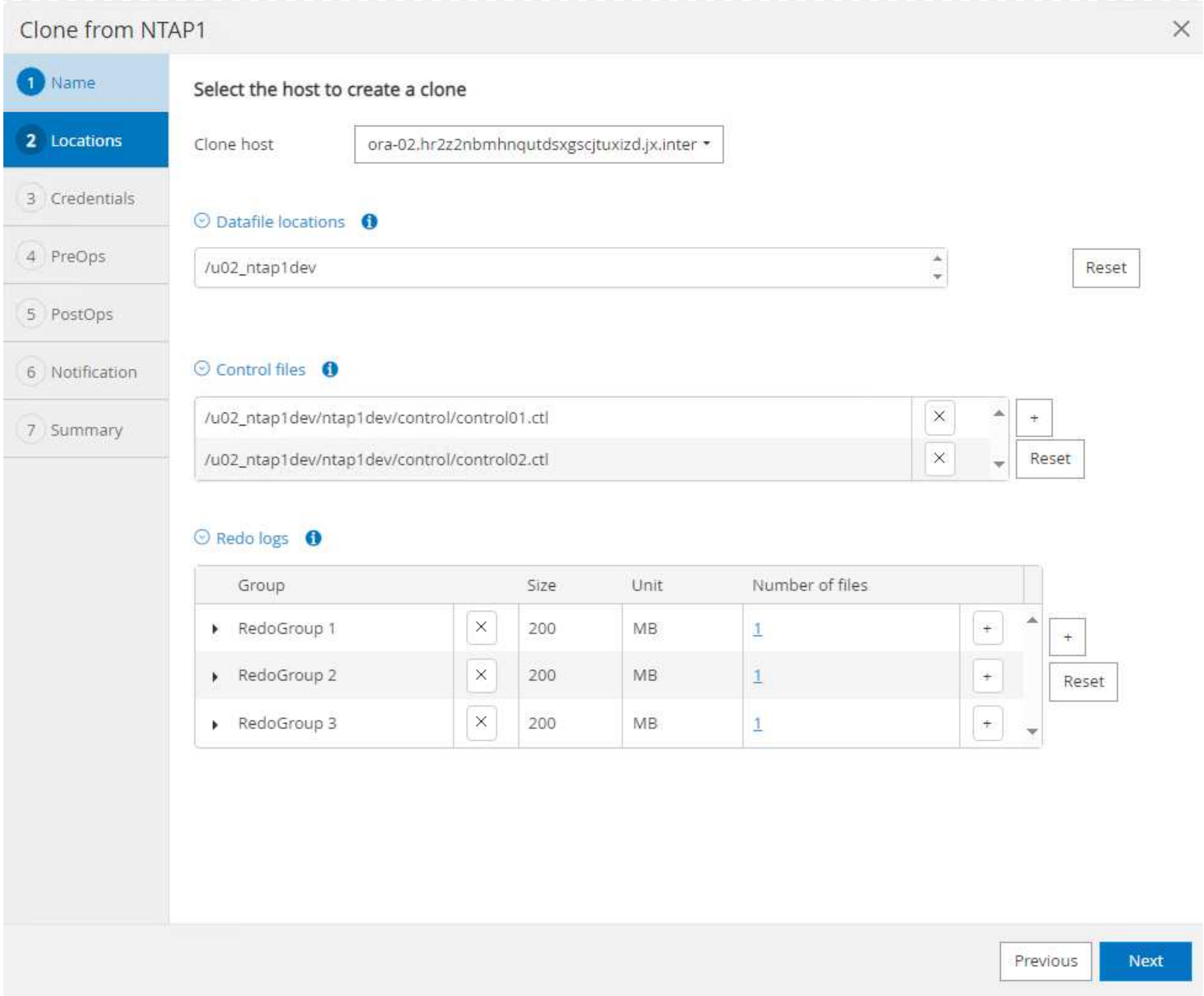
● Complete Database Clone

Clone SID: ntap1dev

Exclude PDBs: Type to find PDBs

○ PDB Clone

3. Select the DB server where you want to place your cloned database copy. Keep the default file locations unless you want to name them differently.



Select the host to create a clone

Clone host: ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.inter

Datafile locations

/u02_ntap1dev

Reset

Control files

/u02_ntap1dev/ntap1dev/control/control01.ctl

/u02_ntap1dev/ntap1dev/control/control02.ctl

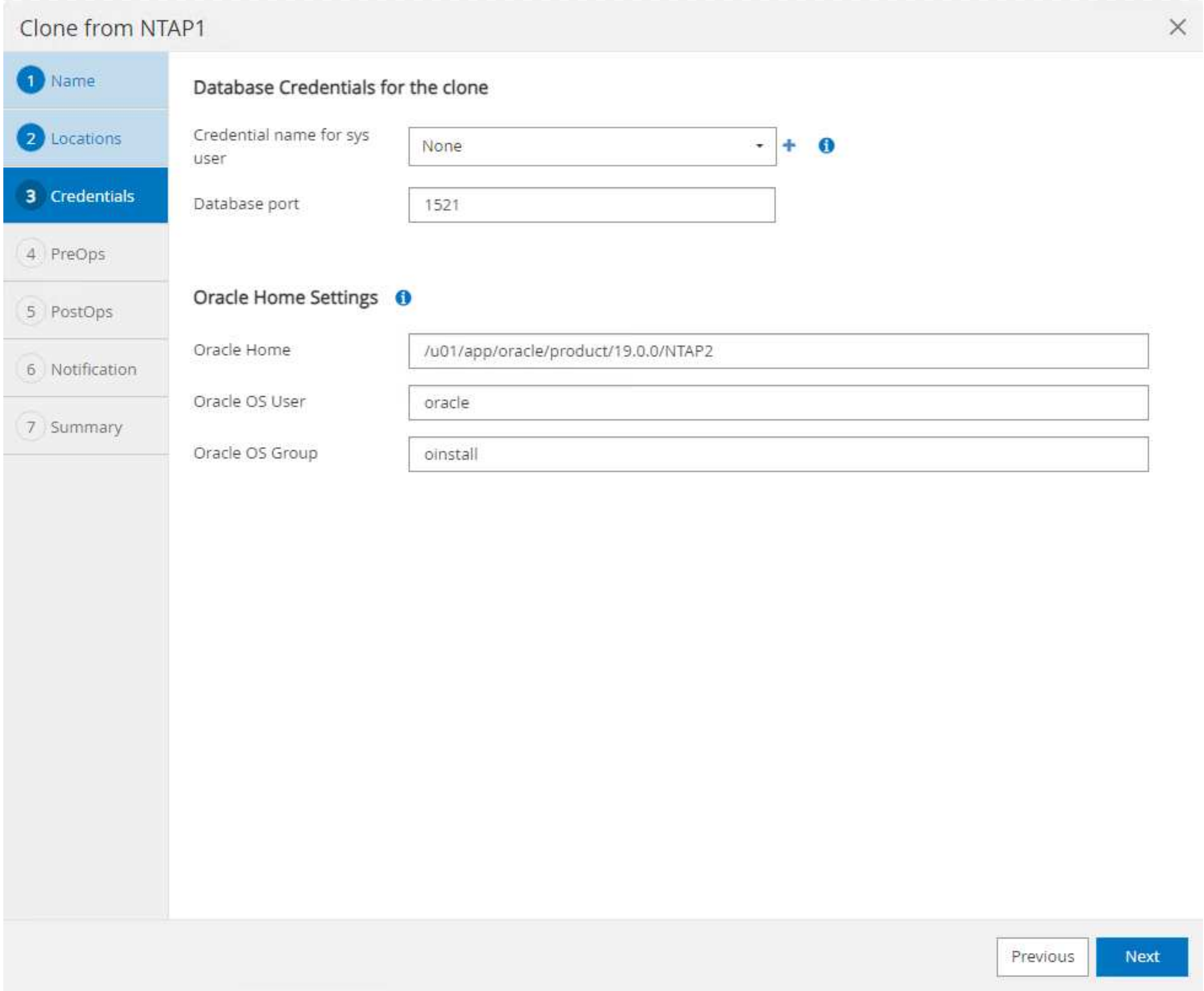
Reset

Redo logs

Group	Size	Unit	Number of files
RedoGroup 1	200	MB	1
RedoGroup 2	200	MB	1
RedoGroup 3	200	MB	1

Reset

4. Identical Oracle software stack as in source database should have been installed and configured on clone DB host. Keep the default credential but change `Oracle Home Settings` to match with settings on clone DB host.



Database Credentials for the clone

Credential name for sys user: None

Database port: 1521

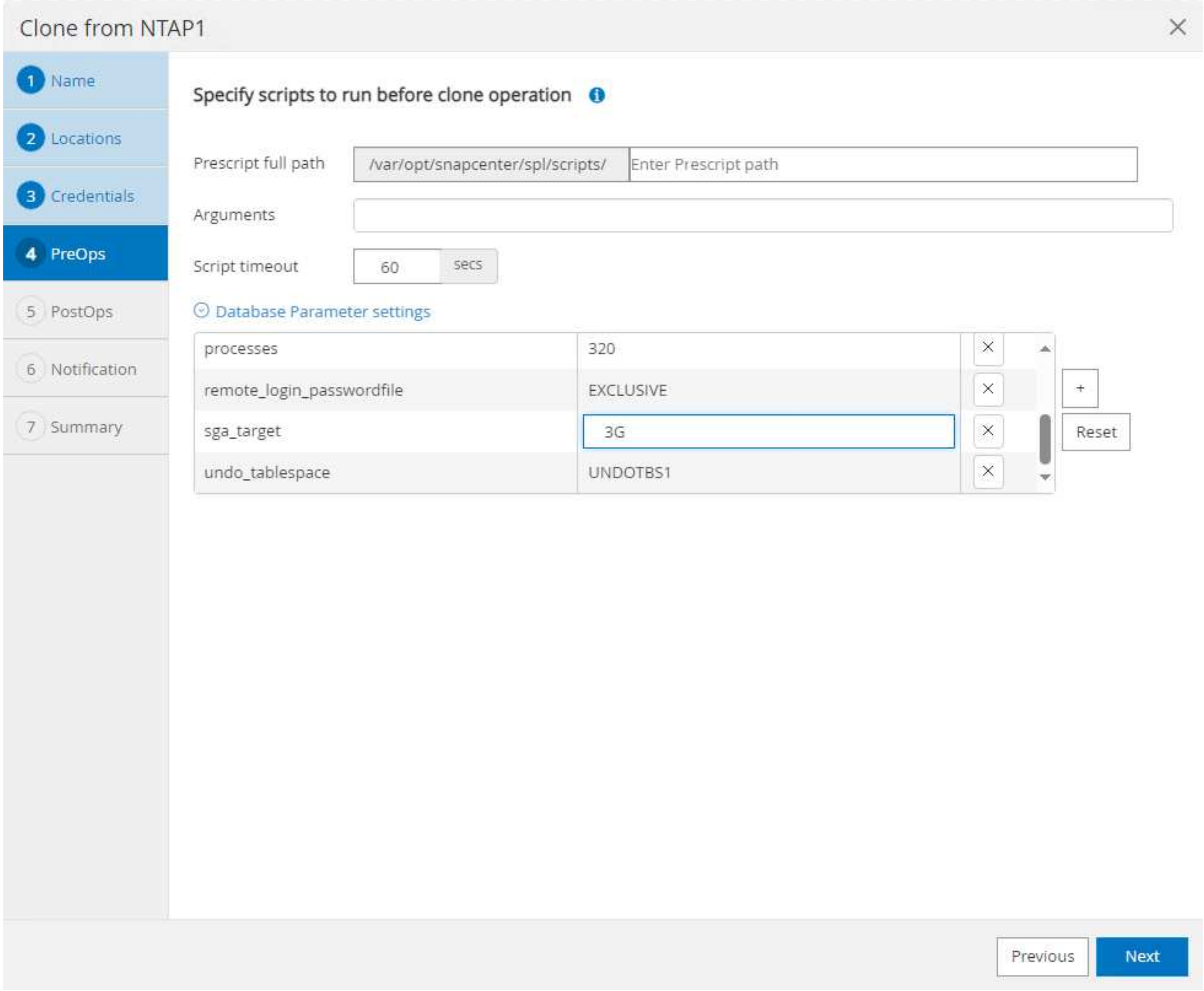
Oracle Home Settings

Oracle Home: /u01/app/oracle/product/19.0.0/NTAP2

Oracle OS User: oracle

Oracle OS Group: oinstall

5. The `PreOps` allows execution of scripts before clone operation. Database parameters can be adjusted to meet a clone DB needs as versus a production database, such as reduced SGA target.



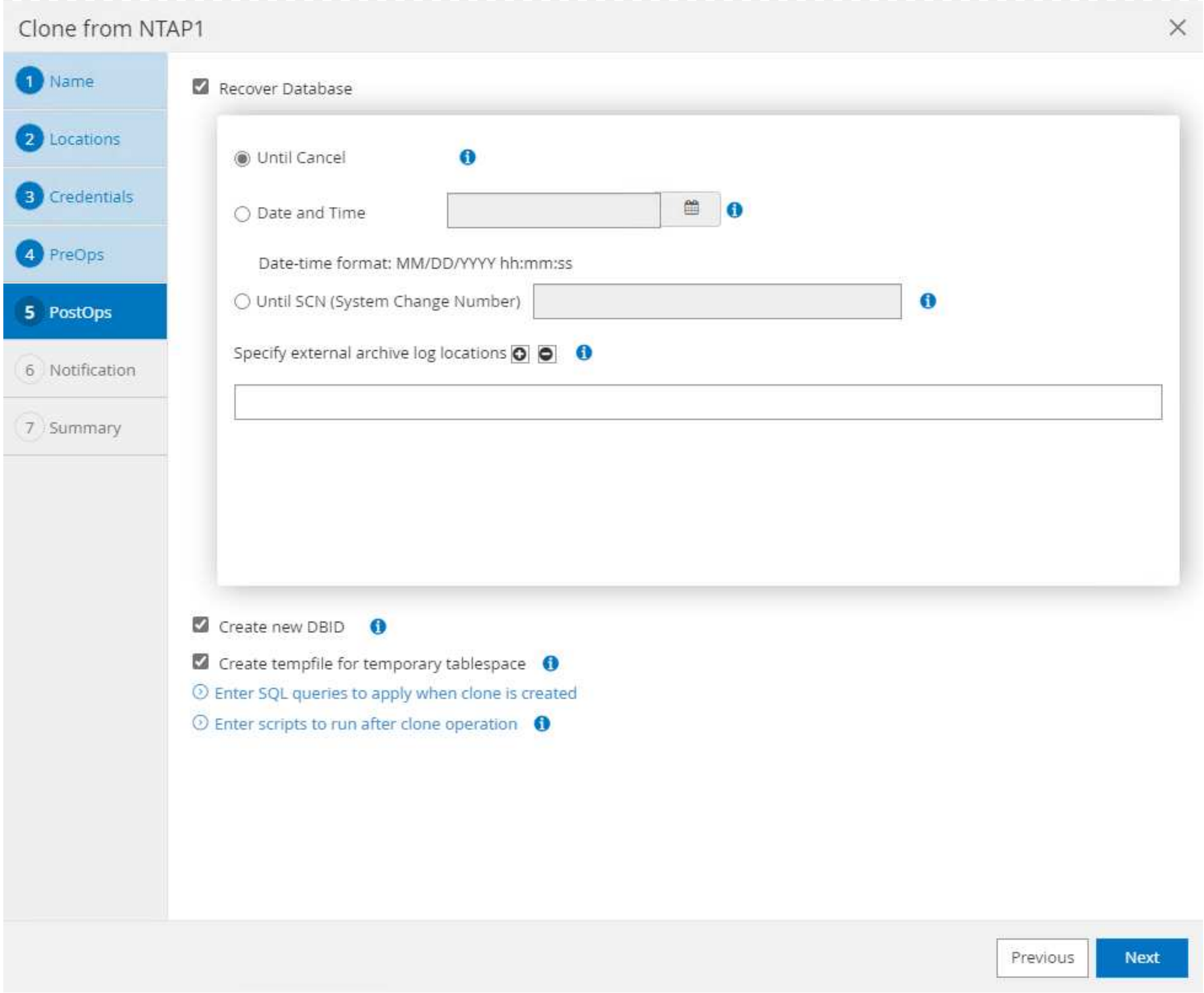
Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Arguments:

Script timeout: 60 secs

processes	320
remote_login_passwordfile	EXCLUSIVE
sga_target	3G
undo_tablespace	UNDOTBS1

6. The `PostOps` allows execution of scripts against database after clone operation. Clone database recovery can be SCN, timestamp based, or Until cancel (rolling forward database to last archived log in the backup set).


Clone from NTAP1

☑ Recover Database

● Until Cancel

○ Date and Time

Date-time format: MM/DD/YYYY hh:mm:ss

○ Until SCN (System Change Number)

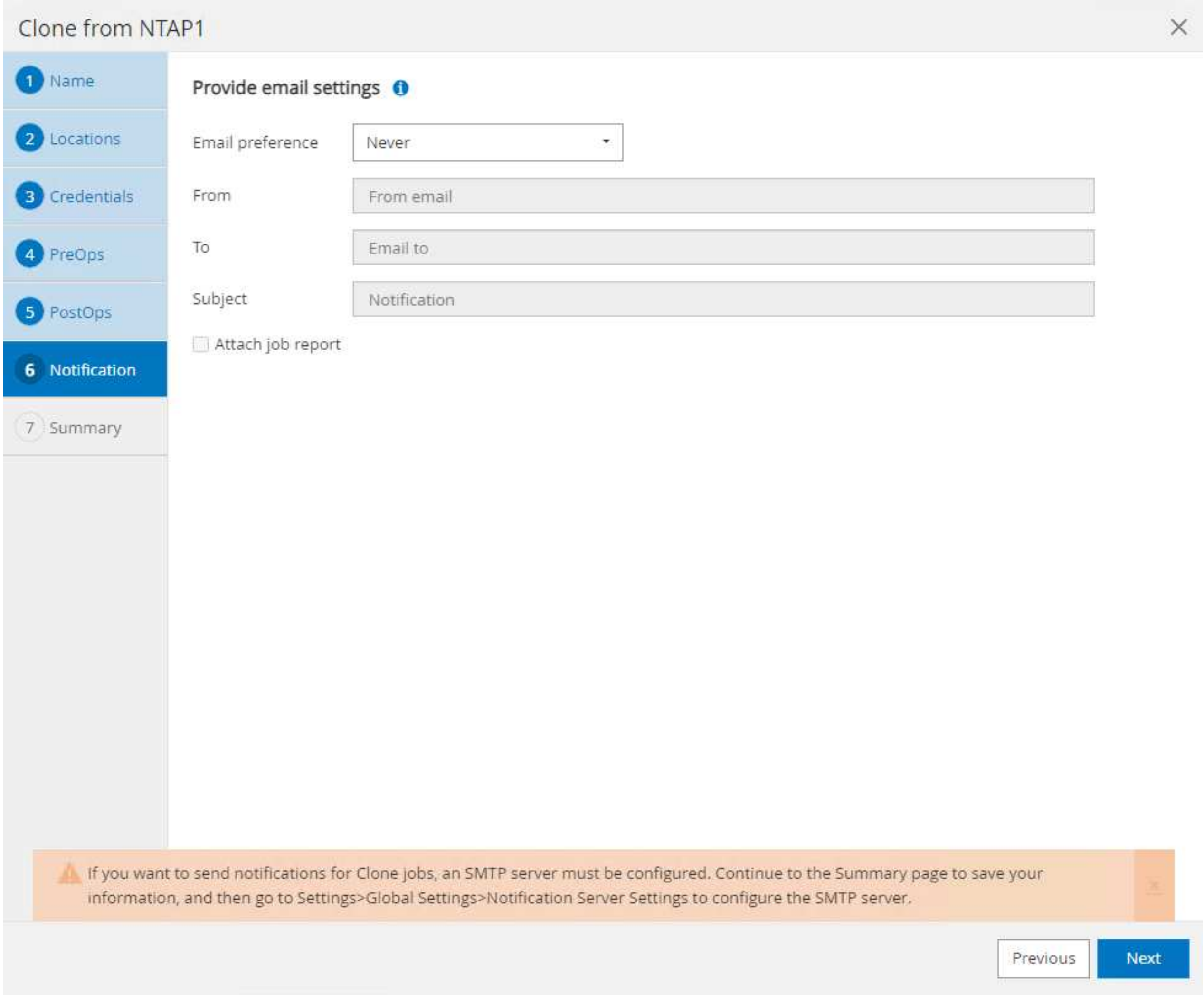
Specify external archive log locations

☑ Create new DBID

☑ Create tempfile for temporary tablespace

1 Name
2 Locations
3 Credentials
4 PreOps
5 PostOps
6 Notification
7 Summary
Enter SQL queries to apply when clone is created
Enter scripts to run after clone operation
Previous
Next

7. Notification via email if desired.



Provide email settings

Email preference: Never

From: From email

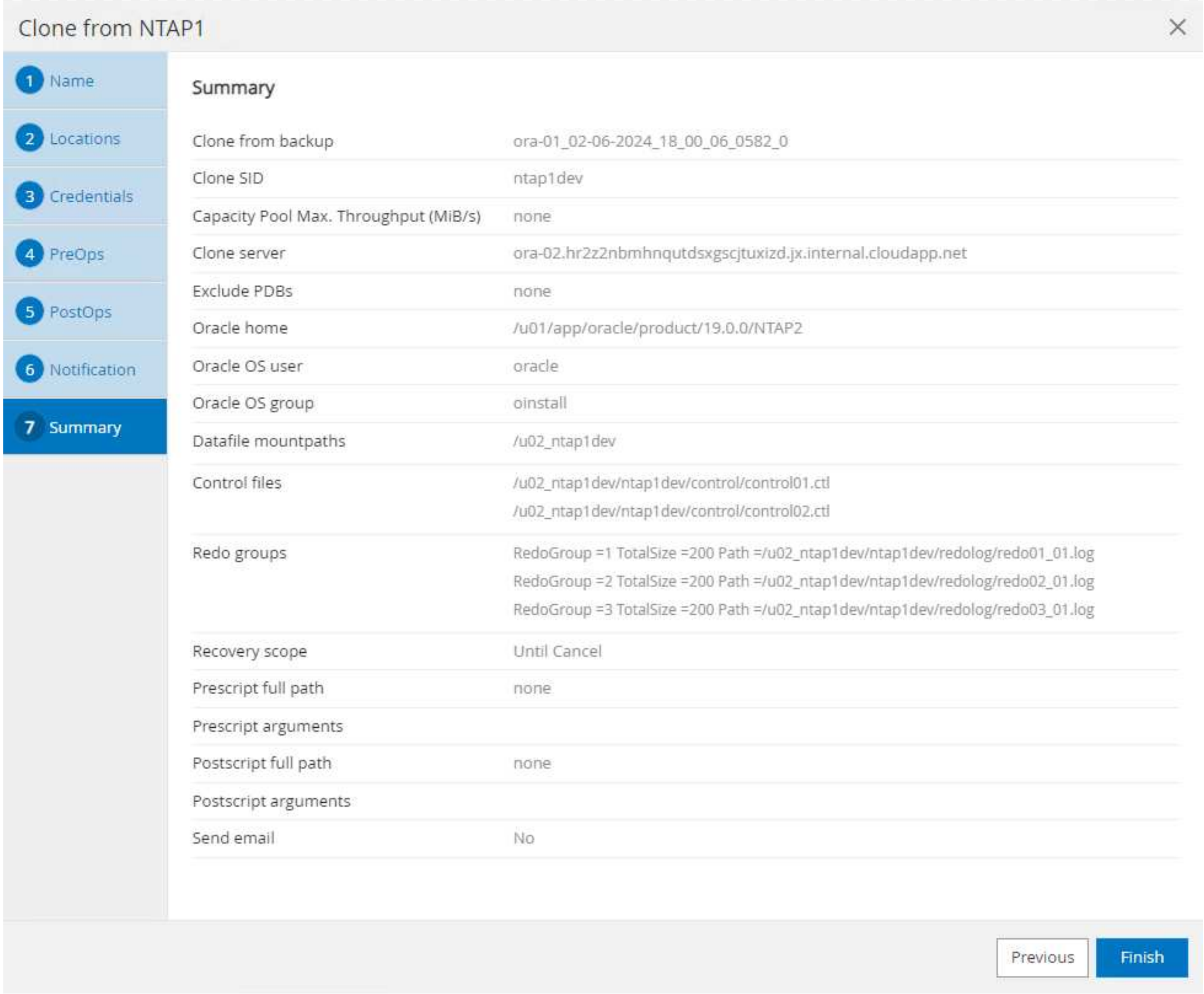
To: Email to

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.

8. Clone job summary.



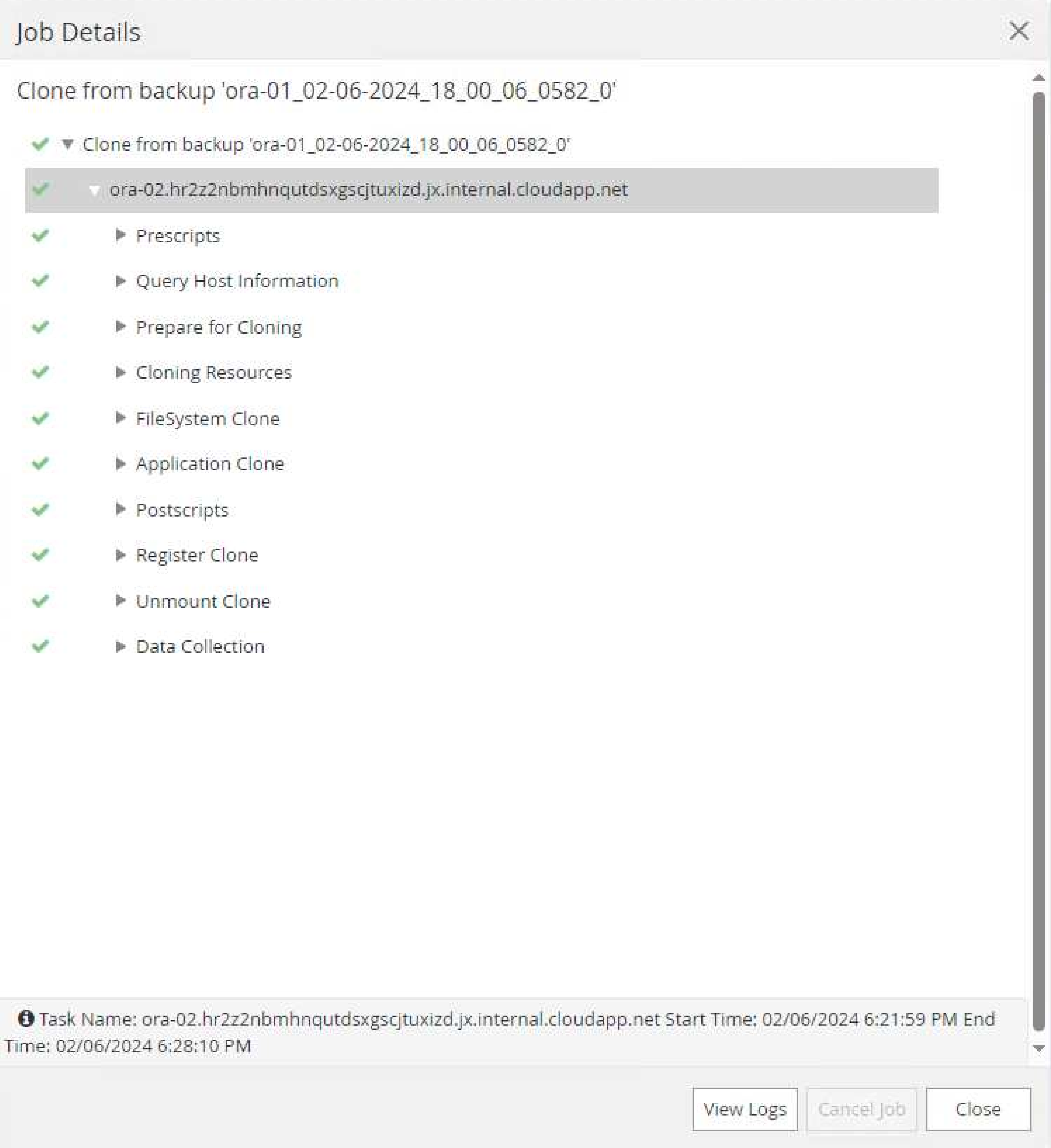
Summary

Clone from backup	ora-01_02-06-2024_18_00_06_0582_0
Clone SID	ntap1dev
Capacity Pool Max. Throughput (MiB/s)	none
Clone server	ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net
Exclude PDBs	none
Oracle home	/u01/app/oracle/product/19.0.0/NTAP2
Oracle OS user	oracle
Oracle OS group	oinstall
Datafile mountpaths	/u02_ntap1dev
Control files	/u02_ntap1dev/ntap1dev/control/control01.ctl /u02_ntap1dev/ntap1dev/control/control02.ctl

Redo groups	RedoGroup =1 TotalSize =200 Path =/u02_ntap1dev/ntap1dev/redolog/redo01_01.log
	RedoGroup =2 TotalSize =200 Path =/u02_ntap1dev/ntap1dev/redolog/redo02_01.log
	RedoGroup =3 TotalSize =200 Path =/u02_ntap1dev/ntap1dev/redolog/redo03_01.log

Recovery scope	Until Cancel
Prescript full path	none
Prescript arguments	
Postscript full path	none
Postscript arguments	
Send email	No

9. Click on running job to open `Job Details` window. The job status can also be opened and viewed from the `Monitor` tab.

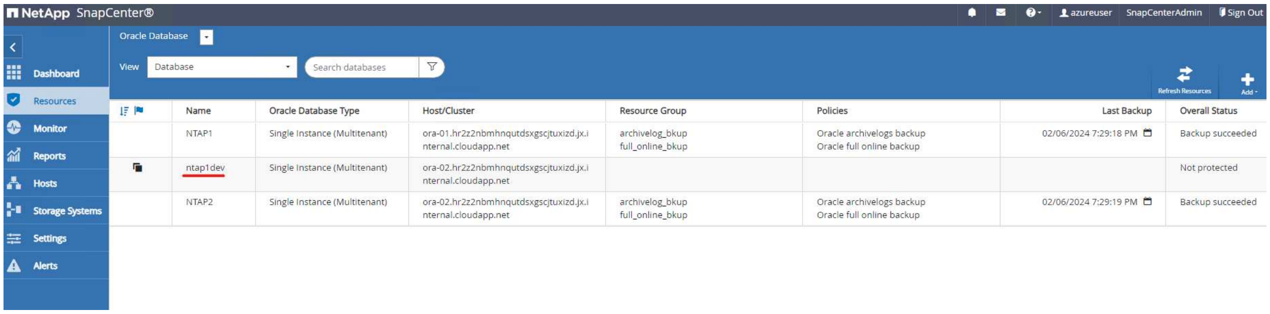


Clone from backup 'ora-01_02-06-2024_18_00_06_0582_0'

- ✓ ▼ Clone from backup 'ora-01_02-06-2024_18_00_06_0582_0'
  - ✓ ▼ ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net
    - ✓ ▶ Prescripts
    - ✓ ▶ Query Host Information
    - ✓ ▶ Prepare for Cloning
    - ✓ ▶ Cloning Resources
    - ✓ ▶ FileSystem Clone
    - ✓ ▶ Application Clone
    - ✓ ▶ Postscripts
    - ✓ ▶ Register Clone
    - ✓ ▶ Unmount Clone
    - ✓ ▶ Data Collection

Task Name: ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net Start Time: 02/06/2024 6:21:59 PM End Time: 02/06/2024 6:28:10 PM

10. Cloned database registers with SnapCenter immediately.



Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
NTAP1	Single Instance (Multitenant)	ora-01.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net	archivelog_bkup full_online_bkup	Oracle archivelogs backup Oracle full online backup	02/06/2024 7:29:18 PM	Backup succeeded
ntap1dev	Single Instance (Multitenant)	ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net				Not protected
NTAP2	Single Instance (Multitenant)	ora-02.hr2z2nbmhnqutdsxgscjtuxizd.jx.internal.cloudapp.net	archivelog_bkup full_online_bkup	Oracle archivelogs backup Oracle full online backup	02/06/2024 7:29:19 PM	Backup succeeded

11. Validate clone database on DB server host. For a cloned development database, database archive mode should be turned off.

```
[azureuser@ora-02 ~]$ sudo su
[root@ora-02 azureuser]# su - oracle
Last login: Tue Feb  6 16:26:28 UTC 2024 on pts/0

[oracle@ora-02 ~]$ uname -a
Linux ora-02 4.18.0-372.9.1.el8.x86_64 #1 SMP Fri Apr 15 22:12:19
EDT 2022 x86_64 x86_64 x86_64 GNU/Linux
[oracle@ora-02 ~]$ df -h
Filesystem                                       Size  Used Avail
Use% Mounted on
devtmpfs                                         7.7G     0  7.7G
0% /dev
tmpfs                                            7.8G     0  7.8G
0% /dev/shm
tmpfs                                            7.8G   49M  7.7G
1% /run
tmpfs                                            7.8G     0  7.8G
0% /sys/fs/cgroup
/dev/mapper/rootvg-rootlv                         22G   17G  5.6G
75% /
/dev/mapper/rootvg-usrlv                          10G  2.0G  8.1G
20% /usr
/dev/mapper/rootvg-homelv                       1014M   40M  975M
4% /home
/dev/sda1                                        496M  106M  390M
22% /boot
/dev/mapper/rootvg-varlv                         8.0G  958M  7.1G
12% /var
/dev/sda15                                       495M  5.9M  489M
2% /boot/efi
/dev/mapper/rootvg-tmplv                          12G  8.4G  3.7G
70% /tmp
tmpfs                                            1.6G     0  1.6G
0% /run/user/54321
172.30.136.68:/ora-02-u03                        250G  2.1G  248G
1% /u03
172.30.136.68:/ora-02-u01                        100G   10G   91G
10% /u01
172.30.136.68:/ora-02-u02                        250G  7.5G  243G
3% /u02
tmpfs                                            1.6G     0  1.6G
0% /run/user/1000
tmpfs                                            1.6G     0  1.6G
0% /run/user/0
172.30.136.68:/ora-01-u02-Clone-020624161543077  250G  8.2G  242G
```

```
4% /u02_ntap1dev

[oracle@ora-02 ~]$ cat /etc/oratab
#
# This file is used by ORACLE utilities.  It is created by root.sh
# and updated by either Database Configuration Assistant while
creating
# a database or ASM Configuration Assistant while creating ASM
instance.

# A colon, ':', is used as the field terminator.  A new line
terminates
# the entry.  Lines beginning with a pound sign, '#', are comments.
#
# Entries are of the form:
#   $ORACLE_SID:$ORACLE_HOME:<N|Y>:
#
# The first and second fields are the system identifier and home
# directory of the database respectively.  The third field indicates
# to the dbstart utility that the database should , "Y", or should
not,
# "N", be brought up at system boot time.
#
# Multiple entries with the same $ORACLE_SID are not allowed.
#
#
NTAP2:/u01/app/oracle/product/19.0.0/NTAP2:Y
# SnapCenter Plug-in for Oracle Database generated entry (DO NOT
REMOVE THIS LINE)
ntap1dev:/u01/app/oracle/product/19.0.0/NTAP2:N


[oracle@ora-02 ~]$ export ORACLE_SID=ntap1dev
[oracle@ora-02 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Tue Feb 6 16:29:02 2024
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, log_mode from v$database;

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
NTAP1DEV  READ WRITE           ARCHIVELOG


SQL> shutdown immediate;
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> startup mount;
ORACLE instance started.

Total System Global Area 3221223168 bytes
Fixed Size                  9168640 bytes
Variable Size             654311424 bytes
Database Buffers         2550136832 bytes
Redo Buffers                7606272 bytes
Database mounted.

SQL> alter database noarchivelog;

Database altered.

SQL> alter database open;

Database altered.

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

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
NTAP1DEV  READ WRITE           NOARCHIVELOG

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP1_PDB1                     MOUNTED
         4 NTAP1_PDB2                     MOUNTED
         5 NTAP1_PDB3                     MOUNTED

SQL> alter pluggable database all open;
```

Where to find additional information

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

- Azure NetApp Files

  https://azure.microsoft.com/en-us/products/netapp

- SnapCenter Software documentation

  https://docs.netapp.com/us-en/snapcenter/index.html

- TR-4987: Simplified, Automated Oracle Deployment on Azure NetApp Files with NFS

  Deployment Procedure

TR-4977: Oracle Database backup, restore and clone with SnapCenter Services - Azure

Allen Cao, Niyaz Mohamed, NetApp

This solution provides overview and details for Oracle database backup, restore, clone using NetApp SnapCenter SaaS using BlueXP console.

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 Azure NetApp Files. 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 on Azure NetApp Files volumes and Azure compute instances. It is very easy to setup data protection for Oracle database deployed on Azure NetApp Files with web based BlueXP user interface.

This solution addresses the following use cases:

- Database backup with snapshots for Oracle databases hosted in Azure NetApp Files and Azure VMs
- Oracle database recovery in the case of a failure
- Fast cloning of primary databases for dev, test environments or other use cases

Audience

This solution is intended for the following audiences:

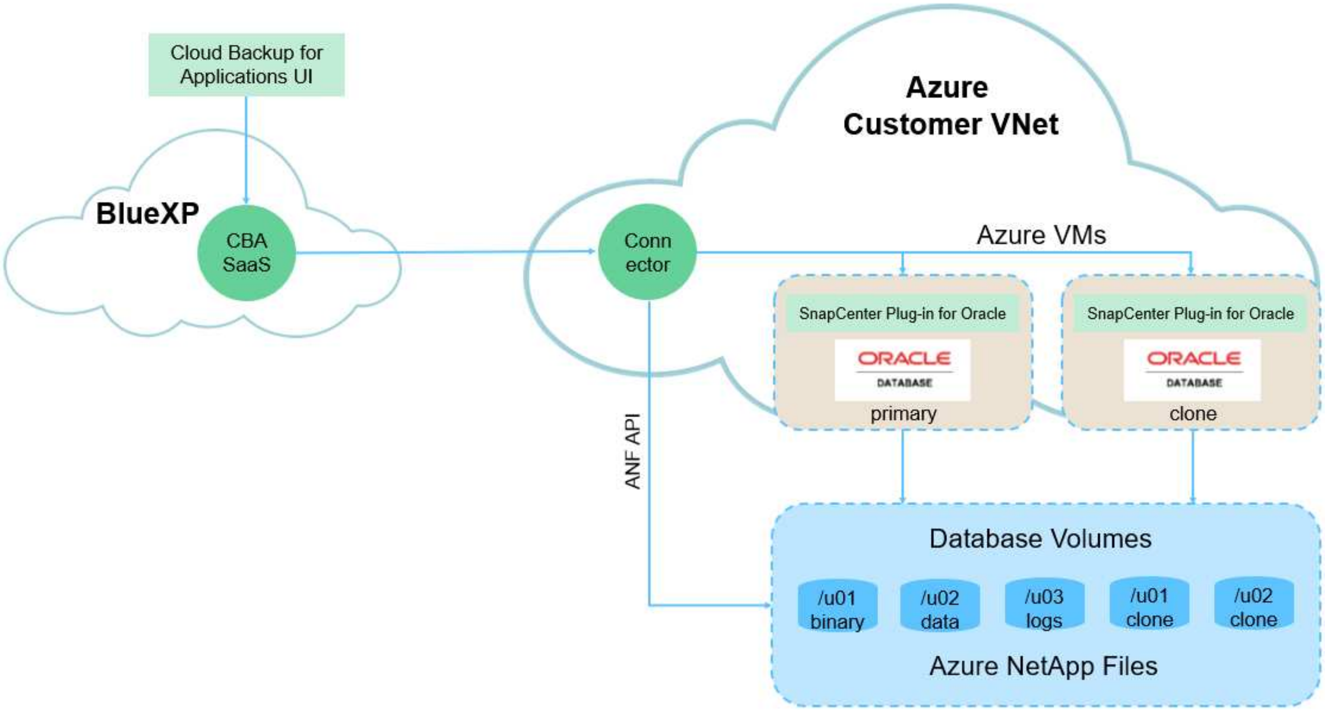
- The DBA who manages Oracle databases running on Azure NetApp Files storage
- The solution architect who is interested in testing Oracle database backup, restore, and clone in Azure
- The storage administrator who supports and manages the Azure NetApp Files storage
- The application owner who owns applications that are deployed to Azure NetApp Files storage and Azure

VMs

Solution test and validation environment

The testing and validation of this solution was performed in a lab 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 BlueXP backup and recovery for applications within the BlueXP console, including the UI, the connector, and the resources it manages.

Hardware and software components

Hardware

Azure NetApp Files storage	Premium Service level	Auto QoS type, and 4TB in storage capacity in testing
Azure instance for compute	Standard B4ms (4 vcpus, 16 GiB memory)	Two instances deployed, one as primary DB server and the other as clone DB server

Software

RedHat Linux	Red Hat Enterprise Linux 8.7 (LVM) - x64 Gen2	Deployed RedHat subscription for testing
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 v2.5.0-2822	Agent Version v2.5.0-2822

Key factors for deployment consideration

- **Connector to be deployed in the same virtual network / subnet as databases and Azure NetApp Files.** When possible, the connector should be deployed in the same Azure virtual networks and resource groups, which enables connectivity to the Azure NetApp Files storage and the Azure compute instances.
- **An Azure user account or Active Directory service principle created at Azure portal for SnapCenter connector.** Deploying a BlueXP Connector requires specific permissions to create and configure a virtual machine and other compute resources, to configure networking, and to get access to the Azure subscription. It also requires permissions to later create roles and permissions for the Connector to operate. Create a custom role in Azure with permissions and assign to the user account or service principle. Review the following link for details:Set up Azure permissions.
- **A ssh key pair created in the Azure resource group.** The ssh key pair is assigned to the Azure VM user for logging into the connector host and also the database VM host for deploying and executing a plug-in. BlueXP console UI uses the ssh key to deploy SnapCenter service plugin to database host for one-step plugin installation and application host database discovery.
- **A credential added to the BlueXP console setting.** To add Azure NetApp Files storage to the BlueXP working environment, a credential that grants permissions to access Azure NetApp Files from the BlueXP console needs to be set up in the BlueXP console setting.
- **java-11-openjdk installed on the Azure VM database instance host.** SnapCenter service installation requires java version 11. It needs to be installed on application host before plugin deployment attempt.

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 on an Azure NetApp Files storage and an Azure compute instance.

To get started, complete the following steps:

- Read the general instructions Protect your cloud native applications data and the sections related to Oracle and Azure NetApp Files.
- Watch the following video walkthrough

  Video of deployment of Oracle and ANF

Prerequisites for SnapCenter service deployment

Deployment requires the following prerequisites.

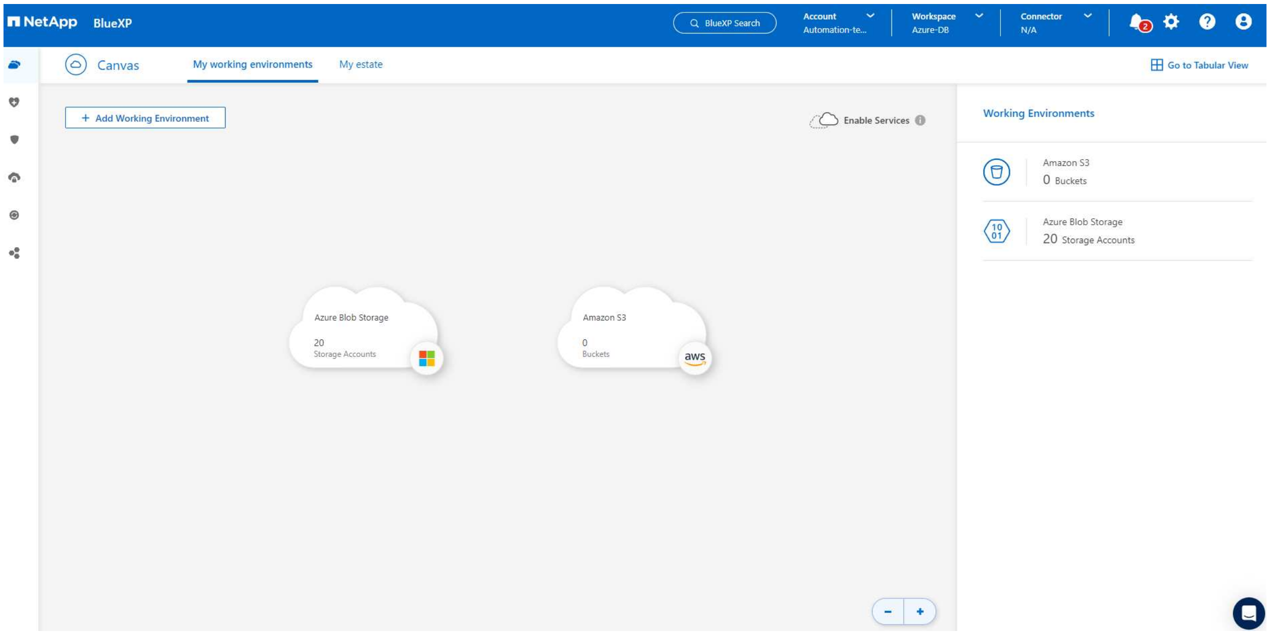
1. A primary Oracle database server on an Azure VM instance with an Oracle database fully deployed and running.
2. An Azure NetApp Files storage service capacity pool deployed in Azure that has capacity to meet the database storage needs listed in hardware component section.
3. A secondary database server on an Azure VM instance that can be used for testing the cloning of an Oracle database to an alternate 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. For additional information for Oracle database deployment on Azure NetApp Files and Azure compute instance, see Oracle Database Deployment and Protection on Azure NetApp Files.

Onboarding to BlueXP preparation

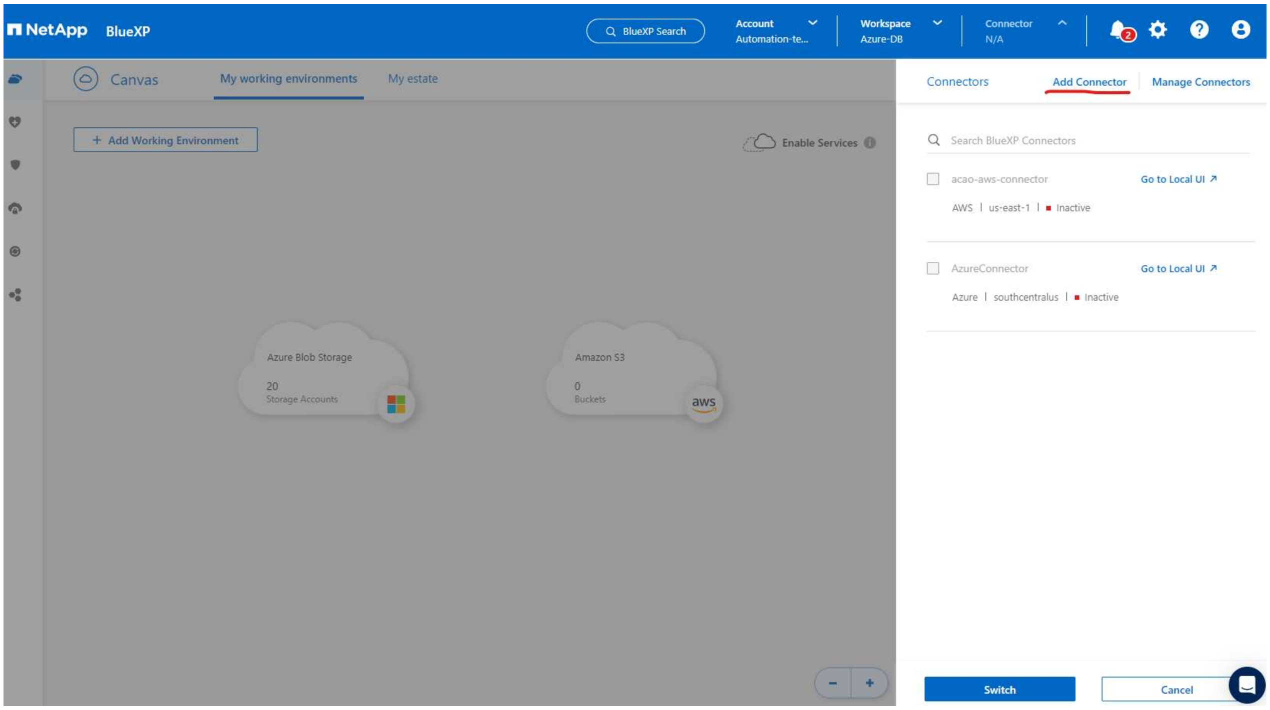
1. Use the link NetApp BlueXP to sign up for BlueXP console access.
2. Create an Azure user account or an Active Directory service principle and grant permissions with role in Azure portal for Azure connector deployment.
3. To set up BlueXP to manage Azure resources, add a BlueXP credential with details of an Active Directory service principal that BlueXP can use to authenticate with Azure Active Directory (App client ID), a client secret for the service principal application (Client Secret), and the Active Directory ID for your organization (Tenant ID).
4. You also need the Azure virtual network, resources group, security group, an SSH key for VM access, etc. ready for connector provisioning and database plugin installation.

Deploy a connector for SnapCenter services

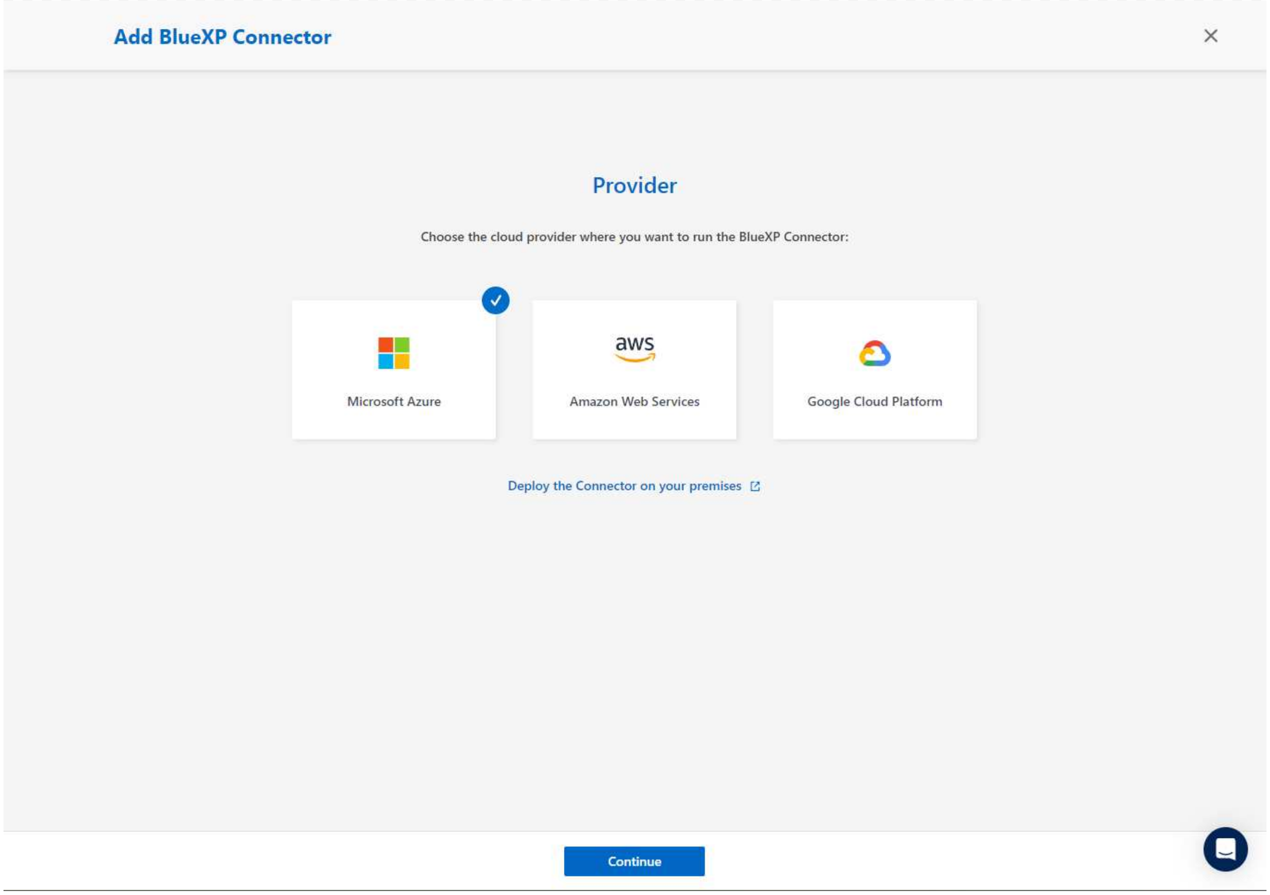
1. Login to the BlueXP console.



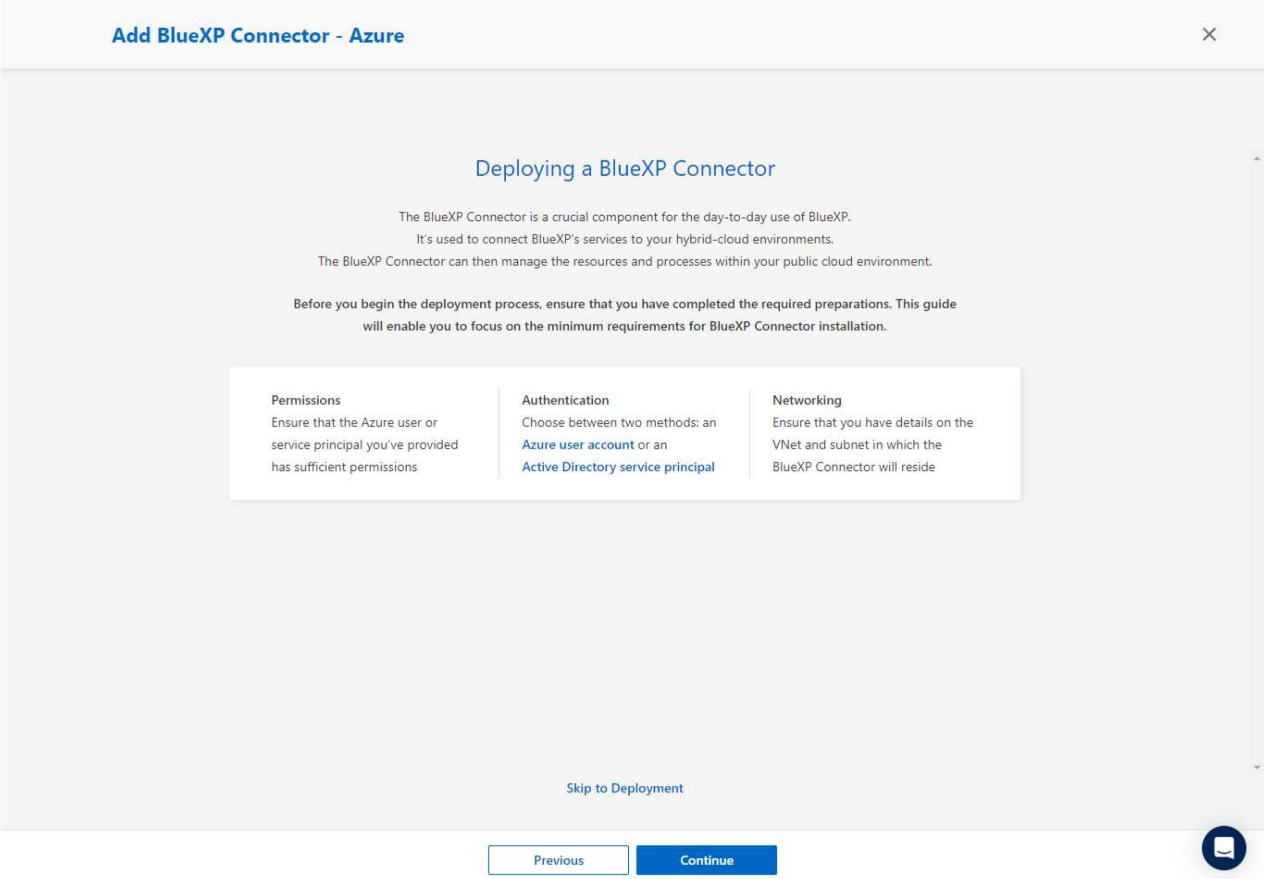
2. Click on **Connector** drop down arrow and **Add Connector** to launch the connector provisioning workflow.



3. Choose your cloud provider (in this case, **Microsoft Azure**).


Add BlueXP Connector
Provider
Choose the cloud provider where you want to run the BlueXP Connector:
Microsoft Azure
aws
Amazon Web Services
Google Cloud Platform
Deploy the Connector on your premises
Continue

4. Skip the **Permission**, **Authentication**, and **Networking** steps if you already have them set up in your Azure account. If not, you must configure these before proceeding. From here, you could also retrieve the permissions for the Azure policy that is referenced in the previous section "Onboarding to BlueXP preparation."



Add BlueXP Connector - Azure

Deploying a BlueXP Connector

The BlueXP Connector is a crucial component for the day-to-day use of BlueXP.
It's used to connect BlueXP's services to your hybrid-cloud environments.
The BlueXP Connector can then manage the resources and processes within your public cloud environment.

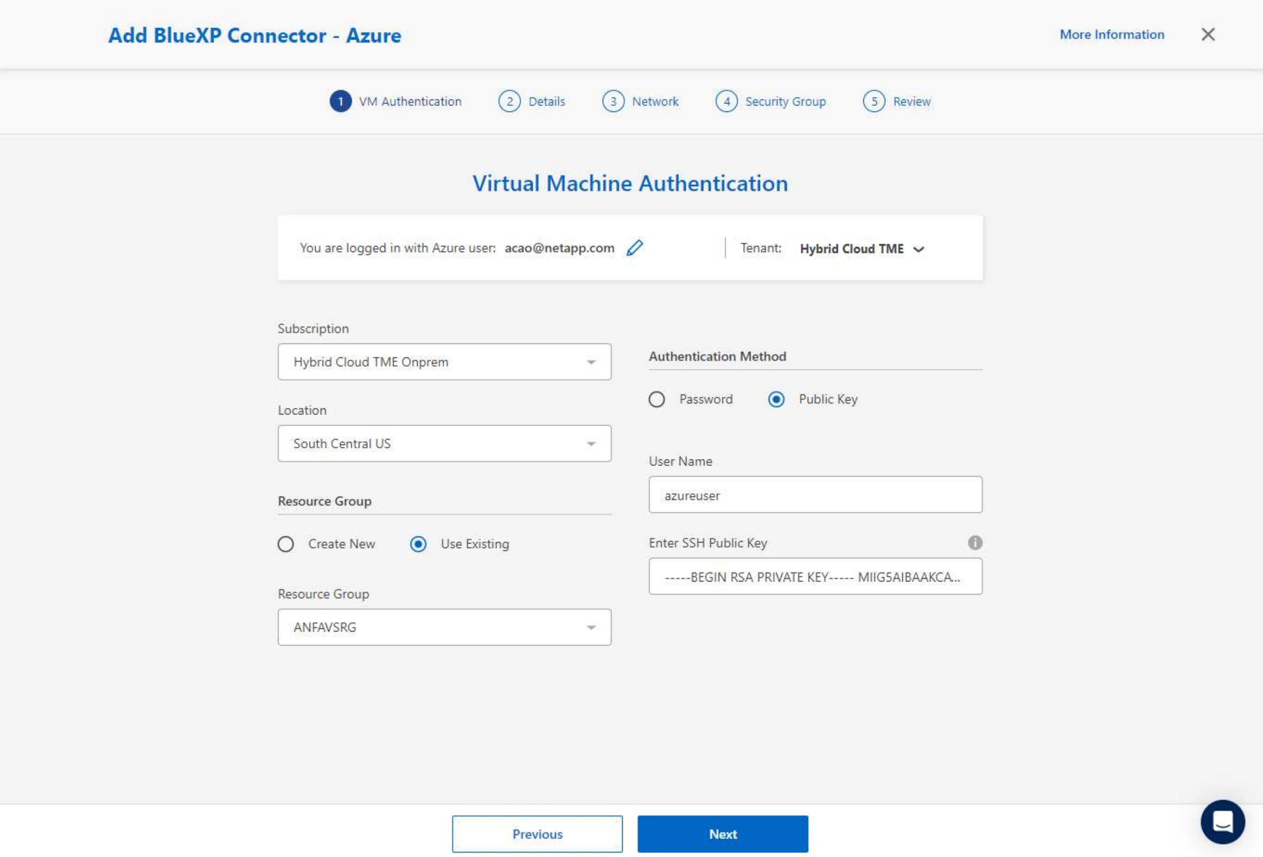
Before you begin the deployment process, ensure that you have completed the required preparations. This guide will enable you to focus on the minimum requirements for BlueXP Connector installation.

Permissions
Ensure that the Azure user or service principal you've provided has sufficient permissions

Authentication
Choose between two methods: an Azure user account or an Active Directory service principal

Networking
Ensure that you have details on the VNet and subnet in which the BlueXP Connector will reside

5. Click on **Skip to Deployment** to configure your connector **Virtual Machine Authentication**. Add the SSH key pair you have created in Azure resource group during onboarding to BlueXP preparation for connector OS authentication.



Virtual Machine Authentication

You are logged in with Azure user: acao@netapp.com | Tenant: Hybrid Cloud TME

Subscription: Hybrid Cloud TME Onprem

Location: South Central US

Resource Group: ○ Create New ● Use Existing

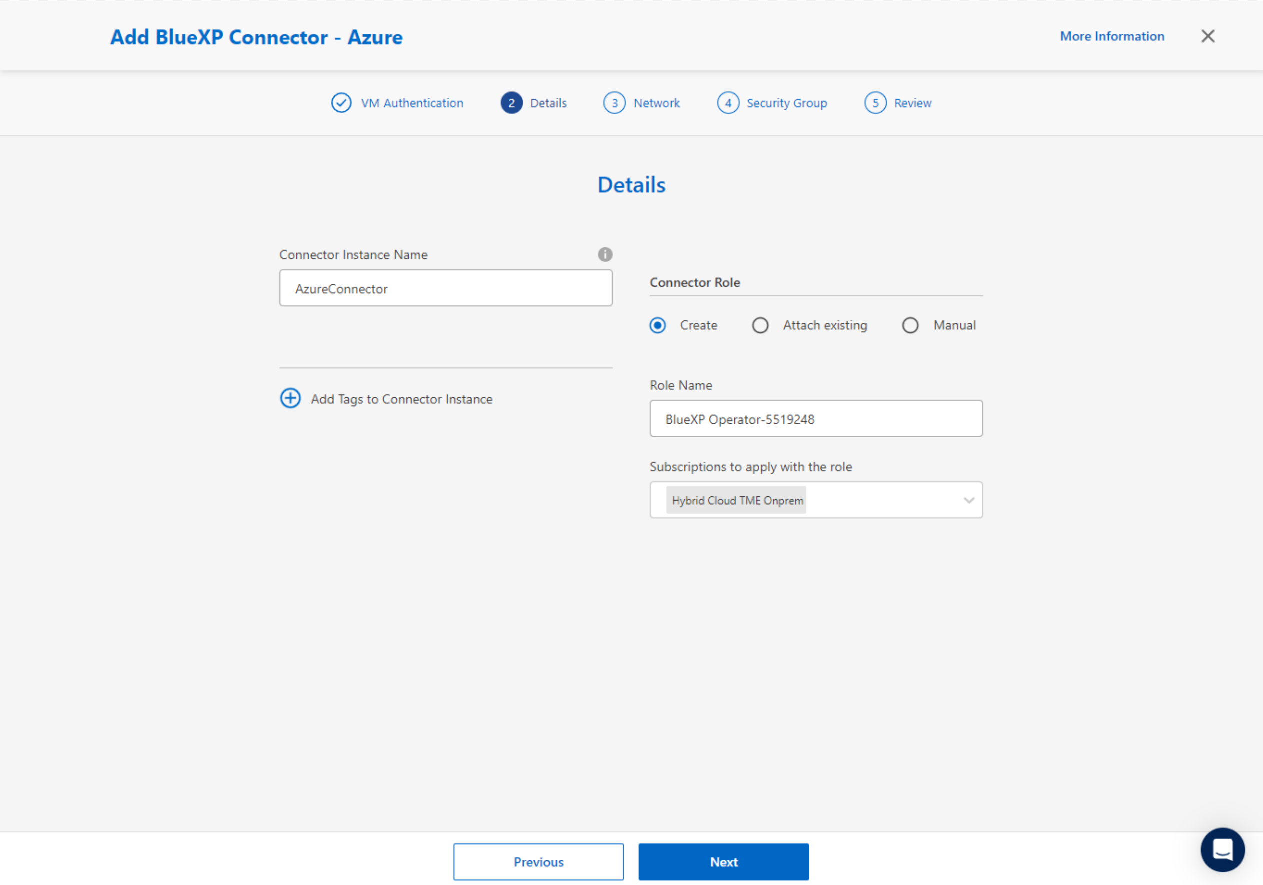
Resource Group: ANFAVSRG

Authentication Method: ○ Password ● Public Key

User Name: azureuser

Enter SSH Public Key: -----BEGIN RSA PRIVATE KEY----- MIIG5AIBAAKCA...

6. Provide a name for the connector instance, select **Create** and accept default **Role Name** under **Details**, and choose the subscription for the Azure account.



Details

Connector Instance Name: AzureConnector

Add Tags to Connector Instance

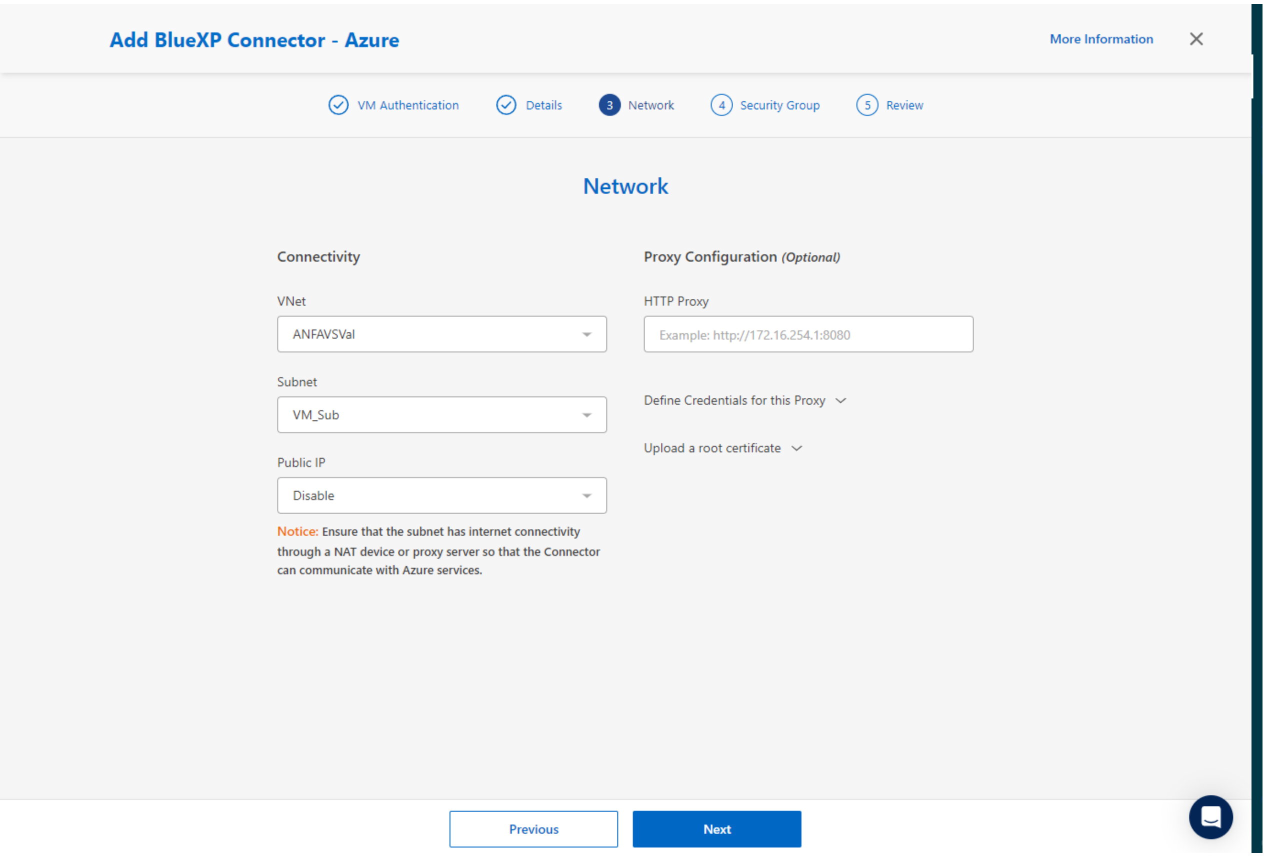
Connector Role

● Create ○ Attach existing ○ Manual

Role Name: BlueXP Operator-5519248

Subscriptions to apply with the role: Hybrid Cloud TME Onprem

7. Configure networking with the proper **VNet**, **Subnet**, and disable **Public IP** but ensure that the connector has the internet access in your Azure environment.



Network

Connectivity

VNet: ANFAVSVal

Subnet: VM_Sub

Public IP: Disable

Notice: Ensure that the subnet has internet connectivity through a NAT device or proxy server so that the Connector can communicate with Azure services.

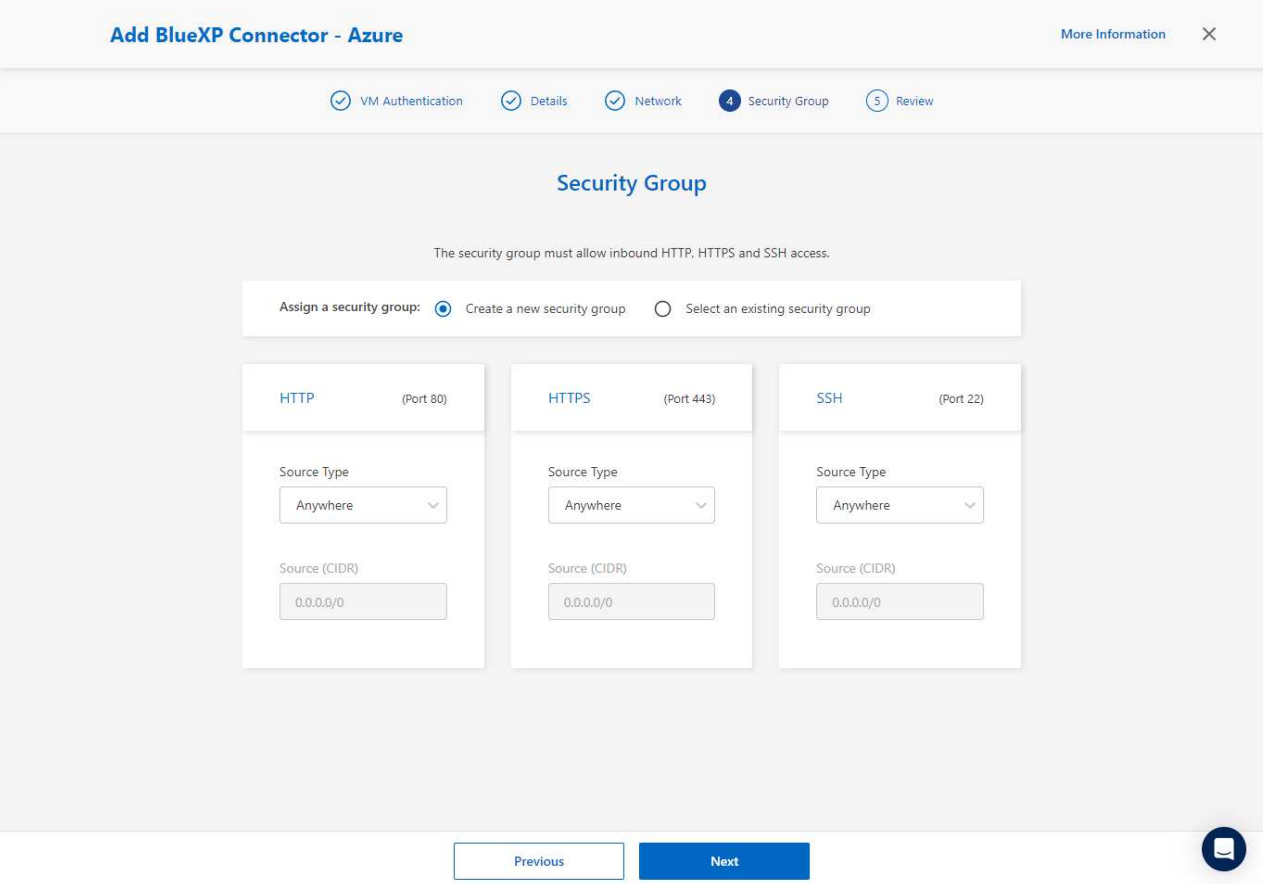
Proxy Configuration *(Optional)*

HTTP Proxy: Example: http://172.16.254.1:8080

Define Credentials for this Proxy

Upload a root certificate

8. Configure the **Security Group** for the connector that allows HTTP, HTTPS, and SSH access.

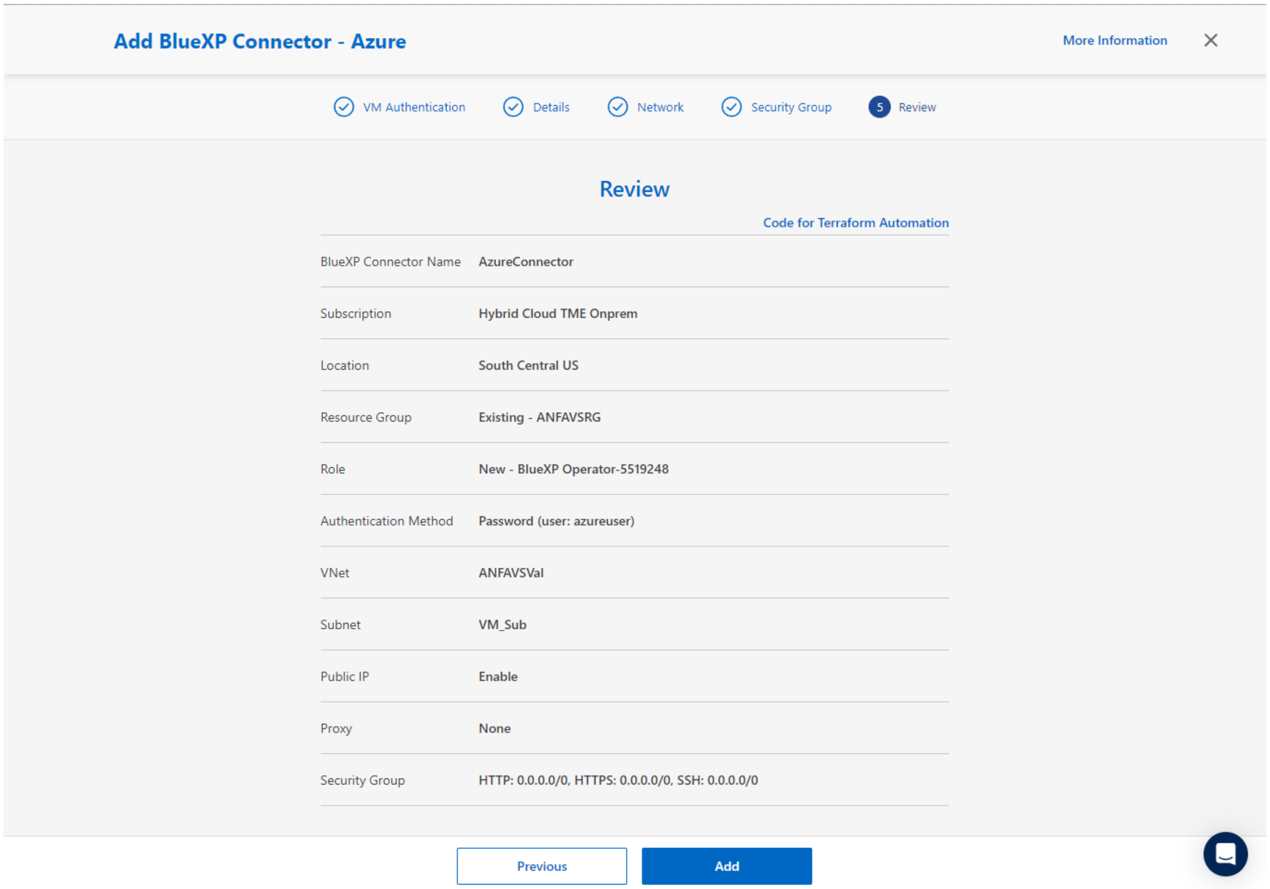


The security group must allow inbound HTTP, HTTPS and SSH access.

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

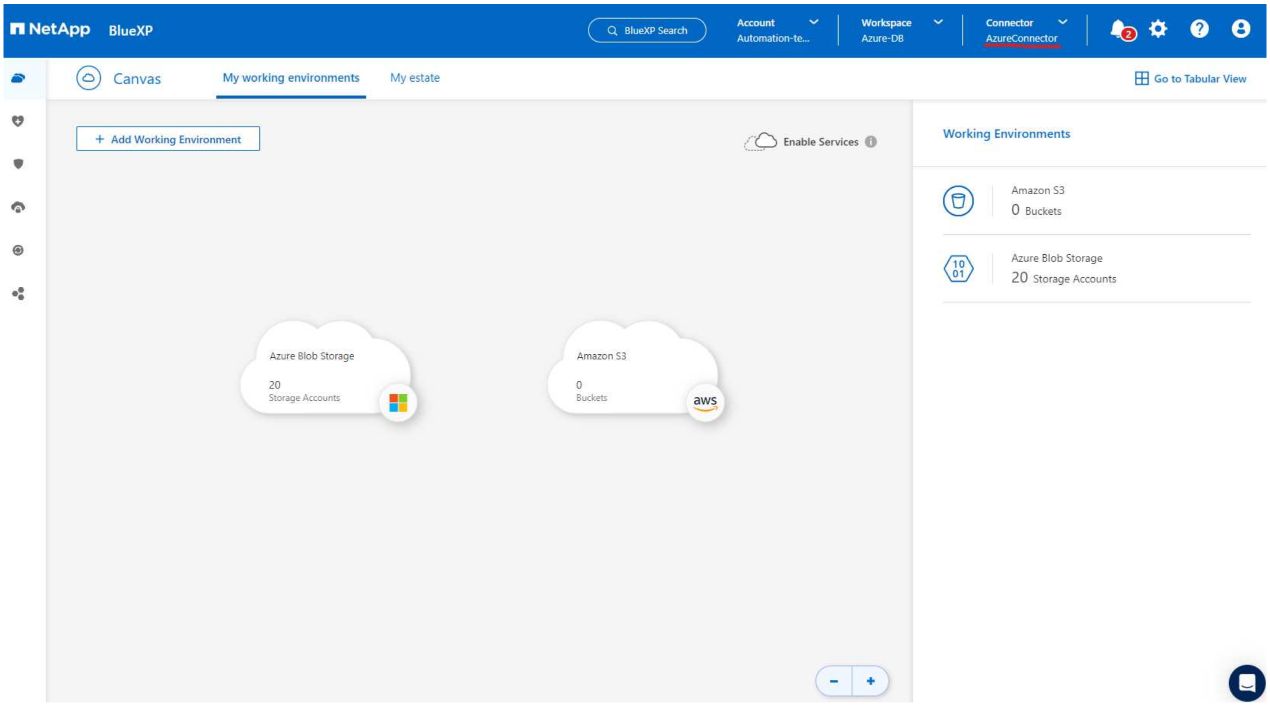
HTTP (Port 80)	HTTPS (Port 443)	SSH (Port 22)
Source Type: Anywhere	Source Type: Anywhere	Source Type: Anywhere
Source (CIDR): 0.0.0.0/0	Source (CIDR): 0.0.0.0/0	Source (CIDR): 0.0.0.0/0

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 VM appears in the Azure portal.



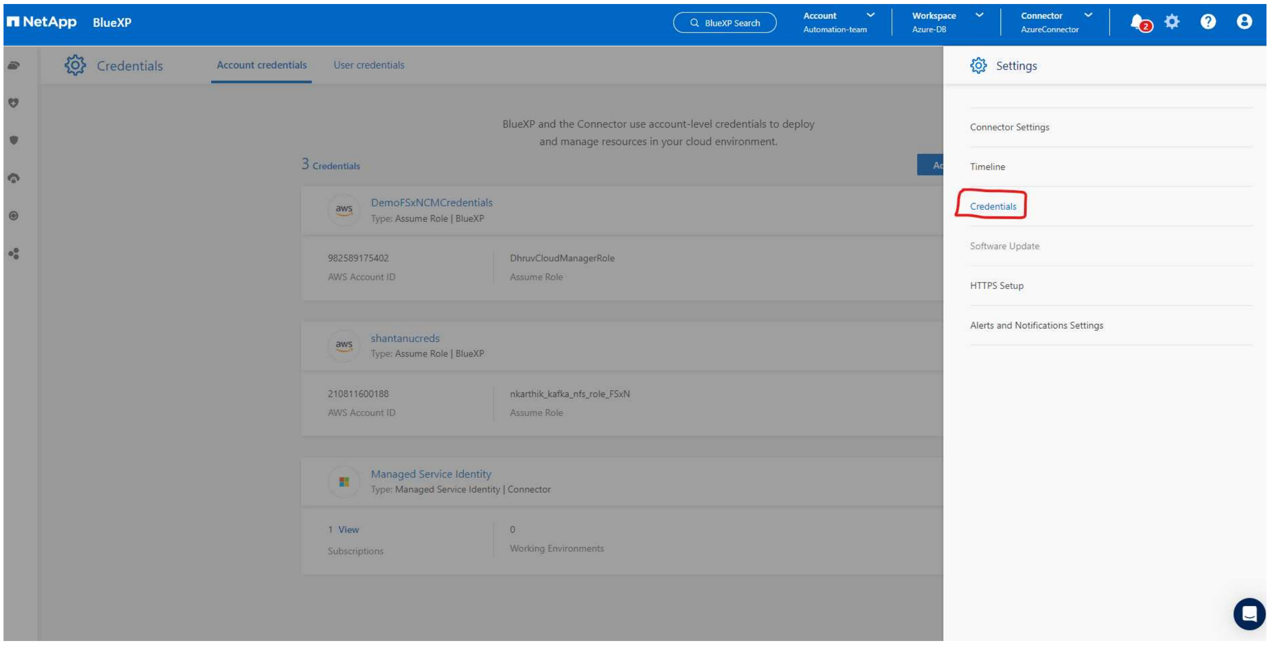
BlueXP Connector Name	AzureConnector
Subscription	Hybrid Cloud TME Onprem
Location	South Central US
Resource Group	Existing - ANFAVSRG
Role	New - BlueXP Operator-5519248
Authentication Method	Password (user: azureuser)
VNet	ANFAVSVal
Subnet	VM_Sub
Public IP	Enable
Proxy	None
Security Group	HTTP: 0.0.0.0/0, HTTPS: 0.0.0.0/0, SSH: 0.0.0.0/0

10. After the connector is deployed, the newly created connector appears under **Connector** drop-down.



Define a credential in BlueXP for Azure resources access

1. Click on setting icon on top right corner of BlueXP console to open **Account credentials** page, click **Add credentials** to start credential configuration workflow.



BlueXP and the Connector use account-level credentials to deploy and manage resources in your cloud environment.

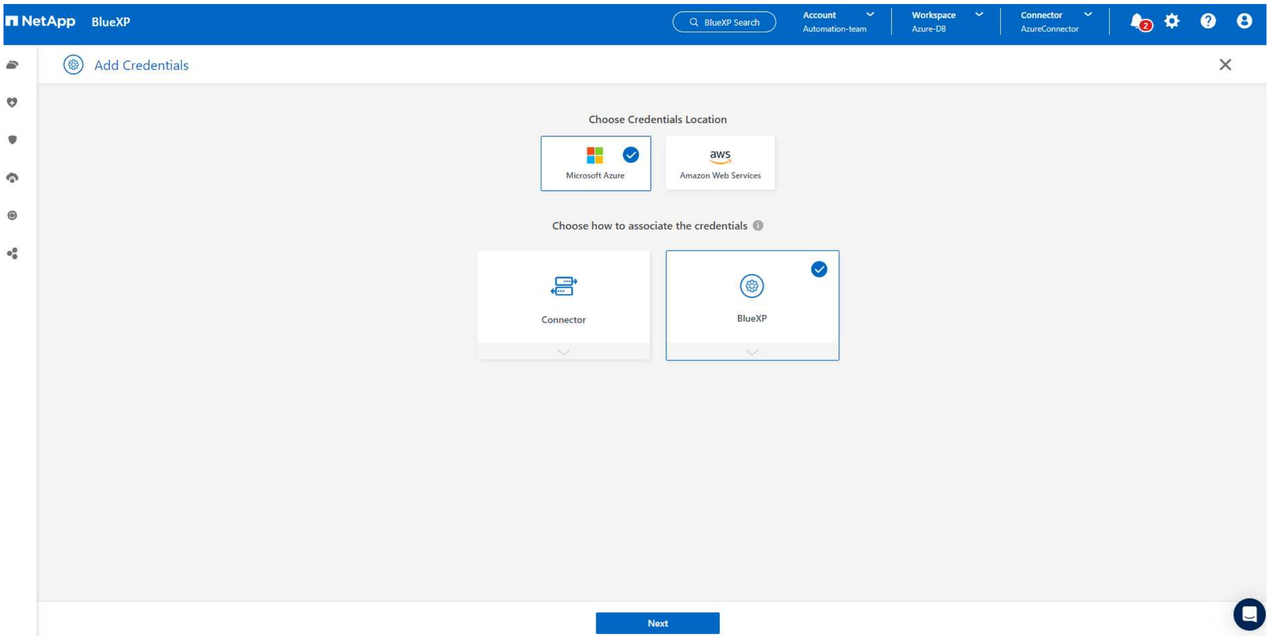
3 Credentials

DemoFSxNCMCredentials
Type: Assume Role | BlueXP
982589175402 AWS Account ID
DhruvCloudManagerRole Assume Role

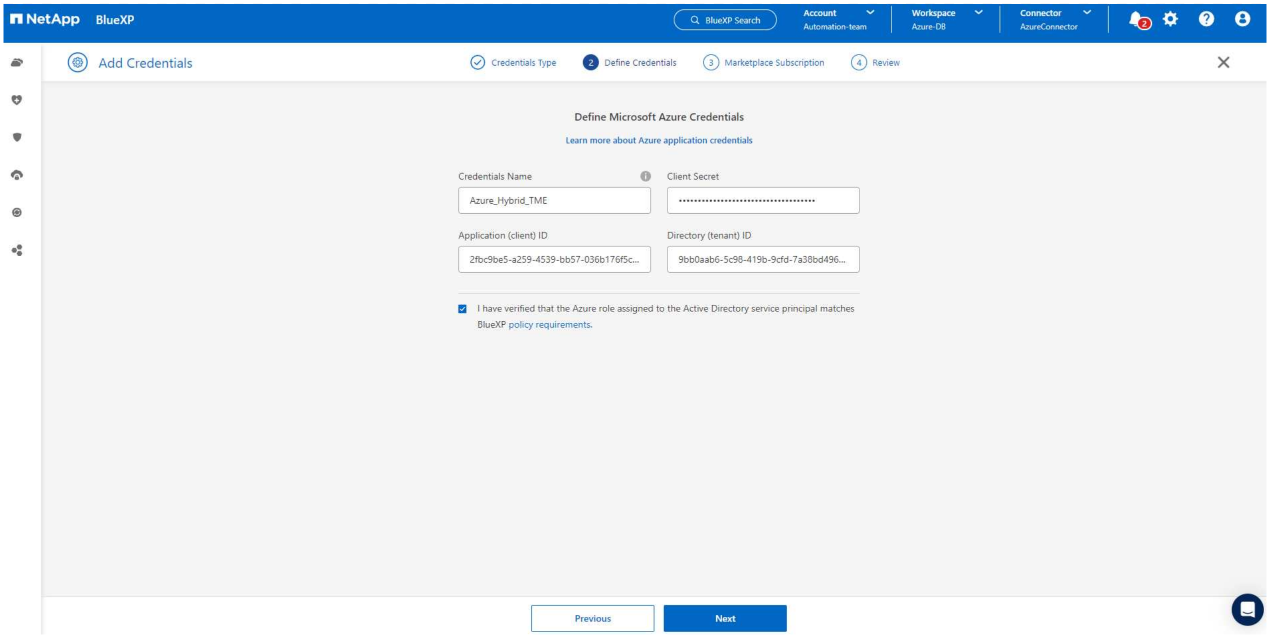
shantanucreds
Type: Assume Role | BlueXP
210811600188 AWS Account ID
nkarthik_kafka_nfs_role_FSxN Assume Role

Managed Service Identity
Type: Managed Service Identity | Connector
1 View Subscriptions
0 Working Environments

2. Choose credential location as - **Microsoft Azure - BlueXP**.



3. Define Azure credentials with proper **Client Secret**, **Client ID**, and **Tenant ID**, which should have been gathered during previous BlueXP onboarding process.



Define Microsoft Azure Credentials

Learn more about Azure application credentials

Credentials Name: Azure_Hybrid_TME

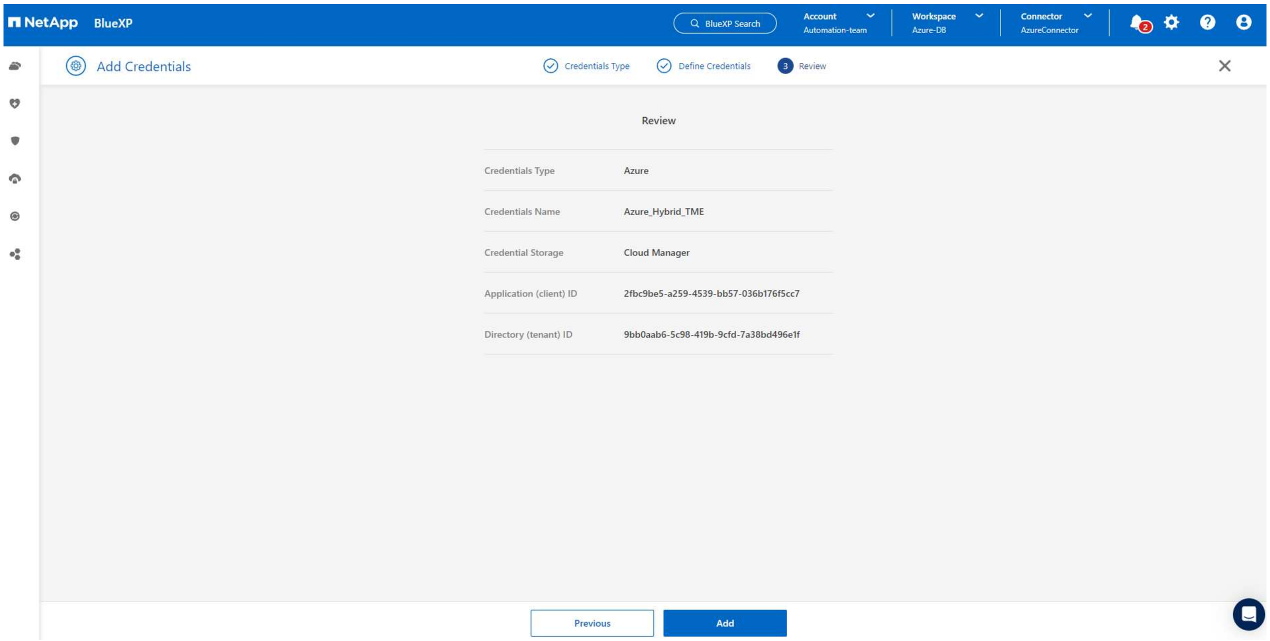
Client Secret: ••

Application (client) ID: 2fbc9be5-a259-4539-bb57-036b176f5c...

Directory (tenant) ID: 9bb0aab6-5c98-419b-9cfd-7a38bd496...

☑ I have verified that the Azure role assigned to the Active Directory service principal matches BlueXP policy requirements.

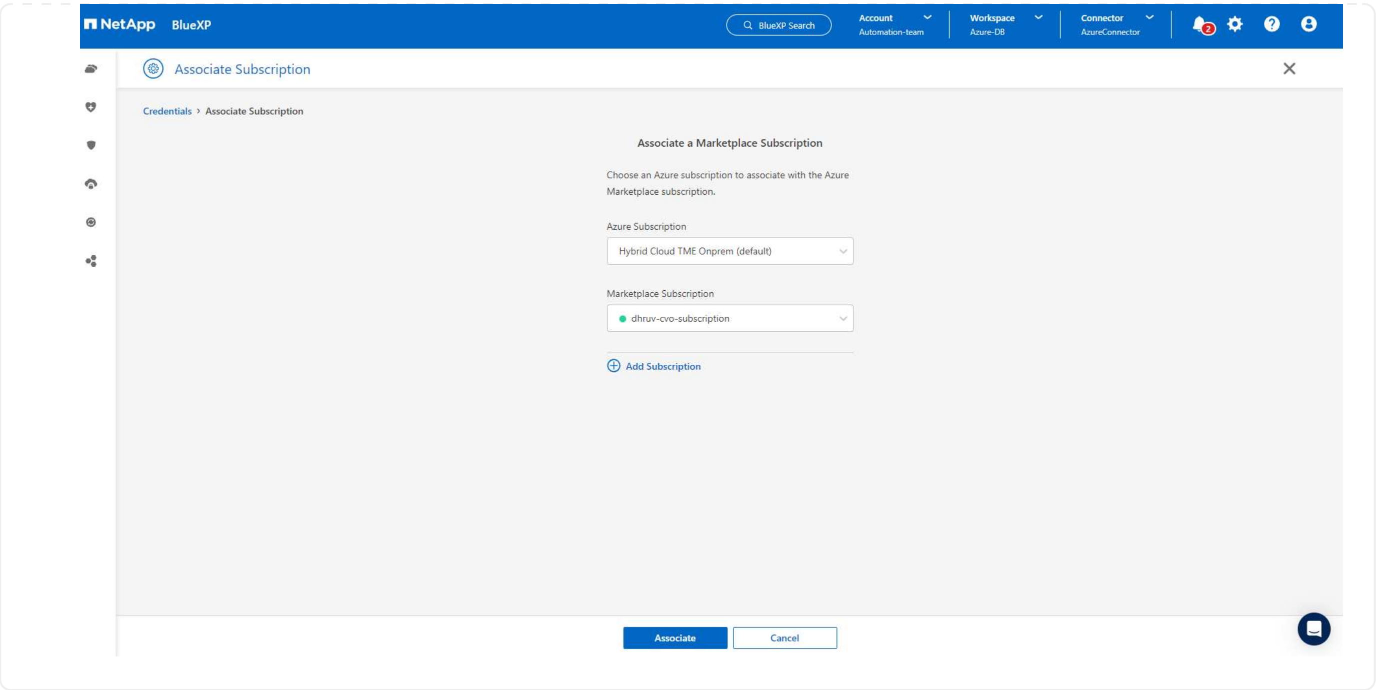
4. Review and **Add**.



Review

Credentials Type	Azure
Credentials Name	Azure_Hybrid_TME
Credential Storage	Cloud Manager
Application (client) ID	2fbc9be5-a259-4539-bb57-036b176f5cc7
Directory (tenant) ID	9bb0aab6-5c98-419b-9cfd-7a38bd496e1f

5. You may also need to associate a **Marketplace Subscription** with the credential.



Associate a Marketplace Subscription

Choose an Azure subscription to associate with the Azure Marketplace subscription.

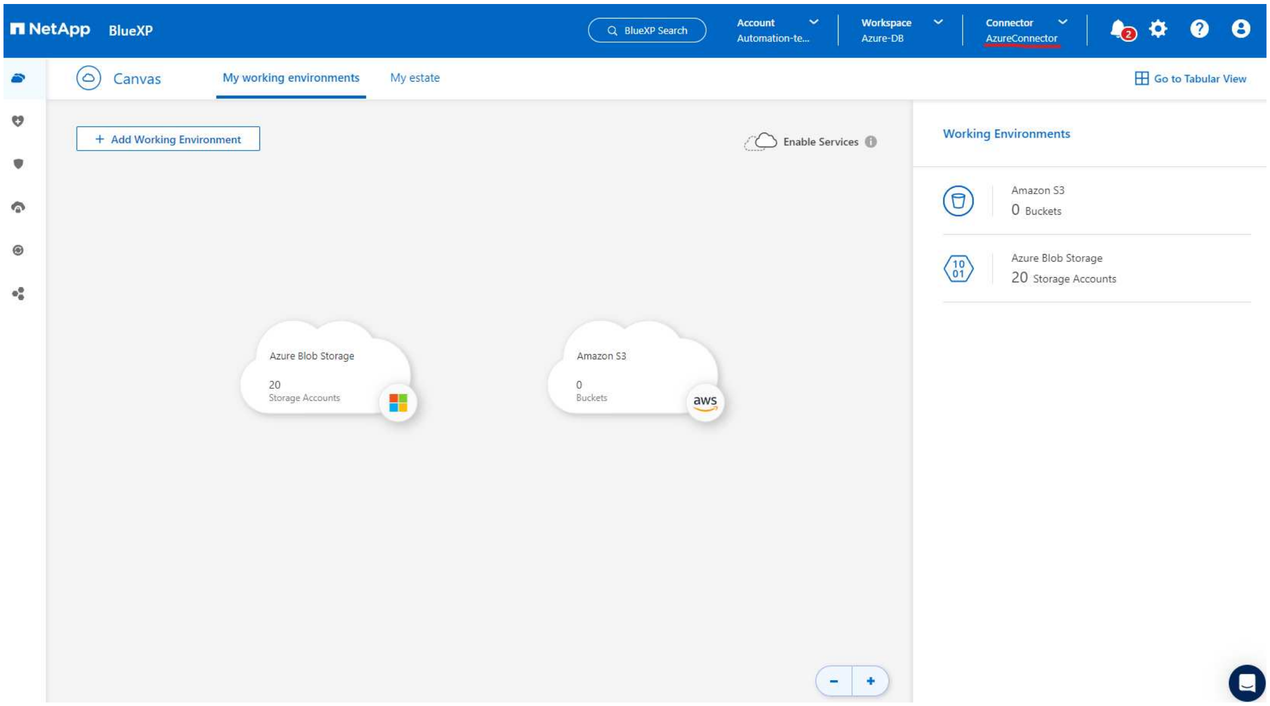
Azure Subscription: Hybrid Cloud TME Onprem (default)

Marketplace Subscription: dhruv-cvo-subscription

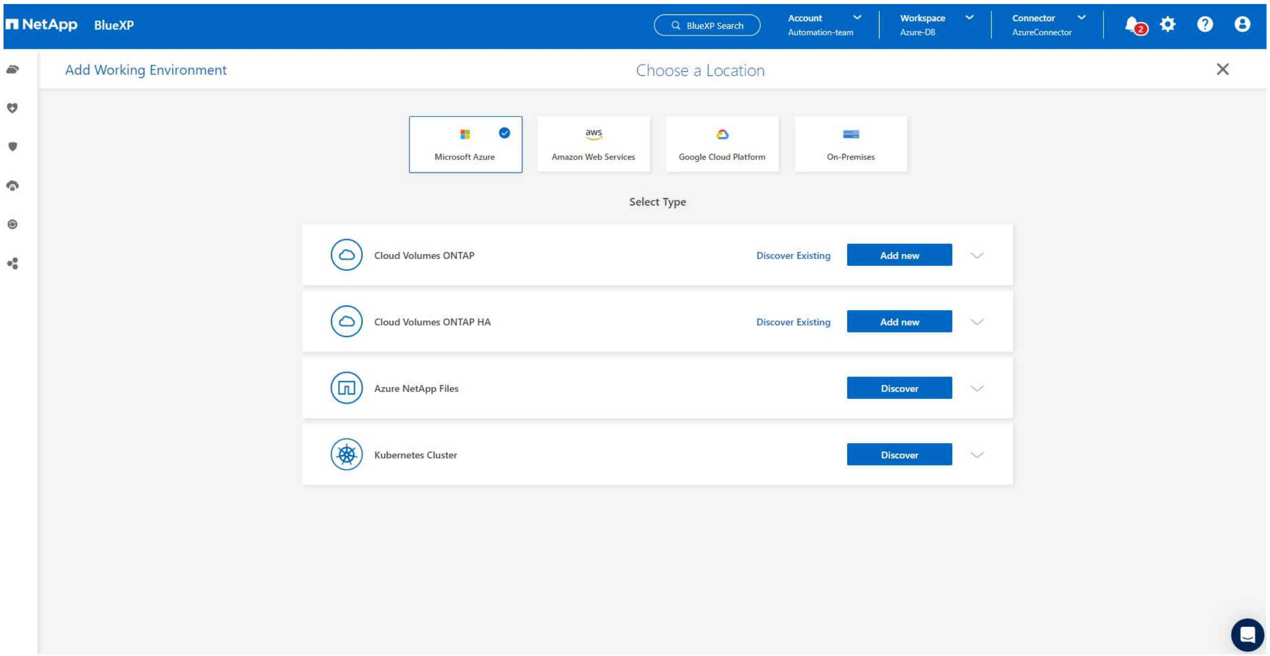
SnapCenter services setup

With the Azure credential configured, SnapCenter services can now be set up with the following procedures:

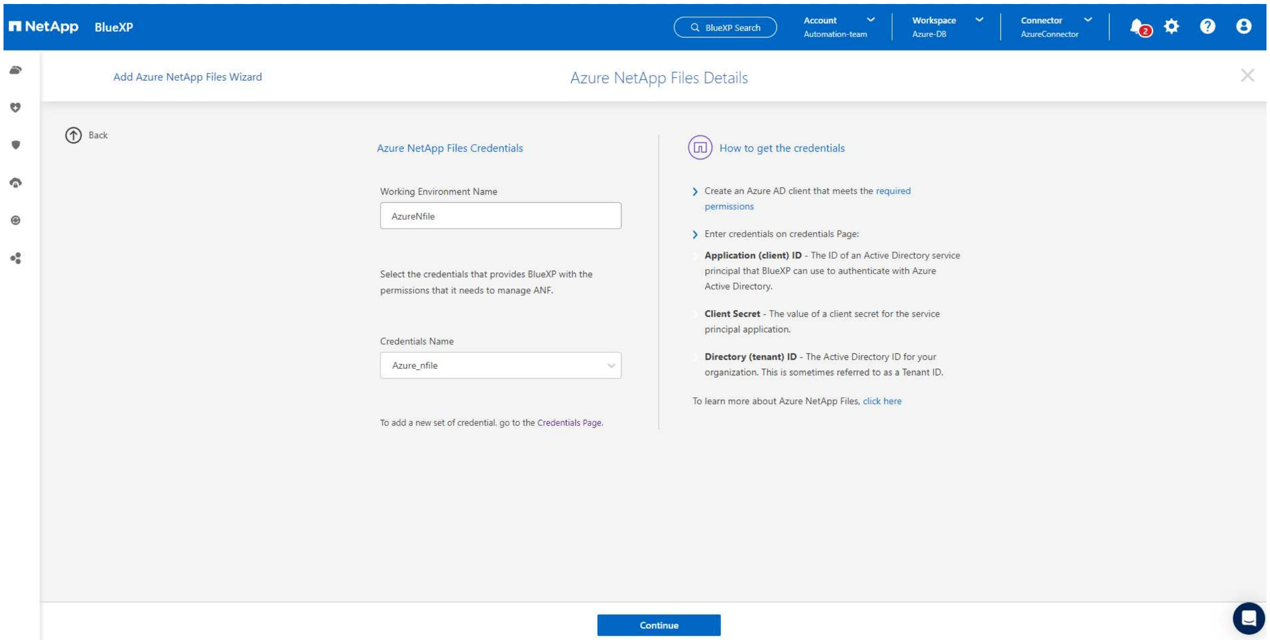
1. Back to Canvas page, from **My Working Environment** click **Add working Environment** to discover Azure NetApp Files deployed in Azure.



2. Choose **Microsoft Azure** as the location and click on **Discover**.



3. Name **Working Environment** and choose **Credential Name** created in previous section, and click **Continue**.



Azure NetApp Files Details

Azure NetApp Files Credentials

Working Environment Name: AzureNfile

Select the credentials that provides BlueXP with the permissions that it needs to manage ANF.

Credentials Name: Azure_nfile

To add a new set of credential. go to the Credentials Page.

How to get the credentials

- Create an Azure AD client that meets the required permissions
- Enter credentials on credentials Page:

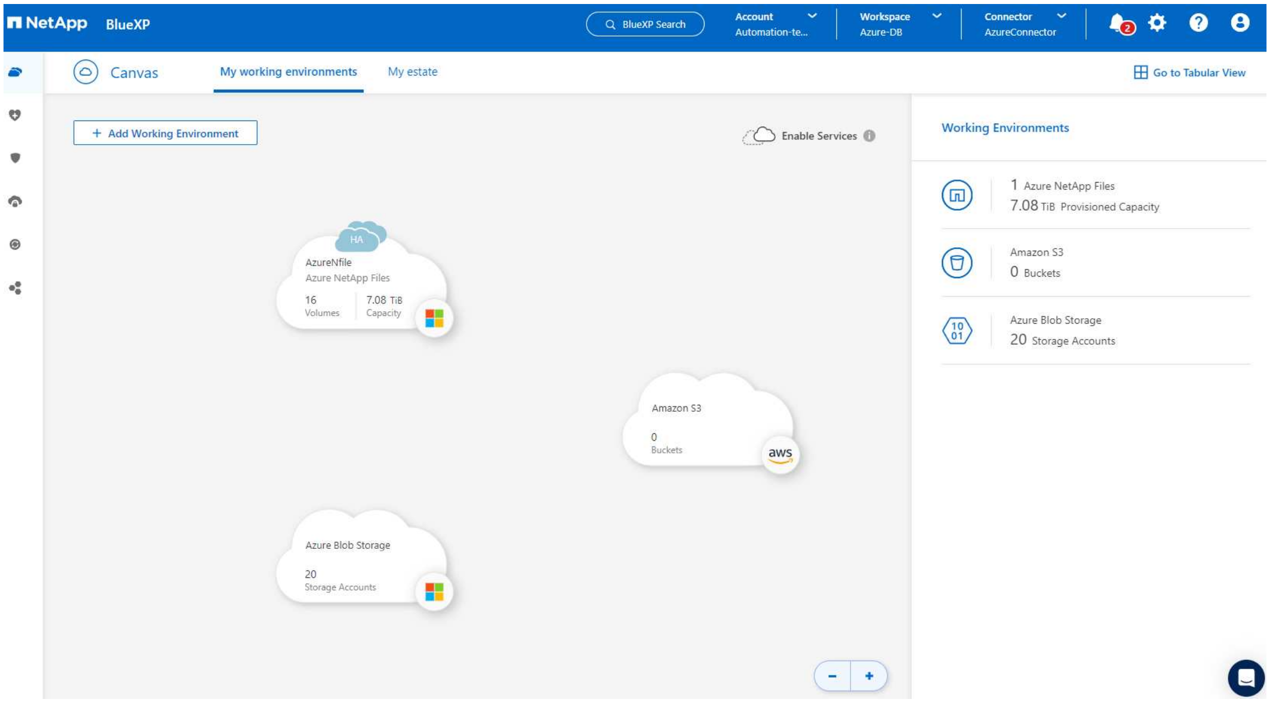
Application (client) ID - The ID of an Active Directory service principal that BlueXP can use to authenticate with Azure Active Directory.

Client Secret - The value of a client secret for the service principal application.

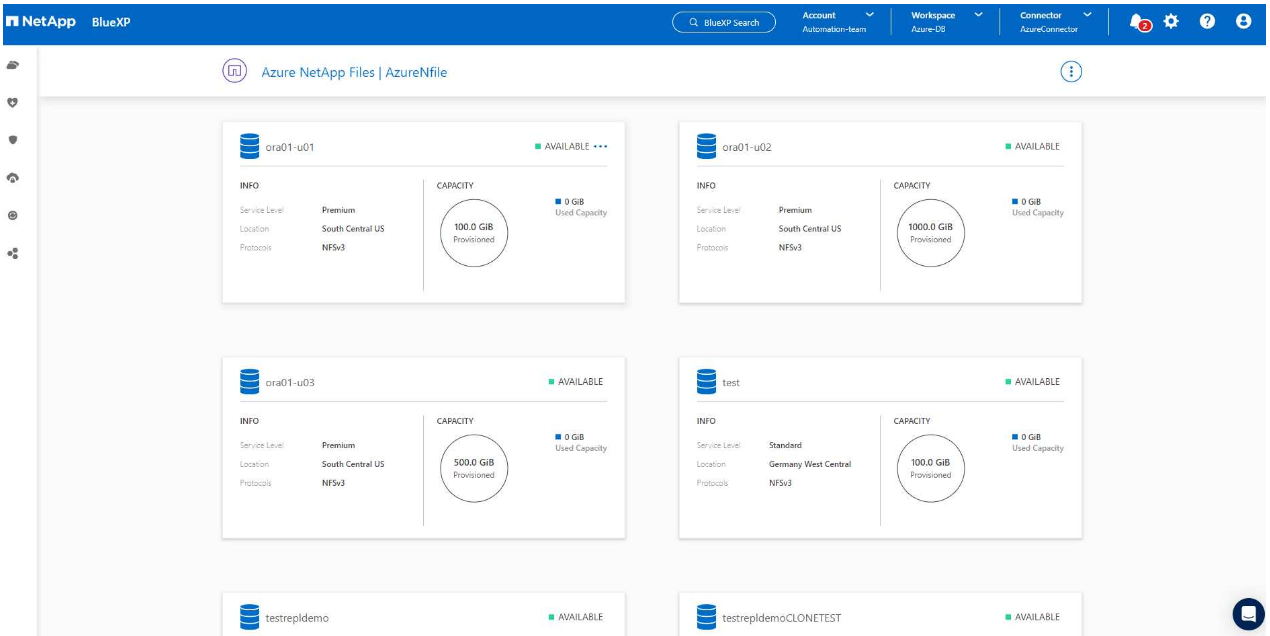
Directory (tenant) ID - The Active Directory ID for your organization. This is sometimes referred to as a Tenant ID.

To learn more about Azure NetApp Files, click here

4. BlueXP console returns to **My working environments** and discovered Azure NetApp Files from Azure now appears on **Canvas**.



5. Click on **Azure NetApp Files** icon, then **Enter Working Environment** to view Oracle database volumes deployed in Azure NetApp Files storage.



ora01-u01 AVAILABLE
INFO
Service Level Premium
Location South Central US
Protocols NFSv3
CAPACITY
100.0 GiB Provisioned
0 GiB Used Capacity

ora01-u02 AVAILABLE
INFO
Service Level Premium
Location South Central US
Protocols NFSv3
CAPACITY
1000.0 GiB Provisioned
0 GiB Used Capacity

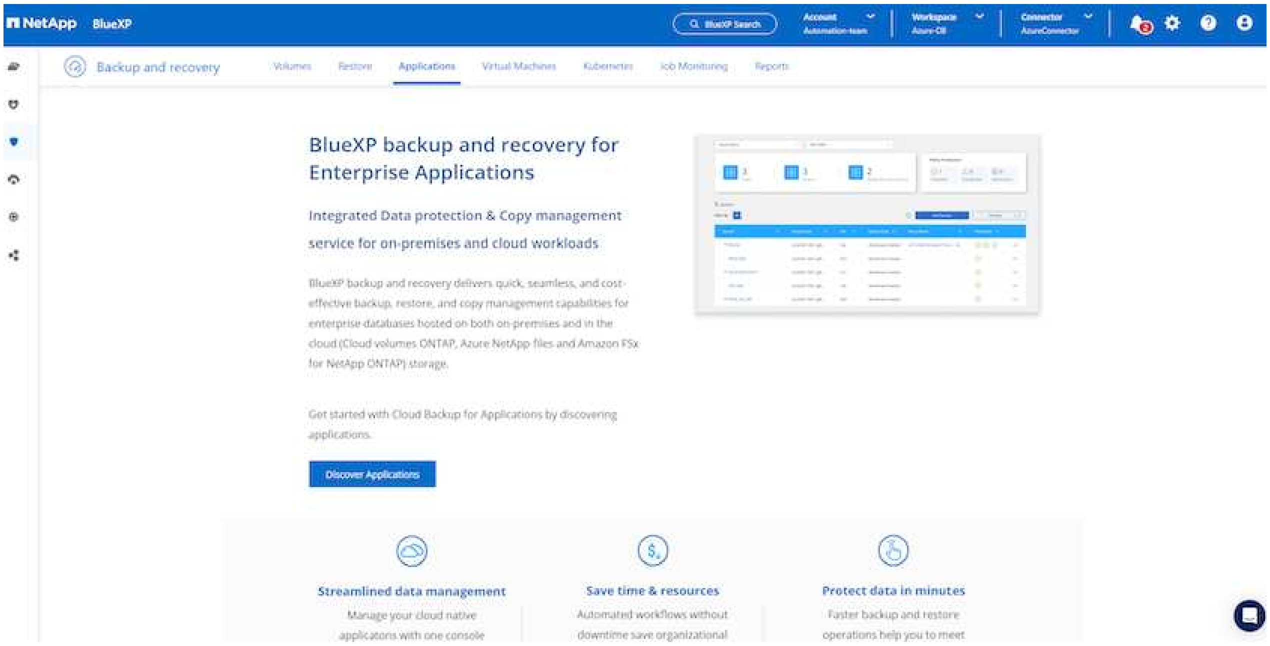
ora01-u03 AVAILABLE
INFO
Service Level Premium
Location South Central US
Protocols NFSv3
CAPACITY
500.0 GiB Provisioned
0 GiB Used Capacity

test AVAILABLE
INFO
Service Level Standard
Location Germany West Central
Protocols NFSv3
CAPACITY
100.0 GiB Provisioned
0 GiB Used Capacity

testrepldemo AVAILABLE

testrepldemoCLONETEST AVAILABLE

6. 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**.



BlueXP backup and recovery for Enterprise Applications

Integrated Data protection & Copy management service for on-premises and cloud workloads

BlueXP backup and recovery delivers quick, seamless, and cost-effective backup, restore, and copy management capabilities for enterprise databases hosted on both on-premises and in the cloud (Cloud volumes ONTAP, Azure NetApp files and Amazon FSx for NetApp ONTAP) storage.

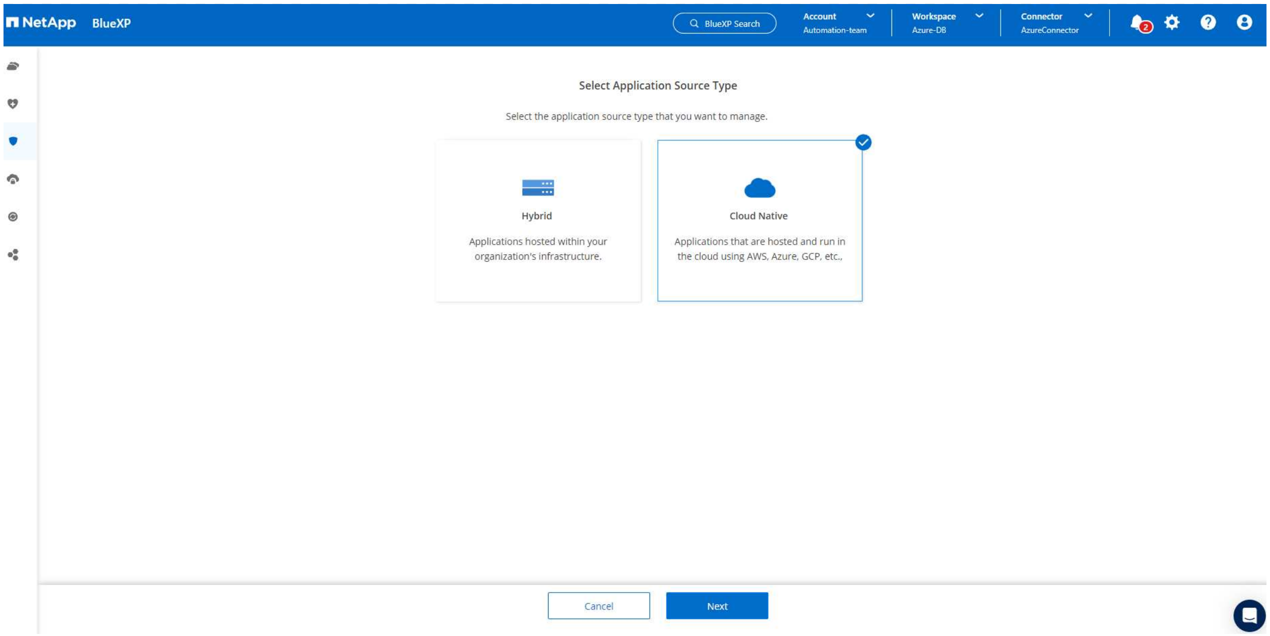
Get started with Cloud Backup for Applications by discovering applications.

Streamlined data management
Manage your cloud native applicatons with one console

Save time & resources
Automated workflows without downtime save organizational

Protect data in minutes
Faster backup and restore operations help you to meet

7. Select **Cloud Native** as the application source type.



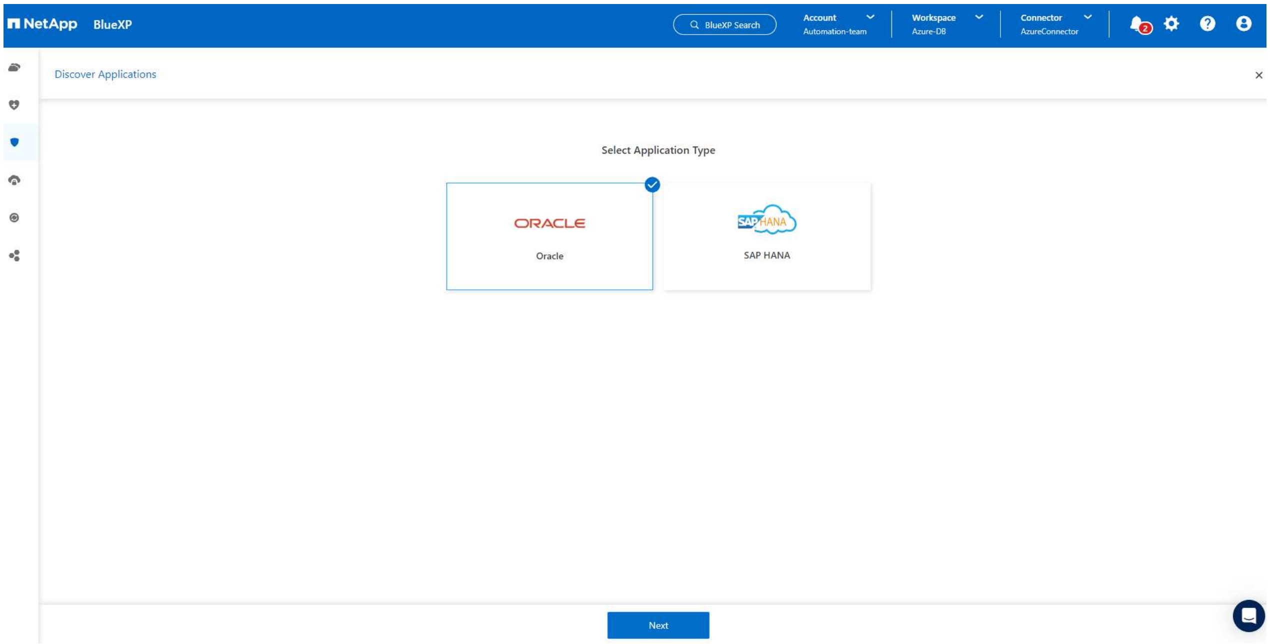
Select Application Source Type

Select the application source type that you want to manage.

Hybrid: Applications hosted within your organization's infrastructure.

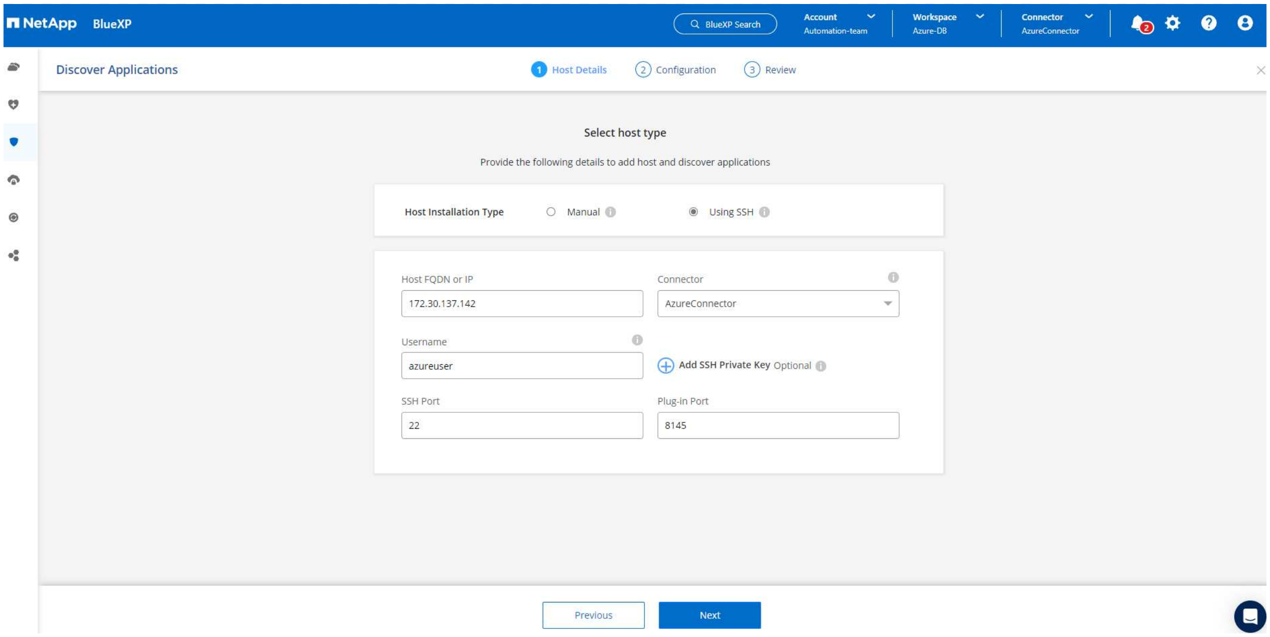
Cloud Native: Applications that are hosted and run in the cloud using AWS, Azure, GCP, etc.,

8. Choose **Oracle** for the application type, click on **Next** to open host details page.



Select Application Type

9. Select **Using SSH** and provide the Oracle Azure VM details such as **IP address**, **Connector**, Azure VM management **Username** such as azureuser. Click on **Add SSH Private Key** to paste in the SSH key pair that you used to deploy the Oracle Azure VM. You will also be prompted to confirm the fingerprint.



Select host type

Provide the following details to add host and discover applications

Host Installation Type ○ Manual ● Using SSH

Host FQDN or IP: 172.30.137.142

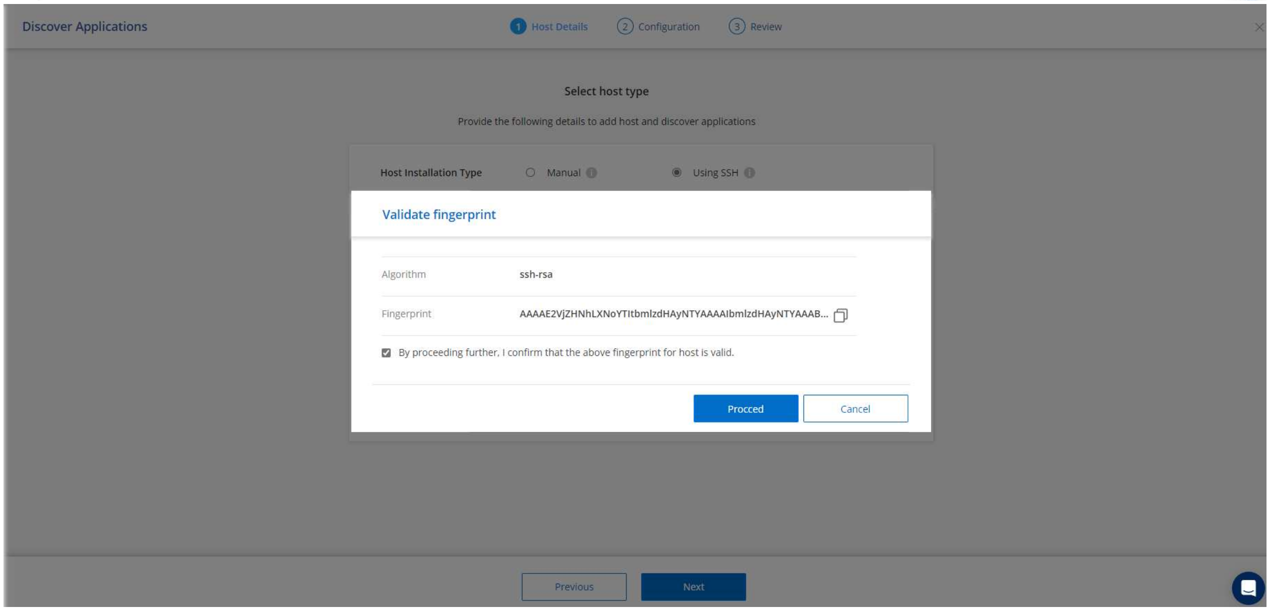
Connector: AzureConnector

Username: azureuser

Add SSH Private Key Optional

SSH Port: 22

Plug-in Port: 8145



Select host type

Provide the following details to add host and discover applications

Host Installation Type ○ Manual ● Using SSH

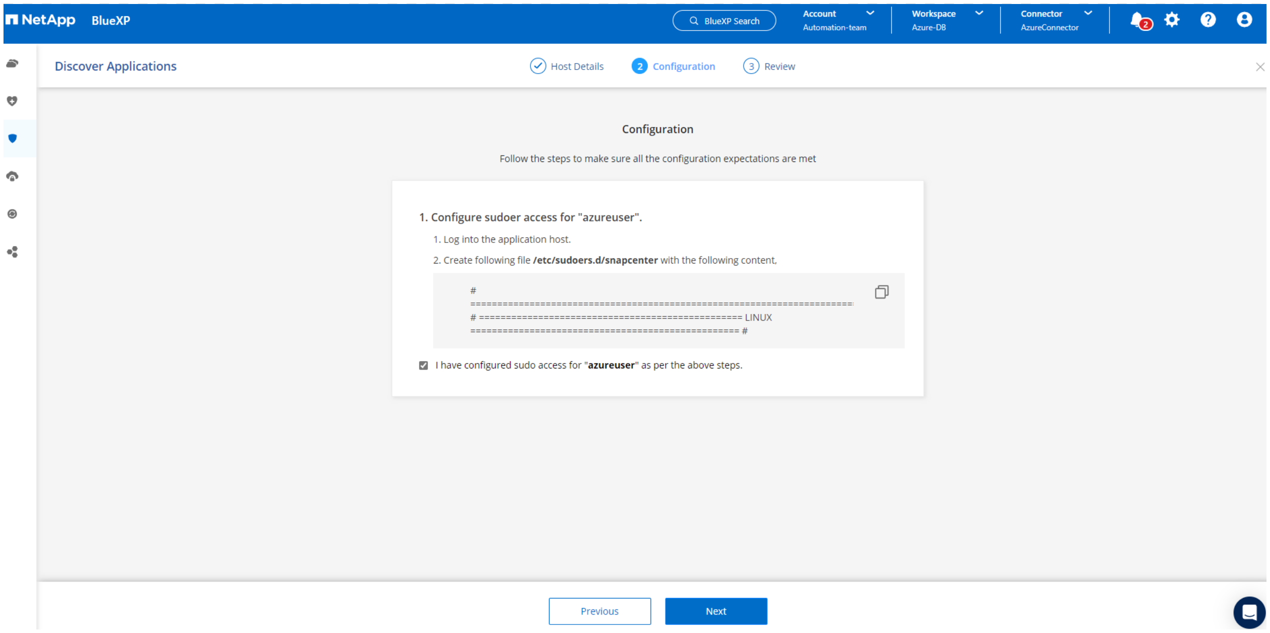
Validate fingerprint

Algorithm: ssh-rsa

Fingerprint: AAAAE2VjZHNhLXNoYTItbmlzdHAyNTYAAAAIbmlzdHAyNTYAAAB...

