



vSphere 7.0: NVMe-RDMA/RoCE Deployment Guide with Pavilion Hyperparallel Flash Array

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1. About This Guide

The **vSphere 7.0: NVMe-RoCE Deployment Guide with Pavilion Hyperparallel Flash Array (HFA)** assists the user to:

- ✓ Install and Configure vSphere 7.0 using **Pavilion HFA** and to make it easy for users to use RDMA with **Pavilion HFA**.
- ✓ Configure ESXi Servers for NVMe-over-RoCE Datastores
- ✓ Configure ESXi Cluster for NVMe over RoCE by VCenter
- ✓ Create Distributed Port Groups for Storage Traffic
- ✓ Add VMkernel Adapters for Distributed Port Groups
- ✓ Configure NVMe over RoCE in Pavilion HFA
- ✓ Create Datastore Volumes on the Pavilion HFA
- ✓ Assign the Datastore Volumes for High Availability
- ✓ VMWare RDMA Client Mounting and Options
- ✓ Configure Multipathing
- ✓ Verify Initiators in Pavilion
- ✓ Create Datastore, VMFS Filesystem, and Virtual Machine
- ✓ Disconnect from a NVMe Datastore

This document is intended for audience familiar with **VMware® vSphere™** client and **ESXi Shell**, so that the user can successfully manage vCenter server systems or standalone ESXi hosts.

Pavilion Data vCenter plugin is a user friendly, browser-based tool. The plugin integrates with the **VMware® vSphere™** client, providing an alternative interface that allows you to monitor and manage **Pavilion HFA**.

It is recommended that you see *Pavilion vCenter Plugin Reference Guide* for more information.

Note: For more detailed implementation assistance, contact your **Pavilion Sales/Support** representative.

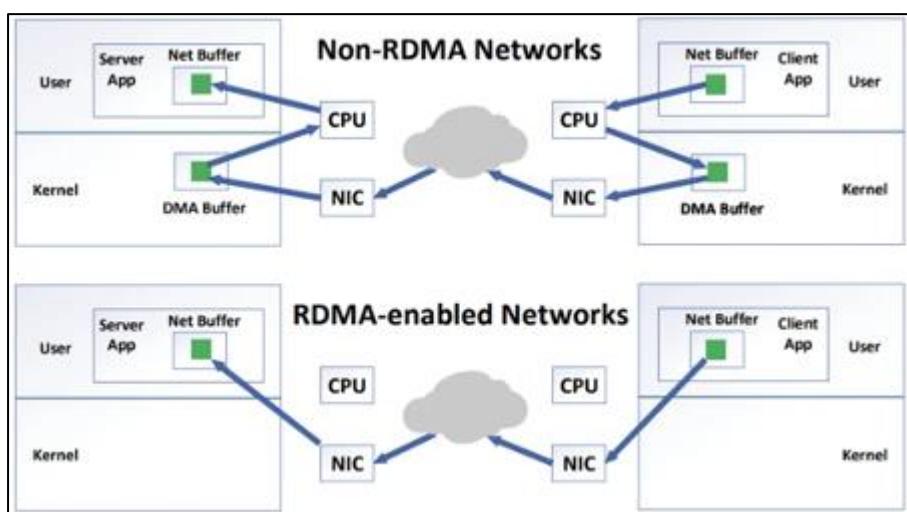
2. About NVMe and NVMe over Fabrics

Non-Volatile Memory express (NVMe) is an advanced protocol used to access flash storage on PCI express bus. **Non-Volatile** stands for **persistent storage**, while **express** refers to the fact that the data travels over the **PCI express (PCIe) interface** on the computer's motherboard. This gives the drive a direct connection with the CPU and memory and eliminates many latency-inducing layers of traditional storage stacks such as SAS or SATA controllers. All modern servers and operating systems support NVMe out-of-the-box, and for enterprise and cloud scale Solid State Drives (SSDs) it is the interface of choice.

