TECHNICAL WHITE PAPER:
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VMware vSAN™ Management, Monitoring & Resiliency

Proof of Concept (PoC) Guide

vmware® by Broadcom

Table of contents

Introduction

The vSAN Management, Monitoring & Hardware Testing guide represents one of a series of vSAN Proof of Concept Guides covering a variety of vSAN related topics. The other guides being:

- vSAN Proof of Concept: vSAN Architecture Overview & Setup
- vSAN Proof of Concept: vSAN Features
- vSAN Proof of Concept: vSAN Performances Testing
- vSAN Proof of Concept: vSAN Stretched Cluster & Two-Node Overview & Testing

This guide is designed to stand largely separate from the other documents. That said, the assumption is that the reader has working knowledge of vSAN cluster creation and Storage Policy Management. Especially since the steps documented herein often assume a vSAN Cluster already exists in your test environment. If you require a refresher, please review the vSAN Proof of Concept: vSAN Architecture Overview & Setup guide

The particular focus of this guide is discussion and walkthrough of specific vSAN features such as:

- Management Tasks (e.g., maintenance mode, disk removal, host scale-out)
- Monitoring Tasks
- Testing Hardware Failures

This document primarily focuses on vSAN Express Storage Architecture™ (ESA) cluster environments. vSAN Original Storage Architecture™ (OSA) environments are covered where they differ from vSAN ESA.

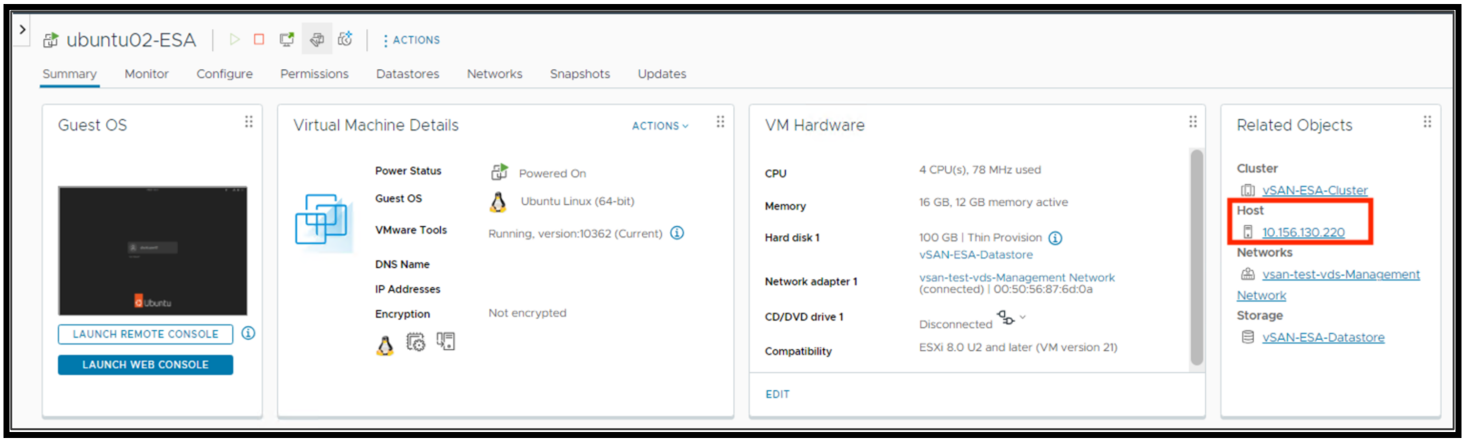
vSAN Management Tasks

Maintenance Mode

In this section we shall look at management tasks, such as the behavior when placing a host into maintenance mode and the evacuation of disks from a host. We will also look at how to turn on and off the identifying LEDs on a disk drive.

There are several options available when placing a host into maintenance mode. The first step is to identify a host that has a running VM:

Ensure that there is at least one VM running on the vSAN cluster. Then select the **summary** tab of the VM to see which host it is running on:



Virtual Machine Details

Power Status: Powered On
Guest OS: Ubuntu Linux (64-bit)
VMware Tools: Running, version:10362 (Current)
DNS Name:
IP Addresses:
Encryption: Not encrypted

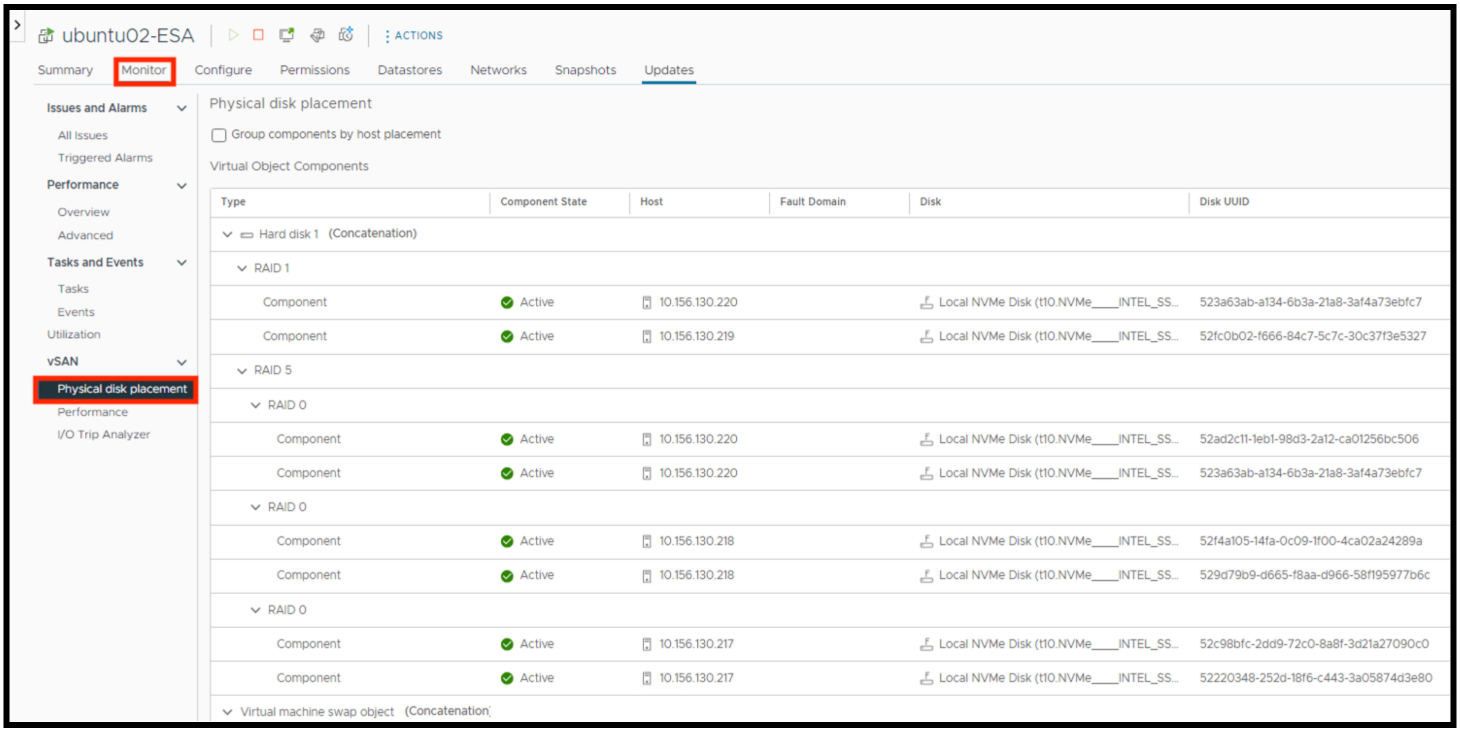
VM Hardware

CPU: 4 CPU(s), 78 MHz used
Memory: 16 GB, 12 GB memory active
Hard disk 1: 100 GB | Thin Provision
vSAN-ESA-Datastore
Network adapter 1: vsan-test-vds-Management Network
(connected) | 00:50:56:87:6d:0a
CD/DVD drive 1: Disconnected
Compatibility: ESXi 8.0 U2 and later (VM version 21)

Related Objects

Cluster: vSAN-ESA-Cluster
Host: 10.156.130.220
Networks: vsan-test-vds-Management Network
Storage: vSAN-ESA-Datastore

Then, navigate to **[VM] > Monitor > vSAN > Physical disk placement** to show which hosts the data components reside on. Clicking on 'Group components by host placement' shows this more clearly:



Physical disk placement

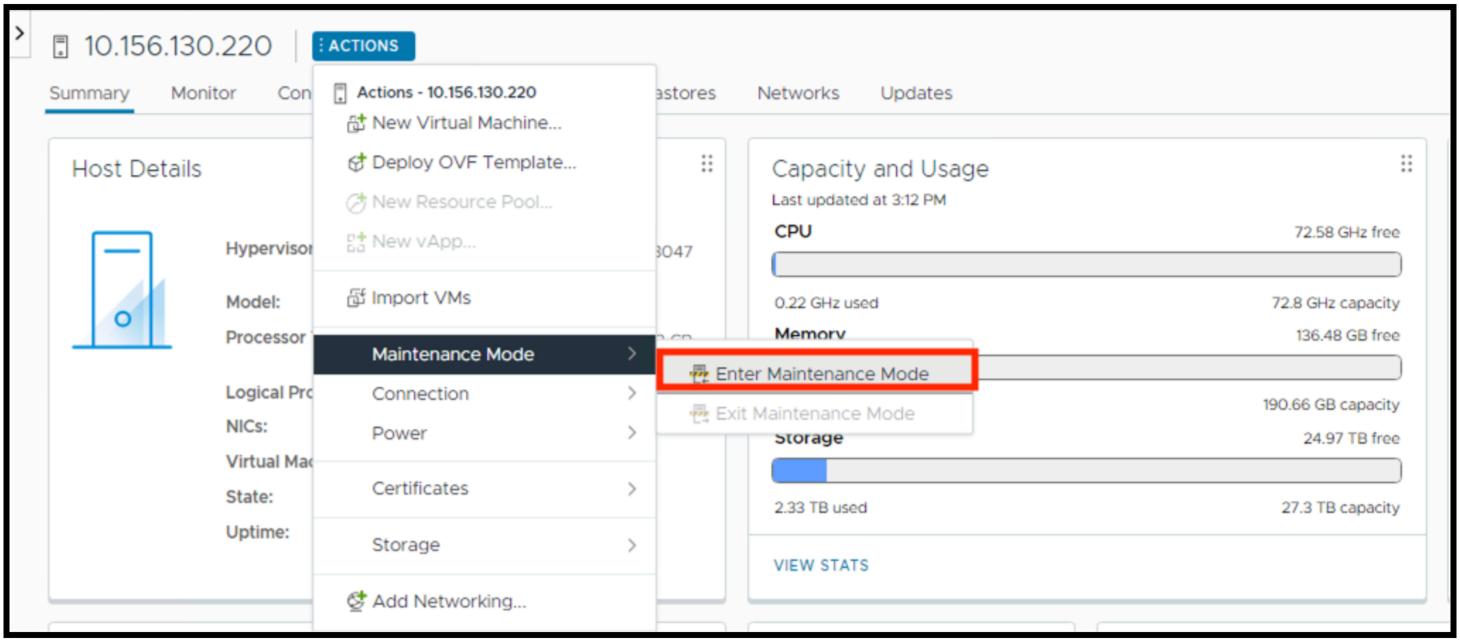
☐ Group components by host placement

Virtual Object Components

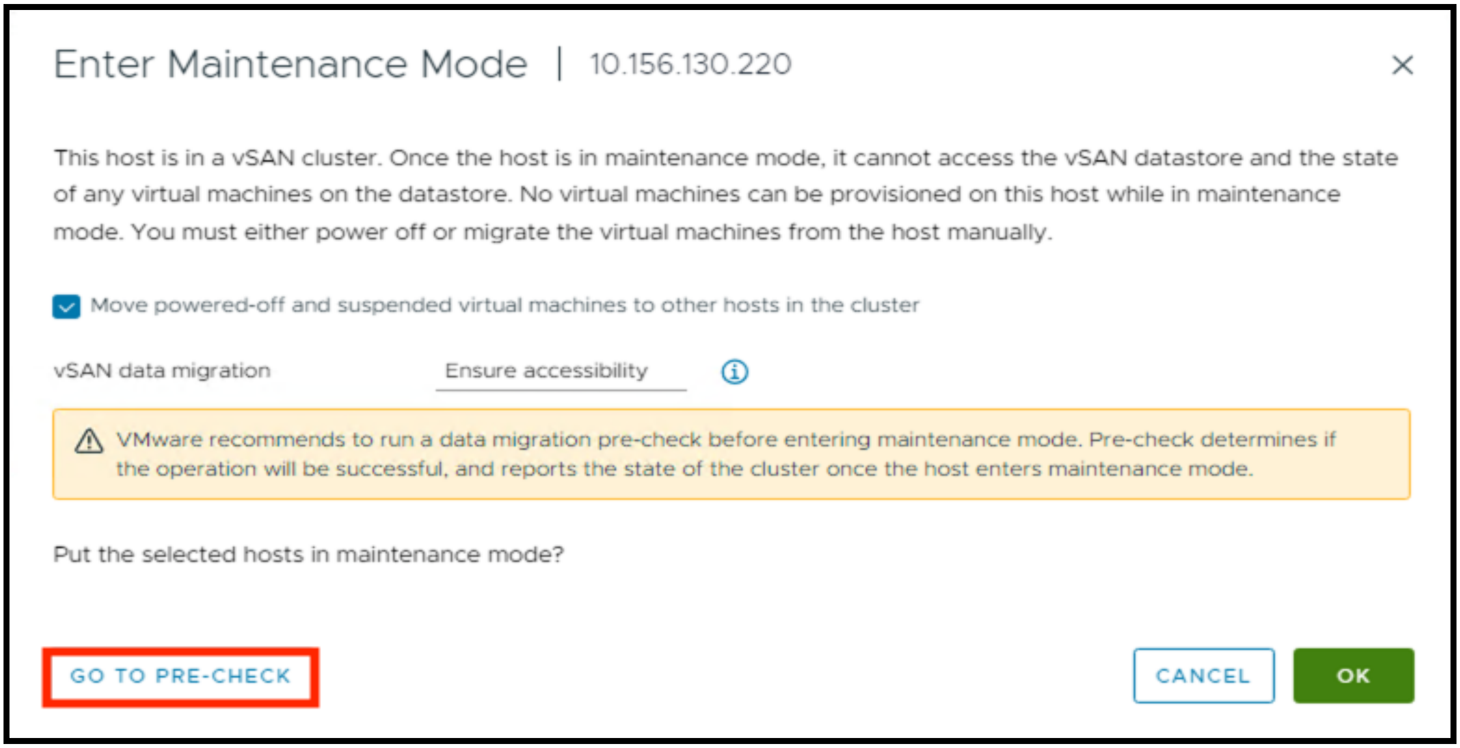
Type	Component State	Host	Fault Domain	Disk	Disk UUID
Hard disk 1 (Concatenation)					
RAID 1					
Component	Active	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	523a63ab-a134-6b3a-21a8-3af4a73ebfc7
Component	Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	52fc0b02-f666-84c7-5c7c-30c37f3e5327
RAID 5					
RAID 0					
Component	Active	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	52ad2c11-1eb1-98d3-2a12-ca01256bc506
Component	Active	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	523a63ab-a134-6b3a-21a8-3af4a73ebfc7
RAID 0					
Component	Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	52f4a105-14fa-0c09-1f00-4ca02a24289a
Component	Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	529d79b9-d665-f8aa-d966-58f195977b6c
RAID 0					
Component	Active	10.156.130.217		Local NVMe Disk (t10.NVMe____INTEL_SS...	52c98bfc-2dd9-72c0-8a8f-3d21a27090c0
Component	Active	10.156.130.217		Local NVMe Disk (t10.NVMe____INTEL_SS...	52220348-252d-18f6-c443-3a05874d3e80
Virtual machine swap object (Concatenation)					

We can see that the VMware ESXi™ (ESXi) host 10.159.130.220 hosts both the running VM and several data components. This is the host that we shall place into maintenance mode.

Navigate to the host Summary view, select **Actions**, then select **Maintenance Mode** from the drop-down menu, then select the option Enter Maintenance Mode:



On the Enter Maintenance Mode pop-up, we are presented with options for vSAN data migration. Here, click on '**Go to pre-check**'. This will enable us to safely test the various scenarios without affecting the system:



Enter Maintenance Mode | 10.156.130.220

This host is in a vSAN cluster. Once the host is in maintenance mode, it cannot access the vSAN datastore and the state of any virtual machines on the datastore. No virtual machines can be provisioned on this host while in maintenance mode. You must either power off or migrate the virtual machines from the host manually.

☑ Move powered-off and suspended virtual machines to other hosts in the cluster

vSAN data migration: Ensure accessibility

VMware recommends to run a data migration pre-check before entering maintenance mode. Pre-check determines if the operation will be successful, and reports the state of the cluster once the host enters maintenance mode.

Put the selected hosts in maintenance mode?

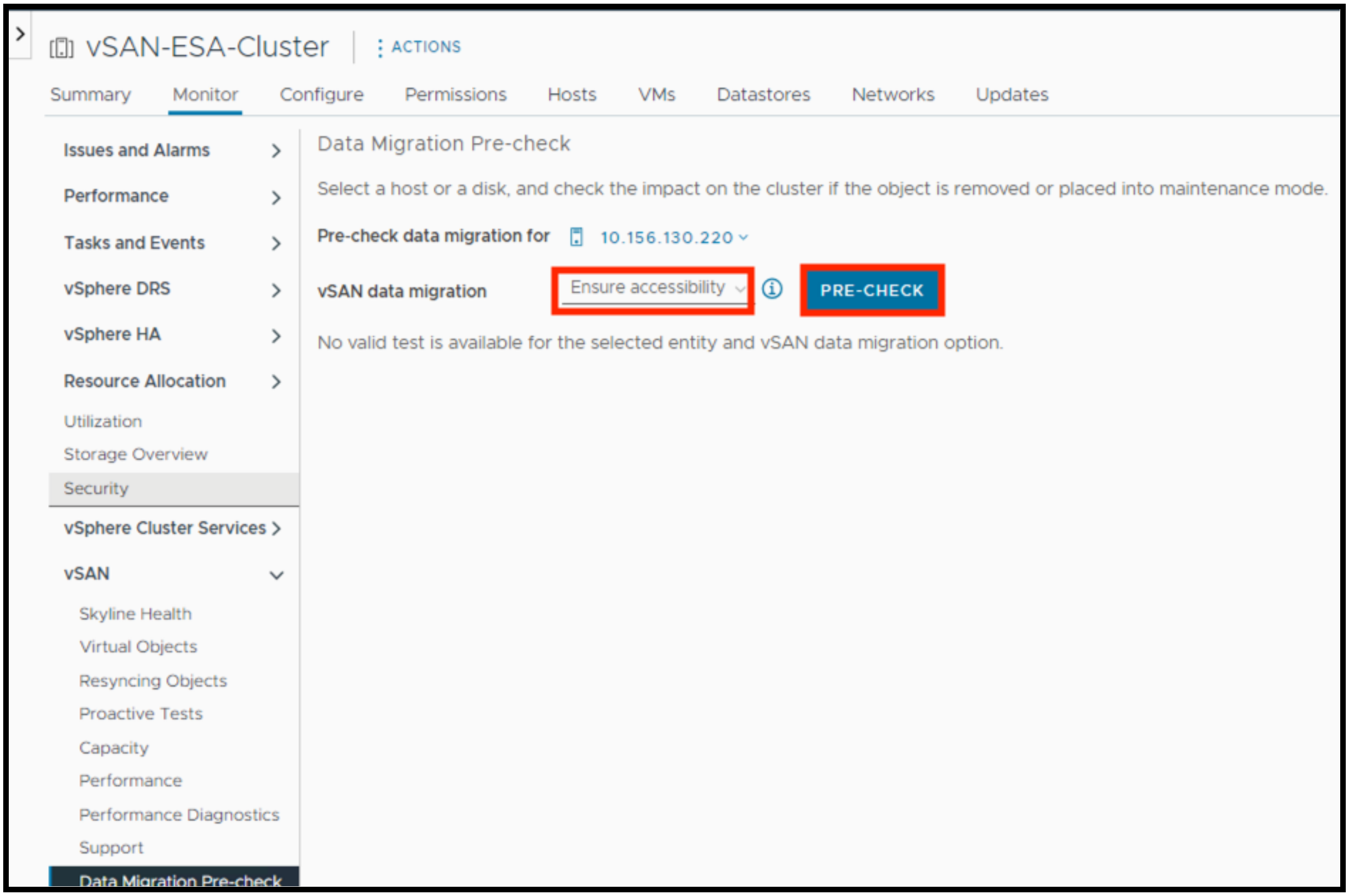
The pre-check can also be accessed by navigating to **[vSAN Cluster] > Monitor > Data Migration Pre-Check**

We can see that there are three options available to enable maintenance mode when vSAN is present

- **Full data migration**: Move all the data away from the affected resource before maintenance
- **Ensure accessibility**: First check for any issues before resources become (temporarily) unavailable (No data is moved)
- **No data migration**: Perform no checks nor move any data.

On the next screen, we can pick one of the options to test the scenario. For maintenance operations where the host is temporarily out of service, the recommendation is to select 'ensure accessibility'. This will ensure that there are sufficient resources available to service the VM (albeit in a compromised state) for the duration of the vSAN cluster services timer.

Once on the Data Migration Pre-Check screen, confirm 'Ensure Accessibility' is selected from the 'vSAN Data Migration' drop-down, then select **Pre-Check**:



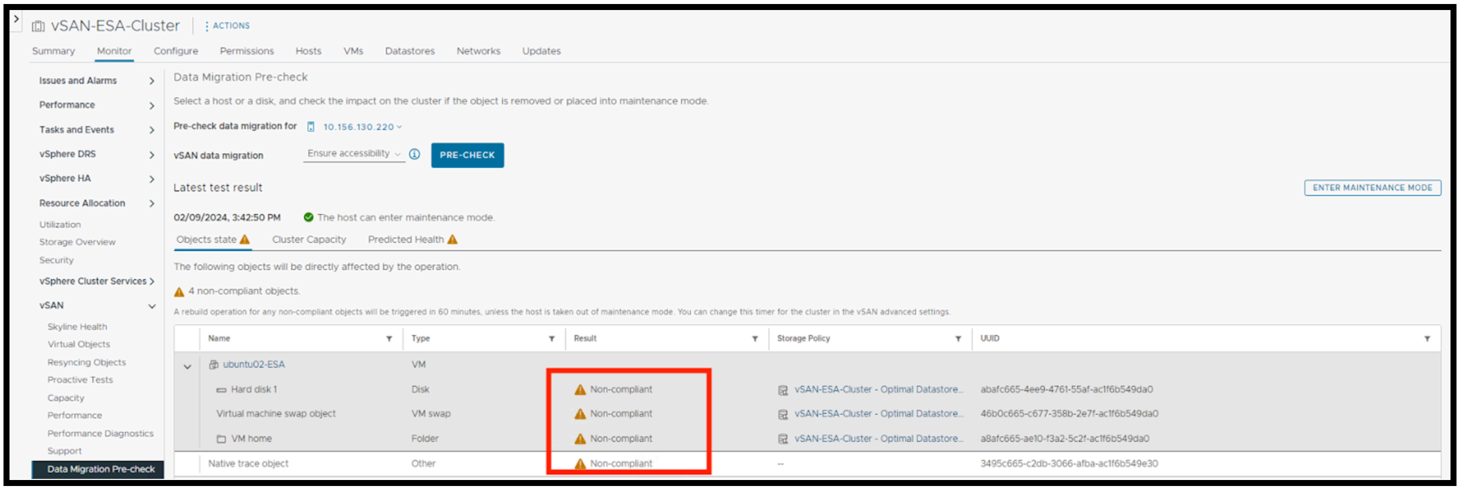
Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.220

vSAN data migration: Ensure accessibility

No valid test is available for the selected entity and vSAN data migration option.



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.220

vSAN data migration: Ensure accessibility

Latest test result

02/09/2024, 3:42:50 PM ✓ The host can enter maintenance mode.

The following objects will be directly affected by the operation.

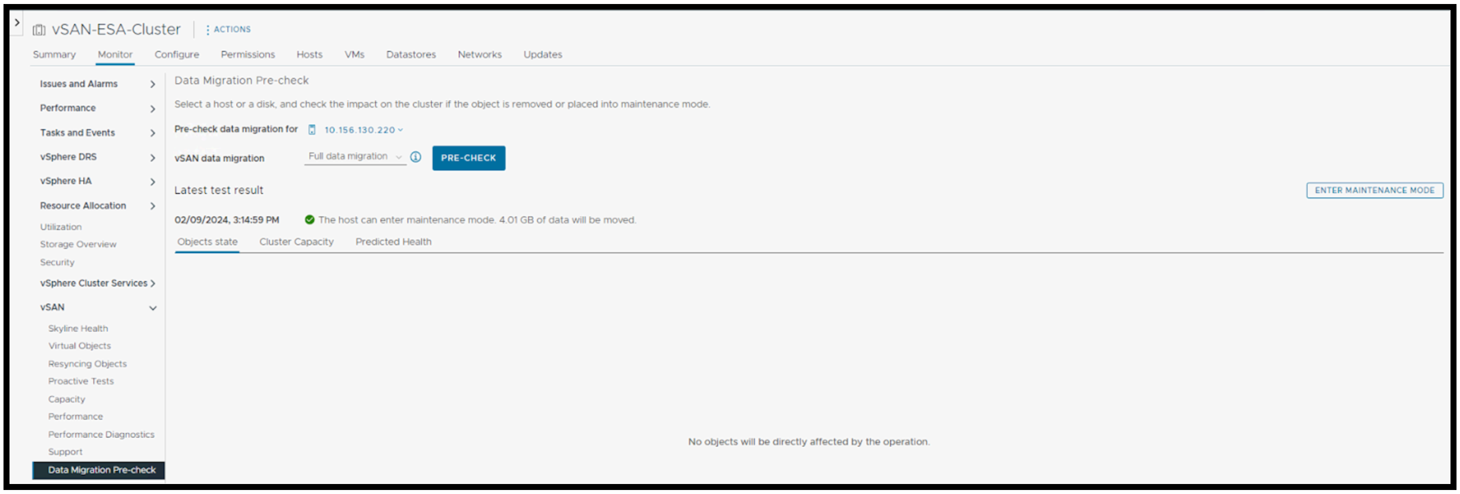
⚠ 4 non-compliant objects.

A rebuild operation for any non-compliant objects will be triggered in 60 minutes, unless the host is taken out of maintenance mode. You can change this timer for the cluster in the vSAN advanced settings.

Name	Type	Result	Storage Policy	UUID
ubuntu02-ESA	VM			
Hard disk 1	Disk	⚠ Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	abafc665-4ee9-4761-55af-ac1f6b549da0
Virtual machine swap object	VM swap	⚠ Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	46b0c665-c677-358b-2e7f-ac1f6b549da0
VM home	Folder	⚠ Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	a8afc665-ae10-f3a2-5c2f-ac1f6b549da0
Native trace object	Other	⚠ Non-compliant	--	3495c665-c2db-3066-afba-ac1f6b549e30

As the host owns several data object components, when the host is offline, those components will be unavailable. Here we compromise moving data objects for a relatively quick maintenance operation.

Perhaps unsurprisingly, if we chose 'full data migration' as the scenario (where all the components will be moved away from the host before enabling maintenance mode) then the components are fully protected:



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.220

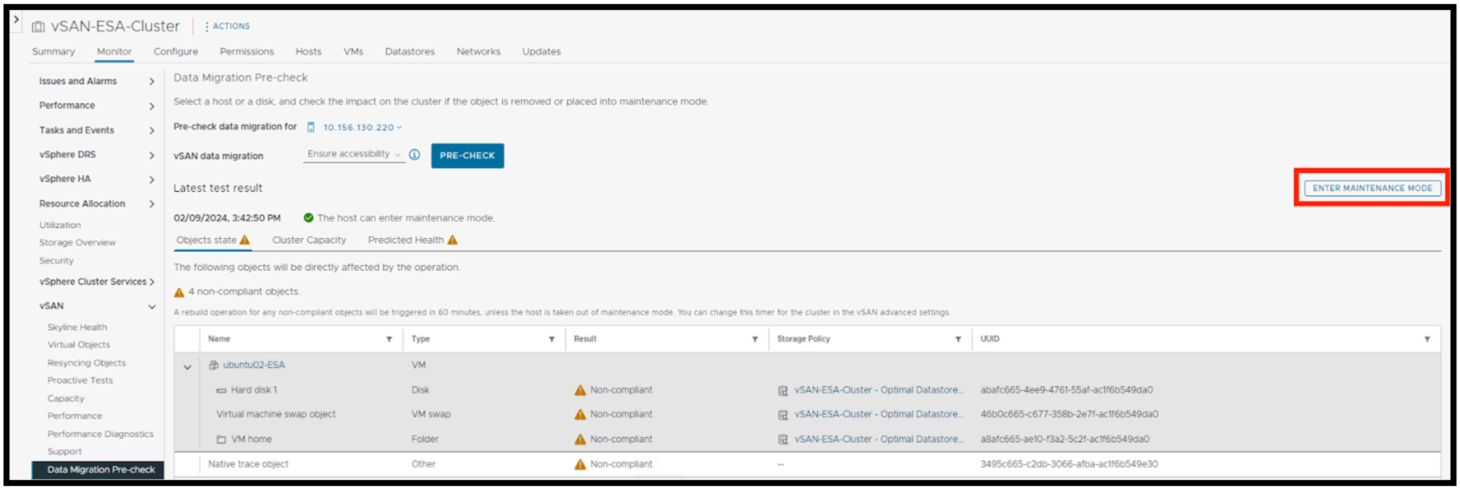
vSAN data migration: Full data migration

Latest test result

02/09/2024, 3:14:59 PM ✓ The host can enter maintenance mode. 4.01 GB of data will be moved.

No objects will be directly affected by the operation.

Changing the maintenance mode option back to 'ensure accessibility', we can select 'enter maintenance mode' to observe what happens:



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.220

vSAN data migration: Ensure accessibility

Latest test result

02/09/2024, 3:42:50 PM ✓ The host can enter maintenance mode.

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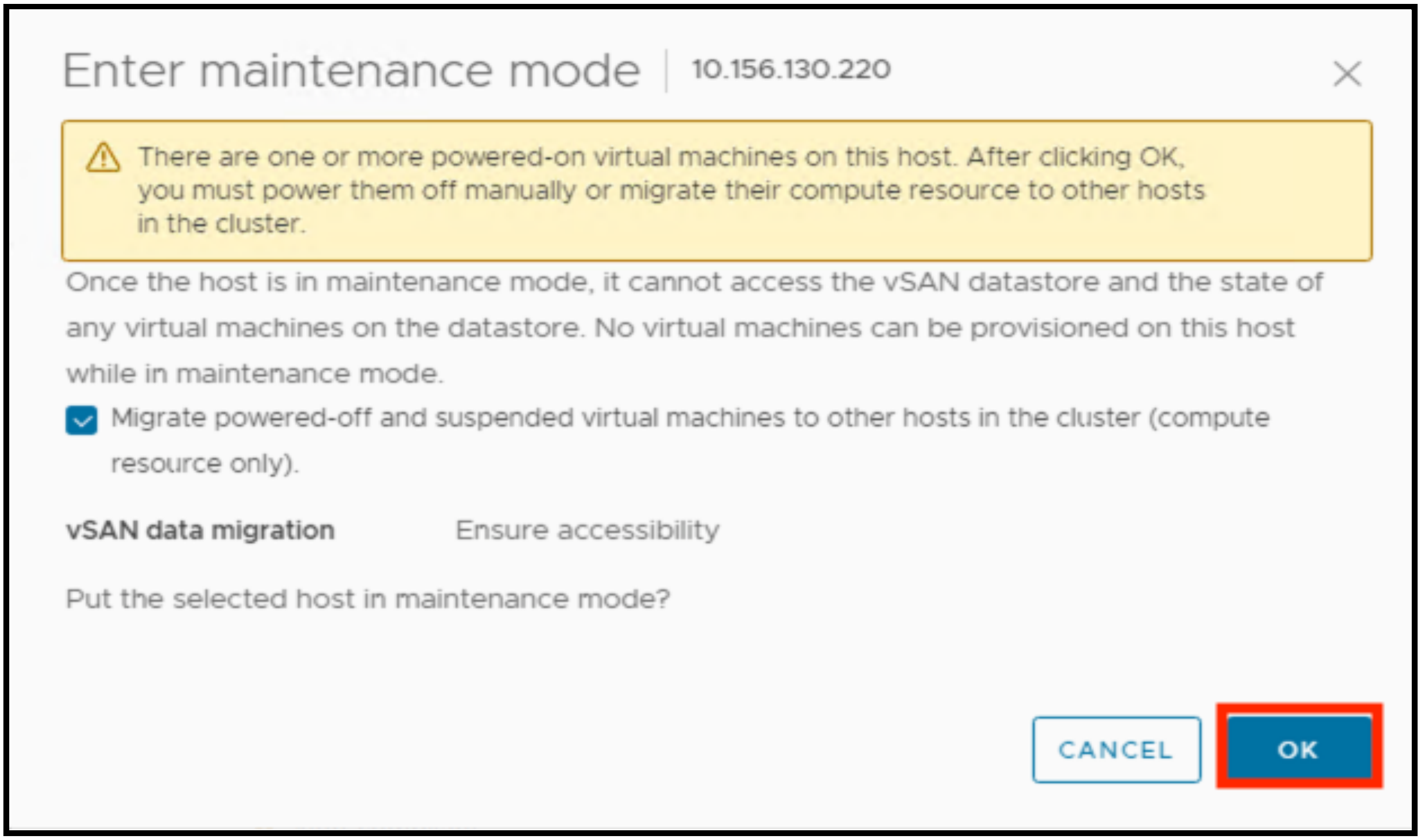
Hard disk 1	Disk	⚠ Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	abafc665-4ee9-4761-55af-ac1f6b549da0
Virtual machine swap object	VM swap	⚠ Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	46b0c665-c677-358b-2e7f-ac1f6b549da0
VM home	Folder	⚠ Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	a8afc665-ae10-f3a2-5c2f-ac1f6b549da0
Native trace object	Other	⚠ Non-compliant	--	3495c665-c2db-3066-afba-ac1f6b549e30

We receive a warning regarding migrating running VMs. If DRS is set to 'fully automated', the virtual machines should be automatically migrated.



Enter maintenance mode | 10.156.130.220

⚠ There are one or more powered-on virtual machines on this host. After clicking OK, you must power them off manually or migrate their compute resource to other hosts in the cluster.

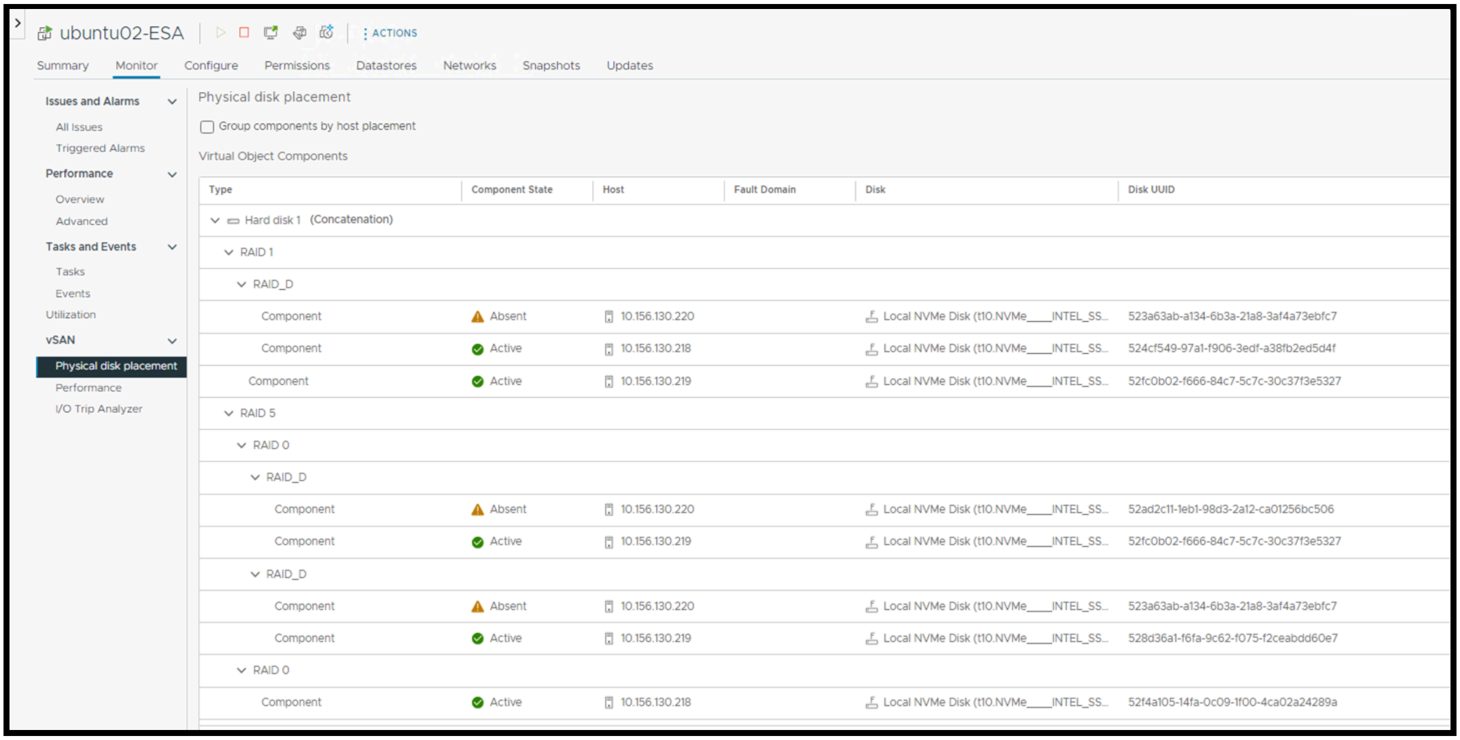
Once the host is in maintenance mode, it cannot access the vSAN datastore and the state of any virtual machines on the datastore. No virtual machines can be provisioned on this host while in maintenance mode.

☑ Migrate powered-off and suspended virtual machines to other hosts in the cluster (compute resource only).

vSAN data migration Ensure accessibility

Put the selected host in maintenance mode?

After the host has entered maintenance mode, we can now examine the state of the components. As expected, since the host is offline, some components are marked as 'absent'. The VM and its data remains accessible.



Physical disk placement

☐ Group components by host placement

Virtual Object Components

Type	Component State	Host	Fault Domain	Disk	Disk UUID
Hard disk 1 (Concatenation)					
RAID 1					
RAID_D					
Component	⚠ Absent	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	523a63ab-a134-6b3a-21a8-3af4a73ebfc7
Component	✓ Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	524cf549-97a1-f906-3edf-a38fb2ed5d4f
Component	✓ Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	52fc0b02-f666-84c7-5c7c-30c37f3e5327
RAID 5					
RAID 0					
RAID_D					
Component	⚠ Absent	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	52ad2c11-1eb1-98d3-2a12-ca01256bc506
Component	✓ Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	52fc0b02-f666-84c7-5c7c-30c37f3e5327
RAID_D					
Component	⚠ Absent	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	523a63ab-a134-6b3a-21a8-3af4a73ebfc7
Component	✓ Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	528d36a1-f6fa-9c62-f075-f2ceabdd60e7
RAID 0					
Component	✓ Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	52f4a105-14fa-0c09-1f00-4ca02a24289a

We introduced the enhanced data durability feature for planned maintenance when using RAID 5/6. In a vSAN Express Storage Architecture (ESA) cluster, when a host enters maintenance mode using the "Ensure Accessibility" option, it will allow vSAN to write all incremental updates to another host in addition to the hosts holding the object data in a stripe with parity. This helps ensure the durability of the changed data if additional hosts participating in the storage of that object fail while the host in maintenance mode remains offline. Durability components also allow vSAN to merge the updated data more quickly into the stripe with parity, allowing clusters to regain the prescribed level of resilience more quickly during these maintenance activities.

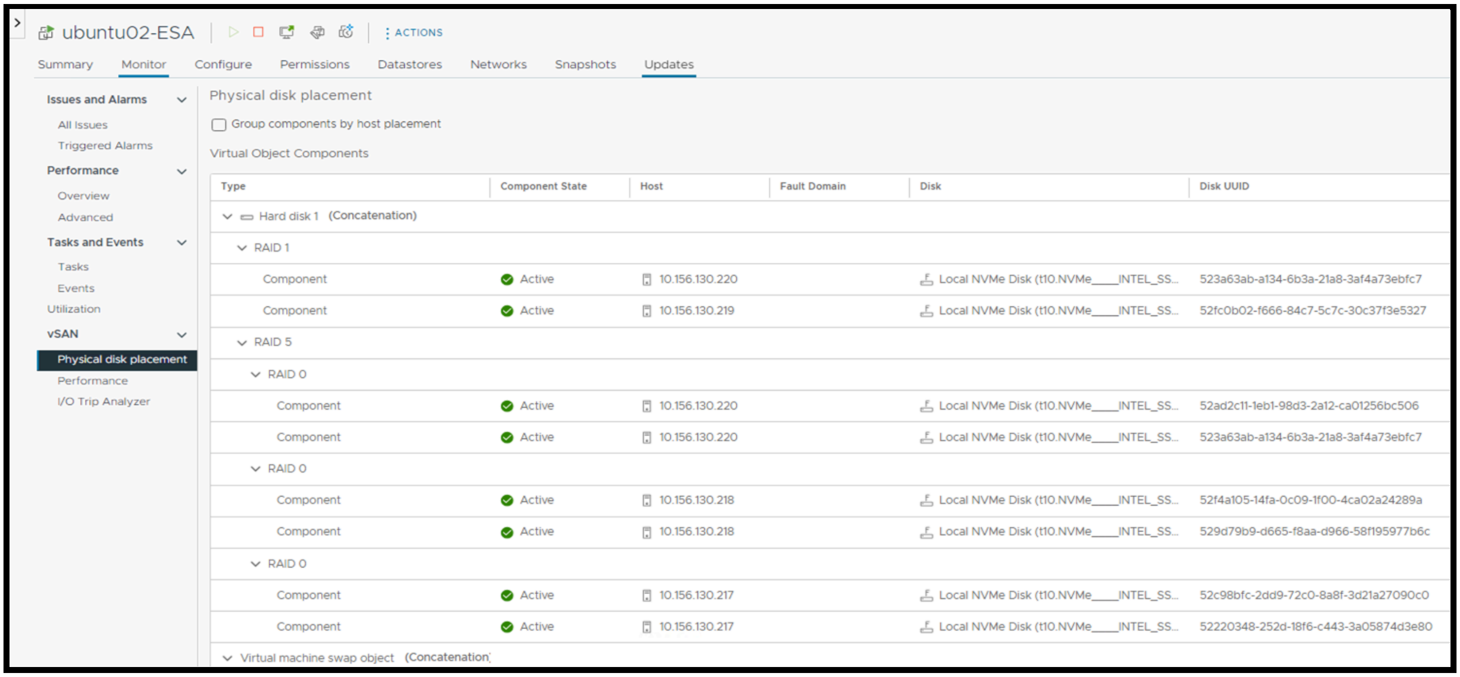
This data durability enhancement significantly speeds up the time required to patch, or perform other maintenance on a vSAN cluster, especially at scale.

For more details on durability components, visit:

- https://core.vmware.com/blog/durability-components-raid-56-using-vsan-esa-vsan-8-u1
- https://blogs.vmware.com/virtualblocks/2020/09/23/enhanced-durability-during-maintenance-mode-operations/
- https://blogs.vmware.com/virtualblocks/2021/03/18/enhanced-data-durability-vsan-7-update-2/

To take the host out of maintenance mode, navigate to the ESXi host. From the actions menu select **Maintenance Mode > Exit Maintenance Mode**:

After exiting maintenance mode, the “Absent” component becomes "Active" once more (if the host exited maintenance mode before the 60-minute vSAN cluster services timer expires):



Physical disk placement

☐ Group components by host placement

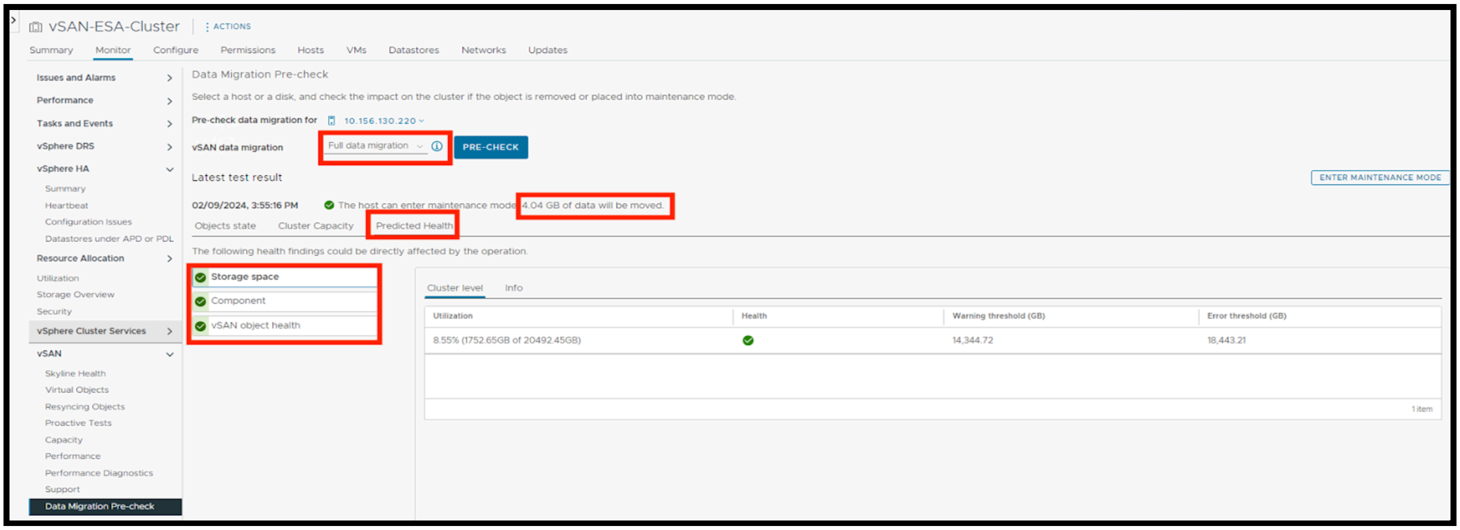
Virtual Object Components

Type	Component State	Host	Fault Domain	Disk	Disk UUID
Hard disk 1 (Concatenation)					
RAID 1					
Component	Active	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	523a63ab-a134-6b3a-21a8-3af4a73ebfc7
Component	Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	52fc0b02-f666-84c7-5c7c-30c37f3e5327
RAID 5					
RAID 0					
Component	Active	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	52ad2c11-1eb1-98d3-2a12-ca01256bc506
Component	Active	10.156.130.220		Local NVMe Disk (t10.NVMe____INTEL_SS...	523a63ab-a134-6b3a-21a8-3af4a73ebfc7
RAID 0					
Component	Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	52f4a105-14fa-0c09-1f00-4ca02a24289a
Component	Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	529d79b9-d665-f8aa-d966-58f195977b6c
RAID 0					
Component	Active	10.156.130.217		Local NVMe Disk (t10.NVMe____INTEL_SS...	52c98bfc-2dd9-72c0-8a8f-3d21a27090c0
Component	Active	10.156.130.217		Local NVMe Disk (t10.NVMe____INTEL_SS...	52220348-252d-18f6-c443-3a05874d3e80
Virtual machine swap object (Concatenation)					

We shall now place the host into maintenance mode once more, but this time we will choose ‘full data migration’. As the name suggests, this will move all data components from the affected host to the remaining hosts in the cluster (thus ensuring full availability during the maintenance operation).

Note that this is only possible when there are enough resources in the cluster to cater for the affected components: there must be enough hosts remaining to fulfill the storage policy requirements, along with enough space left on the hosts.

When we run the pre-check again, we can see that around 2GB data will be moved, and that the VM will be fully protected (health status is fully green):



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.220

vSAN data migration: Full data migration

Latest test result

02/09/2024, 3:55:16 PM ✓ The host can enter maintenance mode 4.04 GB of data will be moved.

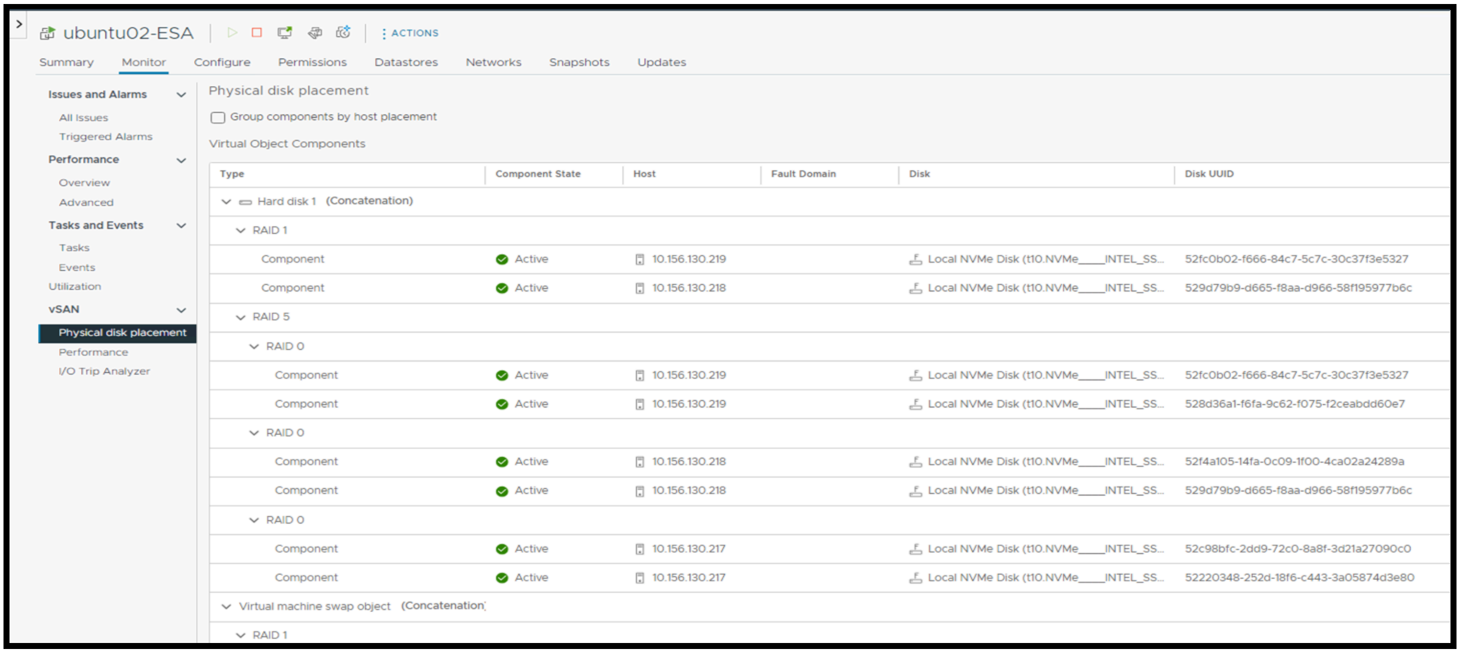
The following health findings could be directly affected by the operation.

- ✓ Storage space
- ✓ Component
- ✓ vSAN object health

Utilization	Health	Warning threshold (GB)	Error threshold (GB)
8.55% (1752.65GB of 20492.45GB)	✓	14,344.72	18,443.21

1 item

As expected, all the components of our VM remain active and healthy. We see that some components have been moved to other hosts:



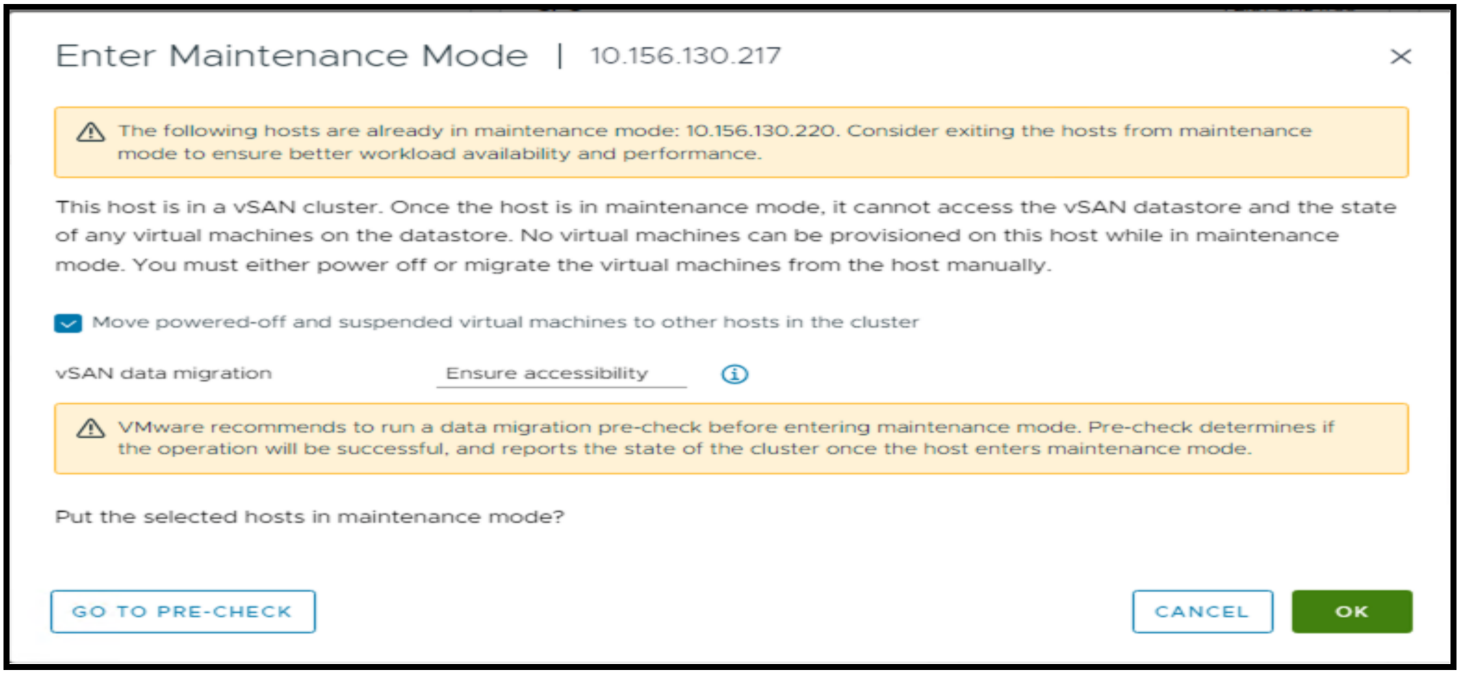
Physical disk placement

□ Group components by host placement

Virtual Object Components

Type	Component State	Host	Fault Domain	Disk	Disk UUID
Hard disk 1 (Concatenation)					
RAID 1					
Component	✓ Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	52fc0b02-f666-84c7-5c7c-30c37f3e5327
Component	✓ Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	529d79b9-d665-f8aa-d966-58f195977b6c
RAID 5					
RAID 0					
Component	✓ Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	52fc0b02-f666-84c7-5c7c-30c37f3e5327
Component	✓ Active	10.156.130.219		Local NVMe Disk (t10.NVMe____INTEL_SS...	528d36a1-f6fa-9c62-f075-f2ceabdd60e7
RAID 0					
Component	✓ Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	52f4a105-14fa-0c09-1f00-4ca02a24289a
Component	✓ Active	10.156.130.218		Local NVMe Disk (t10.NVMe____INTEL_SS...	529d79b9-d665-f8aa-d966-58f195977b6c
RAID 0					
Component	✓ Active	10.156.130.217		Local NVMe Disk (t10.NVMe____INTEL_SS...	52c98bfc-2dd9-72c0-8a8f-3d21a27090c0
Component	✓ Active	10.156.130.217		Local NVMe Disk (t10.NVMe____INTEL_SS...	52220348-252d-18f6-c443-3a05874d3e80
Virtual machine swap object (Concatenation					
RAID 1					

Now, if we try to place another host into maintenance mode, there will be a warning shown. Safeguards are in place when multiple hosts are requested to enter maintenance mode at the same time (along with similar scenarios where recent operations have caused resync activity). This ensures that there are no multiple unintended outages that may cause vSAN objects to become inaccessible.



Enter Maintenance Mode | 10.156.130.217

⚠ The following hosts are already in maintenance mode: 10.156.130.220. Consider exiting the hosts from maintenance mode to ensure better workload availability and performance.

This host is in a vSAN cluster. Once the host is in maintenance mode, it cannot access the vSAN datastore and the state of any virtual machines on the datastore. No virtual machines can be provisioned on this host while in maintenance mode. You must either power off or migrate the virtual machines from the host manually.

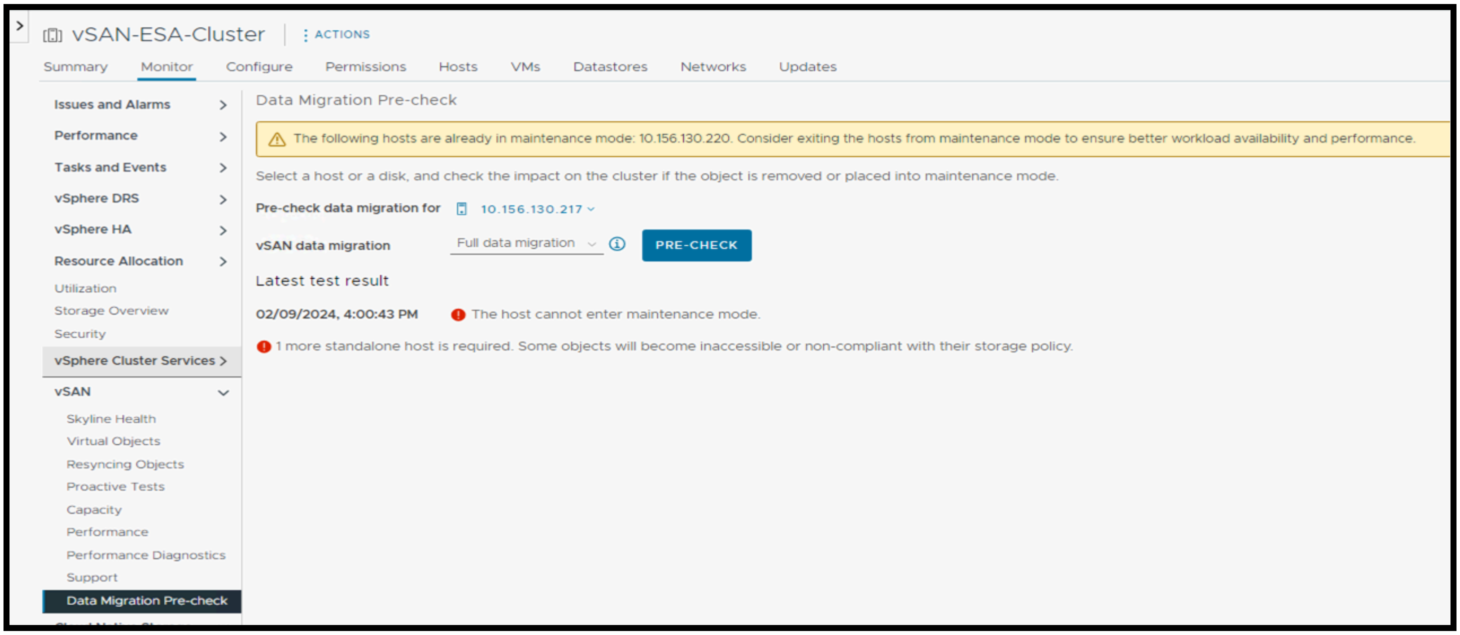
☑ Move powered-off and suspended virtual machines to other hosts in the cluster

vSAN data migration: Ensure accessibility

⚠ VMware recommends to run a data migration pre-check before entering maintenance mode. Pre-check determines if the operation will be successful, and reports the state of the cluster once the host enters maintenance mode.

Put the selected hosts in maintenance mode?

If we look at the pre-check (for the full data migration scenario) for this additional host, we can see that this produces errors. The second host cannot enter maintenance mode with the current storage policy and resources available:



Data Migration Pre-check

⚠ The following hosts are already in maintenance mode: 10.156.130.220. Consider exiting the hosts from maintenance mode to ensure better workload availability and performance.

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.217

vSAN data migration: Full data migration

Latest test result

02/09/2024, 4:00:43 PM ● The host cannot enter maintenance mode.