☑ By proceeding further, I confirm that the above fingerprint for host is valid.

10. Move on to next **Configuration** page to setup sudoer access on Oracle Azure VM.



Configuration

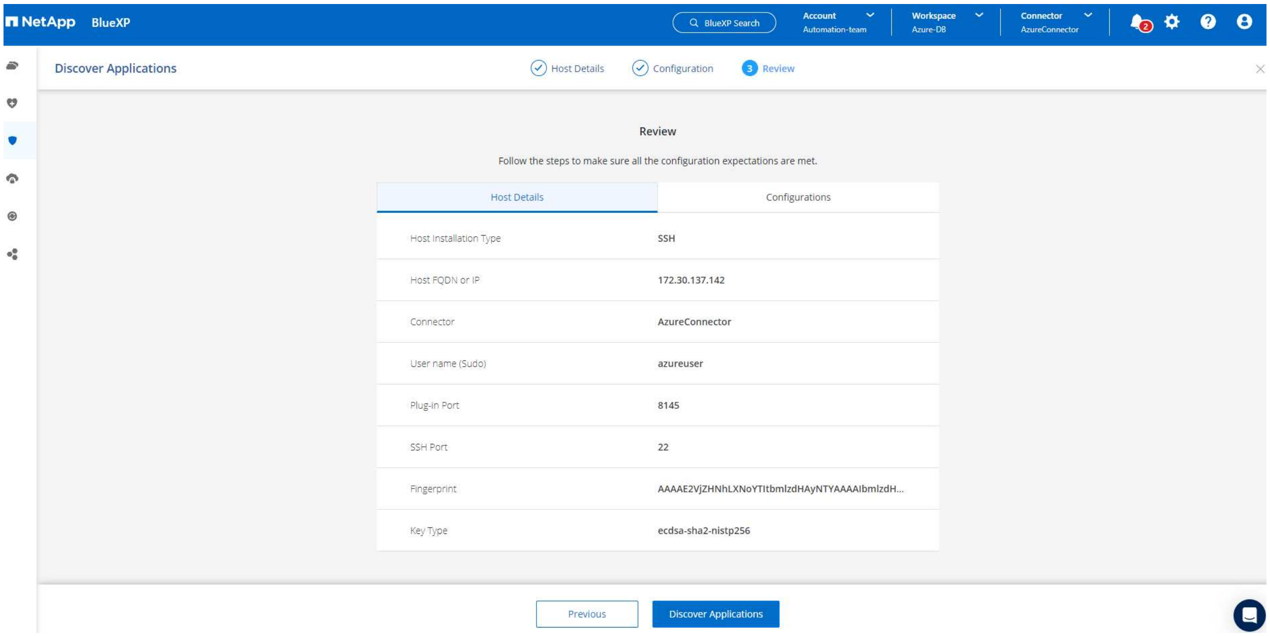
Follow the steps to make sure all the configuration expectations are met

1. Configure sudoer access for "azureuser".
   1. Log into the application host.
   2. Create following file **/etc/sudoers.d/snapcenter** with the following content,

```
#
=========================================================================
# =================================================== LINUX
=================================================== #
```

☑ I have configured sudo access for "**azureuser**" as per the above steps.

11. Review and click on **Discover Applications** to install a plugin on the Oracle Azure VM and discover Oracle database on the VM in one step.

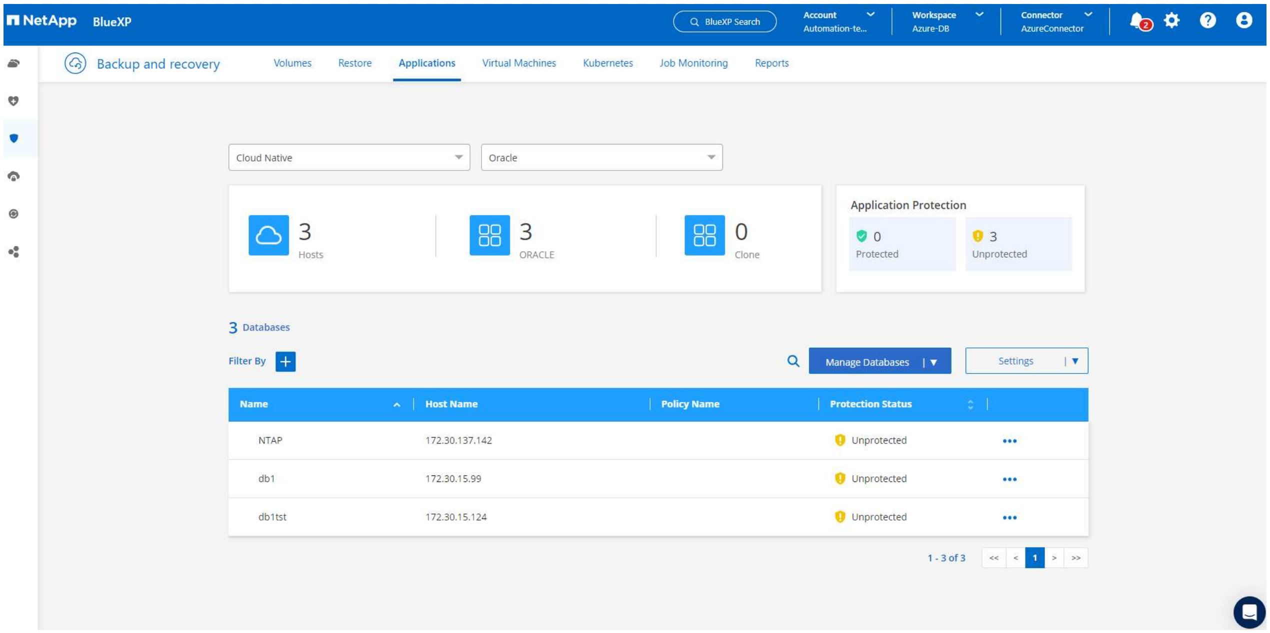


Review

Follow the steps to make sure all the configuration expectations are met.

Host Installation Type	SSH
Host FQDN or IP	172.30.137.142
Connector	AzureConnector
User name (Sudo)	azureuser
Plug-in Port	8145
SSH Port	22
Fingerprint	AAAAE2VjZHNhLXNoYTItbmlzdHAyNTYAAAAIbmlzdH...
Key Type	ecdsa-sha2-nistp256

12. Discovered Oracle databases on Azure VM are added to **Applications**, and the **Applications** page lists the number of hosts and Oracle databases within the environment. The database **Protection Status** initially shows as **Unprotected**.



Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142		Unprotected
db1	172.30.15.99		Unprotected
db1tst	172.30.15.124		Unprotected

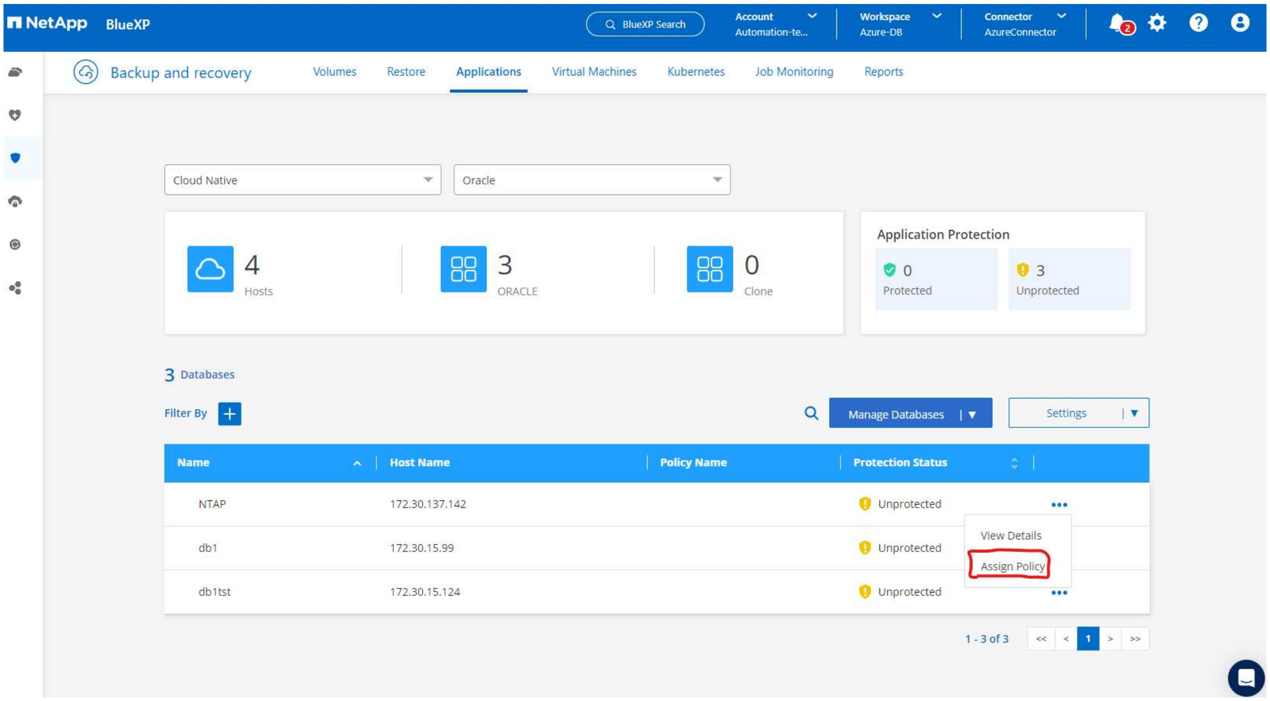
This completes the initial setup of SnapCenter services for Oracle. The next three sections of this document describe Oracle database backup, restore, and clone operations.

Oracle database backup

1. Our test Oracle database in Azure VM is configured with three volumes with an aggregate total storage about 1.6 TiB. This gives context about the timing for the snapshot backup, restore, and clone of a database of this size.

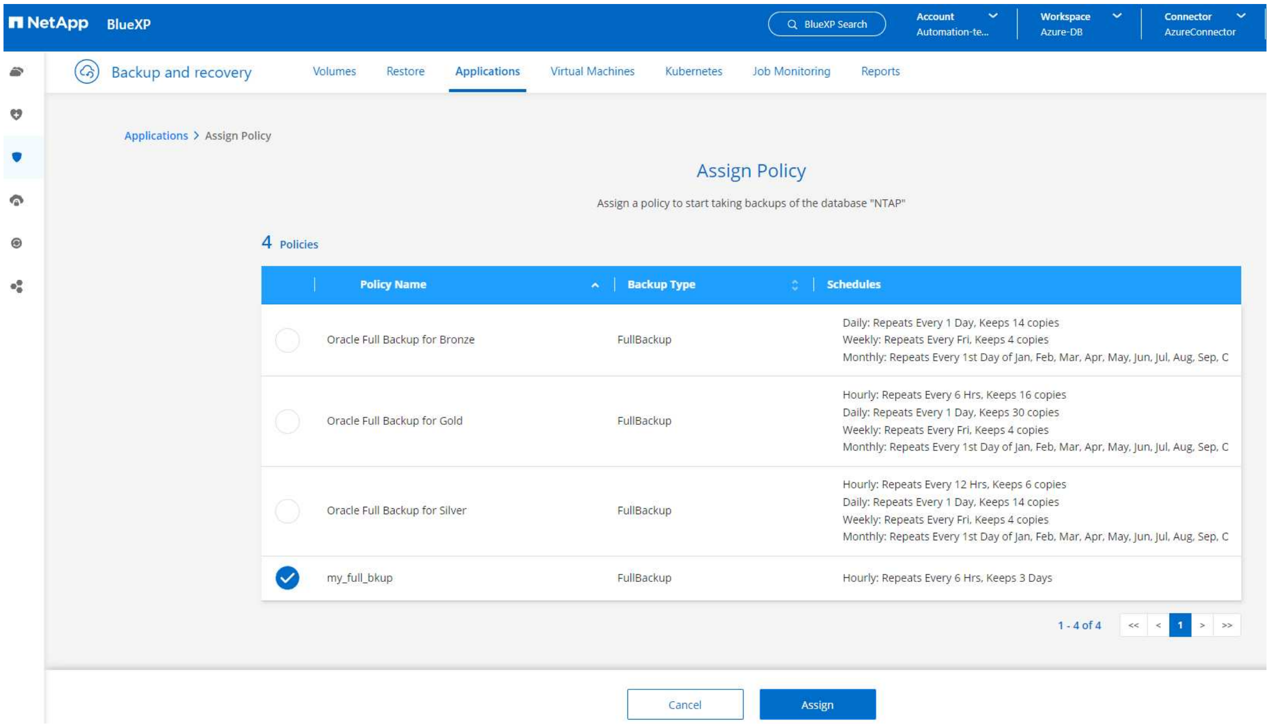
```
[oracle@acao-ora01 ~]$ df -h
Filesystem                 Size  Used Avail Use% Mounted on
devtmpfs                   7.9G     0  7.9G   0% /dev
tmpfs                      7.9G     0  7.9G   0% /dev/shm
tmpfs                      7.9G   17M  7.9G   1% /run
tmpfs                      7.9G     0  7.9G   0% /sys/fs/cgroup
/dev/mapper/rootvg-rootlv   40G   23G   15G  62% /
/dev/mapper/rootvg-usrlv   9.8G  1.6G  7.7G  18% /usr
/dev/sda2                  496M  115M  381M  24% /boot
/dev/mapper/rootvg-varlv   7.9G  787M  6.7G  11% /var
/dev/mapper/rootvg-homelv  976M  323M  586M  36% /home
/dev/mapper/rootvg-optlv   2.0G  9.6M  1.8G   1% /opt
/dev/mapper/rootvg-tmplv   2.0G   22M  1.8G   2% /tmp
/dev/sda1                  500M  6.8M  493M   2% /boot/efi
172.30.136.68:/ora01-u01   100G   23G   78G  23% /u01
172.30.136.68:/ora01-u03   500G  117G  384G  24% /u03
172.30.136.68:/ora01-u02  1000G  804G  197G  81% /u02
tmpfs                      1.6G     0  1.6G   0% /run/user/1000
[oracle@acao-ora01 ~]$
```

1. To protect database, click the three dots next to the database **Protection Status**, and then click **Assign Policy** to view the default preloaded or user defined database protection policies that can be applied to your Oracle databases. Under **Settings** - **Policies**, you have option to create your own policy with a customized backup frequency and backup data-retention window.



Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142		Unprotected
db1	172.30.15.99		Unprotected
db1tst	172.30.15.124		Unprotected

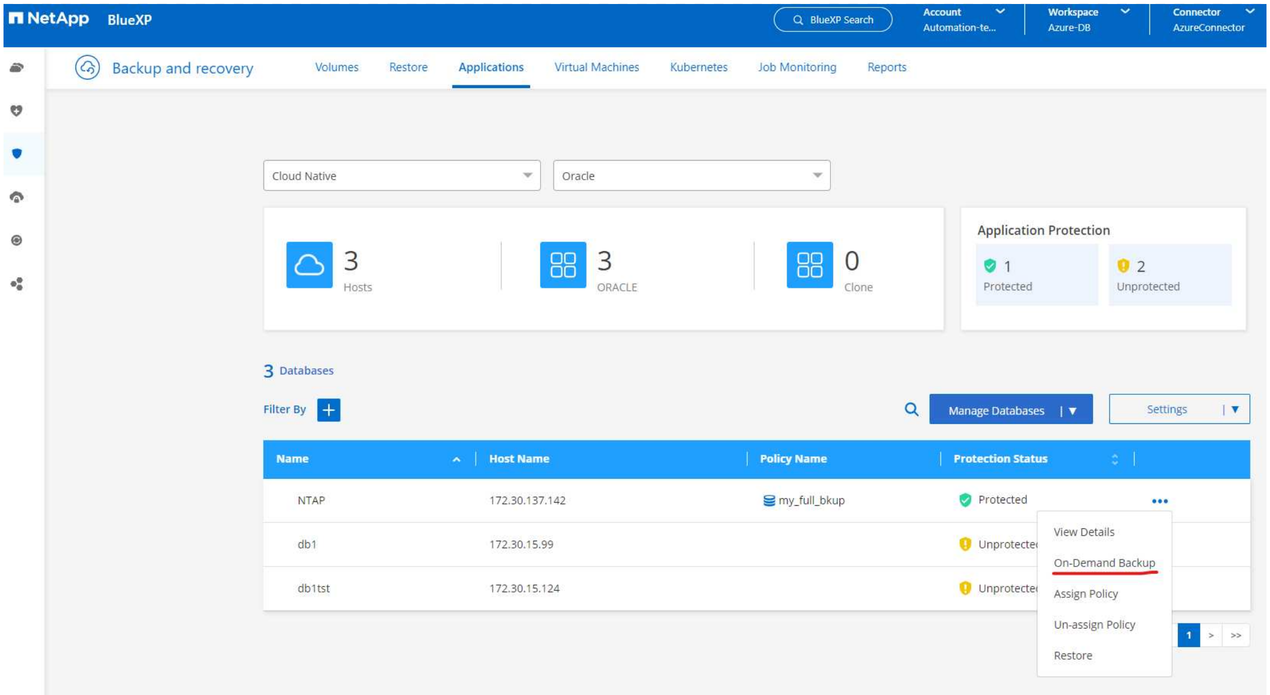
2. When you are happy with the policy configuration, you can then **Assign** your policy of choice to protect the database.



Assign a policy to start taking backups of the database "NTAP"

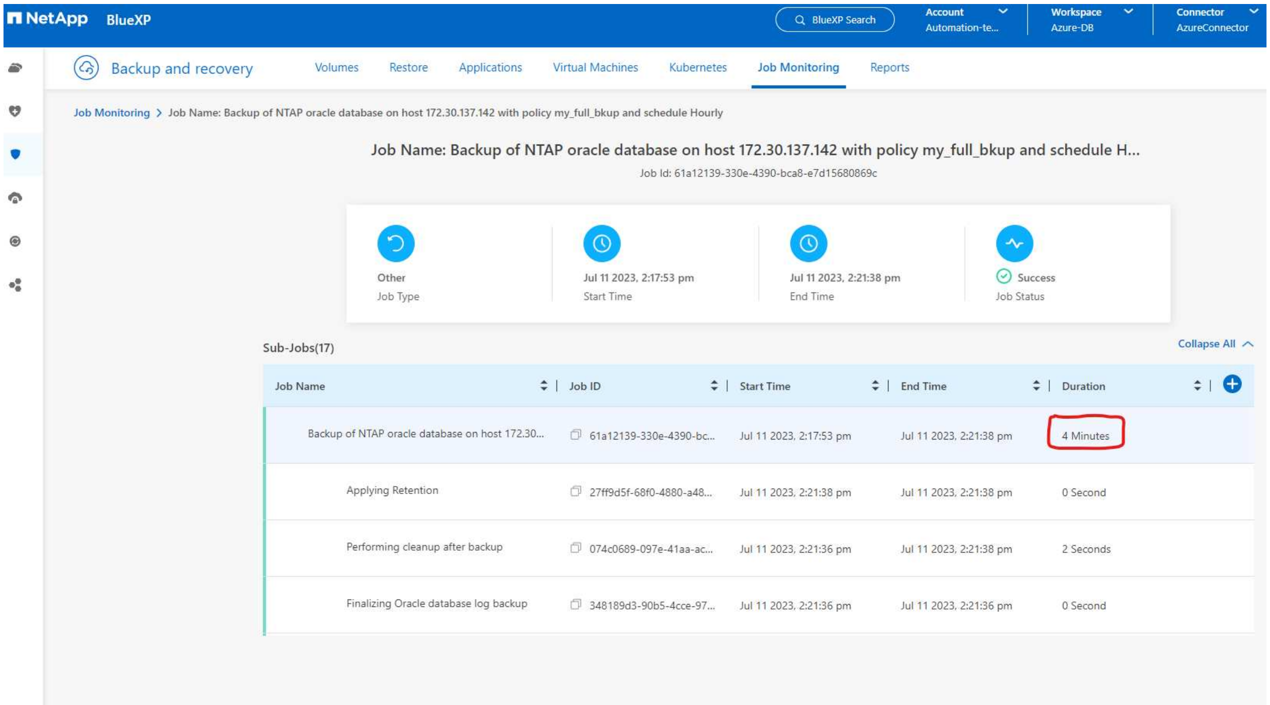
	Policy Name	Backup Type	Schedules
○	Oracle Full Backup for Bronze	FullBackup	Daily: Repeats Every 1 Day, Keeps 14 copies Weekly: Repeats Every Fri, Keeps 4 copies Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, C
○	Oracle Full Backup for Gold	FullBackup	Hourly: Repeats 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 6 Hrs, Keeps 3 Days

3. After the policy is applied, the database protection status changed to **Protected** with a green check mark. BlueXP executes the snapshot backup according to the schedule defined. In addition, **ON-Demand Backup** is available from the three-dot drop down menu as shown below.



Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142	my_full_bkup	Protected
db1	172.30.15.99		Unprotected
db1tst	172.30.15.124		Unprotected

4. From **Job Monitoring** tab, backup job details can be viewed. Our test results showed that it took about 4 minutes to backup an Oracle database about 1.6 TiB.



Job Name: Backup of NTAP oracle database on host 172.30.137.142 with policy my_full_bkup and schedule H...

Job Id: 61a12139-330e-4390-bca8-e7d15680869c

Job Type: Other

Start Time: Jul 11 2023, 2:17:53 pm

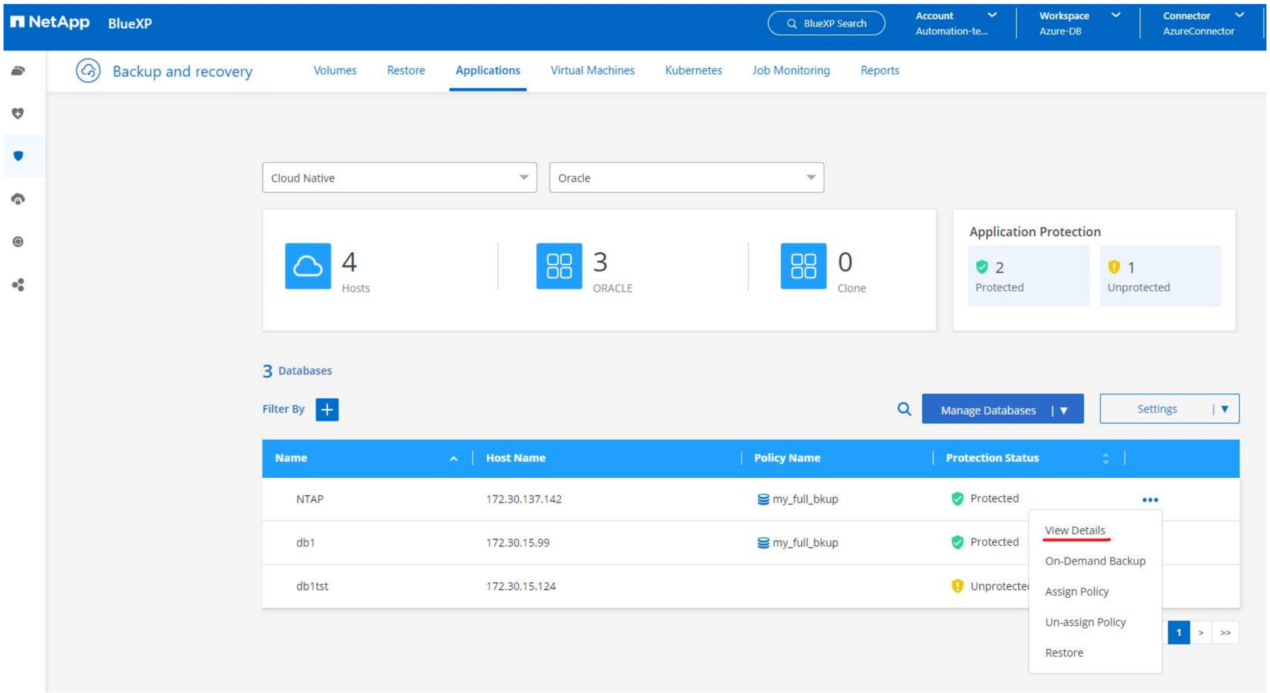
End Time: Jul 11 2023, 2:21:38 pm

Job Status: Success

Sub-Jobs(17)

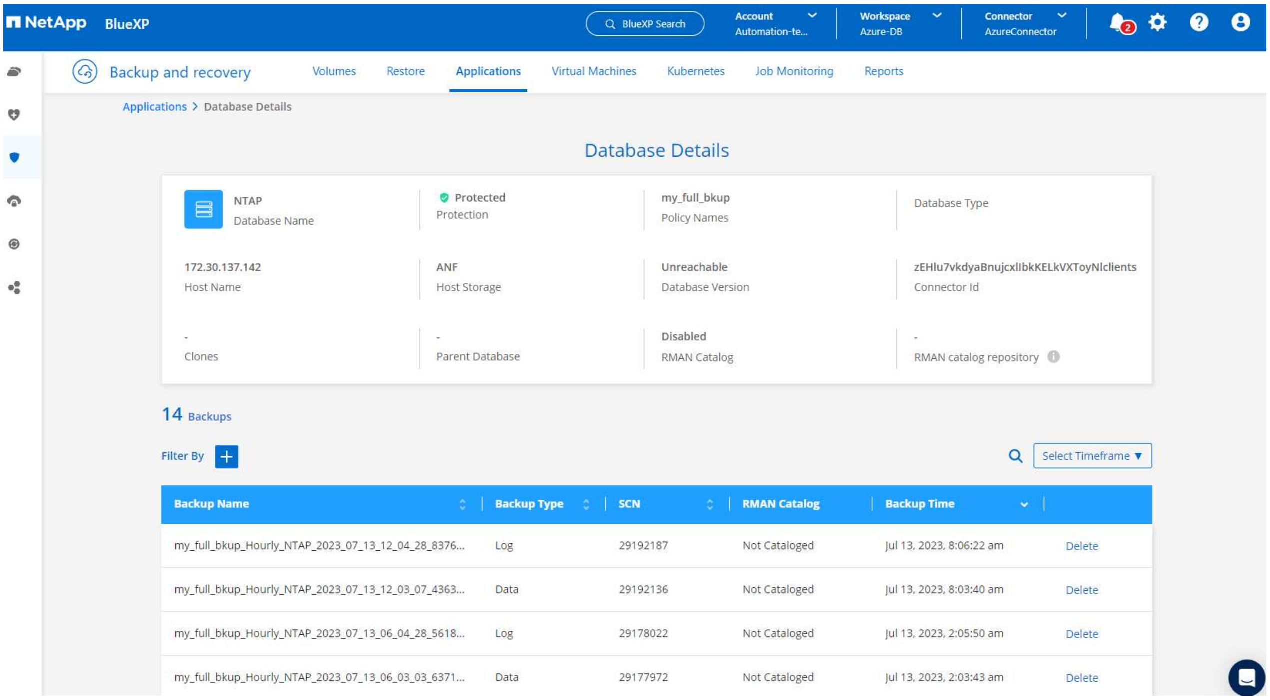
Job Name	Job ID	Start Time	End Time	Duration
Backup of NTAP oracle database on host 172.30...	61a12139-330e-4390-bc...	Jul 11 2023, 2:17:53 pm	Jul 11 2023, 2:21:38 pm	4 Minutes
Applying Retention	27ff9d5f-68f0-4880-a48...	Jul 11 2023, 2:21:38 pm	Jul 11 2023, 2:21:38 pm	0 Second
Performing cleanup after backup	074c0689-097e-41aa-ac...	Jul 11 2023, 2:21:36 pm	Jul 11 2023, 2:21:38 pm	2 Seconds
Finalizing Oracle database log backup	348189d3-90b5-4cce-97...	Jul 11 2023, 2:21:36 pm	Jul 11 2023, 2:21:36 pm	0 Second

5. From three-dot drop down menu **View Details**, you can view the backup sets created from snapshot backup.



Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142	my_full_bkup	Protected
db1	172.30.15.99	my_full_bkup	Protected
db1tst	172.30.15.124		Unprotected

6. Database backup details include the **Backup Name**, **Backup Type**, **SCN**, **RMAN Catalog**, and **Backup Time**. A backup set contains application-consistent snapshots for data volume and log volume respectively. A log volume snapshot takes place right after a database data volume snapshot. You could apply a filter if you are looking for a particular backup in the backup list.

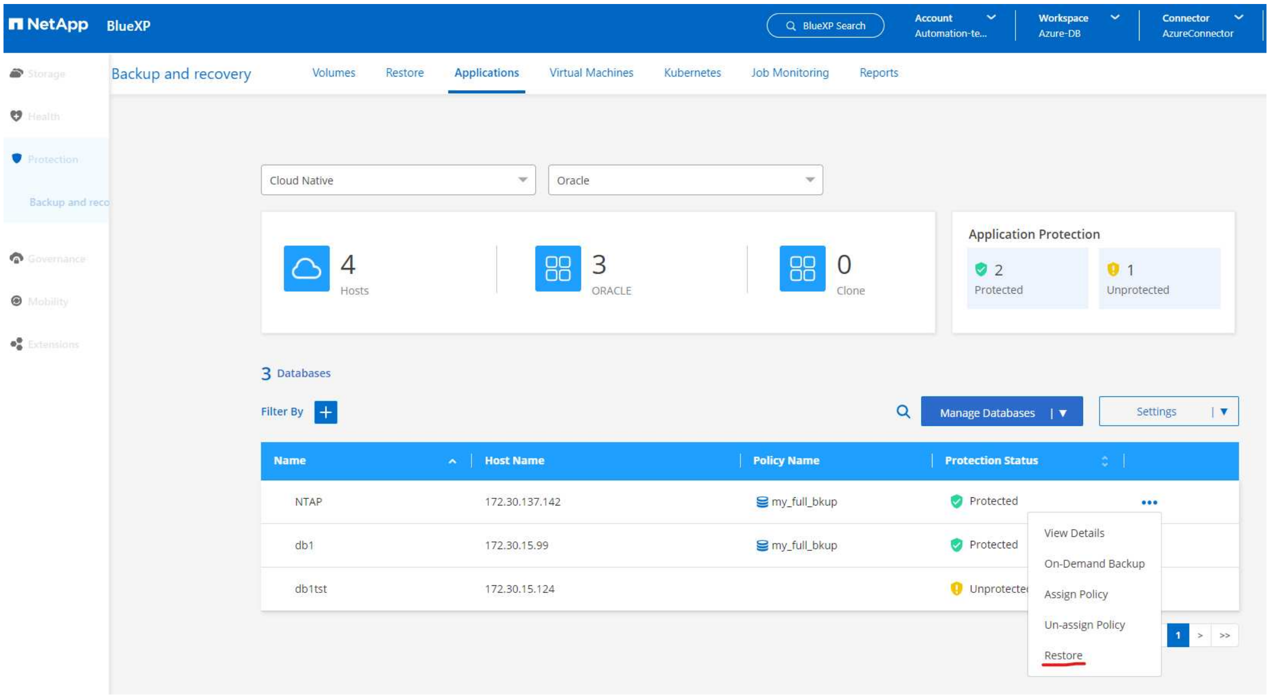


NTAP Database Name	Protected Protection	my_full_bkup Policy Names	Database Type
172.30.137.142 Host Name	ANF Host Storage	Unreachable Database Version	zEHlu7vkdyaBnujcxlIbkKELkVXToyNlclients Connector Id
- Clones	- Parent Database	Disabled RMAN Catalog	- RMAN catalog repository

Backup Name	Backup Type	SCN	RMAN Catalog	Backup Time	
my_full_bkup_Hourly_NTAP_2023_07_13_12_04_28_8376...	Log	29192187	Not Cataloged	Jul 13, 2023, 8:06:22 am	Delete
my_full_bkup_Hourly_NTAP_2023_07_13_12_03_07_4363...	Data	29192136	Not Cataloged	Jul 13, 2023, 8:03:40 am	Delete
my_full_bkup_Hourly_NTAP_2023_07_13_06_04_28_5618...	Log	29178022	Not Cataloged	Jul 13, 2023, 2:05:50 am	Delete
my_full_bkup_Hourly_NTAP_2023_07_13_06_03_03_6371...	Data	29177972	Not Cataloged	Jul 13, 2023, 2:03:43 am	Delete

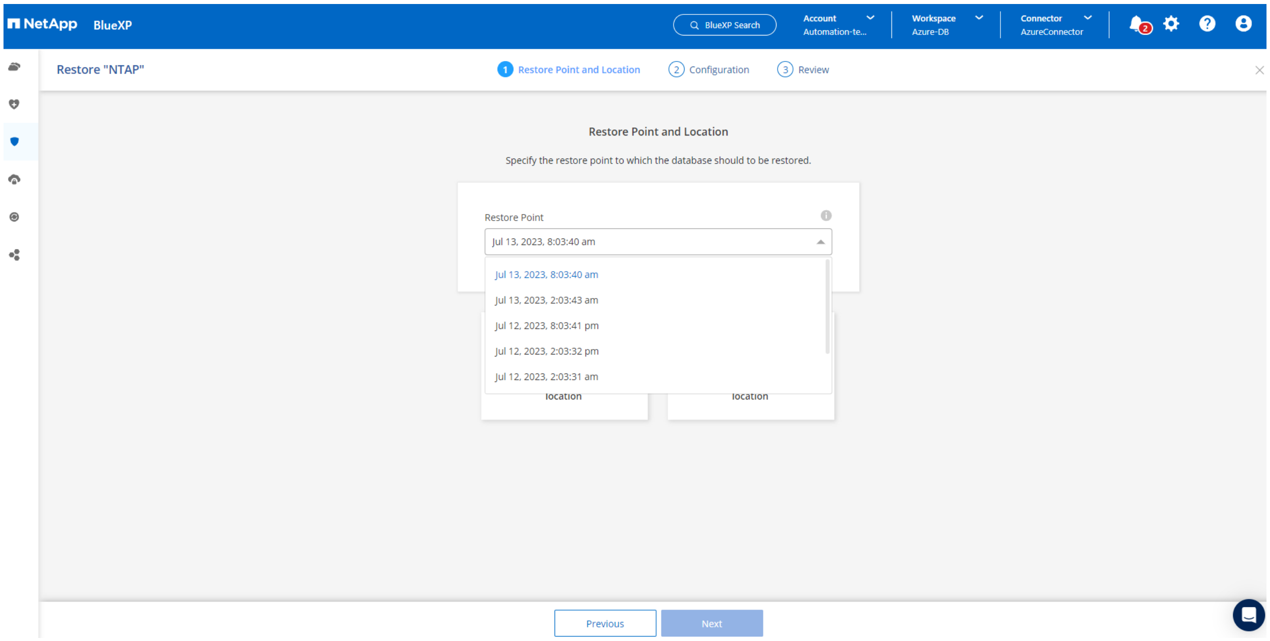
Oracle database restore and recovery

1. For a database restore, click the three-dot drop down menu for the particular database to be restored in **Applications**, then click **Restore** to initiate database restore and recovery workflow.



Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142	my_full_bkup	Protected
db1	172.30.15.99	my_full_bkup	Protected
db1tst	172.30.15.124		Unprotected

2. Choose your **Restore Point** by time stamp. Each time stamp in the list represents an available database backup set.



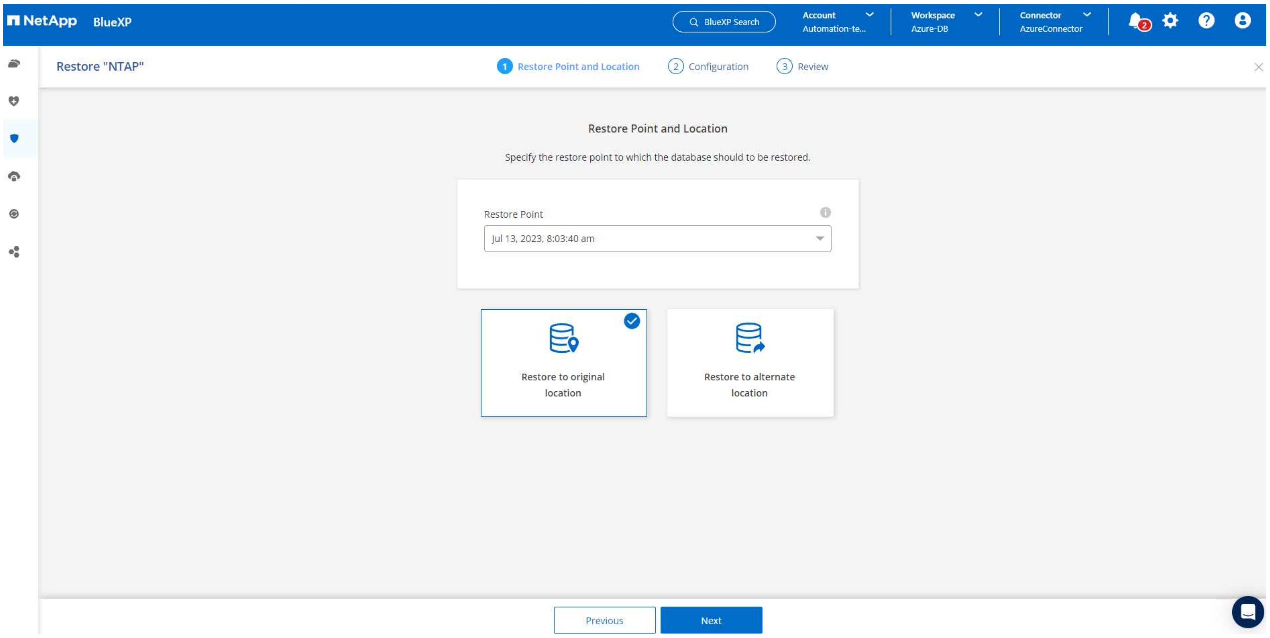
Restore Point and Location

Specify the restore point to which the database should to be restored.

Restore Point: Jul 13, 2023, 8:03:40 am

- Jul 13, 2023, 8:03:40 am
- Jul 13, 2023, 2:03:43 am
- Jul 12, 2023, 8:03:41 pm
- Jul 12, 2023, 2:03:32 pm
- Jul 12, 2023, 2:03:31 am

3. Choose your **Restore Location** to **original location** for an Oracle database in place restore and recovery.



Restore Point and Location

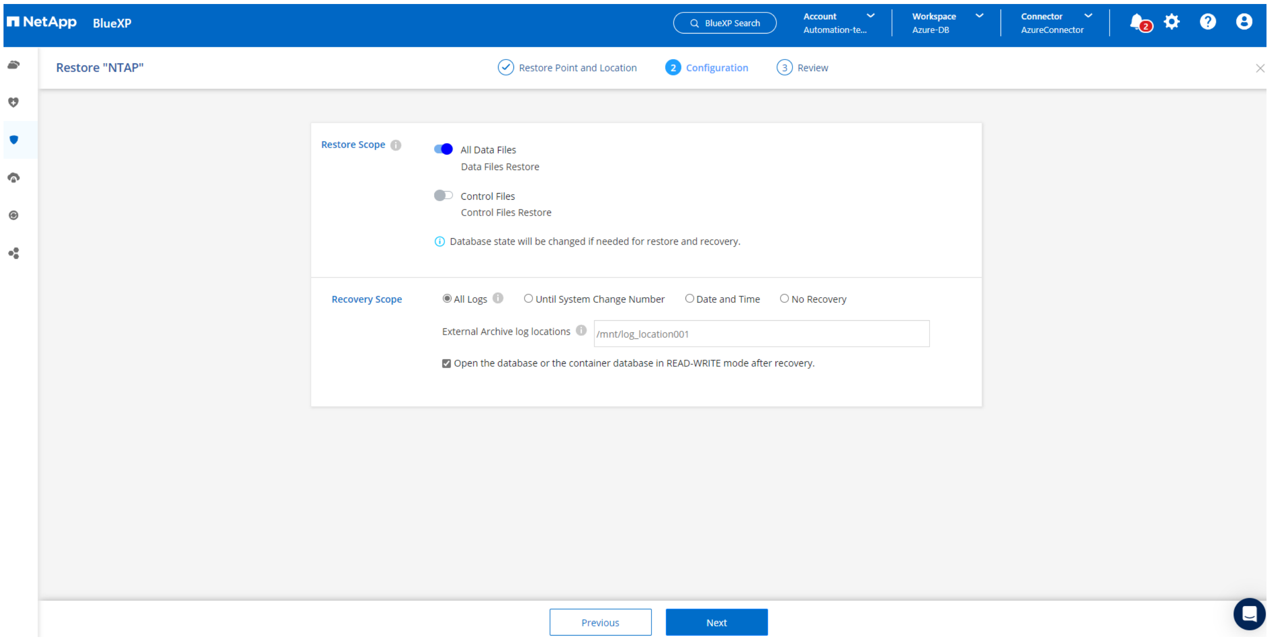
Specify the restore point to which the database should to be restored.

Restore Point: Jul 13, 2023, 8:03:40 am

☑ Restore to original location

Restore to alternate location

4. Define your **Restore Scope**, and **Recovery Scope**. All Logs mean a full recovery up to date including current logs.



Restore Scope

● All Data Files
Data Files Restore

○ Control Files
Control Files Restore

Database state will be changed if needed for restore and recovery.

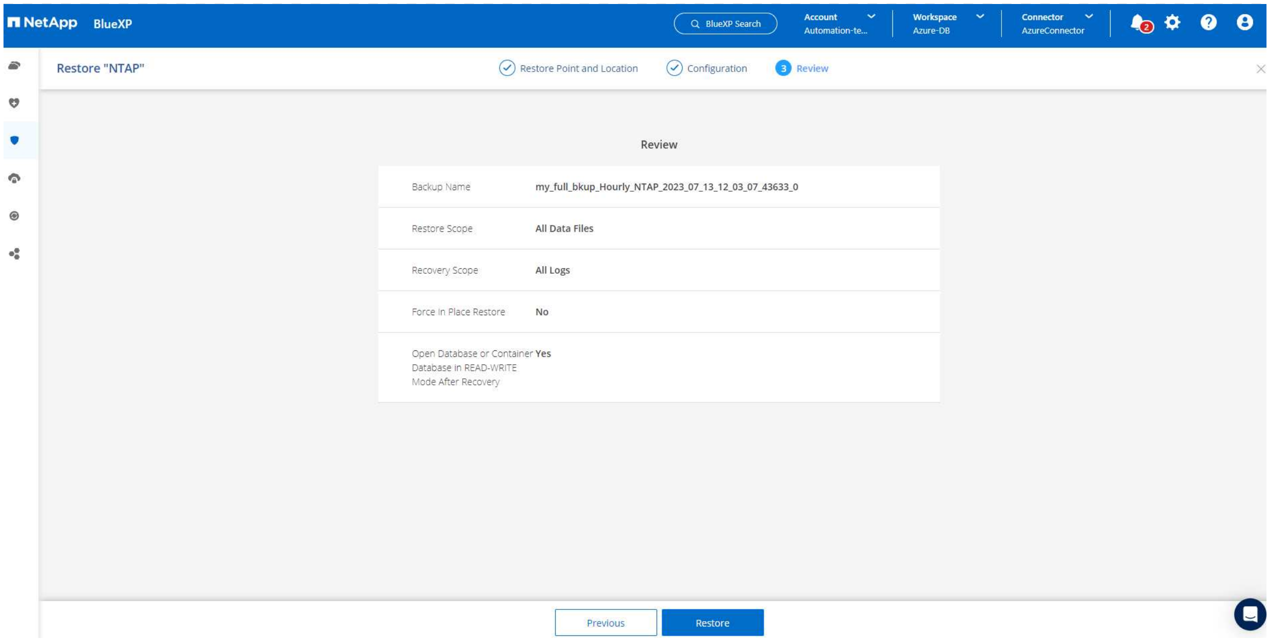
Recovery Scope

● All Logs ○ Until System Change Number ○ Date and Time ○ No Recovery

External Archive log locations: /mnt/log_location001

☑ Open the database or the container database in READ-WRITE mode after recovery.

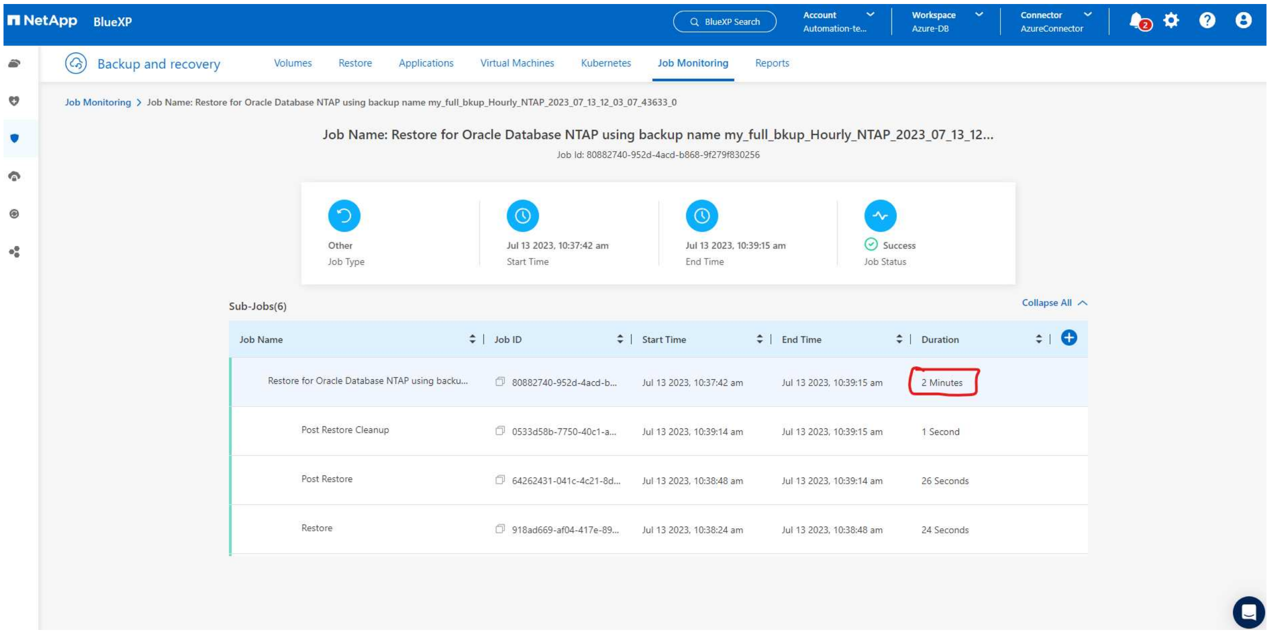
5. Review and **Restore** to start database restore and recovery.



Review

Backup Name	my_full_bkup_Hourly_NTAP_2023_07_13_12_03_07_43633_0
Restore Scope	All Data Files
Recovery Scope	All Logs
Force In Place Restore	No
Open Database or Container Database in READ-WRITE Mode After Recovery	Yes

6. From the **Job Monitoring** tab, we observed that it took 2 minutes to run a full database restore and recovery up to date.



Job Monitoring > Job Name: Restore for Oracle Database NTAP using backup name my_full_bkup_Hourly_NTAP_2023_07_13_12_03_07_43633_0

Job Name: Restore for Oracle Database NTAP using backup name my_full_bkup_Hourly_NTAP_2023_07_13_12...

Job Id: 80882740-952d-4acd-b868-9f279f830256

Other Job Type

Jul 13 2023, 10:37:42 am Start Time

Jul 13 2023, 10:39:15 am End Time

Success Job Status

Sub-Jobs(6)

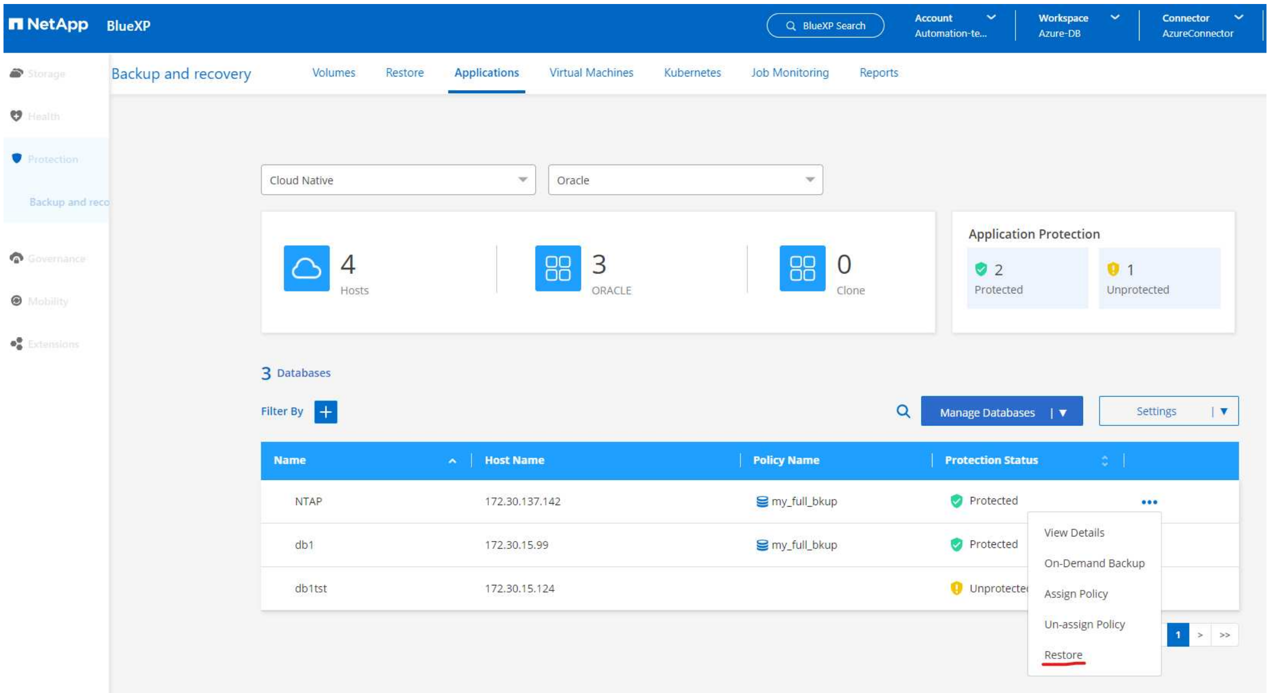
Job Name	Job ID	Start Time	End Time	Duration
Restore for Oracle Database NTAP using backu...	80882740-952d-4acd-b...	Jul 13 2023, 10:37:42 am	Jul 13 2023, 10:39:15 am	2 Minutes
Post Restore Cleanup	0533d58b-7750-40c1-a...	Jul 13 2023, 10:39:14 am	Jul 13 2023, 10:39:15 am	1 Second
Post Restore	64262431-041c-4c21-8d...	Jul 13 2023, 10:38:48 am	Jul 13 2023, 10:39:14 am	26 Seconds
Restore	918ad669-af04-417e-89...	Jul 13 2023, 10:38:24 am	Jul 13 2023, 10:38:48 am	24 Seconds

Oracle database clone

Database clone procedures are similar to restore but to an alternate Azure VM with identical Oracle software stack pre-installed and configured.

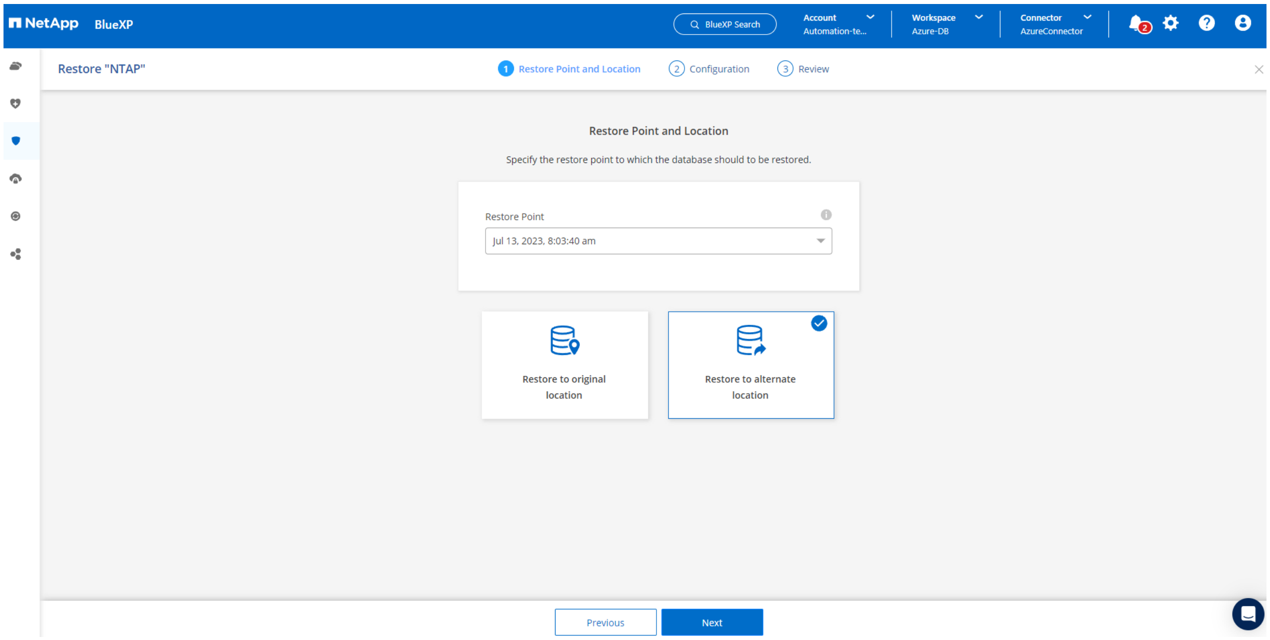
> ⓘ Ensure that your Azure NetApp File storage has sufficient capacity for a cloned database the same size as the primary database to be cloned. The alternate Azure VM has been added to **Applications**.

1. Click the three-dot drop down menu for the particular database to be cloned in **Applications**, then click **Restore** to initiate clone workflow.



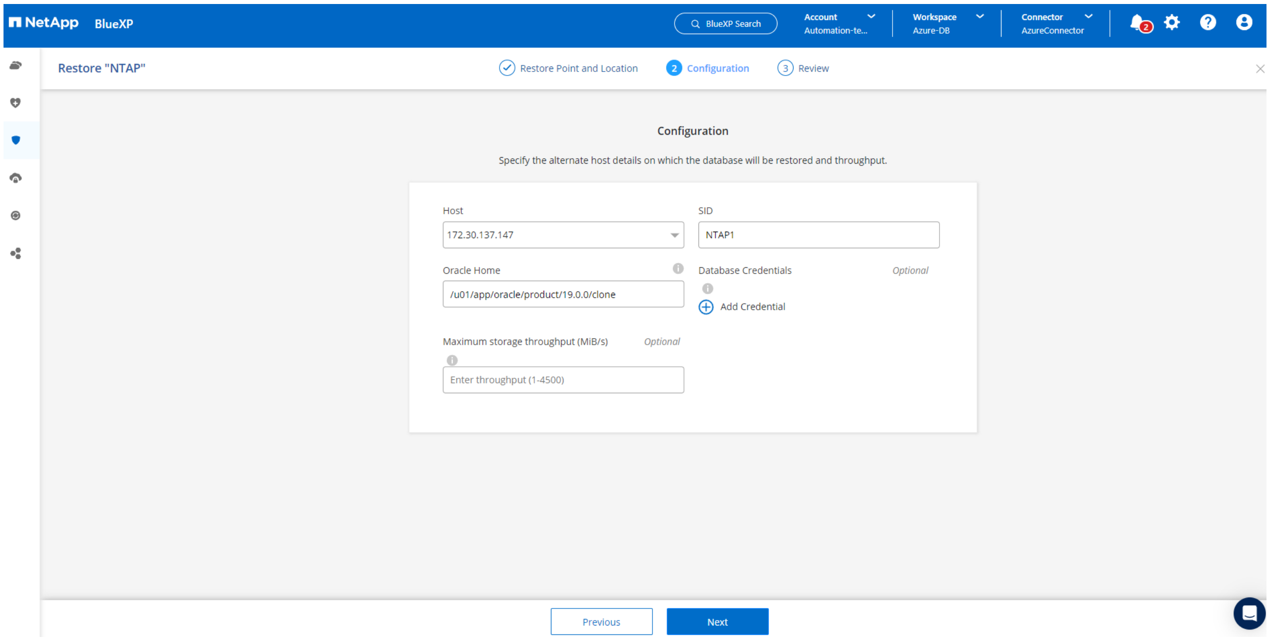
Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142	my_full_bkup	Protected
db1	172.30.15.99	my_full_bkup	Protected
db1tst	172.30.15.124		Unprotected

2. Select the **Restore Point** and check the **Restore to alternate location**.


NetApp BlueXP
BlueXP Search
Account Automation-te...
Workspace Azure-DB
Connector AzureConnector
Restore "NTAP"
1 Restore Point and Location
2 Configuration
3 Review
Restore Point and Location
Specify the restore point to which the database should to be restored.
Restore to original location
Restore to alternate location
Previous
Next

Restore Point: Jul 13, 2023, 8:03:40 am

3. In the next **Configuration** page, set alternate **Host**, new database **SID**, and **Oracle Home** as configured at alternate Azure VM.



Configuration

Specify the alternate host details on which the database will be restored and throughput.

Host: 172.30.137.147

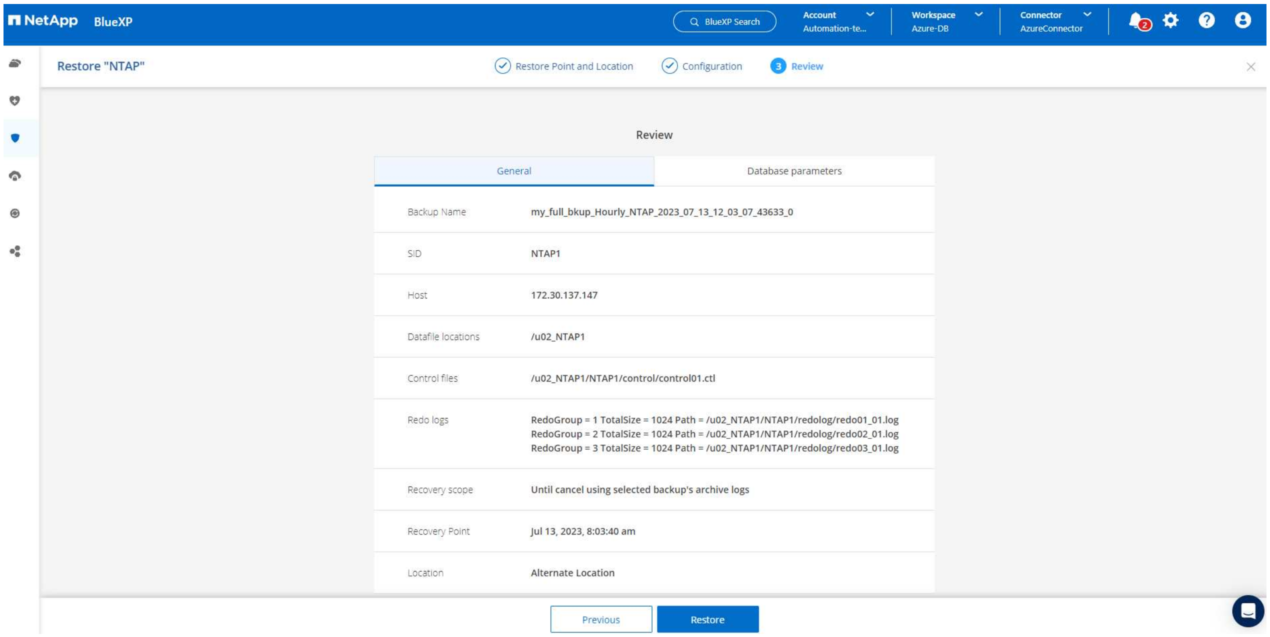
SID: NTAP1

Oracle Home: /u01/app/oracle/product/19.0.0/clone

Database Credentials (Optional): Add Credential

Maximum storage throughput (MiB/s) (Optional): Enter throughput (1-4500)

4. Review **General** page shows the details of cloned database such as SID, alternate host, data file locations, recovery scope etc.



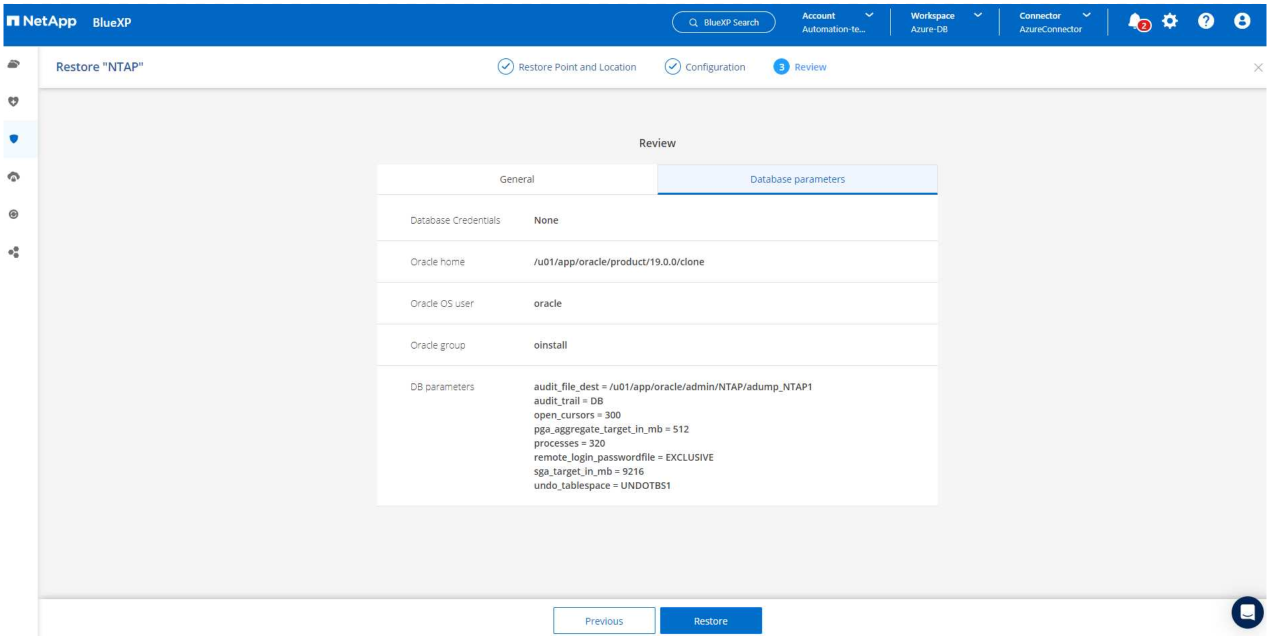
Review

Backup Name	my_full_bkup_Hourly_NTAP_2023_07_13_12_03_07_43633_0
SID	NTAP1
Host	172.30.137.147
Datafile locations	/u02_NTAP1
Control files	/u02_NTAP1/NTAP1/control/control01.ctl

Redo logs	RedoGroup = 1 TotalSize = 1024 Path = /u02_NTAP1/NTAP1/redolog/redo01_01.log
	RedoGroup = 2 TotalSize = 1024 Path = /u02_NTAP1/NTAP1/redolog/redo02_01.log
	RedoGroup = 3 TotalSize = 1024 Path = /u02_NTAP1/NTAP1/redolog/redo03_01.log

Recovery scope	Until cancel using selected backup's archive logs
Recovery Point	Jul 13, 2023, 8:03:40 am
Location	Alternate Location

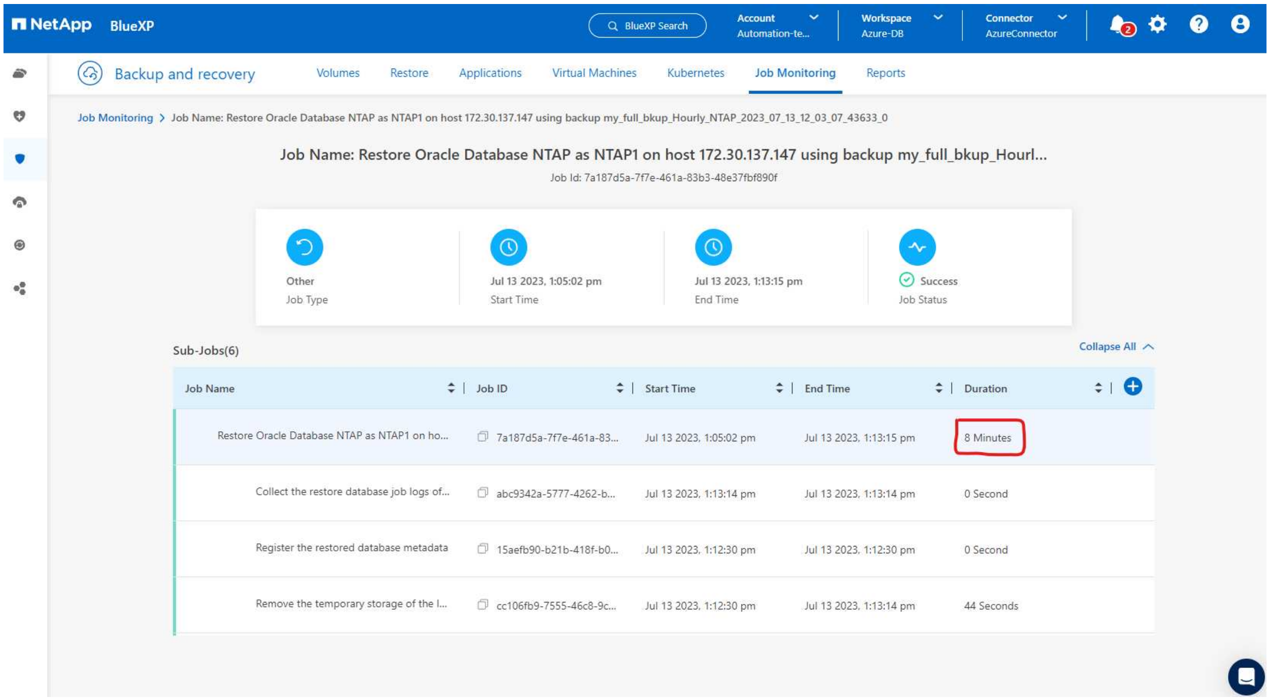
5. Review **Database parameters** page shows the details of cloned database configuration as well as some database parameters setting.



Database Credentials	None
Oracle home	/u01/app/oracle/product/19.0.0/clone
Oracle OS user	oracle
Oracle group	oinstall

DB parameters	audit_file_dest = /u01/app/oracle/admin/NTAP/adump_NTAP1
	audit_trail = DB
	open_cursors = 300
	pga_aggregate_target_in_mb = 512
	processes = 320
	remote_login_passwordfile = EXCLUSIVE
	sga_target_in_mb = 9216
	undo_tablespace = UNDOTBS1

6. Monitor the cloning job status from the **Job Monitoring** tab, we observed that it took 8 minutes to clone a 1.6 TiB Oracle database.



Job Monitoring > Job Name: Restore Oracle Database NTAP as NTAP1 on host 172.30.137.147 using backup my_full_bkup_Hourly_NTAP_2023_07_13_12_03_07_43633_0

Job Name: Restore Oracle Database NTAP as NTAP1 on host 172.30.137.147 using backup my_full_bkup_Hourl...

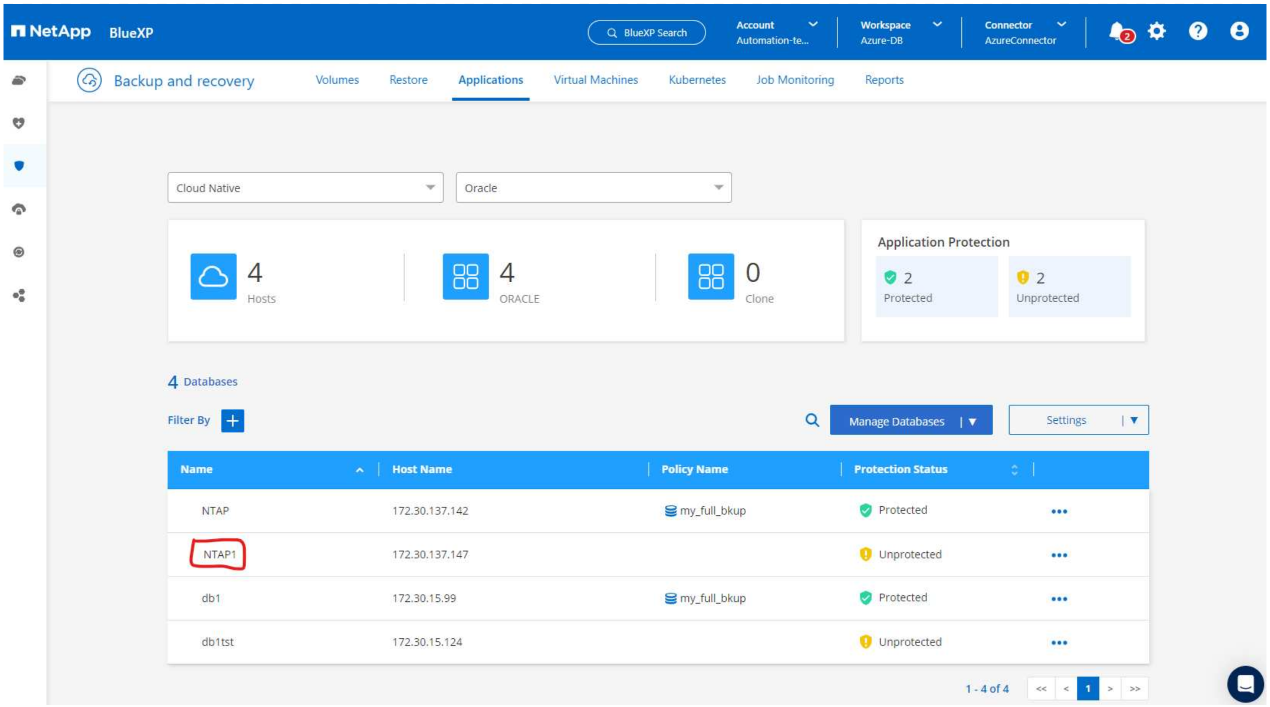
Job Id: 7a187d5a-7f7e-461a-83b3-48e37fbf890f

Job Type	Start Time	End Time	Job Status
Other	Jul 13 2023, 1:05:02 pm	Jul 13 2023, 1:13:15 pm	Success

Sub-Jobs(6)

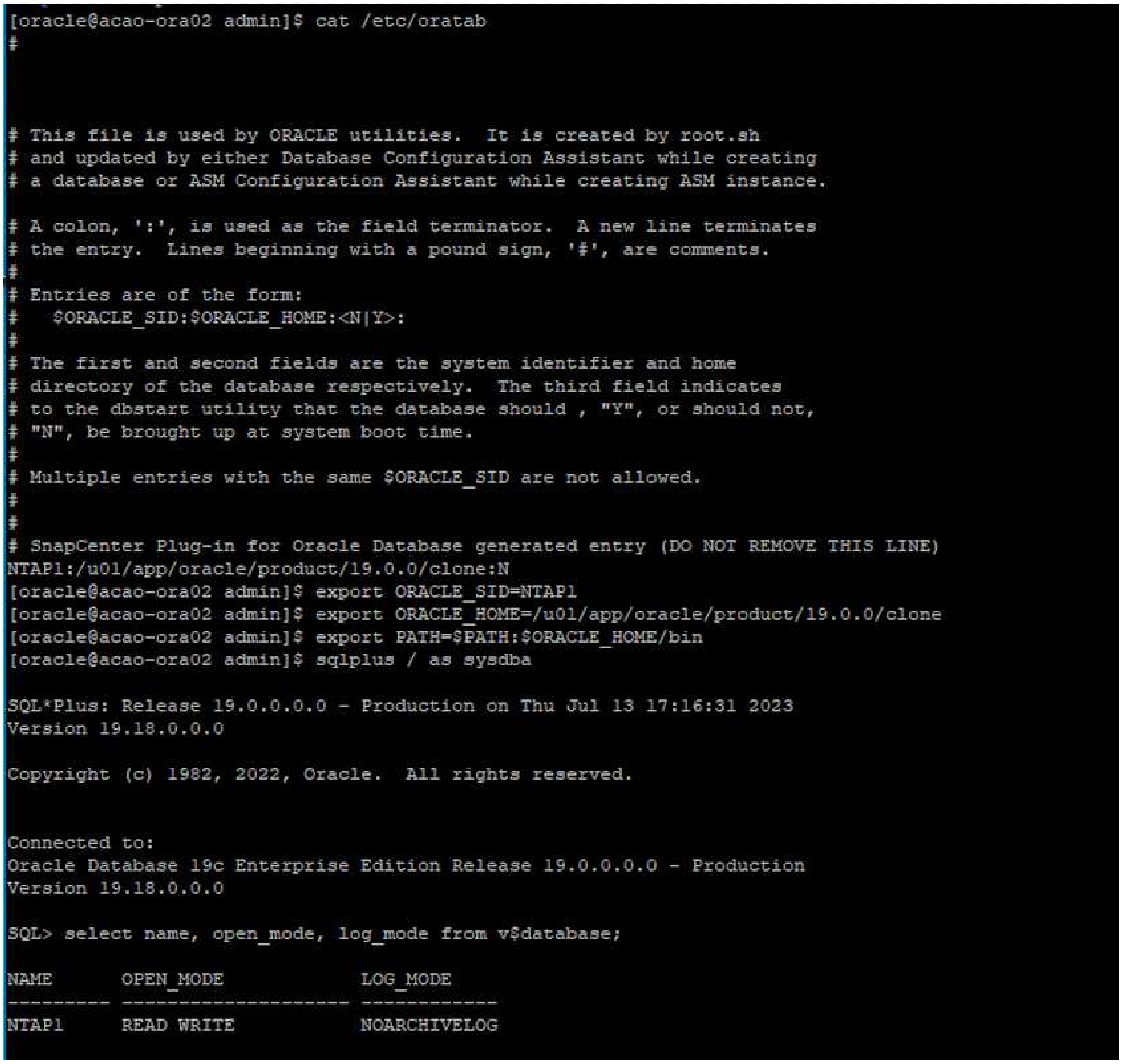
Job Name	Job ID	Start Time	End Time	Duration
Restore Oracle Database NTAP as NTAP1 on ho...	7a187d5a-7f7e-461a-83...	Jul 13 2023, 1:05:02 pm	Jul 13 2023, 1:13:15 pm	8 Minutes
Collect the restore database job logs of...	abc9342a-5777-4262-b...	Jul 13 2023, 1:13:14 pm	Jul 13 2023, 1:13:14 pm	0 Second
Register the restored database metadata	15aefb90-b21b-418f-b0...	Jul 13 2023, 1:12:30 pm	Jul 13 2023, 1:12:30 pm	0 Second
Remove the temporary storage of the l...	cc106fb9-7555-46c8-9c...	Jul 13 2023, 1:12:30 pm	Jul 13 2023, 1:13:14 pm	44 Seconds

7. Validate the cloned database in BlueXP **Applications** page that showed the cloned database was immediately registered with BlueXP.



Name	Host Name	Policy Name	Protection Status
NTAP	172.30.137.142	my_full_bkup	Protected
NTAP1	172.30.137.147		Unprotected
db1	172.30.15.99	my_full_bkup	Protected
db1tst	172.30.15.124		Unprotected

8. Validate the cloned database on the Oracle Azure VM that showed the cloned database was running as expected.



```
[oracle@acao-ora02 admin]$ cat /etc/oratab
#



# This file is used by ORACLE utilities.  It is created by root.sh
# and updated by either Database Configuration Assistant while creating
# a database or ASM Configuration Assistant while creating ASM instance.

# A colon, ':', is used as the field terminator.  A new line terminates
# the entry.  Lines beginning with a pound sign, '#', are comments.
#
# Entries are of the form:
#   $ORACLE_SID:$ORACLE_HOME:<N|Y>:
#
# The first and second fields are the system identifier and home
# directory of the database respectively.  The third field indicates
# to the dbstart utility that the database should , "Y", or should not,
# "N", be brought up at system boot time.
#
# Multiple entries with the same $ORACLE_SID are not allowed.
#
#
# SnapCenter Plug-in for Oracle Database generated entry (DO NOT REMOVE THIS LINE)
NTAP1:/u01/app/oracle/product/19.0.0/clone:N
[oracle@acao-ora02 admin]$ export ORACLE_SID=NTAP1
[oracle@acao-ora02 admin]$ export ORACLE_HOME=/u01/app/oracle/product/19.0.0/clone
[oracle@acao-ora02 admin]$ export PATH=$PATH:$ORACLE_HOME/bin
[oracle@acao-ora02 admin]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Thu Jul 13 17:16:31 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, log_mode from v$database;

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
NTAP1     READ WRITE           NOARCHIVELOG
```

This completes the demonstration of an Oracle database backup, restore, and clone in Azure with NetApp BlueXP console using SnapCenter Service.

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

- BlueXP backup and recovery documentation

  https://docs.netapp.com/us-en/cloud-manager-backup-restore/index.html

- Azure NetApp Files

  https://azure.microsoft.com/en-us/products/netapp

- Get started with Azure

  https://azure.microsoft.com/en-us/get-started/

TR-4964: Oracle Database backup, restore and clone with SnapCenter Services - AWS

This solution provides overview and details for Oracle database backup, restore, clone using NetApp SnapCenter SaaS using BlueXP console in Azure cloud.

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

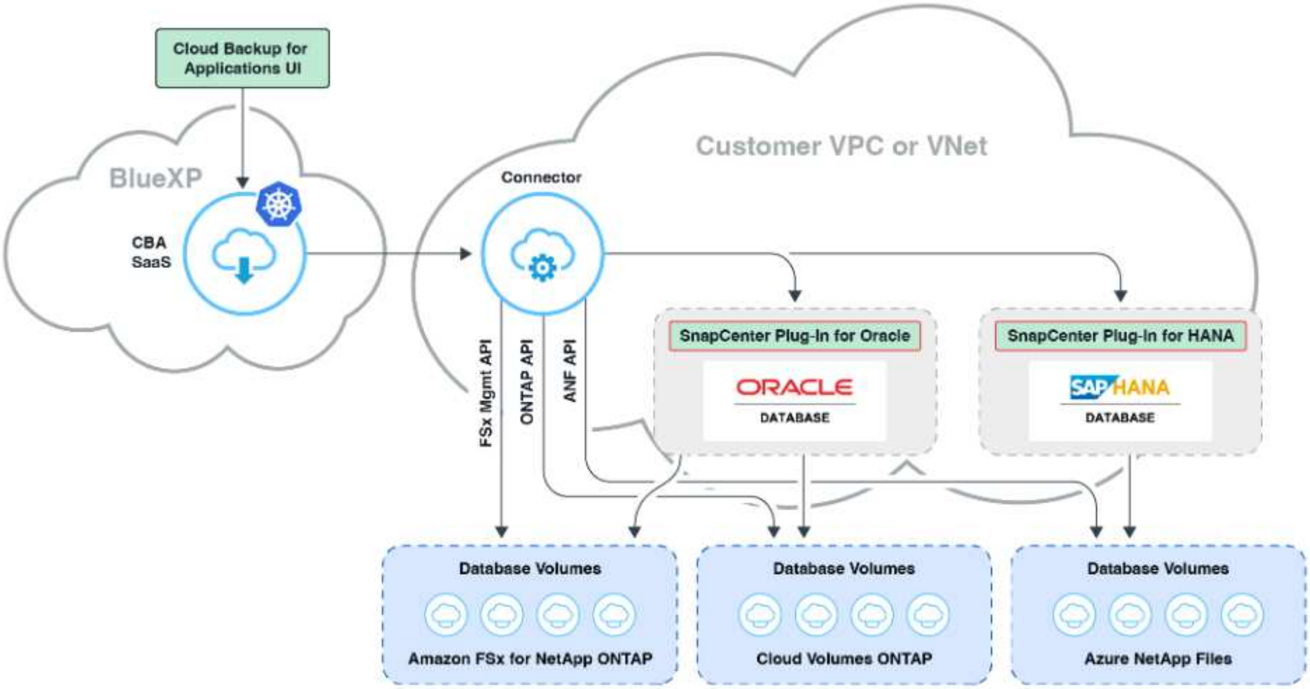
This solution is intended for the following audiences:

- 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 BlueXP backup and recovery for applications 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 xlarge 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 also prompted to set up the prerequisites with details of required permission in JSON format. 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 with IAM policy above.
- **A credential added to the BlueXP console setting.** To add Amazon FSx for ONTAP to the BlueXP working environment, a credential that grants BlueXP permissions to access Amazon FSx for ONTAP is set up in the BlueXP console setting.
- **java-11-openjdk installed on the EC2 database instance host.** SnapCenter service installation requires java version 11. It needs to be installed on application host before plugin deployment attempt.

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.

Solution Deployment

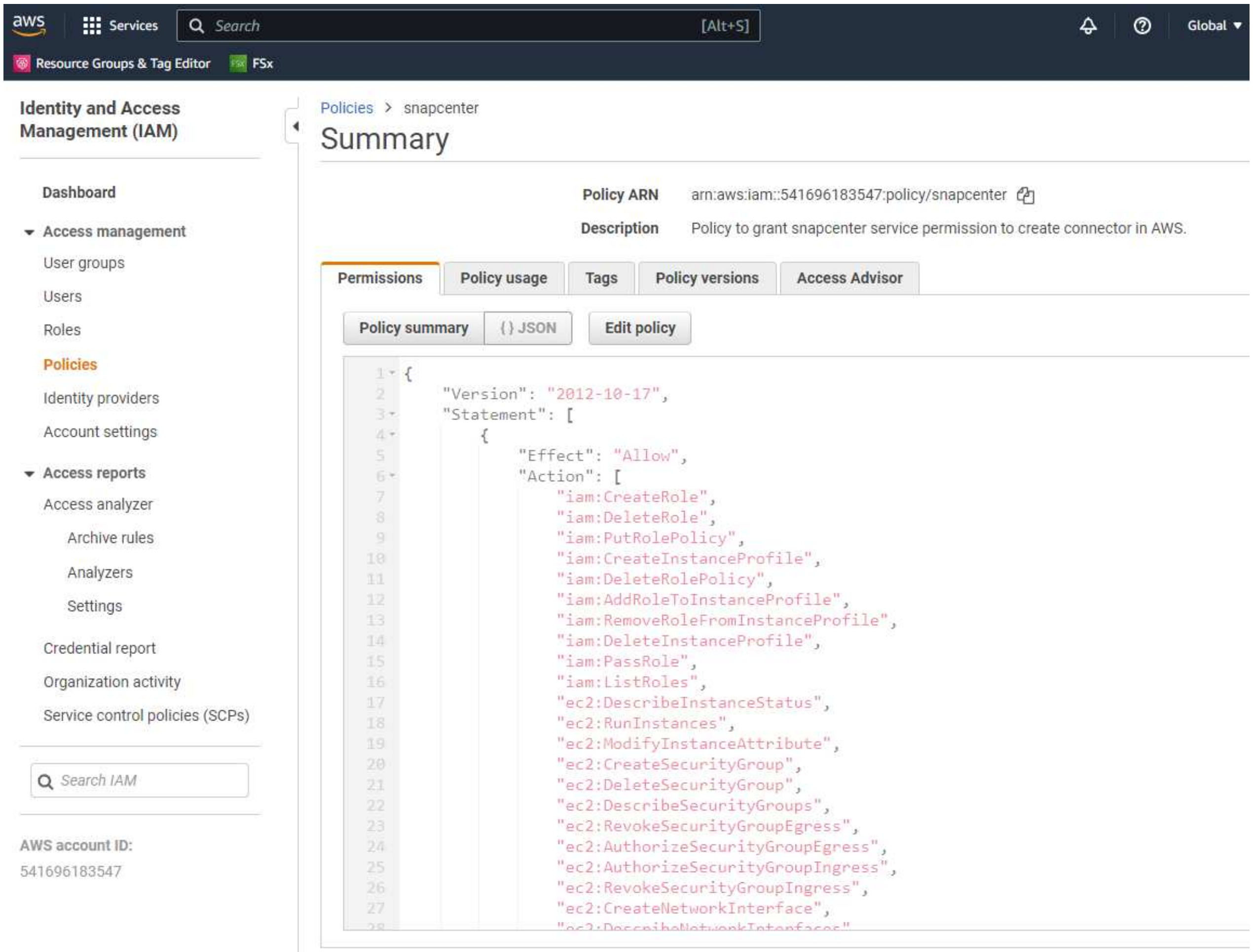
Prerequisites for SnapCenter service deployment

Deployment requires the following prerequisites.

1. A primary Oracle database server on an EC2 instance with an Oracle database fully deployed and running.
2. An Amazon FSx for ONTAP cluster deployed in AWS that is hosting the database volumes above.
3. An optional database server on an EC2 instance that can be used for testing the cloning of an Oracle database to an alternate host for the purpose of supporting a dev/test workload or any use cases that requires a full data set of a 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 or white paper Oracle Database Deployment on EC2 and FSx Best Practices

Onboarding to BlueXP preparation

1. Use the link NetApp BlueXP to sign up for BlueXP console access.
2. Login to your AWS account to create an IAM policy with proper permissions and assign the policy to the AWS account that will be used for BlueXP connector deployment.



Policy ARN arn:aws:iam::541696183547:policy/snapcenter

Description Policy to grant snapcenter service permission to create connector in AWS.

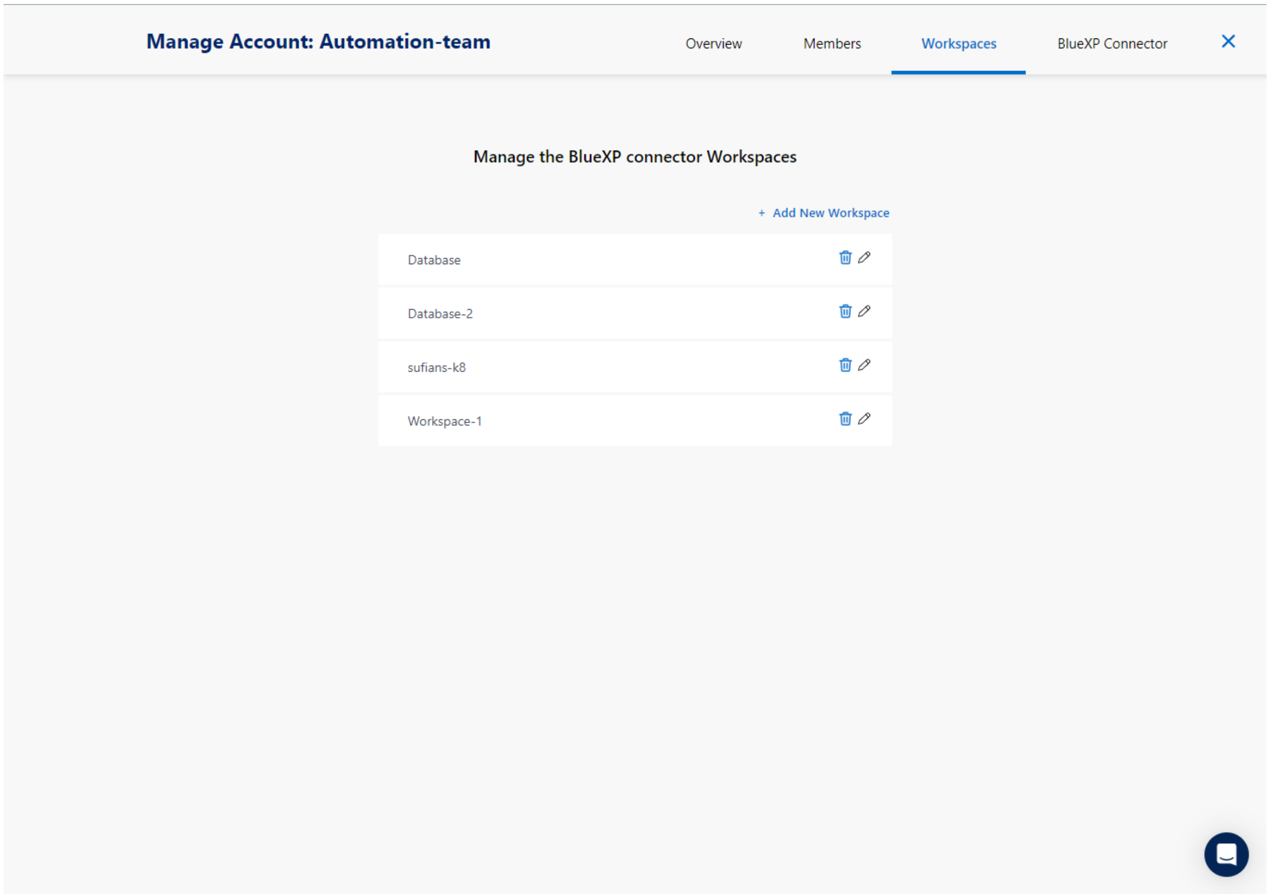
```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "iam:CreateRole",
                "iam:DeleteRole",
                "iam:PutRolePolicy",
                "iam:CreateInstanceProfile",
                "iam:DeleteRolePolicy",
                "iam:AddRoleToInstanceProfile",
                "iam:RemoveRoleFromInstanceProfile",
                "iam:DeleteInstanceProfile",
                "iam:PassRole",
                "iam:ListRoles",
                "ec2:DescribeInstanceStatus",
                "ec2:RunInstances",
                "ec2:ModifyInstanceAttribute",
                "ec2:CreateSecurityGroup",
                "ec2:DeleteSecurityGroup",
                "ec2:DescribeSecurityGroups",
                "ec2:RevokeSecurityGroupEgress",
                "ec2:AuthorizeSecurityGroupEgress",
                "ec2:AuthorizeSecurityGroupIngress",
                "ec2:RevokeSecurityGroupIngress",
                "ec2:CreateNetworkInterface",
```

The policy should be configured with a JSON string that is available in NetApp documentation. The JSON string can also be retrieved from the page when connector provisioning is launched and you are prompted for the prerequisites permissions assignment.

3. You also need the AWS VPC, subnet, security group, an AWS user account access key and secrets, an SSH key for ec2-user, and so on ready for connector provisioning.

Deploy a connector for SnapCenter services

1. Login to 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

Manage the BlueXP connector Workspaces

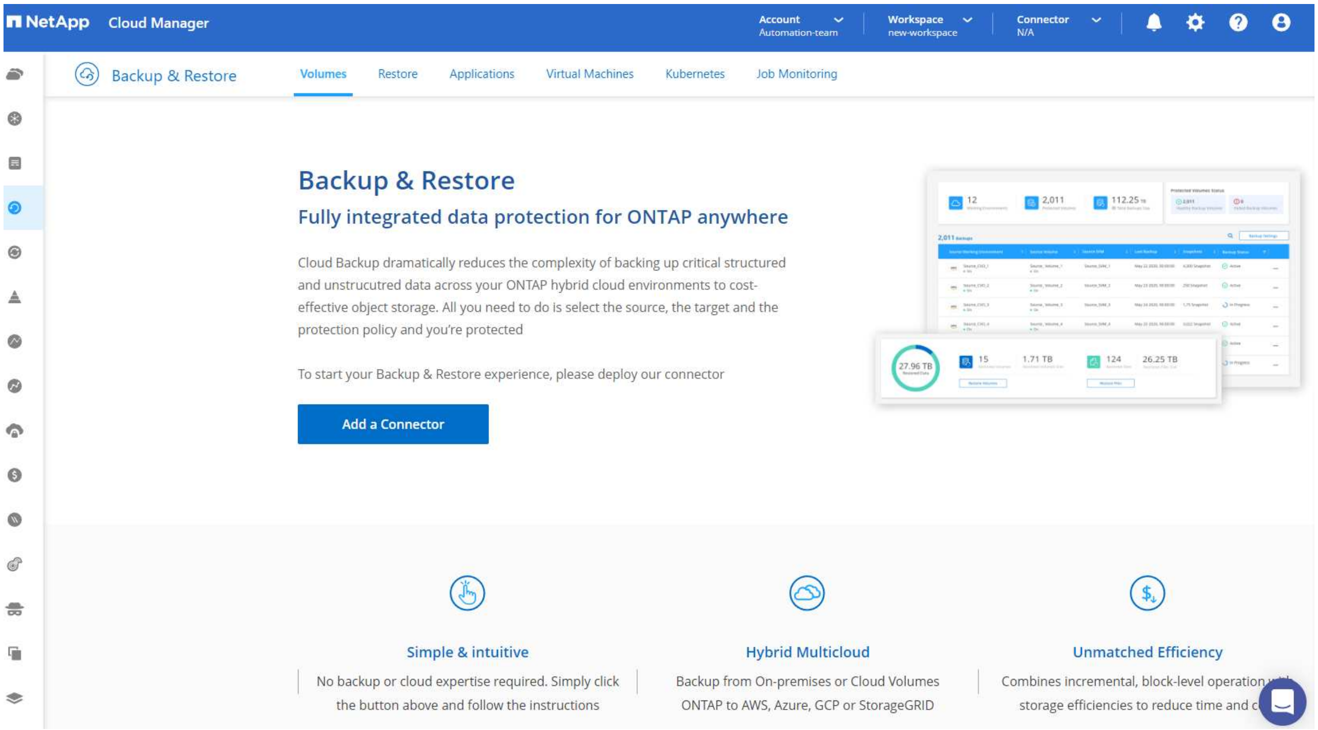
Database

Database-2

sufians-k8

Workspace-1

2. Click **Add a Connector** to launch the connector provisioning workflow.



Backup & Restore

Fully integrated data protection for ONTAP anywhere

Cloud Backup dramatically reduces the complexity of backing up critical structured and unstrucutred 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

Simple & intuitive

No backup or cloud expertise required. Simply click the button above and follow the instructions

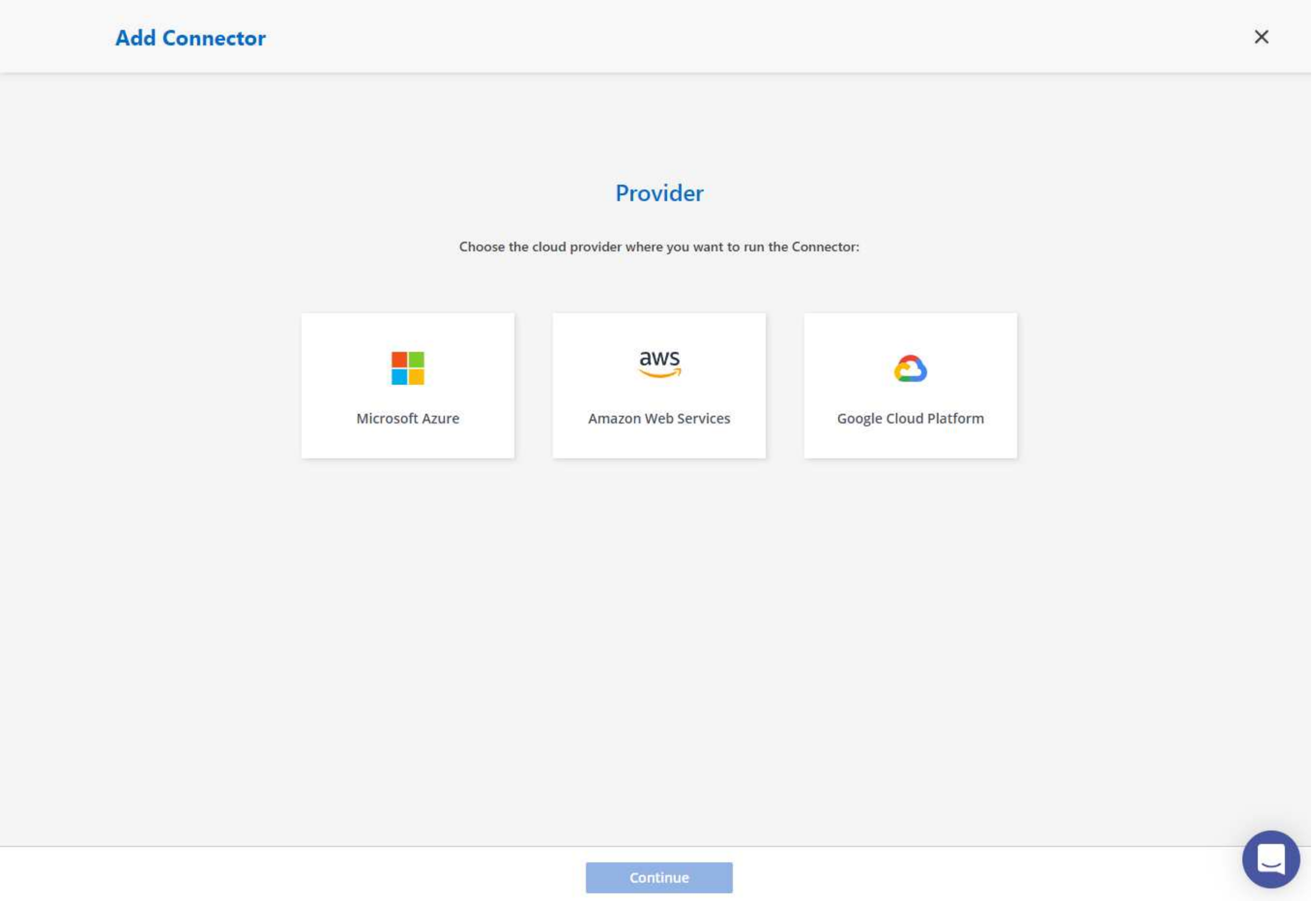
Hybrid Multicloud

Backup from On-premises or Cloud Volumes ONTAP to AWS, Azure, GCP or StorageGRID

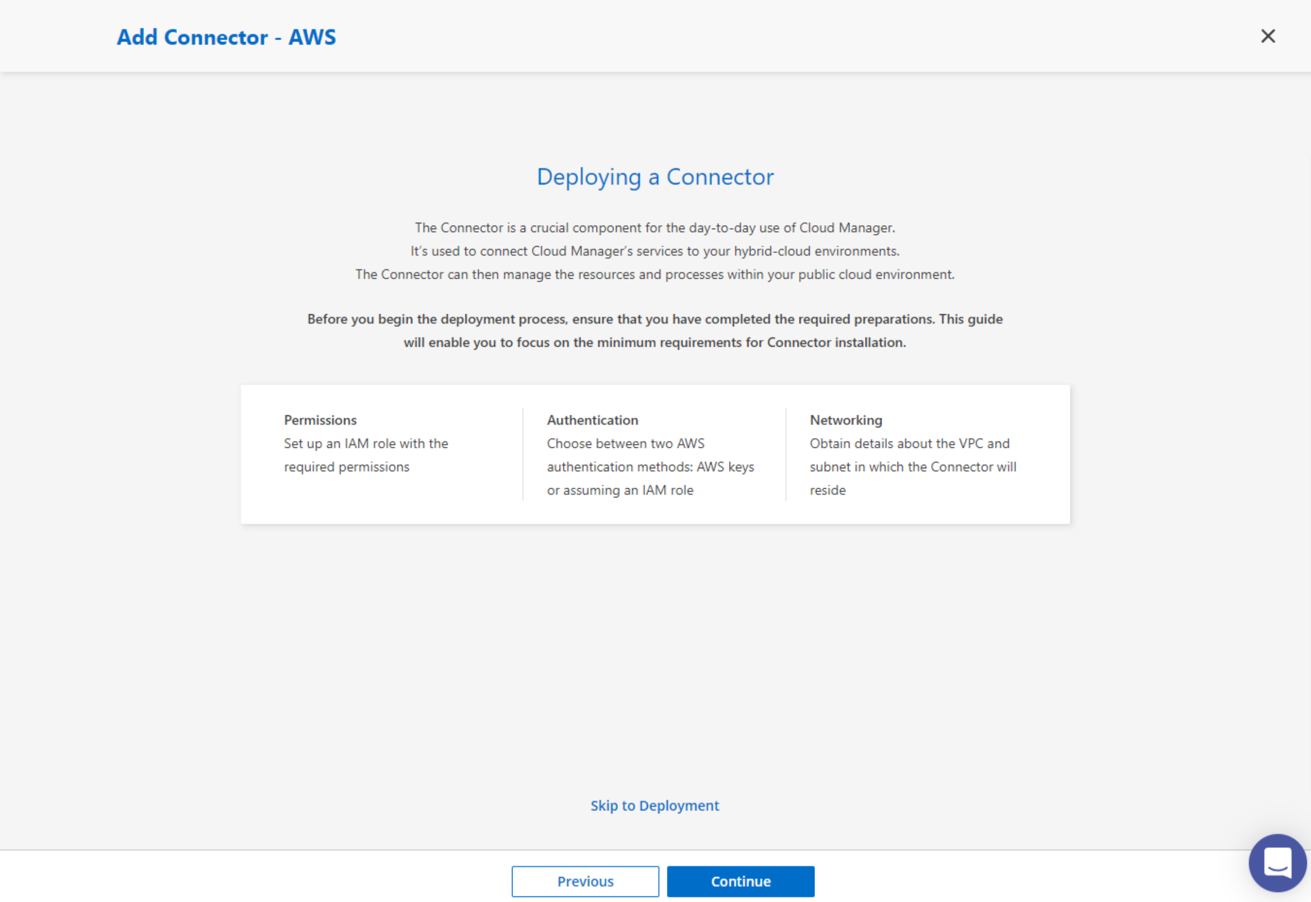
Unmatched Efficiency

Combines incremental, block-level operation storage efficiencies to reduce time and c

1. Choose your cloud provider (in this case, **Amazon Web Services**).



1. 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."



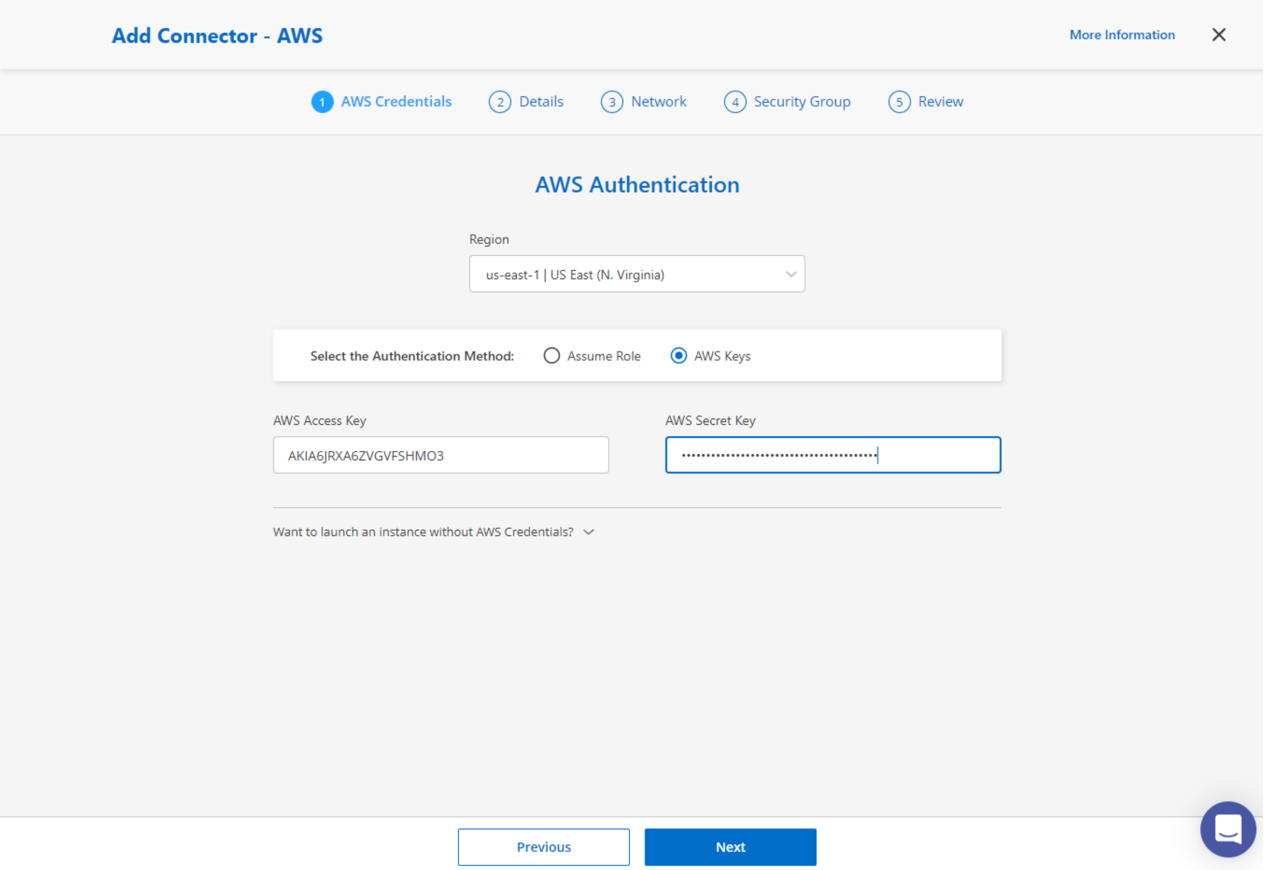
Deploying a Connector

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	Authentication	Networking
Set up an IAM role with the required permissions	Choose between two AWS authentication methods: AWS keys or assuming an IAM role	Obtain details about the VPC and subnet in which the Connector will reside

1. Enter your AWS account authentication with **Access Key** and **Secret Key**.



AWS Authentication

Region: us-east-1 | US East (N. Virginia)

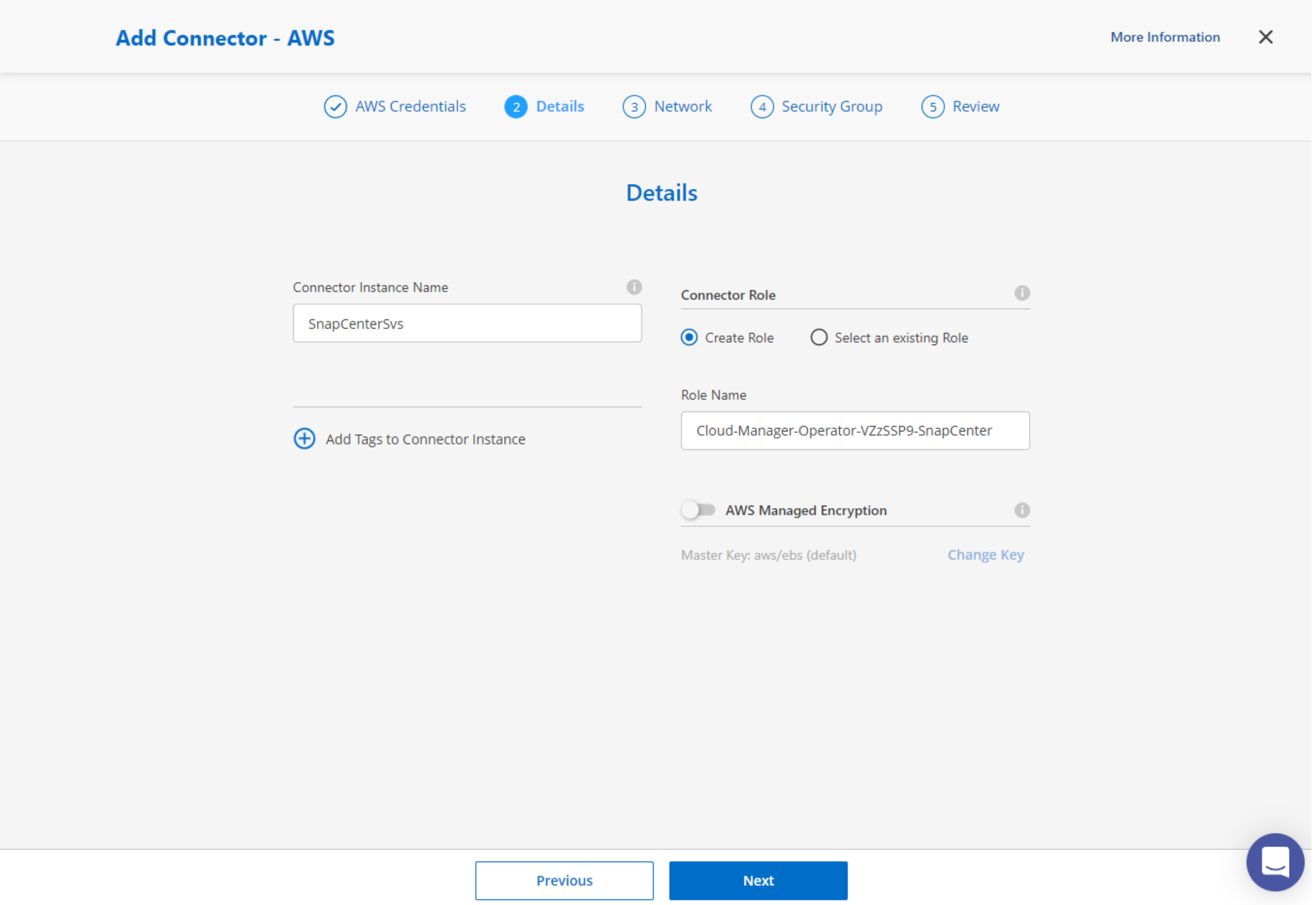
Select the Authentication Method: ○ Assume Role ● AWS Keys

AWS Access Key: AKIA6JRXA6ZVGVFSHMO3

AWS Secret Key: ••

Want to launch an instance without AWS Credentials?

2. Name the connector instance and select **Create Role** under **Details**.



Add Connector - AWS

More Information

AWS Credentials · 2 Details · 3 Network · 4 Security Group · 5 Review

Details

Connector Instance Name: SnapCenterSvs

Add Tags to Connector Instance

Connector Role: ● Create Role ○ Select an existing Role

Role Name: Cloud-Manager-Operator-VZzSSP9-SnapCenter

AWS Managed Encryption

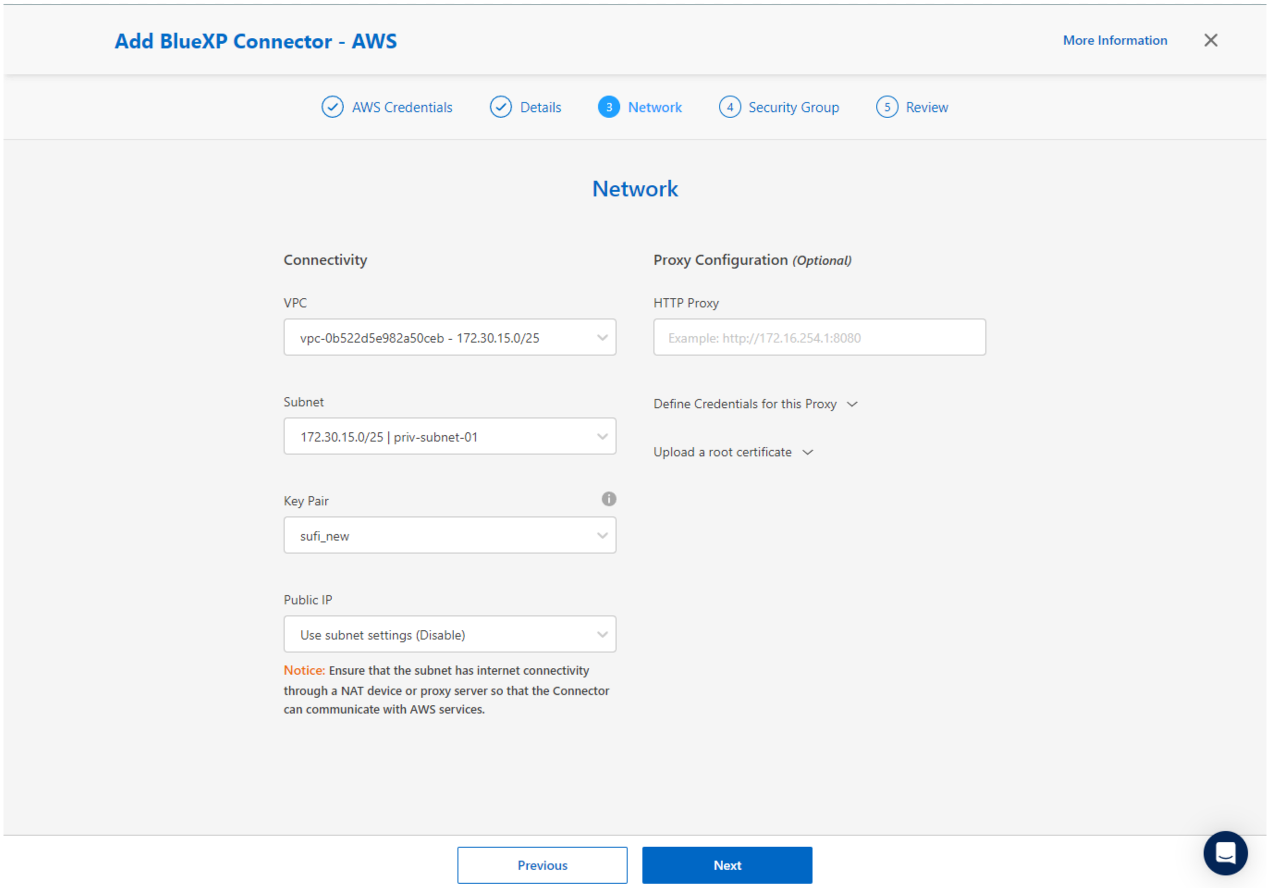
Master Key: aws/ebs (default)

Change Key

Previous

Next

1. Configure networking with the proper **VPC**, **Subnet**, and SSH **Key Pair** for connector access.



Network

Connectivity

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)

Notice: Ensure that the subnet has internet connectivity through a NAT device or proxy server so that the Connector can communicate with AWS services.

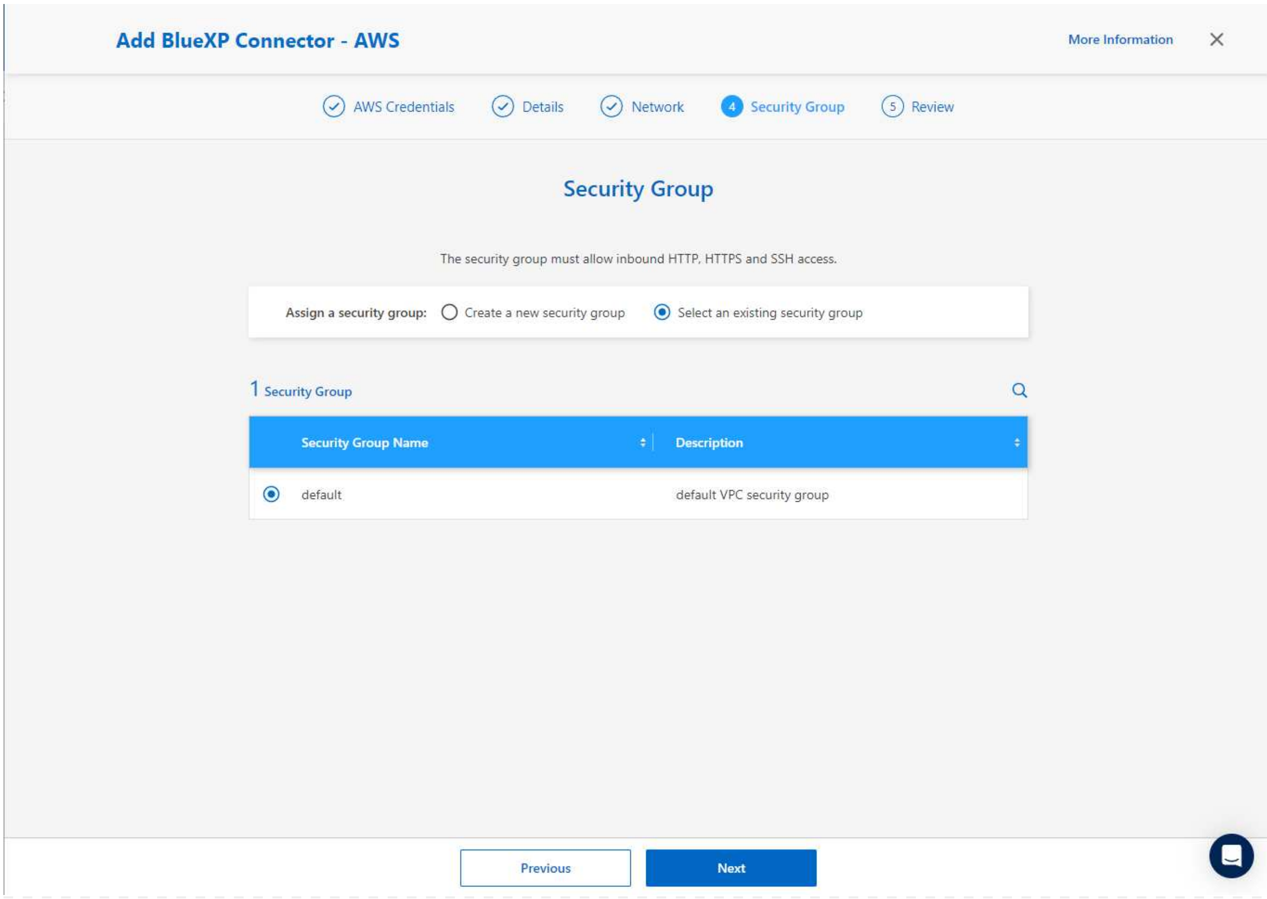
Proxy Configuration *(Optional)*

HTTP Proxy: Example: http://172.16.254.1:8080

Define Credentials for this Proxy

Upload a root certificate

2. Set the **Security Group** for the connector.



Security Group

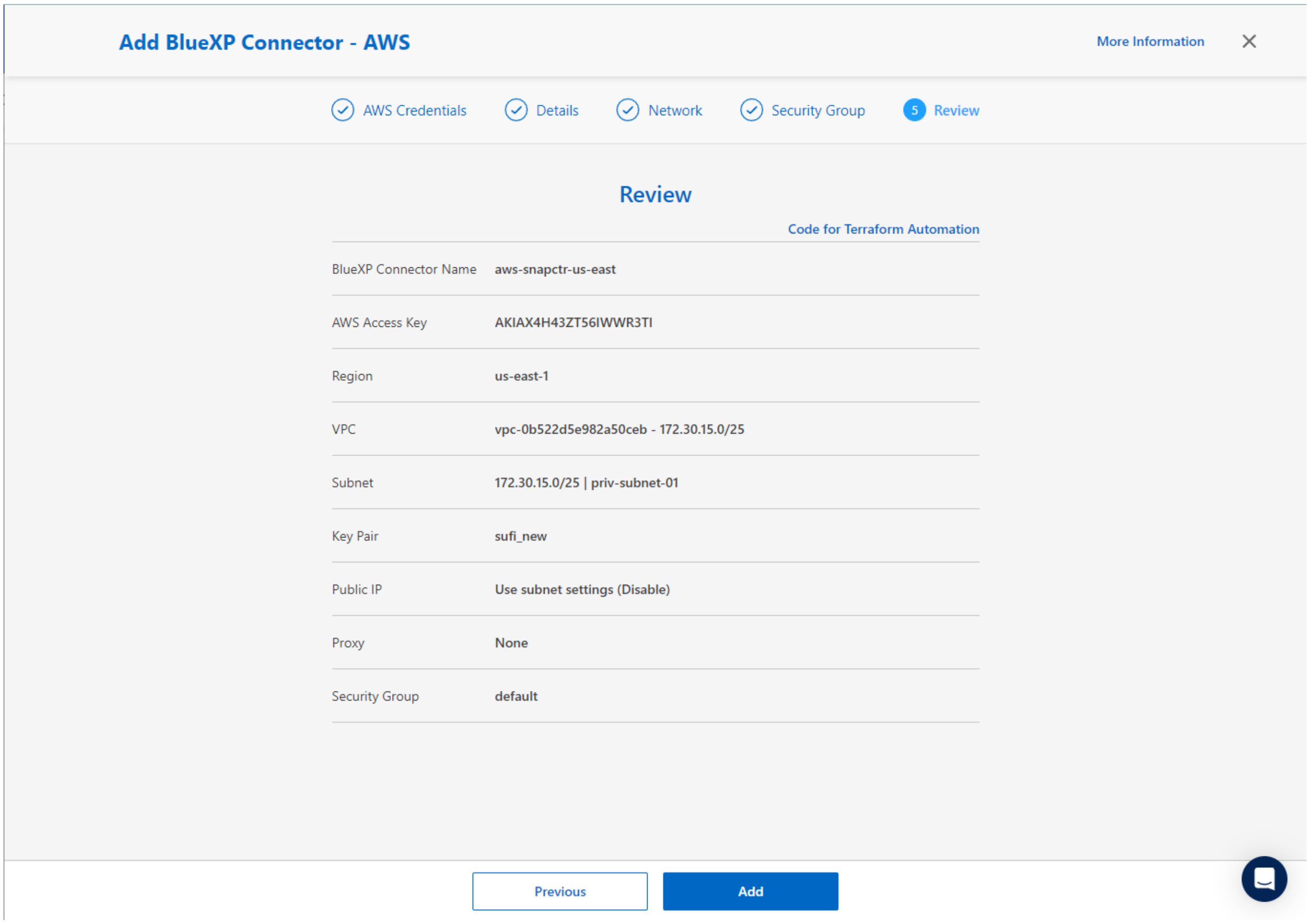
The security group must allow inbound HTTP, HTTPS and SSH access.

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

1 Security Group

	Security Group Name	Description
●	default	default VPC security group

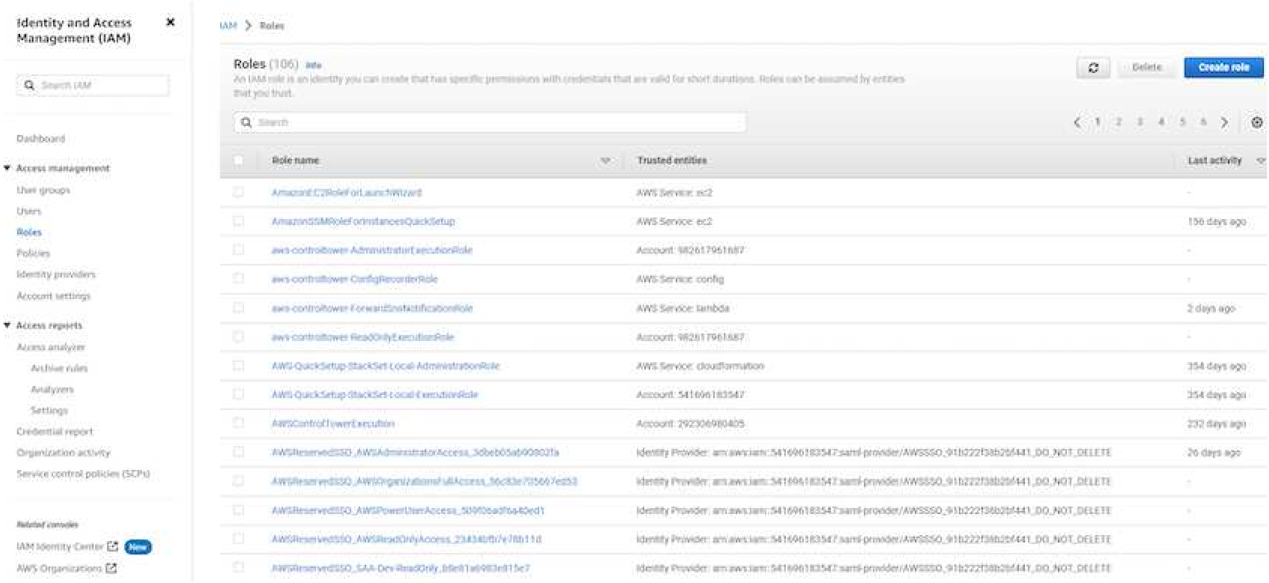
3. Review the summary page and click **Add** to start connector creation. It generally takes about 10 mins to complete deployment. Once completed, the connector instance appears in the AWS EC2 dashboard.