Because NVMe removes the intermediate legacy storage controllers and storage stack from the OS, it can provide significantly reduced latency (on the order of tens of microseconds per 4K I/O on enterprise NVMe SSDs). PCI express interface enables to support individual drive bandwidths of up to 4GB/s per individual NVMe SSD. NVMe over Fabrics (NVMe-oF) is an industry standard extension of the NVMe protocol which allows remote NVMe storage to be accessed as local attached storage to servers. This is like how legacy Fibre Channel and iSCSI protocols enabled servers to utilize remote disks in SAN arrays for data storage, but with massively higher bandwidth and an order of magnitude lower latency. With **vSphere 7.0**, VMware along with Linux supports it out-of-the-box today, with work ongoing for Microsoft Windows and other operating systems.

Direct memory access (DMA) is used in NVMe to allow the SSD to directly load or store data to server memory, without CPU intervention (just like 0-copy accelerated TCP on high-performance NICs). RDMA (Remote DMA) allows direct memory access, from remote targets. An RDMA enabled storage array like the **Pavilion HFA** can handle I/O requests without the server's CPU intervention. See **Image: Non-RDMA and RDMA-enabled Networks** for reference.

Image: Non-RDMA and RDMA-enabled Networks



Note: RDMA is supported on the two standard networking infrastructures deployed today: InfiniBand and/or Ethernet.

3. Using NVMe-oF with ESXi 7.0

VMware has released **version 7.0** of their **ESXi server**, and it provides a great new way to enhance the performance of I/O bound VMs, NVMe-over-Fabrics (**NVMe-oF**) datastore support. NVMe-oF provides the same high availability and shareability of traditional SAN storage, but with 10x the bandwidth and up to 100x lower latency.

The **Pavilion HFA** is one of the first NVMe-oF all-flash arrays to be certified by VMware.

This document gives an overview of the steps required to make use of NVMe-oF in **VMware ESXi 7.0**, using the **Pavilion HFA** and ensuring **High Availability** of your NVMe-oF datastore.

4. Prerequisites

NVMe-oF is a mature, relatively straightforward technology. It does, however, require compatible software and hardware before it can be configured/setup. For more detailed configuration information, refer to the *Pavilion HFA Best Practices Guides for RoCE and High Availability*.

Refer to *Pavilion NVMe-oF Storage Platform Release Notes* for supported NICs in VMware. You could obtain these guides from **Pavilion** Sales/Support contact.

In general, **NVMe-oF** requires:

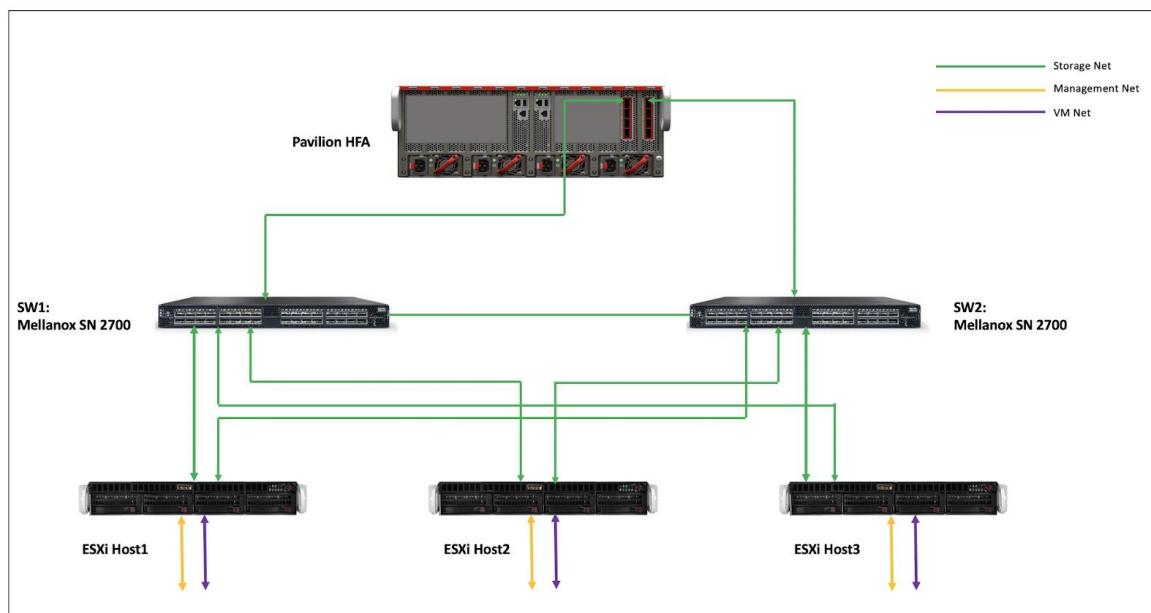
- ✓ 100 GbE-class network infrastructure with RDMA support
- ✓ RDMA compatible Ethernet NICs (RNICs) in the ESXi servers with MTU 9000 (Jumbo ethernet frame).
- ✓ VMware vSphere ESXi 7.0.0 or later
- ✓ vCenter 7.0.0 or later