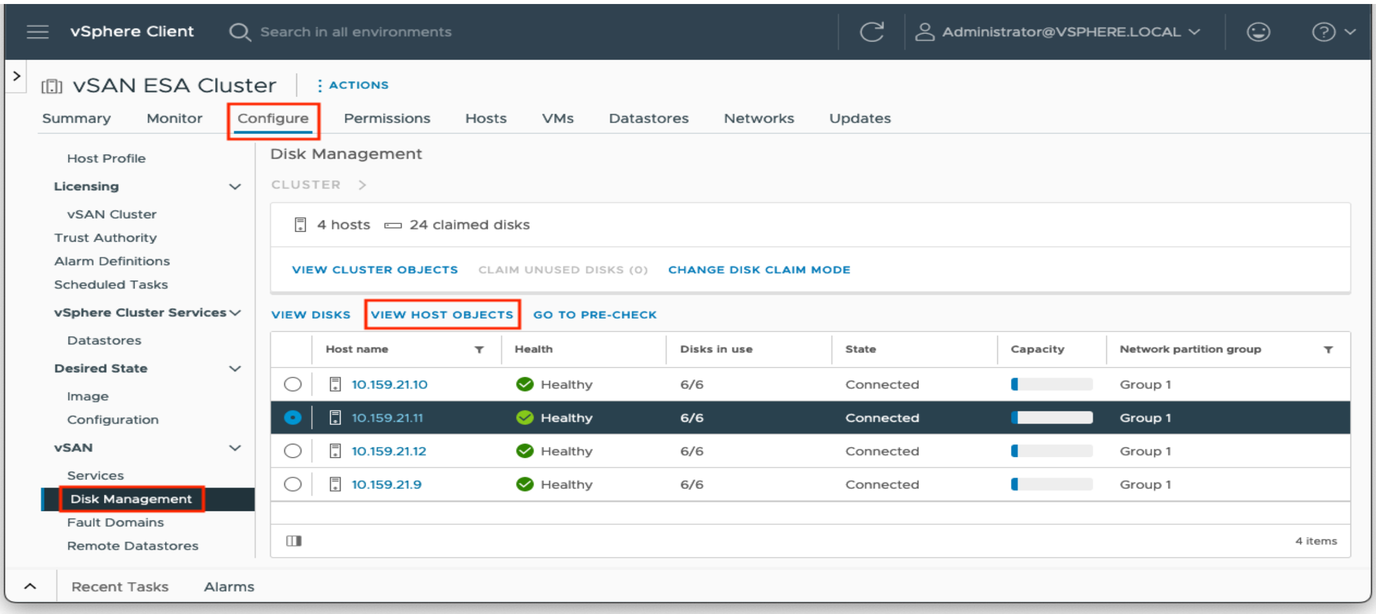
● 1 more standalone host is required. Some objects will become inaccessible or non-compliant with their storage policy.

Ensure that you exit maintenance mode of all the hosts to restore the cluster to a fully functional state.

Remove a Disk

Here, we demonstrate how to remove a disk in vSAN.

Navigate to **[vSAN Cluster]** > **Configure** > **vSAN** > **Disk Management**. Select a host and then click on ‘View Host Objects’ to confirm that there are VM objects on the host



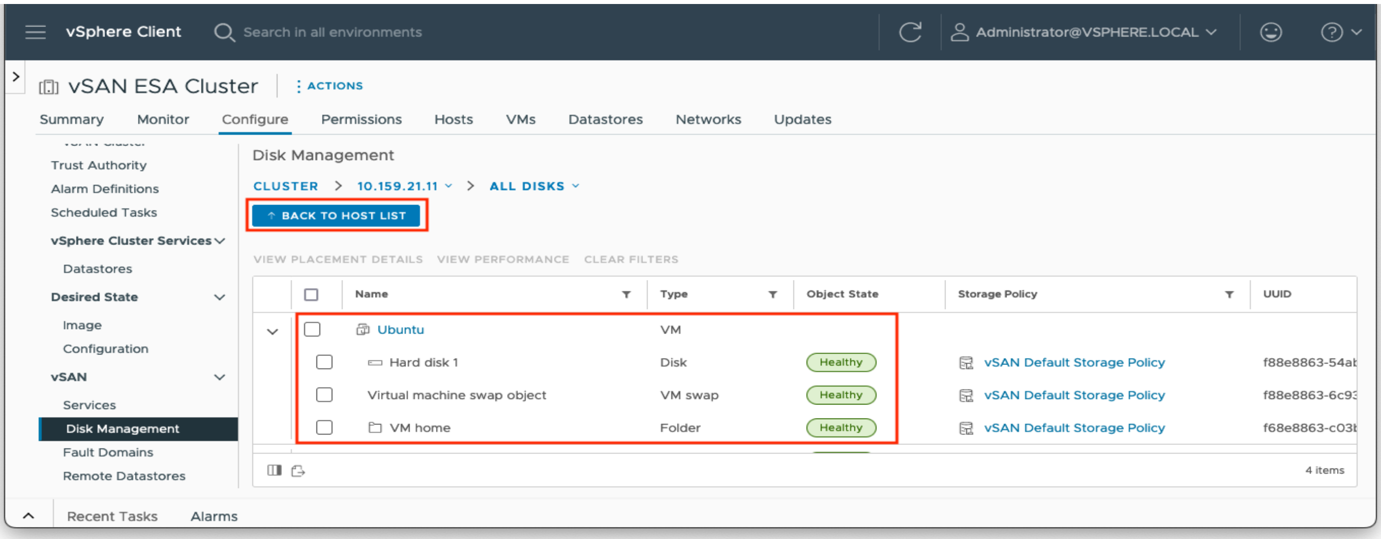
Disk Management

4 hosts 24 claimed disks

	Host name	Health	Disks in use	State	Capacity	Network partition group
○	10.159.21.10	✓ Healthy	6/6	Connected		Group 1
●	10.159.21.11	✓ Healthy	6/6	Connected		Group 1
○	10.159.21.12	✓ Healthy	6/6	Connected		Group 1
○	10.159.21.9	✓ Healthy	6/6	Connected		Group 1

4 items

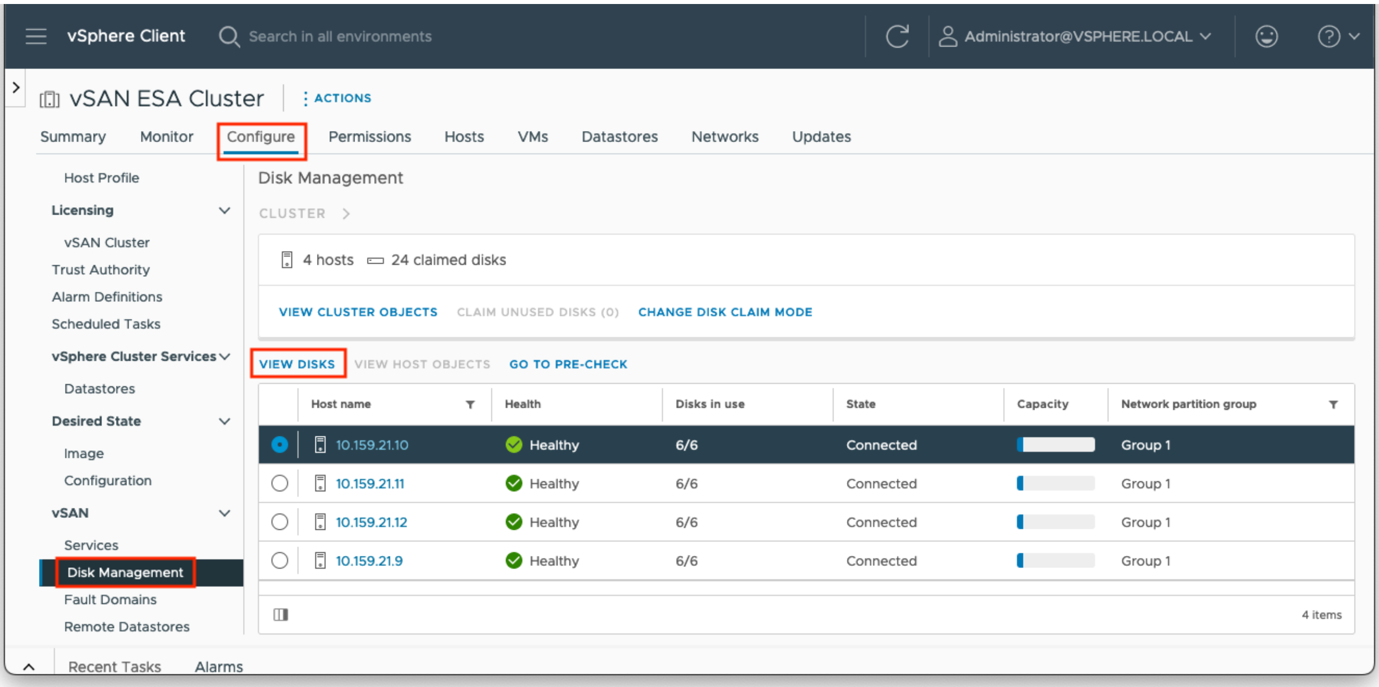
Below we can see that there is indeed VM data on the host 10.159.21.11. Once confirmed, click on **BACK TO HOST LIST**:



Name	Type	Object State	Storage Policy	UUID
Ubuntu	VM			
Hard disk 1	Disk	Healthy	vSAN Default Storage Policy	f88e8863-54ab
Virtual machine swap object	VM swap	Healthy	vSAN Default Storage Policy	f88e8863-6c93
VM home	Folder	Healthy	vSAN Default Storage Policy	f68e8863-c03b

4 items

Then click on **View Disks** on the host with VM data:



4 hosts 24 claimed disks

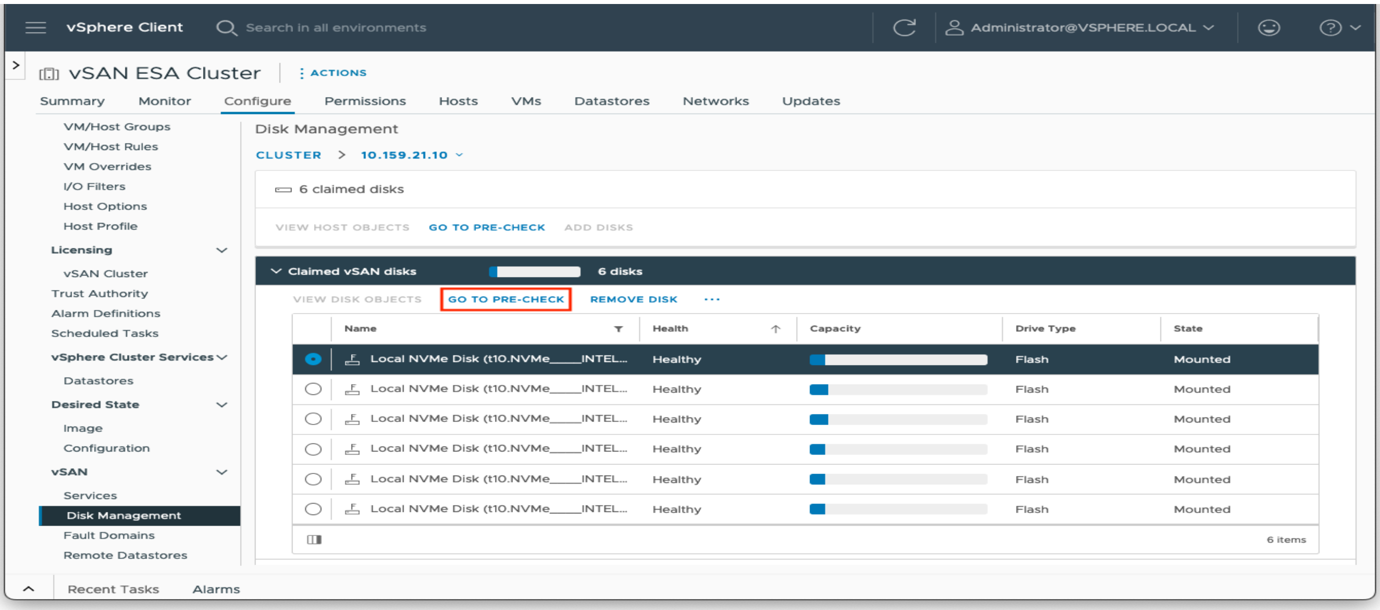
	Host name	Health	Disks in use	State	Capacity	Network partition group
●	10.159.21.10	Healthy	6/6	Connected		Group 1
○	10.159.21.11	Healthy	6/6	Connected		Group 1
○	10.159.21.12	Healthy	6/6	Connected		Group 1
○	10.159.21.9	Healthy	6/6	Connected		Group 1

4 items

Depending on the architecture of vSAN deployed (OSA or ESA), disk groups or a disk pool will be shown.

vSAN ESA Cluster

Here, we can select any disk we'd like to remove.



Disk Management

CLUSTER > 10.159.21.10

6 claimed disks

VIEW HOST OBJECTS | GO TO PRE-CHECK | ADD DISKS

Claimed vSAN disks — 6 disks

VIEW DISK OBJECTS | GO TO PRE-CHECK | REMOVE DISK | ...

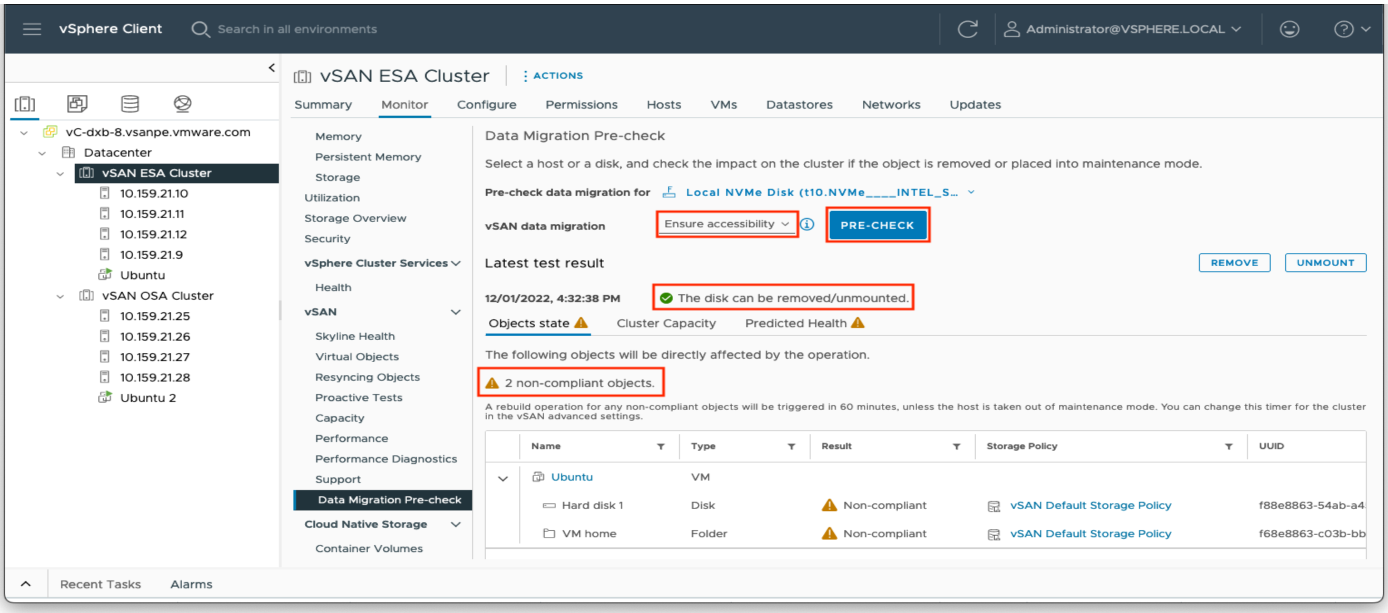
	Name	Health	Capacity	Drive Type	State
●	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted

6 items

Just like with host maintenance, we can choose between the three options:

- **Full data migration**: Move all the data away from the affected resource before maintenance
- **Ensure accessibility**: First check for any issues before resources become (temporarily) unavailable (No data is moved)
- **No data migration**: Perform no checks nor move any data

As before, with the 'ensure accessibility' scenario, we can see that some objects will become non-compliant with the storage policy. We can, however, remove or unmount the disk without affecting the running VM.



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for: Local NVMe Disk (t10.NVMe____INTEL_S...

vSAN data migration: Ensure accessibility | PRE-CHECK

Latest test result — REMOVE | UNMOUNT

12/01/2022, 4:32:38 PM — The disk can be removed/unmounted.

Objects state | Cluster Capacity | Predicted Health

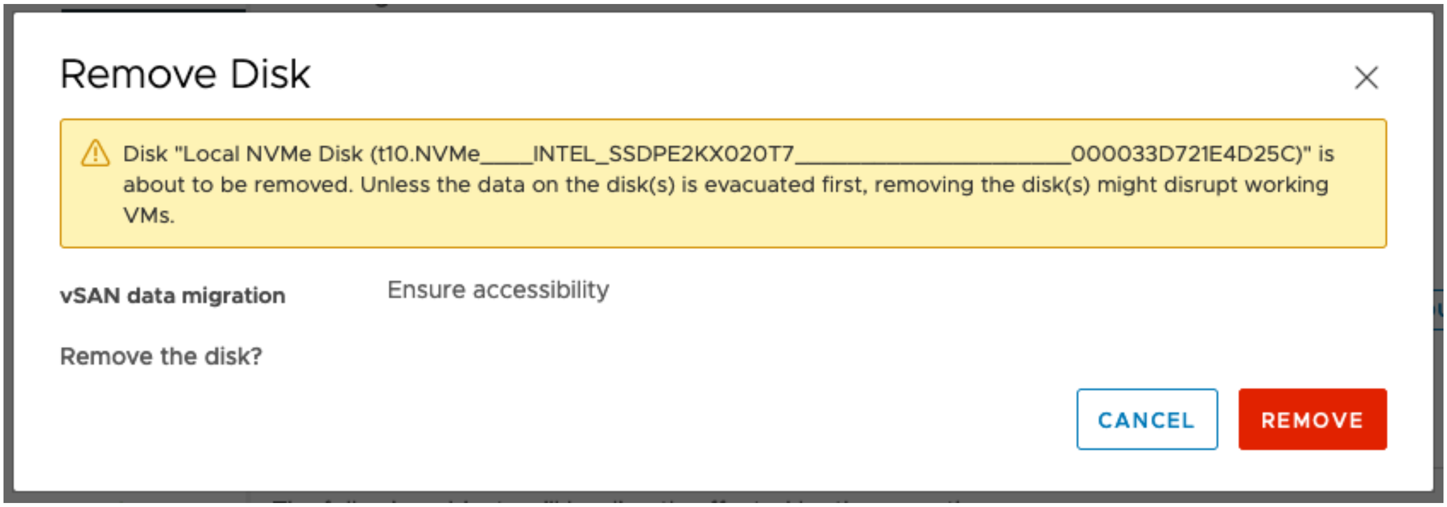
The following objects will be directly affected by the operation.

2 non-compliant objects.

A rebuild operation for any non-compliant objects will be triggered in 60 minutes, unless the host is taken out of maintenance mode. You can change this timer for the cluster in the vSAN advanced settings.

Name	Type	Result	Storage Policy	UUID
Ubuntu	VM			
Hard disk 1	Disk	Non-compliant	vSAN Default Storage Policy	f88e8863-54ab-a4
VM home	Folder	Non-compliant	vSAN Default Storage Policy	f68e8863-c03b-bb

Clicking on remove or unmount will bring up a confirmation window:

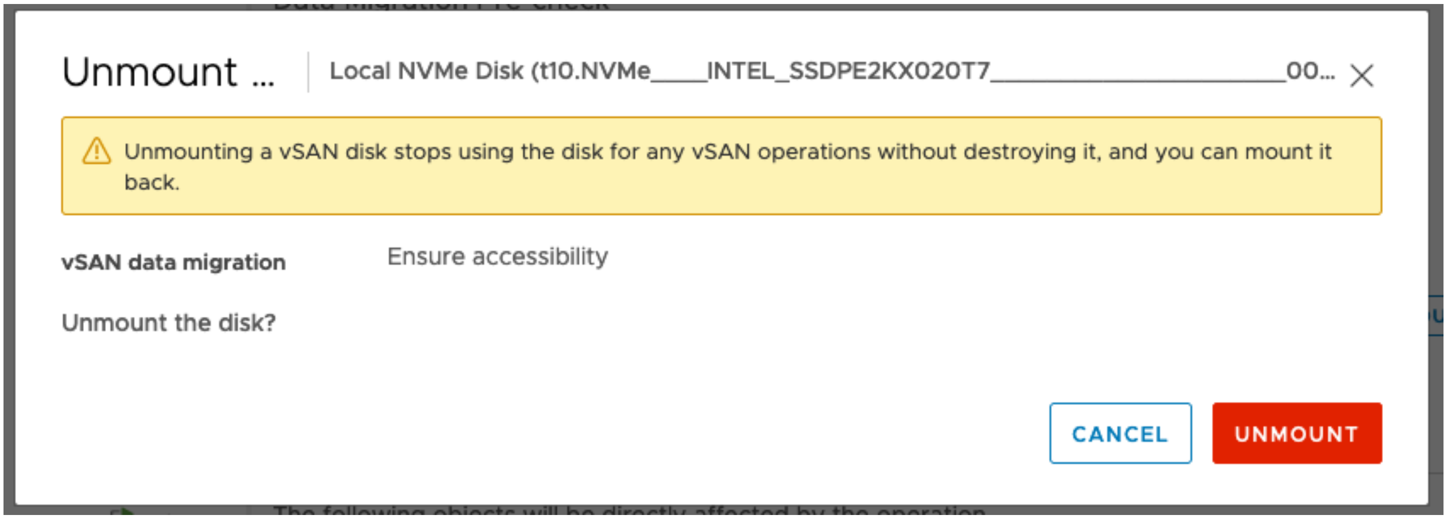


Remove Disk

Disk "Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_______________________000033D721E4D25C)" is about to be removed. Unless the data on the disk(s) is evacuated first, removing the disk(s) might disrupt working VMs.

vSAN data migration Ensure accessibility

Remove the disk?



Unmount ... | Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_______________________00...

Unmounting a vSAN disk stops using the disk for any vSAN operations without destroying it, and you can mount it back.

vSAN data migration Ensure accessibility

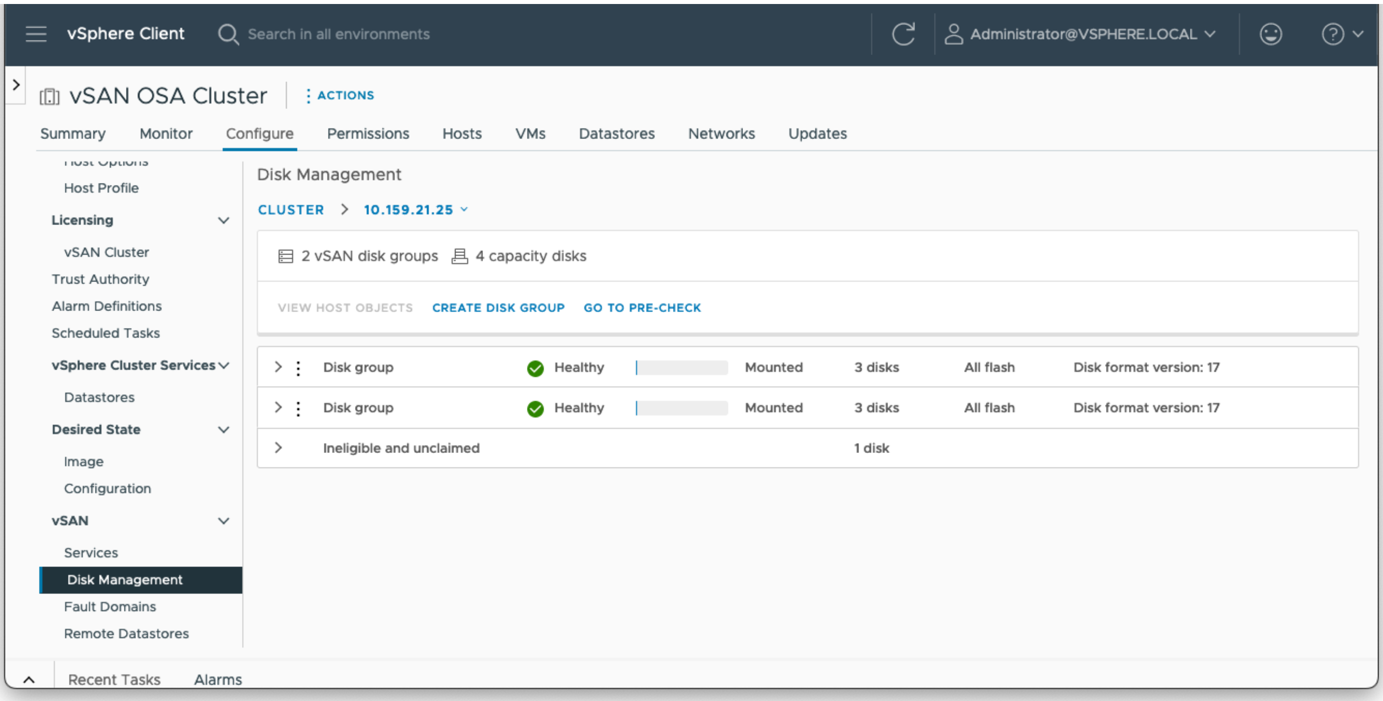
Unmount the disk?

Removing or unmounting the disk group will cause the VM data components to go into the ‘absent’ state.

Remember to re-add back any disks or disk groups removed.

vSAN OSA Cluster

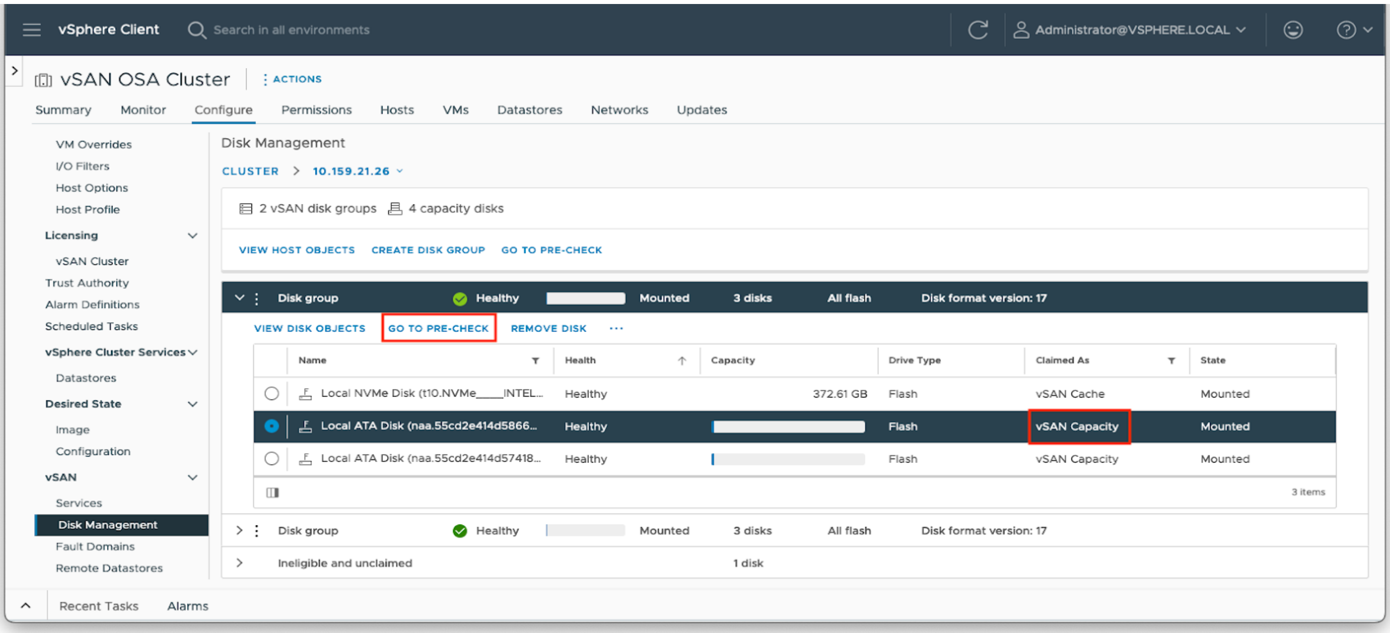
Here, we are presented with the disk groups on the host (same navigation as what was used for the vSAN ESA cluster section):



2 vSAN disk groups 4 capacity disks

Disk group	Healthy		Mounted	3 disks	All flash	Disk format version: 17
Disk group	Healthy		Mounted	3 disks	All flash	Disk format version: 17
Ineligible and unclaimed				1 disk		

Expand one of the disk groups. Select a capacity disk and click on **Go To Pre-Check**:



2 vSAN disk groups 4 capacity disks

Disk group | Healthy | Mounted | 3 disks | All flash | Disk format version: 17

	Name	Health	Capacity	Drive Type	Claimed As	State
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy	372.61 GB	Flash	vSAN Cache	Mounted
●	Local ATA Disk (naa.55cd2e414d5866...	Healthy		Flash	vSAN Capacity	Mounted
○	Local ATA Disk (naa.55cd2e414d57418...	Healthy		Flash	vSAN Capacity	Mounted

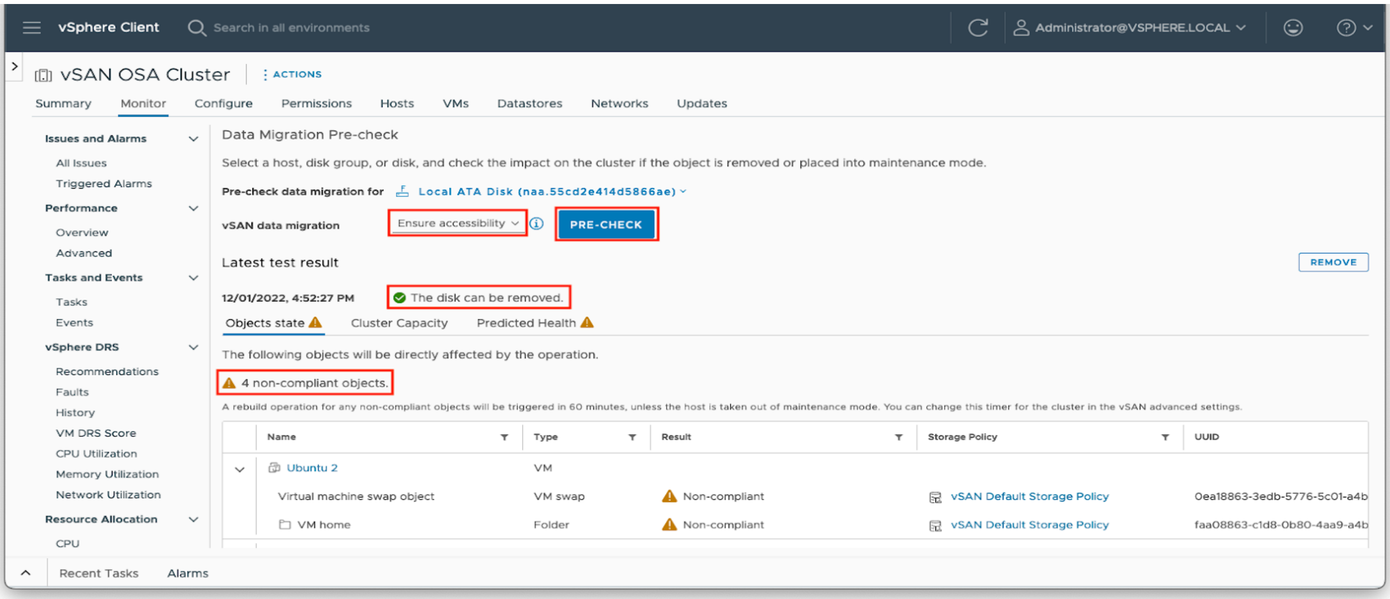
3 items

Disk group	Healthy		Mounted	3 disks	All flash	Disk format version: 17
Ineligible and unclaimed				1 disk		

Just like with host maintenance, we can choose between the three options:

- **Full data migration**: Move all the data away from the affected resource before maintenance
- **Ensure accessibility**: First check for any issues before resources become (temporarily) unavailable (No data is moved)
- **No data migration**: Perform no checks nor move any data

As before, with the 'ensure accessibility' scenario, we can see that some objects will become non-compliant with the storage policy. We can, however, remove the disk without affecting the running VM:



Data Migration Pre-check

Select a host, disk group, or disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for Local ATA Disk (naa.55cd2e414d5866ae)

vSAN data migration Ensure accessibility PRE-CHECK

Latest test result REMOVE

12/01/2022, 4:52:27 PM The disk can be removed.

Objects state ⚠ Cluster Capacity Predicted Health ⚠

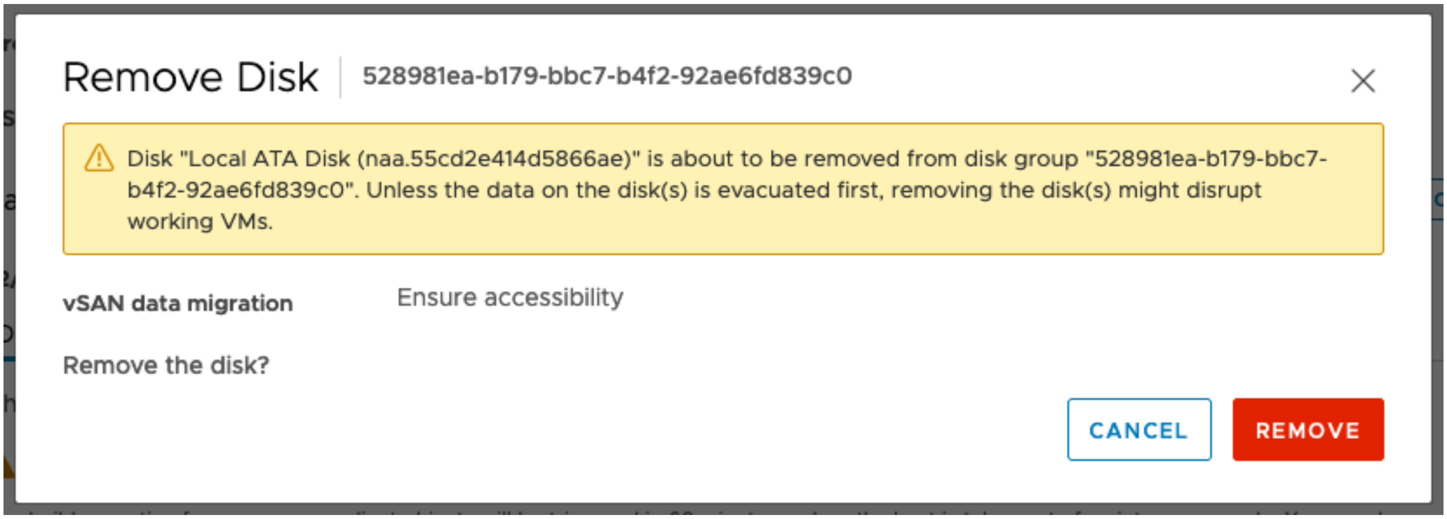
The following objects will be directly affected by the operation.

⚠ 4 non-compliant objects.

A rebuild operation for any non-compliant objects will be triggered in 60 minutes, unless the host is taken out of maintenance mode. You can change this timer for the cluster in the vSAN advanced settings.

Name	Type	Result	Storage Policy	UUID
Ubuntu 2	VM			
Virtual machine swap object	VM swap	⚠ Non-compliant	vSAN Default Storage Policy	0ea18863-3edb-5776-5c01-a4b
VM home	Folder	⚠ Non-compliant	vSAN Default Storage Policy	faa08863-c1d8-0b80-4aa9-a4b

Clicking on remove will bring up a confirmation window:



Remove Disk | 528981ea-b179-bbc7-b4f2-92ae6fd839c0

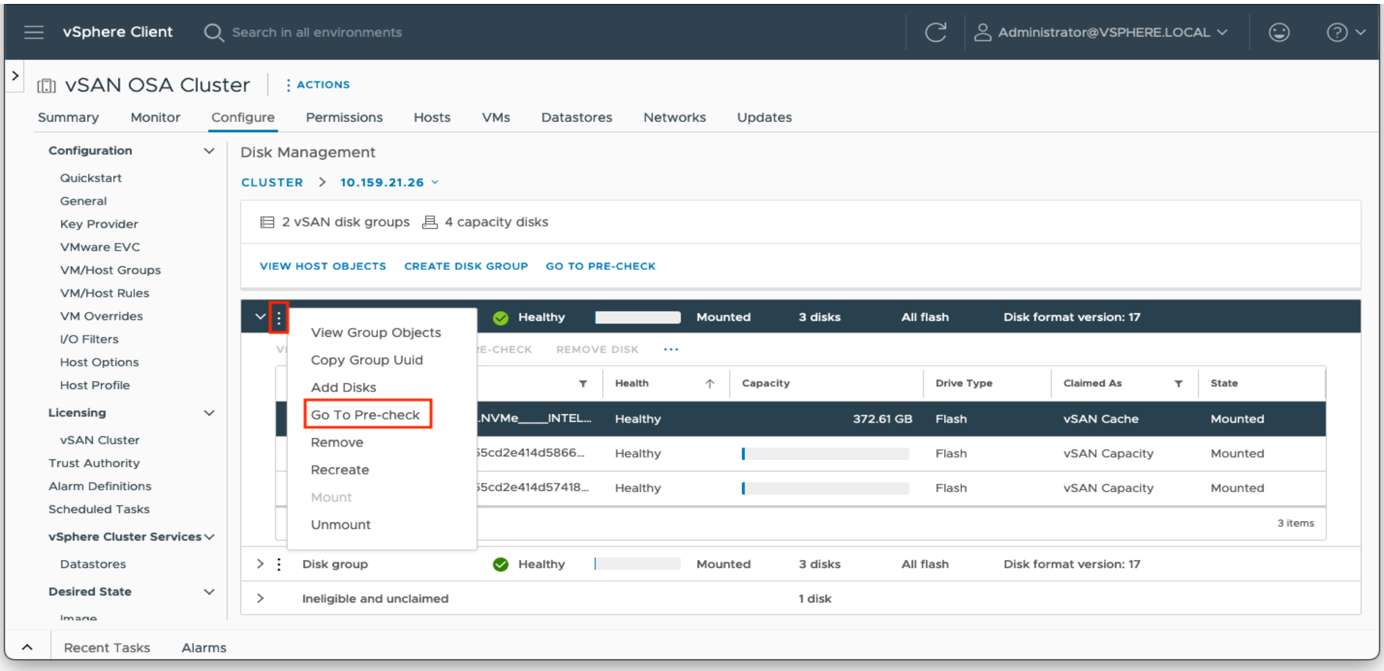
⚠ Disk "Local ATA Disk (naa.55cd2e414d5866ae)" is about to be removed from disk group "528981ea-b179-bbc7-b4f2-92ae6fd839c0". Unless the data on the disk(s) is evacuated first, removing the disk(s) might disrupt working VMs.

vSAN data migration Ensure accessibility

Remove the disk?

Removing the disk group will cause the VM data components to go into the 'absent' state.

We can also do the same with the whole disk group. Navigate back to **Configure > Disk Management** and select the host again and **View Disks**. This time, click on the ellipses (three dots) to the left of **Disk group**. This will bring up a list of options:



2 vSAN disk groups 4 capacity disks

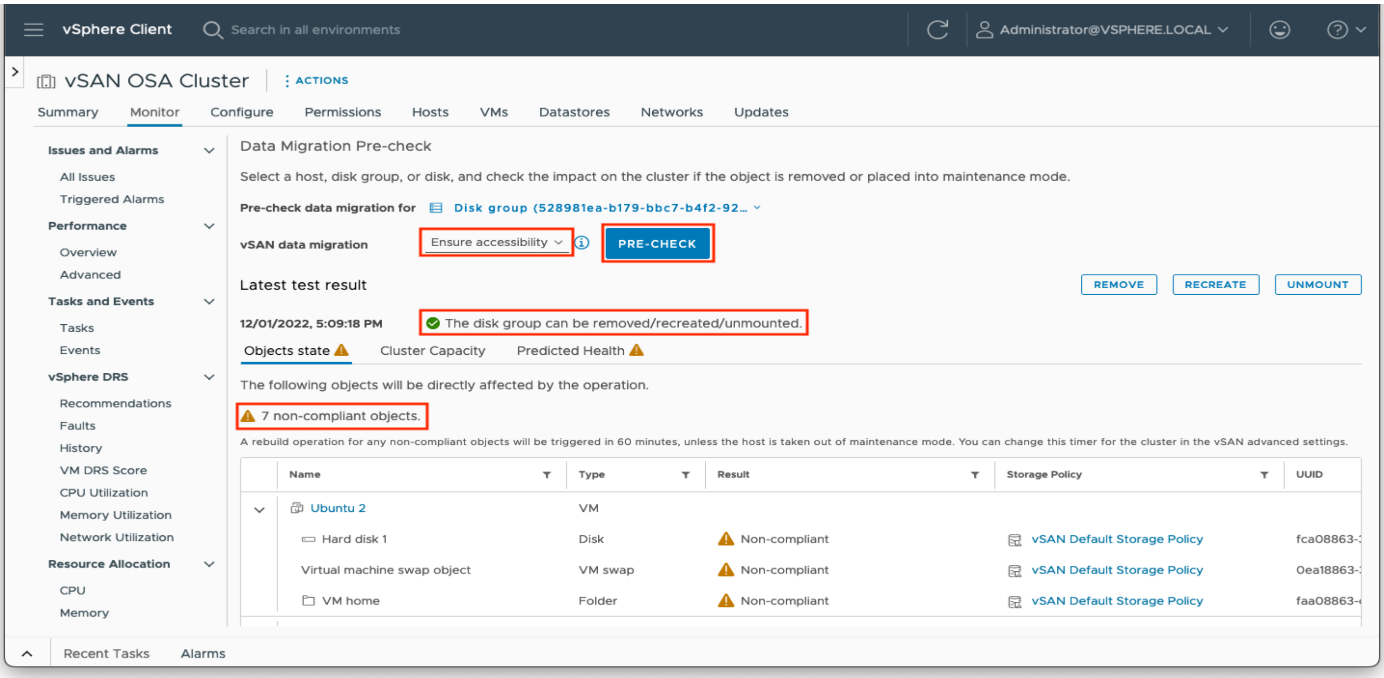
	Health		Disks		Disk format version
	Healthy	Mounted	3 disks	All flash	Disk format version: 17

	Health	Capacity	Drive Type	Claimed As	State
.NVMe____INTEL...	Healthy	372.61 GB	Flash	vSAN Cache	Mounted
5cd2e414d5866...	Healthy		Flash	vSAN Capacity	Mounted
5cd2e414d57418...	Healthy		Flash	vSAN Capacity	Mounted

3 items

Disk group	Healthy	Mounted	3 disks	All flash	Disk format version: 17
Ineligible and unclaimed			1 disk		

Click on **Go To Pre-Check**. Again, we run the 'ensure accessibility' scenario and see that we can remove the whole disk group without affecting the VM runtime (rendering the storage policy non-compliant).



Data Migration Pre-check

Select a host, disk group, or disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for: Disk group (528981ea-b179-bbc7-b4f2-92...

vSAN data migration: Ensure accessibility

Latest test result

12/01/2022, 5:09:18 PM ✓ The disk group can be removed/recreated/unmounted.

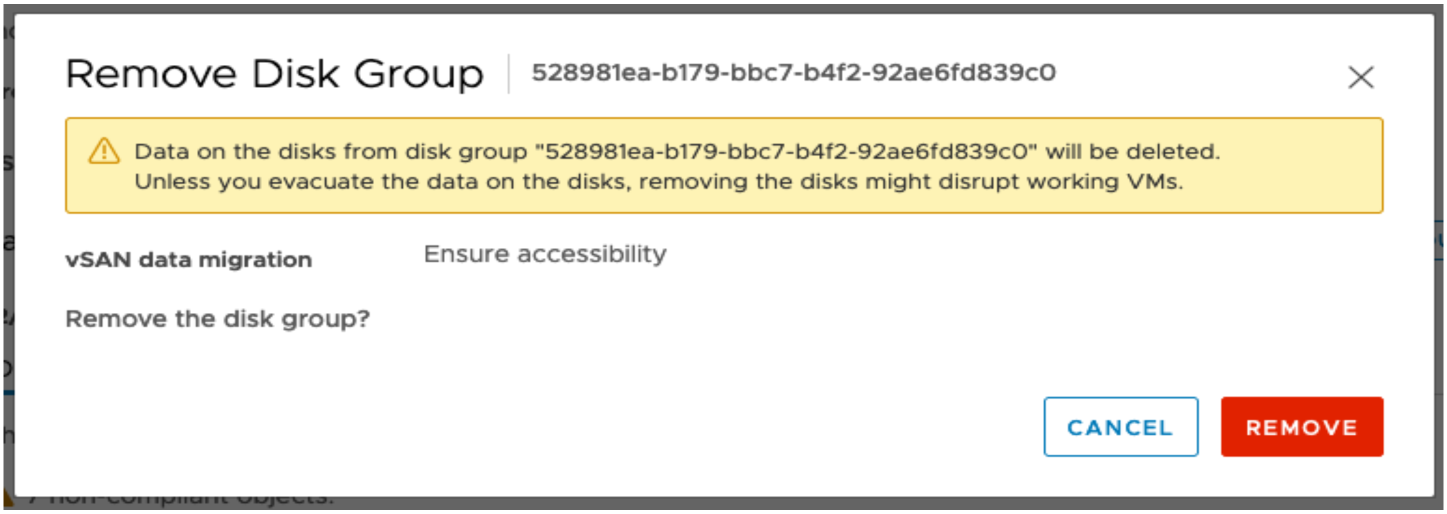
The following objects will be directly affected by the operation.

⚠ 7 non-compliant objects.

A rebuild operation for any non-compliant objects will be triggered in 60 minutes, unless the host is taken out of maintenance mode. You can change this timer for the cluster in the vSAN advanced settings.

Name	Type	Result	Storage Policy	UUID
Ubuntu 2	VM			
Hard disk 1	Disk	⚠ Non-compliant	vSAN Default Storage Policy	fca08863-
Virtual machine swap object	VM swap	⚠ Non-compliant	vSAN Default Storage Policy	0ea18863-
VM home	Folder	⚠ Non-compliant	vSAN Default Storage Policy	faa08863-

Again, clicking on unmount, recreate, or remove will bring up a confirmation dialog:

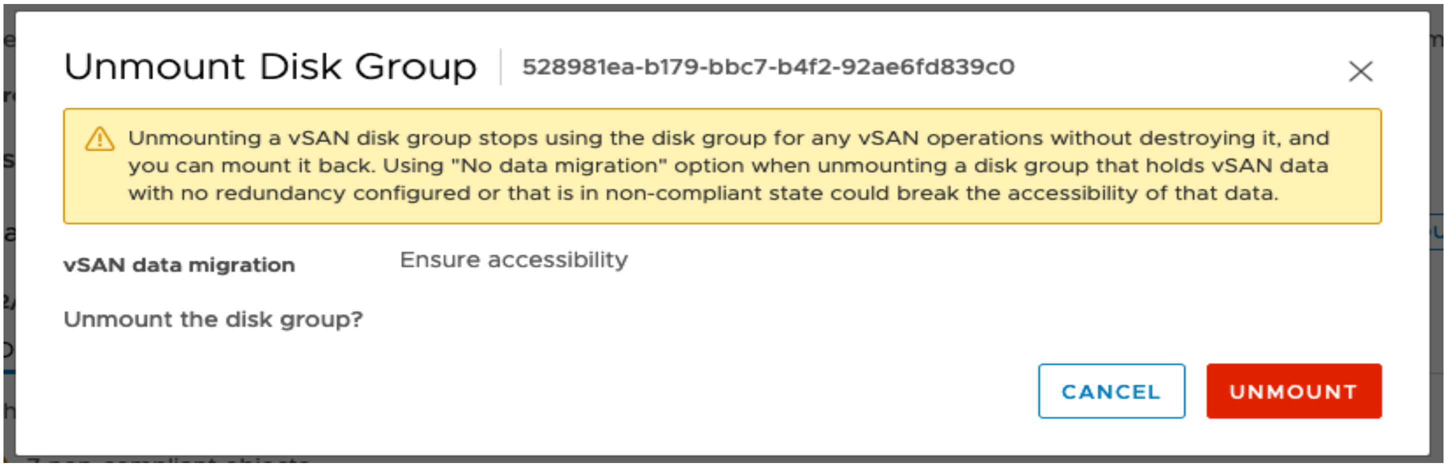


Remove Disk Group | 528981ea-b179-bbc7-b4f2-92ae6fd839c0

⚠ Data on the disks from disk group "528981ea-b179-bbc7-b4f2-92ae6fd839c0" will be deleted. Unless you evacuate the data on the disks, removing the disks might disrupt working VMs.

vSAN data migration: Ensure accessibility

Remove the disk group?

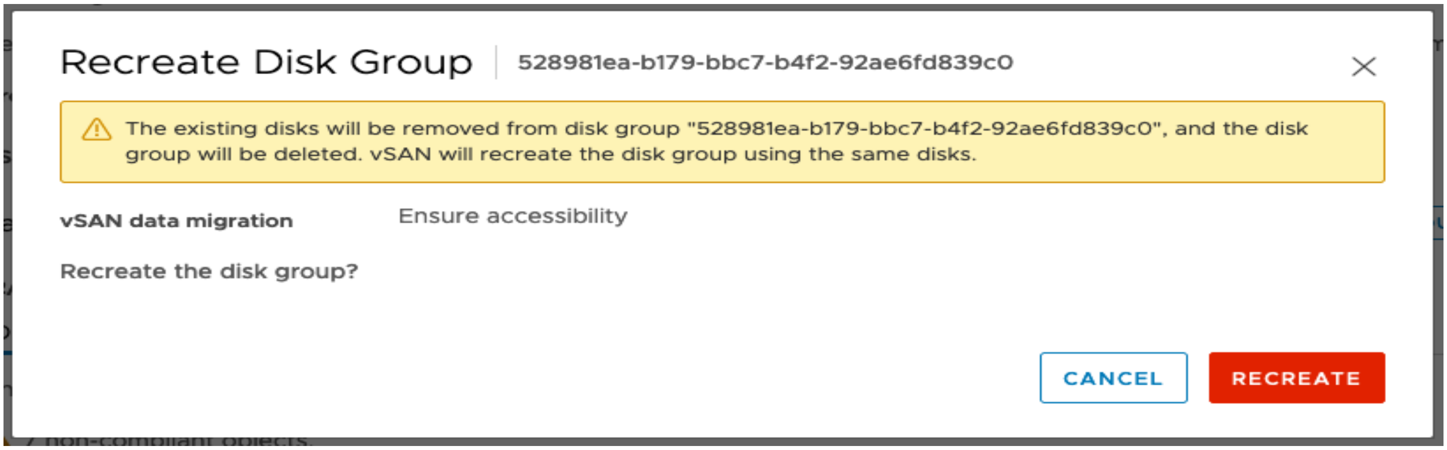


Unmount Disk Group | 528981ea-b179-bbc7-b4f2-92ae6fd839c0

⚠ Unmounting a vSAN disk group stops using the disk group for any vSAN operations without destroying it, and you can mount it back. Using "No data migration" option when unmounting a disk group that holds vSAN data with no redundancy configured or that is in non-compliant state could break the accessibility of that data.

vSAN data migration: Ensure accessibility

Unmount the disk group?



Recreate Disk Group | 528981ea-b179-bbc7-b4f2-92ae6fd839c0

⚠ The existing disks will be removed from disk group "528981ea-b179-bbc7-b4f2-92ae6fd839c0", and the disk group will be deleted. vSAN will recreate the disk group using the same disks.

vSAN data migration: Ensure accessibility

Recreate the disk group?

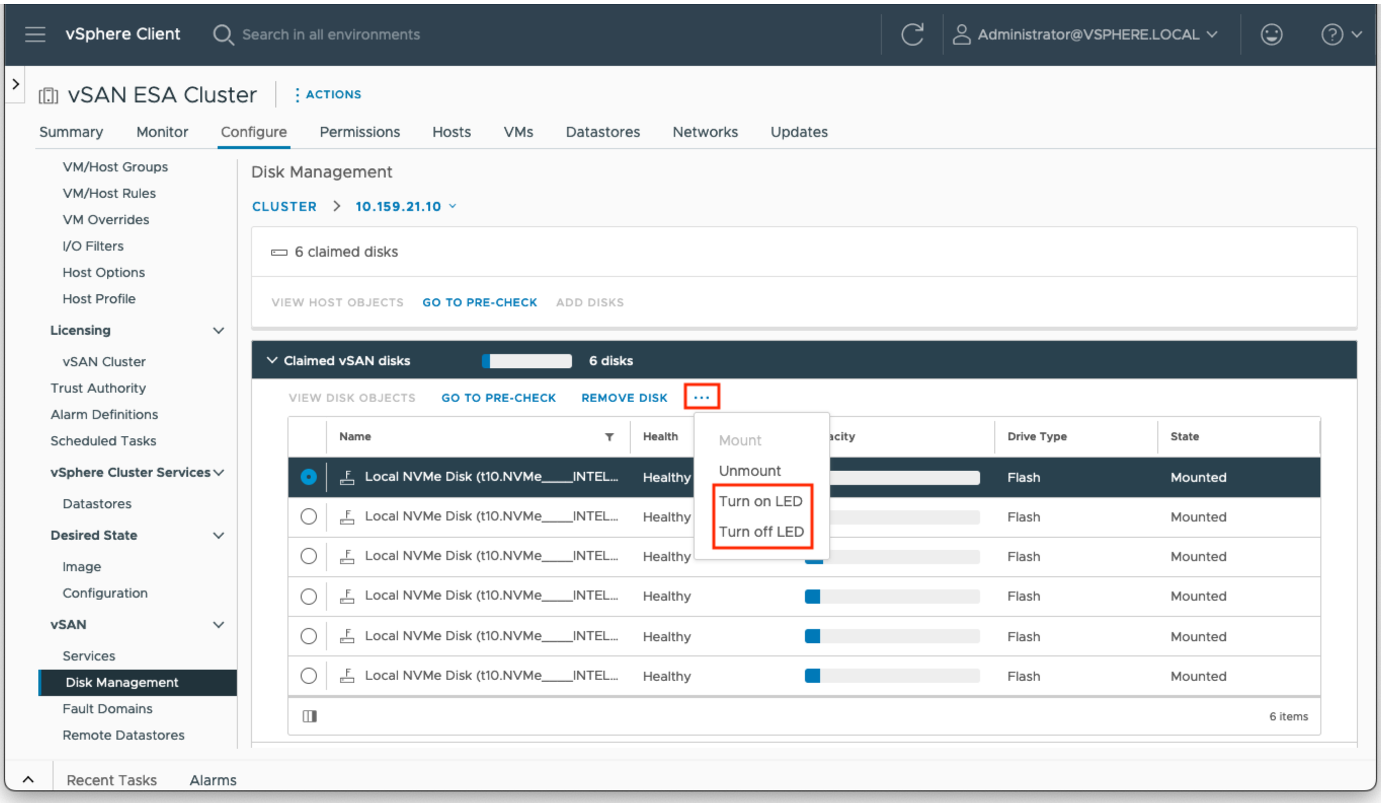
Removing or unmounting the disk group will cause the VM data components to go into the 'absent' state.

Remember to re-add back any disks or disk groups removed.

Turning On/Off Disk LEDs

vSAN supports toggling disk locator LEDs natively for LSI controllers and some NVMe devices. Other controllers are supported via an installed utility (such as *hpssacli* when using HP controllers) on each host. Refer to vendor documentation for information on how to locate and install this utility. For Intel NVMe devices specifically, see https://kb.vmware.com/s/article/2151871

To toggle a locator LED, select a disk and click on the ellipses (three dots) above the table:



	Name	Health	Capacity	Drive Type	State
●	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted

This will launch a VMware vCenter Server® (vCenter) task. In this instance, 'turn on disk locator LEDs'. To see if the task was successful, go to the 'monitor' tab and check the 'events' view. If there is no error, the task was successful. Obviously, a physical inspection of the drive will show the state of the LED.

VMware vSphere® Lifecycle Management™ (vLCM)

Lifecycle management is performed via vLCM. This builds on the previous generation VMware vSphere® Update Manager™ (VUM) with many new features. vLCM operates at the cluster level using a 'desired state' model, which will attempt to reconcile the system to the settings prescribed and remediate if there is a drift (with adherence to the VMware Compatibility Guide). This reduces the effort to monitor compliance for individual components and helps maintain a consistent state for the entire cluster. Moreover, vLCM provides both the lifecycle management for the hypervisor and the full stack of drivers and firmware.

VUM was deprecated from vSphere 8.0. See the following support article for more information: https://kb.vmware.com/s/article/89519

Using vLCM to set the desired image for a vSAN cluster

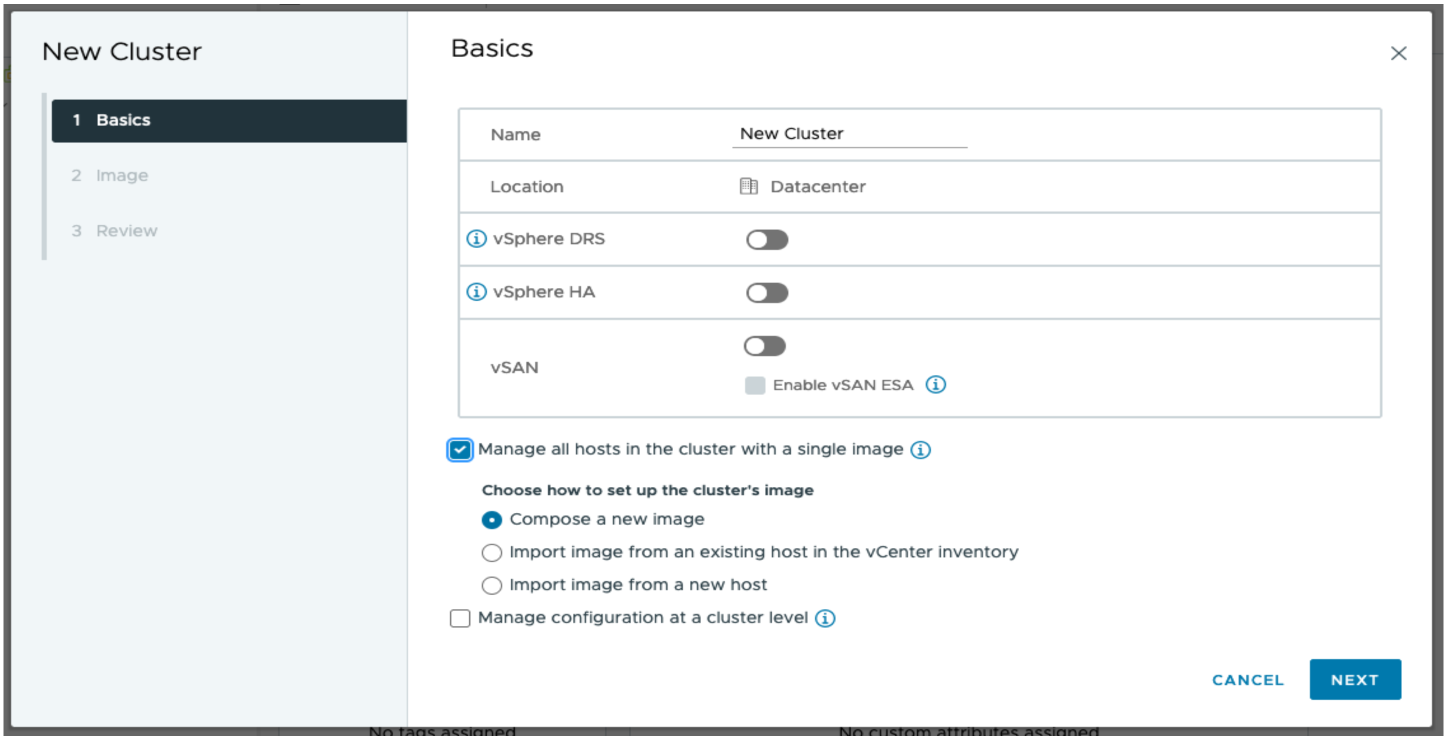
There are prerequisites to using vLCM:

- All hosts are at version 7.0 or higher
- Hosts need to be from the same vendor
- Hosts need to have a local store (should not be stateless)
- Use this link for a full list - https://docs.vmware.com/en/VMware-vSphere/8.0/vsphere-lifecycle-manager/GUID-0295A915-3963-47AD-AA79-C275226B866F.html

A vLCM desired state image consists of a base ESXi image (required), plus any vendor and firmware and driver addons:

- Base Image: The desired ESXi version that can be pulled from VMware software depot or manually uploaded
- Vendor Addons: Packages of vendor specified components such as firmware and drivers

With VMware vSphere® (vSphere) 8.0, when creating a cluster, the option to manage hosts with a single image is pre-selected:



New Cluster

1 Basics
2 Image
3 Review

Basics

Name	New Cluster
Location	Datacenter
vSphere DRS	○
vSphere HA	○
vSAN	○ □ Enable vSAN ESA

☑ Manage all hosts in the cluster with a single image

Choose how to set up the cluster's image

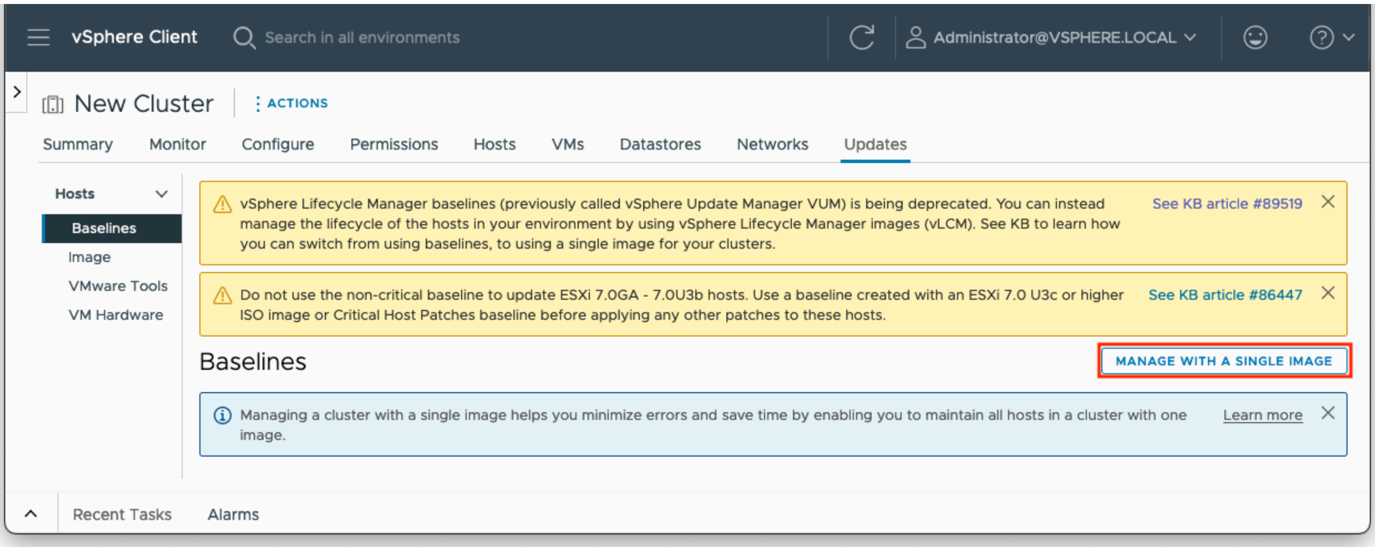
● Compose a new image

○ Import image from an existing host in the vCenter inventory

○ Import image from a new host

□ Manage configuration at a cluster level

For an existing cluster created without using this option, navigate to **[vSAN Cluster] > Updates** and click on **Manage With A Single Image**:



vSphere Client | Search in all environments | Administrator@VSPHERE.LOCAL

New Cluster | ⋮ ACTIONS

Summary | Monitor | Configure | Permissions | Hosts | VMs | Datastores | Networks | Updates

Hosts: Baselines, Image, VMware Tools, VM Hardware

⚠ vSphere Lifecycle Manager baselines (previously called vSphere Update Manager VUM) is being deprecated. You can instead manage the lifecycle of the hosts in your environment by using vSphere Lifecycle Manager images (vLCM). See KB to learn how you can switch from using baselines, to using a single image for your clusters. See KB article #89519

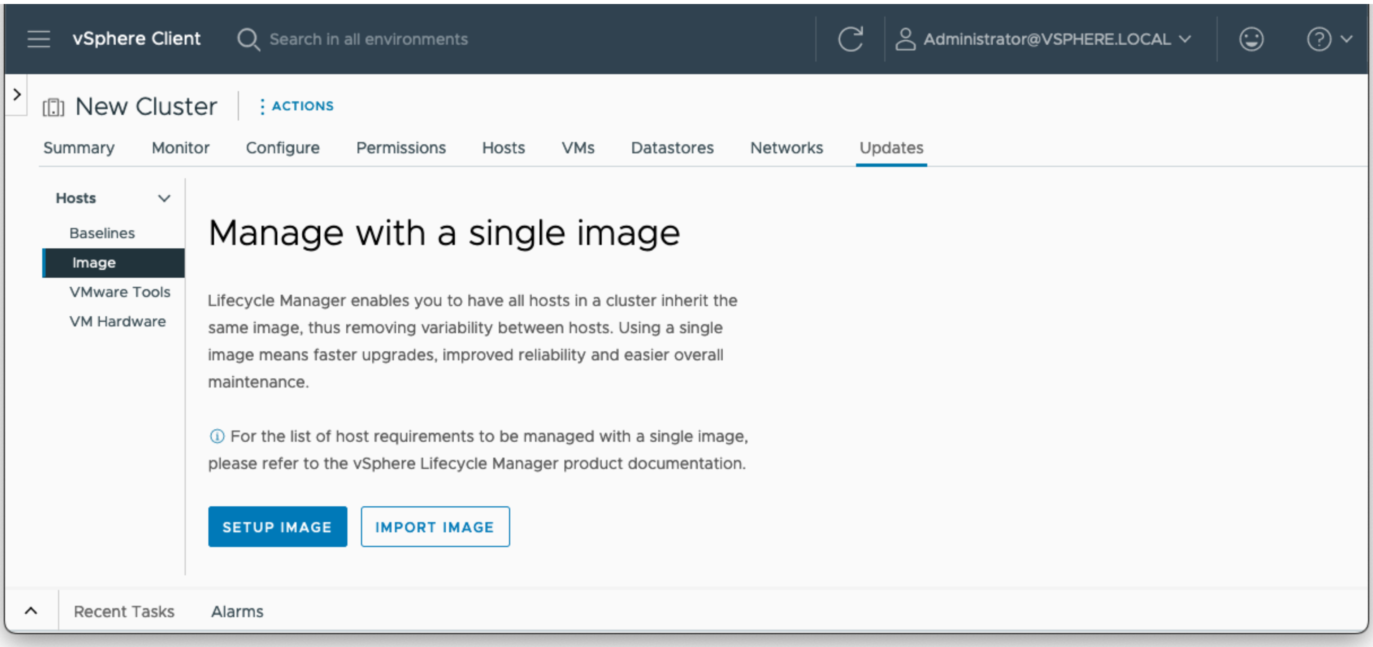
⚠ Do not use the non-critical baseline to update ESXi 7.0GA - 7.0U3b hosts. Use a baseline created with an ESXi 7.0 U3c or higher ISO image or Critical Host Patches baseline before applying any other patches to these hosts. See KB article #86447

Baselines | MANAGE WITH A SINGLE IMAGE

ⓘ Managing a cluster with a single image helps you minimize errors and save time by enabling you to maintain all hosts in a cluster with one image. Learn more

Recent Tasks | Alarms

Here, we can either choose to setup an image with pre-existing versions and addons, or import an image spec via a JSON file or URL:



vSphere Client | Search in all environments | Administrator@VSPHERE.LOCAL

New Cluster | ⋮ ACTIONS

Summary | Monitor | Configure | Permissions | Hosts | VMs | Datastores | Networks | Updates

Hosts: Baselines, Image, VMware Tools, VM Hardware

Manage with a single image

Lifecycle Manager enables you to have all hosts in a cluster inherit the same image, thus removing variability between hosts. Using a single image means faster upgrades, improved reliability and easier overall maintenance.