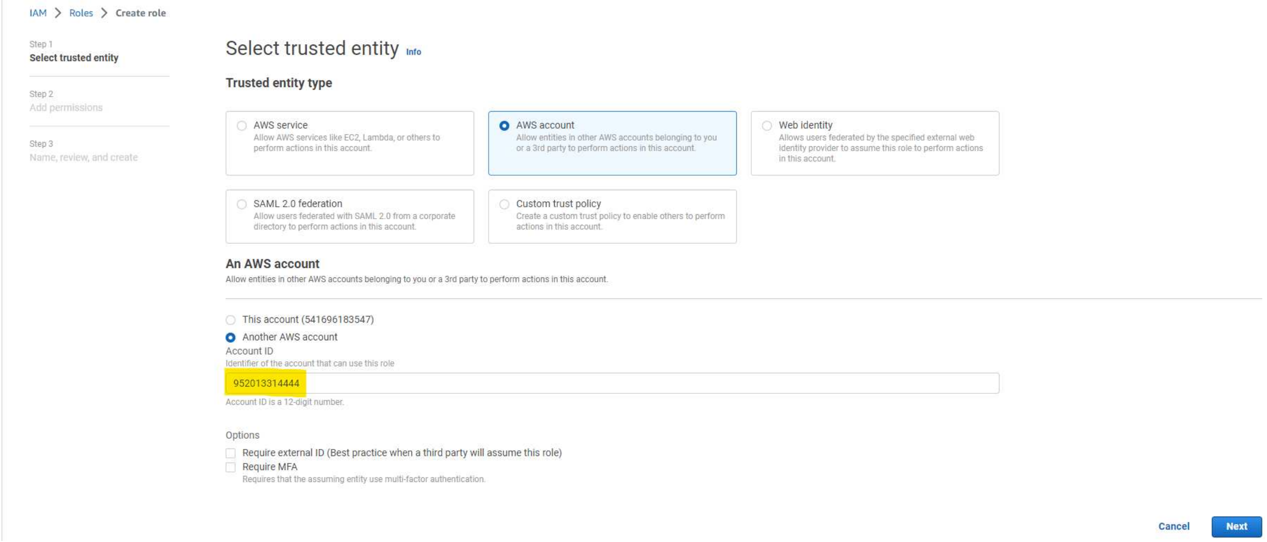
BlueXP Connector Name	aws-snapctr-us-east
AWS Access Key	AKIAX4H43ZT56IWWR3TI
Region	us-east-1
VPC	vpc-0b522d5e982a50ceb - 172.30.15.0/25
Subnet	172.30.15.0/25 | priv-subnet-01
Key Pair	sufi_new
Public IP	Use subnet settings (Disable)
Proxy	None
Security Group	default

Define a credential in BlueXP for AWS resources access

1. First, from AWS EC2 console, create a role in **Identity and Access Management (IAM)** menu **Roles**, **Create role** to start role creation workflow.



2. In **Select trusted entity** page, choose **AWS account**, **Another AWS account**, and paste in the BlueXP account ID, which can be retrieved from BlueXP console.


IAM > Roles > Create role
Step 1
Select trusted entity
Step 2
Add permissions
Step 3
Name, review, and create
Select trusted entity Info
Trusted entity type
AWS service
Allow AWS services like EC2, Lambda, or others to perform actions in this account.
Web identity
Allows users federated by the specified external web identity provider to assume this role to perform actions in this account.
SAML 2.0 federation
Allow users federated with SAML 2.0 from a corporate directory to perform actions in this account.
Custom trust policy
Create a custom trust policy to enable others to perform actions in this account.
Cancel
Next

● AWS account — Allow entities in other AWS accounts belonging to you or a 3rd party to perform actions in this account.

An AWS account

Allow entities in other AWS accounts belonging to you or a 3rd party to perform actions in this account.

○ This account (541696183547)

● Another AWS account

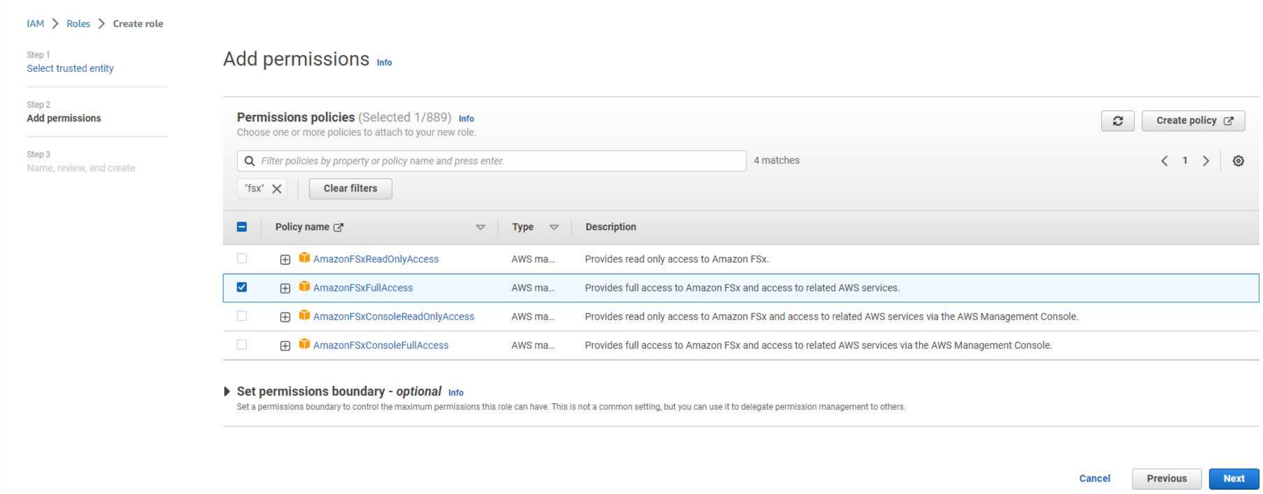
Account ID: 952013314444

Options

☐ Require external ID (Best practice when a third party will assume this role)

☐ Require MFA

3. Filter permission policies by fsx and add **Permissions policies** to the role.



Permissions policies (Selected 1/889) Info

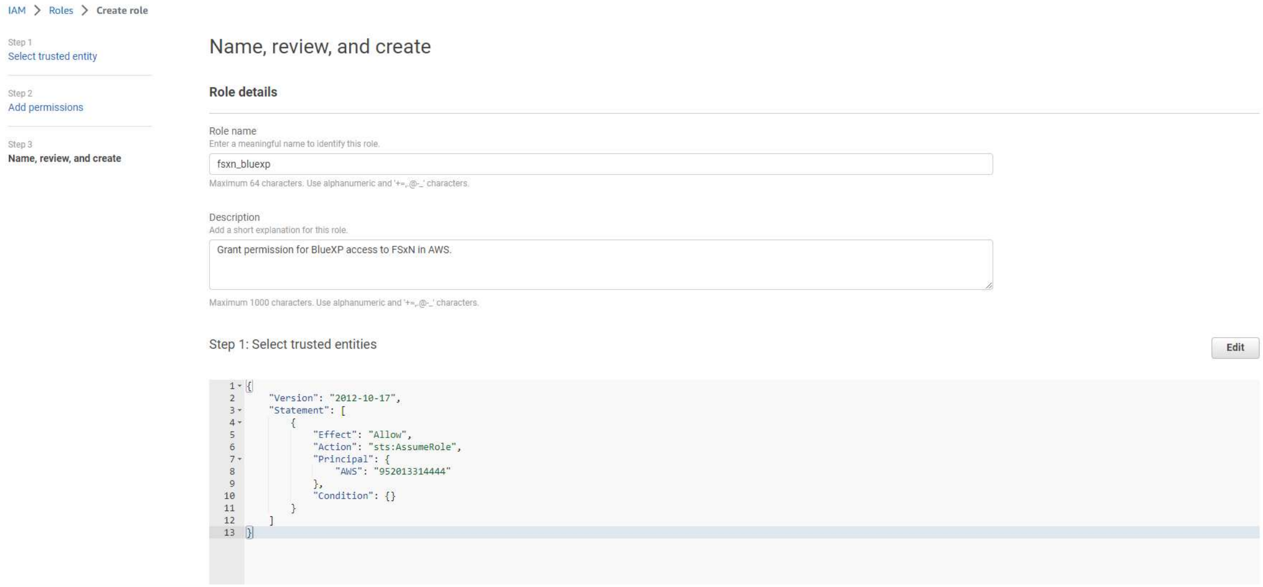
Choose one or more policies to attach to your new role.

4 matches

	Policy name	Type	Description
☐	AmazonFSxReadOnlyAccess	AWS ma...	Provides read only access to Amazon FSx.
☑	AmazonFSxFullAccess	AWS ma...	Provides full access to Amazon FSx and access to related AWS services.
☐	AmazonFSxConsoleReadOnlyAccess	AWS ma...	Provides read only access to Amazon FSx and access to related AWS services via the AWS Management Console.
☐	AmazonFSxConsoleFullAccess	AWS ma...	Provides full access to Amazon FSx and access to related AWS services via the AWS Management Console.

Set a permissions boundary to control the maximum permissions this role can have. This is not a common setting, but you can use it to delegate permission management to others.

4. In **Role details** page, name the role, add a description, then click **Create role**.



Role name

Enter a meaningful name to identify this role.

fsxn_bluexp

Maximum 64 characters. Use alphanumeric and '+=,.@-_' characters.

Description

Add a short explanation for this role.

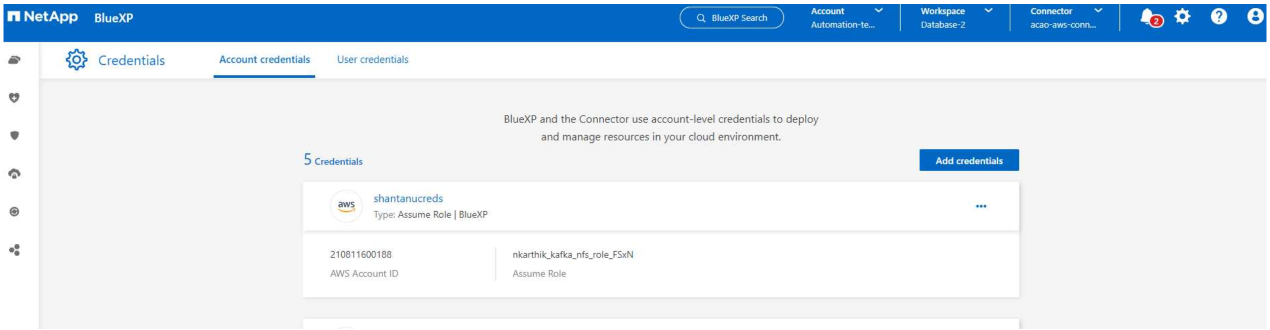
Grant permission for BlueXP access to FSxN in AWS.

Maximum 1000 characters. Use alphanumeric and '+=,.@-_' characters.