5. Solution Overview

The solution for this guide consists of the following components:

- ✓ 3x Supermicro E5-2690 V4 Servers with 1x Mellanox CX-4 Card (dual port)
- ✓ 1x Pavilion HFA
- ✓ 2x Mellanox SN2700 ethernet switches
- ✓ VMware ESXi 7.0 and vCenter 7.0 for hypervisor and management

The below image depicts the **Solution Overview**:



6. Configuring ESXi Servers for NVMe-over-RoCE Datastores

While **VMware® vSphere™** client provides an easy to use GUI for configuring NVMe-oF connectivity, it is still possible to configure individual, unmanaged ESXi servers using the **ESXi Shell** (command line).

Note: All the configurations are persistent across reboots, so the CLI tasks listed in this section, need to be executed only once.

For NVMe-oF connectivity we are using **Mellanox adapters** and the driver is **nmlx5_core** with **RoCEv2** enabled. No change is required if the Mellanox adapter has the nmlx5_core driver.

To check your **Mellanox adapters driver version** run the following command on the ESXi host:

```
[root@localhost:~] esxcfg-nics -l |grep -E 'Name|Mellanox'
Name   PCI     Driver   Link Speed   Duplex MAC Address      MTU   Description
vmnic2 0000:02:00.0 nmlx5_core Up    100000Mbps Full   b8:59:9f:34:89:ba 9000  Mellanox Technologies ConnectX-4 EN NIC; 100GbE;
dual-port QSFP28; (MCX416A-CCA)
vmnic3 0000:02:00.1 nmlx5_core Up    100000Mbps Full   b8:59:9f:34:89:bb 9000  Mellanox Technologies ConnectX-4 EN NIC; 100GbE;
dual-port QSFP28; (MCX416A-CCA)
```

Default operating mode **RoCEv1** and **RoCEv2** is required for NVMe-oF connectivity. Run the following command to verify whether **RoCEv2** is enabled or not:

```
[root@localhost:~] esxcli system module parameters list --module=nmlx4_core |grep -E 'Name|enable_rocev2'
Name          Type  Value  Description
enable_rocev2  int    1      Enable RoCEv2 mode for all devices
```

If your host mellanox adapter runs a version older than **nmlx5_core** then we have to enable **RoCEv2** support using the following command:

```
[root@localhost:~] esxcli system module parameters set -p enable_rocev2=1 -m nmlx4_core
```

