TR-4997: Oracle RAC Deployment and Protection in VCF with vVols

NetApp database solutions

NetApp
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The solution provides an overview and details for Oracle deployment and protection in VMware Cloud Foundation (VCF) with vSphere Virtual Volumes (vVols) as primary database storage and Oracle database in Real Application Clusters (RAC) configuration.

Purpose

VMware vSphere Virtual Volumes (vVols) is a SAN/NAS management and integration framework that exposes virtual disks as native storage objects and enables array-based operations at the virtual disk level. In other words, vVols make SAN/NAS devices VM-aware and unlocks the ability to leverage array-based data services with a VM-centric approach at the granularity of a single virtual disk. vVols allows customers to leverage the unique capabilities of their current storage investments and transition without disruption to a simpler and more efficient operational model optimized for virtual environments that work across all storage types.

In TR-4996, we demonstrated single instance Oracle database deployment and protection in VCF with vVols. This documentation demonstrates the deployment and protection of an Oracle RAC database in a VMware Cloud Foundation environment with vVols as primary database storage in a NetApp ONTAP storage cluster. The Oracle RAC database is configured as if it is deployed in local file systems on a local storage system. This technical report focuses on steps in creating vVols in VCF for Oracle RAC deployment. We also demonstrate Oracle RAC database deployment in VCF on vVols with NetApp automation toolkit and RAC database protection with NetApp SnapCenter UI tool.

This solution addresses the following use cases:

- Oracle RAC database deployment in VCF with vVols datastore on NetApp ONTAP AFF as primary database storage
- Oracle database backup and restore in VCF with vVols datastore using NetApp SnapCenter UI tool

Audience

This solution is intended for the following people:

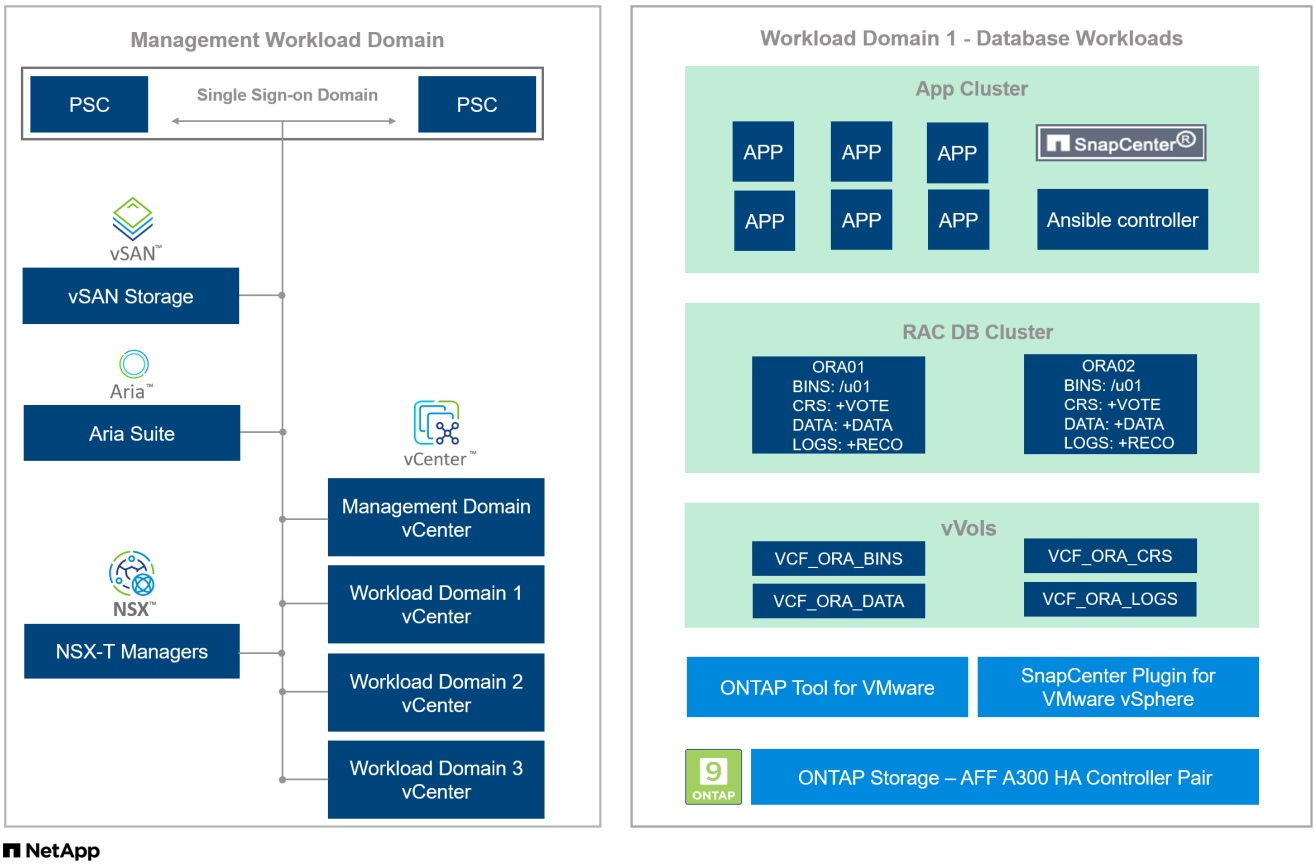
- A DBA who would like to deploy Oracle RAC in VCF with vVols datastore on NetApp ONTAP AFF as primary database storage
- A database solution architect who would like to test Oracle RAC workloads in VCF with vVols datastore on NetApp ONTAP AFF storage
- A storage administrator who would like to deploy and manage an Oracle RAC database deployed to VCF with vVols datastore on NetApp ONTAP AFF storage
- An application owner who would like to stand up an Oracle RAC database in VCF with vVol datastore

Solution test and validation environment

The testing and validation of this solution was performed in a lab environment in VCF with vVols datastore on NetApp ONTAP AFF storage that might not match the final deployment environment. For more information, see the section Key factors for deployment consideration.

Architecture

Oracle RAC Database Deployment and Protection in VCF with vVols



Hardware and software components

Hardware		
NetApp ONTAP AFF A300	Version 9.14.1P4	DS224 shelf with 24 NVMe disks, total capacity 35.2 TiB
VMware VSphere cluster	Version 8.02	12 CPU(s) x Intel® Xeon® Gold 5218 CPU @ 2.30GHz, 8 nodes (4 management and 4 workload domains)
Software		
RedHat Linux	RHEL-8.6, 4.18.0-372.9.1.el8.x86_64 kernel	Hosting Oracle DB servers, deployed RedHat subscription for testing
Windows Server	2022 Standard, 10.0.20348 Build 20348	Hosting SnapCenter server
Centos Linux	CentOS Linux release 8.5.2111	Hosting Ansible controller
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 6.0	Workgroup deployment
SnapCenter Plug-in for VMware vSphere	Version 6.0	Deployed as an ova VM to vSphere cluster
ONTAP tool for VMware vSphere	Version 9.13	Deployed as an ova VM to vSphere cluster
Open JDK	Version java-11-openjdk-11.0.23.0.9-3.el8.x86_64	SnapCenter plugin requirement on DB VMs

Oracle RAC database configuration in VCF

RAC Node	Database	DB Storage
ora01	NTAP(NTAP_pdb1,NTAP_pdb2,NTAP_pdb3)	vVols datastores (VCF_ORA_BINS, VCF_ORA_CRS, VCF_ORA_DAT1, VCF_ORA_DAT2, VCF_ORA_LOGS) on NetApp ONTAP AFF A300
ora02	NTAP(NTAP_pdb1,NTAP_pdb2,NTAP_pdb3)	vVols datastores (VCF_ORA_BINS, VCF_ORA_CRS, VCF_ORA_DAT1, VCF_ORA_DAT2, VCF_ORA_LOGS) on NetApp ONTAP AFF A300

Key factors for deployment consideration

- **Protocol for vVols to ONTAP cluster connectivity.** NFS or iSCSI are good choices. The performance levels are equivalent. In this solution demonstration, we used iSCSI as a storage protocol for vVols connectivity to the underlined ONTAP storage cluster. If VCF infrastructure supports, FC/FCoE, NVMe/FC protocols are also supported for vVols datastores on NetApp ONTAP.
- **Oracle storage layout on vVols datastores.** In our tests and validations, we deployed five vVols datastores for Oracle binary, Oracle cluster registry/vote, Oracle data, and Oracle log files. It's good practice to separate different types of Oracle files into their own datastores so that database backup, recovery, or clone can be easily managed and executed. Create dedicate vVols for large databases and share vVols for smaller databases or databases with similar QoS profile.
- **Oracle storage redundancy.** Use `Normal Redundancy` for critical Oracle RAC cluster registry/vote files so that three vote files on three ASM disk failgroups provide optimal cluster protection and the cluster registry is mirrored among the ASM disk failgroups. Use `External Redundancy` for Oracle binary, data, and log files to optimize storage utilization. The underlined ONTAP RAID-DP provides data protection when `External Redundancy` is employed.

- **Credential for ONTAP storage authentication.** Only use ONTAP cluster-level credentials for the ONTAP storage cluster authentication, including SnapCenter connectivity to the ONTAP storage cluster or ONTAP tool connectivity to the ONTAP storage cluster.
- **Provision storage from vVols datastore to database VM.** Add only one disk at a time to the database VM from the vVols datastore. Adding Multiple disks from vVols datastores at the same time is not supported at this time.
- **Database protection.** NetApp provides a SnapCenter software suite for database backup, restore with a user-friendly UI interface. NetApp recommends implementing such a management tool to achieve fast SnapShot backup, quick database restore and recovery.

Solution deployment

The following sections provide step-by-step procedures for Oracle 19c database deployment in VCF with vVols datastores on NetApp ONTAP storage in an Oracle RAC configuration.

Prerequisites for deployment

Deployment requires the following prerequisites.

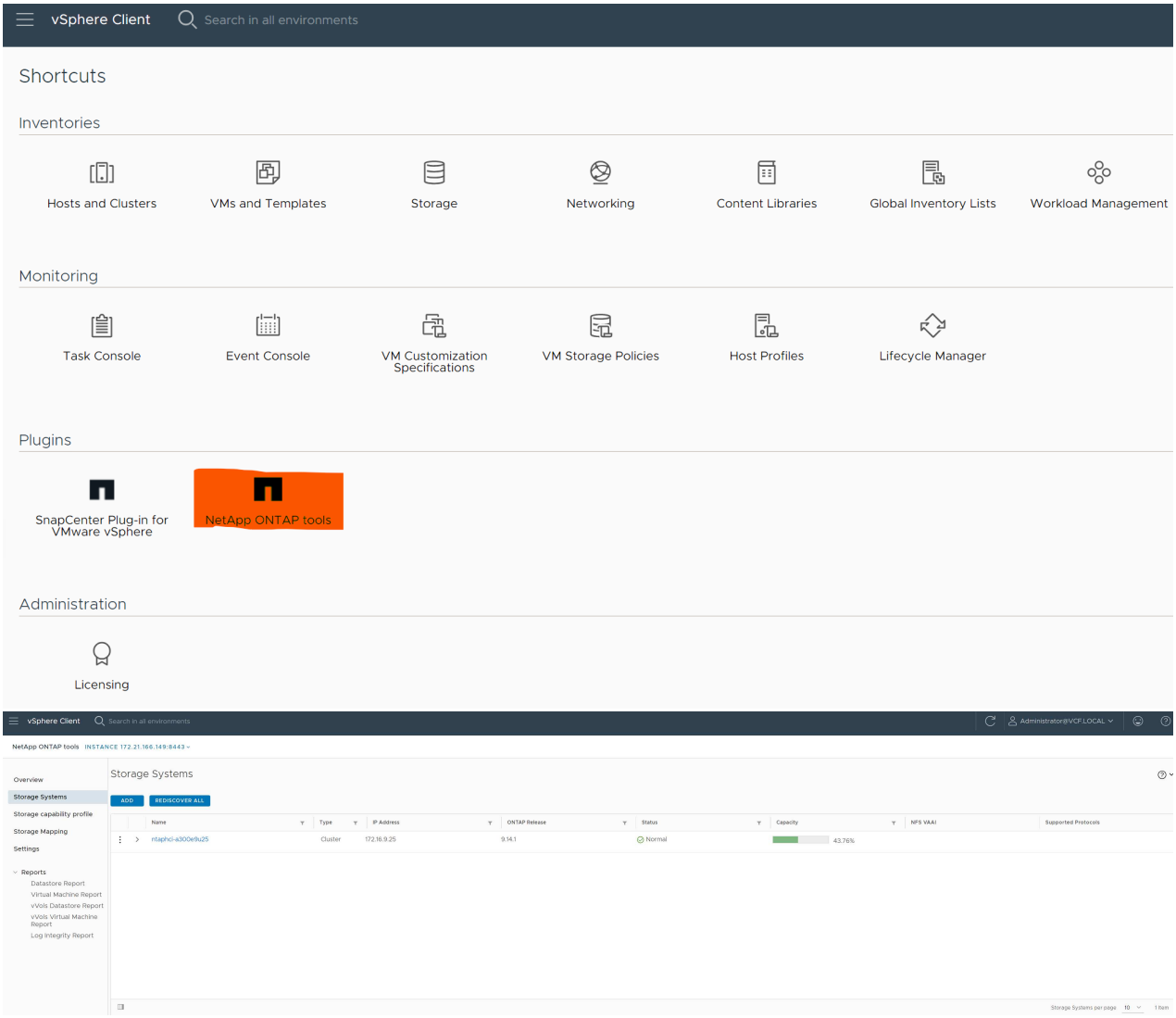
1. A VMware VCF has been setup. For information or instruction on how to create a VCF, please refer to VMware documentation VMware Cloud Foundation Documentation.
2. Provision three Linux VMs, two VMs for Oracle RAC database cluster and one VM for Ansible controller within VCF workload domain. Provision one Windows server VM for running NetApp SnapCenter server. For information on setting up Ansible controller for automated Oracle database deployment, referring to following resources Getting Started with NetApp solution automation^.
3. Oracle RAC database VMs should have provisioned at least two network interfaces - one for Oracle RAC private interconnect and one for apps or public data traffic.
4. SnapCenter plugin version 6.0 for VMware vSphere has been deployed in VCF. Refer to following resources for the plugin deployment: SnapCenter Plug-in for VMware vSphere documentation.
5. ONTAP tool for VMware vSphere has been deployed in VCF. Refer to following resources for the ONTAP tool for VMware vSphere deployment: ONTAP tools for VMware vSphere documentation

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

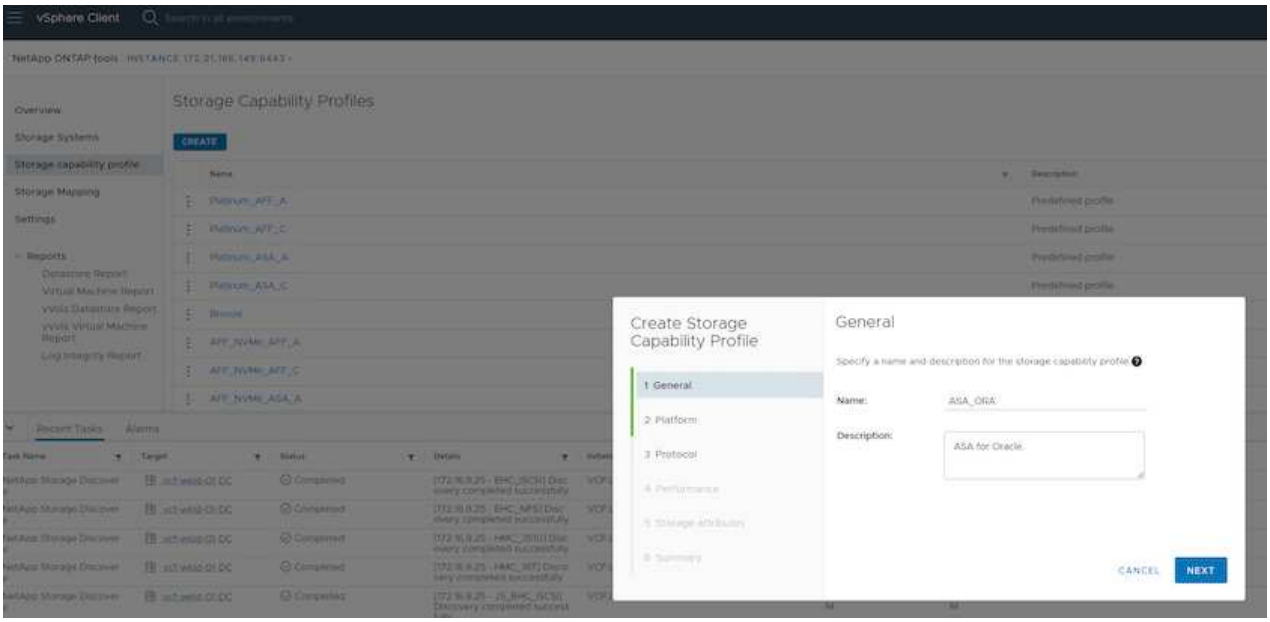
Create storage capability profile

First, create a custom storage capability profile for the underlined ONTAP storage that is hosting the vVols datastore.

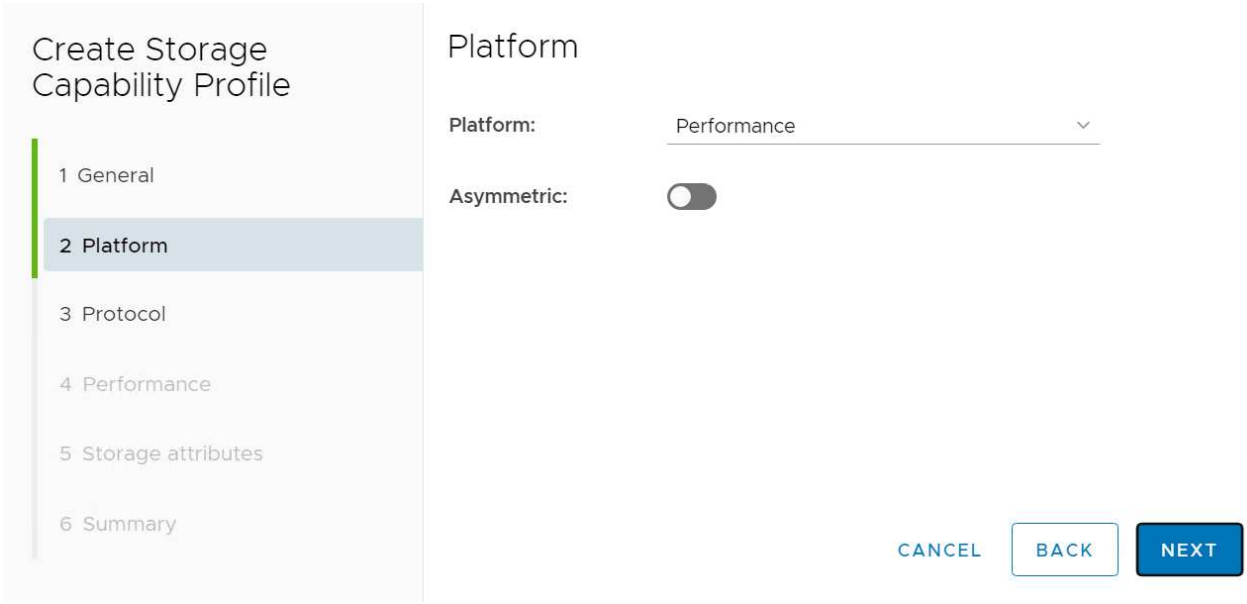
1. From vSphere client shortcuts, open NetApp ONTAP tool. Ensure that ONTAP storage cluster has been added to `Storage Systems` as part of ONTAP tool deployment.



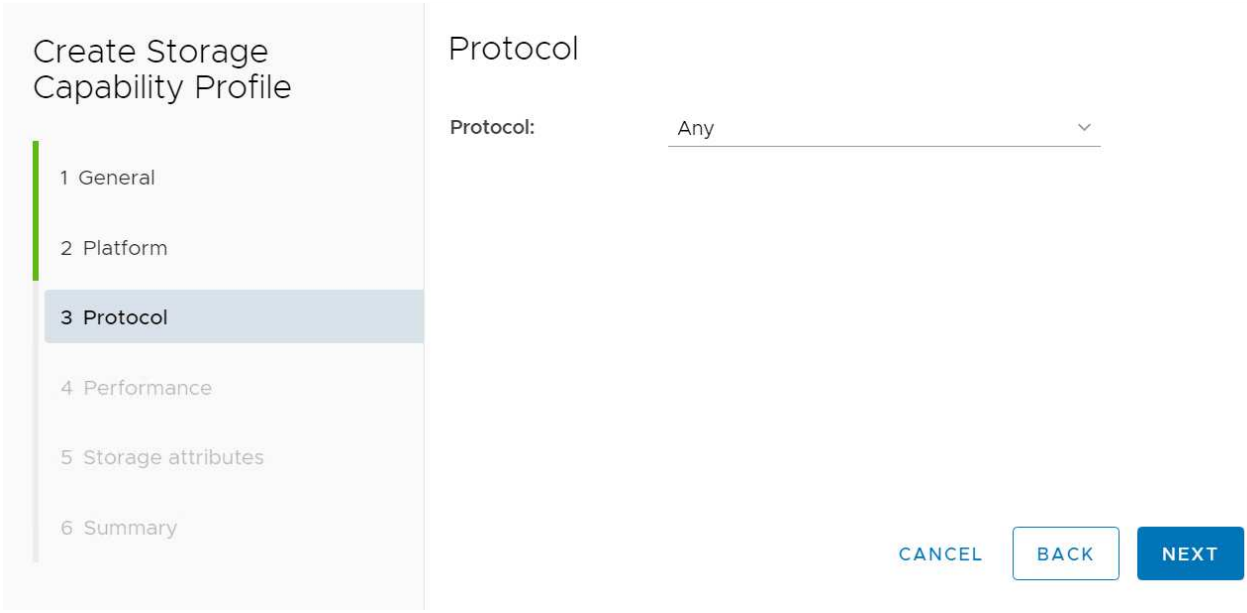
2. Click on `Storage capability profile` to add a custom profile for Oracle. Name the profile and add a brief description.



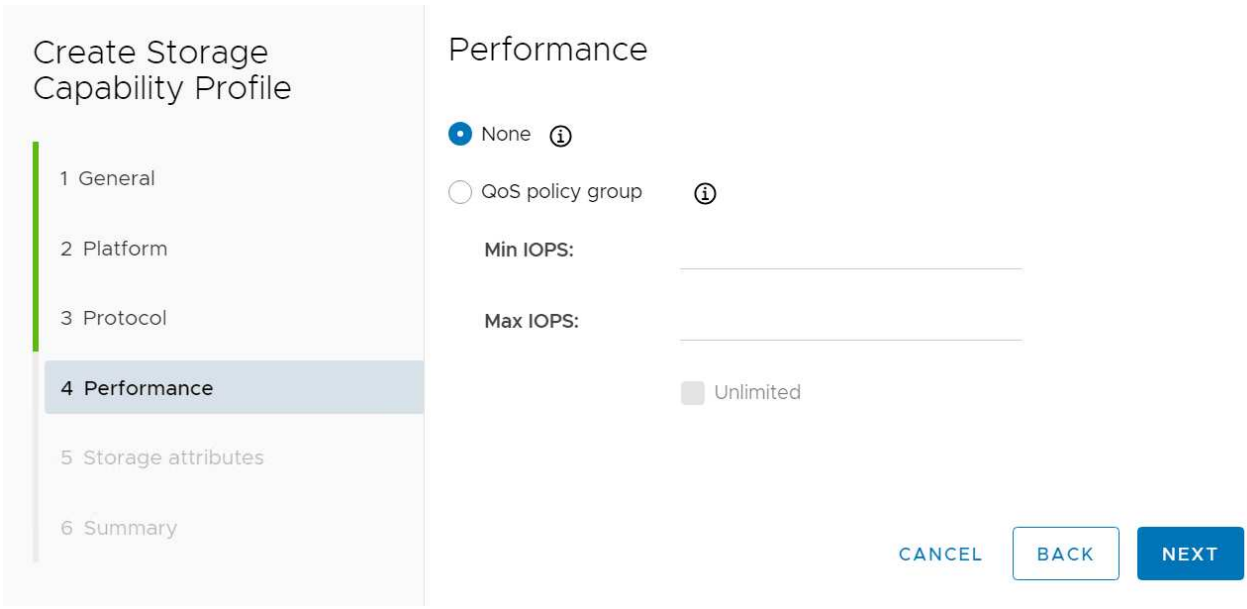
3. Choose storage controller category: performance, capacity, or hybrid.



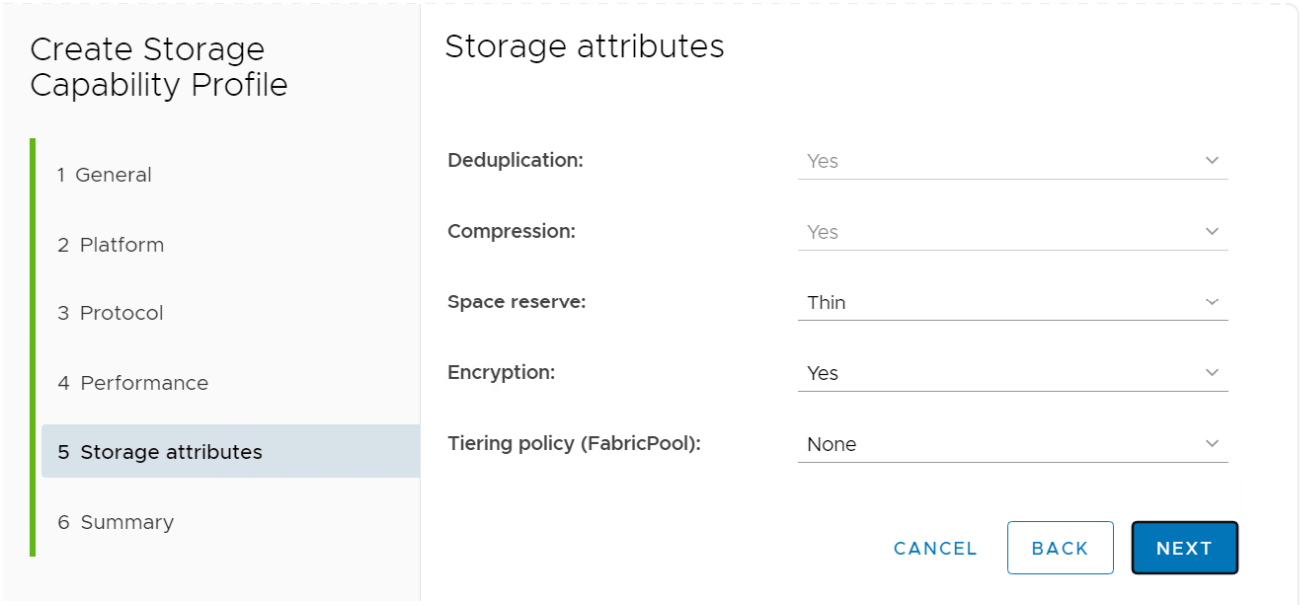
4. Select the protocol.



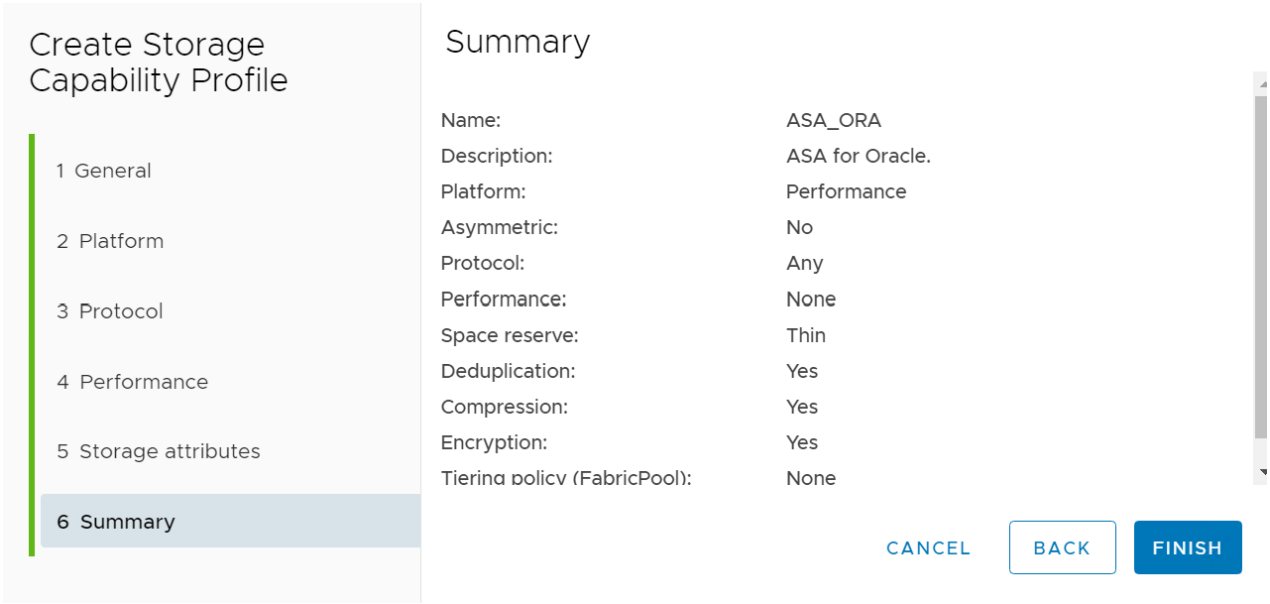
5. Define a QoS policy if desired.



6. Additional storage attributes for the profile. Be sure that the encryption is enabled on the NetApp controller if you want to have the encryption capability or it may cause issues when applying the profile.



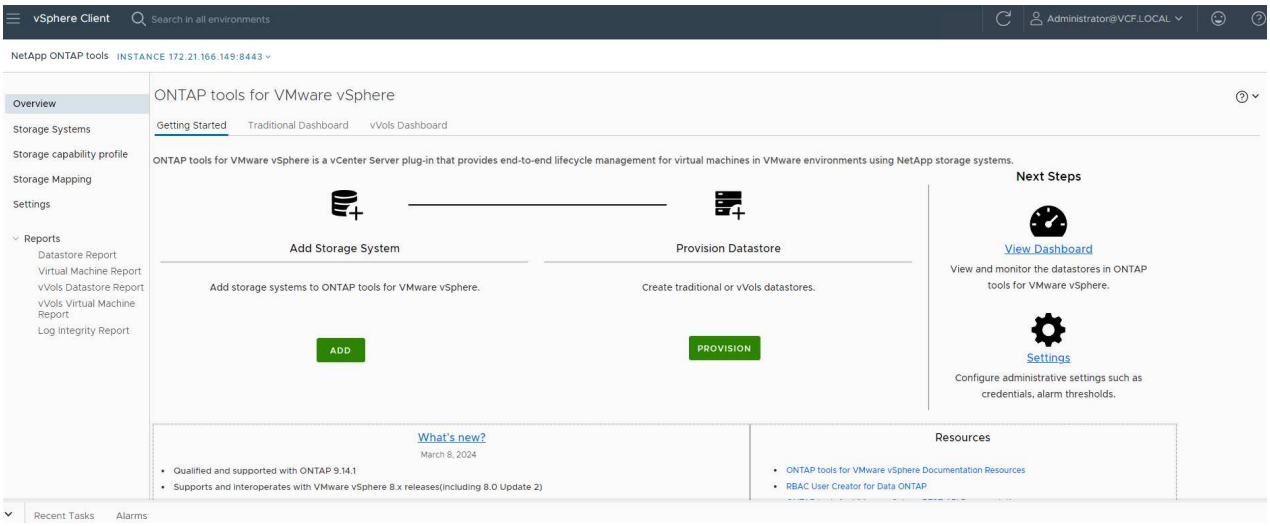
7. Review the summary and finish the storage capability profile creation.