Step 1: Select trusted entities

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": "sts:AssumeRole",
            "Principal": {
                "AWS": "952013314444"
            },
            "Condition": {}
        }
    ]
}
```

5. Back to BlueXP console, click on setting icon on top right corner of the console to open **Account credentials** page, click **Add credentials** to start credential configuration workflow.



BlueXP and the Connector use account-level credentials to deploy and manage resources in your cloud environment.

5 Credentials

shantanucreds

Type: Assume Role | BlueXP

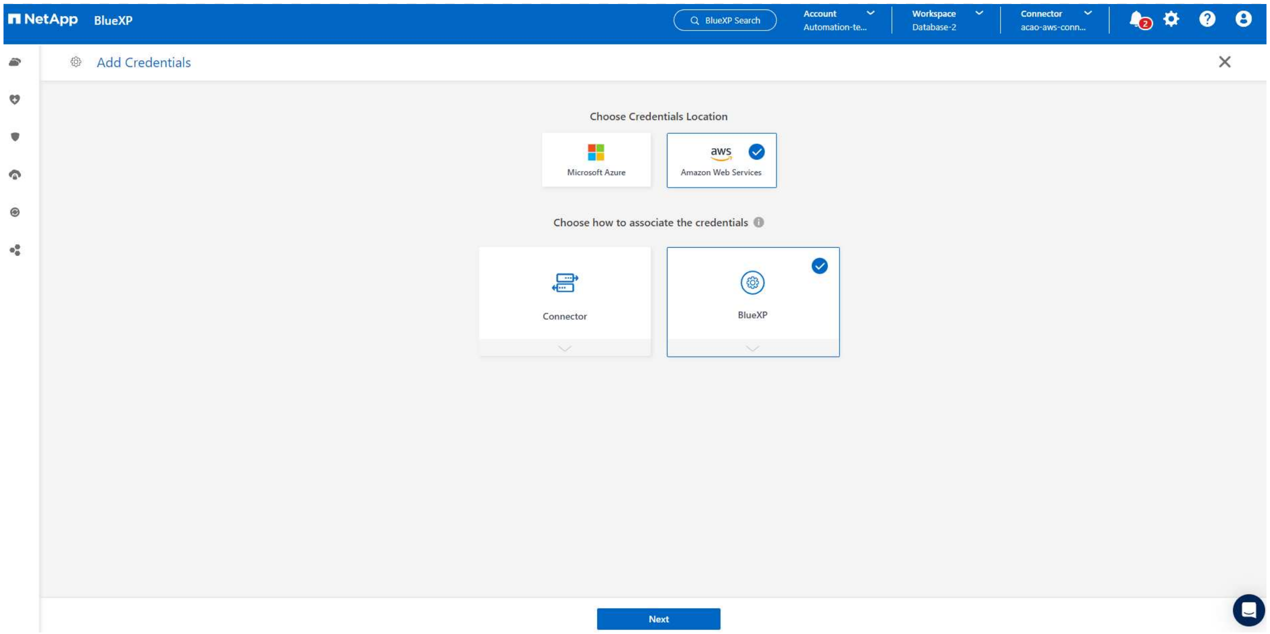
210811600188

AWS Account ID

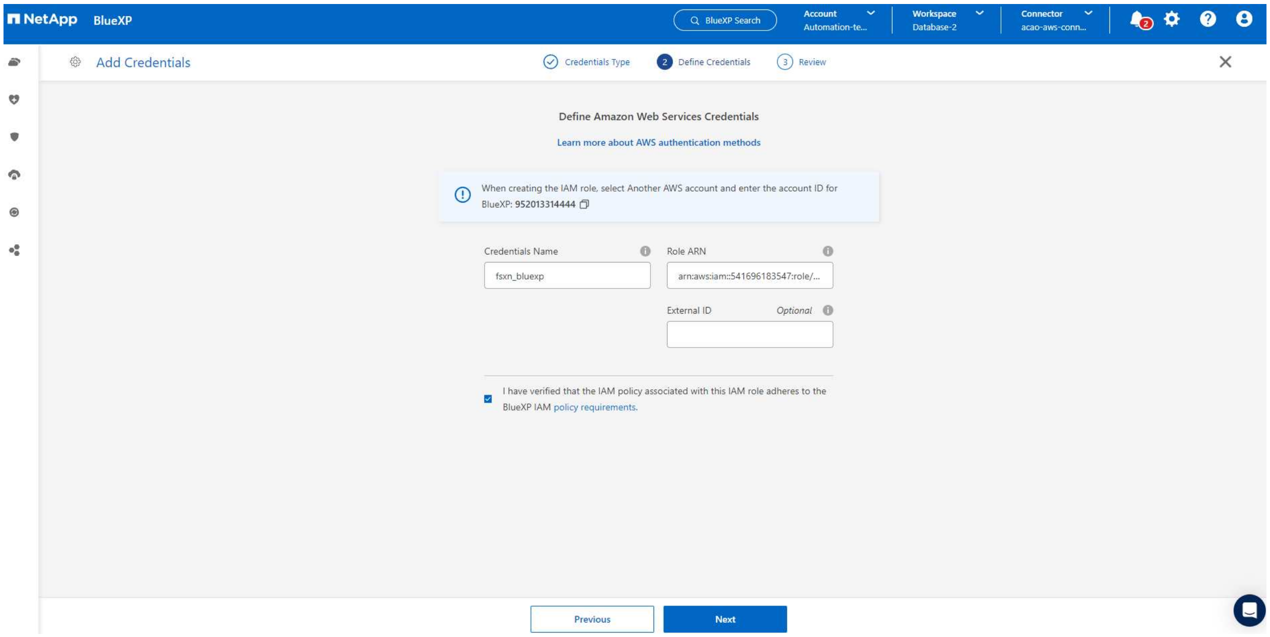
nkarthik_kafka_nfs_role_FSxN

Assume Role

6. Choose credential location as - **Amazon Web Services - BlueXP**.



7. Define AWS credentials with proper **Role ARN**, which can be retrieved from AWS IAM role created in step one above. BlueXP **account ID**, which is used for creating AWS IAM role in step one.



When creating the IAM role, select Another AWS account and enter the account ID for BlueXP: **952013314444**

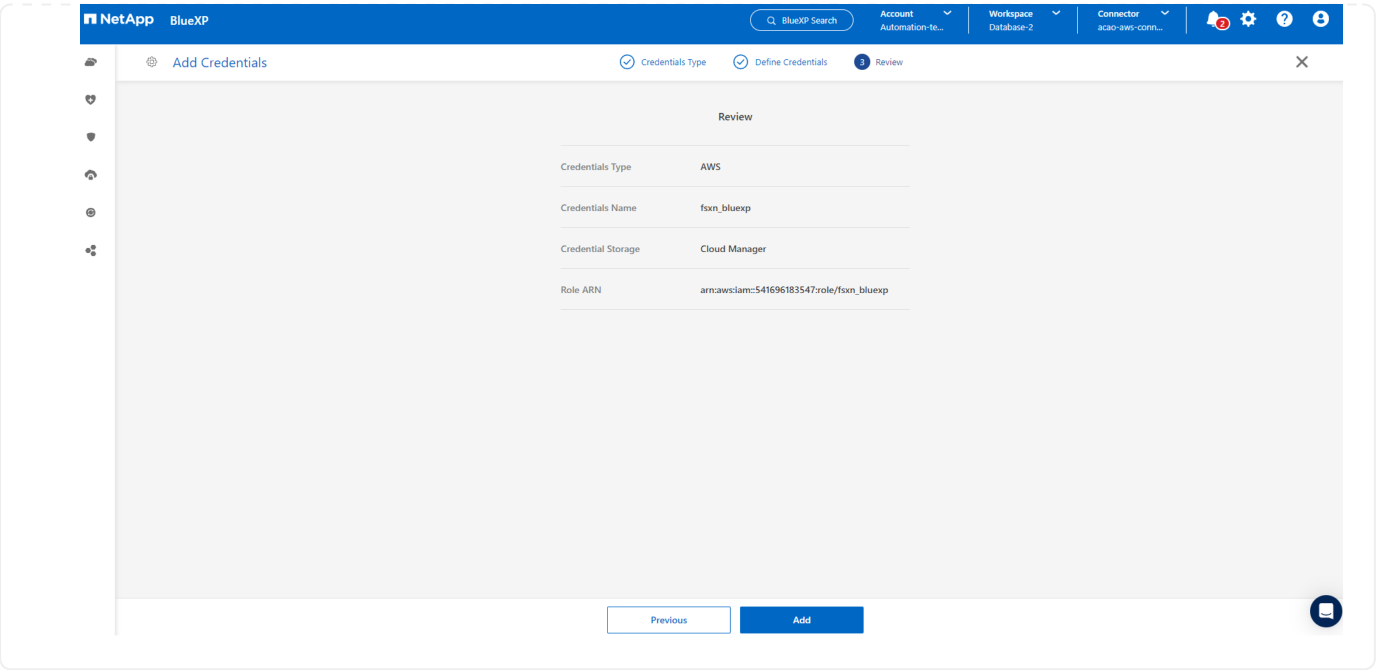
Credentials Name: fsxn_bluexp

Role ARN: arn:aws:iam::541696183547:role/...

External ID *Optional*

☑ I have verified that the IAM policy associated with this IAM role adheres to the BlueXP IAM policy requirements.

8. Review and **Add**.



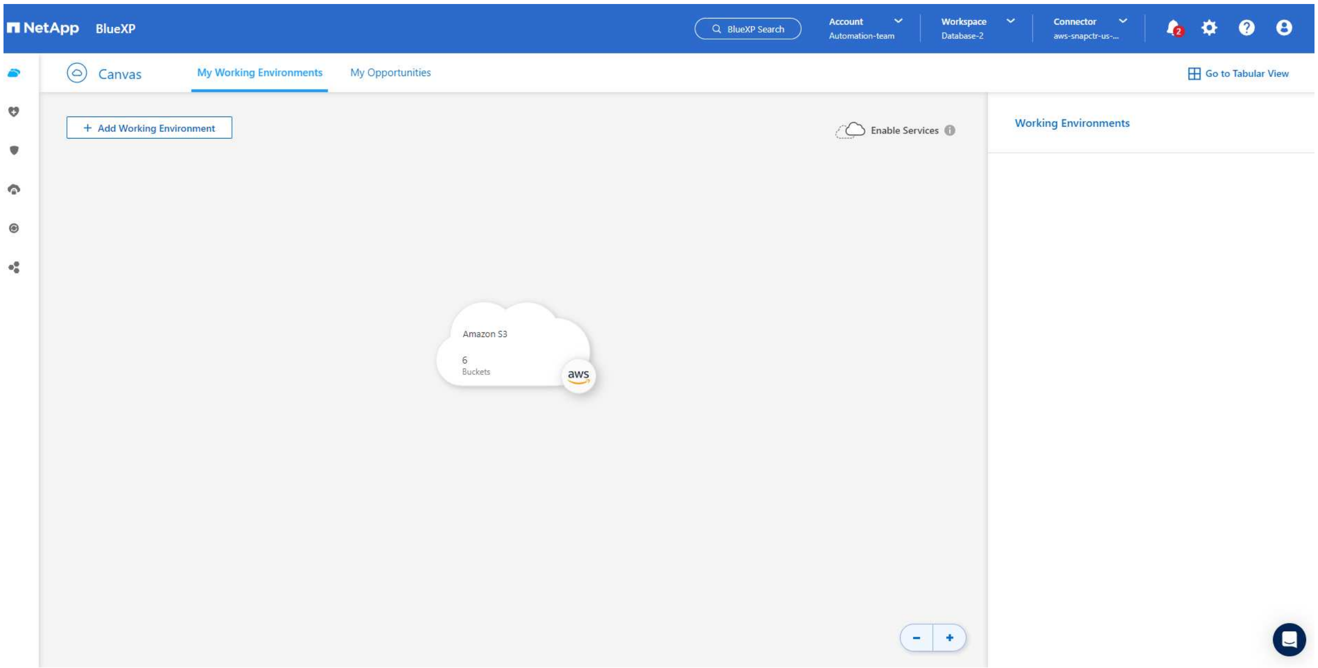
Review

Credentials Type	AWS
Credentials Name	fsxn_bluexp
Credential Storage	Cloud Manager
Role ARN	arn:aws:iam::541696183547:role/fsxn_bluexp

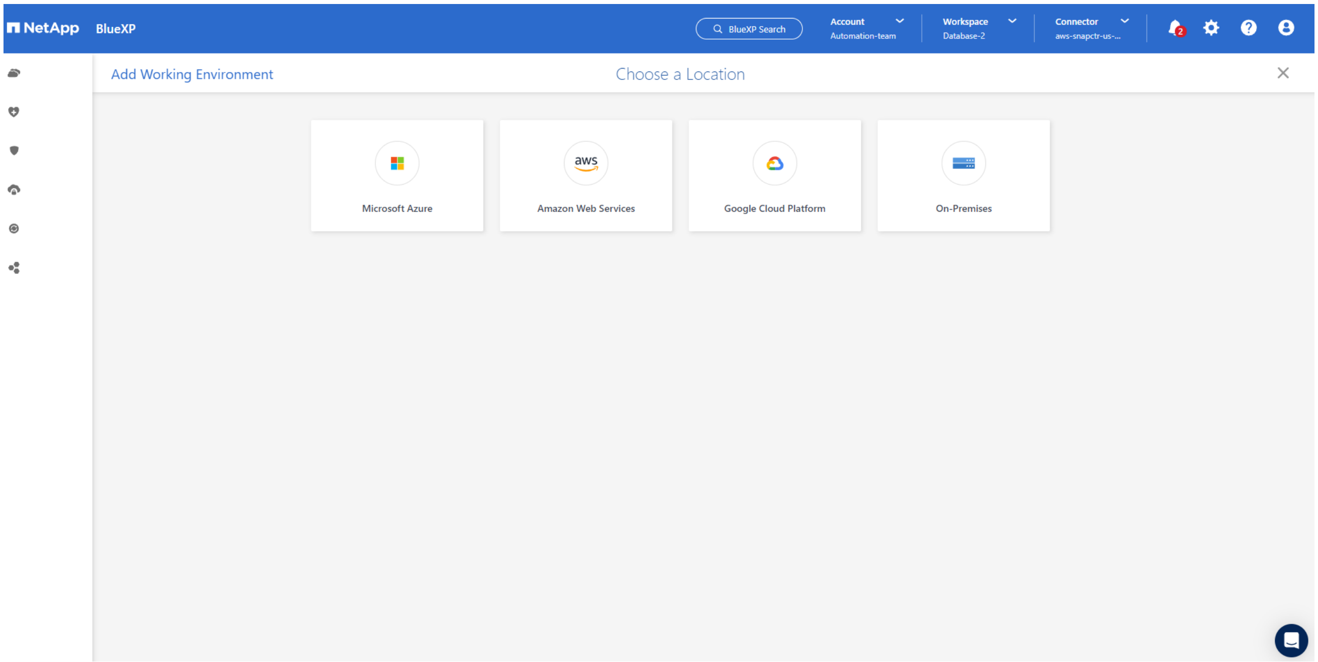
SnapCenter services setup

With the connector deployed and the credential added, SnapCenter services can now be set up with the following procedure:

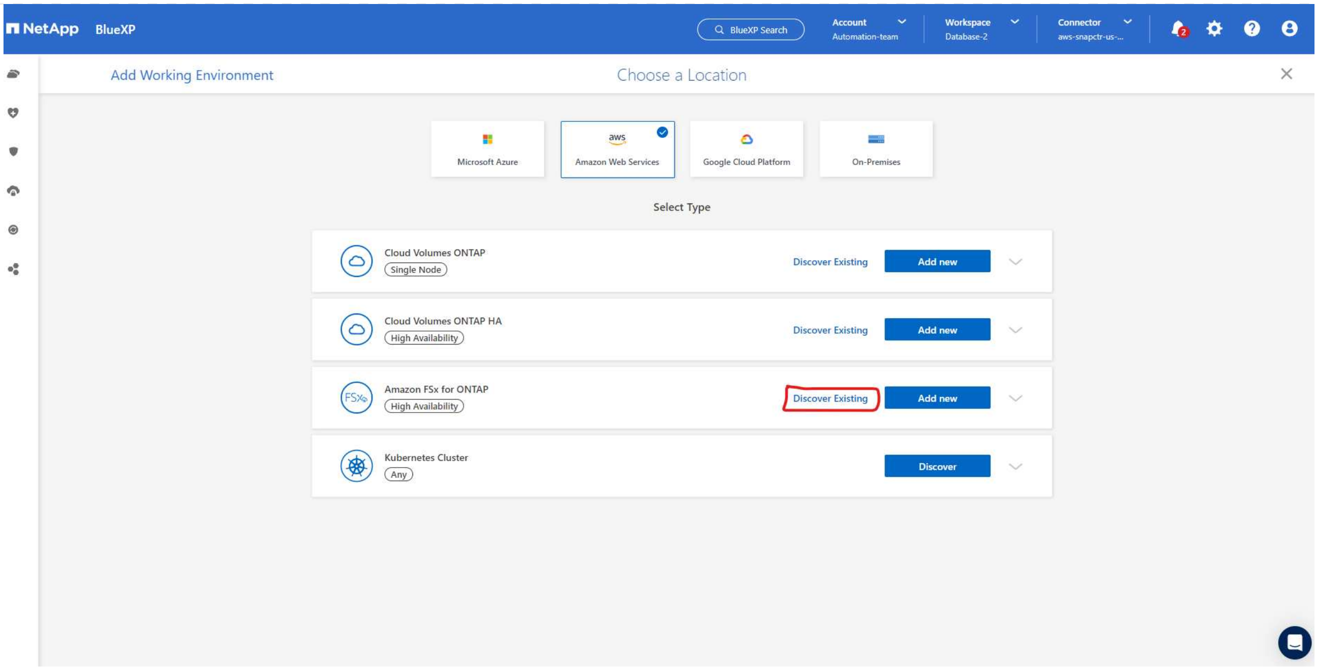
1. From **My Working Environment** click **Add working Environment** to discover FSx deployed in AWS.



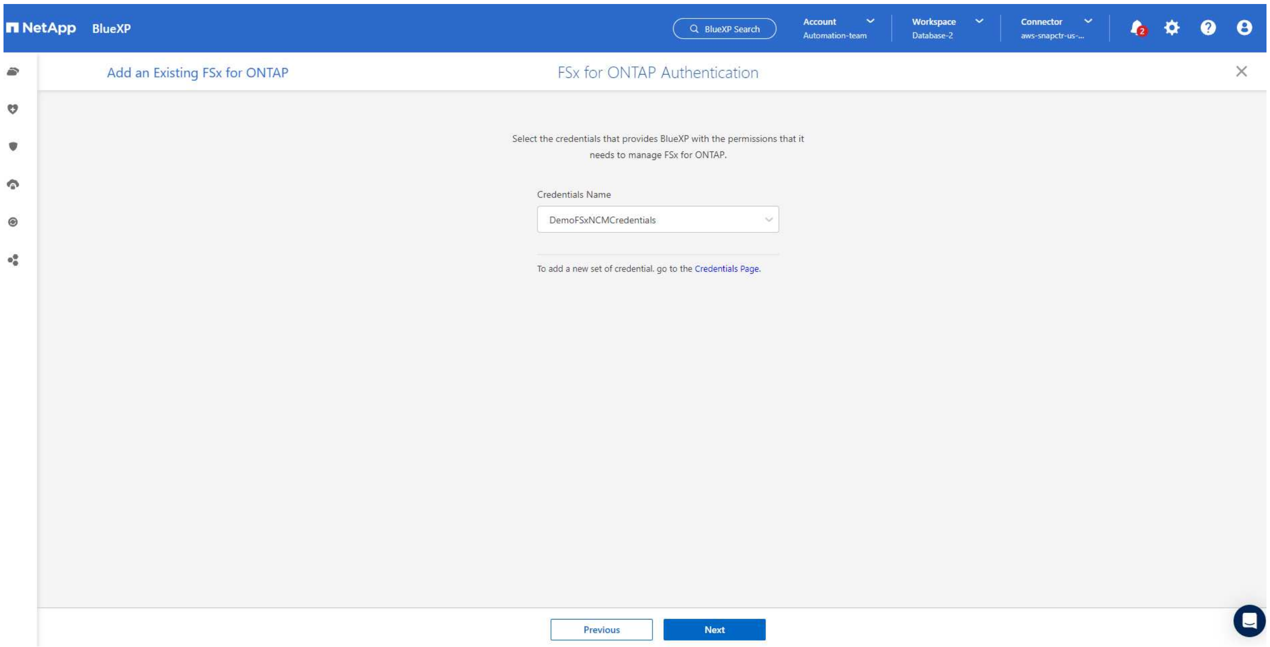
1. Choose **Amazon Web Services** as the location.



1. Click **Discover Existing** next to **Amazon FSx for ONTAP**.



1. Select the **Credentials Name** that you have created in previous section to grant 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.

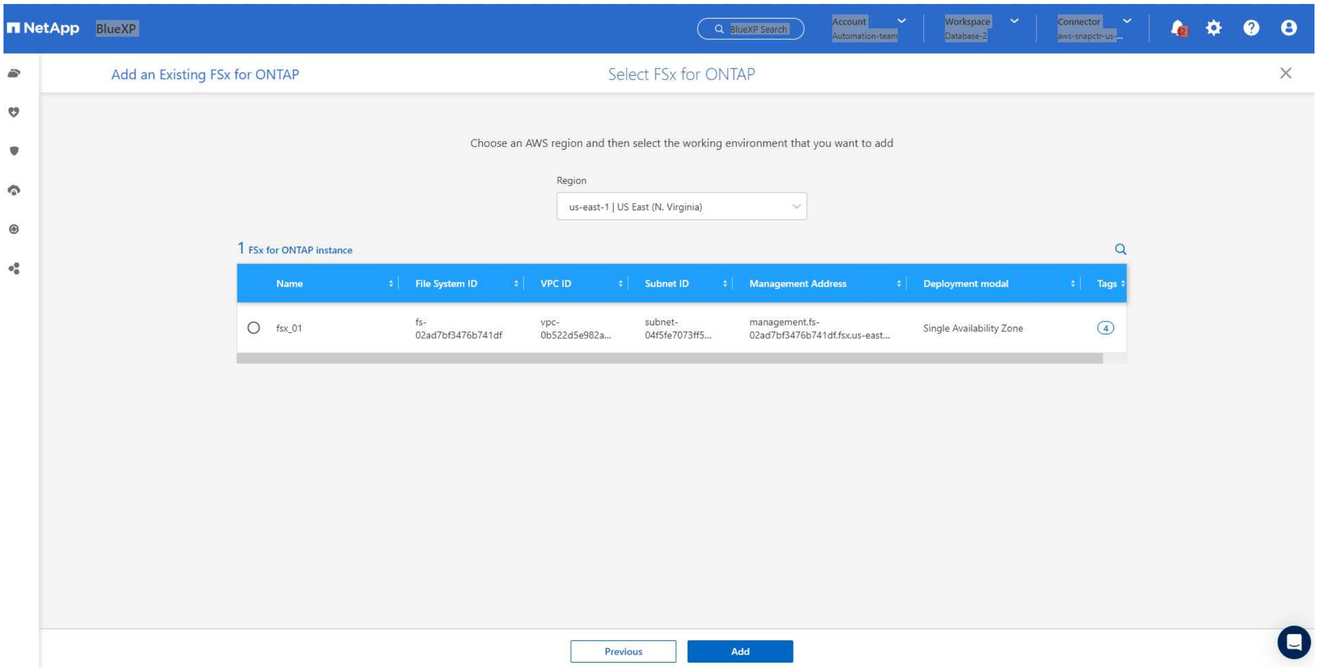

NetApp BlueXP
BlueXP Search
Account Automation-team
Workspace Database-2
Connector aws-snapctr-us-...
Add an Existing FSx for ONTAP
FSx for ONTAP Authentication
Previous
Next

Select the credentials that provides BlueXP with the permissions that it needs to manage FSx for ONTAP.

Credentials Name: DemoFSxNCMCredentials

To add a new set of credential. go to the Credentials Page.

2. Choose the AWS region where Amazon FSx for ONTAP is deployed, select the FSx cluster that is hosting the Oracle database and click Add.



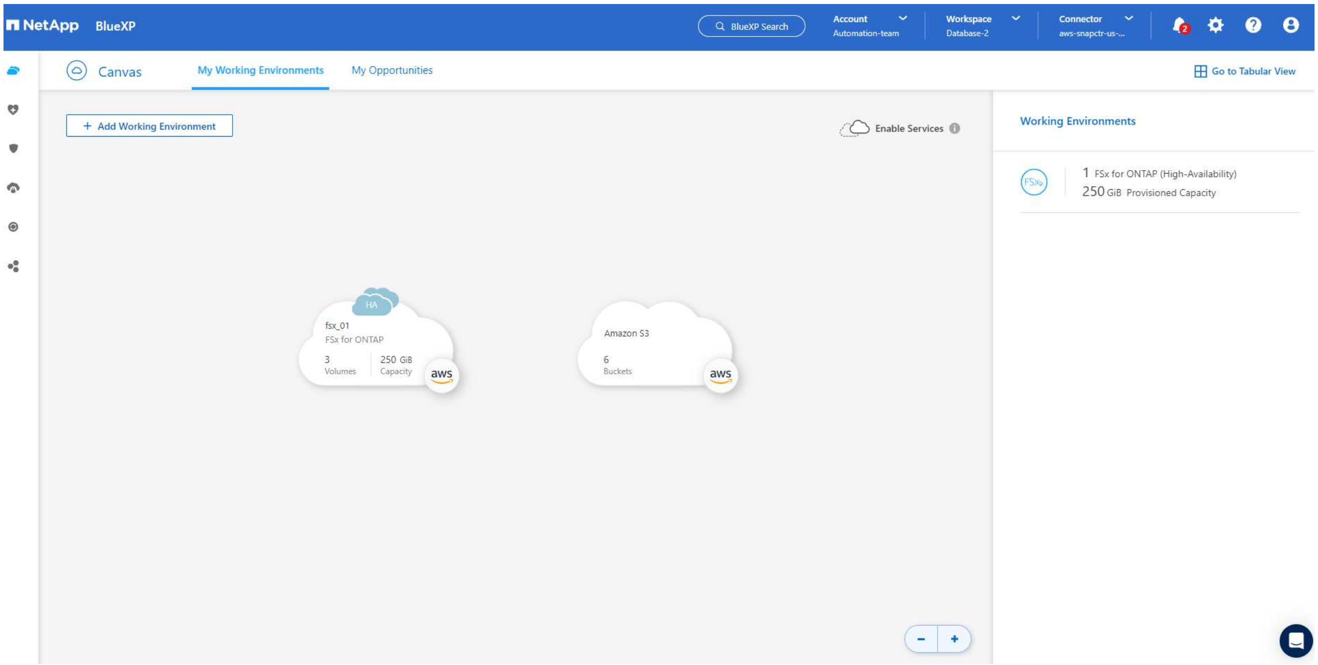
Choose an AWS region and then select the working environment that you want to add

Region: us-east-1 | US East (N. Virginia)

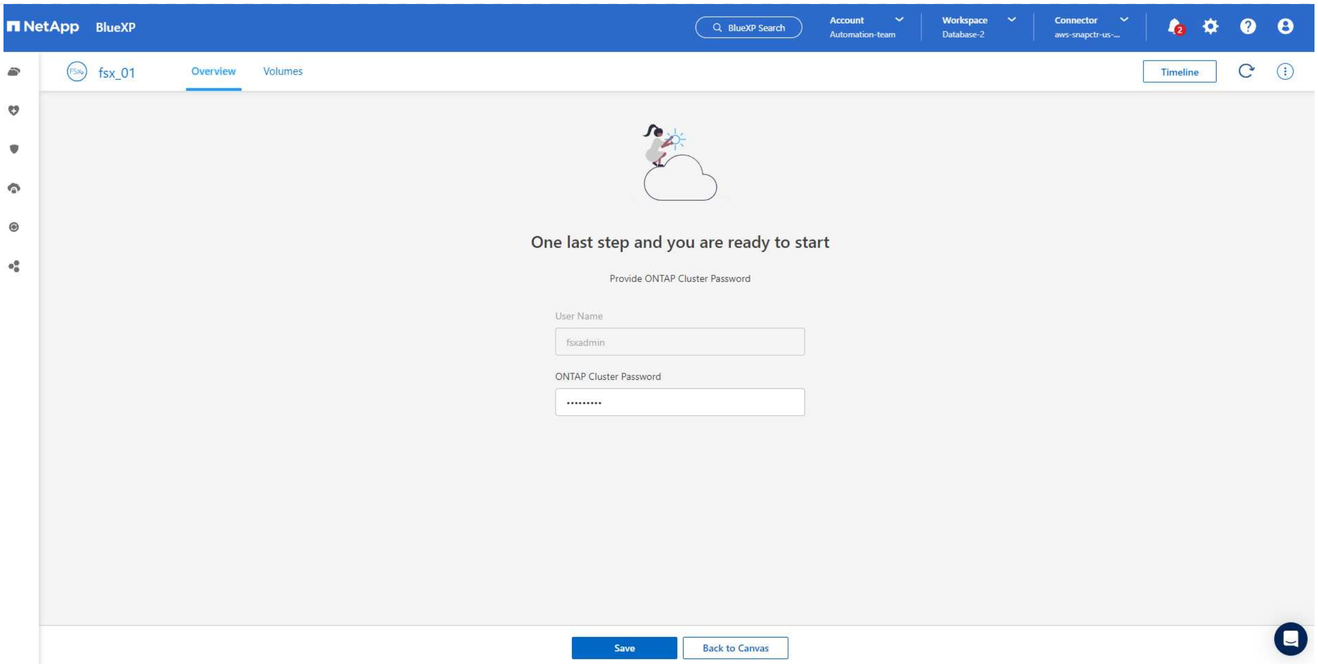
1 FSx for ONTAP instance

	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

1. The discovered Amazon FSx for ONTAP instance now appears in the working environment.



1. You can log into the FSx cluster with your fsxadmin account credentials.



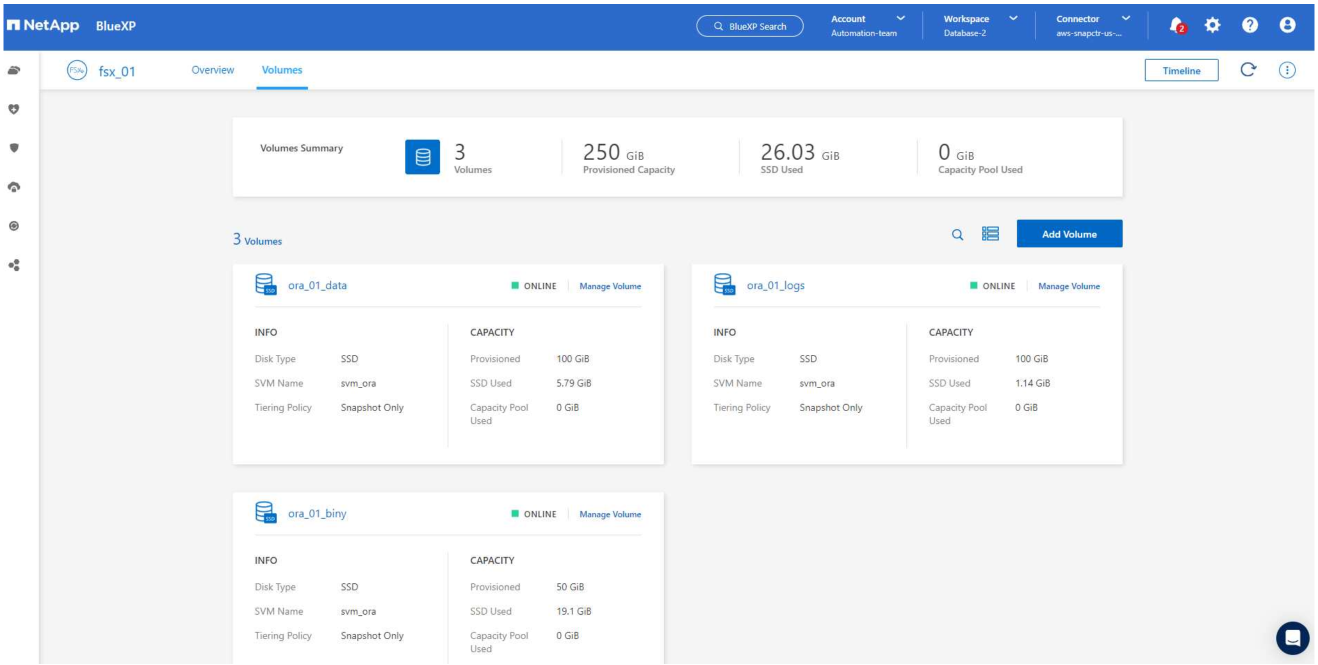
One last step and you are ready to start

Provide ONTAP Cluster Password

User Name: fsxadmin

ONTAP Cluster Password: •••••••••

1. After you log into Amazon FSx for ONTAP, review your database storage information (such as database volumes).



Volumes Summary: 3 Volumes; 250 GiB Provisioned Capacity; 26.03 GiB SSD Used; 0 GiB Capacity Pool Used

3 Volumes

ora_01_data — ONLINE

INFO		CAPACITY	
Disk Type	SSD	Provisioned	100 GiB
SVM Name	svm_ora	SSD Used	5.79 GiB
Tiering Policy	Snapshot Only	Capacity Pool Used	0 GiB

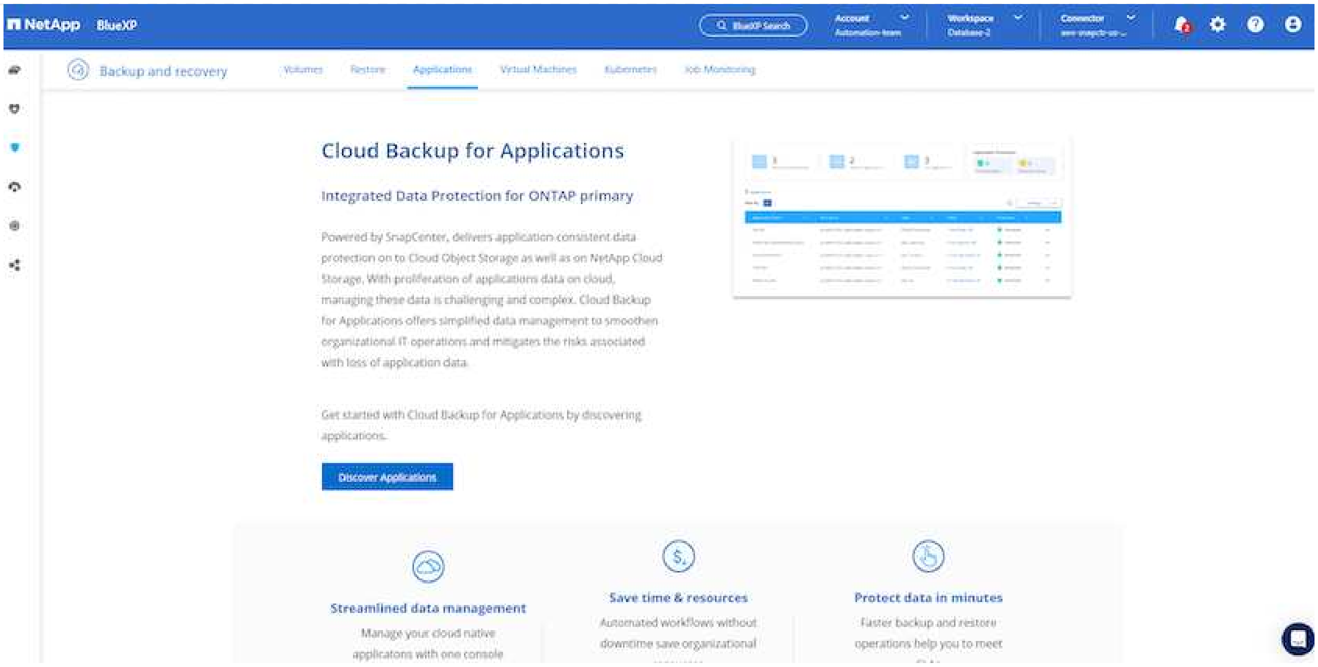
ora_01_logs — ONLINE

INFO		CAPACITY	
Disk Type	SSD	Provisioned	100 GiB
SVM Name	svm_ora	SSD Used	1.14 GiB
Tiering Policy	Snapshot Only	Capacity Pool Used	0 GiB

ora_01_biny — ONLINE

INFO		CAPACITY	
Disk Type	SSD	Provisioned	50 GiB
SVM Name	svm_ora	SSD Used	19.1 GiB
Tiering Policy	Snapshot Only	Capacity Pool Used	0 GiB

1. 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**.



Cloud Backup for Applications

Integrated Data Protection for ONTAP primary

Powered by SnapCenter, delivers application consistent data protection on to Cloud Object Storage as well as on NetApp Cloud Storage. With proliferation of applications data on cloud, managing these data is challenging and complex. Cloud Backup for Applications offers simplified data management to smoothen organizational IT operations and mitigates the risks associated with loss of application data.

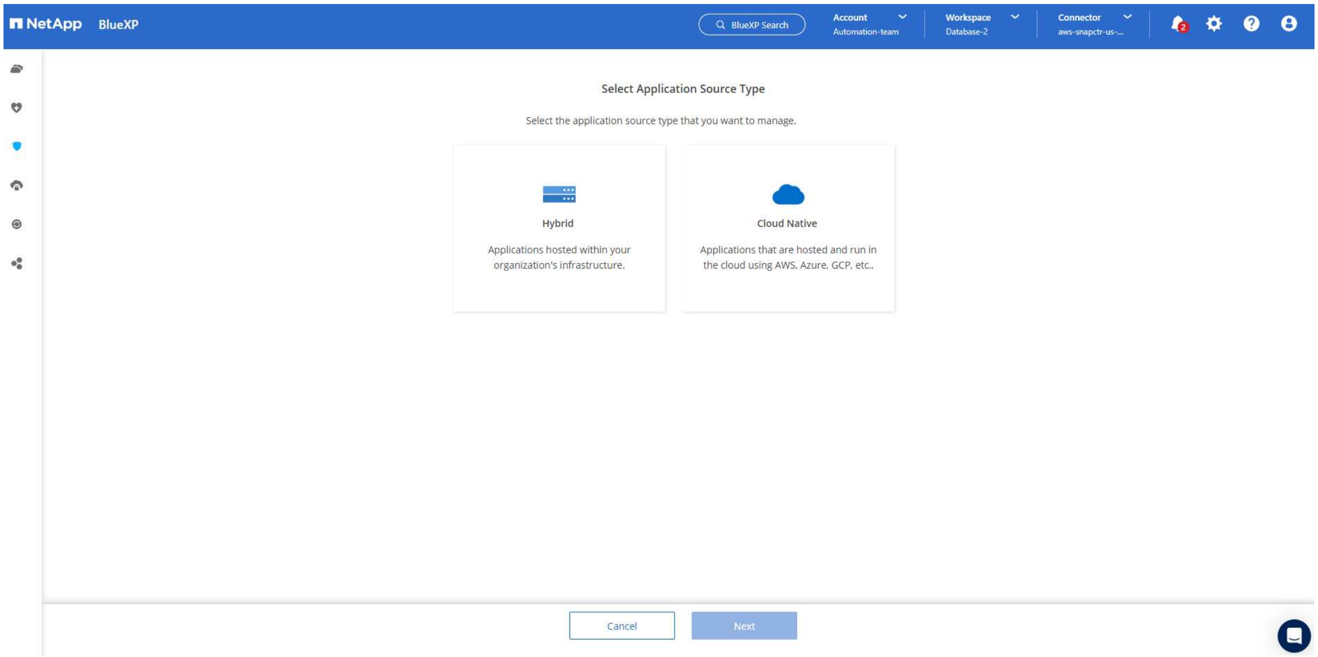
Get started with Cloud Backup for Applications by discovering applications.

Manage your cloud native applicatons with one console

Automated workflows without downtime save organizational

Faster backup and restore operations help you to meet

1. Select **Cloud Native** as the application source type.



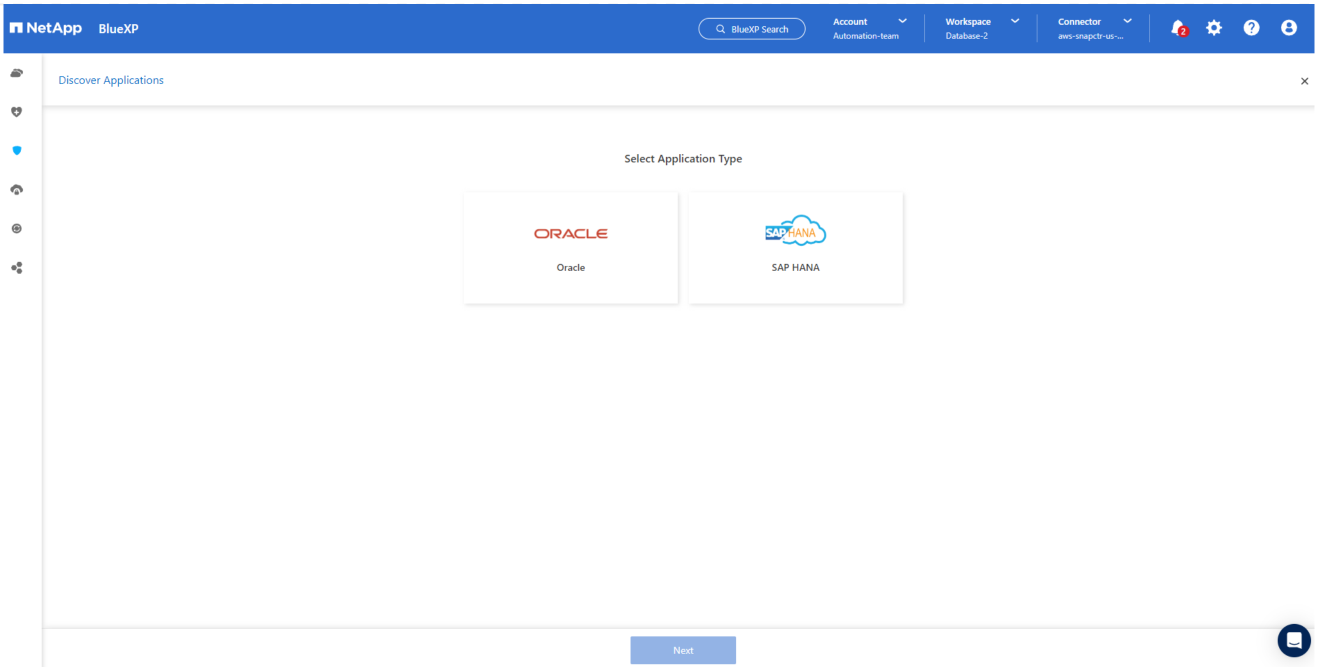
Select Application Source Type

Select the application source type that you want to manage.

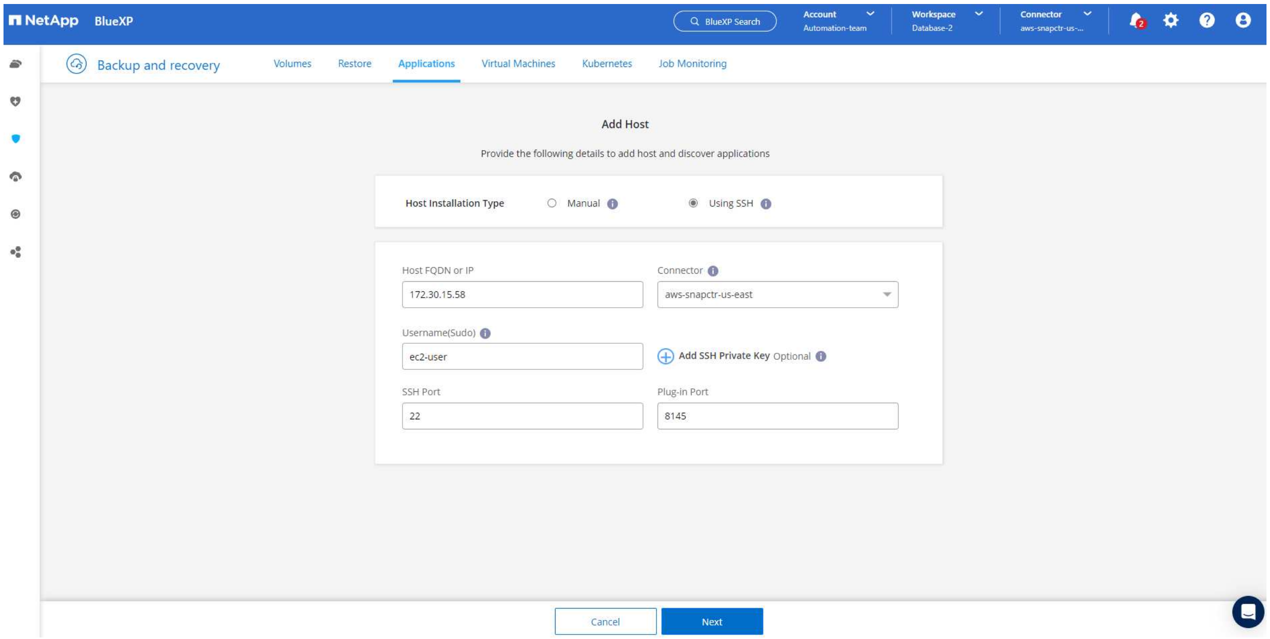
Applications hosted within your organization's infrastructure.

Applications that are hosted and run in the cloud using AWS, Azure, GCP, etc..

1. Choose **Oracle** for the application type.



1. Fill in the AWS EC2 Oracle application host details. Choose **Using SSH** as **Host Installation Type** for one step plugin installation and database discovery. Then, click on **Add SSH Private Key**.



Add Host

Provide the following details to add host and discover applications

Host Installation Type ○ Manual ● Using SSH

Host FQDN or IP: 172.30.15.58

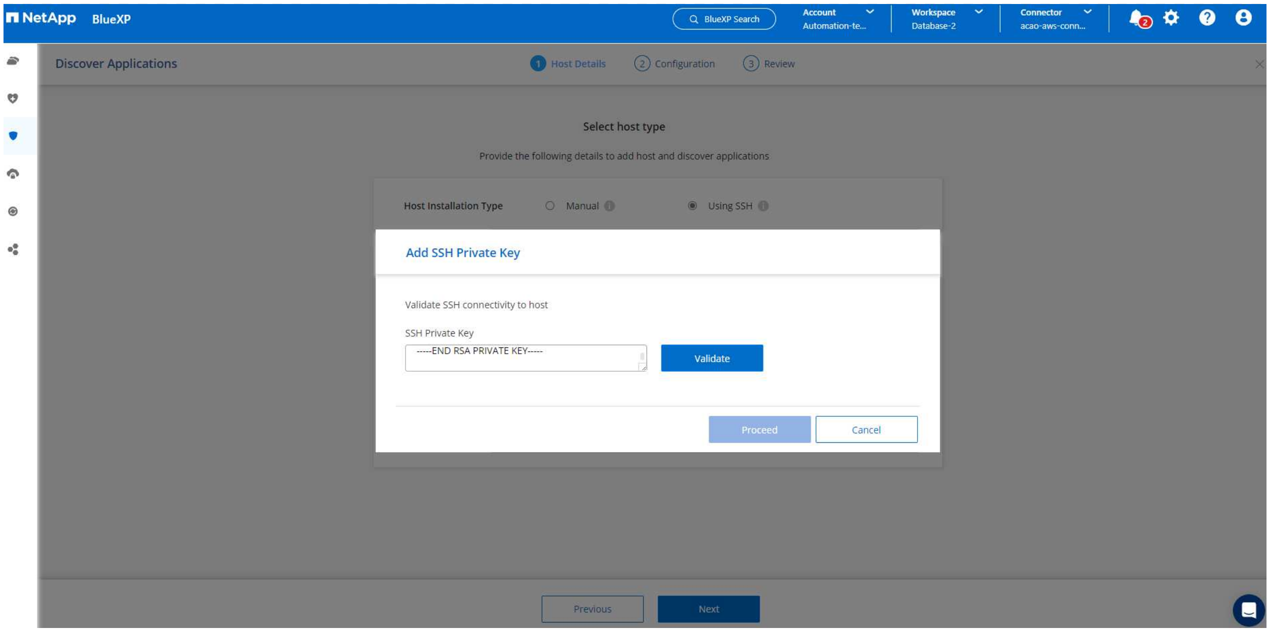
Connector: aws-snapctr-us-east

Username(Sudo): ec2-user

SSH Port: 22

Plug-in Port: 8145

2. Paste in your ec2-user SSH key for the database EC2 host and click on **Validate** to proceed.



Select host type

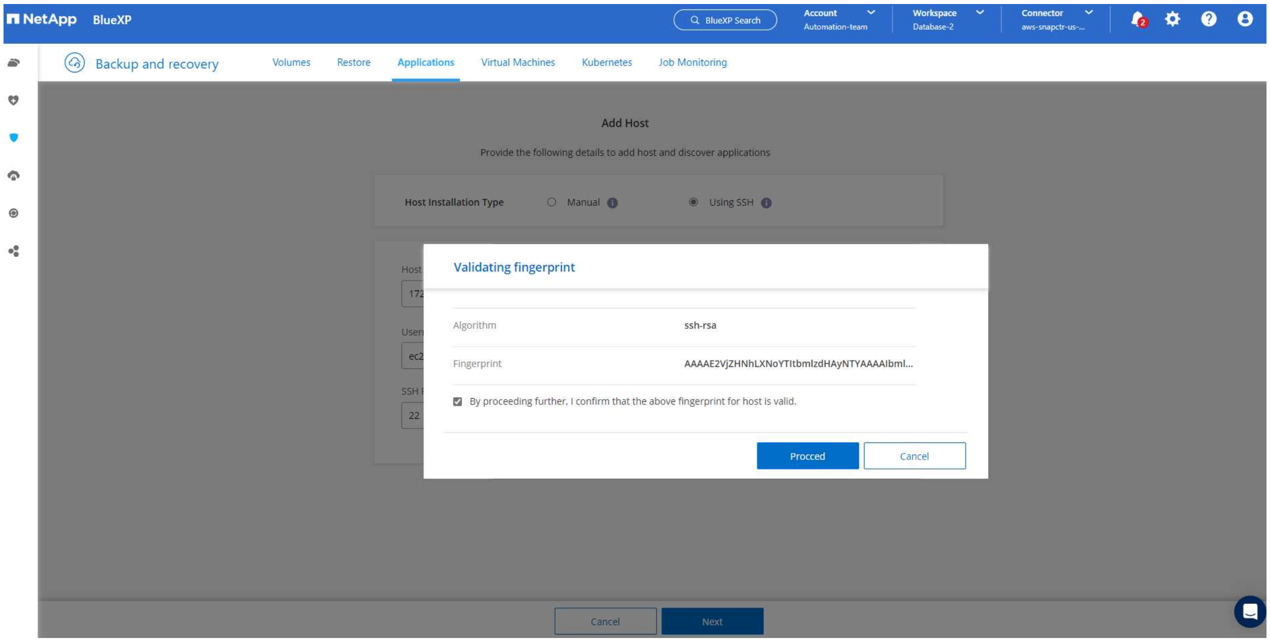
Provide the following details to add host and discover applications

Host Installation Type ○ Manual ● Using SSH

Validate SSH connectivity to host

SSH Private Key: -----END RSA PRIVATE KEY-----

3. You will be prompted for **Validating fingerprint** to proceed.



Add Host

Provide the following details to add host and discover applications

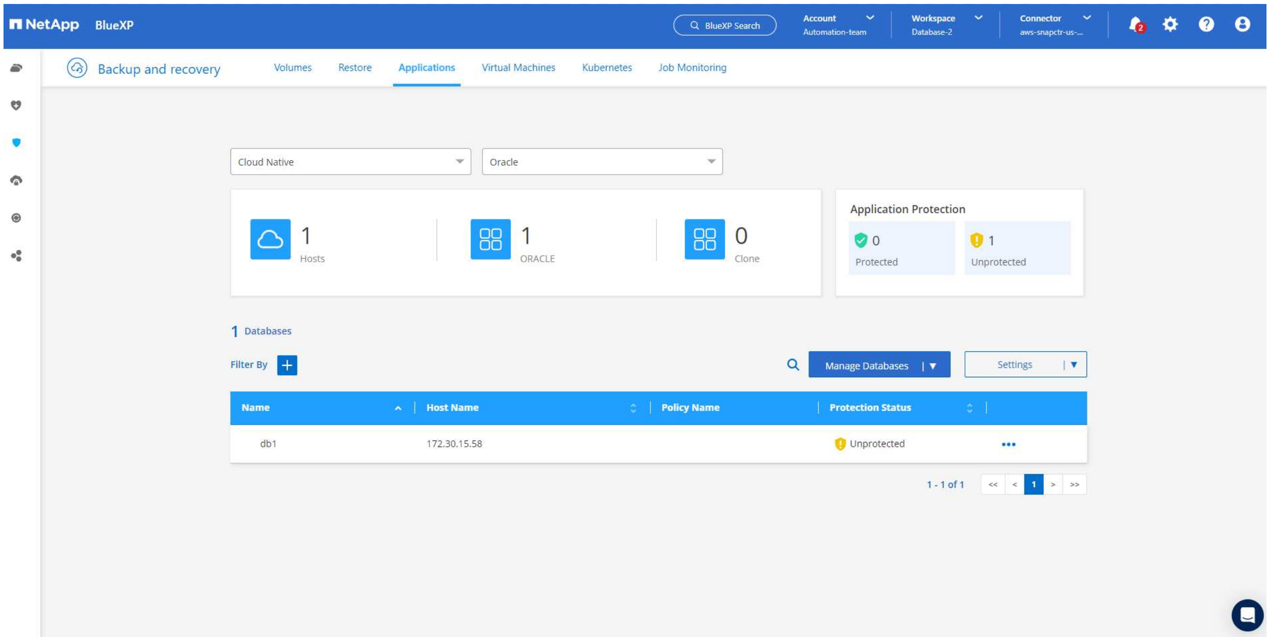
Host Installation Type ○ Manual ● Using SSH

Algorithm: ssh-rsa

Fingerprint: AAAAE2VjZHNhLXNoYTItbmlzdHAyNTYAAAAIbml...

☑ By proceeding further, I confirm that the above fingerprint for host is valid.

4. Click on **Next** to install an Oracle database plugin and discover the Oracle databases on the EC2 host. Discovered databases are added to **Applications**. The database **Protection Status** shows as **Unprotected** when initially discovered.

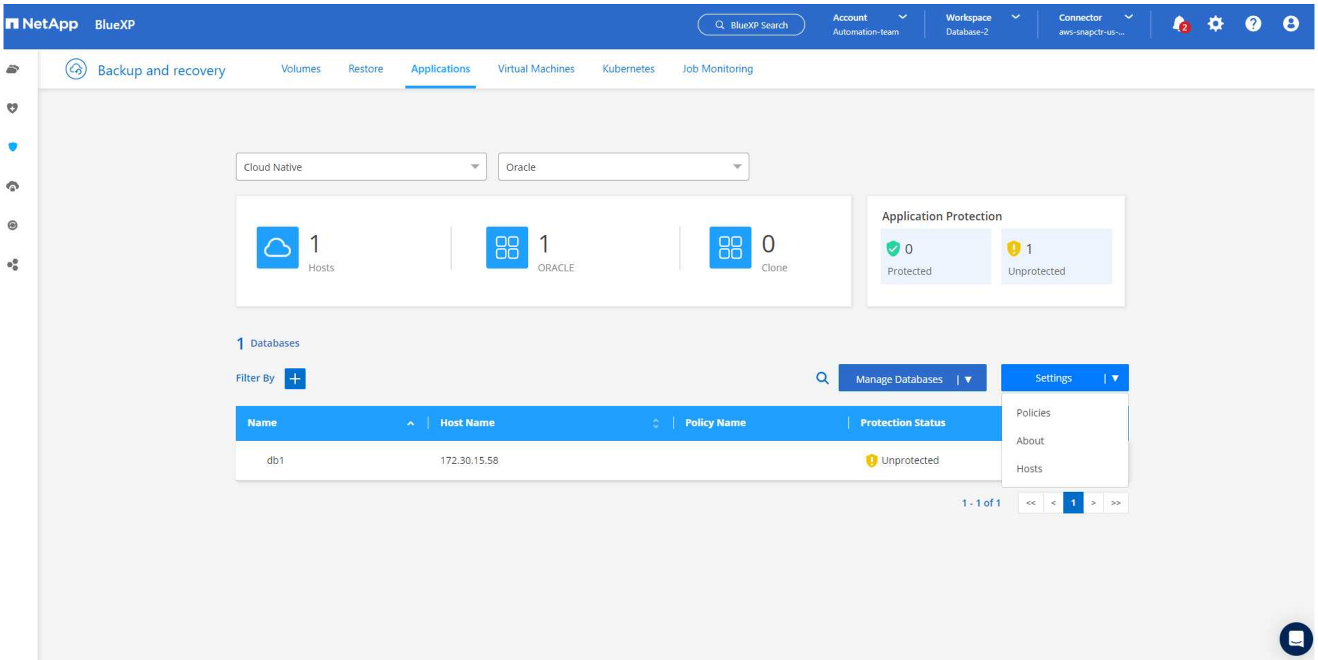


Name	Host Name	Policy Name	Protection Status
db1	172.30.15.58		Unprotected

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.

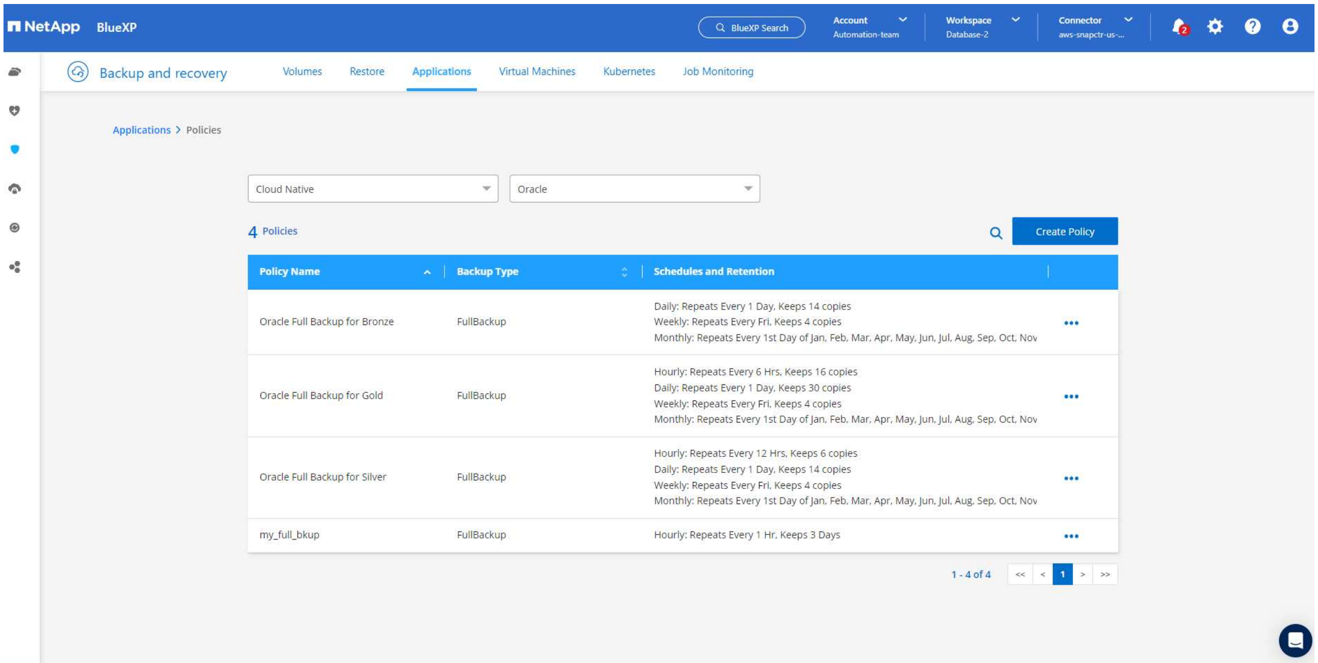
Oracle database backup

1. Click the three dots next to the database **Protection Status**, and then click **Polices** to view the default preloaded database protection policies that can be applied to protect your Oracle databases.



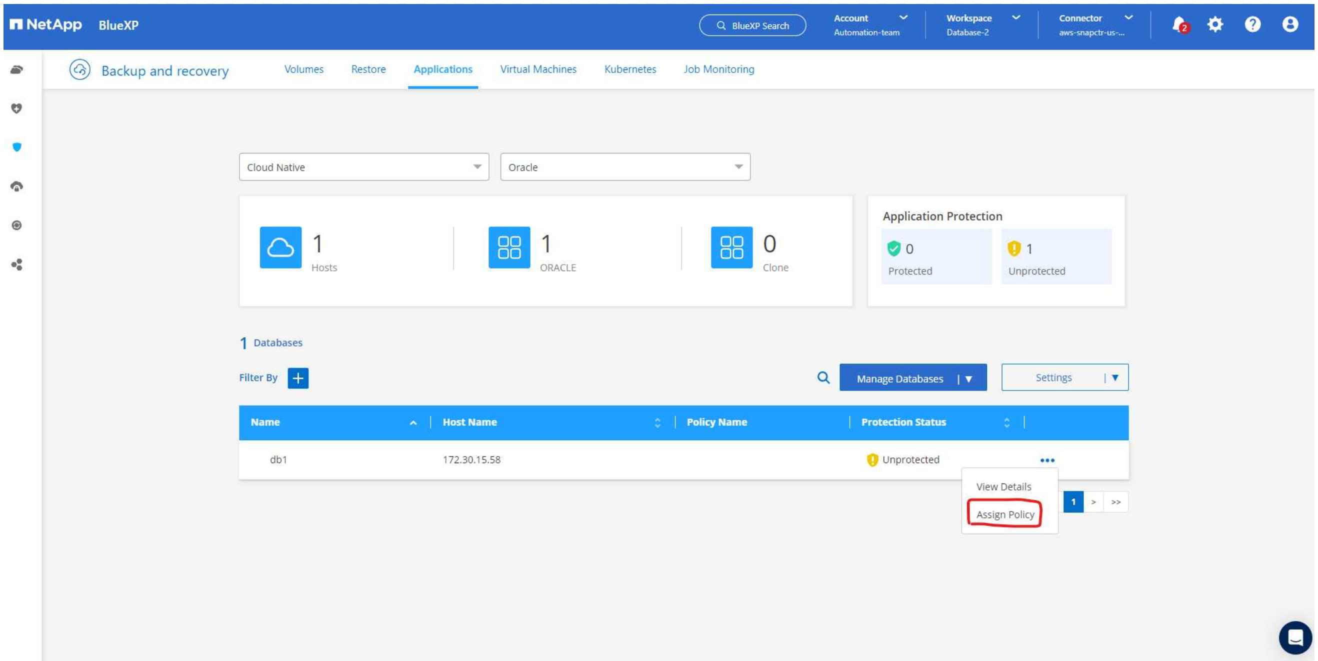
Name	Host Name	Policy Name	Protection Status
db1	172.30.15.58		Unprotected

1. You can also create your own policy with a customized backup frequency and backup data-retention window.



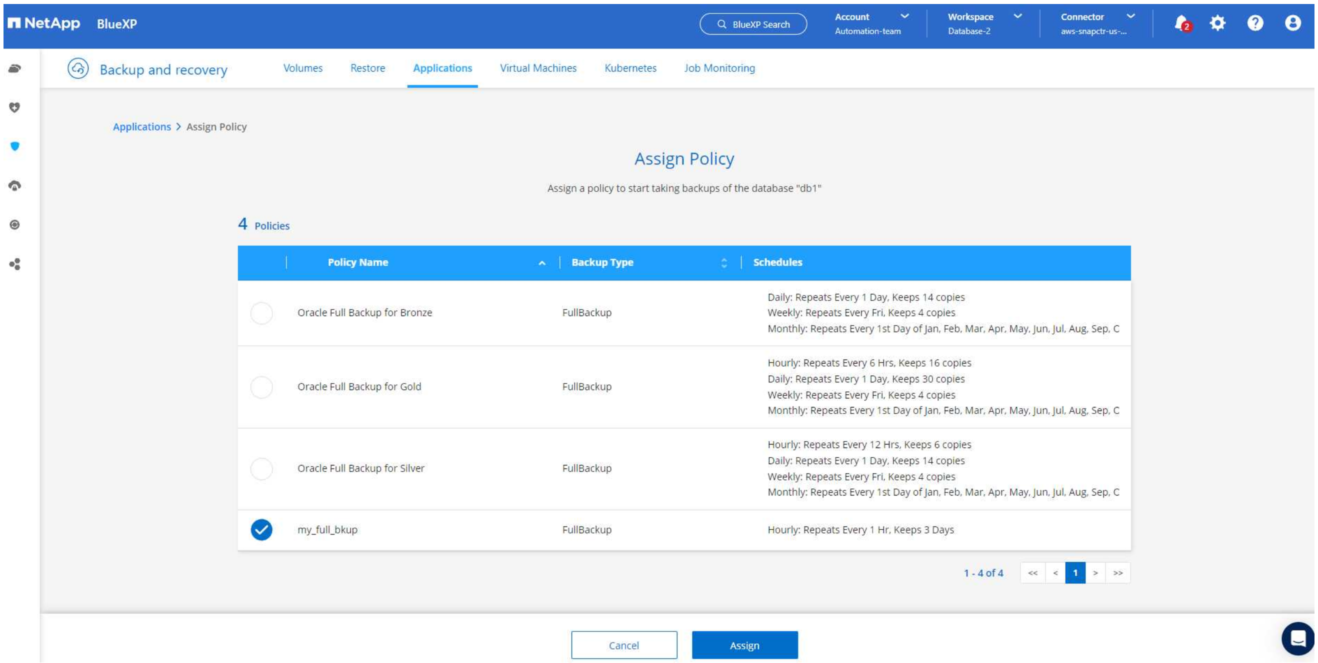
Policy Name	Backup Type	Schedules and Retention
Oracle Full Backup for Bronze	FullBackup	Daily: Repeats Every 1 Day, Keeps 14 copies Weekly: Repeats Every Fri, Keeps 4 copies Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov
Oracle Full Backup for Gold	FullBackup	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, Oct, Nov
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, Oct, Nov
my_full_bkup	FullBackup	Hourly: Repeats Every 1 Hr, Keeps 3 Days

1. When you are happy with the policy configuration, you can then assign your policy of choice to protect the database.



Name	Host Name	Policy Name	Protection Status
db1	172.30.15.58		Unprotected

1. Choose the policy to assign to the database.



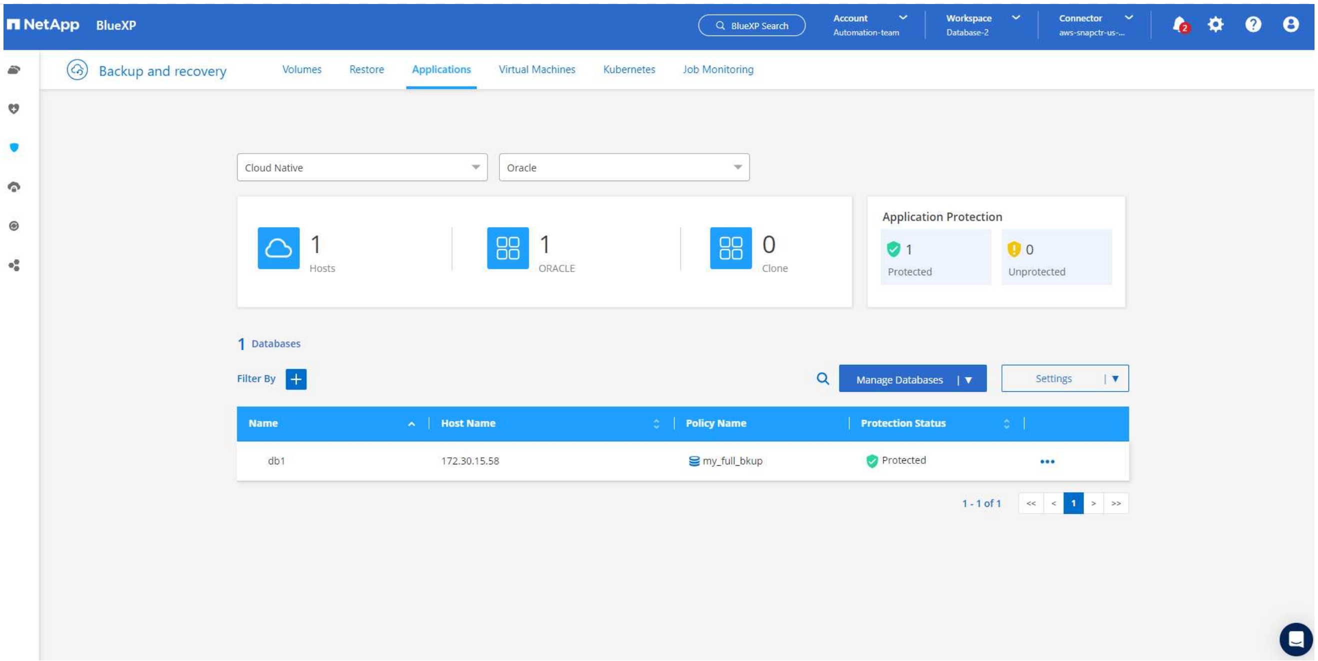
Assign Policy

Assign a policy to start taking backups of the database "db1"

4 Policies

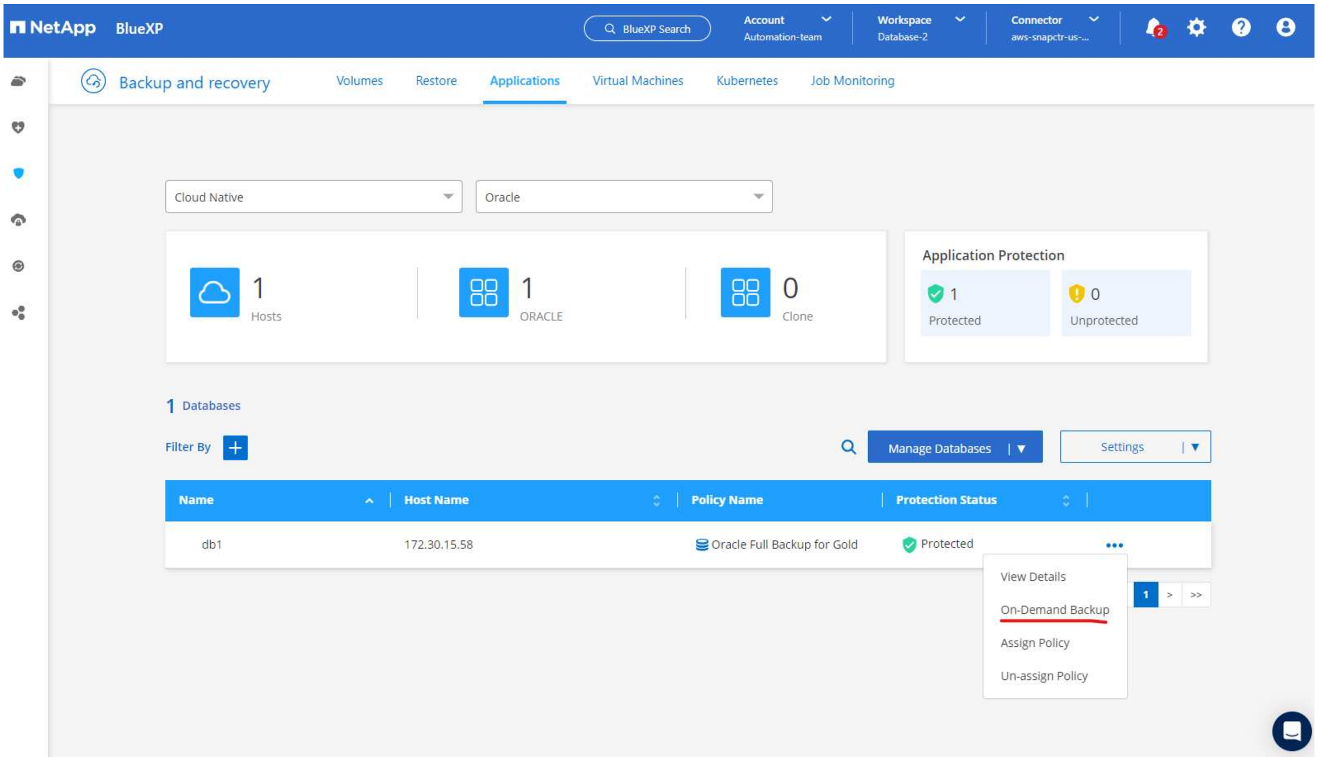
	Policy Name	Backup Type	Schedules
○	Oracle Full Backup for Bronze	FullBackup	Daily: Repeats Every 1 Day, Keeps 14 copies Weekly: Repeats Every Fri, Keeps 4 copies Monthly: Repeats Every 1st Day of Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, C
○	Oracle Full Backup for Gold	FullBackup	Hourly: Repeats 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

1. After the policy is applied, the database protection status changed to **Protected** with a green check mark.



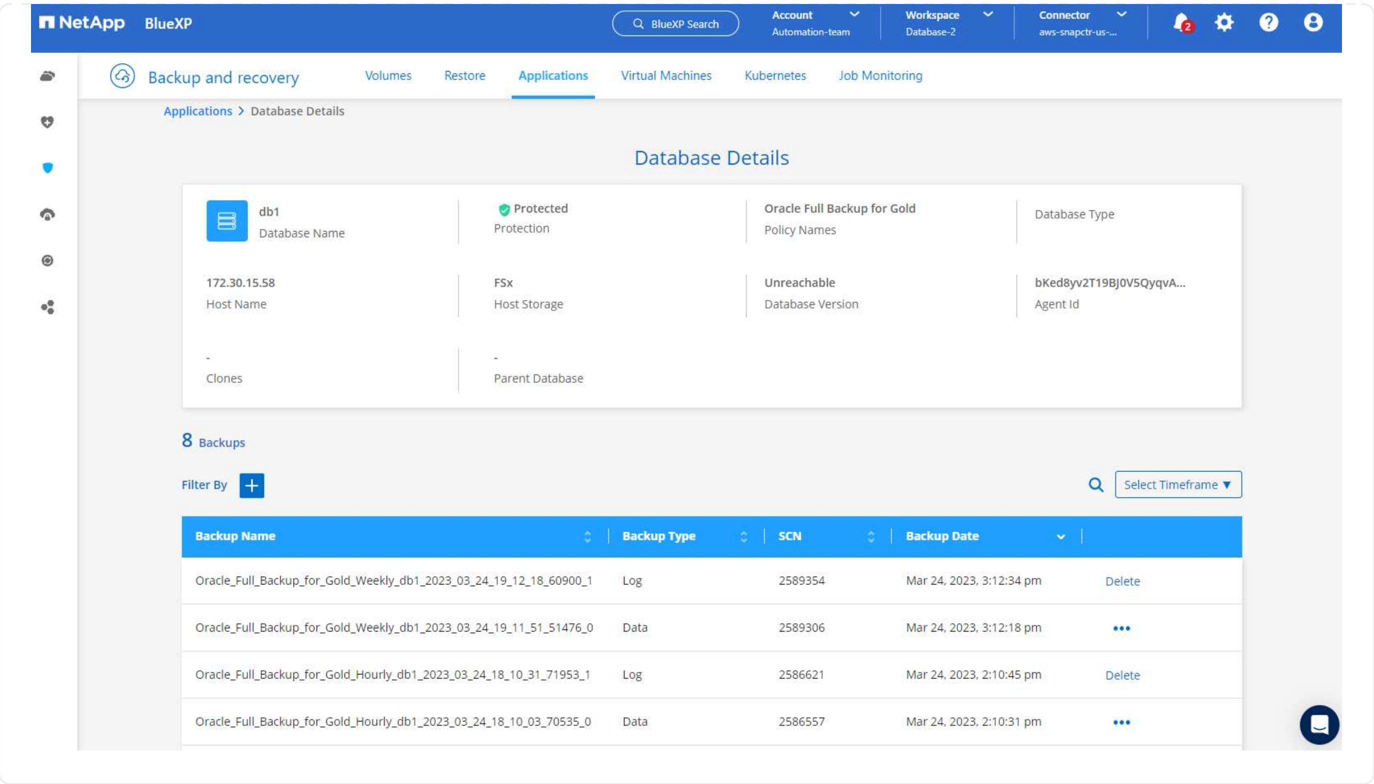
Name	Host Name	Policy Name	Protection Status
db1	172.30.15.58	my_full_bkup	Protected

1. The database backup runs on a predefined schedule. You can also run a one-off on-demand backup as shown below.



Name	Host Name	Policy Name	Protection Status
db1	172.30.15.58	Oracle Full Backup for Gold	Protected

1. 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.



Database Details

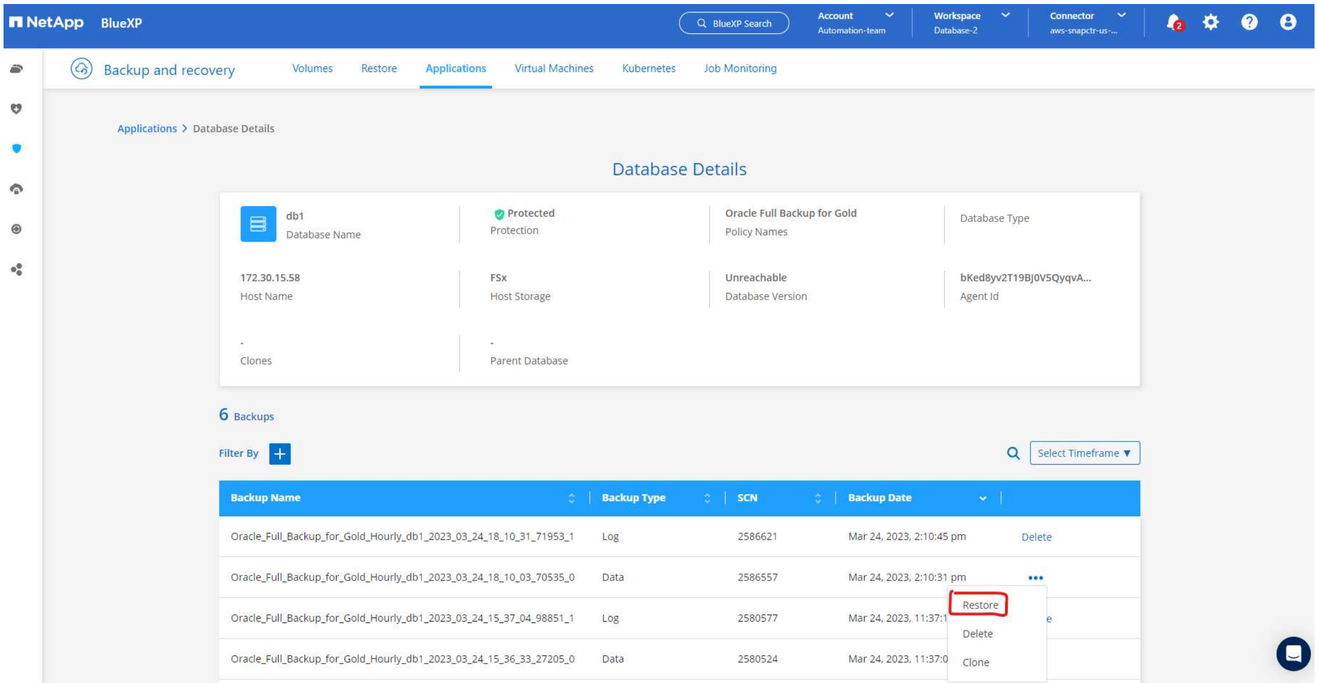
db1 Database Name	Protected Protection	Oracle Full Backup for Gold Policy Names	Database Type
172.30.15.58 Host Name	FSx Host Storage	Unreachable Database Version	bKed8yv2T19BJ0V5QyqvA... Agent Id
- Clones	- Parent Database		

8 Backups

Backup Name	Backup Type	SCN	Backup Date	
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

1. 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.



Database Details

db1
Database Name

Protected
Protection

Oracle Full Backup for Gold
Policy Names

Database Type

172.30.15.58
Host Name

FSx
Host Storage

Unreachable
Database Version

bKed8yv2T19BJ0V5QyqvA...
Agent Id

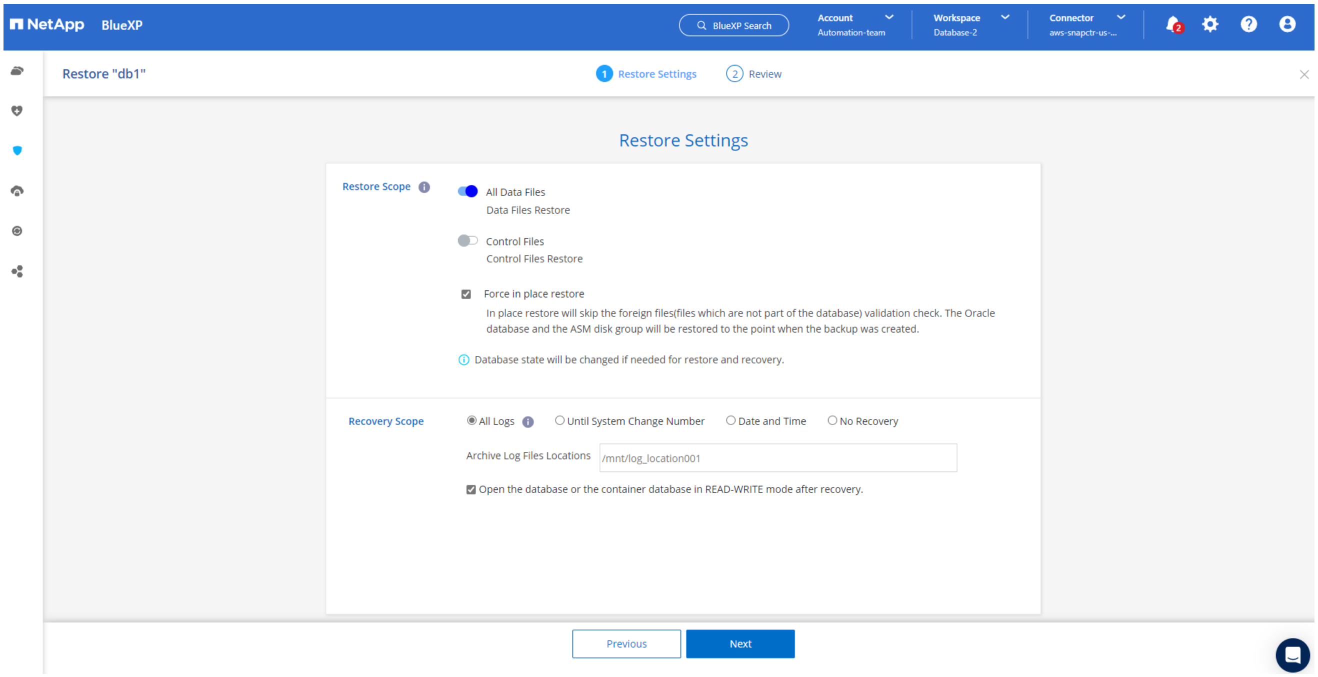
-
Clones

-
Parent Database

6 Backups

Backup Name	Backup Type	SCN	Backup Date	
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_Full_Backup_for_Gold_Hourly_db1_2023_03_24_15_37_04_98851_1	Log	2580577	Mar 24, 2023, 11:37:1	e
Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_15_36_33_27205_0	Data	2580524	Mar 24, 2023, 11:37:0	

1. 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.



Restore Settings

Restore Scope
- ● All Data Files
  Data Files Restore
- ○ Control Files
  Control Files Restore
- ☑ Force in place restore
  In place restore will skip the foreign files(files which are not part of the database) validation check. The Oracle database and the ASM disk group will be restored to the point when the backup was created.

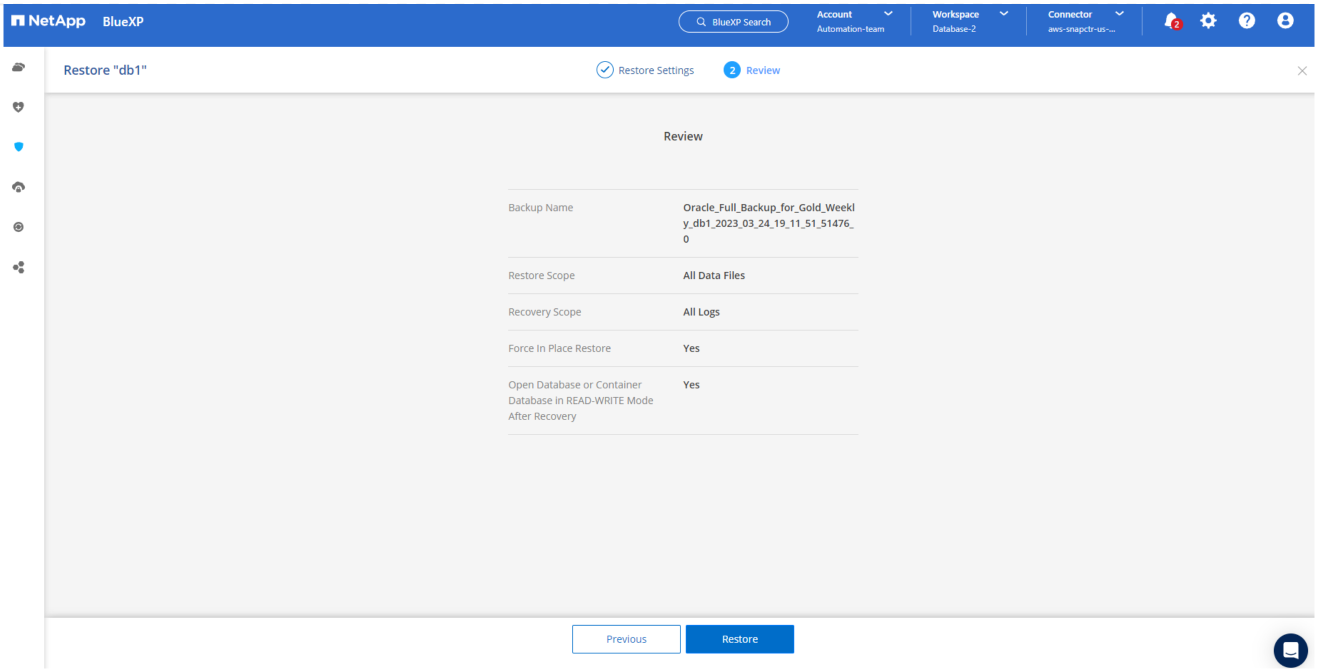
ⓘ Database state will be changed if needed for restore and recovery.

Recovery Scope
● All Logs ○ Until System Change Number ○ Date and Time ○ No Recovery

Archive Log Files Locations: /mnt/log_location001

☑ Open the database or the container database in READ-WRITE mode after recovery.

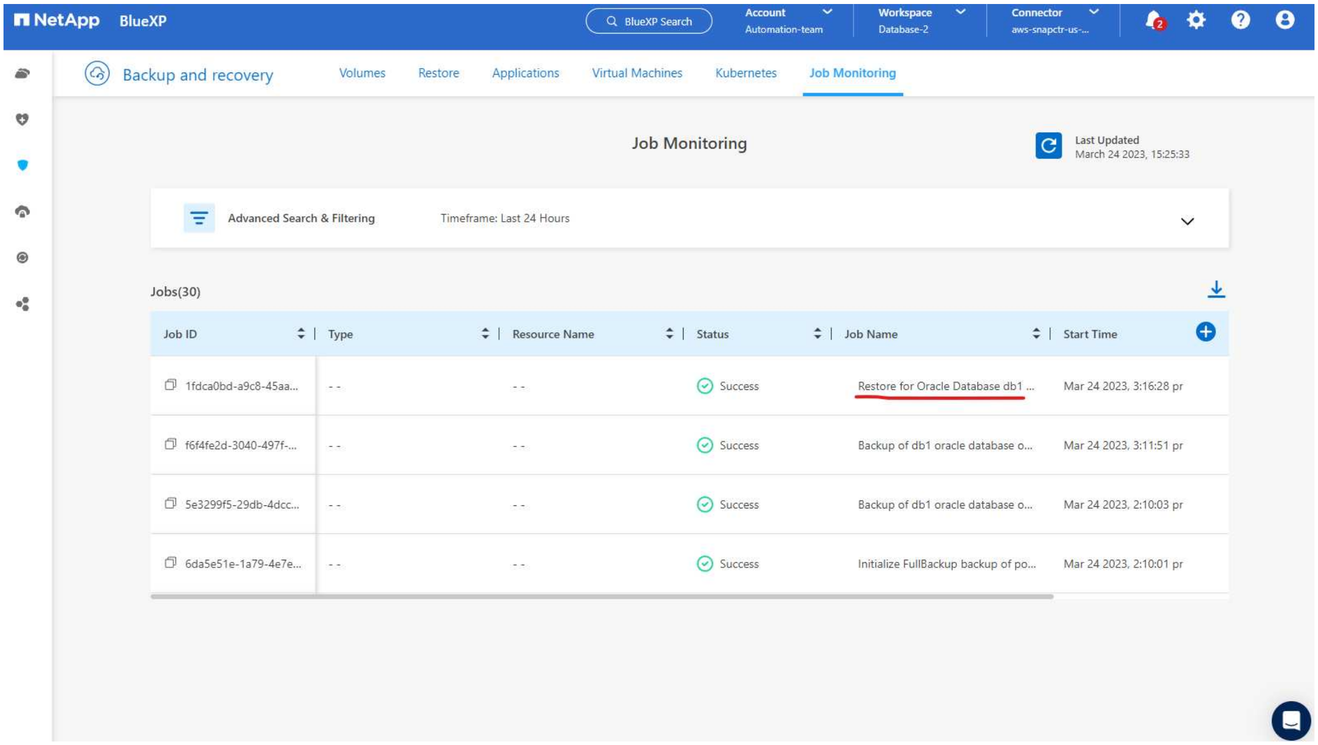
1. Review and start database restore and recovery.



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	Yes

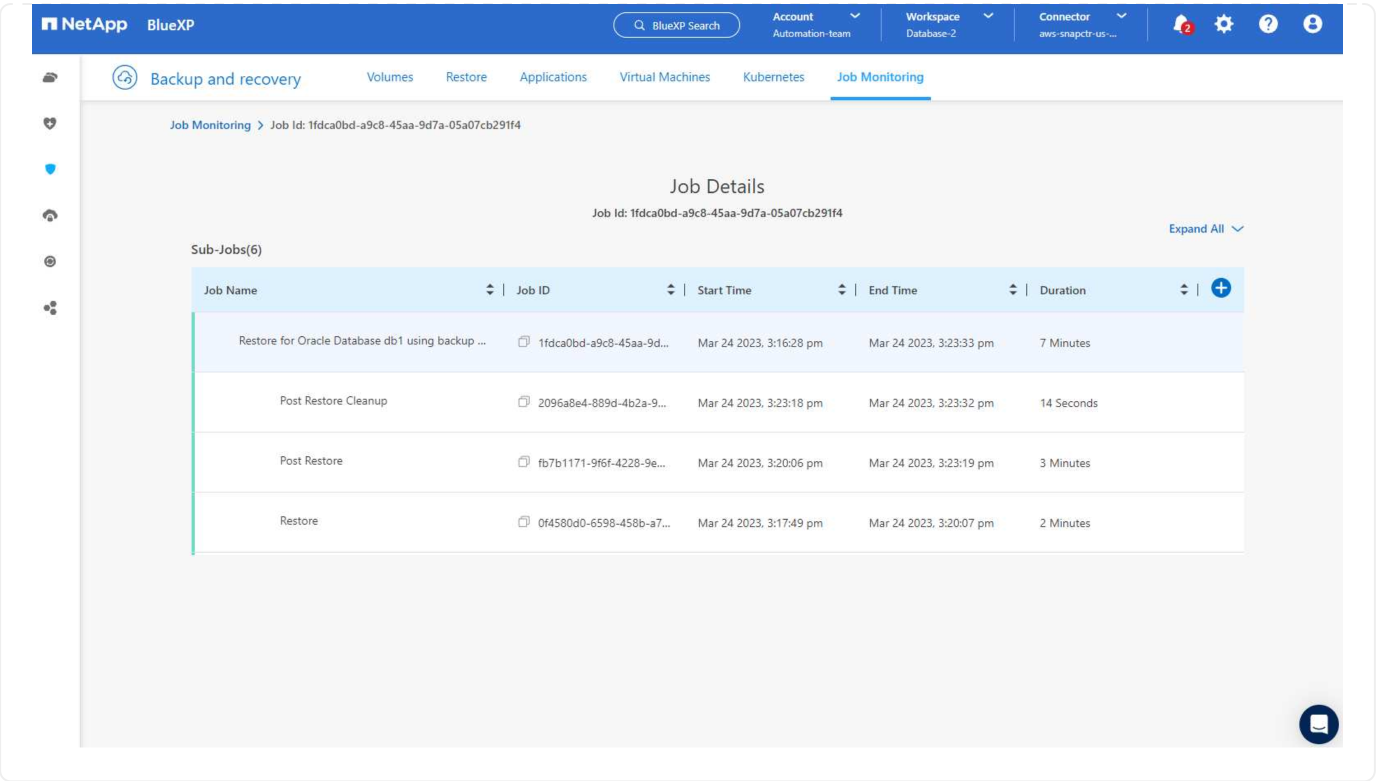
1. From the **Job Monitoring** tab, you can view the status of the restore job as well as any details while it is running.



Job Monitoring

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



Job Monitoring > Job Id: 1fdca0bd-a9c8-45aa-9d7a-05a07cb291f4

Job Details

Job Id: 1fdca0bd-a9c8-45aa-9d7a-05a07cb291f4

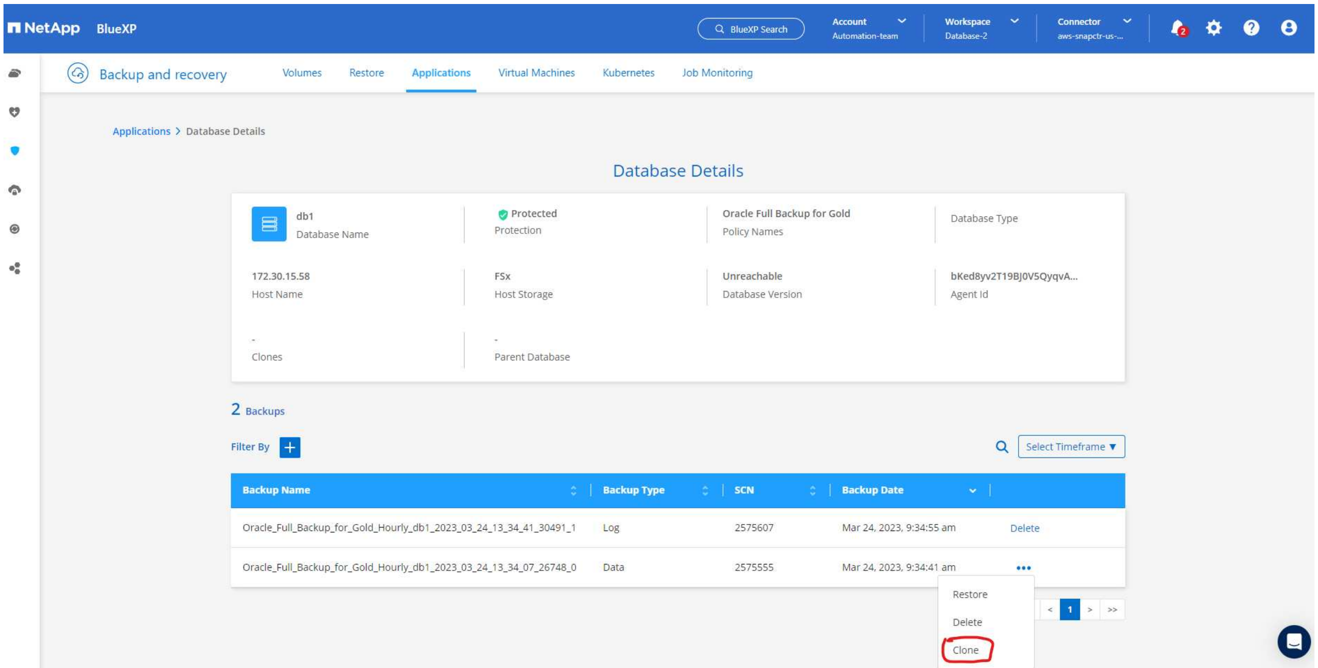
Sub-Jobs(6)

Job Name	Job ID	Start Time	End Time	Duration
Restore for Oracle Database db1 using backup ...	1fdca0bd-a9c8-45aa-9d...	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.



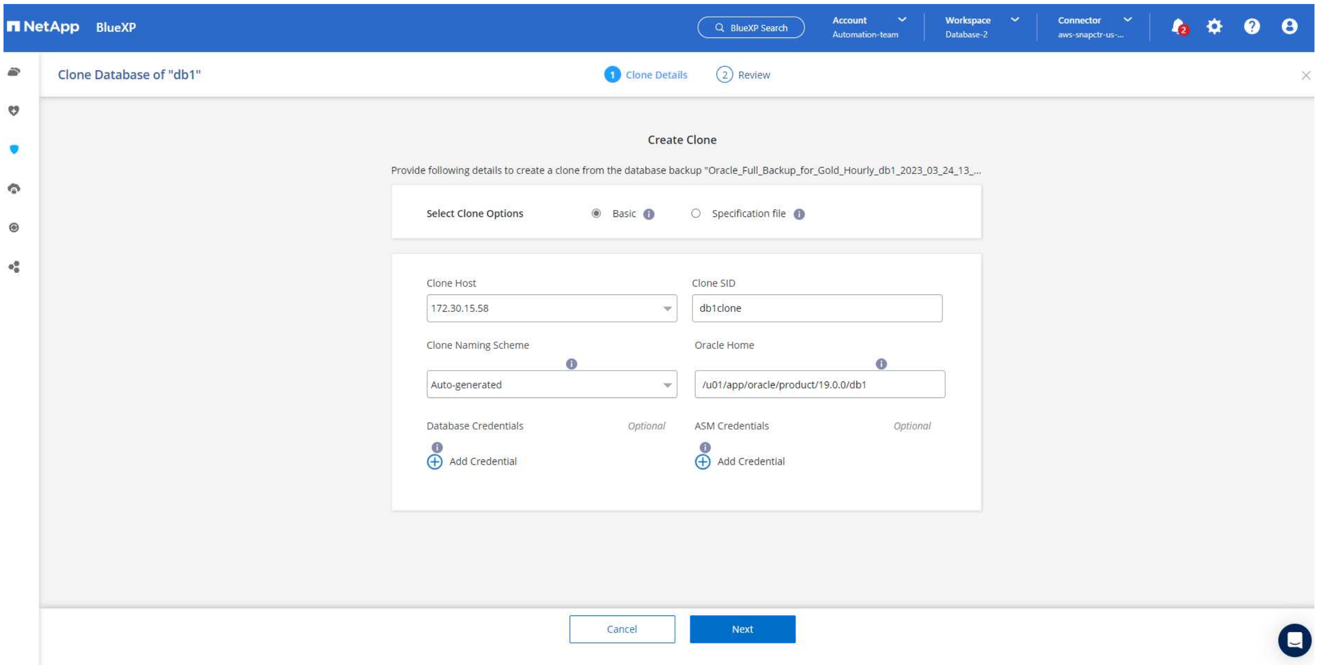
Database Details

db1 Database Name	Protected Protection	Oracle Full Backup for Gold Policy Names	Database Type
172.30.15.58 Host Name	FSx Host Storage	Unreachable Database Version	bKed8yv2T19BJ0V5QyqvA... Agent Id
- Clones	- Parent Database		

2 Backups

Backup Name	Backup Type	SCN	Backup Date	
Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_34_41_30491_1	Log	2575607	Mar 24, 2023, 9:34:55 am	Delete
Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_34_07_26748_0	Data	2575555	Mar 24, 2023, 9:34:41 am	•••

1. Select the **Basic** option if you don't need to change any cloned database parameters.



Create Clone

Provide following details to create a clone from the database backup "Oracle_Full_Backup_for_Gold_Hourly_db1_2023_03_24_13_...

Select Clone Options ● Basic ○ Specification file

Clone Host: 172.30.15.58

Clone SID: db1clone

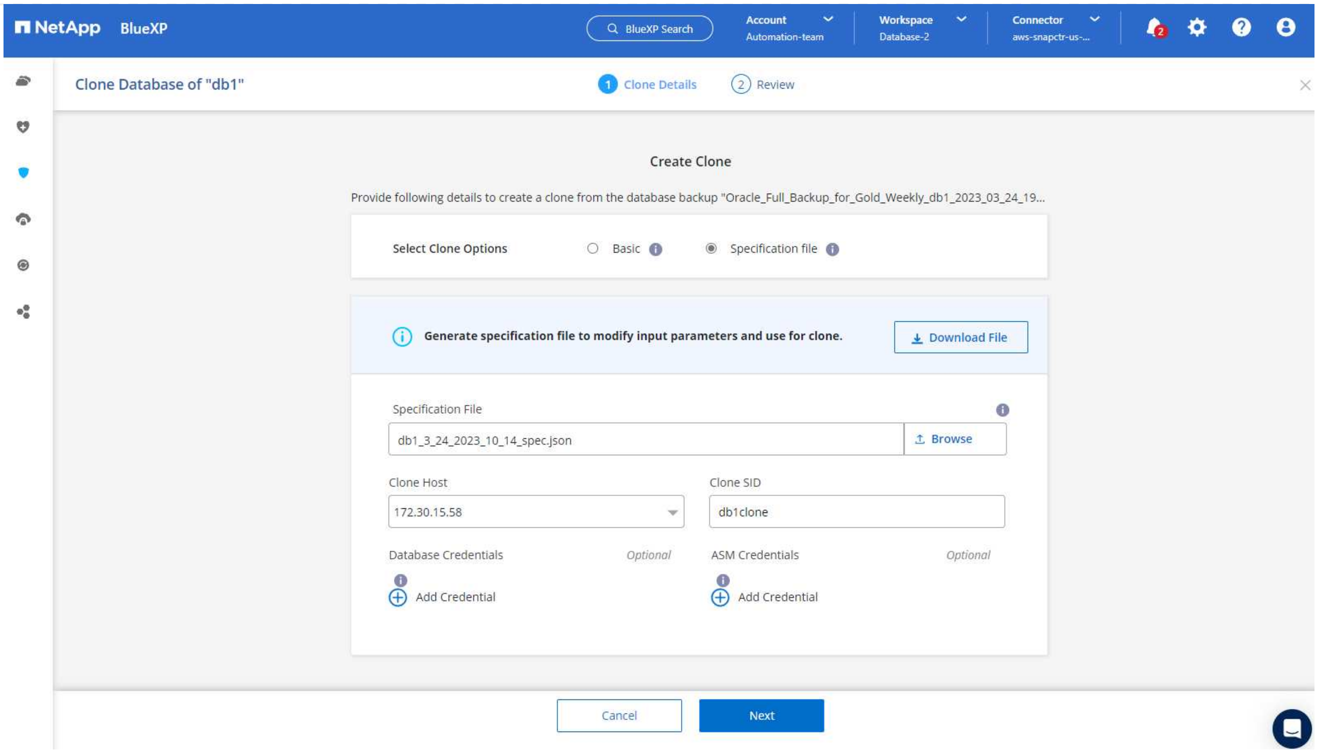
Clone Naming Scheme: Auto-generated

Oracle Home: /u01/app/oracle/product/19.0.0/db1

Database Credentials Optional: Add Credential

ASM Credentials Optional: Add Credential

1. 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.



Create Clone

Provide following details to create a clone from the database backup "Oracle_Full_Backup_for_Gold_Weekly_db1_2023_03_24_19...

Select Clone Options ○ Basic ● Specification file

Generate specification file to modify input parameters and use for clone.

Specification File: db1_3_24_2023_10_14_spec.json

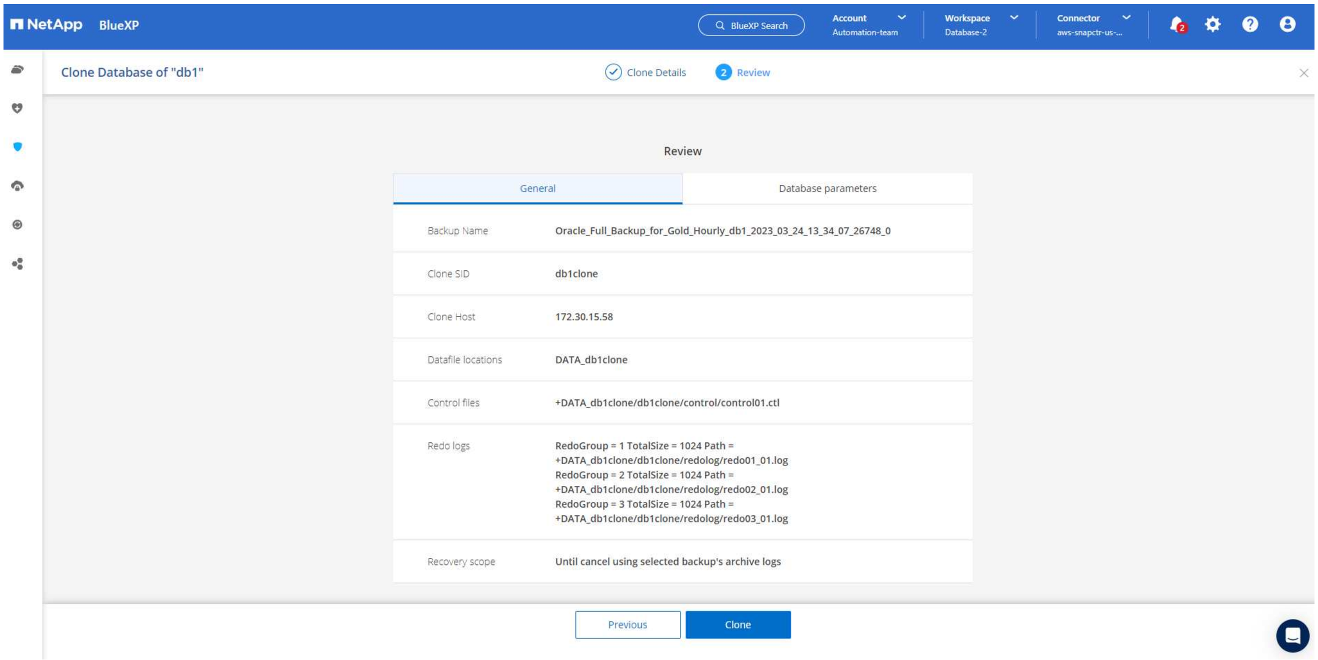
Clone Host: 172.30.15.58

Clone SID: db1clone

Database Credentials *Optional*

ASM Credentials *Optional*

1. Review and launch the job.



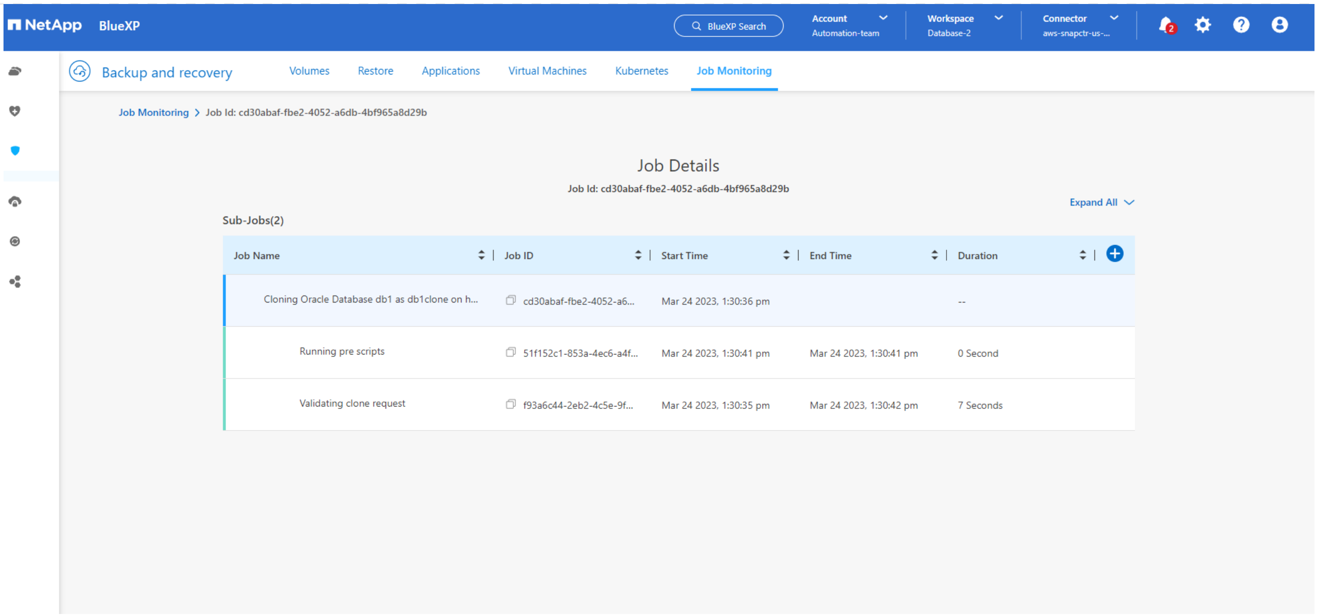
Review

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.ctl

Redo logs	RedoGroup = 1 TotalSize = 1024 Path =
	+DATA_db1clone/db1clone/redolog/redo01_01.log
	RedoGroup = 2 TotalSize = 1024 Path =
	+DATA_db1clone/db1clone/redolog/redo02_01.log
	RedoGroup = 3 TotalSize = 1024 Path =
	+DATA_db1clone/db1clone/redolog/redo03_01.log

Recovery scope	Until cancel using selected backup's archive logs

1. Monitor the cloning job status from the **Job Monitoring** tab.



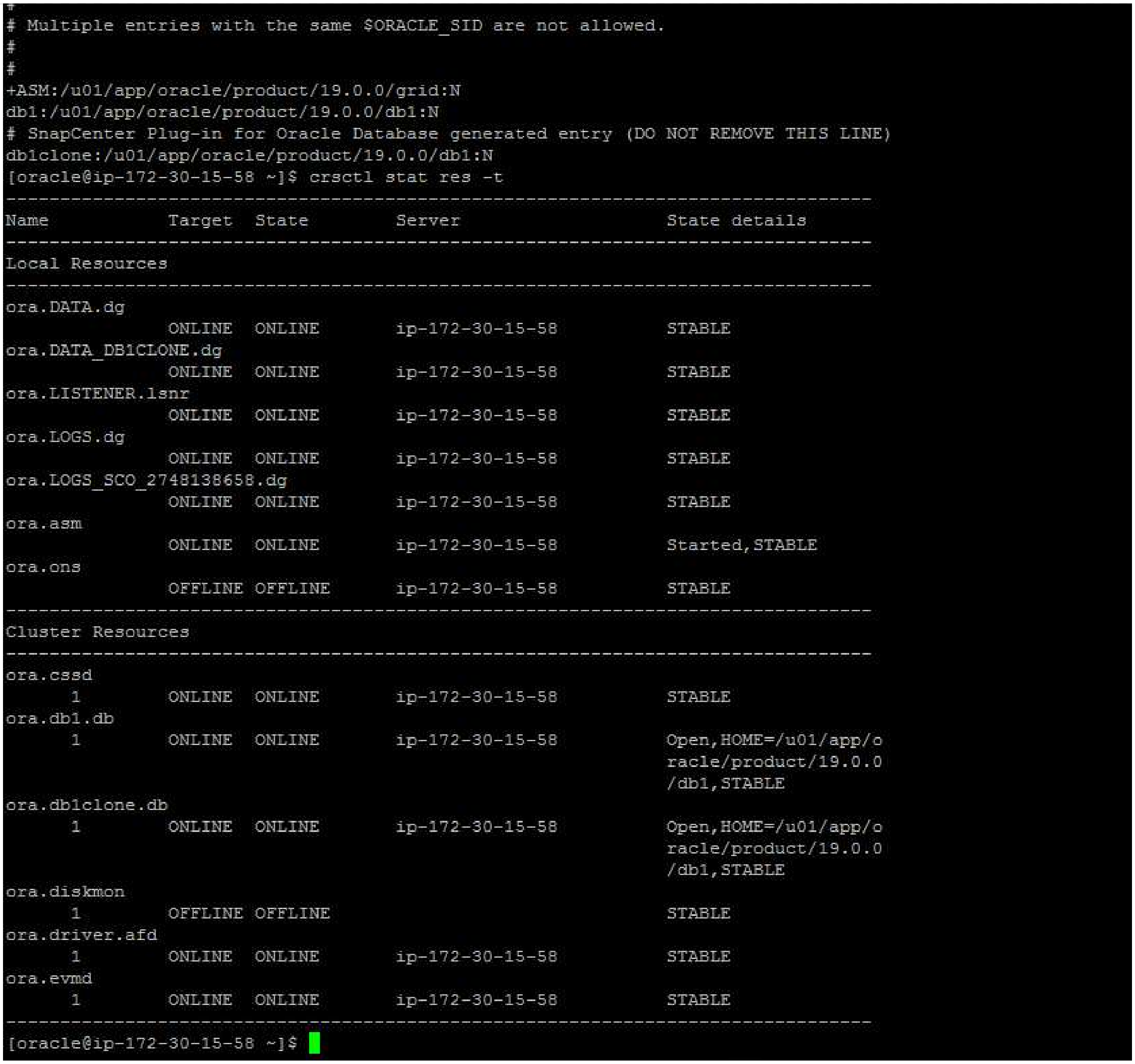
Job Details

Job Id: cd30abaf-fbe2-4052-a6db-4bf965a8d29b

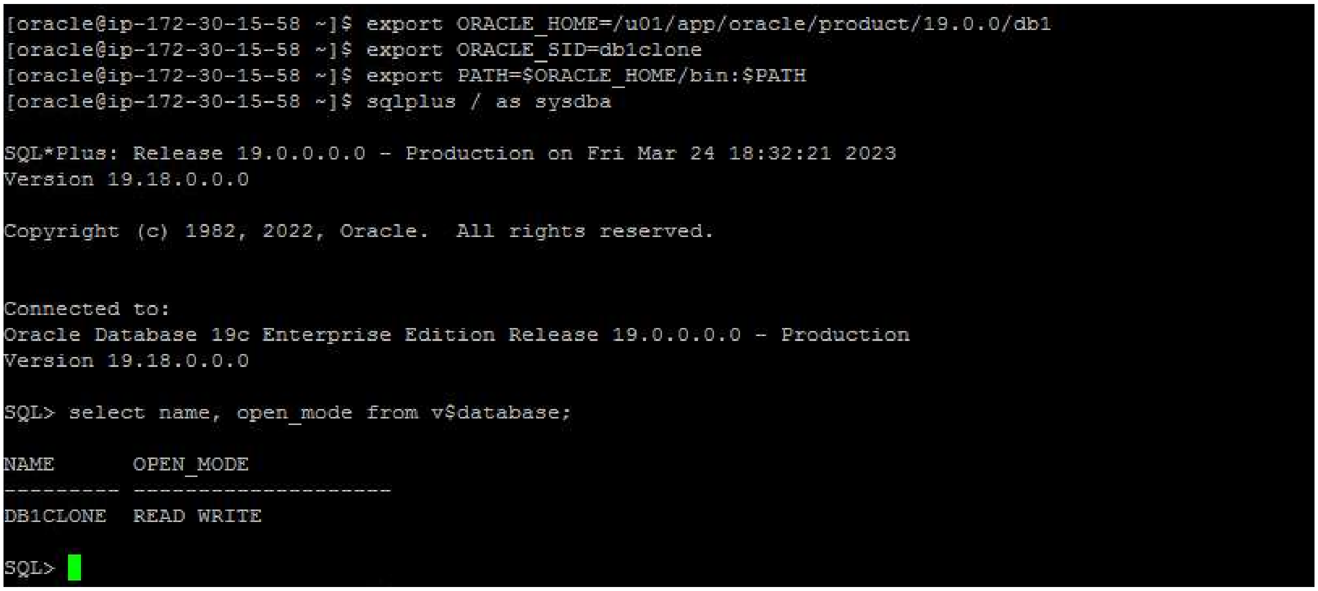
Sub-Jobs(2)

Job Name	Job ID	Start Time	End Time	Duration
Cloning Oracle Database db1 as db1clone on h...	cd30abaf-fbe2-4052-a6...	Mar 24 2023, 1:30:36 pm		--
Running pre scripts	51f152c1-853a-4ec6-a4f...	Mar 24 2023, 1:30:41 pm	Mar 24 2023, 1:30:41 pm	0 Second
Validating clone request	f93a6c44-2eb2-4c5e-9f...	Mar 24 2023, 1:30:35 pm	Mar 24 2023, 1:30:42 pm	7 Seconds

1. 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

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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

- BlueXP backup and recovery 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-8225-4784bced9843&sc_channel=ps&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2&ef_id=Cj0KCQiA54KfBhCKARIsAJzSrdqwQrghn6I71jiWzSeaT9Uh1-vY-VfhJixF-xnv5rWwn2S7RqZOTQ0aAh7eEALw_wcB:G:s&s_kwcid=AL!4422!3!467723097970!e!!g!!aws%20ec2

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:

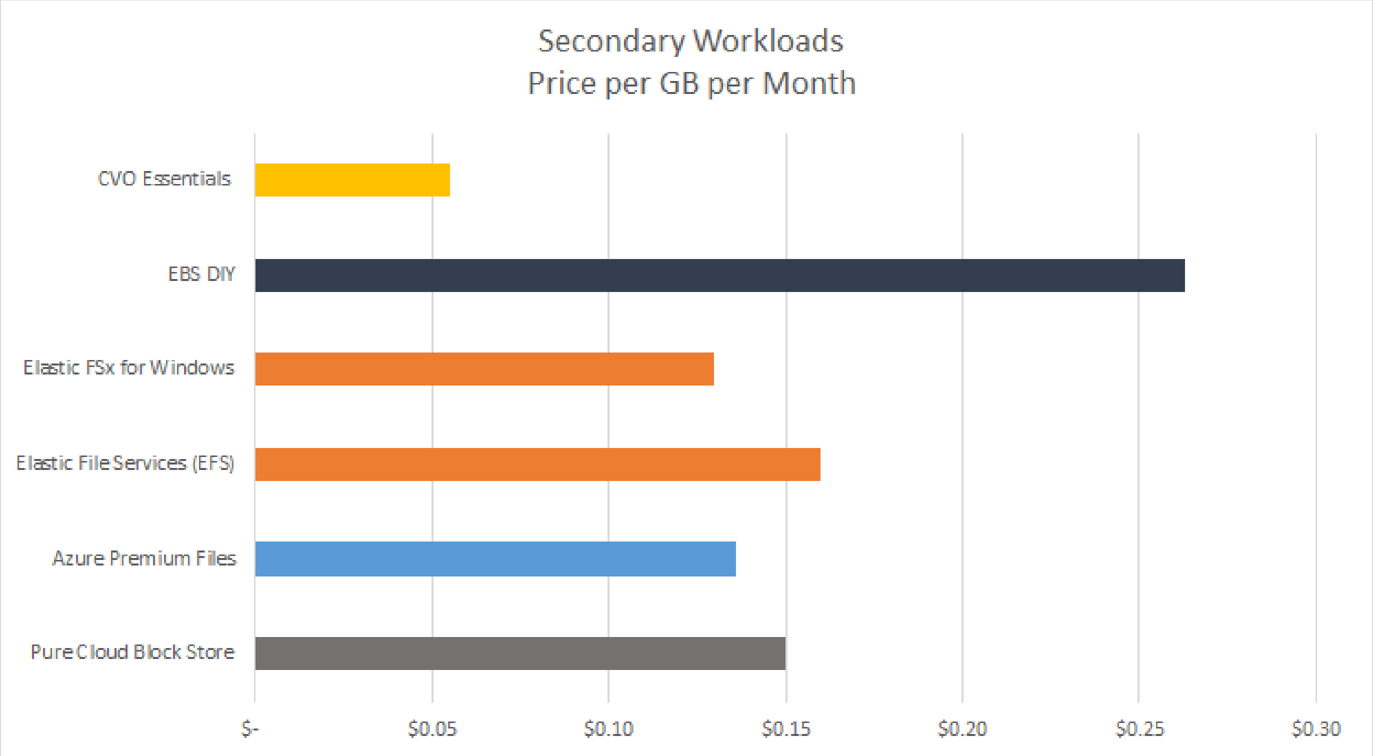
- Database dev/test operations in the hybrid cloud
- Database disaster recovery in the hybrid cloud

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:

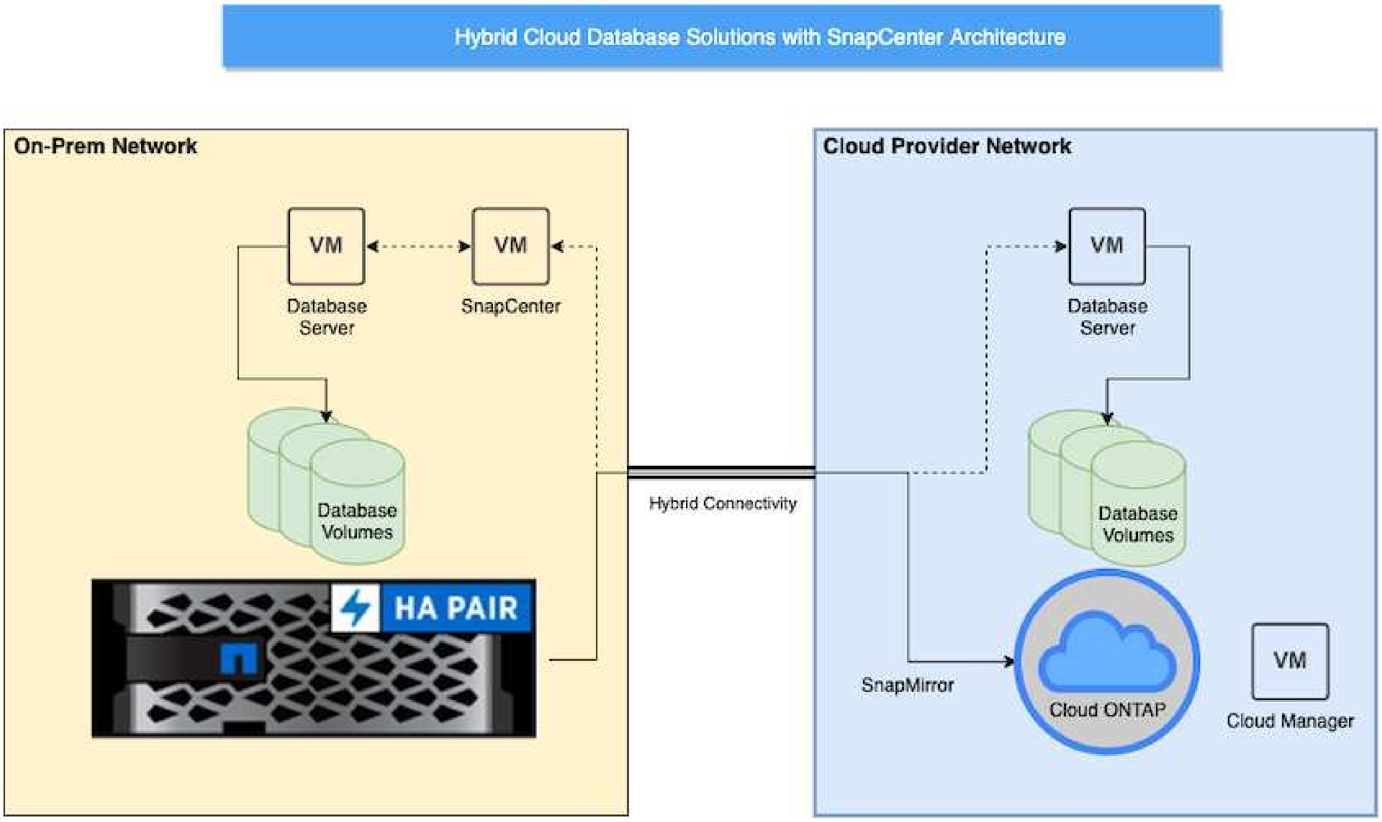
- Backup of an Oracle database across a Hybrid Cloud using SnapCenter
- SnapCenter- Clone DEV/TEST to AWS Cloud for an Oracle database

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).

Solution Architecture

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.

SnapCenter Requirements

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	Any databases and versions supported by SnapCenter
	SnapCenter v4.4 or higher
	Ansible v2.09 or higher
	ONTAP cluster 9.x
	Intercluster LIFs configured
	Connectivity from on-premises to a cloud VPC (VPN, interconnect, and so on)
	Networking ports open - ssh 22 - tcp 8145, 8146, 10000, 11104, 11105
Cloud - AWS	Cloud Manager Connector
	Cloud Volumes ONTAP
	Matching DB OS EC2 instances to On-prem
Cloud - Azure	Cloud Manager Connector
	Cloud Volumes ONTAP
	Matching DB OS Azure Virtual Machines to On-prem
Cloud - GCP	Cloud Manager Connector
	Cloud Volumes ONTAP
	Matching DB OS Google Compute Engine instances to on-premises

Prerequisites configuration

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

Prerequisites on-premises

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 multitiered 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.

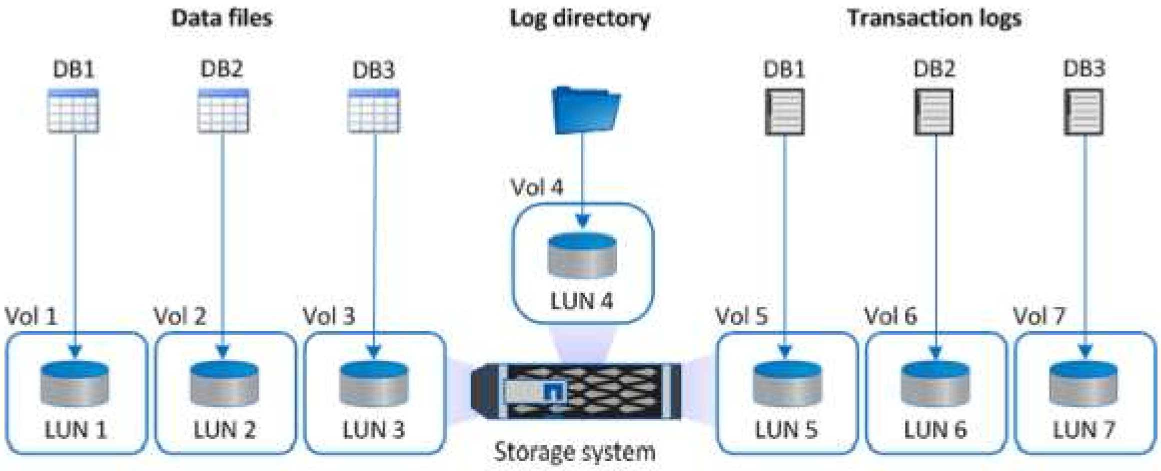
- **Single instance or HA deployment.** HA deployment provides redundancy in the case of a single SnapCenter instance server failure.
- **Name resolution.** DNS must be configured on the SnapCenter server to resolve all database hosts as well as on the storage SVM for forward and reverse lookup. DNS 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.

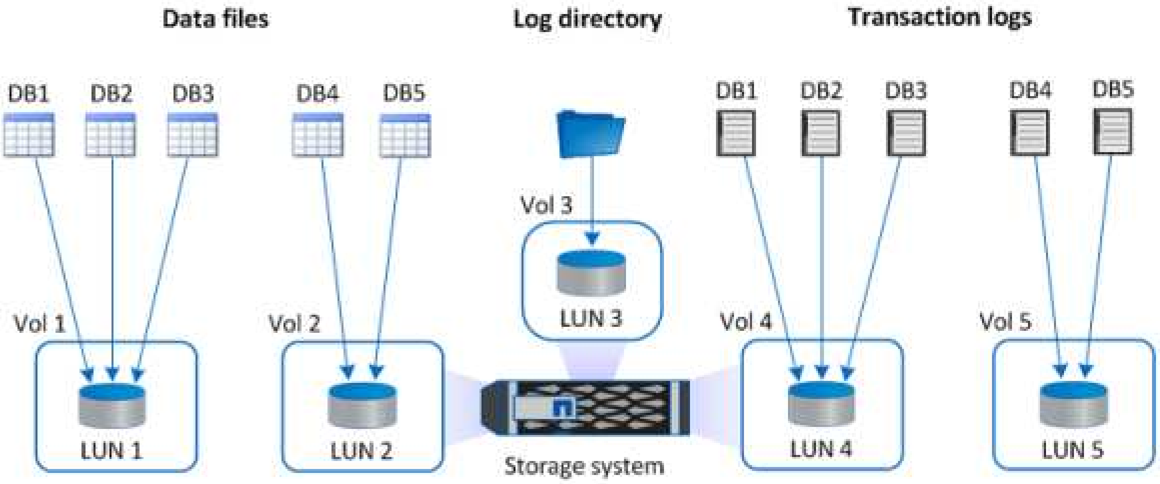
On-premises database server storage configuration

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.

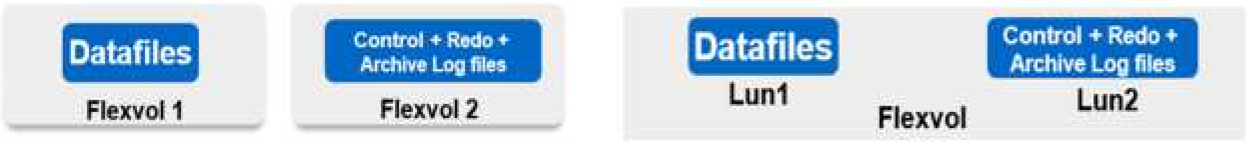


The following figure shows the NetApp recommended storage layout for small or medium SQL Server database on LUNs.

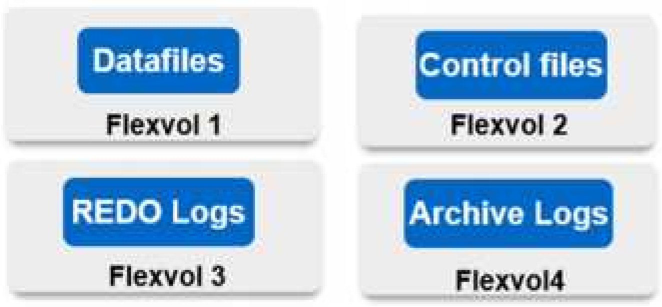


The Log directory is dedicated to SnapCenter to perform transaction log rollup for database recovery. For an extra large database, multiple LUNs can be allocated to a volume for better performance.

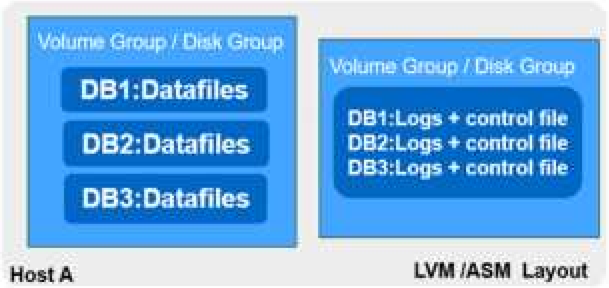
For Oracle database workloads, SnapCenter supports database environments backed by ONTAP storage that are mounted to the host as either physical or virtual devices. You can host the entire database on a single or multiple storage devices based on the criticality of the environment. Typically, customers 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.

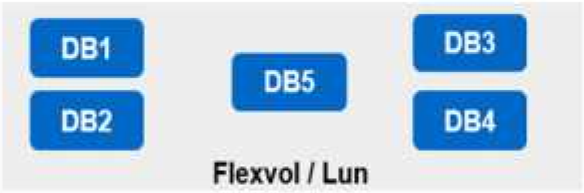

Datafiles
Flexvol 1
Control + Redo + Archive Log files
Flexvol 2
Datafiles
Lun1
Flexvol
Control + Redo + Archive Log files
Lun2

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.

Prerequisites for the public cloud

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.

Getting started overview

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:

On Premises, Public Cloud - AWS

Getting started on premises

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.

On Premises

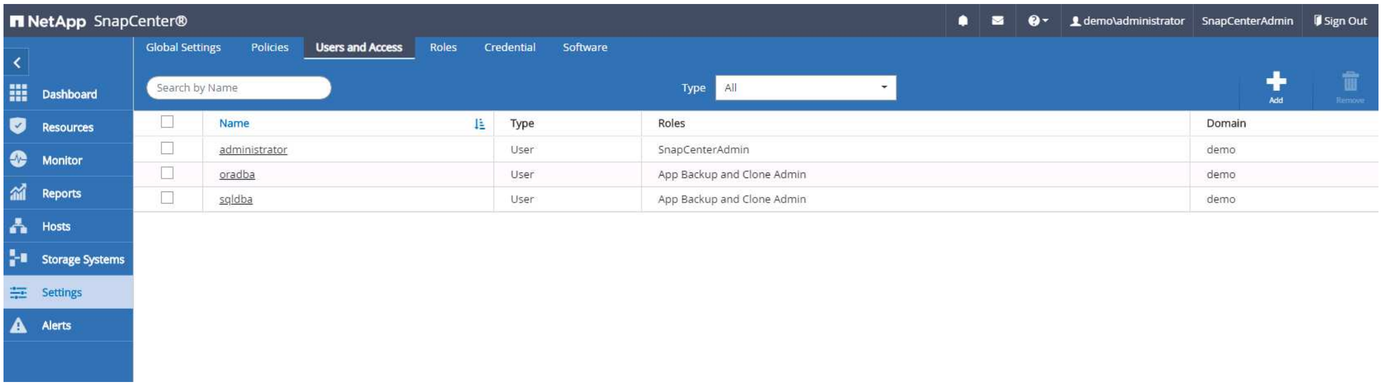
1. Setup database admin user in SnapCenter

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
☐	administrator	User	SnapCenterAdmin	demo
☐	oradba	User	App Backup and Clone Admin	demo
☐	sqldba	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.

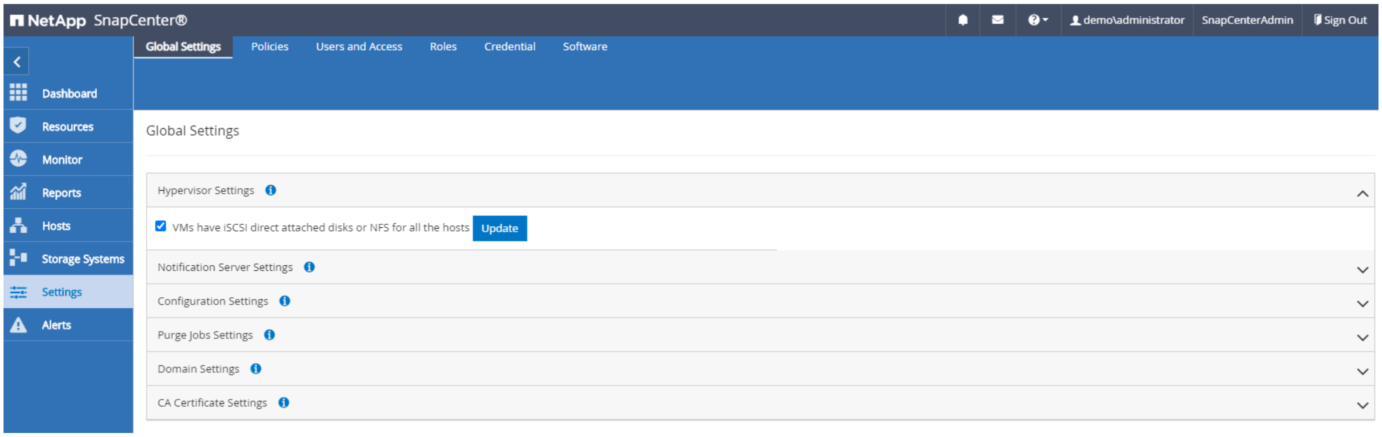
3. SnapCenter host plugin installation

> 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

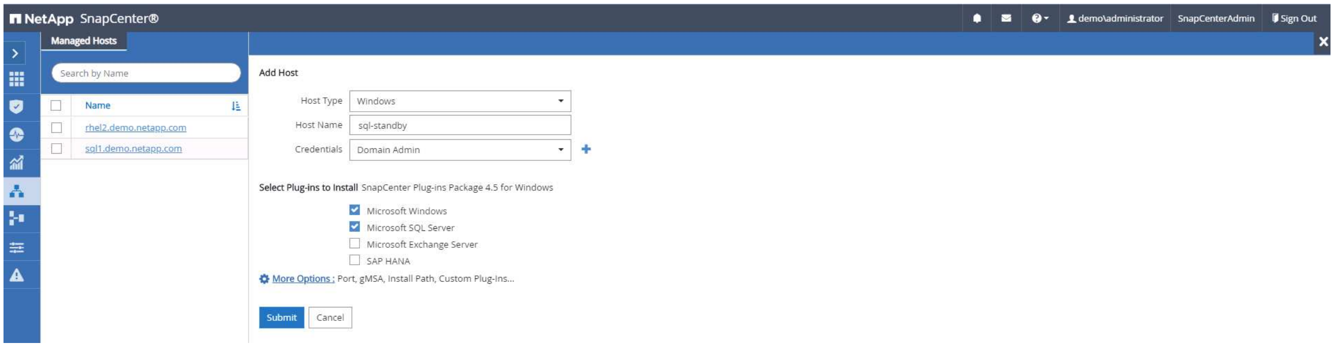
Navigate to Settings > Global Settings. Select "VMs have iSCSI direct attached disks or NFS for all the hosts" under Hypervisor Settings and click Update.



☑ VMs have iSCSI direct attached disks or NFS for all the hosts

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.

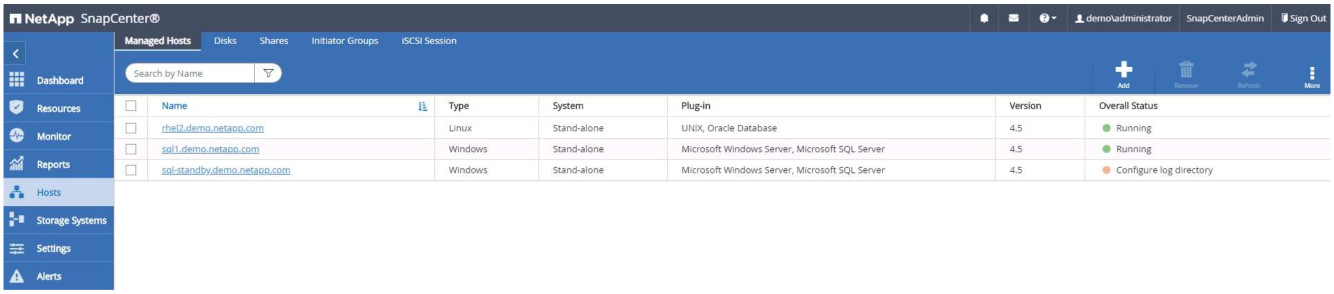


Host Type: Windows
Host Name: sql-standby
Credentials: Domain Admin

Select Plug-ins to Install SnapCenter Plug-ins Package 4.5 for Windows

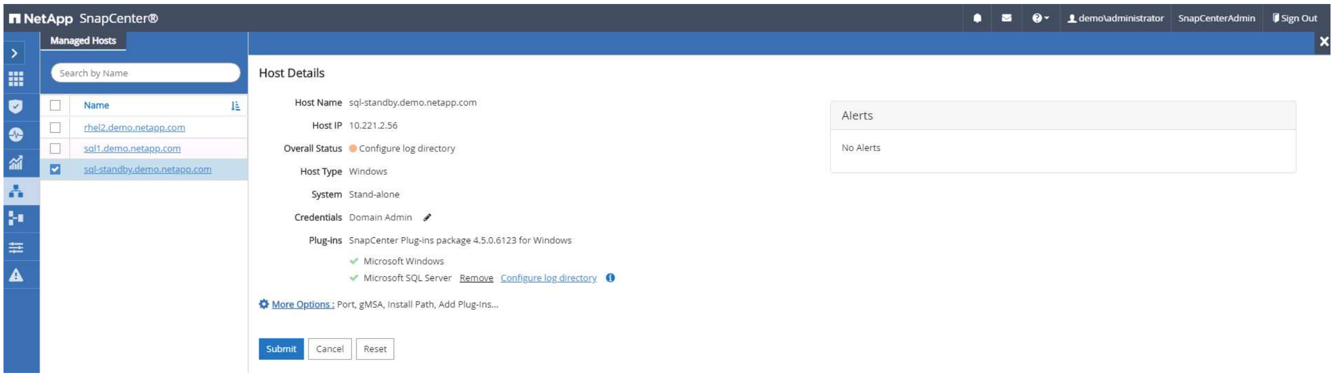
☑ Microsoft Windows
☑ Microsoft SQL Server
☐ Microsoft Exchange Server
☐ SAP HANA

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
☐	sql-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.

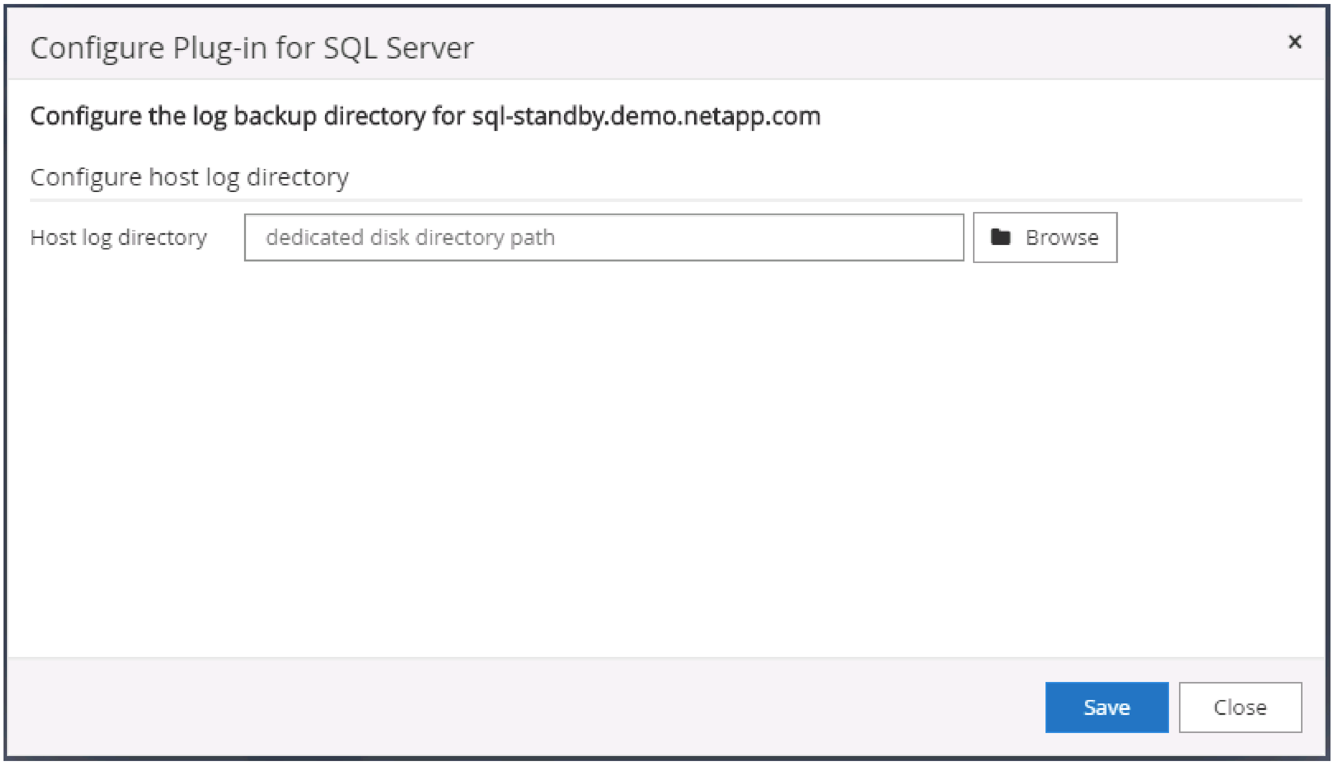


Host Details

Host Name sql-standby.demo.netapp.com
Host IP 10.221.2.56
Overall Status ● Configure log directory
Host Type Windows
System Stand-alone
Credentials Domain Admin
Plug-ins SnapCenter Plug-ins package 4.5.0.6123 for Windows
✓ Microsoft Windows
✓ Microsoft SQL Server Remove Configure log directory

More Options : Port, gMSA, Install Path, Add Plug-ins...

6. Click "Configure log directory" to open "Configure Plug-in for SQL Server."



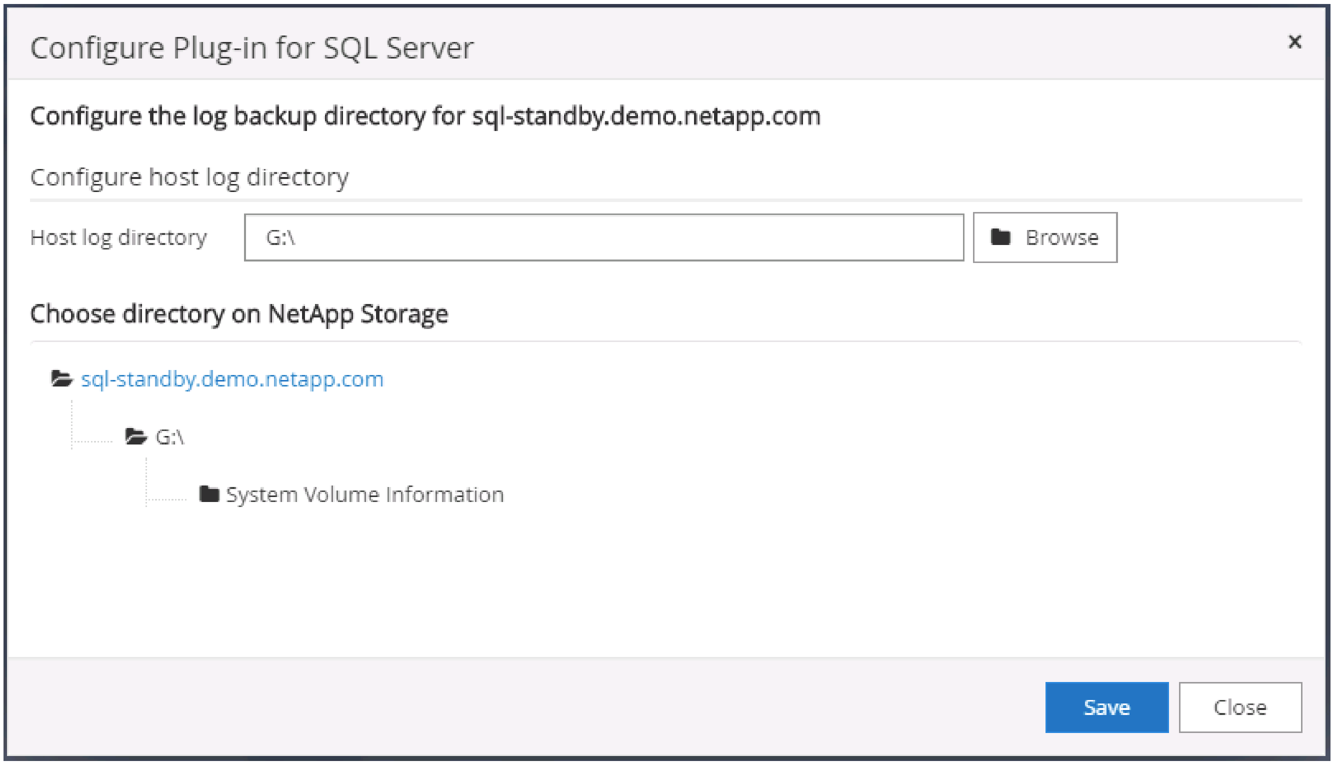
Configure Plug-in for SQL Server

Configure the log backup directory for sql-standby.demo.netapp.com

Configure host log directory

Host log directory dedicated disk directory path

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.



Configure Plug-in for SQL Server

Configure the log backup directory for sql-standby.demo.netapp.com

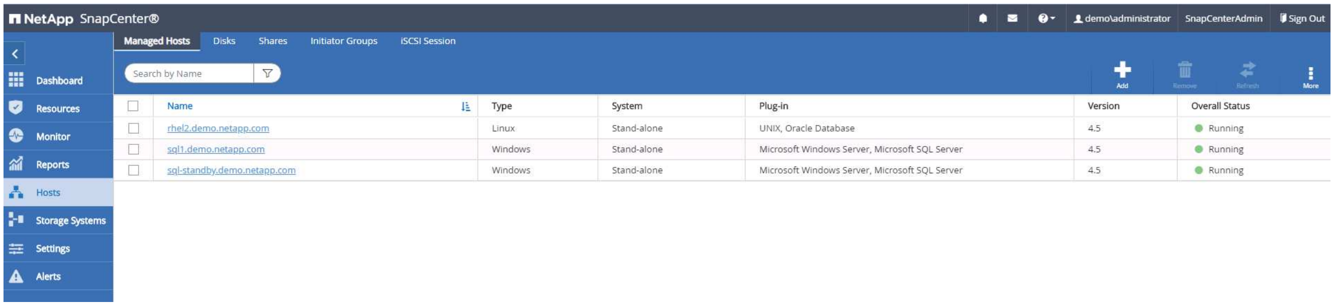
Configure host log directory

Host log directory: G:\

Choose directory on NetApp Storage

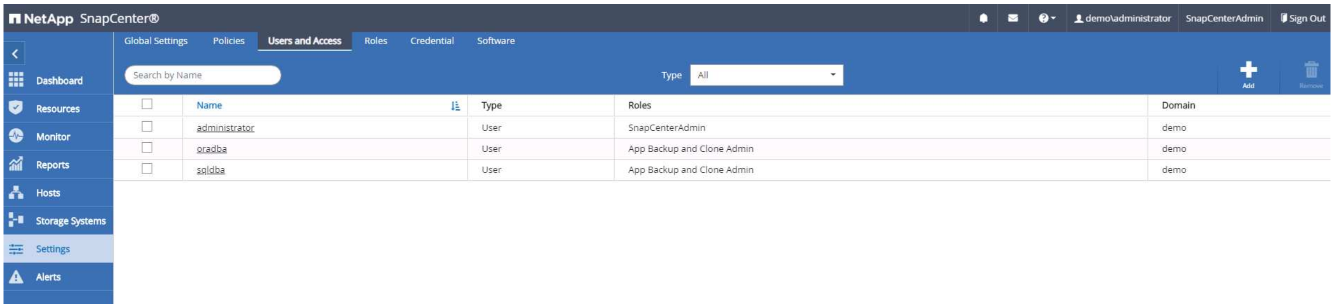
For NetApp storage provisioned to a DB host to be discovered, the storage (on-prem or CVO) must be added to SnapCenter, as illustrated in step 6 for CVO as an example.

8. After the log directory is configured, the Windows host plugin Overall Status is changed to Running.



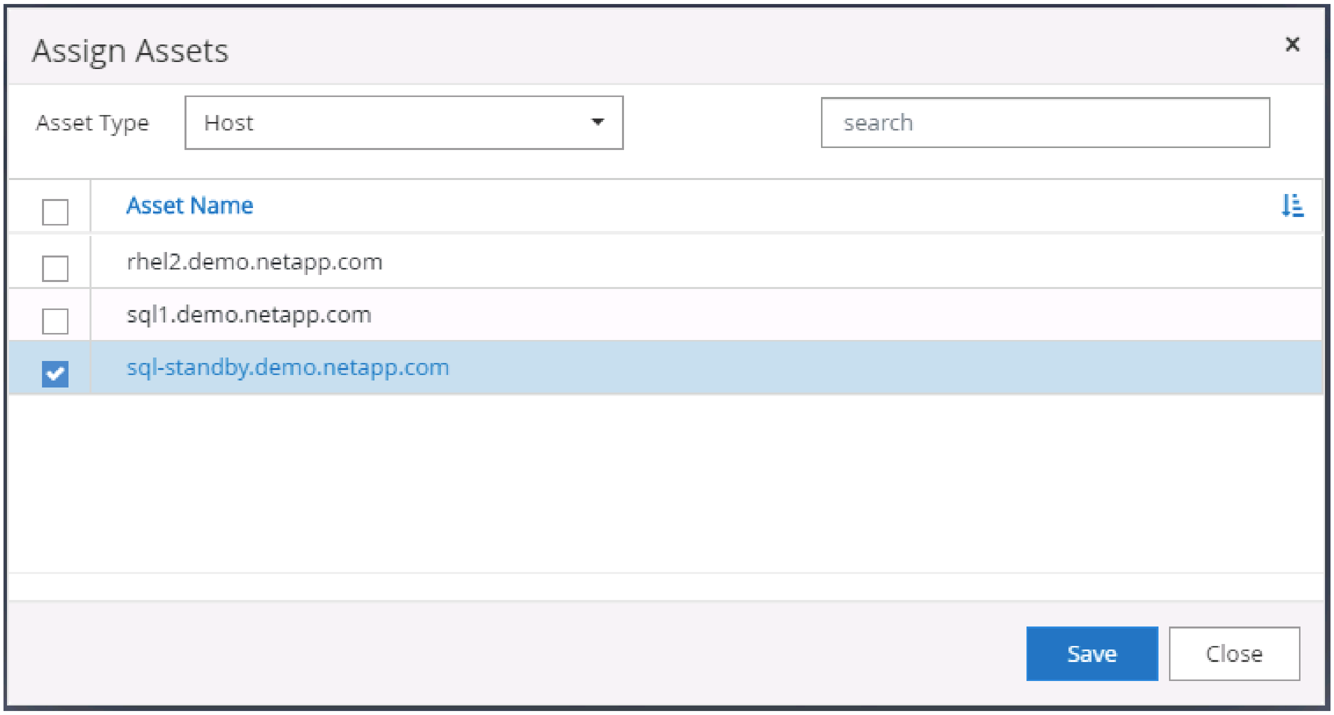
☐	Name	Type	System	Plug-in	Version	Overall Status
☐	rhel2.demo.netapp.com	Linux	Stand-alone	UNIX, Oracle Database	4.5	● Running
☐	sql1.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	● Running
☐	sql-standby.demo.netapp.com	Windows	Stand-alone	Microsoft Windows Server, Microsoft SQL Server	4.5	● Running

9. 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.



Type: All

☐	Name	Type	Roles	Domain
☐	administrator	User	SnapCenterAdmin	demo
☐	oradba	User	App Backup and Clone Admin	demo
☐	sqldba	User	App Backup and Clone Admin	demo



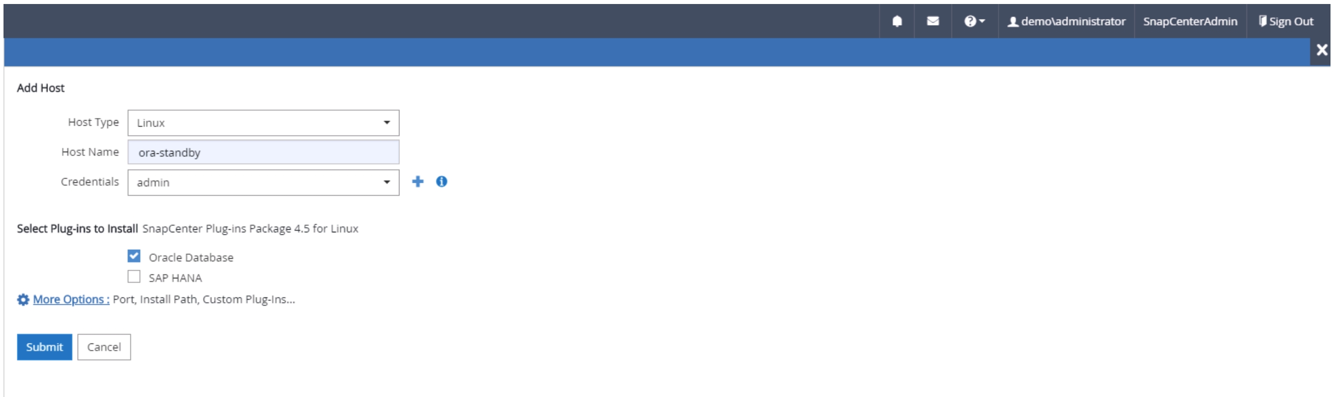
Assign Assets

Asset Type: Host

	Asset Name
☐	rhel2.demo.netapp.com
☐	sql1.demo.netapp.com
☑	sql-standby.demo.netapp.com

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

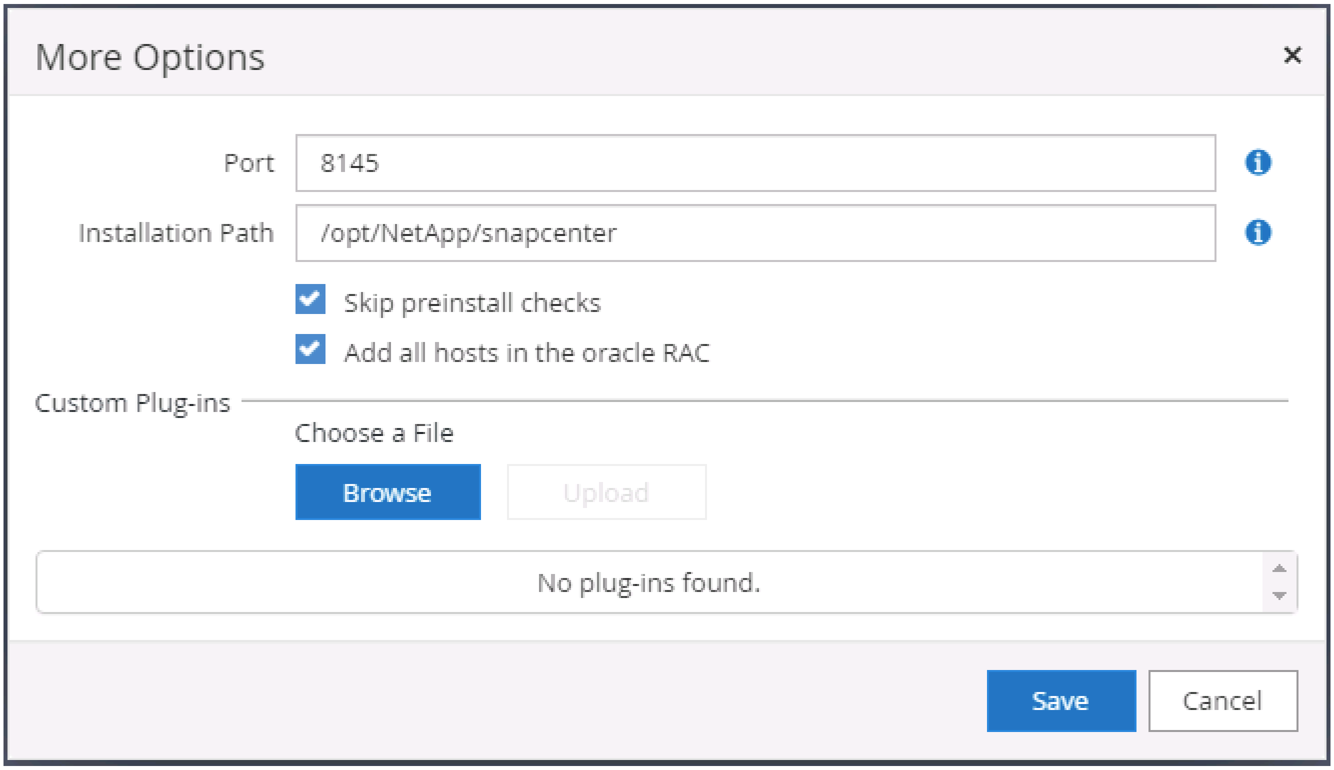
Select Plug-ins to Install SnapCenter Plug-ins Package 4.5 for Linux

☑ Oracle Database

☐ SAP HANA

More Options : Port, Install Path, Custom Plug-ins...

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.



Port: 8145

Installation Path: /opt/NetApp/snapcenter

☑ Skip preinstall checks

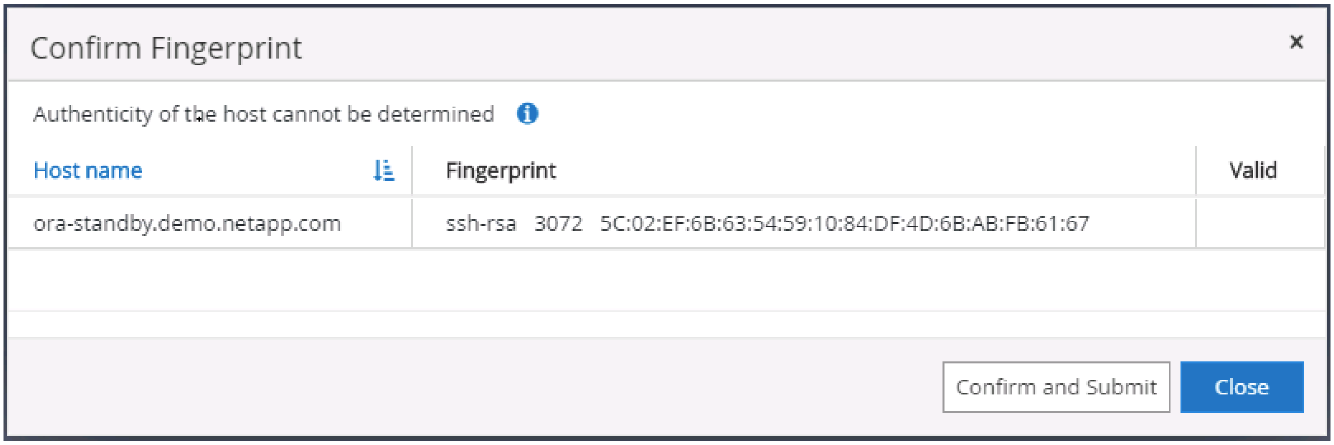
☑ Add all hosts in the oracle RAC

Custom Plug-ins

Choose a File

No plug-ins found.

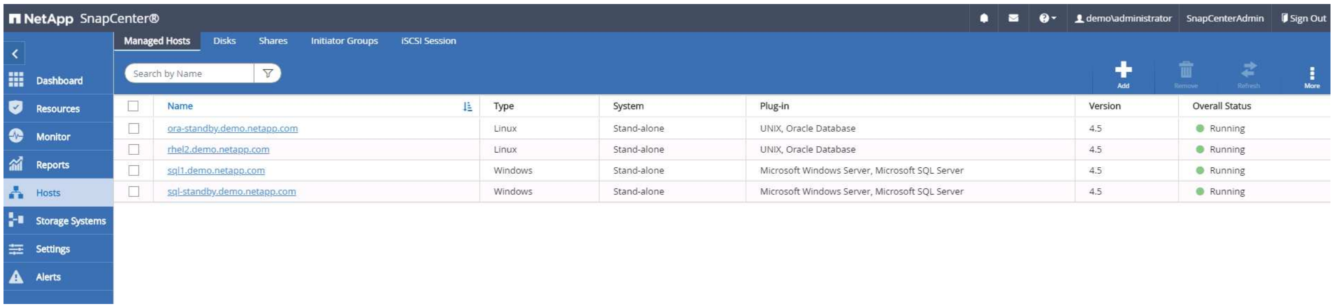
5. Click Submit to start the plugin installation. You are prompted to Confirm Fingerprint as shown below.



Authenticity of the host cannot be determined

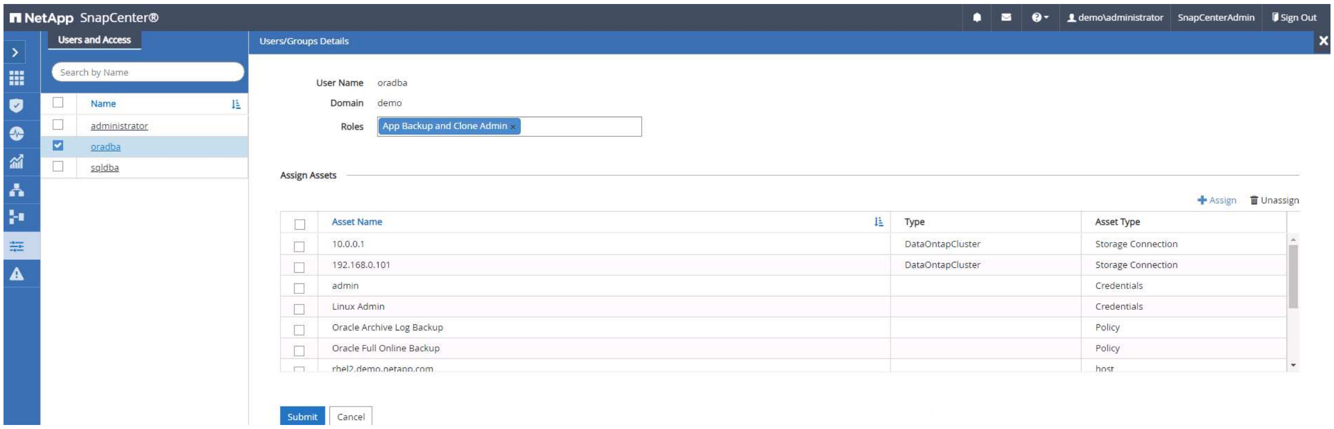
Host name	Fingerprint	Valid
ora-standby.demo.netapp.com	ssh-rsa 3072 5C:02:EF:6B:63:54:59:10:84:DF:4D:6B:AB:FB:61:67	

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).



☐	Name
☐	administrator
☑	oradba
☐	sqldba

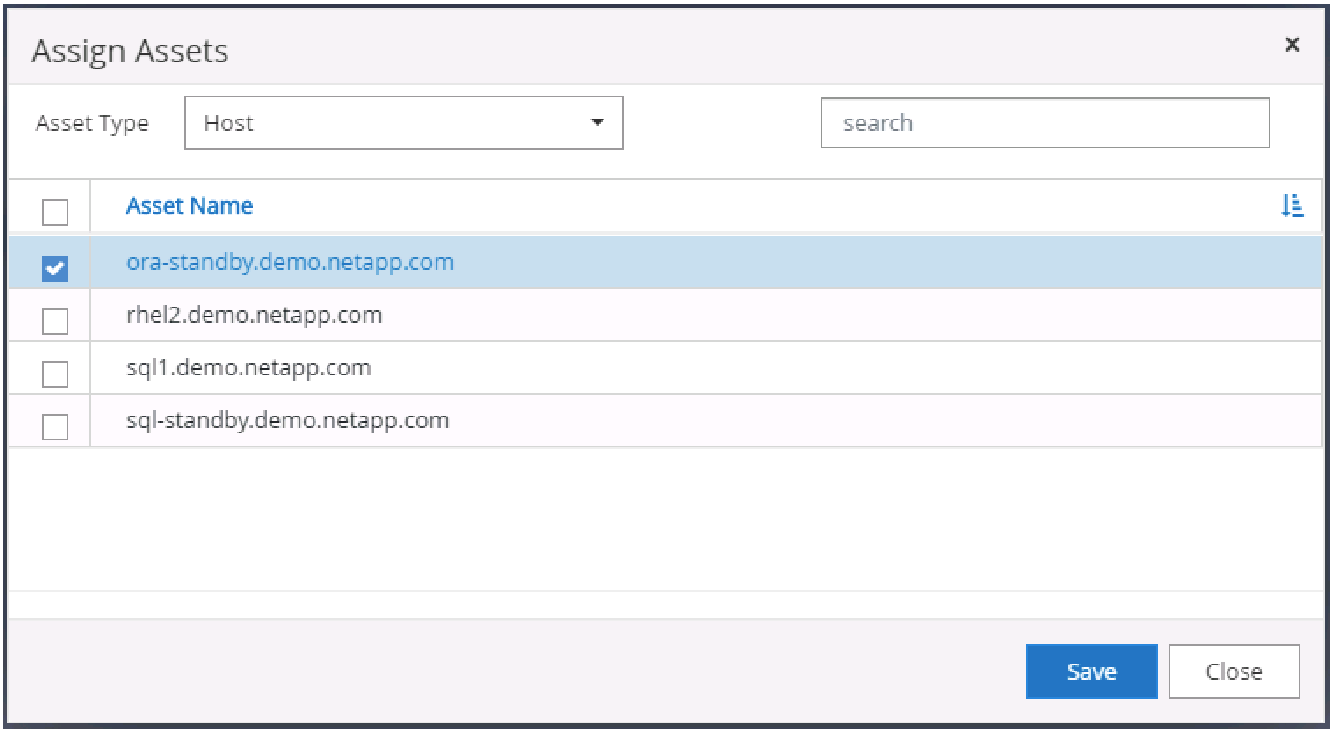
User Name oradba

Domain demo

Roles App Backup and Clone Admin

Assign Assets

☐	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

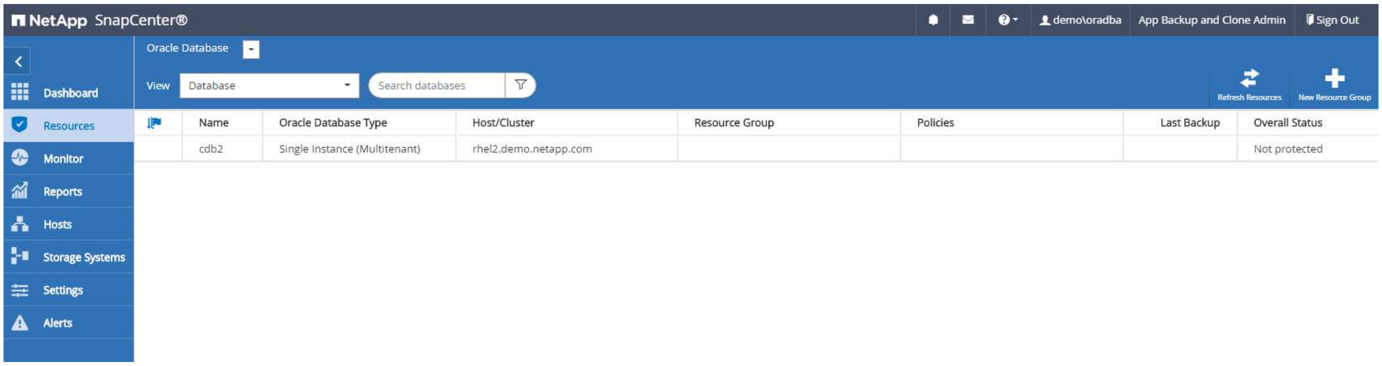


Asset Type Host

☐	Asset Name
☑	ora-standby.demo.netapp.com
☐	rhel2.demo.netapp.com
☐	sql1.demo.netapp.com
☐	sql-standby.demo.netapp.com

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.

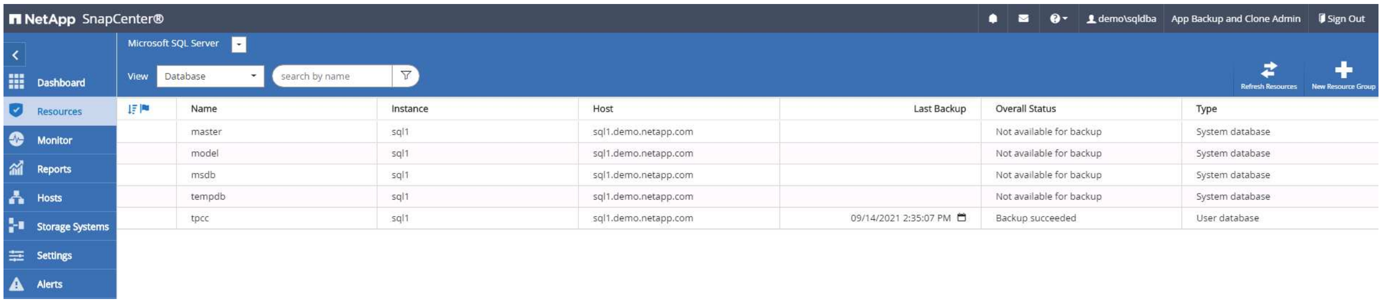


View Database

Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com				Not protected

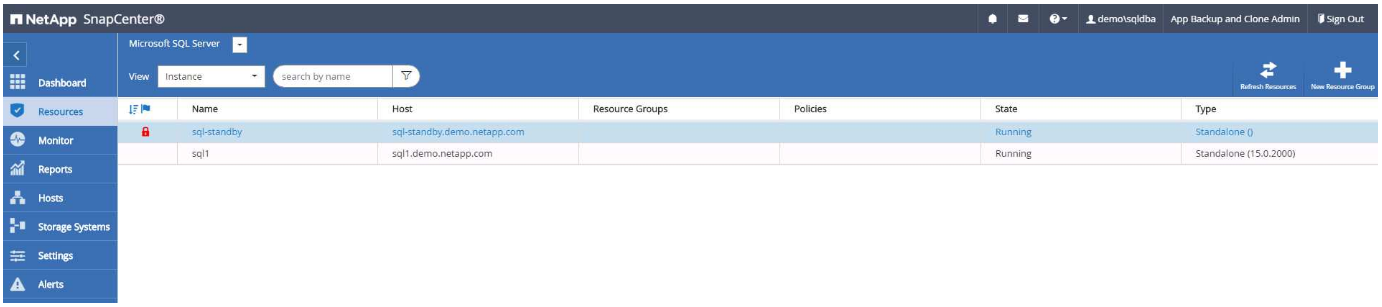
When the database is initially discovered, the Overall Status is shown as "Not protected." The previous screenshot shows an Oracle database not protected yet by a backup policy.

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.

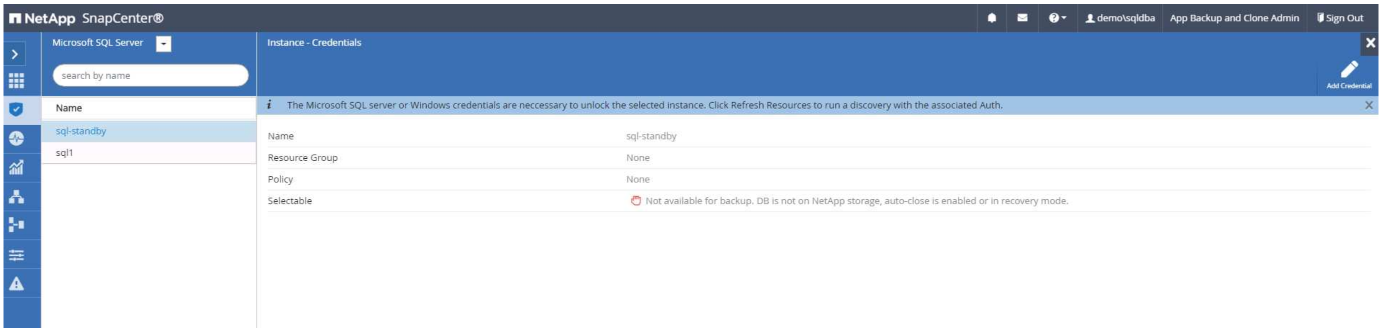


Name	Instance	Host	Last Backup	Overall Status	Type
master	sql1	sql1.demo.netapp.com		Not available for backup	System database
model	sql1	sql1.demo.netapp.com		Not available for backup	System database
msdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tempdb	sql1	sql1.demo.netapp.com		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.



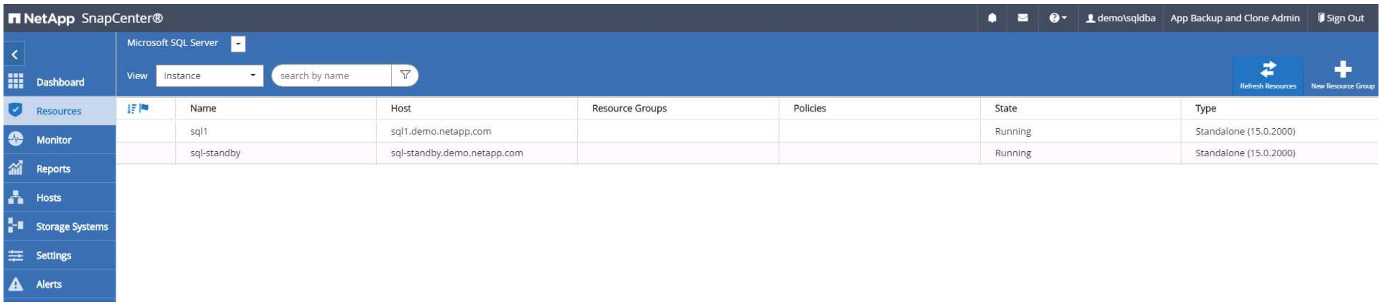
Name	Host	Resource Groups	Policies	State	Type
sql-standby	sql-standby.demo.netapp.com			Running	Standalone ()
sql1	sql1.demo.netapp.com			Running	Standalone (15.0.2000)



The Microsoft SQL server or Windows credentials are neccessary to unlock the selected instance. Click Refresh Resources to run a discovery with the associated Auth.

Name	sql-standby
Resource Group	None
Policy	None
Selectable	Not available for backup. DB is not on NetApp storage, auto-close is enabled or in recovery mode.

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.



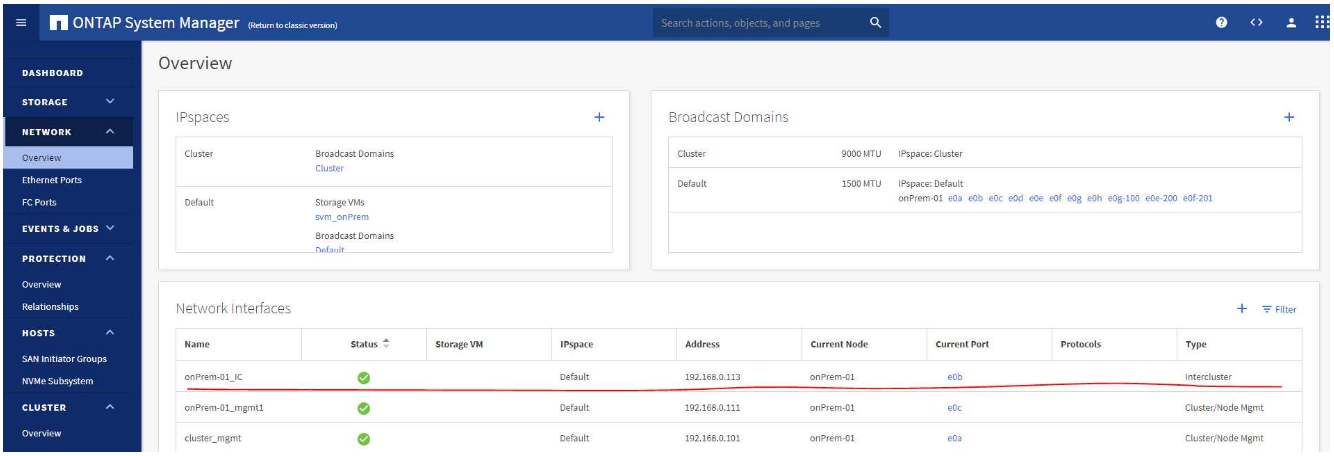
Name	Host	Resource Groups	Policies	State	Type
sql1	sql1.demo.netapp.com			Running	Standalone (15.0.2000)
sql-standby	sql-standby.demo.netapp.com			Running	Standalone (15.0.2000)

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 Manger. A default CVO deployment has inter-cluster LIFs configured automatically.

   On-premises cluster:

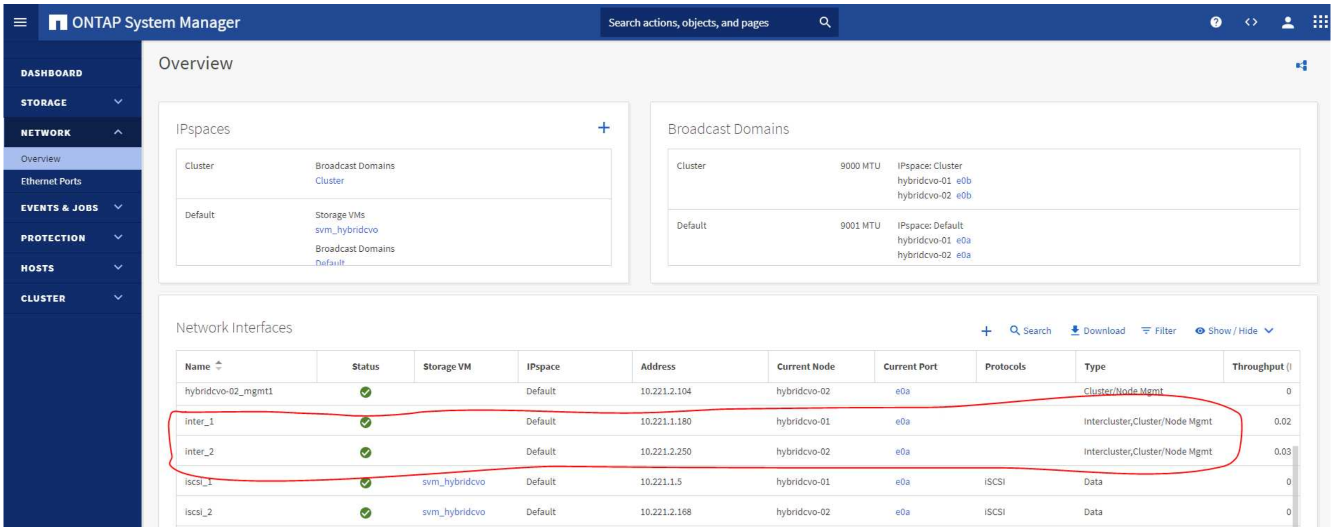


Cluster	Broadcast Domains Cluster
Default	Storage VMs svm_onPrem Broadcast Domains Default

Cluster	9000 MTU	IPspace: Cluster
Default	1500 MTU	IPspace: Default onPrem-01 e0a e0b e0c e0d e0e e0f e0g e0h e0g-100 e0e-200 e0f-201

Name	Status	Storage VM	IPspace	Address	Current Node	Current Port	Protocols	Type
onPrem-01_IC	✓		Default	192.168.0.113	onPrem-01	e0b		Intercluster
onPrem-01_mgmt1	✓		Default	192.168.0.111	onPrem-01	e0c		Cluster/Node Mgmt
cluster_mgmt	✓		Default	192.168.0.101	onPrem-01	e0a		Cluster/Node Mgmt

   Target CVO cluster:



Cluster	Broadcast Domains Cluster
Default	Storage VMs svm_hybridcvo Broadcast Domains Default

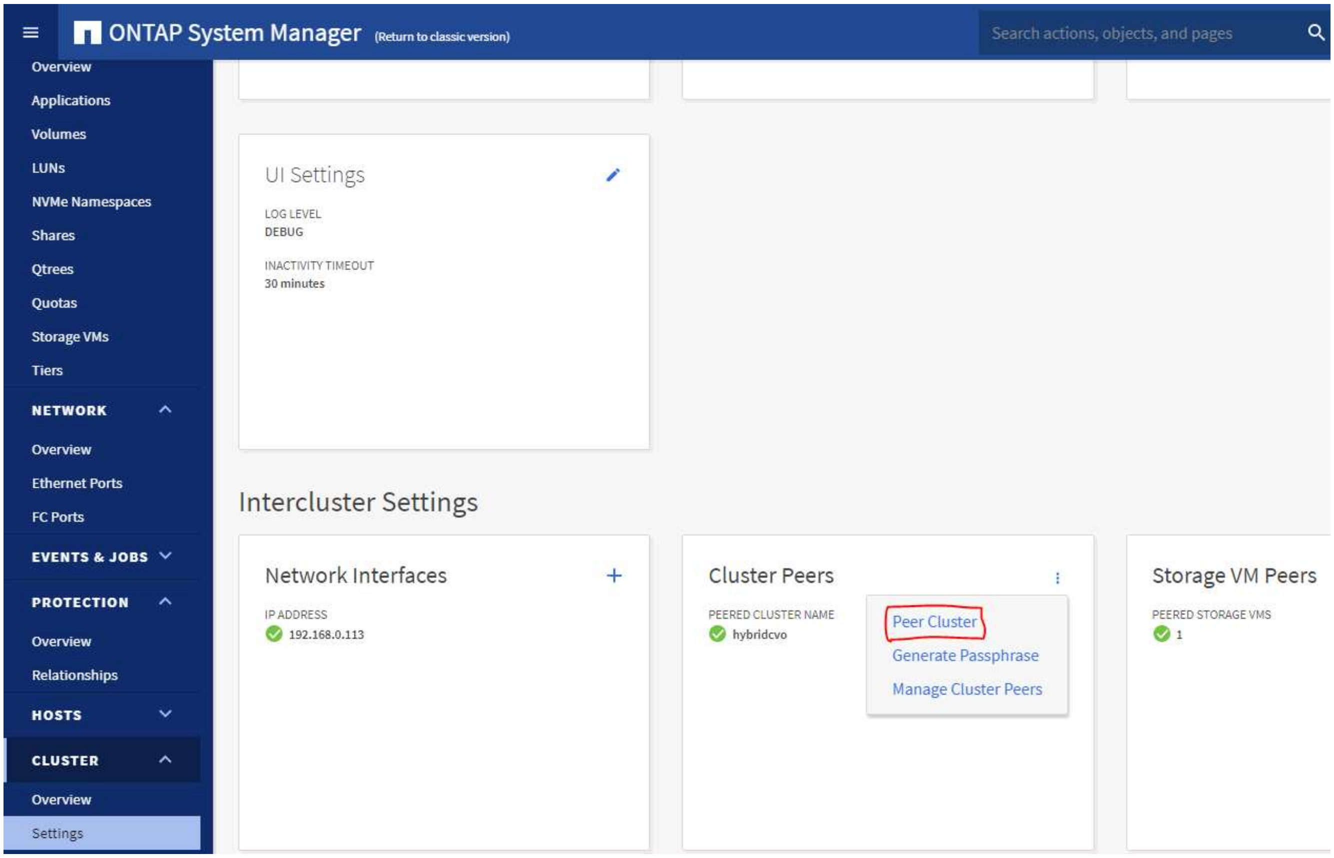
Cluster	9000 MTU	IPspace: Cluster hybridcvo-01 e0b hybridcvo-02 e0b
Default	9001 MTU	IPspace: Default hybridcvo-01 e0a hybridcvo-02 e0a

Name	Status	Storage VM	IPspace	Address	Current Node	Current Port	Protocols	Type	Throughput (I
hybridcvo-02_mgmt1	✓		Default	10.221.2.104	hybridcvo-02	e0a		Cluster/Node Mgmt	0
inter_1	✓		Default	10.221.1.180	hybridcvo-01	e0a		Intercluster,Cluster/Node Mgmt	0.02
inter_2	✓		Default	10.221.2.250	hybridcvo-02	e0a		Intercluster,Cluster/Node Mgmt	0.03
iscsi_1	✓	svm_hybridcvo	Default	10.221.1.5	hybridcvo-01	e0a	iSCSI	Data	0
iscsi_2	✓	svm_hybridcvo	Default	10.221.2.168	hybridcvo-02	e0a	iSCSI	Data	0

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.



LOG LEVEL
DEBUG

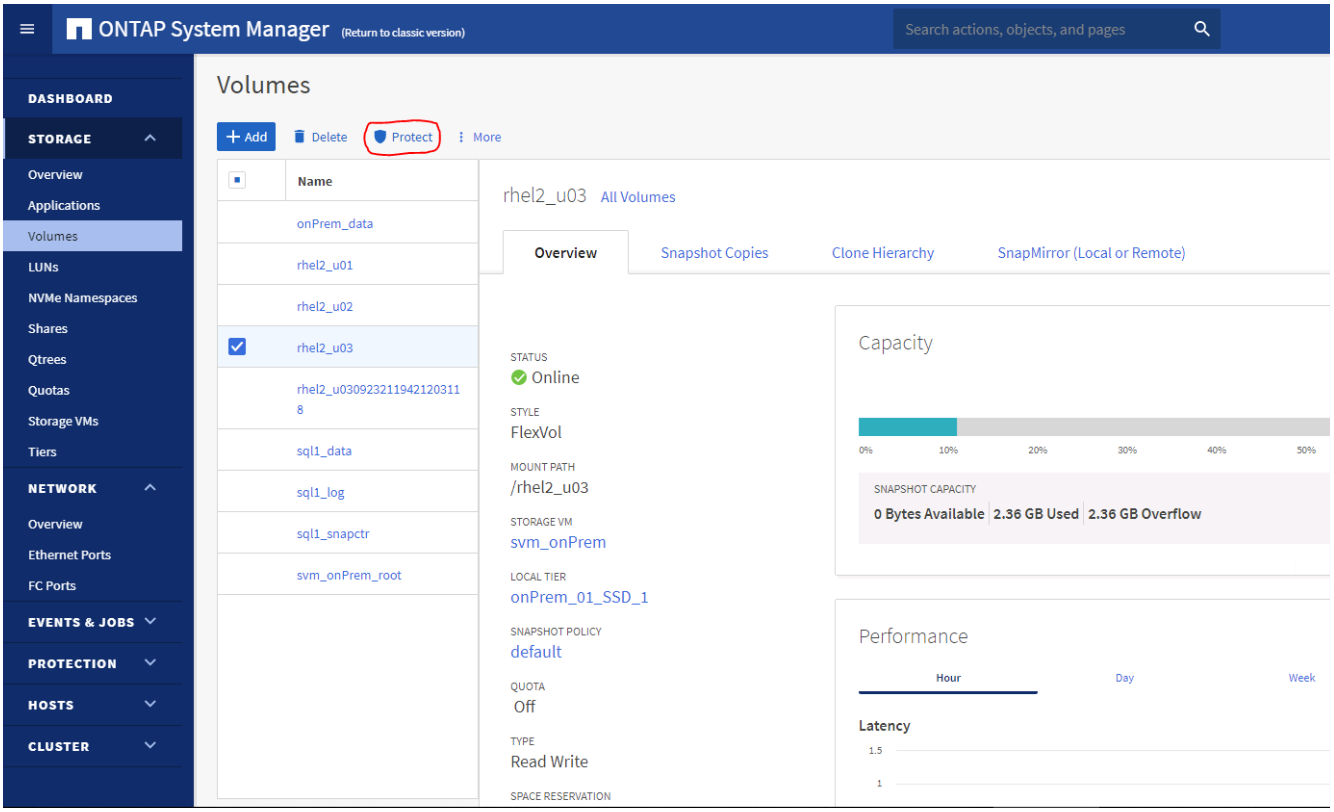
INACTIVITY TIMEOUT
30 minutes

IP ADDRESS
192.168.0.113

PEERED CLUSTER NAME
hybridcvo

PEERED STORAGE VMS
1

4. Go to the Volumes tab. Select the database volume to be replicated and click Protect.



STATUS
Online

STYLE
FlexVol

MOUNT PATH
/rhel2_u03

STORAGE VM
svm_onPrem

LOCAL TIER
onPrem_01_SSD_1

SNAPSHOT POLICY
default

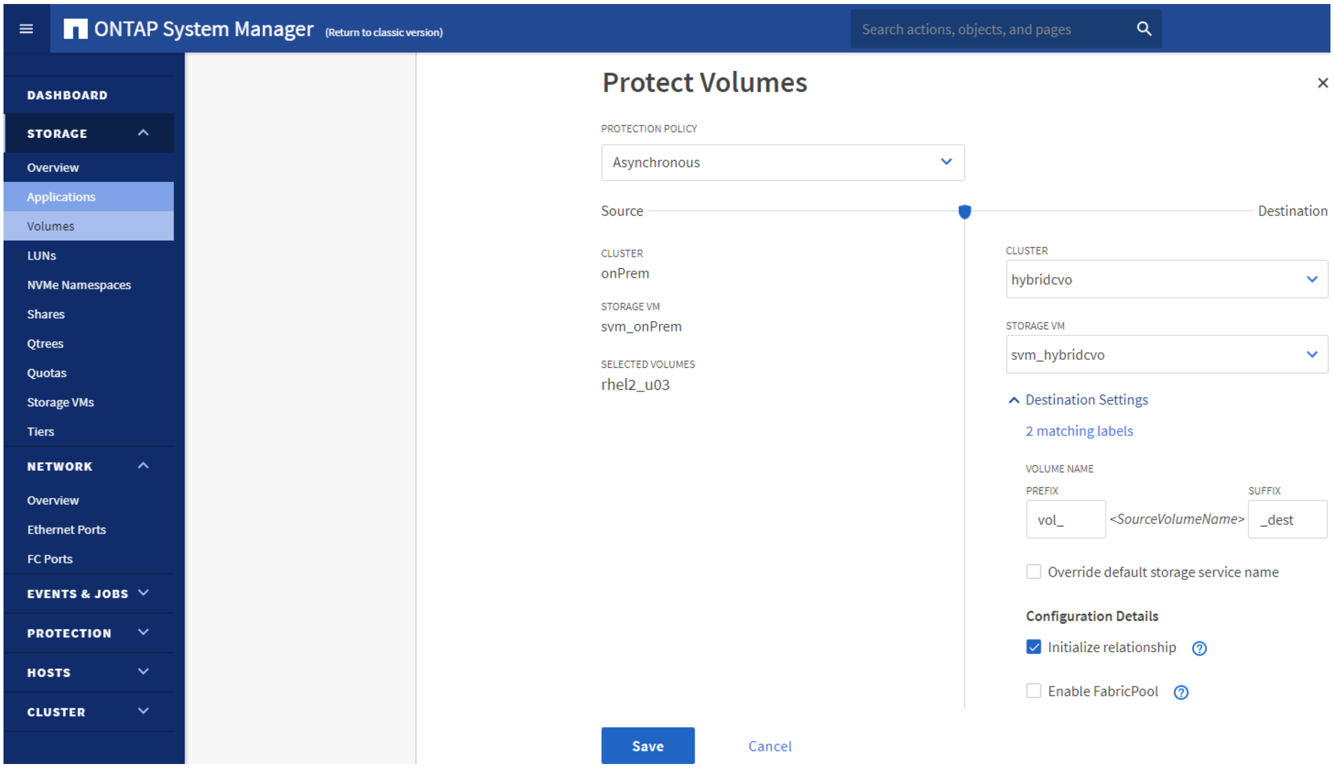
QUOTA
Off

TYPE
Read Write

SPACE RESERVATION

SNAPSHOT CAPACITY
0 Bytes Available | 2.36 GB Used | 2.36 GB Overflow

5. Set the protection policy to Asynchronous. Select the destination cluster and storage SVM.



Protect Volumes

PROTECTION POLICY: Asynchronous

Source Destination

CLUSTER: onPrem

STORAGE VM: svm_onPrem

SELECTED VOLUMES: rhel2_u03

CLUSTER: hybridcvo

STORAGE VM: svm_hybridcvo

Destination Settings

2 matching labels

VOLUME NAME

PREFIX vol_ <SourceVolumeName> SUFFIX _dest

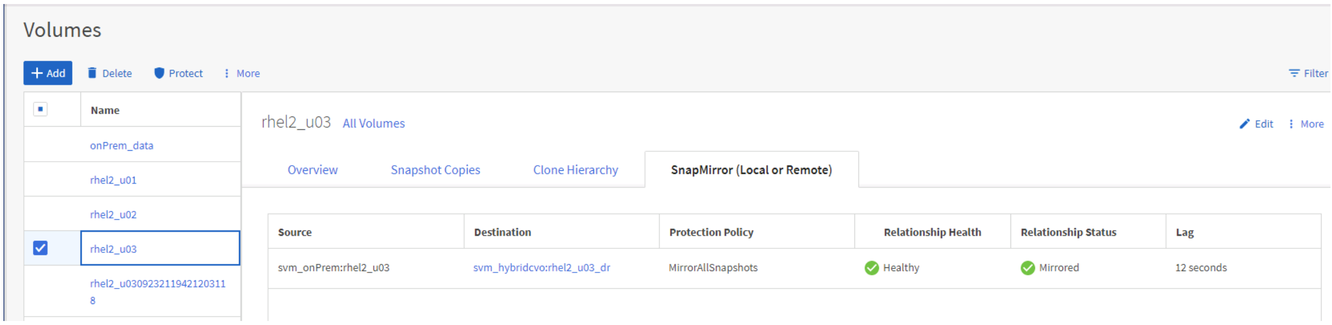
☐ Override default storage service name

Configuration Details

☑ Initialize relationship

☐ Enable FabricPool

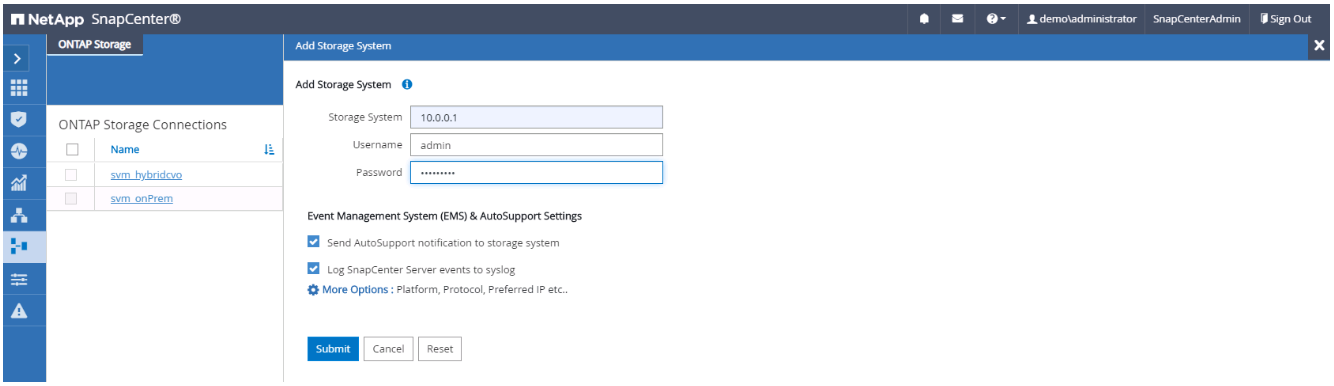
6. Validate that the volume is synced between the source and target and that the replication relationship is healthy.



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

1. Log into SnapCenter with a user ID with SnapCenterAdmin privileges.
2. 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.



ONTAP Storage Connections

☐	Name
☐	svm_hybridcvo
☐	svm_onPrem

Add Storage System

Storage System: 10.0.0.1

Username: admin

Password: •••••••••

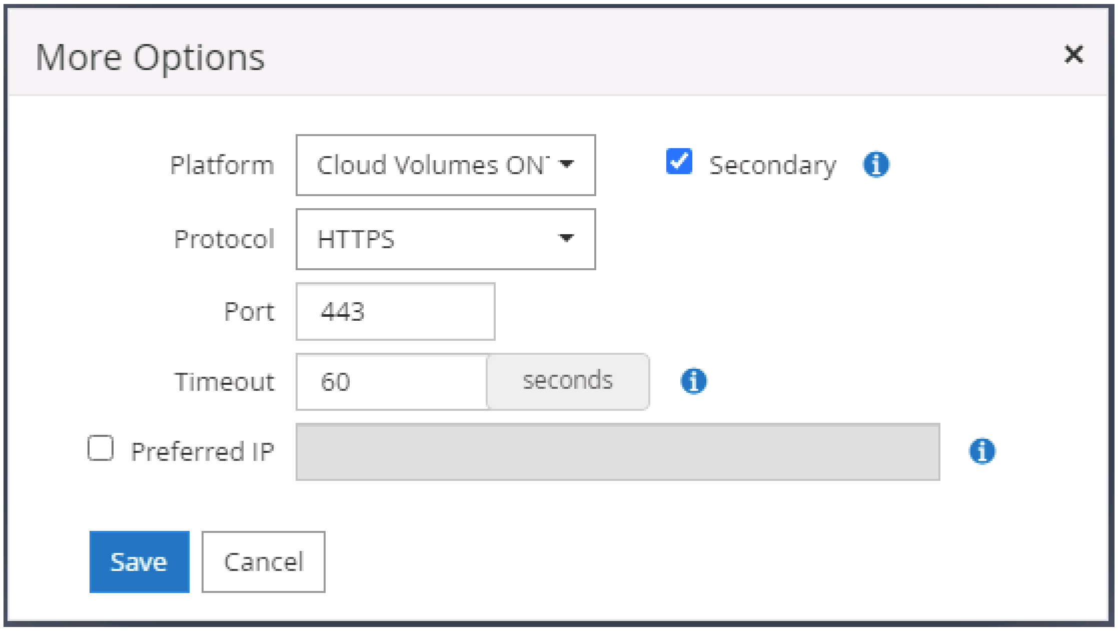
Event Management System (EMS) & AutoSupport Settings

☑ Send AutoSupport notification to storage system

☑ Log SnapCenter Server events to syslog

More Options : Platform, Protocol, Preferred IP etc..

3. Click More Options to open additional storage configuration options. In the Platform field, select Cloud Volumes ONTAP, check Secondary, and then click Save.



More Options

Platform: Cloud Volumes ON˙ ☑ Secondary

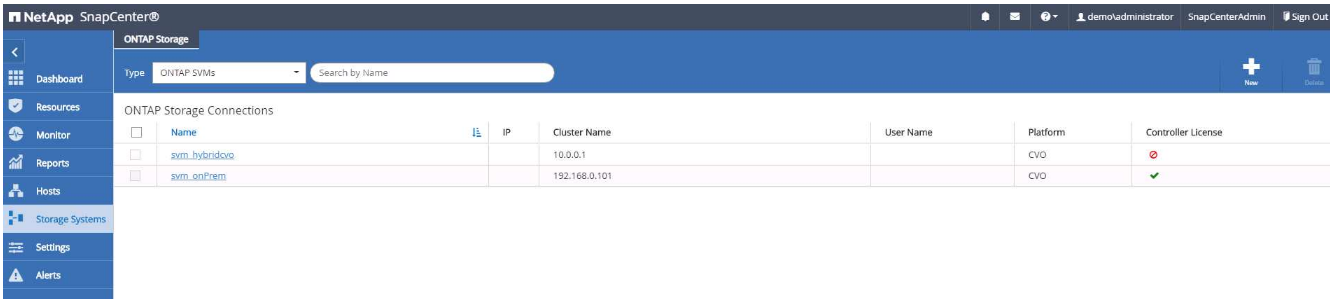
Protocol: HTTPS

Port: 443

Timeout: 60 seconds

☐ Preferred IP

4. Assign the storage systems to SnapCenter database management user IDs as shown in 3. SnapCenter host plugin installation.



Type: ONTAP SVMs

Search by Name

ONTAP Storage Connections

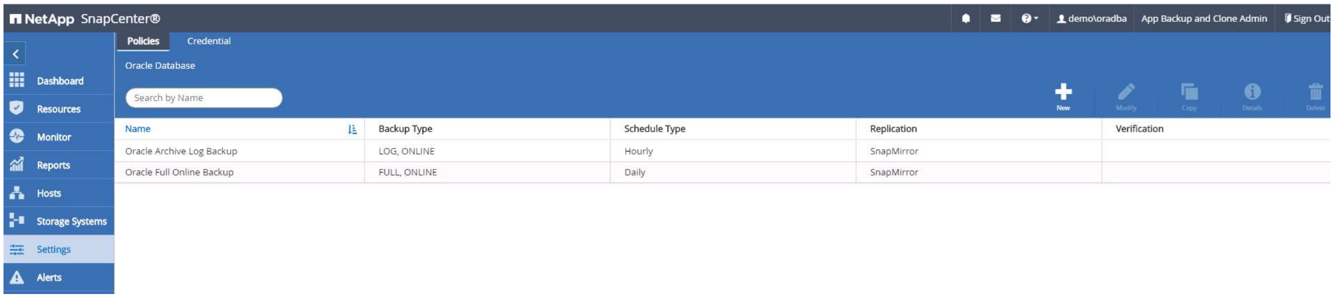
☐	Name	IP	Cluster Name	User Name	Platform	Controller License
☐	svm_hybridcvo		10.0.0.1		CVO	⊘
☐	svm_onPrem		192.168.0.101		CVO	✓

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.

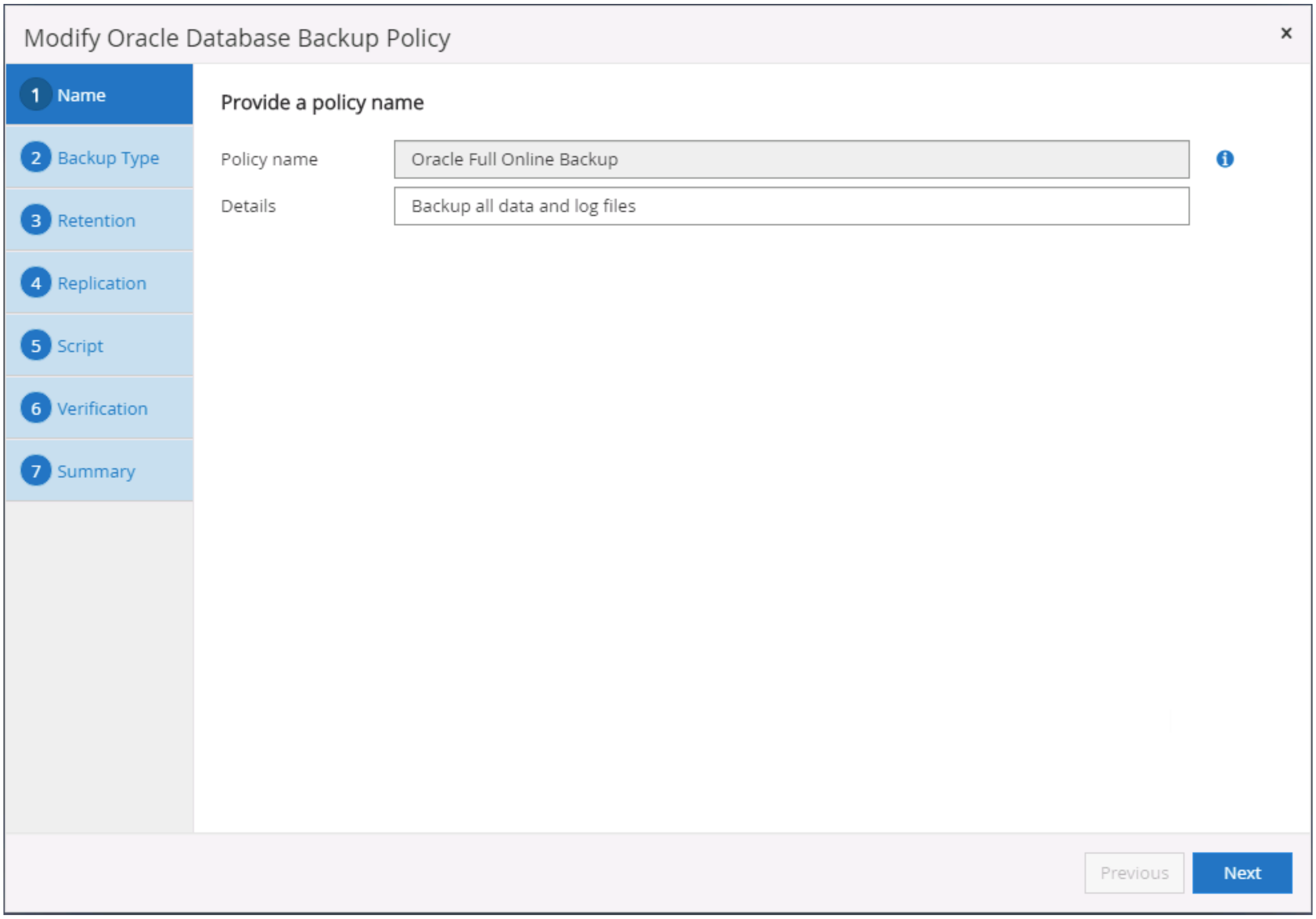
Create a full database backup policy for Oracle

1. Log into SnapCenter as a database management user ID, click Settings, and then click Polices.



Name	Backup Type	Schedule Type	Replication	Verification
Oracle Archive Log Backup	LOG, ONLINE	Hourly	SnapMirror	
Oracle Full Online Backup	FULL, ONLINE	Daily	SnapMirror	

2. Click New to launch a new backup policy creation workflow or choose an existing policy for modification.

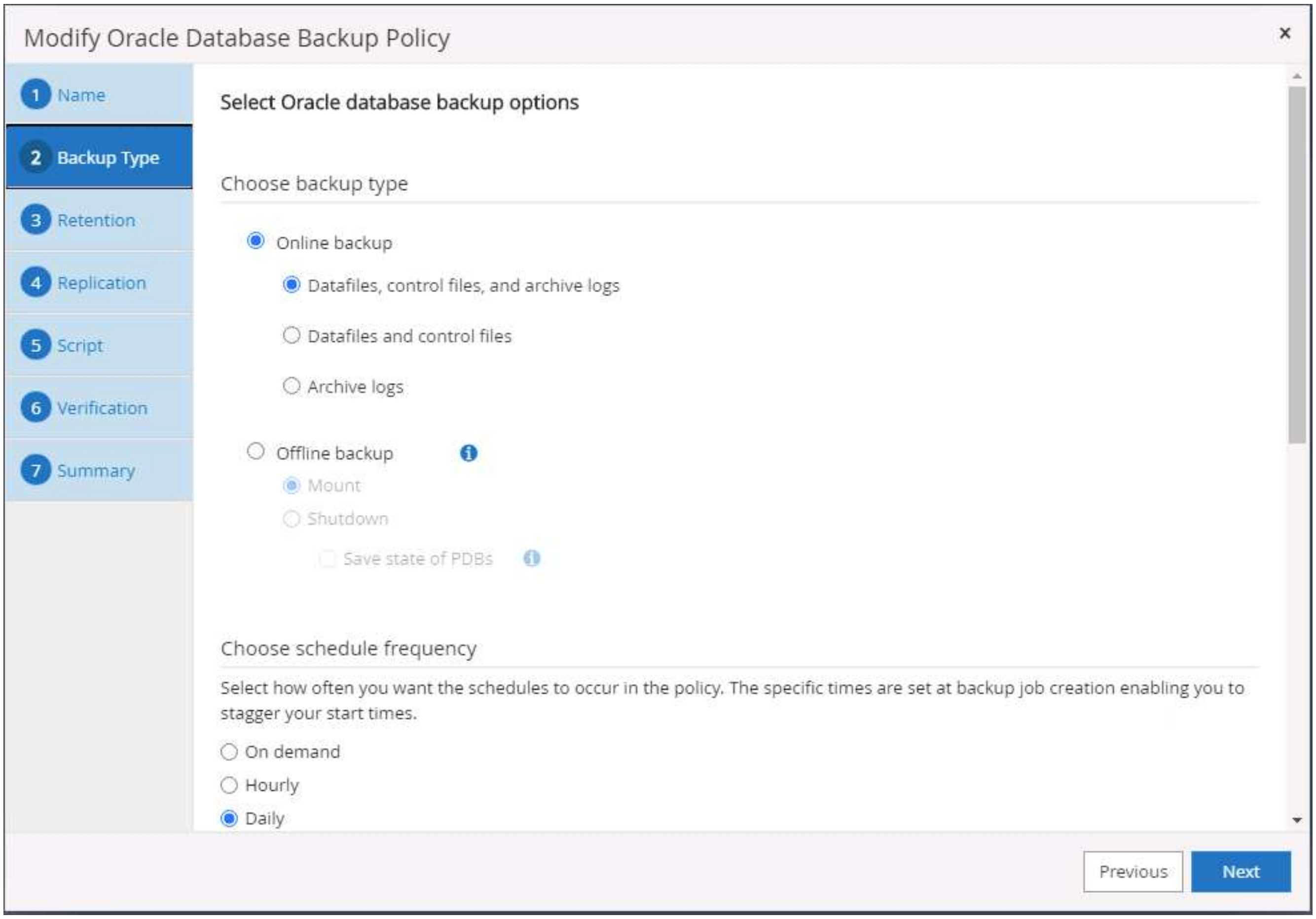


Provide a policy name

Policy name: Oracle Full Online Backup

Details: Backup all data and log files

3. Select the backup type and schedule frequency.



Select Oracle database backup options

Choose backup type

● Online backup

● Datafiles, control files, and archive logs

○ Datafiles and control files

○ Archive logs

○ Offline backup

● Mount

○ Shutdown

☐ Save state of PDBs

Choose schedule frequency

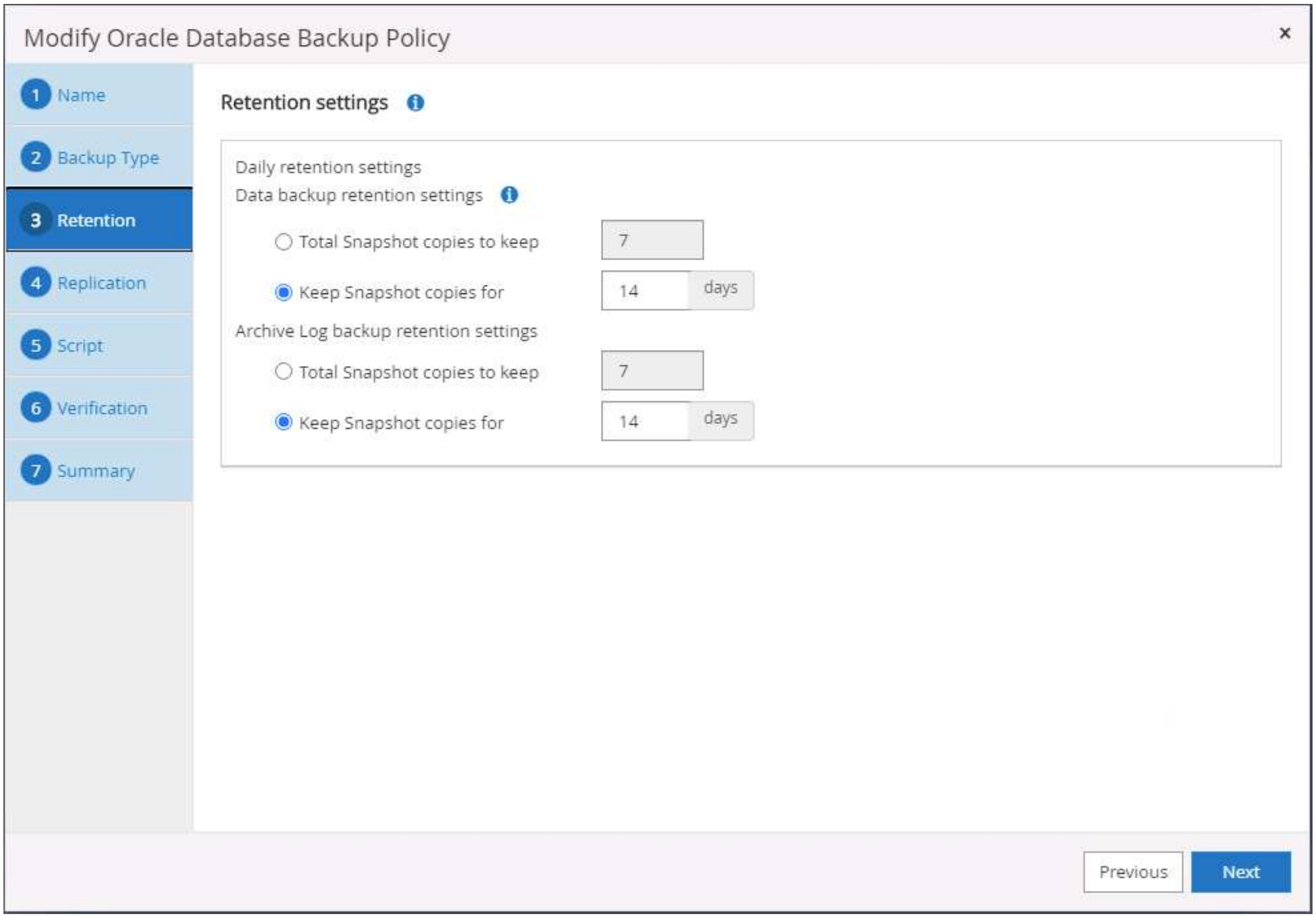
Select how often you want the schedules to occur in the policy. The specific times are set at backup job creation enabling you to stagger your start times.

○ On demand

○ Hourly

● Daily

4. Set the backup retention setting. This defines how many full database backup copies to keep.



Retention settings

Daily retention settings

Data backup retention settings

○ Total Snapshot copies to keep 7

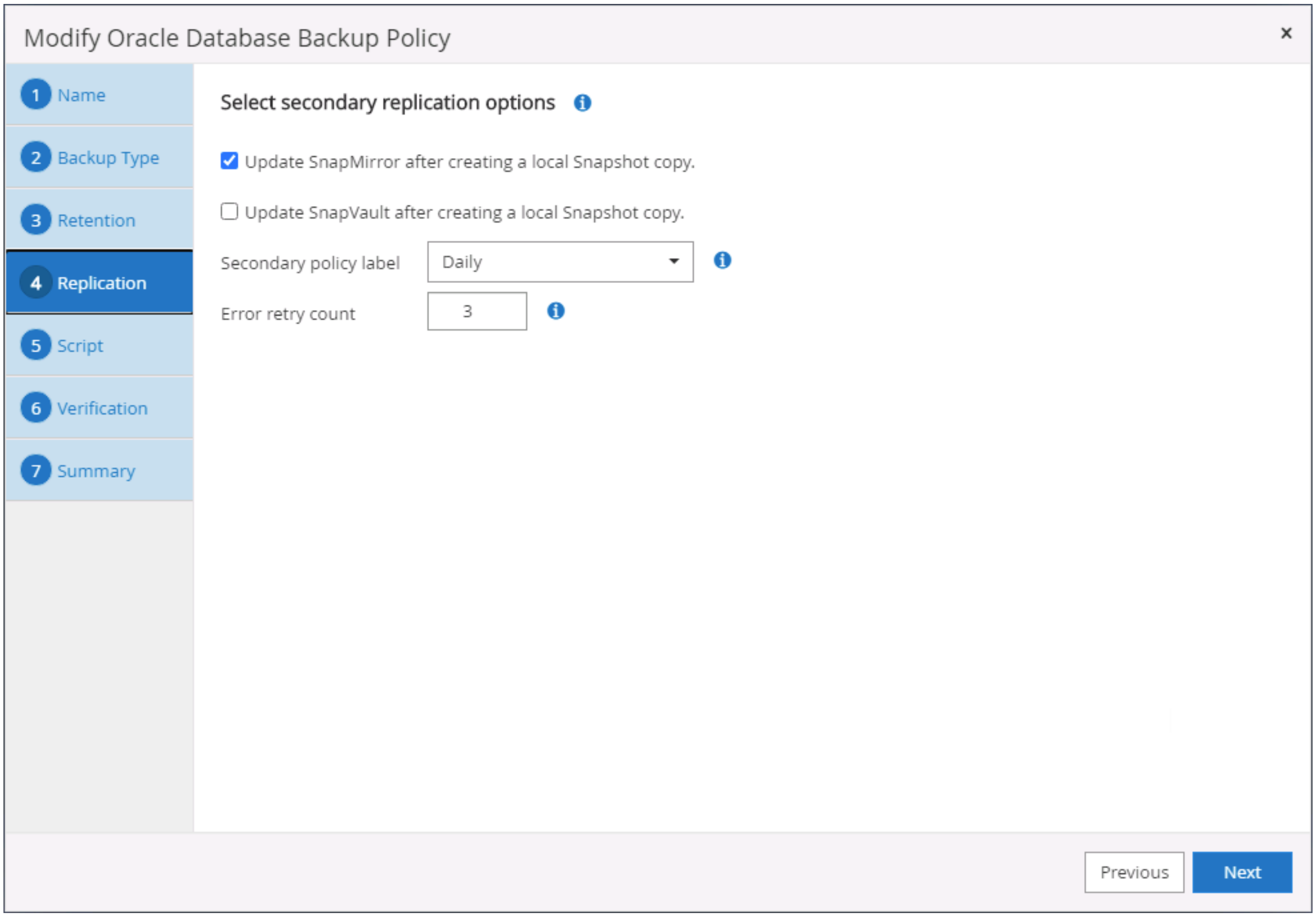
● Keep Snapshot copies for 14 days

Archive Log backup retention settings

○ Total Snapshot copies to keep 7

● Keep Snapshot copies for 14 days

5. Select the secondary replication options to push local primary snapshots backups to be replicated to a secondary location in cloud.



Select secondary replication options

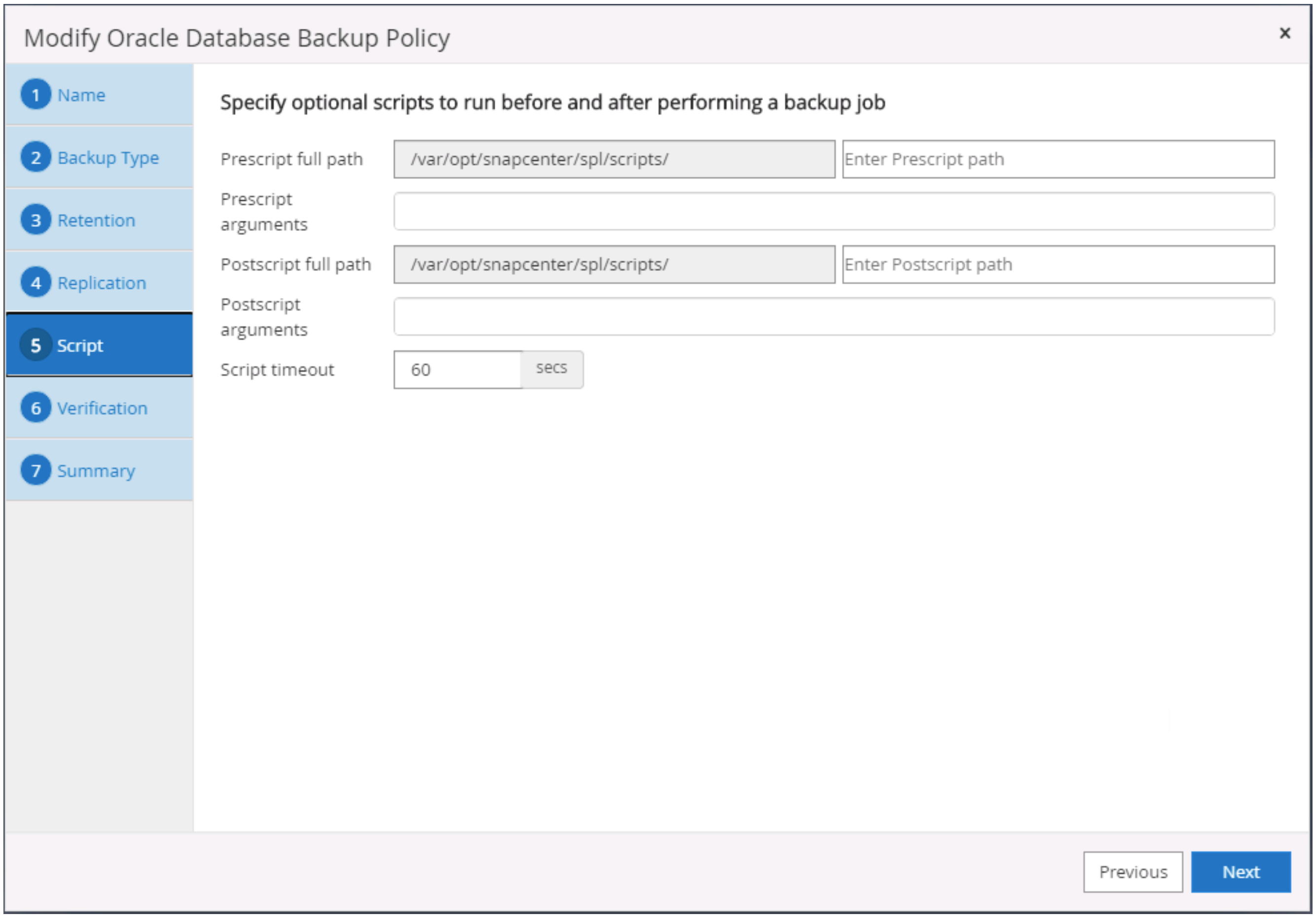
☑ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Daily

Error retry count: 3

6. Specify any optional script to run before and after a backup run.



Specify optional scripts to run before and after performing a backup job

Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

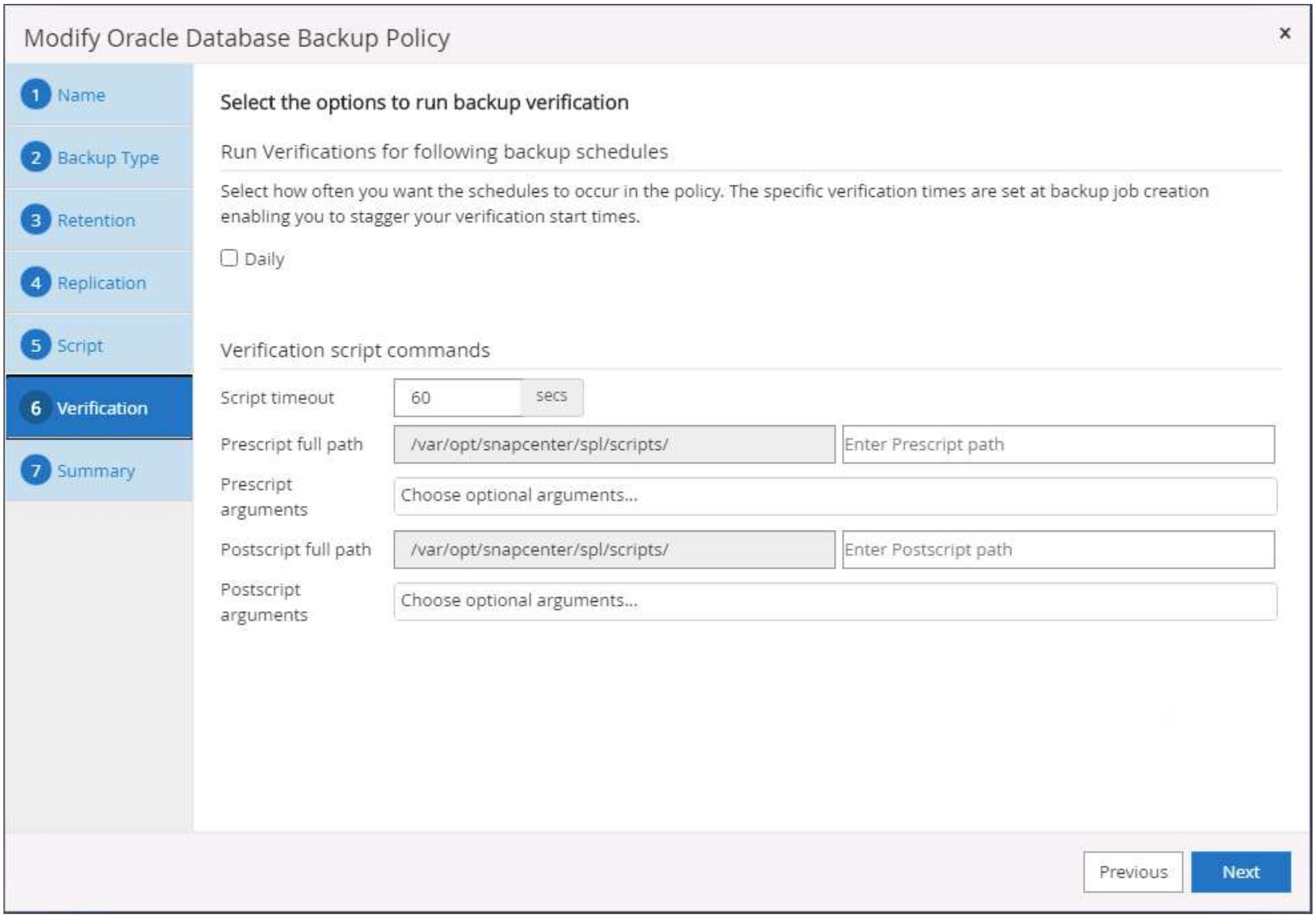
Prescript arguments:

Postscript full path: /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Postscript arguments:

Script timeout: 60 secs

7. Run backup verification if desired.



Select the options to run backup verification

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

Verification script commands

Script timeout: 60 secs

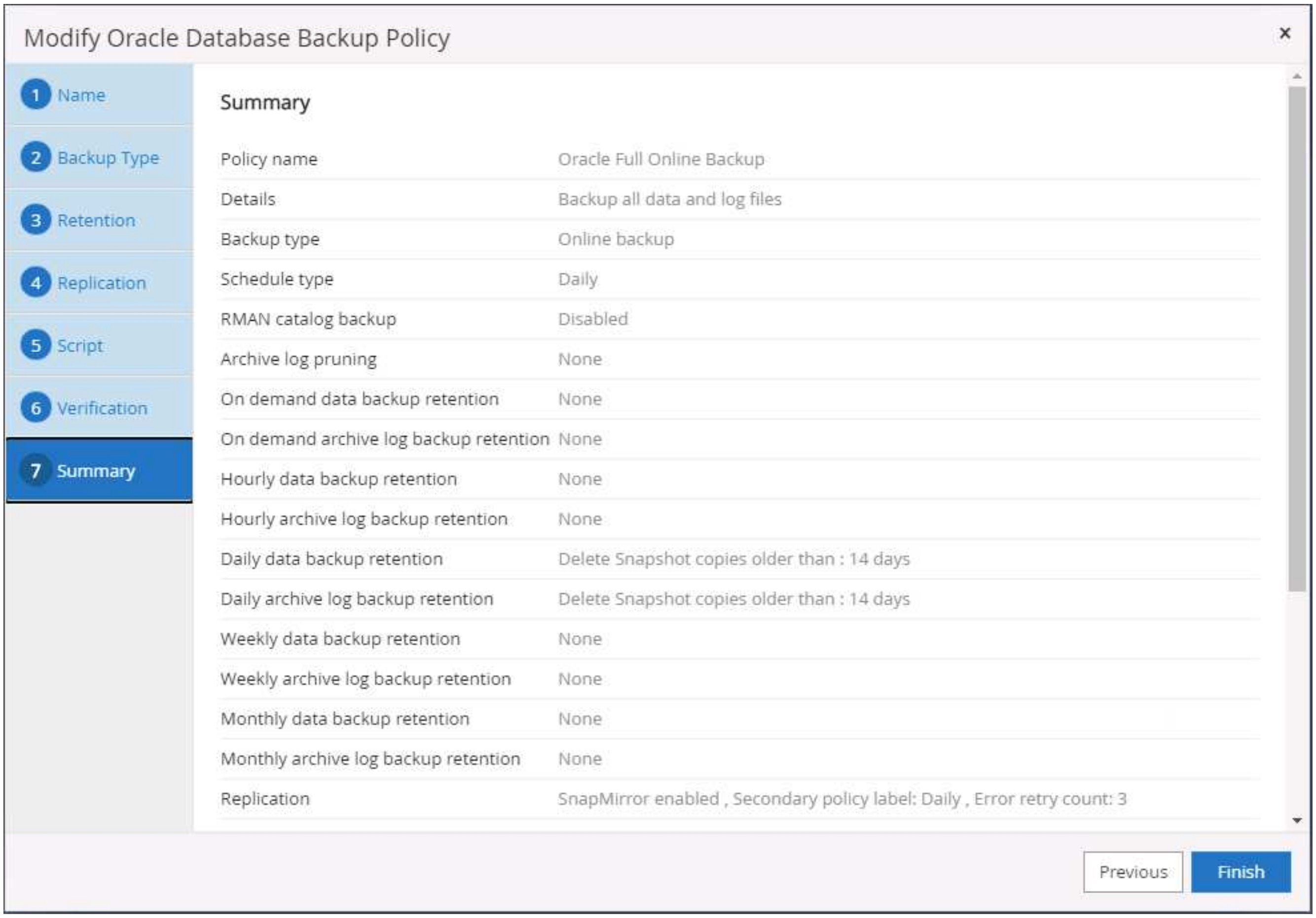
Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Prescript arguments: Choose optional arguments...

Postscript full path: /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Postscript arguments: Choose optional arguments...

8. Summary.

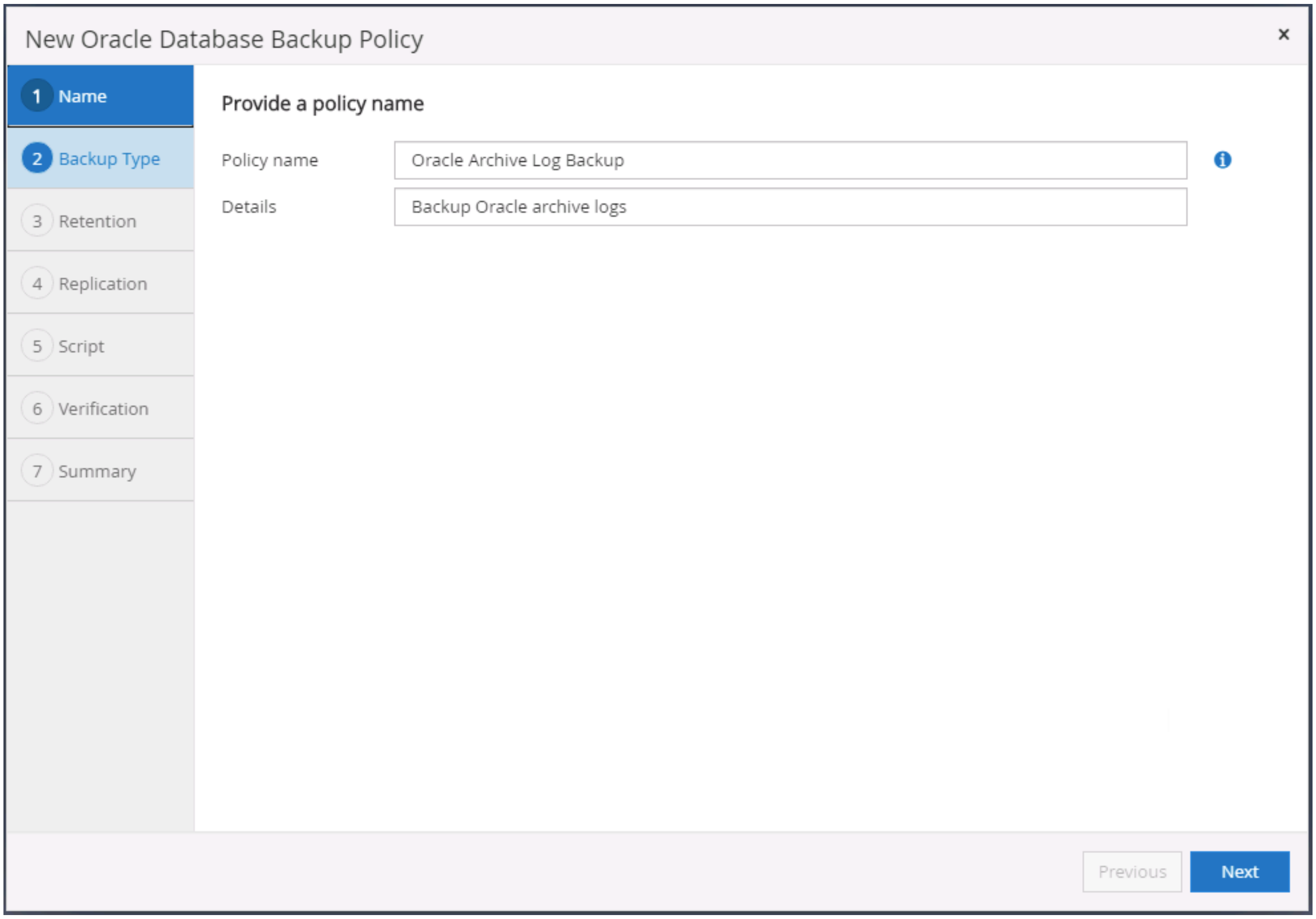


Summary

Policy name	Oracle Full Online Backup
Details	Backup all data and log files
Backup type	Online backup
Schedule type	Daily
RMAN catalog backup	Disabled
Archive log pruning	None
On demand data backup retention	None
On demand archive log backup retention	None
Hourly data backup retention	None
Hourly archive log backup retention	None
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

Create a database log backup policy for Oracle

1. Log into SnapCenter with a database management user ID, click Settings, and then click Polices.
2. Click New to launch a new backup policy creation workflow, or choose an existing policy for modification.

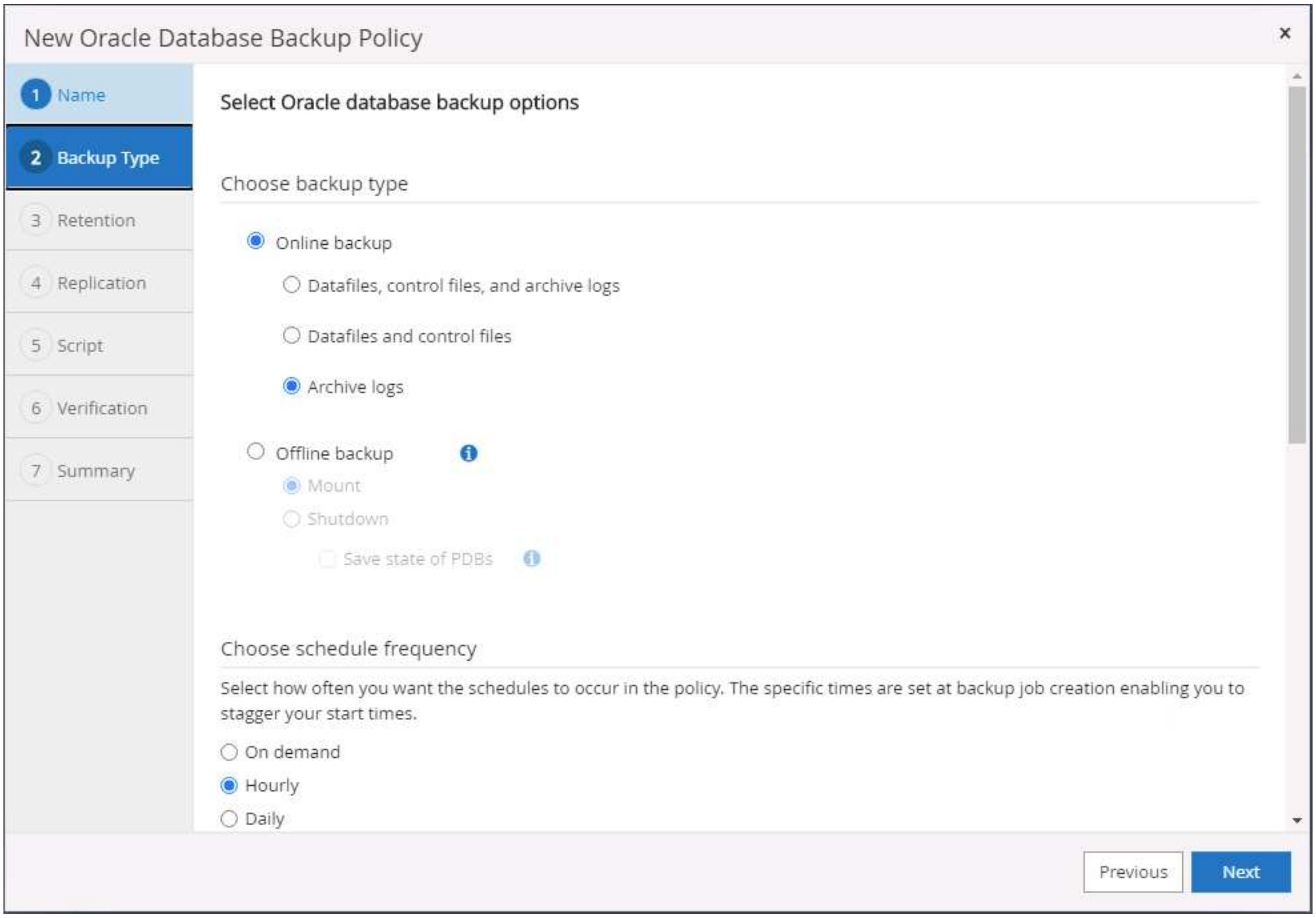


Provide a policy name

Policy name: Oracle Archive Log Backup

Details: Backup Oracle archive logs

3. Select the backup type and schedule frequency.


New Oracle Database Backup Policy

Select Oracle database backup options

Choose backup type

● Online backup

○ Datafiles, control files, and archive logs

○ Datafiles and control files

● Archive logs

○ Offline backup

● Mount

○ Shutdown

☐ Save state of PDBs

Choose schedule frequency

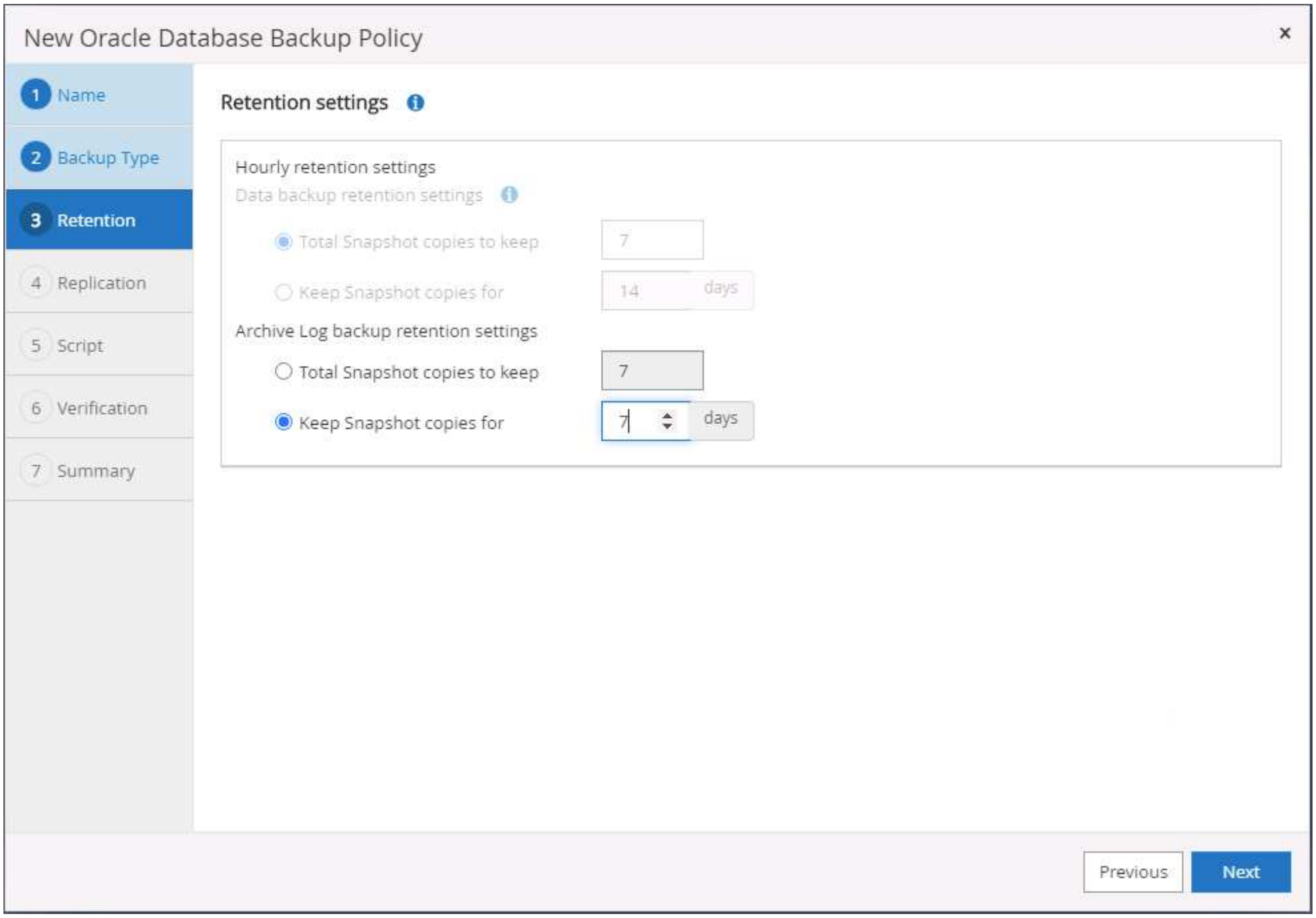
Select how often you want the schedules to occur in the policy. The specific times are set at backup job creation enabling you to stagger your start times.

○ On demand

● Hourly

○ Daily

4. Set the log retention period.



Retention settings

Hourly retention settings

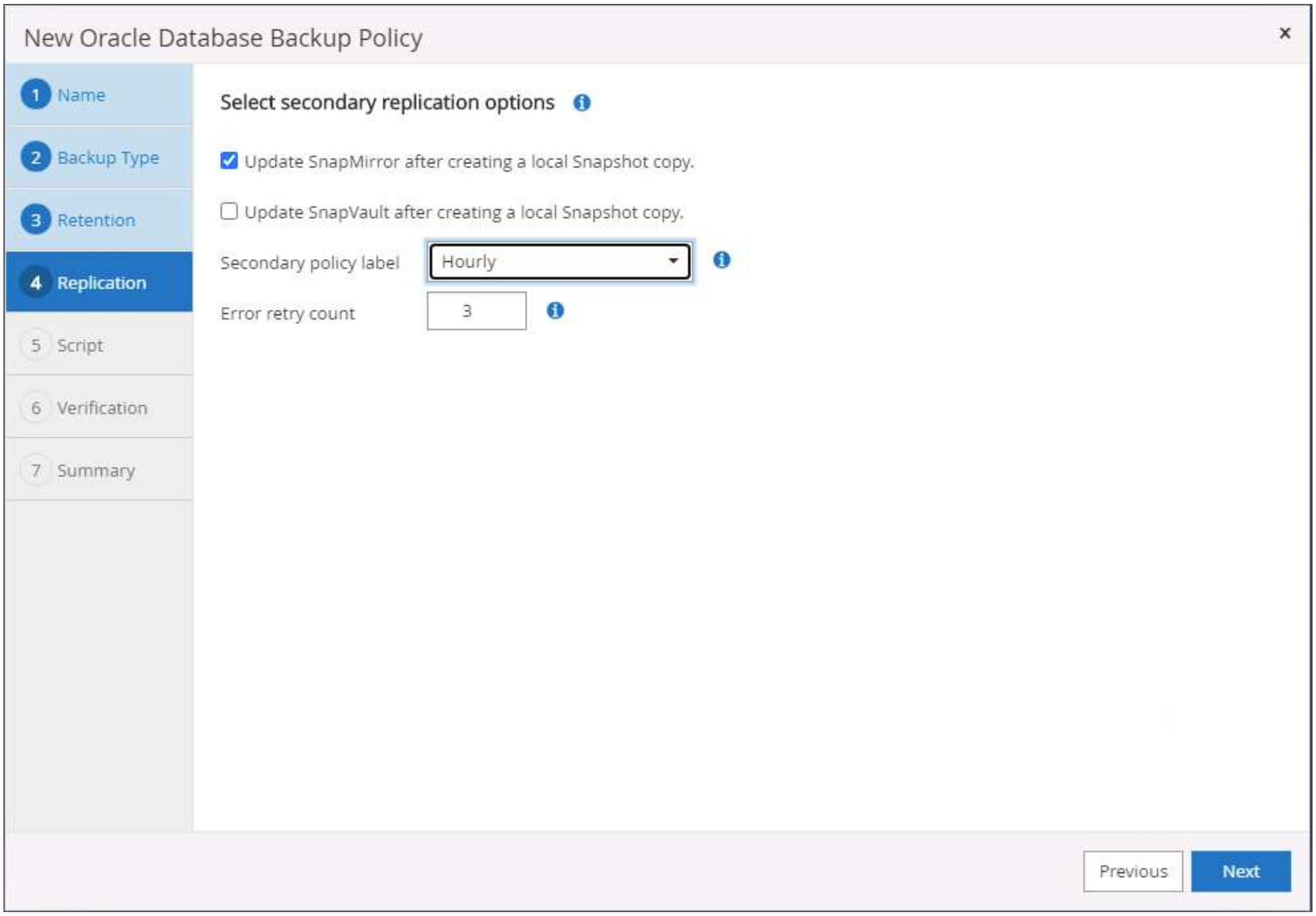
Data backup retention settings

- ● Total Snapshot copies to keep: 7
- ○ Keep Snapshot copies for: 14 days

Archive Log backup retention settings

- ○ Total Snapshot copies to keep: 7
- ● Keep Snapshot copies for: 7 days

5. Enable replication to a secondary location in the public cloud.



Select secondary replication options

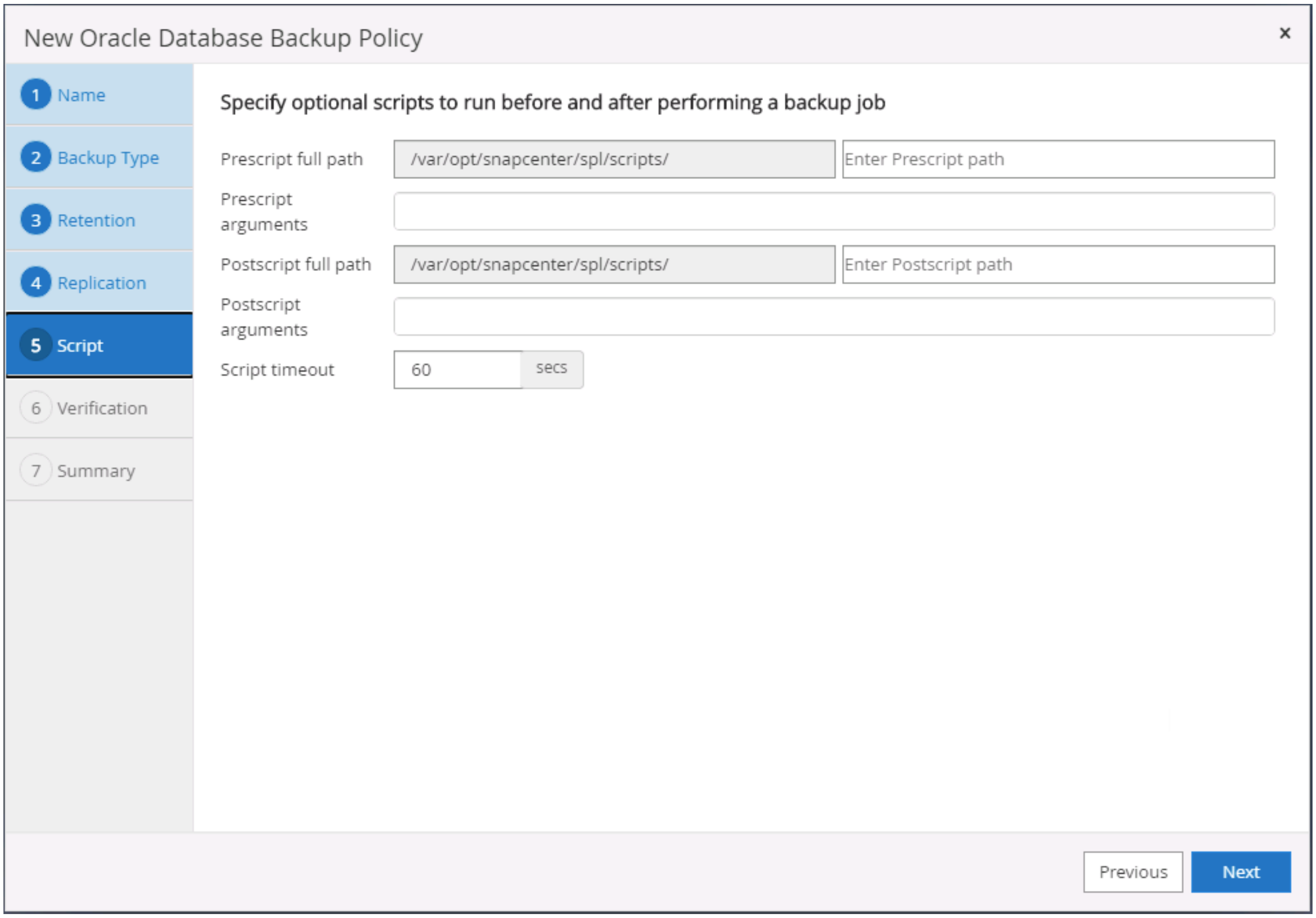
☑ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Hourly

Error retry count: 3

6. Specify any optional scripts to run before and after log backup.



Specify optional scripts to run before and after performing a backup job

Prescript full path /var/opt/snapcenter/spl/scripts/ Enter Prescript path

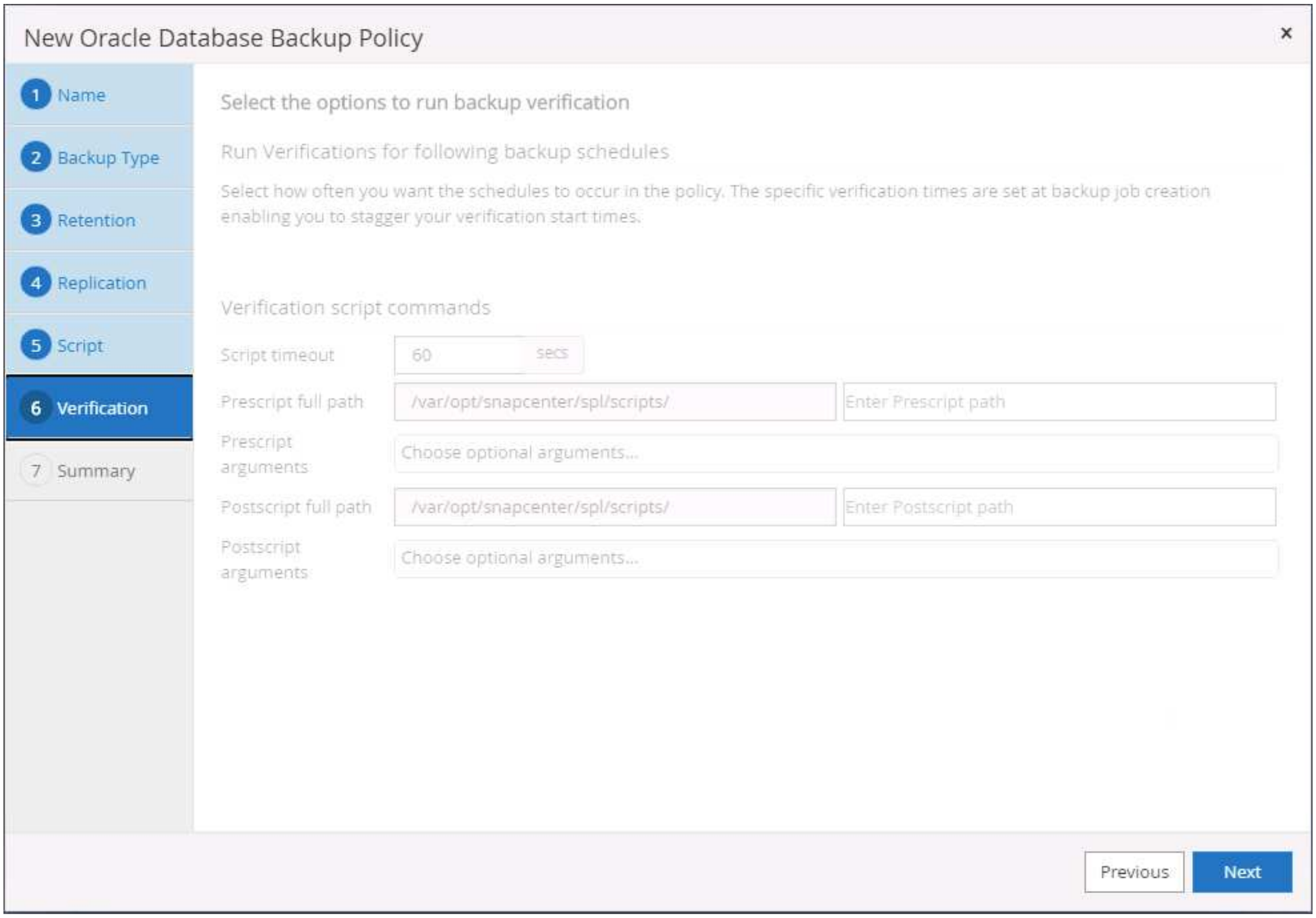
Prescript arguments

Postscript full path /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Postscript arguments

Script timeout 60 secs

7. Specify any backup verification scripts.



Select the options to run backup verification

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.

Verification script commands

Script timeout: 60 secs

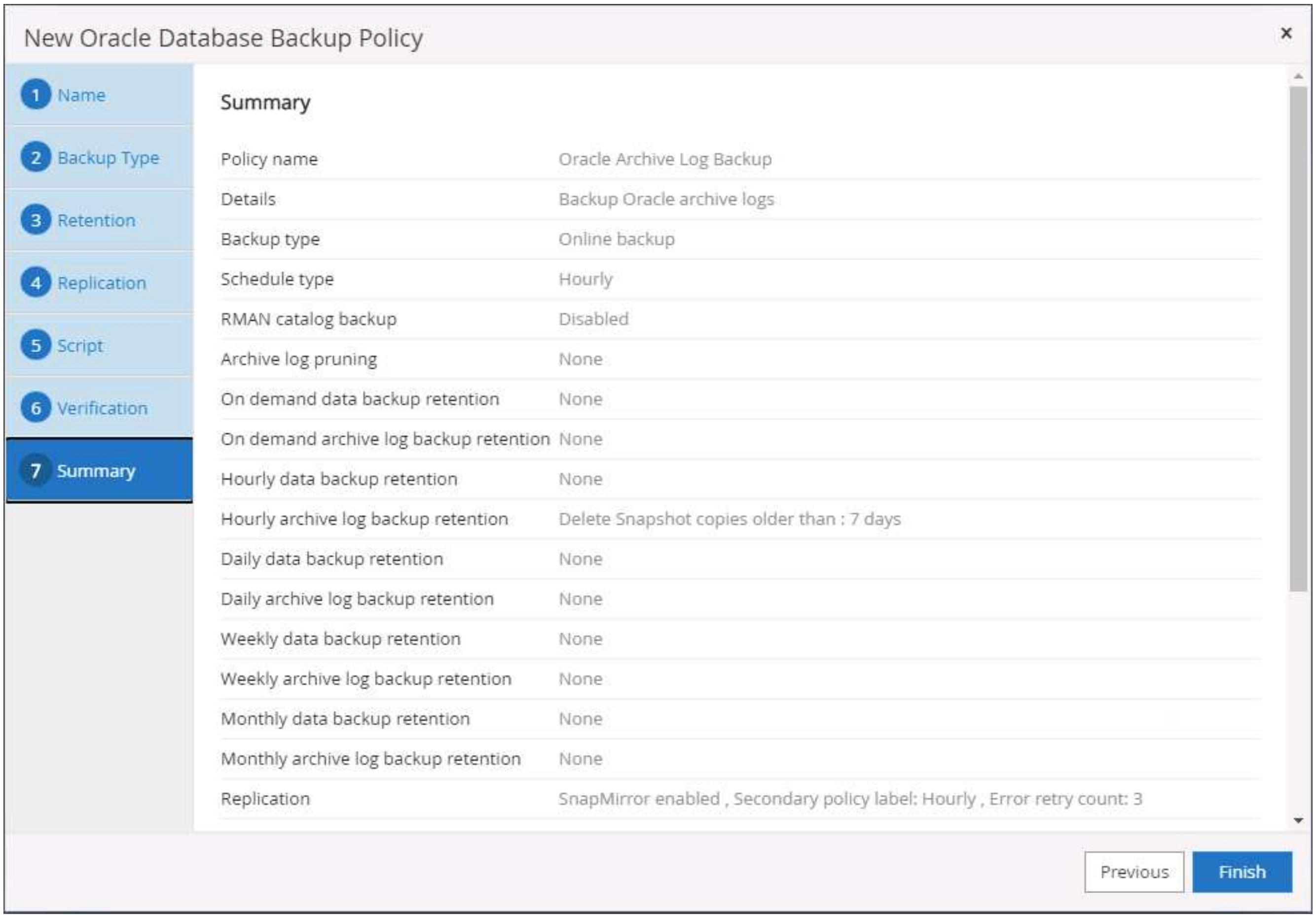
Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

Prescript arguments: Choose optional arguments...

Postscript full path: /var/opt/snapcenter/spl/scripts/ Enter Postscript path

Postscript arguments: Choose optional arguments...

8. Summary.

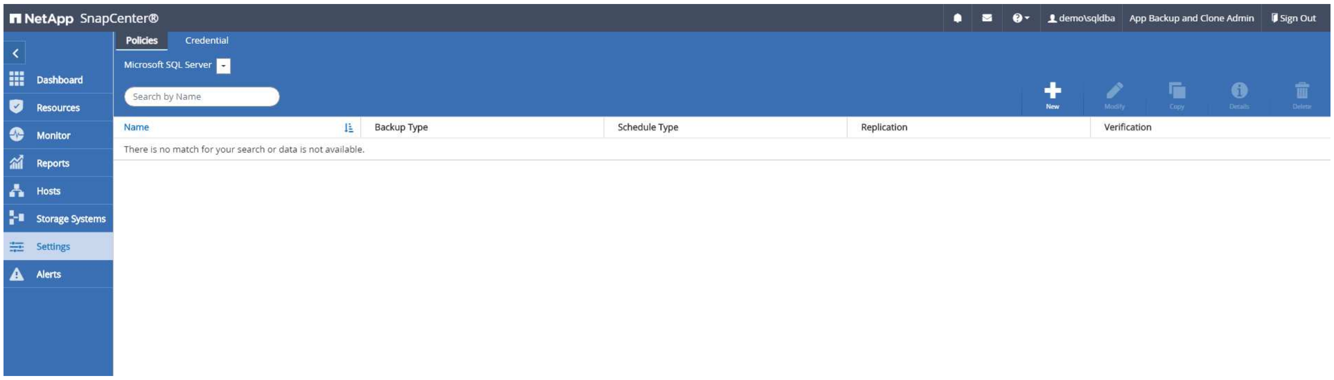


Summary

Policy name	Oracle Archive Log Backup
Details	Backup Oracle archive logs
Backup type	Online backup
Schedule type	Hourly
RMAN catalog backup	Disabled
Archive log pruning	None
On demand data backup retention	None
On demand archive log backup retention	None
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

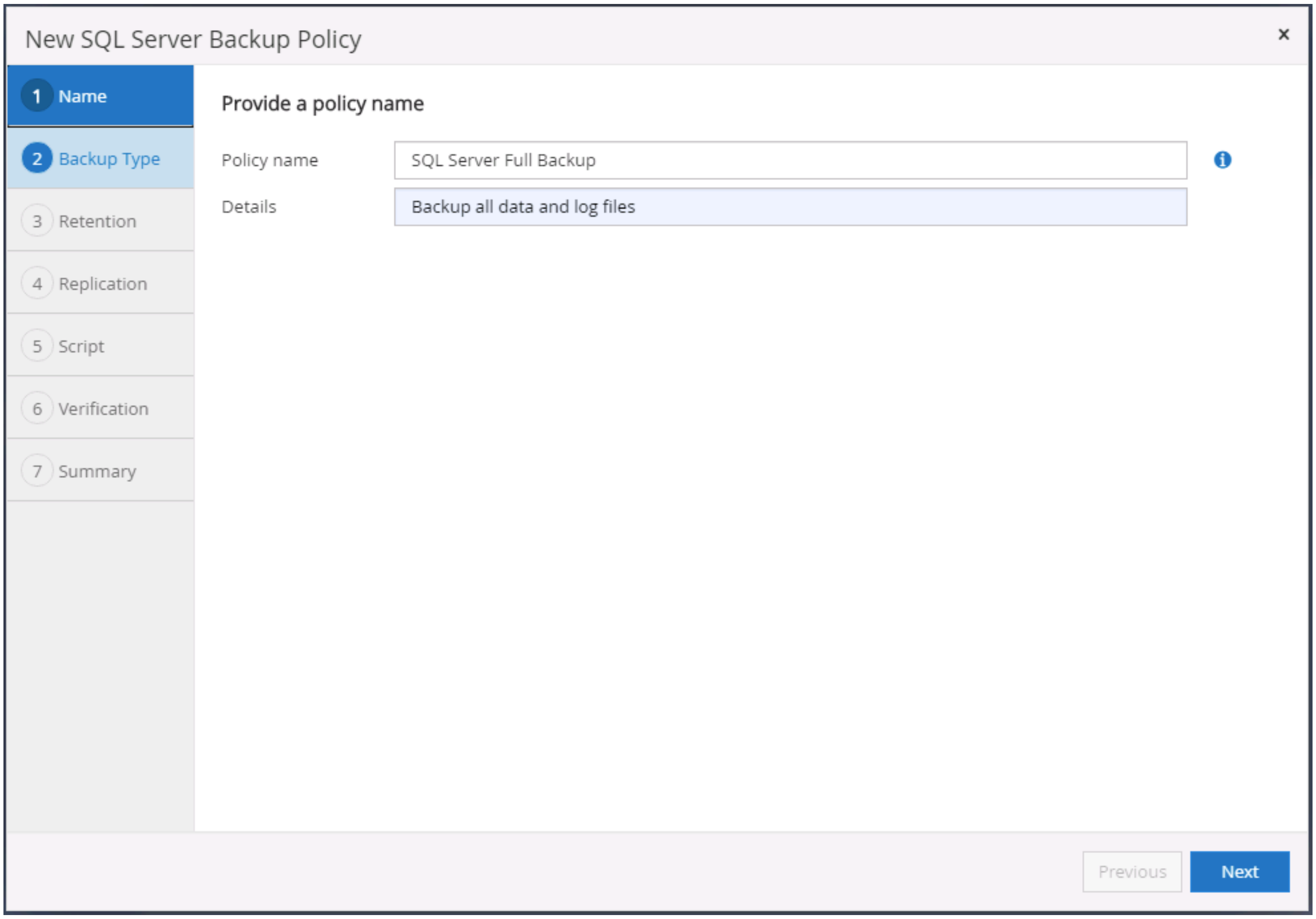
Create a full database backup policy for SQL

1. Log into SnapCenter with a database management user ID, click Settings, and then click Polices.



Name	Backup Type	Schedule Type	Replication	Verification
There is no match for your search or data is not available.				

2. Click New to launch a new backup policy creation workflow, or choose an existing policy for modification.

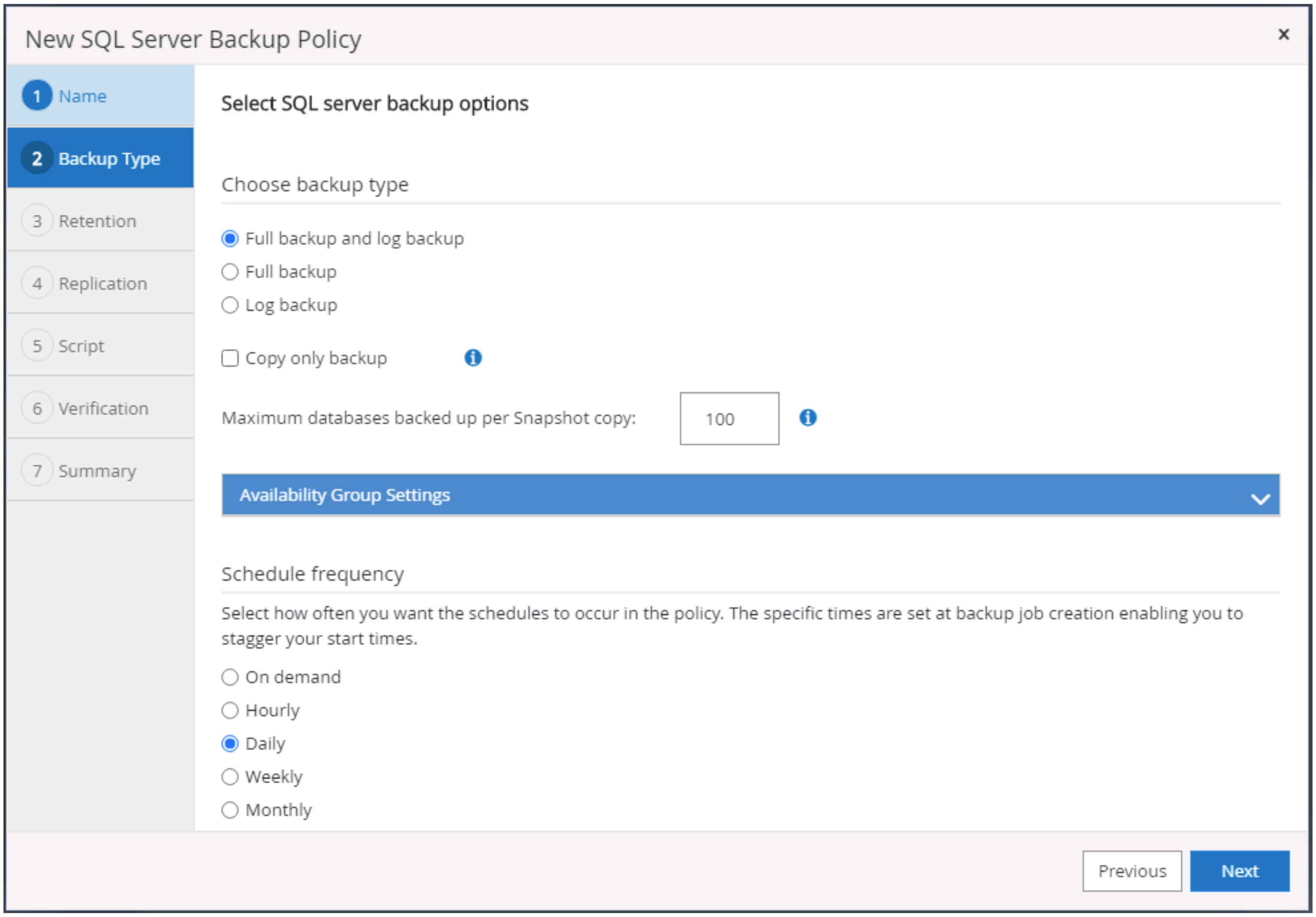


Provide a policy name

Policy name: SQL Server Full Backup

Details: Backup all data and log files

3. Define the backup option and schedule frequency. For SQL Server configured with an availability group, a preferred backup replica can be set.



Select SQL server backup options

Choose backup type

● Full backup and log backup
○ Full backup
○ Log backup

☐ Copy only backup

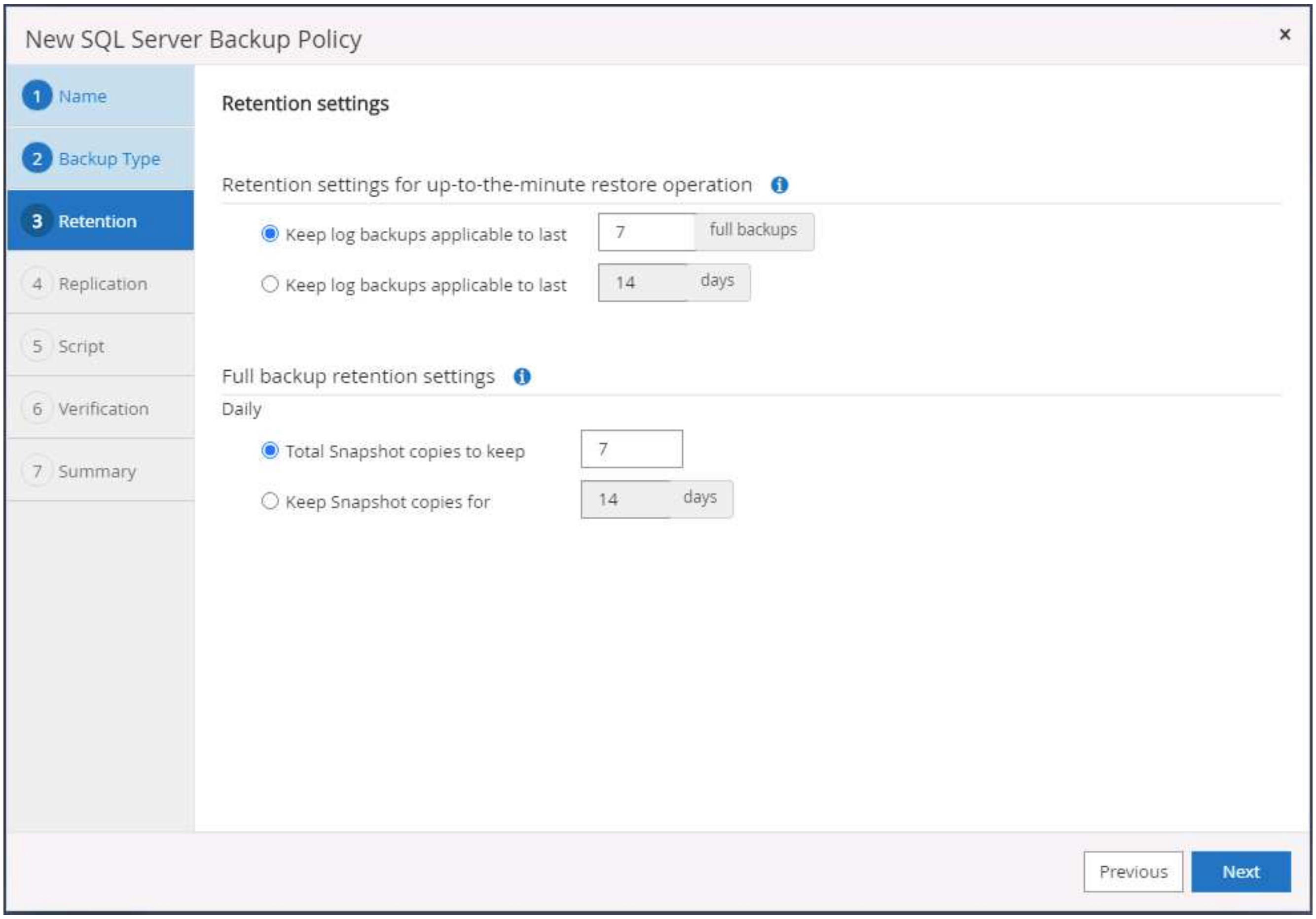
Maximum databases backed up per Snapshot copy: 100

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

4. Set the backup retention period.



Retention settings

Retention settings for up-to-the-minute restore operation

● Keep log backups applicable to last 7 full backups

○ Keep log backups applicable to last 14 days

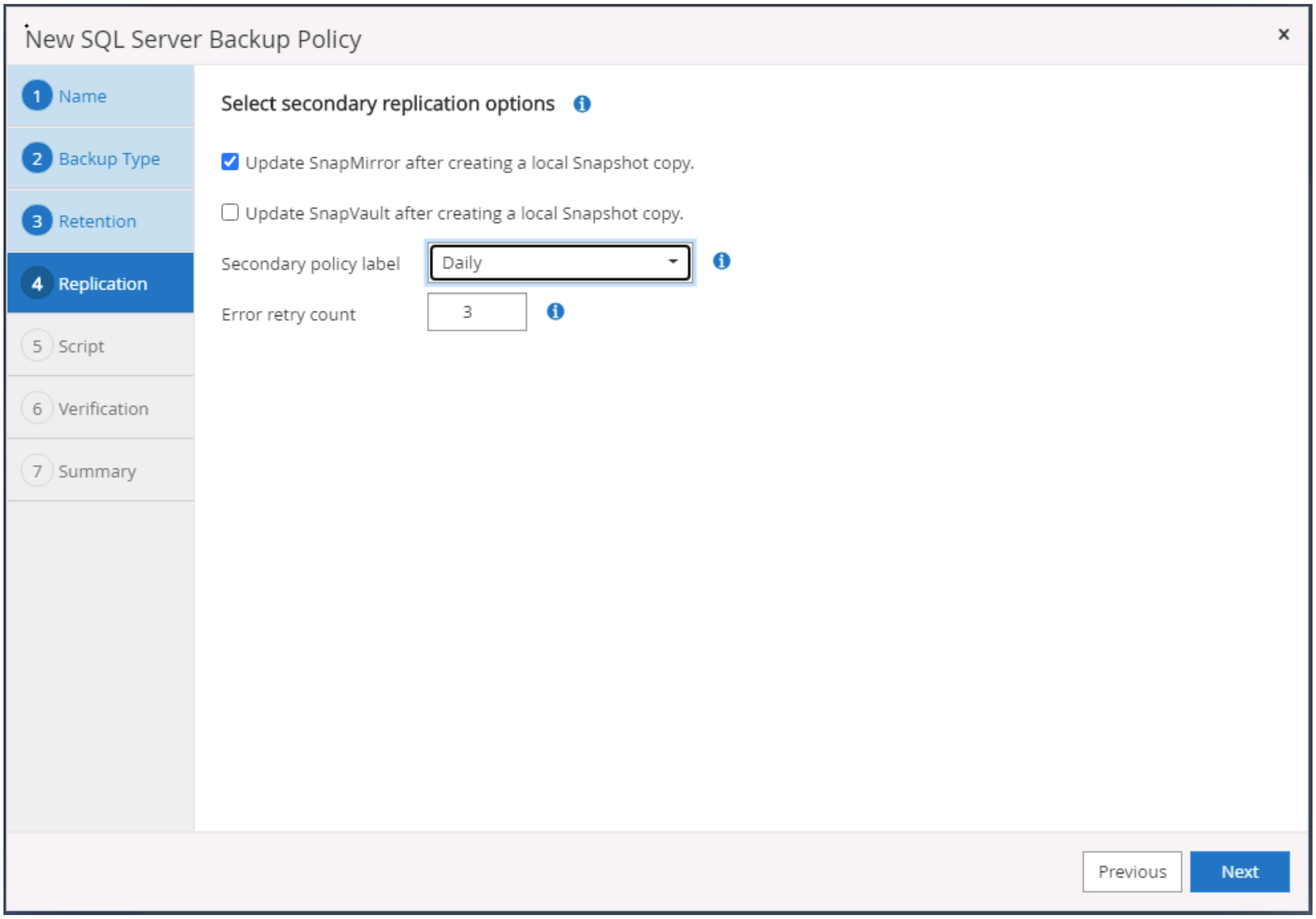
Full backup retention settings

Daily

● Total Snapshot copies to keep 7

○ Keep Snapshot copies for 14 days

5. Enable backup copy replication to a secondary location in cloud.



Select secondary replication options

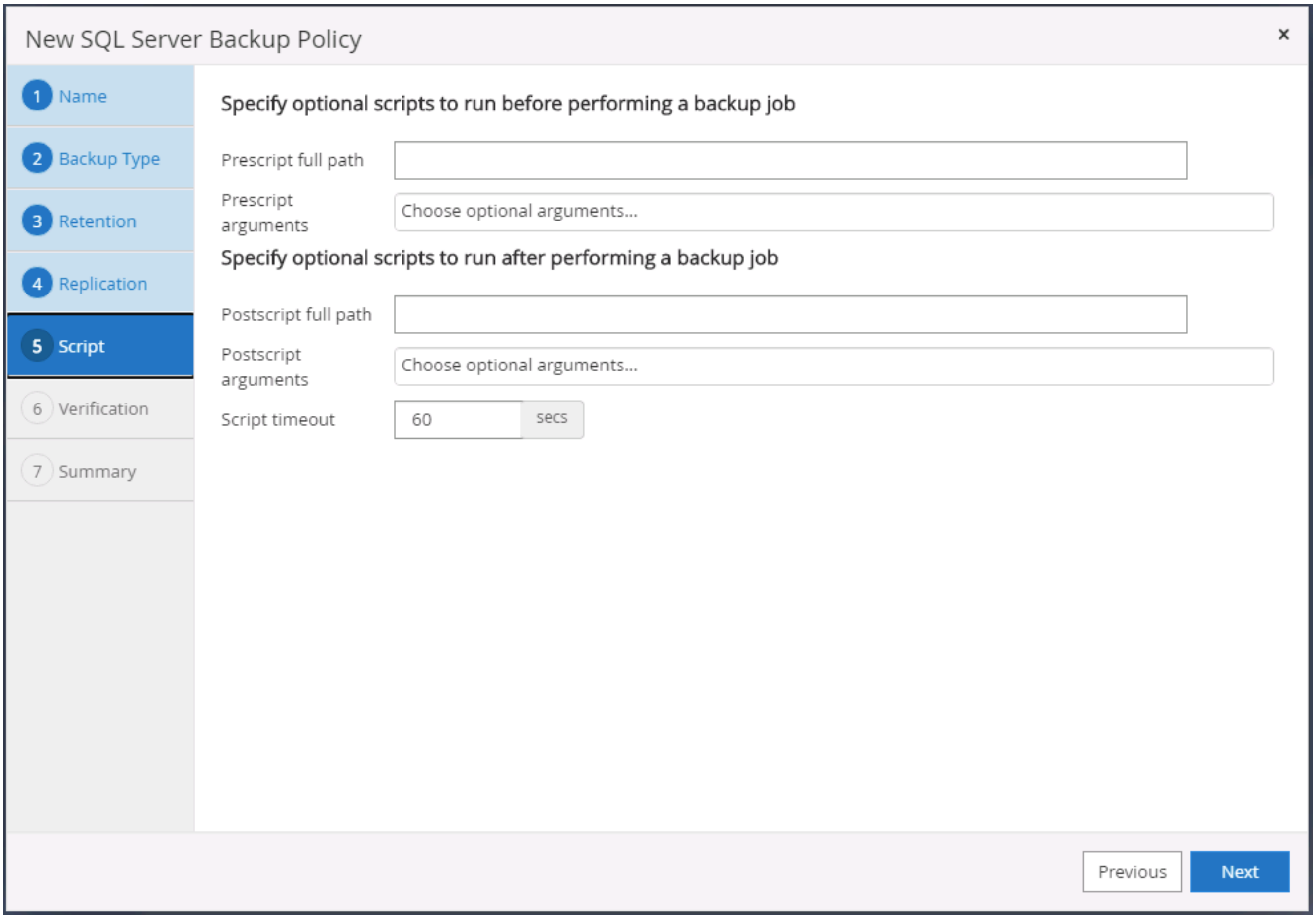
☑ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Daily

Error retry count: 3

6. Specify any optional scripts to run before or after a backup job.



Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments: Choose optional arguments...

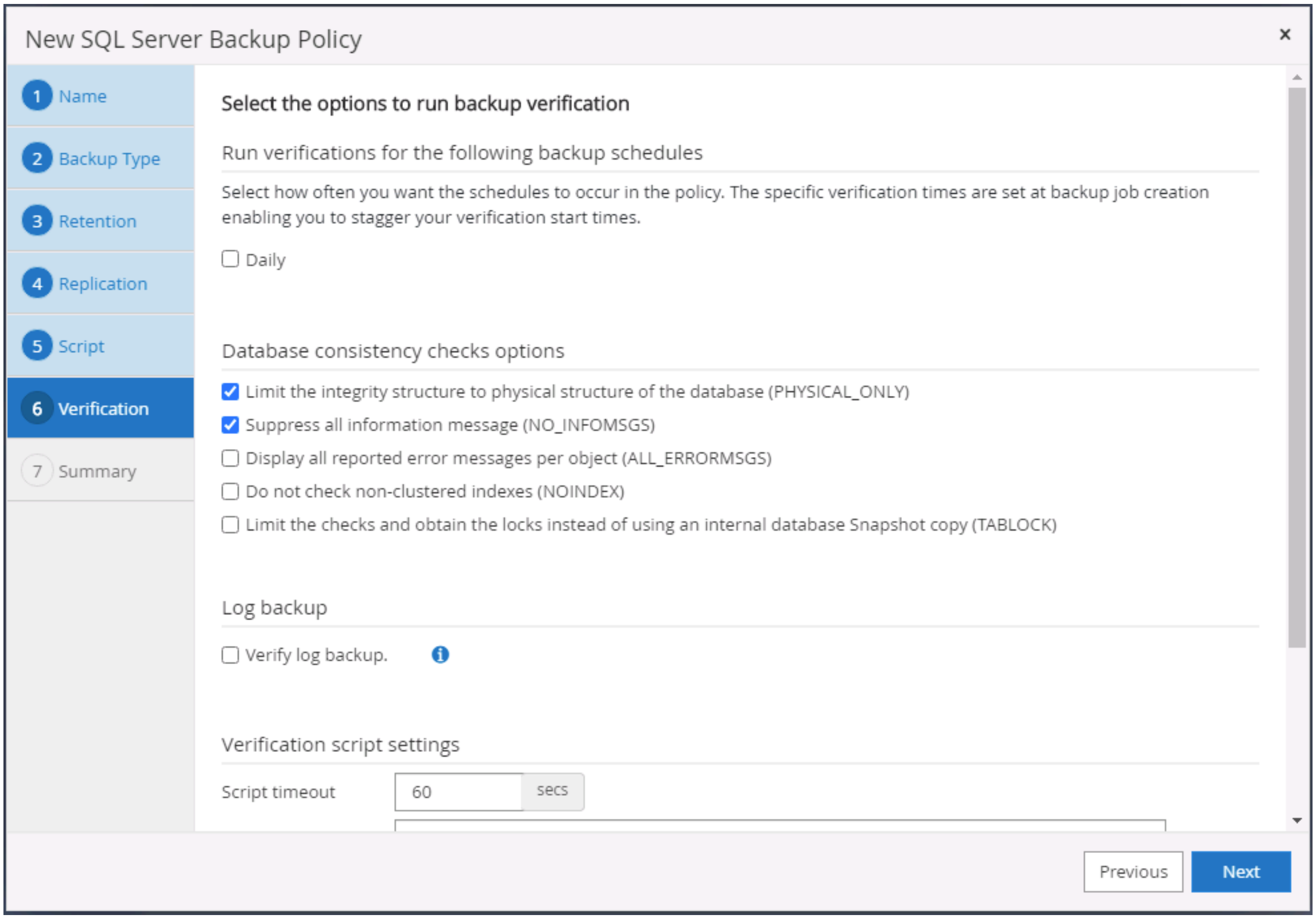
Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

7. Specify the options to run backup verification.



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_ERRORMSGS)
☐ Do not check non-clustered indexes (NOINDEX)
☐ Limit the checks and obtain the locks instead of using an internal database Snapshot copy (TABLOCK)

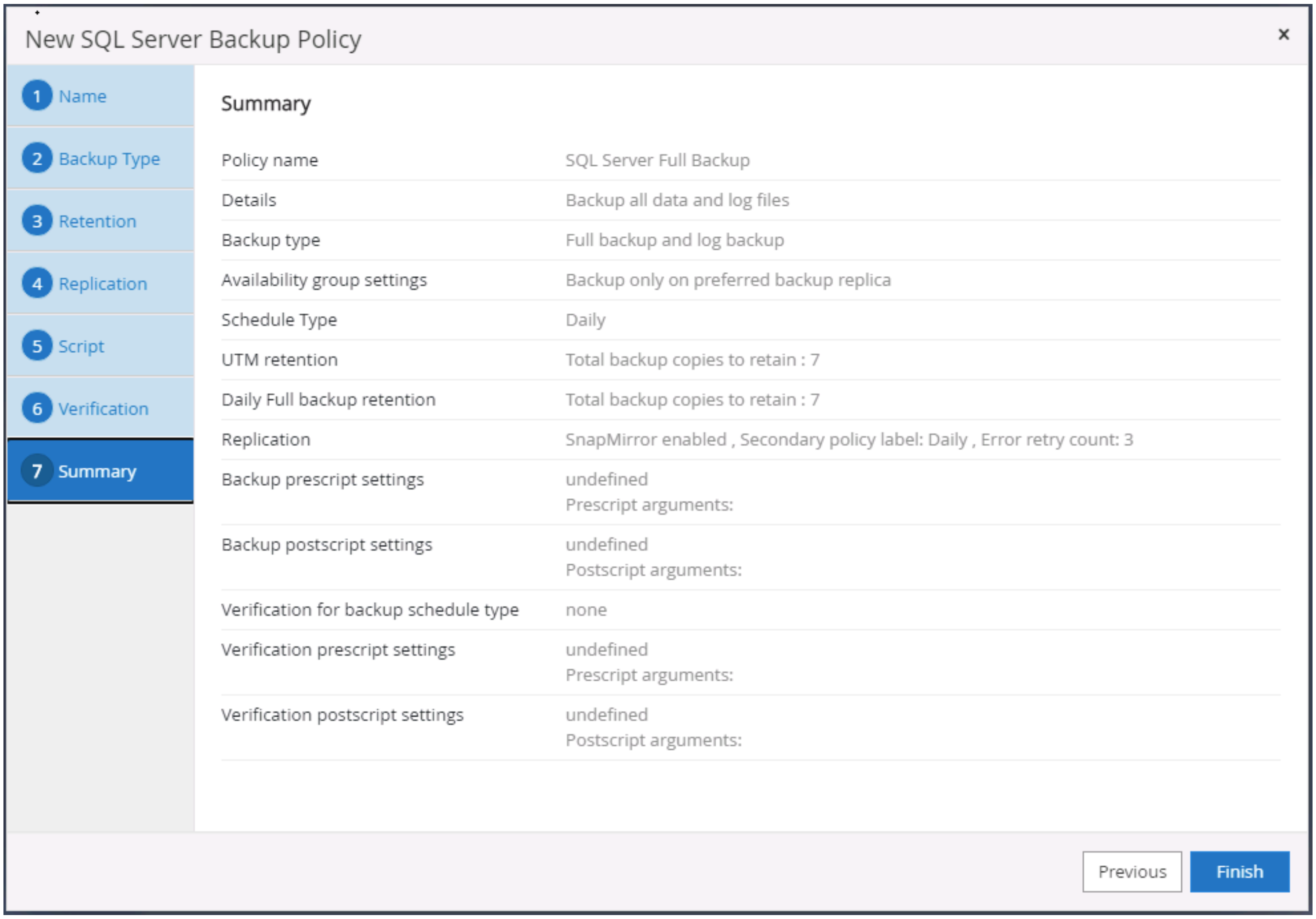
Log backup

☐ Verify log backup.

Verification script settings

Script timeout: 60 secs

8. Summary.

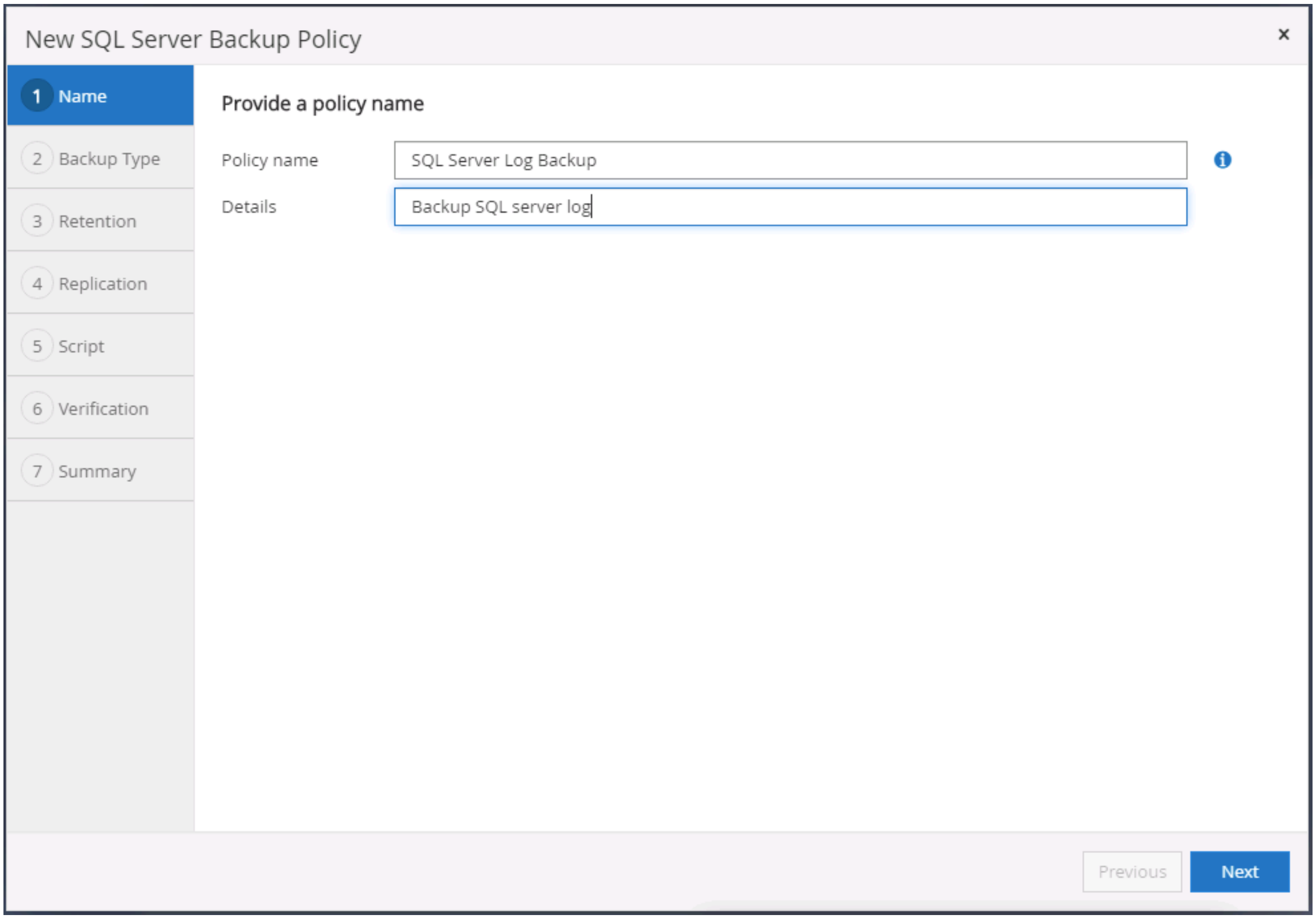


Summary

Policy name	SQL Server Full Backup
Details	Backup all data and log files