ⓘ For the list of host requirements to be managed with a single image, please refer to the vSphere Lifecycle Manager product documentation.

SETUP IMAGE | IMPORT IMAGE

Recent Tasks | Alarms

For further details of setting up and using vLCM, visit: https://core.vmware.com/resource/introducing-vsphere-lifecycle-management-vlcm

vLCM using Hardware Support Manager (HSM)

In the previous section, an image was created to be used by vLCM to continuously check against and reach the desired state. However, this step only covers the configuration of the ESXi image. To fully take advantage of vLCM, repositories can be configured to obtain firmware and drivers, among others, by leveraging the Hardware Support Manager provided by the vendor.

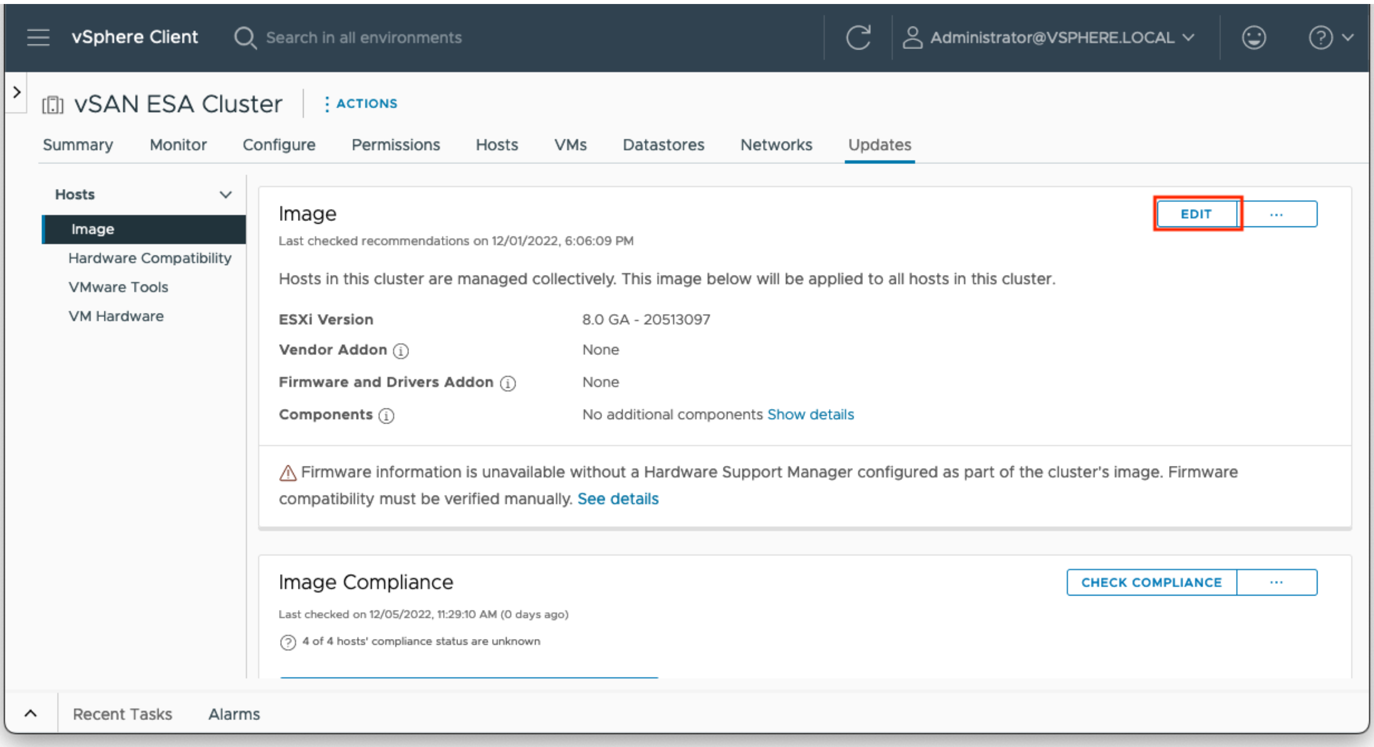
VMware maintains a compatibility list of HSMs here:
https://www.vmware.com/resources/compatibility/search.php?deviceCategory=hsm

In this example, Dell OpenManage Integration for VMware vCenter (OMIVV) will be mentioned. Deploying and configuring HSM will not be covered in this guide, as this varies by vendor.

Overview of steps within HSM prior to vLCM integration (steps may vary)

- Deploy HSM appliance and register plugin with vCenter
- Configure host credentials through a cluster profile
- Configure repository profile (where vLCM will get firmware and drivers)

First navigate to **[vSAN Cluster] > Updates**, then **Edit**:



Image

Last checked recommendations on 12/01/2022, 6:06:09 PM

Hosts in this cluster are managed collectively. This image below will be applied to all hosts in this cluster.

ESXi Version	8.0 GA - 20513097
Vendor Addon	None
Firmware and Drivers Addon	None
Components	No additional components Show details

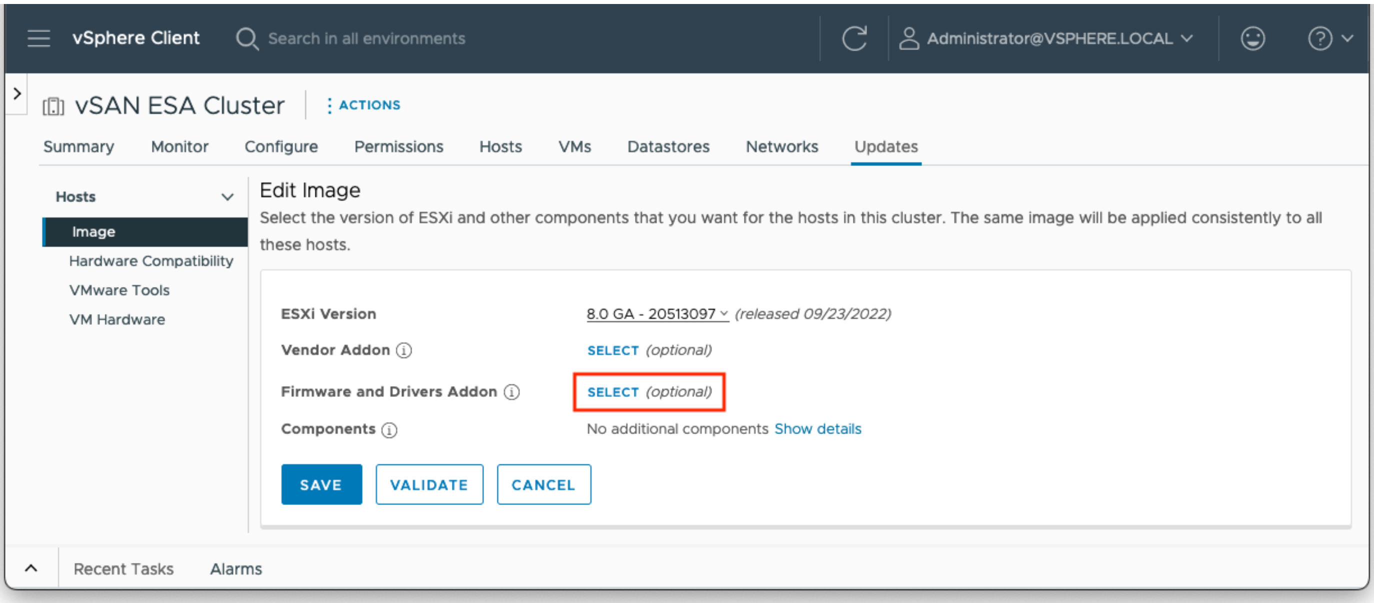
Firmware information is unavailable without a Hardware Support Manager configured as part of the cluster's image. Firmware compatibility must be verified manually. See details

Image Compliance

Last checked on 12/05/2022, 11:29:10 AM (0 days ago)

4 of 4 hosts' compliance status are unknown

Then, click on **Select** next to Firmware and Drivers Addon:



Edit Image

Select the version of ESXi and other components that you want for the hosts in this cluster. The same image will be applied consistently to all these hosts.

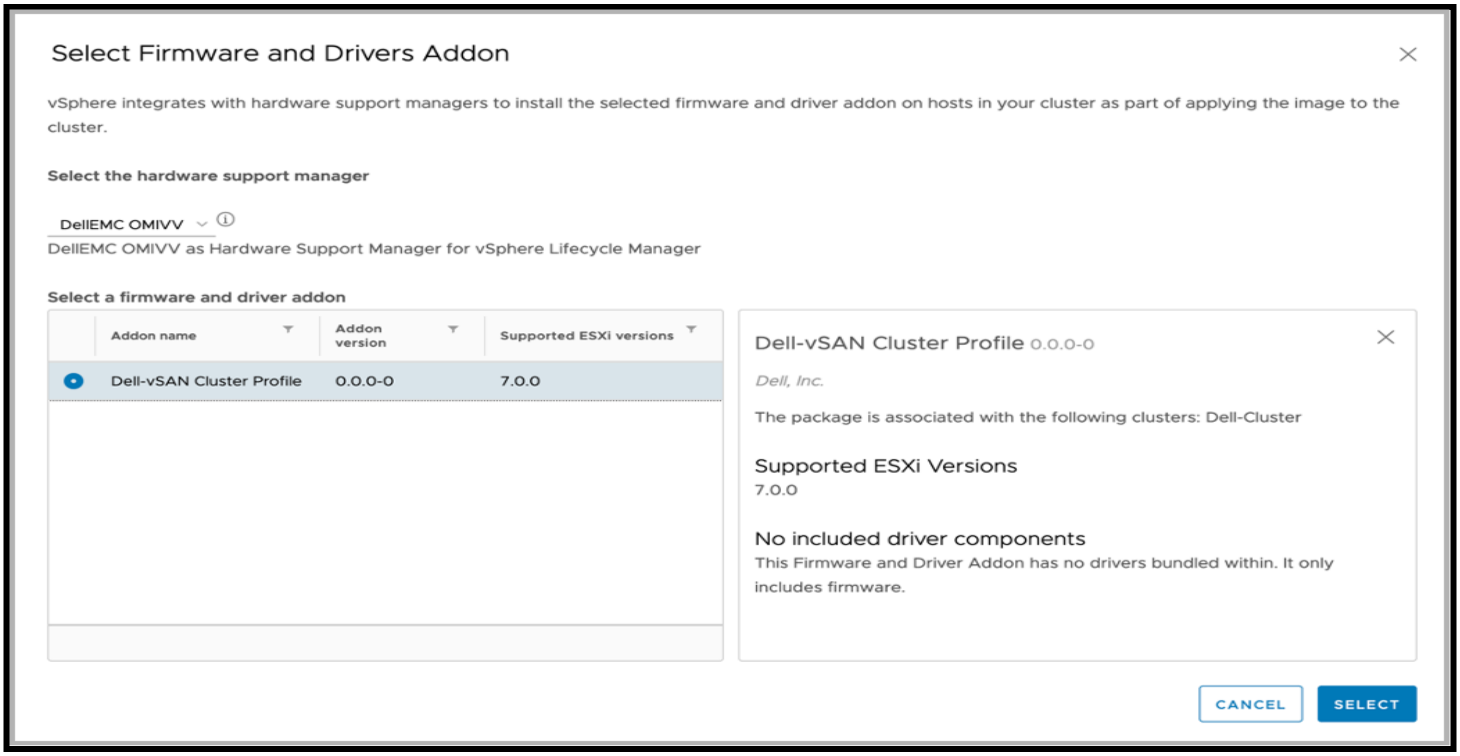
ESXi Version: 8.0 GA - 20513097 *(released 09/23/2022)*

Vendor Addon: SELECT *(optional)*

Firmware and Drivers Addon: SELECT *(optional)*

Components: No additional components Show details

Select the desired HSM, then select firmware and driver addon (previously created profile in HSM), and then save the image settings.



Select Firmware and Drivers Addon

vSphere integrates with hardware support managers to install the selected firmware and driver addon on hosts in your cluster as part of applying the image to the cluster.

Select the hardware support manager

DellEMC OMIVV

DellEMC OMIVV as Hardware Support Manager for vSphere Lifecycle Manager

Select a firmware and driver addon

	Addon name	Addon version	Supported ESXi versions
●	Dell-vSAN Cluster Profile	0.0.0-0	7.0.0

Dell-vSAN Cluster Profile 0.0.0-0

Dell, Inc.

The package is associated with the following clusters: Dell-Cluster

Supported ESXi Versions

7.0.0

No included driver components

This Firmware and Driver Addon has no drivers bundled within. It only includes firmware.

Image compliance check will initiate and the option to remediate will be available

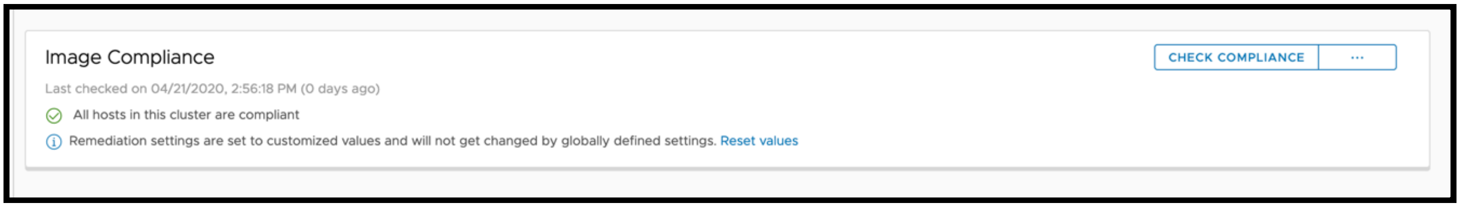


Image Compliance

Last checked on 04/21/2020, 2:56:18 PM (0 days ago)

✓ All hosts in this cluster are compliant

ⓘ Remediation settings are set to customized values and will not get changed by globally defined settings. Reset values

Scale Out vSAN

Add a Host into the Cluster via Quickstart

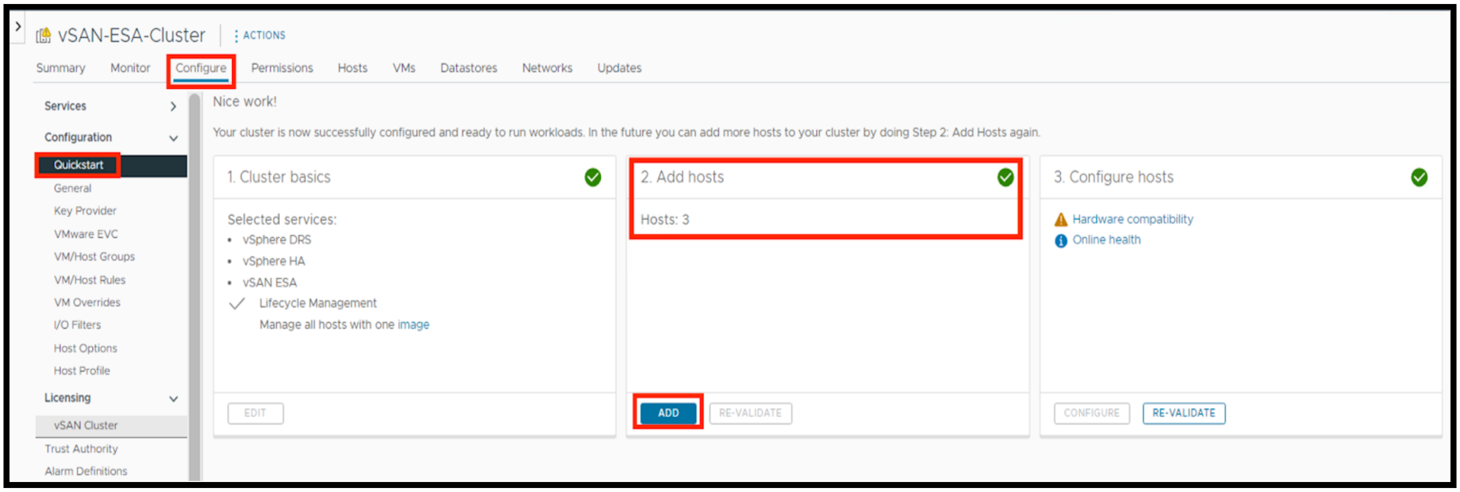
The walkthrough assumes that the vSAN ESA cluster was initially deployed via Quickstart. For more information on deploying a vSAN ESA Cluster via Quickstart, please refer to the vSAN Proof of Concept: vSAN Architecture Overview & Setup guide.

Prerequisites:

- Host identical to the current hosts in the vSAN ESA cluster
- ESXi installed on the target matches that of the vSAN ESA cluster

Note: The steps below apply to vSAN ESA HCI, vSAN Max™ and vSAN OSA clusters respectively.

First navigate to **[vSAN Cluster} > Quickstart**. On the Quickstart screen you will see the current state of the vSAN cluster. In this case it has three hosts. Click **Add:**



Nice work!

Your cluster is now successfully configured and ready to run workloads. In the future you can add more hosts to your cluster by doing Step 2: Add Hosts again.

1. Cluster basics ✓

Selected services:
- vSphere DRS
- vSphere HA
- vSAN ESA

✓ Lifecycle Management
Manage all hosts with one image

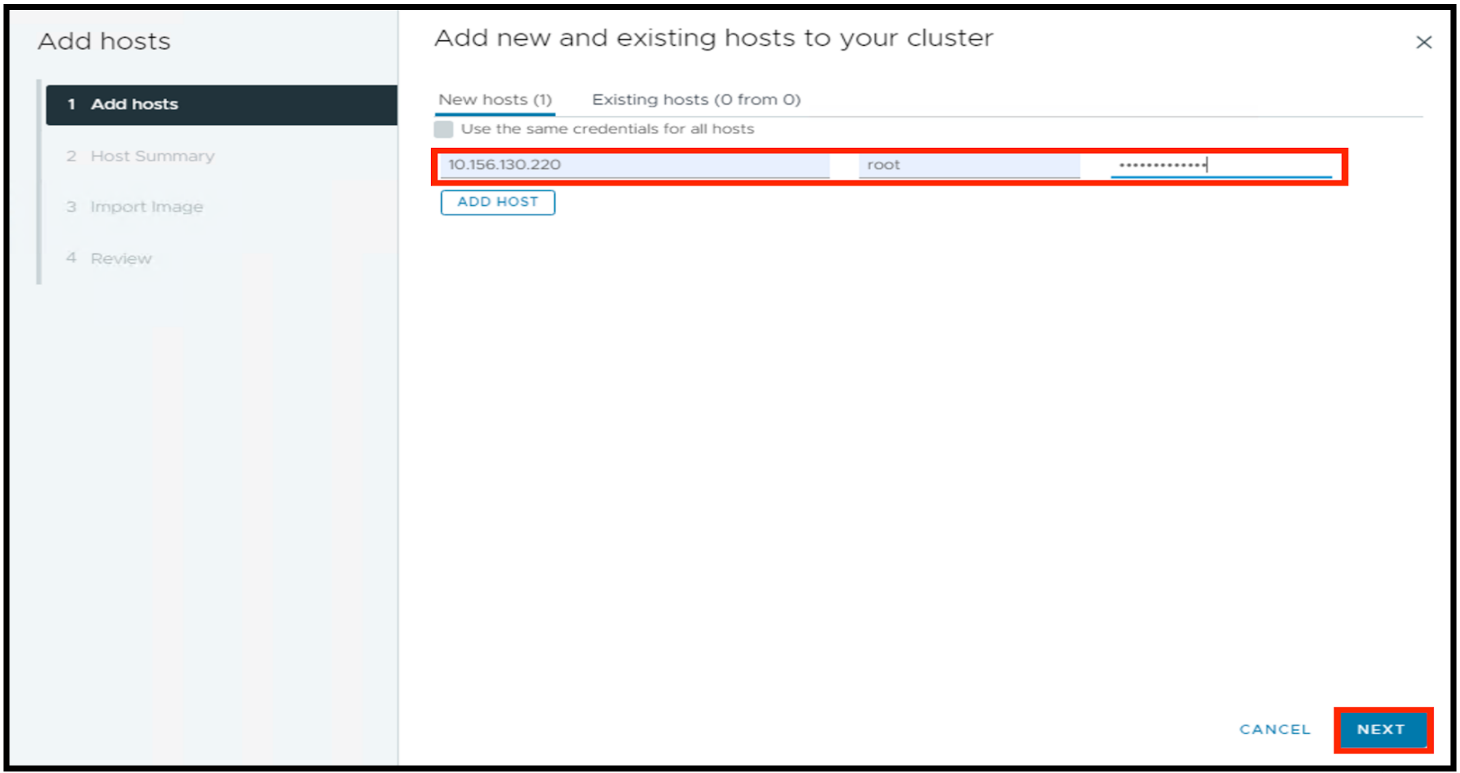
2. Add hosts ✓

Hosts: 3

3. Configure hosts ✓

⚠ Hardware compatibility
ⓘ Online health

The Add Hosts pop-up wizard appears. Walkthrough the wizard adding your host(s). In this example, we are adding a single additional host:

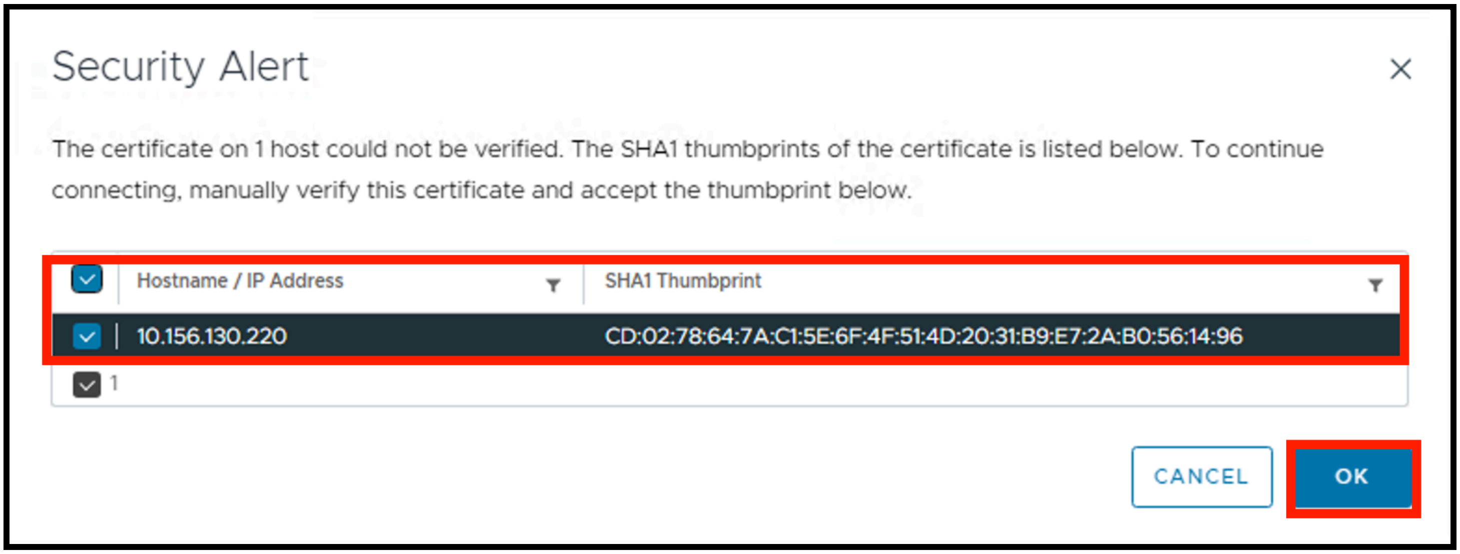


Add new and existing hosts to your cluster

□ Use the same credentials for all hosts

10.156.130.220 | root | •••••••••••••

After you select **Next** above, the Security Alert may appear. If so, accept the thumbprint(s) for the target host(s) and click **OK**:



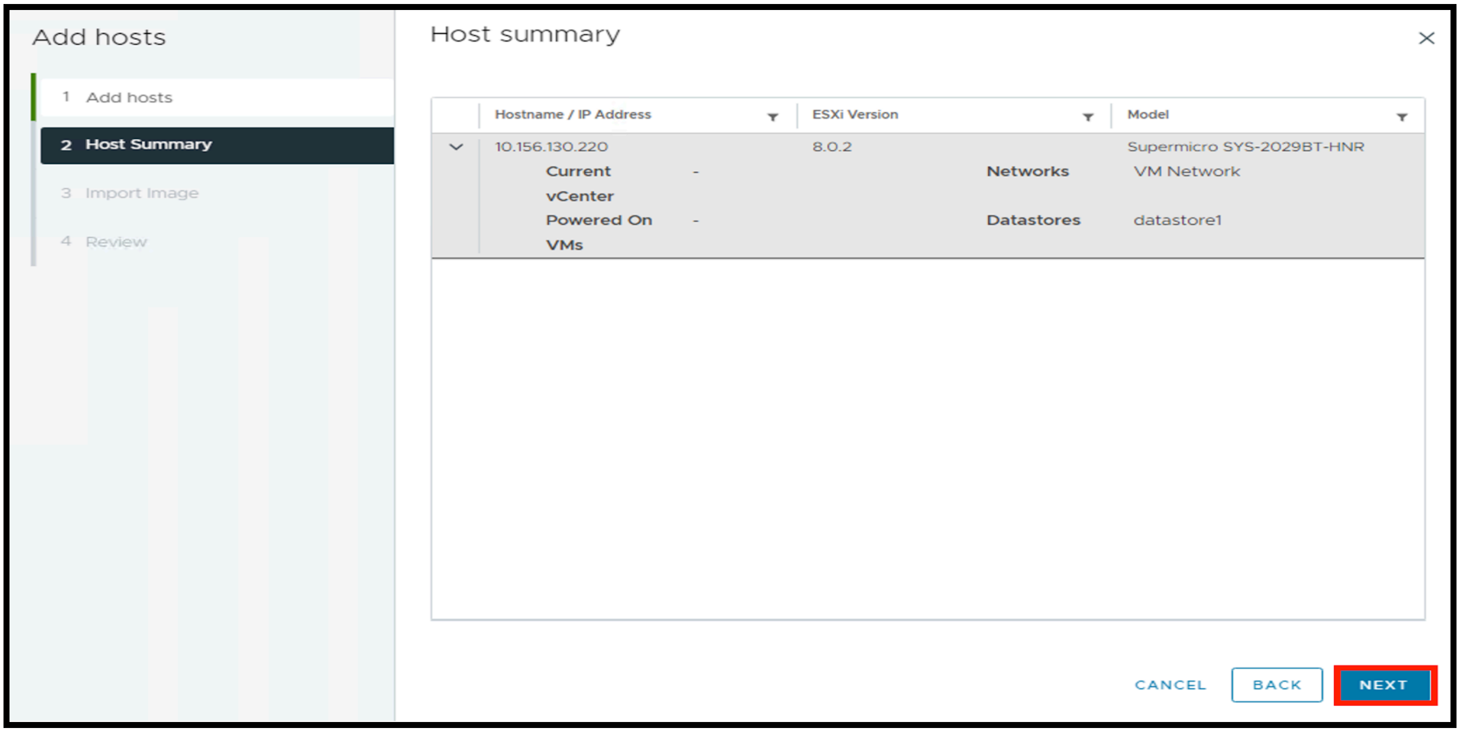
Security Alert

The certificate on 1 host could not be verified. The SHA1 thumbprints of the certificate is listed below. To continue connecting, manually verify this certificate and accept the thumbprint below.

☑	Hostname / IP Address	SHA1 Thumbprint
☑	10.156.130.220	CD:02:78:64:7A:C1:5E:6F:4F:51:4D:20:31:B9:E7:2A:B0:56:14:96

☑ 1

Review the Host Summary, then click **Next**:

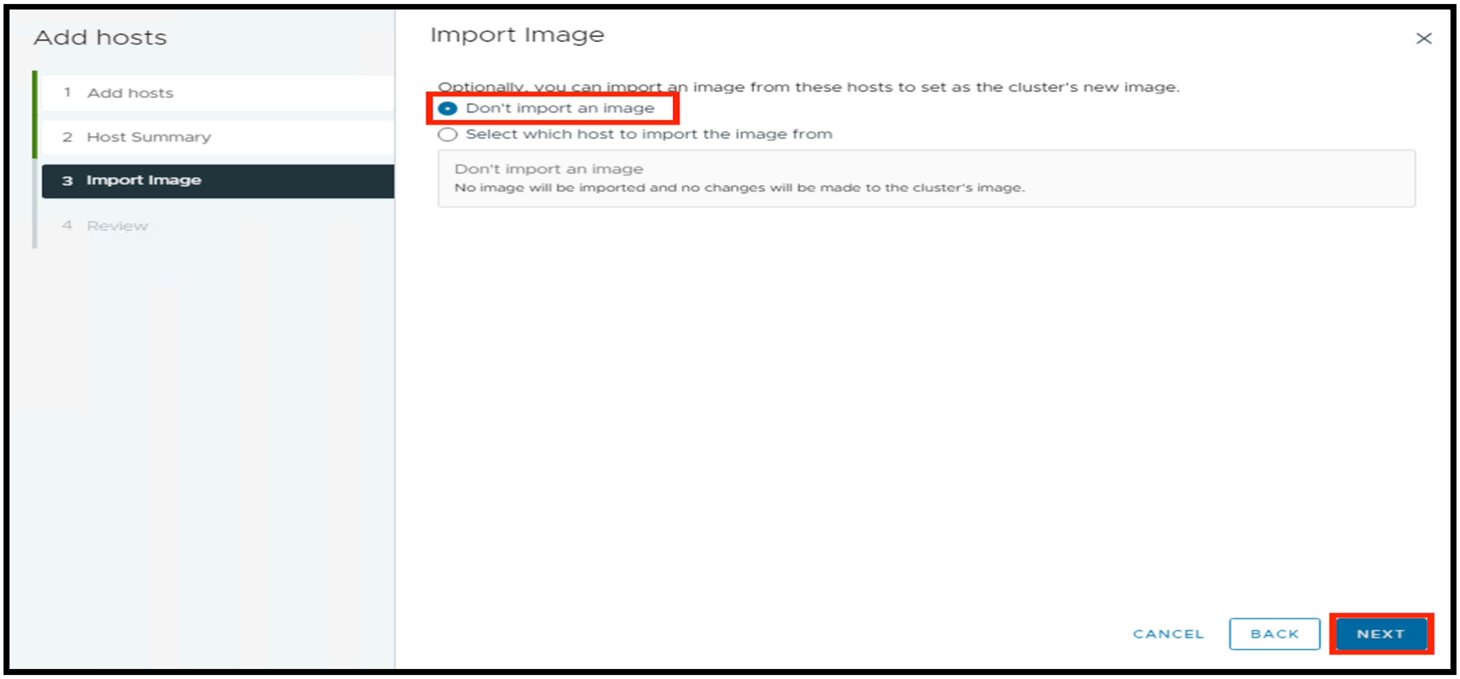


Host summary

Hostname / IP Address	ESXi Version	Model
10.156.130.220	8.0.2	Supermicro SYS-2029BT-HNR

Current vCenter	-	Networks	VM Network
Powered On VMs	-	Datastores	datastore1

Assuming the target host(s) are the same make and model as the current hosts in the cluster (VMware recommended best practice), you will not need to import a new image. Ensure 'Don't import an image' is selected and click **Next**:



Import Image

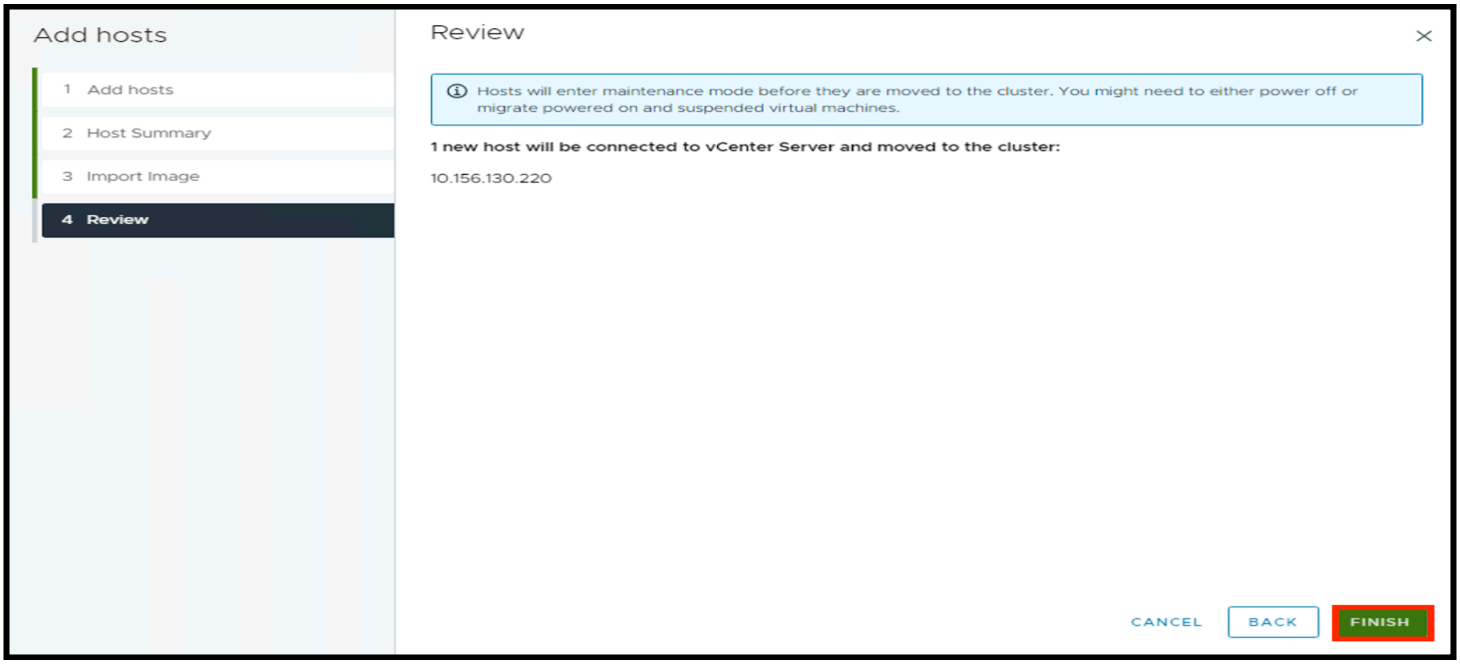
Optionally, you can import an image from these hosts to set as the cluster's new image.

● Don't import an image

○ Select which host to import the image from

Don't import an image
No image will be imported and no changes will be made to the cluster's image.

Review and click **Finish**:



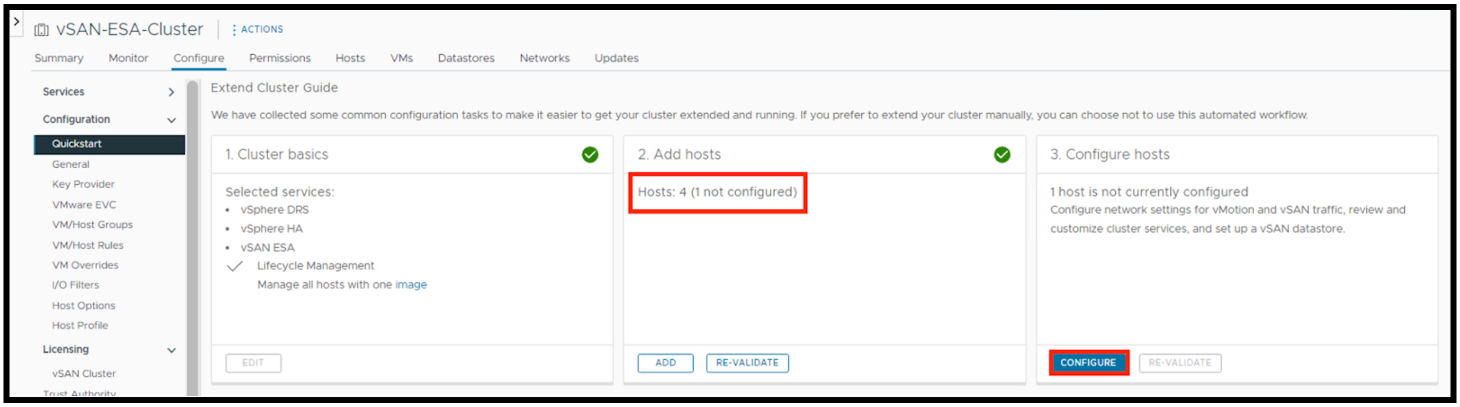
Review

Hosts will enter maintenance mode before they are moved to the cluster. You might need to either power off or migrate powered on and suspended virtual machines.

1 new host will be connected to vCenter Server and moved to the cluster:

10.156.130.220

This starts the host add processes that can be monitored via the Recent Tasks section of the vSphere Client. Once the process finishes you will see the updated Quickstart screen below. Notice that the under ‘Add Hosts’ it now shows four total hosts with one not configured. Click **Continue** under ‘Configure Hosts’ to complete host configuration:



Extend Cluster Guide

We have collected some common configuration tasks to make it easier to get your cluster extended and running. If you prefer to extend your cluster manually, you can choose not to use this automated workflow.

1. Cluster basics

Selected services:
- vSphere DRS
- vSphere HA
- vSAN ESA

✓ Lifecycle Management
Manage all hosts with one image

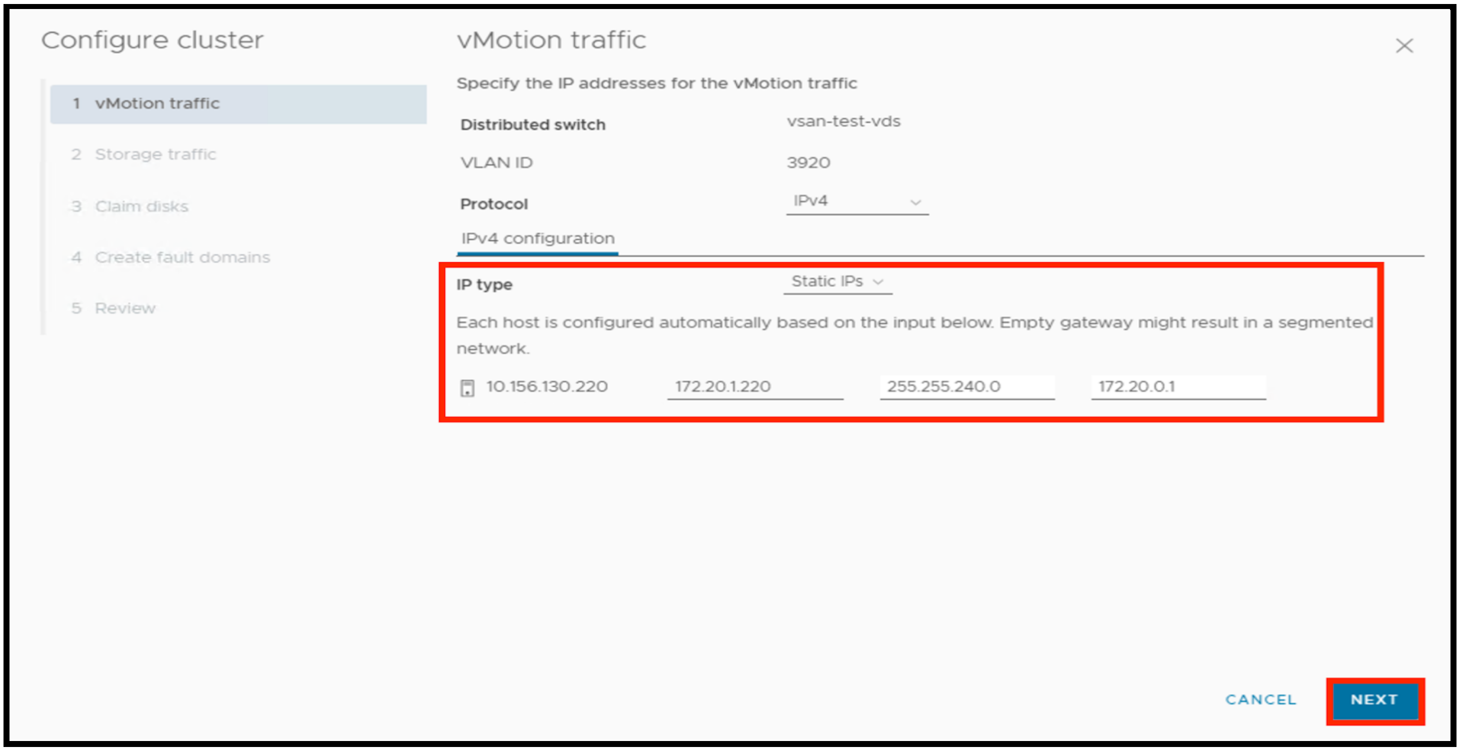
2. Add hosts

Hosts: 4 (1 not configured)

3. Configure hosts

1 host is not currently configured
Configure network settings for vMotion and vSAN traffic, review and customize cluster services, and set up a vSAN datastore.

The Configure Cluster pop-up wizard appears. The wizard walks through the data to configure VMware vSphere® vMotion® (vMotion) and Storage networks; claim disks, and fault domains as necessary for your new host(s). In this example, we are using static IPv4 IPs for vMotion and Storage traffic, however DHCP and IPv6 configurations are possible:



vMotion traffic

Specify the IP addresses for the vMotion traffic

Distributed switch: vsan-test-vds

VLAN ID: 3920

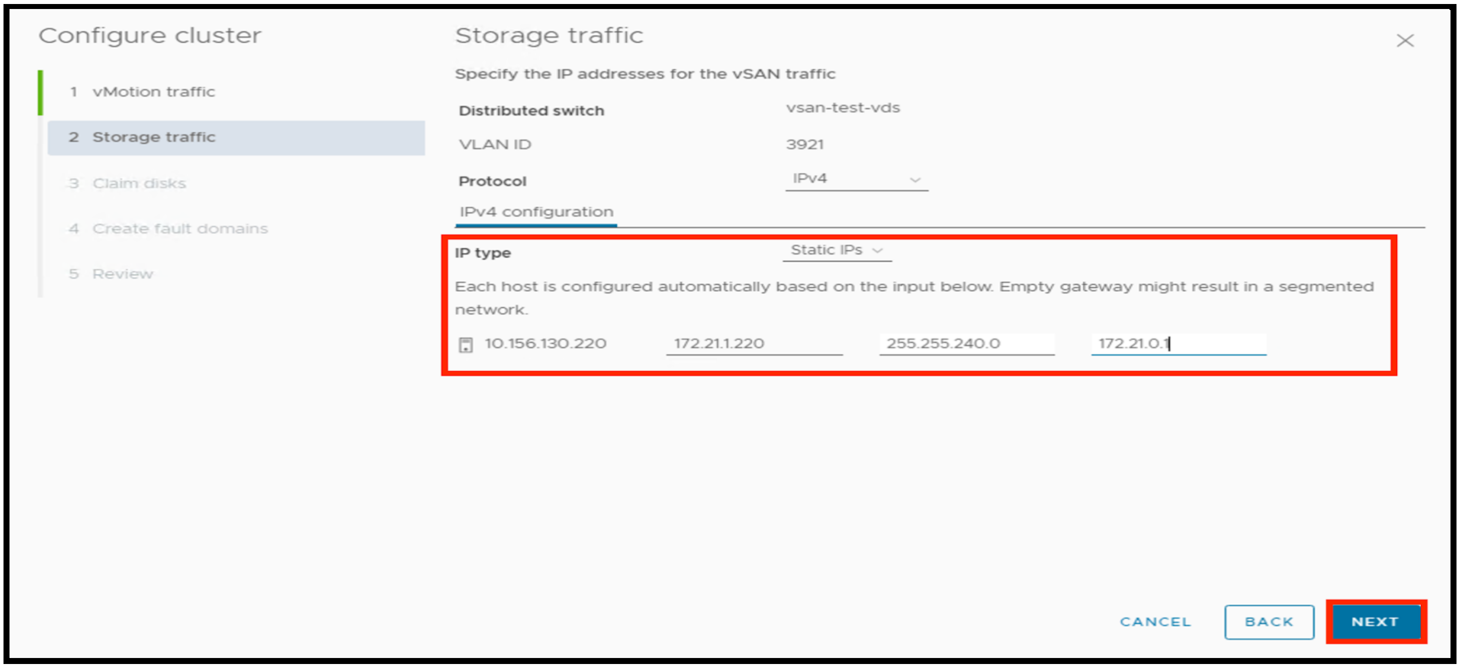
Protocol: IPv4

IPv4 configuration

IP type: Static IPs

Each host is configured automatically based on the input below. Empty gateway might result in a segmented network.

10.156.130.220 | 172.20.1.220 | 255.255.240.0 | 172.20.0.1



Storage traffic

Specify the IP addresses for the vSAN traffic

Distributed switch: vsan-test-vds

VLAN ID: 3921

Protocol: IPv4

IPv4 configuration

IP type: Static IPs

Each host is configured automatically based on the input below. Empty gateway might result in a segmented network.

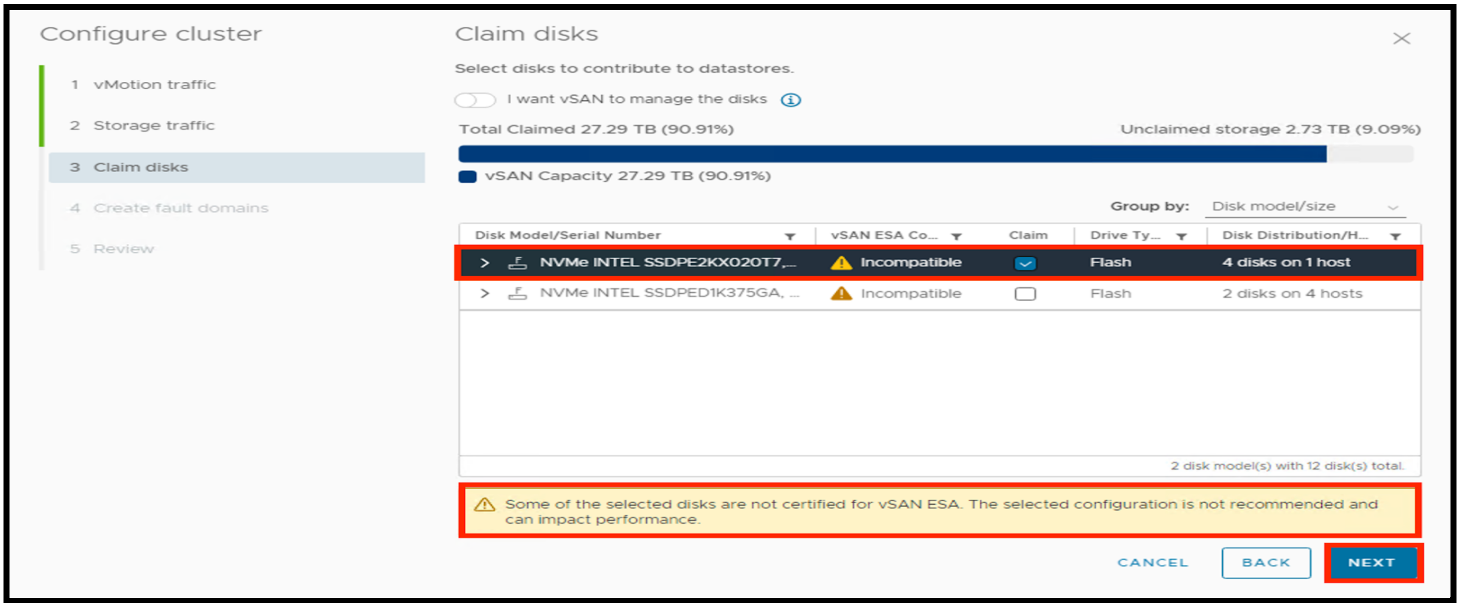
10.156.130.220 | 172.21.1.220 | 255.255.240.0 | 172.21.0.1

On the Claim Disks screen, the administrator can

- Allow vSAN to automatically claim disks (with the ‘I want vSAN to manage the disks’ toggle) or
- Select the disks manually

In this example, we chose manual selection.

Additionally, the system will automatically compare the target disks to the VMware HCL and will present a warning if it detects an issue. As you can see below:



Configure cluster

1 vMotion traffic
2 Storage traffic
3 Claim disks
4 Create fault domains
5 Review

Claim disks

Select disks to contribute to datastores.

I want vSAN to manage the disks

Total Claimed 27.29 TB (90.91%) Unclaimed storage 2.73 TB (9.09%)

vSAN Capacity 27.29 TB (90.91%)

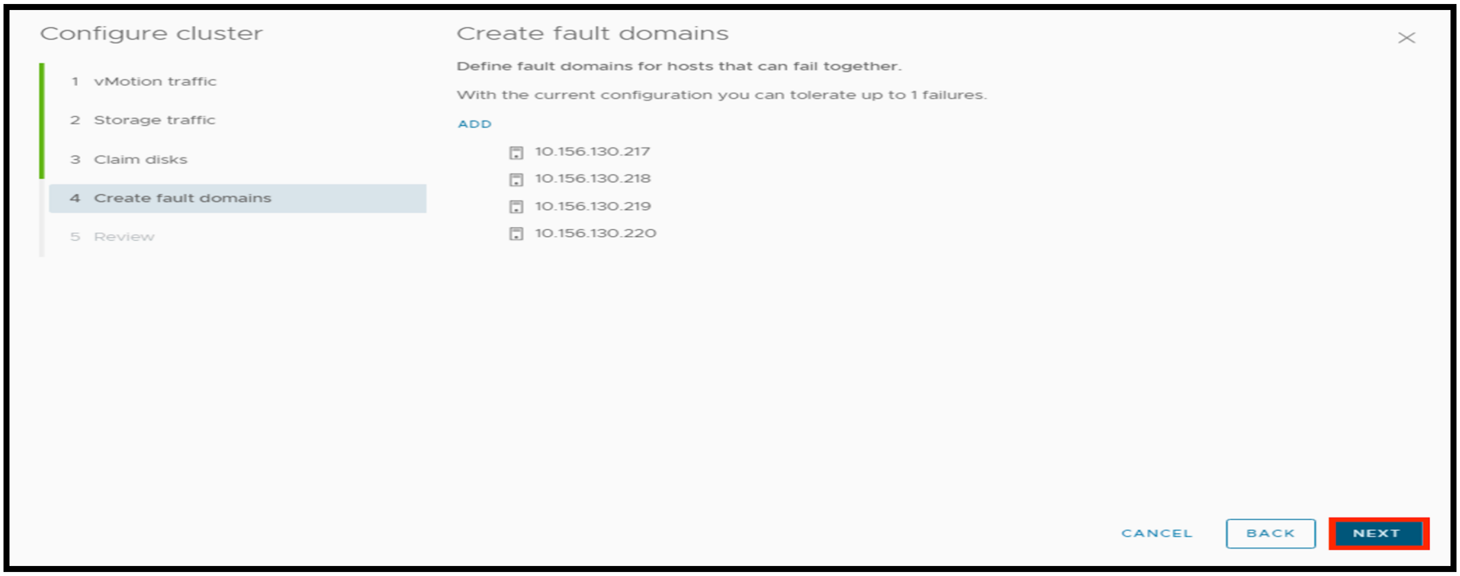
Group by: Disk model/size

Disk Model/Serial Number	vSAN ESA Co...	Claim	Drive Ty...	Disk Distribution/H...
NVMe INTEL SSDPE2KX020T7,...	Incompatible	☑	Flash	4 disks on 1 host
NVMe INTEL SSDPED1K375GA, ...	Incompatible	☐	Flash	2 disks on 4 hosts

2 disk model(s) with 12 disk(s) total.

Some of the selected disks are not certified for vSAN ESA. The selected configuration is not recommended and can impact performance.

In this example, only one fault domain was configured. If the vSAN cluster has more than one fault domain, new host assignment to the fault domains occurs here:



Configure cluster

1 vMotion traffic
2 Storage traffic
3 Claim disks
4 Create fault domains
5 Review

Create fault domains

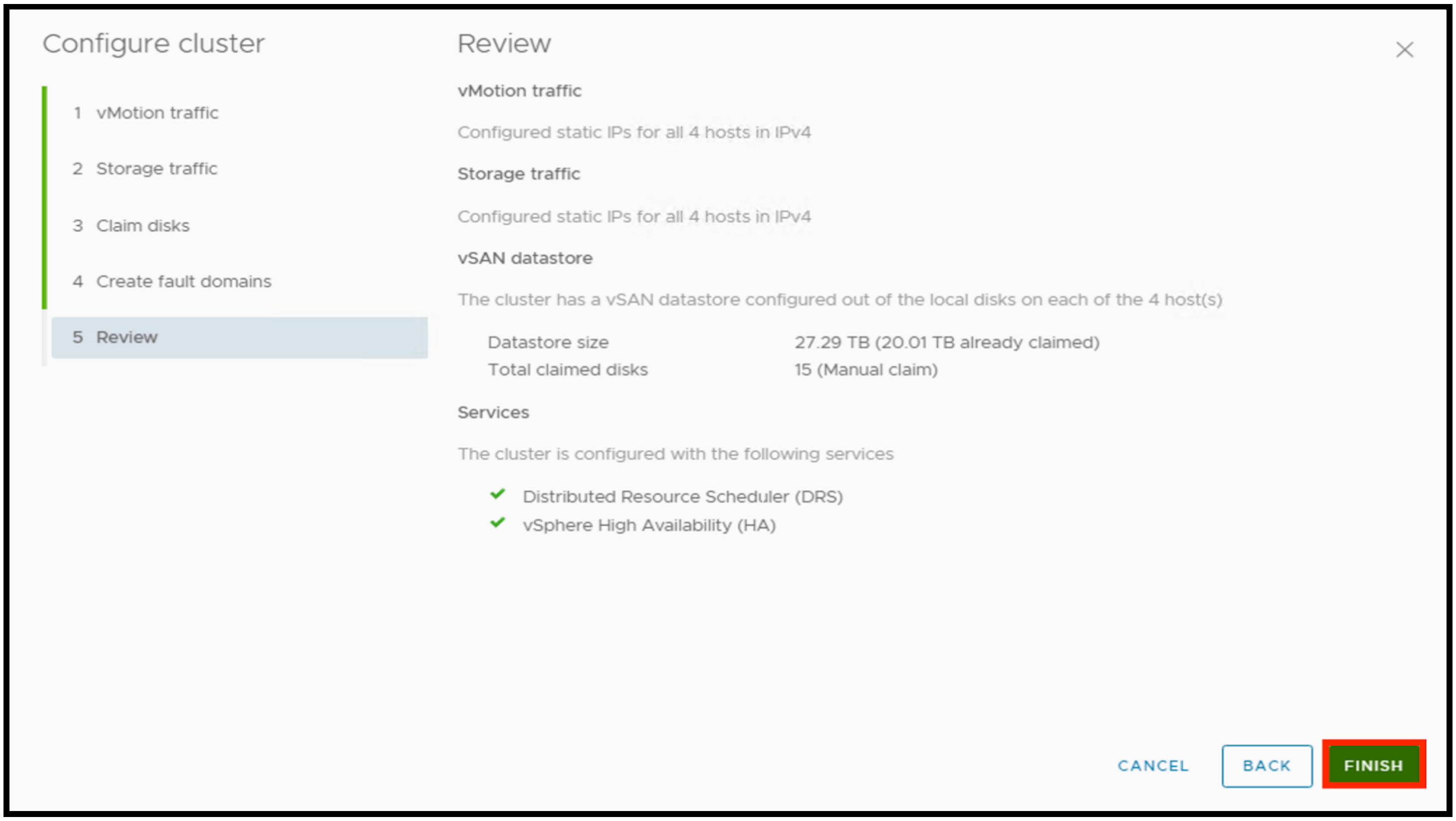
Define fault domains for hosts that can fail together.

With the current configuration you can tolerate up to 1 failures.