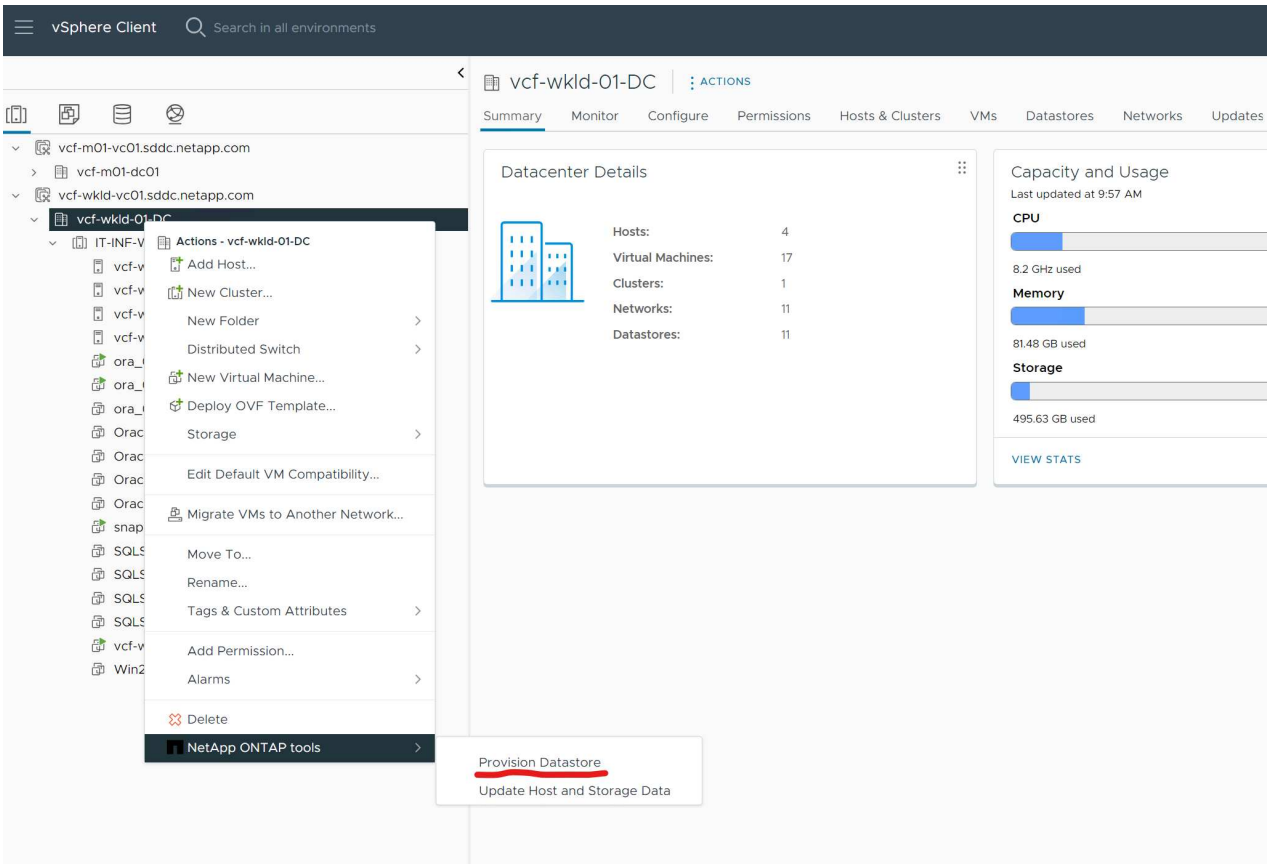


Create and configure vVols datastore

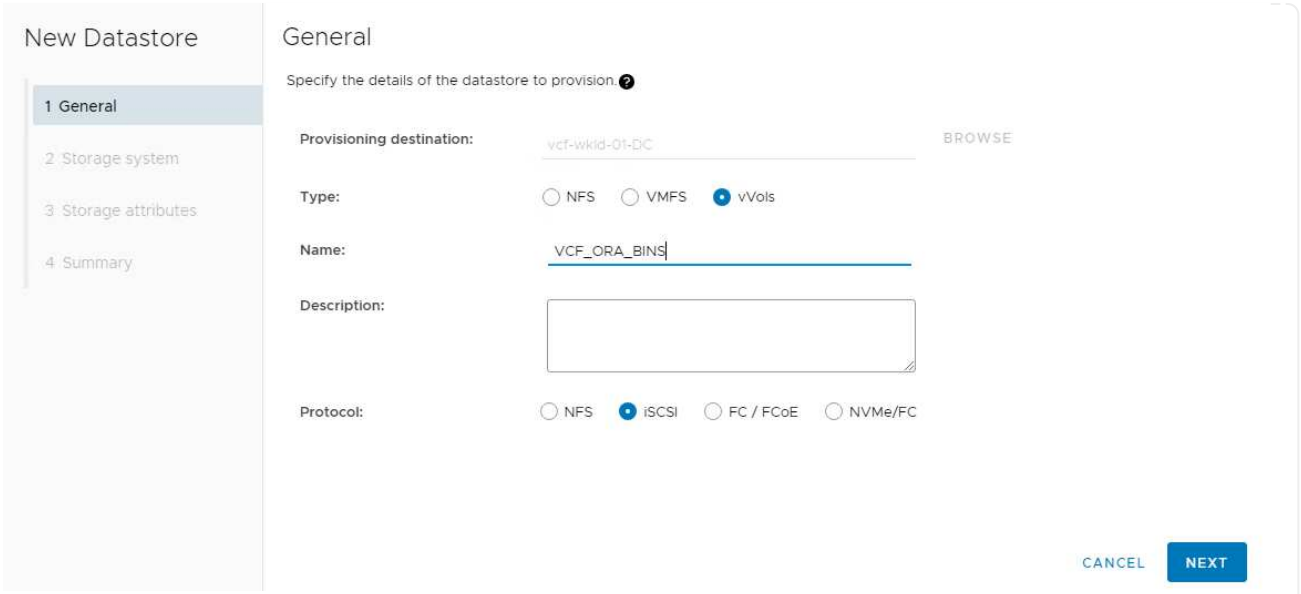
With the prerequisites completed, login to the VCF as an admin user via vSphere client, navigating to workload domain. Do not use built-in VMware storage option to create vVols. Instead, use NetApp ONTAP tool to create vVols. Following demonstrates the procedures to create and configure vVols.

1. The vVols creation workflow can be triggered either from ONTAP tool interface or from VCF workload domain cluster.

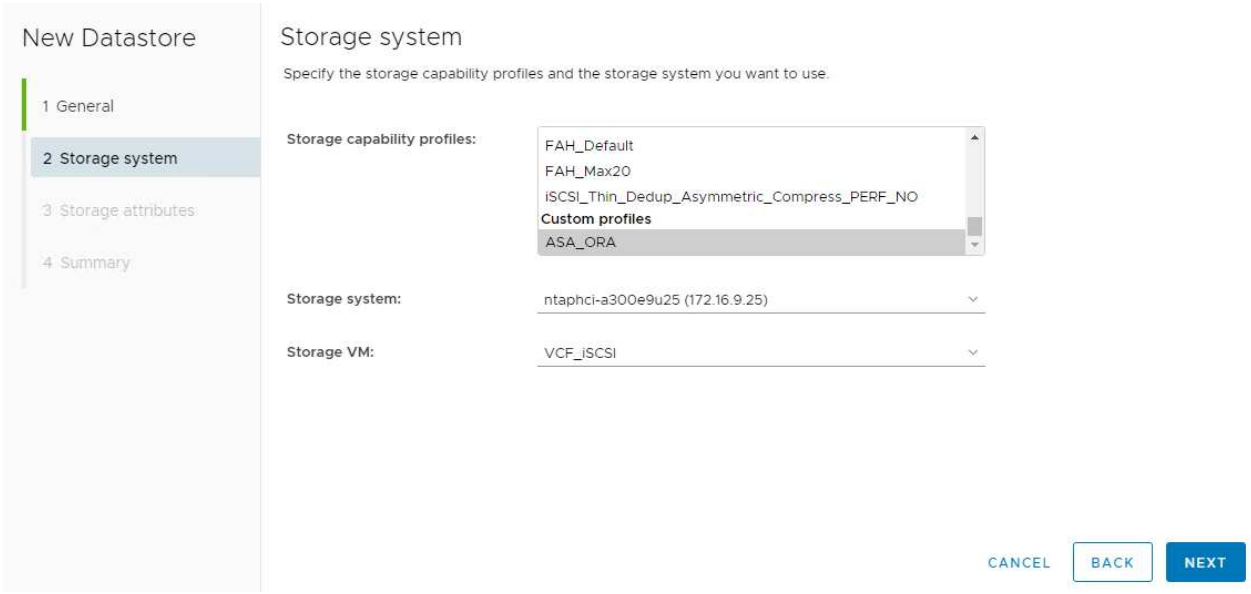




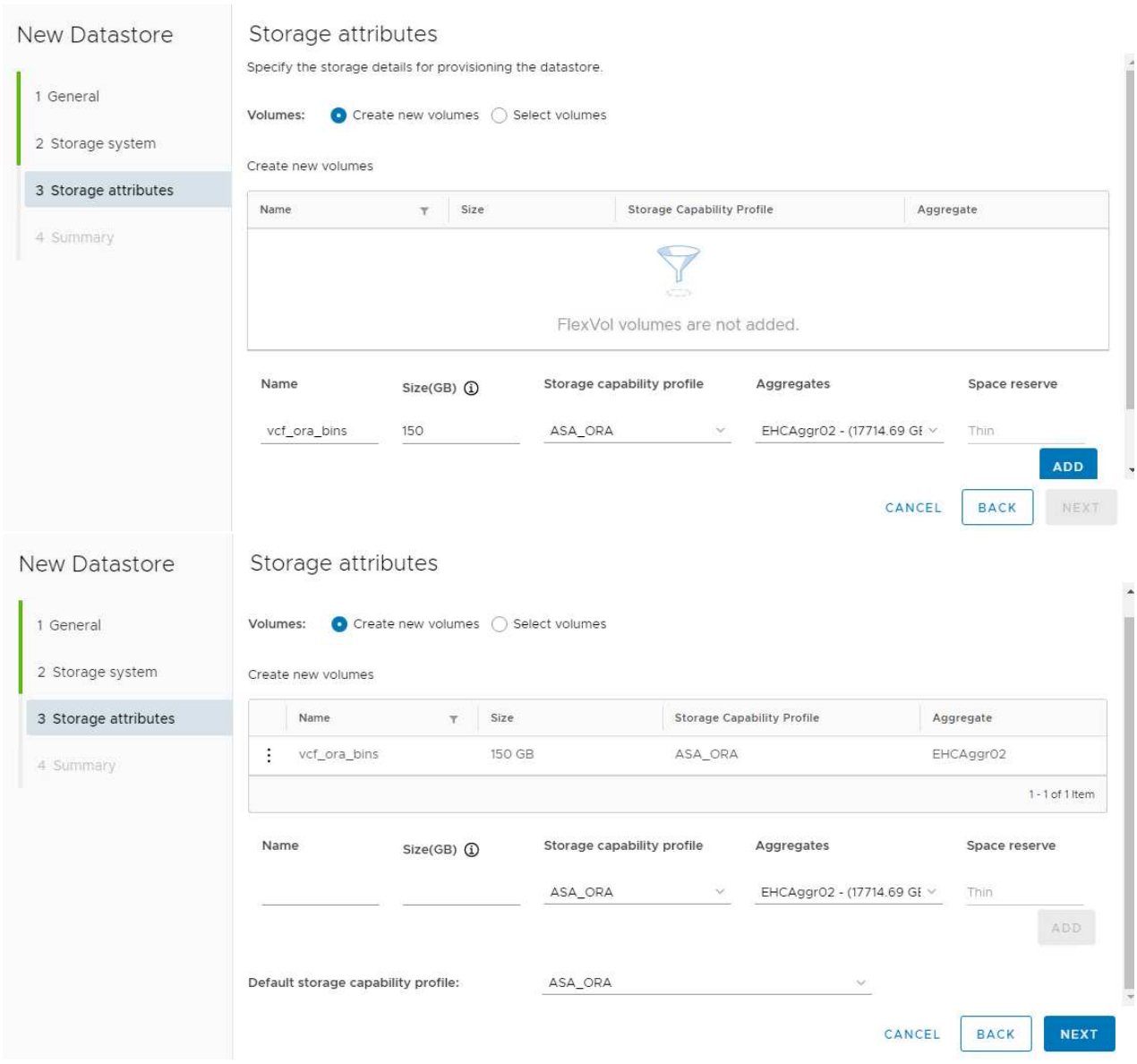
2. Filling in general information for datastore including provisioning destination, type, name, and protocol.



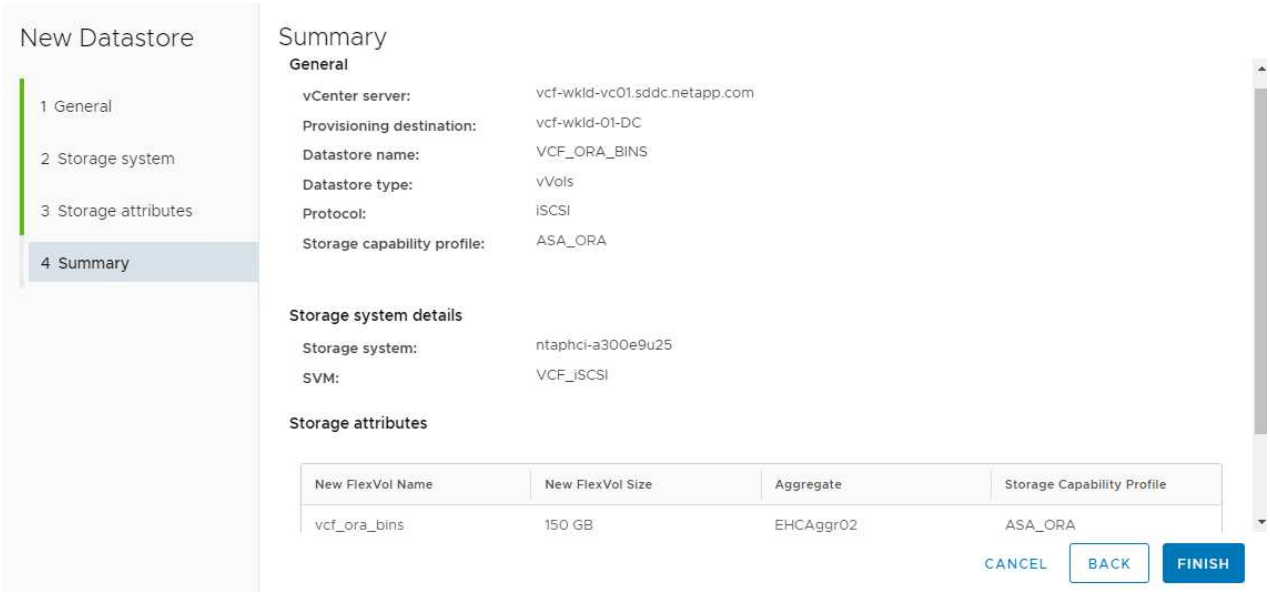
3. Select the custom storage capability profile created from previous step, the `Storage system`, and `Storage VM`, where vVols are to be created.



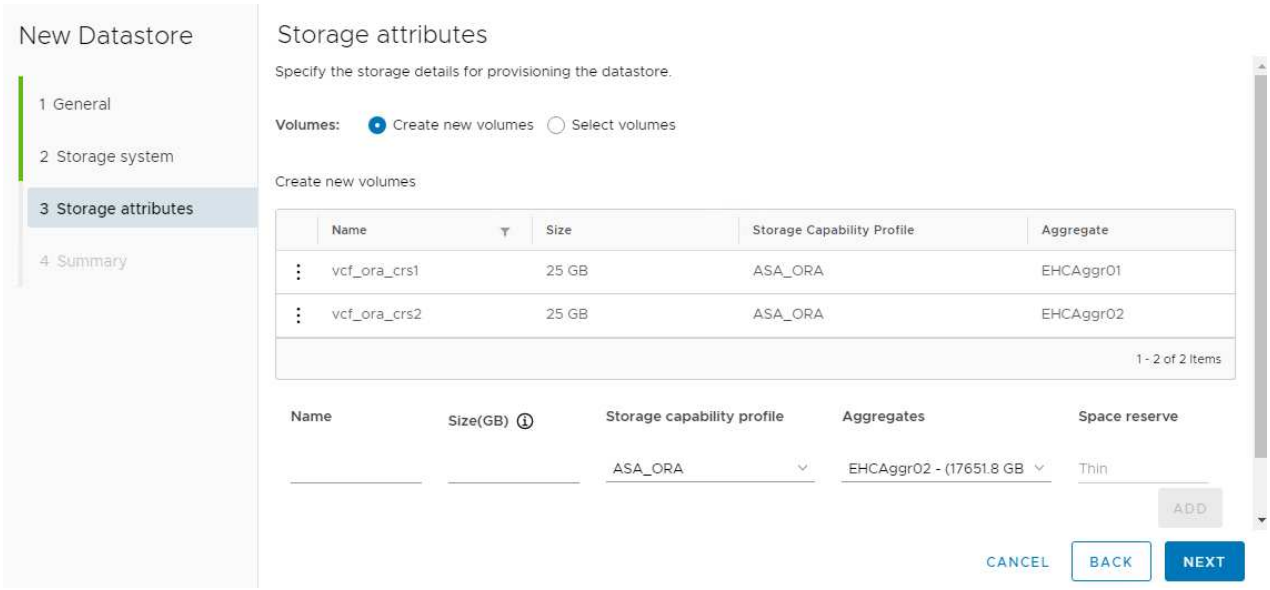
4. Choose `Create new volumes`, fill in the volume name and size and click on `ADD` then `NEXT` to move to the summary page.



5. Click `Finish` to create vVols datastore for Oracle binary.

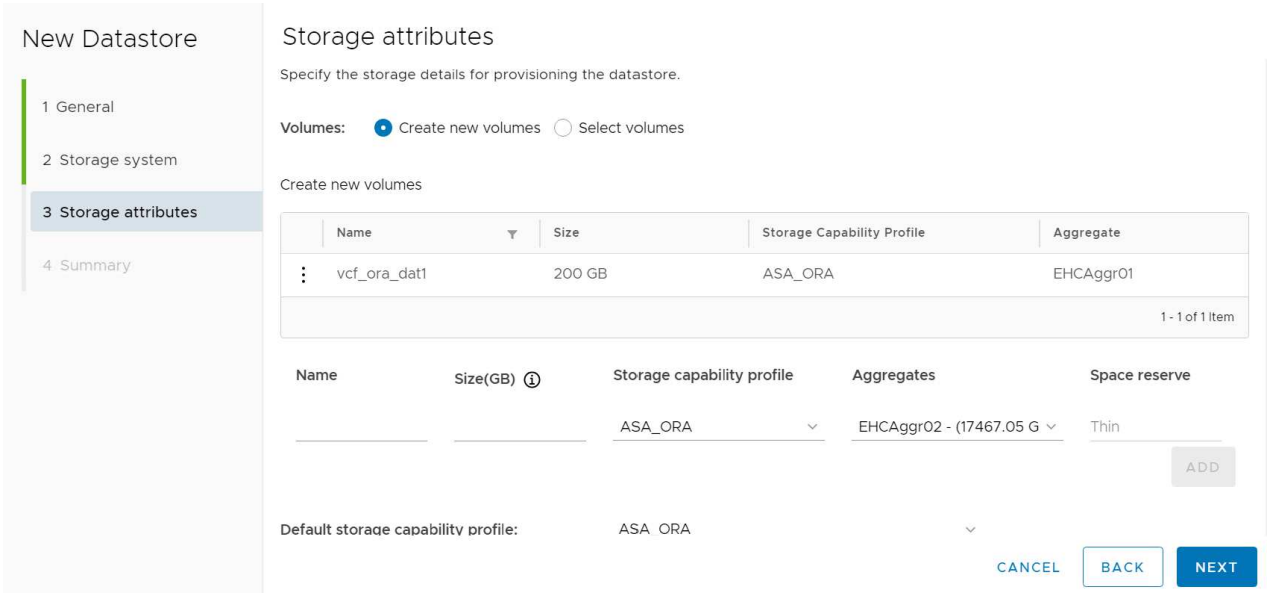


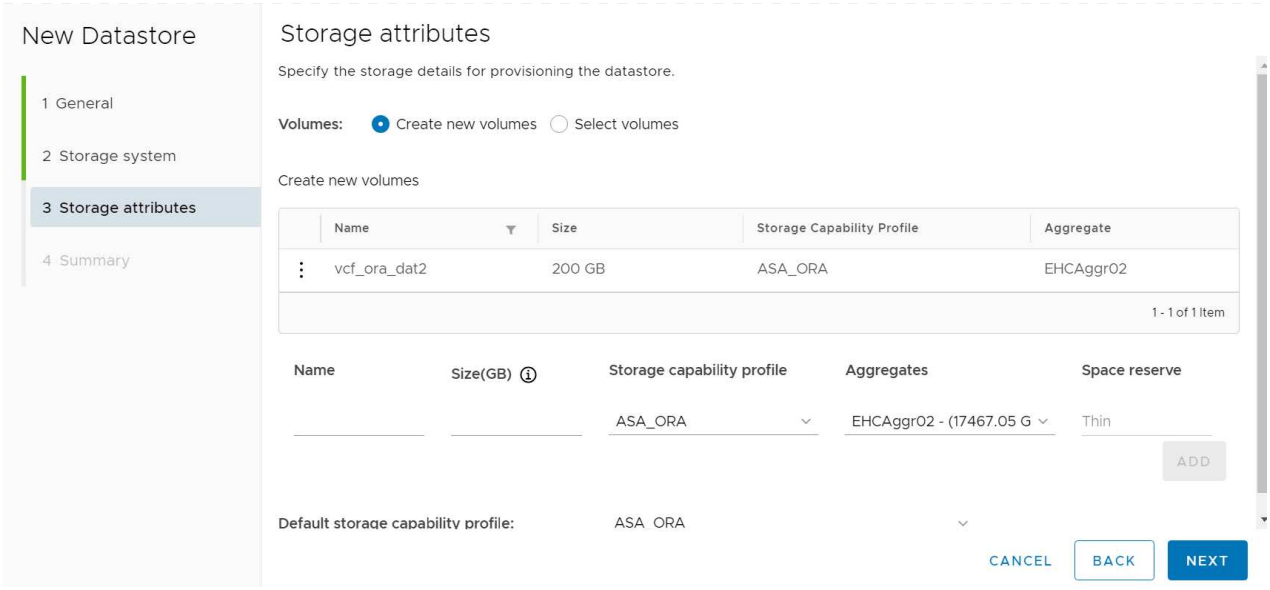
6. Create datastore for Oracle cluster registry or CRS.



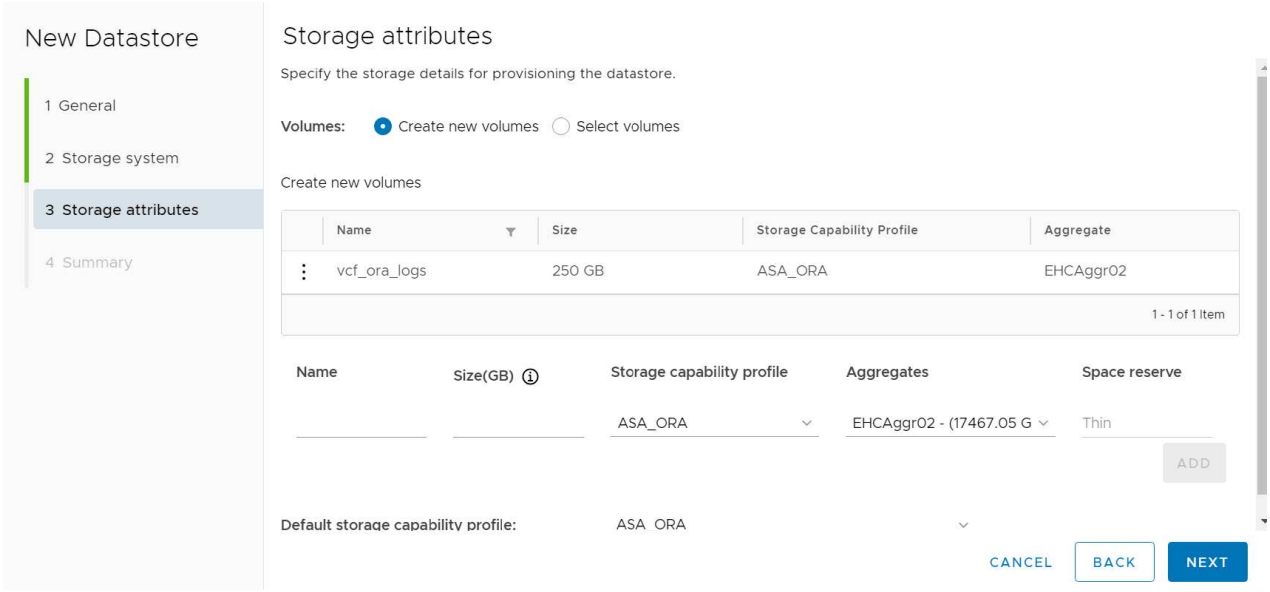
You could add more than one volume to a vVols datastore or span a vVols datastore volumes across ONTAP controller nodes for performance or redundancy.

7. Create datastore for Oracle data. Ideally, create separate datastores on each ONTAP controller node and employ Oracle ASM to stripe data across controller nodes to maximize utilization of ONTAP storage cluster capacity.

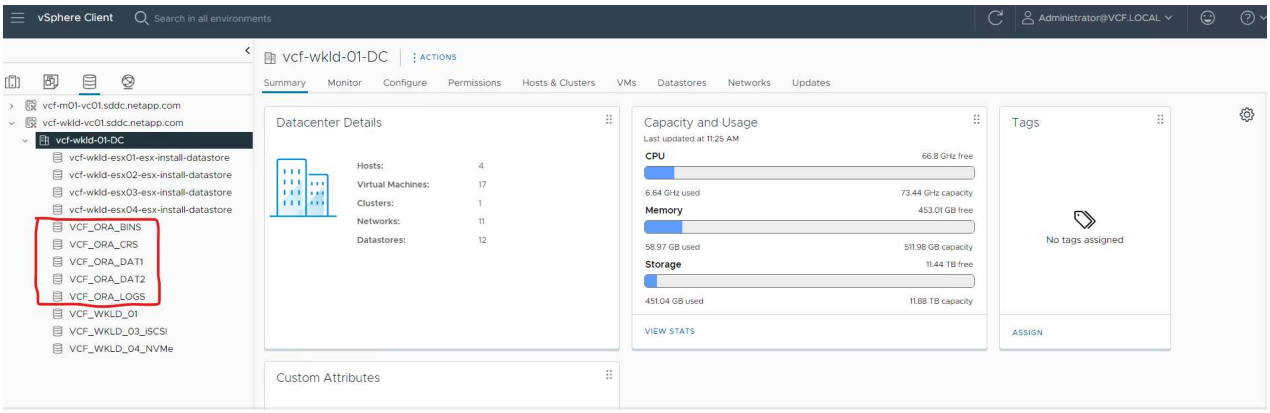




8. Create datastore for Oracle log. Given sequential nature of Oracle log writing, it is good just place it on a single ONTAP controller node.



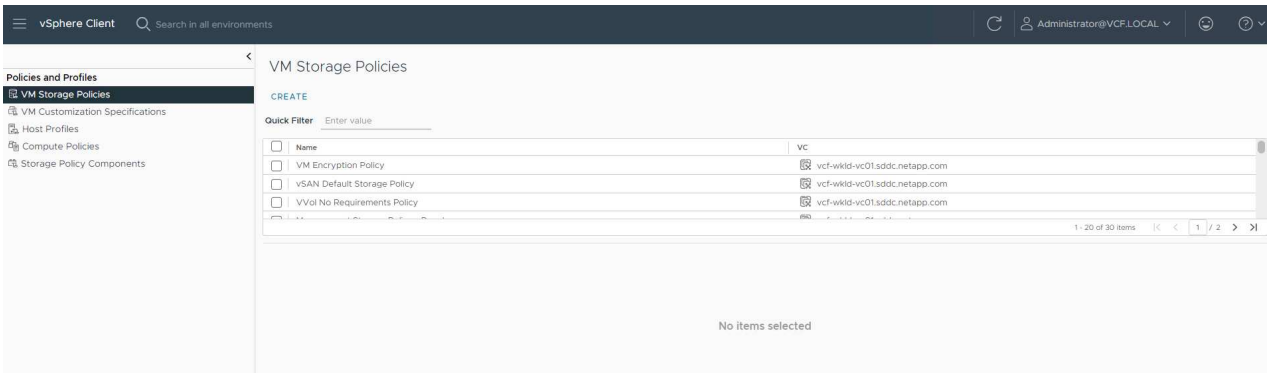
9. Validate the Oracle datastores after deployment.