Backup type	Full backup and log backup
Availability group settings	Backup only on preferred backup replica
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
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:

Create a database log backup policy for SQL.

1. Log into SnapCenter with a database management user ID, click Settings > Polices, and then New to launch a new policy creation workflow.

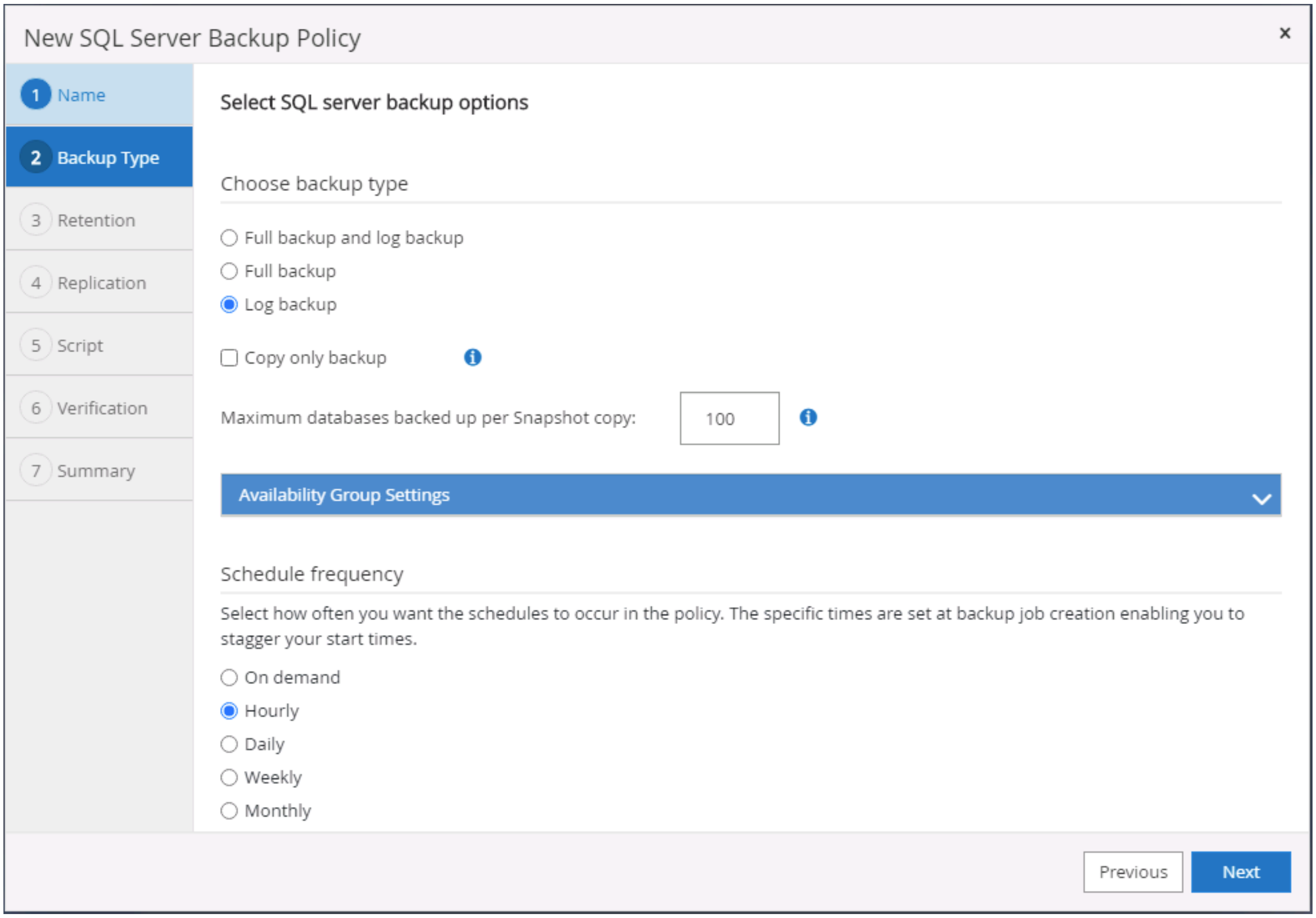


Provide a policy name

Policy name: SQL Server Log Backup

Details: Backup SQL server log

2. Define the log backup option and schedule frequency. For SQL Server configured with a availability group, a preferred backup replica can be set.



Select SQL server backup options

Choose backup type

○ Full backup and log backup
○ Full backup
● Log backup

☐ Copy only backup

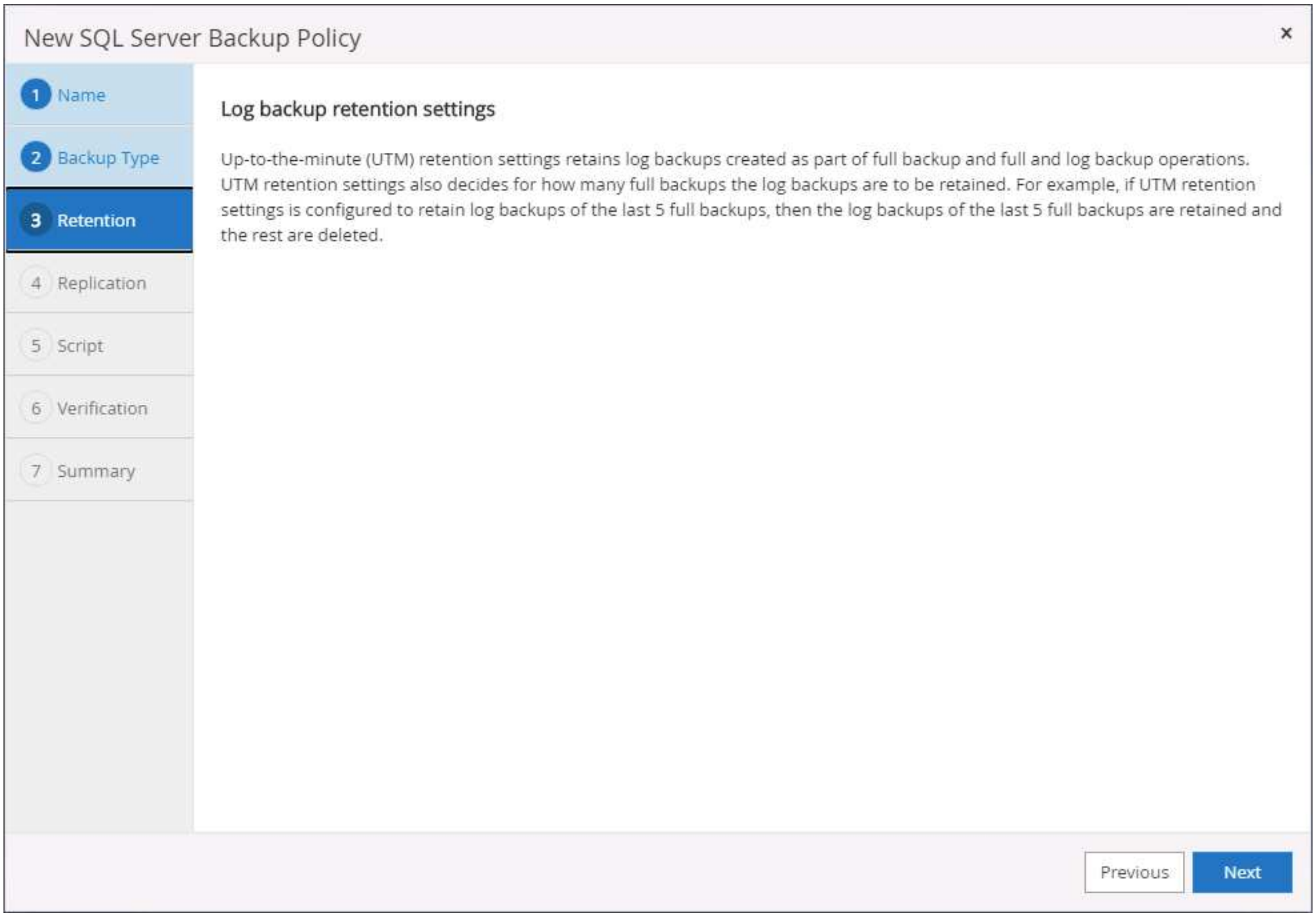
Maximum databases backed up per Snapshot copy: 100

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

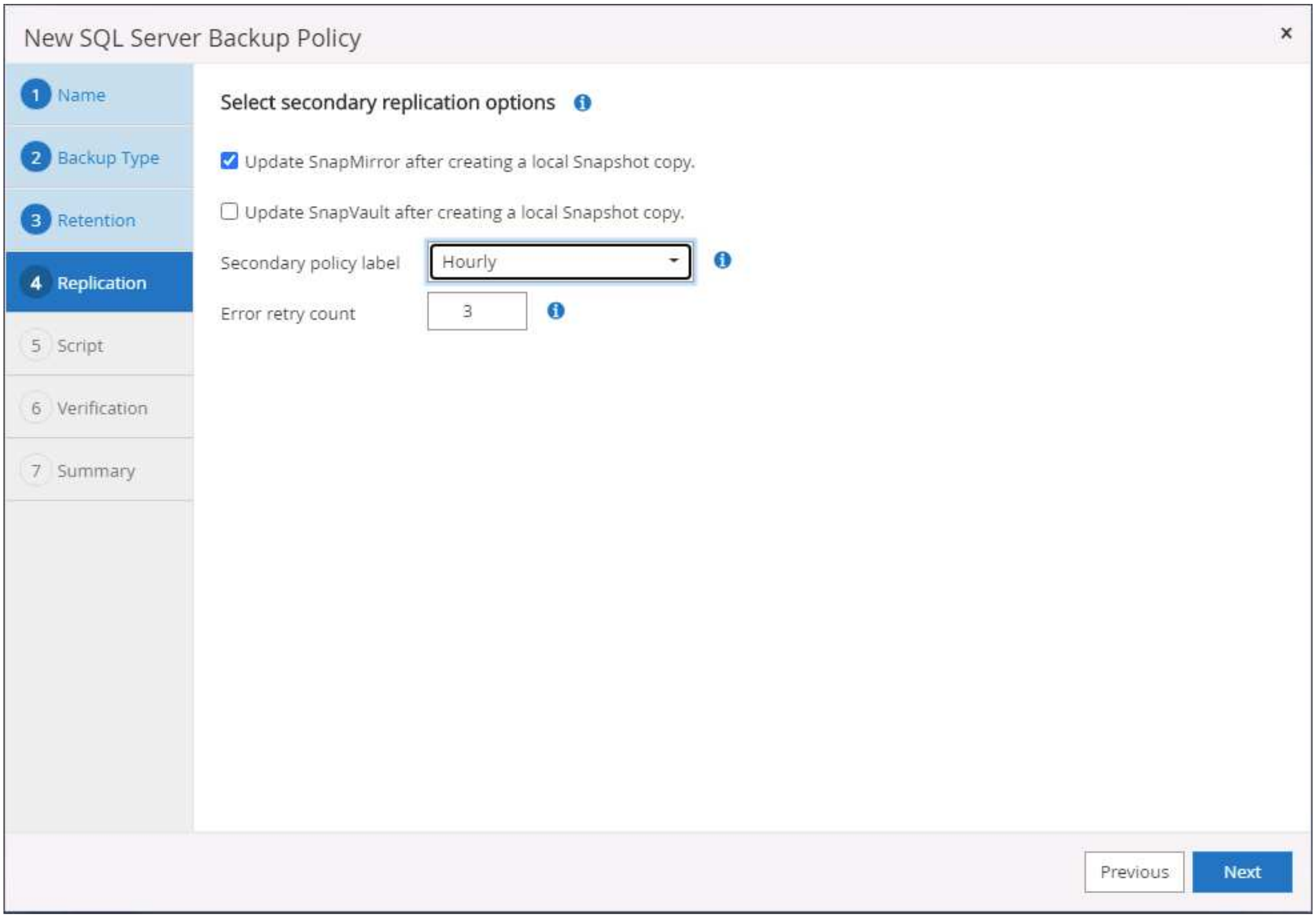
3. SQL server data backup policy defines the log backup retention; accept the defaults here.



Log backup retention settings

Up-to-the-minute (UTM) retention settings retains log backups created as part of full backup and full and log backup operations. UTM retention settings also decides for how many full backups the log backups are to be retained. For example, if UTM retention settings is configured to retain log backups of the last 5 full backups, then the log backups of the last 5 full backups are retained and the rest are deleted.

4. Enable log backup replication to secondary in the cloud.



Select secondary replication options

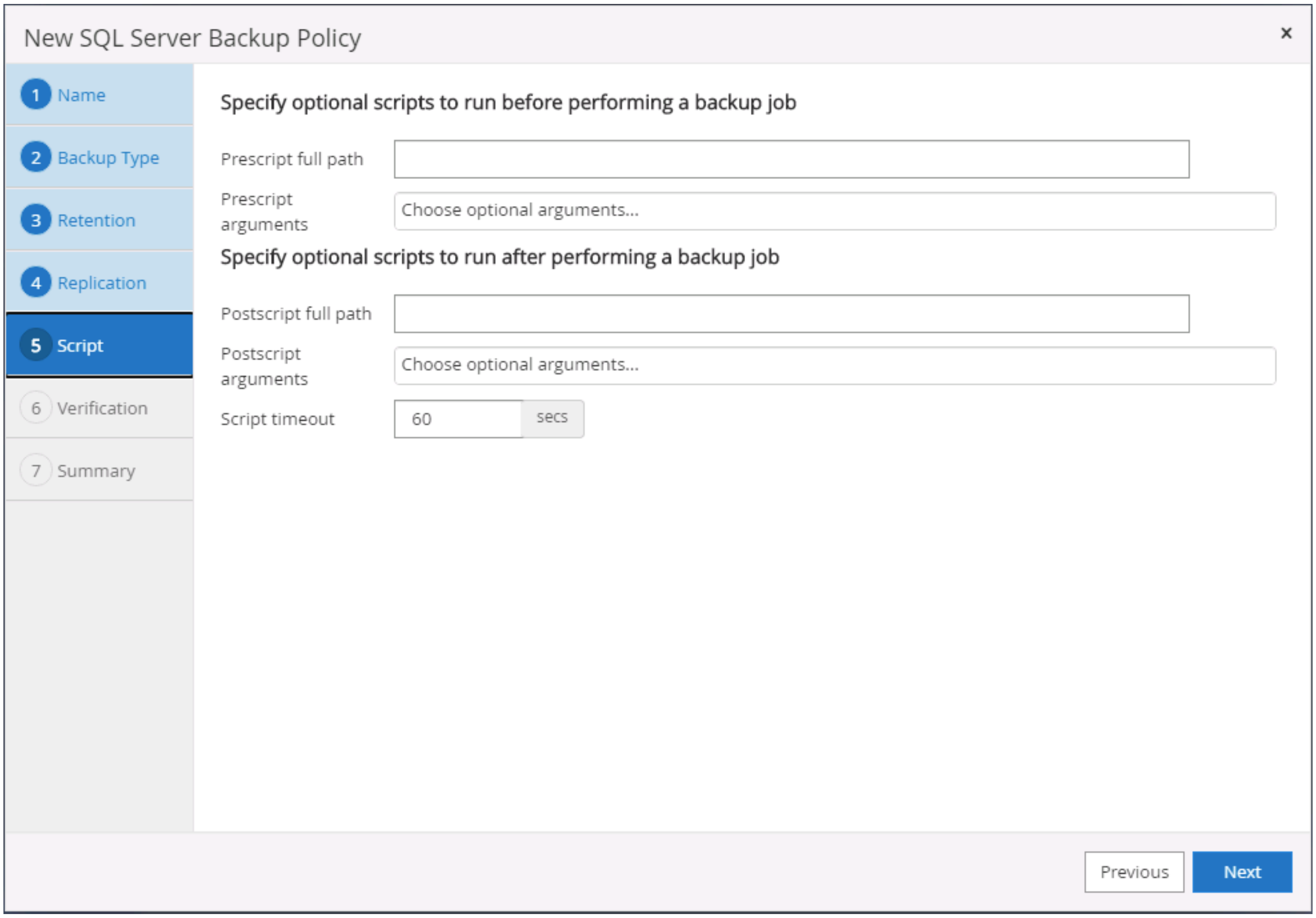
☑ Update SnapMirror after creating a local Snapshot copy.

☐ Update SnapVault after creating a local Snapshot copy.

Secondary policy label: Hourly

Error retry count: 3

5. Specify any optional scripts to run before or after a backup job.



Specify optional scripts to run before performing a backup job

Prescript full path

Prescript arguments: Choose optional arguments...

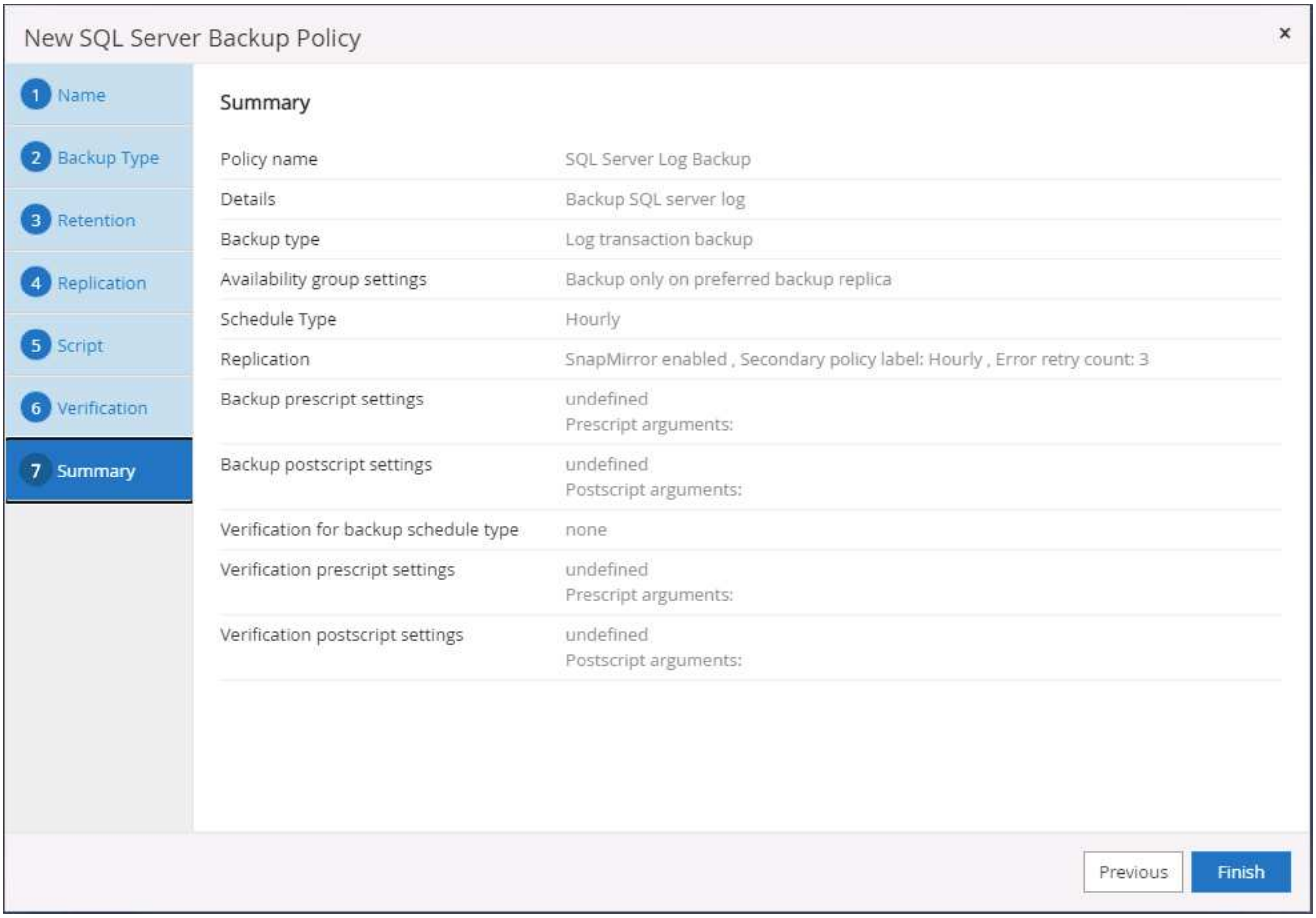
Specify optional scripts to run after performing a backup job

Postscript full path

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

6. Summary.



Summary

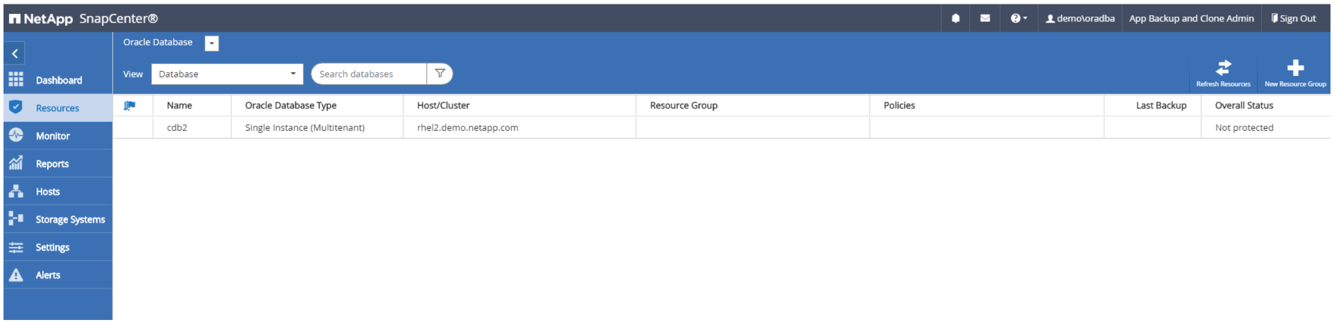
Policy name	SQL Server Log Backup
Details	Backup SQL server log
Backup type	Log transaction backup
Availability group settings	Backup only on preferred backup replica
Schedule Type	Hourly
Replication	SnapMirror enabled , Secondary policy label: Hourly , Error retry count: 3
Backup prescript settings	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:

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.

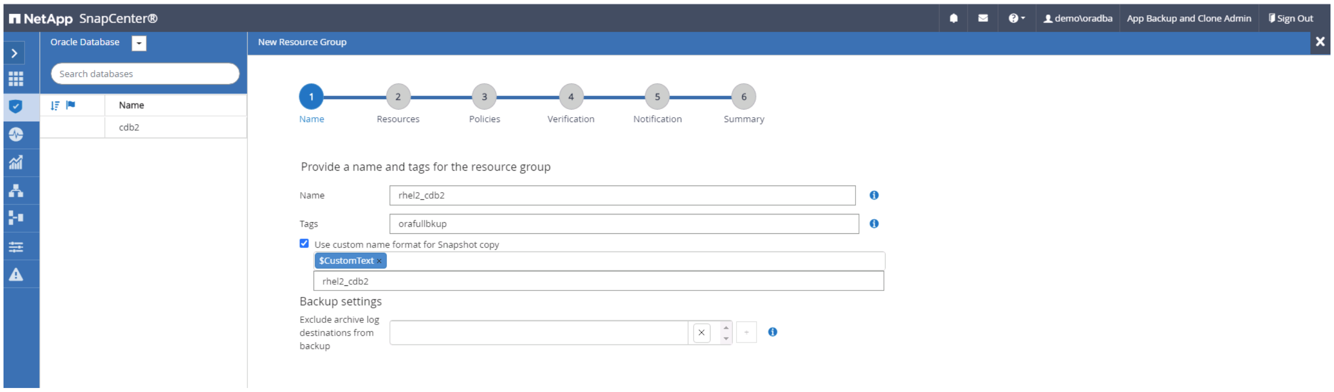
Create a resource group for full backup of Oracle

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.



Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com				Not protected

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.



Provide a name and tags for the resource group

Name: rhel2_cdb2

Tags: orafullbkup

☑ Use custom name format for Snapshot copy

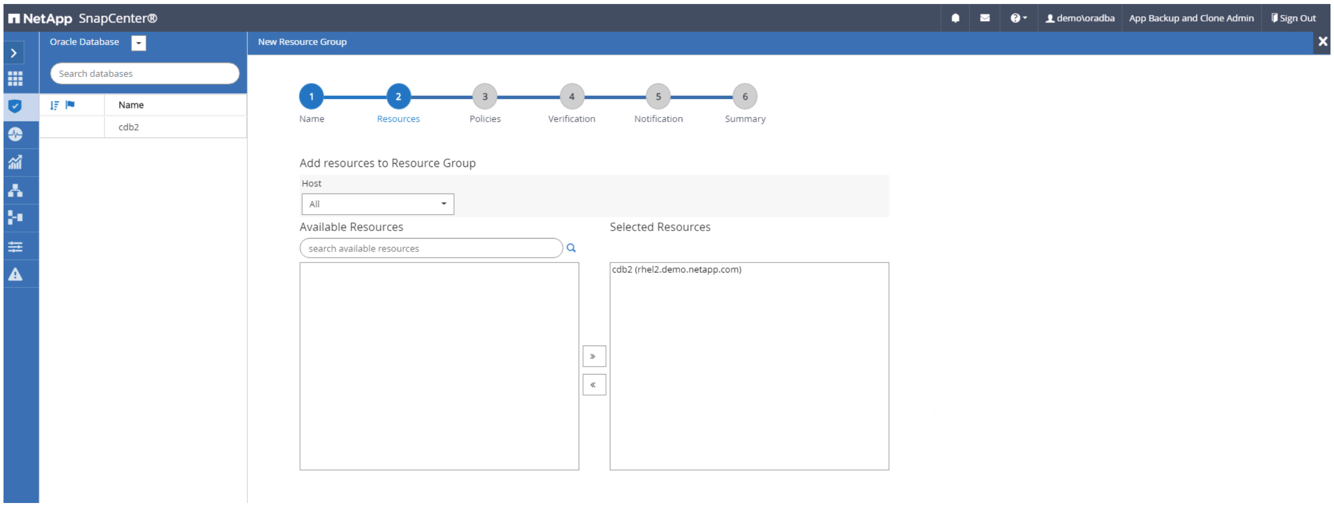
$CustomText

rhel2_cdb2

Backup settings

Exclude archive log destinations from backup

3. Add database resources to the resource group.



Add resources to Resource Group

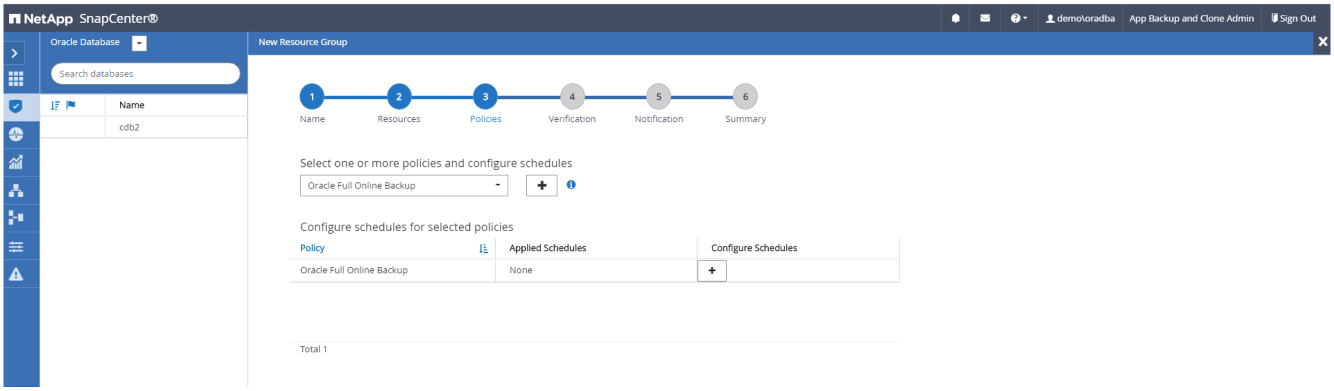
Host: All

Available Resources

Selected Resources

cdb2 (rhel2.demo.netapp.com)

4. Select a full backup policy created in section 7 from the drop-down list.



Select one or more policies and configure schedules

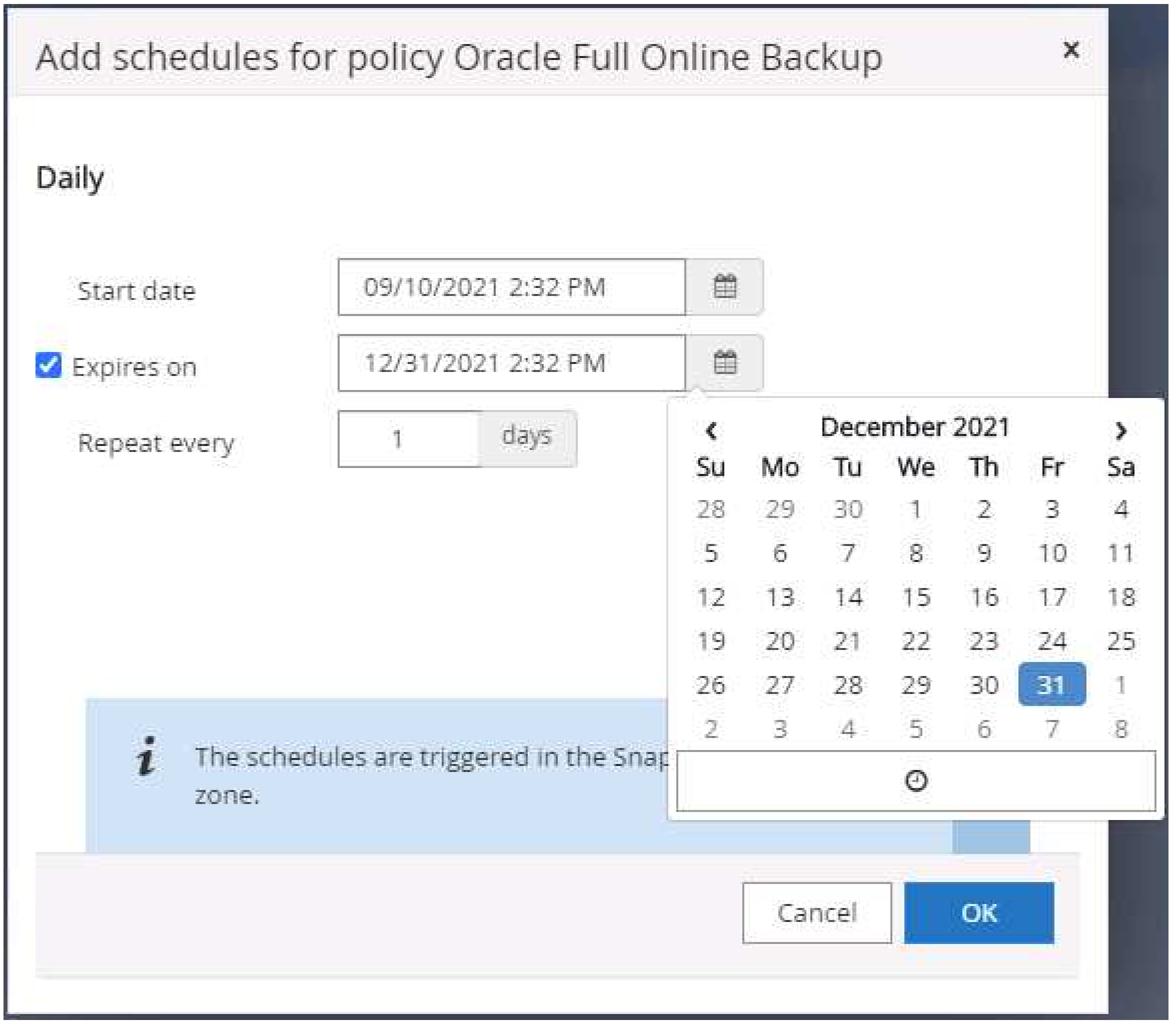
Oracle Full Online Backup

Configure schedules for selected policies

Policy	Applied Schedules	Configure Schedules
Oracle Full Online Backup	None	+

Total 1

5. Click the (+) sign to configure the desired backup schedule.



Add schedules for policy Oracle Full Online Backup

Daily

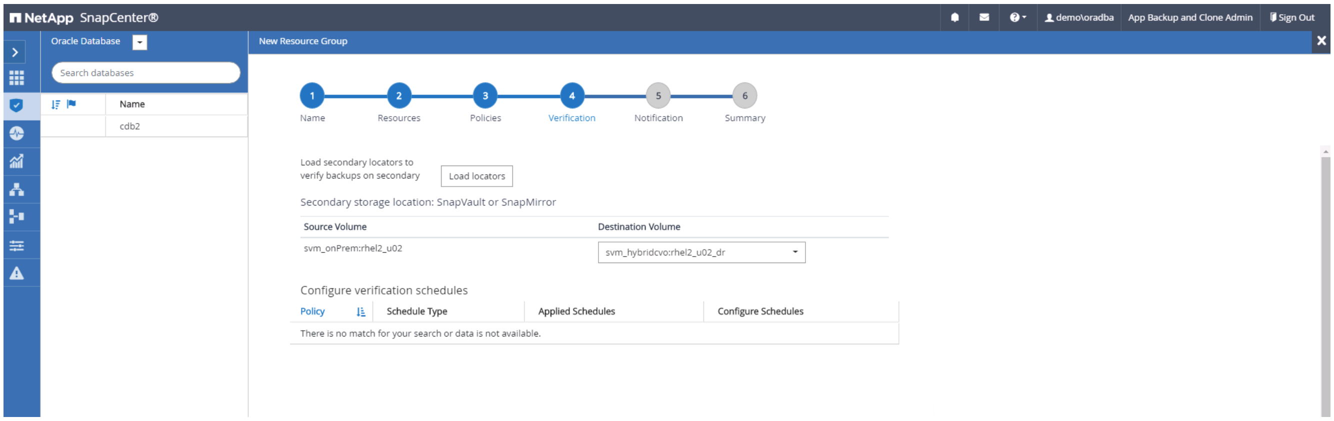
Start date: 09/10/2021 2:32 PM

☑ Expires on: 12/31/2021 2:32 PM

Repeat every: 1 days

The schedules are triggered in the Snap
zone.

6. Click Load Locators to load the source and destination volume.



Load secondary locators to verify backups on secondary

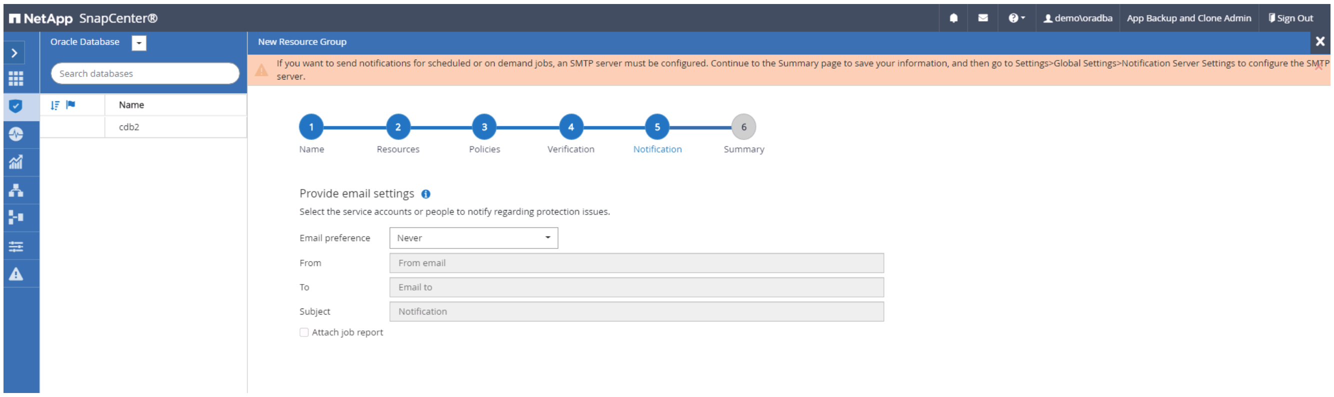
Secondary storage location: SnapVault or SnapMirror

Source Volume	Destination Volume
svm_onPrem:rhel2_u02	svm_hybridcvo:rhel2_u02_dr

Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
There is no match for your search or data is not available.			

7. Configure the SMTP server for email notification if desired.



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.

Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

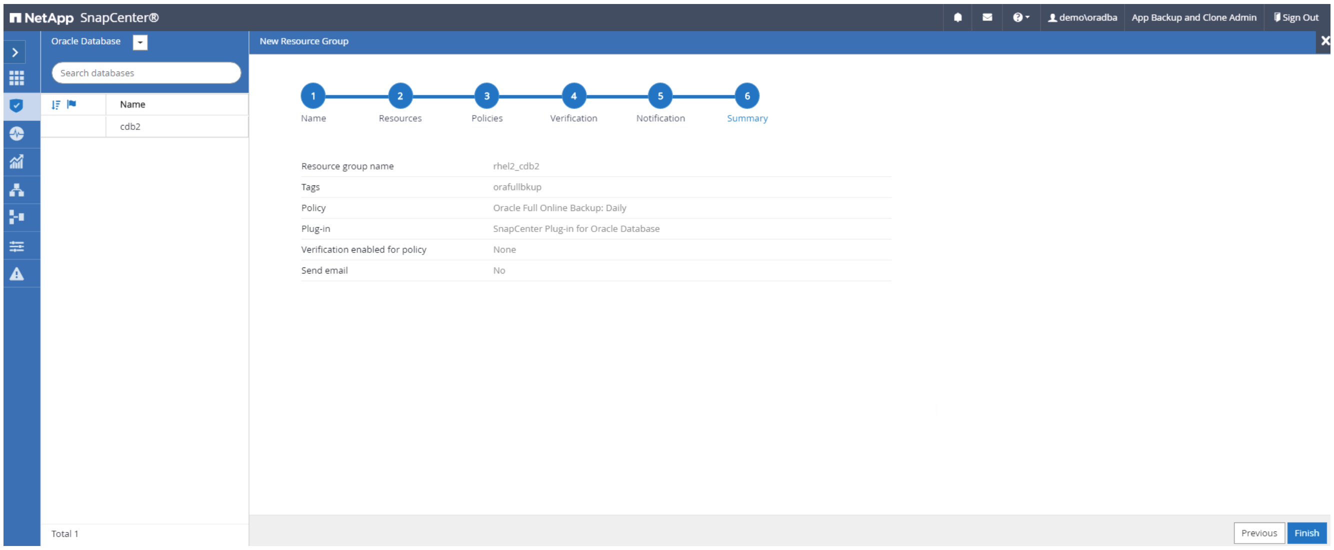
From: From email

To: Email to

Subject: Notification

☐ Attach job report

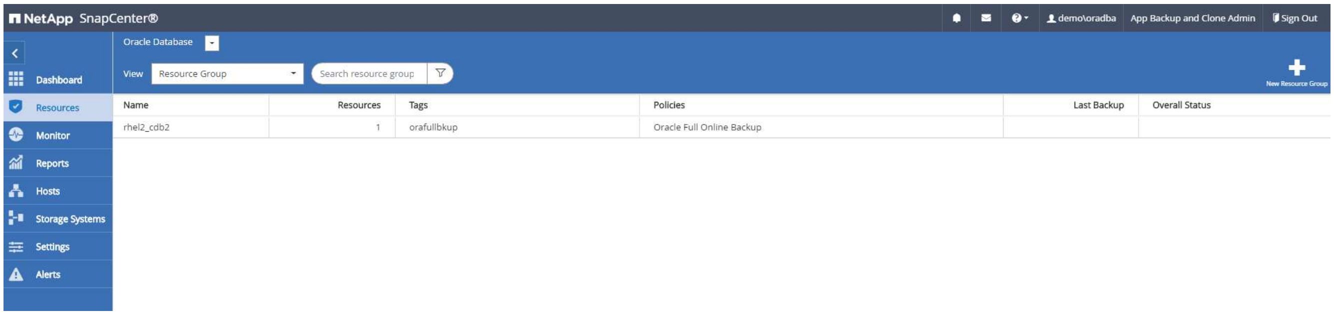
8. Summary.



Resource group name	rhel2_cdb2
Tags	orafullbkup
Policy	Oracle Full Online Backup: Daily
Plug-in	SnapCenter Plug-in for Oracle Database
Verification enabled for policy	None
Send email	No

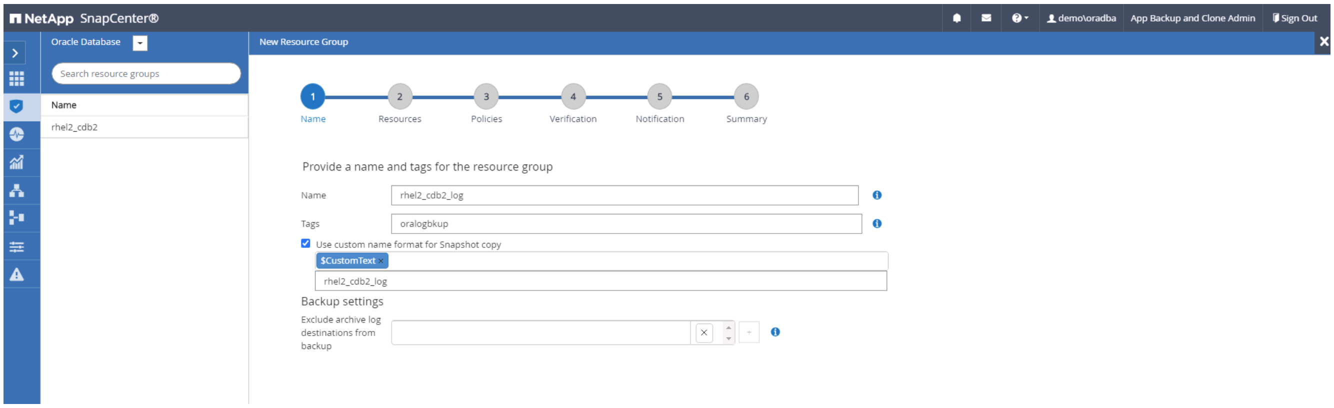
Create a resource group for log backup of Oracle

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.



Name	Resources	Tags	Policies	Last Backup	Overall Status
rhel2_cdb2	1	orafullbkup	Oracle Full Online Backup		

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.



Provide a name and tags for the resource group

Name: rhel2_cdb2_log

Tags: oralogbkup

☑ Use custom name format for Snapshot copy

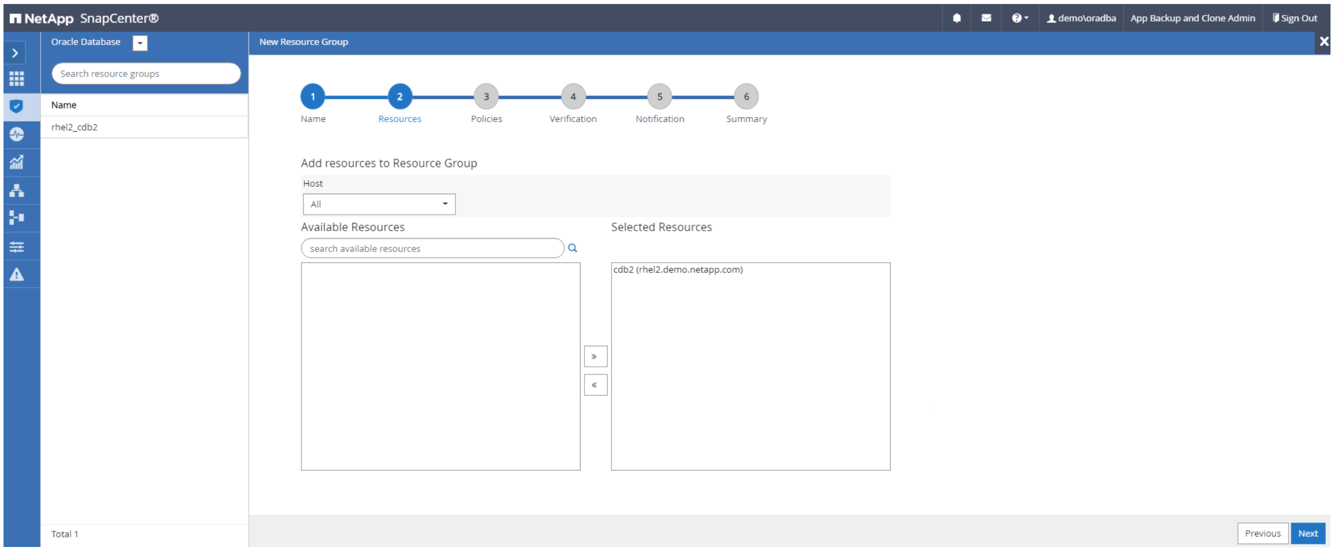
$CustomText

rhel2_cdb2_log

Backup settings

Exclude archive log destinations from backup

3. Add database resources to the resource group.



Add resources to Resource Group

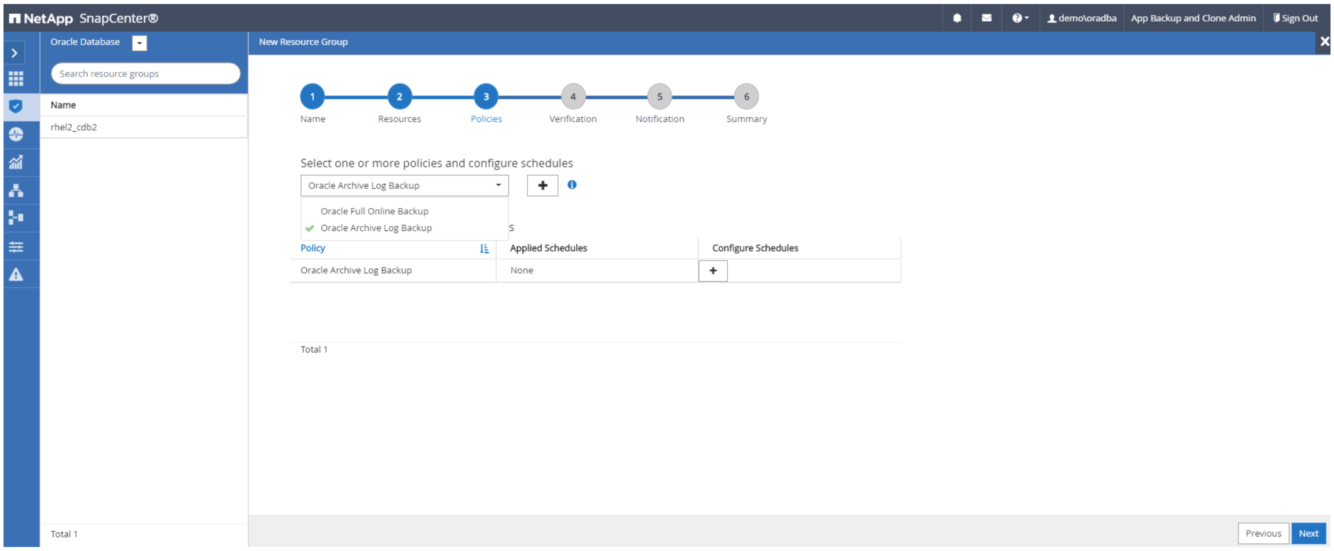
Host: All

Available Resources

Selected Resources

cdb2 (rhel2.demo.netapp.com)

4. Select a log backup policy created in section 7 from the drop-down list.



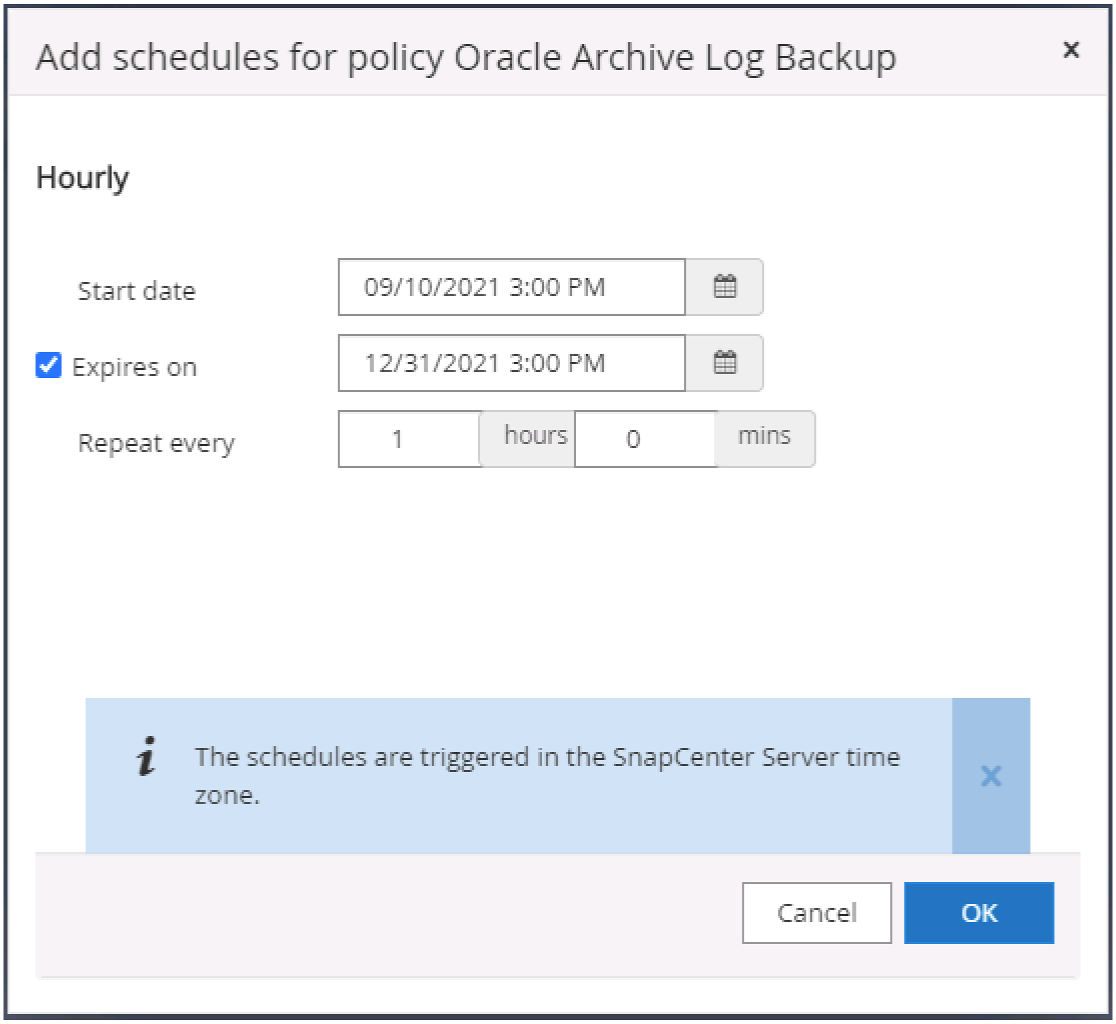
Select one or more policies and configure schedules

Oracle Archive Log Backup

Policy	Applied Schedules	Configure Schedules
Oracle Archive Log Backup	None	+

Total 1

5. Click on the (+) sign to configure the desired backup schedule.


Add schedules for policy Oracle Archive Log Backup

Hourly

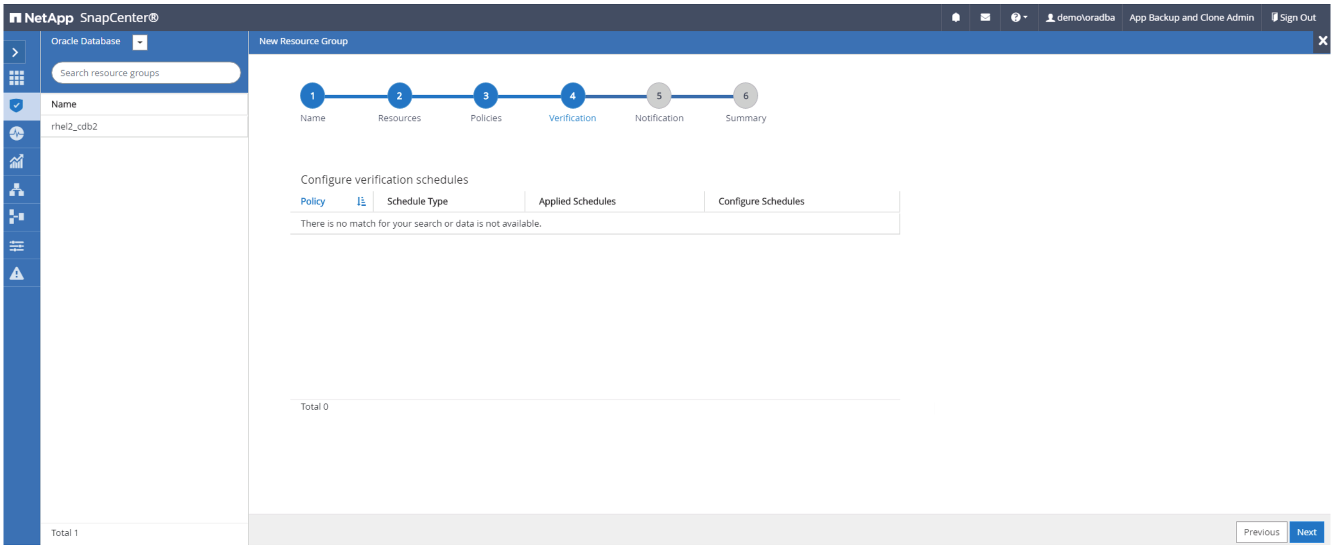
Start date: 09/10/2021 3:00 PM

☑ Expires on: 12/31/2021 3:00 PM

Repeat every: 1 hours 0 mins

The schedules are triggered in the SnapCenter Server time zone.

6. If backup verification is configured, it displays here.

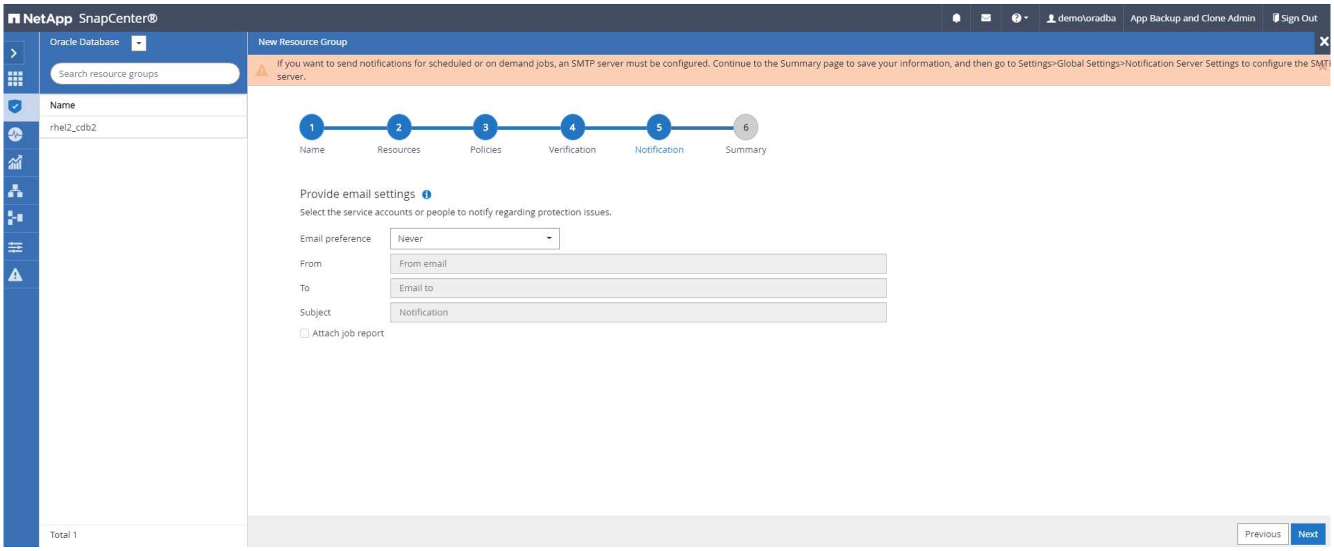


Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
There is no match for your search or data is not available.			

Total 0

7. Configure an SMTP server for email notification if desired.



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 SMT server.

Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

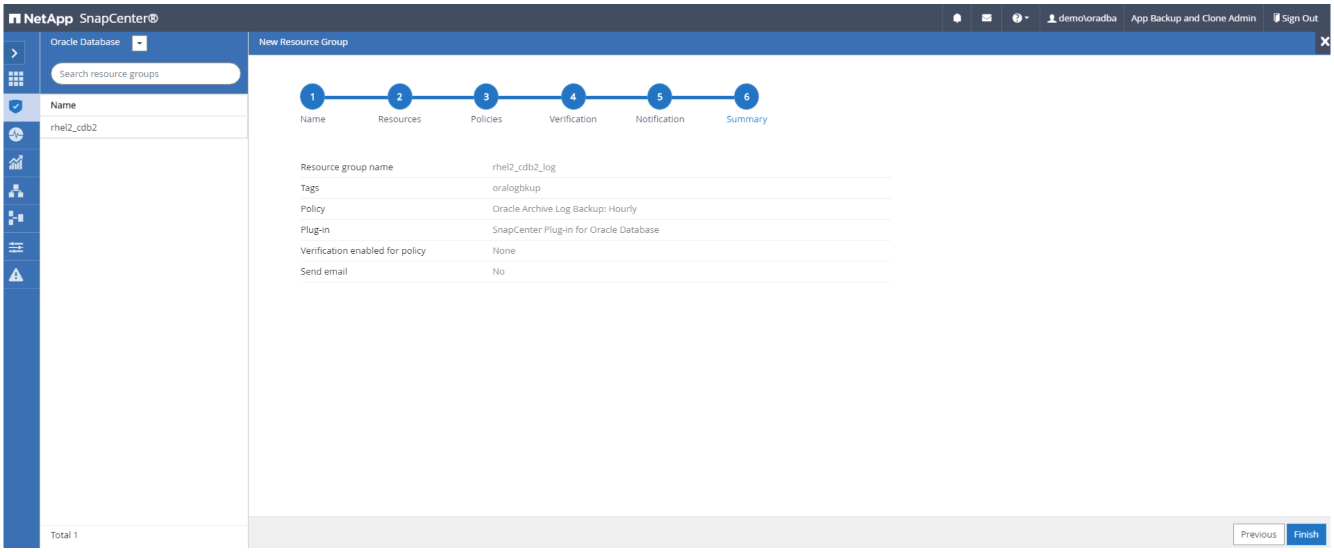
From: From email

To: Email to

Subject: Notification

☐ Attach job report

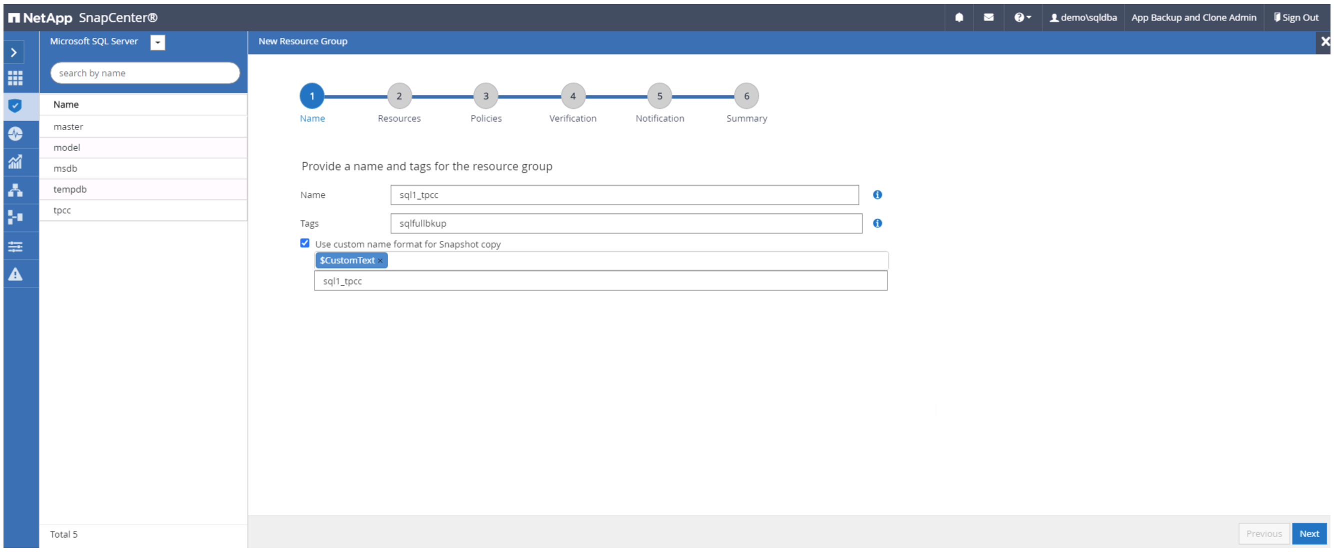
8. Summary.



Resource group name	rhel2_cdb2_log
Tags	oralogbkup
Policy	Oracle Archive Log Backup: Hourly
Plug-in	SnapCenter Plug-in for Oracle Database
Verification enabled for policy	None
Send email	No

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.



Provide a name and tags for the resource group

Name: sql1_tpcc

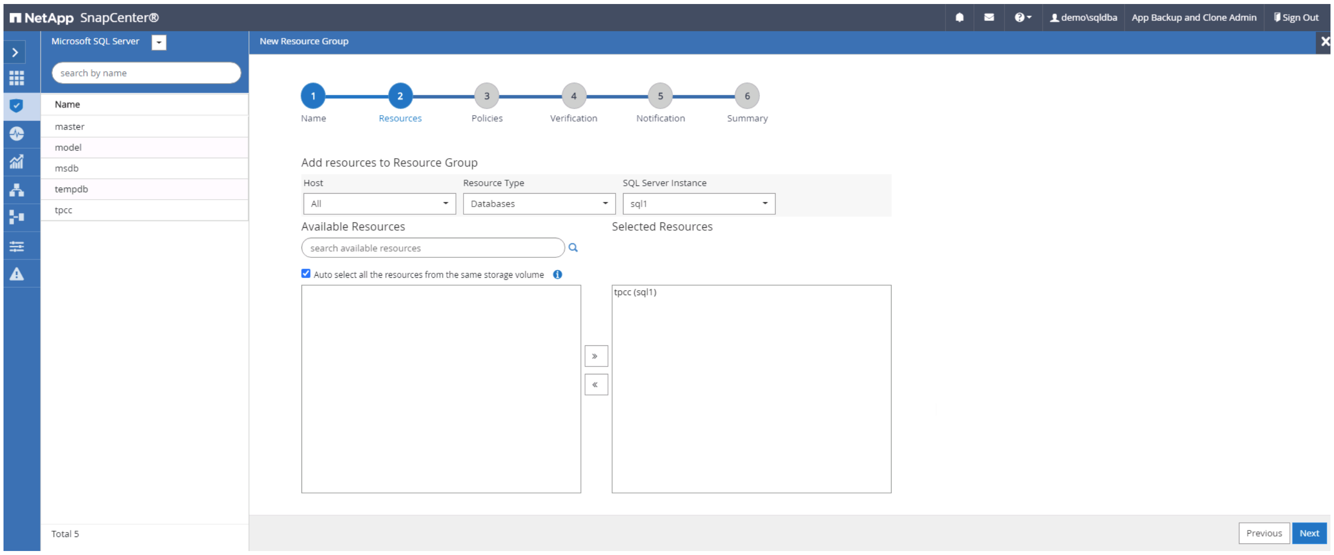
Tags: sqlfullbkup

☑ Use custom name format for Snapshot copy

$CustomText

sql1_tpcc

2. Select the database resources to be backed up.



Add resources to Resource Group

Host: All

Resource Type: Databases

SQL Server Instance: sql1

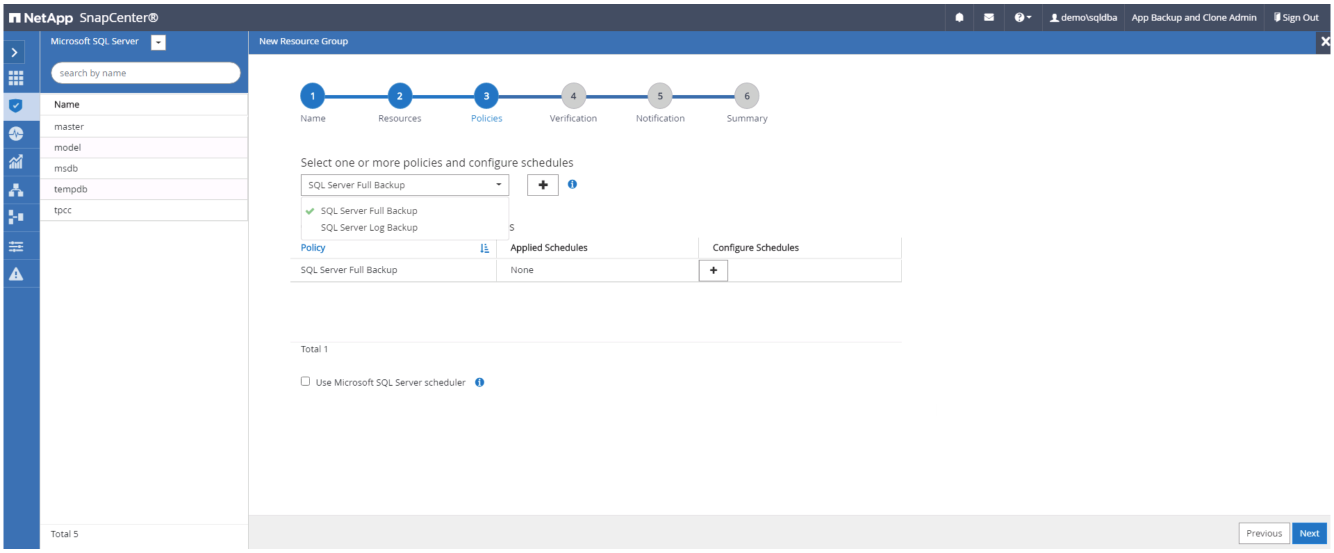
Available Resources

Selected Resources

☑ Auto select all the resources from the same storage volume

tpcc (sql1)

3. Select a full SQL backup policy created in section 7.



Select one or more policies and configure schedules

SQL Server Full Backup

✓ SQL Server Full Backup

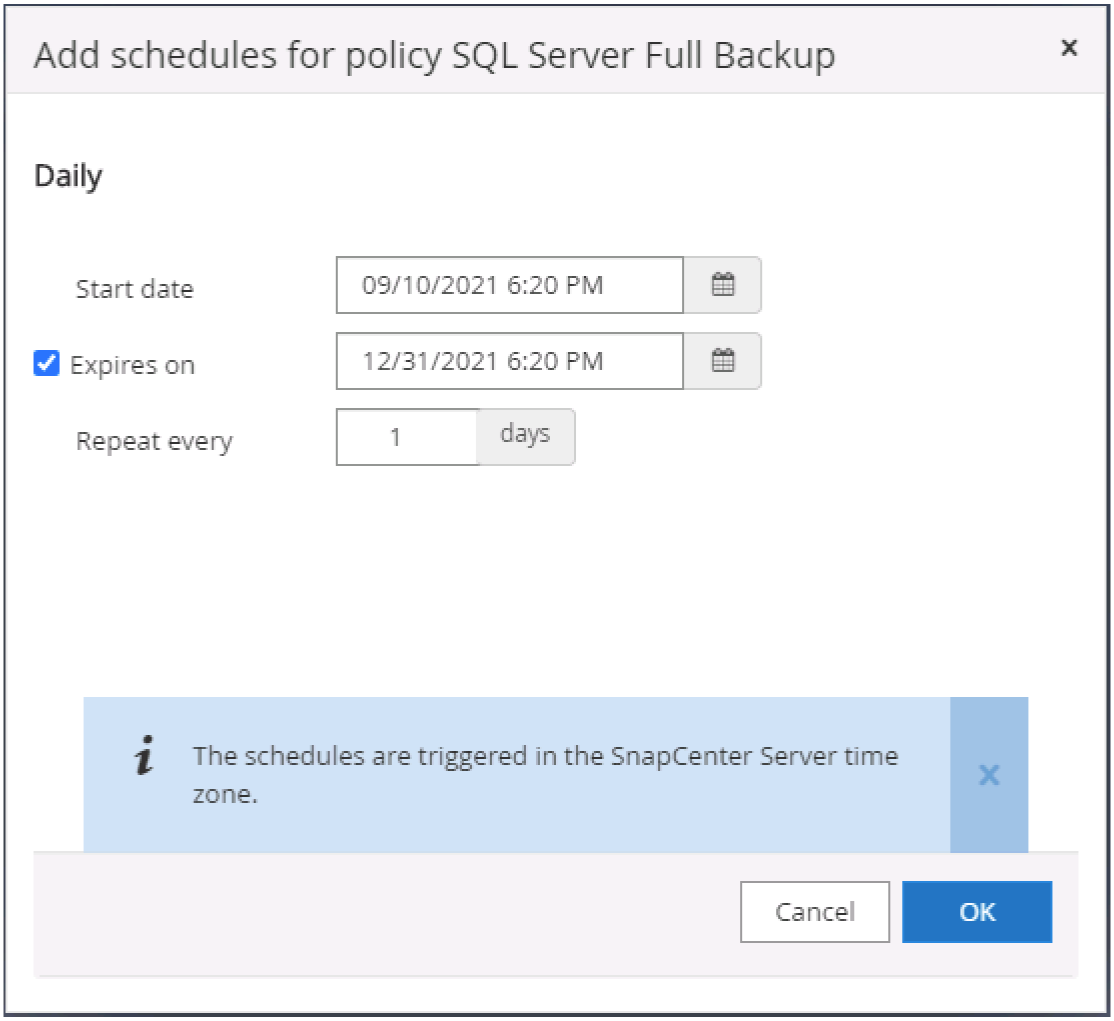
SQL Server Log Backup

Policy	Applied Schedules	Configure Schedules
SQL Server Full Backup	None	+

Total 1

☐ Use Microsoft SQL Server scheduler

4. Add exact timing for backups as well as the frequency.



Add schedules for policy SQL Server Full Backup

Daily

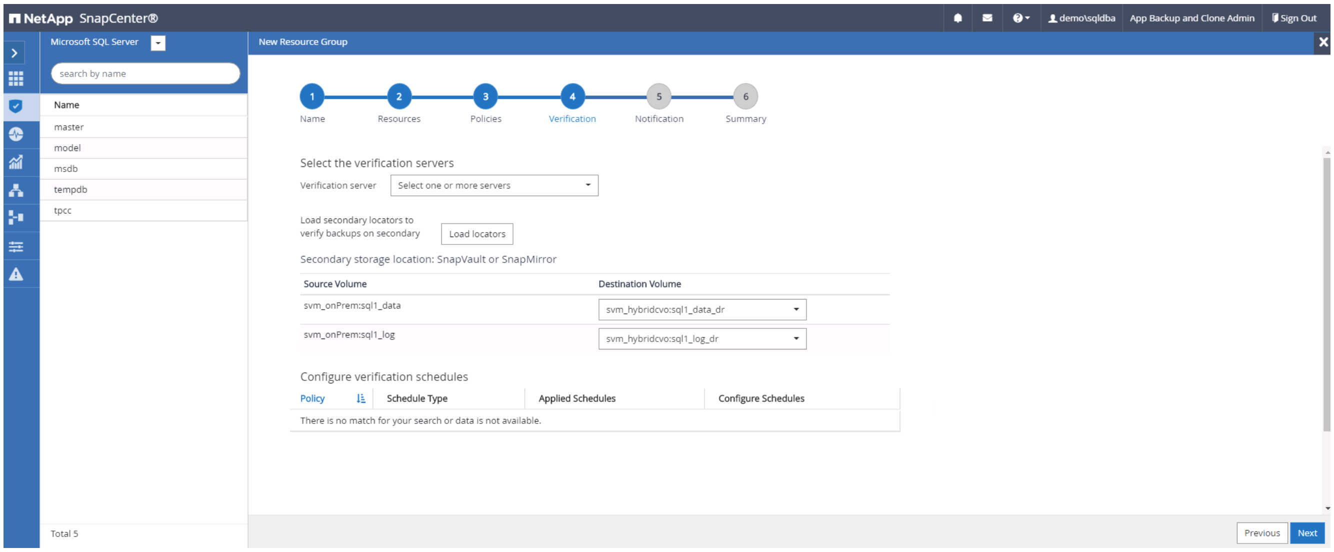
Start date: 09/10/2021 6:20 PM

☑ Expires on: 12/31/2021 6:20 PM

Repeat every: 1 days

The schedules are triggered in the SnapCenter Server time zone.

5. 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.



Select the verification servers

Verification server: Select one or more servers

Load secondary locators to verify backups on secondary: Load locators

Secondary storage location: SnapVault or SnapMirror

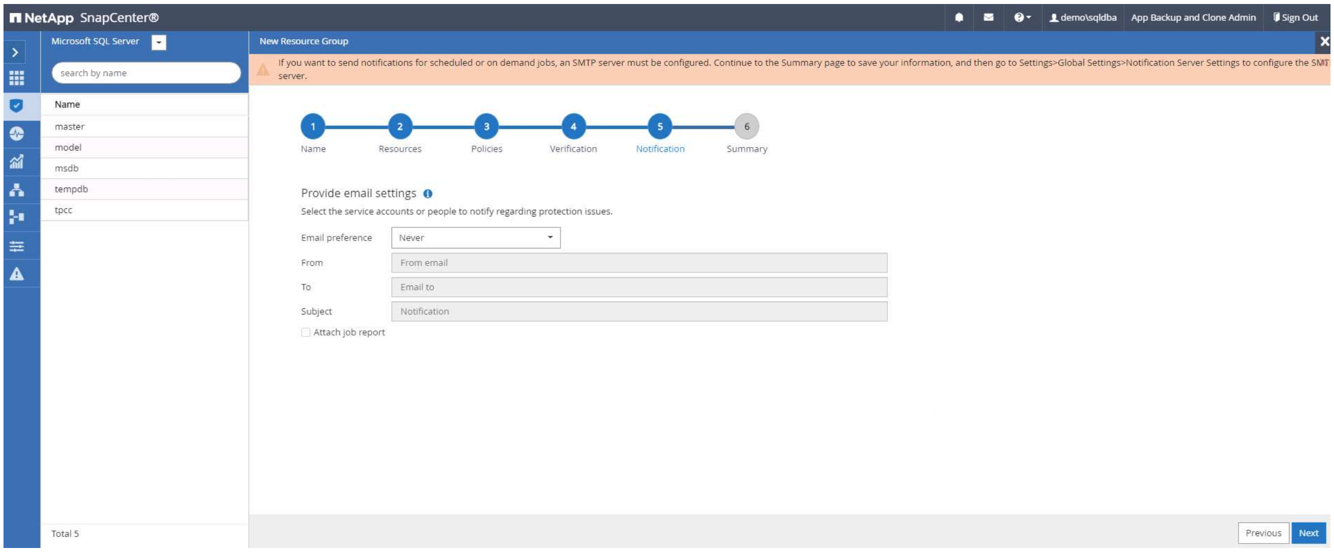
Source Volume	Destination Volume
svm_onPrem:sql1_data	svm_hybridcvo:sql1_data_dr
svm_onPrem:sql1_log	svm_hybridcvo:sql1_log_dr

Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules

There is no match for your search or data is not available.

6. Configure the SMTP server for email notification if desired.



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 SMT server.

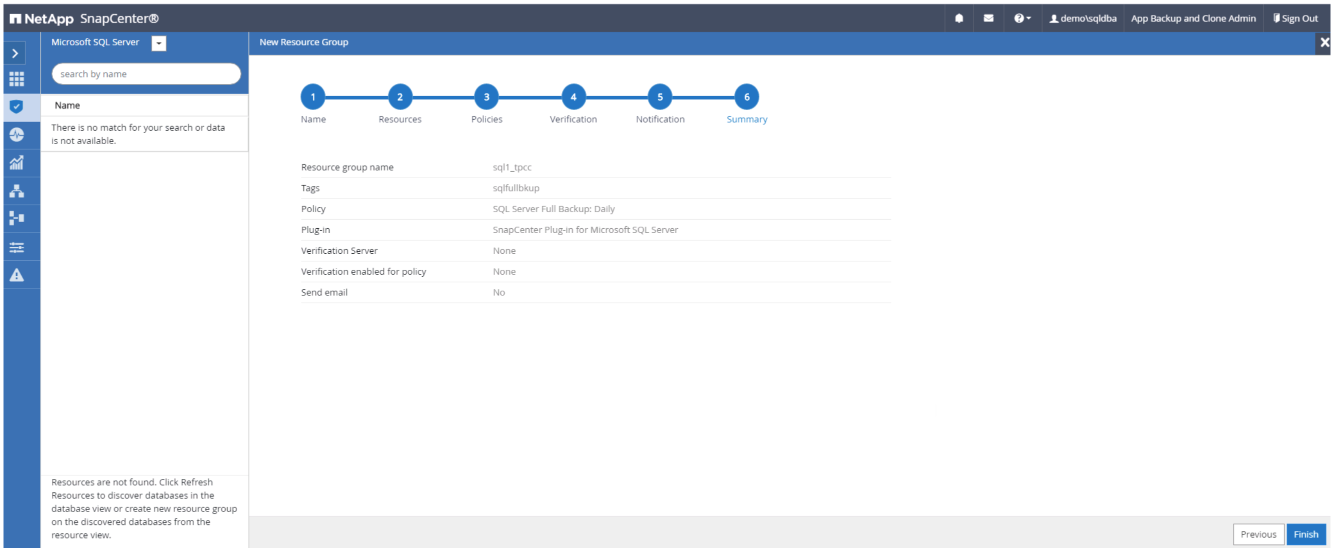
Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference	Never
From	From email
To	Email to
Subject	Notification

☐ Attach job report

7. Summary.



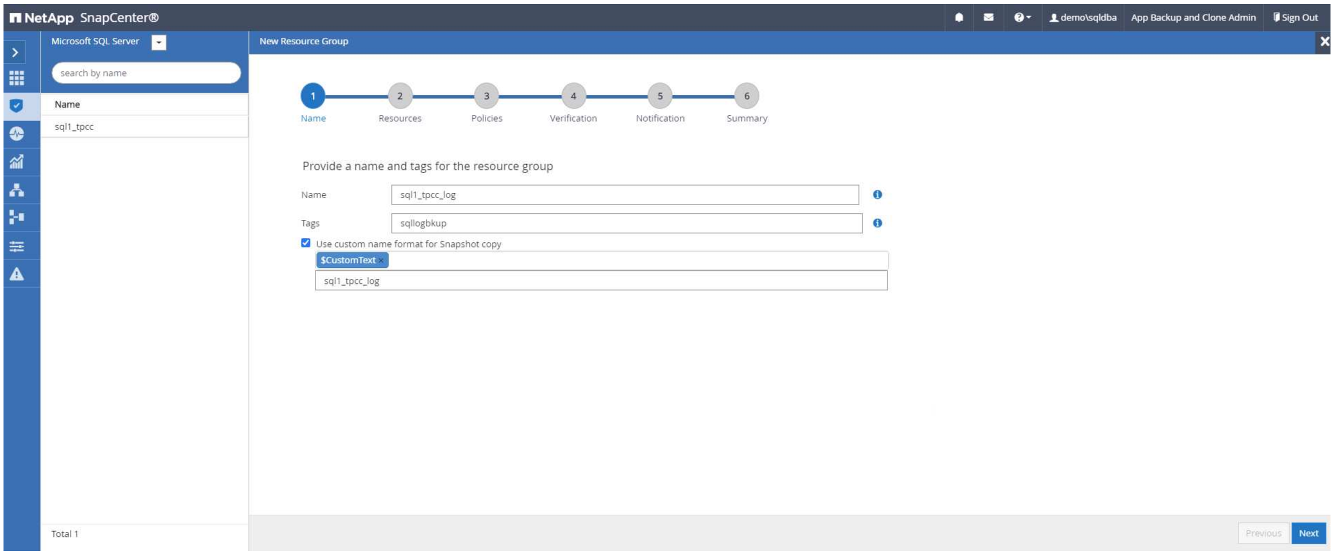
There is no match for your search or data is not available.

Resource group name	sql1_tpcc
Tags	sqlfullbkup
Policy	SQL Server Full Backup: Daily
Plug-in	SnapCenter Plug-in for Microsoft SQL Server
Verification Server	None
Verification enabled for policy	None
Send email	No

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.

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.



Provide a name and tags for the resource group

Name: sql1_tpcc_log

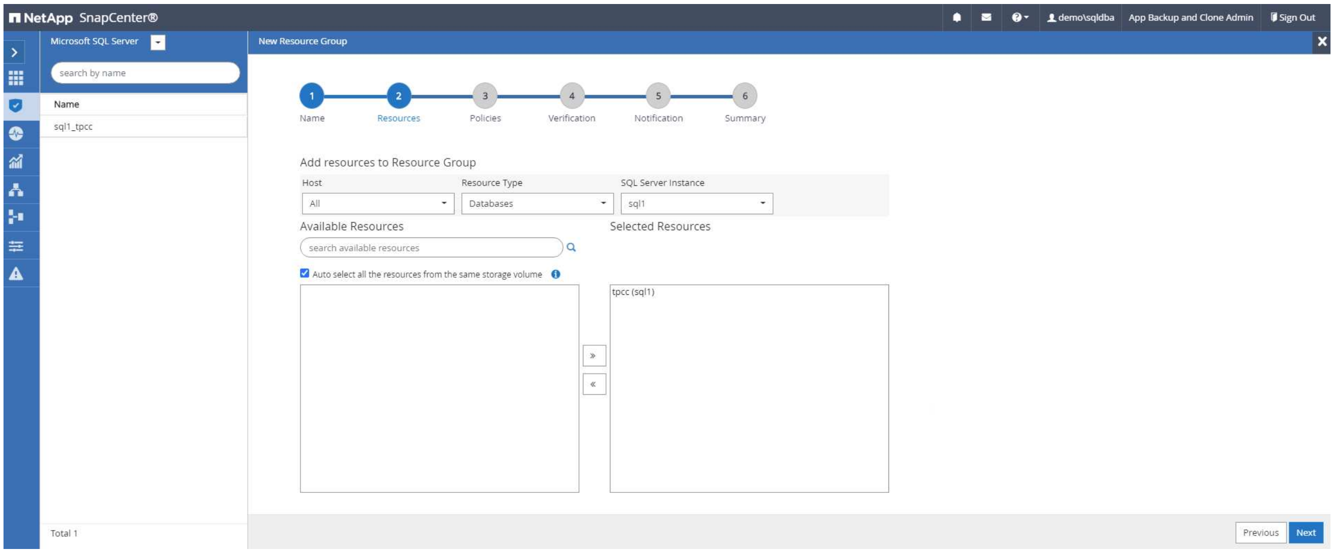
Tags: sqllogbkup

☑ Use custom name format for Snapshot copy

$CustomText

sql1_tpcc_log

2. Select the database resources to be backed up.



Add resources to Resource Group

Host: All

Resource Type: Databases

SQL Server Instance: sql1

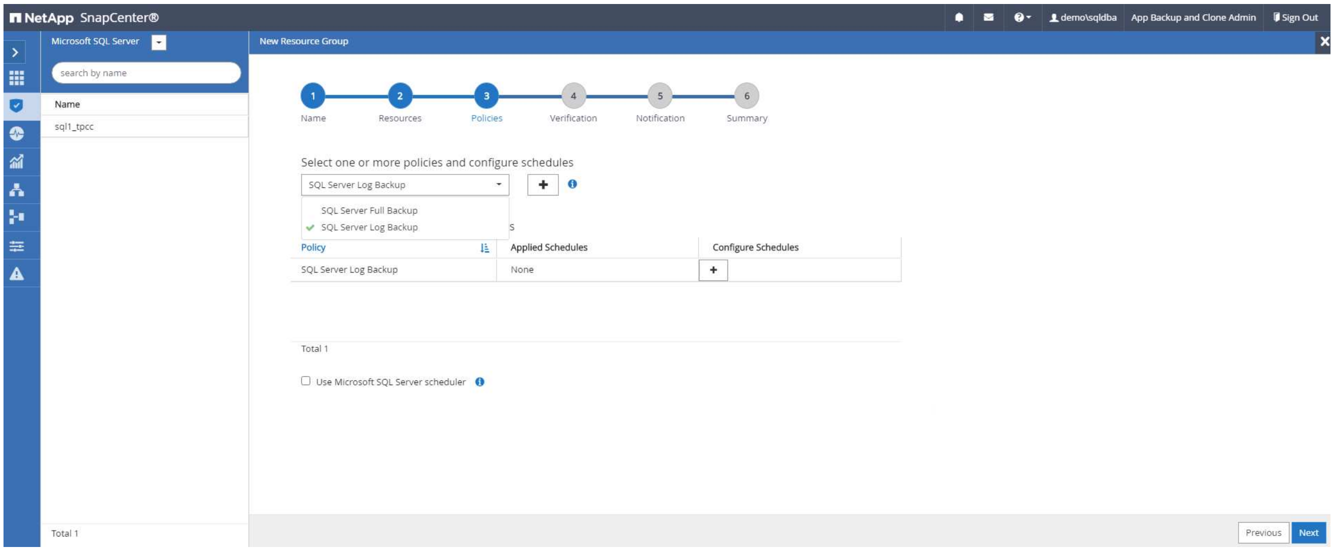
Available Resources

☑ Auto select all the resources from the same storage volume

Selected Resources

tpcc (sql1)

3. Select a SQL log backup policy created in section 7.



Select one or more policies and configure schedules

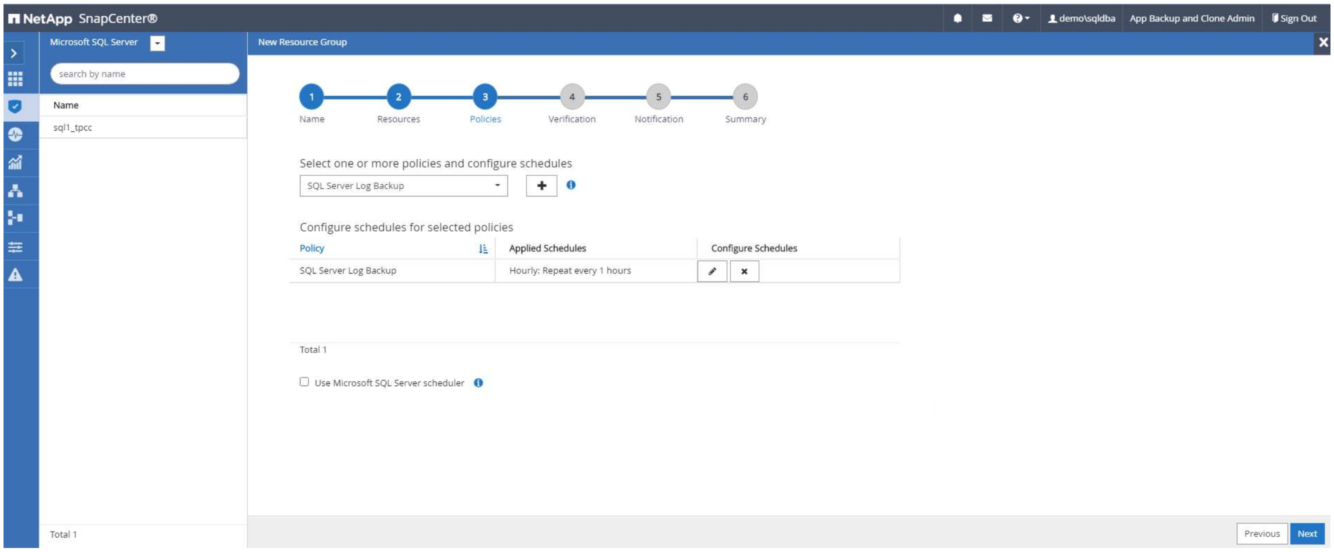
SQL Server Log Backup

Policy	Applied Schedules	Configure Schedules
SQL Server Log Backup	None	+

Total 1

☐ Use Microsoft SQL Server scheduler

4. Add exact timing for the backup as well as the frequency.



Select one or more policies and configure schedules

SQL Server Log Backup

Configure schedules for selected policies

Policy	Applied Schedules	Configure Schedules
SQL Server Log Backup	Hourly: Repeat every 1 hours	

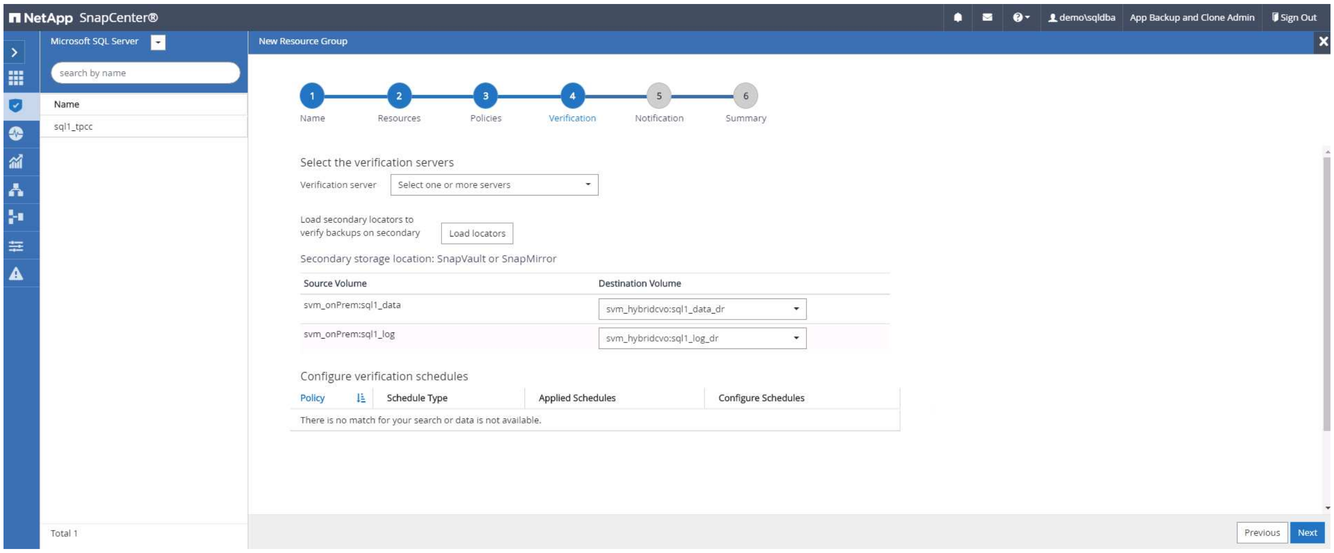
Total 1

☐ Use Microsoft SQL Server scheduler

Name
sql1_tpcc

Total 1

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.



Select the verification servers

Verification server: Select one or more servers

Load secondary locators to verify backups on secondary

Secondary storage location: SnapVault or SnapMirror

Source Volume	Destination Volume
svm_onPrem:sql1_data	svm_hybridcvo:sql1_data_dr
svm_onPrem:sql1_log	svm_hybridcvo:sql1_log_dr

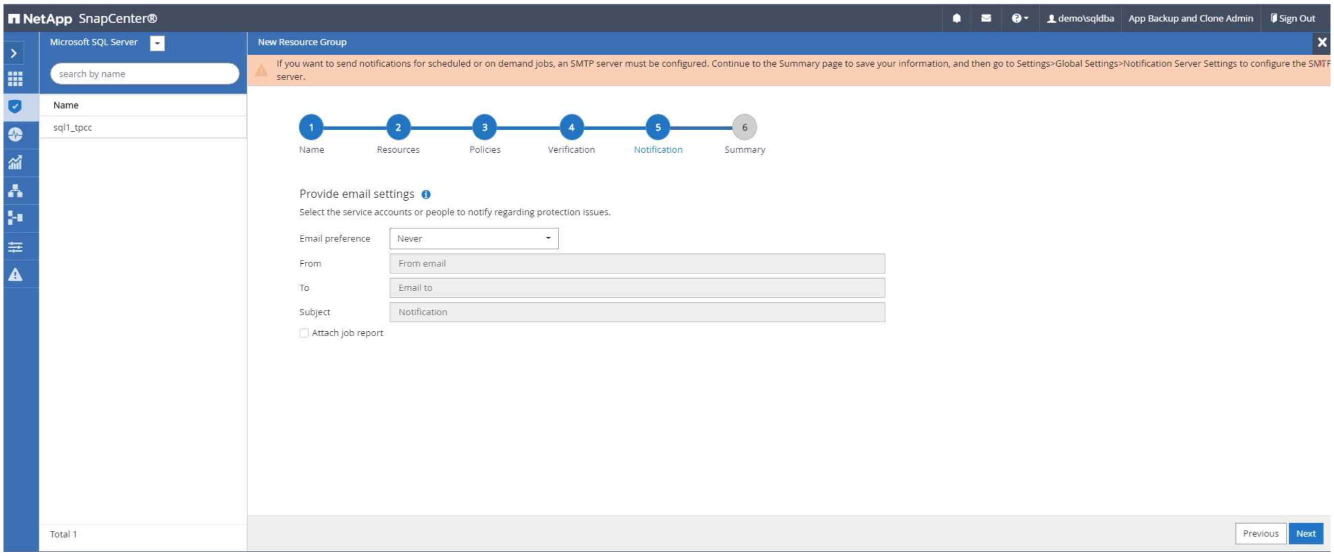
Configure verification schedules

Policy	Schedule Type	Applied Schedules	Configure Schedules
There is no match for your search or data is not available.			

Name
sql1_tpcc

Total 1

6. Configure the SMTP server for email notification if desired.



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.

Provide email settings

Select the service accounts or people to notify regarding protection issues.

Email preference: Never

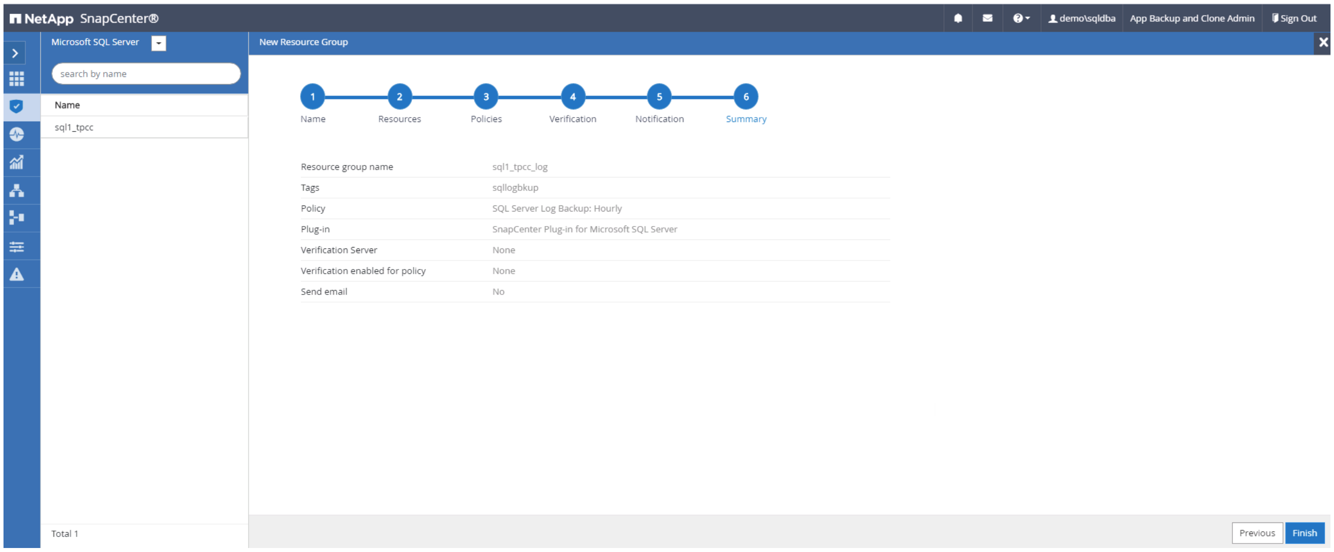
From: From email

To: Email to

Subject: Notification

☐ Attach job report

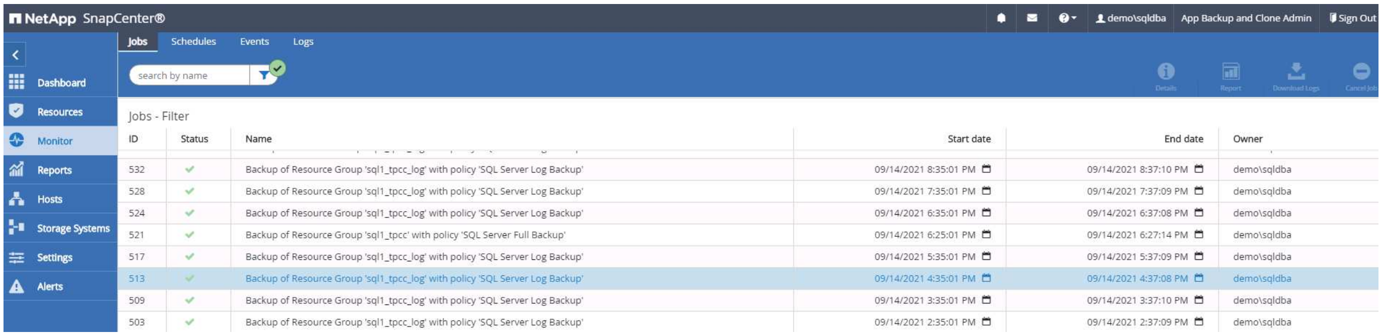
7. Summary.



Resource group name	sql1_tpcc_log
Tags	sqllogbkup
Policy	SQL Server Log Backup: Hourly
Plug-in	SnapCenter Plug-in for Microsoft SQL Server
Verification Server	None
Verification enabled for policy	None
Send email	No

9. Validate backup

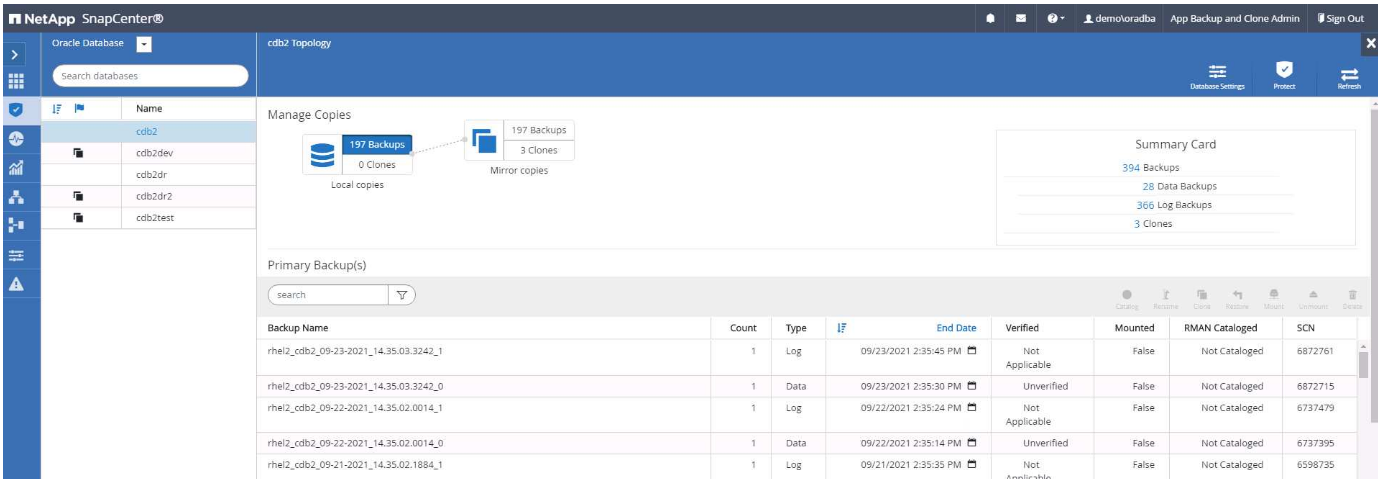
After database backup resource groups are created to protect database resources, the backup jobs runs according to the predefined schedule. Check the job execution status under the Monitor tab.



Jobs - Filter

ID	Status	Name	Start date	End date	Owner
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
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
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
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
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 3:37:10 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.



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	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.

Getting Started with AWS public cloud

This section describes the process of deploying Cloud Manager and Cloud Volumes ONTAP in AWS.

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:

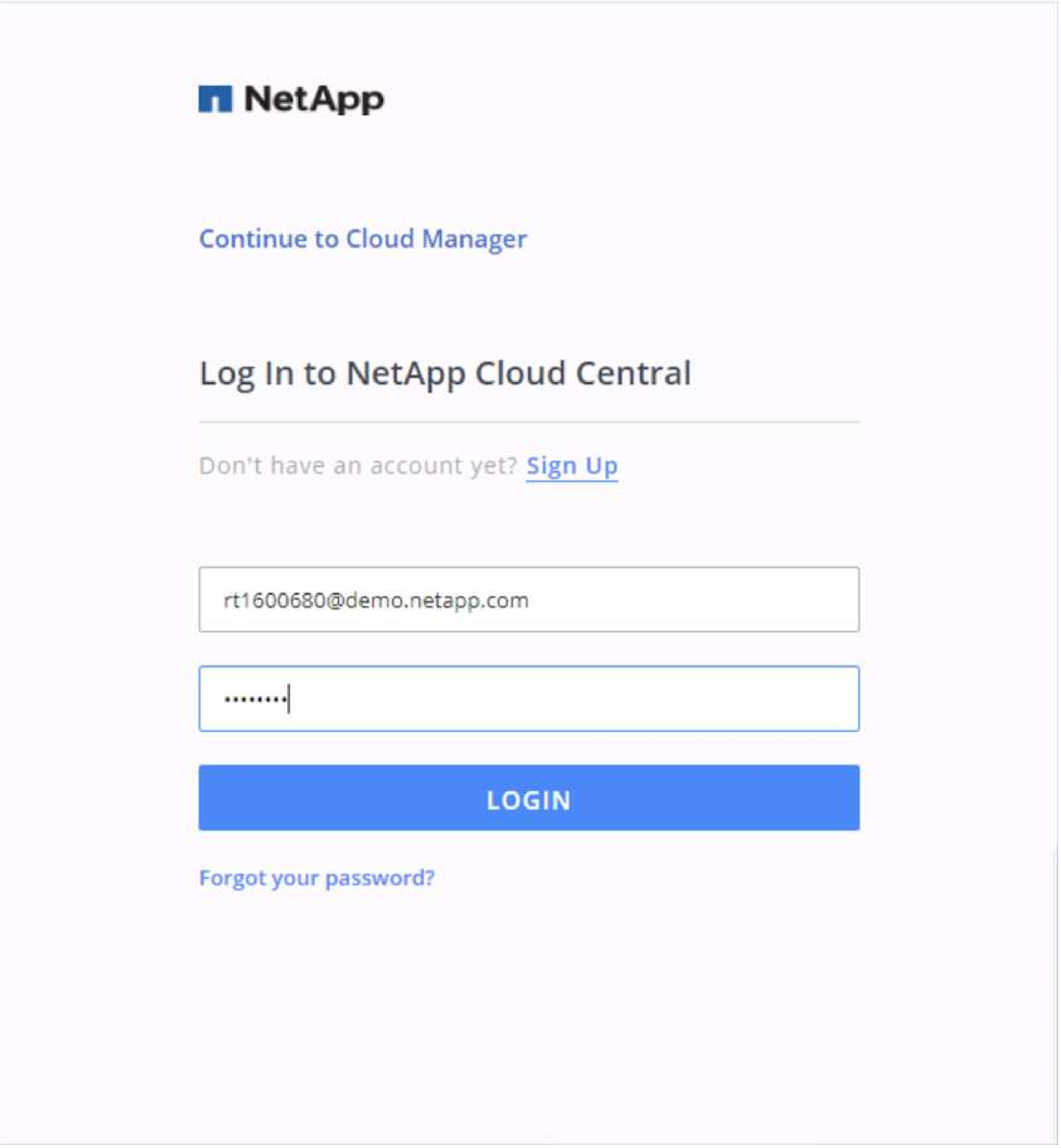
- ☐ AWS account
- ☐ VPC in your region of choice
- ☐ Subnet with access to the public internet
- ☐ Permissions to add IAM roles into your AWS account
- ☐ A secret key and access key for your AWS user

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

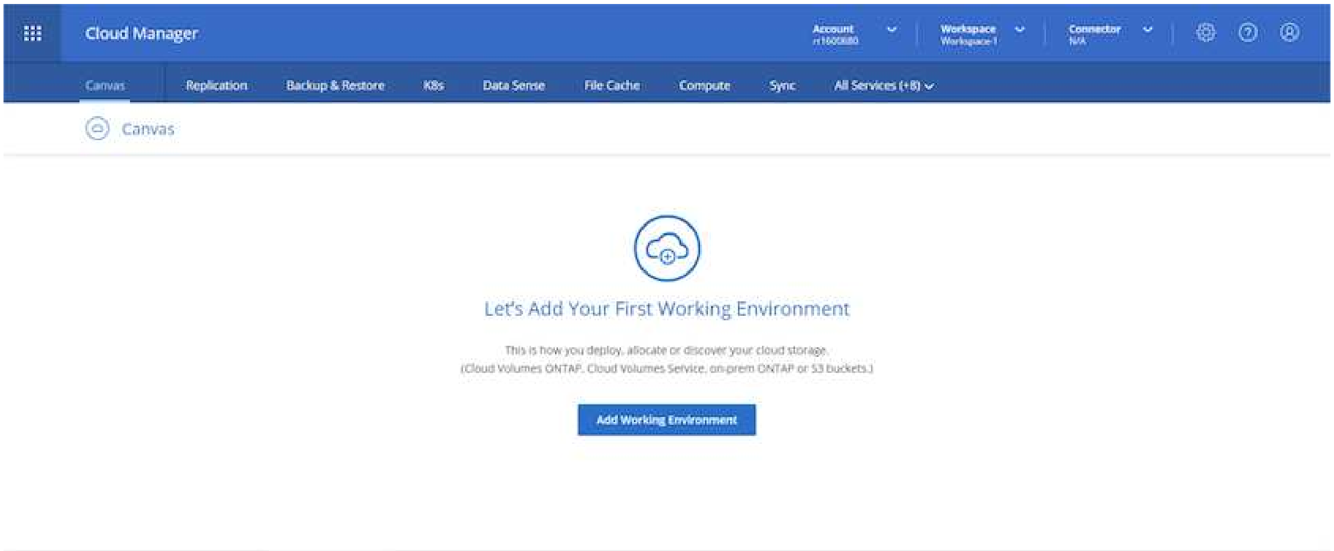
Log In to NetApp Cloud Central

Don't have an account yet? Sign Up

rt1600680@demo.netapp.com

••••••••

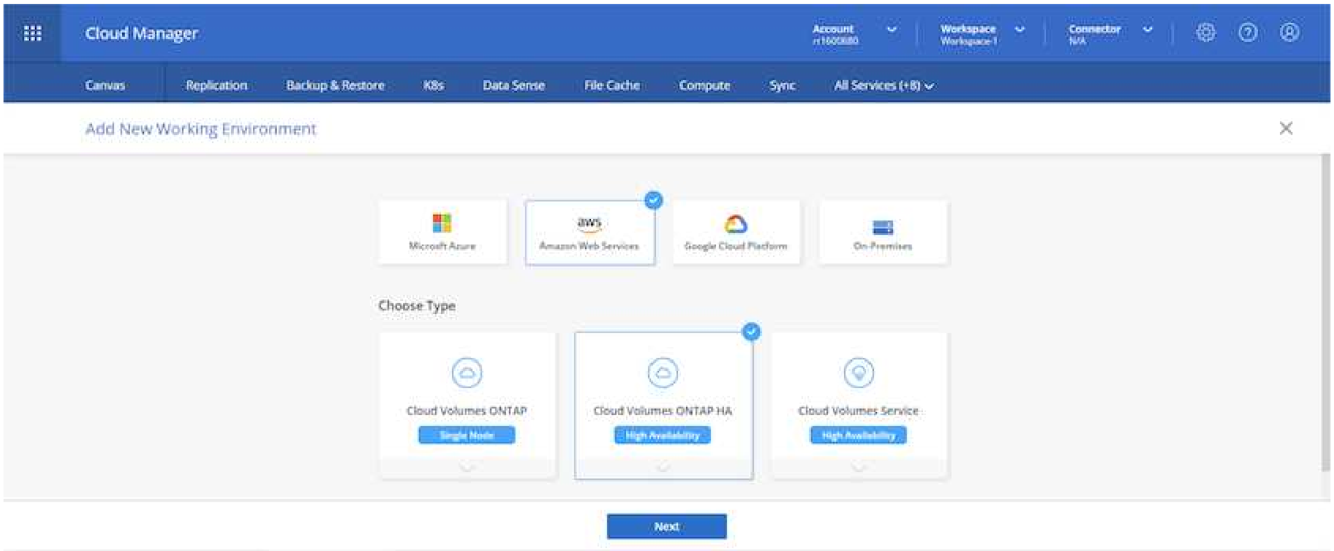
2. After you log in, you should be taken to the Canvas.



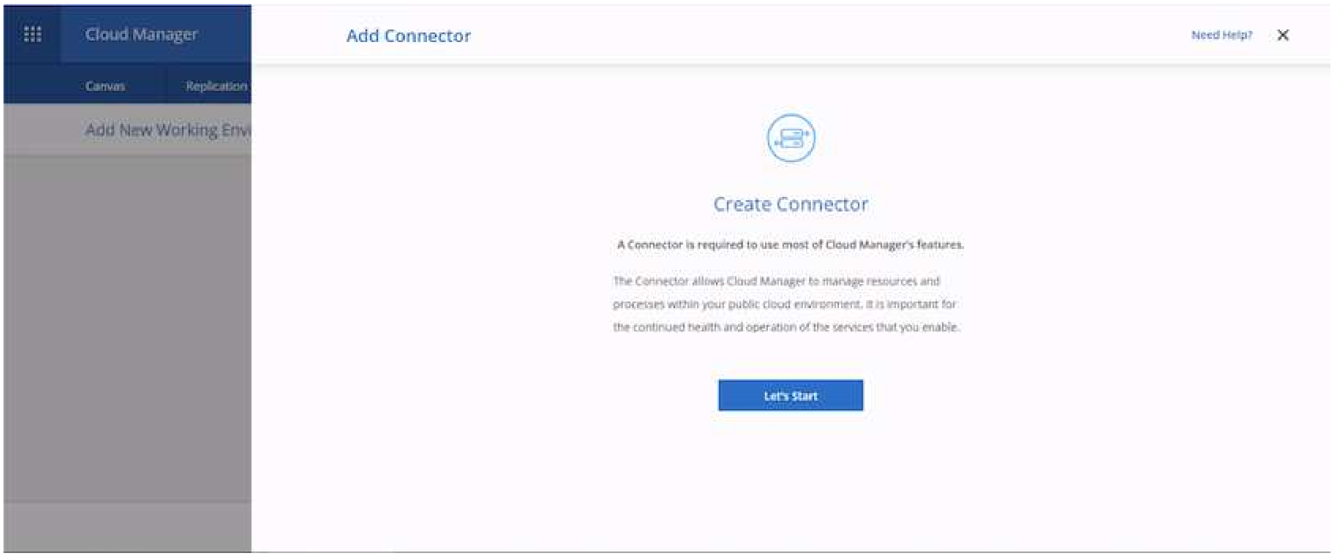
Let's Add Your First Working Environment

This is how you deploy, allocate or discover your cloud storage.
(Cloud Volumes ONTAP, Cloud Volumes Service, on-prem ONTAP or S3 buckets.)

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.



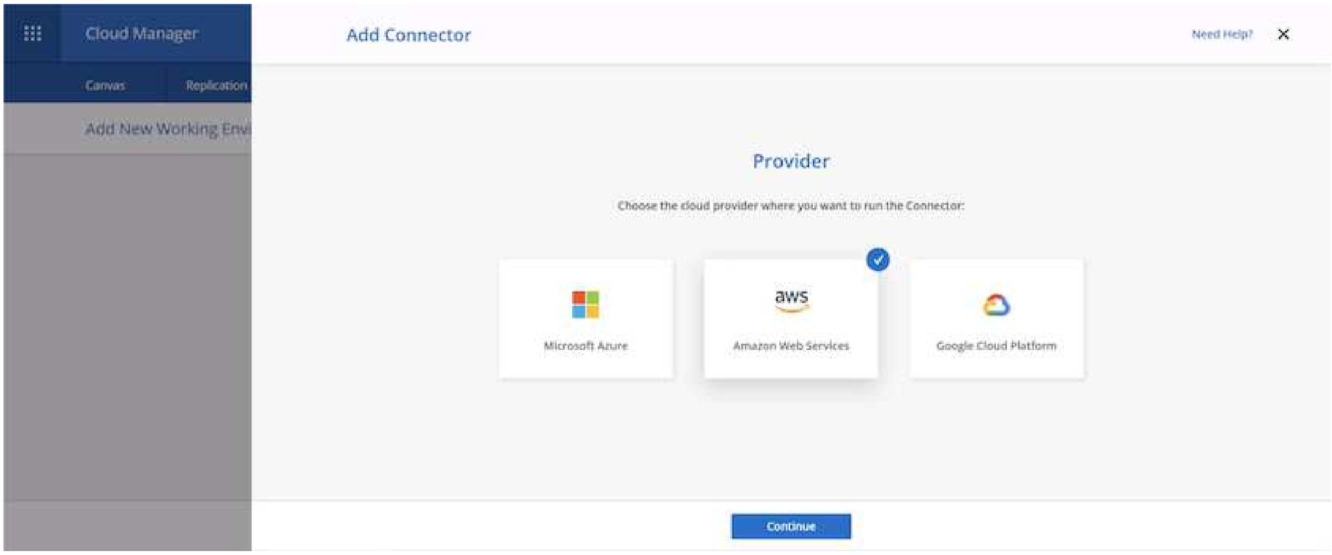
4. If no connector has been created, a pop-up appears asking you to create a connector.



A Connector is required to use most of Cloud Manager's features.

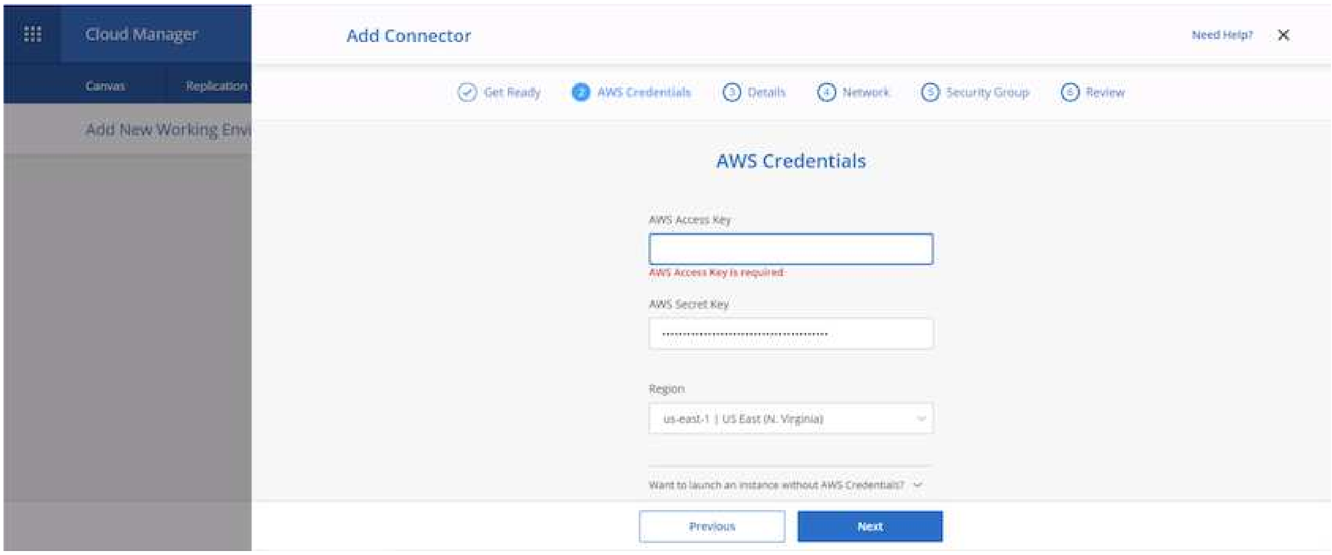
The Connector allows Cloud Manager to manage resources and processes within your public cloud environment. It is important for the continued health and operation of the services that you enable.

5. Click Lets Start, and then choose AWS.



Choose the cloud provider where you want to run the Connector:

6. Enter your secret key and access key. Make sure that your user has the correct permissions outlined on the NetApp policies page.



AWS Access Key

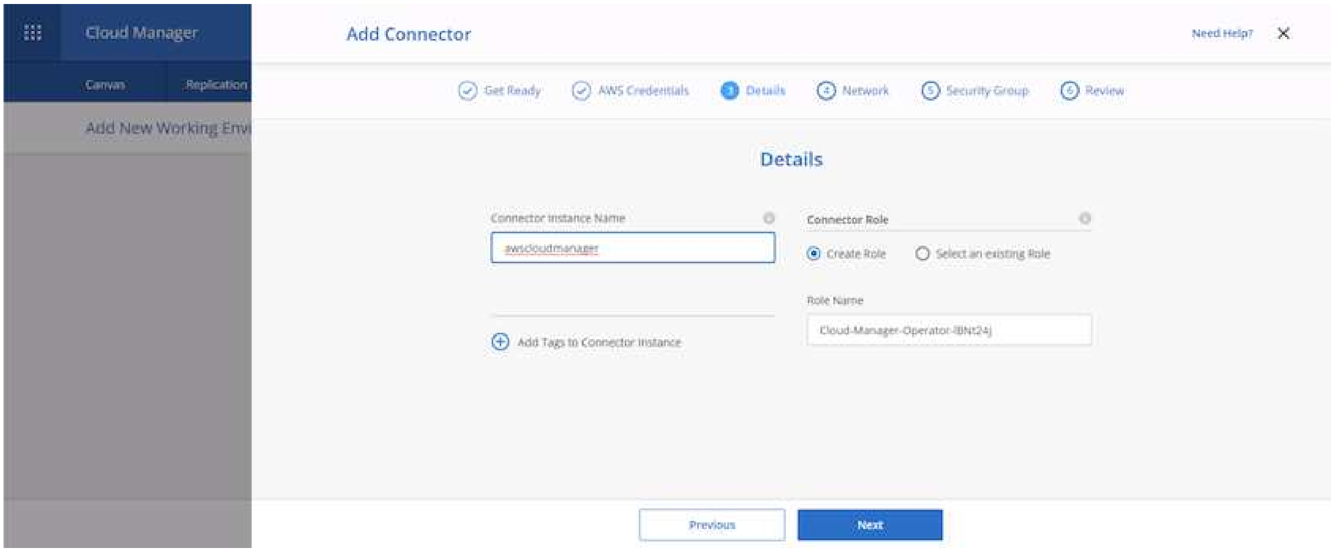
AWS Access Key is required

AWS Secret Key: ••

Region: us-east-1 | US East (N. Virginia)

Want to launch an instance without AWS Credentials?

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.

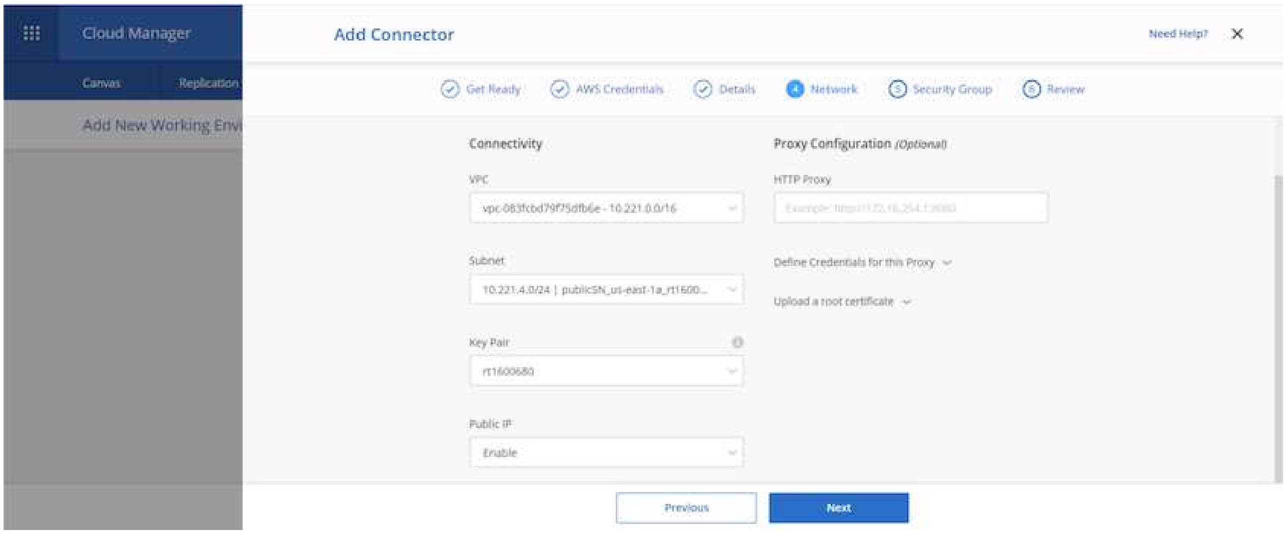


Connector Instance Name: awscloudmanager

Connector Role: ● Create Role ○ Select an existing Role

Role Name: Cloud-Manager-Operator-IBNt24j

8. Give the networking information needed to deploy the connector. Verify that outbound internet access is enabled by:
   a. Giving the connector a public IP address
   b. Giving the connector a proxy to work through
   c. Giving the connector a route to the public internet through an Internet Gateway



Connectivity

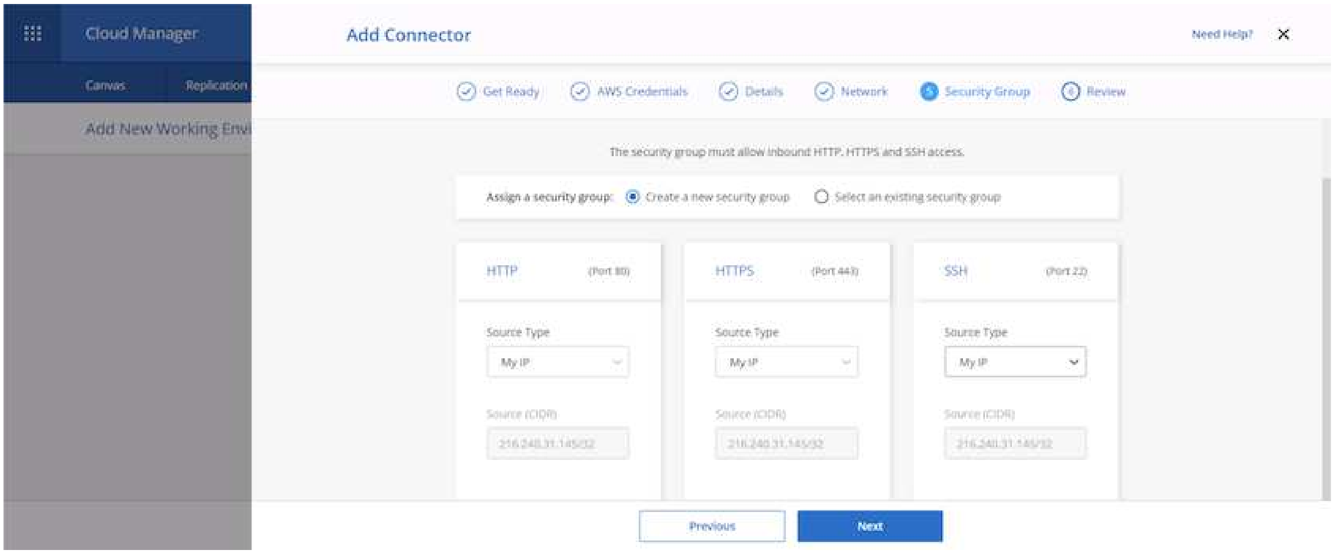
VPC: vpc-083fcbd79f75dfb6e - 10.221.0.0/16

Subnet: 10.221.4.0/24 | publicSN_us-east-1a_rt1600...

Key Pair: rt1600680

Public IP: Enable

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.

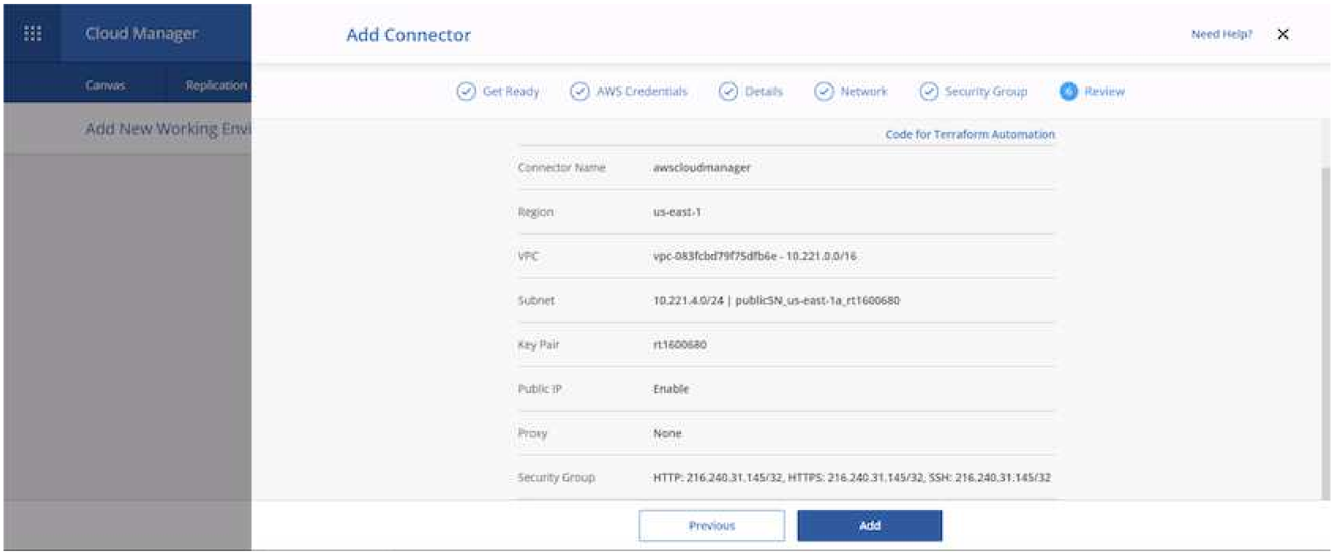


The security group must allow inbound HTTP, HTTPS and SSH access.

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

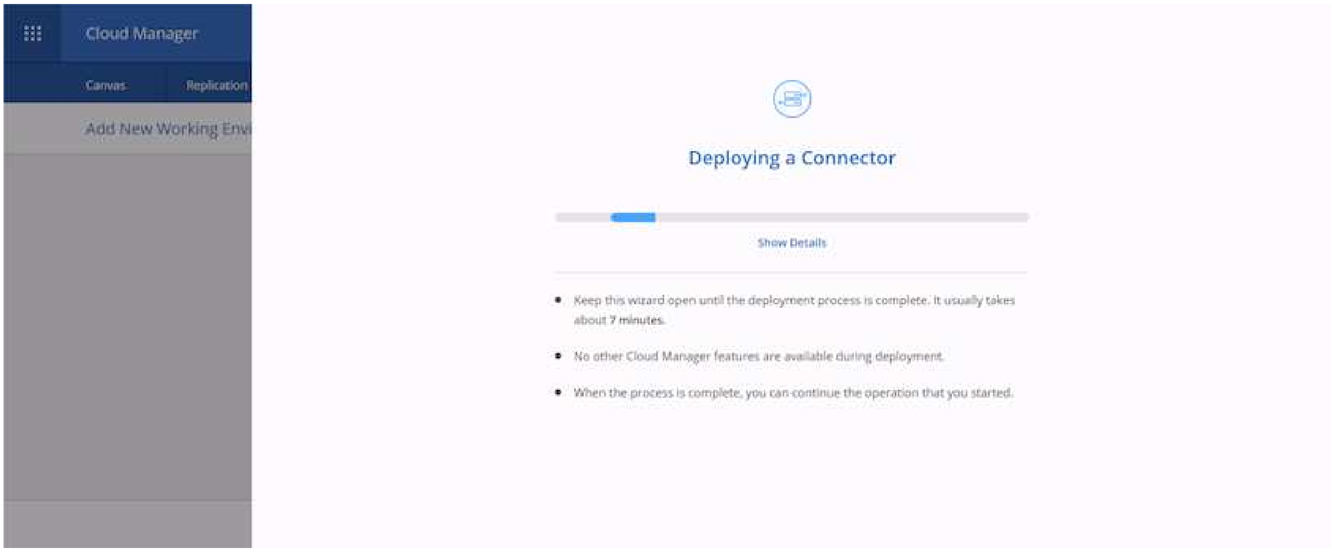
HTTP (Port 80)	HTTPS (Port 443)	SSH (Port 22)
Source Type: My IP	Source Type: My IP	Source Type: My IP
Source (CIDR): 216.240.31.145/32	Source (CIDR): 216.240.31.145/32	Source (CIDR): 216.240.31.145/32

10. Review the information on the summary page and click Add to deploy the connector.



Connector Name	awscloudmanager
Region	us-east-1
VPC	vpc-083fcbd79f75dfb6e - 10.221.0.0/16
Subnet	10.221.4.0/24 | publicSN_us-east-1a_rt1600680
Key Pair	rt1600680
Public IP	Enable
Proxy	None
Security Group	HTTP: 216.240.31.145/32, HTTPS: 216.240.31.145/32, SSH: 216.240.31:145/32

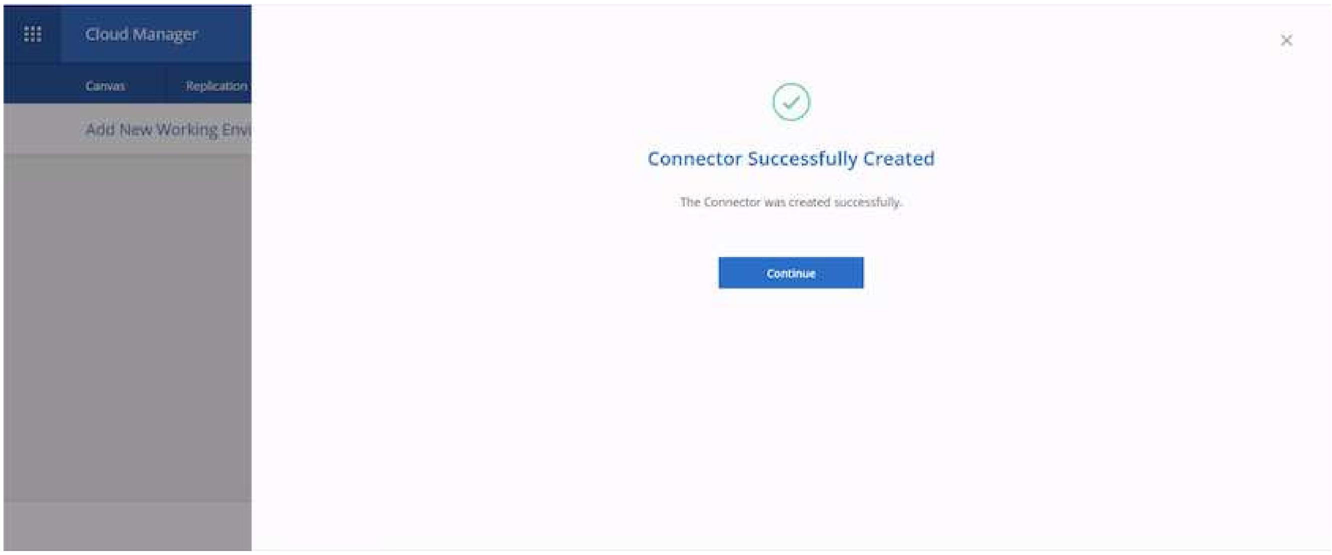
11. The connector now deploys using a cloud formation stack. You can monitor its progress from Cloud Manager or through AWS.



Deploying a Connector

- Keep this wizard open until the deployment process is complete. It usually takes about 7 minutes.
- No other Cloud Manager features are available during deployment.
- When the process is complete, you can continue the operation that you started.

12. When the deployment is complete, a success page appears.

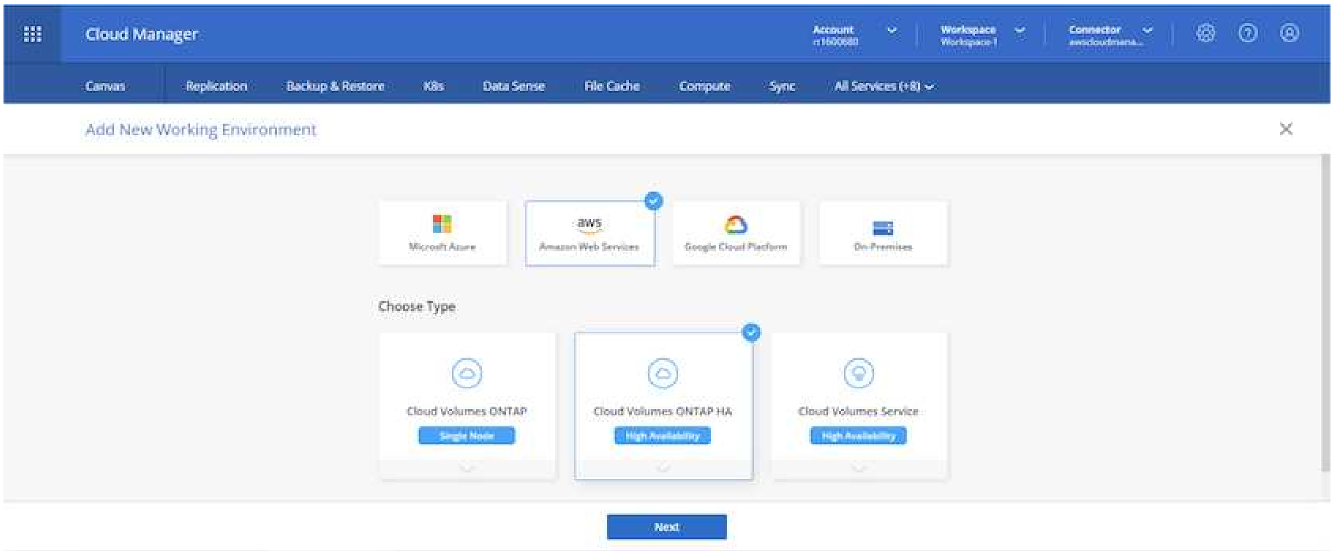


Connector Successfully Created

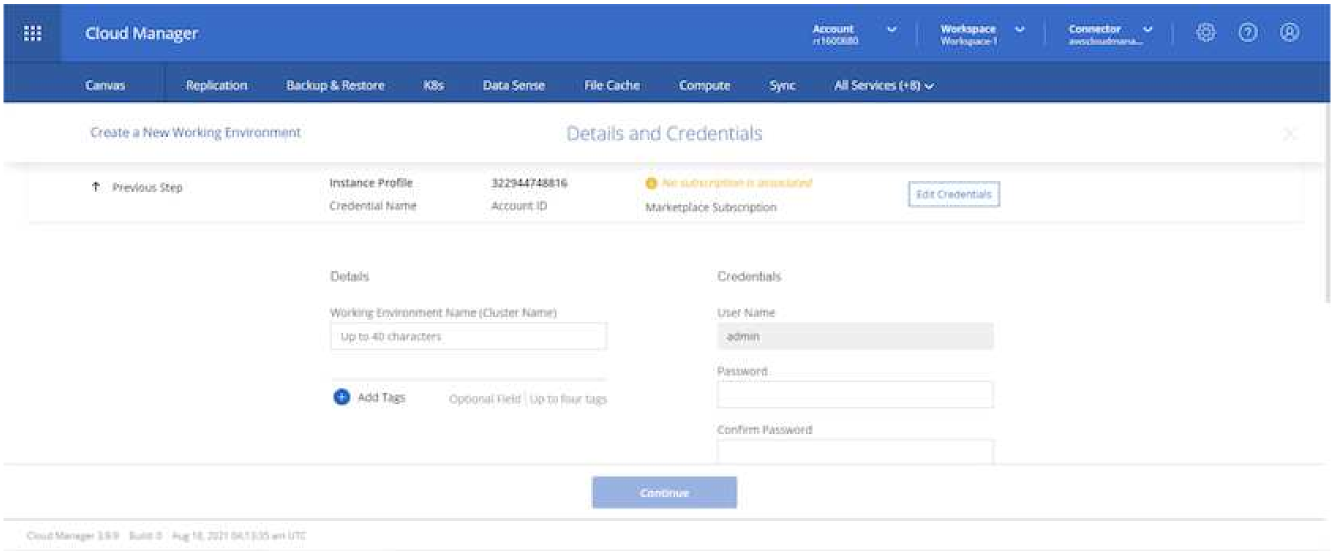
The Connector was created successfully.

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.



Instance Profile
Credential Name

322944748816
Account ID

No subscription is associated
Marketplace Subscription

Working Environment Name (Cluster Name): Up to 40 characters

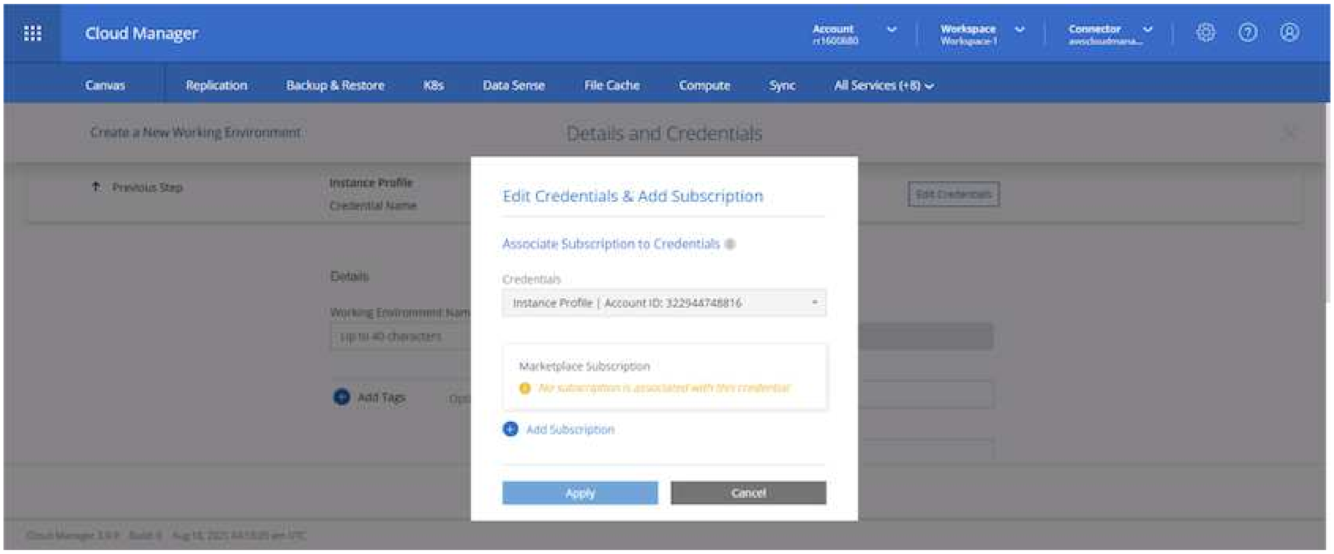
Optional Field | Up to four tags

User Name: admin

Password

Confirm Password

3. Choose Add Subscription.

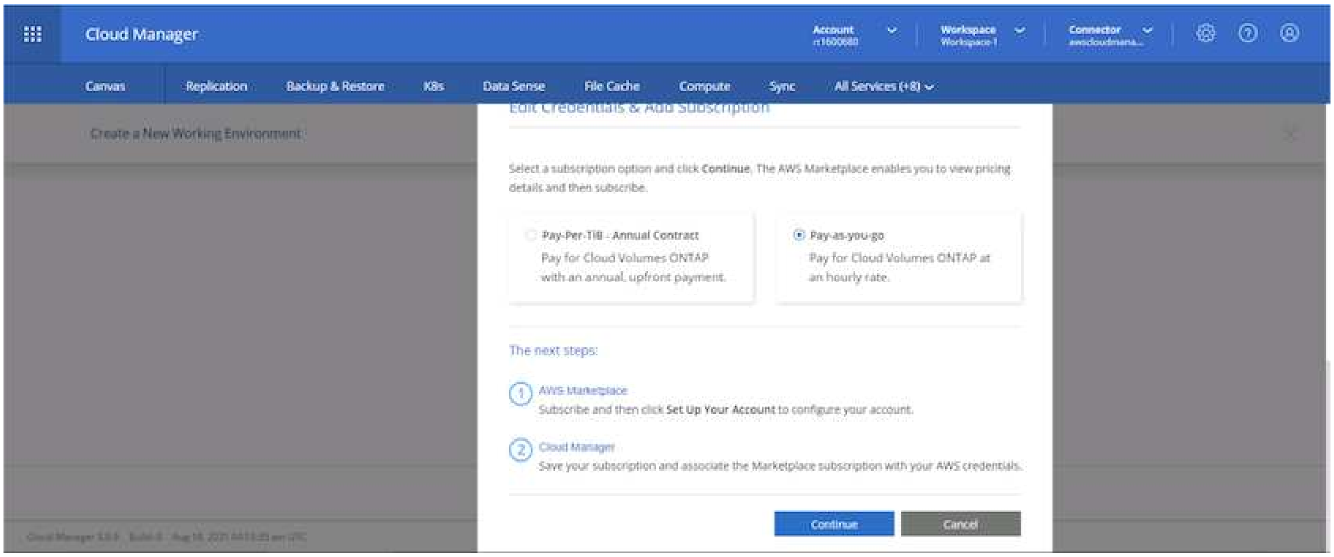


Credentials: Instance Profile | Account ID: 322944748816

Marketplace Subscription

No subscription is associated with this credential

4. Choose the type of contract that you wish to subscribe to. I chose Pay-as-you-go.



Edit Credentials & Add Subscription

Select a subscription option and click **Continue**. The AWS Marketplace enables you to view pricing details and then subscribe.

○ Pay-Per-TiB - Annual Contract
Pay for Cloud Volumes ONTAP with an annual, upfront payment.

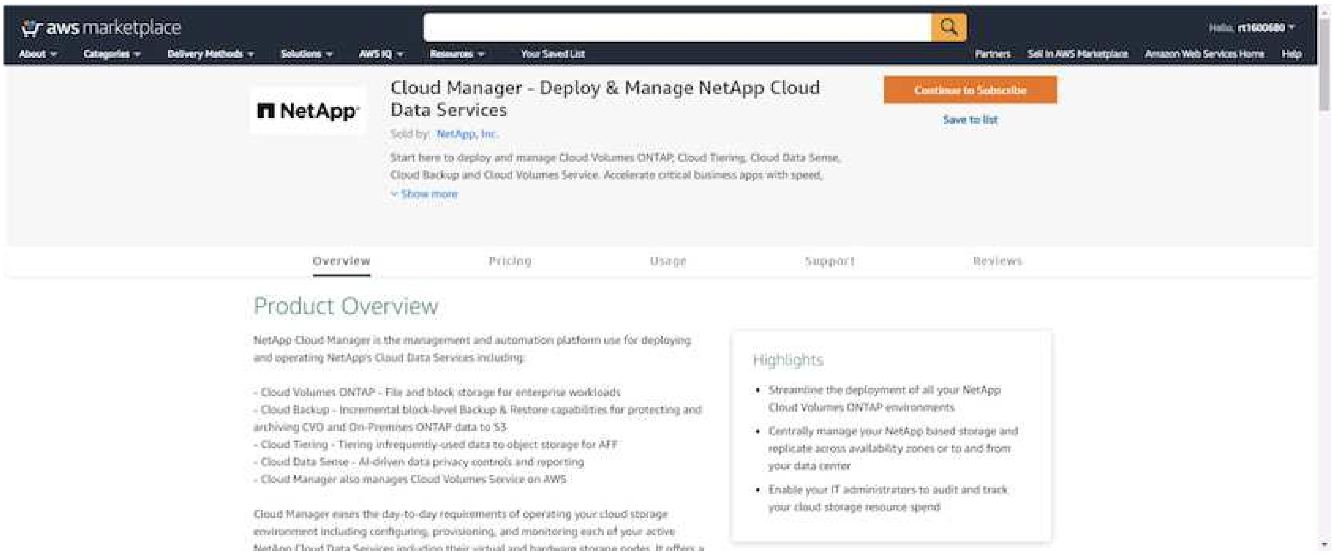
● Pay-as-you-go
Pay for Cloud Volumes ONTAP at an hourly rate.

The next steps:

① AWS Marketplace
Subscribe and then click **Set Up Your Account** to configure your account.

② Cloud Manager
Save your subscription and associate the Marketplace subscription with your AWS credentials.

5. You are redirected to AWS; choose Continue to Subscribe.



Cloud Manager - Deploy & Manage NetApp Cloud Data Services

Sold by: NetApp, Inc.

Start here to deploy and manage Cloud Volumes ONTAP, Cloud Tiering, Cloud Data Sense, Cloud Backup and Cloud Volumes Service. Accelerate critical business apps with speed,

Product Overview

NetApp Cloud Manager is the management and automation platform use for deploying and operating NetApp's Cloud Data Services including:

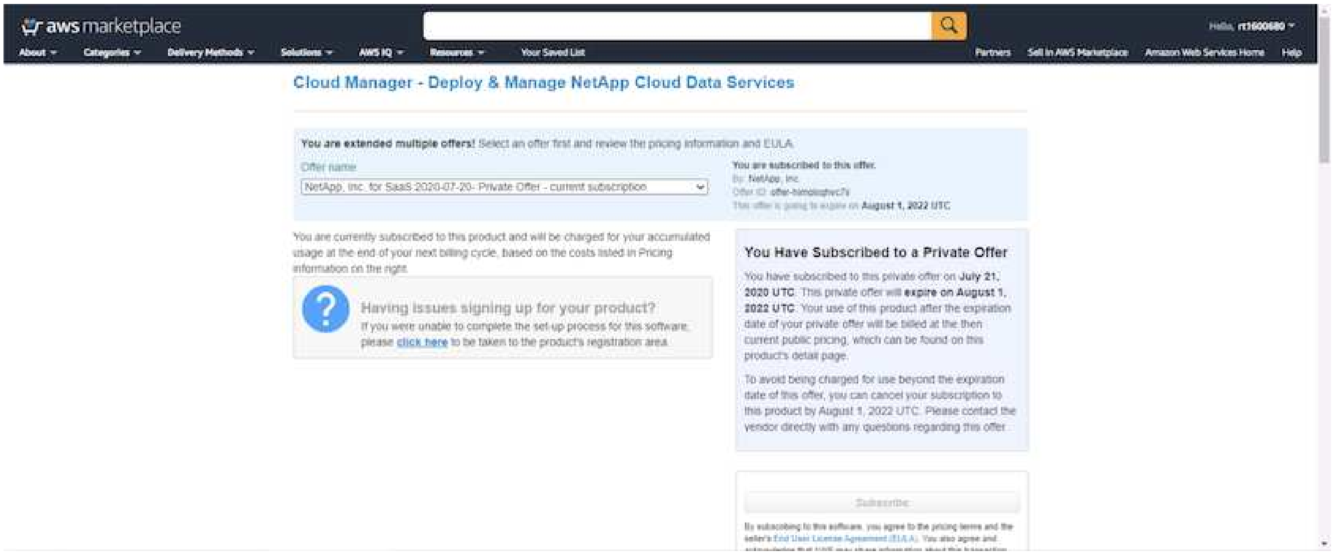
- Cloud Volumes ONTAP - File and block storage for enterprise workloads
- Cloud Backup - Incremental block-level Backup & Restore capabilities for protecting and archiving CVO and On-Premises ONTAP data to S3
- Cloud Tiering - Tiering infrequently-used data to object storage for AFF
- Cloud Data Sense - AI-driven data privacy controls and reporting
- Cloud Manager also manages Cloud Volumes Service on AWS

Cloud Manager eases the day-to-day requirements of operating your cloud storage environment including configuring, provisioning, and monitoring each of your active

Highlights

- Streamline the deployment of all your NetApp Cloud Volumes ONTAP environments
- Centrally manage your NetApp based storage and replicate across availability zones or to and from your data center
- Enable your IT administrators to audit and track your cloud storage resource spend

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.



Cloud Manager - Deploy & Manage NetApp Cloud Data Services

You are extended multiple offers! Select an offer first and review the pricing information and EULA.

Offer name: NetApp, Inc. for SaaS 2020-07-20- Private Offer - current subscription

You are subscribed to this offer.
By: NetApp, Inc.
This offer is going to expire on **August 1, 2022 UTC**

You are currently subscribed to this product and will be charged for your accumulated usage at the end of your next billing cycle, based on the costs listed in Pricing information on the right.

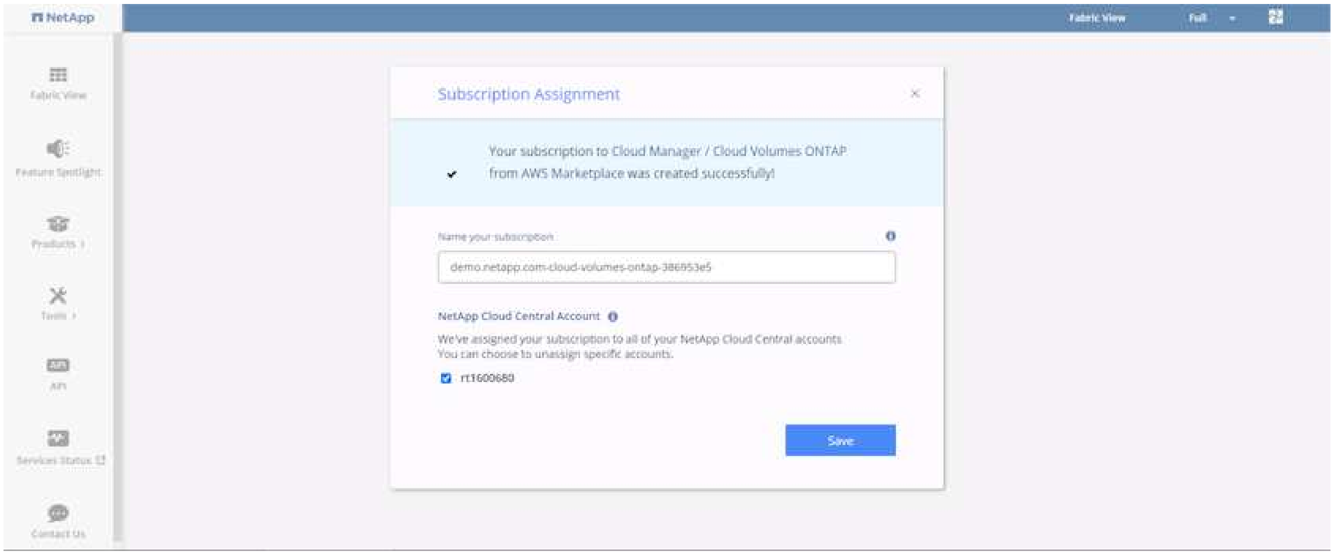
Having issues signing up for your product?
If you were unable to complete the set-up process for this software, please click here to be taken to the product's registration area.

You Have Subscribed to a Private Offer

You have subscribed to this private offer on **July 21, 2020 UTC**. This private offer will **expire on August 1, 2022 UTC**. Your use of this product after the expiration date of your private offer will be billed at the then current public pricing, which can be found on this product's detail page.

To avoid being charged for use beyond the expiration date of this offer, you can cancel your subscription to this product by August 1, 2022 UTC. Please contact the vendor directly with any questions regarding this offer.

7. You are redirected to Cloud Central where you must name your subscription and assign it to your Cloud Central account.



Subscription Assignment

✓ Your subscription to Cloud Manager / Cloud Volumes ONTAP from AWS Marketplace was created successfully!

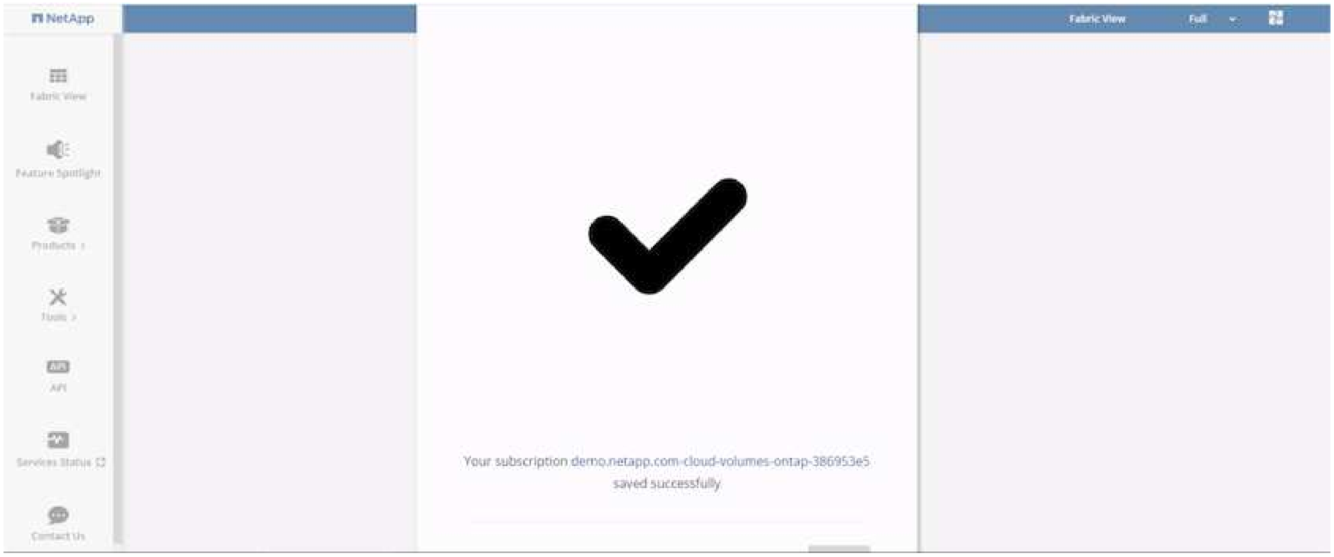
Name your subscription: demo.netapp.com-cloud-volumes-ontap-386953e5

NetApp Cloud Central Account

We've assigned your subscription to all of your NetApp Cloud Central accounts. You can choose to unassign specific accounts.

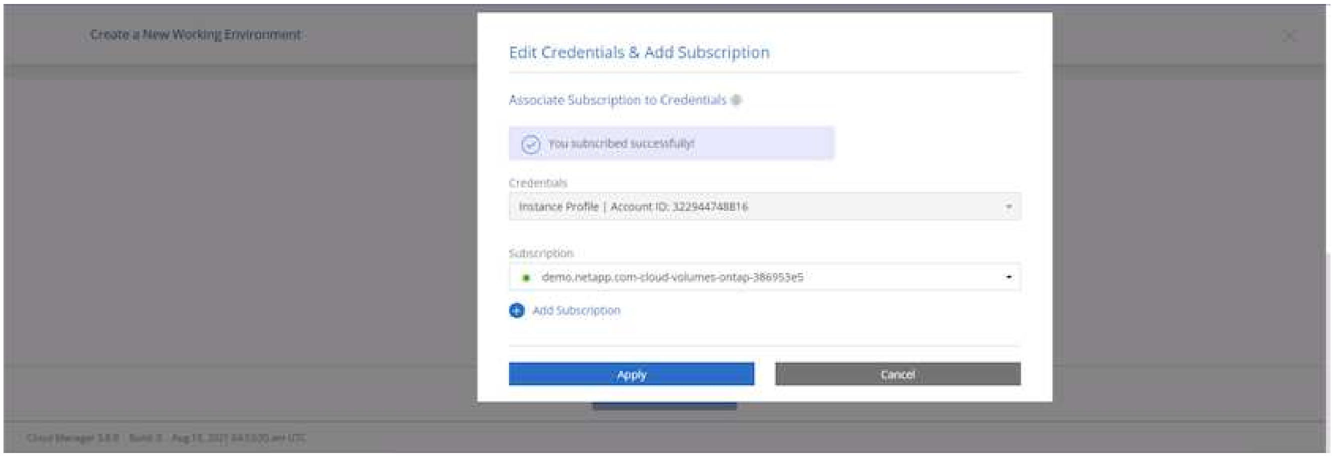
☑ rt1600680

8. When successful, a check mark page appears. Navigate back to your Cloud Manager tab.



Your subscription demo.netapp.com-cloud-volumes-ontap-386953e5 saved successfully

9. The subscription now appears in Cloud Central. Click Apply to continue.

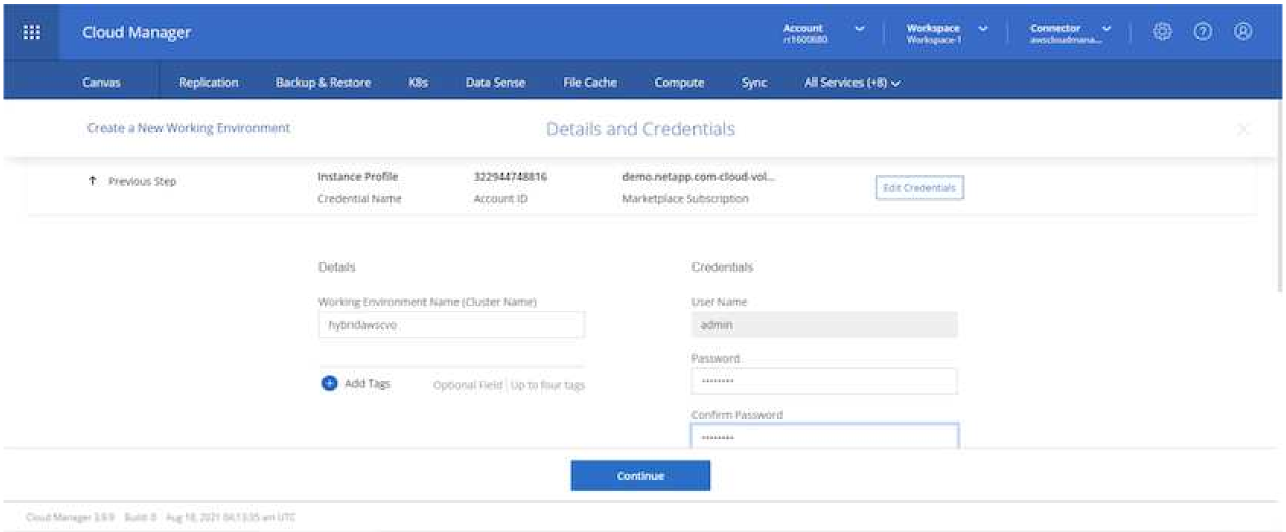

Create a New Working Environment
Edit Credentials & Add Subscription
Associate Subscription to Credentials
Add Subscription
Apply
Cancel

You subscribed successfully!

Credentials: Instance Profile | Account ID: 322944748816

Subscription: demo.netapp.com-cloud-volumes-ontap-386953e5

10. Enter the working environment details such as:
    a. Cluster name
    b. Cluster password
    c. AWS tags (Optional)



Instance Profile — Credential Name

322944748816 — Account ID

demo.netapp.com-cloud-vol... — Marketplace Subscription

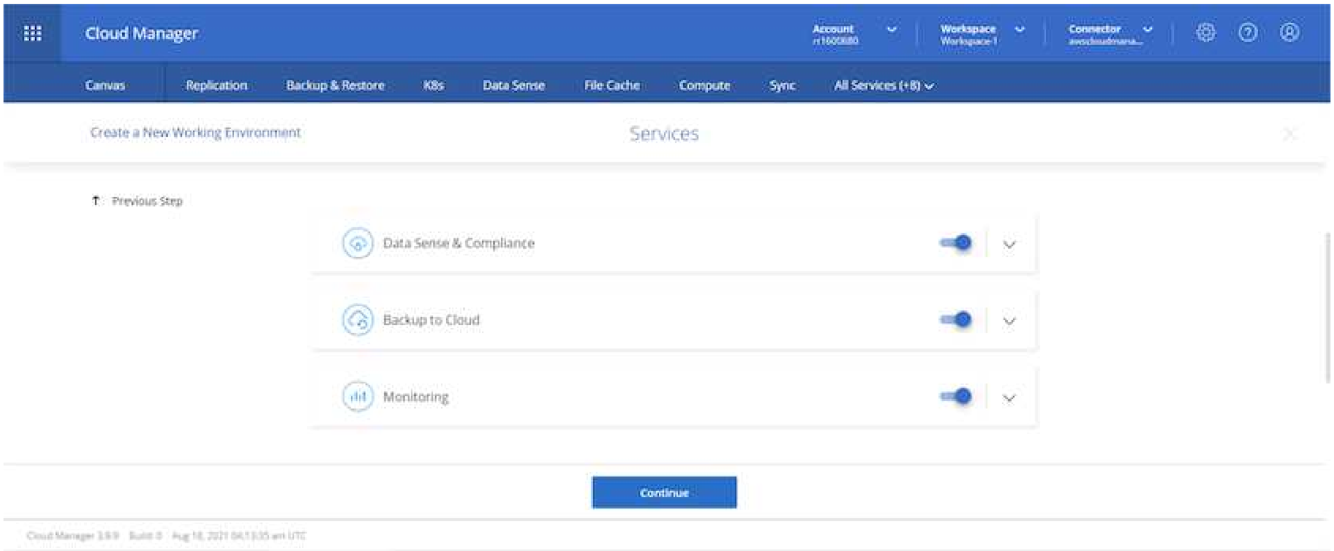
Working Environment Name (Cluster Name): hybridawscvo

User Name: admin

Password: ********

Confirm Password: ********

11. Choose which additional services you would like to deploy. To discover more about these services, visit the NetApp Cloud Homepage.

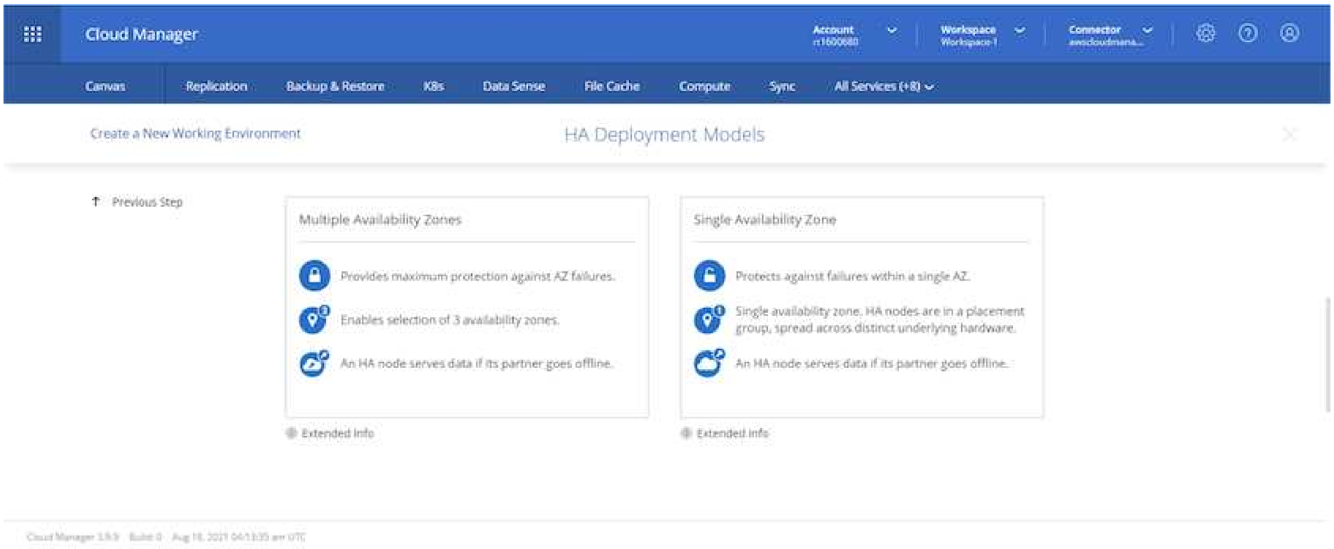


Data Sense & Compliance ●

Backup to Cloud ●

Monitoring ●

12. Choose whether to deploy in multiple availability zones (reguires three subnets, each in a different AZ), or a single availability zone. I chose multiple AZs.



HA Deployment Models

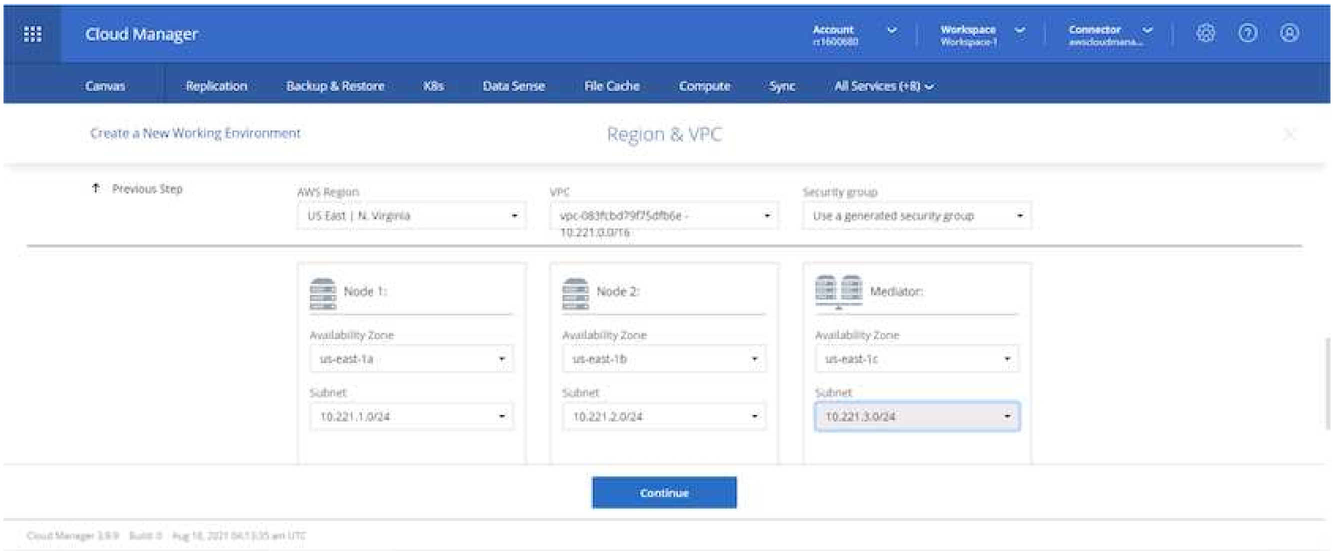
Multiple Availability Zones

- 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.

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.



Region & VPC

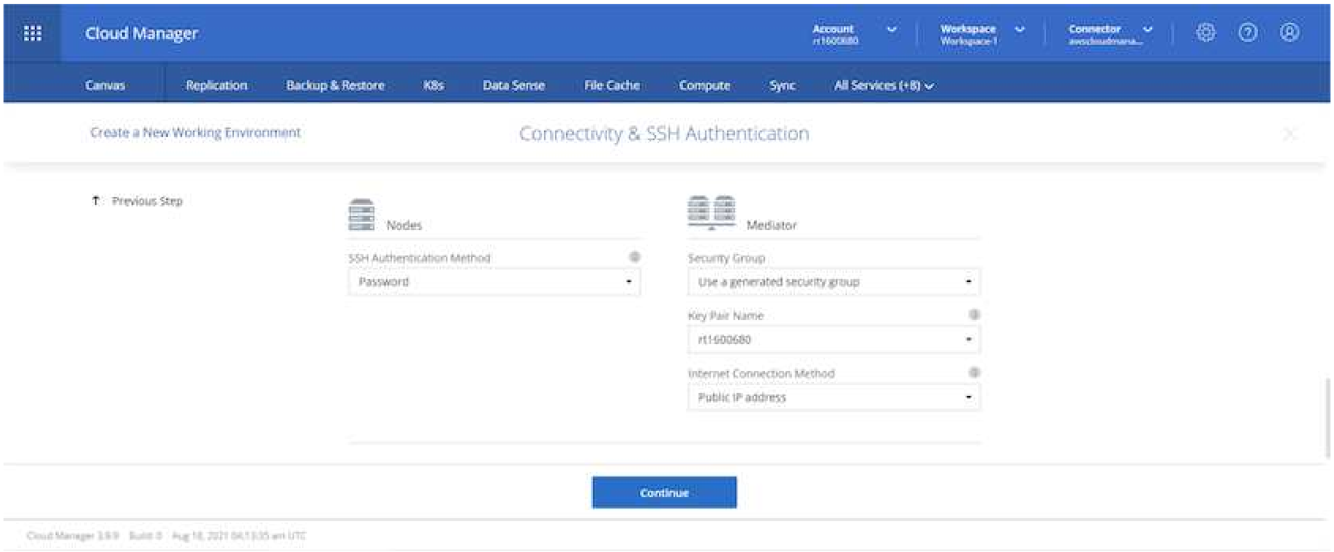
AWS Region: US East | N. Virginia
VPC: vpc-083fcbd79f75dfb6e - 10.221.0.0/16
Security group: Use a generated security group

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

14. Choose the connection methods for the nodes as well as the mediator.



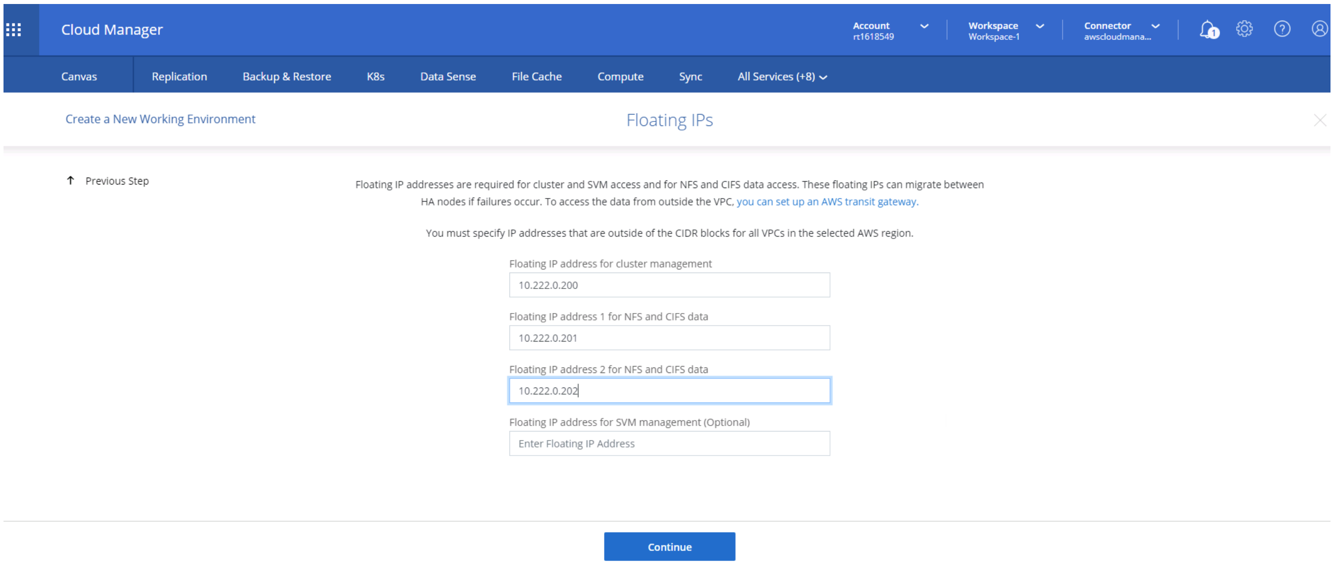
Connectivity & SSH Authentication

Nodes
SSH Authentication Method: Password

Mediator
Security Group: Use a generated security group
Key Pair Name: rt1600680
Internet Connection Method: Public IP address

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 Documenation.



Floating IPs

Floating IP addresses are required for cluster and SVM access and for NFS and CIFS data access. These floating IPs can migrate between HA nodes if failures occur. To access the data from outside the VPC, you can set up an AWS transit gateway.

You must specify IP addresses that are outside of the CIDR blocks for all VPCs in the selected AWS region.

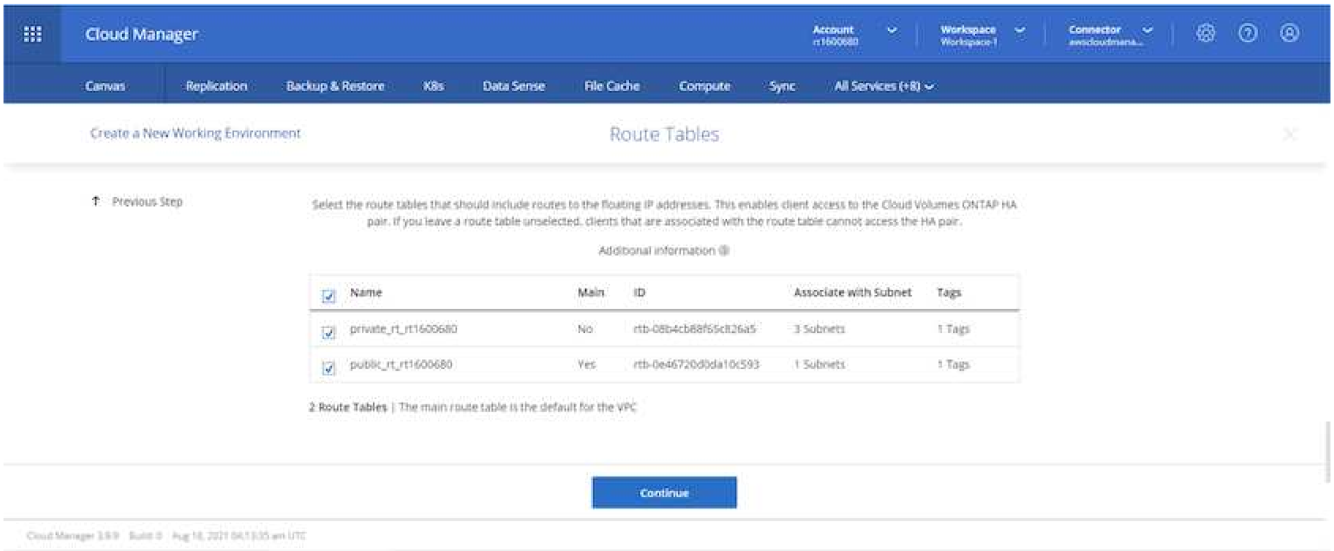
Floating IP address for cluster management: 10.222.0.200

Floating IP address 1 for NFS and CIFS data: 10.222.0.201

Floating IP address 2 for NFS and CIFS data: 10.222.0.202

Floating IP address for SVM management (Optional): Enter Floating IP Address

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.



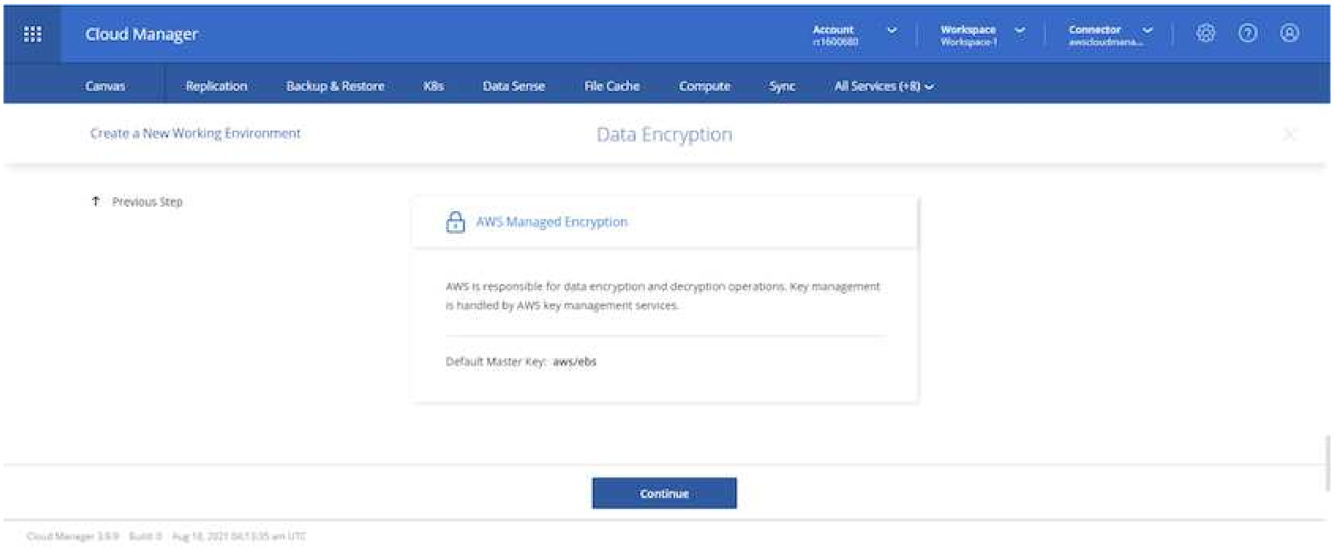
Route Tables

Select the route tables that should include routes to the floating IP addresses. This enables client access to the Cloud Volumes ONTAP HA pair. If you leave a route table unselected, clients that are associated with the route table cannot access the HA pair.

☑	Name	Main	ID	Associate with Subnet	Tags
☑	private_rt_rt1600680	No	rtb-08b4cb88f55c826a5	3 Subnets	1 Tags
☑	public_rt_rt1600680	Yes	rtb-0e46720d0da10c593	1 Subnets	1 Tags

2 Route Tables | The main route table is the default for the VPC

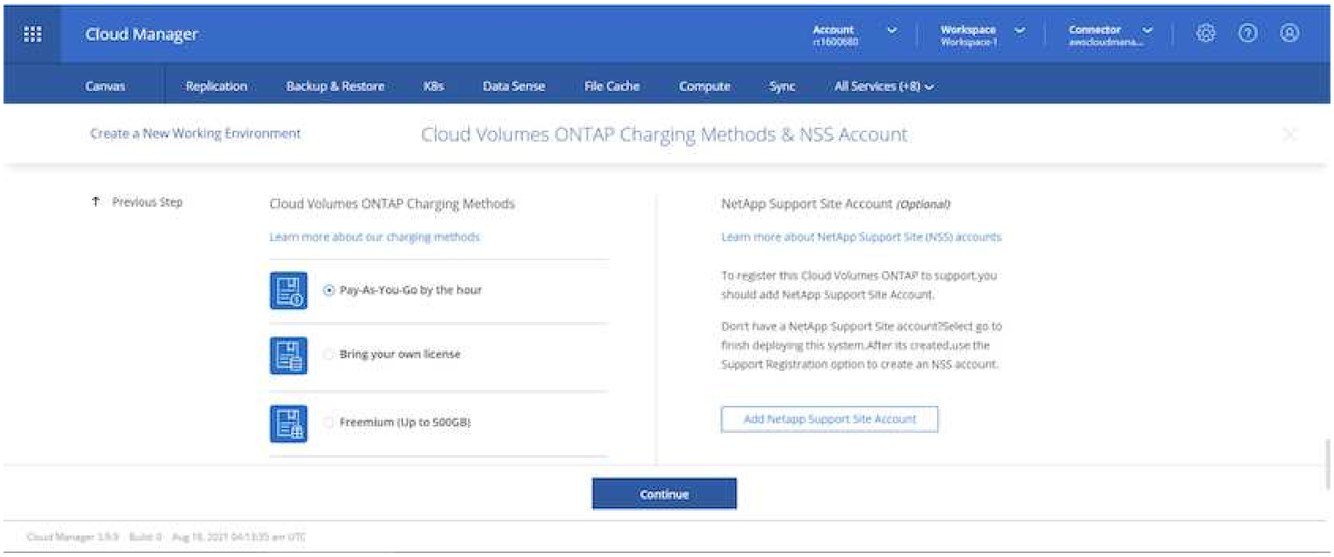
3. Choose whether to enable AWS managed encryption or AWS KMS to encrypt the ONTAP root, boot, and data disks.



AWS is responsible for data encryption and decryption operations. Key management is handled by AWS key management services.

Default Master Key: aws/ebs

4. Choose your licensing model. If you don’t know which to choose, contact your NetApp representative.


Cloud Manager
Account
Workspace
Workspace-1
Connector
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
Previous Step
Cloud Volumes ONTAP Charging Methods
Learn more about our charging methods
NetApp Support Site Account (Optional)
Learn more about NetApp Support Site (NSS) accounts
Add Netapp Support Site Account
Continue
Cloud Manager 3.9.9 Build 0 Aug 18, 2021 04:13:35 am UTC

● Pay-As-You-Go by the hour

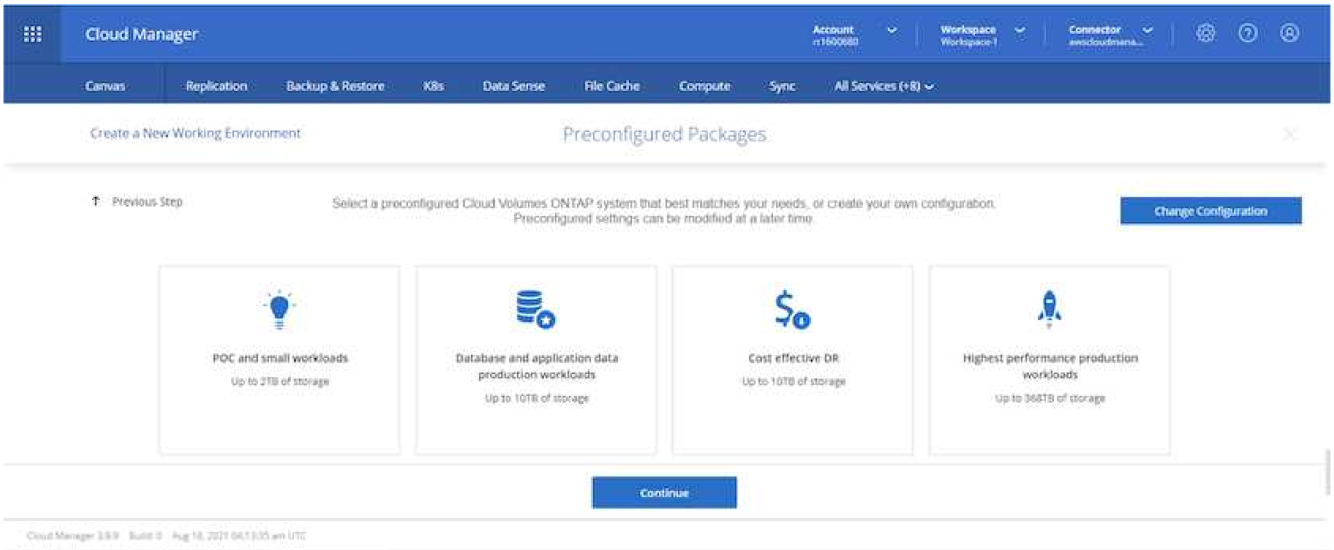
○ Bring your own license

○ Freemium (Up to 500GB)

To register this Cloud Volumes ONTAP to support,you should add NetApp Support Site Account.

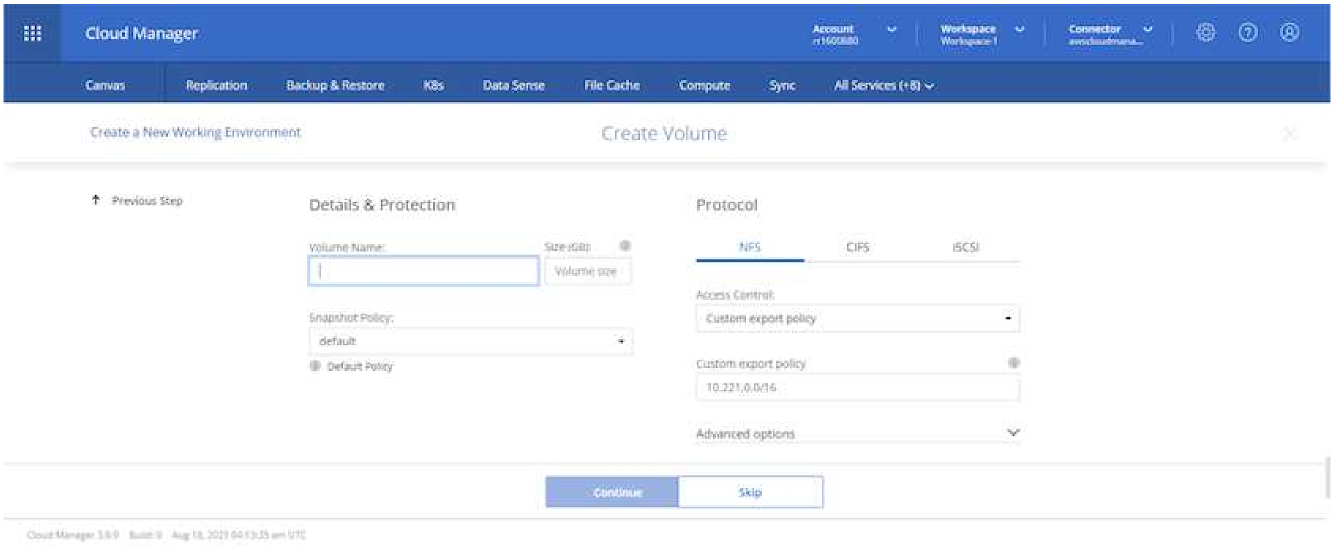
Don't have a NetApp Support Site account?Select go to finish deploying this system.After its created,use the Support Registration option to create an NSS account.

5. Select which configuration best suits your use case. This is related to the sizing considerations covered in the prerequisites page.



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.

6. Optionally, create a volume. This is not required, because the next steps use SnapMirror, which creates the volumes for us.



Create Volume

Details & Protection

Volume Name:

Size (GB): Volume size

Snapshot Policy: default

Default Policy

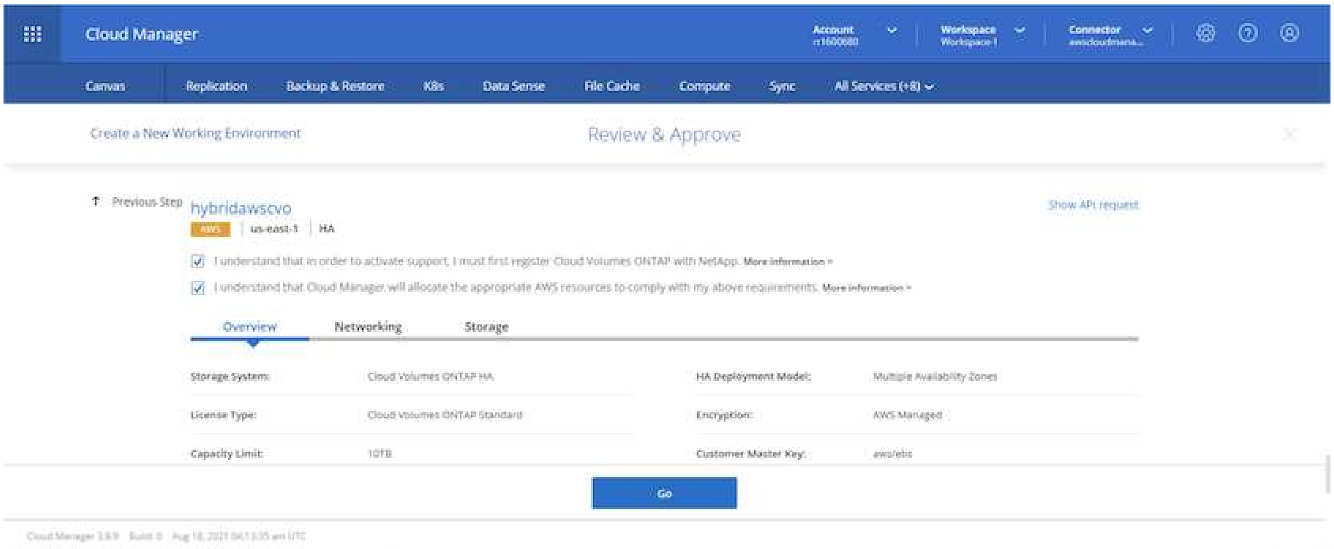
Protocol

Access Control: Custom export policy

Custom export policy: 10.221.0.0/16

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.



Review & Approve

hybridawscvo

AWS | us-east-1 | HA

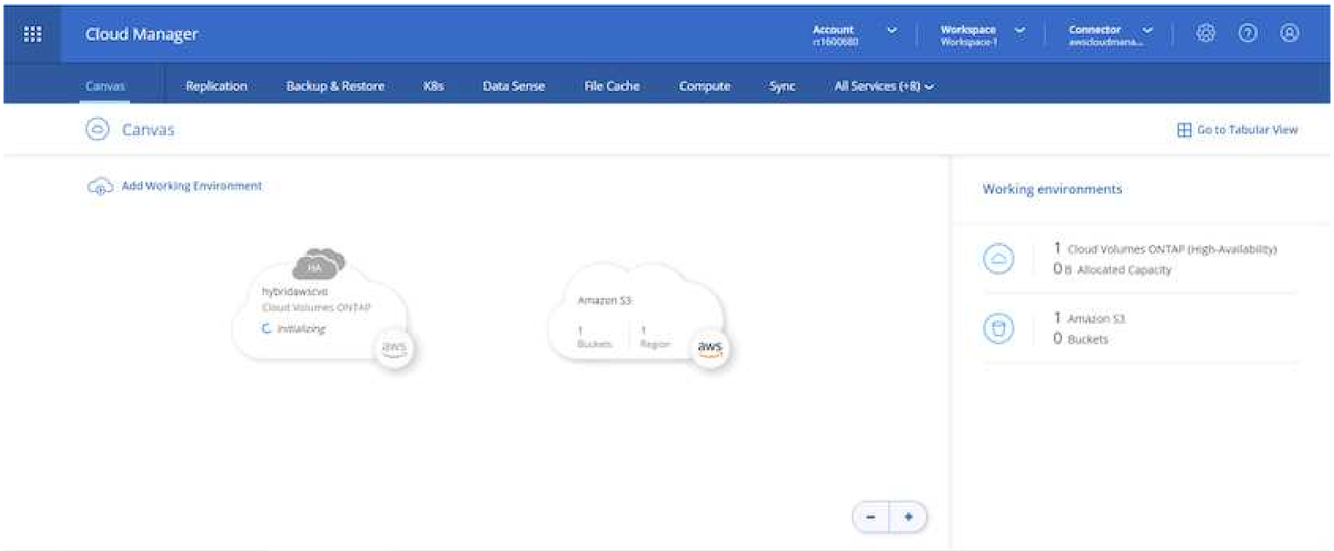
☑ I understand that in order to activate support, I must first register Cloud Volumes ONTAP with NetApp. More information »

☑ I understand that Cloud Manager will allocate the appropriate AWS resources to comply with my above requirements. More information »

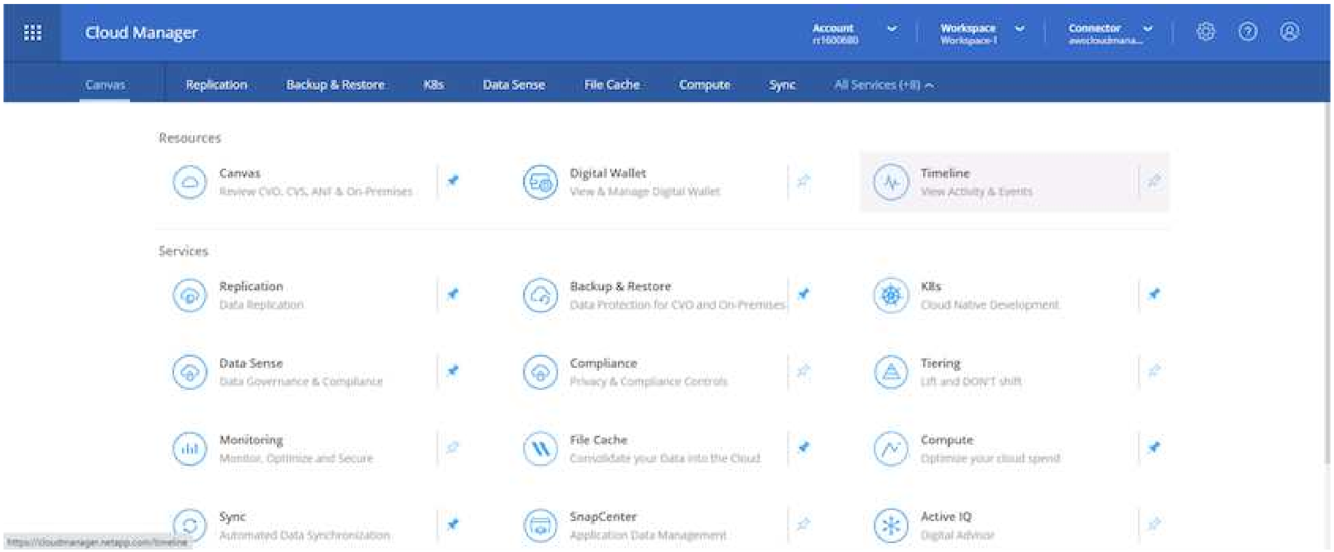
Storage System:	Cloud Volumes ONTAP HA	HA Deployment Model:	Multiple Availability Zones
License Type:	Cloud Volumes ONTAP Standard	Encryption:	AWS Managed
Capacity Limit:	10TB	Customer Master Key:	aws/ebs

Cloud Manager 3.9.9 Build: 0 Aug 18, 2021 04:13:35 am UTC

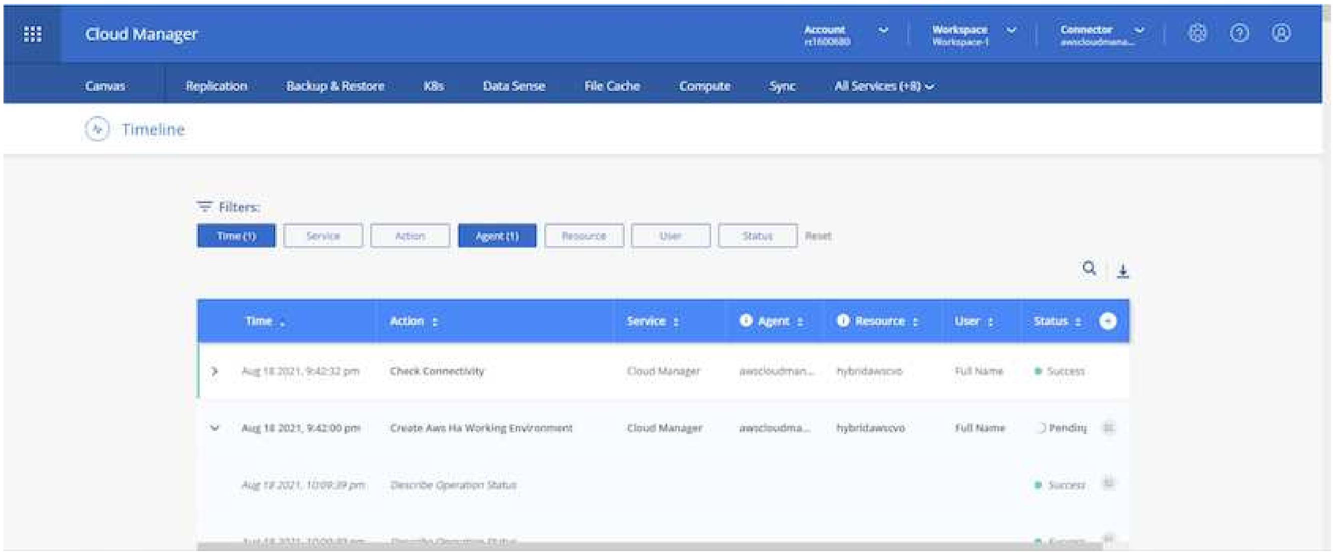
8. Cloud Volumes ONTAP now starts its deployment process. Cloud Manager uses AWS APIs and cloud formation stacks to deploy Cloud Volumes ONTAP. It then configures the system to your specifications, giving you a ready-to-go system that can be instantly utilized. The timing for this process varies depending on the selections made.



9. You can monitor the progress by navigating to the Timeline.

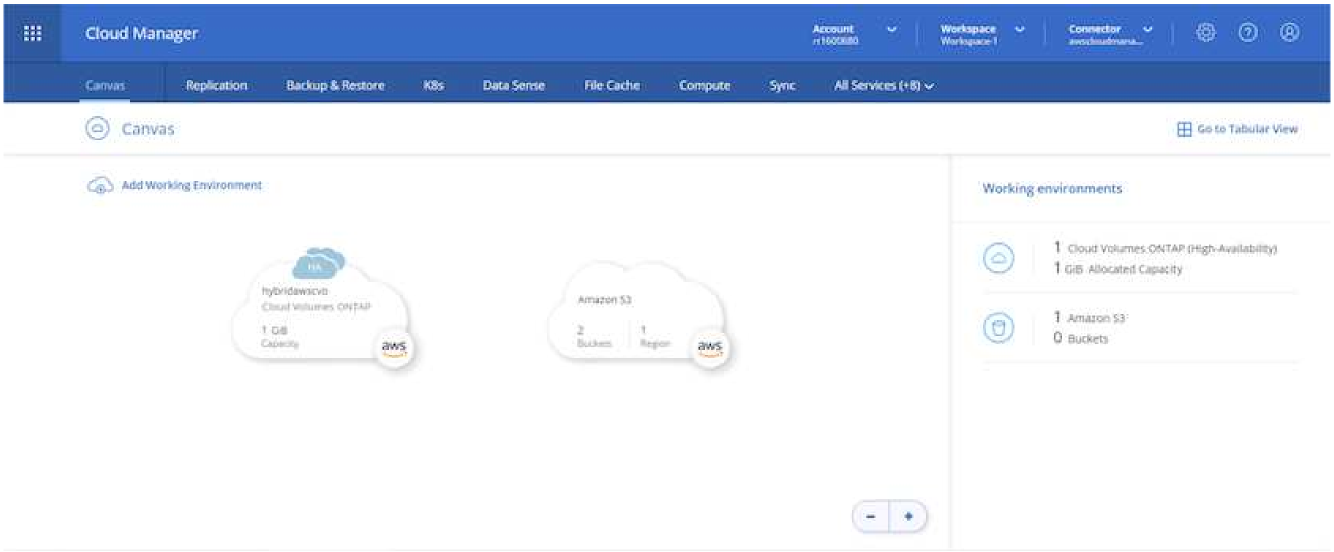


10. The Timeline acts as an audit of all actions performed in Cloud Manager. You can view all of the API calls that are made by Cloud Manager during setup to both AWS as well as the ONTAP cluster. This can also be effectively used to troubleshoot any issues that you face.



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

11. 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.

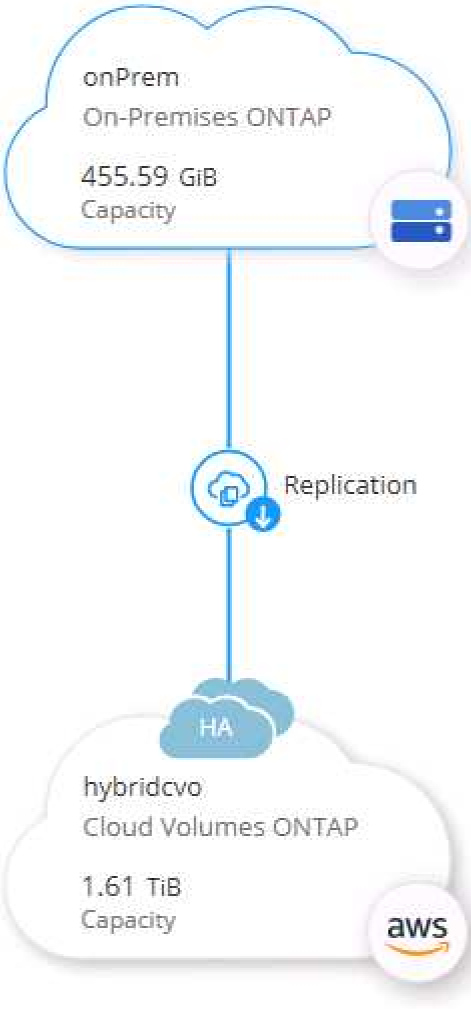


Configure SnapMirror from on-premises to cloud

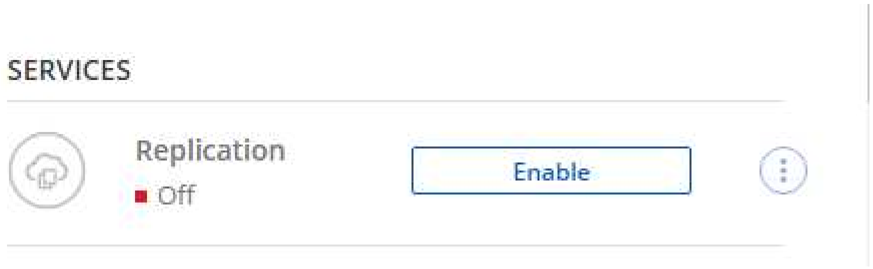
Now that you have a source ONTAP system and a destination ONTAP system deployed, you can replicate volumes containing database data into the cloud.

For a guide on compatible ONTAP versions for SnapMirror, see the SnapMirror Compatibility Matrix.

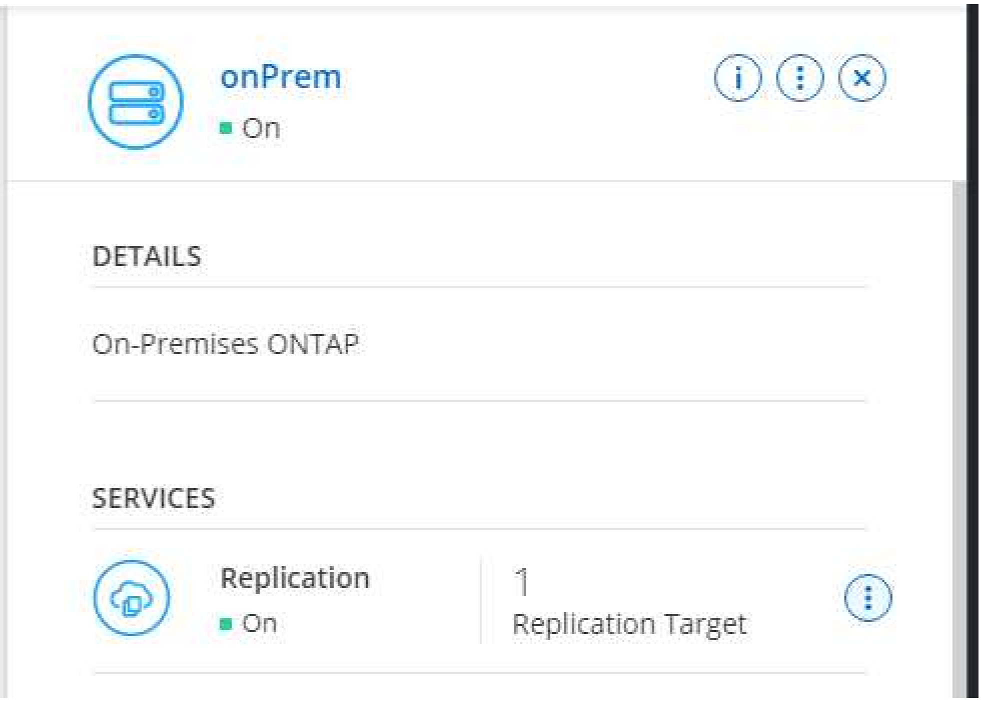
1. Click the source ONTAP system (on-premises) and either drag and drop it to the destination, select Replication > Enable, or select Replication > Menu > Replicate.



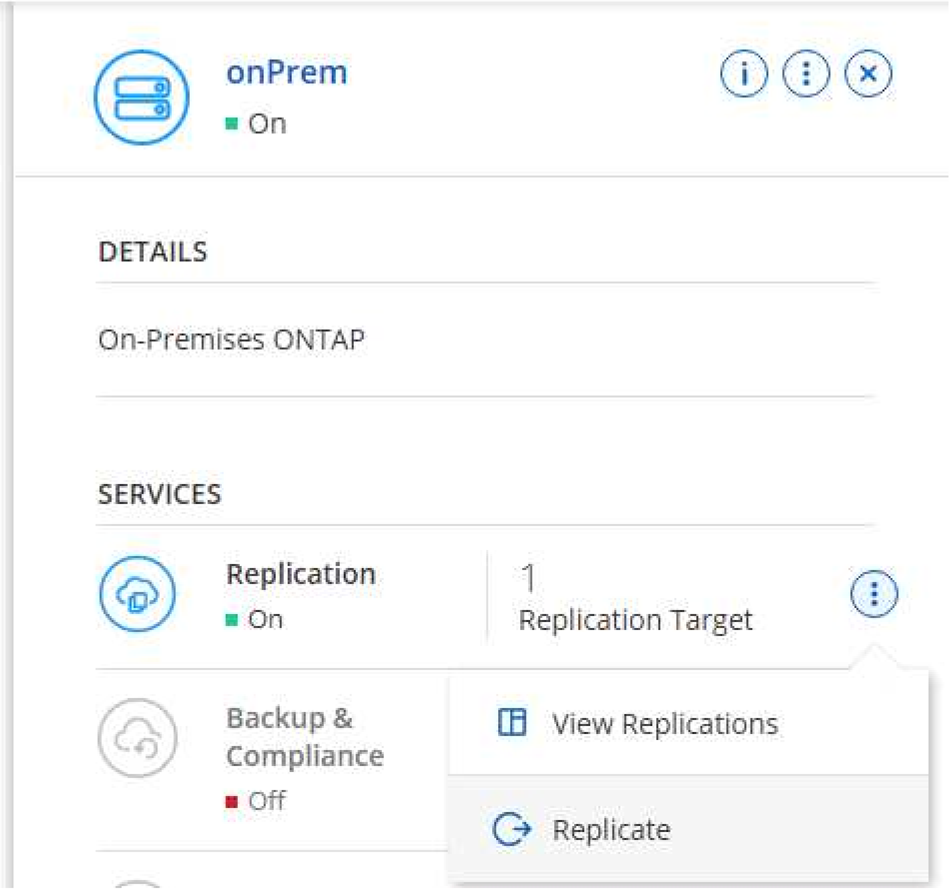
Select Enable.



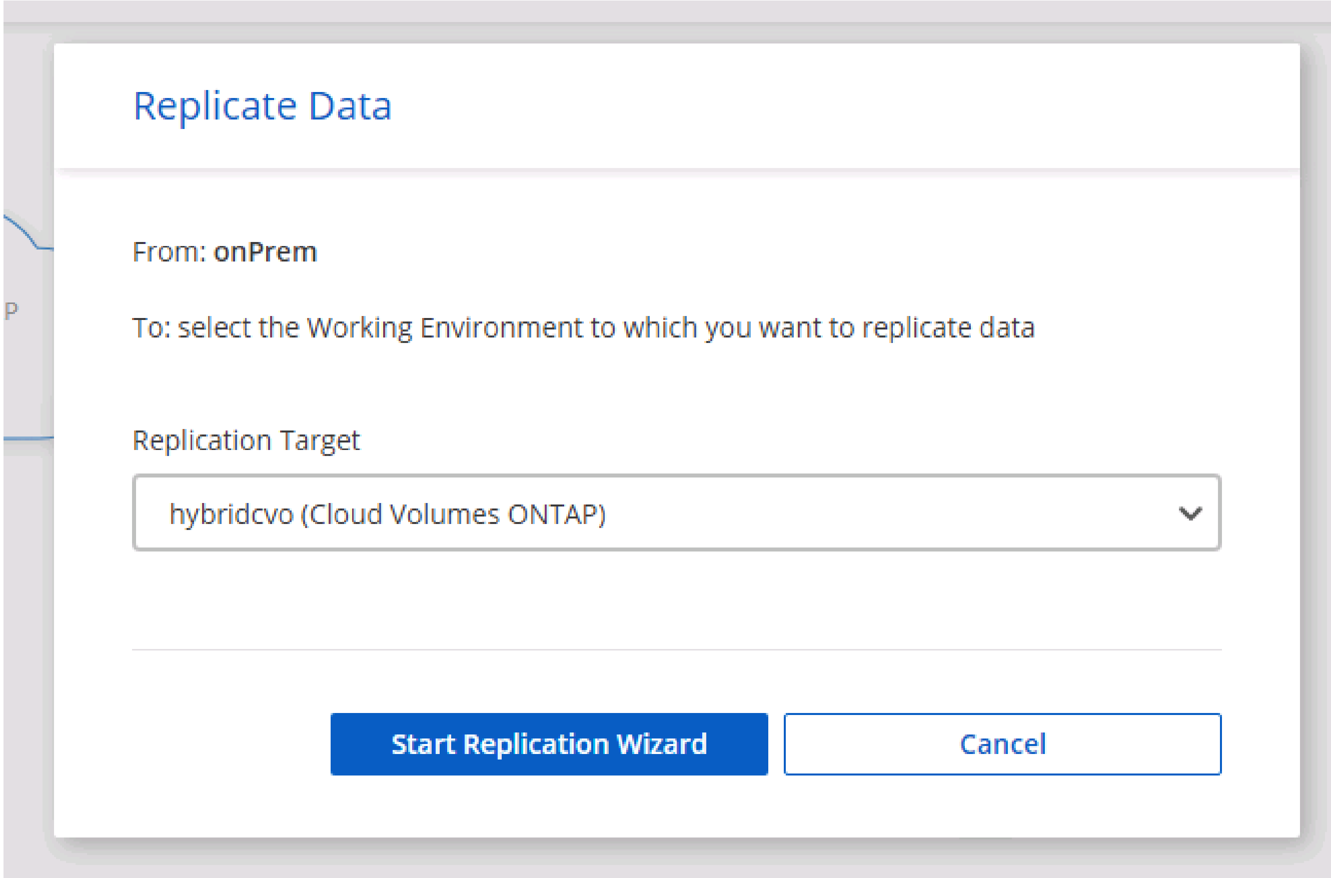
Or Options.



Replicate.



2. If you did not drag and drop, choose the destination cluster to replicate to.



Replicate Data

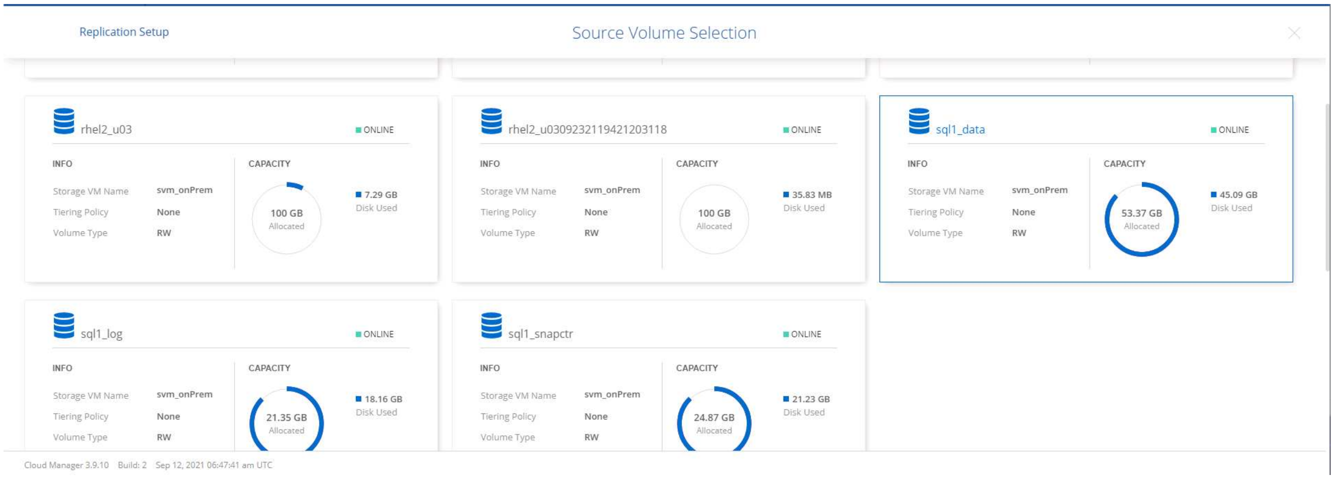
From: onPrem

To: select the Working Environment to which you want to replicate data

Replication Target

hybridcvo (Cloud Volumes ONTAP)

3. Choose the volume that you’d like to replicate. We replicated the data and all log volumes.



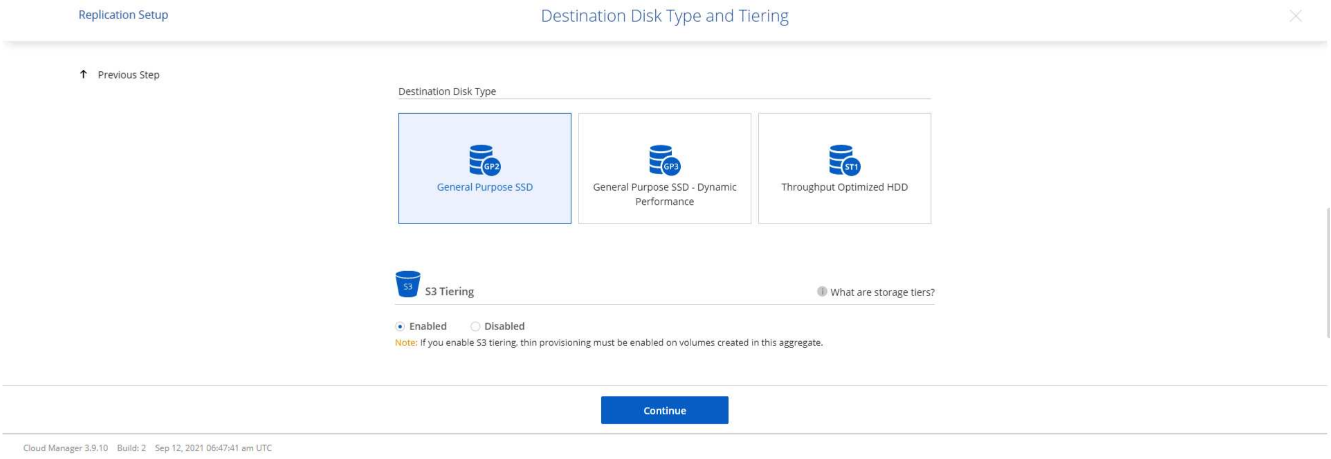
Replication Setup

Source Volume Selection

Volume	Status	Storage VM Name	Tiering Policy	Volume Type	Allocated	Disk Used
rhel2_u03	ONLINE	svm_onPrem	None	RW	100 GB	7.29 GB
rhel2_u0309232119421203118	ONLINE	svm_onPrem	None	RW	100 GB	35.83 MB
sql1_data	ONLINE	svm_onPrem	None	RW	53.37 GB	45.09 GB
sql1_log	ONLINE	svm_onPrem	None	RW	21.35 GB	18.16 GB
sql1_snapctr	ONLINE	svm_onPrem	None	RW	24.87 GB	21.23 GB

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.


Replication Setup
Destination Disk Type and Tiering
↑ Previous Step

Destination Disk Type

GP2
General Purpose SSD
GP3
General Purpose SSD - Dynamic Performance
ST1
Throughput Optimized HDD
S3

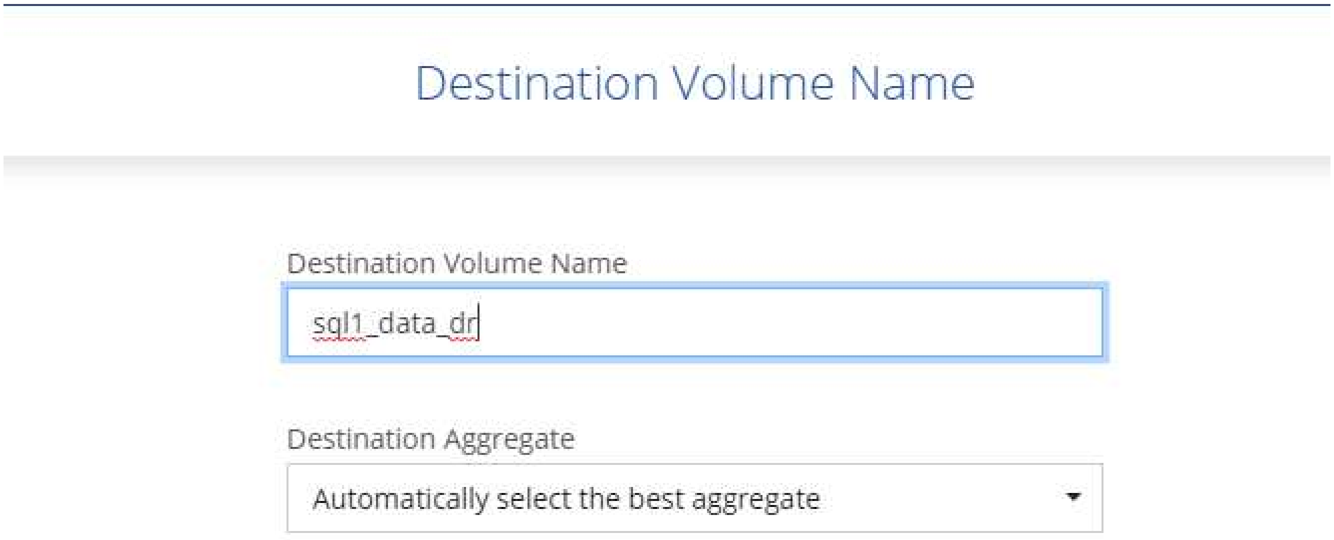
S3 Tiering

● Enabled ○ Disabled

Note: 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

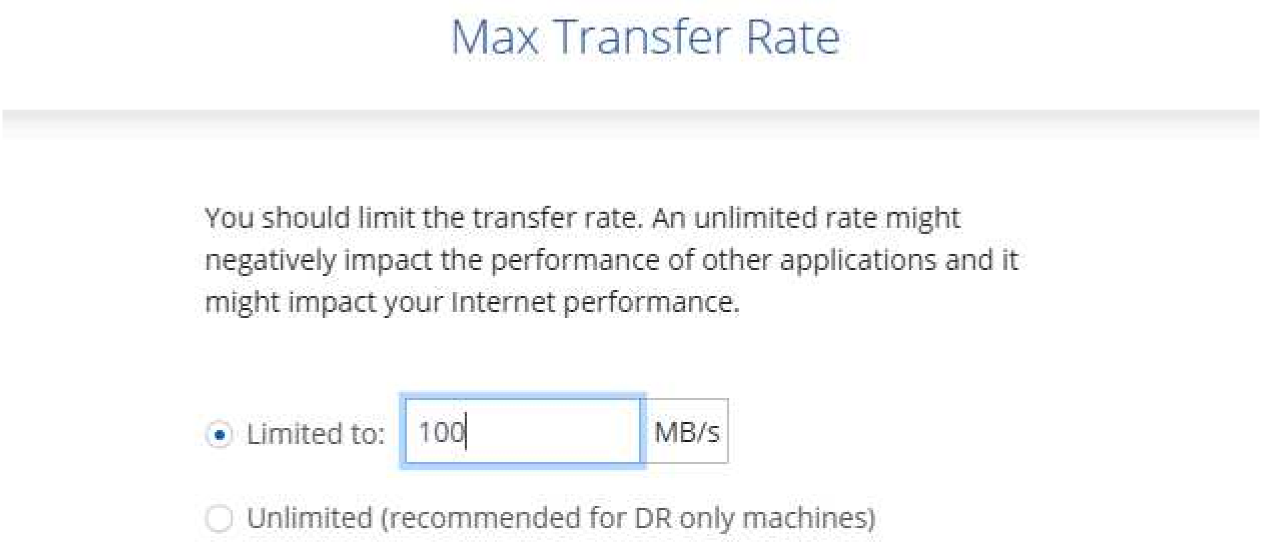
5. Select the destination volume name: we chose `[source_volume_name]_dr`.



Destination Volume Name: 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.



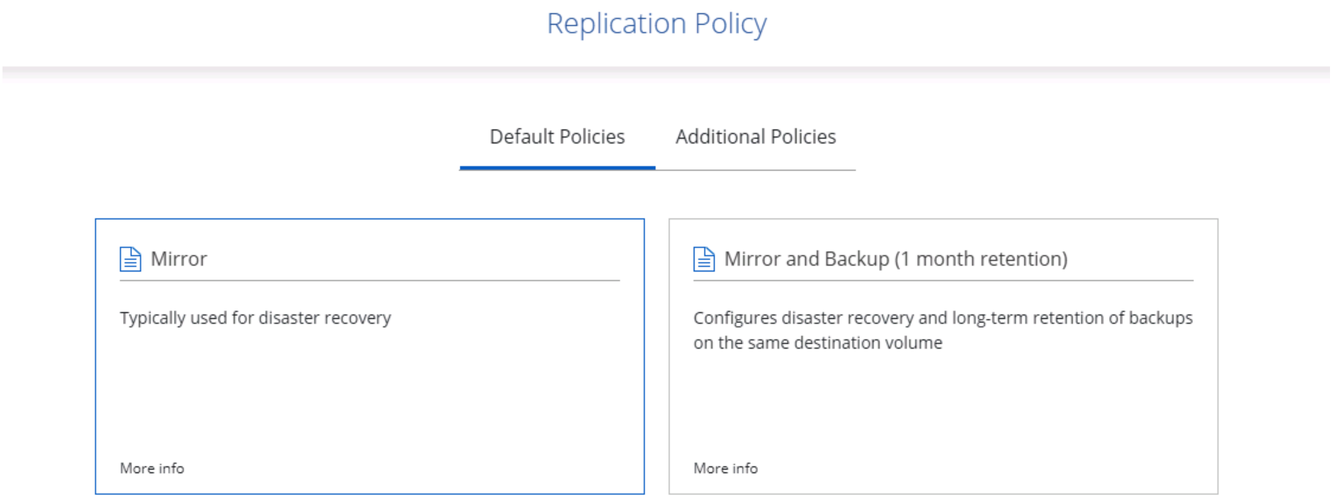
Max Transfer Rate

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

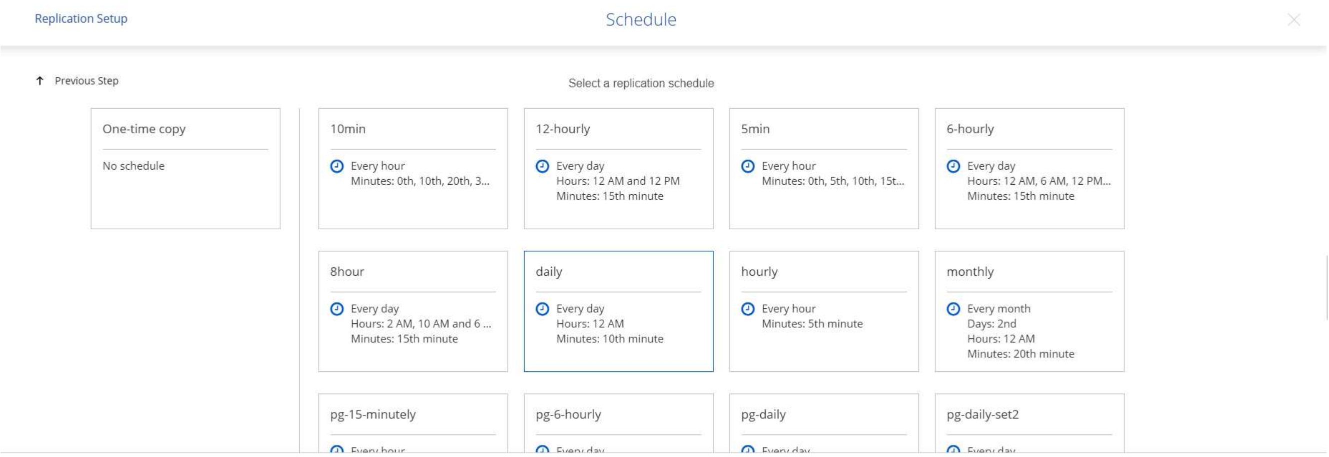
Mirror

Typically used for disaster recovery

Mirror and Backup (1 month retention)

Configures disaster recovery and long-term retention of backups on the same destination volume

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.



Select a replication schedule

One-time copy
No schedule

10min
Every hour
Minutes: 0th, 10th, 20th, 3...

12-hourly
Every day
Hours: 12 AM and 12 PM
Minutes: 15th minute

5min
Every hour
Minutes: 0th, 5th, 10th, 15t...

6-hourly
Every day
Hours: 12 AM, 6 AM, 12 PM...
Minutes: 15th minute

8hour
Every day
Hours: 2 AM, 10 AM and 6 ...
Minutes: 15th minute

daily
Every day
Hours: 12 AM
Minutes: 10th minute

hourly
Every hour
Minutes: 5th minute

monthly
Every month
Days: 2nd
Hours: 12 AM
Minutes: 20th minute

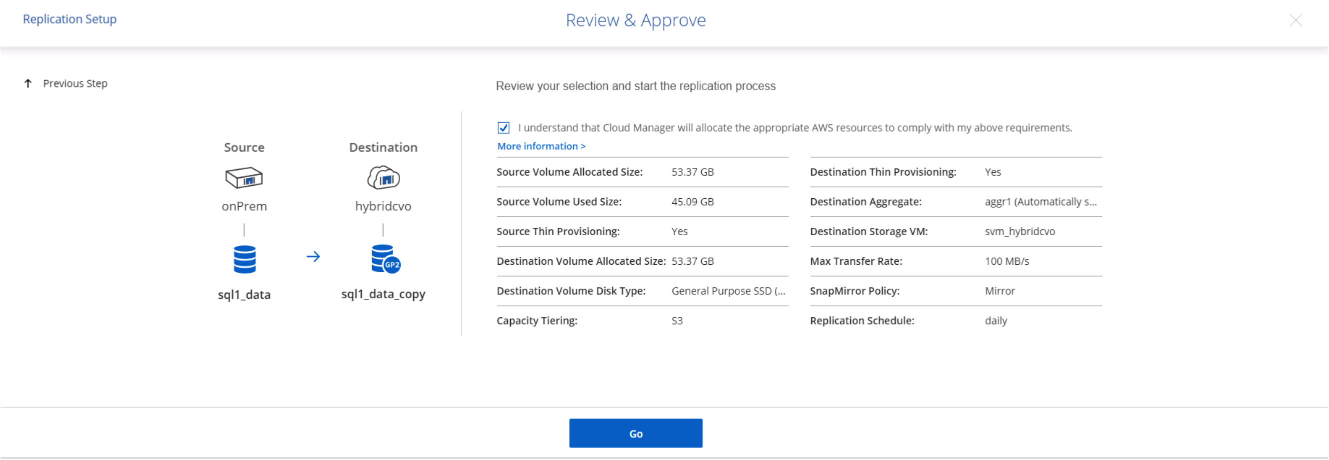
pg-15-minutely

pg-6-hourly

pg-daily

pg-daily-set2

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.



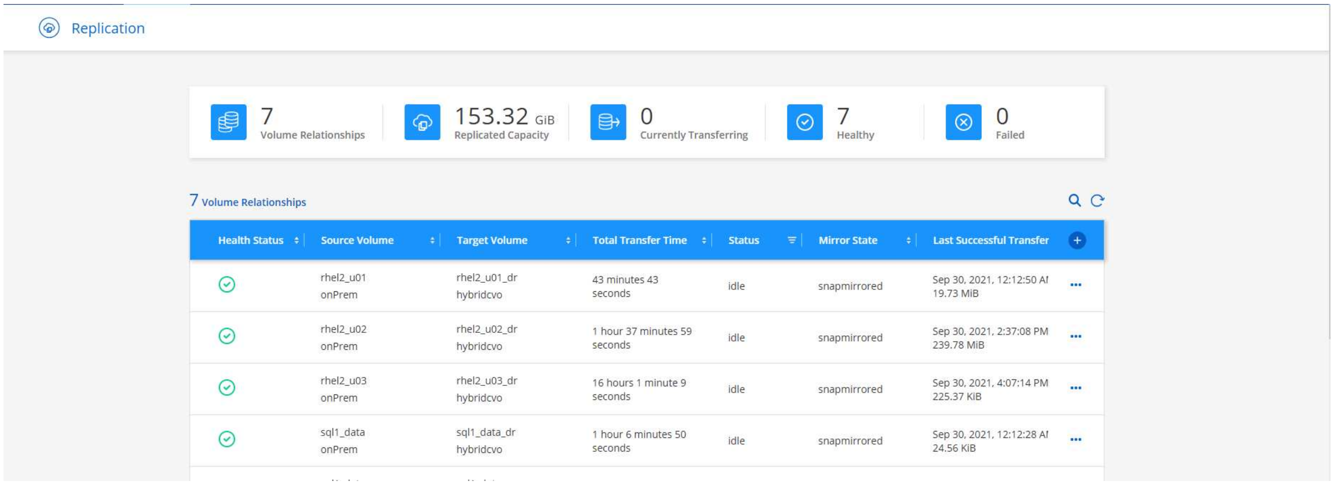
Review your selection and start the replication process

☑ I understand that Cloud Manager will allocate the appropriate AWS resources to comply with my above requirements.
More information >

Source Volume Allocated Size:	53.37 GB	Destination Thin Provisioning:	Yes
Source Volume Used Size:	45.09 GB	Destination Aggregate:	aggr1 (Automatically s...
Source Thin Provisioning:	Yes	Destination Storage VM:	svm_hybridcvo
Destination Volume Allocated Size:	53.37 GB	Max Transfer Rate:	100 MB/s
Destination Volume Disk Type:	General Purpose SSD (...	SnapMirror Policy:	Mirror
Capacity Tiering:	S3	Replication Schedule:	daily

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 AI 19.73 MiB
✓	rhel2_u02 onPrem	rhel2_u02_dr hybridcvo	1 hour 37 minutes 59 seconds	idle	snapmirrored	Sep 30, 2021, 2:37:08 PM 239.78 MiB
✓	rhel2_u03 onPrem	rhel2_u03_dr hybridcvo	16 hours 1 minute 9 seconds	idle	snapmirrored	Sep 30, 2021, 4:07:14 PM 225.37 KiB
✓	sql1_data onPrem	sql1_data_dr hybridcvo	1 hour 6 minutes 50 seconds	idle	snapmirrored	Sep 30, 2021, 12:12:28 AI 24.56 KiB

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.

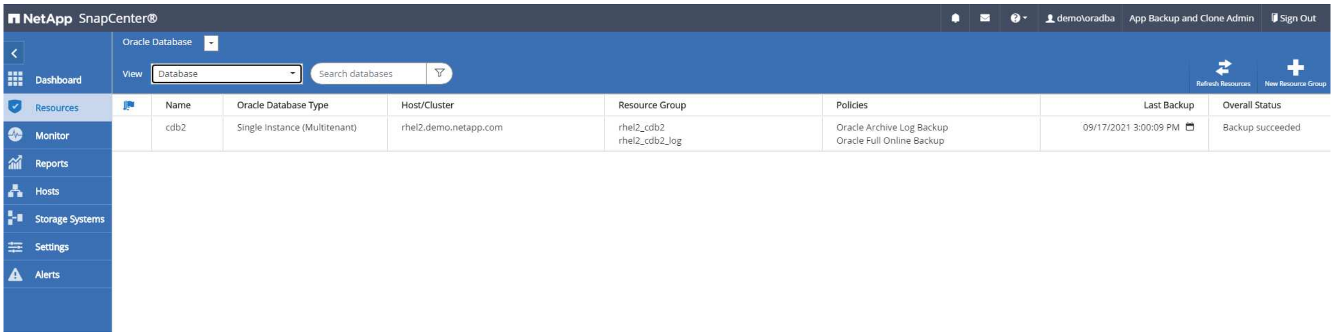
1. Retrieve the Windows administrator password to log in to an instance via RDP.
2. Disable the Windows firewall, join the host to Windows SnapCenter domain, and add the instance to the DNS server for name resolution.
3. Provision a SnapCenter log volume to store SQL Server log files.
4. Configure iSCSI 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.

Workflow for dev/test bursting to 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 it 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.

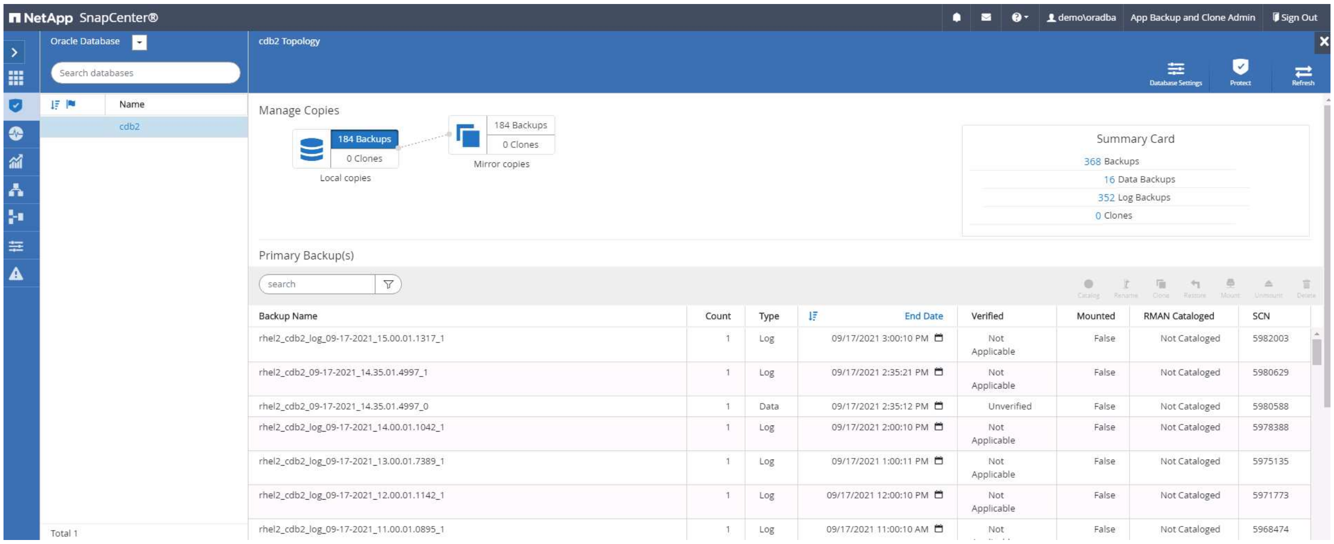
Clone an Oracle Database for dev/test from a replicated snapshot backup

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.



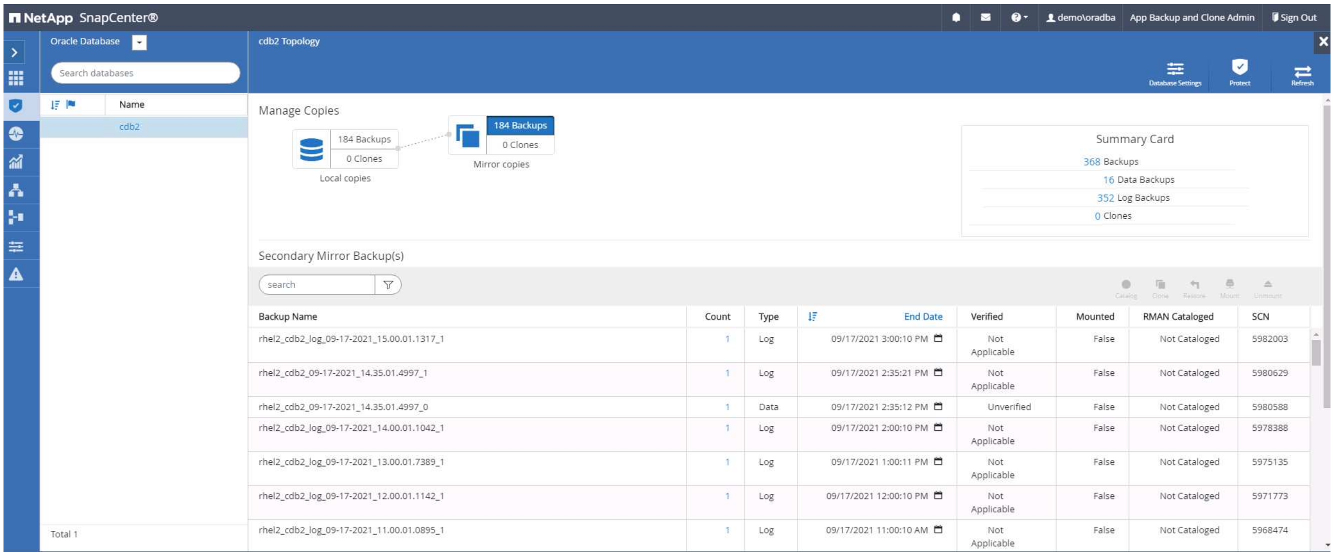
Name	Oracle Database Type	Host/Cluster	Resource Group	Policies	Last Backup	Overall Status
cdb2	Single Instance (Multitenant)	rhel2.demo.netapp.com	rhel2_cdb2 rhel2_cdb2_log	Oracle Archive Log Backup Oracle Full Online Backup	09/17/2021 3:00:09 PM	Backup succeeded

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.



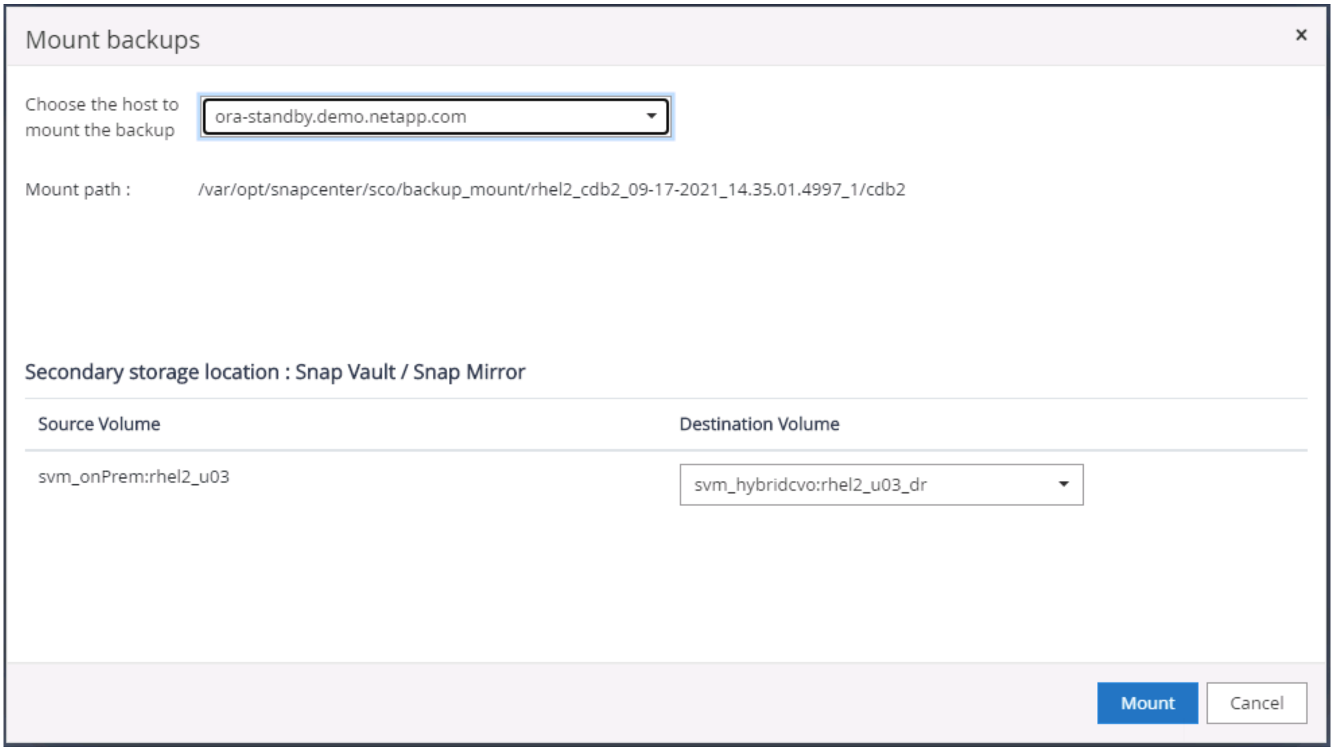
Backup Name	Count	Type	End Date	Verified	Mounted	RMAN Cataloged	SCN
rhel2_cdb2_log_09-17-2021_15.00.01.1317_1	1	Log	09/17/2021 3:00:10 PM	Not Applicable	False	Not Cataloged	5982003
rhel2_cdb2_09-17-2021_14.35.01.4997_1	1	Log	09/17/2021 2:35:21 PM	Not Applicable	False	Not Cataloged	5980629
rhel2_cdb2_09-17-2021_14.35.01.4997_0	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.



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	5982003
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

4. 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.

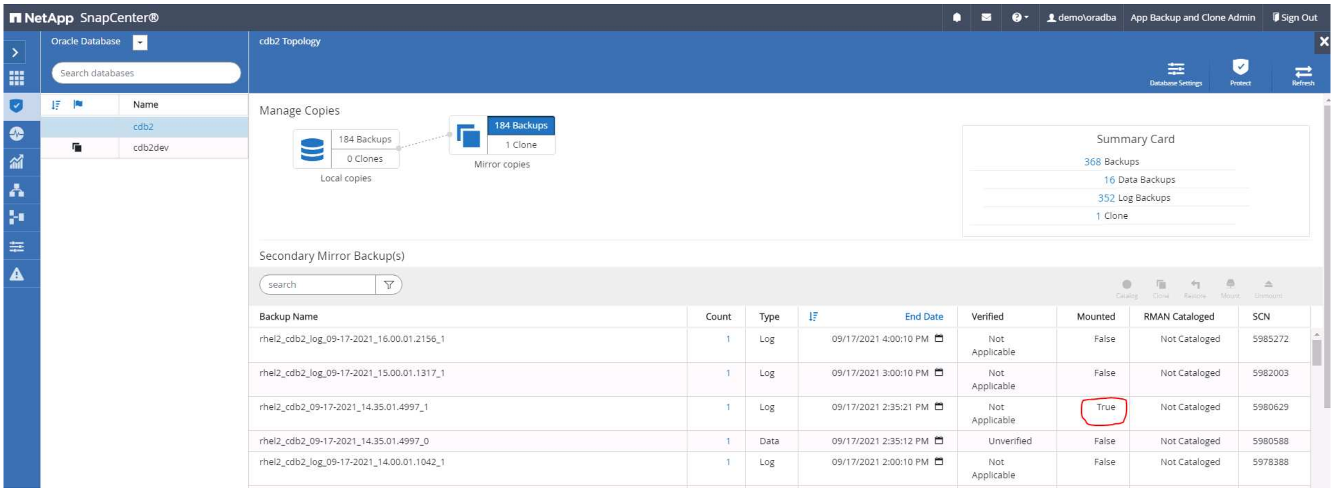


Choose the host to mount the backup: ora-standby.demo.netapp.com

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

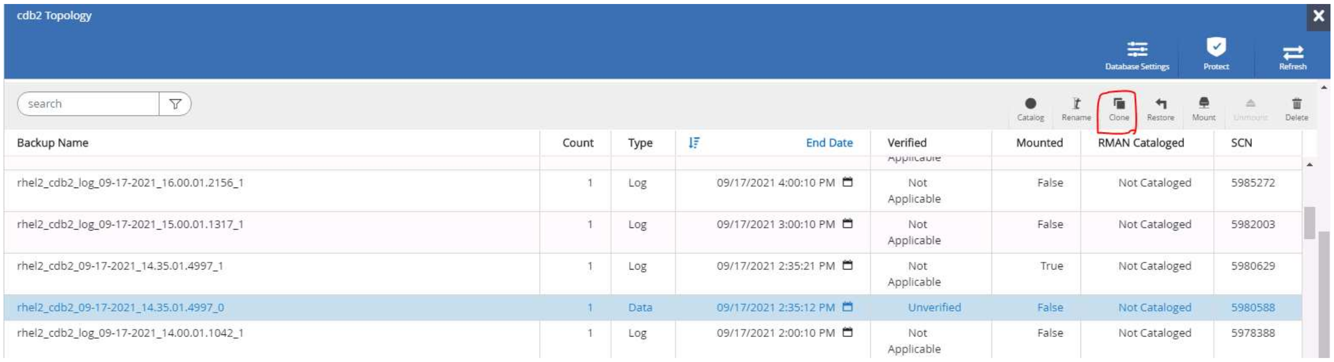
Source Volume	Destination Volume
svm_onPrem:rhel2_u03	svm_hybridcvo:rhel2_u03_dr



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

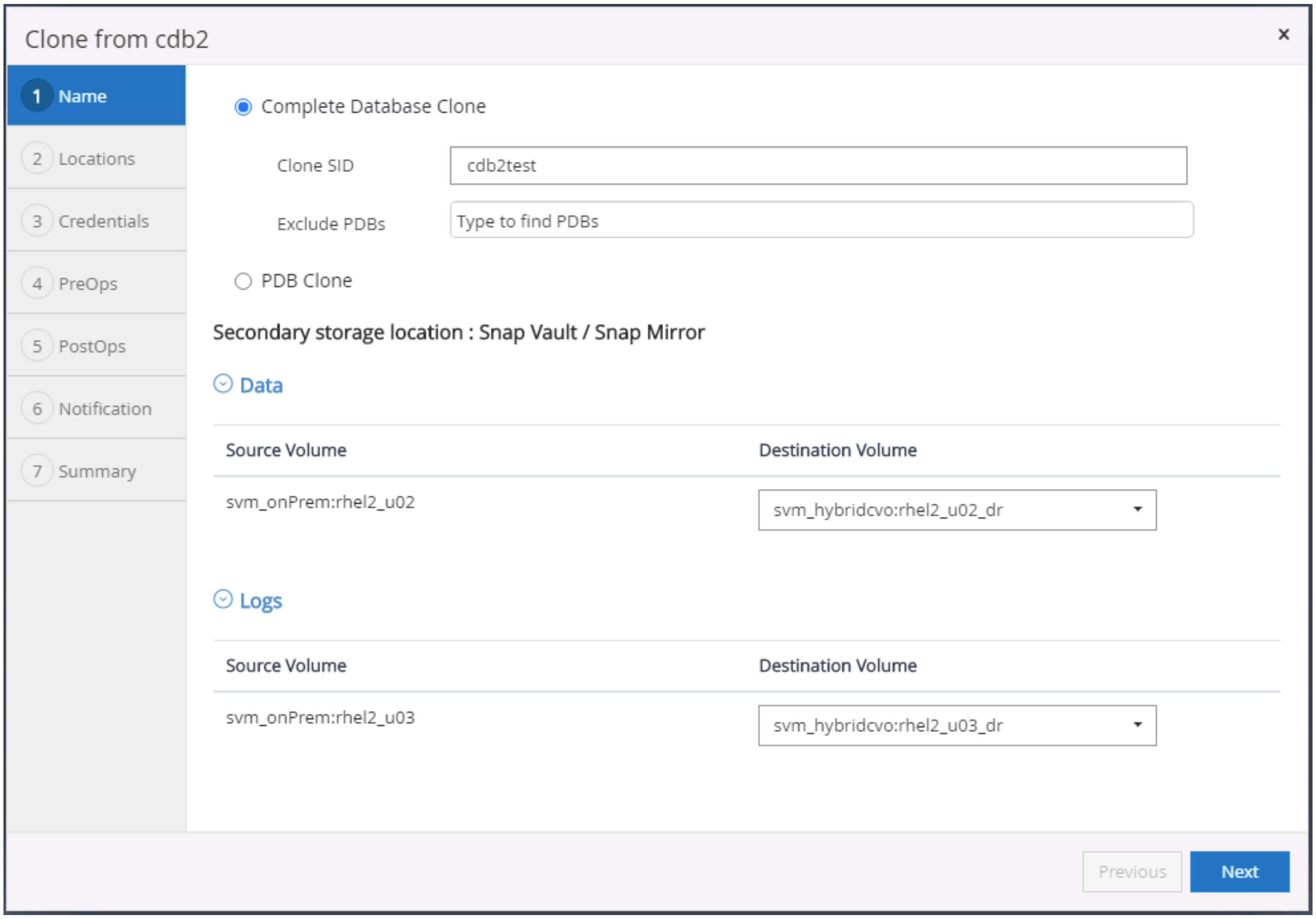
If log pruning is enabled and the recovery point is extended beyond the last log pruning, multiple archive log backups might need to be mounted.

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.



● Complete Database Clone

Clone SID: cdb2test

Exclude PDBs: Type to find PDBs

○ PDB Clone

Secondary storage location : Snap Vault / Snap Mirror

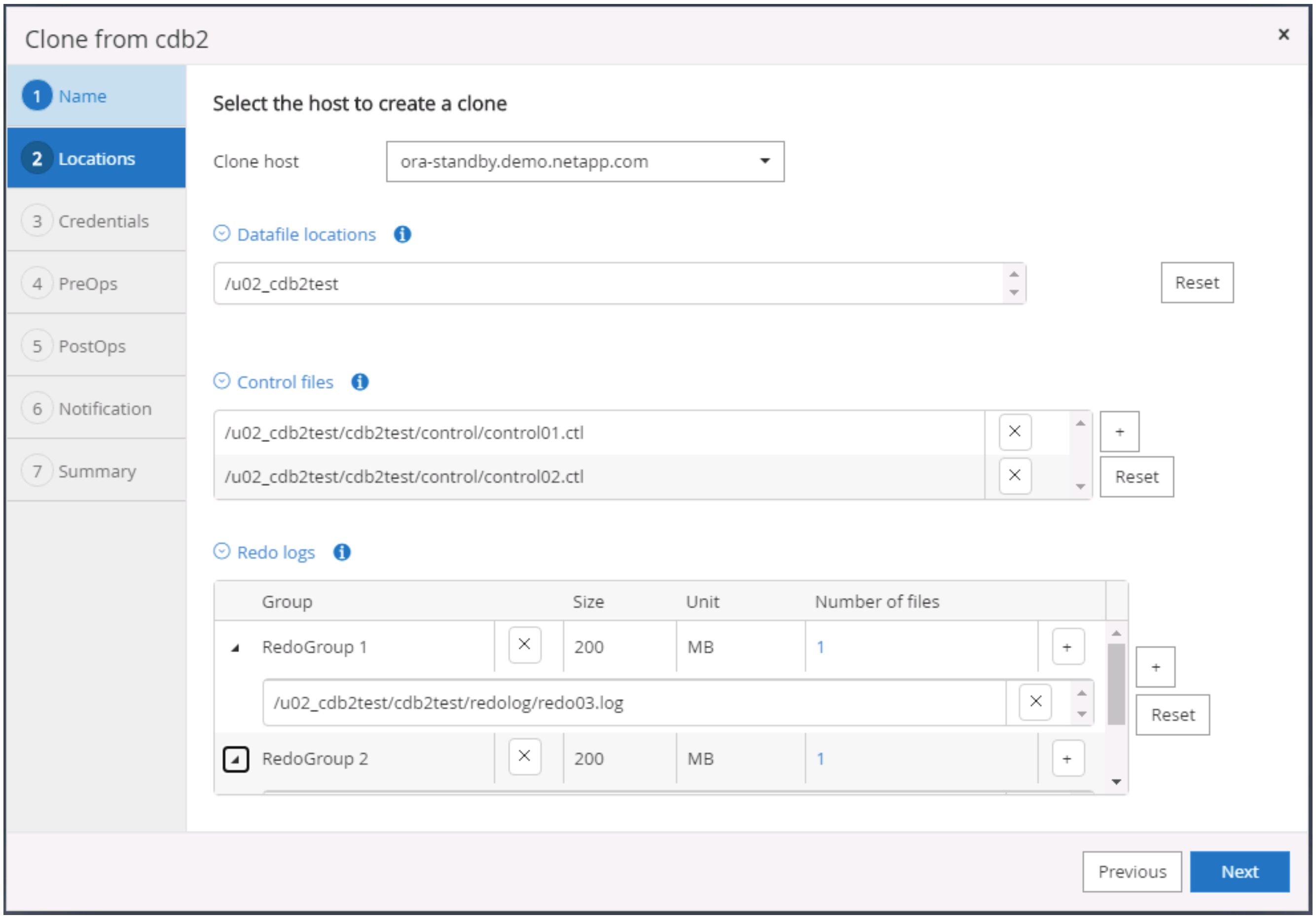
Data

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

7. Select the target clone host in the cloud, and datafile, control file, and redo log directories are created by the clone workflow.



Select the host to create a clone

Clone host: ora-standby.demo.netapp.com

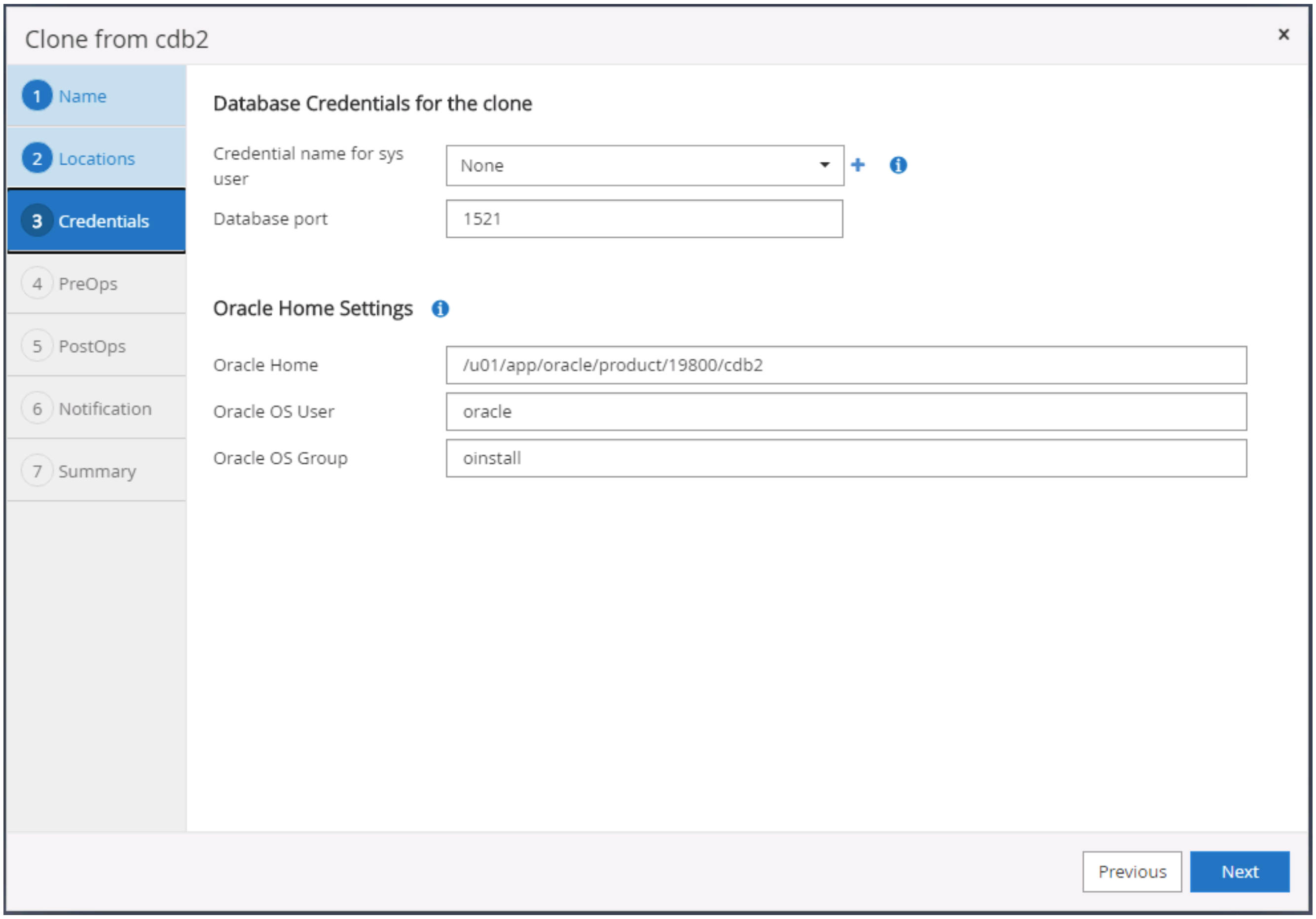
Datafile locations: /u02_cdb2test

Control files:
/u02_cdb2test/cdb2test/control/control01.ctl
/u02_cdb2test/cdb2test/control/control02.ctl

Redo logs

Group	Size	Unit	Number of files
RedoGroup 1	200	MB	1
/u02_cdb2test/cdb2test/redolog/redo03.log			
RedoGroup 2	200	MB	1

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

Database Credentials for the clone

Credential name for sys user: None

Database port: 1521

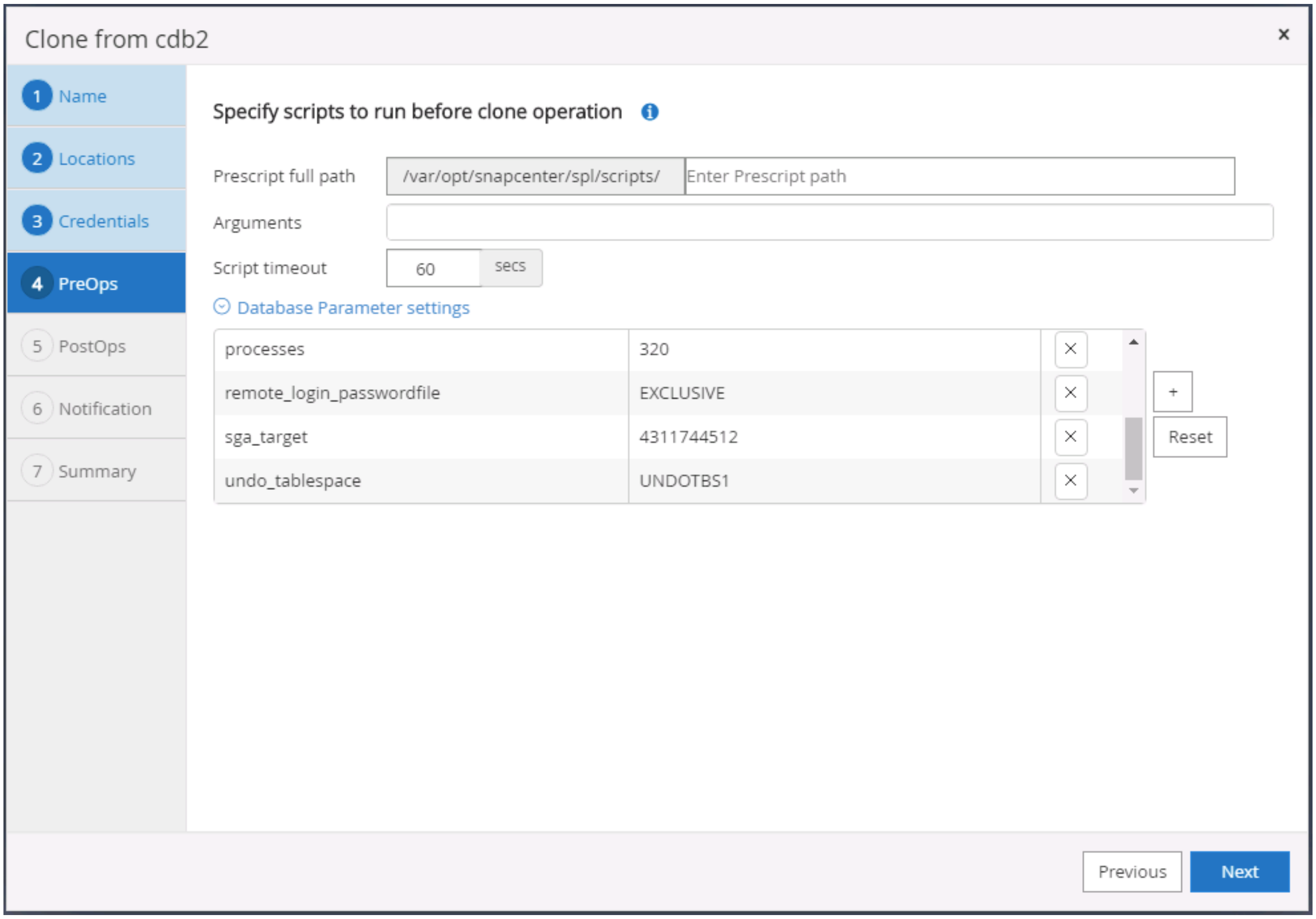
Oracle Home Settings

Oracle Home: /u01/app/oracle/product/19800/cdb2

Oracle OS User: oracle

Oracle OS Group: oinstall

9. Specify the scripts to run before clone operation. More importantly, the database instance parameter can be adjusted or defined here.



Specify scripts to run before clone operation

Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

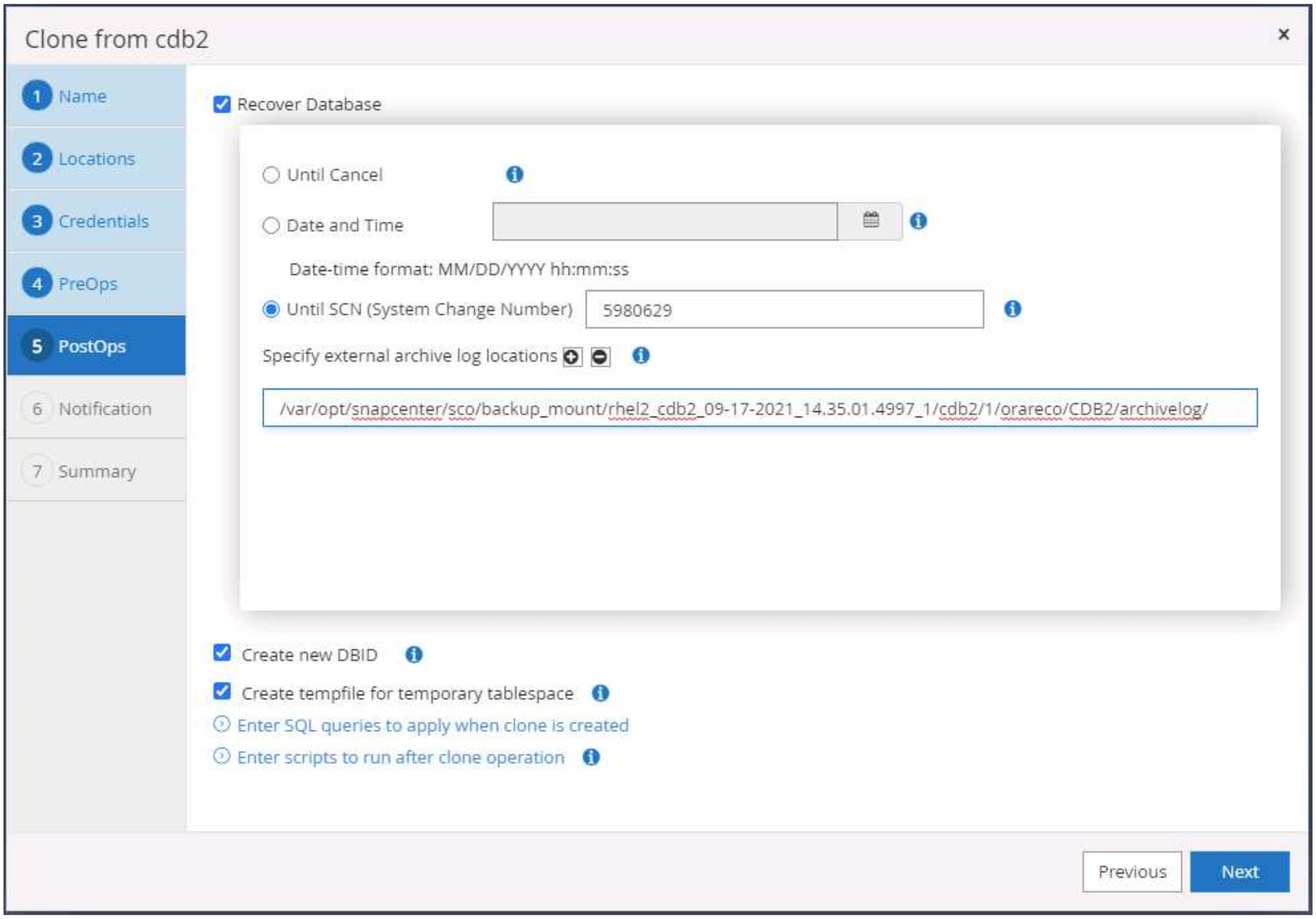
Arguments:

Script timeout: 60 secs

Database Parameter settings

processes	320
remote_login_passwordfile	EXCLUSIVE
sga_target	4311744512
undo_tablespace	UNDOTBS1

10. 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.



☑ Recover Database

○ Until Cancel

○ Date and Time

Date-time format: MM/DD/YYYY hh:mm:ss

● Until SCN (System Change Number) 5980629

Specify external archive log locations

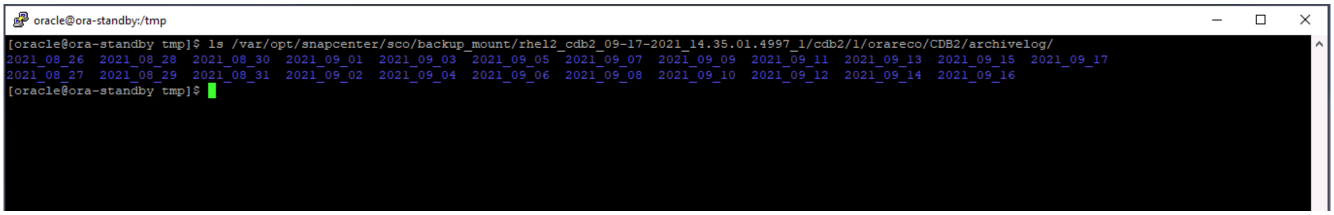
/var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_09-17-2021_14.35.01.4997_1/cdb2/1/orareco/CDB2/archivelog/

☑ Create new DBID

☑ Create tempfile for temporary tablespace

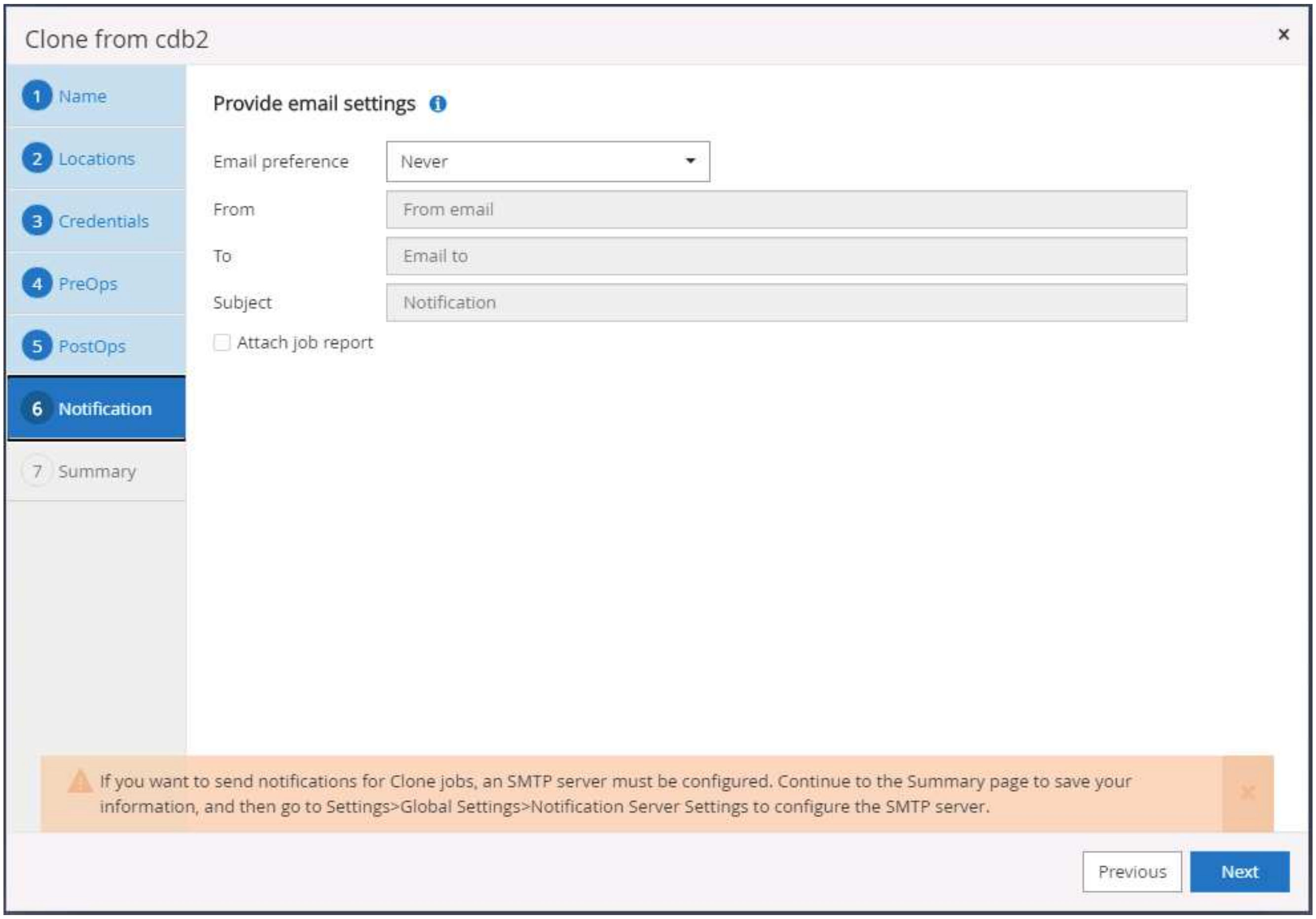
Enter SQL queries to apply when clone is created

Enter scripts to run after clone operation