ADD

10.156.130.217
10.156.130.218
10.156.130.219
10.156.130.220

Confirm the configuration and click **Finish**:



Configure cluster

1 vMotion traffic
2 Storage traffic
3 Claim disks
4 Create fault domains
5 Review

Review

vMotion traffic

Configured static IPs for all 4 hosts in IPv4

Storage traffic

Configured static IPs for all 4 hosts in IPv4

vSAN datastore

The cluster has a vSAN datastore configured out of the local disks on each of the 4 host(s)

Datastore size	27.29 TB (20.01 TB already claimed)
Total claimed disks	15 (Manual claim)

Services

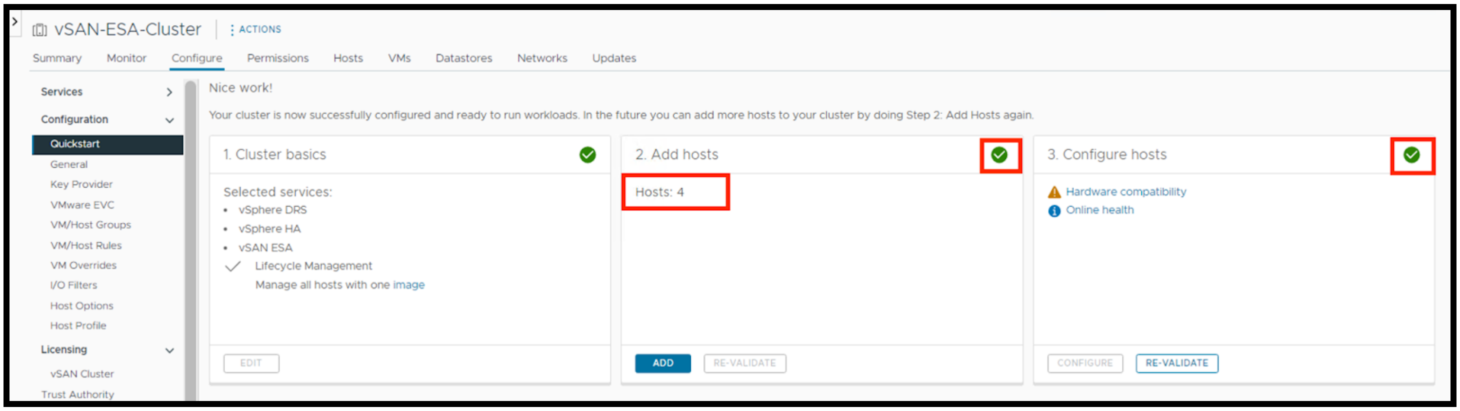
The cluster is configured with the following services

✓ Distributed Resource Scheduler (DRS)
✓ vSphere High Availability (HA)

This starts the host configuration processes that can be monitored via the Recent Tasks section of the vSphere Client. The process automatically

- Configures vMotion and Storage networking
- Adds/configures the disks on the new host(s) into the vSAN array
- Configures the fault domain(s)

Once the process finishes you will see the updated Quickstart screen below. Notice that the ‘Add Hosts’ and ‘Configure Hosts’ sections have green checks and that it shows 4 hosts configured:



vSAN-ESA-Cluster

Nice work!

Your cluster is now successfully configured and ready to run workloads. In the future you can add more hosts to your cluster by doing Step 2: Add Hosts again.

1. Cluster basics

Selected services:
- vSphere DRS
- vSphere HA
- vSAN ESA

✓ Lifecycle Management
Manage all hosts with one image

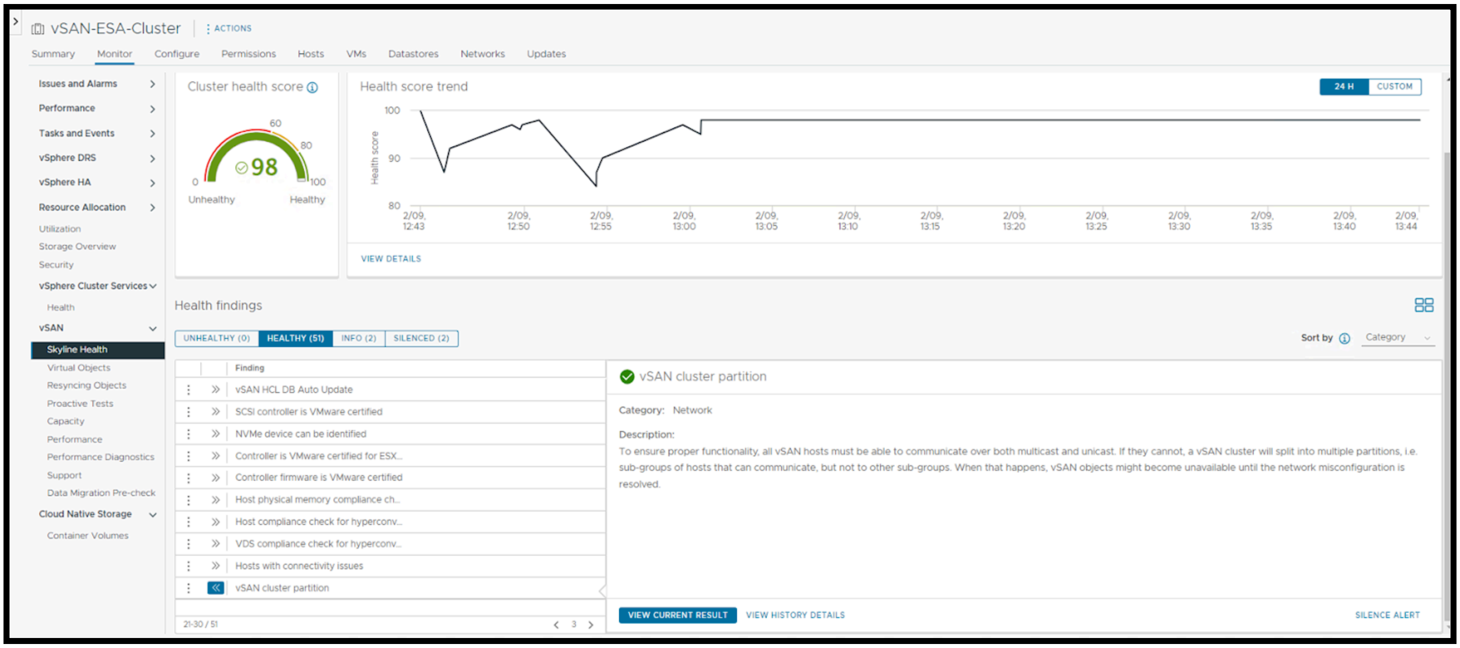
2. Add hosts

Hosts: 4

3. Configure hosts

⚠ Hardware compatibility
ℹ Online health

At this point, it would be good practice to re-run the health check tests, under **[vSAN Cluster] > Monitor > vSAN > Skyline Health** and address any issues seen. In particular, verify that the 'vSAN cluster partition' test is healthy:



Finding
vSAN HCL DB Auto Update
SCSI controller is VMware certified
NVMe device can be identified
Controller is VMware certified for ESX...
Controller firmware is VMware certified
Host physical memory compliance ch...
Host compliance check for hyperconv...
VDS compliance check for hyperconv...
Hosts with connectivity issues
vSAN cluster partition

✓ vSAN cluster partition

Category: Network

Description:
To ensure proper functionality, all vSAN hosts must be able to communicate over both multicast and unicast. If they cannot, a vSAN cluster will split into multiple partitions, i.e. sub-groups of hosts that can communicate, but not to other sub-groups. When that happens, vSAN objects might become unavailable until the network misconfiguration is resolved.

In this example we quickly added a host and completely configured it within a vSAN cluster. The additional resources are now available.

Manually Adding a Host to a vSAN Cluster

Note: If Quickstart was used (as per the earlier section) then this section can be skipped.

Manual vSAN enablement is available for those that do not wish to use the Quickstart process.

For this scenario, please follow the instructions on the VMware Docs page linked below.

- Manually create VMkernel adapters - https://docs.vmware.com/en/VMware-vSphere/8.0/vsphere-networking/GUID-8244BA51-BD0F-424E-A00E-DDEC21CF280A.html
- Adding a Host to a vSAN Cluster - https://docs.vmware.com/en/VMware-vSphere/8.0/vsan-administration/GUID-EA47DC82-4678-4430-AEF7-1D77FB9C77DB.html
- Claim Disks for vSAN - https://docs.vmware.com/en/VMware-vSphere/8.0/vsan-administration/GUID-F926CACE-1A97-44A3-9887-029B6B76549B.html#GUID-F926CACE-1A97-44A3-9887-029B6B76549B

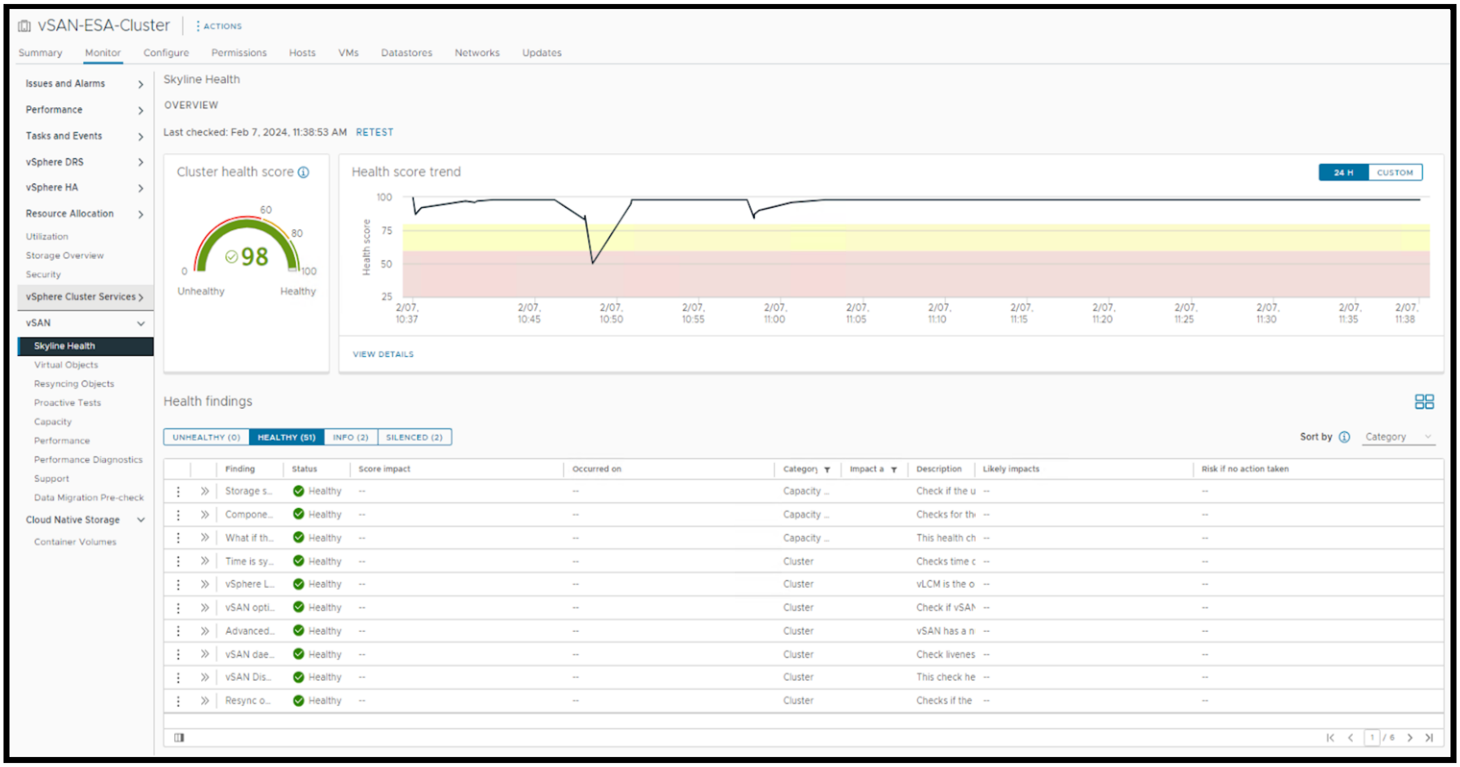
Monitoring vSAN

To effectively monitor vSAN, there are several elements that need consideration. Below we will look at the overall health and capacity views; resynchronization and rebalance operations and performance metrics available in vCenter.

Overall vSAN Health

For a quick summary of the health of a vSAN cluster, vSAN Skyline Health provides a consolidated list of health checks. These checks are grouped into several categories, such as hardware compatibility, physical disk health and networking.

Navigate to **[vSAN Cluster] > Monitor** > **vSAN** > **Skyline Health**. This will show the holistic health state of the cluster, along with any alerts. On multiple issues (whereupon many alerts are generated) the system will try to list the primary issue affecting the cluster:

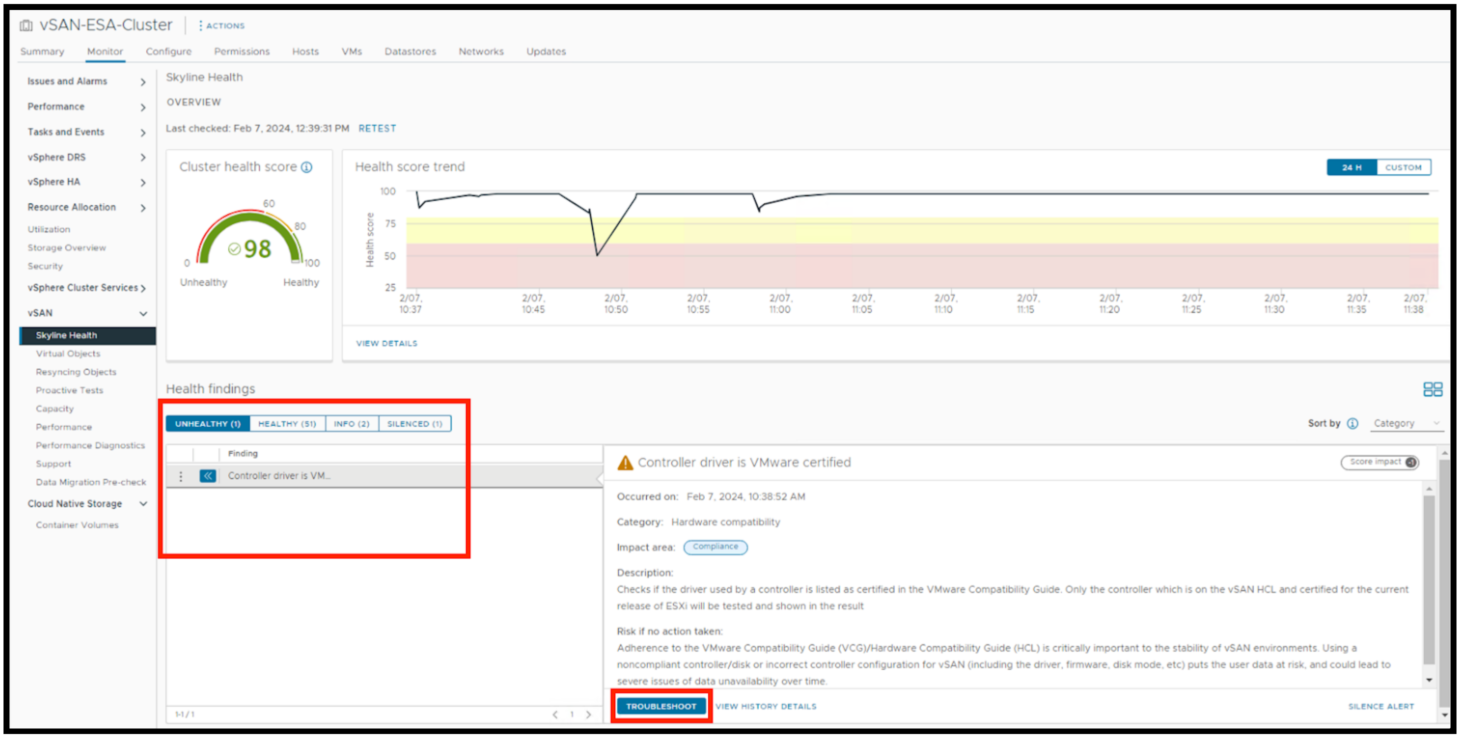


Last checked: Feb 7, 2024, 11:38:53 AM RETEST

Sort by: Category

Finding	Status	Score impact	Occurred on	Categor	Impact a	Description	Likely impacts	Risk if no action taken
Storage s...	✓ Healthy	--	--	Capacity ...		Check if the u	--	--
Compone...	✓ Healthy	--	--	Capacity ...		Checks for th	--	--
What if th...	✓ Healthy	--	--	Capacity ...		This health ch	--	--
Time is sy...	✓ Healthy	--	--	Cluster		Checks time c	--	--
vSphere L...	✓ Healthy	--	--	Cluster		vLCM is the o	--	--
vSAN opti...	✓ Healthy	--	--	Cluster		Check if vSAN	--	--
Advanced...	✓ Healthy	--	--	Cluster		vSAN has a n	--	--
vSAN dae...	✓ Healthy	--	--	Cluster		Check livenes	--	--
vSAN Dis...	✓ Healthy	--	--	Cluster		This check he	--	--
Resync o...	✓ Healthy	--	--	Cluster		Checks if the	--	--

Selecting the issue and clicking on **Troubleshooting** will show a new screen with detailed information about the problem.



Last checked: Feb 7, 2024, 12:39:31 PM

Controller driver is VMware certified

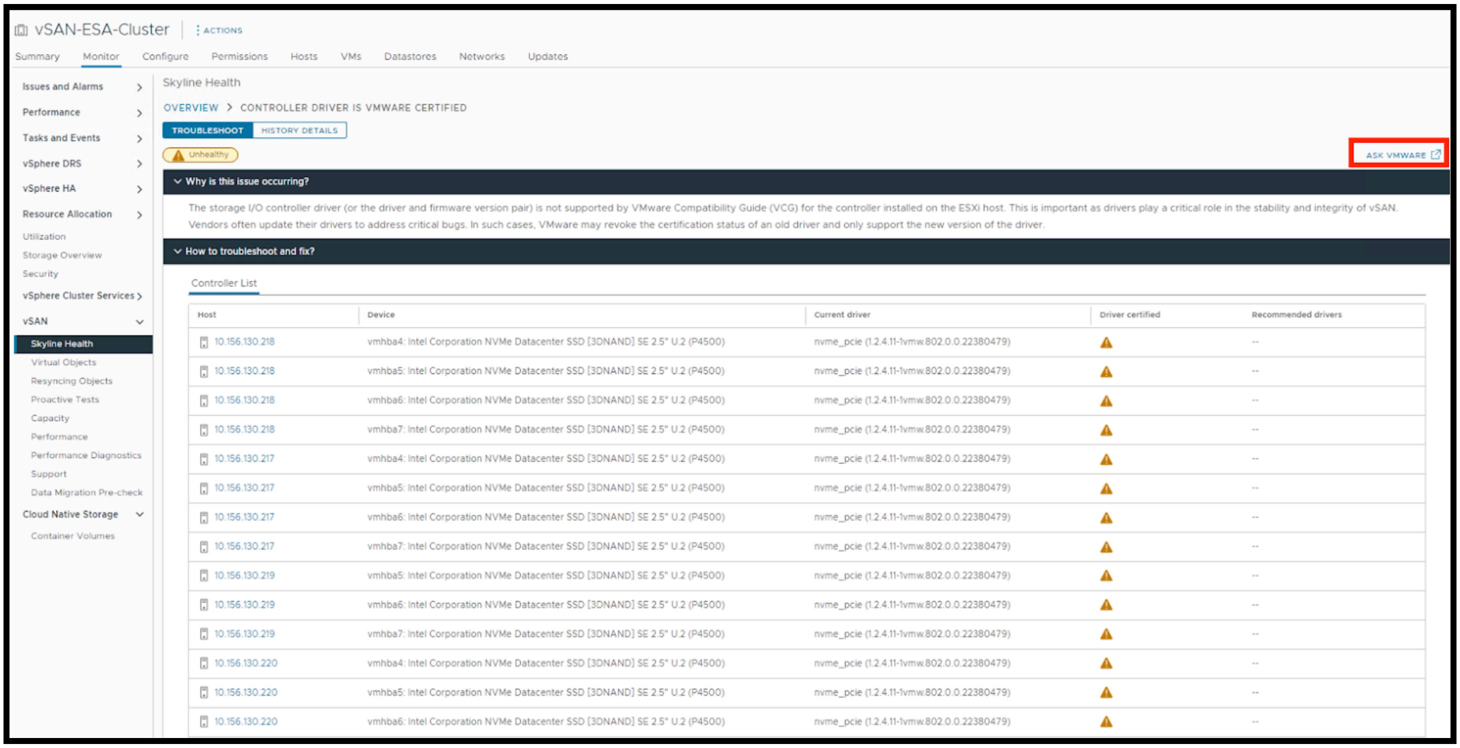
Occurred on: Feb 7, 2024, 10:38:52 AM

Category: Hardware compatibility

Impact area: Compliance

Description:
Checks if the driver used by a controller is listed as certified in the VMware Compatibility Guide. Only the controller which is on the vSAN HCL and certified for the current release of ESXi will be tested and shown in the result

Risk if no action taken:
Adherence to the VMware Compatibility Guide (VCG)/Hardware Compatibility Guide (HCL) is critically important to the stability of vSAN environments. Using a noncompliant controller/disk or incorrect controller configuration for vSAN (including the driver, firmware, disk mode, etc) puts the user data at risk, and could lead to severe issues of data unavailability over time.



Why is this issue occurring?

The storage I/O controller driver (or the driver and firmware version pair) is not supported by VMware Compatibility Guide (VCG) for the controller installed on the ESXi host. This is important as drivers play a critical role in the stability and integrity of vSAN. Vendors often update their drivers to address critical bugs. In such cases, VMware may revoke the certification status of an old driver and only support the new version of the driver.

How to troubleshoot and fix?

Controller List

Host	Device	Current driver	Driver certified	Recommended drivers
10.156.130.218	vmhba4: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.218	vmhba5: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.218	vmhba6: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.218	vmhba7: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.217	vmhba4: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.217	vmhba5: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.217	vmhba6: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.217	vmhba7: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.219	vmhba5: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.219	vmhba6: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.219	vmhba7: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.220	vmhba4: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.220	vmhba5: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--
10.156.130.220	vmhba6: Intel Corporation NVMe Datacenter SSD [3DNAND] SE 2.5" U.2 (P4500)	nvme_pcie (1.2.4.11-1vmw.802.0.0.22380479)	⚠	--

Clicking on '**Ask VMware**' will open a knowledgebase article on how to fix the issue:

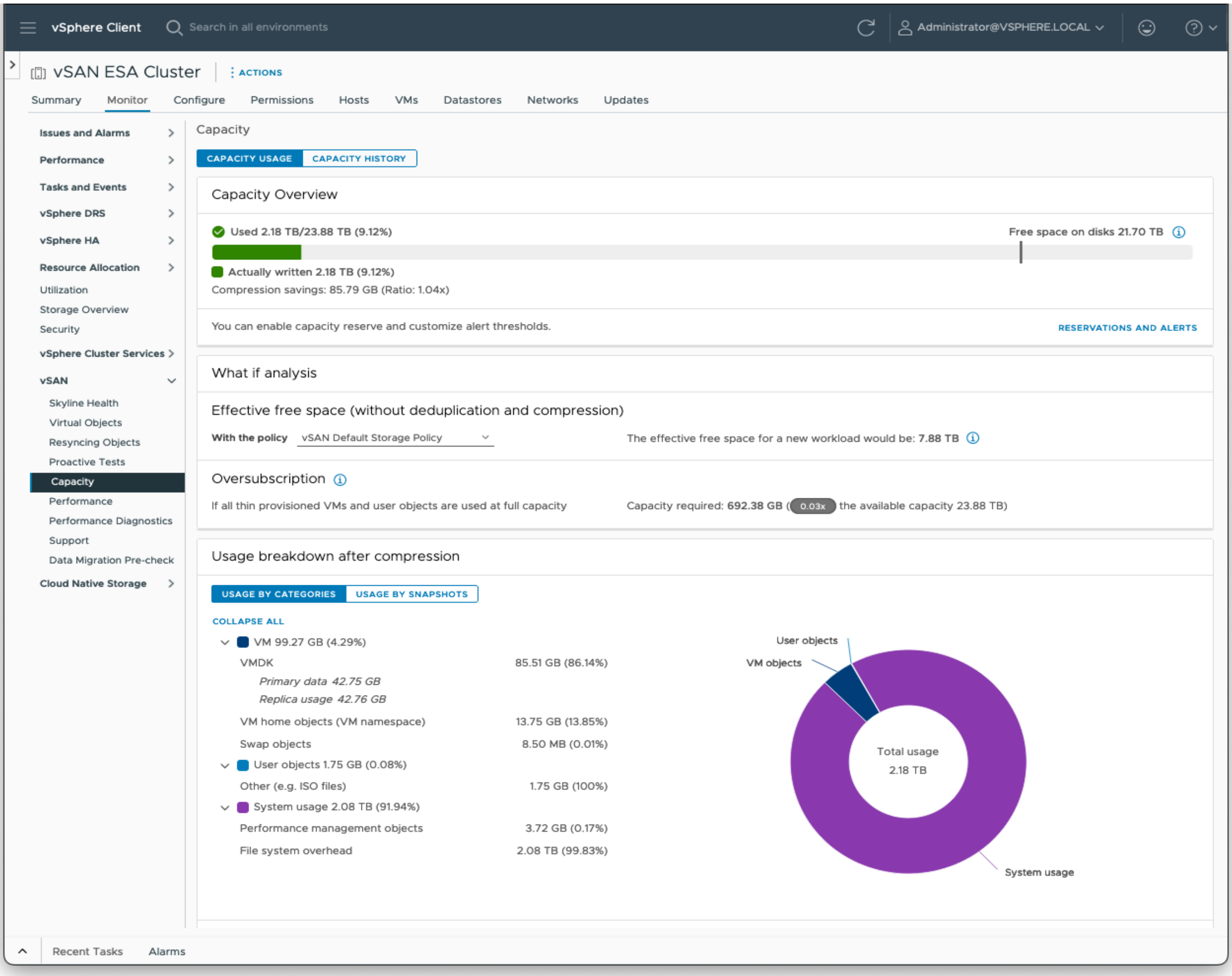
More information about this is available here:

- https://docs.vmware.com/en/VMware-vSphere/8.0/vsan-monitoring-troubleshooting/GUID-B0A8BF17-E3FB-421A-AC1A-8C1EC27294D5.html
- https://core.vmware.com/blog/health-and-performance-monitoring-enhancements-vsan-8-u2

vSAN Capacity

vSAN storage capacity usage may be examined by navigating to **[vSAN Cluster] > Monitor > vSAN > Capacity**.

This view provides a summary of current vSAN capacity usage and displays historical capacity usage information when **Capacity History** is selected. From the default view, a breakdown of capacity usage per object type is presented. In addition, a capacity analysis tool that facilitates effective free space remaining with respect to individual storage policies is available.



Capacity

Capacity Overview

Used 2.18 TB/23.88 TB (9.12%)

Free space on disks 21.70 TB

Actually written 2.18 TB (9.12%)

Compression savings: 85.79 GB (Ratio: 1.04x)

You can enable capacity reserve and customize alert thresholds.

What if analysis

Effective free space (without deduplication and compression)

With the policy: vSAN Default Storage Policy

The effective free space for a new workload would be: 7.88 TB

Oversubscription

If all thin provisioned VMs and user objects are used at full capacity

Capacity required: 692.38 GB (0.03x the available capacity 23.88 TB)

Usage breakdown after compression

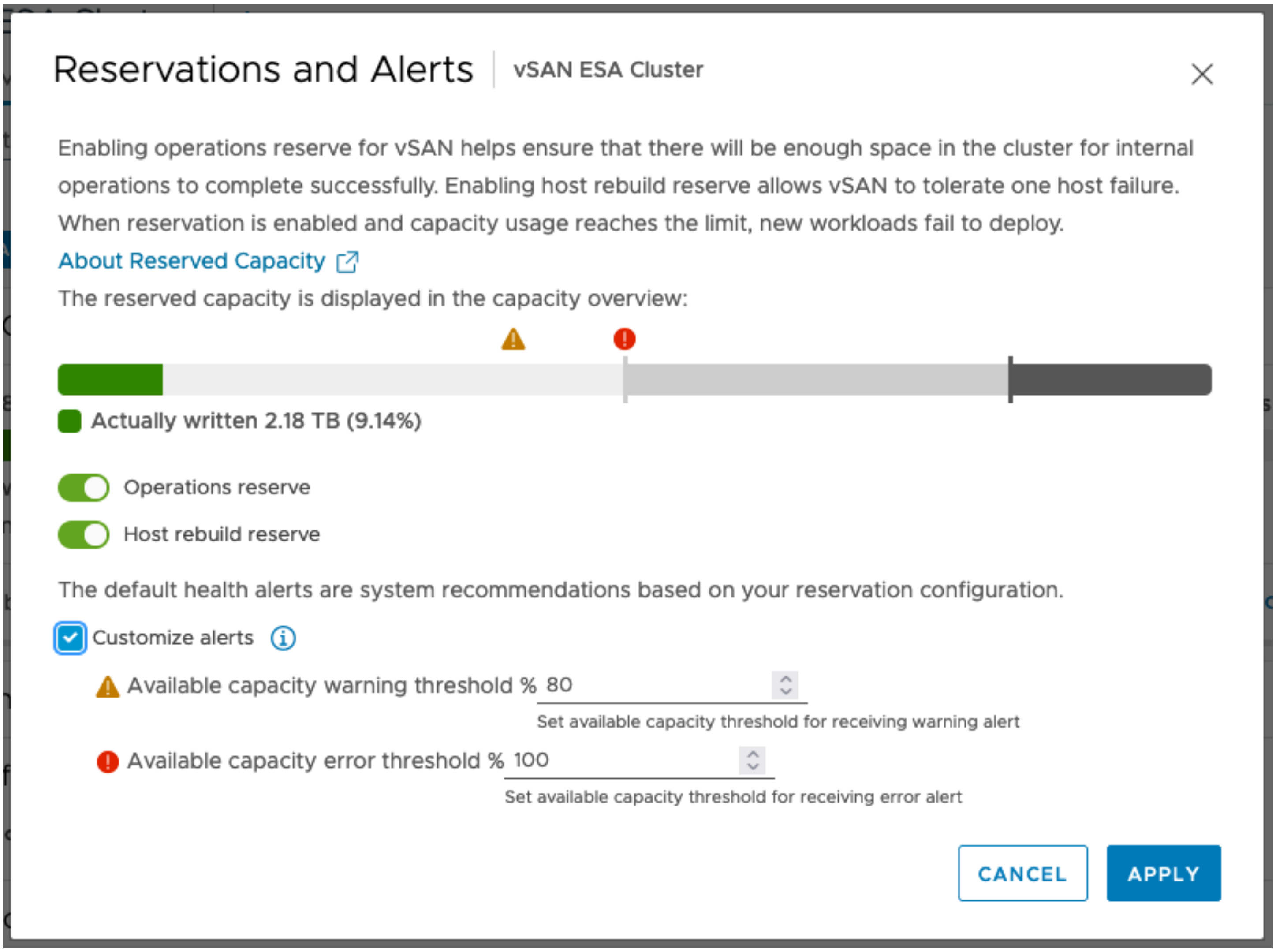
VM 99.27 GB (4.29%)	
VMDK	85.51 GB (86.14%)
Primary data 42.75 GB	
Replica usage 42.76 GB	
VM home objects (VM namespace)	13.75 GB (13.85%)
Swap objects	8.50 MB (0.01%)
User objects 1.75 GB (0.08%)	
Other (e.g. ISO files)	1.75 GB (100%)
System usage 2.08 TB (91.94%)	
Performance management objects	3.72 GB (0.17%)
File system overhead	2.08 TB (99.83%)

The vSAN Capacity UI distinguishes between the different vSphere replication objects within the capacity view.

Prior to vSAN 7u1, VMware recommended reserving 25-30% of total capacity for use as "slack space". This space is utilized during operations that temporarily consume additional storage space, such as host rebuilds, maintenance mode, or when VMs change storage policies.

Slack space is replaced by "capacity reservation," which is an improved methodology for calculating the amount of capacity set aside for vSAN operations. It yields significant gains in capacity savings (up to 18% in some cases). Additionally, the UI makes it simple to understand what amount of capacity is being reserved for temporary operations associated with normal usage, versus for host rebuilds (one host of capacity reserved for maintenance and host failure events).

This feature should be enabled during normal vSAN operations. To enable this new feature, click **Reservations and Alerts** and toggle the **Operations Reserve** and the **Host Rebuild Reserve** options. With 'customize alerts' custom thresholds can be set:



Reservations and Alerts | vSAN ESA Cluster

Enabling operations reserve for vSAN helps ensure that there will be enough space in the cluster for internal operations to complete successfully. Enabling host rebuild reserve allows vSAN to tolerate one host failure. When reservation is enabled and capacity usage reaches the limit, new workloads fail to deploy.

About Reserved Capacity

The reserved capacity is displayed in the capacity overview:

🟩 Actually written 2.18 TB (9.14%)

Operations reserve

Host rebuild reserve

The default health alerts are system recommendations based on your reservation configuration.

☑ Customize alerts

Available capacity warning threshold % 80
Set available capacity threshold for receiving warning alert

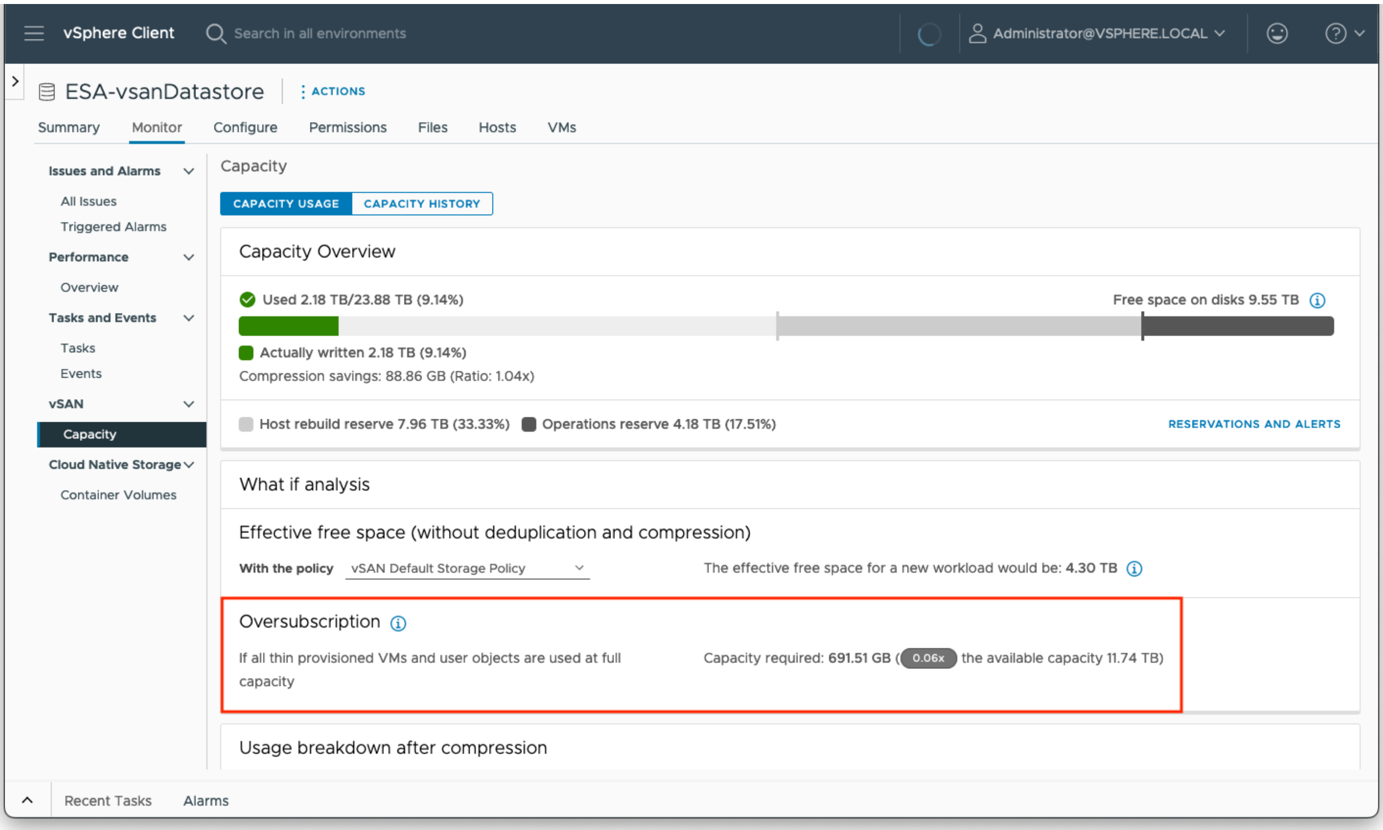
Available capacity error threshold % 100
Set available capacity threshold for receiving error alert

When Operations Reserve and Host Rebuild Reserve are enabled, "soft" thresholds are implemented that will attempt to prevent over-consumption of vSAN datastore capacity. In addition to triggering warnings/alerts in vSphere when capacity utilization is in danger of consuming space set aside as reserved, once the capacity threshold is met, operations such as provisioning new VMs, virtual disks, FCDs, clones, iSCSI targets, snapshots, file shares, or other new objects consuming vSAN datastore capacity will not be allowed.

Note, I/O activity for existing VMs and objects will continue even if the threshold is exceeded, ensuring that current workloads remain available and functioning as expected.

As VMs will continue to be able to write to provisioned space, it is important that administrators monitor for capacity threshold alerts and take action to free up (or add) capacity to the vSAN cluster before capacity consumption significantly exceeds the set thresholds.

Additionally, the vSAN Capacity UI provides an estimate of the capacity required if thin-provisioned objects were fully provisioned has been added to the monitoring summary at **vSAN Datastore > Monitor > vSAN > Capacity**:



Capacity

Capacity Overview

✓ Used 2.18 TB/23.88 TB (9.14%)

Free space on disks 9.55 TB

🟩 Actually written 2.18 TB (9.14%)

Compression savings: 88.86 GB (Ratio: 1.04x)

□ Host rebuild reserve 7.96 TB (33.33%) ■ Operations reserve 4.18 TB (17.51%)

What if analysis

Effective free space (without deduplication and compression)

With the policy vSAN Default Storage Policy

The effective free space for a new workload would be: **4.30 TB**

Oversubscription

If all thin provisioned VMs and user objects are used at full capacity

Capacity required: **691.51 GB** (0.06x the available capacity 11.74 TB)

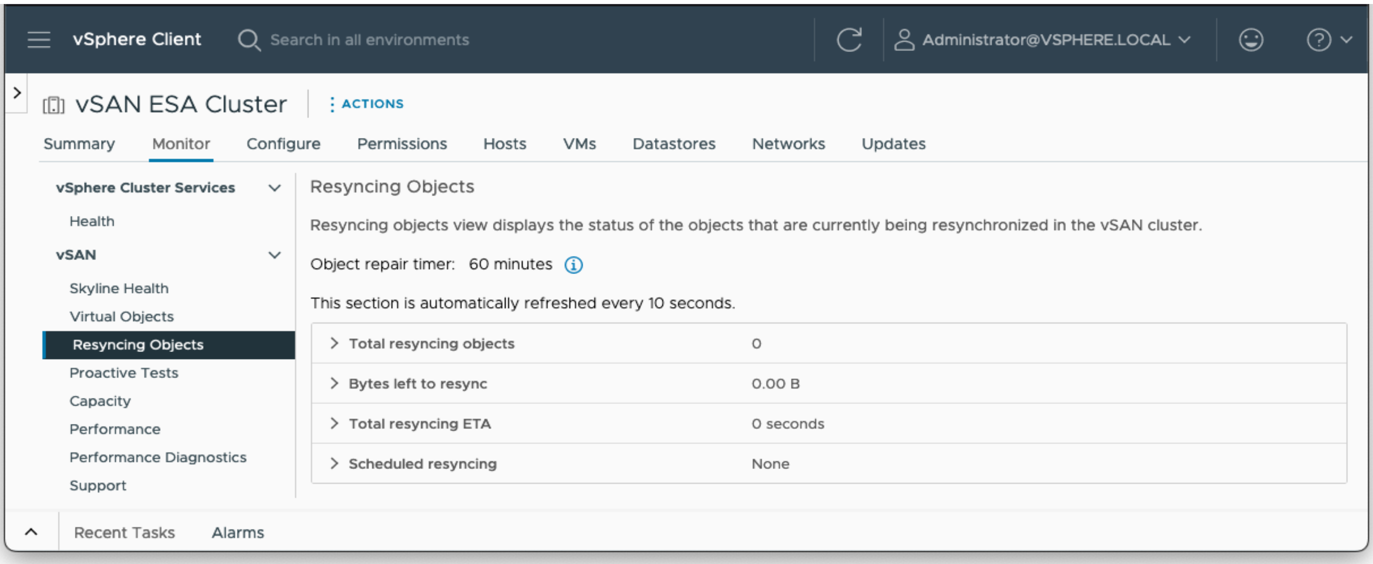
Usage breakdown after compression

Resync Operations

Another very useful view is the **[vSAN Cluster] > Monitor > vSAN > Resyncing Objects** view. This will display any resyncing or rebalancing operation that might be taking place on the cluster. For example, if there was a device failure, resyncing or rebuilding activity could be observed here. Resync can also happen if a device was removed or a host failed, and the CLOMd (Cluster Logical Object Manager daemon) timer expired. Resyncing objects dashboard provides details of the resync status, amount of data in transit, and estimated time to completion.

With regards to rebalancing, vSAN attempts to keep all physical devices at less than 80% capacity. If any physical device capacity passes this threshold, vSAN will move components from this device to other devices in the cluster to rebalance the physical storage.

In an ideal state, no resync activity should be observed, as shown below.



Resyncing Objects

Resyncing objects view displays the status of the objects that are currently being resynchronized in the vSAN cluster.

Object repair timer: 60 minutes

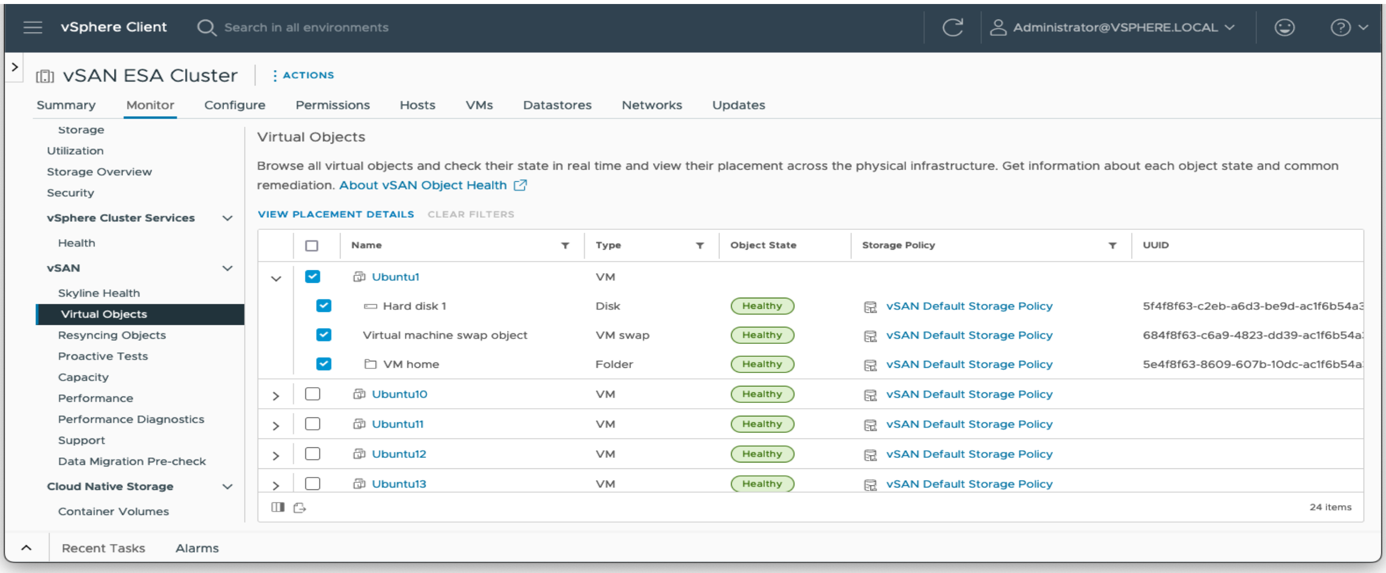
This section is automatically refreshed every 10 seconds.

Total resyncing objects	0
Bytes left to resync	0.00 B
Total resyncing ETA	0 seconds
Scheduled resyncing	None

Resyncing activity usually indicates:

- Failure of a device or host in the cluster
- Device has been removed from the cluster
- Physical disk has greater than 80% of its capacity consumed
- Policy change has been implemented which necessitates a rebuilding of a VM's object layout (In this case, a new object layout is created, synchronized with the source object, and then discards the source object)

vSphere replication object types are visible within the Virtual Objects view, allowing administrators to clearly distinguish replica data from other data types.



Virtual Objects

Browse all virtual objects and check their state in real time and view their placement across the physical infrastructure. Get information about each object state and common remediation. About vSAN Object Health

	Name	Type	Object State	Storage Policy	UUID
☑	Ubuntu1	VM			
☑	Hard disk 1	Disk	Healthy	vSAN Default Storage Policy	5f4f8f63-c2eb-a6d3-be9d-ac1f6b54a3
☑	Virtual machine swap object	VM swap	Healthy	vSAN Default Storage Policy	684f8f63-c6a9-4823-dd39-ac1f6b54a
☑	VM home	Folder	Healthy	vSAN Default Storage Policy	5e4f8f63-8609-607b-10dc-ac1f6b54a
□	Ubuntu10	VM	Healthy	vSAN Default Storage Policy	
□	Ubuntu11	VM	Healthy	vSAN Default Storage Policy	
□	Ubuntu12	VM	Healthy	vSAN Default Storage Policy	
□	Ubuntu13	VM	Healthy	vSAN Default Storage Policy	

24 items

Performance Monitoring

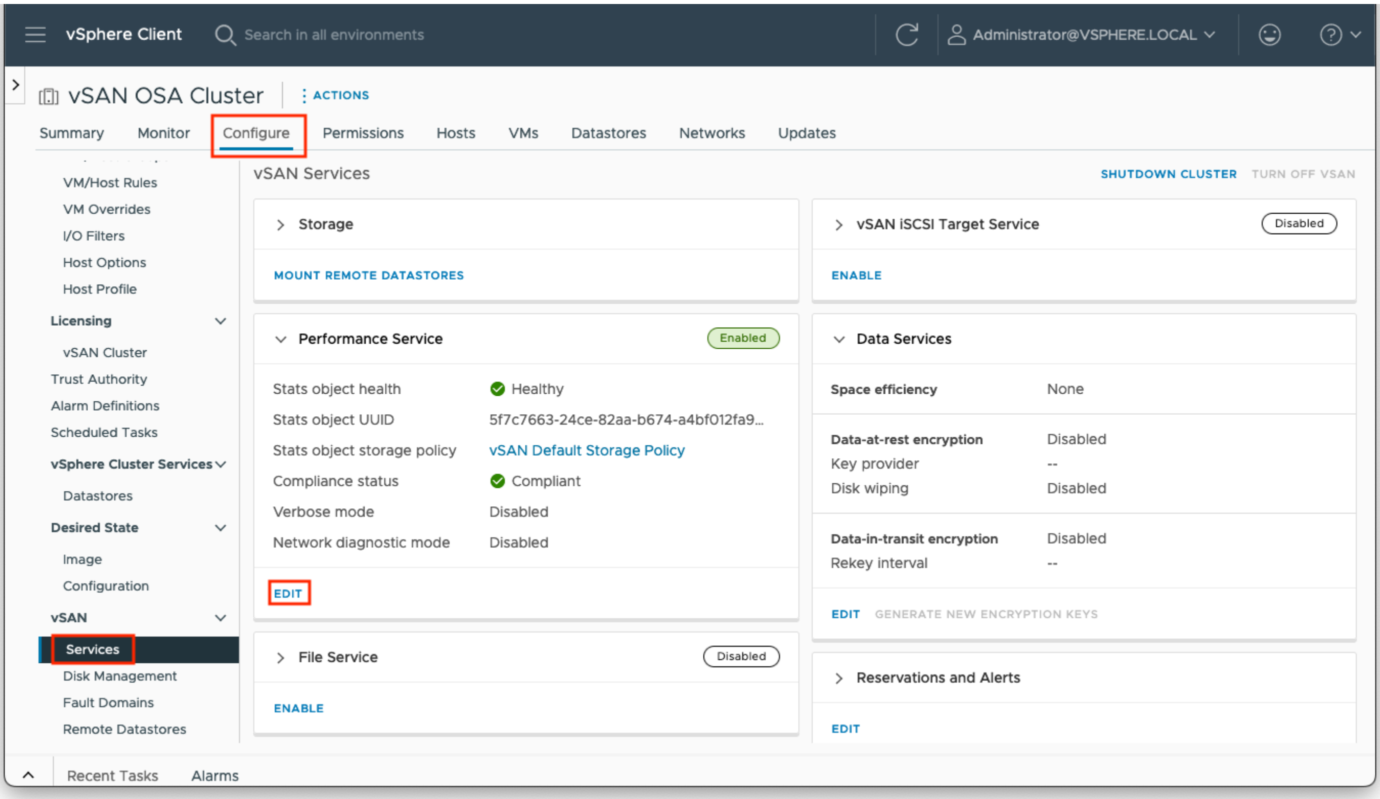
Performance monitoring service can be used for verification of performance as well as quick troubleshooting of performance-related issues. Performance charts are available for many different levels.

- Cluster
- Hosts
- Virtual Machines and Virtual Disks
- Disk groups
- Physical disks

A detailed list of performance graphs and descriptions can be found here:

- https://kb.vmware.com/s/article/2144493 (part 1)
- https://kb.vmware.com/s/article/91976 (part 2)
- https://kb.vmware.com/s/article/91977 (part 3)

The performance service should be enabled by default when a vSAN cluster is created in vCenter. In case it is not, enable the performance monitoring service by navigating to **[vSAN Cluster] > Configure > vSAN > Services** and clicking on **Edit**:



Performance Service

Stats object health	Healthy
Stats object UUID	5f7c7663-24ce-82aa-b674-a4bf012fa9...
Stats object storage policy	vSAN Default Storage Policy
Compliance status	Compliant
Verbose mode	Disabled
Network diagnostic mode	Disabled

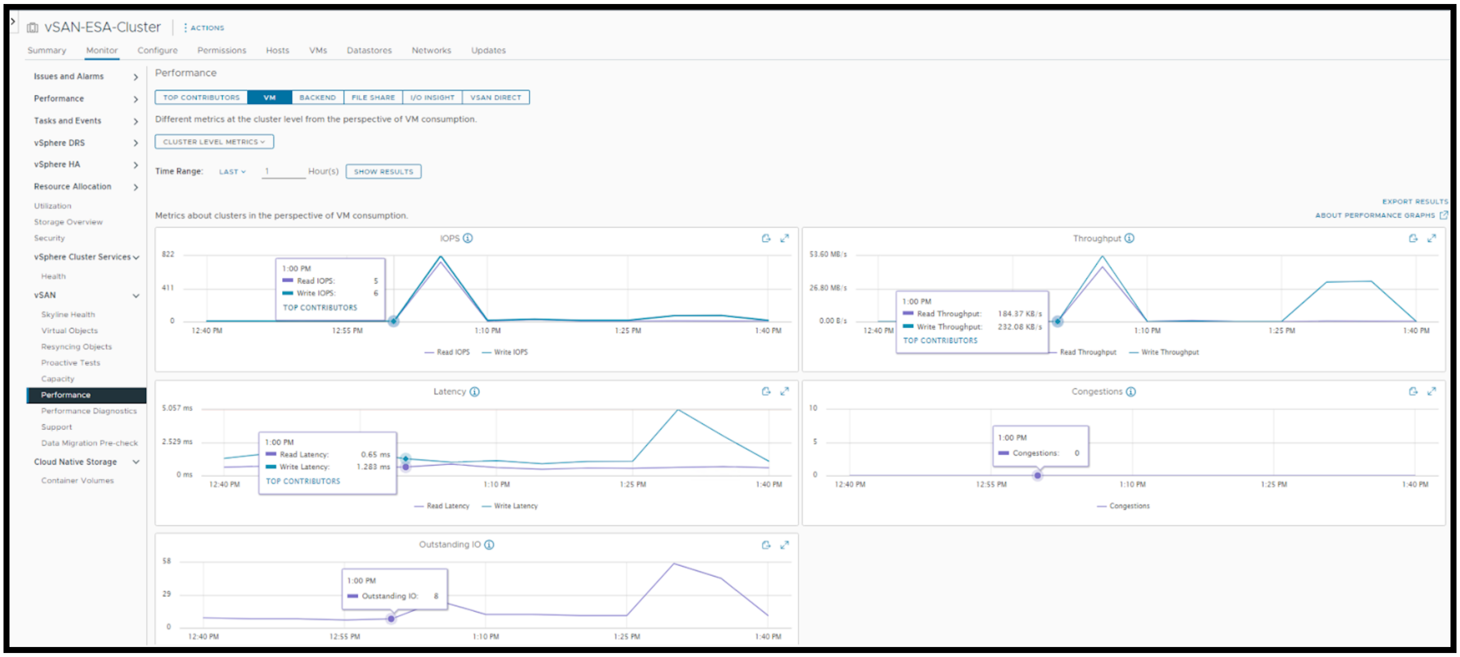
Data Services

Space efficiency	None
Data-at-rest encryption	Disabled
Key provider	--
Disk wiping	Disabled
Data-in-transit encryption	Disabled
Rekey interval	--

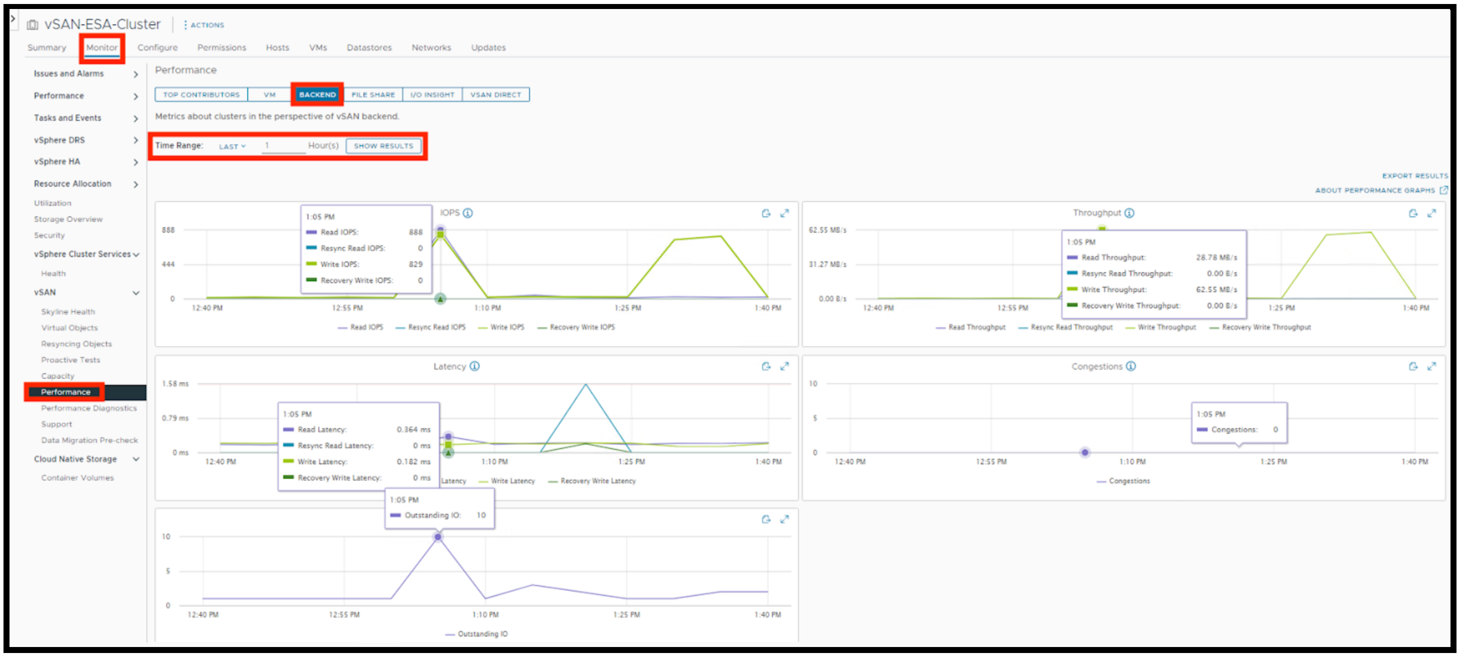
Once the service has been enabled performance statistics can be viewed from the performance menus in vCenter. In the following example, we will examine IOPS, throughput, and latency from the Virtual Machine level and the vSAN Backend level.

vSAN Cluster Performance Graphs

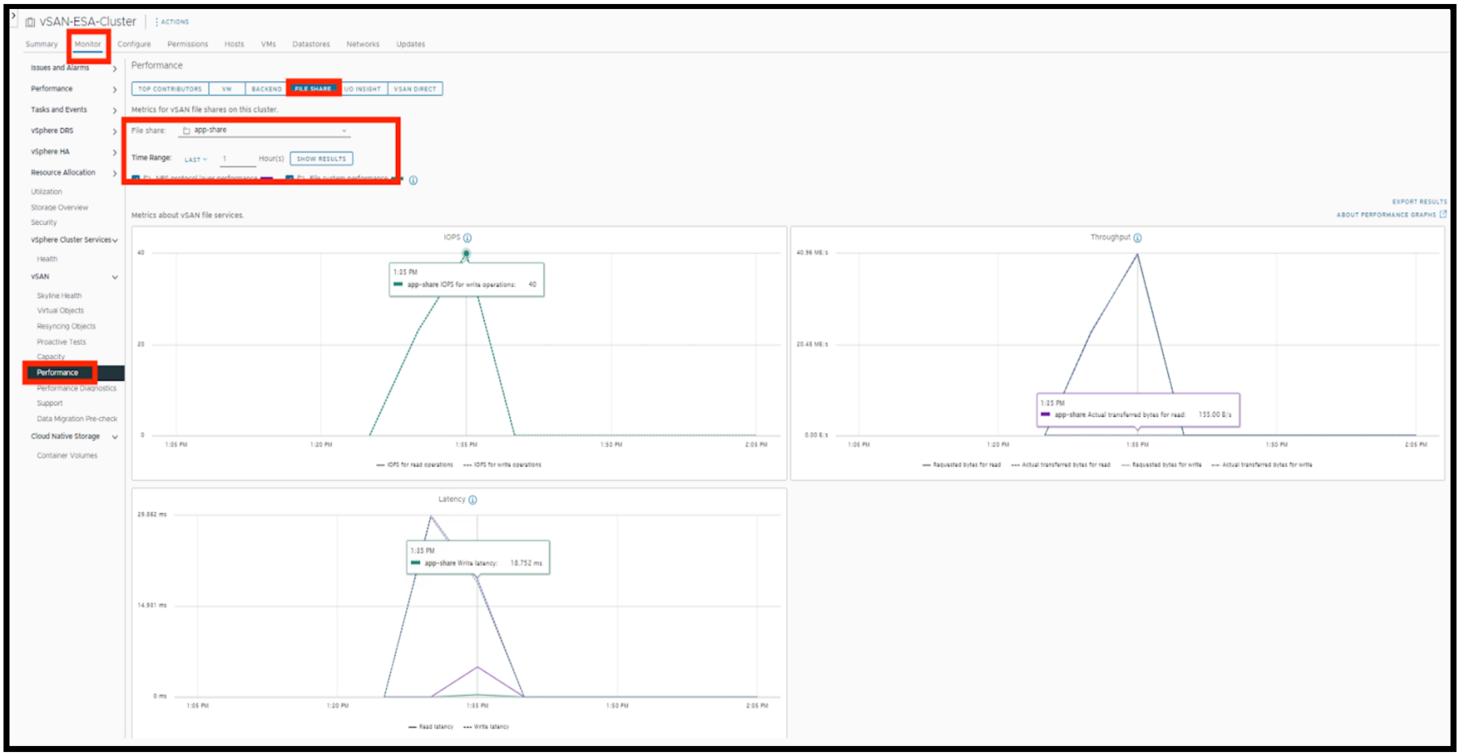
To access cluster-level performance graphs, navigate to **[Cluster] > Monitor > Performance**. Choose an appropriate time frame and click **Show Results**:



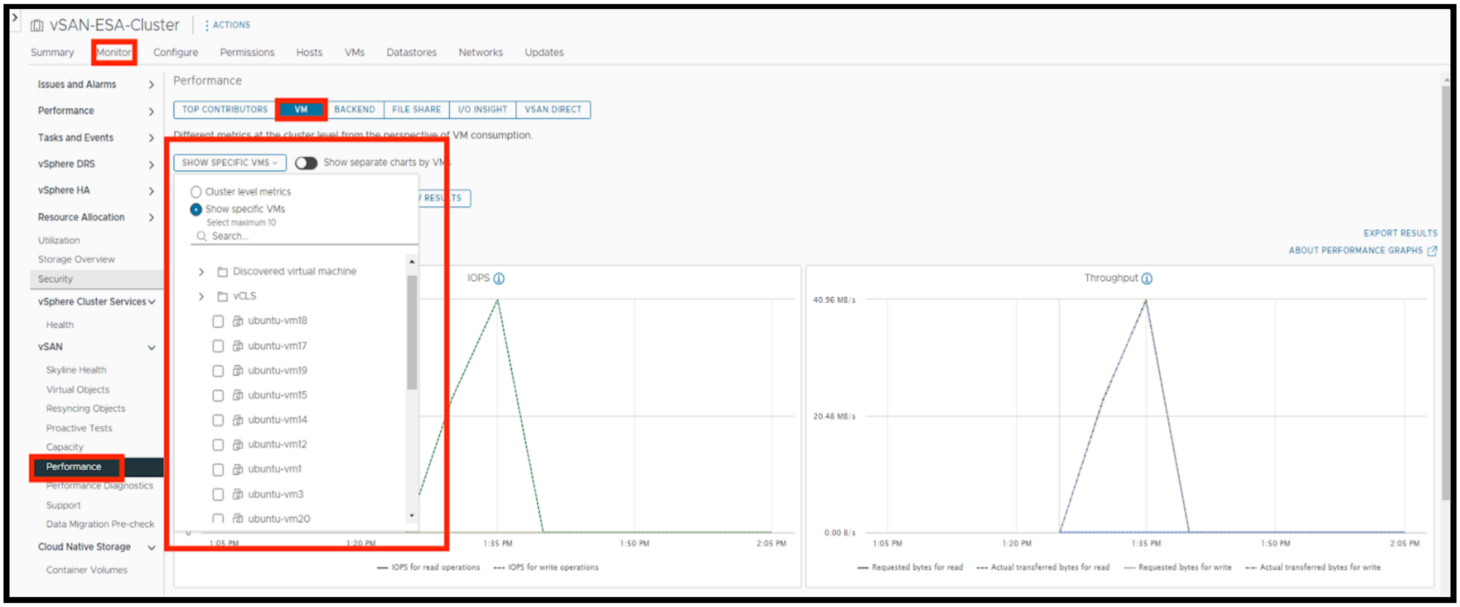
Access the vSAN Backend performance metrics, select the **BACKEND** tab from the menu at the top:



If vSAN File Shares are configured, **FILE SHARE** tab becomes available to show information on file share performance, (for more information on vSAN File Shares, refer to the vSAN Proof of Concept: vSAN Features guide):

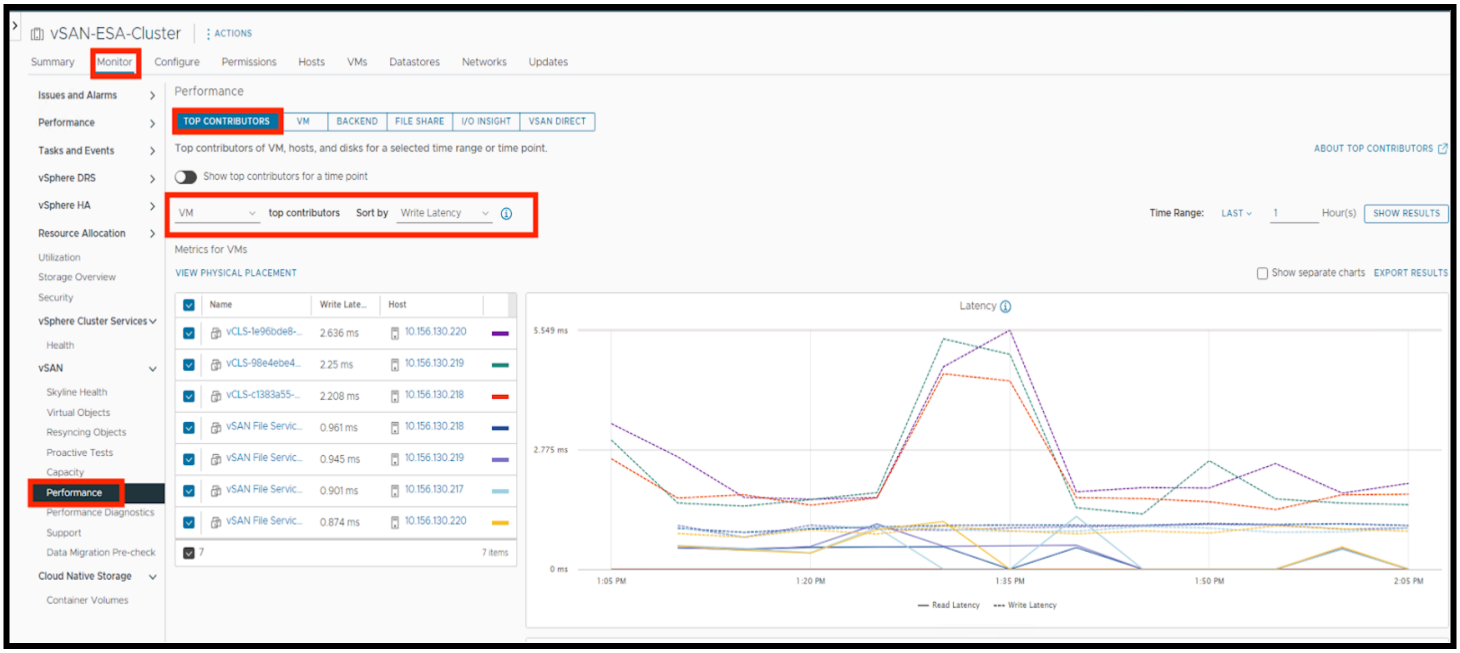


It is easier to compare performance across VMs. From the cluster level, click **Monitor** and then Performance. Now we can look at the cluster level or show specific VMs (Up to 10 at a time). This makes it easy to compare IOPS, Throughput, and Latency for multiple VMs:



We can also look at the ‘top contributors’ to performance (the defined metrics are for read/write latency, read/write IOPS and read/write throughput, from VM, Disk, Host-frontend, and Host-backend).