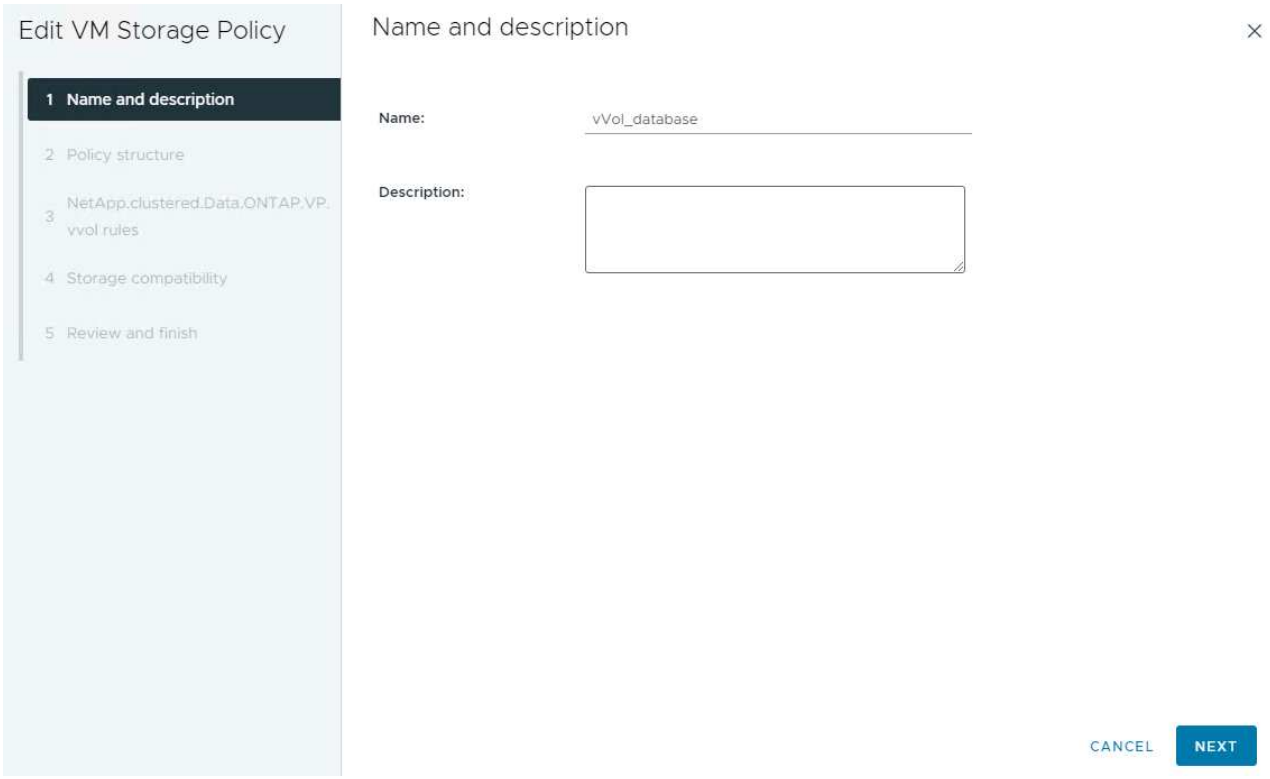
Create VM storage policy based on storage capability profile

Before provisioning storage from vVols datastore to database VM, add a VM storage policy based on storage capability profile created from previous step. Following are the procedures.

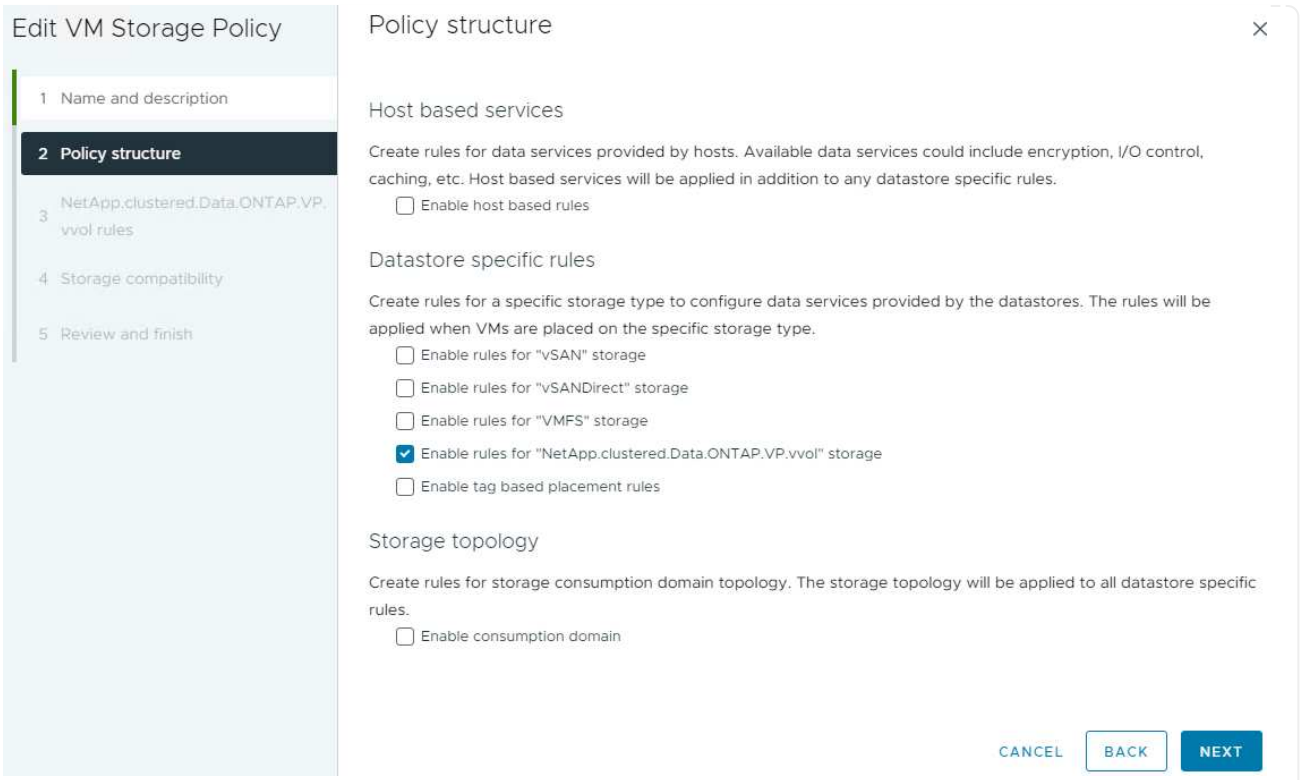
1. From vSphere client menus, open `Policies and Profiles` and highlight `VM Storage Policies`. Click `Create` to open `VM Storage Policies` workflow.



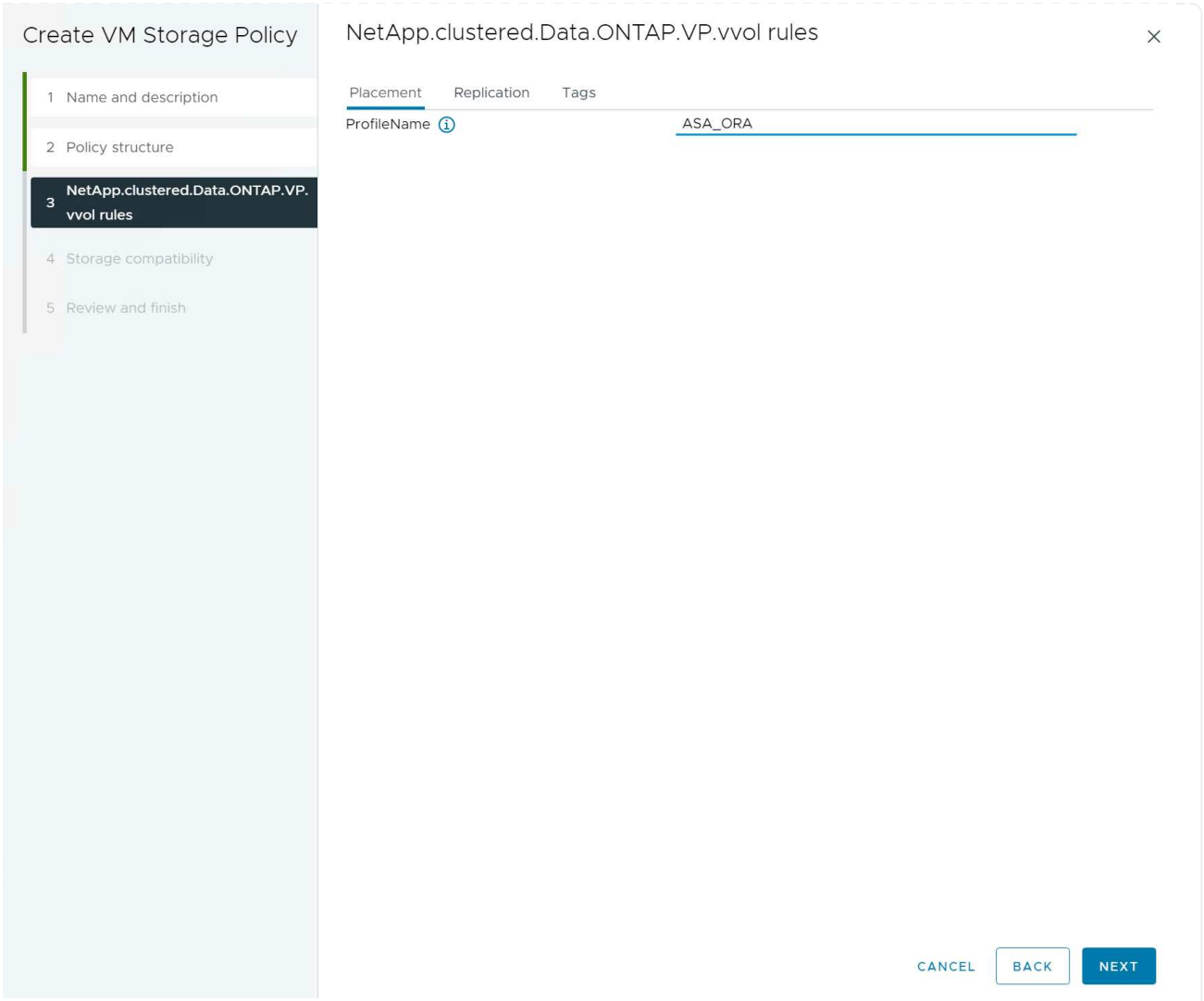
2. Name the VM storage policy.



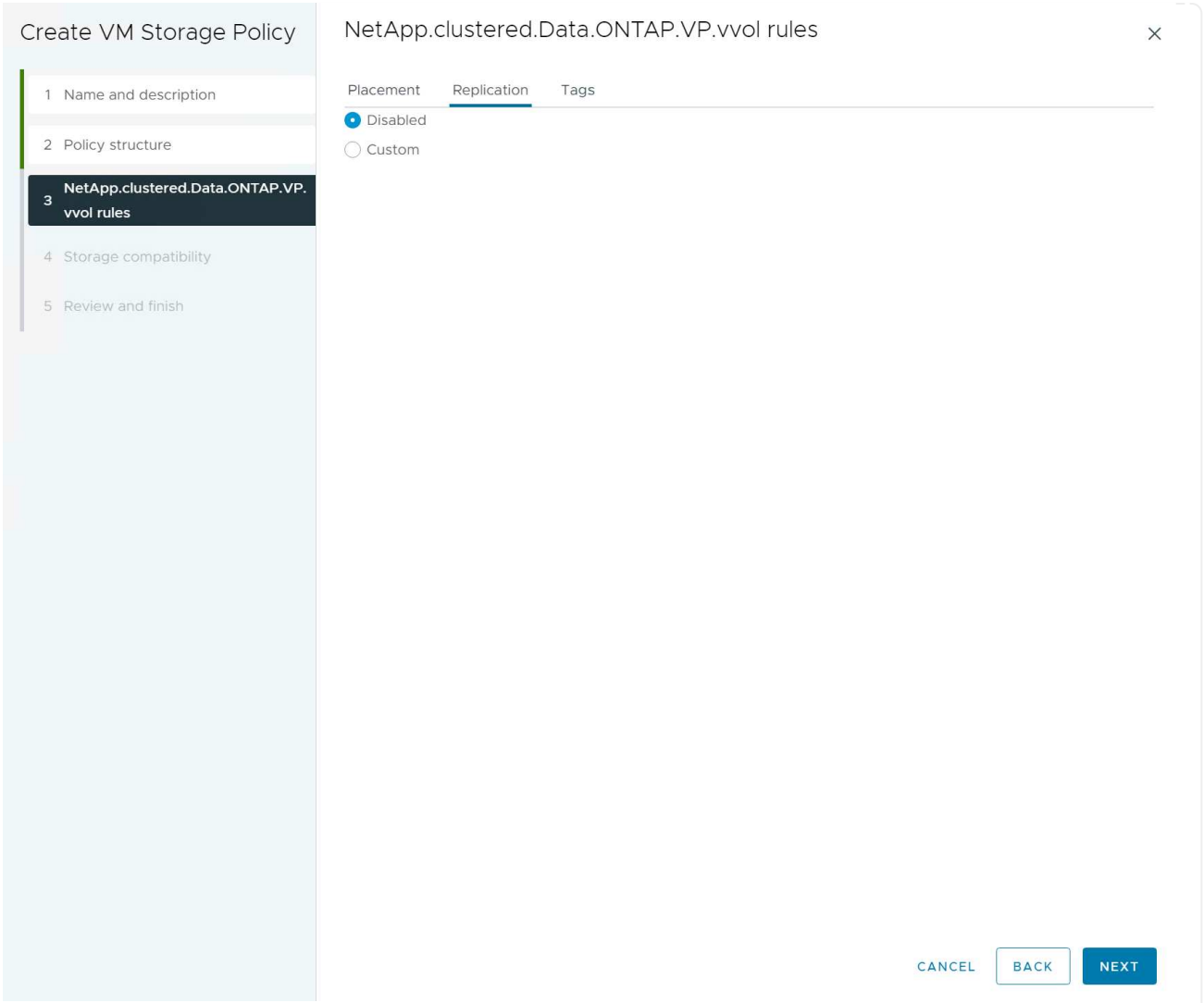
3. In `Datastore specific rules`, check `Enable rules for "NetAPP.clustered.Data.ONTAP.VP.vvol" storage`



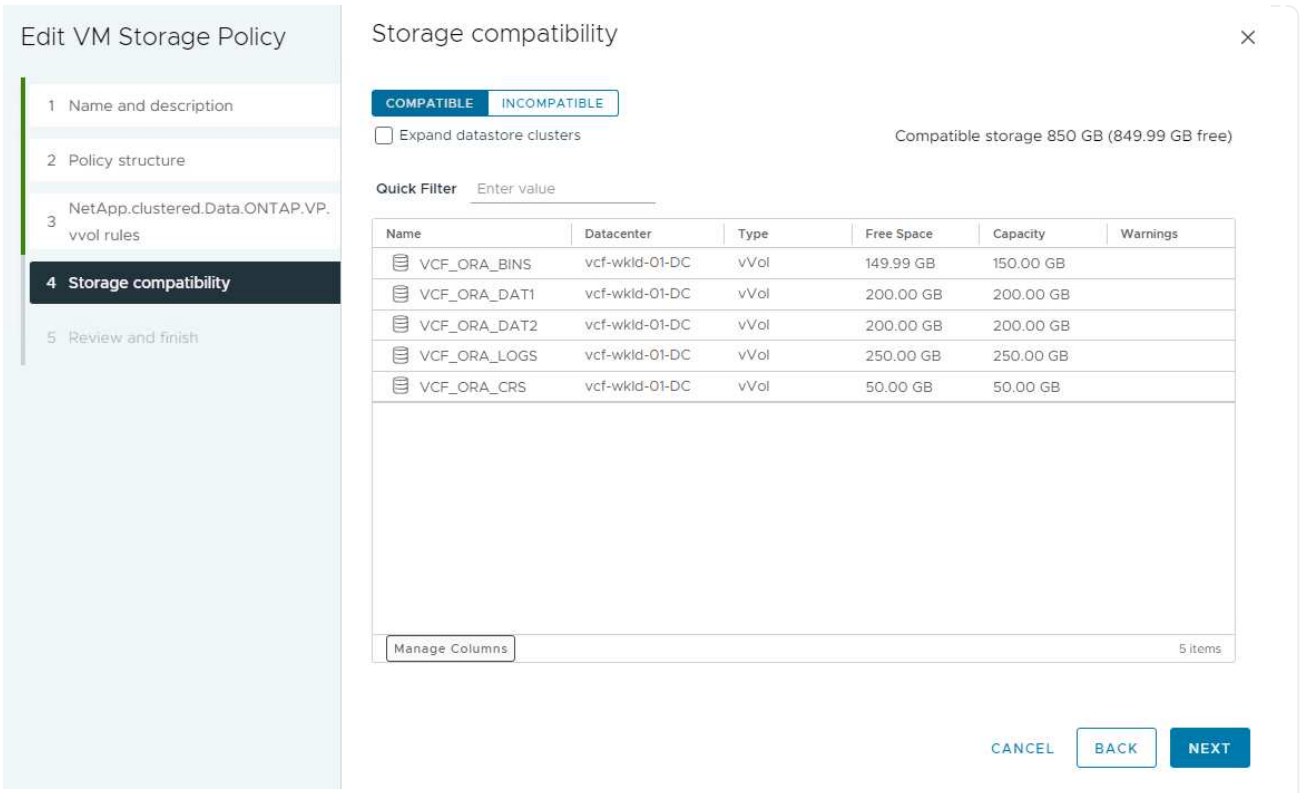
4. For NetApp.clustered.Data.ONTAP.VP.vvol rules `Placement`, select the custom storage capacity profile created from the previous step.



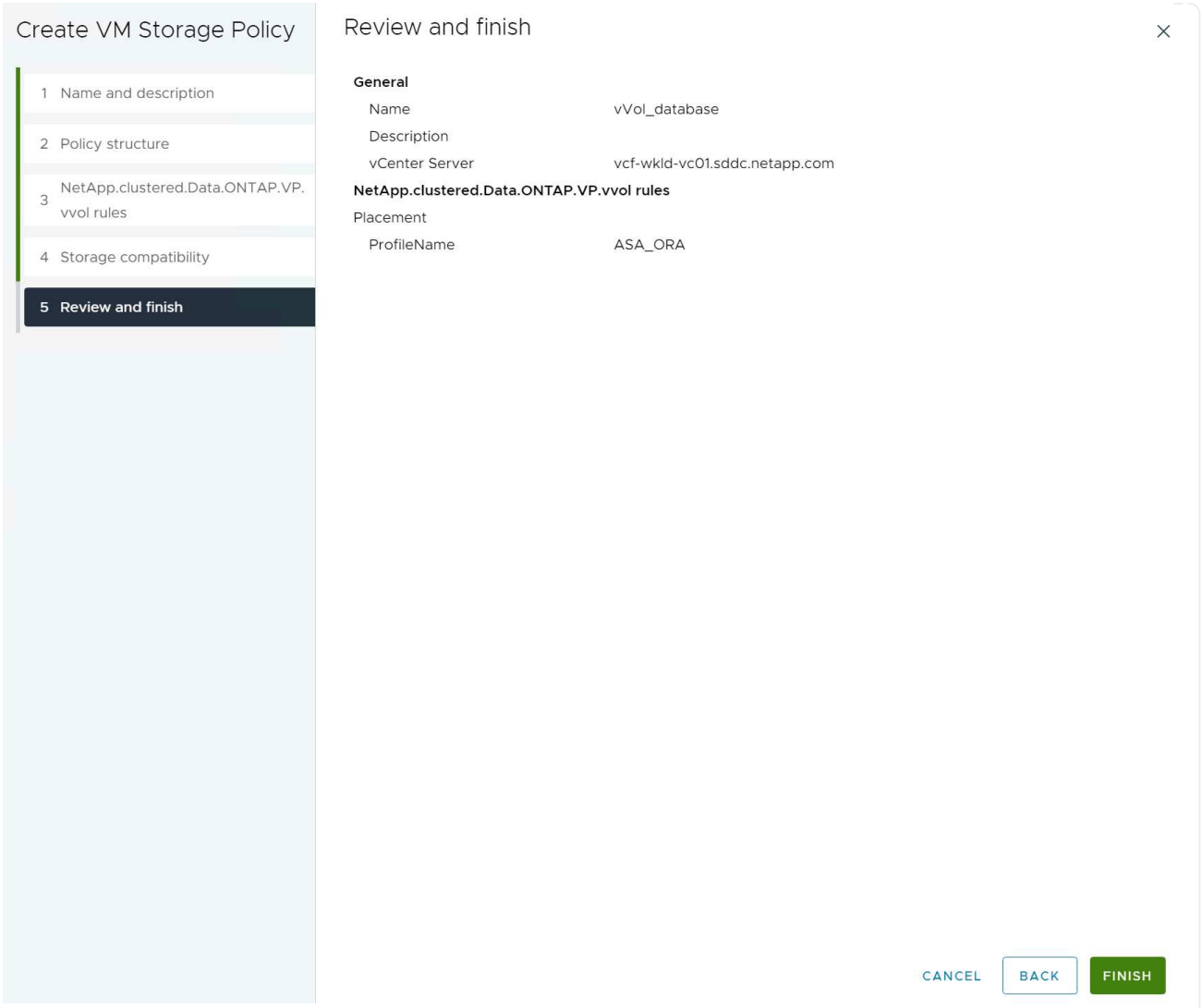
5. For NetApp.clustered.Data.ONTAP.VP.vvol rules `Replication`, choose `Disabled` if vVols are not replicated.



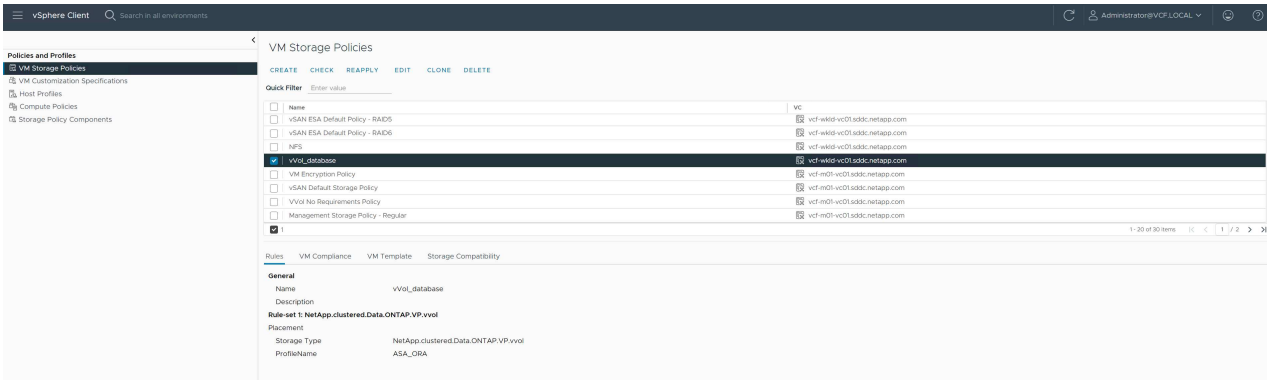
6. Storage compatibility page displays the compatible vVols datastores in VCF environment.



7. Review and finish to create the VM Storage Policy.



8. Validate the VM Storage Policy just created.



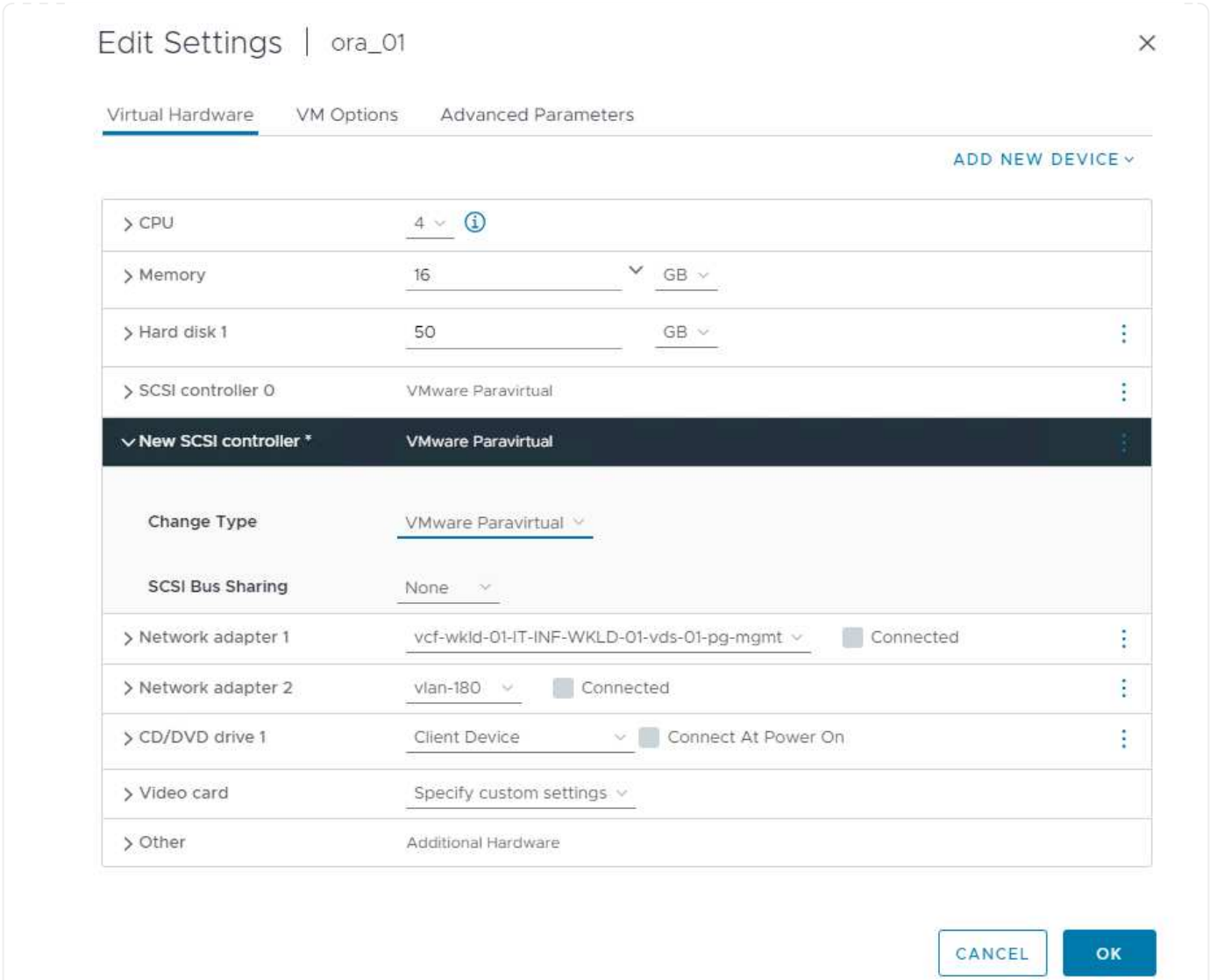
Allocate disks to RAC VMs from vVols datastores and configure DB storage

From vSphere client, add desired disks from the vVols datastores to database VM by editing VM settings. Then, login to VM to format and mount the binary disk to mount points /u01. The following demonstrates the exact steps and tasks.

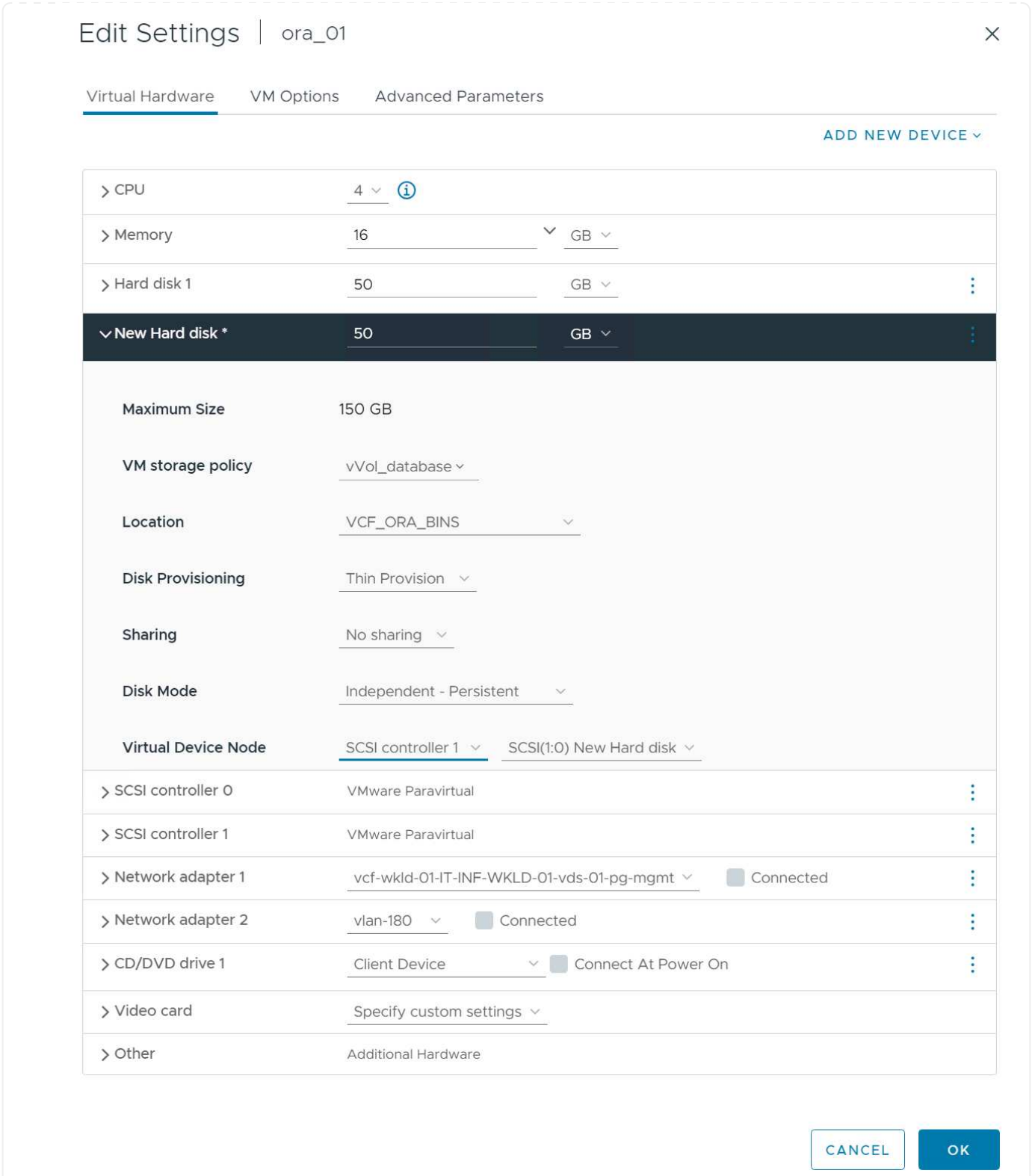
1. Before allocating disks from datastore to database VM, login to VMware ESXi hosts to validate and ensure multi-writer are enabled (GBLAllowMW value set to 1) on ESXi level.

```
[root@vcf-wkld-esx01:~] which esxcli
/bin/esxcli
[root@vcf-wkld-esx01:~] esxcli system settings advanced list -o
/VMFS3/GBLAllowMW
   Path: /VMFS3/GBLAllowMW
   Type: integer
   Int Value: 1
   Default Int Value: 1
   Min Value: 0
   Max Value: 1
   String Value:
   Default String Value:
   Valid Characters:
   Description: Allow multi-writer GBLs.
   Host Specific: false
   Impact: none
[root@vcf-wkld-esx01:~]
```

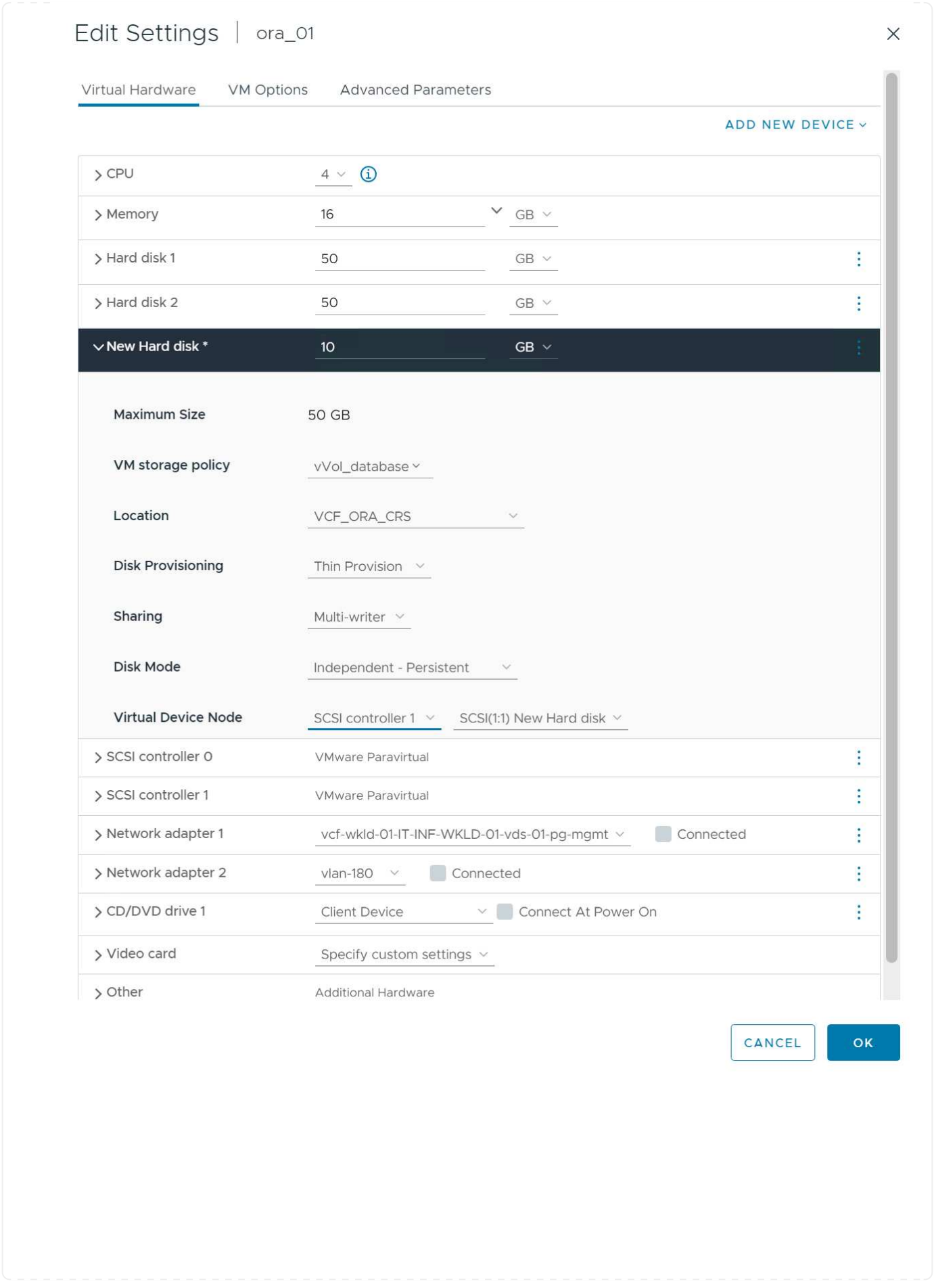
2. Add a new, dedicate SCSI controller for use with Oracle RAC disks. Disable SCSI bus sharing.