```
[oracle@ora-standby tmp]$ 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 tmp]$
```

11. Configure the SMTP server for email notification if desired.



Provide email settings

Email preference: Never

From: From email

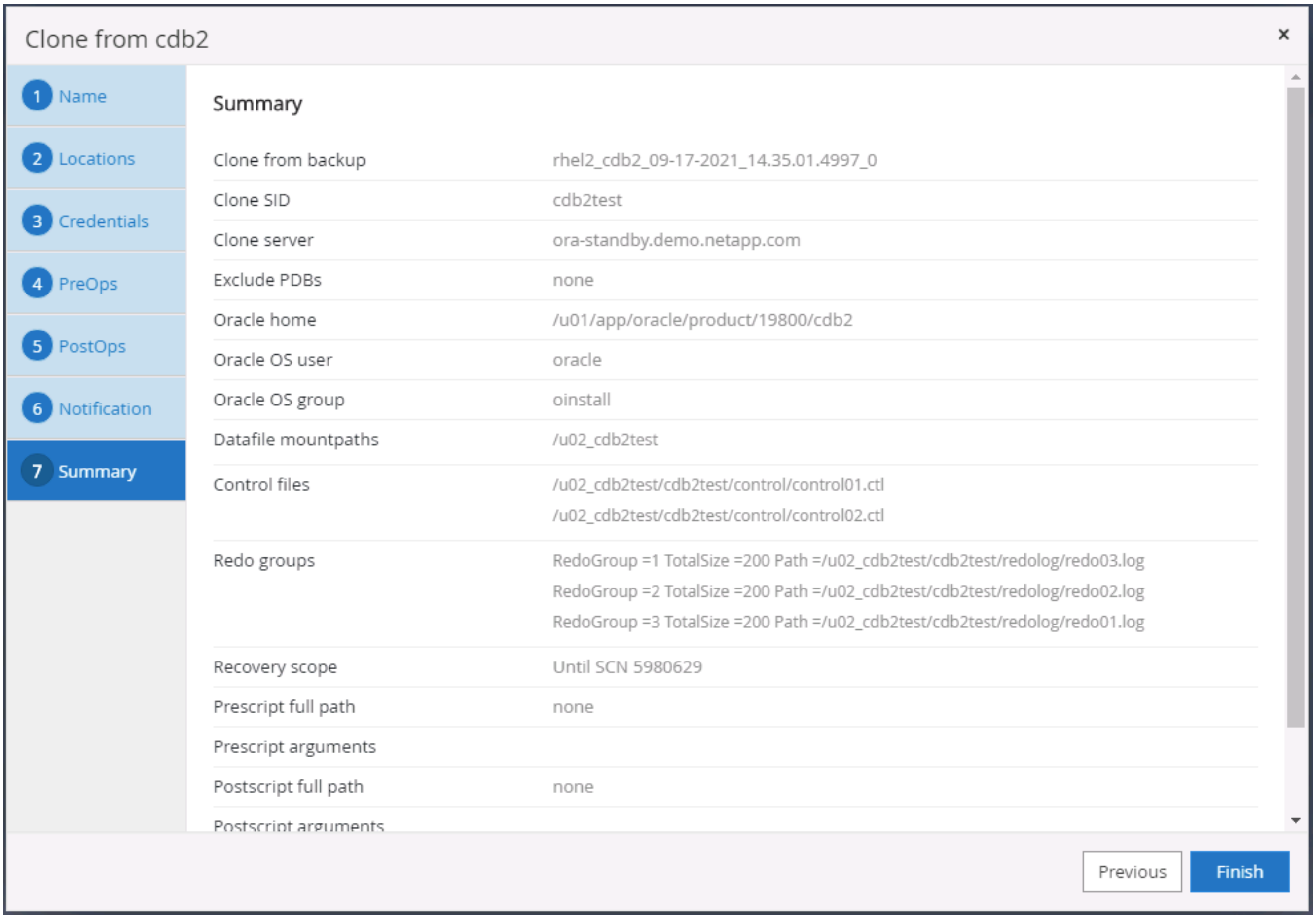
To: Email to

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.

12. Clone summary.



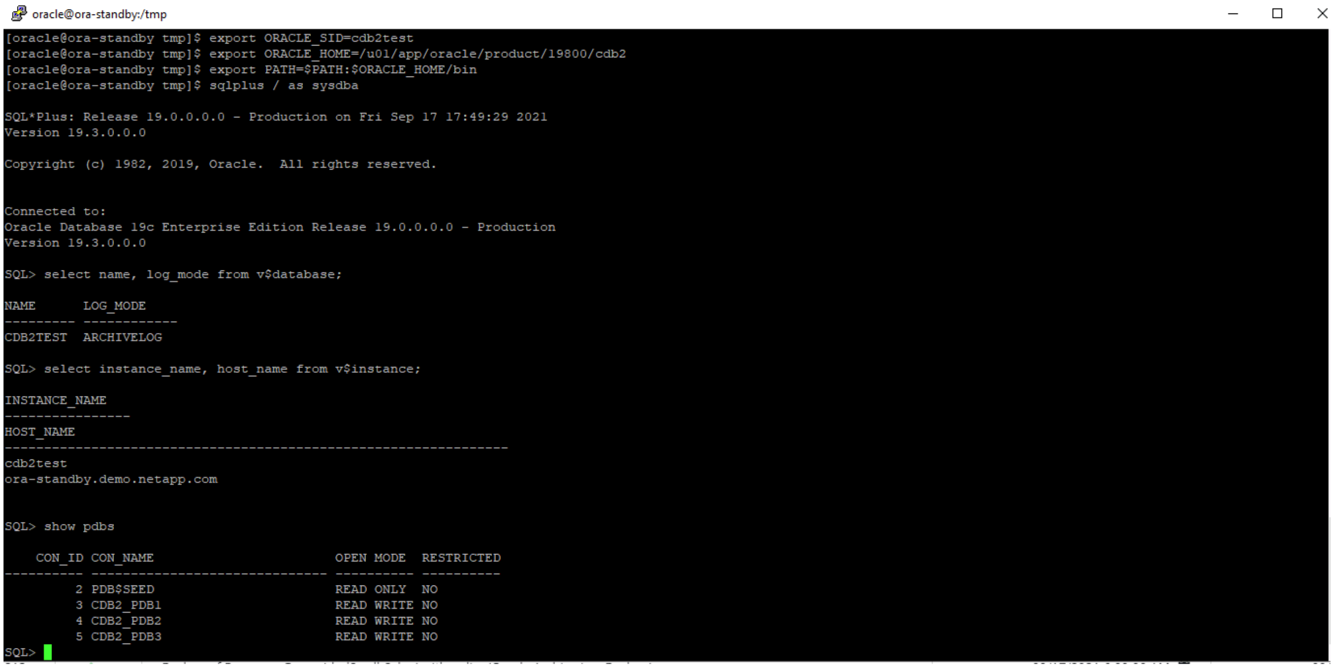
Summary

Clone from backup	rhel2_cdb2_09-17-2021_14.35.01.4997_0
Clone SID	cdb2test
Clone server	ora-standby.demo.netapp.com
Exclude PDBs	none
Oracle home	/u01/app/oracle/product/19800/cdb2
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	

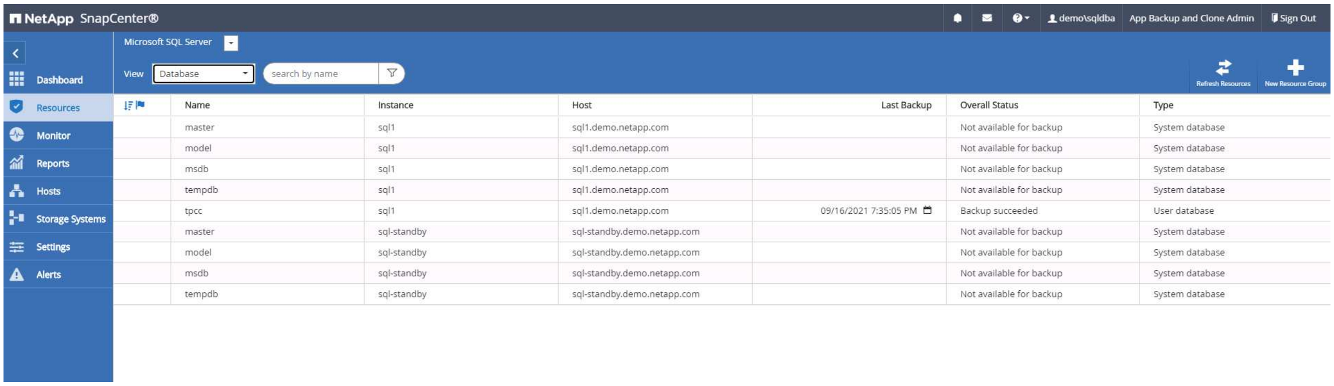
13. You should validate after cloning to make sure that the cloned database is operational. Some additional tasks, such as starting up the listener or turning off the DB log archive mode, can be performed on the dev/test database.