Here we look at the VM write latency (over a 1-hour period):



Top contributors of VM, hosts, and disks for a selected time range or time point.

Show top contributors for a time point

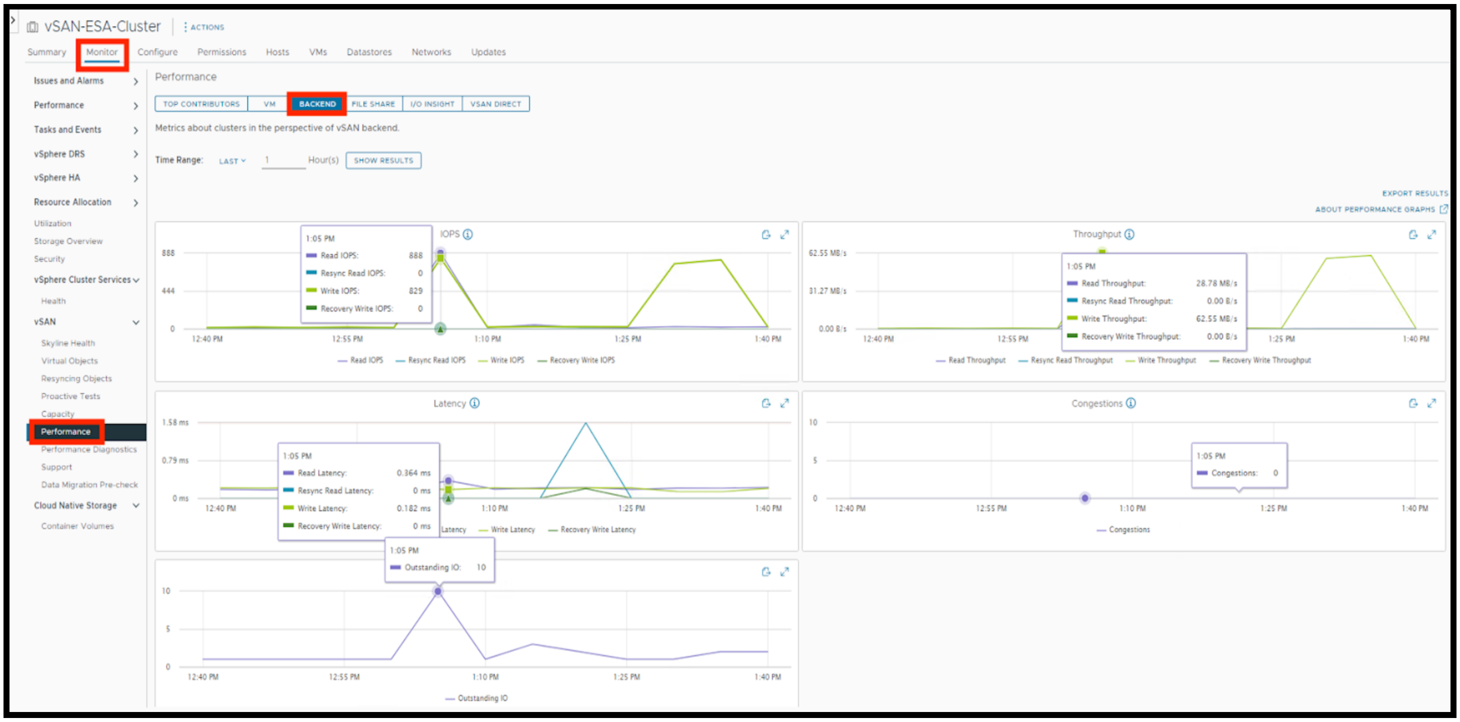
VM top contributors Sort by Write Latency

Time Range: LAST 1 Hour(s)

Metrics for VMs

☑	Name	Write Late...	Host
☑	vCLS-1e96bde8-...	2.636 ms	10.156.130.220
☑	vCLS-98e4ebe4...	2.25 ms	10.156.130.219
☑	vCLS-c1383a55-...	2.208 ms	10.156.130.218
☑	vSAN File Servic...	0.961 ms	10.156.130.218
☑	vSAN File Servic...	0.945 ms	10.156.130.219
☑	vSAN File Servic...	0.901 ms	10.156.130.217
☑	vSAN File Servic...	0.874 ms	10.156.130.220
☑	7		7 items

The **BACKEND** tab shows various holistic metrics – in particular any latency spikes or congestion here (for example, due to failing hardware) are easily spotted here:



Metrics about clusters in the perspective of vSAN backend.

Time Range: LAST 1 Hour(s)

1:05 PM
Read IOPS: 888
Resync Read IOPS: 0
Write IOPS: 829
Recovery Write IOPS: 0

1:05 PM
Read Throughput: 28.78 MB/s
Resync Read Throughput: 0.00 B/s
Write Throughput: 62.55 MB/s
Recovery Write Throughput: 0.00 B/s

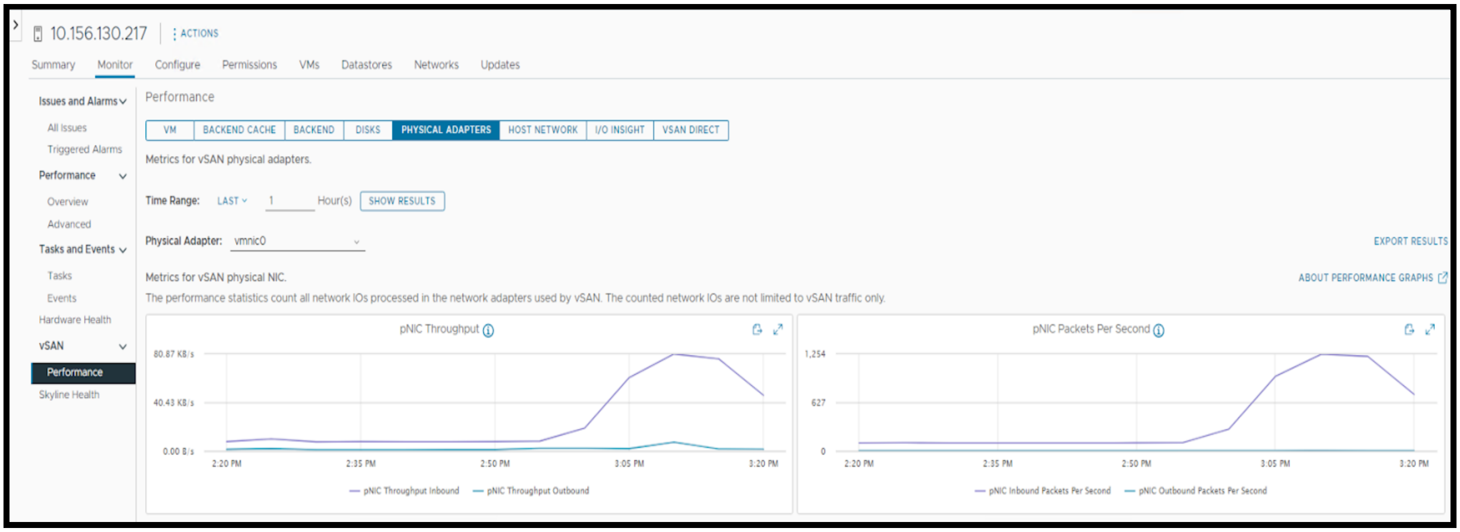
1:05 PM
Read Latency: 0.364 ms
Resync Read Latency: 0 ms
Write Latency: 0.182 ms
Recovery Write Latency: 0 ms

1:05 PM
Congestions: 0

1:05 PM
Outstanding IO: 10

vSAN Host Performance Graphs

In addition to the cluster level, further performance detail per host can be found by navigating to **[Host] > Monitor > vSAN > Performance**. This includes metrics for the backend cache, physical adapters, and host network. In particular, the physical adapter view can be useful in troubleshooting network issues:



Metrics for vSAN physical adapters.

Time Range: LAST 1 Hour(s)

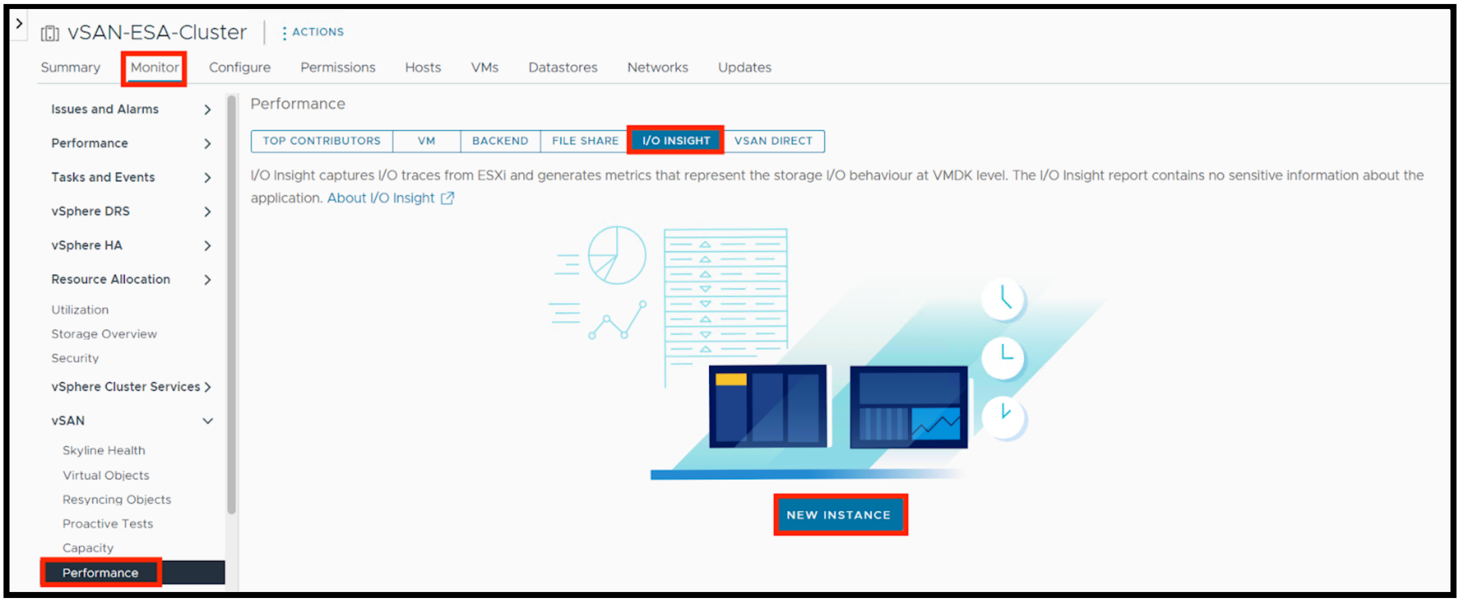
Physical Adapter: vmnic0

Metrics for vSAN physical NIC.

The performance statistics count all network IOs processed in the network adapters used by vSAN. The counted network IOs are not limited to vSAN traffic only.

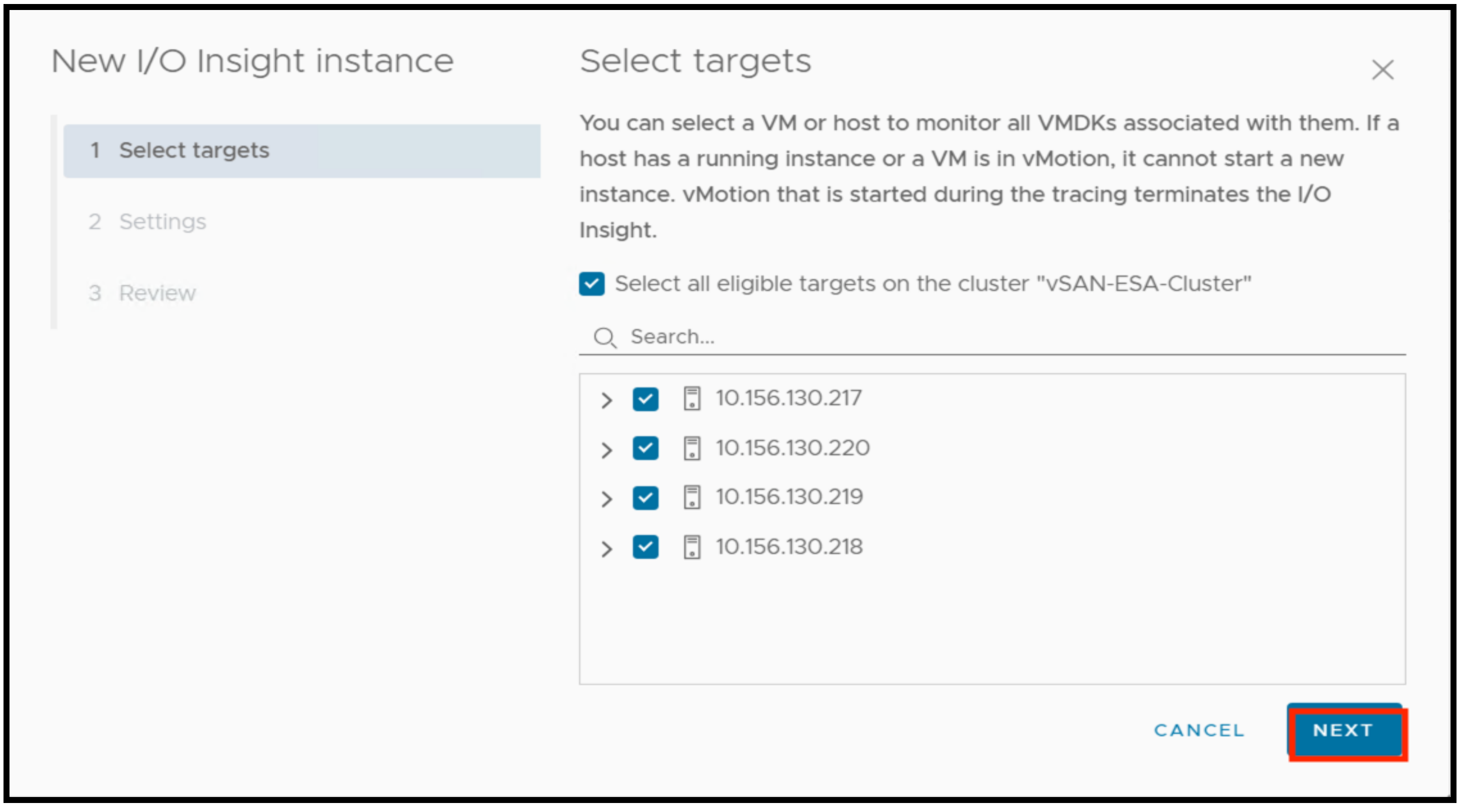
I/O Insight

To capture a deeper level of metrics, I/O Insight gathers traces from the hosts. Navigate to **[Cluster] > Monitor > vSAN > Performance** and select the **I/O INSIGHT** tab. Then click on **NEW INSTANCE**:



I/O Insight captures I/O traces from ESXi and generates metrics that represent the storage I/O behaviour at VMDK level. The I/O Insight report contains no sensitive information about the application. About I/O Insight

Then select the targets to monitor. Here we have selected all the hosts in the cluster:



New I/O Insight instance

1 Select targets

2 Settings

3 Review

Select targets

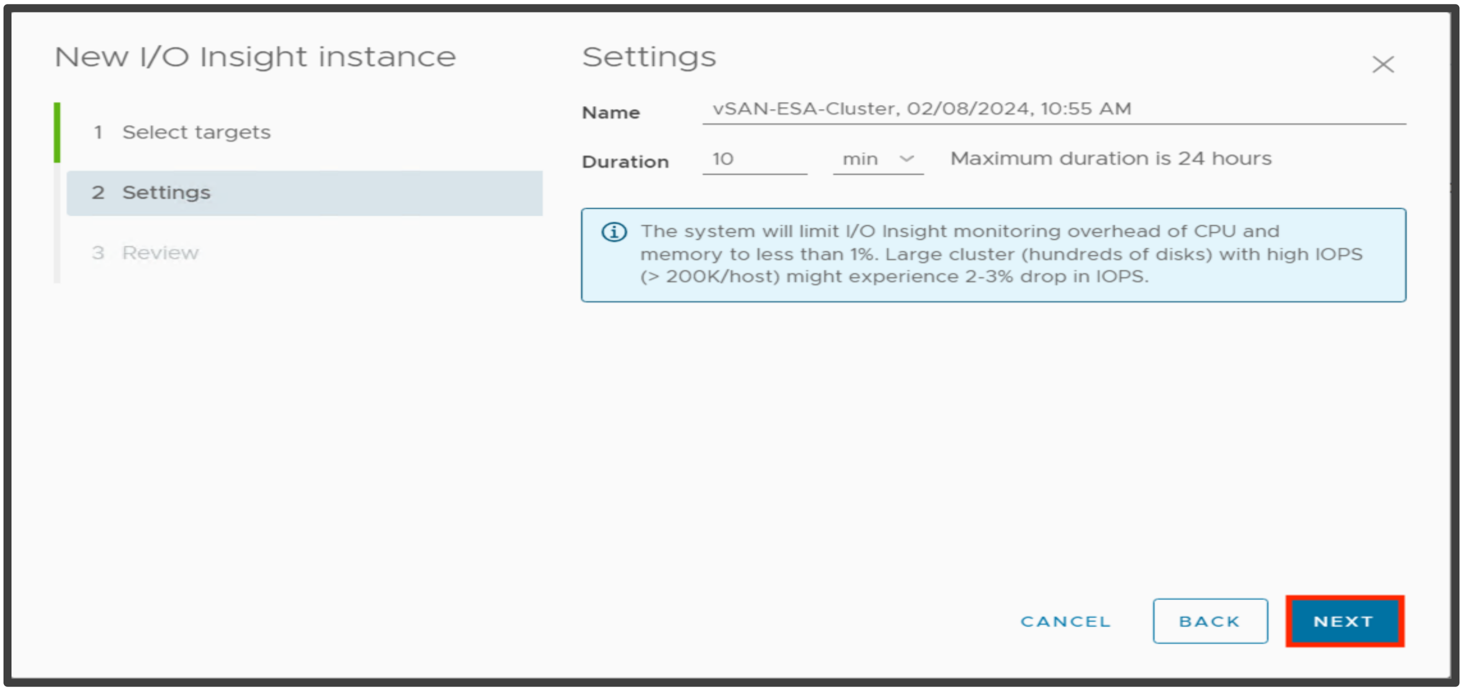
You can select a VM or host to monitor all VMDKs associated with them. If a host has a running instance or a VM is in vMotion, it cannot start a new instance. vMotion that is started during the tracing terminates the I/O Insight.

☑ Select all eligible targets on the cluster "vSAN-ESA-Cluster"

Search...

- ☑ 10.156.130.217
- ☑ 10.156.130.220
- ☑ 10.156.130.219
- ☑ 10.156.130.218

Next, select the duration. The default is 10 minutes:



New I/O Insight instance

1 Select targets

2 Settings

3 Review

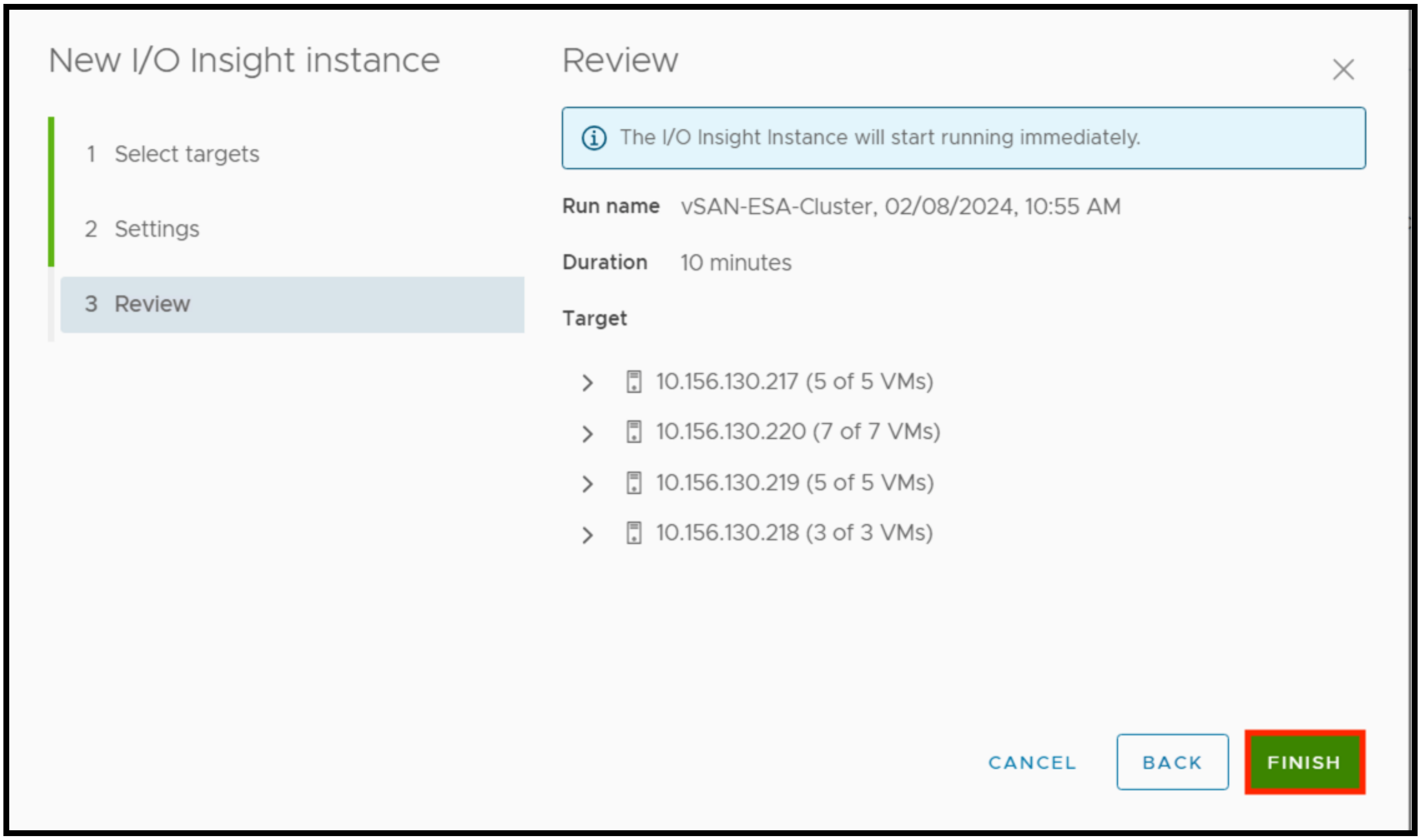
Settings

Name: vSAN-ESA-Cluster, 02/08/2024, 10:55 AM

Duration: 10 min Maximum duration is 24 hours

The system will limit I/O Insight monitoring overhead of CPU and memory to less than 1%. Large cluster (hundreds of disks) with high IOPS (> 200K/host) might experience 2-3% drop in IOPS.

Then review and click **Finish** to start I/O Insight.



New I/O Insight instance

1 Select targets

2 Settings

3 Review

Review

The I/O Insight Instance will start running immediately.

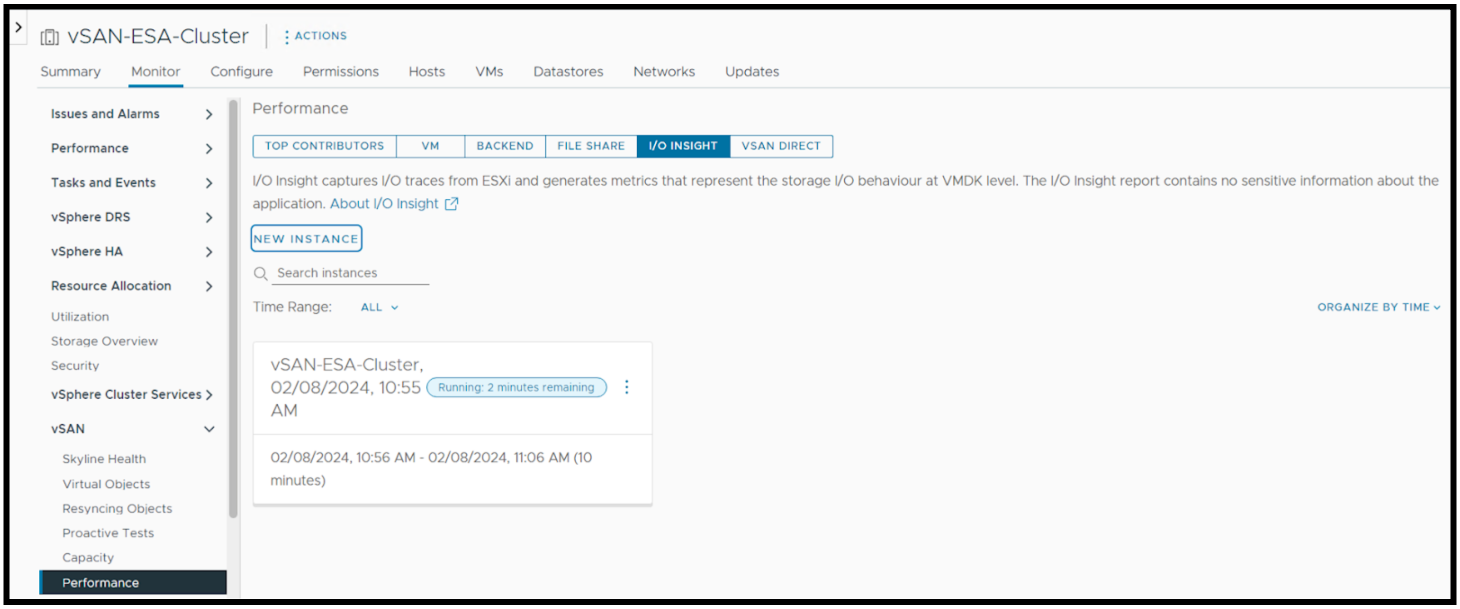
Run name vSAN-ESA-Cluster, 02/08/2024, 10:55 AM

Duration 10 minutes

Target

- 10.156.130.217 (5 of 5 VMs)
- 10.156.130.220 (7 of 7 VMs)
- 10.156.130.219 (5 of 5 VMs)
- 10.156.130.218 (3 of 3 VMs)

We can then see that the metric gathering has started, and the time remaining:



Performance

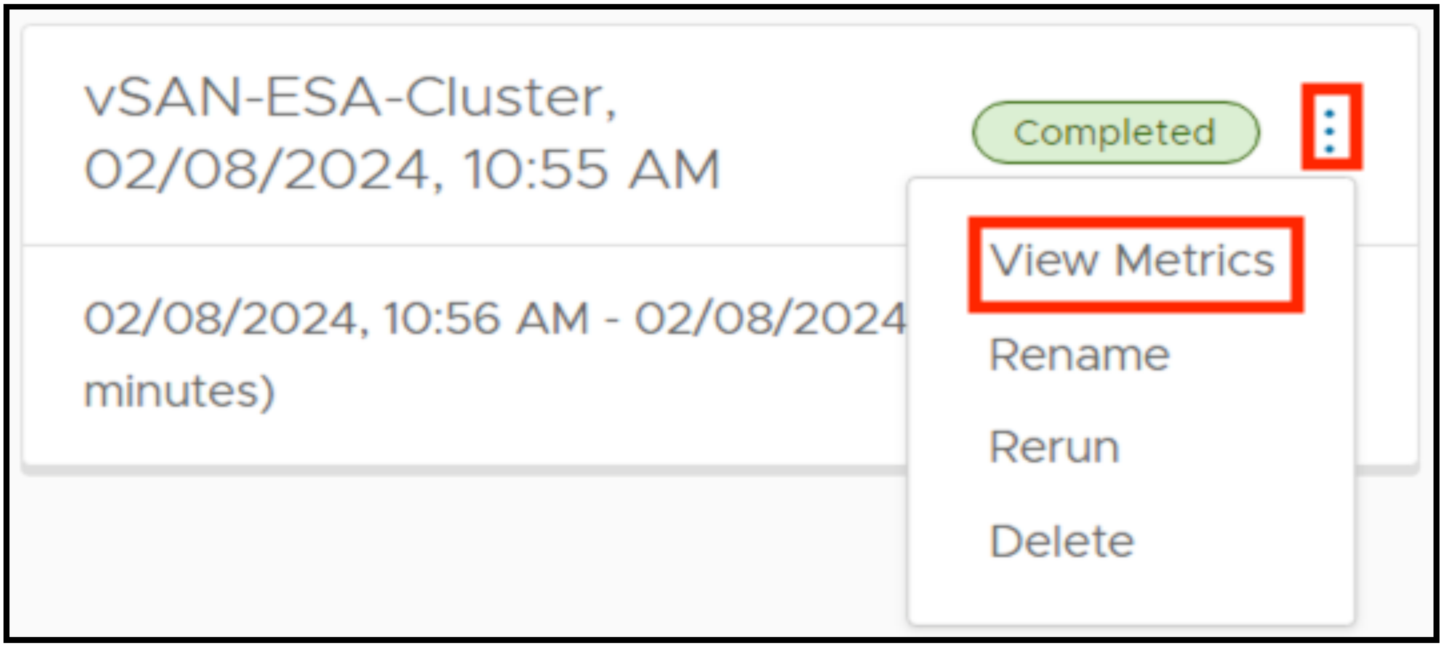
I/O Insight captures I/O traces from ESXi and generates metrics that represent the storage I/O behaviour at VMDK level. The I/O Insight report contains no sensitive information about the application. About I/O Insight

Time Range: ALL

vSAN-ESA-Cluster, 02/08/2024, 10:55 AM Running: 2 minutes remaining

02/08/2024, 10:56 AM - 02/08/2024, 11:06 AM (10 minutes)

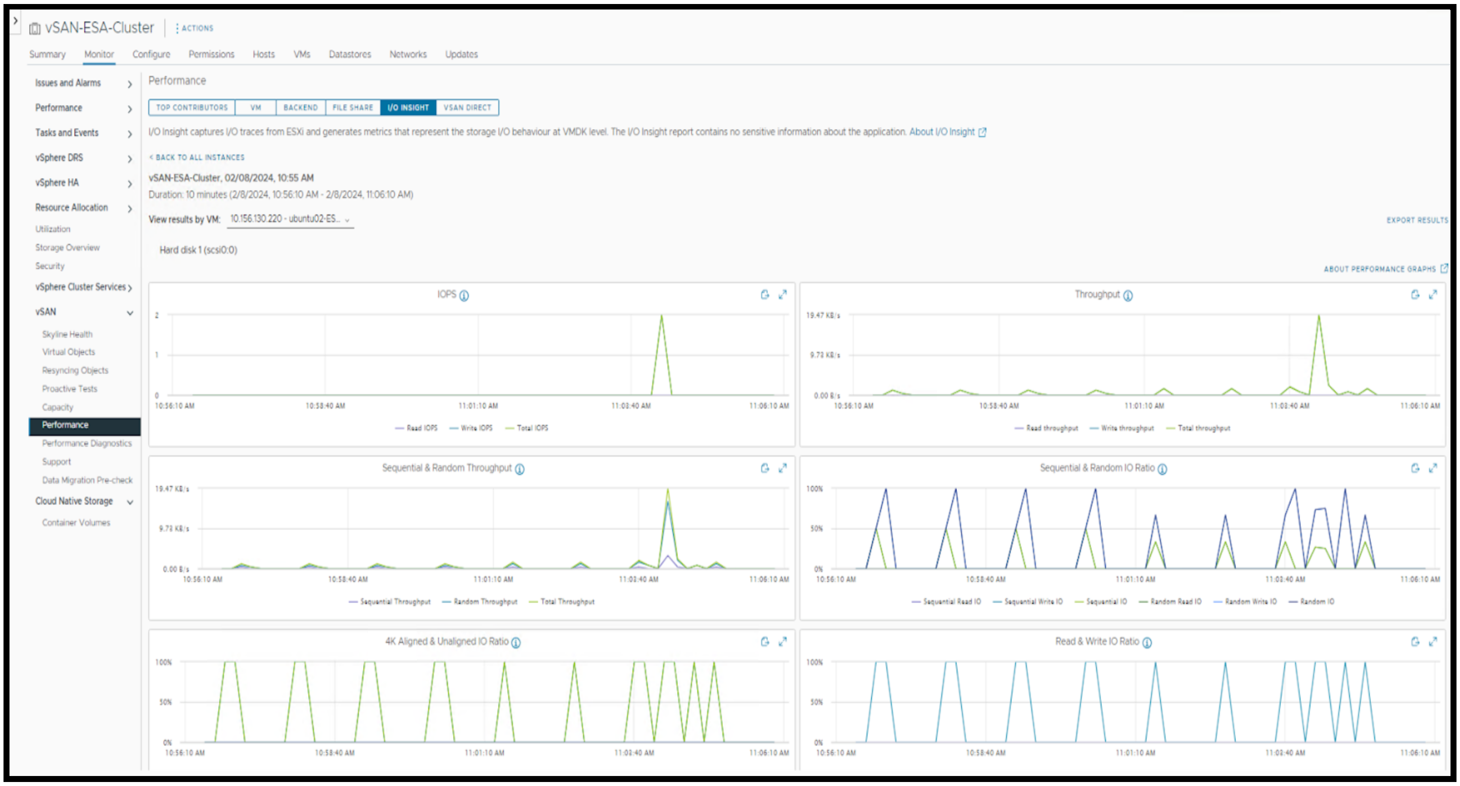
Once completed, click on the ellipses (three dots) and **View Metrics**:



vSAN-ESA-Cluster, 02/08/2024, 10:55 AM

02/08/2024, 10:56 AM - 02/08/2024 minutes)

The results are filtered by VM. Select a VM of interest to see detailed metrics, such as IO size/ latency distribution, IO randomness and read/write ratio:



I/O Insight captures I/O traces from ESXi and generates metrics that represent the storage I/O behaviour at VMDK level. The I/O Insight report contains no sensitive information about the application. About I/O Insight

vSAN-ESA-Cluster, 02/08/2024, 10:55 AM

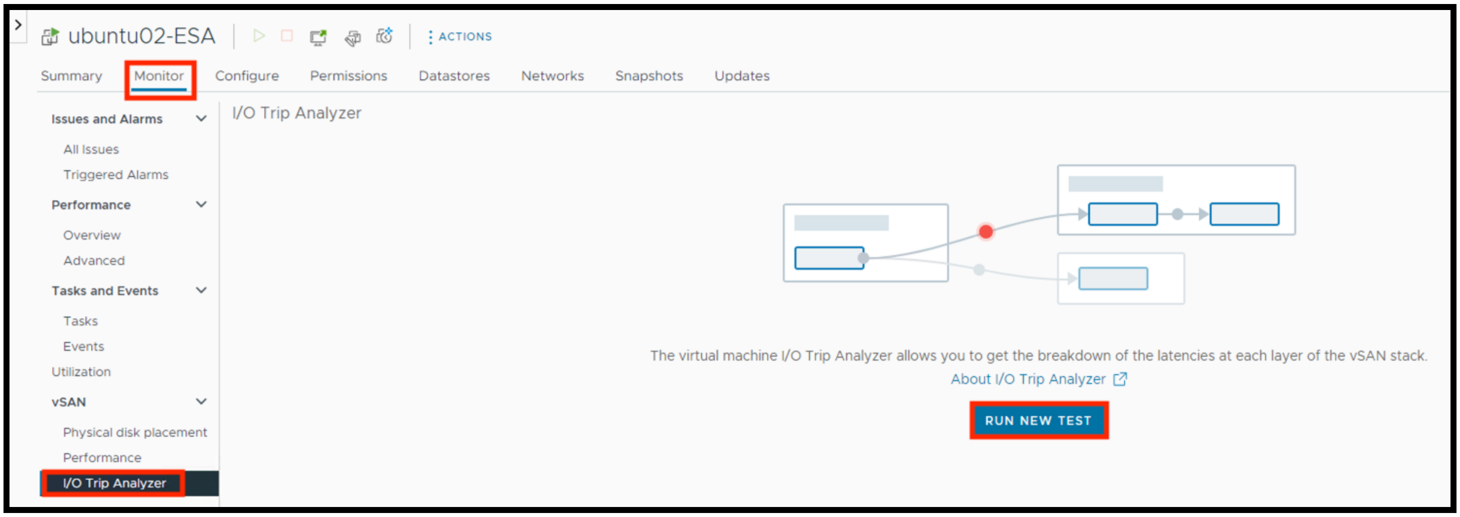
Duration: 10 minutes (2/8/2024, 10:56:10 AM - 2/8/2024, 11:06:10 AM)

View results by VM: 10.156.130.220 - ubuntu02-ES...

Hard disk 1 (scsi0:0)

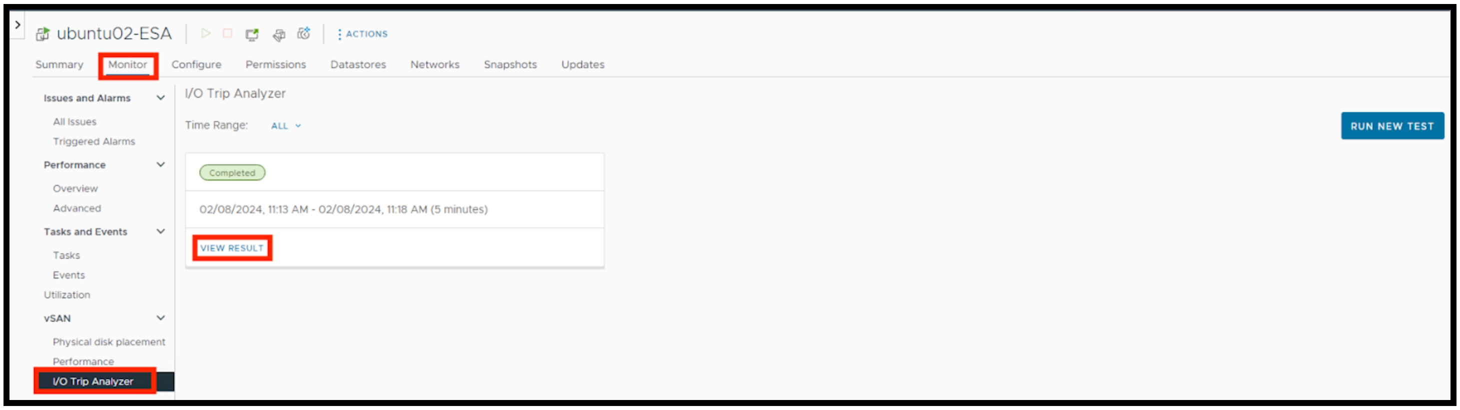
I/O Trip Analyzer

I/O trip analyzer is a per-vm tool used to obtain a breakdown of latencies from the vSAN stack. To launch an instance, navigate to **[VM] > Monitor > vSAN > I/O Trip Analyzer** and click **on RUN NEW TEST**:



The virtual machine I/O Trip Analyzer allows you to get the breakdown of the latencies at each layer of the vSAN stack.

Set the time to analyze (the default is five minutes) and click on 'RUN' to start the test. Once the test is complete, click on **VIEW RESULT**:

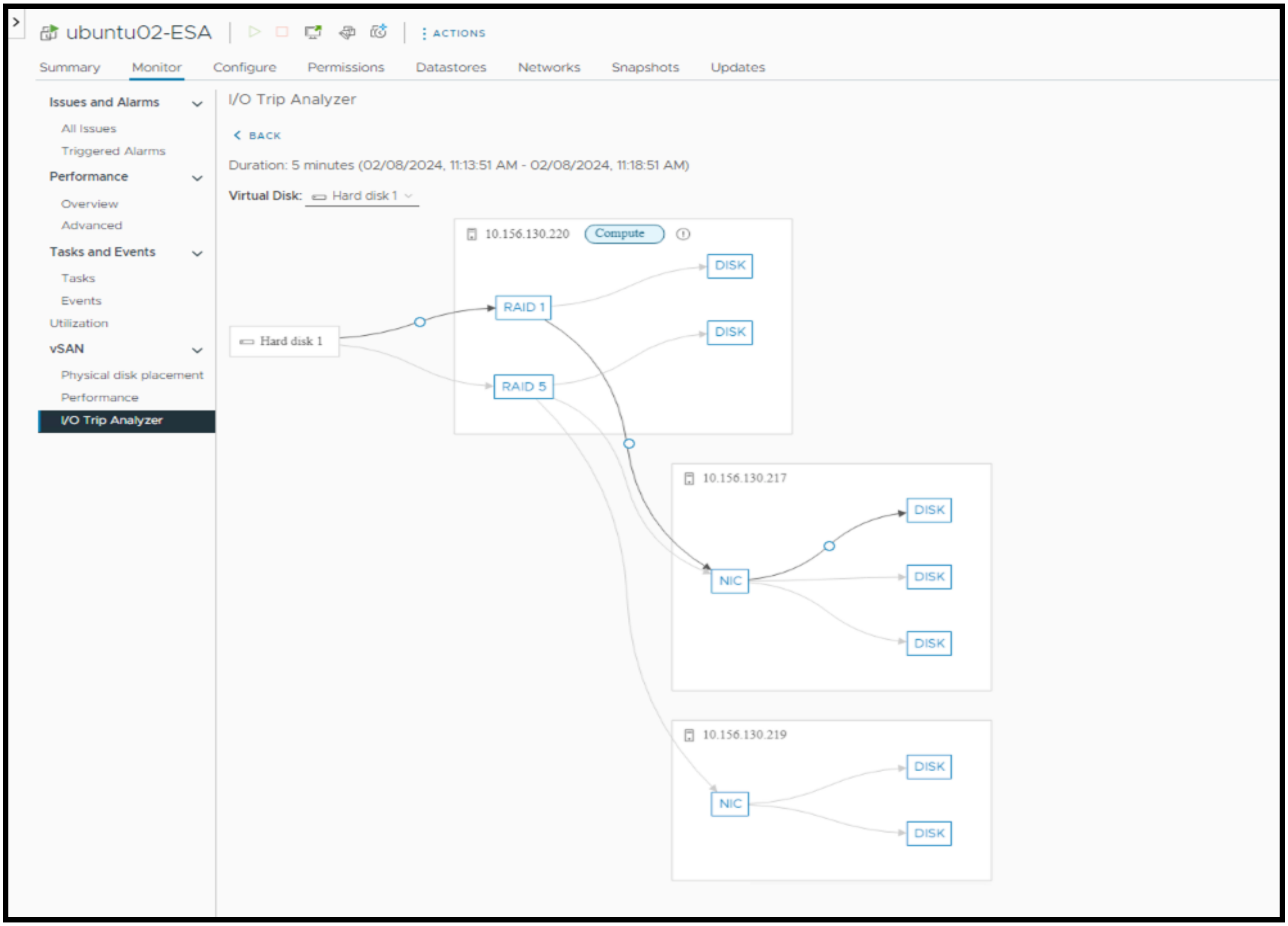


Time Range: ALL

Completed

02/08/2024, 11:13 AM - 02/08/2024, 11:18 AM (5 minutes)

This will then show a map of how the virtual disk in the host interacts with the network adapters and physical disks:

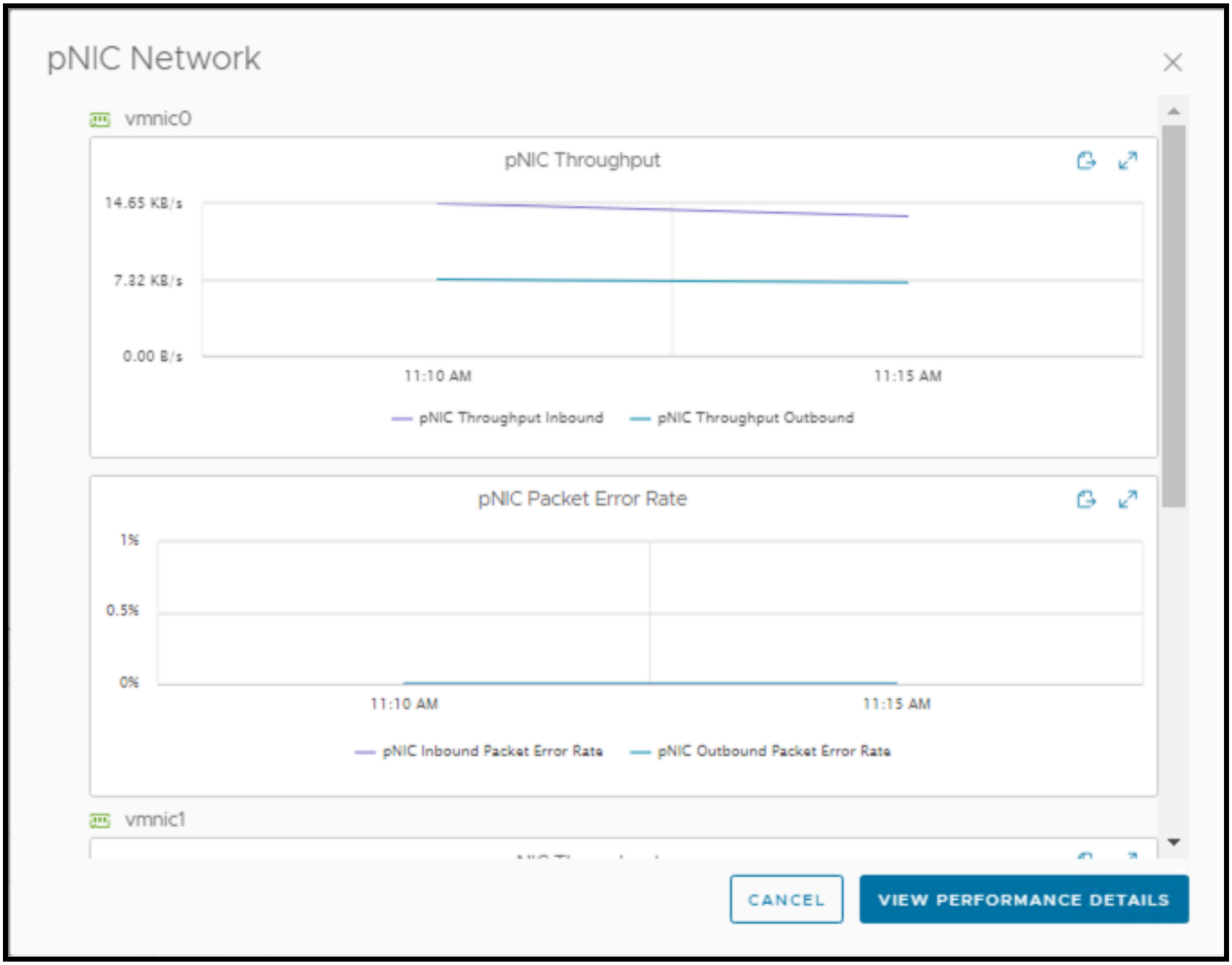


I/O Trip Analyzer

Duration: 5 minutes (02/08/2024, 11:13:51 AM - 02/08/2024, 11:18:51 AM)

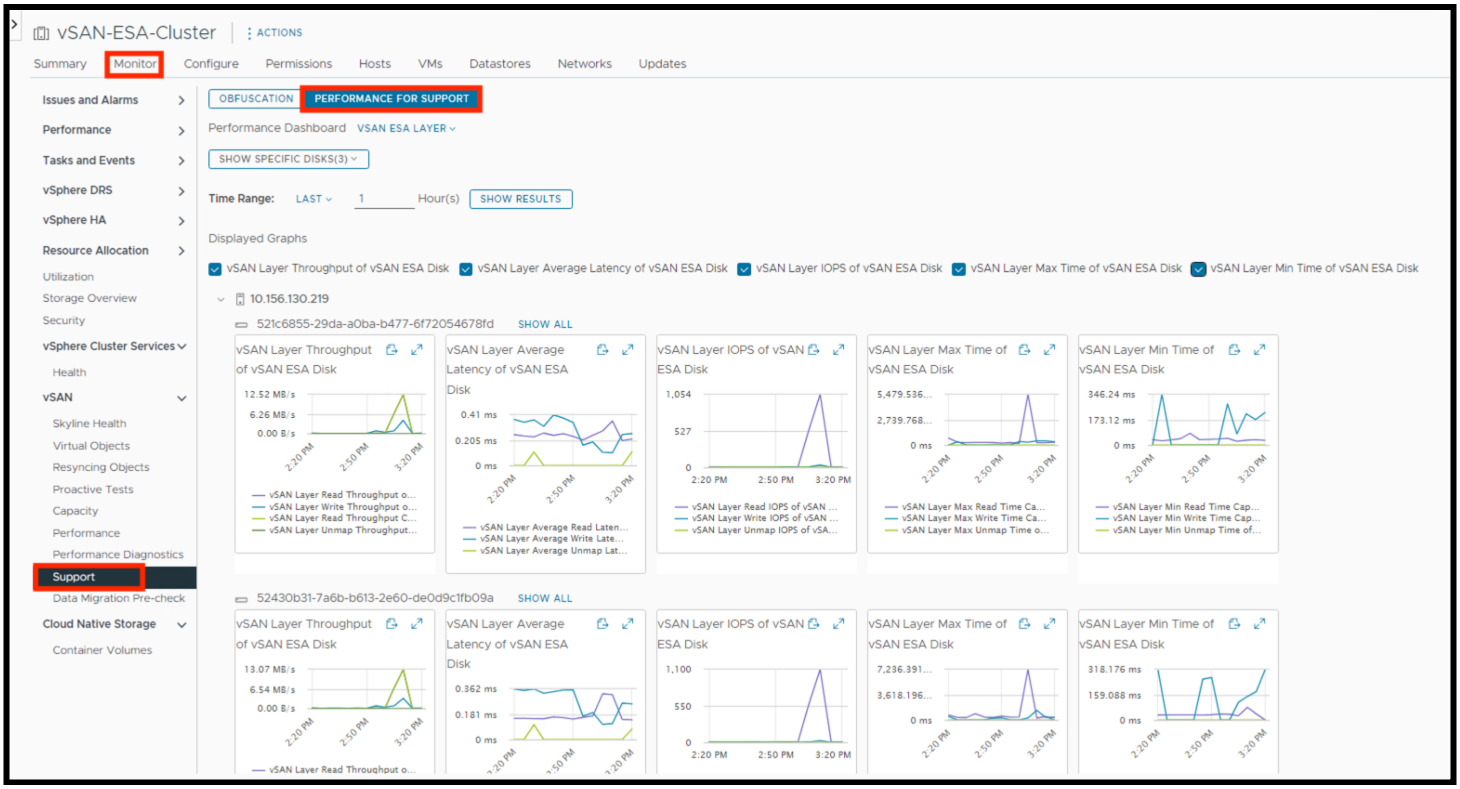
Virtual Disk: Hard disk 1

Clicking on any of the elements in the I/O Trip Analyzer screen will bring up performance details for that object, for instance:



Advanced Statistics

In day-to-day operations, the graphs above should be sufficient for most. To view advanced and debug information, navigate to **[vSAN Cluster]** > **Monitor > vSAN > Support** and click on **PERFORMANCE FOR SUPPORT:**

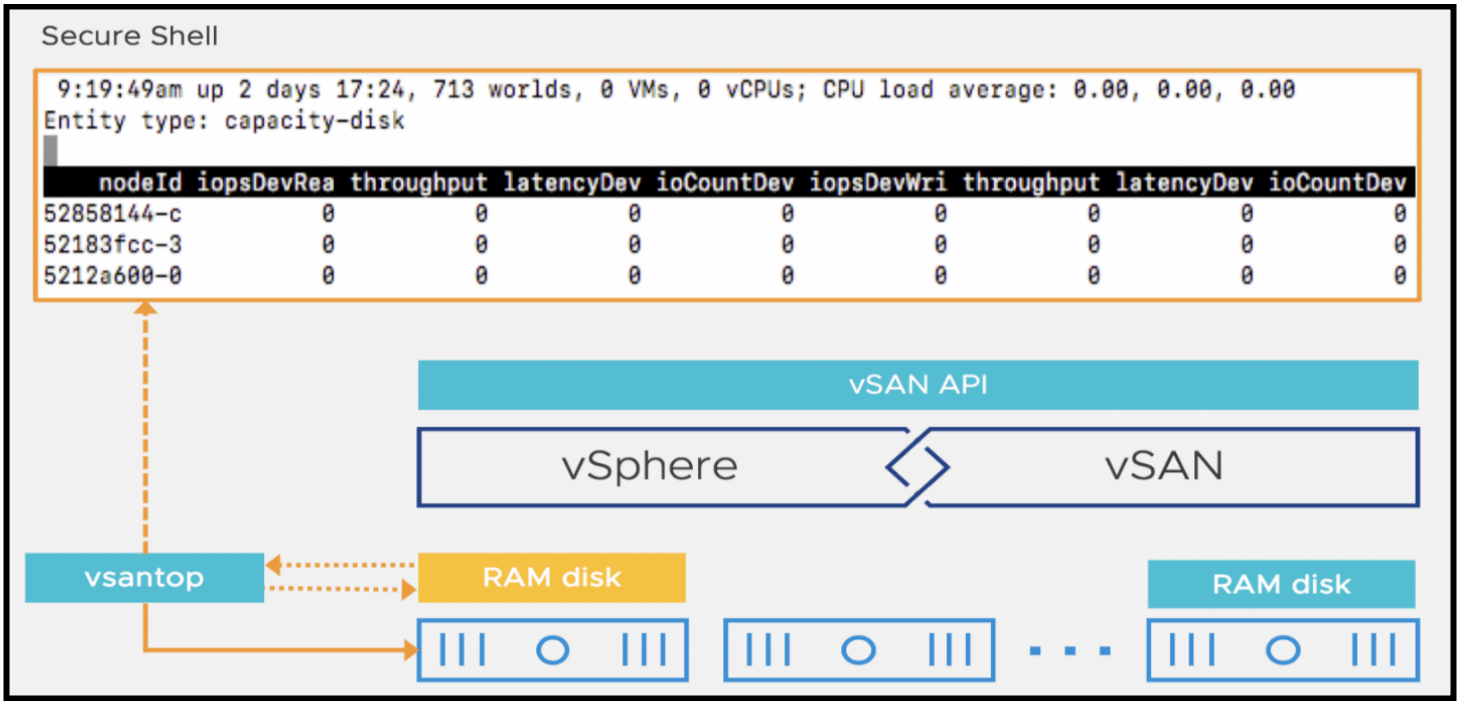

vSAN-ESA-Cluster
ACTIONS
Summary
Monitor
Configure
Permissions
Hosts
VMs
Datastores
Networks
Updates
Issues and Alarms
Performance
Tasks and Events
vSphere DRS
vSphere HA
Resource Allocation
Utilization
Storage Overview
Security
vSphere Cluster Services
Health
vSAN
Skyline Health
Virtual Objects
Resyncing Objects
Proactive Tests
Capacity
Performance
Performance Diagnostics
Support
Data Migration Pre-check
Cloud Native Storage
Container Volumes
OBFUSCATION
PERFORMANCE FOR SUPPORT
Performance Dashboard VSAN ESA LAYER
SHOW SPECIFIC DISKS(3)
Time Range: LAST 1 Hour(s)
SHOW RESULTS
Displayed Graphs
☑ vSAN Layer Throughput of vSAN ESA Disk
☑ vSAN Layer Average Latency of vSAN ESA Disk
☑ vSAN Layer IOPS of vSAN ESA Disk
☑ vSAN Layer Max Time of vSAN ESA Disk
☑ vSAN Layer Min Time of vSAN ESA Disk
10.156.130.219
521c6855-29da-a0ba-b477-6f72054678fd SHOW ALL
vSAN Layer Throughput of vSAN ESA Disk
12.52 MB/s
6.26 MB/s
0.00 B/s
2:20 PM
2:50 PM
3:20 PM
vSAN Layer Read Throughput o...
vSAN Layer Write Throughput o...
vSAN Layer Read Throughput C...
vSAN Layer Unmap Throughput...
vSAN Layer Average Latency of vSAN ESA Disk
0.41 ms
0.205 ms
0 ms
vSAN Layer Average Read Laten...
vSAN Layer Average Write Late...
vSAN Layer Average Unmap Lat...
vSAN Layer IOPS of vSAN ESA Disk
1,054
527
0
vSAN Layer Read IOPS of vSAN ...
vSAN Layer Write IOPS of vSAN ...
vSAN Layer Unmap IOPS of vSA...
vSAN Layer Max Time of vSAN ESA Disk
5,479,536...
2,739,768...
0 ms
vSAN Layer Max Read Time Ca...
vSAN Layer Max Write Time Ca...
vSAN Layer Max Unmap Time o...
vSAN Layer Min Time of vSAN ESA Disk
346.24 ms
173.12 ms
0 ms
vSAN Layer Min Read Time Cap...
vSAN Layer Min Write Time Cap...
vSAN Layer Min Unmap Time of...
52430b31-7a6b-b613-2e60-de0d9c1fb09a SHOW ALL
vSAN Layer Throughput of vSAN ESA Disk
13.07 MB/s
6.54 MB/s
0.00 B/s
vSAN Layer Read Throughput o...
vSAN Layer Average Latency of vSAN ESA Disk
0.362 ms
0.181 ms
0 ms
vSAN Layer IOPS of vSAN ESA Disk
1,100
550
0
vSAN Layer Max Time of vSAN ESA Disk
7,236,391...
3,618,196...
0 ms
vSAN Layer Min Time of vSAN ESA Disk
318.176 ms
159.088 ms
0 ms
2:20 PM
2:50 PM
3:20 PM

The metrics here are extensive; a variety of performance stats are available for review.