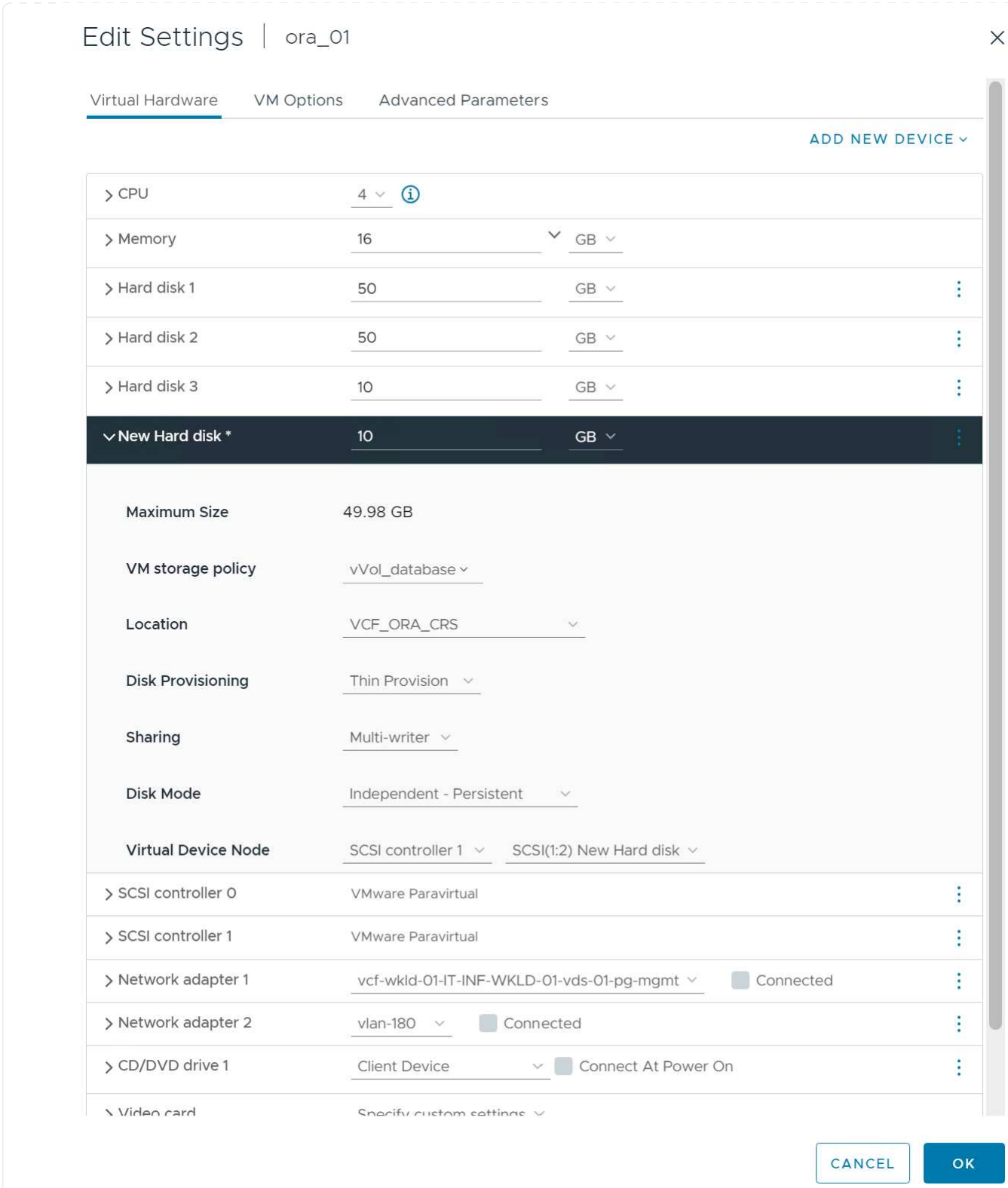


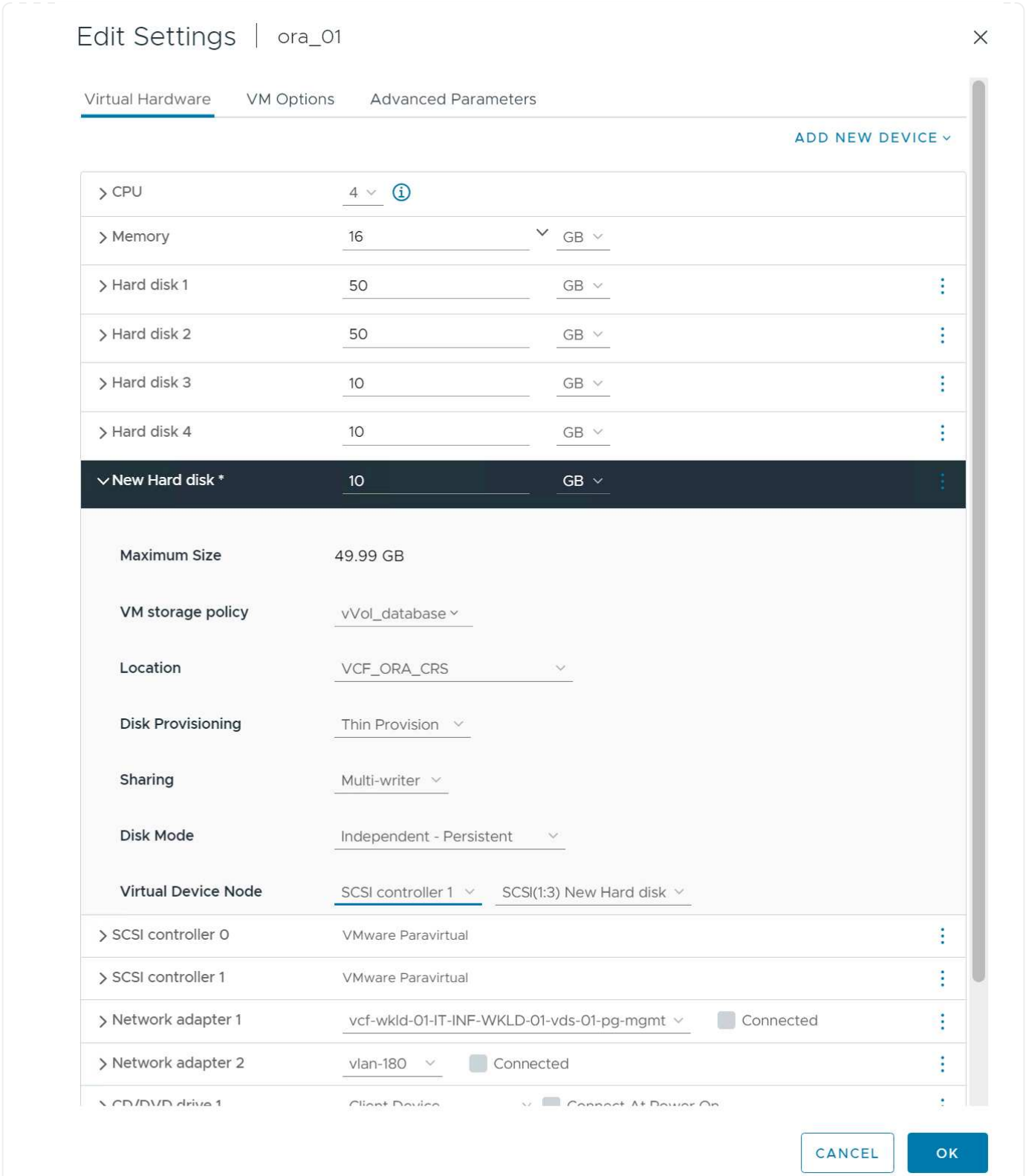
3. From RAC node 1 - ora01, add a disk to VM for Oracle binary storage without sharing.



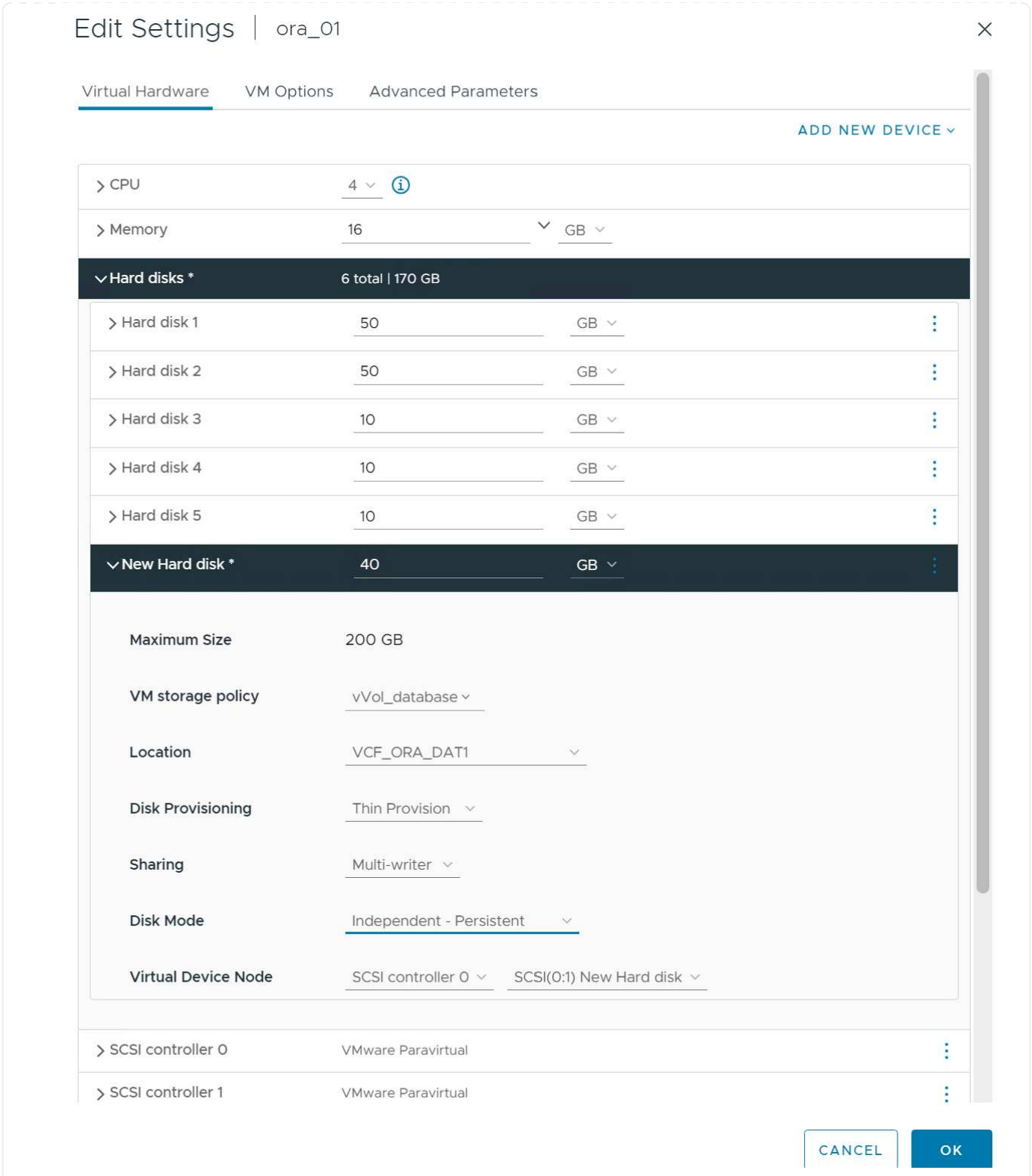
4. From RAC node 1, add three disks to VM for Oracle RAC CRS storage and enable multi-writer sharing.

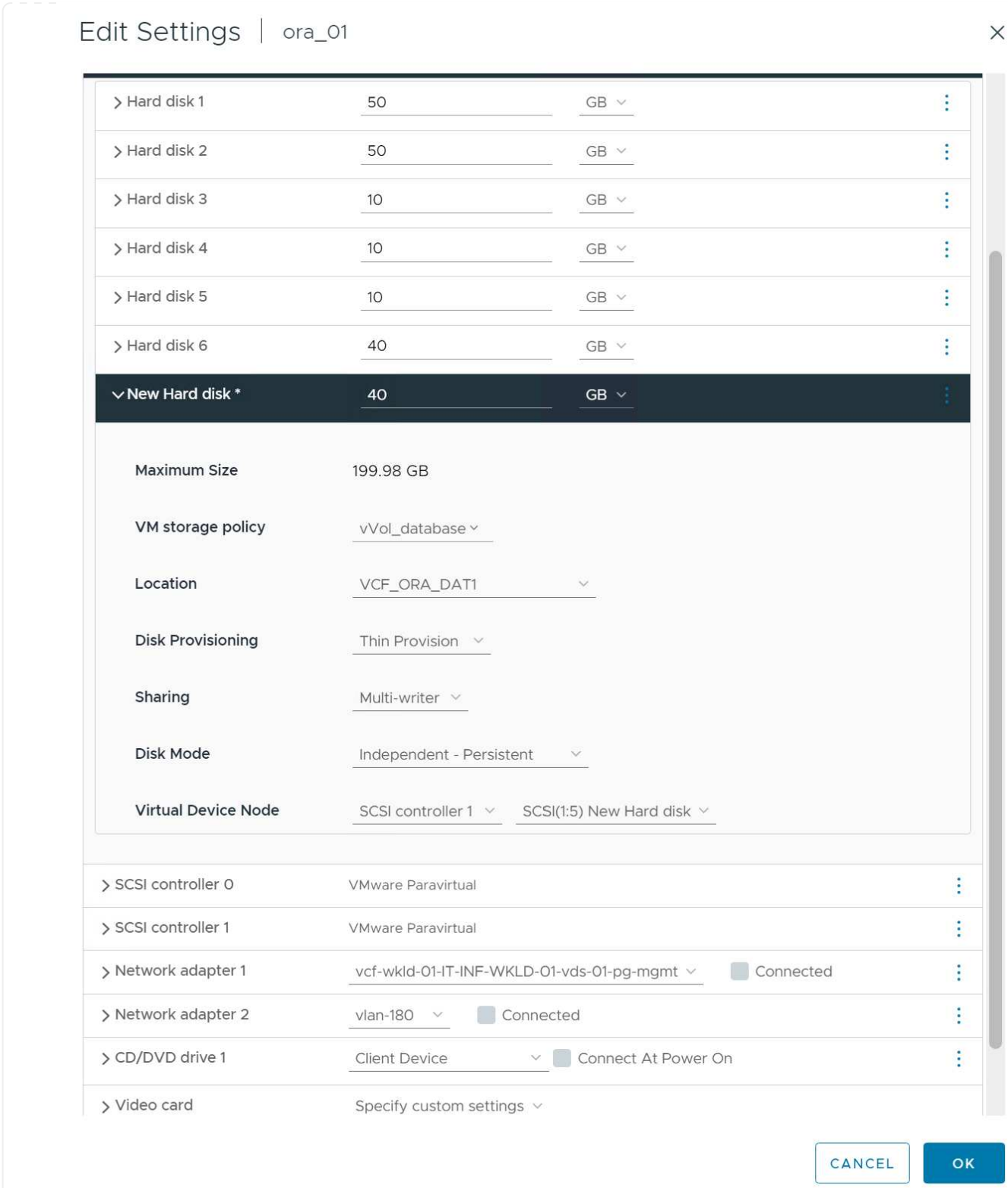

Edit Settings | ora_01
Virtual Hardware
VM Options
Advanced Parameters
ADD NEW DEVICE
CPU 4
Memory 16 GB
Hard disk 1 50 GB
Hard disk 2 50 GB
New Hard disk * 10 GB
Maximum Size 50 GB
VM storage policy vVol_database
Location VCF_ORA_CRS
Disk Provisioning Thin Provision
Sharing Multi-writer
Disk Mode Independent - Persistent
Virtual Device Node SCSI controller 1 SCSI(1:1) New Hard disk
SCSI controller 0 VMware Paravirtual
SCSI controller 1 VMware Paravirtual
Network adapter 1 vcf-wkld-01-IT-INF-WKLD-01-vds-01-pg-mgmt Connected
Network adapter 2 vlan-180 Connected
CD/DVD drive 1 Client Device Connect At Power On
Video card Specify custom settings
Other Additional Hardware
CANCEL
OK

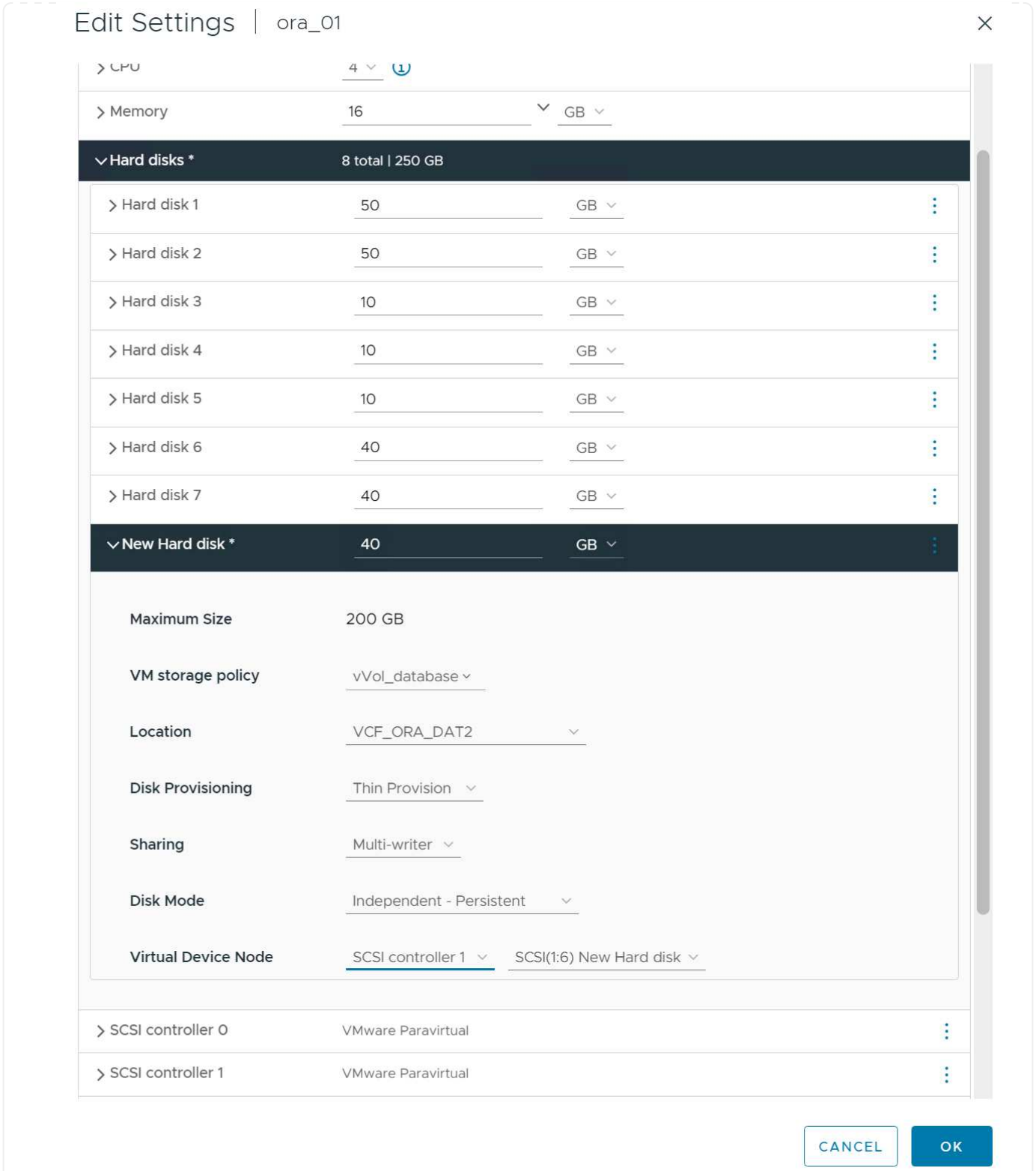

Edit Settings | ora_01
Virtual Hardware
VM Options
Advanced Parameters
ADD NEW DEVICE
CPU 4
Memory 16 GB
Hard disk 1 50 GB
Hard disk 2 50 GB
Hard disk 3 10 GB
New Hard disk * 10 GB
Maximum Size 49.98 GB
VM storage policy vVol_database
Location VCF_ORA_CRS
Disk Provisioning Thin Provision
Sharing Multi-writer
Disk Mode Independent - Persistent
Virtual Device Node SCSI controller 1 SCSI(1:2) New Hard disk
SCSI controller 0 VMware Paravirtual
SCSI controller 1 VMware Paravirtual
Network adapter 1 vcf-wkld-01-IT-INF-WKLD-01-vds-01-pg-mgmt Connected
Network adapter 2 vlan-180 Connected
CD/DVD drive 1 Client Device Connect At Power On
Video card Specify custom settings
CANCEL
OK

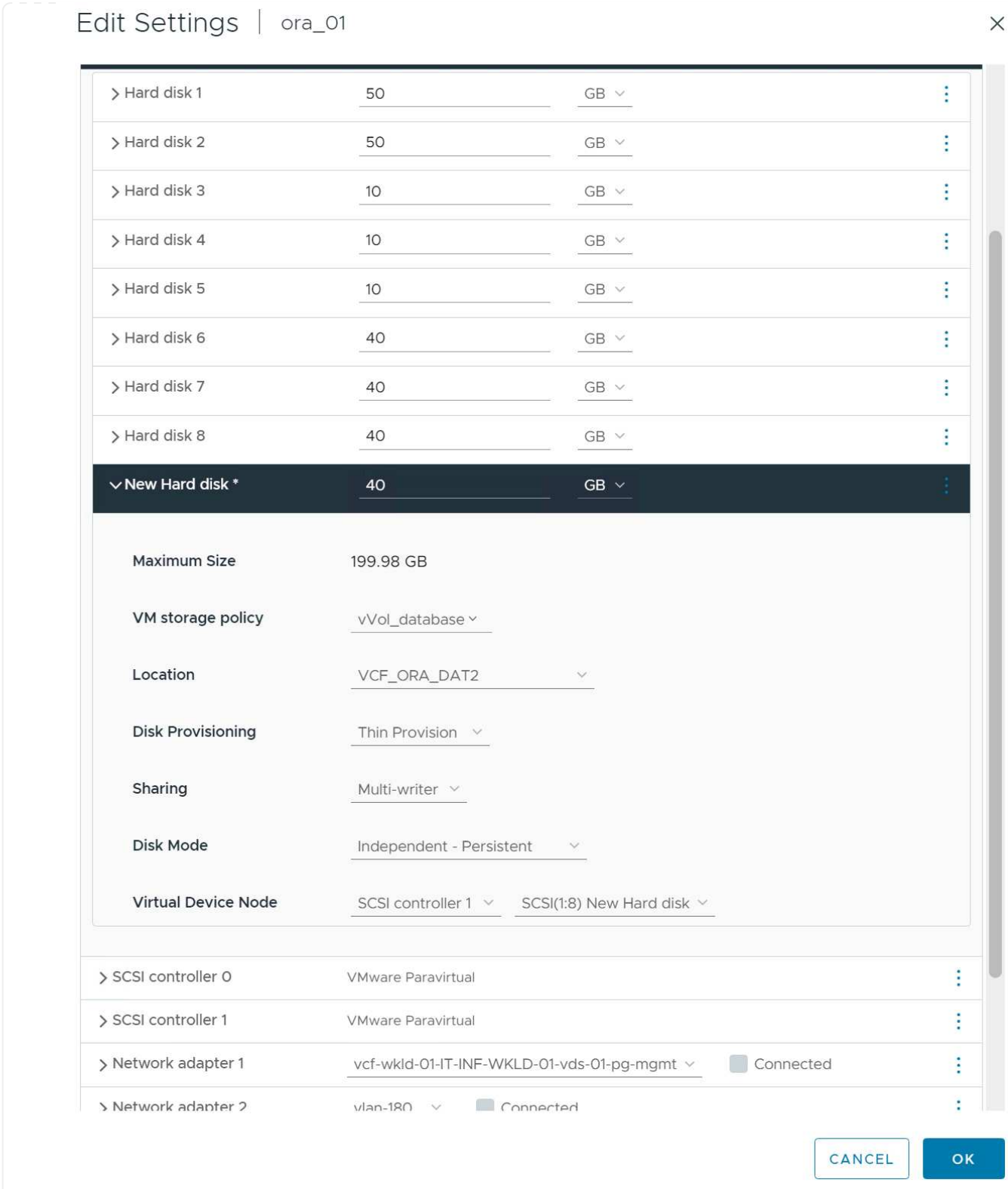


5. From RAC node 1, add two disks each from each datastore for data to VM for shared Oracle data storage.

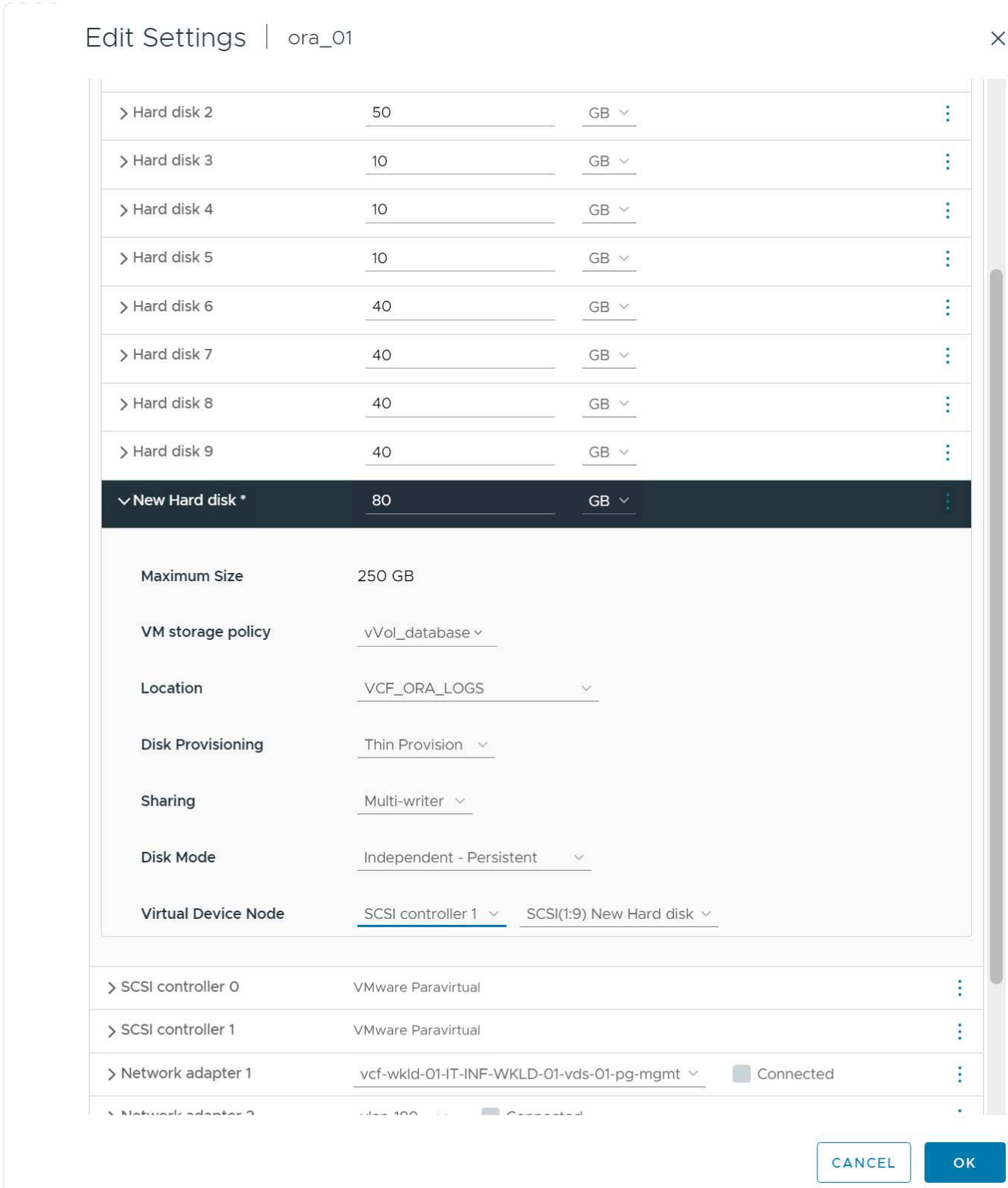

Edit Settings | ora_01
Virtual Hardware
VM Options
Advanced Parameters
ADD NEW DEVICE
CPU
4
Memory
16
GB
Hard disks *
6 total | 170 GB
Hard disk 1
50
GB
Hard disk 2
50
GB
Hard disk 3
10
GB
Hard disk 4
10
GB
Hard disk 5
10
GB
New Hard disk *
40
GB
Maximum Size
200 GB
VM storage policy
vVol_database
Location
VCF_ORA_DAT1
Disk Provisioning
Thin Provision
Sharing
Multi-writer
Disk Mode
Independent - Persistent
Virtual Device Node
SCSI controller 0
SCSI(0:1) New Hard disk
SCSI controller 0
VMware Paravirtual
SCSI controller 1
VMware Paravirtual
CANCEL
OK