```
[oracle@ora-standby tmp]$ 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>
```

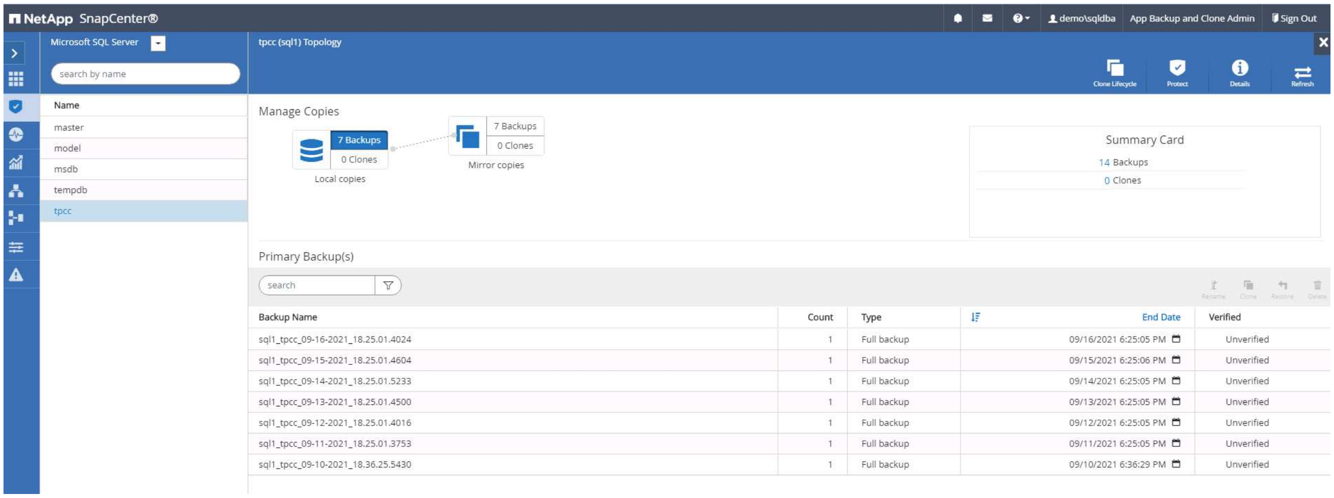
Clone a SQL database for dev/test from a replicated Snapshot backup

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.



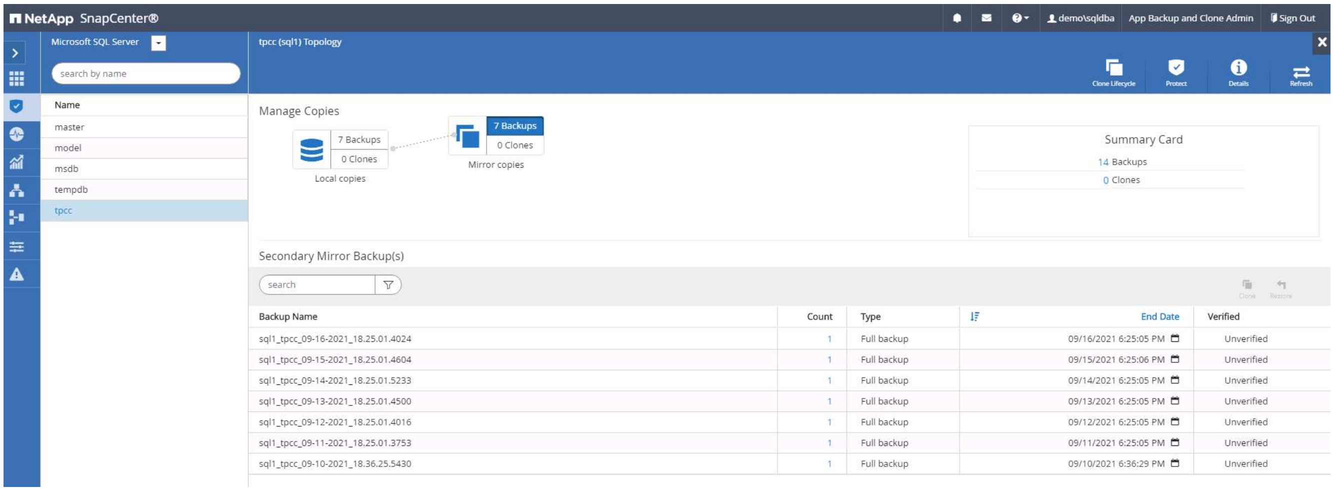
Name	Instance	Host	Last Backup	Overall Status	Type
master	sql1	sql1.demo.netapp.com		Not available for backup	System database
model	sql1	sql1.demo.netapp.com		Not available for backup	System database
msdb	sql1	sql1.demo.netapp.com		Not available for backup	System database
tempdb	sql1	sql1.demo.netapp.com		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.



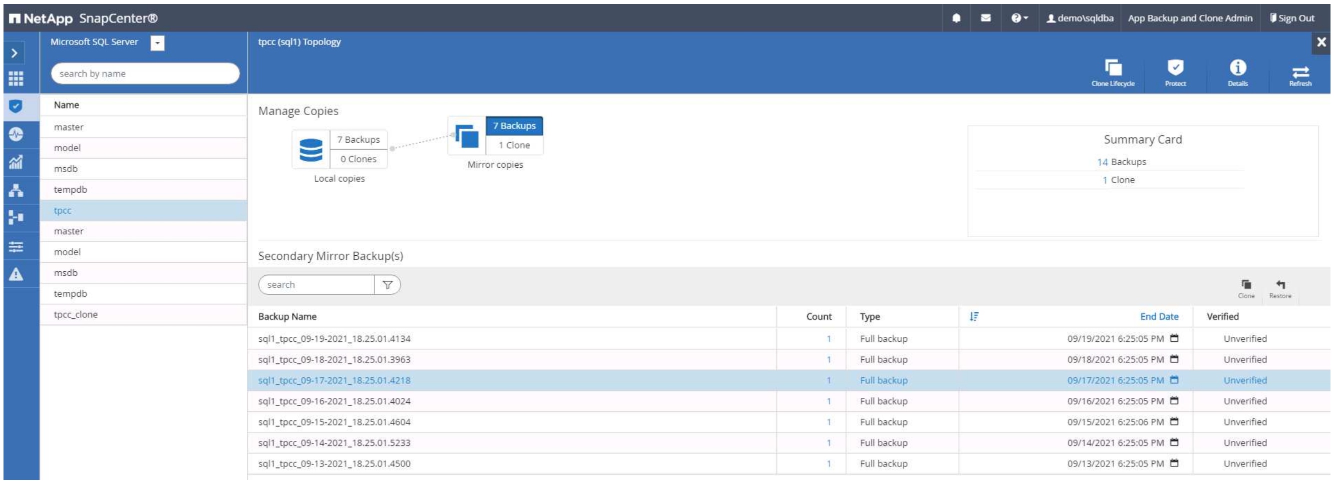
Backup Name	Count	Type	End Date	Verified
sql1_tpcc_09-16-2021_18.25.01.4024	1	Full backup	09/16/2021 6:25:05 PM	Unverified
sql1_tpcc_09-15-2021_18.25.01.4604	1	Full backup	09/15/2021 6:25:06 PM	Unverified
sql1_tpcc_09-14-2021_18.25.01.5233	1	Full backup	09/14/2021 6:25:05 PM	Unverified
sql1_tpcc_09-13-2021_18.25.01.4500	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.

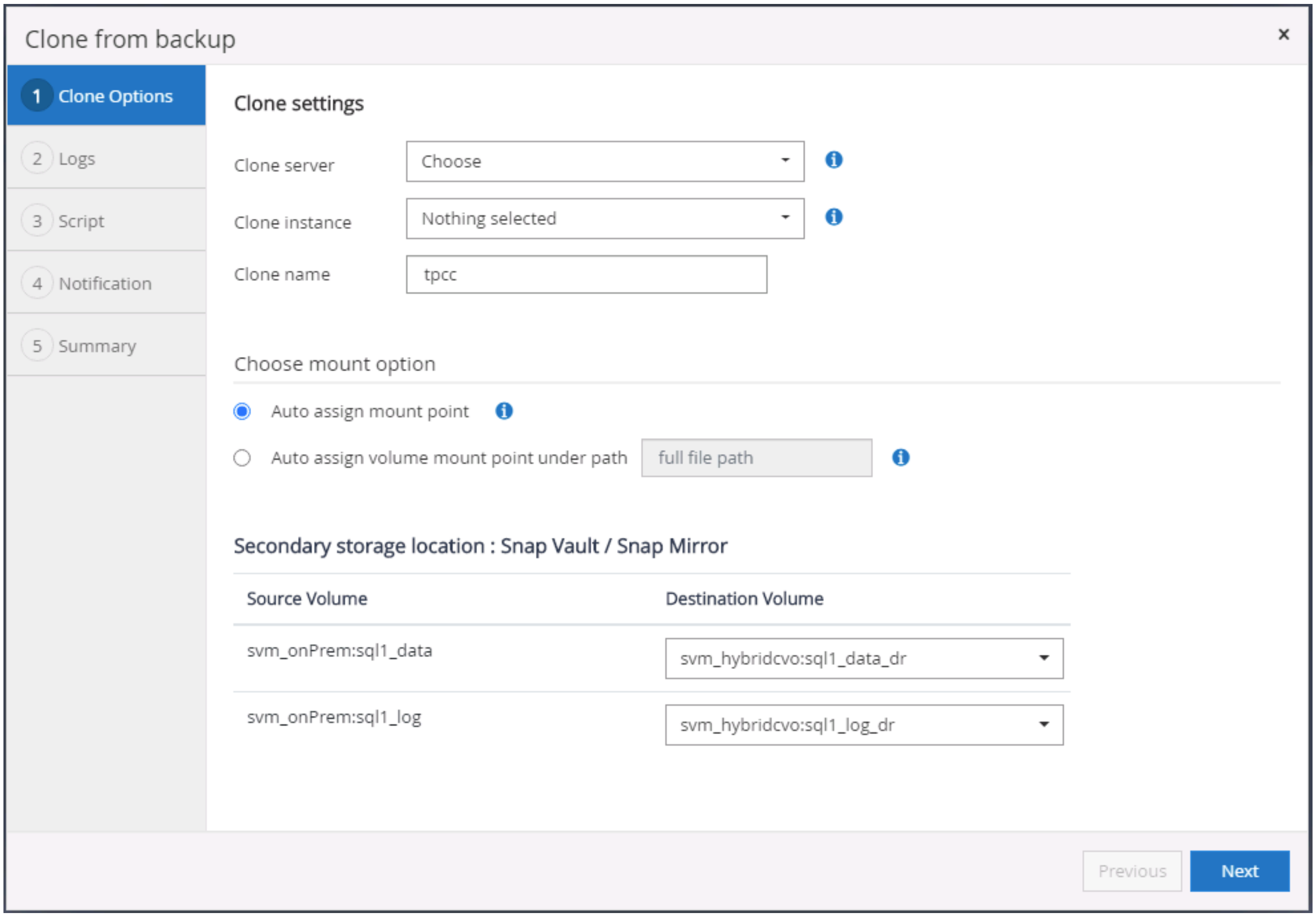


Backup Name	Count	Type	End Date	Verified
sql1_tpcc_09-16-2021_18.25.01.4024	1	Full backup	09/16/2021 6:25:05 PM	Unverified
sql1_tpcc_09-15-2021_18.25.01.4604	1	Full backup	09/15/2021 6:25:06 PM	Unverified
sql1_tpcc_09-14-2021_18.25.01.5233	1	Full backup	09/14/2021 6:25:05 PM	Unverified
sql1_tpcc_09-13-2021_18.25.01.4500	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 settings

Clone server: Choose

Clone instance: Nothing selected

Clone name: tpcc

Choose mount option

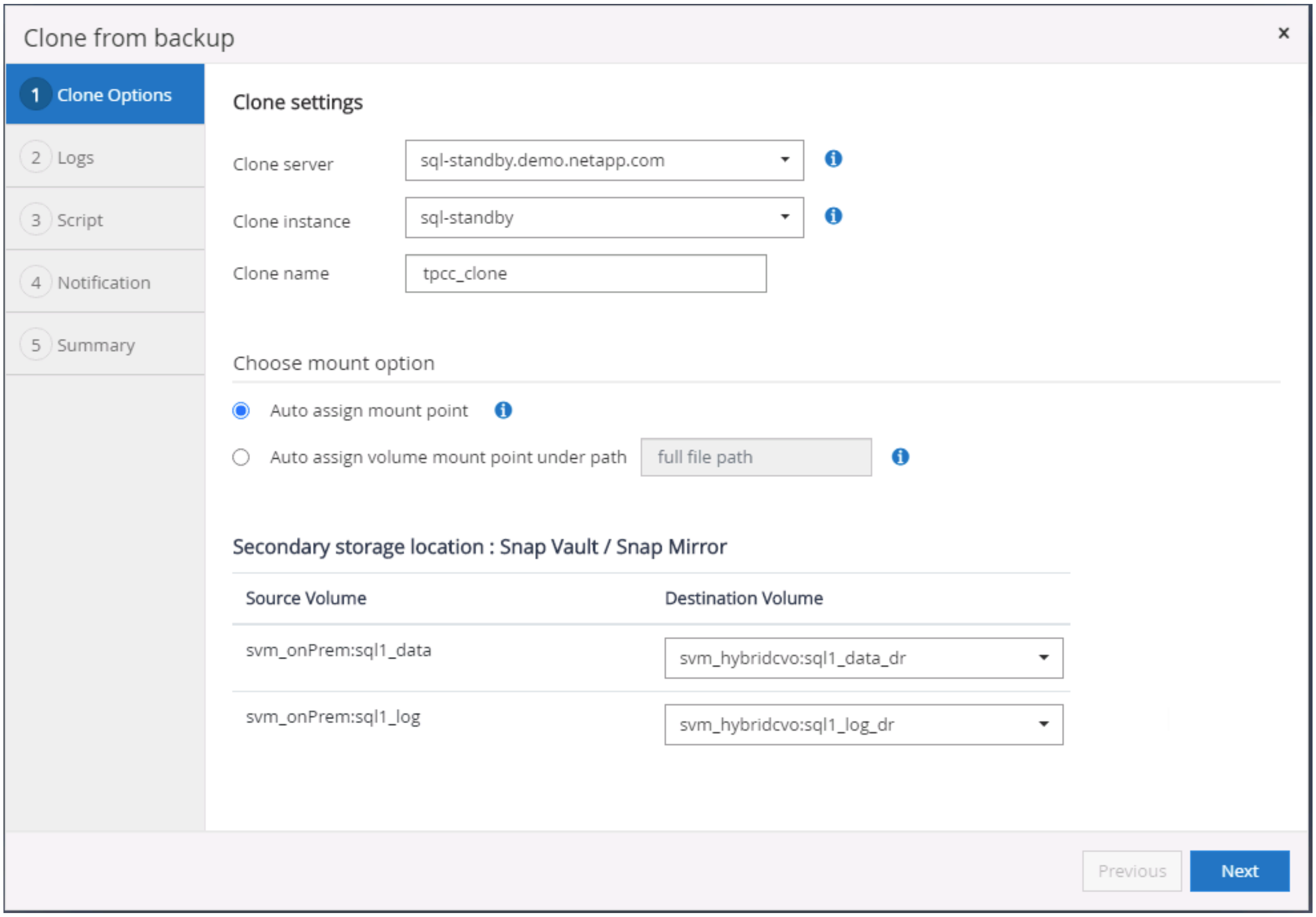
● Auto assign mount point

○ 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

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 settings

Clone server: sql-standby.demo.netapp.com

Clone instance: sql-standby

Clone name: tpcc_clone

Choose mount option

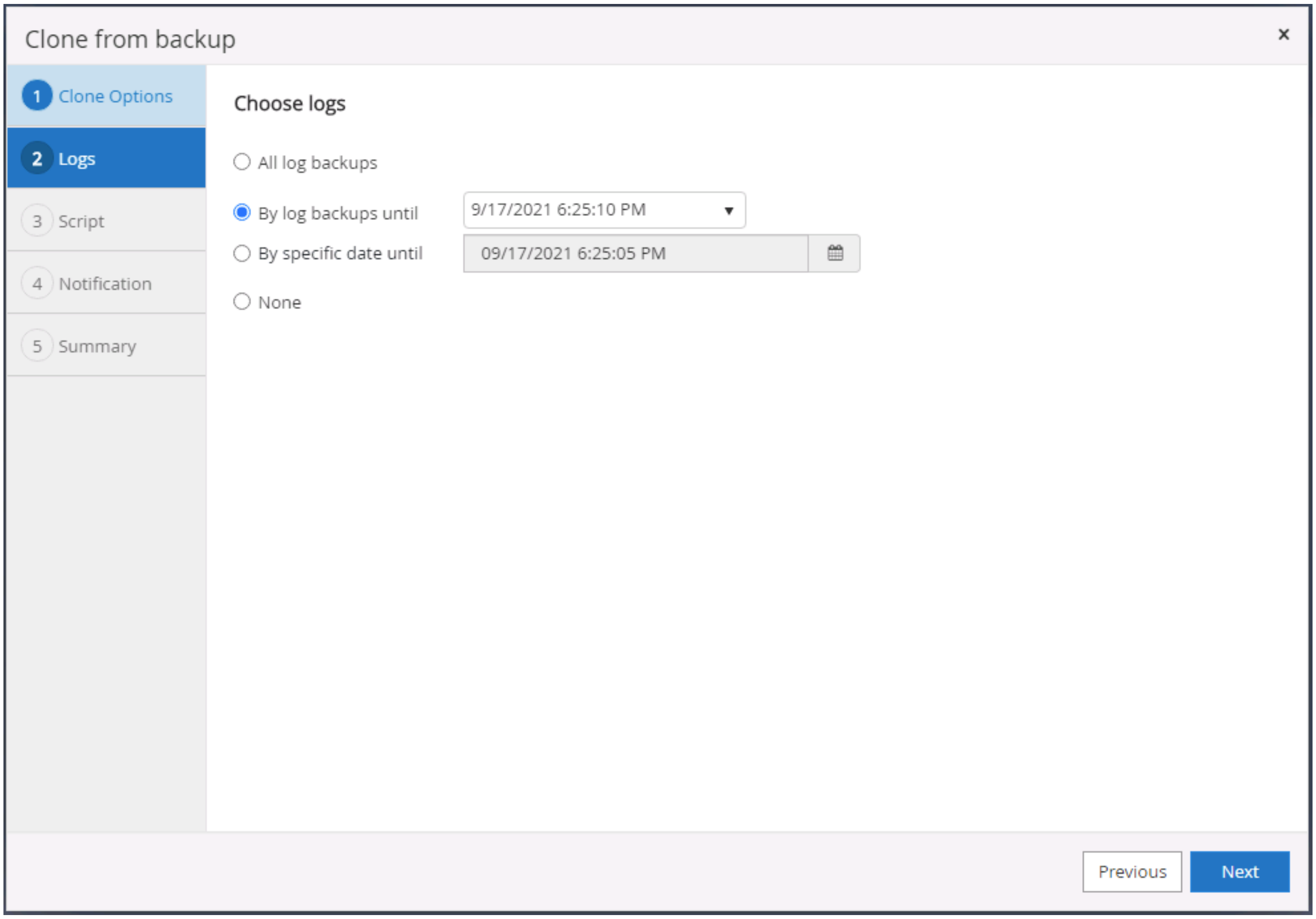
● Auto assign mount point

○ 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

6. Determine a recovery point either by a log backup time or by a specific date and time.



Choose logs

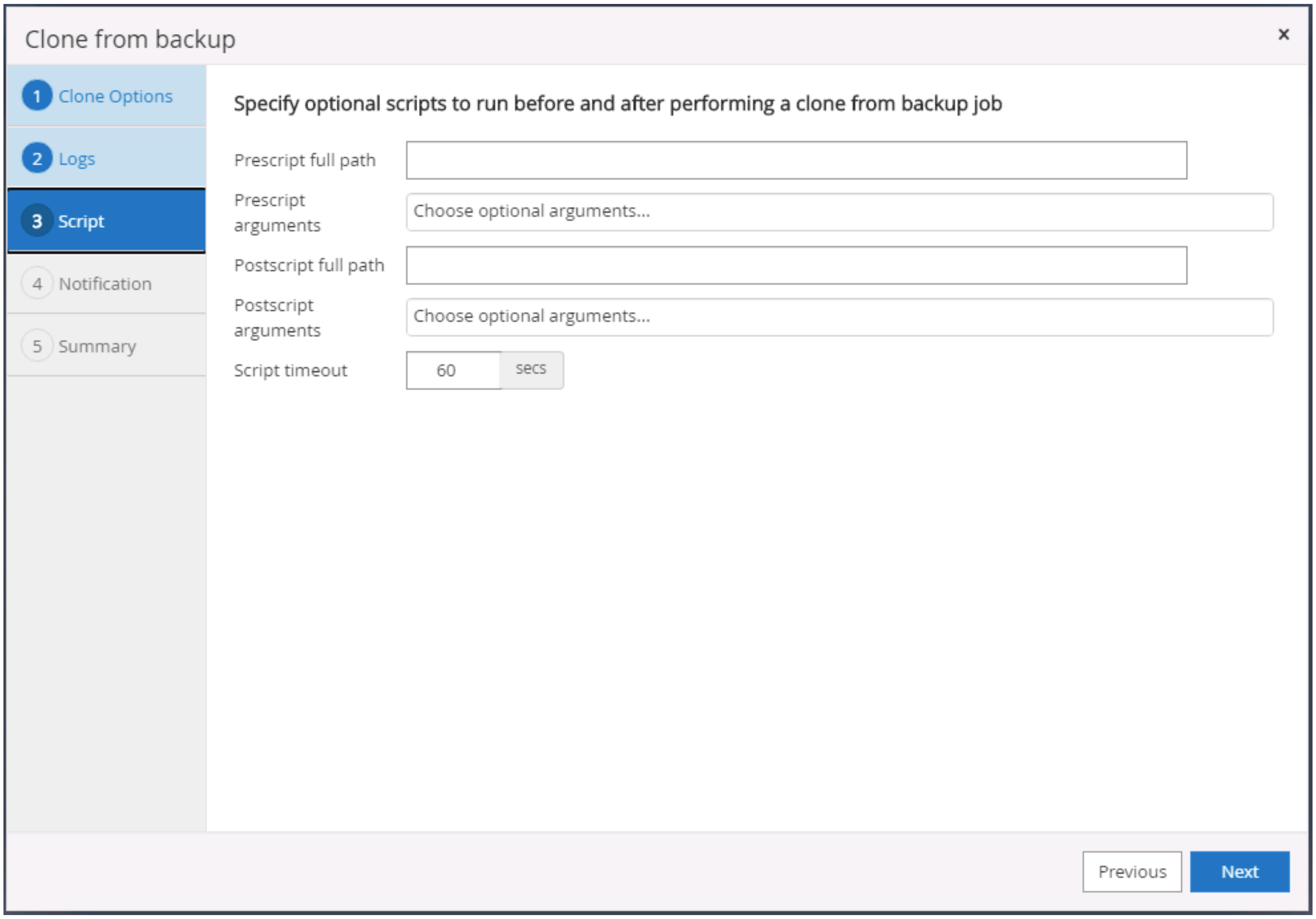
○ All log backups

● By log backups until 9/17/2021 6:25:10 PM

○ By specific date until 09/17/2021 6:25:05 PM

○ None

7. Specify optional scripts to run before and after the cloning operation.



Specify optional scripts to run before and after performing a clone from backup job

Prescript full path

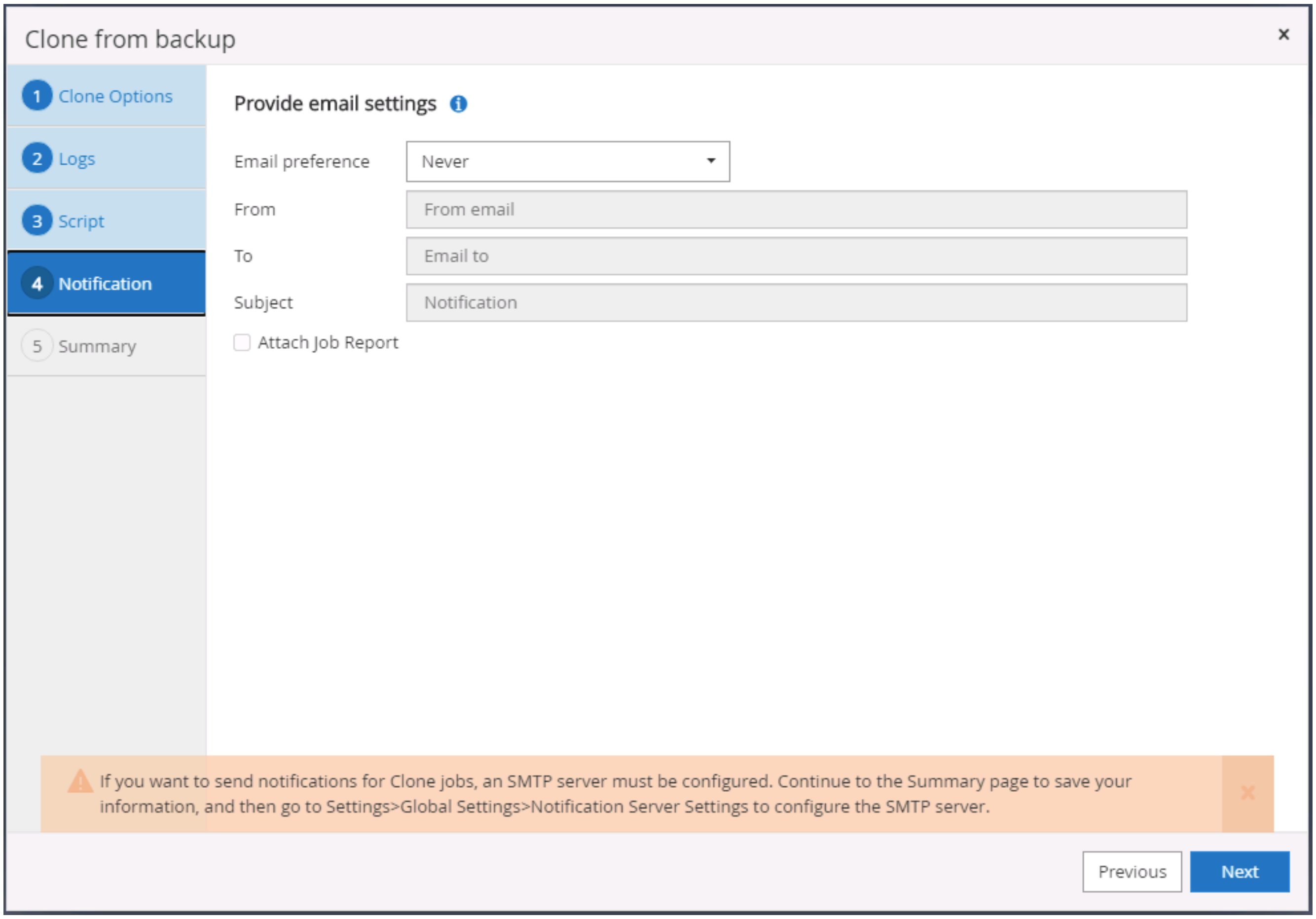
Prescript arguments: Choose optional arguments...

Postscript full path

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

8. Configure an SMTP server if email notification is desired.



Provide email settings

Email preference: Never

From: From email

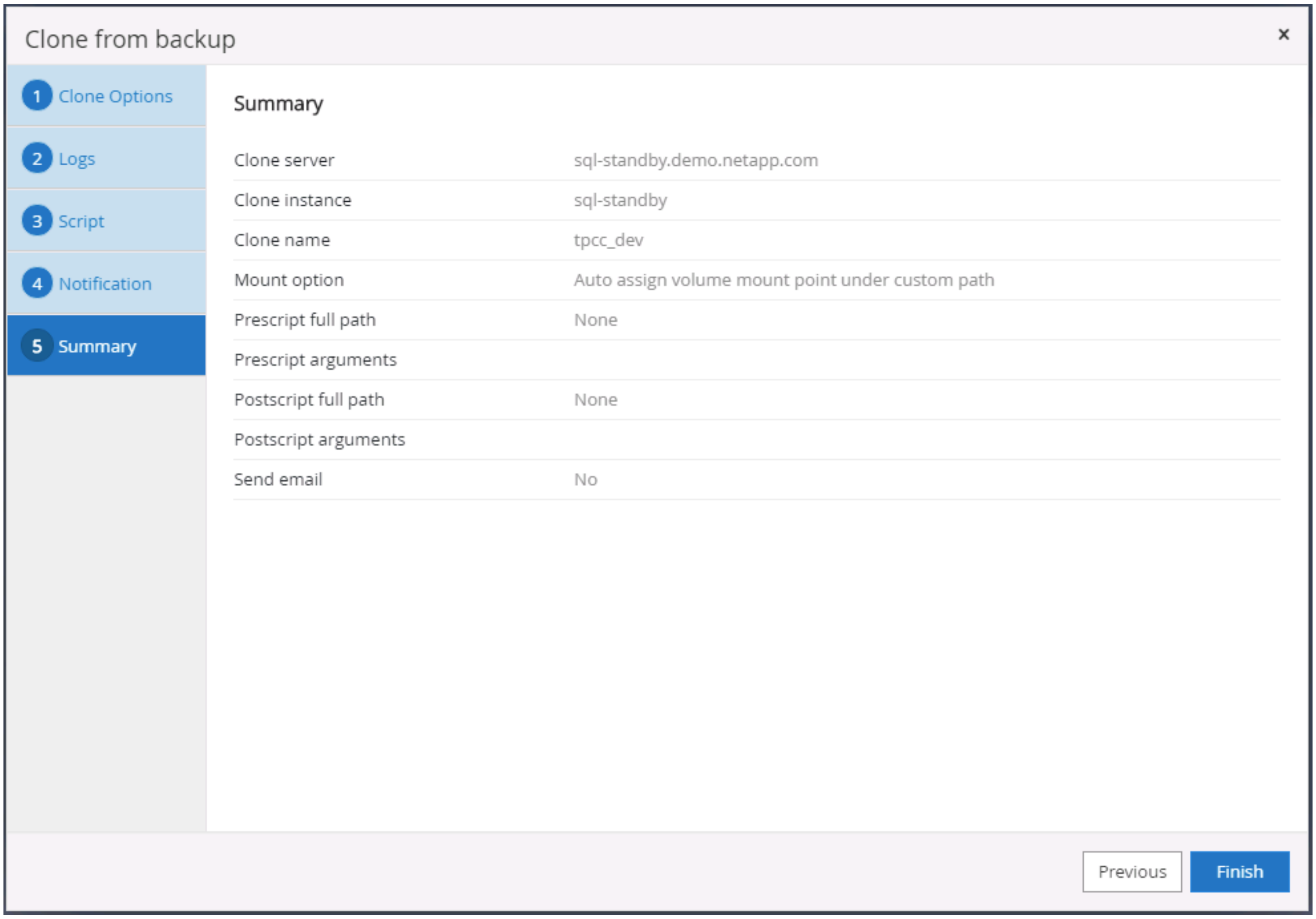
To: Email to

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.

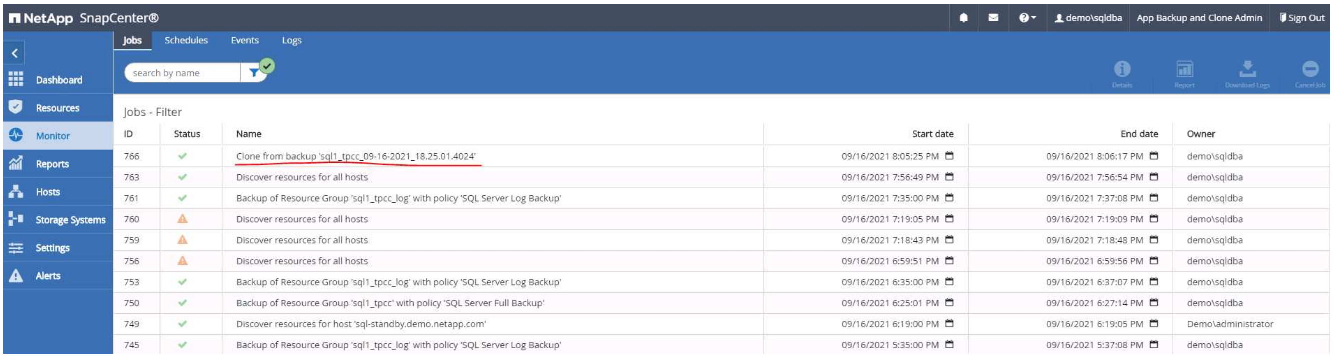
9. Clone Summary.



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

10. Monitor the job status and validate that the intended user database has been attached to a target SQL instance in the cloud clone server.



Jobs - Filter

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 7:35:00 PM	09/16/2021 7:37:08 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

1. 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.
2. Configure an Oracle listener, or register the newly cloned DB with an existing listener for user access.
3. 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?

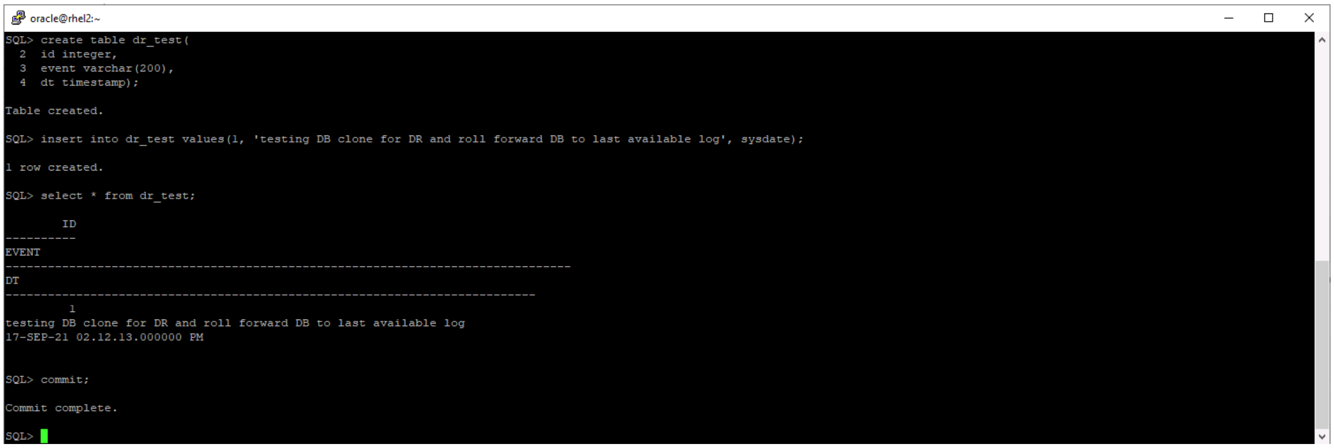
If you need help with this solution and use cases, join the NetApp Solution Automation community support Slack channel and look for the solution-automation channel to post your questions or inquires.

Disaster recovery workflow

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.

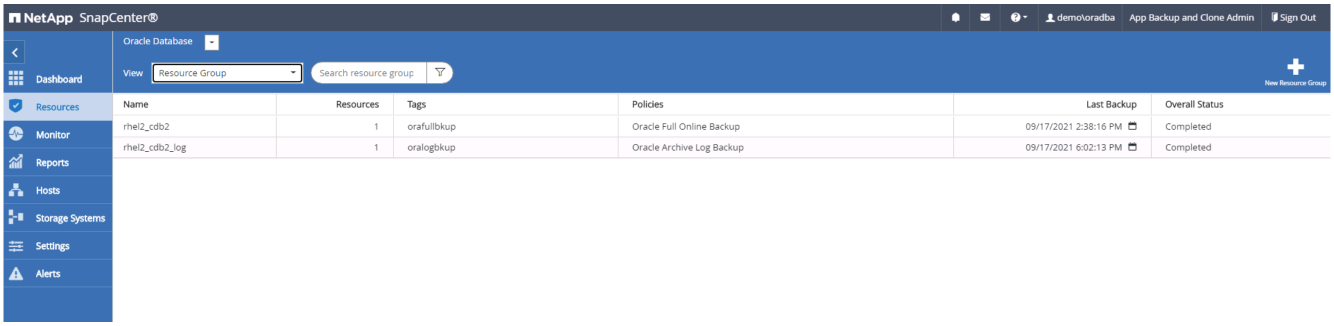
Clone an on-premises Oracle production DB to cloud for DR

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.



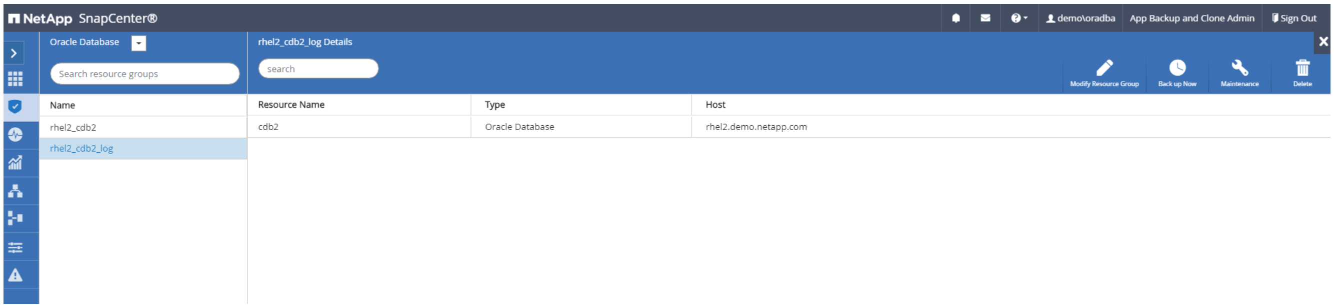
```
SQL> create table dr_test(
  2  id integer,
  3  event varchar(200),
  4  dt timestamp);

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.



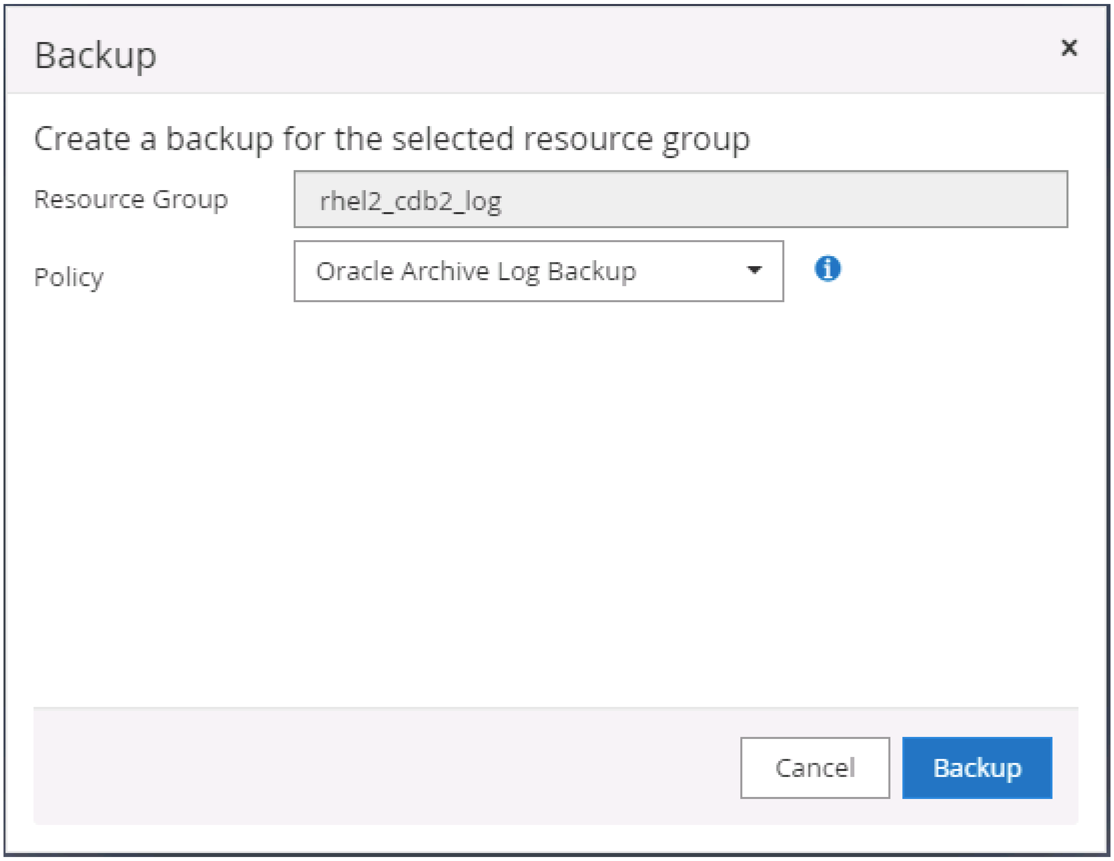
Name	Resources	Tags	Policies	Last Backup	Overall Status
rhel2_cdb2	1	orafullbkup	Oracle Full Online Backup	09/17/2021 2:38:16 PM	Completed
rhel2_cdb2_log	1	oralogbkup	Oracle Archive Log Backup	09/17/2021 6:02:13 PM	Completed

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.



Name
rhel2_cdb2
rhel2_cdb2_log

Resource Name	Type	Host
cdb2	Oracle Database	rhel2.demo.netapp.com



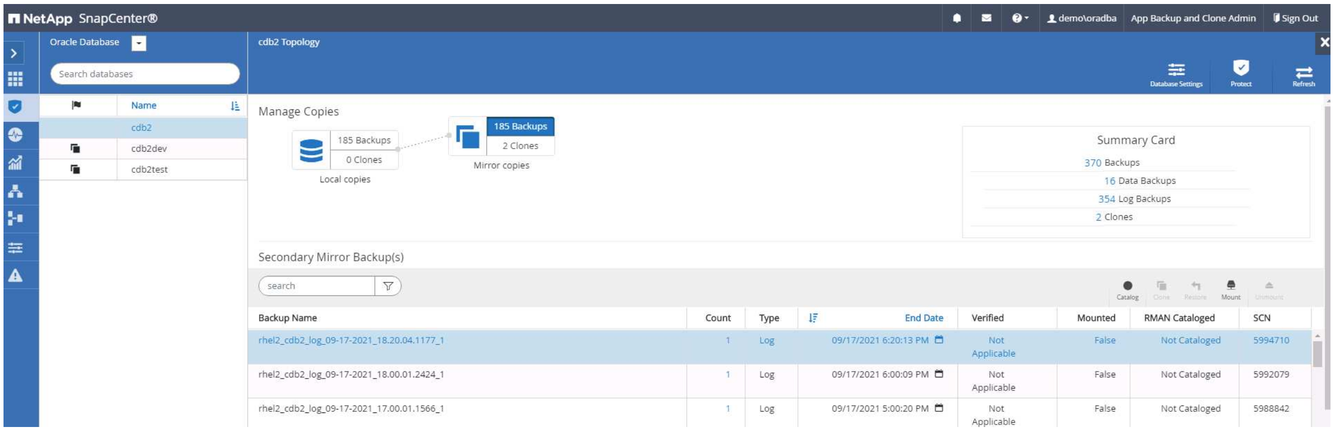
Create a backup for the selected resource group

Resource Group: rhel2_cdb2_log

Policy: Oracle Archive Log Backup

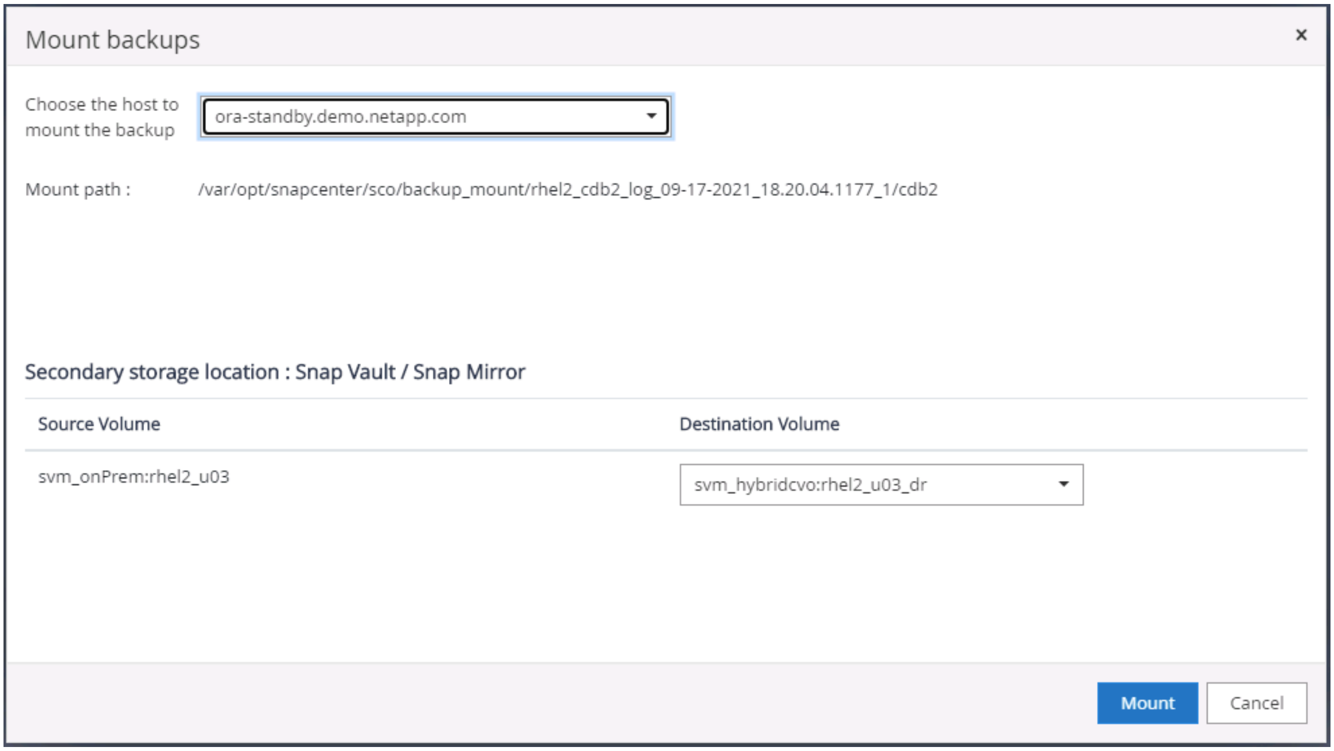
> Asynchronous SnapMirror loses data that has not made it to the cloud destination in the database log backup interval in a disaster recovery scenario. To minimize data loss, more frequent log backup can be scheduled. However there is a limit to the log backup frequency that is technically achievable.