Advanced Performance Monitoring using vsantop

The *vsantop* utility monitors vSAN performance metrics within an individual ESXi host. Traditionally with ESXi, an embedded utility called *esxtop* was used to view real-time performance metrics. This utility assisted in ascertaining the resource utilization and performance of the system.

Like esxtop, vsantop collects and persists statistical data in a RAM disk. Based on the configured interval rate, the metrics are displayed on the secure shell console (this interval is configurable, dependent on the amount of detail required). The workflow is illustrated below for a better understanding:

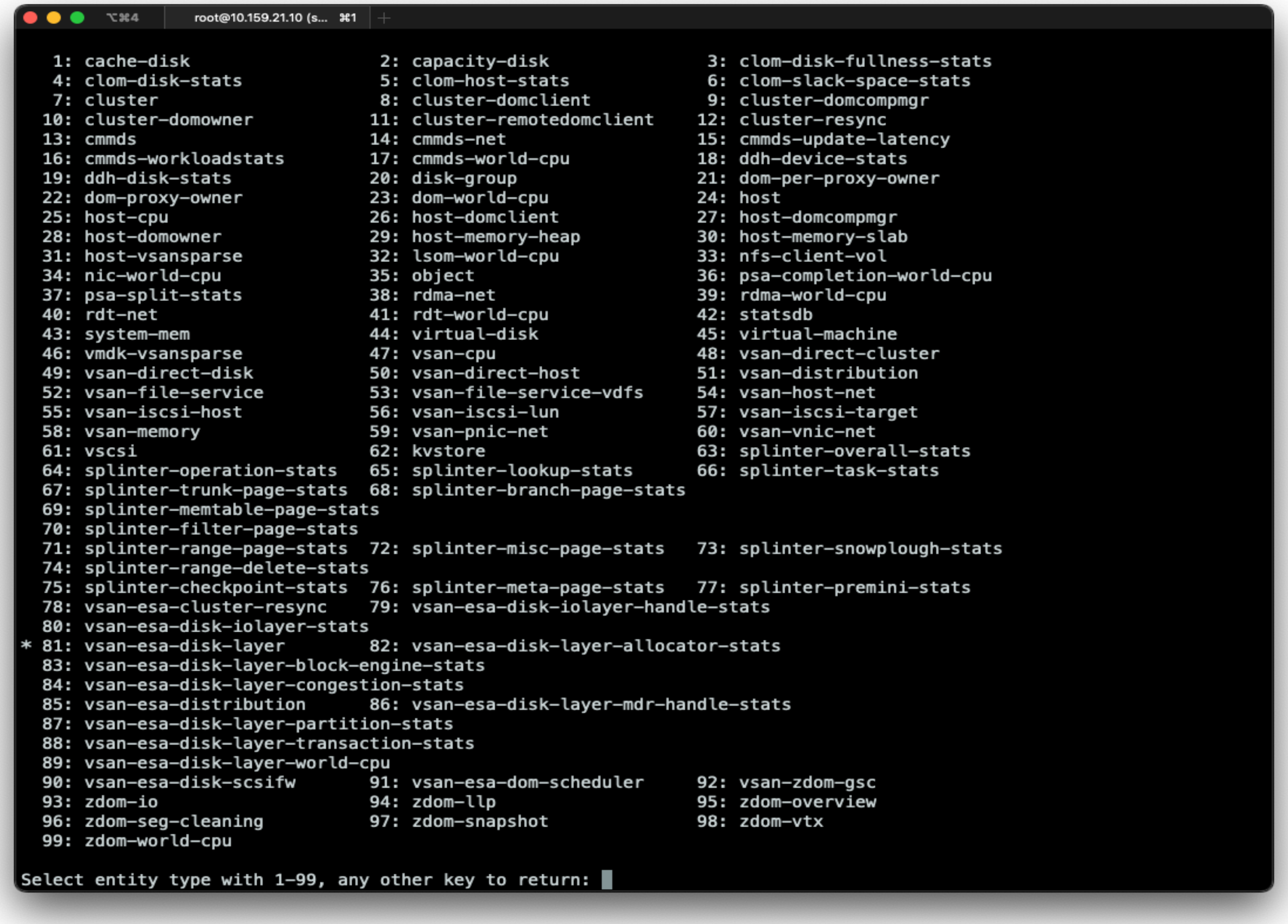


```
 9:19:49am up 2 days 17:24, 713 worlds, 0 VMs, 0 vCPUs; CPU load average: 0.00, 0.00, 0.00
Entity type: capacity-disk

    nodeId iopsDevRea throughput latencyDev ioCountDev iopsDevWri throughput latencyDev ioCountDev
52858144-c          0          0          0          0          0          0          0          0
52183fcc-3          0          0          0          0          0          0          0          0
5212a600-0          0          0          0          0          0          0          0          0
```

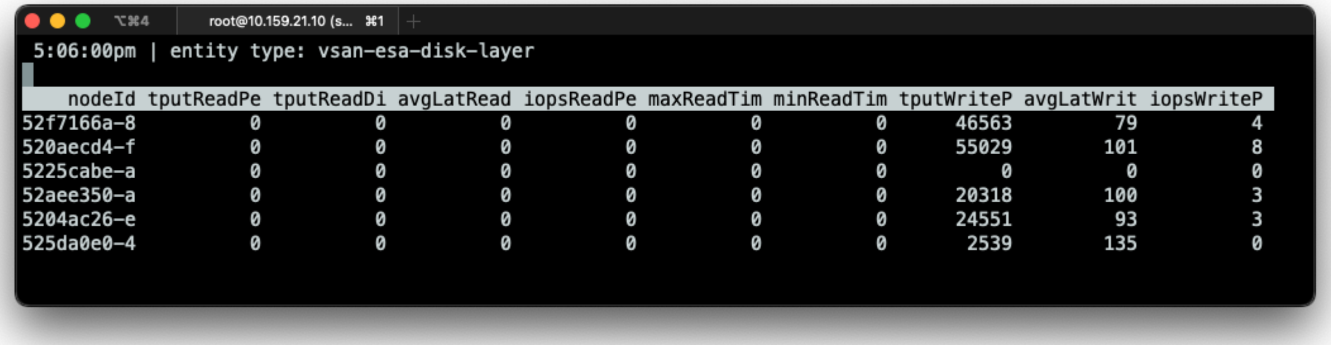
To initiate a vsantop session, open an SSH session to a host and run ‘vsantop’. The default view shows the cluster manager (CMMDS) output. To select another field, type the letter ‘E’ (for entity), which will bring up a menu to choose other views (note, it may take a while for data to populate):

For example, here we can see the vSAN ESA disk layer statistics:



```
   1: cache-disk                 2: capacity-disk              3: clom-disk-fullness-stats
   4: clom-disk-stats            5: clom-host-stats            6: clom-slack-space-stats
   7: cluster                    8: cluster-domclient          9: cluster-domcompmgr
  10: cluster-domowner          11: cluster-remotedomclient   12: cluster-resync
  13: cmmds                     14: cmmds-net                 15: cmmds-update-latency
  16: cmmds-workloadstats       17: cmmds-world-cpu           18: ddh-device-stats
  19: ddh-disk-stats            20: disk-group                21: dom-per-proxy-owner
  22: dom-proxy-owner           23: dom-world-cpu             24: host
  25: host-cpu                  26: host-domclient            27: host-domcompmgr
  28: host-domowner             29: host-memory-heap          30: host-memory-slab
  31: host-vsansparse           32: lsom-world-cpu            33: nfs-client-vol
  34: nic-world-cpu             35: object                    36: psa-completion-world-cpu
  37: psa-split-stats           38: rdma-net                  39: rdma-world-cpu
  40: rdt-net                   41: rdt-world-cpu             42: statsdb
  43: system-mem                44: virtual-disk              45: virtual-machine
  46: vmdk-vsansparse           47: vsan-cpu                  48: vsan-direct-cluster
  49: vsan-direct-disk          50: vsan-direct-host          51: vsan-distribution
  52: vsan-file-service         53: vsan-file-service-vdfs    54: vsan-host-net
  55: vsan-iscsi-host           56: vsan-iscsi-lun            57: vsan-iscsi-target
  58: vsan-memory               59: vsan-pnic-net             60: vsan-vnic-net
  61: vscsi                     62: kvstore                   63: splinter-overall-stats
  64: splinter-operation-stats  65: splinter-lookup-stats     66: splinter-task-stats
  67: splinter-trunk-page-stats  68: splinter-branch-page-stats
  69: splinter-memtable-page-stats
  70: splinter-filter-page-stats
  71: splinter-range-page-stats  72: splinter-misc-page-stats   73: splinter-snowplough-stats
  74: splinter-range-delete-stats
  75: splinter-checkpoint-stats  76: splinter-meta-page-stats   77: splinter-premini-stats
  78: vsan-esa-cluster-resync    79: vsan-esa-disk-iolayer-handle-stats
  80: vsan-esa-disk-iolayer-stats
* 81: vsan-esa-disk-layer        82: vsan-esa-disk-layer-allocator-stats
  83: vsan-esa-disk-layer-block-engine-stats
  84: vsan-esa-disk-layer-congestion-stats
  85: vsan-esa-distribution      86: vsan-esa-disk-layer-mdr-handle-stats
  87: vsan-esa-disk-layer-partition-stats
  88: vsan-esa-disk-layer-transaction-stats
  89: vsan-esa-disk-layer-world-cpu
  90: vsan-esa-disk-scsifw       91: vsan-esa-dom-scheduler     92: vsan-zdom-gsc
  93: zdom-io                    94: zdom-llp                   95: zdom-overview
  96: zdom-seg-cleaning          97: zdom-snapshot              98: zdom-vtx
  99: zdom-world-cpu

Select entity type with 1-99, any other key to return: 
```



```
 5:06:00pm | entity type: vsan-esa-disk-layer

    nodeId tputReadPe tputReadDi avgLatRead iopsReadPe maxReadTim minReadTim tputWriteP avgLatWrit iopsWriteP
52f7166a-8          0          0          0          0          0          0      46563         79          4
520aecd4-f          0          0          0          0          0          0      55029        101          8
5225cabe-a          0          0          0          0          0          0          0          0          0
52aee350-a          0          0          0          0          0          0      20318        100          3
5204ac26-e          0          0          0          0          0          0      24551         93          3
525da0e0-4          0          0          0          0          0          0       2539        135          0
```

For more information on vsantop, visit: https://core.vmware.com/resource/getting-started-vsantop

Monitoring vSAN through Integrated VMware Aria® Operations™ in vCenter

Overview

Further metrics and detail can be seen through VMware Aria Operations dashboards. There are a variety of ways to integrate Aria Operations with your vCenter instance.

This guide focuses on deploying a new Aria Operations instance directly from the vCenter GUI.

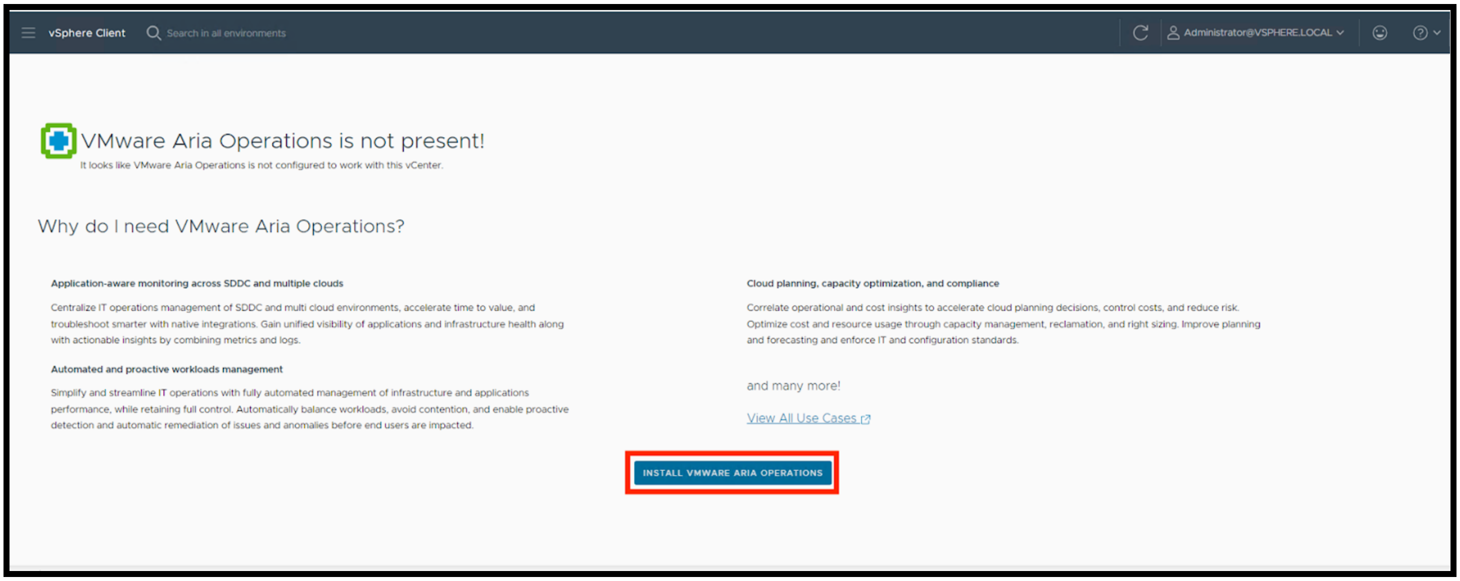
If you have an existing Aria Operations instance or you do not want the vCenter GUI integration, use these options:

- Integrating with an existing Aria Operations install
    - Ensure your vCenter instance is configured in Aria Operations - https://docs.vmware.com/en/VMware-Aria-Operations/8.14/Configuring-Operations/GUID-315C57B6-A383-4DBA-A8D0-FEF6CC56F0B4.html
    - Ensure you vSAN deployment is configured in Aria Operations - https://docs.vmware.com/en/VMware-Aria-Operations/8.14/Configuring-Operations/GUID-D2031BAE-43EA-47AA-AF53-1D62C86C3EA5.html

- Manually install Aria Operations, then integrate with your vCenter and vSAN deployment
    - Install - https://docs.vmware.com/en/VMware-Aria-Operations/8.14/Getting-Started-Operations/GUID-7FFC61A0-7562-465C-A0DC-46D092533984.html
    - Configuration - https://docs.vmware.com/en/VMware-Aria-Operations/8.14/Configuring-Operations/GUID-C4CABB37-43B0-4638-9AE0-0E6A15EC1442.html

Deploying Aria Operations via vCenter Integration

You can initiate the workflow by navigating to **Menu > VMware Aria Operations Configuration.** Once on the **VMware Aria Operations** screen, click **Install VMware Aria Operations**:


vSphere Client
Search in all environments
Administrator@VSPHERE.LOCAL
INSTALL VMWARE ARIA OPERATIONS

VMware Aria Operations is not present!

It looks like VMware Aria Operations is not configured to work with this vCenter.

Why do I need VMware Aria Operations?

Application-aware monitoring across SDDC and multiple clouds

Centralize IT operations management of SDDC and multi cloud environments, accelerate time to value, and troubleshoot smarter with native integrations. Gain unified visibility of applications and infrastructure health along with actionable insights by combining metrics and logs.

Automated and proactive workloads management

Simplify and streamline IT operations with fully automated management of infrastructure and applications performance, while retaining full control. Automatically balance workloads, avoid contention, and enable proactive detection and automatic remediation of issues and anomalies before end users are impacted.

Cloud planning, capacity optimization, and compliance

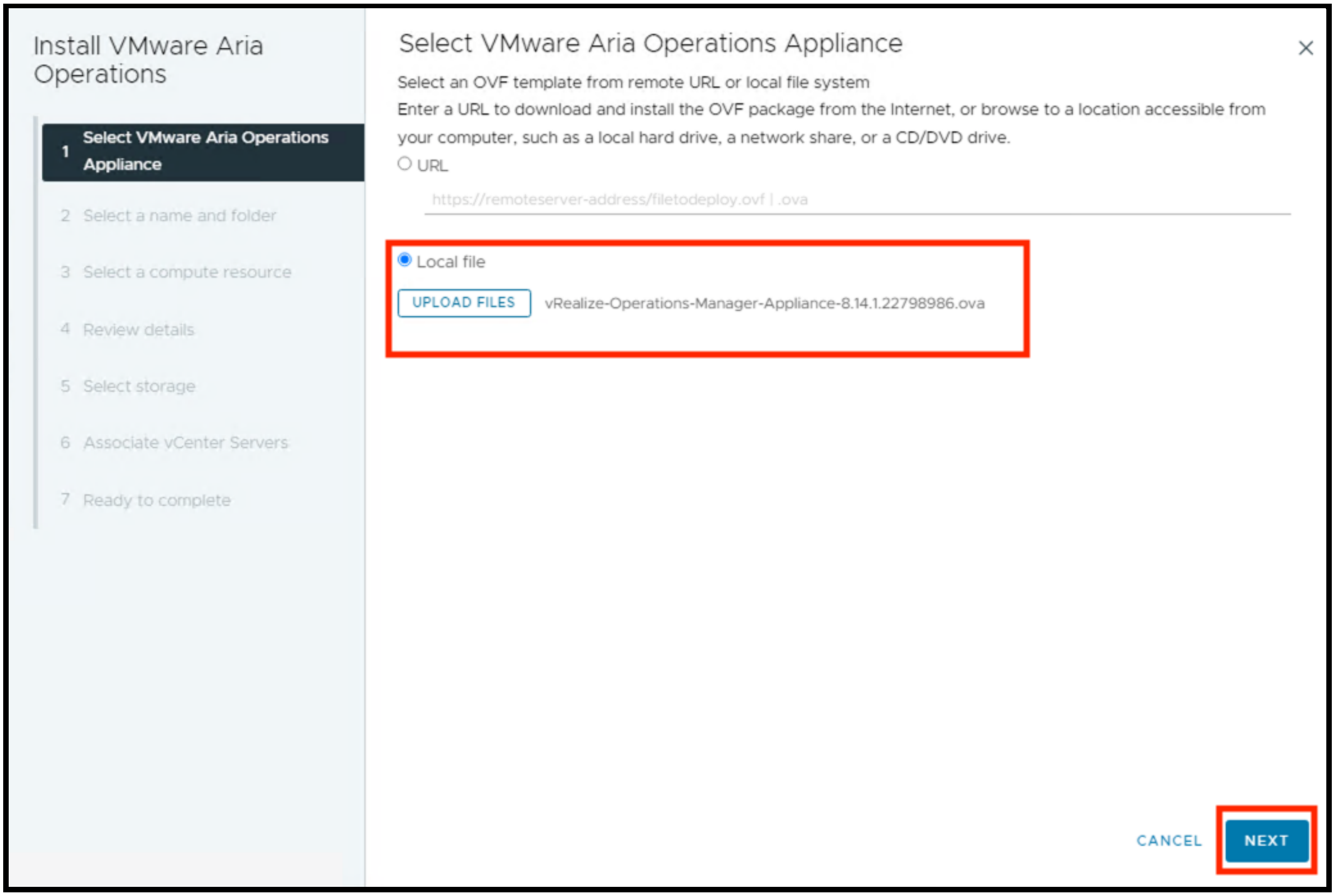
Correlate operational and cost insights to accelerate cloud planning decisions, control costs, and reduce risk. Optimize cost and resource usage through capacity management, reclamation, and right sizing. Improve planning and forecasting and enforce IT and configuration standards.

and many more!

View All Use Cases

This will call up the Install VMware Aria Operations wizard. Fill out the details as required for the connection to deploy a Aria Operations instance via OVF.

Note: The workflow assumes either Internet access to directly download the appliance or a previous locally downloaded copy. In this example we used a locally downloaded copy:



Install VMware Aria Operations

1 Select VMware Aria Operations Appliance
2 Select a name and folder
3 Select a compute resource
4 Review details
5 Select storage
6 Associate vCenter Servers
7 Ready to complete

Select VMware Aria Operations Appliance

Select an OVF template from remote URL or local file system

Enter a URL to download and install the OVF package from the Internet, or browse to a location accessible from your computer, such as a local hard drive, a network share, or a CD/DVD drive.

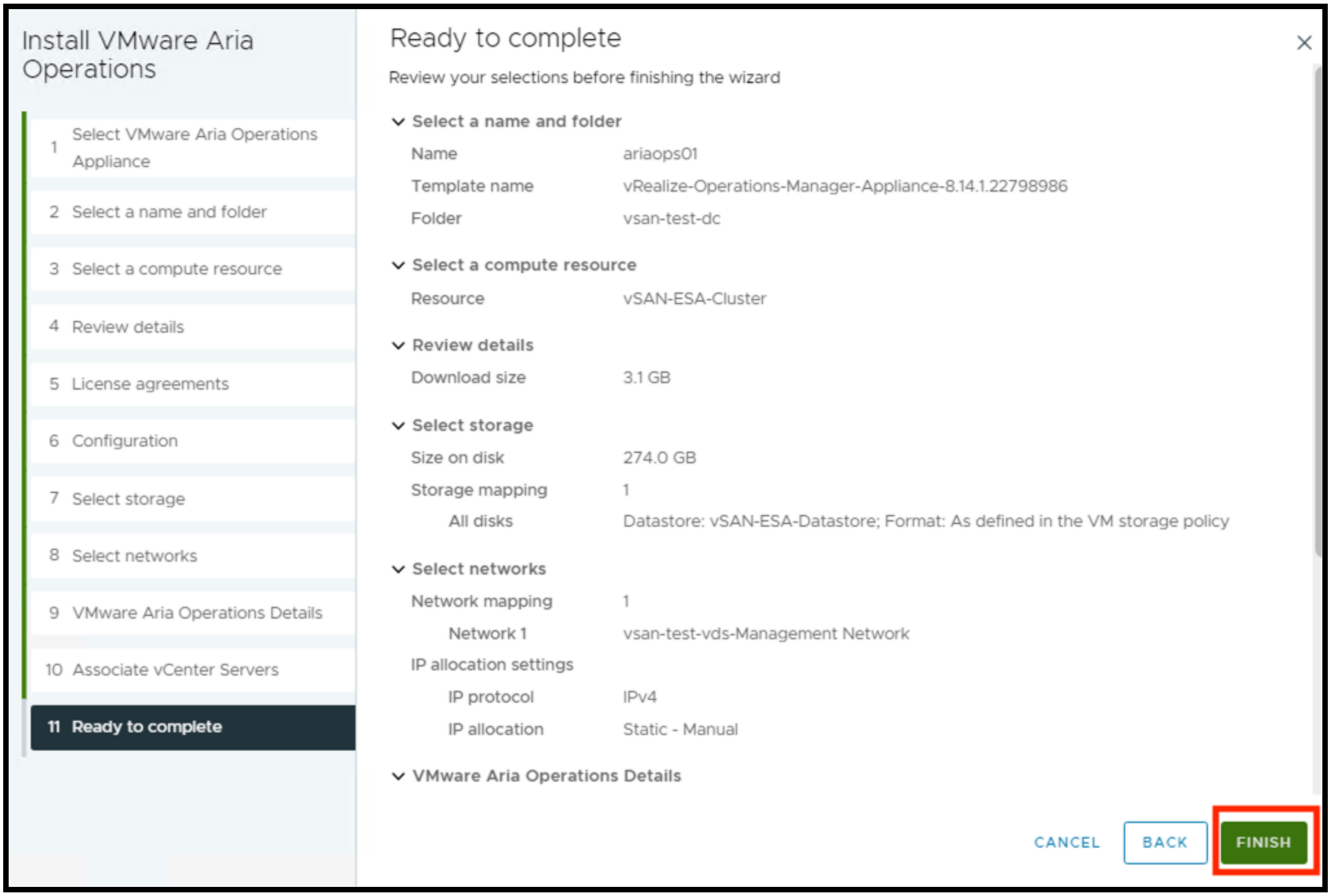
○ URL

https://remoteserver-address/filetodeploy.ovf | .ova

● Local file

UPLOAD FILES vRealize-Operations-Manager-Appliance-8.14.1.22798986.ova

Continue through the Install VMware Aria Operations wizard, then click **Finish**:



Install VMware Aria Operations

1 Select VMware Aria Operations Appliance
2 Select a name and folder
3 Select a compute resource
4 Review details
5 License agreements
6 Configuration
7 Select storage
8 Select networks
9 VMware Aria Operations Details
10 Associate vCenter Servers
11 Ready to complete

Ready to complete

Review your selections before finishing the wizard

Select a name and folder

Name	ariaops01
Template name	vRealize-Operations-Manager-Appliance-8.14.1.22798986
Folder	vsan-test-dc

Select a compute resource

Resource	vSAN-ESA-Cluster

Review details

Download size	3.1 GB

Select storage

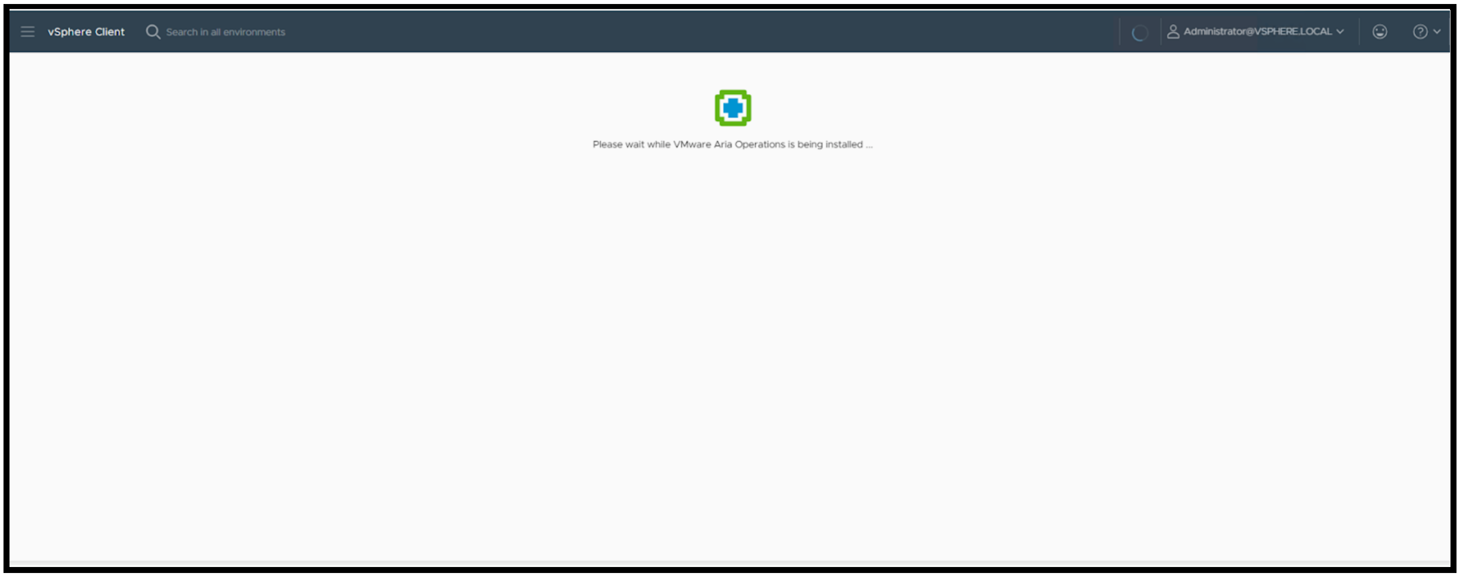
Size on disk	274.0 GB
Storage mapping	1
All disks	Datastore: vSAN-ESA-Datastore; Format: As defined in the VM storage policy

Select networks

Network mapping	1
Network 1	vsan-test-vds-Management Network
IP allocation settings	
IP protocol	IPv4
IP allocation	Static - Manual

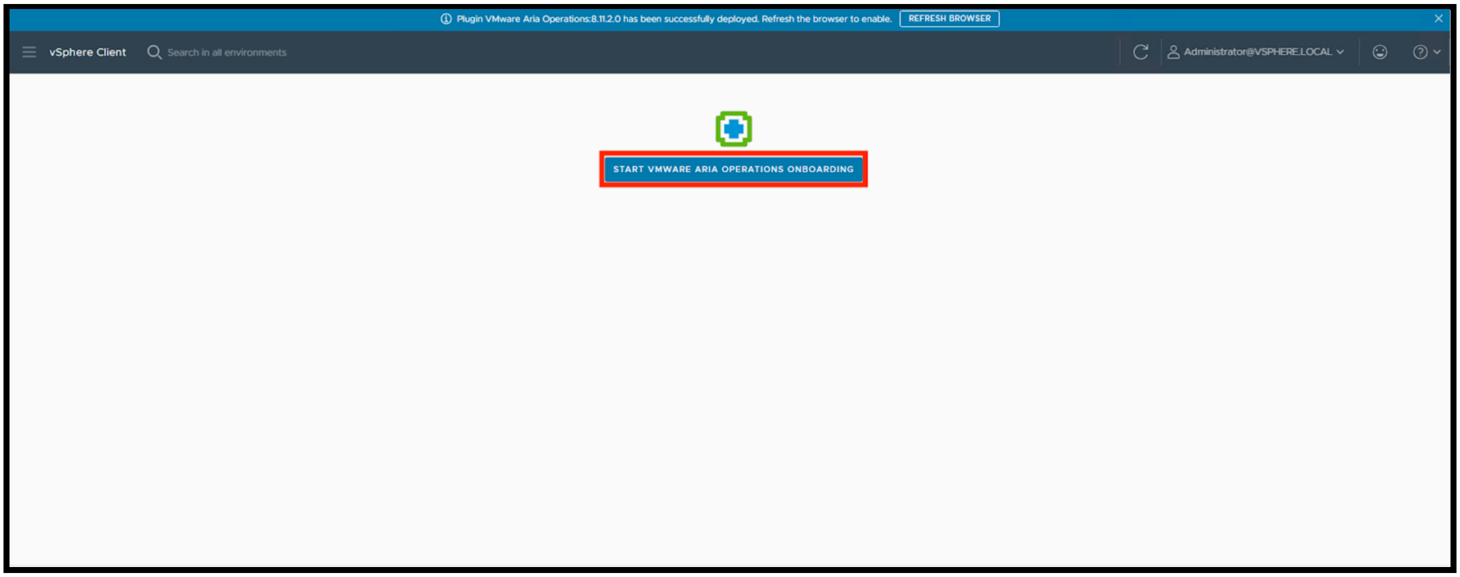
VMware Aria Operations Details

The Aria Operations OVF will be deployed. During the process you will see the wait screen below:



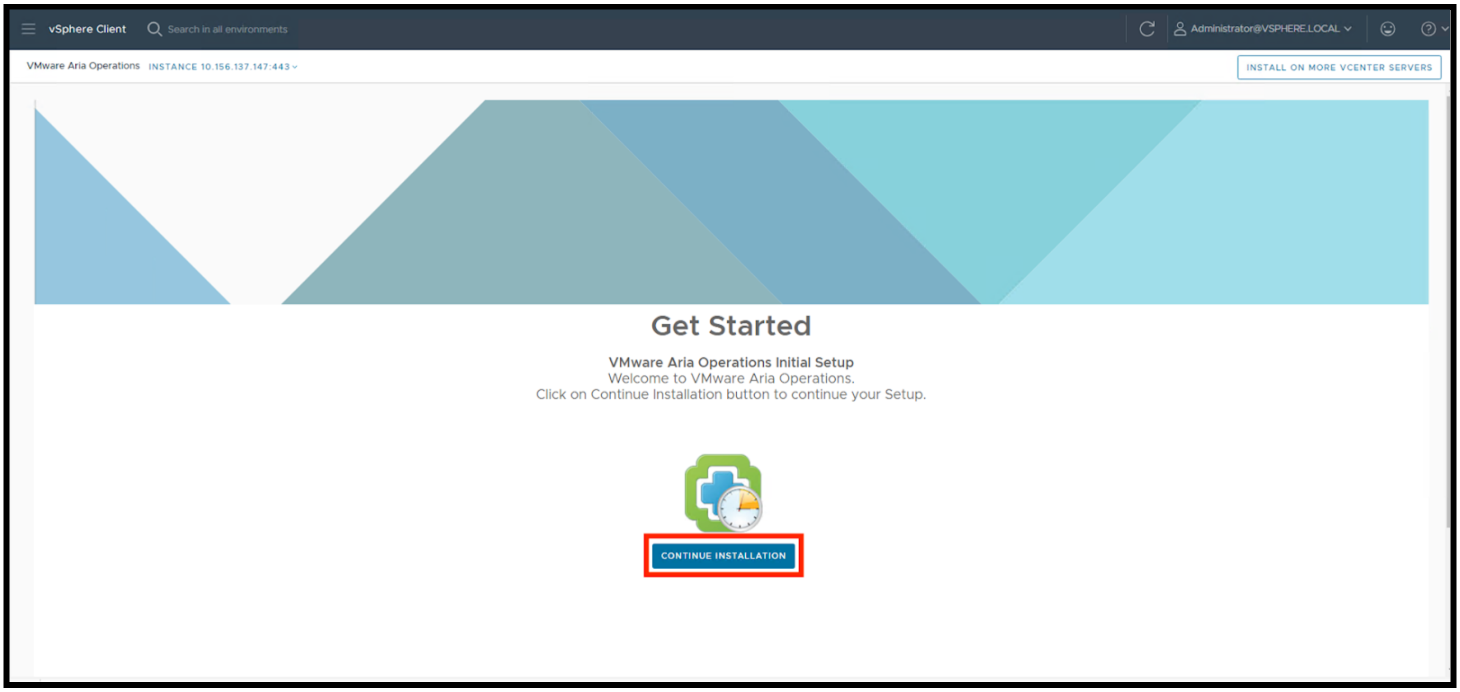
Please wait while VMware Aria Operations is being installed ...

After the Aria Operations OVF is deployed and started, the configuration wizard will begin. Click **Start VMware Aria Operations Onboarding**, then **Continue Installation**:



Plugin VMware Aria Operations:8.11.2.0 has been successfully deployed. Refresh the browser to enable.

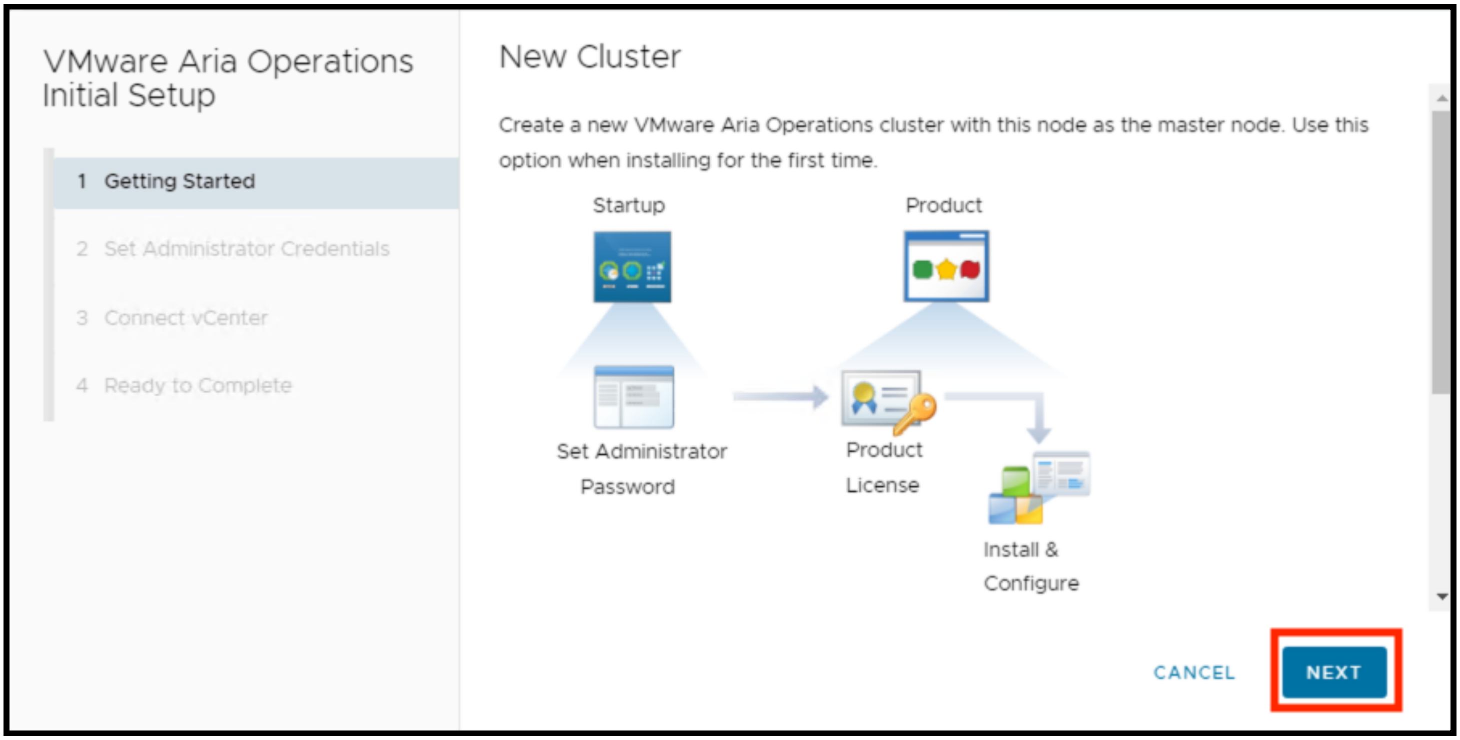
REFRESH BROWSER
vSphere Client
Search in all environments
Administrator@VSPHERE.LOCAL
START VMWARE ARIA OPERATIONS ONBOARDING


vSphere Client
Search in all environments
Administrator@VSPHERE.LOCAL
VMware Aria Operations
INSTANCE 10.156.137.147:443
INSTALL ON MORE VCENTER SERVERS

Get Started

VMware Aria Operations Initial Setup
Welcome to VMware Aria Operations.
Click on Continue Installation button to continue your Setup.

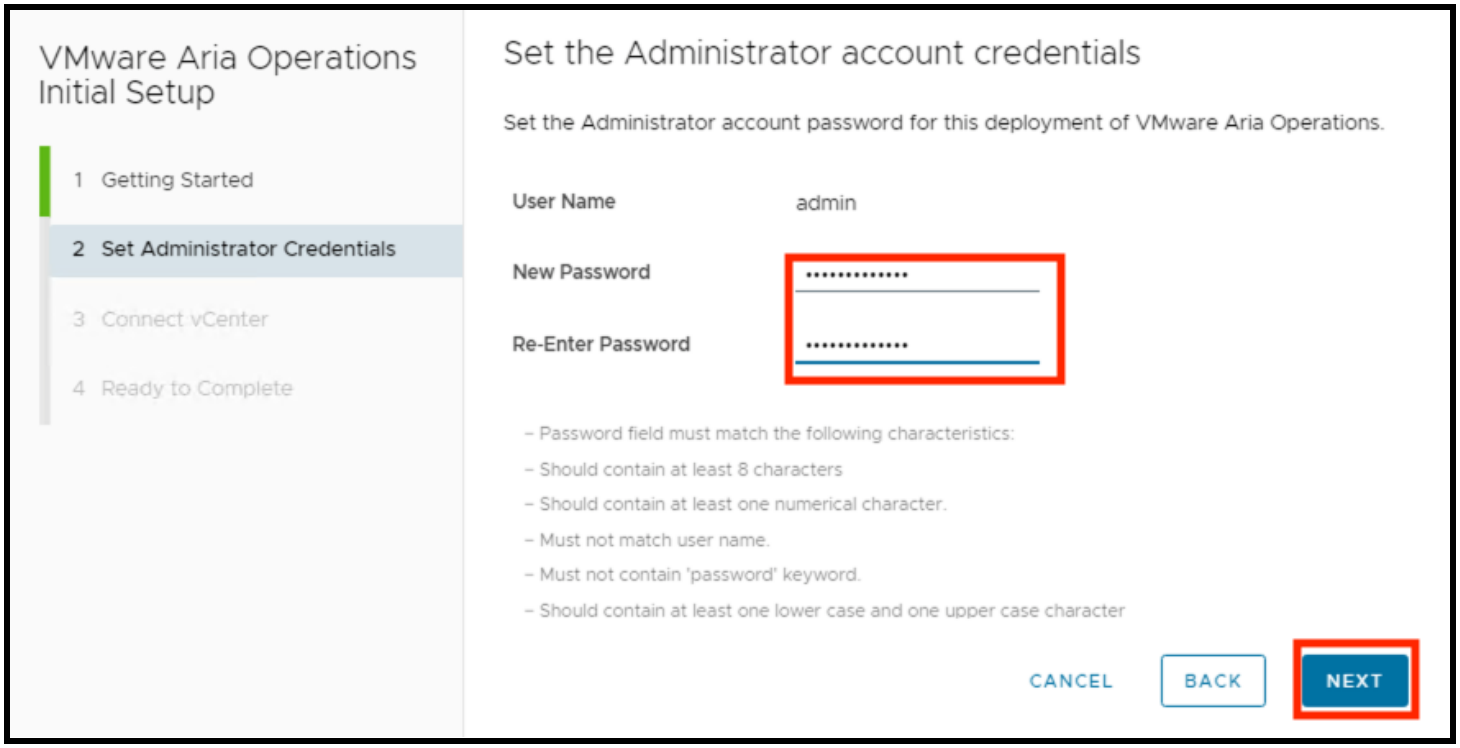
The final steps are to initialize the New Cluster. This wizard will have you set the admin password for the Aria Ops instance and connection to your vCenter server. Walkthrough the steps below:


VMware Aria Operations Initial Setup

1 Getting Started
2 Set Administrator Credentials
3 Connect vCenter
4 Ready to Complete

New Cluster

Create a new VMware Aria Operations cluster with this node as the master node. Use this option when installing for the first time.



VMware Aria Operations Initial Setup

1 Getting Started

2 Set Administrator Credentials

3 Connect vCenter

4 Ready to Complete

Set the Administrator account credentials

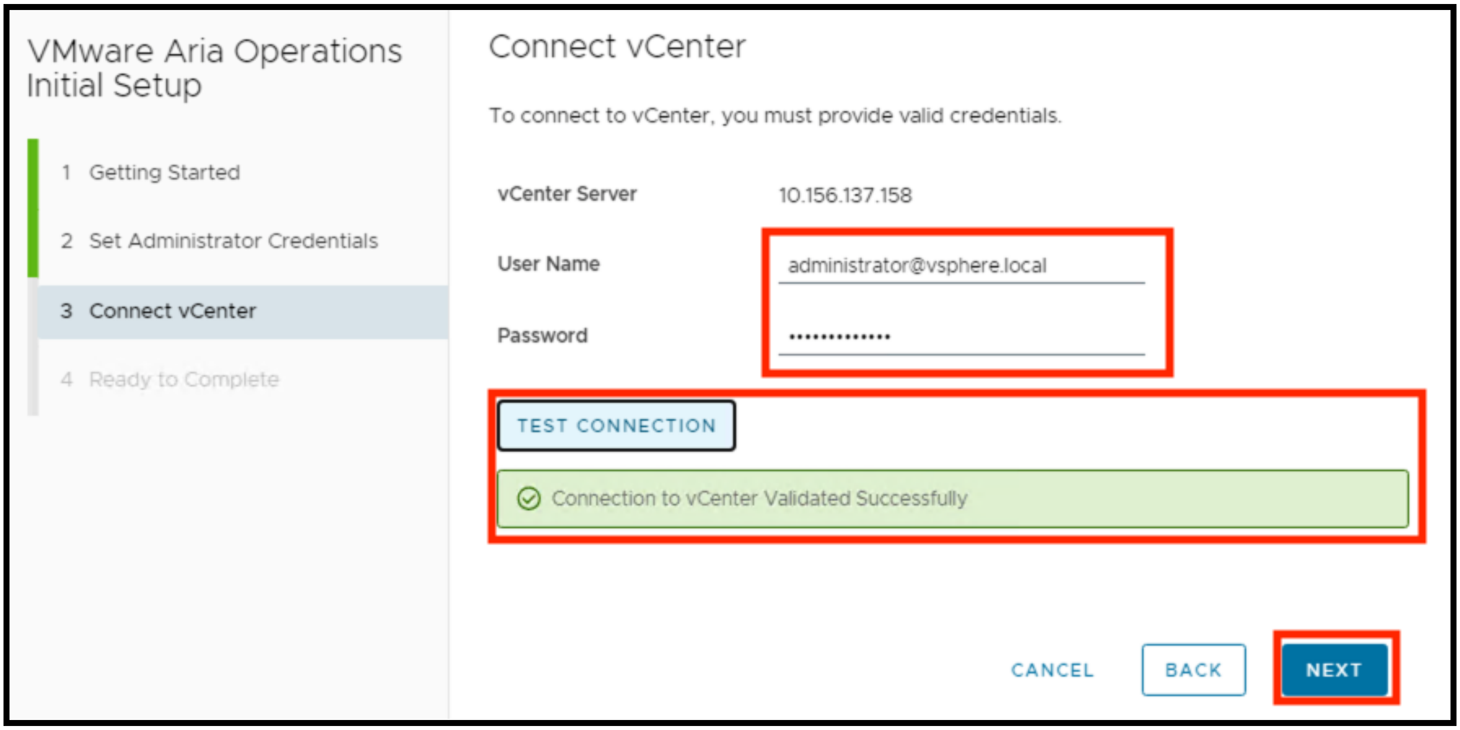
Set the Administrator account password for this deployment of VMware Aria Operations.

User Name admin

New Password •••••••••••••

Re-Enter Password •••••••••••••

- Password field must match the following characteristics:
- Should contain at least 8 characters
- Should contain at least one numerical character.
- Must not match user name.
- Must not contain 'password' keyword.
- Should contain at least one lower case and one upper case character



VMware Aria Operations Initial Setup

1 Getting Started

2 Set Administrator Credentials

3 Connect vCenter

4 Ready to Complete

Connect vCenter

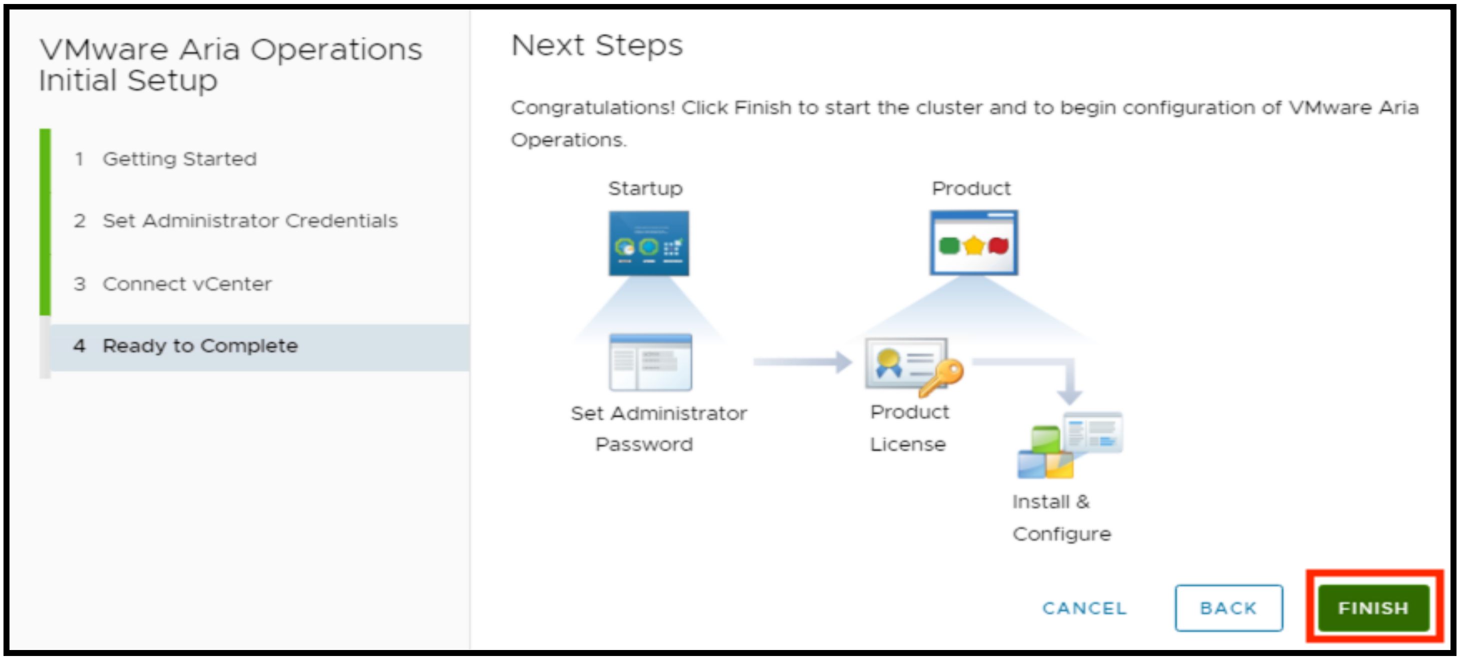
To connect to vCenter, you must provide valid credentials.

vCenter Server 10.156.137.158

User Name administrator@vsphere.local

Password •••••••••••••

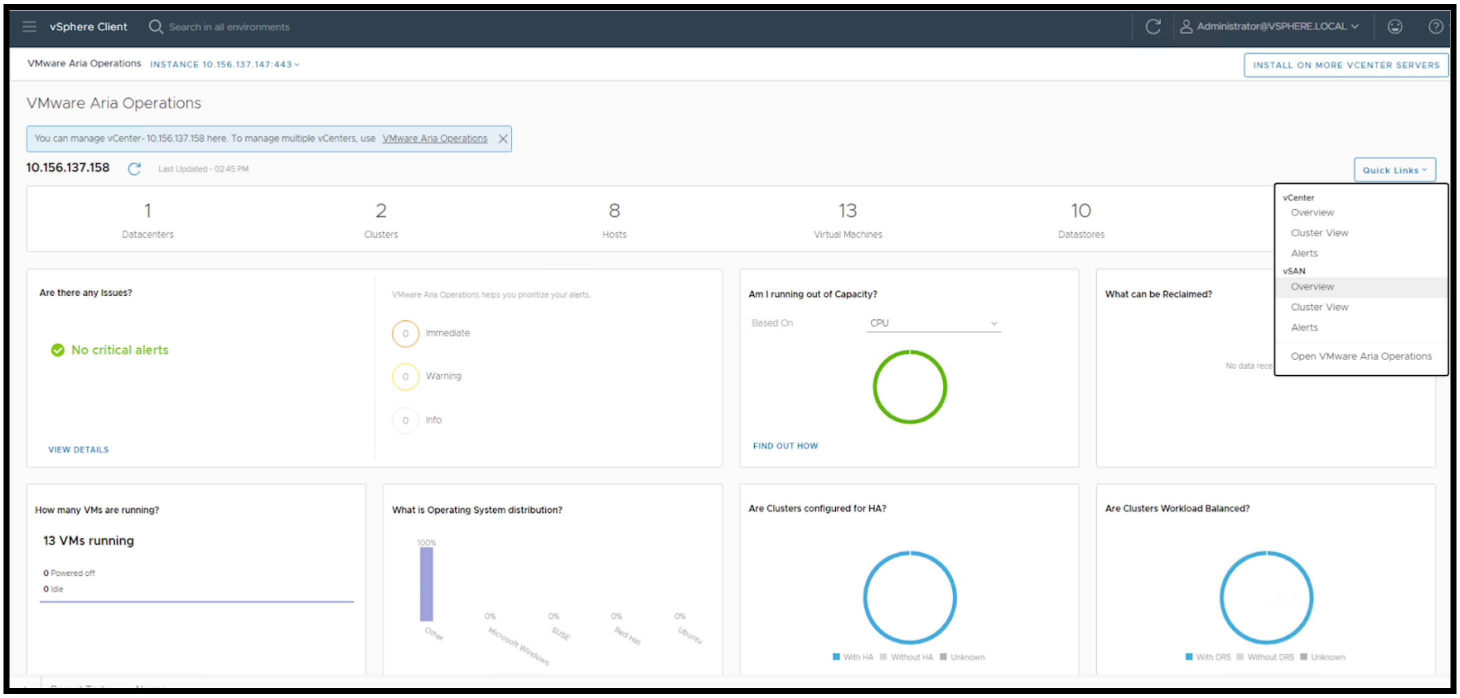
Connection to vCenter Validated Successfully



Congratulations! Click Finish to start the cluster and to begin configuration of VMware Aria Operations.

Once these screens are completed Aria Operations will finish configuration. To include registering the vCenter and vSAN instances with Aria Operations as well as start data collection and processing.

After the process is complete, you can access the predefined dashboards as shown below, using the **Quick Links**’ menu. Depending on the size of your environment it may take a few hours for data to process and display on screen:



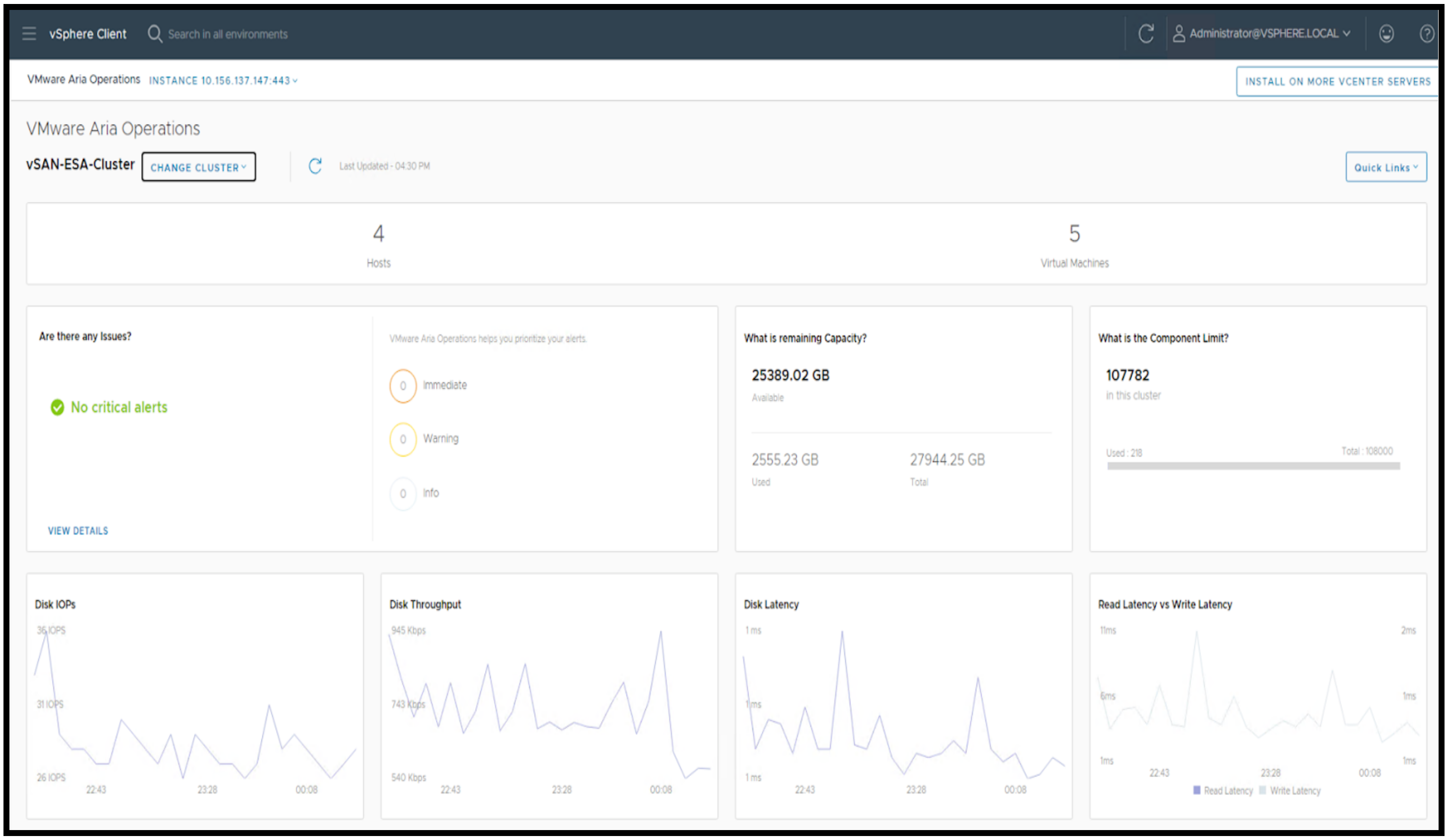
You can manage vCenter- 10.156.137.158 here. To manage multiple vCenters, use VMware Aria Operations

VMware Aria Operations helps you prioritize your alerts.

The following out-of-the-box dashboards are available for monitoring purposes,

- vCenter - Overview
- vCenter - Cluster View
- vCenter - Alerts
- vSAN- Overview
- vSAN - Cluster View
- vSAN - Alerts

For example, in the vSAN cluster view, useful metrics such as disk IOPs and capacity are shown. This allows administrators to quickly assess the state of the cluster:



VMware Aria Operations

vSAN-ESA-Cluster

Last Updated - 04:30 PM

4 Hosts

5 Virtual Machines

Are there any Issues?

No critical alerts

VMware Aria Operations helps you prioritize your alerts.

0 Immediate

0 Warning

0 Info

What is remaining Capacity?

25389.02 GB Available

2555.23 GB Used

27944.25 GB Total

What is the Component Limit?

107782 in this cluster

Used : 218

Total : 108000

For further information please review:

- VMware Aria Suite in vSAN Environments - https://core.vmware.com/resource/vrealize-operations-and-log-insight-vsan-environments
- VMware Aria Operations documentation - https://docs.vmware.com/en/vRealize-Operations/index.html

Testing Hardware Failures

Understanding Expected Behaviors

When conducting any failure testing, it is important to consider the expected outcome before the test is conducted. With each test described in this section, you should first read the preceding description to first understand how the test will affect the system.

Note: It is important to test one scenario at a time and restore completely before the next test condition. Only test one thing at time.

As with any system design, a configuration is built to tolerate a certain level of availability and performance. It is important that each test is conducted within the limit of the design systematically. By default, VMs deployed on vSAN inherit the default storage policy, with the ability to tolerate one failure. When a second failure is introduced without resolving the first, the VMs will not be able to tolerate the second failure and may become inaccessible. It is important that you resolve the first failure or test within the system limits to avoid such unexpected outcomes.

VM Behavior when Multiple Failures Encountered

A VM remains accessible when a full mirror copy of the objects are available, as well as greater than 50% of the components that make up the VM (to maintain quorum).

Below, we discuss VM behavior when there are more failures in the cluster than the *NumberOfFailuresToTolerate* setting in the policy associated with the VM.

VM Powered on and VM Home Namespace Object Goes Inaccessible

If a running VM has its VM Home Namespace object go inaccessible due to failures in the cluster, several different things may happen. Once the VM is powered off, it will be marked "inaccessible" in vCenter. There can also be other effects, such as the VM being renamed to its ".vmx" path rather than VM name, or the VM being marked "orphaned".

VM Powered on and Disk Object is inaccessible

If a running VM has one of its disk objects become inaccessible, the VM may keep running in memory. Typically, the Guest OS will eventually time out due to I/O operations to disk. Operating systems may either crash when this occurs or downgrade the affected filesystems to read-only (the OS behavior and even the VM behavior is not vSAN specific). These effects can also be seen on VMs on traditional storage when the host suffers from an *APD* (All Paths Down) state.

Once the VM becomes accessible again, the status should resolve, and things go back to normal. Of course, data remains intact during these scenarios.

What happens when a Host Fails?

A host failure can occur in numerous ways, it could be a crash, or it could be a network issue (which is discussed in more detail in the next section). However, it could also be something as innocent as a reboot.

Any components that were part of the failed host are marked as 'absent'. I/O flow to the object is restored by removing the absent component from the active set of components in the object.

The 'absent' state is chosen rather than the 'degraded' state because of the likelihood of the failure being transient (i.e. due to a reboot). For instance, a host might be configured to auto-reboot after a crash, or the host's power was temporarily interrupted. For this reason, a set amount of time is allowed before starting to rebuild objects on other hosts, so as not to waste resources. By default, this timer is set to 60 minutes. If the timer expires, and the host has not rejoined the cluster, a rebuild of components on the remaining hosts in the cluster commences.

Moreover, if a host fails or is rebooted, this event will trigger a 'host connection and power state' alarm in vCenter. If vSphere HA is enabled on the cluster, it will also trigger a 'vSphere HA host status' alarm and a 'Host cannot communicate with all other nodes in the vSAN Enabled Cluster' warning message on all remaining hosts. If any VMs were running on the failed host, they are restarted on another host in the cluster.