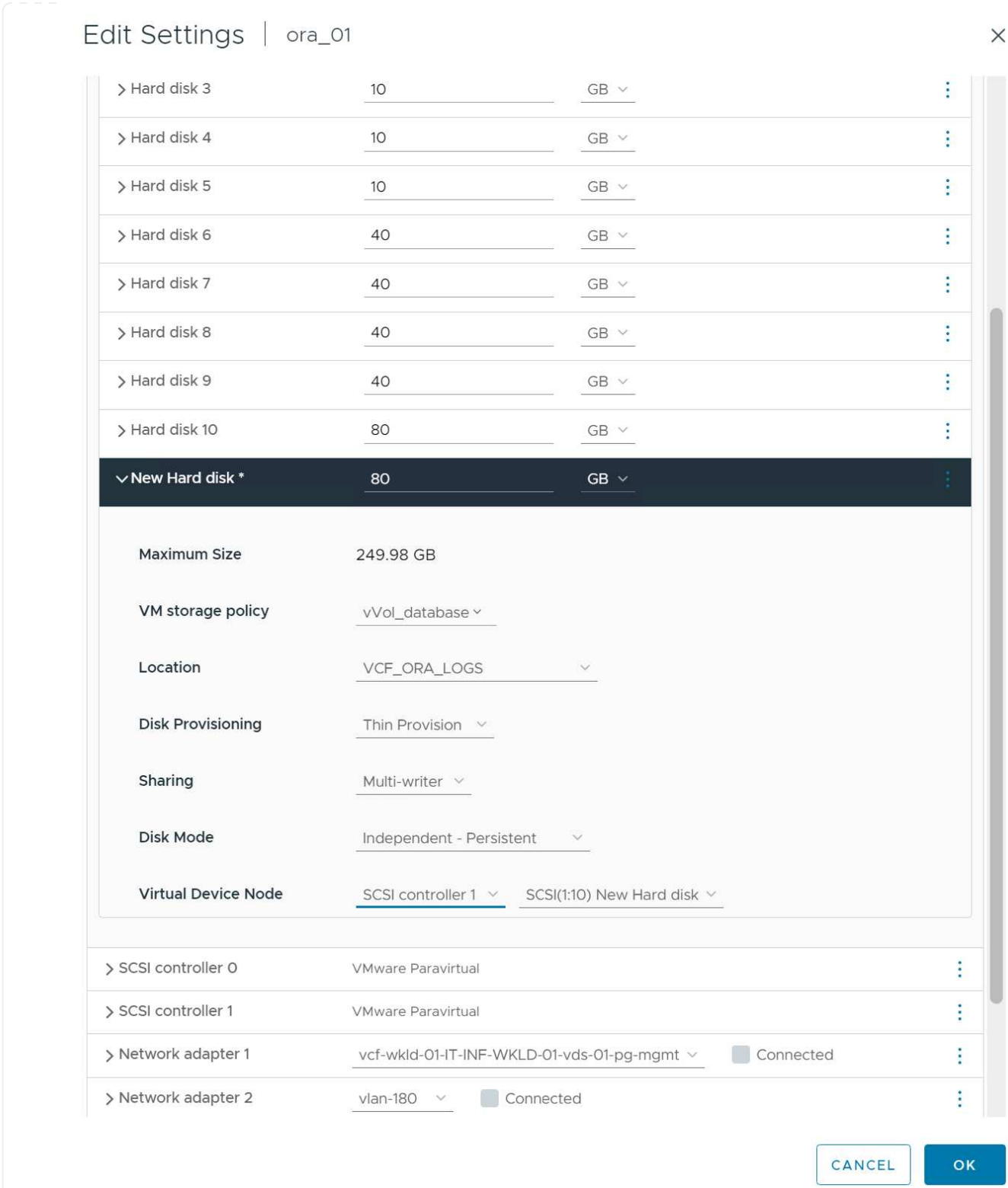

Edit Settings | ora_01
Hard disk 1 50 GB
Hard disk 2 50 GB
Hard disk 3 10 GB
Hard disk 4 10 GB
Hard disk 5 10 GB
Hard disk 6 40 GB
New Hard disk * 40 GB
Maximum Size 199.98 GB
VM storage policy vVol_database
Location VCF_ORA_DAT1
Disk Provisioning Thin Provision
Sharing Multi-writer
Disk Mode Independent - Persistent
Virtual Device Node SCSI controller 1 SCSI(1:5) New Hard disk
SCSI controller 0 VMware Paravirtual
SCSI controller 1 VMware Paravirtual
Network adapter 1 vcf-wkld-01-IT-INF-WKLD-01-vds-01-pg-mgmt Connected
Network adapter 2 vlan-180 Connected
CD/DVD drive 1 Client Device Connect At Power On
Video card Specify custom settings
CANCEL
OK


Edit Settings | ora_01
CPU 4
Memory 16 GB
Hard disks * 8 total | 250 GB
Hard disk 1 50 GB
Hard disk 2 50 GB
Hard disk 3 10 GB
Hard disk 4 10 GB
Hard disk 5 10 GB
Hard disk 6 40 GB
Hard disk 7 40 GB
New Hard disk * 40 GB
Maximum Size 200 GB
VM storage policy vVol_database
Location VCF_ORA_DAT2
Disk Provisioning Thin Provision
Sharing Multi-writer
Disk Mode Independent - Persistent
Virtual Device Node SCSI controller 1 SCSI(1:6) New Hard disk
SCSI controller 0 VMware Paravirtual
SCSI controller 1 VMware Paravirtual
CANCEL
OK

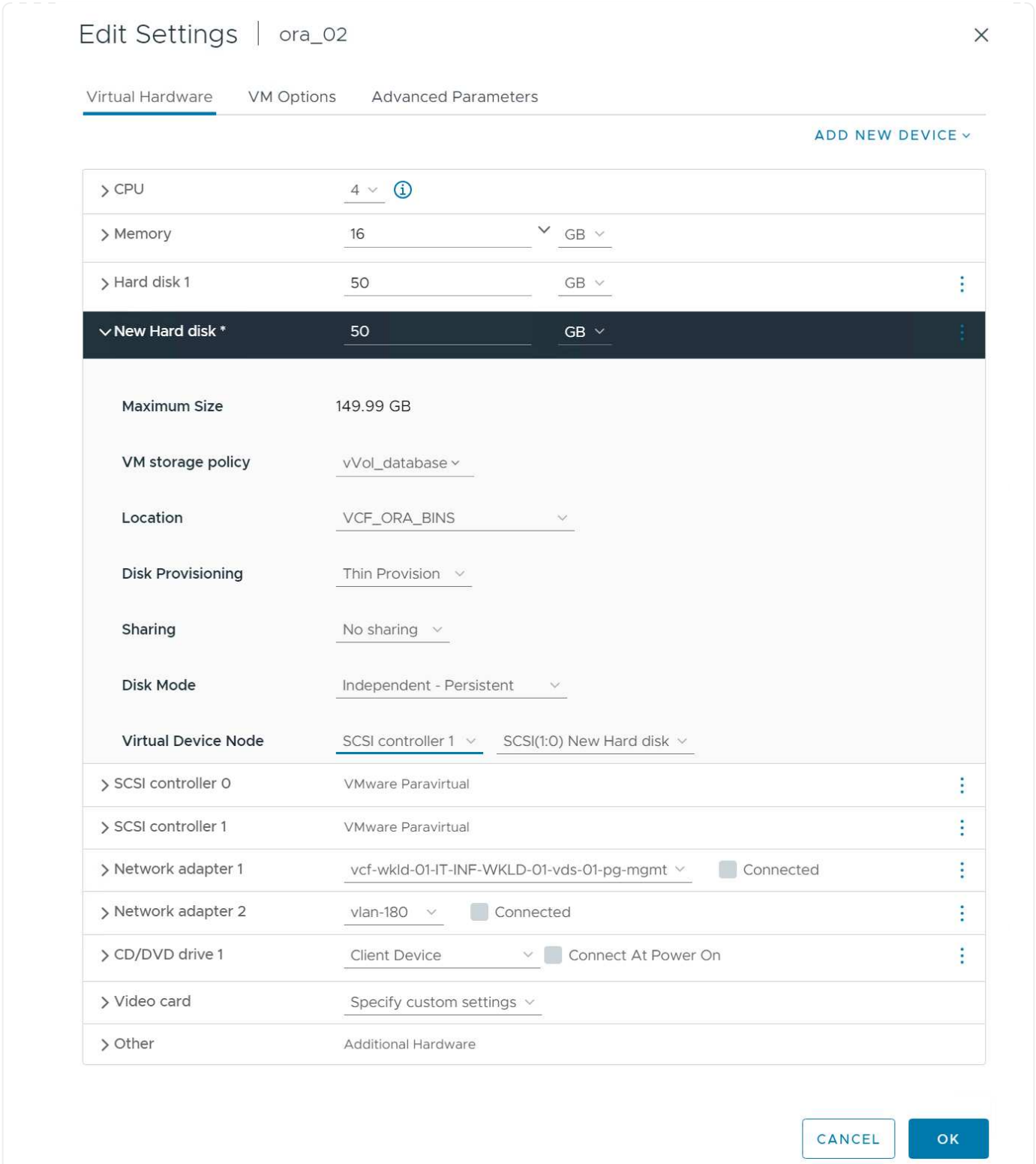


6. From RAC node 1, add two disks to VM from logs datastore for shared Oracle log files storage.

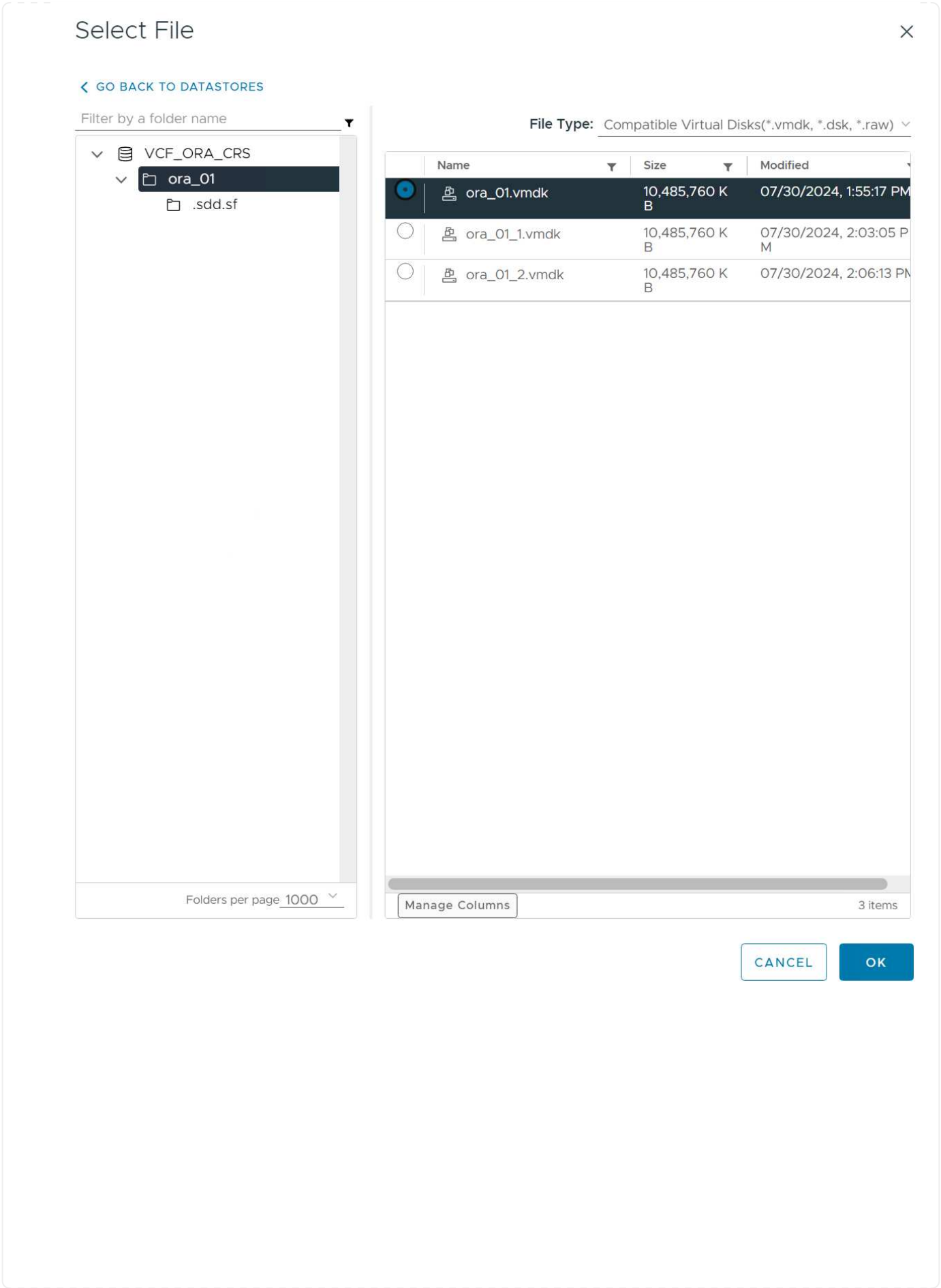

Edit Settings | ora_01
Hard disk 2 50 GB
Hard disk 3 10 GB
Hard disk 4 10 GB
Hard disk 5 10 GB
Hard disk 6 40 GB
Hard disk 7 40 GB
Hard disk 8 40 GB
Hard disk 9 40 GB
New Hard disk * 80 GB
Maximum Size 250 GB
VM storage policy vVol_database
Location VCF_ORA_LOGS
Disk Provisioning Thin Provision
Sharing Multi-writer
Disk Mode Independent - Persistent
Virtual Device Node SCSI controller 1 SCSI(1:9) New Hard disk
SCSI controller 0 VMware Paravirtual
SCSI controller 1 VMware Paravirtual
Network adapter 1 vcf-wkld-01-IT-INF-WKLD-01-vds-01-pg-mgmt Connected
CANCEL
OK

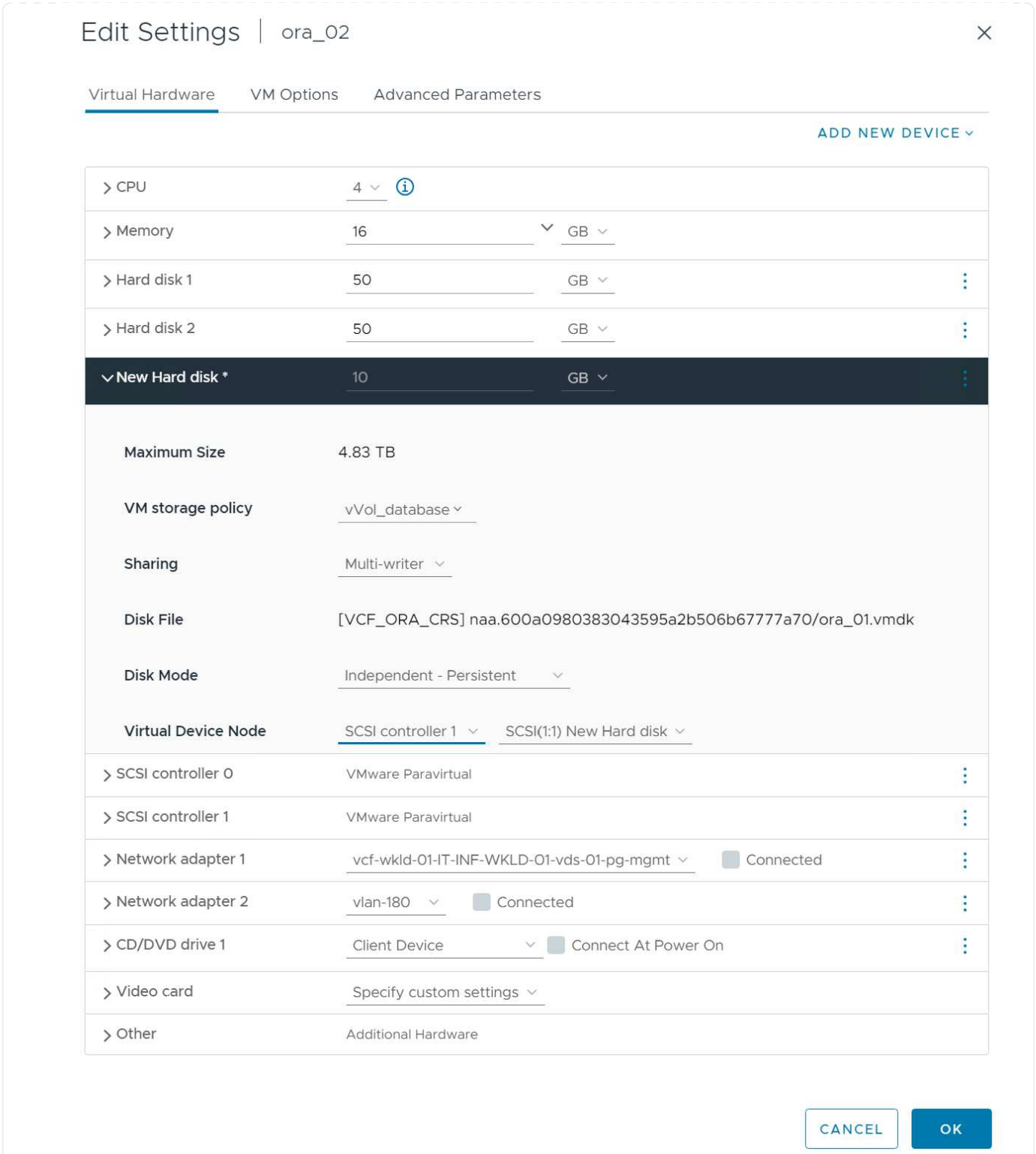


7. From RAC node 2, add a disk to VM for Oracle binary storage without sharing.

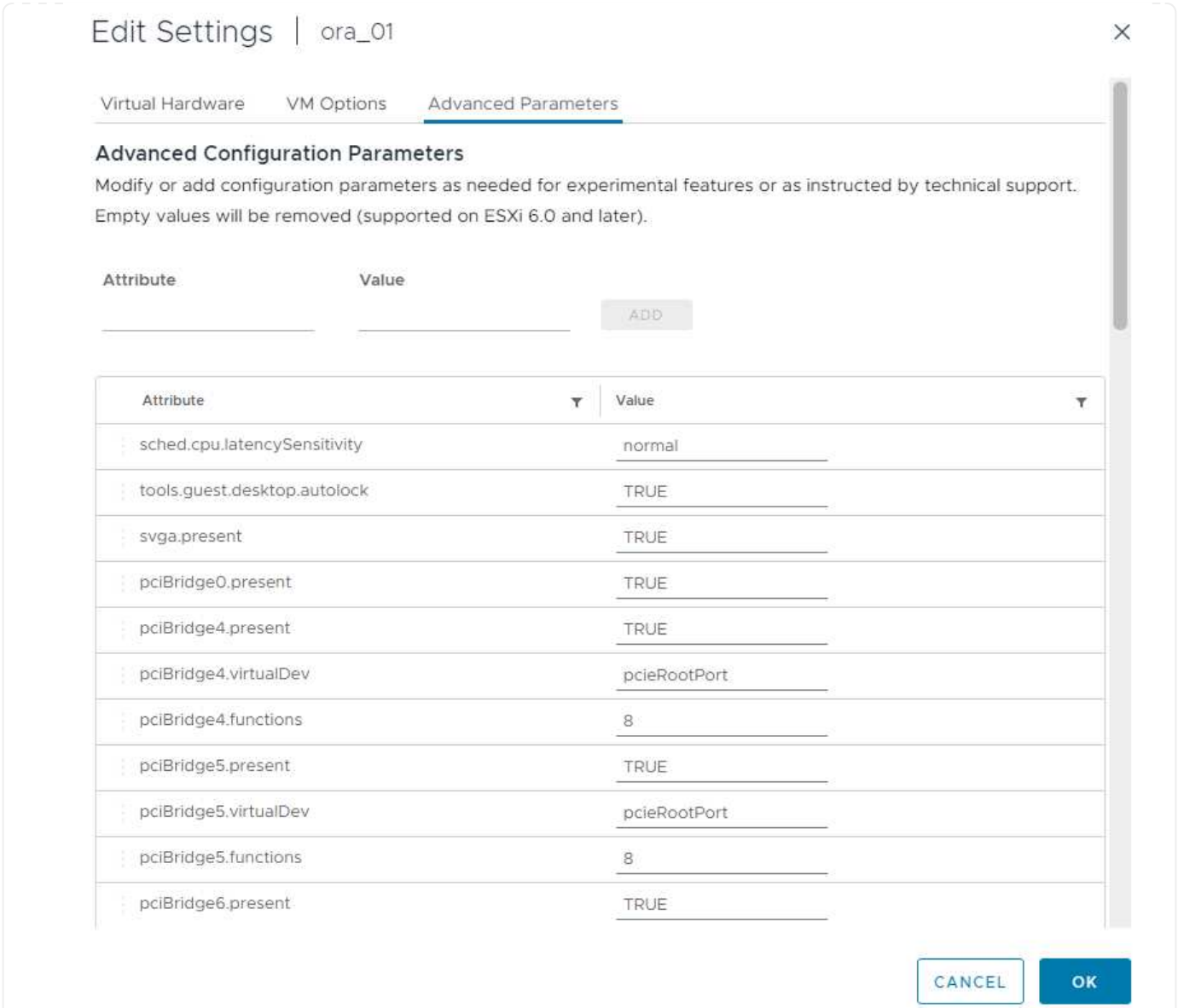


8. From RAC node 2, add other shared disks by selecting `Existing Hard Disks` option and enable multi-writer sharing for each shared disk.


Select File
GO BACK TO DATASTORES
Filter by a folder name
VCF_ORA_CRS
ora_01
.sdd.sf
Folders per page 1000
File Type: Compatible Virtual Disks(*.vmdk, *.dsk, *.raw)
Name
Size
Modified
ora_01.vmdk
10,485,760 KB
07/30/2024, 1:55:17 PM
ora_01_1.vmdk
10,485,760 KB
07/30/2024, 2:03:05 PM
ora_01_2.vmdk
10,485,760 KB
07/30/2024, 2:06:13 PM
Manage Columns
3 items
CANCEL
OK



9. From VM `Edit Settings`, `Advanced Parameters`, add Attribute `disk.enableuuid` with Value `TRUE`. The VM needs to be down to add the advanced parameter. Setting this option enables SnapCenter to precisely identify the vVol in your environment. This should be done on all RAC nodes.



10. Now, restart the VM. Login to VM as an admin user via ssh to review the newly added disk drives.

```
[admin@ora01 ~]$ sudo lsblk
NAME          MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
sda             8:0    0   50G  0 disk
├─sda1          8:1    0  600M  0 part /boot/efi
├─sda2          8:2    0    1G  0 part /boot
└─sda3          8:3    0 48.4G  0 part
  ├─rhel-root 253:0    0 43.4G  0 lvm  /
  └─rhel-swap 253:1    0    5G  0 lvm  [SWAP]
sdb             8:16   0   50G  0 disk
sdc             8:32   0   10G  0 disk
sdd             8:48   0   10G  0 disk
sde             8:64   0   10G  0 disk
sdf             8:80   0   40G  0 disk
sdg             8:96   0   40G  0 disk
sdh             8:112  0   40G  0 disk
sdi             8:128  0   40G  0 disk
sdj             8:144  0   80G  0 disk
sdk             8:160  0   80G  0 disk
sr0            11:0    1 1024M  0 rom
[admin@ora01 ~]$

[admin@ora02 ~]$ sudo lsblk
NAME          MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
sda             8:0    0   50G  0 disk
├─sda1          8:1    0  600M  0 part /boot/efi
├─sda2          8:2    0    1G  0 part /boot
└─sda3          8:3    0 48.4G  0 part
  ├─rhel-root 253:0    0 43.4G  0 lvm  /
  └─rhel-swap 253:1    0    5G  0 lvm  [SWAP]
sdb             8:16   0   50G  0 disk
sdc             8:32   0   10G  0 disk
sdd             8:48   0   10G  0 disk
sde             8:64   0   10G  0 disk
sdf             8:80   0   40G  0 disk
sdg             8:96   0   40G  0 disk
sdh             8:112  0   40G  0 disk
sdi             8:128  0   40G  0 disk
sdj             8:144  0   80G  0 disk
sdk             8:160  0   80G  0 disk
sr0            11:0    1 1024M  0 rom
[admin@ora02 ~]$
```

11. From each RAC node, partition the Oracle binary disk (/dev/sdb) as a primary and single partition by simply accepting the default choices.

```
sudo fdisk /dev/sdb
```

12. Format the partitioned disks as xfs file systems.

```
sudo mkfs.xfs /dev/sdb1
```

13. Mount the disk to mount point /u01.

```
[admin@ora01 ~]$ df -h
Filesystem             Size  Used Avail Use% Mounted on
devtmpfs               7.7G   36K  7.7G   1% /dev
tmpfs                  7.8G  1.4G  6.4G  18% /dev/shm
tmpfs                  7.8G   34M  7.7G   1% /run
tmpfs                  7.8G     0  7.8G   0% /sys/fs/cgroup
/dev/mapper/rhel-root   44G   29G   16G  66% /
/dev/sda2             1014M  249M  766M  25% /boot
/dev/sda1              599M  5.9M  593M   1% /boot/efi
/dev/sdb1               50G   24G   27G  47% /u01
tmpfs                  1.6G   12K  1.6G   1% /run/user/42
tmpfs                  1.6G     0  1.6G   0% /run/user/54331
tmpfs                  1.6G  4.0K  1.6G   1% /run/user/1000
```

14. Add mount points to /etc/fstab so that disk drives will be mounted when VM reboots.

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

```
[oracle@ora_01 ~]$ cat /etc/fstab

#
# /etc/fstab
# Created by anaconda on Wed Oct 18 19:43:31 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/rhel-root   /                       xfs     defaults
0 0
UUID=aff942c4-b224-4b62-807d-6a5c22f7b623 /boot
xfs     defaults        0 0
/dev/mapper/rhel-swap   none                    swap    defaults
0 0
/root/swapfile swap swap defaults 0 0
/dev/sdb1               /u01                    xfs     defaults
0 0
```

Oracle RAC deployment in VCF

It's recommended to leverage NetApp automation toolkit to deploy Oracle RAC in VCF with vVols. Read the included instruction (READme) carefully and configure deployment parameter files such as deployment target file - hosts, global variables file - vars/vars.yml, and local DB VM variables file - host_vars/host_name.yml by following instructions in the toolkit. Following is the step by step procedures.

1. Login to Ansible controller VM as admin user via ssh and clone a copy of automation toolkit for Oracle RAC deployment in VCF with vVols.

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

2. Stage the following Oracle installation files in /tmp/archive folder on RAC node 1 database VM. The folder should allow all user access with 777 permission.

```
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
```

3. Set up ssh keyless authentication between Ansible controller and database VMs, which requires to generate a ssh key pair and copy the public key to database VMs admin user root directory .ssh folder authorized_keys file.

```
ssh-keygen
```

4. Configure the user defined target host parameters files. Following is an example of typical configuration for target hosts file - hosts.

```
#Oracle hosts
[oracle]
ora01 ansible_host=10.61.180.21
ansible_ssh_private_key_file=ora01.pem
ora02 ansible_host=10.61.180.22
ansible_ssh_private_key_file=ora02.pem
```

5. Configure the user defined local host specific parameters files. Following is an example of typical configuration for local host_name.yml file - ora01.yml.

```
# Binary lun
ora_bin: /dev/sdb

# Host DB configuration
ins_sid: "{{ oracle_sid }}1"
asm_sid: +ASM1
```

6. Configure the user defined global parameters file. Following is an example of typical configuration for global parameters file - vars.yml

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

# ONTAP storage platform: on-prem, vmware-vvols
ontap_platform: vmware-vvols

# Prerequisite to create five vVolss in VMware vCenter
# VCF_ORA_BINS - Oracle binary
# VCF_ORA_CRS  - Oracle cluster registry and vote
# VCF_ORA_DAT1 - Oracle data on node1
# VCF_ORA_DAT2 - Oracle data on node2
# VCF_ORA_LOGS - Oracle logs on node1 or node2

# Oracle disks are added to VM from vVols: 1 binary disk, 3 CRS
disks, 4 data disks, and 2 log disks.


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

redhat_sub_username: XXXXXXXX
redhat_sub_password: "XXXXXXXX"

# Networking configuration
cluster_pub_ip:
  - {ip: 10.61.180.21, hostname: ora01}
  - {ip: 10.61.180.22, hostname: ora02}
```

```
cluster_pri_ip:
  - {ip: 172.21.166.22, hostname: ora01-pri}
  - {ip: 172.21.166.24, hostname: ora02-pri}

cluster_vip_ip:
  - {ip: 10.61.180.93, hostname: ora01-vip}
  - {ip: 10.61.180.94, hostname: ora02-vip}

cluster_scan_name: ntap-scan
cluster_scan_ip:
  - {ip: 10.61.180.90, hostname: ntap-scan}
  - {ip: 10.61.180.91, hostname: ntap-scan}
  - {ip: 10.61.180.92, hostname: ntap-scan}


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

# Shared Oracle RAC storage
ora_crs:
  - { device: /dev/sdc, name: ora_crs_01 }
  - { device: /dev/sdd, name: ora_crs_02 }
  - { device: /dev/sde, name: ora_crs_03 }

ora_data:
  - { device: /dev/sdf, name: ora_data_01 }
  - { device: /dev/sdg, name: ora_data_02 }
  - { device: /dev/sdh, name: ora_data_03 }
  - { device: /dev/sdi, name: ora_data_04 }

ora_logs:
  - { device: /dev/sdj, name: ora_logs_01 }
  - { device: /dev/sdk, name: ora_logs_02 }

# Oracle RAC configuration

oracle_sid: NTAP
cluster_name: ntap-rac
cluster_nodes: ora01,ora02
cluster_domain: solutions.netapp.com
grid_cluster_nodes: ora01:ora01-vip:HUB,ora02:ora02-vip:HUB
```

```
network_interface_list: ens33:10.61.180.0:1,ens34:172.21.166.0:5
memory_limit: 10240
```

```
# Set initial password for all required Oracle passwords. Change
them after installation.
initial_pwd_all: "XXXXXXXX"
```

7. From Ansible controller, cloned automation toolkit home directory /home/admin/na_oracle_deploy_rac, execute prerequisites playbook to setup ansible prerequisites.