4. Select the last log backup on the Secondary Mirror Backup(s), and mount the log backup.



Secondary Mirror Backup(s)

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



Mount backups

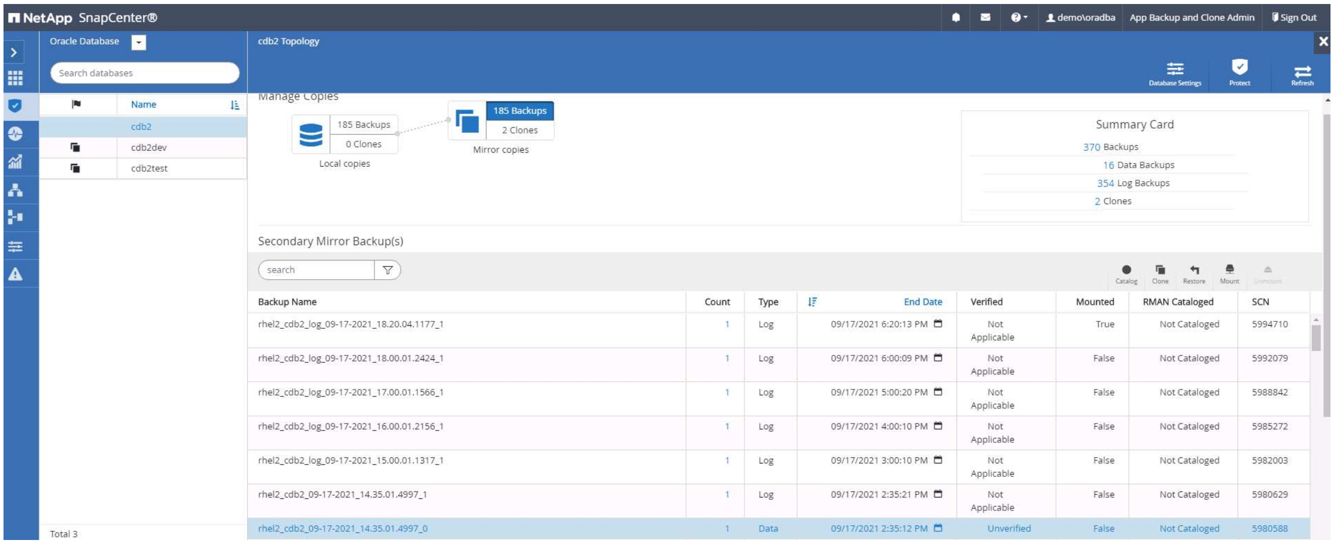
Choose the host to mount the backup: ora-standby.demo.netapp.com

Mount path : /var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_log_09-17-2021_18.20.04.1177_1/cdb2

Secondary storage location : Snap Vault / Snap Mirror

Source Volume	Destination Volume
svm_onPrem:rhel2_u03	svm_hybridcvo:rhel2_u03_dr

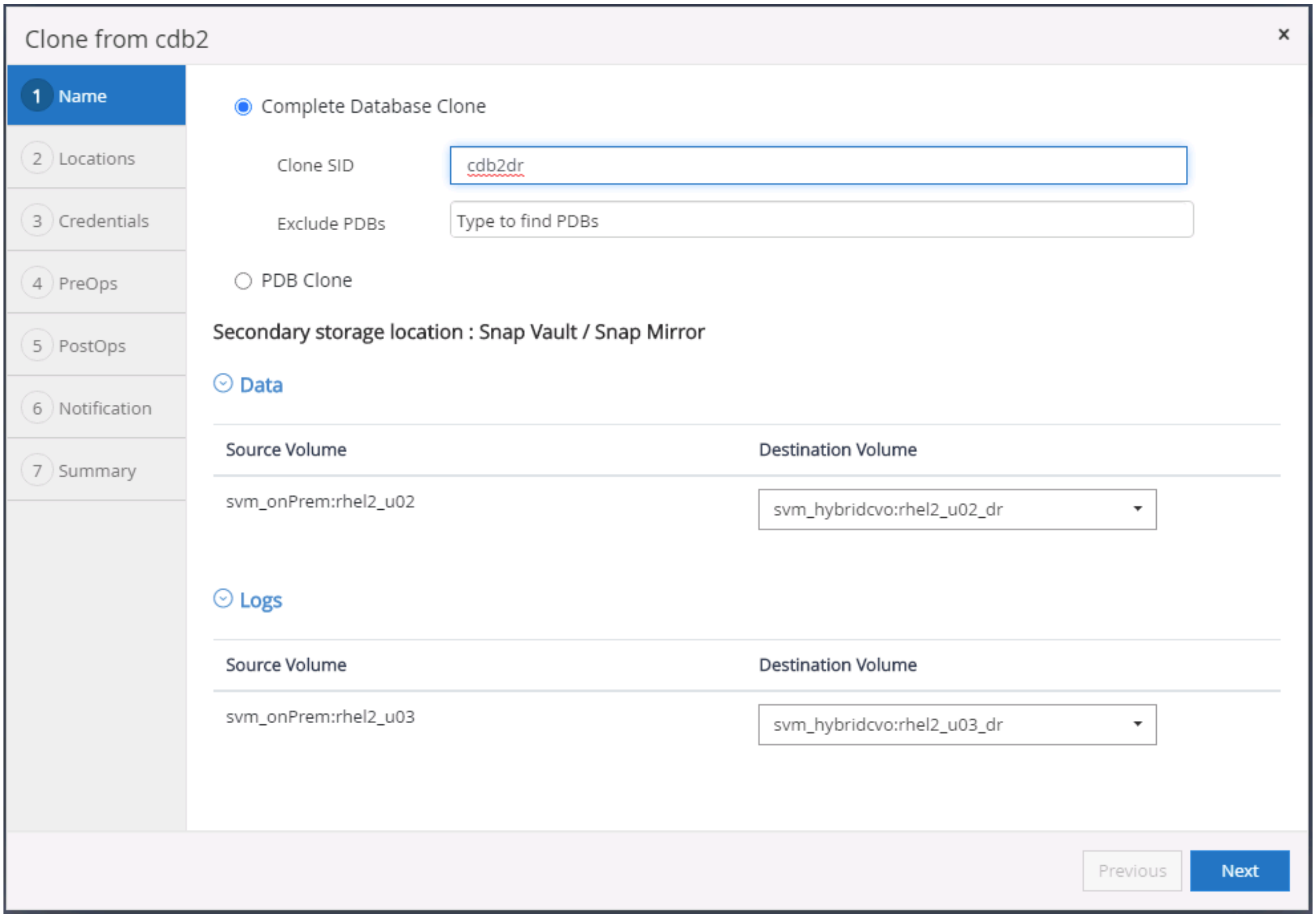
5. Select the last full database backup and click Clone to initiate the clone workflow.



Secondary Mirror Backup(s)

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	True	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
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	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

6. Select a unique clone DB ID on the host.



● Complete Database Clone

Clone SID: cdb2dr

Exclude PDBs: Type to find PDBs

○ PDB Clone

Secondary storage location : Snap Vault / Snap Mirror

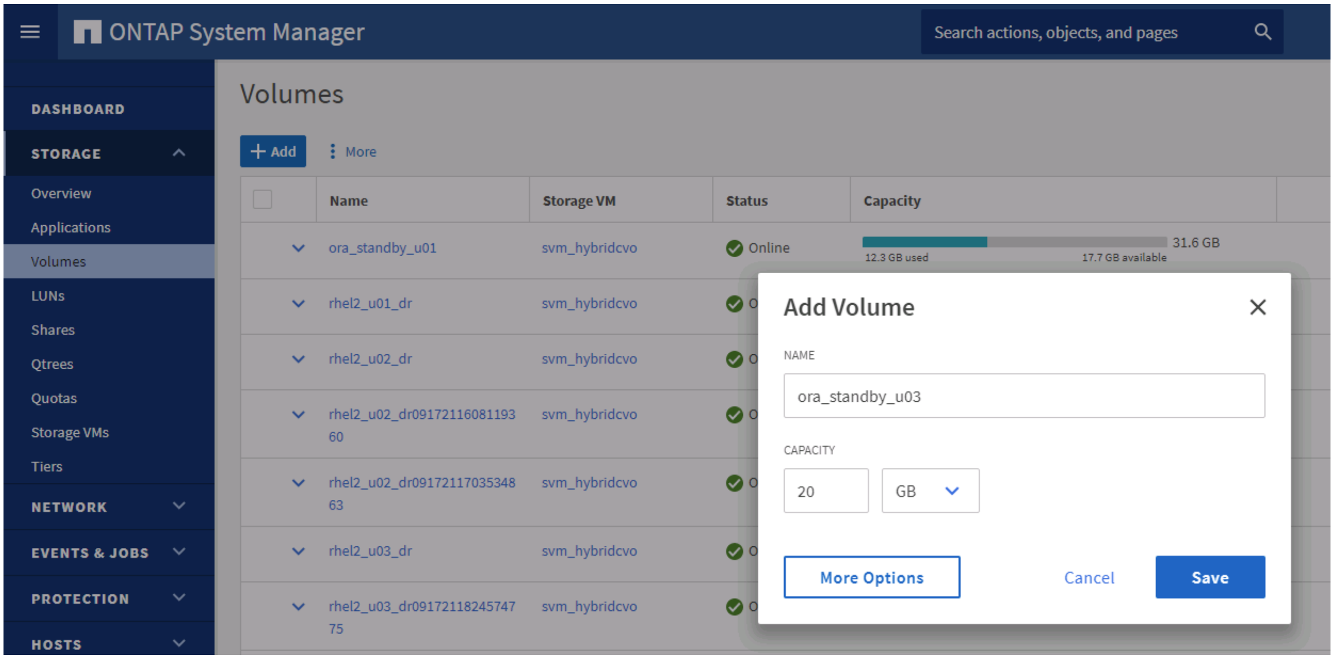
Data

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

7. Provision a log volume and mount it to the target DR server for the Oracle flash recovery area and online logs.

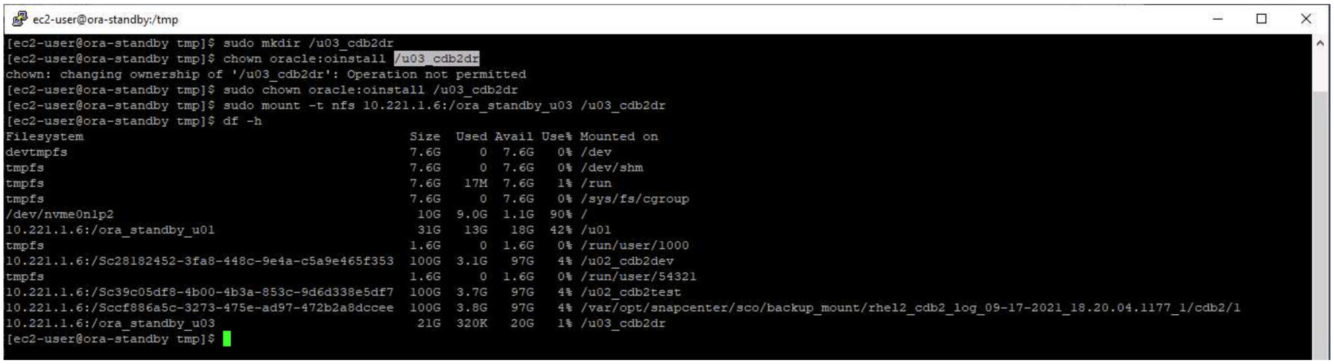


Name	Storage VM	Status	Capacity
ora_standby_u01	svm_hybridcvo	Online	31.6 GB 12.3 GB used 17.7 GB available
rhel2_u01_dr	svm_hybridcvo	O	
rhel2_u02_dr	svm_hybridcvo	O	
rhel2_u02_dr0917211608119360	svm_hybridcvo	O	
rhel2_u02_dr0917211703534863	svm_hybridcvo	O	
rhel2_u03_dr	svm_hybridcvo	O	
rhel2_u03_dr0917211824574775	svm_hybridcvo	O	

Add Volume

NAME: ora_standby_u03

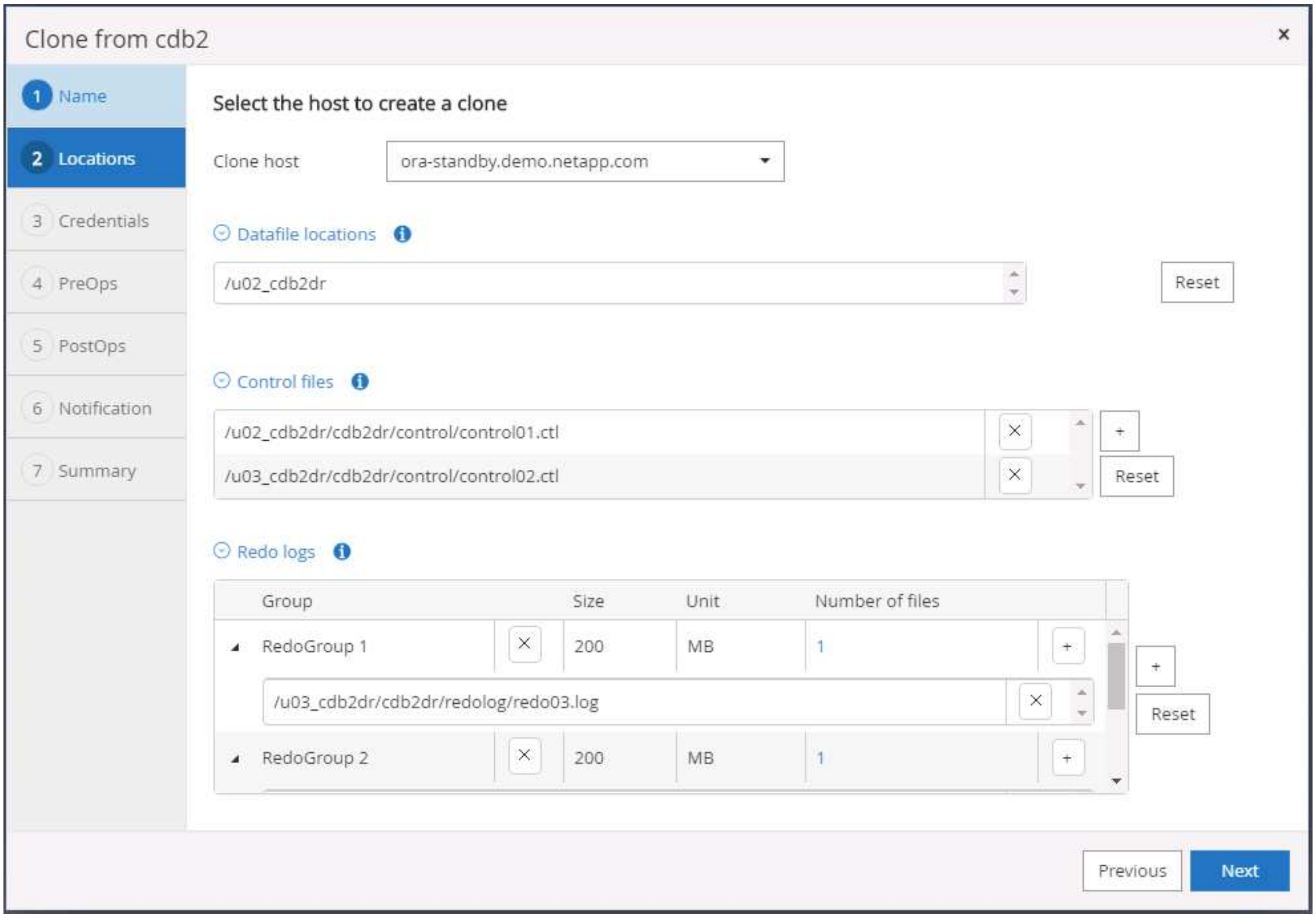
CAPACITY: 20 GB



```
[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
devtmpfs                                            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/nvme0n1p2                                       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:/Sccf886a5c-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.



Select the host to create a clone

Clone host: ora-standby.demo.netapp.com

Datafile locations: /u02_cdb2dr

Control files:

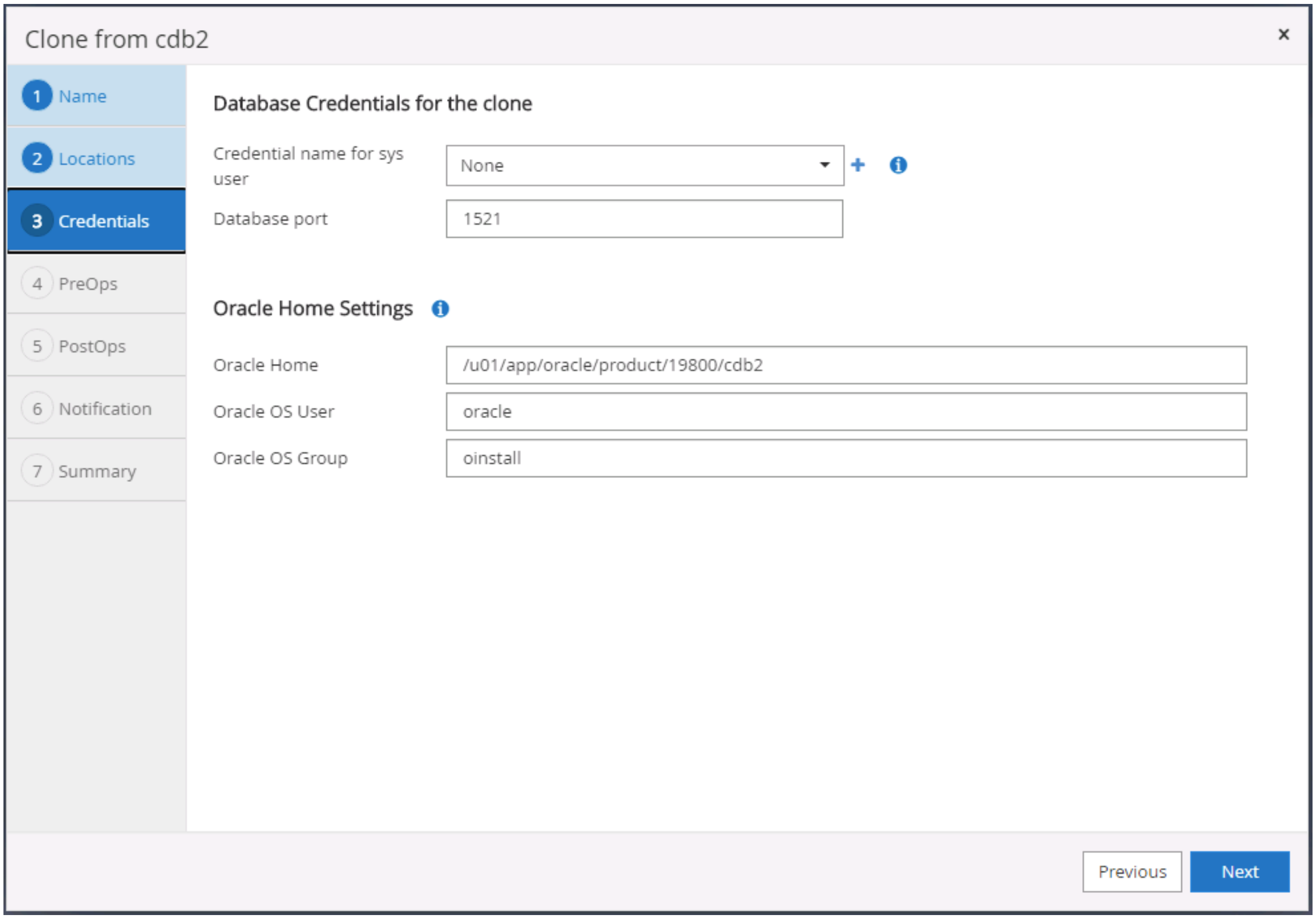
/u02_cdb2dr/cdb2dr/control/control01.ctl

/u03_cdb2dr/cdb2dr/control/control02.ctl

Redo logs

Group	Size	Unit	Number of files
RedoGroup 1	200	MB	1
/u03_cdb2dr/cdb2dr/redolog/redo03.log			
RedoGroup 2	200	MB	1

9. Select the credentials for the clone. Fill in the details of the Oracle home configuration on the target server.



Database Credentials for the clone

Credential name for sys user: None

Database port: 1521

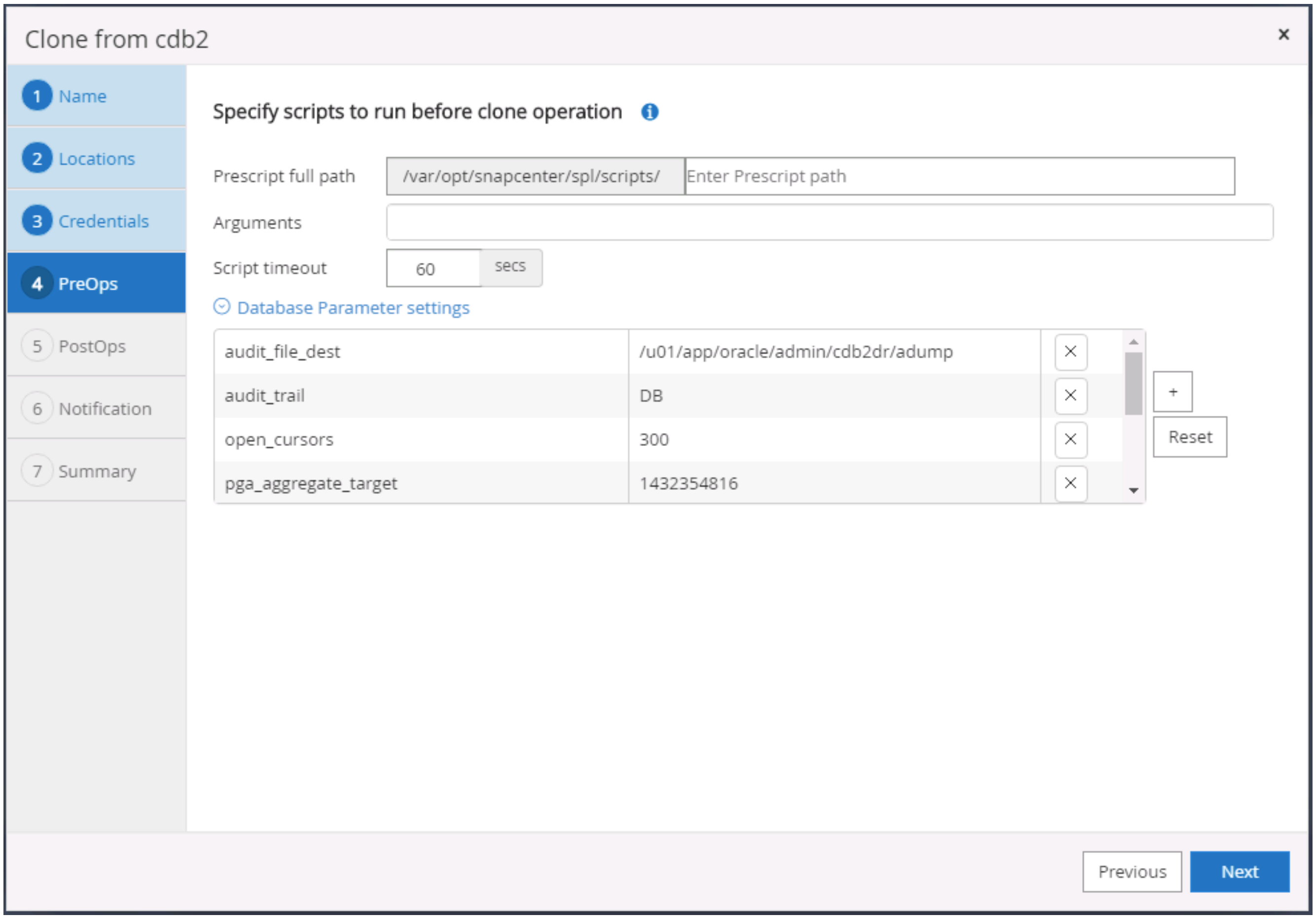
Oracle Home Settings

Oracle Home: /u01/app/oracle/product/19800/cdb2

Oracle OS User: oracle

Oracle OS Group: oinstall

10. Specify the scripts to run before cloning. Database parameters can be adjusted if needed.



Prescript full path: /var/opt/snapcenter/spl/scripts/ Enter Prescript path

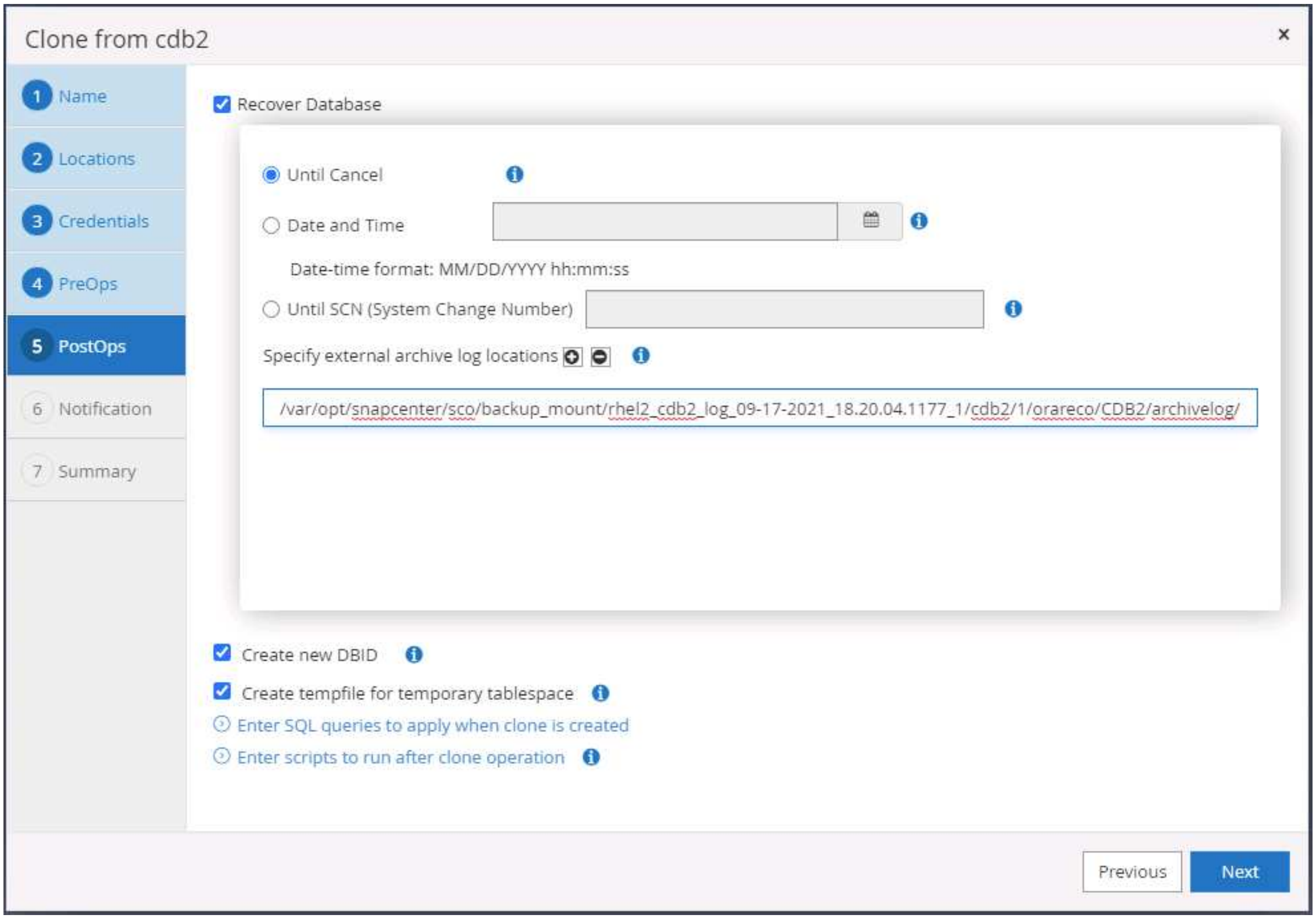
Arguments:

Script timeout: 60 secs

Database Parameter settings

audit_file_dest	/u01/app/oracle/admin/cdb2dr/adump
audit_trail	DB
open_cursors	300
pga_aggregate_target	1432354816

11. 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.



☑ Recover Database

● Until Cancel

○ Date and Time

Date-time format: MM/DD/YYYY hh:mm:ss

○ Until SCN (System Change Number)

Specify external archive log locations

/var/opt/snapcenter/sco/backup_mount/rhel2_cdb2_log_09-17-2021_18.20.04.1177_1/cdb2/1/orareco/CDB2/archivelog/

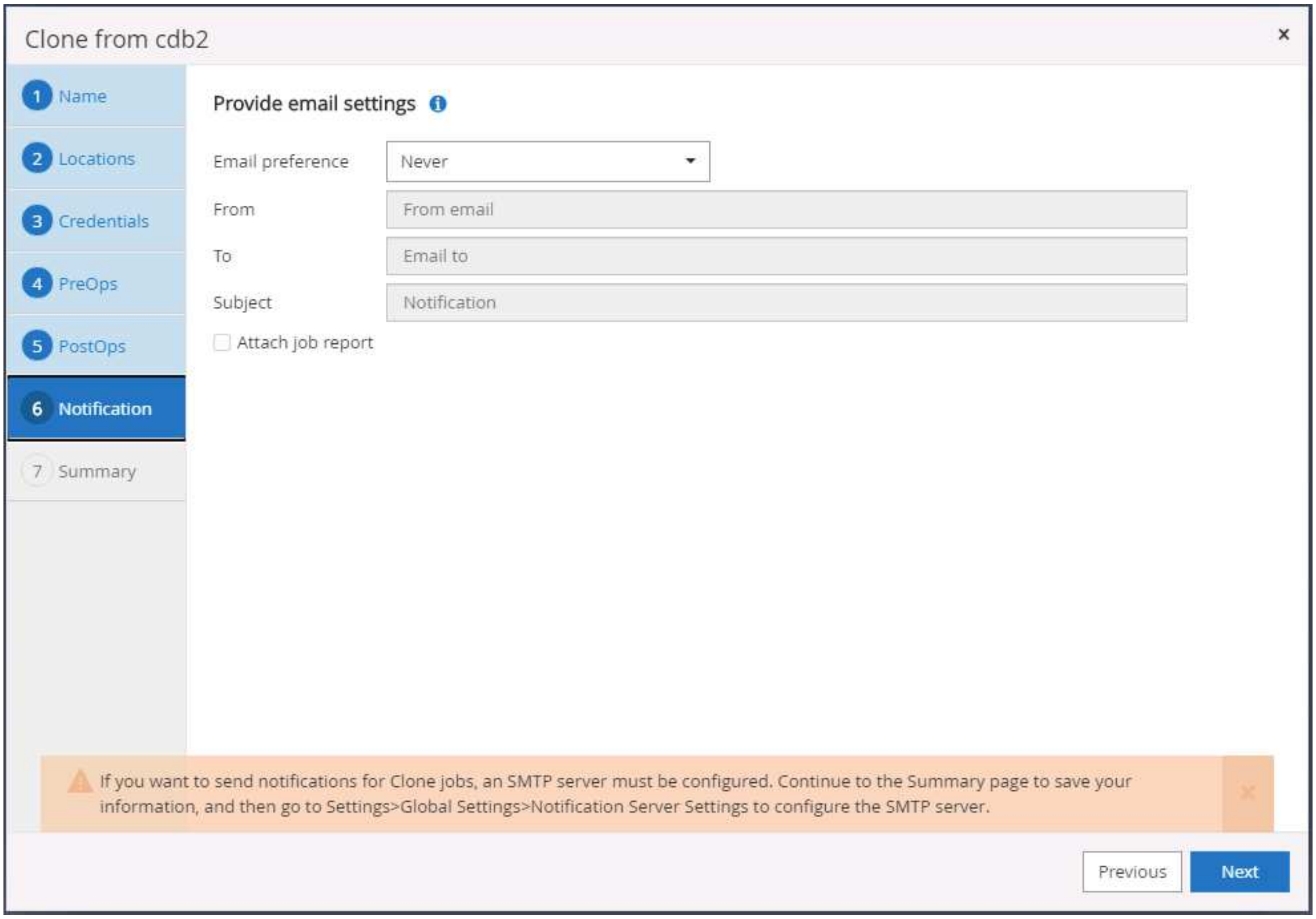
☑ Create new DBID

☑ Create tempfile for temporary tablespace

Enter SQL queries to apply when clone is created

Enter scripts to run after clone operation

12. Configure the SMTP server for email notification if needed.



Email preference: Never

From: From email

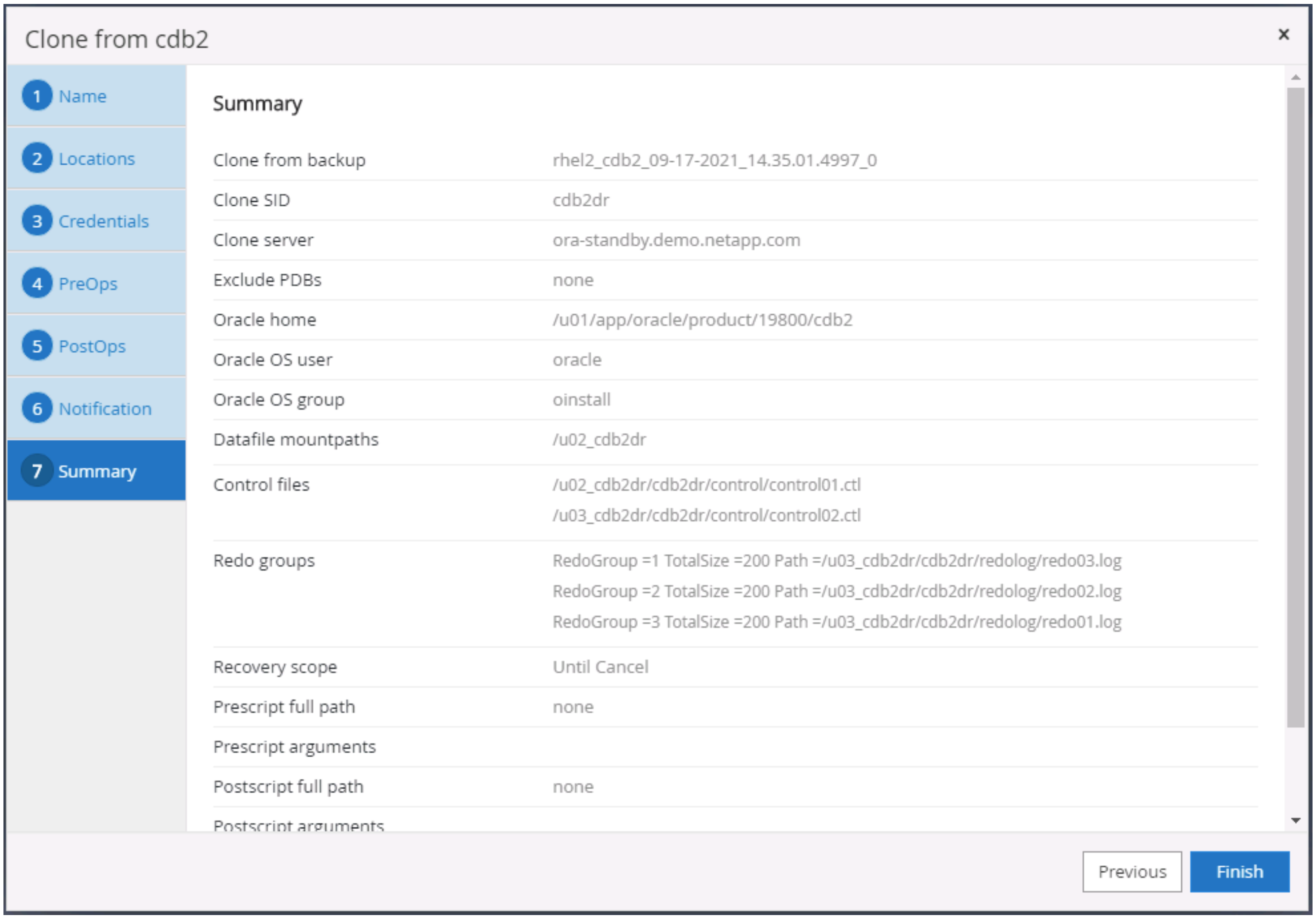
To: Email to

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.

13. DR clone summary.



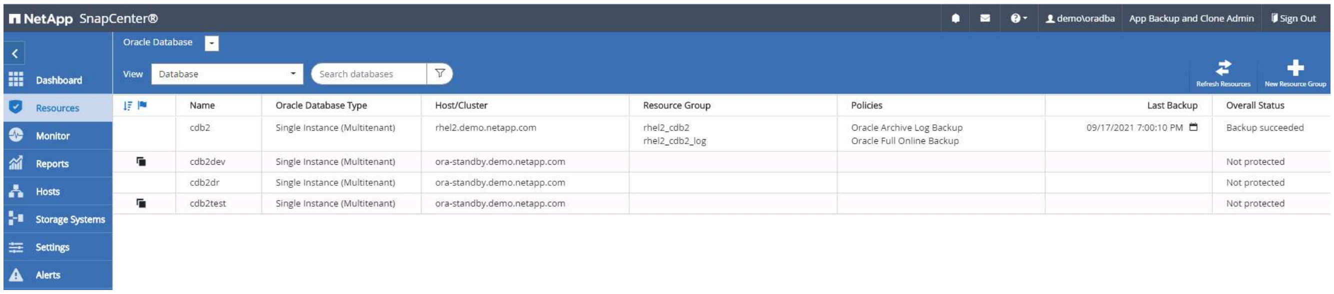
Summary

Clone from backup	rhel2_cdb2_09-17-2021_14.35.01.4997_0
Clone SID	cdb2dr
Clone server	ora-standby.demo.netapp.com
Exclude PDBs	none
Oracle home	/u01/app/oracle/product/19800/cdb2
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	

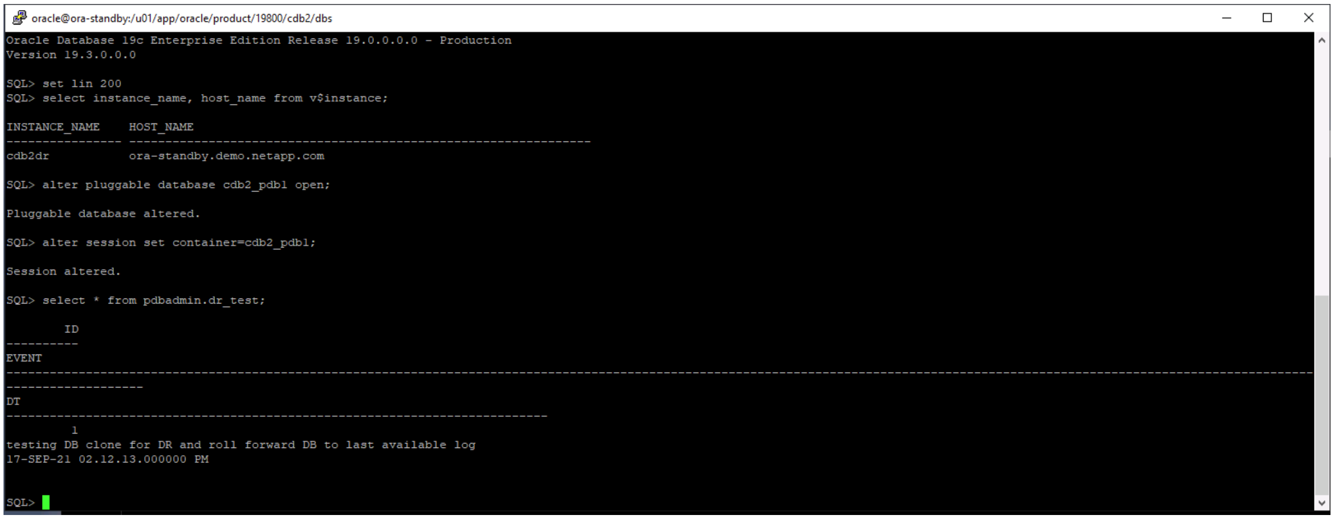
14. Cloned DBs are registered with SnapCenter immediately after clone completion and are then available for backup protection.



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 7:00:10 PM	Backup succeeded
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

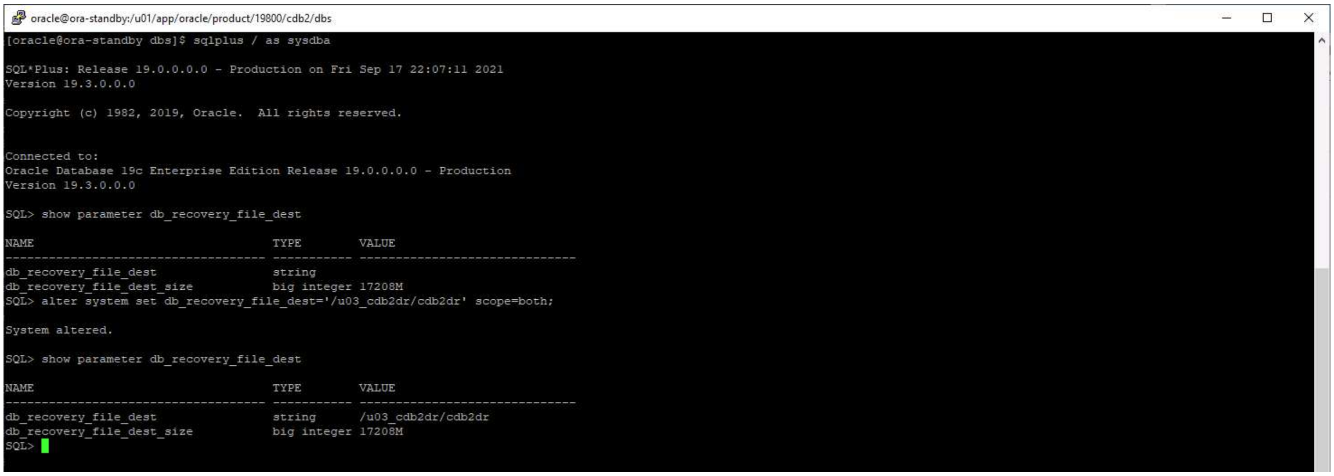
Post DR clone validation and configuration for Oracle

1. Validate the last test transaction that has been flushed, replicated, and recovered at the DR location in the cloud.



```
Oracle 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.



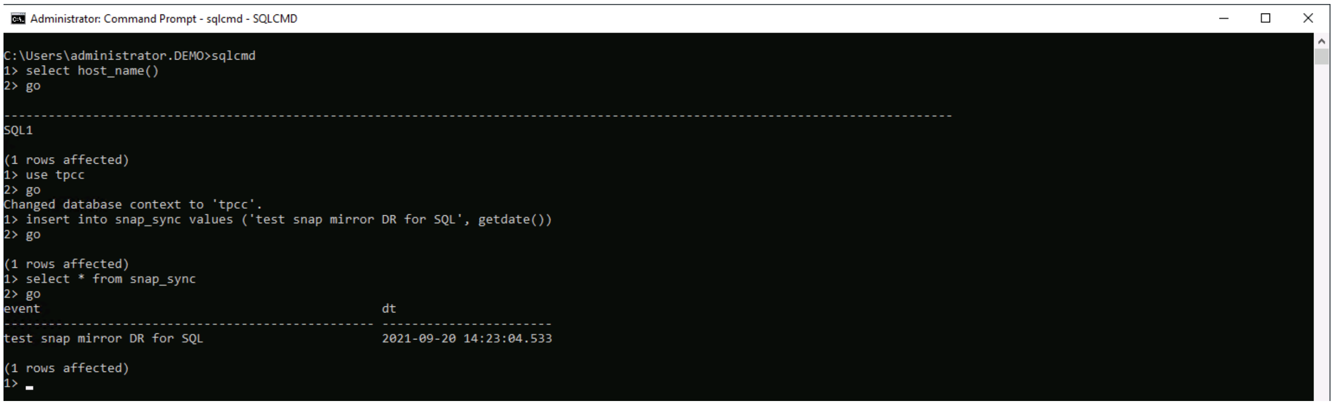
```
[oracle@ora-standby dbs]$ sqlplus / as sysdba

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.

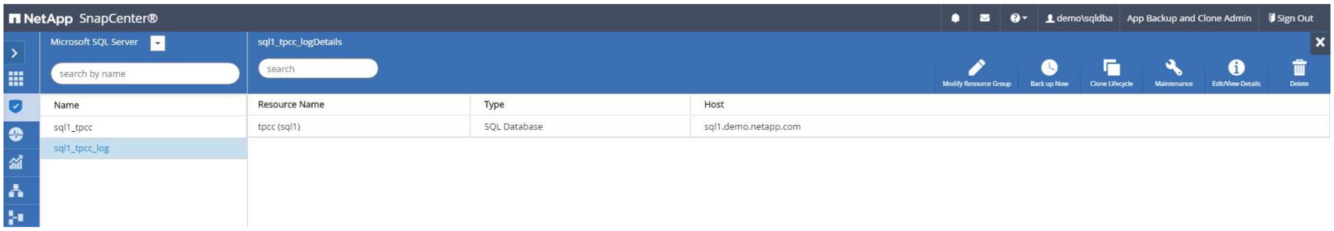
Clone an on-premises SQL production DB to cloud for DR

1. 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.



```
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> _
```

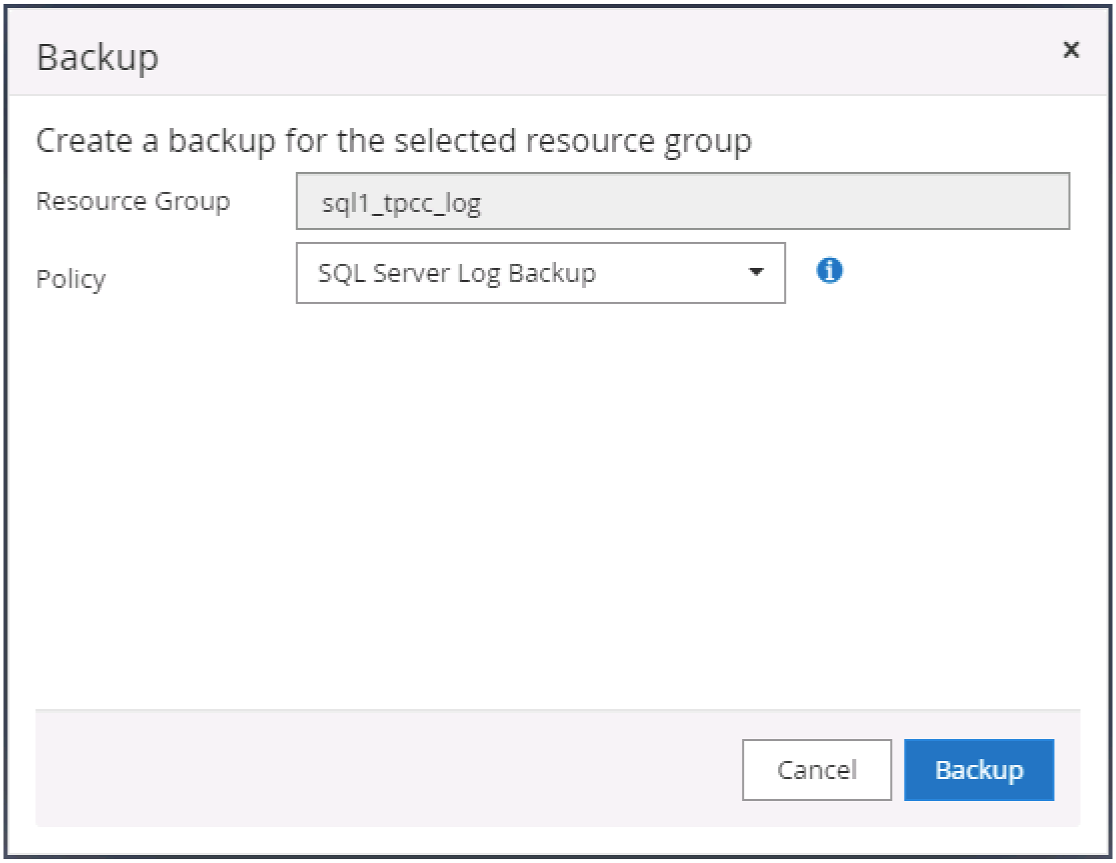
2. Log into SnapCenter with a database management user ID for SQL Server. Navigate to the Resources tab, which shows the SQL Server protection resources group.



Name
sql1_tpcc
sql1_tpcc_log

Resource Name	Type	Host
tpcc (sql1)	SQL Database	sql1.demo.netapp.com

3. Manually run a log backup to flush the last transaction to be replicated to secondary storage in the public cloud.

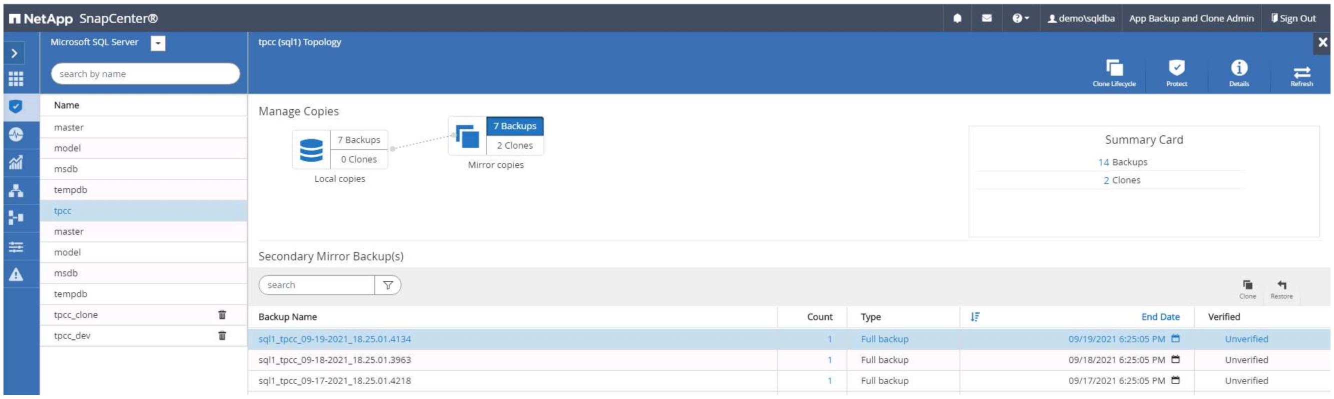


Create a backup for the selected resource group

Resource Group: sql1_tpcc_log

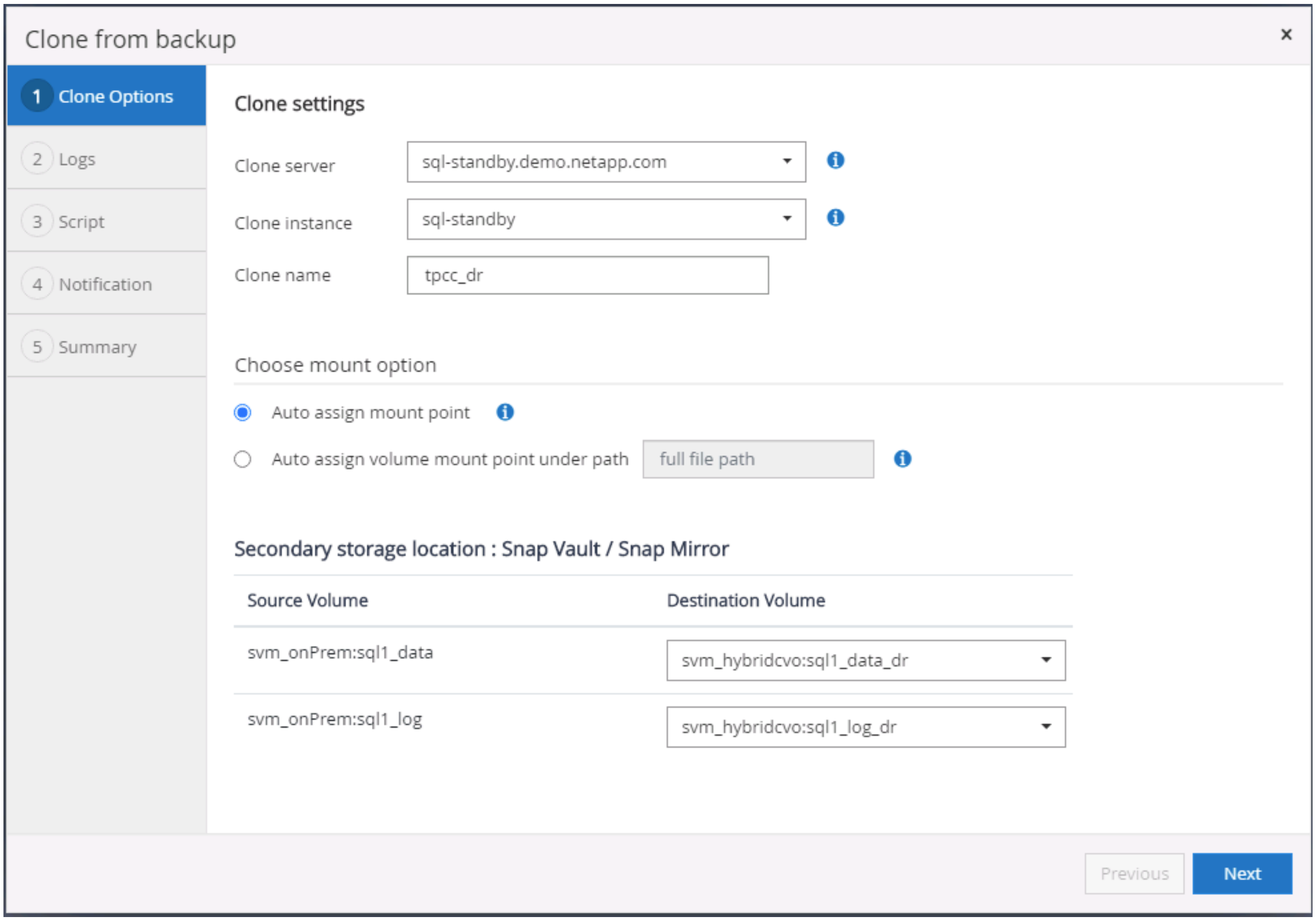
Policy: SQL Server Log Backup

4. 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 settings

Clone server: sql-standby.demo.netapp.com

Clone instance: sql-standby

Clone name: tpcc_dr

Choose mount option

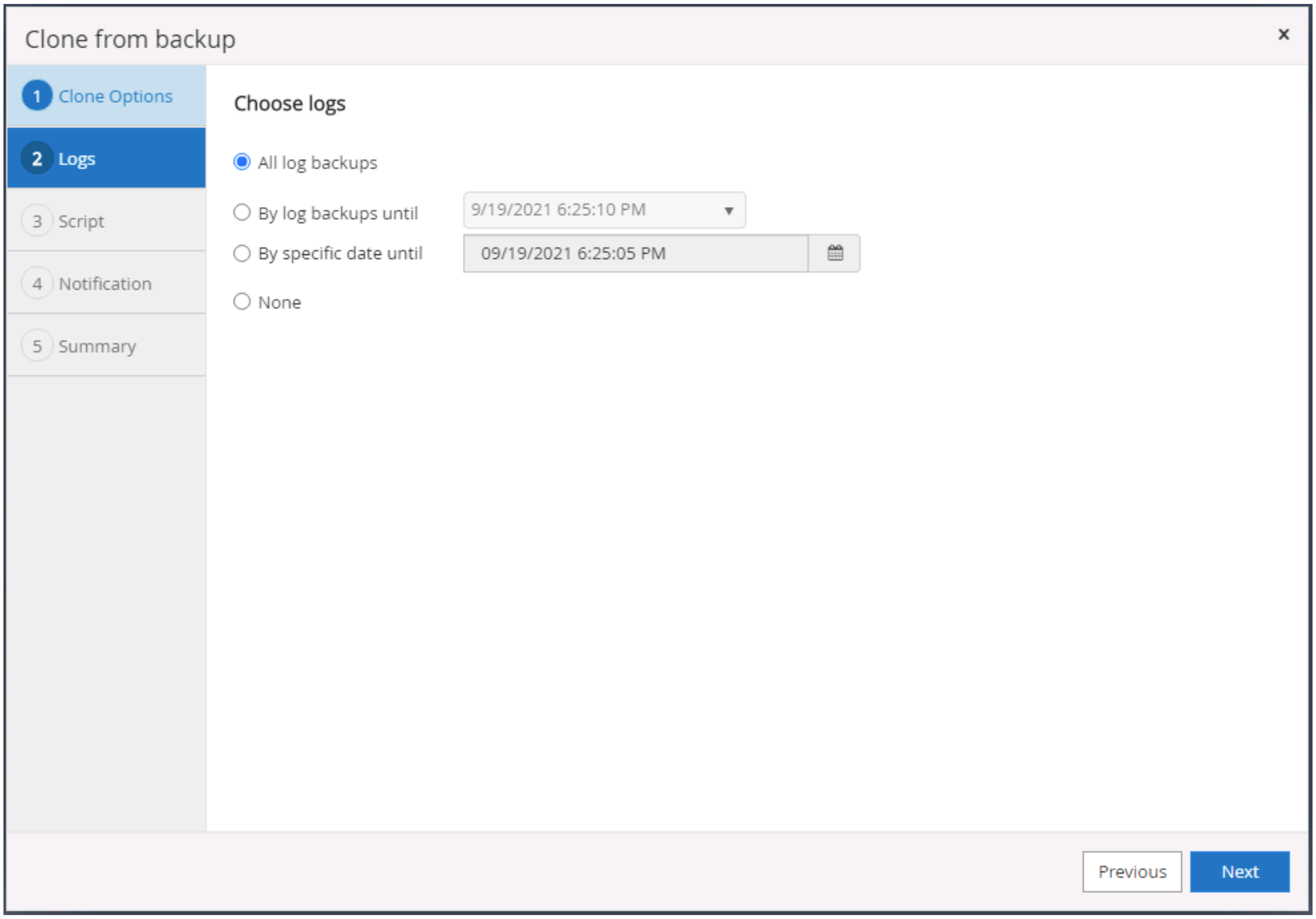
● Auto assign mount point

○ 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

6. Select all log backups to be applied.



Choose logs

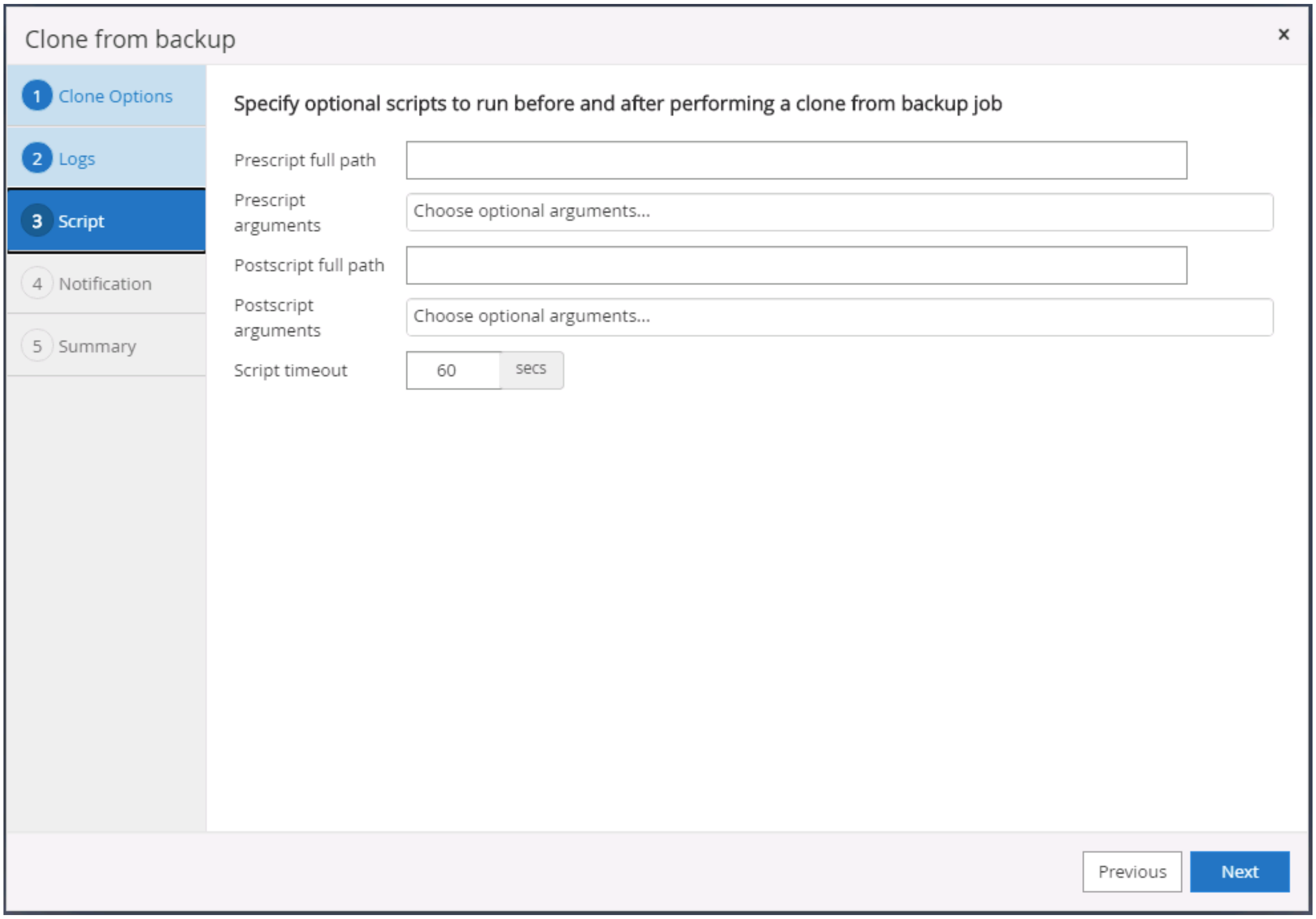
● All log backups

○ By log backups until 9/19/2021 6:25:10 PM

○ By specific date until 09/19/2021 6:25:05 PM

○ None

7. Specify any optional scripts to run before or after cloning.



Specify optional scripts to run before and after performing a clone from backup job

Prescript full path

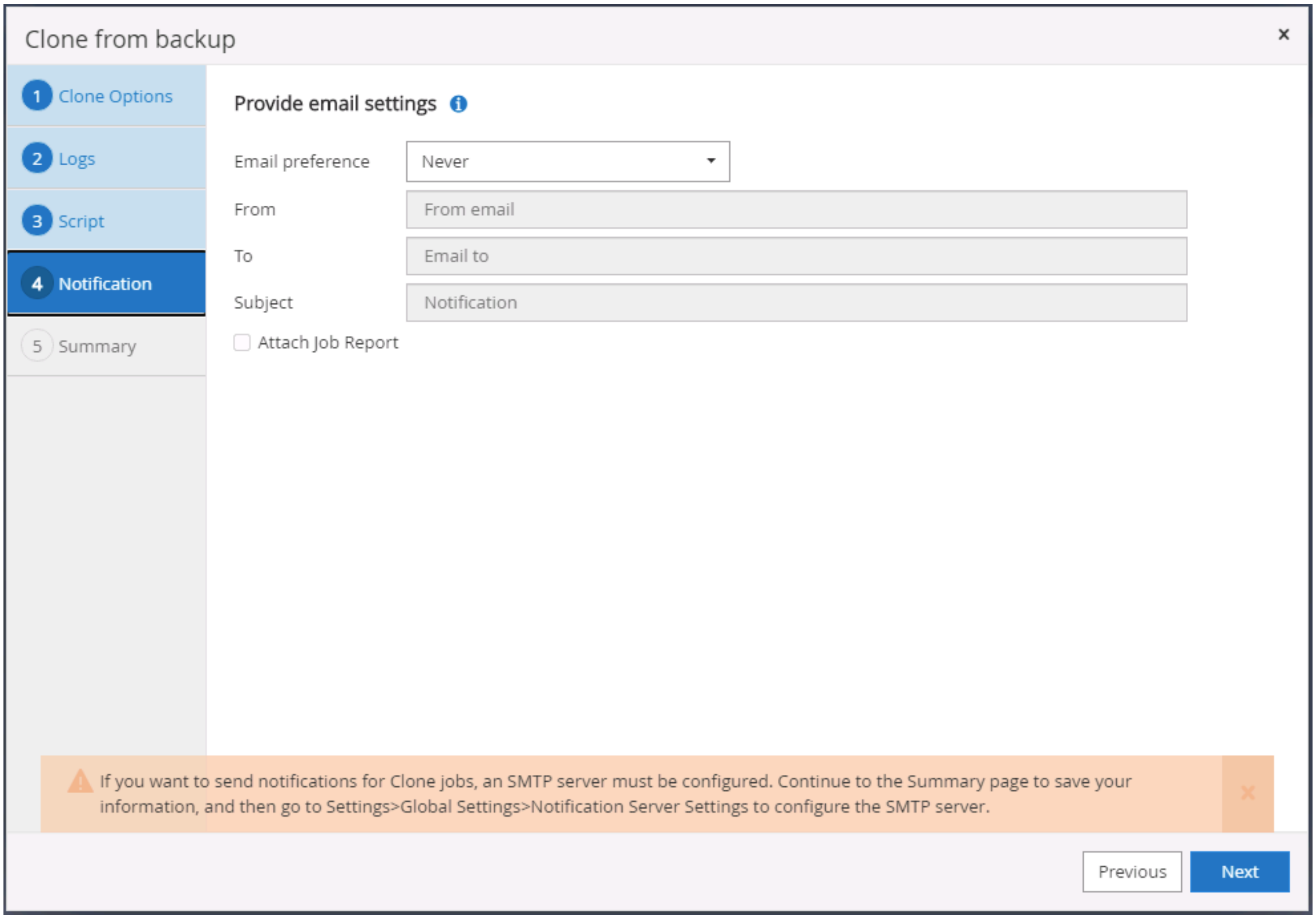
Prescript arguments: Choose optional arguments...

Postscript full path

Postscript arguments: Choose optional arguments...

Script timeout: 60 secs

8. Specify an SMTP server if email notification is desired.



Provide email settings

Email preference: Never

From: From email

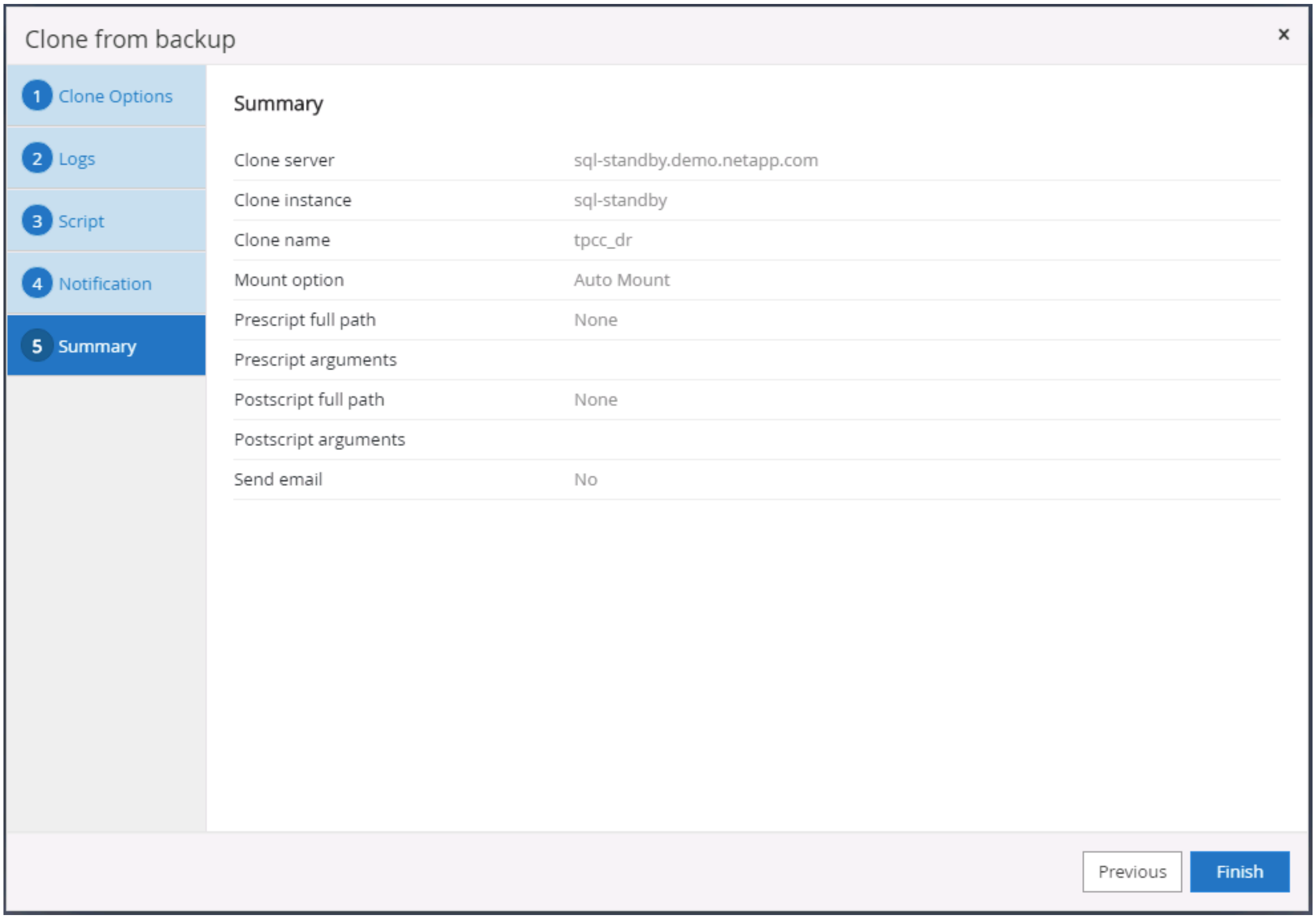
To: Email to

Subject: Notification

☐ Attach Job Report

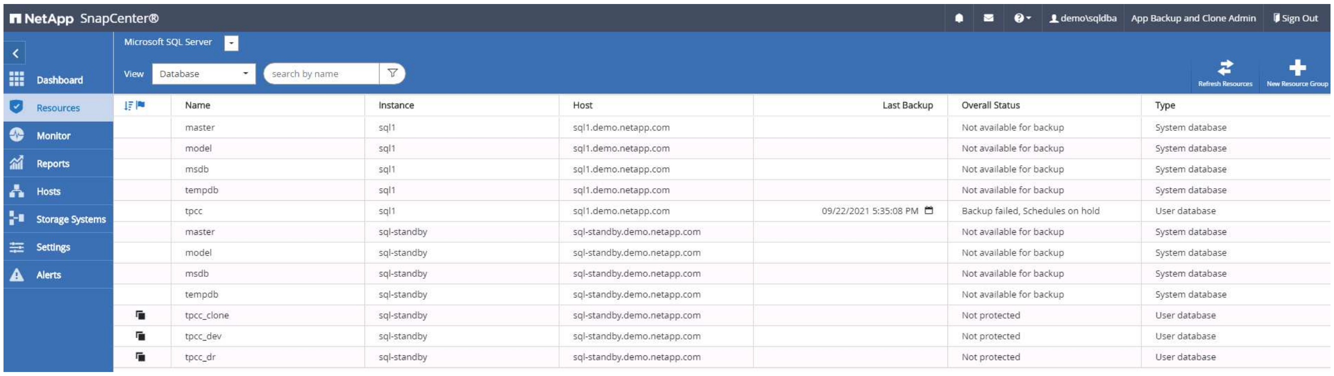
If you want to send notifications for Clone jobs, an SMTP server must be configured. Continue to the Summary page to save your information, and then go to Settings>Global Settings>Notification Server Settings to configure the SMTP server.

9. DR clone summary. Cloned databases are immediately registered with SnapCenter and available for backup protection.



Summary

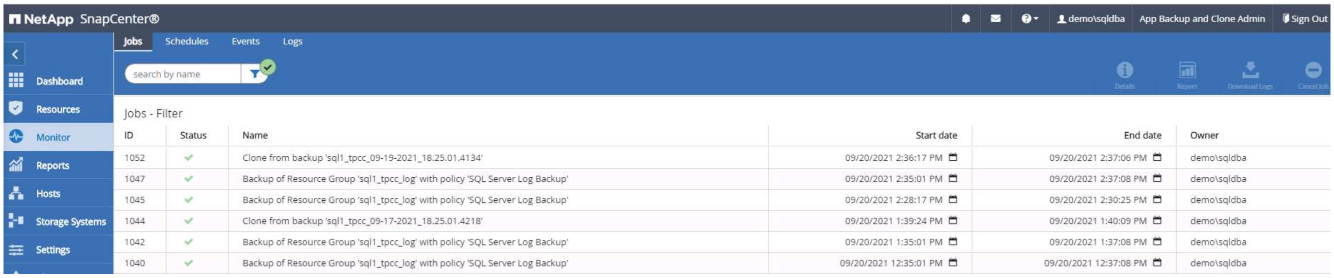
Clone server	sql-standby.demo.netapp.com
Clone instance	sql-standby
Clone name	tpcc_dr
Mount option	Auto Mount
Prescript full path	None
Prescript arguments	
Postscript full path	None
Postscript arguments	
Send email	No



	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_dev	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

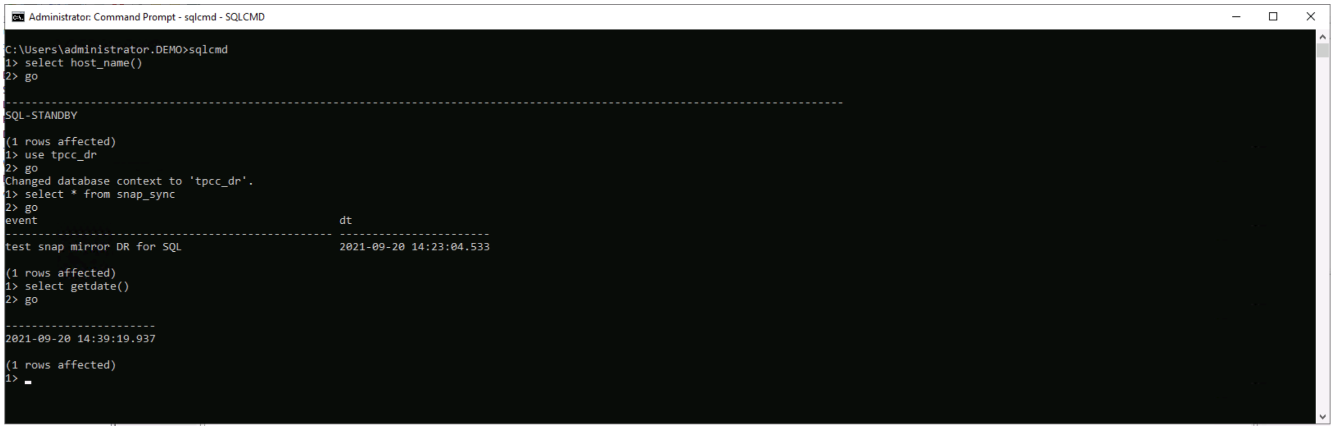
1. Monitor clone job status.



Jobs - Filter

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 2:28:17 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 1:35:01 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 12:35:01 PM	09/20/2021 12:37:08 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 inquires.

DB Automation Toolkits

SnapCenter Oracle Clone Lifecycle Automation

Allen Cao, Niyaz Mohamed, NetApp

This solution provides an Ansible based automation toolkit for configuring Oracle database High Availability and Disaster Recovery (HA/DR) with AWS FSx ONTAP as Oracle database storage and EC2 instances as the compute instances in AWS.

Purpose

Customers love the FlexClone feature of NetApp ONTAP storage for databases with significant storage cost savings. This Ansible based toolkit automates the setup, cloning, and refreshing of cloned Oracle databases on schedule using the NetApp SnapCenter command line utilities for streamlined lifecycle management. The toolkit is applicable to Oracle databases deployed to ONTAP storage either on-premisses or public cloud and managed by NetApp SnapCenter UI tool.

This solution addresses the following use cases:

- Setup Oracle database clone-specification configuration file.
- Create and refresh clone Oracle database on user defined schedule.

Audience

This solution is intended for the following people:

- A DBA who manages Oracle databases with SnapCenter.
- A storage administrator who manages ONTAP storage with SnapCenter.

- An application owner who has access to SnapCenter UI.

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Solution deployment

Prerequisites for deployment

Deployment requires the following prerequisites.

```
Ansible controller:
  Ansible v.2.10 and higher
  ONTAP collection 21.19.1
  Python 3
  Python libraries:
    netapp-lib
    xmltodict
    jmespath
```

```
SnapCenter server:
  version 5.0
  backup policy configured
  Source database protected with a backup policy
```

```
Oracle servers:
  Source server managed by SnapCenter
  Target server managed by SnapCenter
  Target server with identical Oracle software stack as source server
installed and configured
```

Download the toolkit

```
git clone https://bitbucket.ngage.netapp.com/scm/ns-
bb/na_oracle_clone_lifecycle.git
```

Ansible target hosts file configuration

The toolkit includes a hosts file which define the targets that an Ansible playbook running against. Usually, it is the target Oracle clone hosts. Following is an example file. A host entry includes target host IP address as well as ssh key for an admin user access to the host to execute clone or refresh command.

#Oracle clone hosts

```
[clone_1]
ora_04.cie.netapp.com ansible_host=10.61.180.29
ansible_ssh_private_key_file=ora_04.pem
```

```
[clone_2]
```

```
[clone_3]
```

Global variables configuration

The Ansible playbooks take variable inputs from several variable files. Below is an example global variable file vars.yml.

```
# ONTAP specific config variables
```

```
# SnapCtr specific config variables
```

```
snapctr_usr: xxxxxxxx
snapctr_pwd: 'xxxxxxxx'
```

```
backup_policy: 'Oracle Full offline Backup'
```

```
# Linux specific config variables
```

```
# Oracle specific config variables
```

Host variables configuration

Host variables are defined in host_vars directory named as {{ host_name }}.yml. Below is an example of target Oracle host variable file ora_04.cie.netapp.com.yml that shows typical configuration.

```
# User configurable Oracle clone db host specific parameters
```

```
# Source database to clone from
source_db_sid: NTAP1
source_db_host: ora_03.cie.netapp.com
```

```
# Clone database
clone_db_sid: NTAP1DEV
```

```
snapctr_obj_id: '{{ source_db_host }}\{{ source_db_sid }}'
```

Additional clone target Oracle server configuration

Clone target Oracle server should have the same Oracle software stack as source Oracle server installed and patched. Oracle user .bash_profile has $ORACLE_BASE, and $ORACLE_HOME configured. Also, $ORACLE_HOME variable should match with source Oracle server setting. Following is an example.

```
# .bash_profile
```

```
# Get the aliases and functions
if [ -f ~/.bashrc ]; then
        . ~/.bashrc
fi
```

```
# User specific environment and startup programs
export ORACLE_BASE=/u01/app/oracle
export ORACLE_HOME=/u01/app/oracle/product/19.0.0/NTAP1
```

Playbook execution

There are total of three playbooks to execute Oracle database clone lifecycle with SnapCenter CLI utilities.

1. Install Ansible controller prerequisites - one time only.

   ```
   ansible-playbook -i hosts ansible_requirements.yml
   ```

2. Setup clone specification file - one time only.

   ```
   ansible-playbook -i hosts clone_1_setup.yml -u admin -e
   @vars/vars.yml
   ```

3. Create and refresh clone database regularly from crontab with a shell script to call a refresh playbook.

   ```
   0 */4 * * * /home/admin/na_oracle_clone_lifecycle/clone_1_refresh.sh
   ```

For an additional clone database, create a separate clone_n_setup.yml and clone_n_refresh.yml, and clone_n_refresh.sh. Configure the Ansible target hosts and hostname.yml file in host_vars directory accordingly.

Where to find additional information

To learn more about the NetApp solution automation, review the following website NetApp Solution Automation

Automated Oracle Migration

NetApp Solutions Engineering Team

This solution provides an Ansible based automation toolkit for migrating Oracle database using PDB relocation with maximum availability methodology. The migration can be any combinations of on-premises and cloud as either source or target.

Purpose

This toolkit automates Oracle database migration from on-premises to AWS cloud with FSx ONTAP storage and EC2 compute instance as target infrastructure. It assumes the customer already has an on-premises Oracle database deployed in the CDB/PDB model. The toolkit will allow the customer to relocate a named PDB from a container database on an Oracle host using the Oracle PDB relocation procedure with a maximum availability option. That means the source PDB on any on-premises storage array relocates to a new container database with minimal service interruption. The Oracle relocation procedure will move the Oracle data files while database is online. It subsequently reroutes user sessions from on-premises to the relocated database services at the time of switching over when all data files move over to AWS cloud. The underlined technology is proven Oracle PDB hot clone methodology.

> Although the migration toolkit is developed and validated on AWS cloud infrastructure, it builds on Oracle application-level solutions. Therefore, the toolkit is applicable to other public cloud platforms, such as Azure, GCP, etc.

This solution addresses the following use cases:

- Create migration user and grant required privileges at on-prem source DB server.
- Relocate a PDB from on-premises CDB to a target CDB in cloud while the source PDB is online until switch over.

Audience

This solution is intended for the following people:

- A DBA who migrates Oracle databases from on-premisses to AWS cloud.
- A database solution architect who is interested in Oracle database migration from on-premisses to AWS cloud.
- A storage administrator who manages AWS FSx ONTAP storage that supports Oracle databases.
- An application owner who likes to migrate Oracle database from on-premisses to AWS cloud.

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Solution deployment

Prerequisites for deployment

Deployment requires the following prerequisites.

```
Ansible v.2.10 and higher
ONTAP collection 21.19.1
Python 3
Python libraries:
  netapp-lib
  xmltodict
  jmespath
```

```
Source Oracle CDB with PDBs on-premises
Target Oracle CDB in AWS hosted on FSx and EC2 instance
Source and target CDB on same version and with same options installed
```

```
Network connectivity
  Ansible controller to source CDB
  Ansible controller to target CDB
  Source CDB to target CDB on Oracle listener port (typical 1521)
```

Download the toolkit

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

Host variables configuration

Host variables are defined in host_vars directory named as {{ host_name }}.yml. An example host variable file host_name.yml is included to demonstrate typical configuration. Following are key considerations:

```
Source Oracle CDB - define host specific variables for the on-prem CDB
  ansible_host: IP address of source database server host
  source_oracle_sid: source Oracle CDB instance ID
  source_pdb_name: source PDB name to migrate to cloud
  source_file_directory: file directory of source PDB data files
  target_file_directory: file directory of migrated PDB data files
```

```
Target Oracle CDB - define host specific variables for the target CDB
including some variables for on-prem CDB
  ansible_host: IP address of target database server host
  target_oracle_sid: target Oracle CDB instance ID
  target_pdb_name: target PDB name to be migrated to cloud (for max
availability option, the source and target PDB name must be the same)
  source_oracle_sid: source Oracle CDB instance ID
  source_pdb_name: source PDB name to be migrated to cloud
  source_port: source Oracle CDB listener port
  source_oracle_domain: source Oracle database domain name
  source_file_directory: file directory of source PDB data files
  target_file_directory: file directory of migrated PDB data files
```

DB server host file configuration

AWS EC2 instance use IP address for host naming by default. If you use different name in hosts file for Ansible, setup host naming resolution in /etc/hosts file for both source and target server. Following is an example.

```
127.0.0.1   localhost localhost.localdomain localhost4
localhost4.localdomain4
::1         localhost localhost.localdomain localhost6
localhost6.localdomain6
172.30.15.96 source_db_server
172.30.15.107 target_db_server
```

Playbook execution - executed in sequence

1. Install Ansible controller prerequisites.

   ```
   ansible-playbook -i hosts requirements.yml
   ```

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

2. Execute pre-migration tasks against on-prem server - assuming admin is ssh user for connection to on-prem Oracle host with sudo permission.

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

3. Execute Oracle PDB relocation from on-prem CDB to target CDB in AWS EC2 instance - assuming ec2-user for EC2 DB instance connection, and db1.pem with ec2-user ssh key pairs.

   ```
   ansible-playbook -i hosts ora_pdb_relocate.yml -u ec2-user --private
   -key db1.pem -t ora_pdb_relo_primary
   ```

Where to find additional information

To learn more about the NetApp solution automation, review the following website NetApp Solution Automation

Automated Oracle HA/DR in AWS FSx ONTAP

NetApp Solutions Engineering Team

This solution provides an Ansible based automation toolkit for configuring Oracle database High Availability and Disaster Recovery (HA/DR) with AWS FSx ONTAP as Oracle database storage and EC2 instances as the compute instances in AWS.

Purpose

This toolkit automates the tasks of setting up and managing a High Availability and Disaster Recovery (HR/DR) environment for Oracle database deployed in AWS cloud with FSx for ONTAP storage and EC2 compute instances.

This solution addresses the following use cases:

- Setup HA/DR target host - kernel configuration, Oracle configuration to match up with source server host.
- Setup FSx ONTAP - cluster peering, vserver peering, Oracle volumes snapmirror relationship setup from source to target.

- Backup Oracle database data via snapshot - execute off crontab
- Backup Oracle database archive log via snapshot - execute off crontab
- Run failover and recovery on HA/DR host - test and validate HA/DR environment
- Run resync after failover test - re-establish database volumes snapmirror relationship in HA/DR mode

Audience

This solution is intended for the following people:

- A DBA who set up Oracle database in AWS for high availability, data protection, and disaster recovery.
- A database solution architect who is interested in storage level Oracle HA/DR solution in the AWS cloud.
- A storage administrator who manages AWS FSx ONTAP storage that supports Oracle databases.
- An application owner who like to stand up Oracle database for HA/DR in AWS FSx/EC2 environment.

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Solution deployment

Prerequisites for deployment

Deployment requires the following prerequisites.

```
Ansible v.2.10 and higher
ONTAP collection 21.19.1
Python 3
Python libraries:
  netapp-lib
  xmltodict
  jmespath
```

```
AWS FSx storage as is available
```

```
AWS EC2 Instance
  RHEL 7/8, Oracle Linux 7/8
  Network interfaces for NFS, public (internet) and optional management
  Existing Oracle environment on source, and the equivalent Linux
operating system at the target
```

Download the toolkit

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

Global variables configuration

The Ansible playbooks are variable driven. An example global variable file fsx_vars_example.yml is included to demonstrate typical configuration. Following are key considerations:

```
ONTAP - retrieve FSx storage parameters using AWS FSx console for both
source and target FSx clusters.
  cluster name: source/destination
  cluster management IP: source/destination
  inter-cluster IP: source/destination
  vserver name: source/destination
  vserver management IP: source/destination
  NFS lifs: source/destination
  cluster credentials: fsxadmin and vsadmin pwd to be updated in
roles/ontap_setup/defaults/main.yml file
```

```
Oracle database volumes - they should have been created from AWS FSx
console, volume naming should follow strictly with following standard:
  Oracle binary: {{ host_name }}_bin, generally one lun/volume
  Oracle data: {{ host_name }}_data, can be multiple luns/volume, add
additional line for each additional lun/volume in variable such as {{
host_name }}_data_01, {{ host_name }}_data_02 ...
  Oracle log: {{ host_name }}_log, can be multiple luns/volume, add
additional line for each additional lun/volume in variable such as {{
host_name }}_log_01, {{ host_name }}_log_02 ...
  host_name: as defined in hosts file in root directory, the code is
written to be specifically matched up with host name defined in host
file.
```

```
Linux and DB specific global variables - keep it as is.
  Enter redhat subscription if you have one, otherwise leave it black.
```

Host variables configuration

Host variables are defined in host_vars directory named as {{ host_name }}.yml. An example host variable file host_name.yml is included to demonstrate typical configuration. Following are key considerations:

```
Oracle - define host specific variables when deploying Oracle in
multiple hosts concurrently
  ansible_host: IP address of database server host
  log_archive_mode: enable archive log archiving (true) or not (false)
  oracle_sid: Oracle instance identifier
  pdb: Oracle in a container configuration, name pdb_name string and
number of pdbs (Oracle allows 3 pdbs free of multitenant license fee)
  listener_port: Oracle listener port, default 1521
  memory_limit: set Oracle SGA size, normally up to 75% RAM
  host_datastores_nfs: combining of all Oracle volumes (binary, data,
and log) as defined in global vars file. If multi luns/volumes, keep
exactly the same number of luns/volumes in host_var file
```

```
Linux - define host specific variables at Linux level
  hugepages_nr: set hugepage for large DB with large SGA for
performance
  swap_blocks: add swap space to EC2 instance. If swap exist, it will
be ignored.
```

DB server host file configuration

AWS EC2 instance use IP address for host naming by default. If you use different name in hosts file for Ansible, setup host naming resolution in /etc/hosts file for both source and target servers. Following is an example.

```
127.0.0.1   localhost localhost.localdomain localhost4
localhost4.localdomain4
::1         localhost localhost.localdomain localhost6
localhost6.localdomain6
172.30.15.96 db1
172.30.15.107 db2
```

Playbook execution - executed in sequence

1. Install Ansible controller prerequsites.

```
ansible-playbook -i hosts requirements.yml
```

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

2. Setup target EC2 DB instance.

```
ansible-playbook -i hosts ora_dr_setup.yml -u ec2-user --private-key
db2.pem -e @vars/fsx_vars.yml
```

3. Setup FSx ONTAP snapmirror relationship between source and target database volumes.

```
ansible-playbook -i hosts ontap_setup.yml -u ec2-user --private-key
db2.pem -e @vars/fsx_vars.yml
```

4. Backup Oracle database data volumes via snapshot from crontab.

```
10 * * * * cd /home/admin/na_ora_hadr_failover_resync &&
/usr/bin/ansible-playbook -i hosts ora_replication_cg.yml -u ec2-
user --private-key db1.pem -e @vars/fsx_vars.yml >>
logs/snap_data_`date +"%Y-%m%d-%H%M%S"`.log 2>&1
```

5. Backup Oracle database archive log volumes via snapshot from crontab.

```
0,20,30,40,50 * * * * cd /home/admin/na_ora_hadr_failover_resync &&
/usr/bin/ansible-playbook -i hosts ora_replication_logs.yml -u ec2-
user --private-key db1.pem -e @vars/fsx_vars.yml >>
logs/snap_log_`date +"%Y-%m%d-%H%M%S"`.log 2>&1
```

6. Run failover and recover Oracle database on target EC2 DB instance - test and validate HA/DR configuration.

```
ansible-playbook -i hosts ora_recovery.yml -u ec2-user --private-key
db2.pem -e @vars/fsx_vars.yml
```

7. Run resync after failover test - re-establish database volumes snapmirror relationship in replication mode.

```
ansible-playbook -i hosts ontap_ora_resync.yml -u ec2-user --private
-key db2.pem -e @vars/fsx_vars.yml
```

Where to find additional information

To learn more about the NetApp solution automation, review the following website NetApp Solution Automation

AWS FSx ONTAP Cluster and EC2 Instance Provision

NetApp Solutions Engineering Team

This solution provides a Terraform based automation toolkit for provisioning of FSx ONTAP cluster and EC2 compute instance.

Purpose

This toolkit automates the tasks of provisioning of an AWS FSx ONTAP storage cluster and an EC2 compute instance, which can be subsequently used for database deployment.

This solution addresses the following use cases:

- Provision an EC2 compute instance in AWS cloud in a predefined VPC subnet and set ssh key for EC2 instance access as ec2-user.
- Provision an AWS FSx ONTAP storage cluster in desired availability zones and configure a storage SVM and set cluster admin user fsxadmin password.

Audience

This solution is intended for the following people:

- A DBA who manages databases in AWS EC2 environment.
- A database solution architect who is interested in database deployment in AWS EC2 ecosystem.
- A storage administrator who manages AWS FSx ONTAP storage that supports databases.
- An application owner who likes to standup database in AWS EC2 ecosystem.

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Solution deployment

Prerequisites for deployment

Deployment requires the following prerequisites.

```
An Organization and AWS account has been setup in AWS public cloud
  An user to run the deployment has been created
  IAM roles has been configured
  IAM roles granted to user to permit provisioning the resources
```

```
VPC and security configuration
  A VPC has been created to host the resources to be provisioned
  A security group has been configured for the VPC
  A ssh key pair has been created for EC2 instance access
```

```
Network configuration
  Subnets has been created for VPC with network segments assigned
  Route tables and network ACL configured
  NAT gateways or internet gateways configured for internet access
```

Download the toolkit

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

Connectivity and authentication

The toolkit is supposed to be executed from an AWS cloud shell. AWS cloud shell is a browser-based shell that makes it easy to securely manage, explore, and interact with your AWS resources. CloudShell is pre-authenticated with your console credentials. Common development and operations tools are pre-installed, so no local installation or configuration is required.

Terraform provider.tf and main.tf files configuration

The provider.tf defines the provider that Terraform is provisioning resources from via API calls. The main.tf defines the resources and attributes of resources that are to be provisioned. Following are some details:

```
provider.tf:
  terraform {
    required_providers {
      aws = {
        source  = "hashicorp/aws"
        version = "~> 4.54.0"
      }
    }
  }
```

```
main.tf:
  resource "aws_instance" "ora_01" {
    ami                           = var.ami
    instance_type                 = var.instance_type
    subnet_id                     = var.subnet_id
    key_name                      = var.ssh_key_name
    root_block_device {
      volume_type                 = "gp3"
      volume_size                 = var.root_volume_size
    }
    tags = {
      Name                        = var.ec2_tag
    }
  }
  ....
```

Terraform variables.tf and terraform.tfvars configuration

The variables.tf declares the variables to be used in main.tf. The terraform.tfvars contains the actual values for the variables. Following are some examples:

```
variables.tf:
  ### EC2 instance variables ###
```

```
variable "ami" {
  type        = string
  description = "EC2 AMI image to be deployed"
}
```

```
variable "instance_type" {
  type        = string
  description = "EC2 instance type"
}
....
```

```
terraform.tfvars:
  # EC2 instance variables
```

```
ami                       = "ami-06640050dc3f556bb" //RedHat 8.6  AMI
instance_type             = "t2.micro"
ec2_tag                   = "ora_01"
subnet_id                 = "subnet-04f5fe7073ff514fb"
ssh_key_name              = "sufi_new"
root_volume_size          = 30
....
```

Step by step procedures - executed in sequence

1. Install Terraform in AWS cloud shell.

   ```
   git clone https://github.com/tfutils/tfenv.git ~/.tfenv
   ```

   ```
   mkdir ~/bin
   ```

   ```
   ln -s ~/.tfenv/bin/* ~/bin/
   ```

   ```
   tfenv install
   ```

   ```
   tfenv use 1.3.9
   ```

2. Download the toolkit from NetApp GitHub public site

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

3. Run init to initialize terraform

   ```
   terraform init
   ```

4. Output the execution plan

   ```
   terraform plan -out=main.plan
   ```

5. Apply the execution plan

   ```
   terraform apply "main.plan"
   ```

6. Run destroy to remove the resources when done

   ```
   terraform destroy
   ```

Where to find additional information

To learn more about the NetApp solution automation, review the following website NetApp Solution Automation

DB Sizing Toolkits

Oracle Sizing Guidance for Azure NetApp Files

Allen Cao, Niyaz Mohamed, NetApp

This solution provides an useful toolkit for sizing compute and storage for Oracle deployment on ANF in Azure cloud.

Purpose

Moving existing Oracle workload from one platform to another, such as from on-prem to public cloud, needs sizing compute and storage in the target platform to meet performance and service level requirements. This documentation demonstrates a simple toolkit to accomplish that goal.

Unlike a new database application, which may grow over time, an existing Oracle workload has established workload patterns in compute and storage requirements, which are recorded in an Oracle Workload Repository or AWR. This toolkit utilizes an HTML parser to retrieve relevant information from Oracle AWR. The results are supplemented by additional sizing information obtained via SQL scripts against the database to provide meaningful compute and storage guidance when relocating the Oracle database.

This solution addresses the following use cases:

- Provide sizing guidance for Oracle database server compute when relocating database from on-prem to Microsoft Azure cloud.
- Provide sizing guidance for Oracle database server storage when relocating database from on-prem to Microsoft Azure NetApp Files.

Audience

This solution is intended for the following people:

- A DBA who manages Oracle databases in on-prem private data center or Microsoft Azure cloud environment.
- A storage administrator who manages on-prem storage or Microsoft Azure NetApp Files storage that supports Oracle databases.
- An application owner who likes to migrate Oracle database from on-prem to Microsoft Azure cloud.

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Solution deployment

Prerequisites for deployment

Deployment requires the following prerequisites.

- Oracle AWR reports that capture the snapshots of database activities during peak application workload.
- Access to Oracle database to execute SQL scripts with DBA privilege.

Download the toolkit

Retrieve the toolkit from repository Oracle Sizing Guidance for ANF

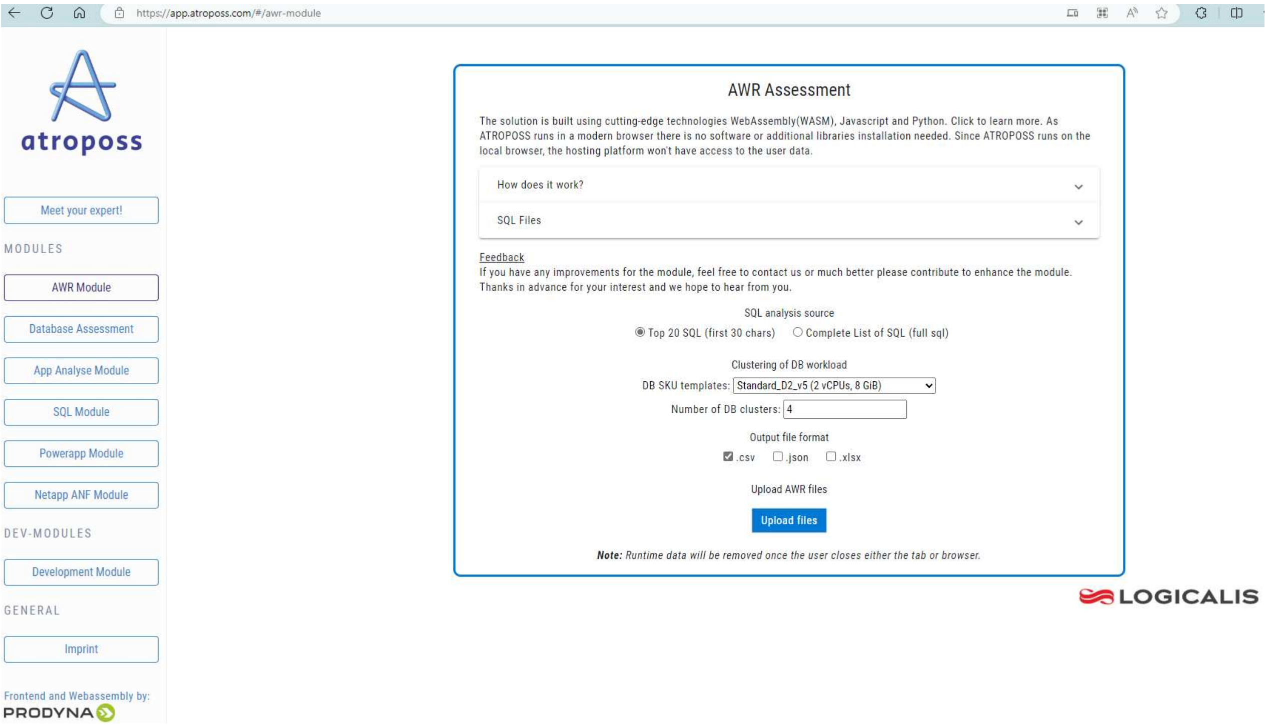
How to use the toolkit?

The toolkit consists of a web-based HTML parser and two SQL scripts to gather Oracle database information. The output is then input into an Excel template to generate sizing guidance of computing and storage for the Oracle database server.

- Use an HTML parser AWR module to retrieve sizing information of a current Oracle database from an AWR report.
- Execute ora_db_data_szie.sql as a DBA to retrieve physical Oracle data file size from database.
- Execute ora_db_logs_size.sql as a DBA to retrieve Oracle archived logs size with desired archive logs retention window (days).
- Input sizing information obtained above into excel template file oracle_db_sizing_template_anf.xlsx to create a sizing guidance on compute and storage for Oracle DB server.

Toolkit usage demonstration

1. Open HTML parser AWR module.



AWR Assessment

The solution is built using cutting-edge technologies WebAssembly(WASM), Javascript and Python. Click to learn more. As ATROPOSS runs in a modern browser there is no software or additional libraries installation needed. Since ATROPOSS runs on the local browser, the hosting platform won't have access to the user data.

How does it work?

SQL Files

Feedback
If you have any improvements for the module, feel free to contact us or much better please contribute to enhance the module. Thanks in advance for your interest and we hope to hear from you.

SQL analysis source
● Top 20 SQL (first 30 chars) ○ Complete List of SQL (full sql)

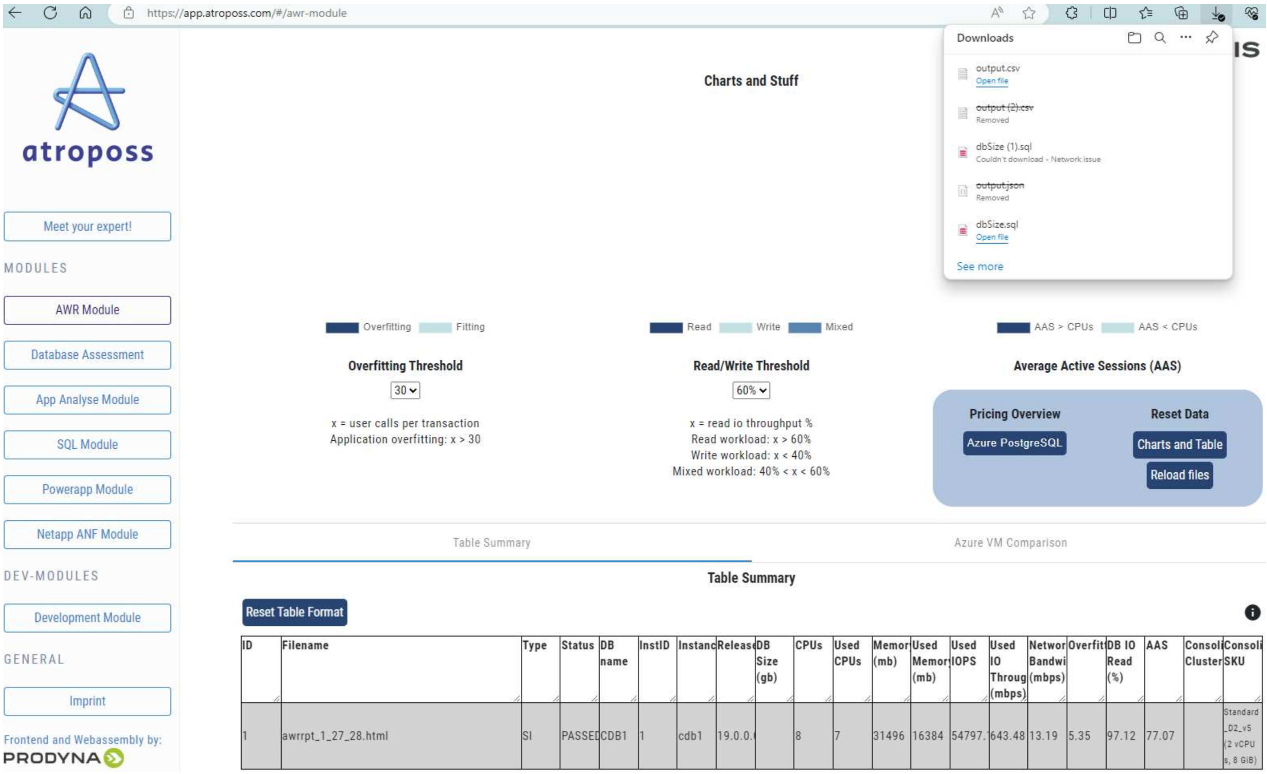
Clustering of DB workload
DB SKU templates: Standard_D2_v5 (2 vCPUs, 8 GiB)
Number of DB clusters: 4

Output file format
☑ .csv ☐ .json ☐ .xlsx

Upload AWR files
Upload files

Note: Runtime data will be removed once the user closes either the tab or browser.

2. Check output format as .csv and click `Upload files` to upload awr report. The parser returns results in a HTML page with a table summary as well as an output.csv file in `Download` folder.



Overfitting Threshold
30
x = user calls per transaction
Application overfitting: x > 30

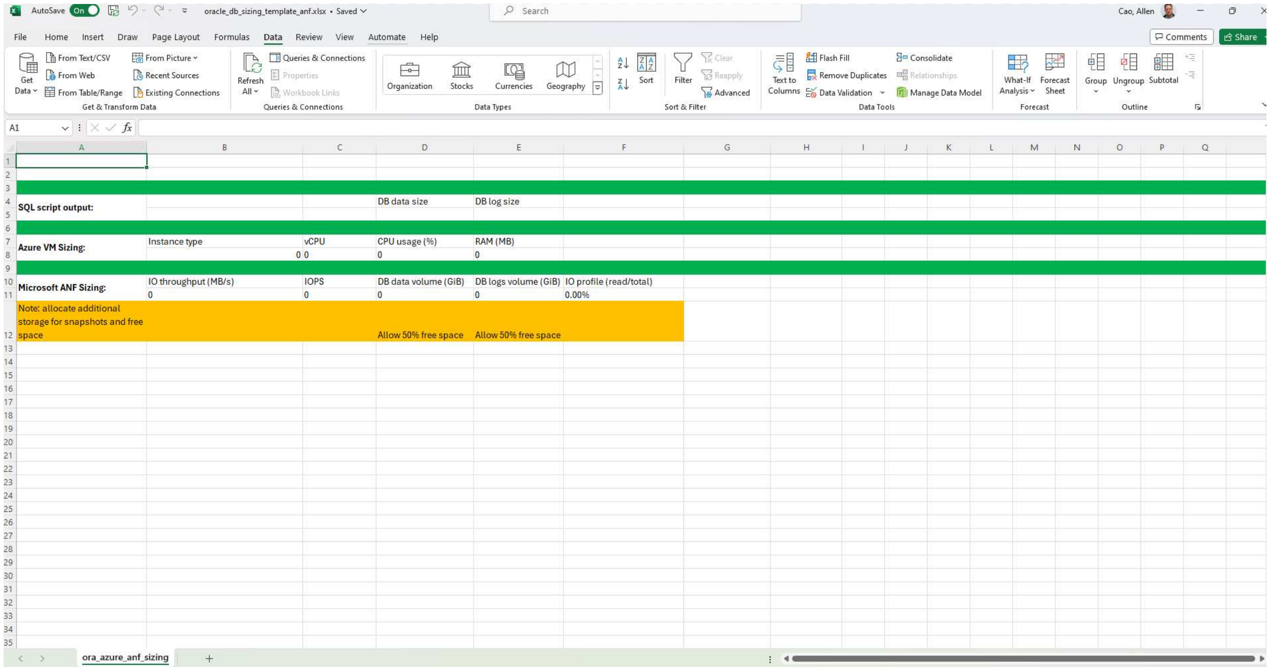
Read/Write Threshold
60%
x = read io throughput %
Read workload: x > 60%
Write workload: x < 40%
Mixed workload: 40% < x < 60%

Average Active Sessions (AAS)

Table Summary

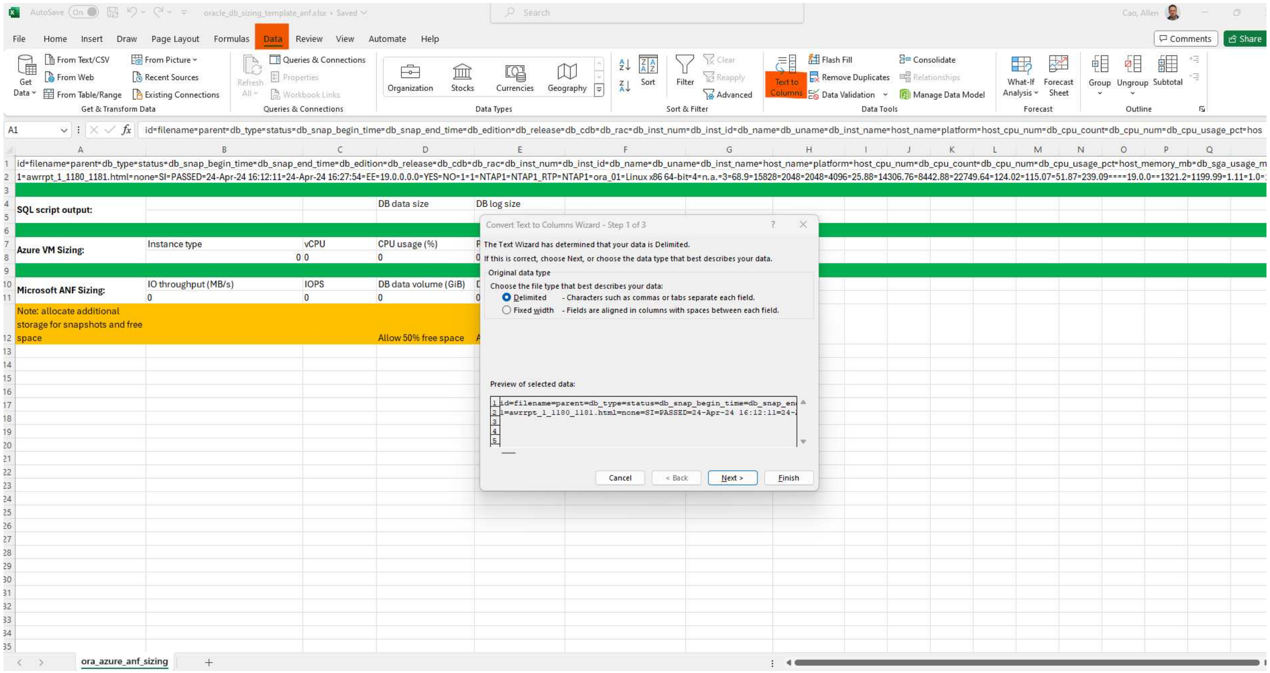
ID	Filename	Type	Status	DB name	InstID	Instanc	Release	DB Size (gb)	CPUs	Used CPUs	Memor (mb)	Used Memor (mb)	Used IOPS	Used IO Throug (mbps)	Networ Bandwi (mbps)	Overfit	DB IO Read (%)	AAS	Consoli Cluster	Consoli SKU
1	awrrpt_1_27_28.html	SI	PASSED	CDB1	1	cdb1	19.0.0.(		8	7	31496	16384	54797.	643.48	13.19	5.35	97.12	77.07		Standard_D2_v5 (2 vCPUs, 8 GiB)

3. Open the excel template file and copy paste the csv content into column A and cell 1 to generate the DB server sizing information.



	A	B	C	D	E	F
4–5	**SQL script output:**			DB data size	DB log size	
7	**Azure VM Sizing:**	Instance type	vCPU	CPU usage (%)	RAM (MB)	
8		0	0	0	0	
10	**Microsoft ANF Sizing:**	IO throughput (MB/s)	IOPS	DB data volume (GiB)	DB logs volume (GiB)	IO profile (read/total)
11		0	0	0	0	0.00%
12	Note: allocate additional storage for snapshots and free space			Allow 50% free space	Allow 50% free space	

4. Highlight column A and fields 1 and 2, click on `Data`, then `Text to Columns` to open the Text Wizzard. Choose `Delimited`, then `Next` to next screen.



```
1 id=filename=parent=db_type=status=db_snap_begin_time=db_snap_end_time=db_edition=db_release=db_cdb=db_rac=db_inst_num=db_inst_id=db_name=db_uname=db_inst_name=host_name=platform=host_cpu_num=db_cpu_count=db_cpu_num=db_cpu_usage_pct=host_memory_mb=db_sga_usage_m
2 1=awrrpt_1_1180_1181.html=none=SI=PASSED=24-Apr-24 16:12:11=24-Apr-24 16:27:54=EE=19.0.0.0.0=YES=NO=1=1=NTAP1=NTAP1_RTP=NTAP1=ora_01=Linux x86 64-bit=4=n.a.=3=68.9=15828=2048=2048=4096=25.88=14306.76=8442.88=22749.64=124.02=115.07=51.87=239.09====19.0.0==1321.2=1199.99=1.11=1.0=
```

The Text Wizard has determined that your data is Delimited.

If this is correct, choose Next, or choose the data type that best describes your data.

Original data type

Choose the file type that best describes your data:

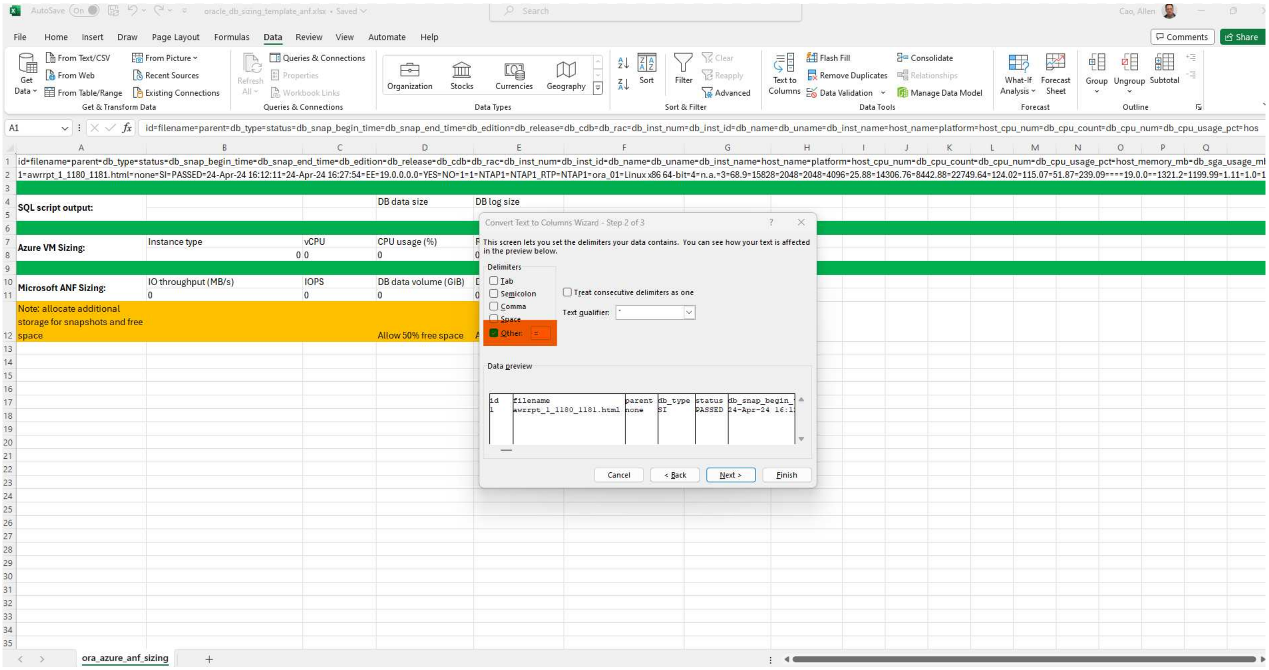
● Delimited - Characters such as commas or tabs separate each field.

○ Fixed width - Fields are aligned in columns with spaces between each field.

Preview of selected data:

```
1 id=filename=parent=db_type=status=db_snap_begin_time=db_snap_en
2 1=awrrpt_1_1180_1181.html=none=SI=PASSED=24-Apr-24 16:12:11=24-
3
4
5
```

5. Check `Other`, then enter '=' as `Delimiters`. Click on `Next` to next screen.



Convert Text to Columns Wizard - Step 2 of 3

This screen lets you set the delimiters your data contains. You can see how your text is affected in the preview below.

Delimiters

☐ Tab
☐ Semicolon
☐ Comma
☐ Space
☑ Other: =

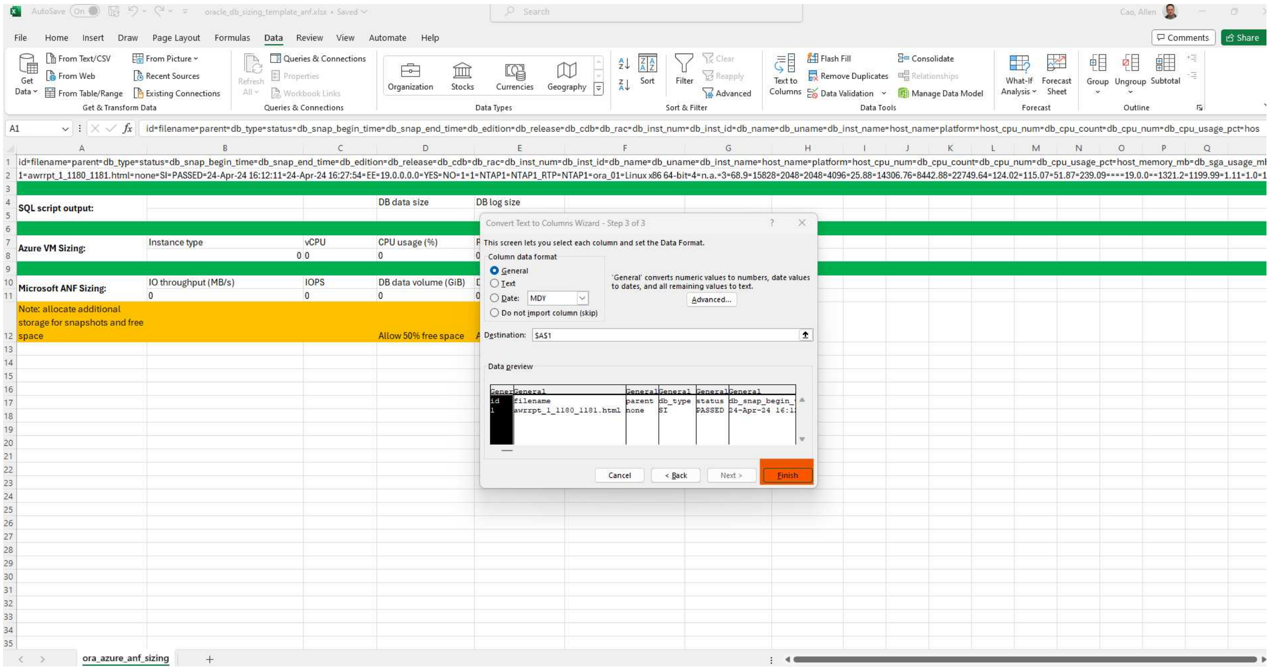
☐ Treat consecutive delimiters as one

Text qualifier: "

Data preview

```
id  filename                  parent  db_type  status  db_snap_begin_
1   awrrpt_1_1180_1181.html   none    SI       PASSED  24-Apr-24 16:1
```

6. Click on `Finish` to complete the string conversion into readable column format. Note the VM and ANF sizing fields have been populated with data retrieved from the Oracle AWR report.



Convert Text to Columns Wizard - Step 3 of 3

This screen lets you select each column and set the Data Format.

Column data format

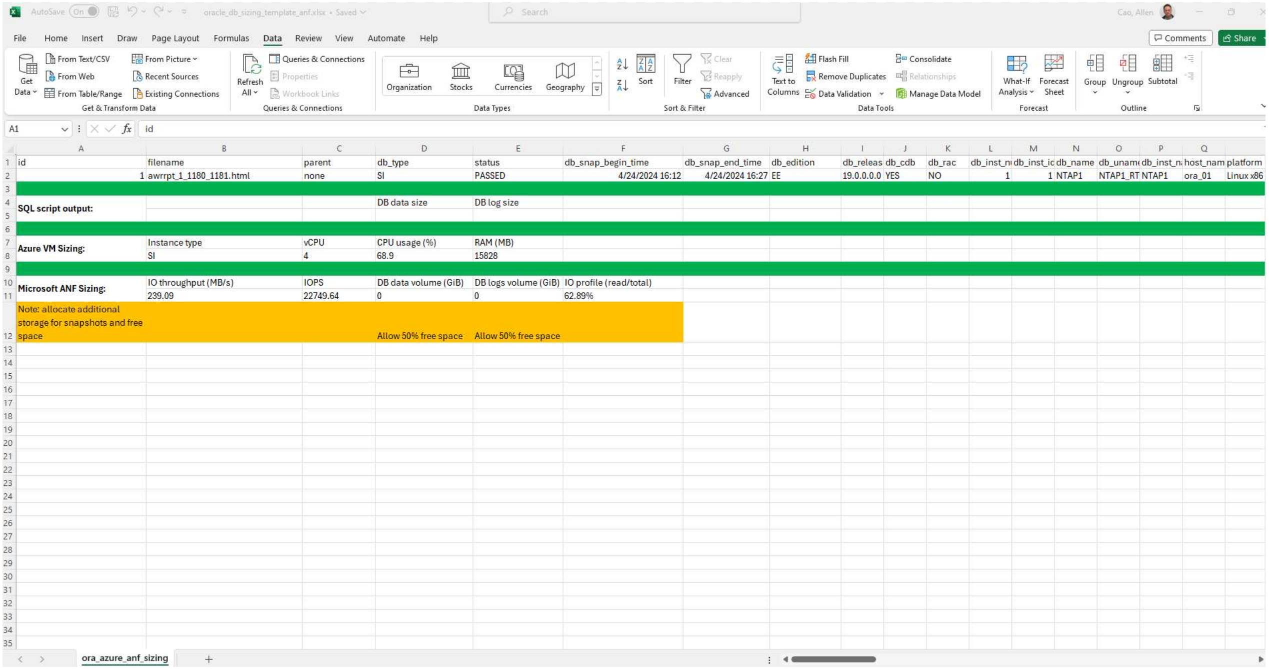
● General
○ Text
○ Date: MDY
○ Do not import column (skip)

'General' converts numeric values to numbers, date values to dates, and all remaining values to text.

Destination: A1

Data preview

```
GenerGeneral                  GeneralGeneral GeneralGeneral
id   filename                 parent  db_type status  db_snap_begin_
1    awrrpt_1_1180_1181.html  none    SI      PASSED  24-Apr-24 16:1
```



id	filename	parent	db_type	status	db_snap_begin_time	db_snap_end_time	db_edition	db_releas	db_cdb	db_rac	db_inst_n	db_inst_ic	db_name	db_uname	db_inst_n	host_nam	platform
1	awrrpt_1_1180_1181.html	none	SI	PASSED	4/24/2024 16:12	4/24/2024 16:27	EE	19.0.0.0.0	YES	NO	1	1	NTAP1	NTAP1_RT	NTAP1	ora_01	Linux x86

SQL script output:			DB data size	DB log size	
Azure VM Sizing:	Instance type	vCPU	CPU usage (%)	RAM (MB)	
	SI	4	68.9	15828	
Microsoft ANF Sizing:	IO throughput (MB/s)	IOPS	DB data volume (GiB)	DB logs volume (GiB)	IO profile (read/total)
	239.09	22749.64	0	0	62.89%
Note: allocate additional storage for snapshots and free space			Allow 50% free space	Allow 50% free space	

7. Execute script ora_db_data_size.sql, ora_db_logs_size.sql as a DBA in sqlplus to retrieve existing Oracle database data size and archived logs size with the number of days of retention window.

```
[oracle@ora_01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Tue Mar 5 15:25:27 2024
Version 19.18.0.0.0

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Connected to:
Oracle Database 19c Enterprise Edition Release 19.0.0.0.0 -
Production
Version 19.18.0.0.0


SQL> @/home/oracle/ora_db_data_size.sql;

Aggregate DB File Size, GiB Aggregate DB File RW, GiB Aggregate DB
File RO, GiB
--------------------------- -------------------------
-------------------------
                     159.05                    159.05
0

SQL> @/home/oracle/ora_db_logs_size.sql;
Enter value for archivelog_retention_days: 14
old   6:       where first_time >= sysdate -
&archivelog_retention_days
new   6:       where first_time >= sysdate - 14

Log Size, GiB
-------------
        93.83

SQL>
```
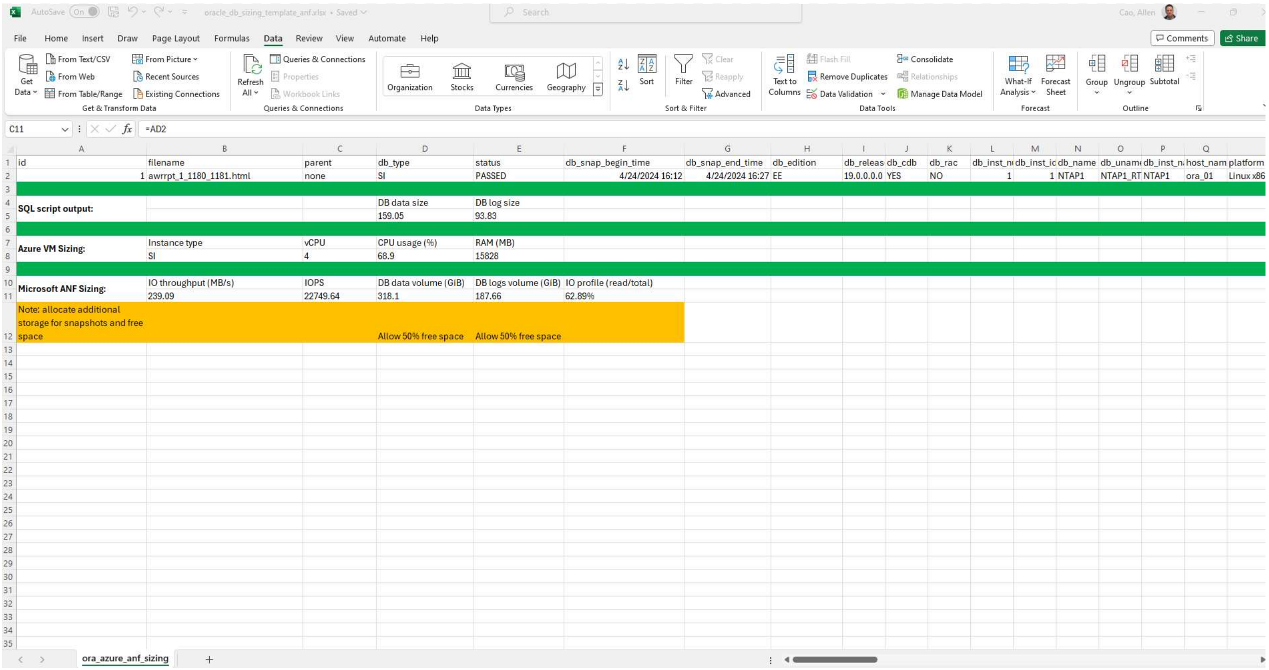

ⓘ The database sizing information retrieved using above scripts is the sum of actual size of all physical database data files or log files. It does not factor into the free space that may be available inside each data file.

8. Input the result into excel file to complete the sizing guidance output.



C11 =AD2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
1	id	filename	parent	db_type	status	db_snap_begin_time	db_snap_end_time	db_edition	db_releas	db_cdb	db_rac	db_inst_n	db_inst_ic	db_name	db_uname	db_inst_n	host_nam	platform
2	1	awrrpt_1_1180_1181.html	none	SI	PASSED	4/24/2024 16:12	4/24/2024 16:27	EE	19.0.0.0.0	YES	NO	1	1	NTAP1	NTAP1_RT	NTAP1	ora_01	Linux x86
3																		
4	**SQL script output:**			DB data size	DB log size													
5				159.05	93.83													
6																		
7	**Azure VM Sizing:**	Instance type	vCPU	CPU usage (%)	RAM (MB)													
8		SI	4	68.9	15828													
9																		
10	**Microsoft ANF Sizing:**	IO throughput (MB/s)	IOPS	DB data volume (GiB)	DB logs volume (GiB)	IO profile (read/total)												
11		239.09	22749.64	318.1	187.66	62.89%												
12	Note: allocate additional storage for snapshots and free space			Allow 50% free space	Allow 50% free space													

9. ANF uses a three-tier service level (Standard, Premium, Ultra) to manage database volume throughput limit. Refer to Service levels for Azure NetApp Files for details. Based on sizing guidance output, choose an ANF service level that provides throughput that meet the requirment for the database.

Where to find additional information

To learn more about the NetApp database solutions, review the following website NetApp Enterprise Database Solutions