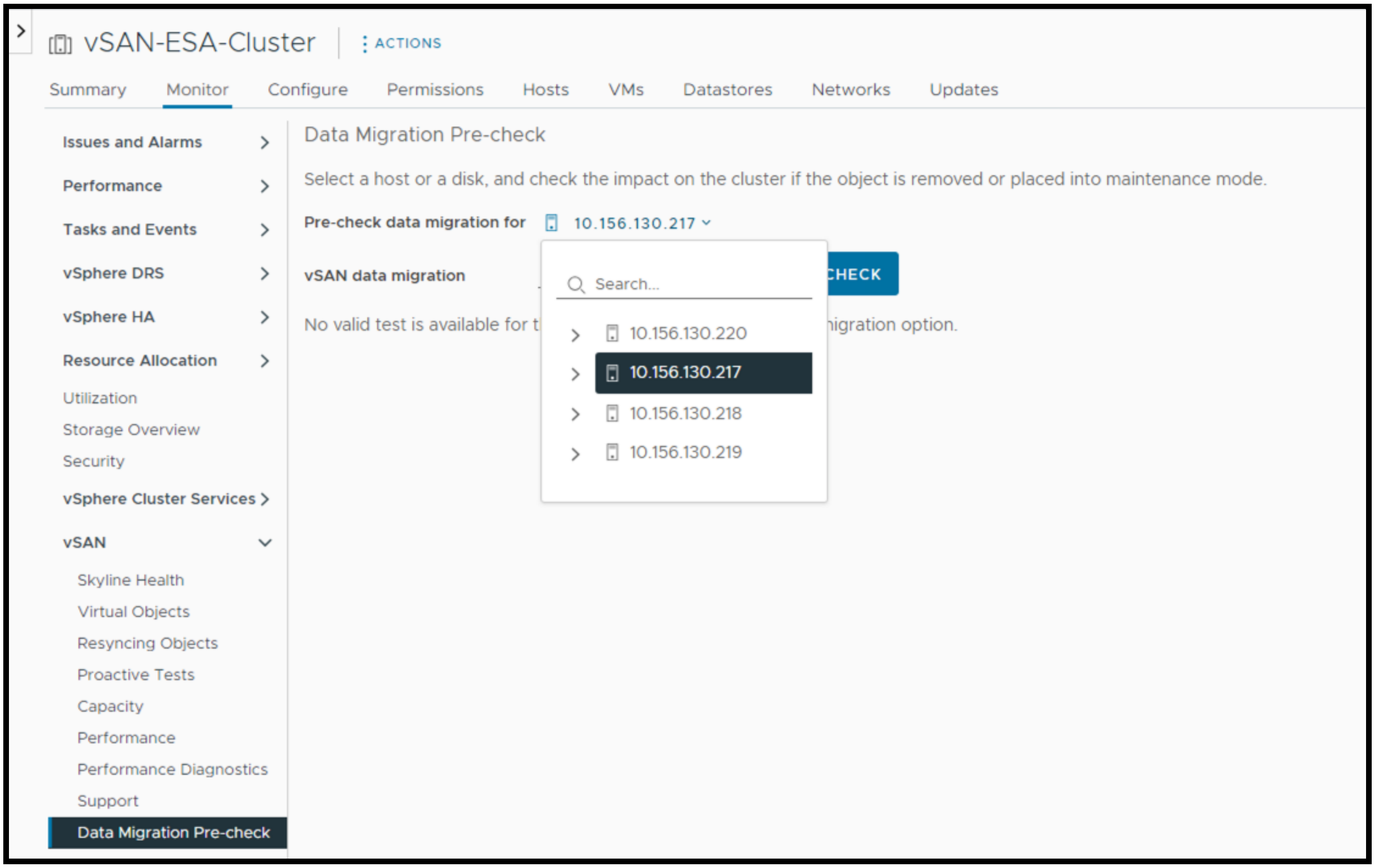
Simulating Failure Scenarios Using Pre-Check

It can be useful to run simulations on the loss of a particular host or disk, to see the effects of planned maintenance or hardware failure. The Data Migration Pre-Check feature can be used to check object availability for any given host or disk. These can be run at any time without affecting VM traffic.

Loss of a Host - vSAN ESA

Navigate to: **[vSAN Cluster] > Monitor > vSAN > Data Migration Pre-check**

From here, you can select the host to run the simulations on:



Data Migration Pre-check

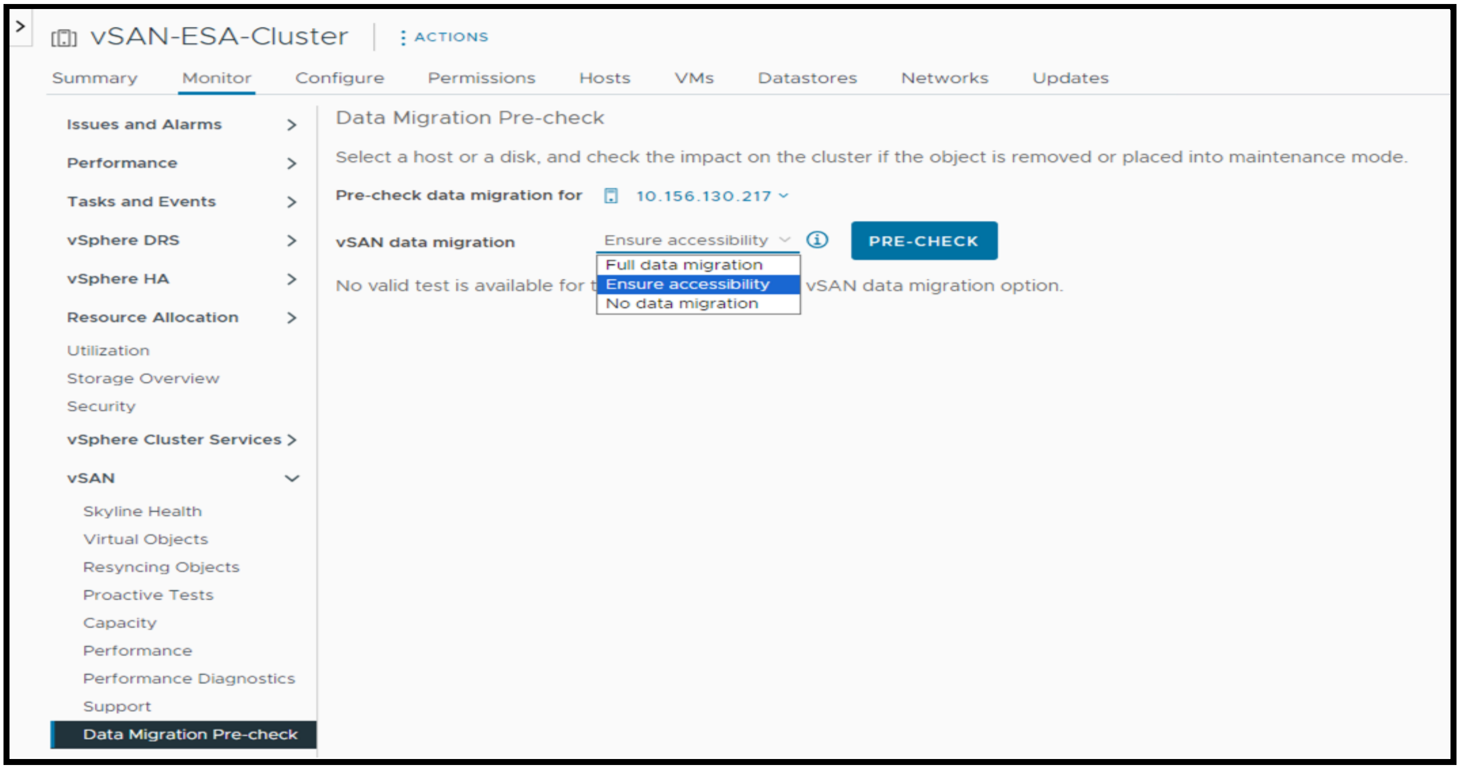
Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.217

vSAN data migration

No valid test is available for t… …igration option.

After a host is selected, the pre-check can be run against three available options, i.e., Full data migration, Ensure accessibility, No data migration:



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

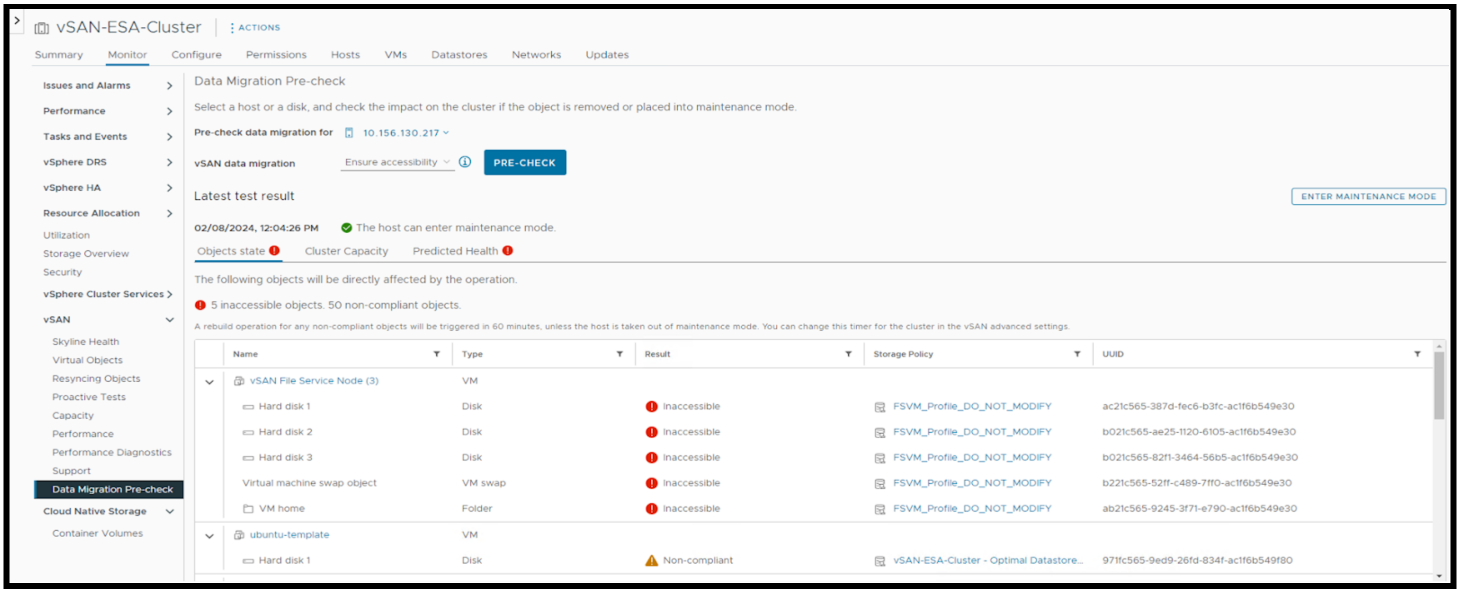
Pre-check data migration for 10.156.130.217

vSAN data migration Ensure accessibility

No valid test is available for t[…] vSAN data migration option.

Select the desired option and click the Pre-Check button. This gives us the results of the simulation. From the results, three sections are shown: Object State, Cluster Capacity and Predicted Health.

The **Object State** view shows how the individual objects will be affected:



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for 10.156.130.217

vSAN data migration Ensure accessibility

Latest test result

02/08/2024, 12:04:26 PM ✓ The host can enter maintenance mode.

The following objects will be directly affected by the operation.

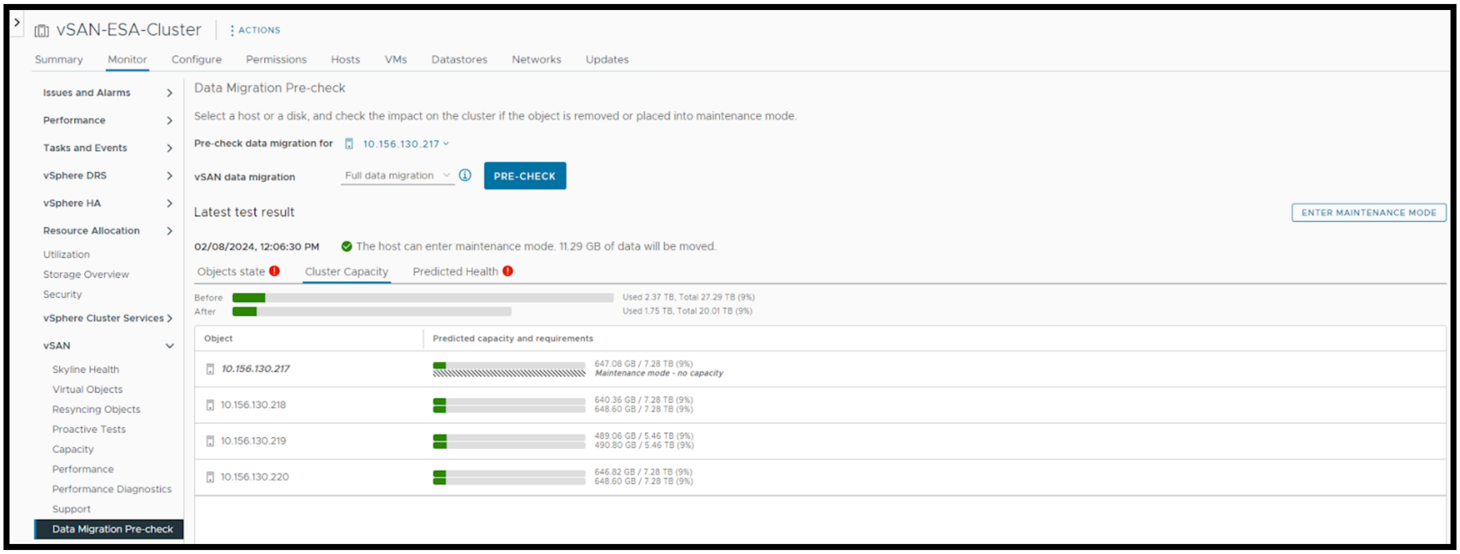
● 5 inaccessible objects. 50 non-compliant objects.

A rebuild operation for any non-compliant objects will be triggered in 60 minutes, unless the host is taken out of maintenance mode. You can change this timer for the cluster in the vSAN advanced settings.

Name	Type	Result	Storage Policy	UUID
vSAN File Service Node (3)	VM			
Hard disk 1	Disk	Inaccessible	FSVM_Profile_DO_NOT_MODIFY	ac21c565-387d-fec6-b3fc-ac1f6b549e30
Hard disk 2	Disk	Inaccessible	FSVM_Profile_DO_NOT_MODIFY	b021c565-ae25-1120-6105-ac1f6b549e30
Hard disk 3	Disk	Inaccessible	FSVM_Profile_DO_NOT_MODIFY	b021c565-82f1-3464-56b5-ac1f6b549e30
Virtual machine swap object	VM swap	Inaccessible	FSVM_Profile_DO_NOT_MODIFY	b221c565-52ff-c489-7ff0-ac1f6b549e30
VM home	Folder	Inaccessible	FSVM_Profile_DO_NOT_MODIFY	ab21c565-9245-3f71-e790-ac1f6b549e30
ubuntu-template	VM			
Hard disk 1	Disk	Non-compliant	vSAN-ESA-Cluster - Optimal Datastore...	971fc565-9ed9-26fd-834f-ac1f6b549f80

The example pre-check shows a vSAN File Services appliance as inaccessible. vSAN File Services leverages an internal multi-appliance clustering solution. In case of a host going down the file services appliance on said host will be in a down-state. The other file service appliance will continue to support vSAN File Service functionality. When the host comes back-up, the administrator can ensure the local file service appliance is restarted. Once restarted it will automatically return to service.

Cluster Capacity shows how the capacity of the other hosts will be affected. Below we see the effects of the **Full data migration**' option:



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for: 10.156.130.217

vSAN data migration: Full data migration

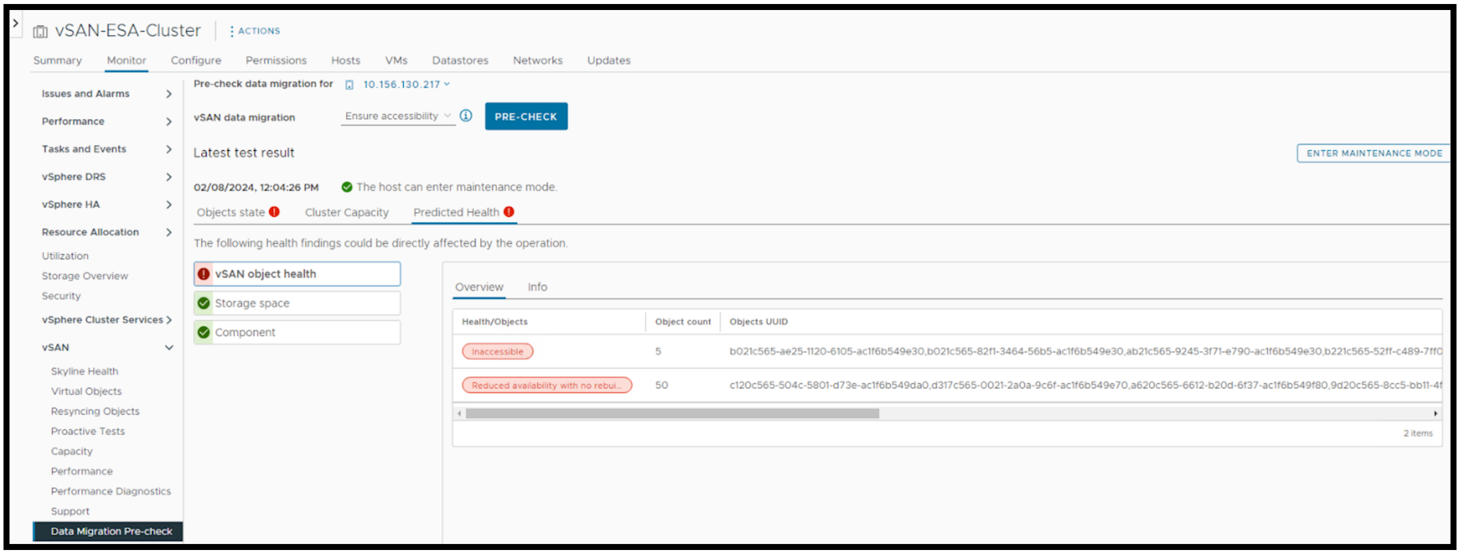
Latest test result

02/08/2024, 12:06:30 PM ✓ The host can enter maintenance mode. 11.29 GB of data will be moved.

Before: Used 2.37 TB, Total 27.29 TB (9%)
After: Used 1.75 TB, Total 20.01 TB (9%)

Object	Predicted capacity and requirements
10.156.130.217	647.08 GB / 7.28 TB (9%) *Maintenance mode - no capacity*
10.156.130.218	640.36 GB / 7.28 TB (9%) 648.60 GB / 7.28 TB (9%)
10.156.130.219	489.06 GB / 5.46 TB (9%) 490.80 GB / 5.46 TB (9%)
10.156.130.220	646.82 GB / 7.28 TB (9%) 648.60 GB / 7.28 TB (9%)

Predicted Health shows how the health of the cluster will be affected:



Pre-check data migration for: 10.156.130.217

vSAN data migration: Ensure accessibility

Latest test result

02/08/2024, 12:04:26 PM ✓ The host can enter maintenance mode.

The following health findings could be directly affected by the operation.

- vSAN object health
- ✓ Storage space
- ✓ Component

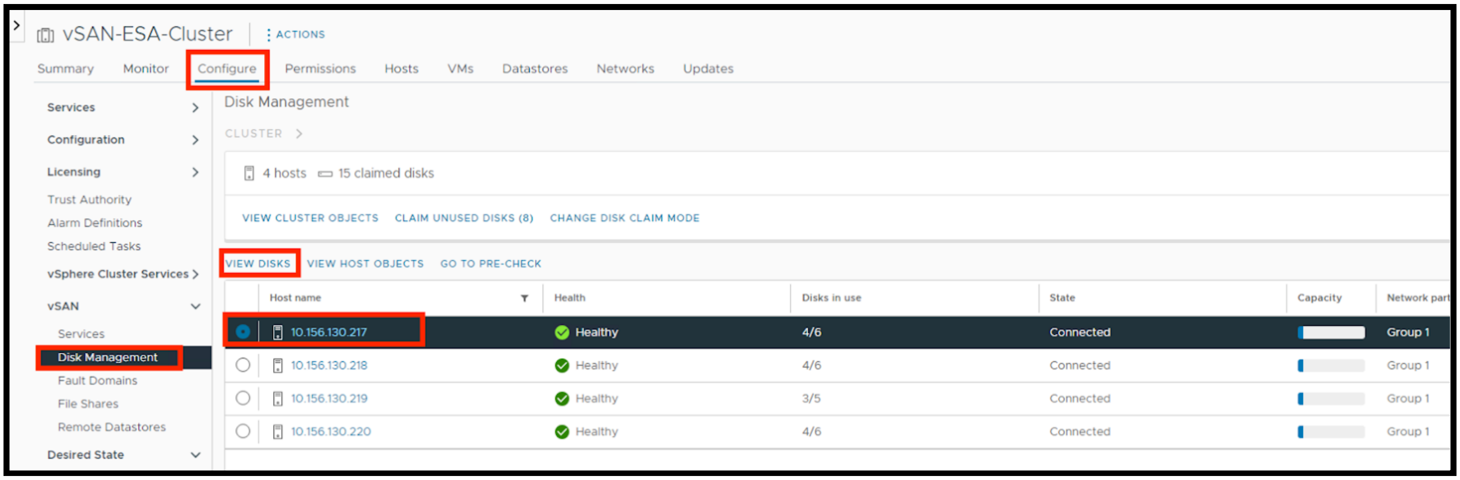
Health/Objects	Object count	Objects UUID
Inaccessible	5	b021c565-ae25-1120-6105-ac1f6b549e30,b021c565-82f1-3464-56b5-ac1f6b549e30,ab21c565-9245-3f71-e790-ac1f6b549e30,b221c565-52ff-c489-7ff0
Reduced availability with no rebui...	50	c120c565-504c-5801-d73e-ac1f6b549da0,d317c565-0021-2a0a-9c6f-ac1f6b549e70,a620c565-6612-b20d-6f37-ac1f6b549f80,9d20c565-8cc5-bb11-4f

2 items

Loss of a Disk -vSAN ESA

Navigate to **[vSAN Cluster] > Configure > vSAN > Disk Management:**

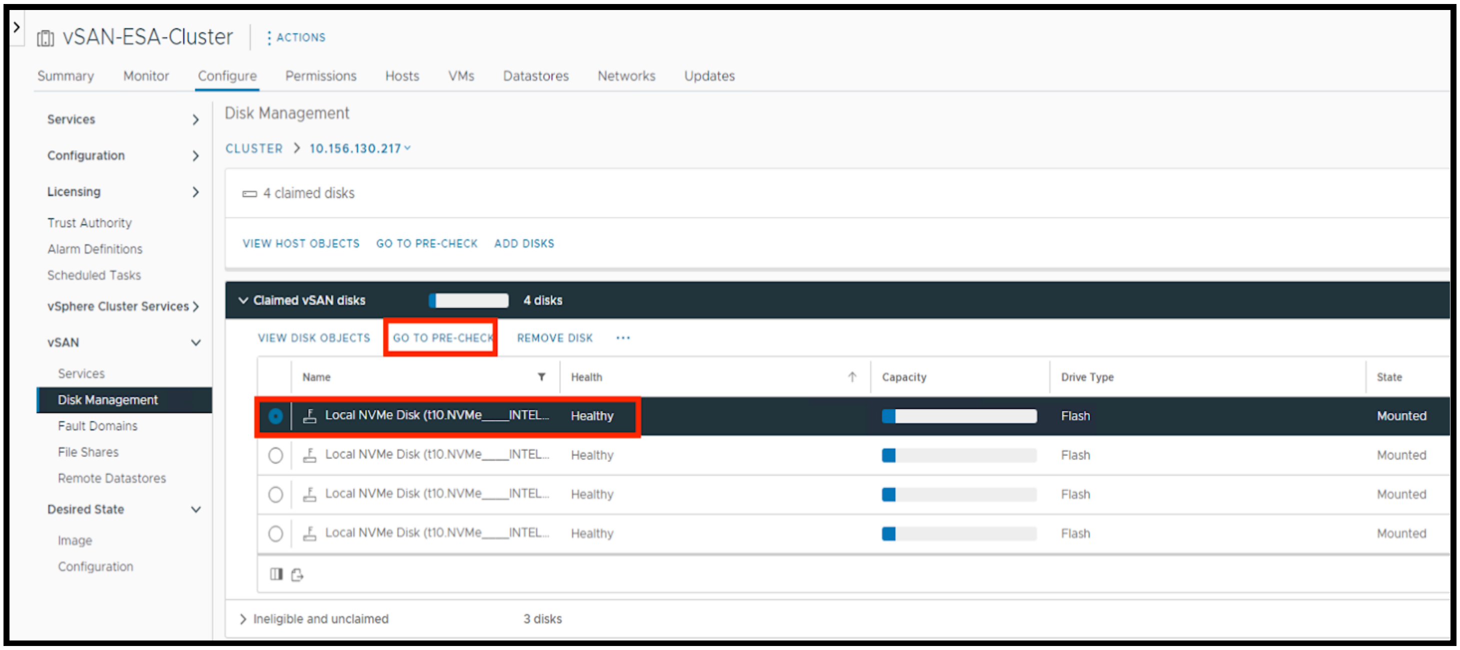
From here, select a **host**. Then click **View Disks**:



	Host name	Health	Disks in use	State	Capacity	Network part
●	10.156.130.217	Healthy	4/6	Connected		Group 1
○	10.156.130.218	Healthy	4/6	Connected		Group 1
○	10.156.130.219	Healthy	3/5	Connected		Group 1
○	10.156.130.220	Healthy	4/6	Connected		Group 1

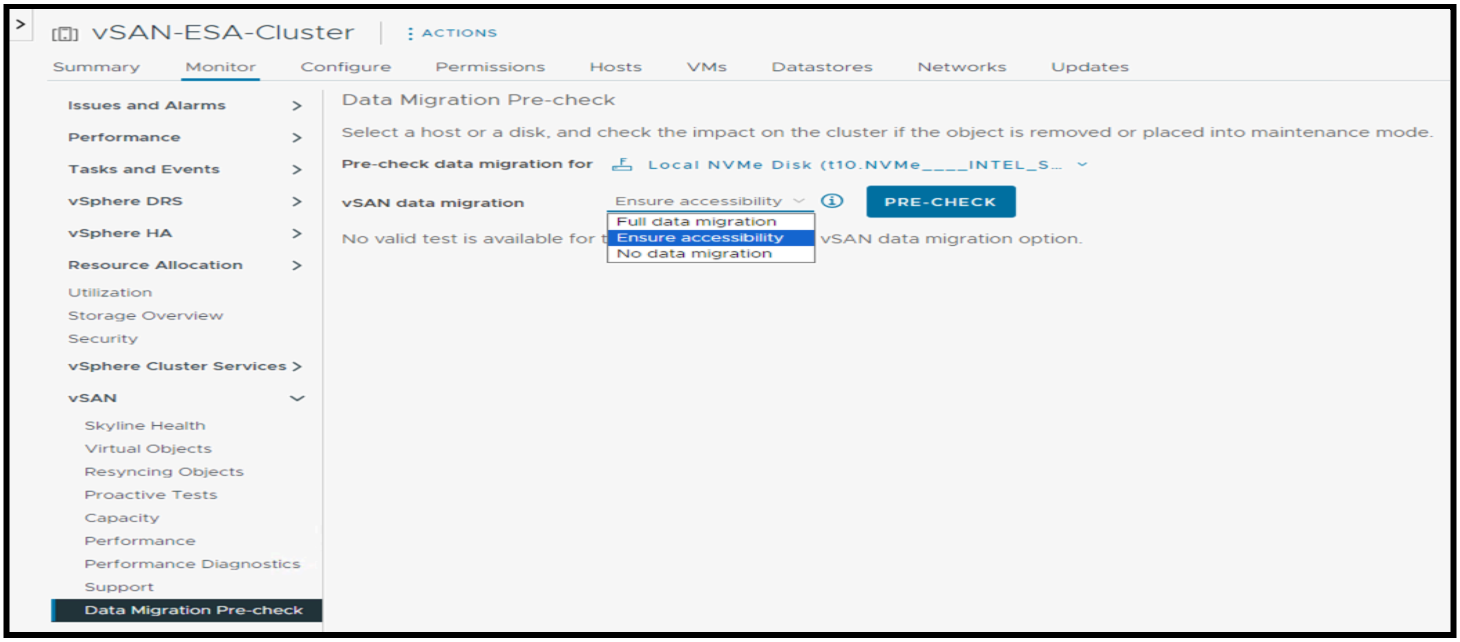
Then select an individual disk and click **Go To Pre-Check** to run simulation on the selected disk:

If you click on **Go To Pre-Check** at the higher-level on this screen it will run the analysis at the host level instead:



	Name	Health	Capacity	Drive Type	State
●	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted
○	Local NVMe Disk (t10.NVMe____INTEL...	Healthy		Flash	Mounted

Once the **Pre-Check Data Migration** button option is selected, we can run different simulations to see how the objects on the disk are affected. Again, the options are **Full data migration**, **Ensure accessibility** (default) and **No data migration**:



Data Migration Pre-check

Select a host or a disk, and check the impact on the cluster if the object is removed or placed into maintenance mode.

Pre-check data migration for: Local NVMe Disk (t10.NVMe____INTEL_S...

vSAN data migration: Ensure accessibility

No valid test is available for t... vSAN data migration option.

Conducting Failure Testing

Unlike the previous section (where the effects of known failure scenarios are depicted) here we attempt to re-create real world issues to see how the system reacts.

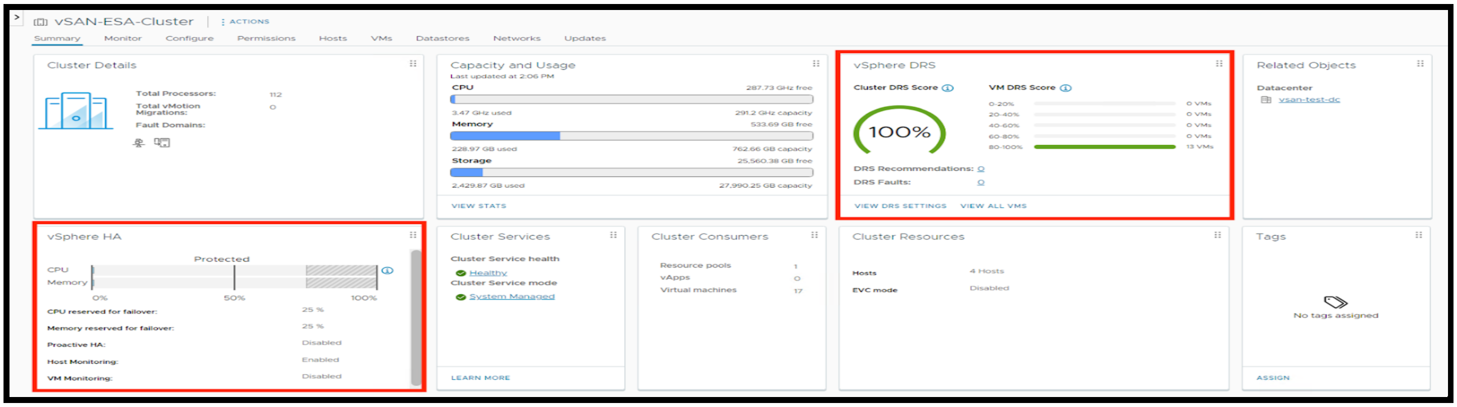
Host Failure

The test will show that in a host failure:

- vSAN-backed VMs will still seamlessly migrate to a new host
- Even with the loss of vSAN Virtual Objects on a particular failed host, vSAN will maintain data integrity

The assumption of this test is that vSphere High Availability (HA) and Distributed Resource Scheduler (DRS) are enabled.

Navigate to **[vSAN Cluster] > Summary** to verify vSphere HA and DRS status:



Cluster Details

Total Processors: 112
Total vMotion Migrations: 0
Fault Domains:

Capacity and Usage
Last updated at 2:06 PM
CPU: 287.73 GHz free; 3.47 GHz used; 291.2 GHz capacity
Memory: 533.69 GB free; 228.97 GB used; 762.66 GB capacity
Storage: 25,560.38 GB free; 2,429.87 GB used; 27,990.25 GB capacity

vSphere DRS

Cluster DRS Score: 100%

VM DRS Score	
0-20%	0 VMs
20-40%	0 VMs
40-60%	0 VMs
60-80%	0 VMs
80-100%	13 VMs

DRS Recommendations: 0
DRS Faults: 0

Related Objects
Datacenter: vsan-test-dc

vSphere HA
Protected
CPU
Memory

CPU reserved for failover:	25 %
Memory reserved for failover:	25 %
Proactive HA:	Disabled
Host Monitoring:	Enabled
VM Monitoring:	Disabled

Cluster Services
Cluster Service health: Healthy
Cluster Service mode: System Managed

Cluster Consumers

Resource pools	1
vApps	0
Virtual machines	17

Cluster Resources

Hosts	4 Hosts
EVC mode	Disabled

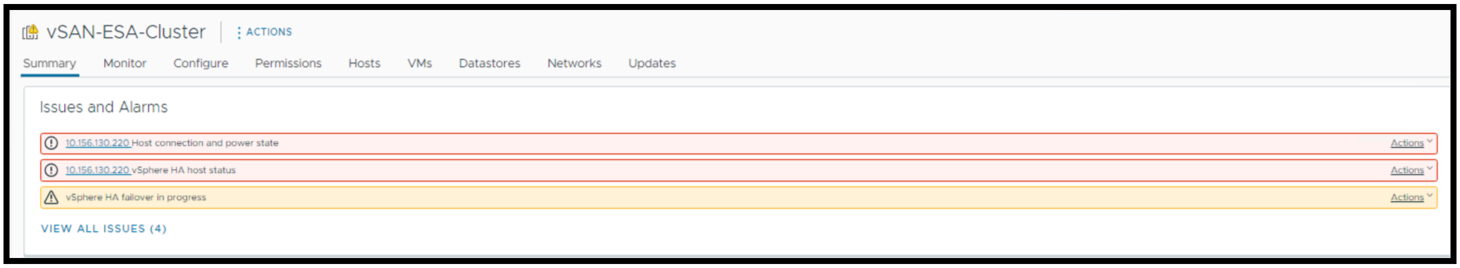
Tags
No tags assigned

Select a host with running VMs. Make note of which VMs are running on the target host for later reference.

To simulate the failure, we reboot the host: this is best achieved with the host's out-of-band (OOB) management interface, such as an iLO or iDRAC (or as a last resort, via an SSH session).

We can now observe what happens with the protection mechanisms in place.

Once the host reboots, several HA related events should be displayed on the '**Summary**' tab of the vSAN cluster (you may need to refresh the UI to see these):



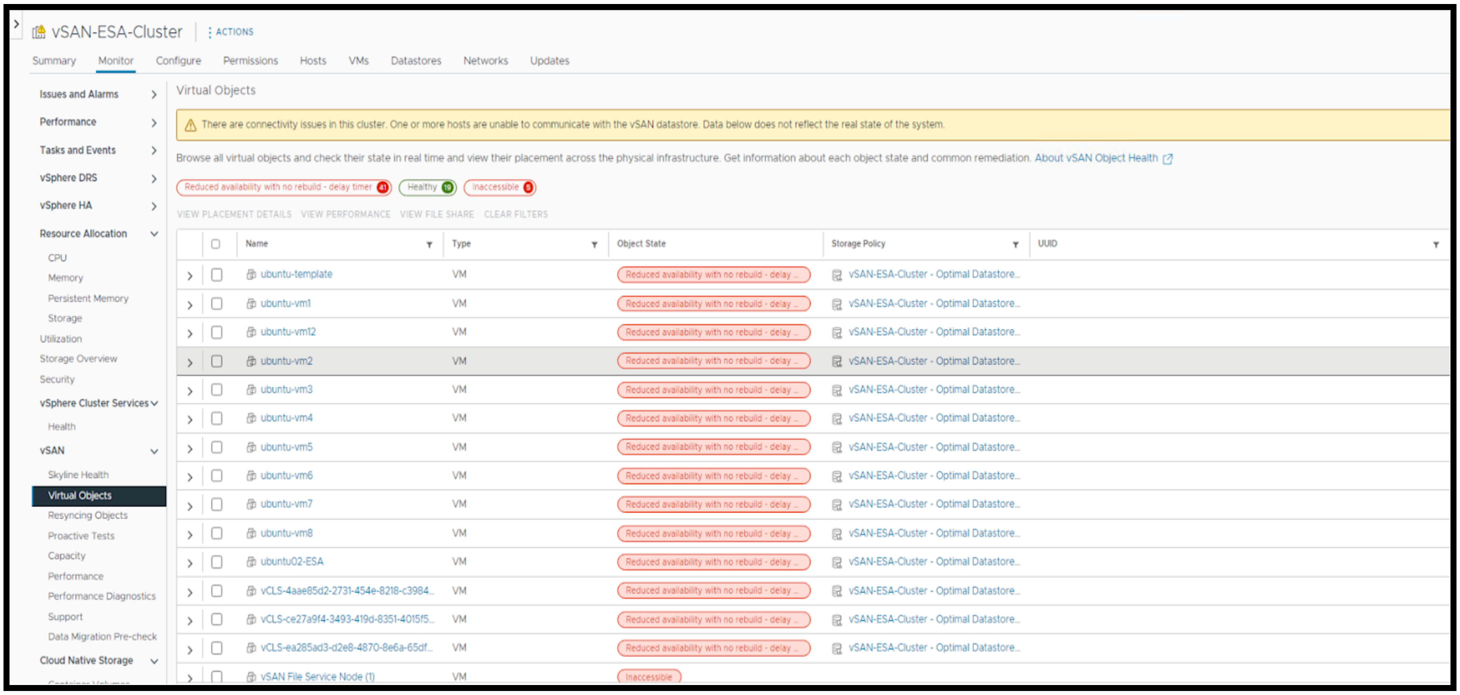
Issues and Alarms

- 10.156.130.220 Host connection and power state — Actions
- 10.156.130.220 vSphere HA host status — Actions
- vSphere HA failover in progress — Actions

VIEW ALL ISSUES (4)

Confirm that vSphere HA restarted the VMs, you noted previously, on another host. If there was a vCLS VM or vSAN File Services appliance (if vSAN File Services are configured) on the host, we can ignore them. Those specialized VMs are tied to a specific host and would not be restarted by HA on another host.

Once you have confirmed the VMs are restarted on another host, navigate to **[vSAN Cluster] > Monitor > vSAN > Virtual Objects**. In this view, we see that some components are temporarily unavailable.



Virtual Objects

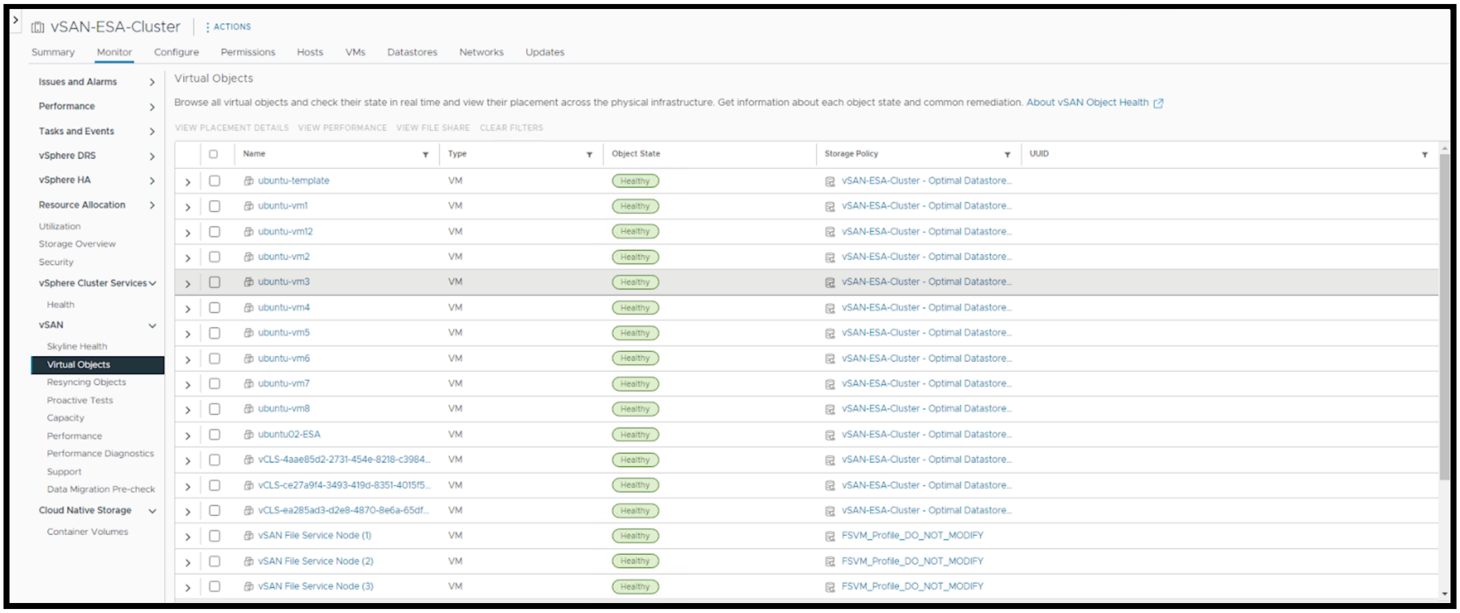
There are connectivity issues in this cluster. One or more hosts are unable to communicate with the vSAN datastore. Data below does not reflect the real state of the system.

Browse all virtual objects and check their state in real time and view their placement across the physical infrastructure. Get information about each object state and common remediation. About vSAN Object Health

Reduced availability with no rebuild - delay timer 41 | Healthy 19 | Inaccessible 5

Name	Type	Object State	Storage Policy	UUID
ubuntu-template	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm1	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm12	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm2	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm3	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm4	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm5	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm6	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm7	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm8	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu02-ESA	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
vCLS-4aae85d2-2731-454e-8218-c3984...	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
vCLS-ce27a9f4-3493-419d-8351-4015f5...	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
vCLS-ea285ad3-d2e8-4870-8e6a-65df...	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...	
vSAN File Service Node (1)	VM	Inaccessible		

Once the host reboot completes, you will see the virtual objects warnings clear. This may take a few minutes and you may need to refresh the screen:



Virtual Objects

Browse all virtual objects and check their state in real time and view their placement across the physical infrastructure. Get information about each object state and common remediation. About vSAN Object Health

Name	Type	Object State	Storage Policy	UUID
ubuntu-template	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm1	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm12	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm2	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm3	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm4	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm5	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm6	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm7	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu-vm8	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
ubuntu02-ESA	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
vCLS-4aae85d2-2731-454e-8218-c3984...	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
vCLS-ce27a9f4-3493-419d-8351-4015f5...	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
vCLS-ea285ad3-d2e8-4870-8e6a-65df...	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...	
vSAN File Service Node (1)	VM	Healthy	FSVM_Profile_DO_NOT_MODIFY	
vSAN File Service Node (2)	VM	Healthy	FSVM_Profile_DO_NOT_MODIFY	
vSAN File Service Node (3)	VM	Healthy	FSVM_Profile_DO_NOT_MODIFY	

vSAN will wait for a prescribed time, based on the Object Repair Timer setting, before initiating rebuild operations. Rebuild operations will recreate unavailable virtual objects to another available host in the cluster. If the failed host comes back on-line (or is replaced) later, vSAN will automatically rebalance. The default wait time is 60 minutes.

vSAN Disk Fault Injection Script for Failure Testing

A script to help with storage device failure testing is included with ESXi and is available on all hosts. The script, **`vsanDiskFaultInjection.pyc`** can be found in **`/usr/lib/vmware/vsan/bin`**:

```
[root@localhost:~] python /usr/lib/vmware/vsan/bin/vsanDiskFaultInjection.pyc -h
Usage:
            injectError.py -t -r error_durationSecs -d deviceName
            injectError.py -p -d deviceName
            injectError.py -z -d deviceName
            injectError.py -T -d deviceName
            injectError.py -c -d deviceName


Options:
  -h, --help            show this help message and exit
  -u                    Inject hot unplug
  -t                    Inject unrecoverable read error
  -p                    Inject permanent error
  -z                    Inject health error
  -c                    Clear injected error
  -T                    Inject Transient error
  -r ERRORDURATION      unrecoverable read error duration in seconds
  -d DEVICENAME, --deviceName=DEVICENAME
```

Note: This command should only be used in test environments. Using this command to mark devices as failed can have a catastrophic effect on a vSAN cluster.

In some circumstances, transient device errors could cause vSAN objects to be marked as degraded and vSAN may unnecessarily mark a device as failed. vSAN, through Full Rebuild Avoidance (FRA), can differentiate between transient and permanent storage errors, thus avoiding unnecessary object rebuilds.

For the purposes of testing, however, we need to simulate hardware failures and rebuilds. The below procedure outlines toggling this feature on or off.

As the setting is enabled on a per vSAN node basis, to view the current value issue from an ESXi host issue:

```
esxcli system settings advanced list -o /LSOM/lsomEnableFullRebuildAvoidance
```

To disable FRA (required to run the failure tests):

```
esxcli system settings advanced set -o /LSOM/lsomEnableFullRebuildAvoidance -i 0
```

Once failure testing is complete, re-enable:

```
esxcli system settings advanced set -o /LSOM/lsomEnableFullRebuildAvoidance -i 1
```

It should be noted that the same tests can be run by simply removing the disk from the host. If physical access to the host is convenient, literally pulling a disk would test exact physical conditions as opposed to emulating it within the software.

Also, note that not all I/O controllers support hot unplugging drives. Check the vSAN Compatibility Guide to see if your controller model supports the hot unplug feature.

vSAN ESA combines cache/capacity functions within each disk in the cluster. There is no separation of caching and capacity functions. A failure of one disk in a vSAN ESA cluster is isolated to only the failed disk. vSAN OSA separate cache and capacity functions on separate disks.

The two tests below leverage a vSAN ESA cluster:

- The results are the same applied to a vSAN OSA capacity disk
- If a vSAN OSA cache disk fails, the underlying capacity disks in that disk group are unavailable as well (regardless of the health of those capacity disks)

Storage Device is Removed Unexpectedly - vSAN ESA

When a storage device is suddenly removed from a vSAN host, all the components residing on the device will go into an 'absent' state.

The 'absent' state is chosen over 'degraded' as vSAN assumes that the device is temporarily unavailable (rather than failed). If the disk is placed back in the server before the cluster services timeout (60 minutes by default), then the state will return to a healthy state without the (expensive) rebuild of data.

Thus:

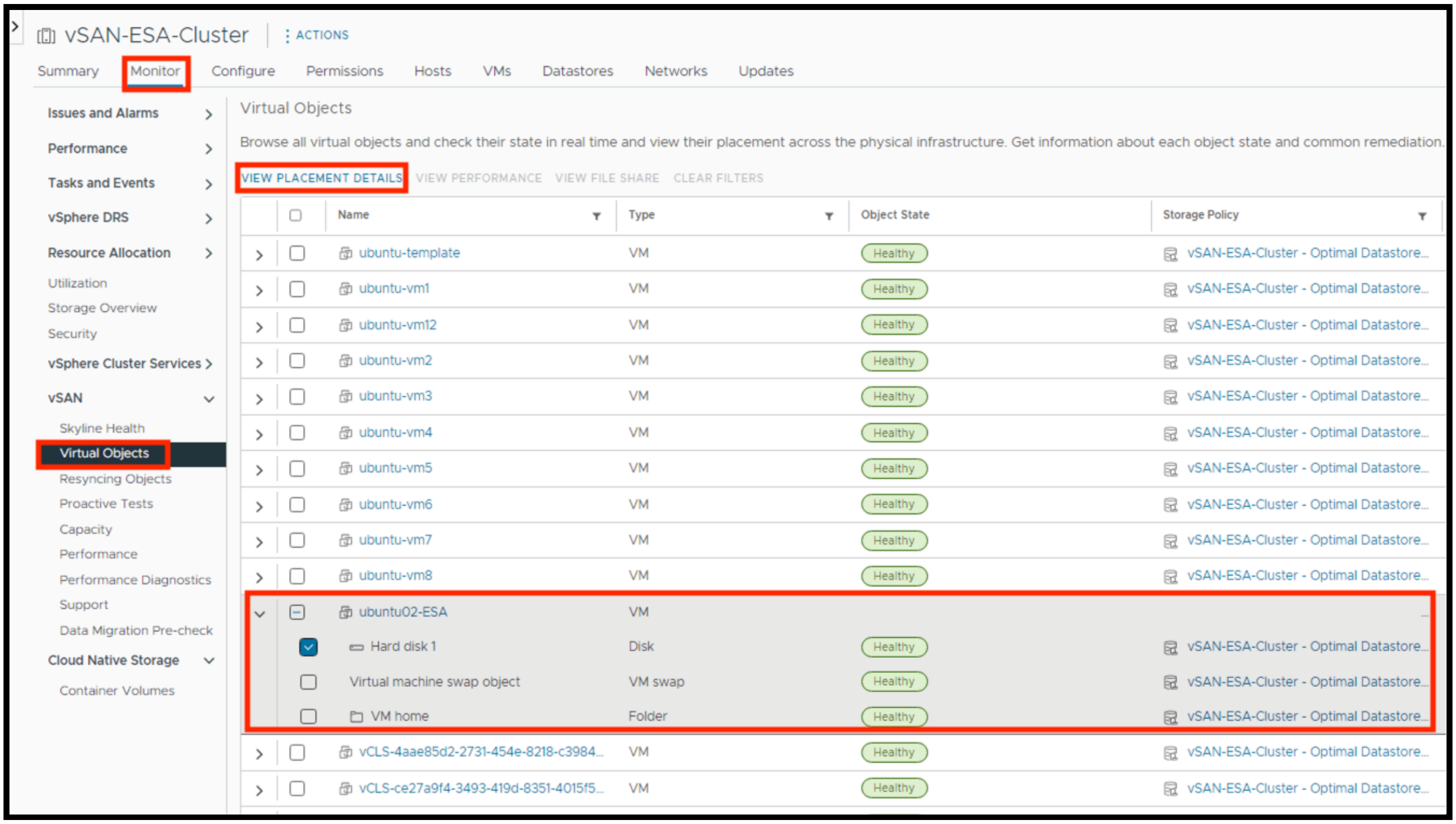
- The device state is marked as 'absent' in vCenter
- If the object has a policy that dictates the 'failures to tolerate' of one or greater, the object will still be accessible from another host in the vSAN Cluster (marked with 'reduced availability with no rebuild - delay timer')
- If the same device is available again within the timer delay (60 min. by default), no components will be rebuilt

- If the timer elapses and the device is still unavailable, components on the removed disk will be built elsewhere in the cluster (if capacity is available), including any newly claimed devices
- If the VM Storage Policy has the 'failures to tolerate' set to zero, the object will be inaccessible
- To restore the object, the same device must be made available again

In this example, we shall remove a storage device from the host using the `vsanDiskFaultInjection.pyc` python script rather than physically removing it from the host.

We shall then 'replace' the storage device before the object repair timeout delay expires (default 60 minutes), which will mean that no rebuilding activity will occur during this test.

To start, select a running VM. Then navigate to **[vSAN Cluster] > Monitor > Virtual Objects** and find the VM from the list and select an object. In the example below, we have selected 'Hard disk 1':

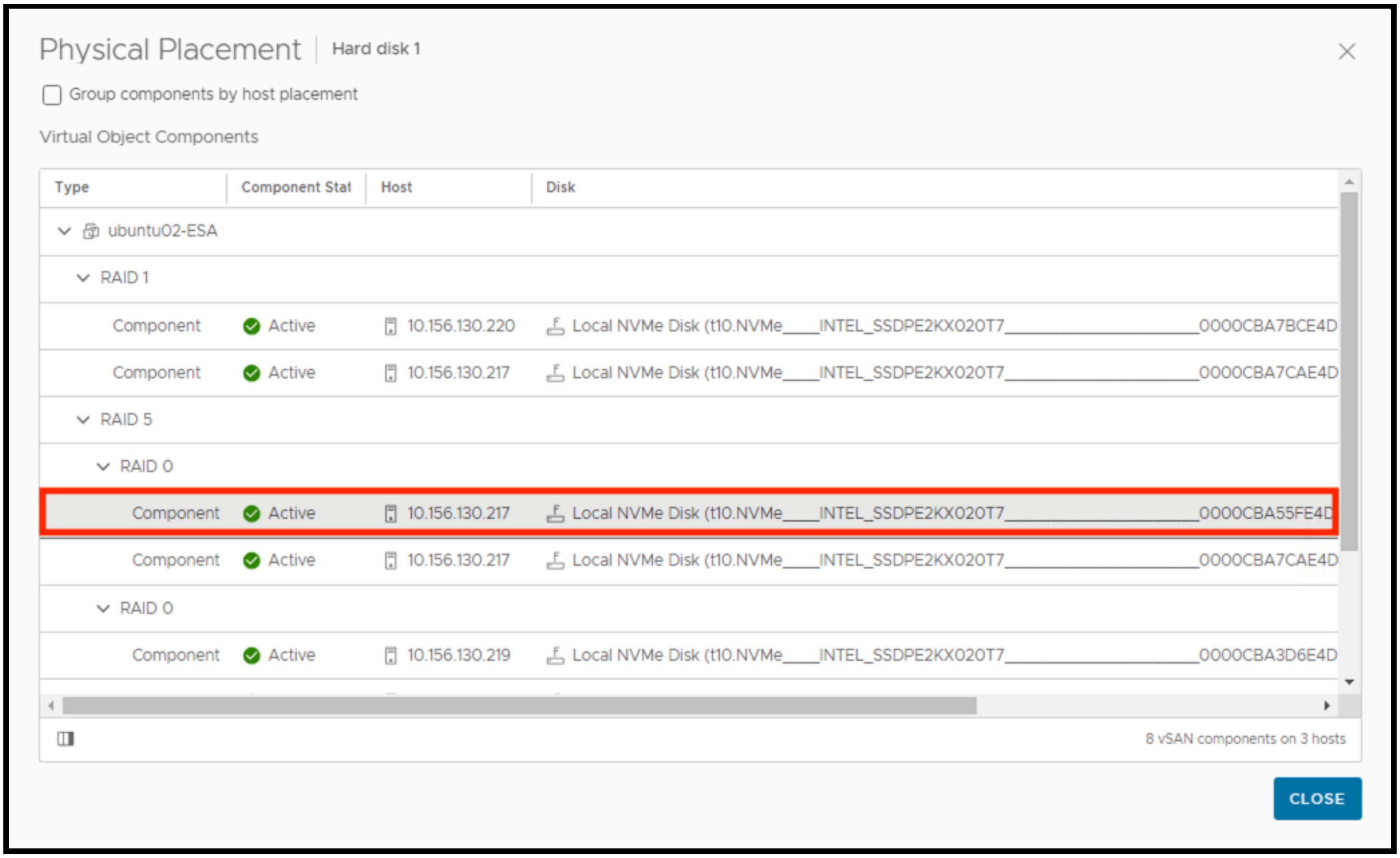


Virtual Objects

Browse all virtual objects and check their state in real time and view their placement across the physical infrastructure. Get information about each object state and common remediation.

☐	Name	Type	Object State	Storage Policy
☐	ubuntu-template	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm1	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm12	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm2	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm3	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm4	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm5	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm6	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm7	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	ubuntu-vm8	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
⊟	ubuntu02-ESA	VM		
☑	Hard disk 1	Disk	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	Virtual machine swap object	VM swap	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	VM home	Folder	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	vCLS-4aae85d2-2731-454e-8218-c3984…	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…
☐	vCLS-ce27a9f4-3493-419d-8351-4015f5…	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore…

Select **View Placement Details** to show which hosts the object has components on. In the below example, the components are in a vSAN ESA cluster:



Physical Placement | Hard disk 1

☐ Group components by host placement

Virtual Object Components

Type	Component Stat	Host	Disk
ubuntu02-ESA			
RAID 1			
Component	Active	10.156.130.220	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA7BCE4D
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA7CAE4D
RAID 5			
RAID 0			
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA55FE4D
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA7CAE4D
RAID 0			
Component	Active	10.156.130.219	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA3D6E4D

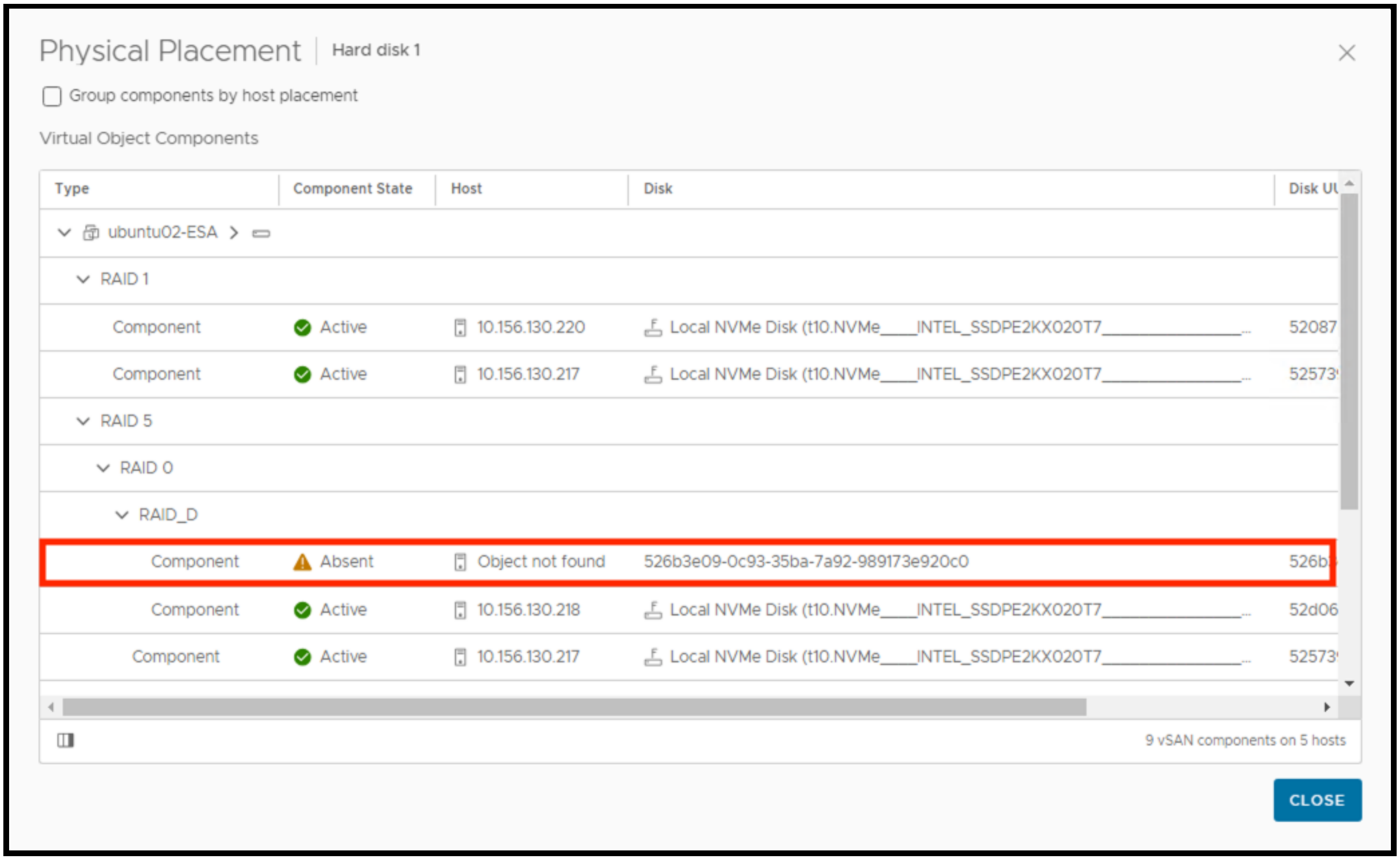
8 vSAN components on 3 hosts

The column that we are interested in here is the ‘Disk’ identifier and the host it resides on. The component that will be impacted by the test is highlighted in the example. Note it may be easier to see by selecting the column toggle (on the bottom left) and selecting the appropriate information to display. In this case, the ‘Fault Domain’ column filtered out and the remaining columns resized.