```
ansible-playbook -i hosts 1-ansible_requirements.yml
```

8. Execute Linux configuration playbook.

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

9. Execute Oracle deployment playbook.

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

10. Optionally, all above playbooks can be executed from a single playbook run as well.

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

Oracle RAC deployment validation in VCF

This section provides details on Oracle RAC deployment validation in VCF to ensure all Oracle RAC resources are fully deployed, configured, and functioning as expected.

1. Login to RAC VM as admin user to validate Oracle grid infrastructure.

```
[admin@ora01 ~]$ sudo su
[root@ora01 admin]# su - grid
[grid@ora01 ~]$ crsctl stat res -t
--------------------------------------------------------------------------------
------------
Name           Target  State        Server                   State
details
--------------------------------------------------------------------------------
------------
Local Resources
--------------------------------------------------------------------------------
------------
ora.LISTENER.lsnr
               ONLINE  ONLINE       ora01                    STABLE
               ONLINE  ONLINE       ora02                    STABLE
ora.chad
               ONLINE  ONLINE       ora01                    STABLE
               ONLINE  ONLINE       ora02                    STABLE
ora.net1.network
               ONLINE  ONLINE       ora01                    STABLE
               ONLINE  ONLINE       ora02                    STABLE
ora.ons
               ONLINE  ONLINE       ora01                    STABLE
               ONLINE  ONLINE       ora02                    STABLE
ora.proxy_advm
               OFFLINE OFFLINE      ora01                    STABLE
               OFFLINE OFFLINE      ora02                    STABLE
--------------------------------------------------------------------------------
------------
Cluster Resources
--------------------------------------------------------------------------------
------------
ora.ASMNET1LSNR_ASM.lsnr(ora.asmgroup)
      1        ONLINE  ONLINE       ora01                    STABLE
      2        ONLINE  ONLINE       ora02                    STABLE
ora.DATA.dg(ora.asmgroup)
      1        ONLINE  ONLINE       ora01                    STABLE
      2        ONLINE  ONLINE       ora02                    STABLE
ora.LISTENER_SCAN1.lsnr
      1        ONLINE  ONLINE       ora01                    STABLE
```

```
ora.LISTENER_SCAN2.lsnr
      1        ONLINE  ONLINE       ora02                    STABLE
ora.LISTENER_SCAN3.lsnr
      1        ONLINE  ONLINE       ora02                    STABLE
ora.RECO.dg(ora.asmgroup)
      1        ONLINE  ONLINE       ora01                    STABLE
      2        ONLINE  ONLINE       ora02                    STABLE
ora.VOTE.dg(ora.asmgroup)
      1        ONLINE  ONLINE       ora01                    STABLE
      2        ONLINE  ONLINE       ora02                    STABLE
ora.asm(ora.asmgroup)
      1        ONLINE  ONLINE       ora01
Started,STABLE
      2        ONLINE  ONLINE       ora02
Started,STABLE
ora.asmnet1.asmnetwork(ora.asmgroup)
      1        ONLINE  ONLINE       ora01                    STABLE
      2        ONLINE  ONLINE       ora02                    STABLE
ora.cvu
      1        ONLINE  ONLINE       ora02                    STABLE
ora.ntap.db
      1        ONLINE  ONLINE       ora01
Open,HOME=/u01/app/o

racle2/product/19.0.

0/NTAP,STABLE
      2        ONLINE  ONLINE       ora02
Open,HOME=/u01/app/o

racle2/product/19.0.

0/NTAP,STABLE
ora.ora01.vip
      1        ONLINE  ONLINE       ora01                    STABLE
ora.ora02.vip
      1        ONLINE  ONLINE       ora02                    STABLE
ora.qosmserver
      1        ONLINE  ONLINE       ora02                    STABLE
ora.scan1.vip
      1        ONLINE  ONLINE       ora01                    STABLE
ora.scan2.vip
      1        ONLINE  ONLINE       ora02                    STABLE
ora.scan3.vip
      1        ONLINE  ONLINE       ora02                    STABLE
--------------------------------------------------------------------------------
```

```
------------
[grid@ora01 ~]$
```

2. Validate Oracle ASM.

```
[grid@ora01 ~]$ 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
163840   163723                0          163723              0
N  DATA/
MOUNTED  EXTERN  N         512             512   4096  1048576
163840   163729                0          163729              0
N  RECO/
MOUNTED  NORMAL  N         512             512   4096  4194304
30720    29732            10240            9746              0
Y  VOTE/
ASMCMD> lsdsk
Path
AFD:ORA_CRS_01
AFD:ORA_CRS_02
AFD:ORA_CRS_03
AFD:ORA_DATA_01
AFD:ORA_DATA_02
AFD:ORA_DATA_03
AFD:ORA_DATA_04
AFD:ORA_LOGS_01
AFD:ORA_LOGS_02
ASMCMD> afd_state
ASMCMD-9526: The AFD state is 'LOADED' and filtering is 'ENABLED' on
host 'ora01'
ASMCMD>
```

3. List cluster nodes.

```
[grid@ora01 ~]$ olsnodes
ora01
ora02
```

4. Validate OCR/VOTE.

```
[grid@ora01 ~]$ ocrcheck
Status of Oracle Cluster Registry is as follows :
         Version                  :          4
         Total space (kbytes)     :     901284
         Used space (kbytes)      :      84536
         Available space (kbytes) :     816748
         ID                       :  118267044
         Device/File Name         :      +VOTE
                                    Device/File integrity check
succeeded

                                    Device/File not configured

                                    Device/File not configured

                                    Device/File not configured

                                    Device/File not configured

         Cluster registry integrity check succeeded

         Logical corruption check bypassed due to non-privileged
user

[grid@ora01 ~]$ crsctl query css votedisk
##  STATE    File Universal Id               File Name Disk group
--  -----    -----------------               --------- ---------
 1. ONLINE   1ca3fcb0bd354f8ebf00ac97d70e0824 (AFD:ORA_CRS_01)
[VOTE]
 2. ONLINE   708f84d505a54f58bf41124e09a5115a (AFD:ORA_CRS_02)
[VOTE]
 3. ONLINE   133ecfcedb684fe6bfdc1899b90f91c7 (AFD:ORA_CRS_03)
[VOTE]
Located 3 voting disk(s).
[grid@ora01 ~]$
```

5. Validate Oracle listener.

```
[grid@ora01 ~]$ lsnrctl status listener

LSNRCTL for Linux: Version 19.0.0.0.0 - Production on 16-AUG-2024
10:21:38

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

```
Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=IPC)(KEY=LISTENER)))
STATUS of the LISTENER
------------------------
Alias                     LISTENER
Version                   TNSLSNR for Linux: Version 19.0.0.0.0 -
Production
Start Date                14-AUG-2024 16:24:48
Uptime                    1 days 17 hr. 56 min. 49 sec
Trace Level               off
Security                  ON: Local OS Authentication
SNMP                      OFF
Listener Parameter File
/u01/app/grid/19.0.0/network/admin/listener.ora
Listener Log File
/u01/app/oracle/diag/tnslsnr/ora01/listener/alert/log.xml
Listening Endpoints Summary...
  (DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=LISTENER)))

(DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=10.61.180.21)(PORT=1521)))

(DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=10.61.180.93)(PORT=1521)))

(DESCRIPTION=(ADDRESS=(PROTOCOL=tcps)(HOST=ora01.solutions.netapp.co
m)(PORT=5500))(Security=(my_wallet_directory=/u01/app/oracle2/produc
t/19.0.0/NTAP/admin/NTAP/xdb_wallet))(Presentation=HTTP)(Session=RAW
))
Services Summary...
Service "+ASM" has 1 instance(s).
  Instance "+ASM1", status READY, has 1 handler(s) for this
service...
Service "+ASM_DATA" has 1 instance(s).
  Instance "+ASM1", status READY, has 1 handler(s) for this
service...
Service "+ASM_RECO" has 1 instance(s).
  Instance "+ASM1", status READY, has 1 handler(s) for this
service...
Service "+ASM_VOTE" has 1 instance(s).
  Instance "+ASM1", status READY, has 1 handler(s) for this
service...
Service "1fbf0aaa1d13cb5ae06315b43d0ab734.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "1fbf142e7db2d090e06315b43d0a6894.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
```

```
service...
Service "1fbf203c3a46d7bae06315b43d0ae055.solutions.netapp.com" has
1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "NTAP.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "NTAPXDB.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap_pdb1.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap_pdb2.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
Service "ntap_pdb3.solutions.netapp.com" has 1 instance(s).
  Instance "NTAP1", status READY, has 1 handler(s) for this
service...
The command completed successfully
[grid@ora01 ~]$

[grid@ora01 ~]$ tnsping ntap-scan

TNS Ping Utility for Linux: Version 19.0.0.0.0 - Production on 16-
AUG-2024 12:07:58

Copyright (c) 1997, 2022, Oracle.  All rights reserved.

Used parameter files:
/u01/app/grid/19.0.0/network/admin/sqlnet.ora

Used EZCONNECT adapter to resolve the alias
Attempting to contact
(DESCRIPTION=(CONNECT_DATA=(SERVICE_NAME=))(ADDRESS=(PROTOCOL=tcp)(H
OST=10.61.180.90)(PORT=1521))(ADDRESS=(PROTOCOL=tcp)(HOST=10.61.180.
91)(PORT=1521))(ADDRESS=(PROTOCOL=tcp)(HOST=10.61.180.92)(PORT=1521)
))
OK (10 msec)
```

6. Change to oracle user to validate the clustered database.

```
[oracle@ora02 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Fri Aug 16 11:32:23
```

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

NAME      OPEN_MODE            LOG_MODE
--------- -------------------- ------------
NTAP      READ WRITE           ARCHIVELOG

SQL> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP_PDB1                      READ WRITE NO
         4 NTAP_PDB2                      READ WRITE NO
         5 NTAP_PDB3                      READ WRITE NO
SQL> select name from v$datafile
  2  union
  3  select name from v$controlfile
  4  union
  5  select member from v$logfile;

NAME
------------------------------------------------------------------------
------------
+DATA/NTAP/1FBF0AAA1D13CB5AE06315B43D0AB734/DATAFILE/sysaux.275.1177
083797
+DATA/NTAP/1FBF0AAA1D13CB5AE06315B43D0AB734/DATAFILE/system.274.1177
083797
+DATA/NTAP/1FBF0AAA1D13CB5AE06315B43D0AB734/DATAFILE/undo_2.277.1177
083853
+DATA/NTAP/1FBF0AAA1D13CB5AE06315B43D0AB734/DATAFILE/undotbs1.273.11
77083797
+DATA/NTAP/1FBF0AAA1D13CB5AE06315B43D0AB734/DATAFILE/users.278.11770
83901
+DATA/NTAP/1FBF142E7DB2D090E06315B43D0A6894/DATAFILE/sysaux.281.1177
083903
```
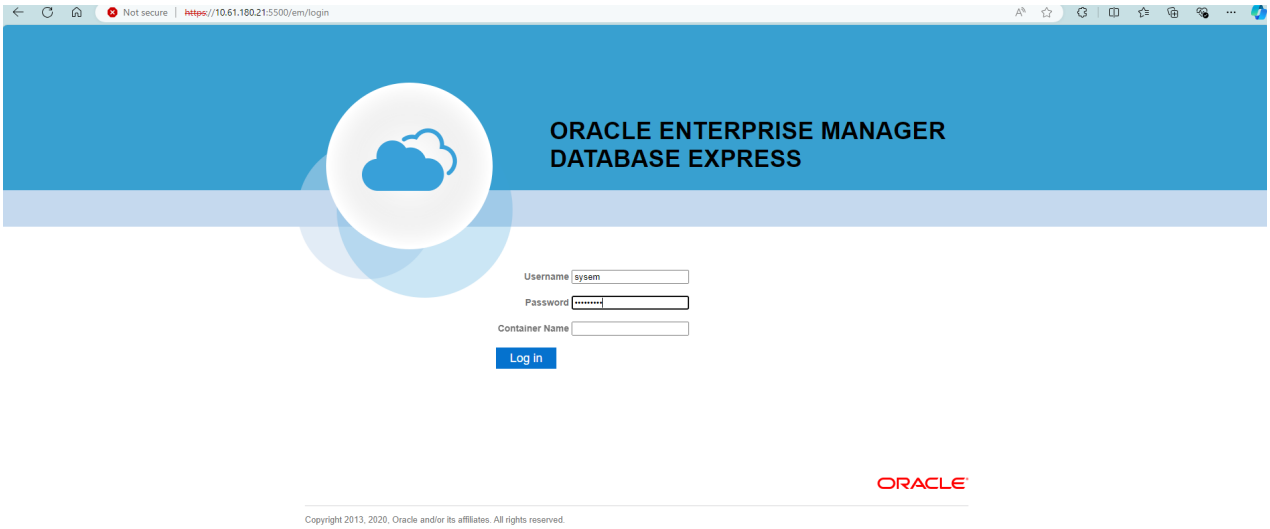
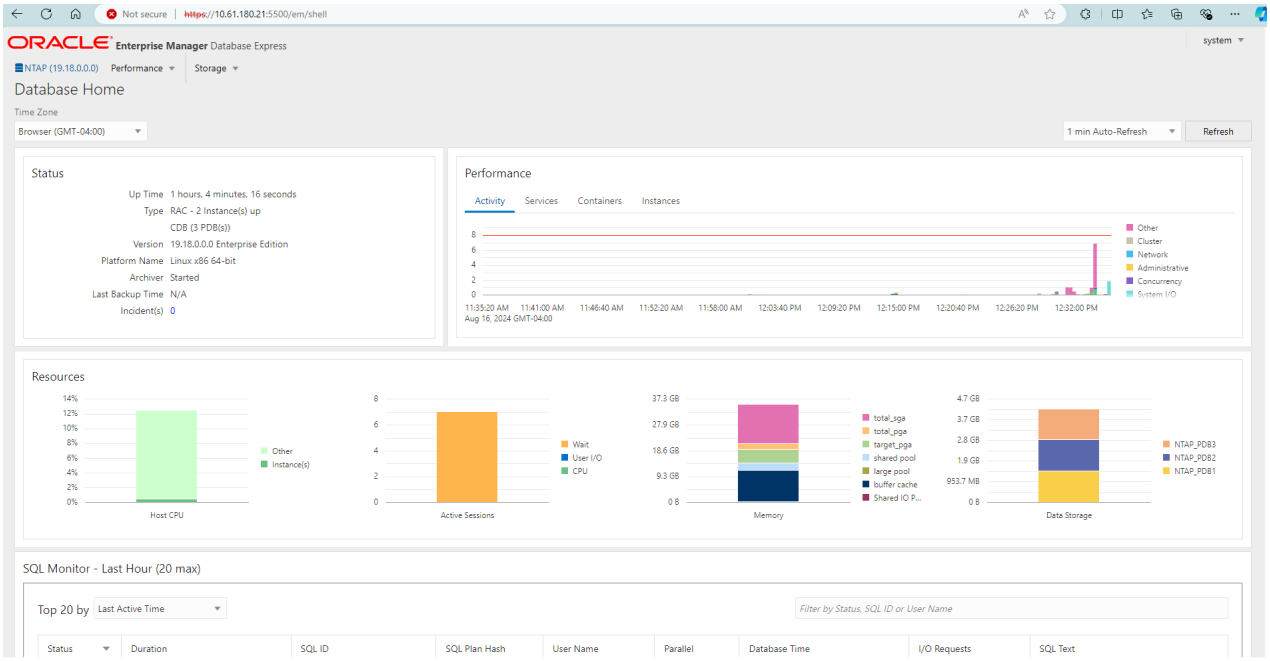

```
+DATA/NTAP/1FBF142E7DB2D090E06315B43D0A6894/DATAFILE/system.280.1177
083903
+DATA/NTAP/1FBF142E7DB2D090E06315B43D0A6894/DATAFILE/undo_2.283.1177
084061
+DATA/NTAP/1FBF142E7DB2D090E06315B43D0A6894/DATAFILE/undotbs1.279.11
77083903
+DATA/NTAP/1FBF142E7DB2D090E06315B43D0A6894/DATAFILE/users.284.11770
84103
+DATA/NTAP/1FBF203C3A46D7BAE06315B43D0AE055/DATAFILE/sysaux.287.1177
084105

NAME
--------------------------------------------------------------------
------------
+DATA/NTAP/1FBF203C3A46D7BAE06315B43D0AE055/DATAFILE/system.286.1177
084105
+DATA/NTAP/1FBF203C3A46D7BAE06315B43D0AE055/DATAFILE/undo_2.289.1177
084123
+DATA/NTAP/1FBF203C3A46D7BAE06315B43D0AE055/DATAFILE/undotbs1.285.11
77084105
+DATA/NTAP/1FBF203C3A46D7BAE06315B43D0AE055/DATAFILE/users.290.11770
84125
+DATA/NTAP/86B637B62FE07A65E053F706E80A27CA/DATAFILE/sysaux.266.1177
081837
+DATA/NTAP/86B637B62FE07A65E053F706E80A27CA/DATAFILE/system.265.1177
081837
+DATA/NTAP/86B637B62FE07A65E053F706E80A27CA/DATAFILE/undotbs1.267.11
77081837
+DATA/NTAP/CONTROLFILE/current.261.1177080403
+DATA/NTAP/DATAFILE/sysaux.258.1177080245
+DATA/NTAP/DATAFILE/system.257.1177080129
+DATA/NTAP/DATAFILE/undotbs1.259.1177080311

NAME
--------------------------------------------------------------------
------------
+DATA/NTAP/DATAFILE/undotbs2.269.1177082203
+DATA/NTAP/DATAFILE/users.260.1177080311
+DATA/NTAP/ONLINELOG/group_1.262.1177080427
+DATA/NTAP/ONLINELOG/group_2.263.1177080427
+DATA/NTAP/ONLINELOG/group_3.270.1177083297
+DATA/NTAP/ONLINELOG/group_4.271.1177083313
+RECO/NTAP/CONTROLFILE/current.256.1177080403
+RECO/NTAP/ONLINELOG/group_1.257.1177080427
+RECO/NTAP/ONLINELOG/group_2.258.1177080427
+RECO/NTAP/ONLINELOG/group_3.259.1177083313
```