Copy the disk ID string and SSH into the host that contains the component. We can then inject a hot unplug event using the python script:

```
[root@10.156.130.217:~] python /usr/lib/vmware/vsan/bin/vsanDiskFaultInjection.pyc -u -d
t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA55FE4D25C
vsish -e set /reliability/vmkstress/ScsiPathInjectError 1
Injecting hot unplug on device t10.NVMe____INTEL_SSDPE2KX020T7______________________0000CBA55FE4D25C
vsish -e set /storage/scsifw/paths/vmhba7:C0:T0:L0/injectError nvme 0x0000b000000
esxcli storage core adapter rescan --all
```

In vCenter, we observe the effects of the action. As expected, the component that resided on that disk on host 10.159.130.217 shows up as ‘Absent.:



Physical Placement | Hard disk 1

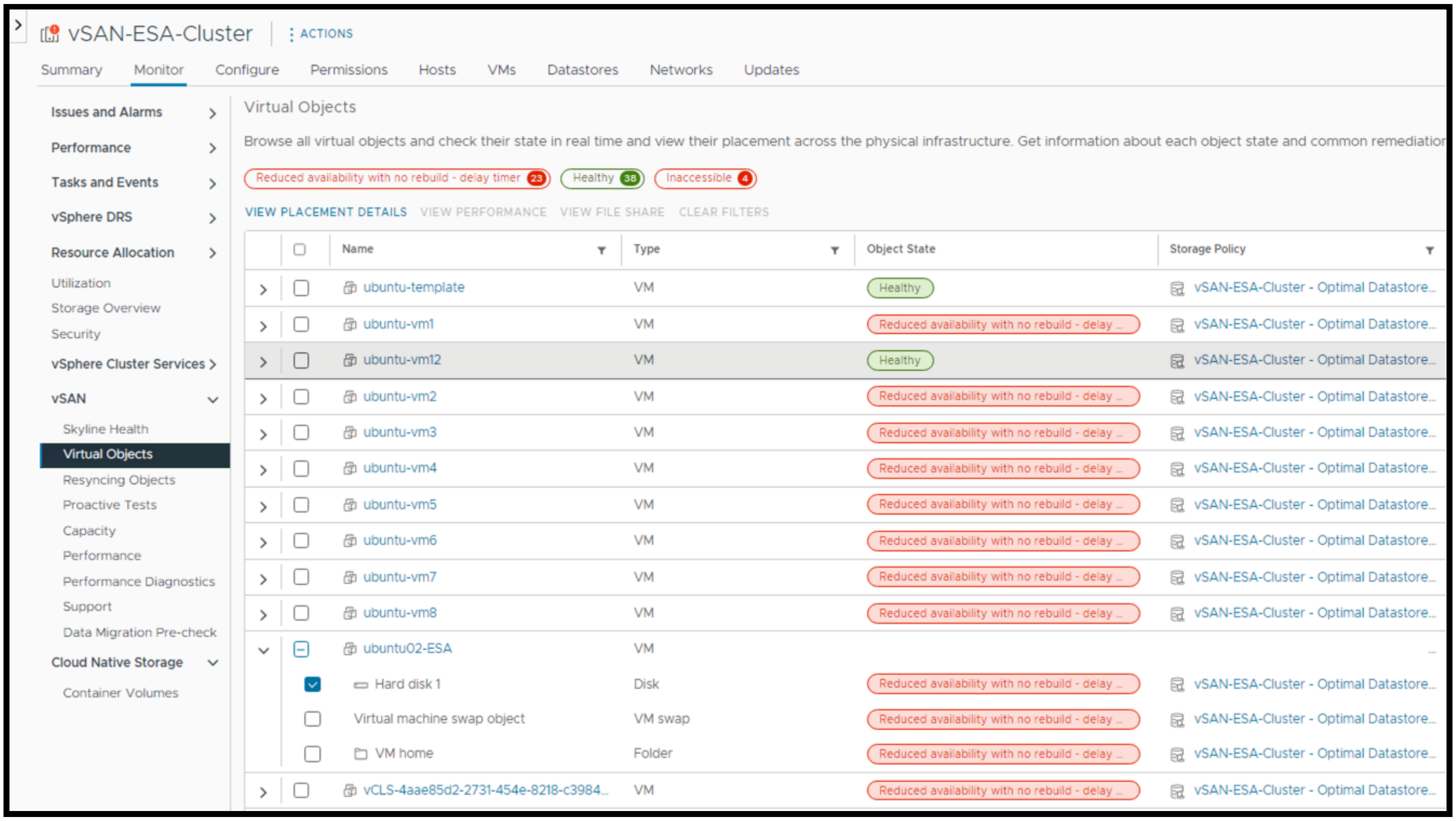
□ Group components by host placement

Virtual Object Components

Type	Component State	Host	Disk	Disk Ul
ubuntu02-ESA				
RAID 1				
Component	✓ Active	10.156.130.220	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________...	52087
Component	✓ Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________...	52573
RAID 5				
RAID 0				
RAID_D				
Component	⚠ Absent	Object not found	526b3e09-0c93-35ba-7a92-989173e920c0	526b
Component	✓ Active	10.156.130.218	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________...	52d06
Component	✓ Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7______________...	52573

9 vSAN components on 5 hosts

The ‘Virtual Objects’ page should also show the component state as ‘Reduced availability with no rebuild – delay timer’. Notice that this screen shows all VMs impacted by the failure.



Virtual Objects

Browse all virtual objects and check their state in real time and view their placement across the physical infrastructure. Get information about each object state and common remediatior

Reduced availability with no rebuild - delay timer 23 | Healthy 38 | Inaccessible 4

	□	Name	Type	Object State	Storage Policy
>	□	ubuntu-template	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm1	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm12	VM	Healthy	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm2	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm3	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm4	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm5	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm6	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm7	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	ubuntu-vm8	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
⌄	⊟	ubuntu02-ESA	VM		...
	☑	Hard disk 1	Disk	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
	□	Virtual machine swap object	VM swap	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
	□	VM home	Folder	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...
>	□	vCLS-4aae85d2-2731-454e-8218-c3984...	VM	Reduced availability with no rebuild - delay ...	vSAN-ESA-Cluster - Optimal Datastore...

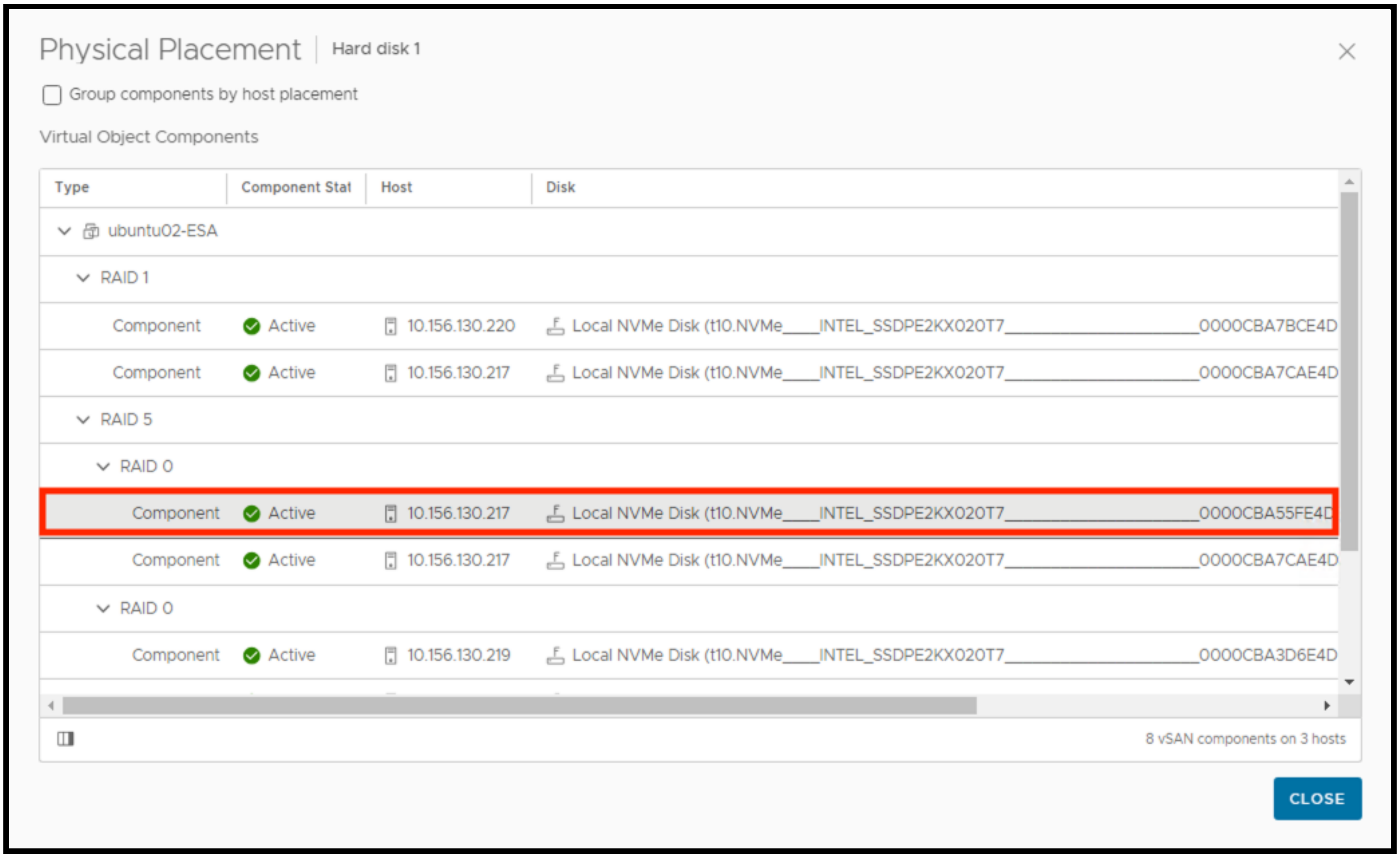
Go back to the SSH session from earlier and run the below command. The command again will perform a quick disk group unmount/remount to clear the simulated disk failure:

```
[root@10.156.130.217:~] python /usr/lib/vmware/vsan/bin/vsanDiskFaultInjection.pyc -c -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
vsish -e set /storage/scsifw/paths/vmhba7:C0:T0:L0/injectError nvme 0x00000
vsish -e set /reliability/vmkstress/ScsiPathInjectError 0
esxcli storage core adapter rescan --all
vsish -e set /reliability/vmkstress/ScsiDeviceInjectError 0
Clearing health on device t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
esxcli vsan storagepool unmount -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
esxcli vsan storagepool mount -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
```

Return to the Virtual Objects page and observe that the storage device has re-appeared, and the components are healthy.

Storage Device Removed, Not Replaced Before Timeout

Here, we will repeat the test above, but will leave the device 'unplugged' for longer than the timeout. We should expect to see vSAN rebuilding the component to another disk to achieve policy compliance. We begin again by identifying the disk on which the component resides:



Physical Placement | Hard disk 1

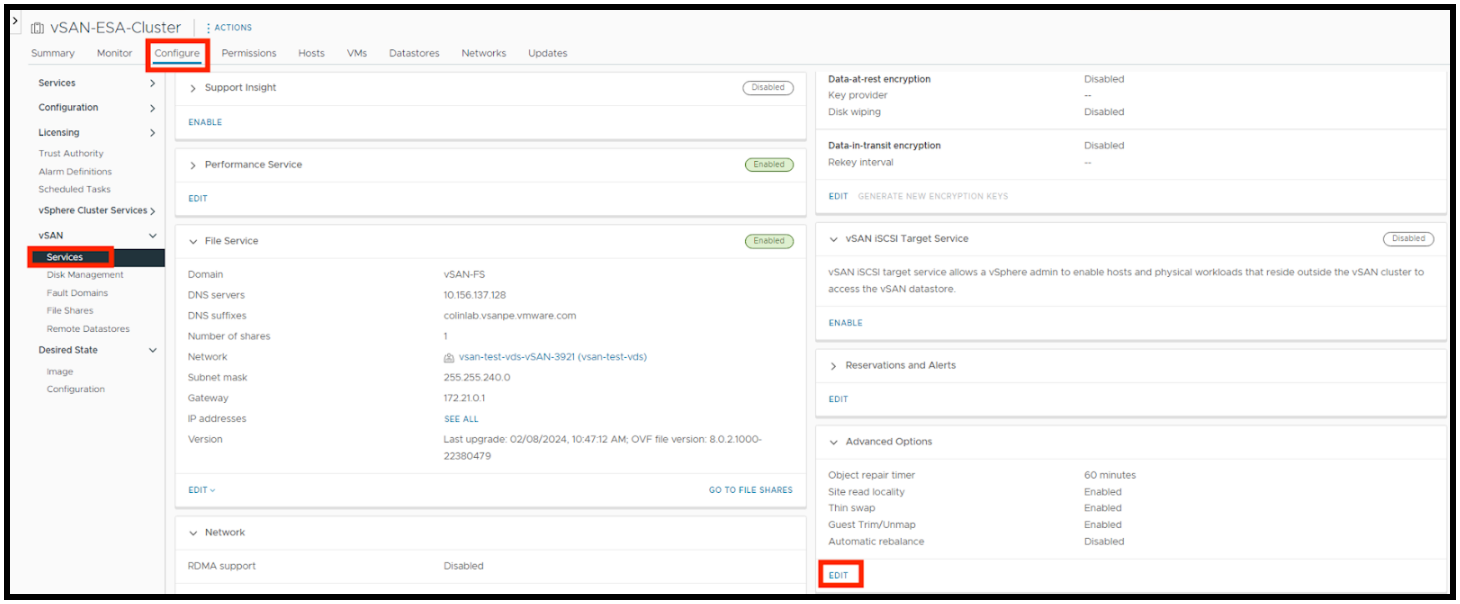
□ Group components by host placement

Virtual Object Components

Type	Component Stat	Host	Disk
ubuntu02-ESA			
RAID 1			
Component	✓ Active	10.156.130.220	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7____________________0000CBA7BCE4D
Component	✓ Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7____________________0000CBA7CAE4D
RAID 5			
RAID 0			
Component	✓ Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7____________________0000CBA55FE4D
Component	✓ Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7____________________0000CBA7CAE4D
RAID 0			
Component	✓ Active	10.156.130.219	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7____________________0000CBA3D6E4D

8 vSAN components on 3 hosts

The default 'Object Repair Timer' is 60 minutes. To speed up this test, we will reduce the object repair timer to suit our needs. To do this, navigate to [vSAN Cluster] > Configure > vSAN > Services > Advanced Options > Edit:



Support Insight — Disabled

Performance Service — Enabled

File Service — Enabled

Domain: vSAN-FS
DNS servers: 10.156.137.128
DNS suffixes: colinlab.vsanpe.vmware.com
Number of shares: 1
Network: vsan-test-vds-vSAN-3921 (vsan-test-vds)
Subnet mask: 255.255.240.0
Gateway: 172.21.0.1
IP addresses: SEE ALL
Version: Last upgrade: 02/08/2024, 10:47:12 AM; OVF file version: 8.0.2.1000-22380479

Network

RDMA support: Disabled

Data-at-rest encryption: Disabled
Key provider: --
Disk wiping: Disabled

Data-in-transit encryption: Disabled
Rekey interval: --

vSAN iSCSI Target Service — Disabled

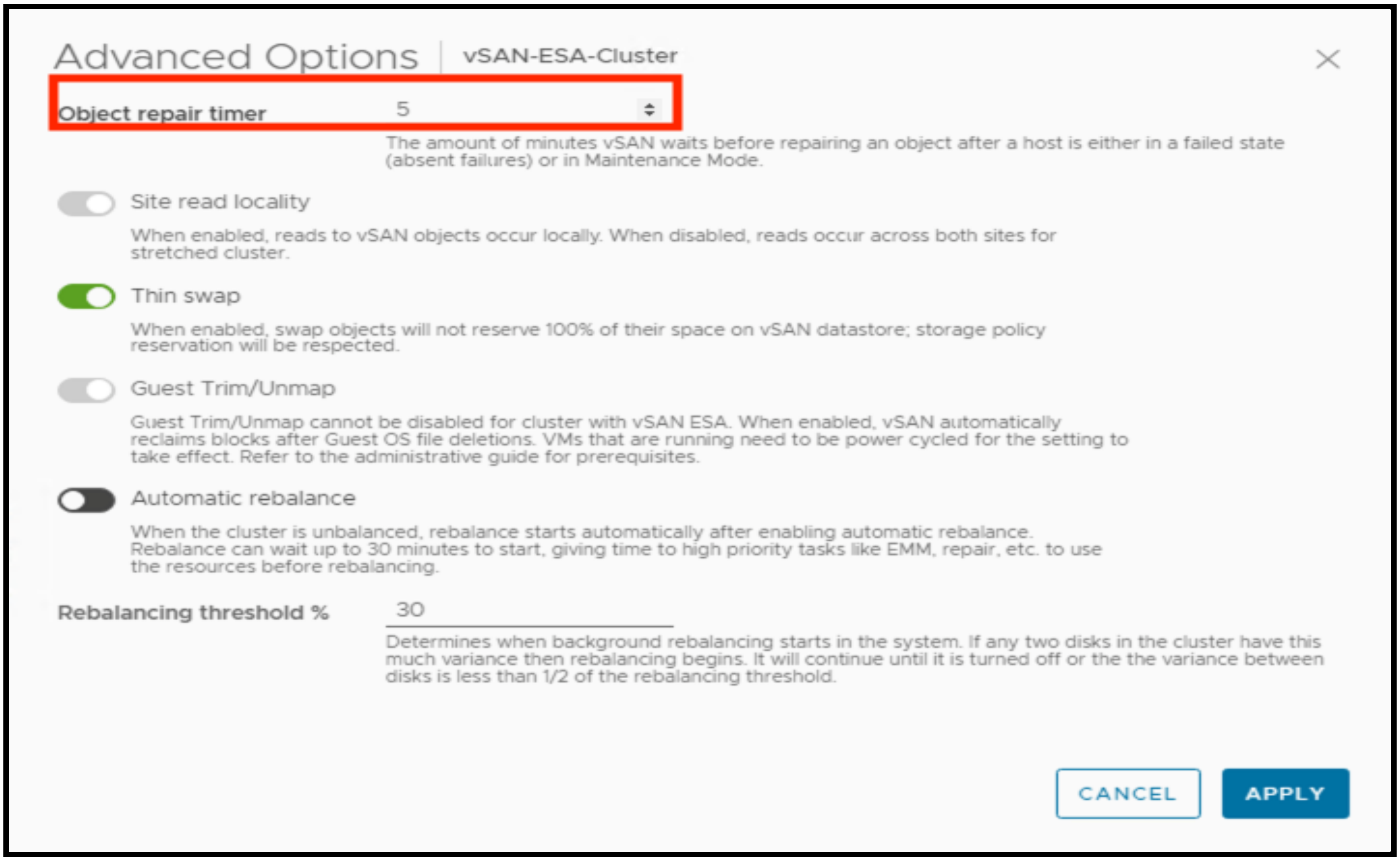
vSAN iSCSI target service allows a vSphere admin to enable hosts and physical workloads that reside outside the vSAN cluster to access the vSAN datastore.

Reservations and Alerts

Advanced Options

Object repair timer: 60 minutes
Site read locality: Enabled
Thin swap: Enabled
Guest Trim/Unmap: Enabled
Automatic rebalance: Disabled

Then adjust the timer. Here we set it to five minutes, meaning vSAN will wait a total of five minutes before starting any rebuild activities:



Advanced Options | vSAN-ESA-Cluster

Object repair timer: 5

The amount of minutes vSAN waits before repairing an object after a host is either in a failed state (absent failures) or in Maintenance Mode.

Site read locality

When enabled, reads to vSAN objects occur locally. When disabled, reads occur across both sites for stretched cluster.

Thin swap

When enabled, swap objects will not reserve 100% of their space on vSAN datastore; storage policy reservation will be respected.

Guest Trim/Unmap

Guest Trim/Unmap cannot be disabled for cluster with vSAN ESA. When enabled, vSAN automatically reclaims blocks after Guest OS file deletions. VMs that are running need to be power cycled for the setting to take effect. Refer to the administrative guide for prerequisites.

Automatic rebalance

When the cluster is unbalanced, rebalance starts automatically after enabling automatic rebalance. Rebalance can wait up to 30 minutes to start, giving time to high priority tasks like EMM, repair, etc. to use the resources before rebalancing.

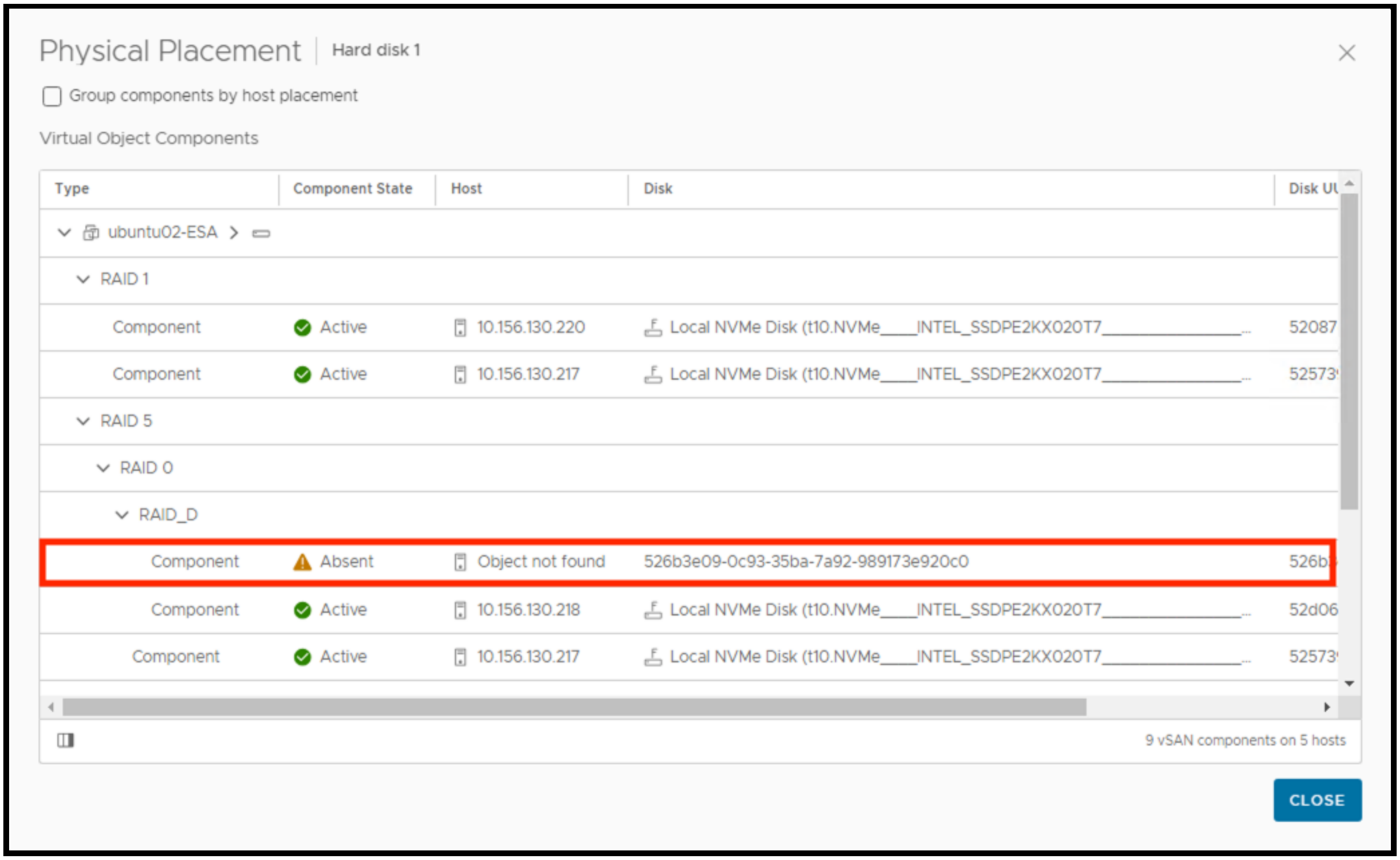
Rebalancing threshold %: 30

Determines when background rebalancing starts in the system. If any two disks in the cluster have this much variance then rebalancing begins. It will continue until it is turned off or the the variance between disks is less than 1/2 of the rebalancing threshold.

To start the test, run the Python script again, taking note of the date:

```
[root@10.156.130.217:~] date
Fri Feb  9 18:08:04 UTC 2024
[root@w10.156.130.217:~] python /usr/lib/vmware/vsan/bin/vsanDiskFaultInjection.pyc -u -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
vsish -e set /reliability/vmkstress/ScsiPathInjectError 1
Injecting hot unplug on device t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
vsish -e set /storage/scsifw/paths/vmhba7:C0:T0:L0/injectError nvme 0x0000b000000
esxcli storage core adapter rescan --all
```

At this point, we can once again see that the state of the component is set to 'Absent':



Physical Placement | Hard disk 1

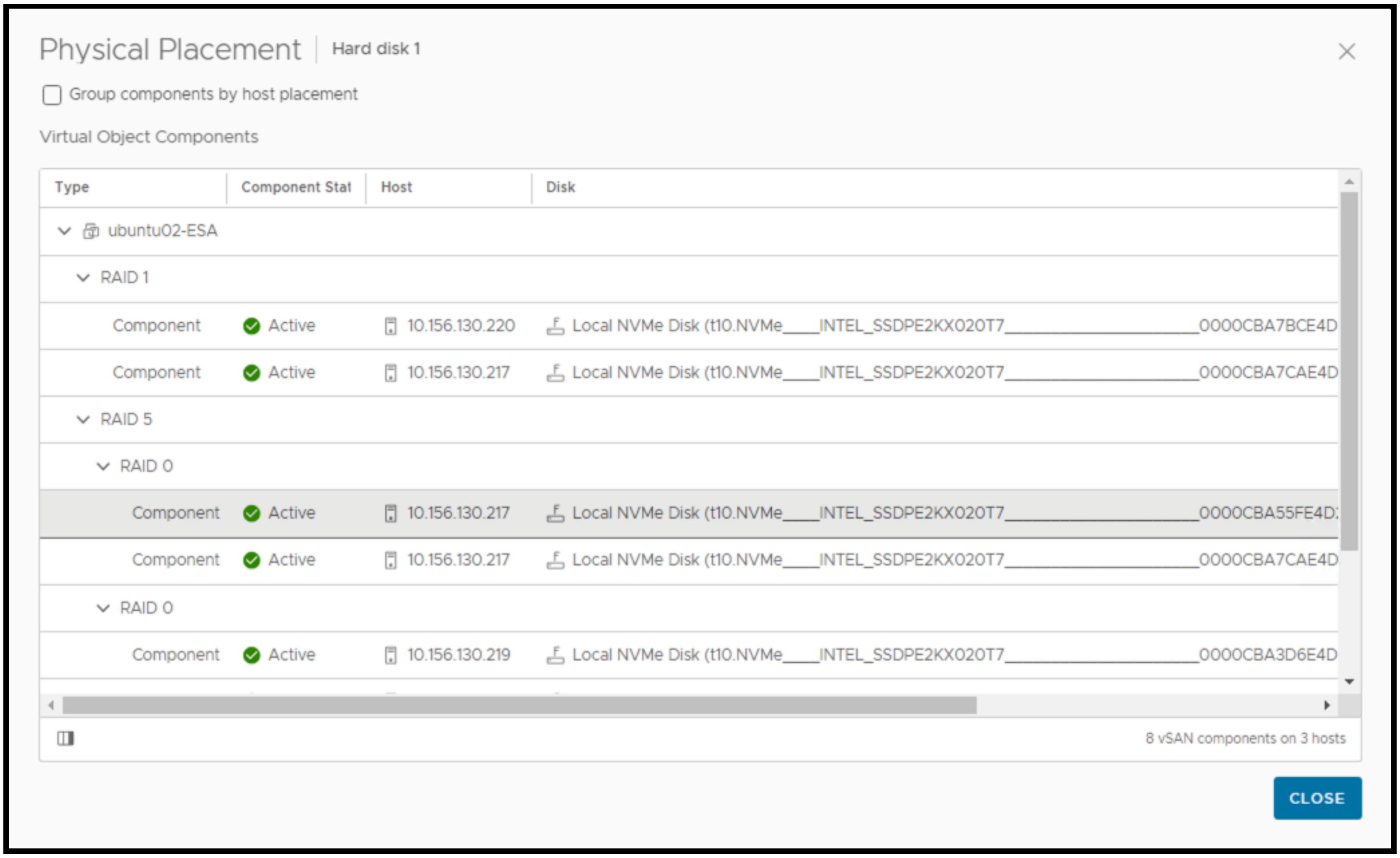
☐ Group components by host placement

Virtual Object Components

Type	Component State	Host	Disk	Disk UU
ubuntu02-ESA				
RAID 1				
Component	Active	10.156.130.220	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7________________...	52087
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7________________...	52573
RAID 5				
RAID 0				
RAID_D				
Component	Absent	Object not found	526b3e09-0c93-35ba-7a92-989173e920c0	526b
Component	Active	10.156.130.218	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7________________...	52d06
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7________________...	52573

9 vSAN components on 5 hosts

After the ‘Object Repair Timer’ has elapsed, vSAN will rebuild the component onto another disk in the cluster. This may take a few minutes after the timer elapses for the rebuild to complete for all virtual objects impacted by the disk failure:



Physical Placement | Hard disk 1

□ Group components by host placement

Virtual Object Components

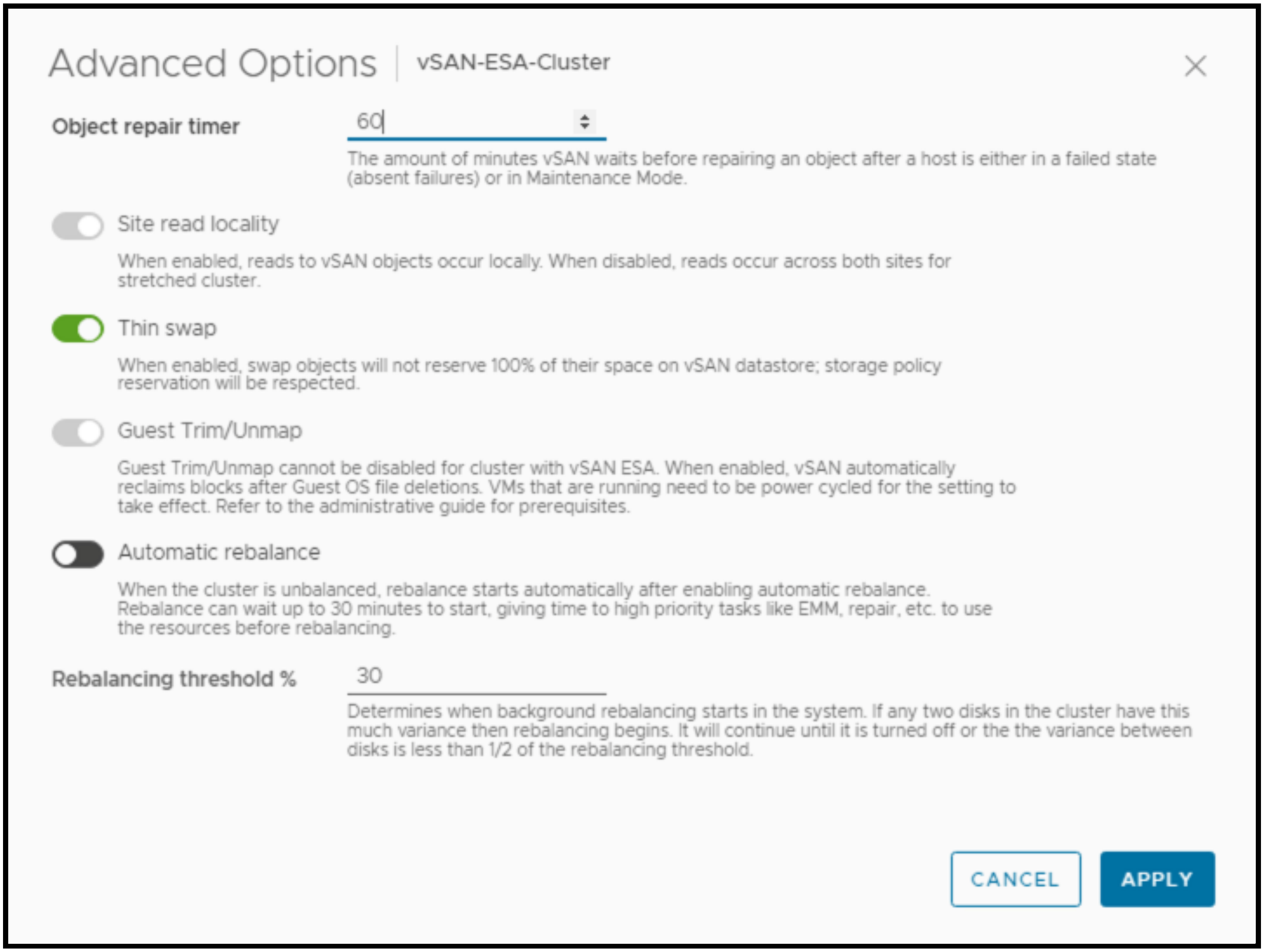
Type	Component Stat	Host	Disk
ubuntu02-ESA			
RAID 1			
Component	Active	10.156.130.220	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA7BCE4D
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA7CAE4D
RAID 5			
RAID 0			
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D:
Component	Active	10.156.130.217	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA7CAE4D
RAID 0			
Component	Active	10.156.130.219	Local NVMe Disk (t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA3D6E4D

8 vSAN components on 3 hosts

Go back to the SSH session from earlier and run the below command. The command again will perform a quick diskgroup unmount/remount to clear the simulated disk failure:

```
[root@10.156.130.217:~] python /usr/lib/vmware/vsan/bin/vsanDiskFaultInjection.pyc -c -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
vsish -e set /storage/scsifw/paths/vmhba7:C0:T0:L0/injectError nvme 0x00000
vsish -e set /reliability/vmkstress/ScsiPathInjectError 0
esxcli storage core adapter rescan --all
vsish -e set /reliability/vmkstress/ScsiDeviceInjectError 0
Clearing health on device t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
esxcli vsan storagepool unmount -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
esxcli vsan storagepool mount -d
t10.NVMe____INTEL_SSDPE2KX020T7_____________________0000CBA55FE4D25C
```

If the object repair timer was changed, you can reset it back to the default (60 minutes):



Advanced Options | vSAN-ESA-Cluster

Object repair timer: 60

The amount of minutes vSAN waits before repairing an object after a host is either in a failed state (absent failures) or in Maintenance Mode.

Site read locality

When enabled, reads to vSAN objects occur locally. When disabled, reads occur across both sites for stretched cluster.

Thin swap

When enabled, swap objects will not reserve 100% of their space on vSAN datastore; storage policy reservation will be respected.

Guest Trim/Unmap

Guest Trim/Unmap cannot be disabled for cluster with vSAN ESA. When enabled, vSAN automatically reclaims blocks after Guest OS file deletions. VMs that are running need to be power cycled for the setting to take effect. Refer to the administrative guide for prerequisites.

Automatic rebalance

When the cluster is unbalanced, rebalance starts automatically after enabling automatic rebalance. Rebalance can wait up to 30 minutes to start, giving time to high priority tasks like EMM, repair, etc. to use the resources before rebalancing.

Rebalancing threshold %: 30

Determines when background rebalancing starts in the system. If any two disks in the cluster have this much variance then rebalancing begins. It will continue until it is turned off or the the variance between disks is less than 1/2 of the rebalancing threshold.

Permanent Disk Error on a Device

If a disk drive has an unrecoverable error, vSAN marks the device as ‘degraded’ as the failure is permanent.

- If the object has a policy that dictates the ‘failures to tolerate’ of one or greater, the object will still be accessible from another host in the vSAN Cluster
- The disk state is marked as ‘degraded’ in vCenter
- If the VM Storage Policy has the ‘failures to tolerate’ set to zero, the object will be inaccessible (requires a restore of the VM from a known good backup)
- This applies to any vSAN ESA devices as well as vSAN OSA capacity devices

A vSAN OSA cache device failure follows a similar sequence of events to that of a storage device failure with one major difference; vSAN will mark the entire disk group as 'degraded'. As the failure is permanent (disk is offline) it is no longer visible.

- If the object has a policy that dictates the 'failures to tolerate' of one or greater, the object will still be accessible from another host in the vSAN Cluster
- Disk group and the disks under the disk group states will be marked as 'degraded' in vCenter
- If the VM Storage Policy has the 'failures to tolerate' set to zero, the object will be inaccessible (requires a restore of the VM from a known good backup)

When Might a Rebuild of Components Not Occur?

There are a couple of reasons why a rebuild of components might not occur. Start by looking at vSAN Health Check UI [vSAN Cluster] > Monitor > vSAN > Skyline Health for any alerts or failures.

Lack of Resources

Verify that there are enough resources to rebuild components before testing with the simulation tests detailed in the previous section.

Of course, if you are testing with a cluster size that cannot satisfy the 'failures to tolerate' defined in the hosted storage policies, and a failure is introduced, there will be no rebuilding of objects as the polices cannot be satisfied.

Underlying Failures

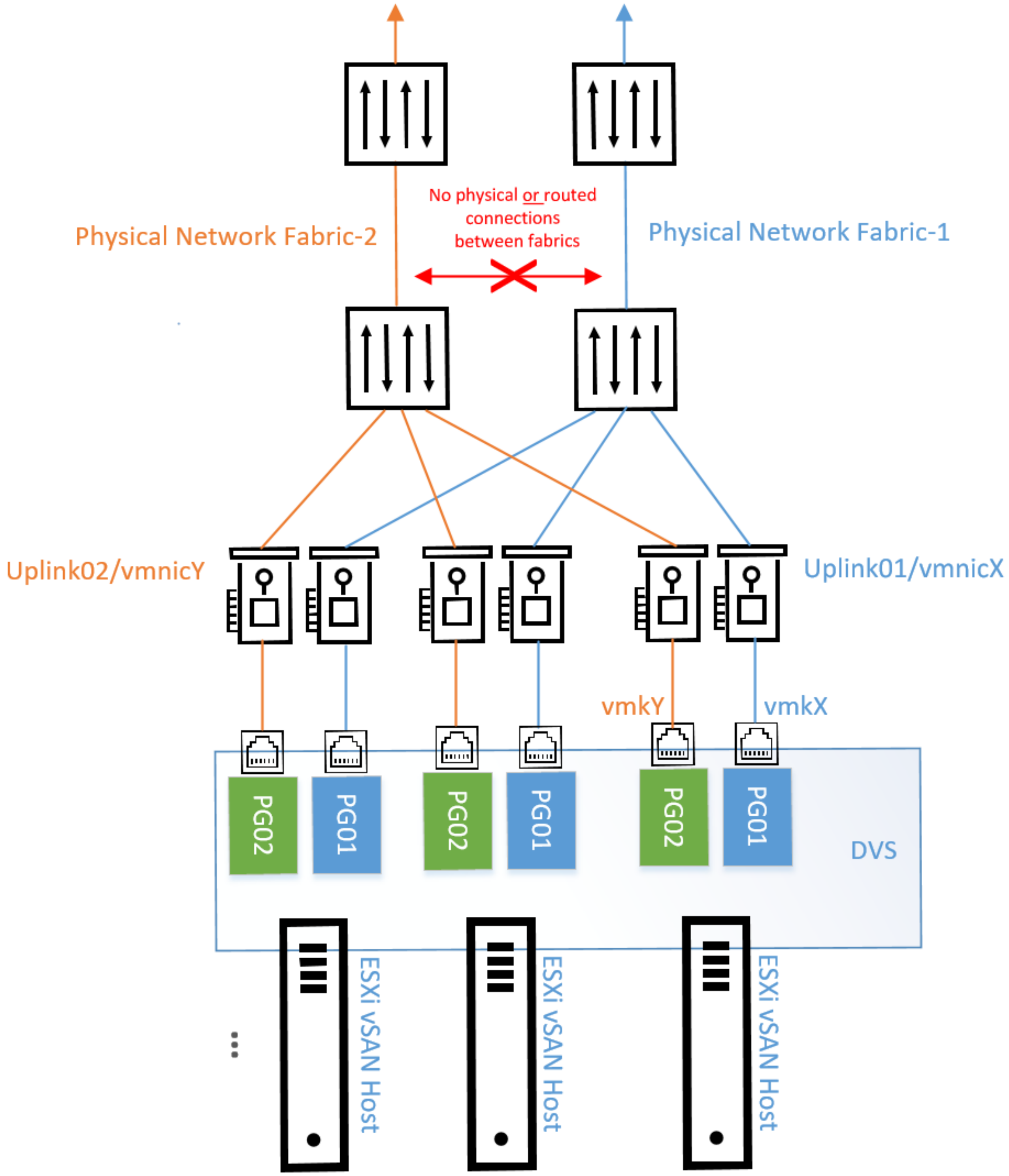
Another cause of a rebuild not occurring is due to an underlying failure already present in the cluster. Verify there are none before testing by checking the health status of the cluster.

Air-gapped Network Failures

Air-gapped vSAN network design is built around the idea of redundant, yet completely isolated storage networks. It is used in conjunction with multiple VMkernel interfaces tagged for vSAN traffic, where each VMkernel interface is on different VLANs/subnets. Thus, there is physical and logical network separation. A primary use case is to separate the IO data flow onto redundant data paths. Each path is then independent, and failure of one does not affect the other.

Note: The system will attempt to (round-robin) balance the traffic between the two VMkernel adaptors to tolerate link failure across redundant data paths.

The figure below shows the vmnic uplinks on each host, physically separated by connecting to different switches (and thus networks). The VMkernel ports are logically separated on separate VLANs (in different port groups on the distributed switch). Therefore, each host has a separate, redundant network path:


No physical or routed connections between fabrics
Physical Network Fabric-2
Physical Network Fabric-1
Uplink02/vmnicY
Uplink01/vmnicX
vmkY
vmkX
PG02
PG01
PG02
PG01
PG02
PG01
DVS
ESXi vSAN Host
ESXi vSAN Host
ESXi vSAN Host

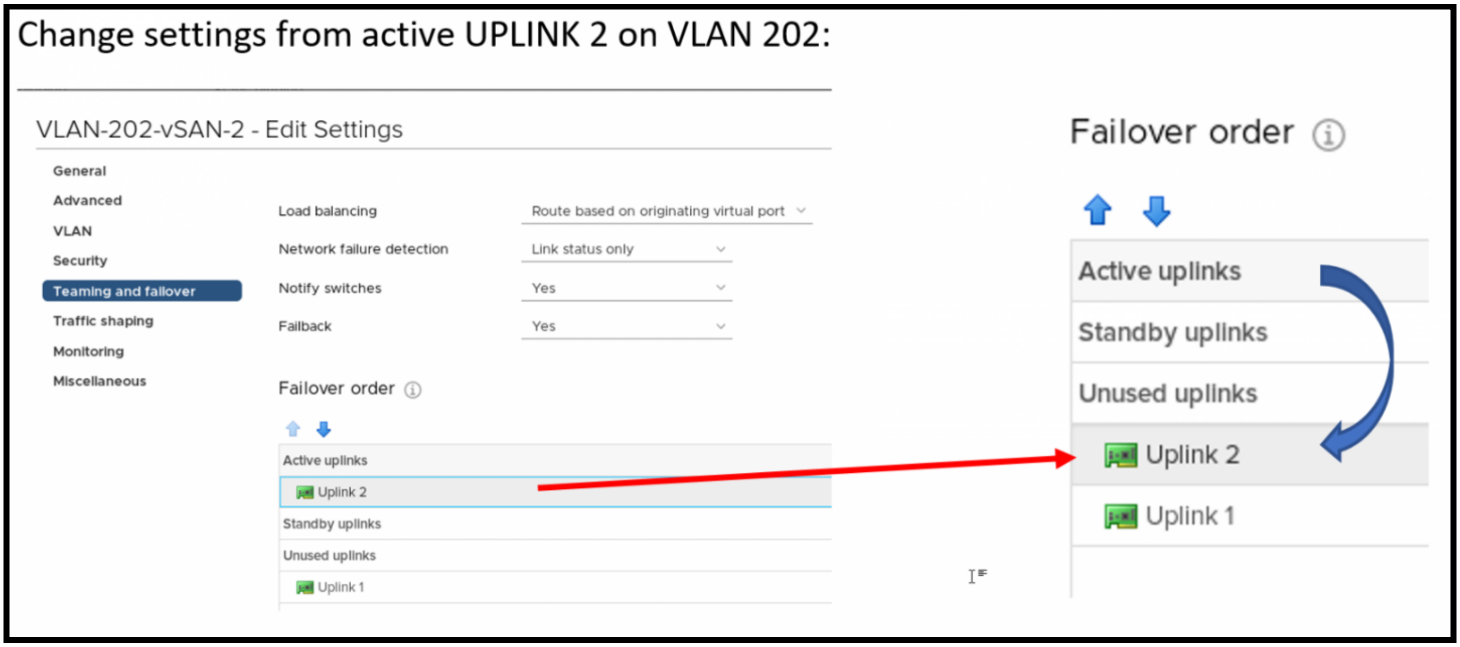
The table below shows the IP, VLAN and uplink details. Again, note that there is one uplink per VMkernel adapter. Each VMkernel adapter is on a separate VLAN.

vSAN VMkernel	IP Address	Port Group Name	VLAN	Port Group Uplinks
vmk1	192.168.201.0/24	VLAN-201-vSAN-1	201	Uplink 1
vmk2	192.168.202.0/24	VLAN-202-vSAN-2	202	Uplink 2

Failover Test Scenario using DVS Portgroup Uplink Priority

Before we initiate a path failover, we need to generate some background workload to maintain a steady network flow through the two VMkernel adapters. You may choose your own workload tool or initate a HCIbench workload set.

Using the functionality in DVS, we can simulate a physical switch failure or physical link down by moving an "active" uplink for a port group to "unused" as shown below. This affects all VMkernel ports that are assigned to the port group.



Change settings from active UPLINK 2 on VLAN 202:

VLAN-202-vSAN-2 - Edit Settings

Load balancing: Route based on originating virtual port

Network failure detection: Link status only

Notify switches: Yes

Failback: Yes

Failover order

Active uplinks
Uplink 2
Standby uplinks
Unused uplinks
Uplink 1

Failover order

Active uplinks
Standby uplinks
Unused uplinks
Uplink 2
Uplink 1

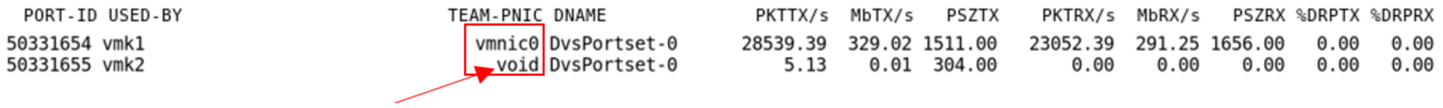
Expected outcome on vSAN IO traffic failover

When a data path is down in air-gapped network topology, failover time is no more than 15 seconds as vSAN proactively monitors failed data path and takes corrective action as soon as a failure is detected.

Monitoring network traffic failover

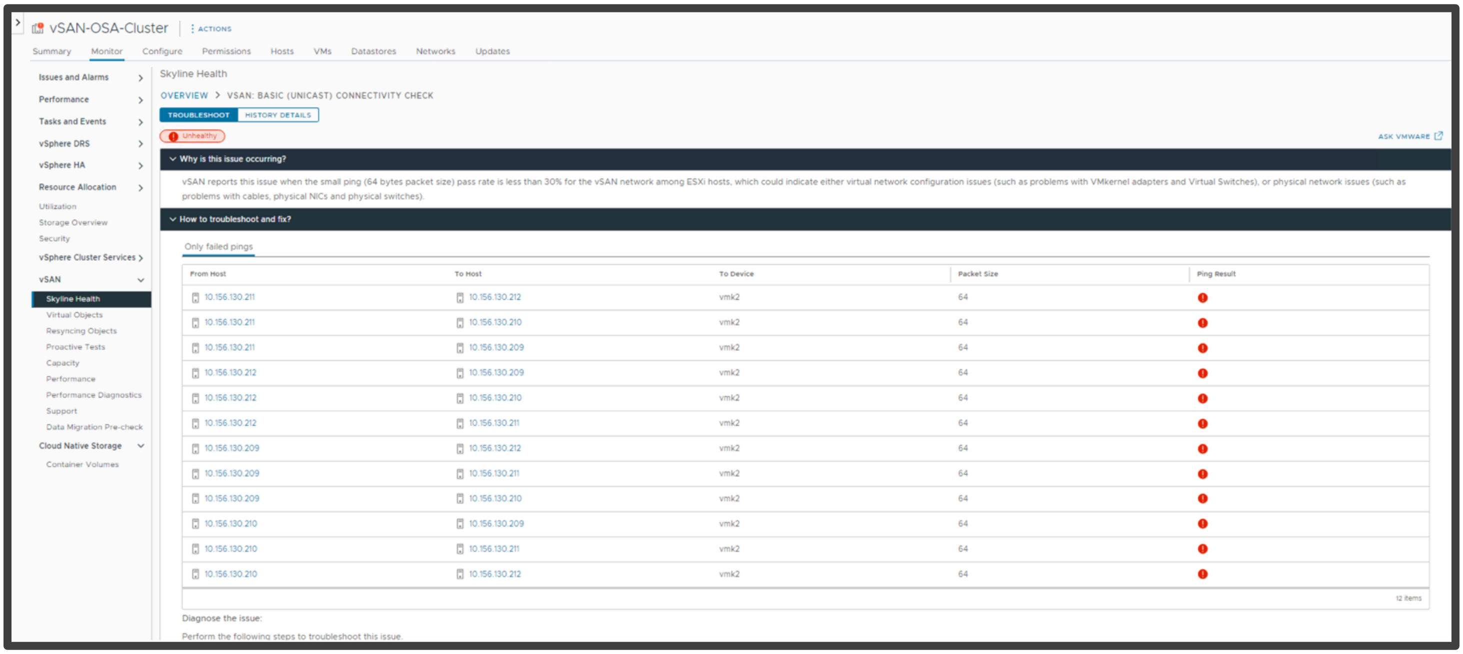
To verify the traffic failover from one VMkernel interface to another, and capture the timeout window, we open an SSH session to each host and use the esxtop utility. Press "n" to actively monitor host network activities before and after a failure is introduced.

The screenshot below illustrates that the data path through vmk2 is down when the "unused" state is set for the corresponding uplink ("void" status is reported for that physical uplink). Notice that TCP packet flow has suspended on that VMkernel interface (as zeroes are reported under the Mb/s transmit (TX) and receive (RX) columns).



```
  PORT-ID USED-BY                        TEAM-PNIC DNAME             PKTTX/s  MbTX/s   PSZTX    PKTRX/s  MbRX/s   PSZRX %DRPTX %DRPRX
 50331654 vmk1                              vmnic0 DvsPortset-0     28539.39  329.02 1511.00   23052.39  291.25 1656.00   0.00   0.00
 50331655 vmk2                                void DvsPortset-0         5.13    0.01  304.00       0.00    0.00    0.00   0.00   0.00
```

It is expected that vSAN health check reports failed pings on vmk2 as we set uplink 1 to "Unused".



Why is this issue occurring?

vSAN reports this issue when the small ping (64 bytes packet size) pass rate is less than 30% for the vSAN network among ESXi hosts, which could indicate either virtual network configuration issues (such as problems with VMkernel adapters and Virtual Switches), or physical network issues (such as problems with cables, physical NICs and physical switches).

How to troubleshoot and fix?

From Host	To Host	To Device	Packet Size	Ping Result
10.156.130.211	10.156.130.212	vmk2	64	●
10.156.130.211	10.156.130.210	vmk2	64	●
10.156.130.211	10.156.130.209	vmk2	64	●
10.156.130.212	10.156.130.209	vmk2	64	●
10.156.130.212	10.156.130.210	vmk2	64	●
10.156.130.212	10.156.130.211	vmk2	64	●
10.156.130.209	10.156.130.212	vmk2	64	●
10.156.130.209	10.156.130.211	vmk2	64	●
10.156.130.209	10.156.130.210	vmk2	64	●
10.156.130.210	10.156.130.209	vmk2	64	●
10.156.130.210	10.156.130.211	vmk2	64	●
10.156.130.210	10.156.130.212	vmk2	64	●

12 items

Diagnose the issue:

Perform the following steps to troubleshoot this issue.

To restore the failed data path after a failover test, modify the affected uplink from "unused" back to "active". Network traffic should be restored through both VMkernel interfaces (though not necessarily load-balanced).

Before testing other scenarios, be sure to remove the second VMkernel interface on each host and perform a vSAN health check and ensure all tests pass.

APPENDIX A: Creating Test VMs

Here we demonstrate how to quickly create a set of identical VMs for testing.

Requirements:

- FreeBSD, Linux or MacOS VM/host environment
- Latest version of govc (download instructions below)

Download govc:

Govc is a lightweight, open-source CLI tool written in Go (and part of the Govmomi/Go library for the vSphere API). Project page: https://github.com/vmware/govmomi/tree/master/govc

To download the latest release, use the command below, or visit the release page:
https://github.com/vmware/govmomi/releases

As with the majority of Go projects, it is packaged as a single binary (note that the tar command requires root privileges to copy the binary to the correct location):

```
curl -L -o - "https://github.com/vmware/govmomi/releases/latest/download/govc_$(uname -s)_$(uname -
m).tar.gz" | tar -C /usr/local/bin -xvzf - govc
```

Connecting to vCenter

To authenticate with vCenter, we need to define the username, password and URL, as per the example below:

```
export GOVC_USERNAME=administrator@vsphere.local
export GOVC_PASSWORD=P@ssw0rd
export GOVC_INSECURE=1
export GOVC_URL=10.156.163.1
```

Additionally, we will need to specify the default datastore and resource pool (we can define this as the default/top-level cluster, as per blow) for deploying our VMs:

```
export GOVC_DATASTORE=ESA-vsanDatastore
export GOVC_RESOURCE_POOL='vSAN ESA Cluster/Resources'
```

Finally test the connection to vCenter by issuing the command below, it should return with details:

```
govc about
FullName:     VMware vCenter Server 8.0.0 build-20519528
Name:         VMware vCenter Server
Vendor:       VMware, Inc.
Version:      8.0.0
Build:        20519528
...
```

Configure Test VM

First, specify a location of an OVA file to use. In the example below, we use an Ubuntu 22.04 cloud image:

```
export vmLocation=https://cloud-images.ubuntu.com/releases/22.04/release/ubuntu-22.04-server-
cloudimg-amd64.ova
```

We can then add our customizations, etc. by extracting the JSON from the OVA:

```
govc import.spec $vmLocation > ubuntu-vm.json
```

Ubuntu uses cloud-init to setup the OS environment. As we will be cloning the deployed VM, we need to define specific user-data (which will be encoded in base-64 and added to the customization JSON). Here we ensure that vSphere specific configuration is not disabled, and we modify the default netplan configuration file to ensure DHCP addresses are assigned by mac address (rather than machine-id).

To simplify the process, the user-data file can be downloaded from the link below:
https://raw.githubusercontent.com/vmware-tanzu-experiments/vsphere-with-tanzu-proof-of-concept-samples/main/VCF/test_vms/user-data

```
#cloud-config
runcmd:
  - 'echo "disable_vmware_customization: false" >> /etc/cloud/cloud.cfg'
  - echo -n > /etc/machine-id
  - |
    sed -i '' -e 's/match.*/dhcp-identifier: mac/g' -e '/mac/q' /etc/netplan/50-cloud-init.yaml
final_message: "The system is prepped, after $UPTIME seconds"
power_state:
  timeout: 30
  mode: poweroff
```

If available, use the cloud-init CLI to check the user-data file:

```
$ cloud-init schema --config-file user-data
```

Next, we encode the user-data to base64:

```
base64 -i user-data
```

Now we can edit the JSON file we extracted earlier. Change the file with the following:

- Disk provisioning set to 'thin'
- Add the public key of the machine we are connecting from
- Remove the hostname and password data
- Set the network for the VM (the name of the relevant portgroup in vCenter)

- Set the name of the VM
- In the ‘user-data’ section, paste in the base64 encoded data

Note we can avoid hand-editing the JSON by using jq. For example, we can update the user-data field directly in the JSON file:

```
jq 'select(.Key=="user-data").Value="$(base64 -i user-data)"' ubuntu-vm.json
```

Similarly, adding a public key stored in a user's GitHub profile:

```
jq 'select(.Key=="public-keys").Value="$(curl -sk https://api.github.com/users/[github user]/keys |
jq -r '.[].key')"' ubuntu-v.json
```

An example of this file can be seen here:
https://raw.githubusercontent.com/vmware-tanzu-experiments/vsphere-with-tanzu-proof-of-concept-samples/main/VCF/test_vms/ubuntu-vm.json

```
{
  "DiskProvisioning": "thin",
  "IPAllocationPolicy": "dhcpPolicy",
  "IPProtocol": "IPv4",
  "PropertyMapping": [
    {
      "Key": "instance-id",
      "Value": "id-ovf"
    },
    {
      "Key": "hostname",
      "Value": ""
    },
    {
      "Key": "seedfrom",
      "Value": ""
    },
    {
      "Key": "public-keys",
      "Value": "ssh-rsa AAAAB3NzaC1yc2EAAAAD..."
    },
    {
      "Key": "user-data",
      "Value": "I2Nsb3VkLWNvbmZpZwpy..."
    },
    {
      "Key": "password",
      "Value": ""
    }
  ],
  "NetworkMapping": [
    {
      "Name": "VM Network",
      "Network": "DSwitch-DHCP"
    }
  ],
  "MarkAsTemplate": false,
  "PowerOn": false,
  "InjectOvfEnv": false,
  "WaitForIP": false,
  "Name": "ubuntu-vm"
}
```

Once this JSON file has been defined, we can double-check our user-data encoding is still correct:

```
awk -F '"' '/user-data/{getline; print $4}' ubuntu-vm.json | base64 -d
```

This should return the user-data as we defined above.

Import OVA to vCenter and Clone

We can then import the OVA into vCenter, specifying our JSON customization file:

```
govc import.ova -options=ubuntu-vm.json -name=ubuntu-template $vmLocation
```

After this has imported, we can update the virtual disk size. Here we set it to 100G:

```
govc vm.disk.change -vm ubuntu-template -disk.label "Hard disk 1" -size 100G
```

Power on the VM to allow it to run cloud-init (and thus our previously defined commands). Once complete, the VM will shutdown:

```
govc vm.power -on ubuntu-template
```

Once the VM has shutdown, mark it as a template:

```
govc vm.markastemplate ubuntu-template
```

Finally, we can clone our template VM as we need to. In the example below, we clone it ten times:

```
for x in {1..10};do govc vm.clone -vm ubuntu-vm ubuntu-vm$x;done
```

To do this for a large number of VMs, in parallel (and output to a log file) we could run:

```
for x in {1..250};do (govc vm.clone -vm ubuntu-template ubuntu-vm$x >> $(date +%d%m-%H%M)_clone.log
2>&1 &);done
```

We can monitor progress by probing the vCenter task-list:

```
govc tasks -f -l
```

After cloning, we can batch-execute commands on all the VMs. For example, the 'ls' command:

```
govc find -type m -name 'ubuntu-vm*' | xargs -P0 -I '{}' bash -c 'ssh -o "StrictHostKeyChecking=no"
ubuntu@$(govc vm.ip {}) ls'
```

APPENDIX B: PCI HOTPLUG

NVMe has helped usher in all-new levels of performance capabilities for storage systems. vSphere 7 introduced hotplug support for NVMe devices. Consult the vSAN HCL to verify supportability and required driver and firmware versions

vSphere 7.0 and above follow the standard hot plug controller process and can be categorized into two processes, *surprised* and *planned* PCIe device hot-add.

Surprise Hot-Add

The device is inserted into the hot-plug slot without prior notification: without the attention button or software interface (UI/CLI) mechanism.

Step	User Action	ESXi Action	Power Indicator
1	User selects an empty, disabled slot and inserts a PCIe device	Platform/PCI hotplug layer detects the new additional hardware and notifies the ESXi device manger to scan for hot-added devices. In case of any failure, the Power Indicator goes OFF.	BLINKS
2	User waits for the slot to be enabled	PCI bus driver enumerates the hot-added device and registers it with the vSphere device manager	ON

Planned Hot-Add

Step	User Action	ESXi Action	Power Indicator
1	User selects an empty, disabled slot and inserts a PCIe device		OFF
2	User presses attention button / issues software UI/CLI command to enable the slot	In case of software interface (UI/CLI), there is no provision to abort a hot-add request, so once the command is issued control directly jumps to Step 4 In case of attention button, PCIe hotplug layer waits for ABORT INTERVAL (=5sec)	BLINKS
3	User cancels the operation by pressing the attention button a second time within 'abort interval'	If canceled, the Power Indicator goes back to previous state OFF	OFF

4	No user action in the 'abort interval'	PCIe hotplug layer validates the hot-add operation, powers the slot. On success, it notifies the ESXi device manager to scan for the hot-added device(s). in case of any failure, the Power Indicator goes back to previous state OFF	BLINKS
5	User waits for the slot to be enabled	PCI bus driver enumerates the hot-added device and registers it with the ESXi device manager.	ON

Note: After these steps, the ESXi device manager attaches the devices to the driver and the storage stack, presents the HBA, and the associated disk(s) to the upper layer, for example vSAN/VMFS.

Surprise Hot-Remove

In this case, the drive is removed without any prior notification through attention button or UI/CLI. If the user did not run preparatory steps, data consistency cannot be guaranteed. In the case of failed drives, the scenario is the same as abrupt removal without the preparatory steps, in which case no data consistency can be guaranteed.

Step	User Action	ESXi Action	Power Indicator
1	User selects an enabled slot with a PCIe device to be removed.	ESXi executes the requested preparatory steps for the drive corresponding to this device and flags as an error if unable to perform any step. User can choose to skip preparatory steps and directly remove the device in which case data consistency cannot be guaranteed.	ON
2	User removes the PCIe device	Platform/PCIe hot-unplug layer detects the device removal and notifies the ESXi device manager to remove the device. In case of any failure, the Power Indicator goes OFF. ESXi device manager issues a series of quiesce instructions, detach from all the drivers (storage stack, device driver, etc…), and finally remove the PCI bus driver. In case of any failure, the Power Indicator goes back to the previous state ON indicating that the device cannot be removed.	BLINKS
3	User waits for the slot to become disabled	PCIe bus driver removes the device from the system and power down the PCI slot.	OFF

Planned Hot-Remove

It is expected that the user runs the preparatory steps to ensure the data consistency, before initiating hot remove operation via the attention button/software interface (UI/CLI). Even in this case, if the user does not run preparatory steps, data consistency cannot be guaranteed.

Step	User Action	ESXi Action	Power Indicator
1	User selects an enabled slot with a PCIe device to be removed and initiates preparatory steps.	ESXi executes the requested preparatory steps for the drive corresponding to this PCIe device and flags an error if unable to perform any step.	ON
2	User presses Attention Button/issues software UI command to disable the slot	In the case of software interface (UI/CLI), there is no provision to abort the hot-remove request, so once the command is issued, control directly jumps to Step 5. PCI Hot-unplug layer gets an interrupt and waits for ABORT INTERVAL (= 5 seconds).	BLINKS
3	User can cancel the operation by pressing the Attention Button a second time	The Power Indicator goes back to previous state ON	ON
4	No user action in the 'abort interval'	PCI Bus driver removes the device from the system and power down the slot.	OFF
5	User waits for the slot to be disabled	PCI Bus driver removes the device from the system and power down the slot.	OFF
6	User removes the PCIe device		OFF

For more information on PCI hotplug, visit:

- PCIe hotplug: ESX host may crash when PCIe NVMe device(s) surprise hot removed and hot inserted back quickly - https://kb.vmware.com/s/article/78390
- Supported scenarios of NVME hot plug/removal in ESXi (78297) - https://kb.vmware.com/s/article/78297

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