```
+RECO/NTAP/ONLINELOG/group_4.260.1177083315

33 rows selected.
```

7. Or login to EM express to to validate RAC database after successful playbook execution.



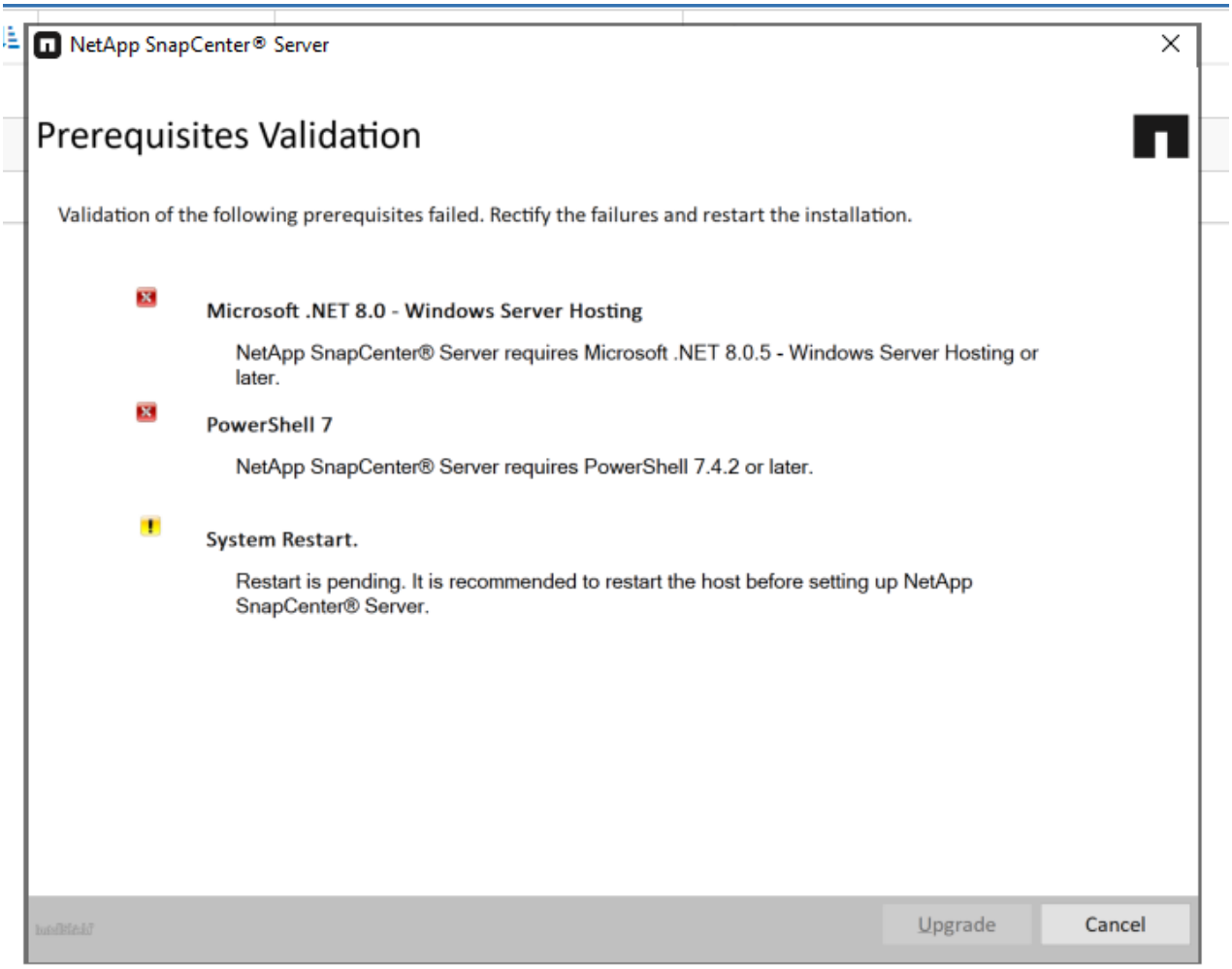


Oracle RAC database backup and recovery in VCF with SnapCenter

SnapCenter Setup

SnapCenter version 6 has many feature enhancements over version 5, including support for VMware vVols datastore. SnapCenter relies on a host-side plug-in on a database VM to perform application-aware data protection management activities. For detailed information on NetApp SnapCenter plug-in for Oracle, refer to this documentation What can you do with the Plug-in for Oracle Database. The following provides high-level steps to set up SnapCenter version 6 for Oracle RAC database backup and recovery in VCF.

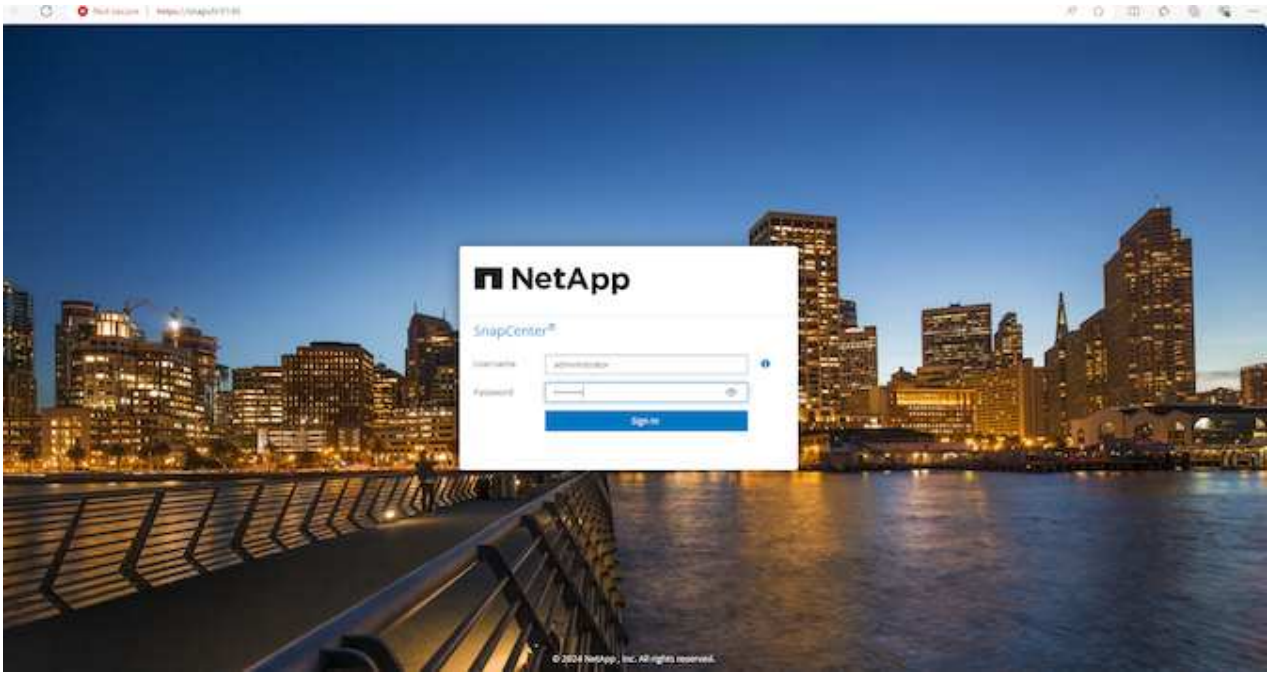
1. Download the version 6 of SnapCenter software from NetApp support site: NetApp Support Downloads.
2. Login to the SnapCenter hosting Windows VM as administrator. Install prerequisites for SnapCenter 6.0.



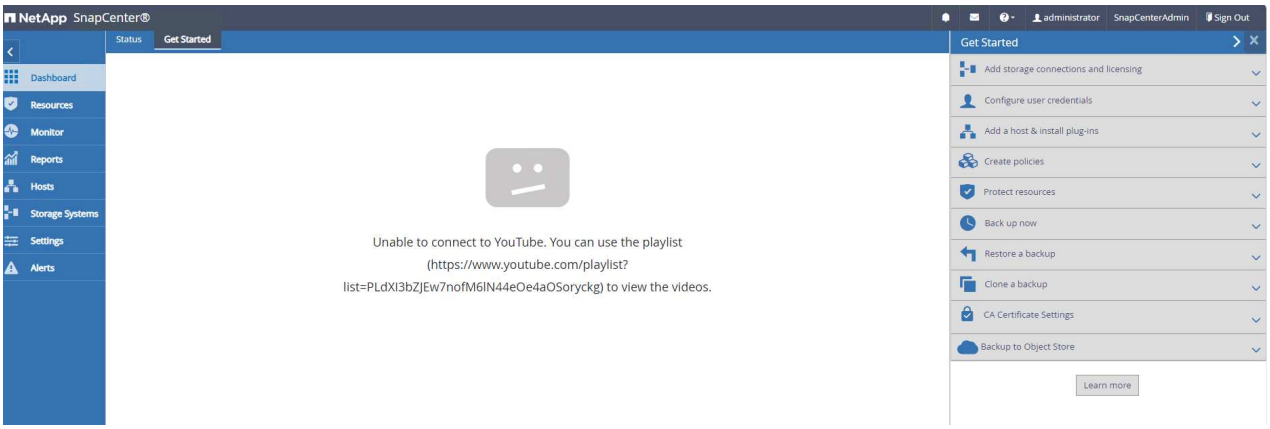
3. As administrator, install latest java JDK from Get Java for desktop applications.

> 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.

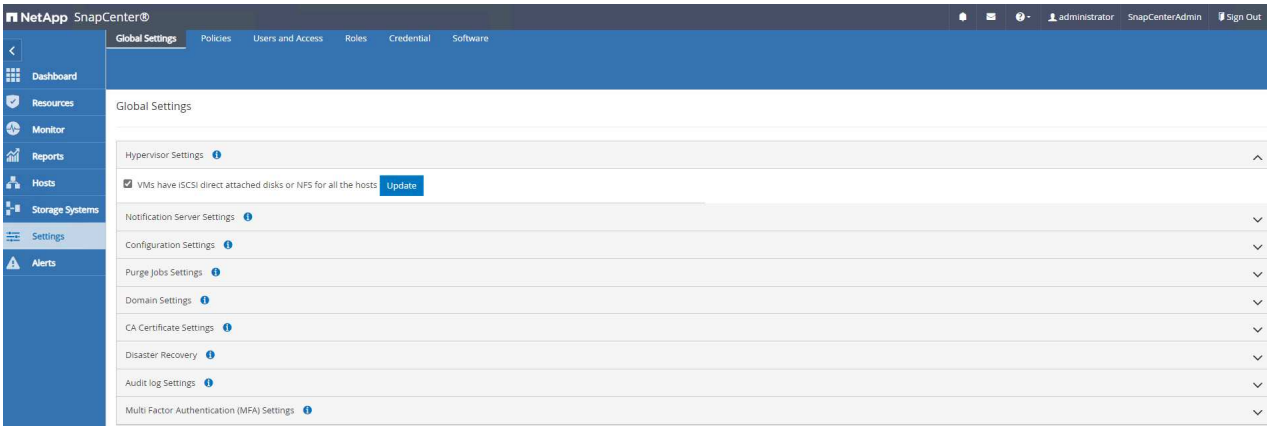
4. Login to SnapCenter UI via HTTPS port 8846 as installation user to configure SnapCenter for Oracle.



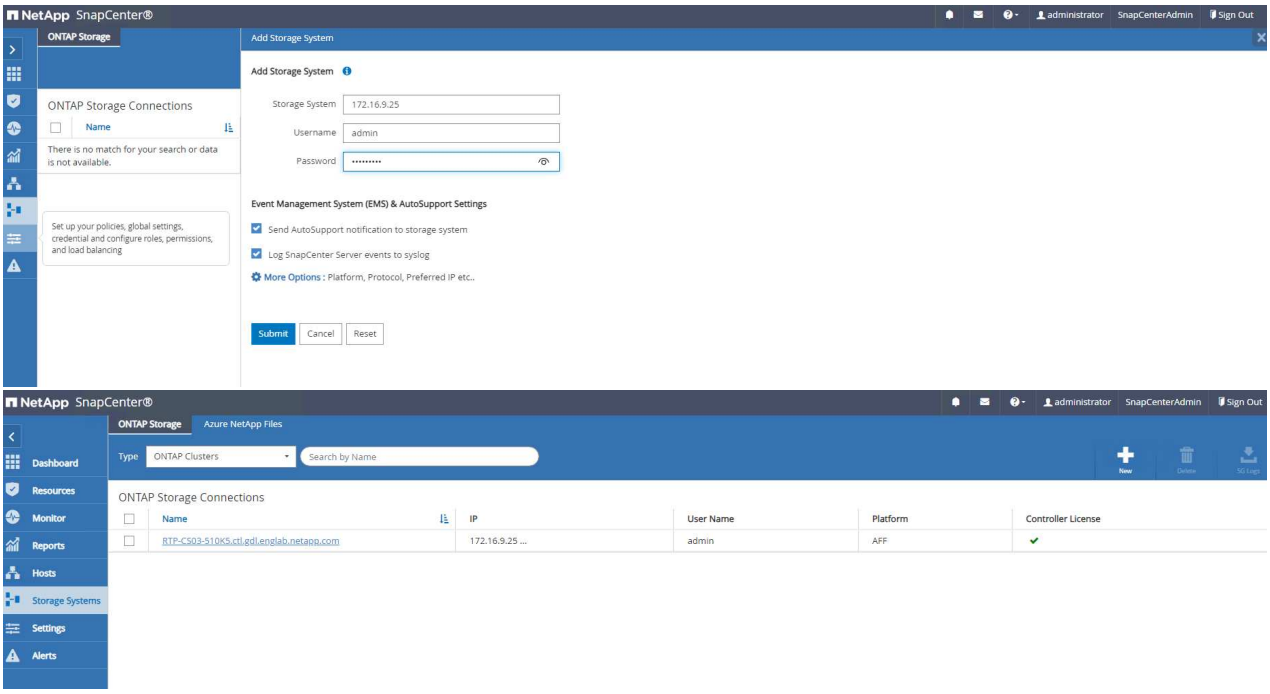
5. Review `Get Started` menu to get up to speed on SnapCenter if you are a new user.



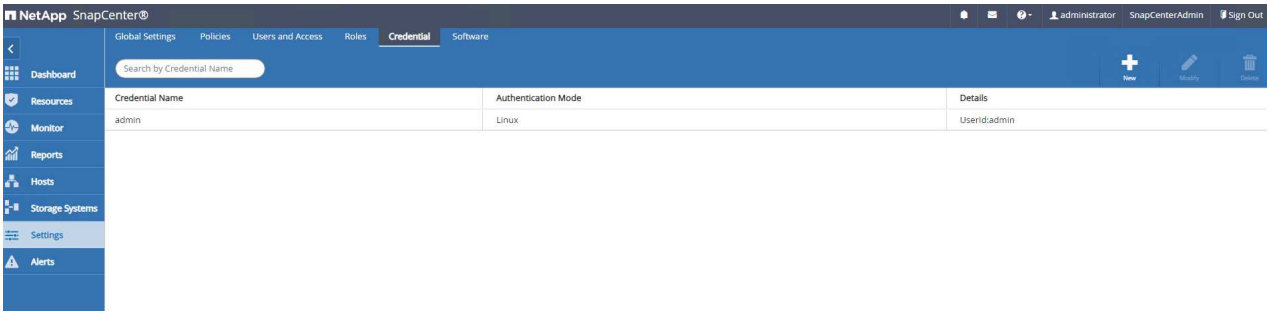
6. Update `Hypervisor Settings` in global settings.



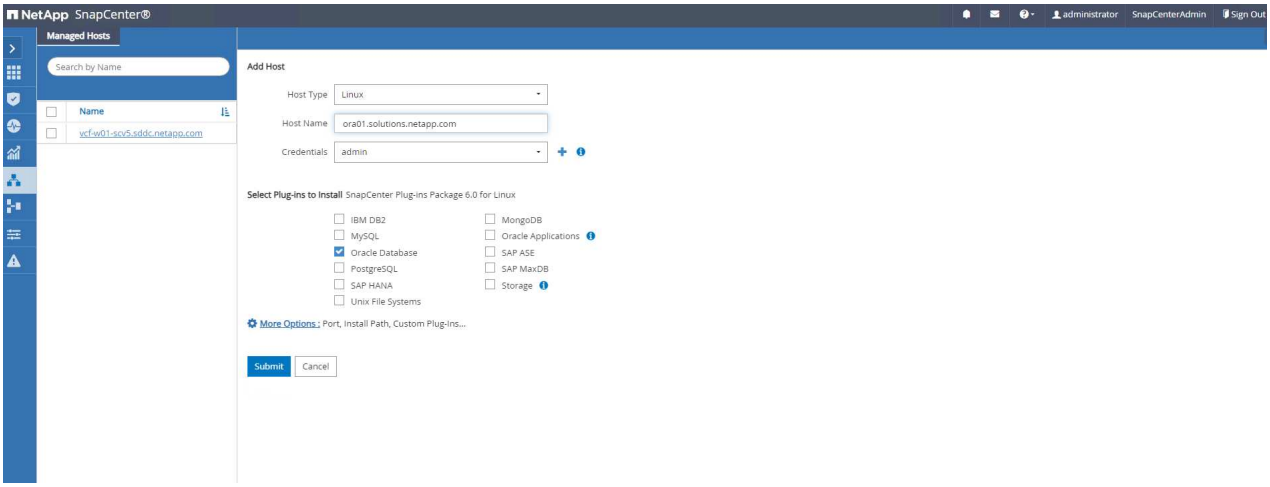
7. Add ONTAP storage cluster to `Storage Systems` with cluster management IP and authenticated via cluster admin user ID.

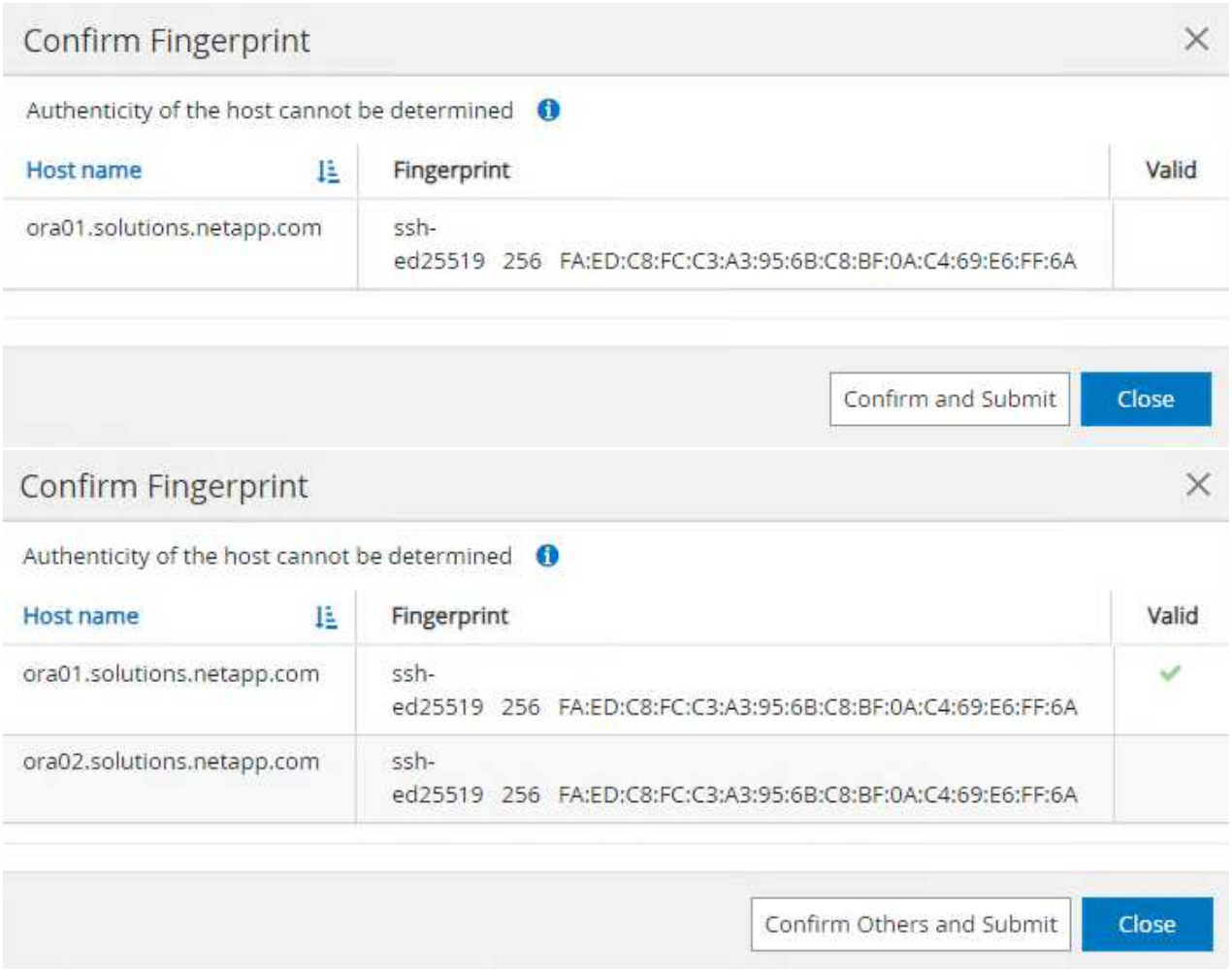


8. Add Oracle RAC database VMs and vSphere plugin VM `Credential` for SnapCenter access to DB VM and vSphere plugin VM. The credential should have sudo privilege on the Linux VMs. You may create different credentials for different management user IDs for the VMs. vShpere plugin VM management user ID is defined when the plugin VM is deployed in vCenter.

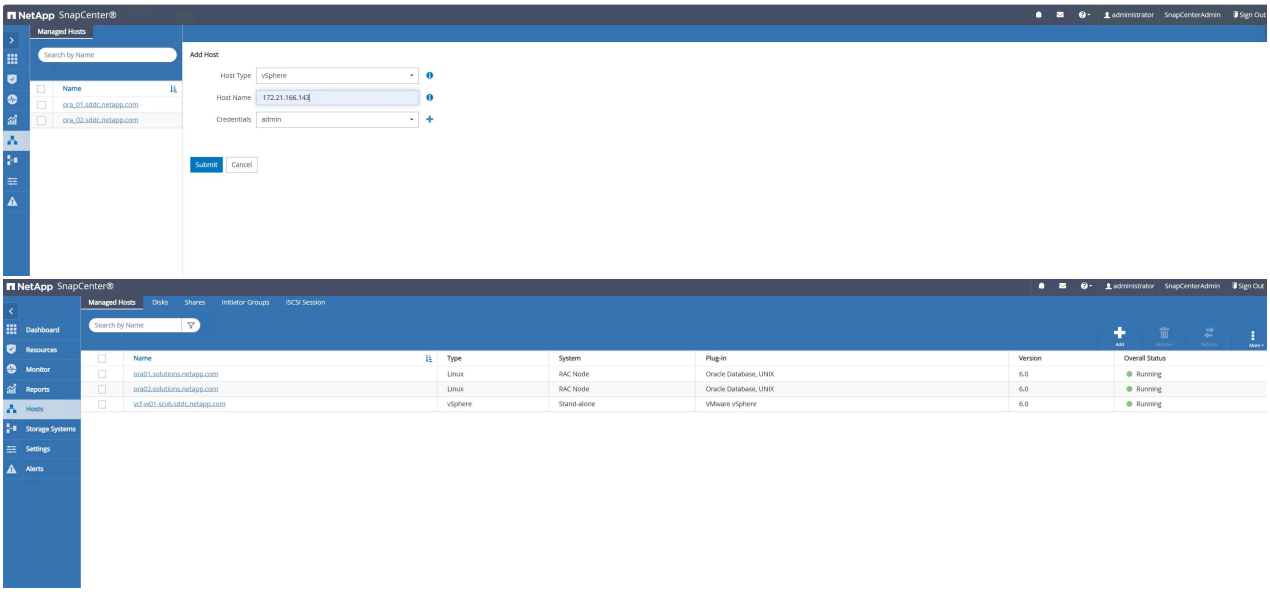


9. Add Oracle RAC database VM in VCF to `Hosts` with DB VM credential created in previous step.

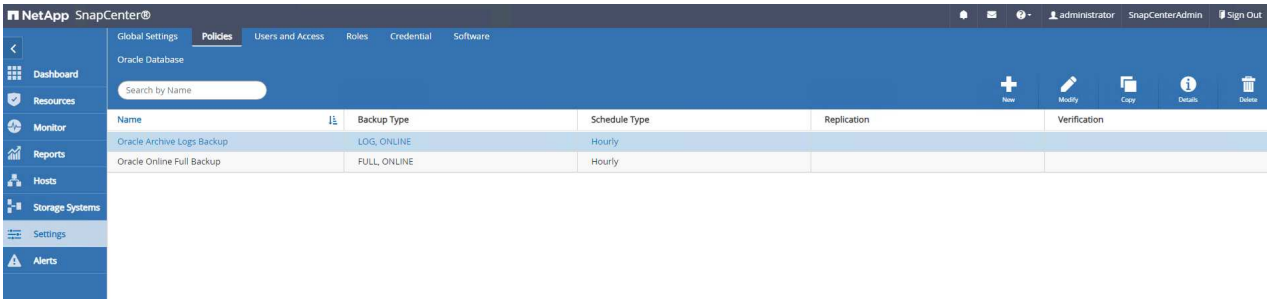




10. Similarly, add NetApp VMware plugin VM to `Hosts` with vSphere plugin VM credential created in previous step.



11. Finally, after Oracle database is discovered on DB VM, back to `Settings-Policies` to 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.

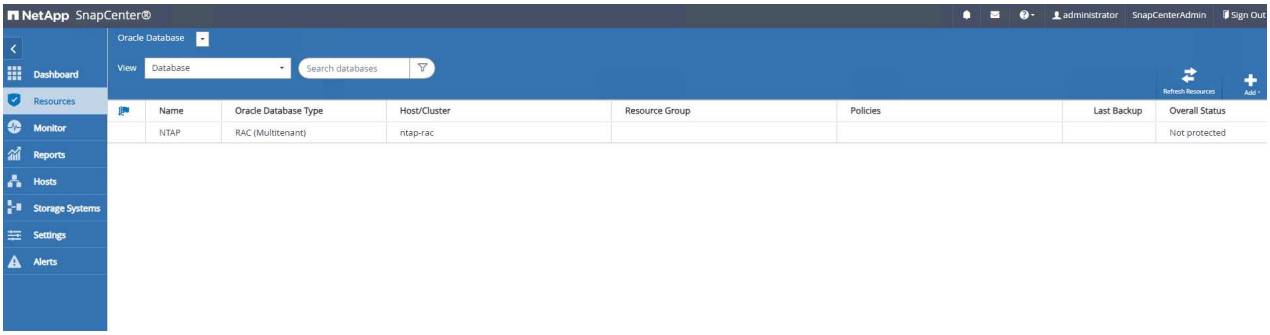


Ensure that the SnapCenter server name can be resolved to the IP address from the DB VM and vSphere plugin VM. Equally, the DB VM name and vSphere plugin VM name can be resolved to the IP address from the SnapCenter server.

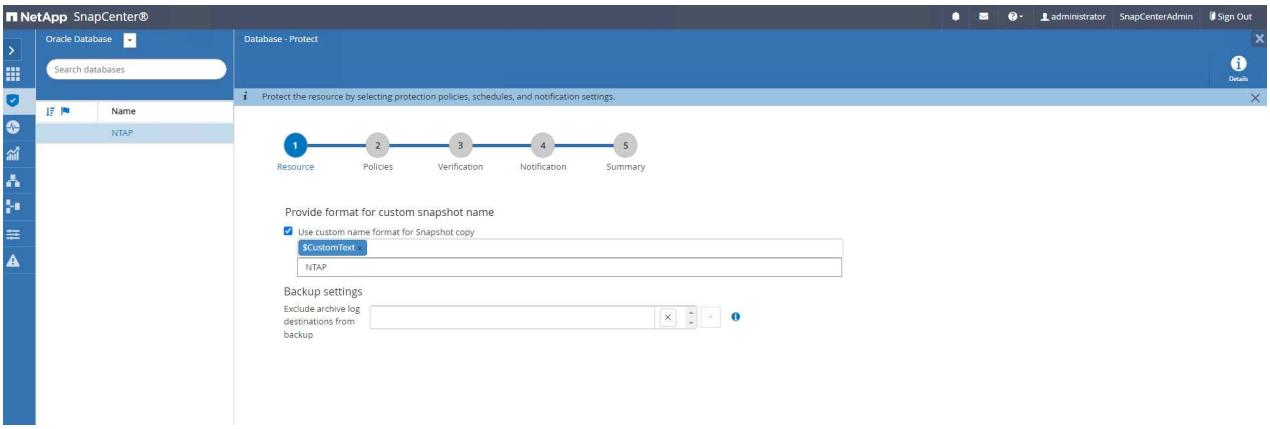
Database backup

SnapCenter leverages 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.

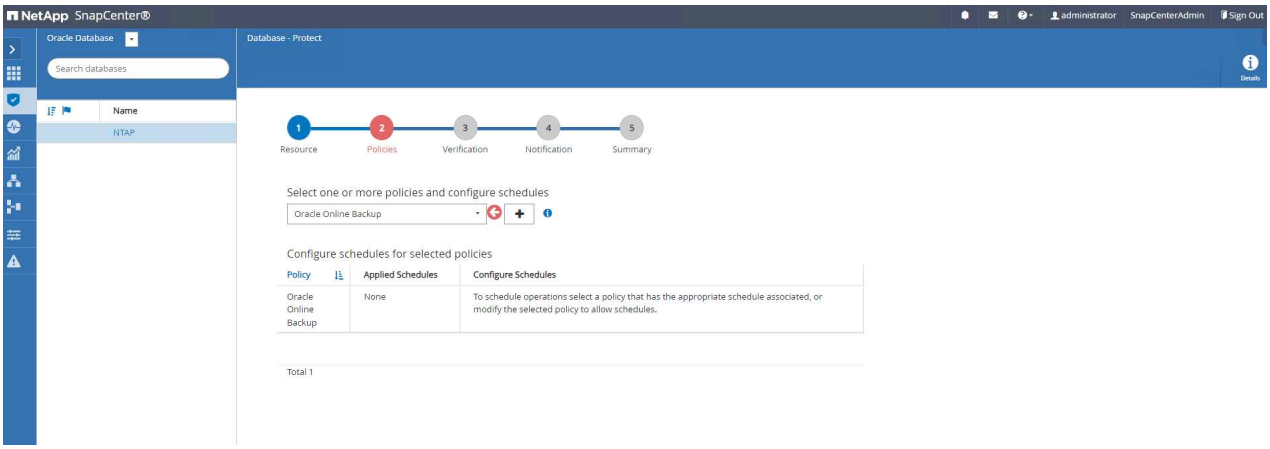
1. From the `Resources` tab, any databases on the VM are auto-discovered after the VM is added to SnapCenter. Initially, the database status shows as `Not protected`.



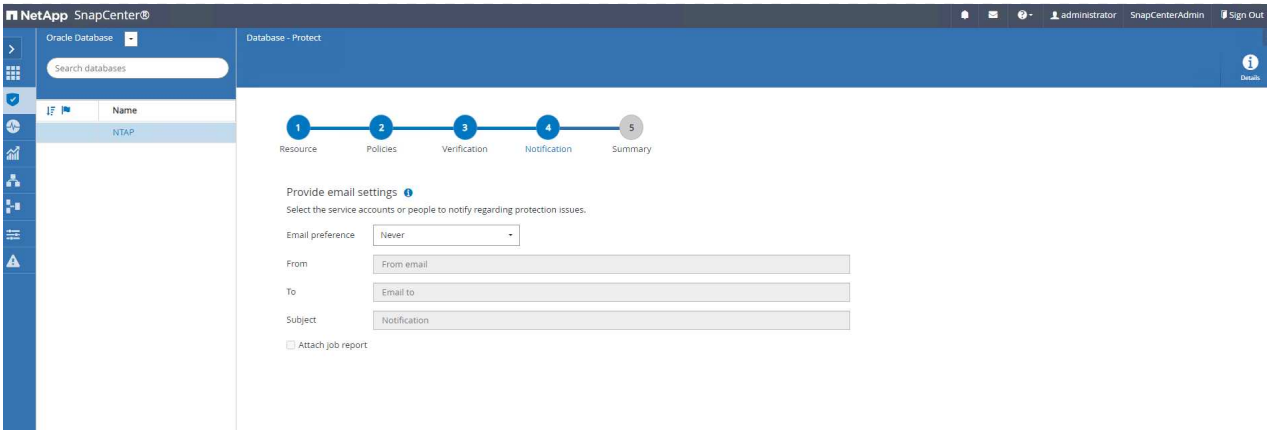
2. Click on database to start a workflow to enable protection for the database.



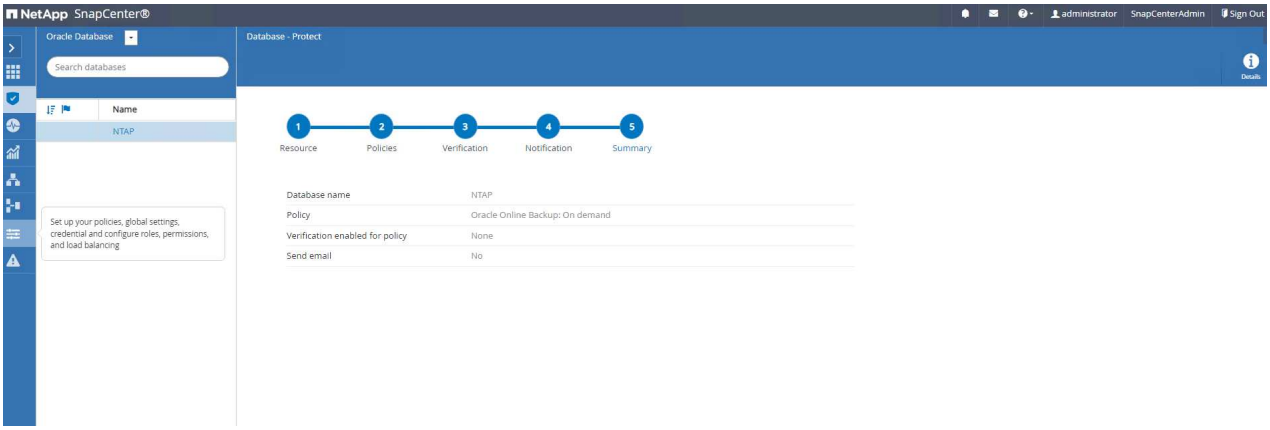
3. Apply backup policy, setup scheduling if needed.



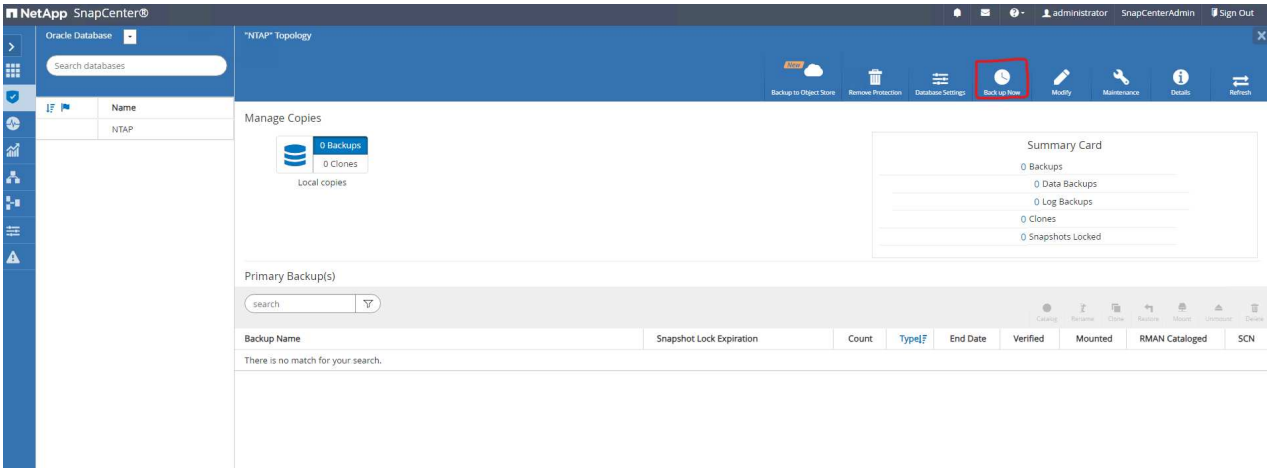
4. Setup backup job notification if required.

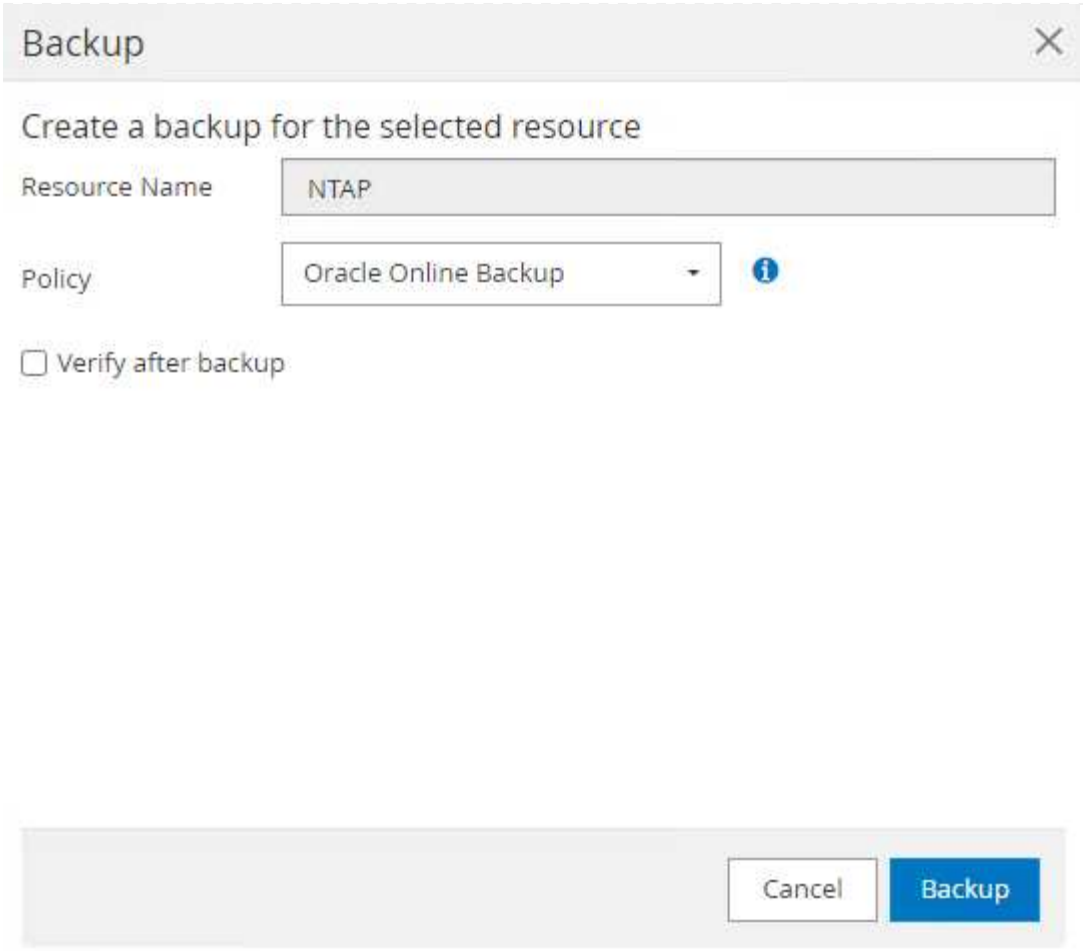


5. Review the summary and finish to enable database protection.

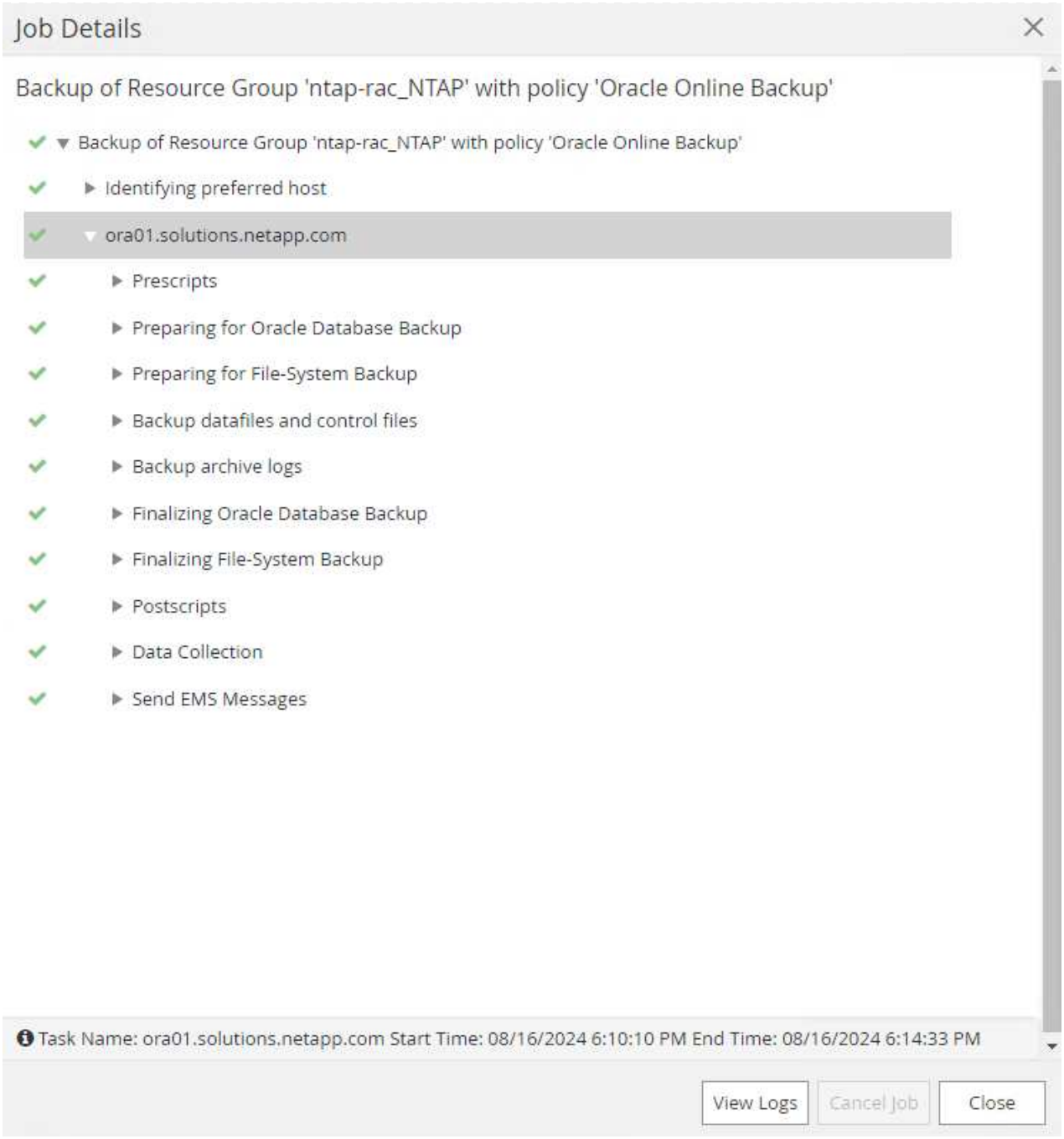


6. On-demand backup job can be triggered by click on `Back up Now`.

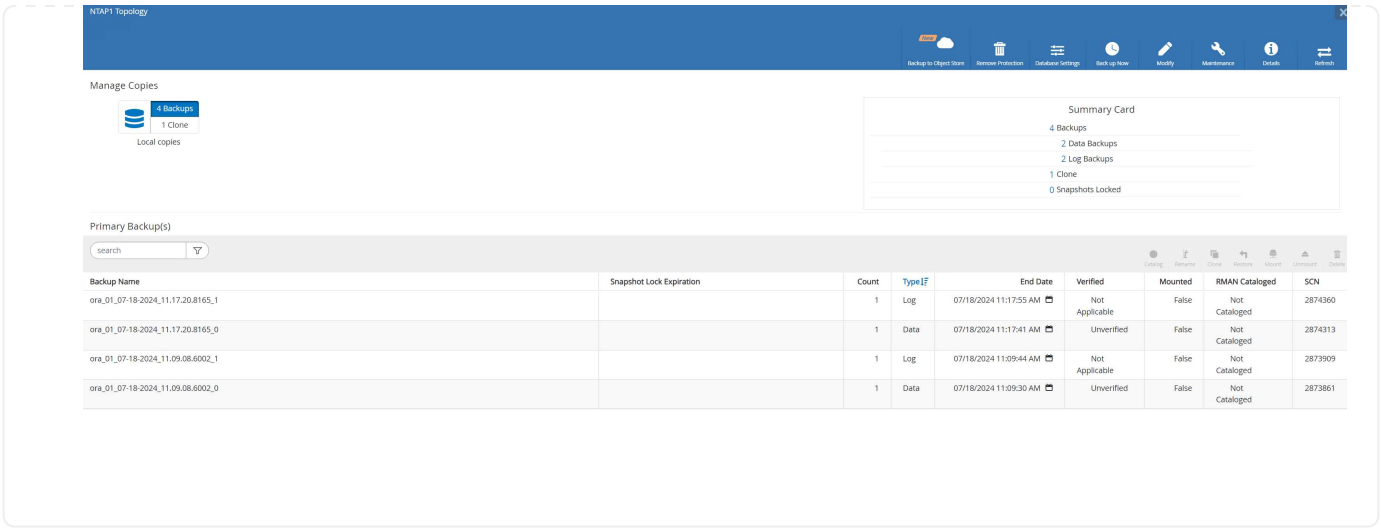




7. The backup job can be monitored at the `Monitor` tab by clicking on the running job.



8. Click on database to review the backup sets completed for RAC database.



Database restore/recovery

SnapCenter provides a number of restore and recovery options for Oracle RAC database from snapshot backup. In this example, we demonstrate to restore from a older snapshot backup, then roll forward the database to the last available log.

1. First, run a snapshot backup. Then, create a test table and insert a row into table to validate that recovered database from snapshot image before test table creation regains the test table.

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

SQL*Plus: Release 19.0.0.0.0 - Production on Mon Aug 19 10:31:12
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> show pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP_PDB1                      READ WRITE NO
         4 NTAP_PDB2                      READ WRITE NO
         5 NTAP_PDB3                      READ WRITE NO
SQL> alter session set container=ntap_pdb1;

Session altered.


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

Table created.

SQL> insert into test values (1, sysdate, 'validate SnapCenter rac
database restore on VMware vVols storage');

1 row created.

SQL> commit;
```
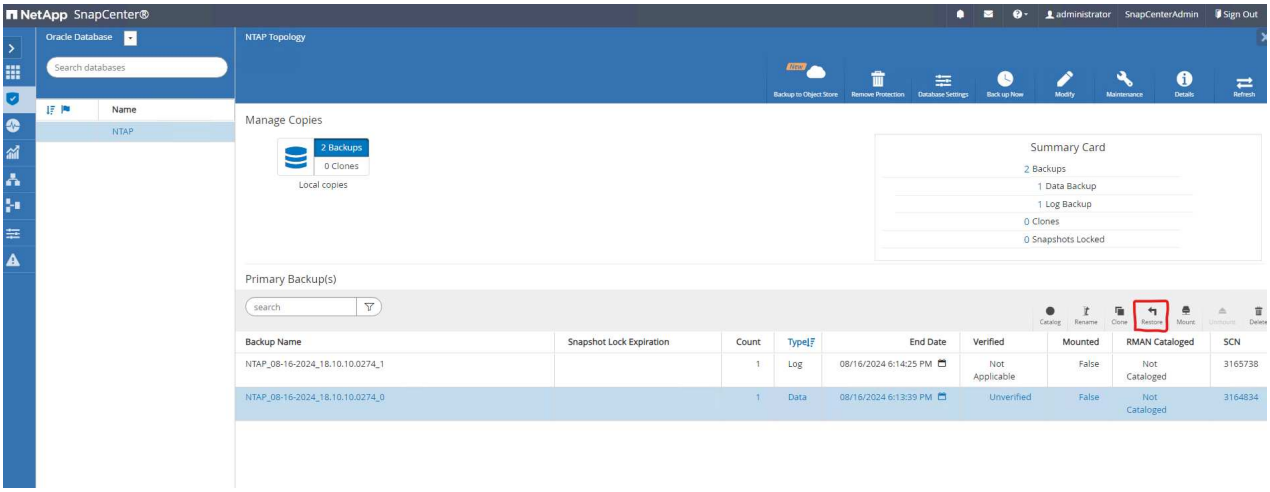
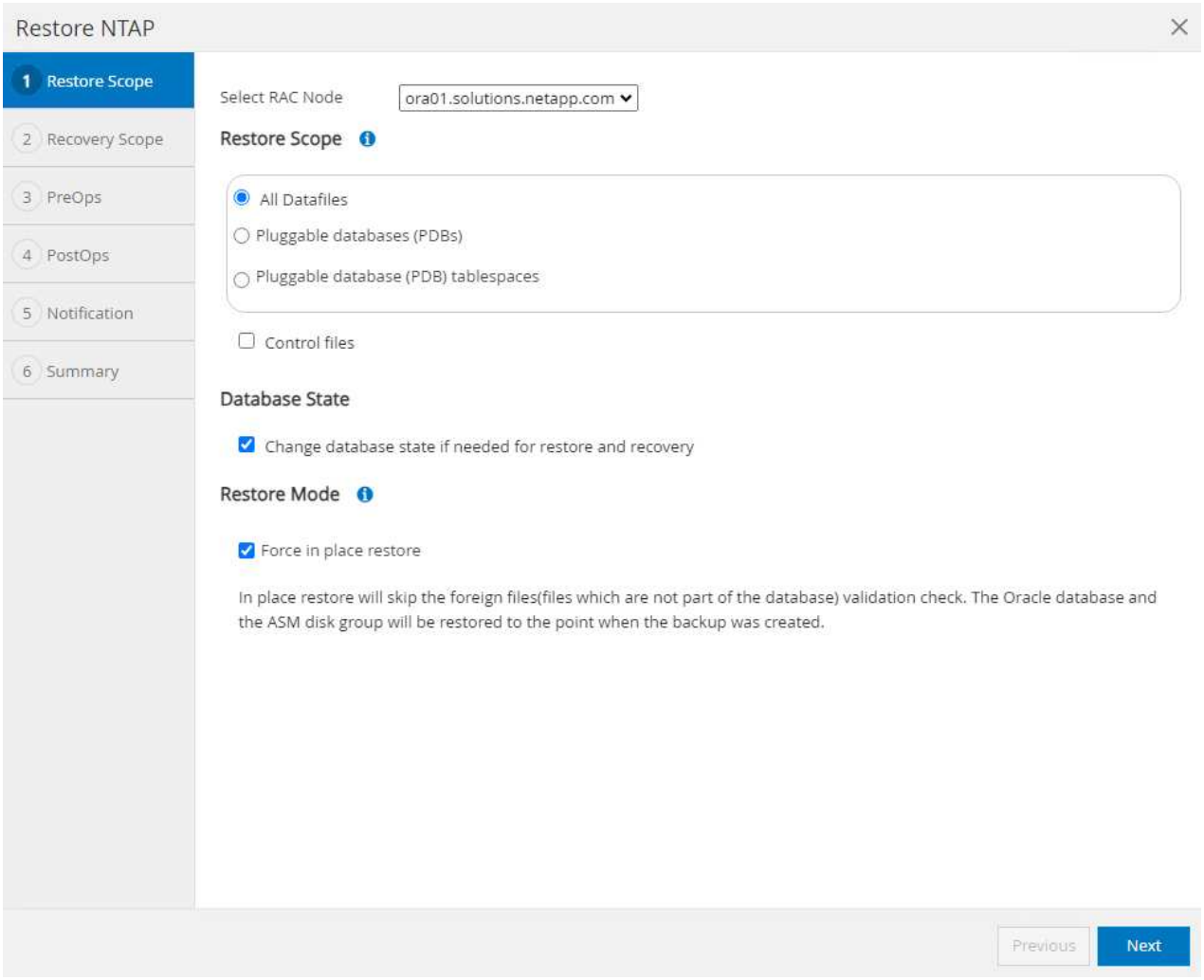

```
Commit complete.

SQL> select * from test;

        ID
----------
DT
---------------------------------------------------------------------------
-------
EVENT
---------------------------------------------------------------------------
------------
         1
19-AUG-24 10.36.04.000000 AM
validate SnapCenter rac database restore on VMware vVols storage


SQL>
```

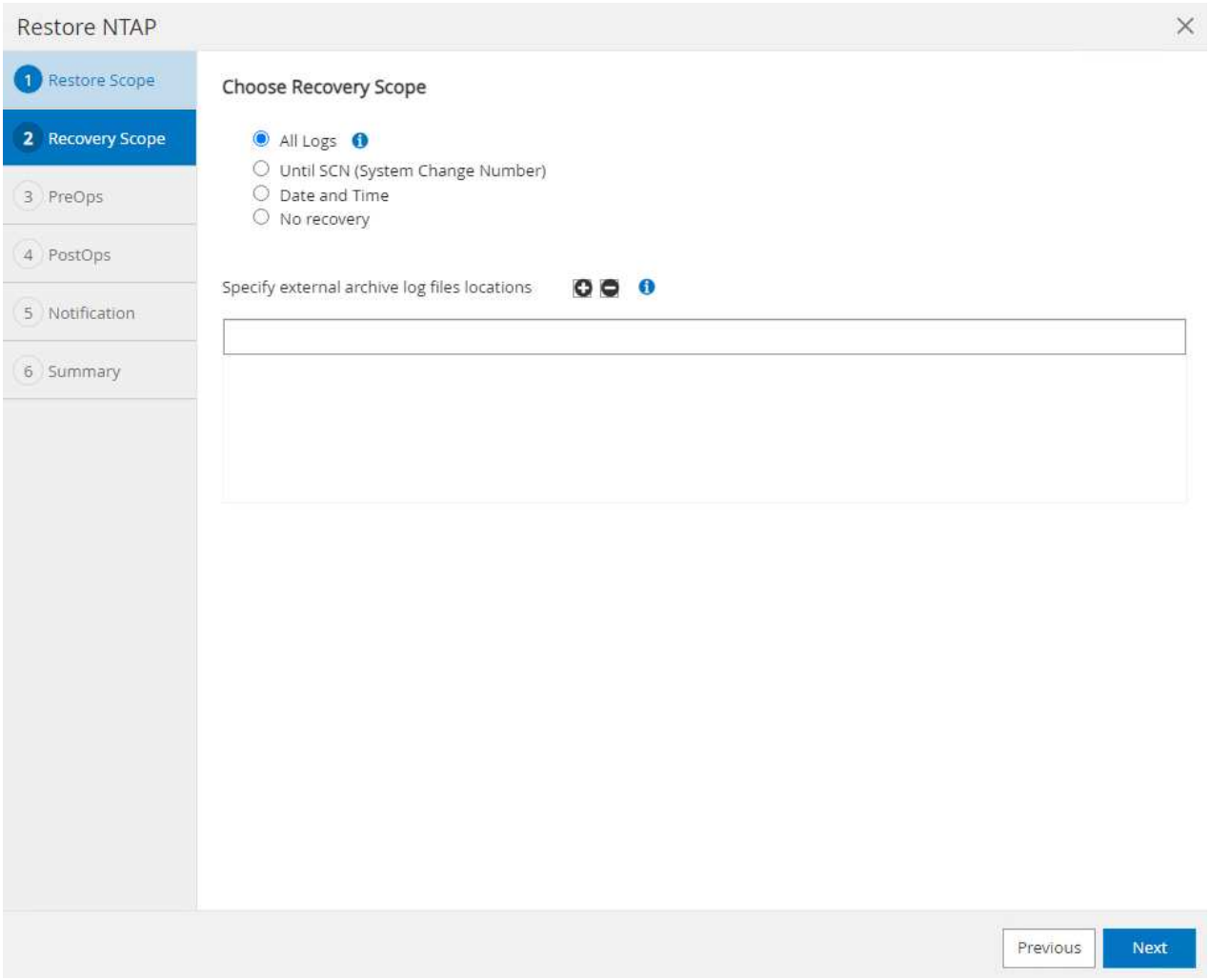
2. From SnapCenter `Resources` tab, open the database NTAP1 backup topology page. Highlight the snapshot data backup set created 3 days ago. Click on `Restore` to launch restore-recover workflow.



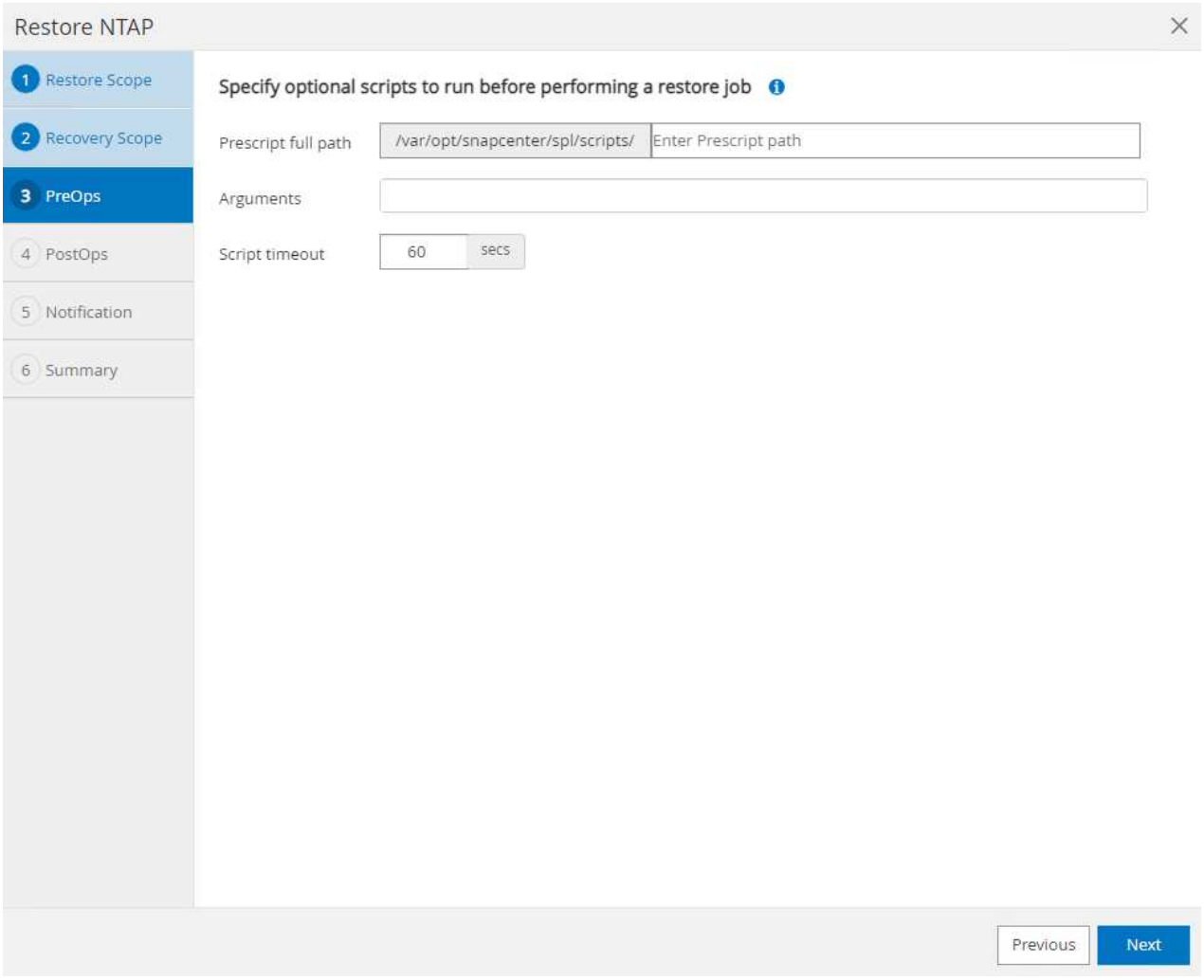
3. Choose restore scope.



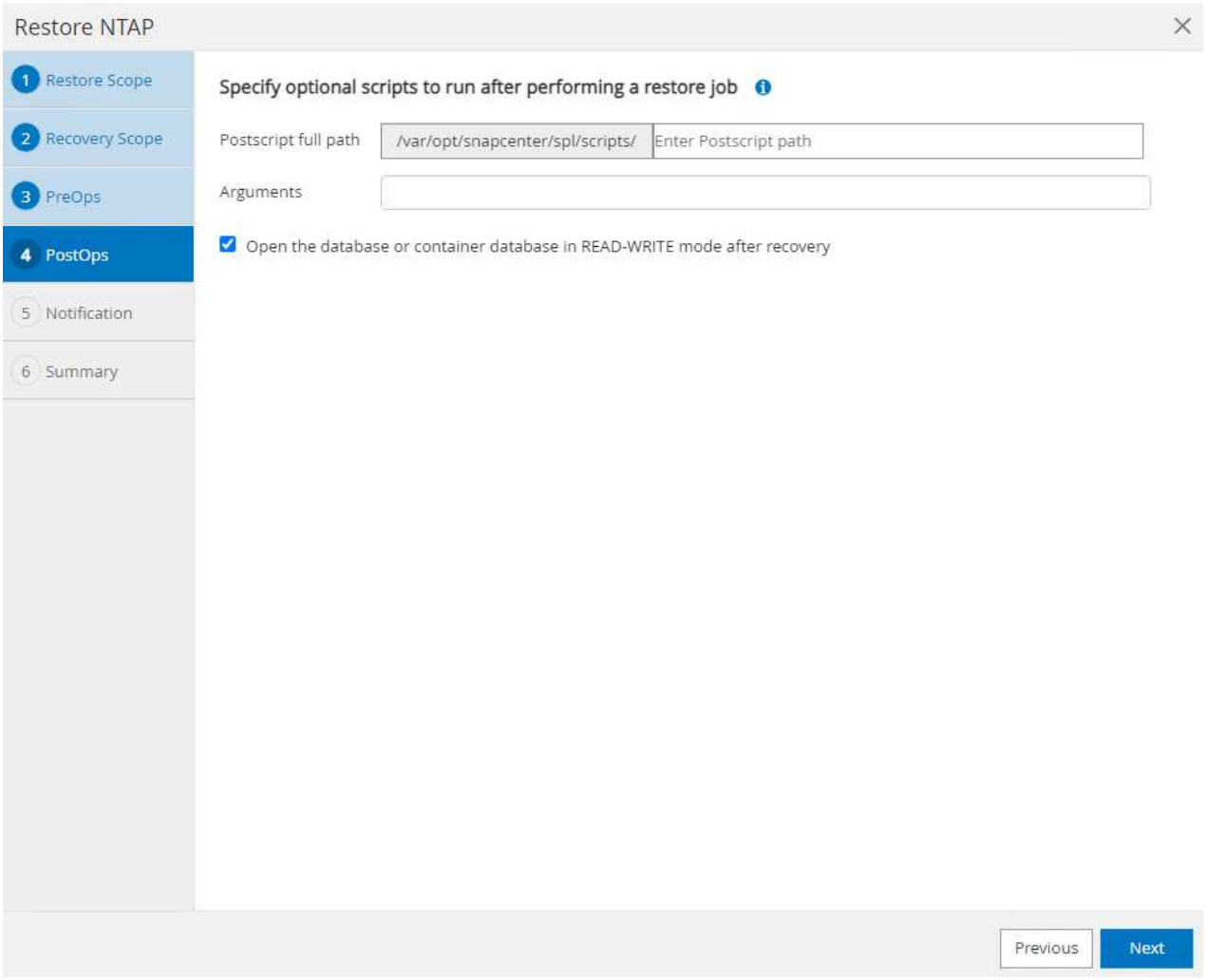
4. Choose recovery scope to `All Logs`.



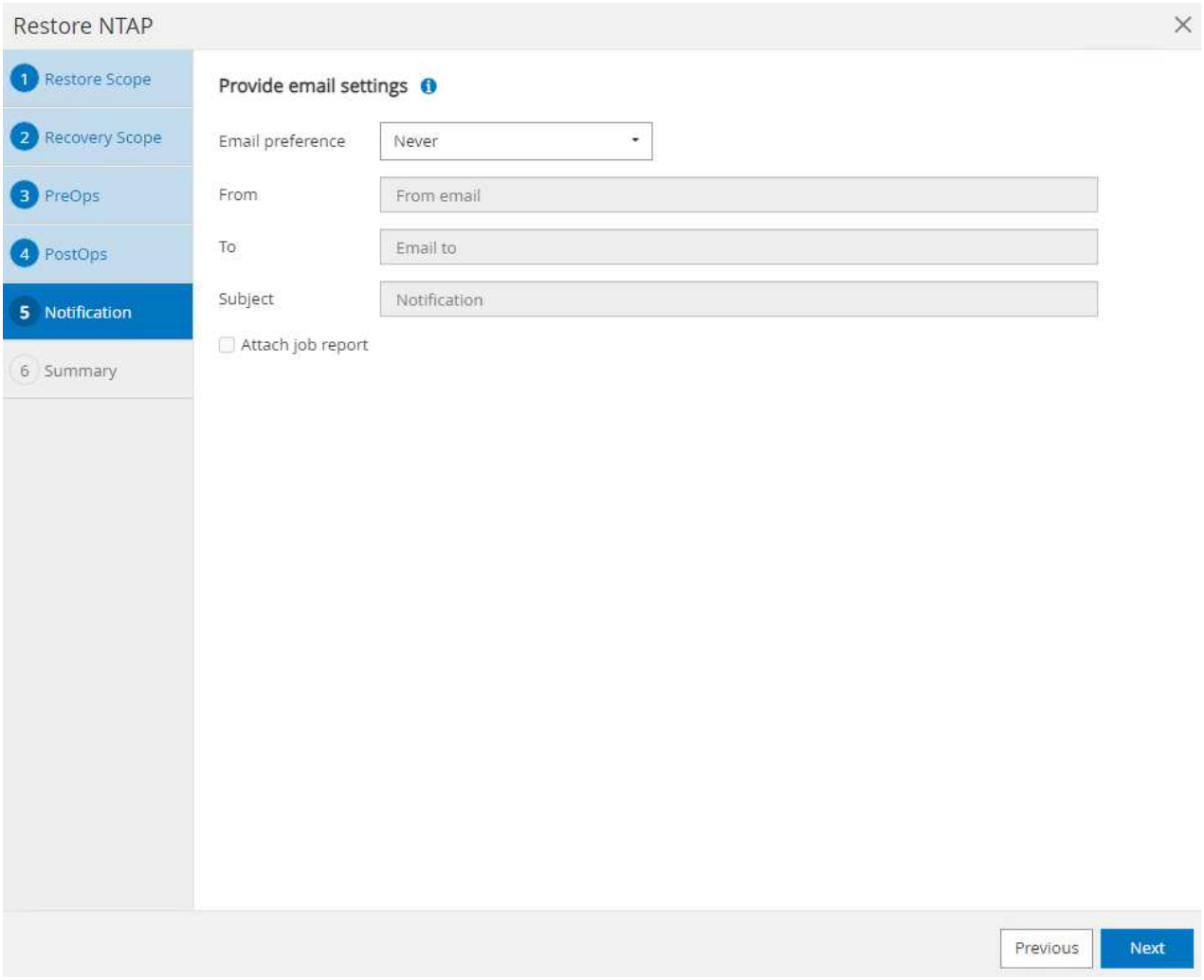
5. Specify any optional pre-scripts to run.



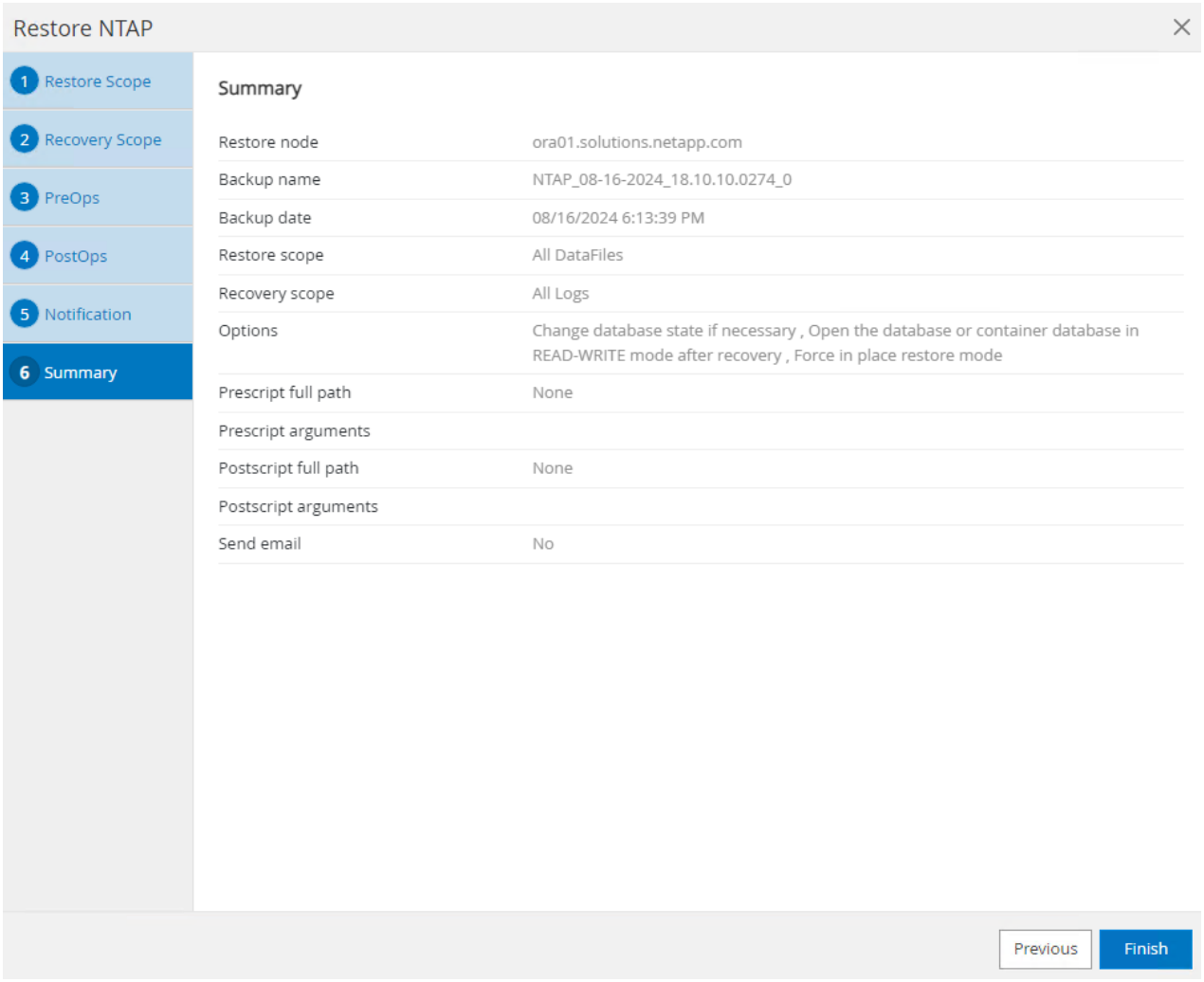
6. Specify any optional after-script to run.



7. Send a job report if desired.



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



9. From RAC DB VM ora01, validate that a successful restore/recovery of database rolled forward to its most recent state and recovered the test table created 3 days later.

```
[root@ora01 ~]# su - oracle
[oracle@ora01 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Mon Aug 19 11:51:15
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> select name, open_mode from v$database;
```

```
NAME      OPEN_MODE
--------- --------------------
NTAP      READ WRITE

SQL> sho pdbs

    CON_ID CON_NAME                       OPEN MODE  RESTRICTED
---------- ------------------------------ ---------- ----------
         2 PDB$SEED                       READ ONLY  NO
         3 NTAP_PDB1                      READ WRITE NO
         4 NTAP_PDB2                      READ WRITE NO
         5 NTAP_PDB3                      READ WRITE NO
SQL> alter session set container=ntap_pdb1;

Session altered.

SQL> select * from test;

        ID
----------
DT
---------------------------------------------------------------------------
-------
EVENT
---------------------------------------------------------------------------
------------
         1
19-AUG-24 10.36.04.000000 AM
validate SnapCenter rac database restore on VMware vVols storage

SQL> select current_timestamp from dual;

CURRENT_TIMESTAMP
---------------------------------------------------------------------------
-------
19-AUG-24 11.55.20.079686 AM -04:00



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

This completes the demonstration of SnapCenter backup, restore, and recovery of Oracle RAC database in VCF with vVols.

Where to find additional information

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

- VMware Cloud Foundation
- SnapCenter software documentation
- ONTAP tools for VMware vSphere documentation