Reboot the host. Once the host is rebooted, you can verify the changes by executing the following command:

```
# esxcli system module parameters list --module=nmlx4_core |grep -E 'Name|enable_rocev2'

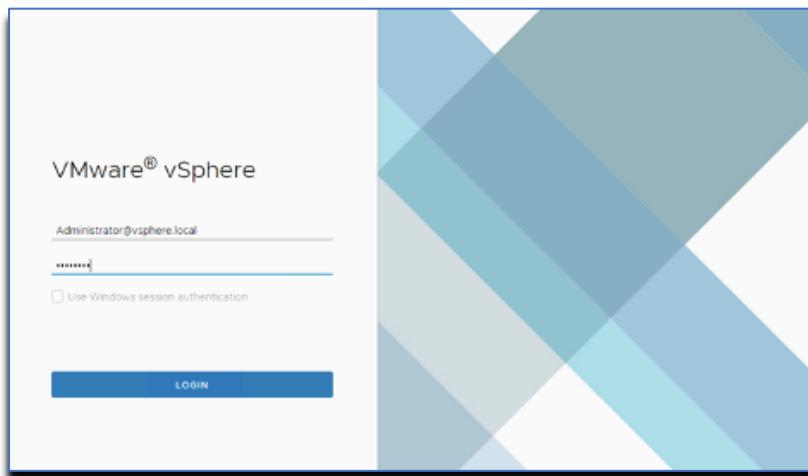
Name          Type  Value  Description
enable_rocev2  int    1      Enable RoCEv2 mode for all devices
```

7. Configuring ESXi Cluster for NVMe over RoCE by vCenter

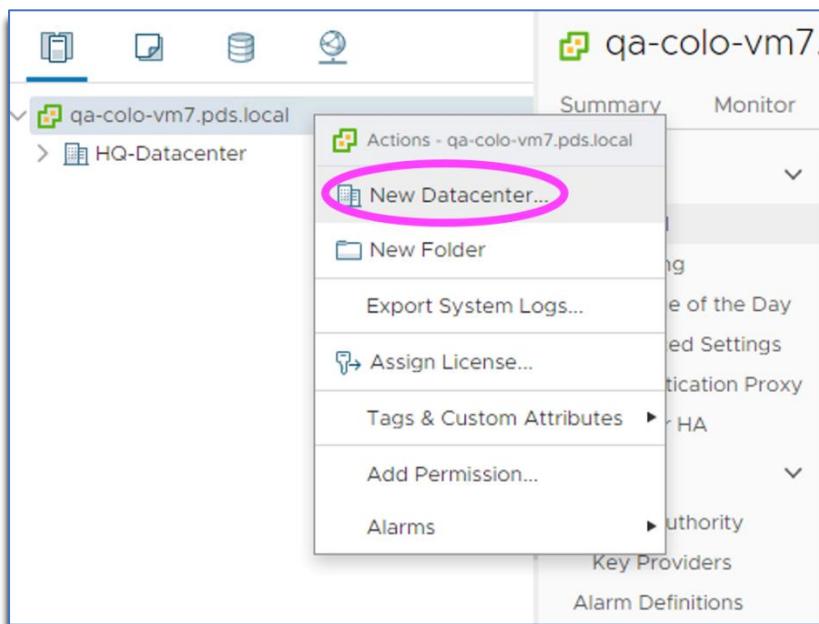
This section lists the steps required to set up **3 Node ESXi Cluster** for accessing **Pavilion NVMe-oF** devices using **NVM-over-RoCE** protocol.

The upcoming sections lists the steps required to create datacenter, ESXi cluster and configure networking for NVMe-over-RoCE traffic.

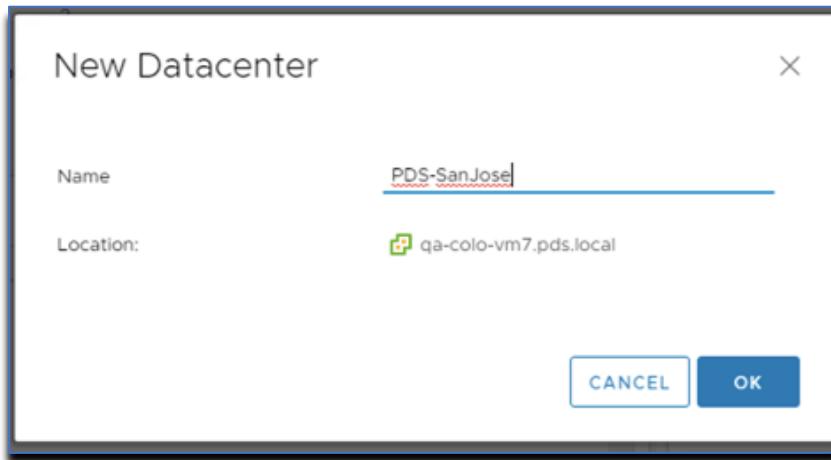
Step 1: Log in to the **VMware® vSphere™** client as seen in the below image:



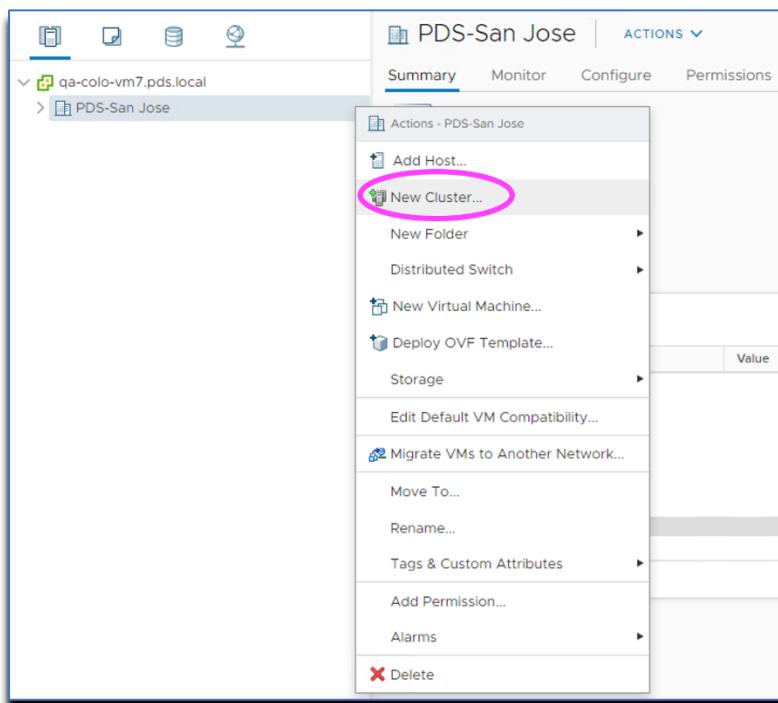
Step 2: Select a location for which you are to create **New Datacenter**, as seen in the below image:



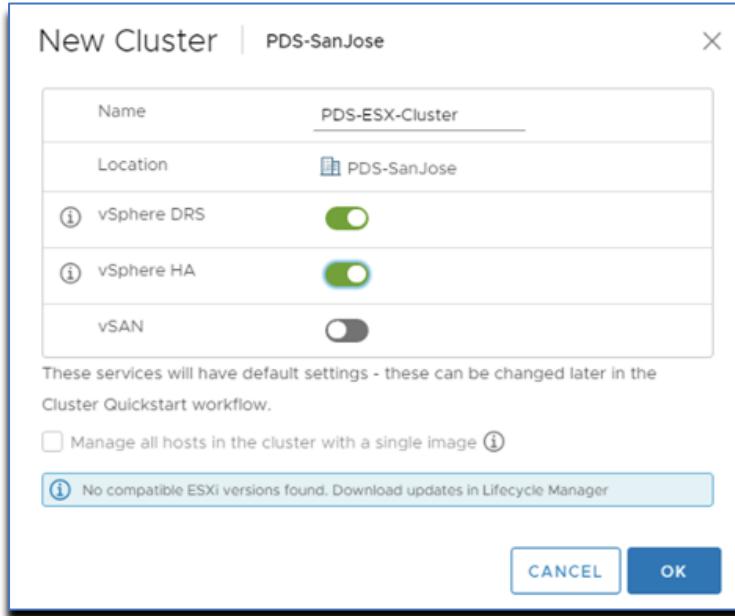
Step 3: In the **New DataCenter** dialog box, enter **Name** of the datacenter, as seen in the below image:



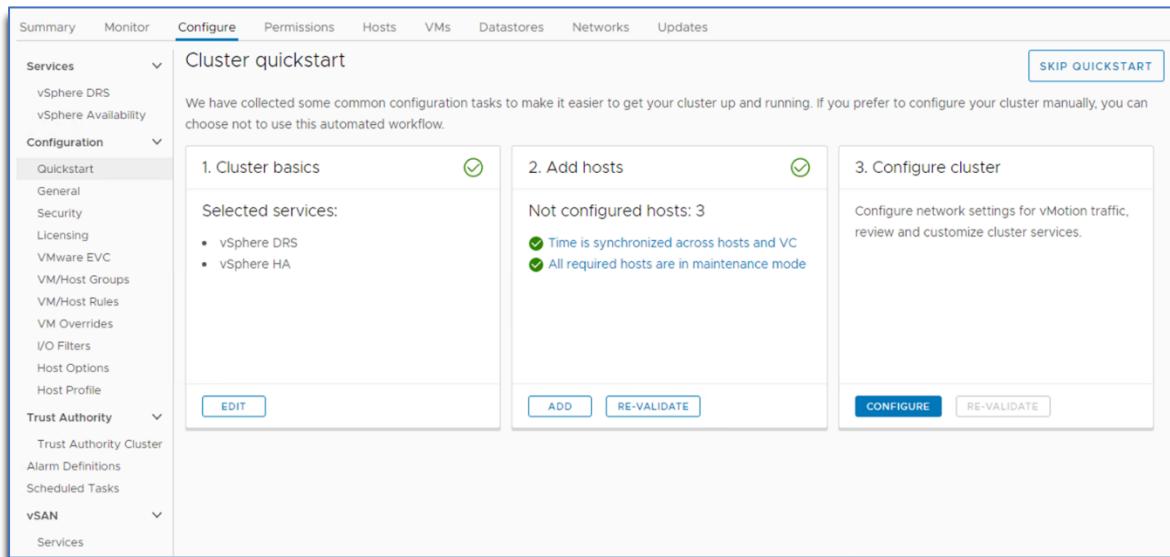
Step 4: Select the Datacentre created, create **New Cluster** for ESX, as seen in the below image:



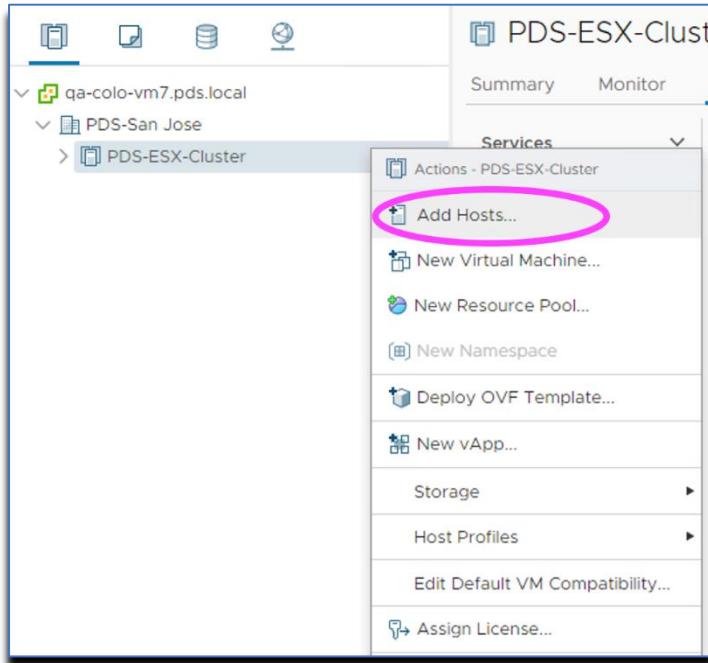
Step 5: In the New Cluster dialog box, enter the **Cluster Name** and enable features for **vSphere DRS** and **vSphere HA**. Click **OK**, as seen in the below image:



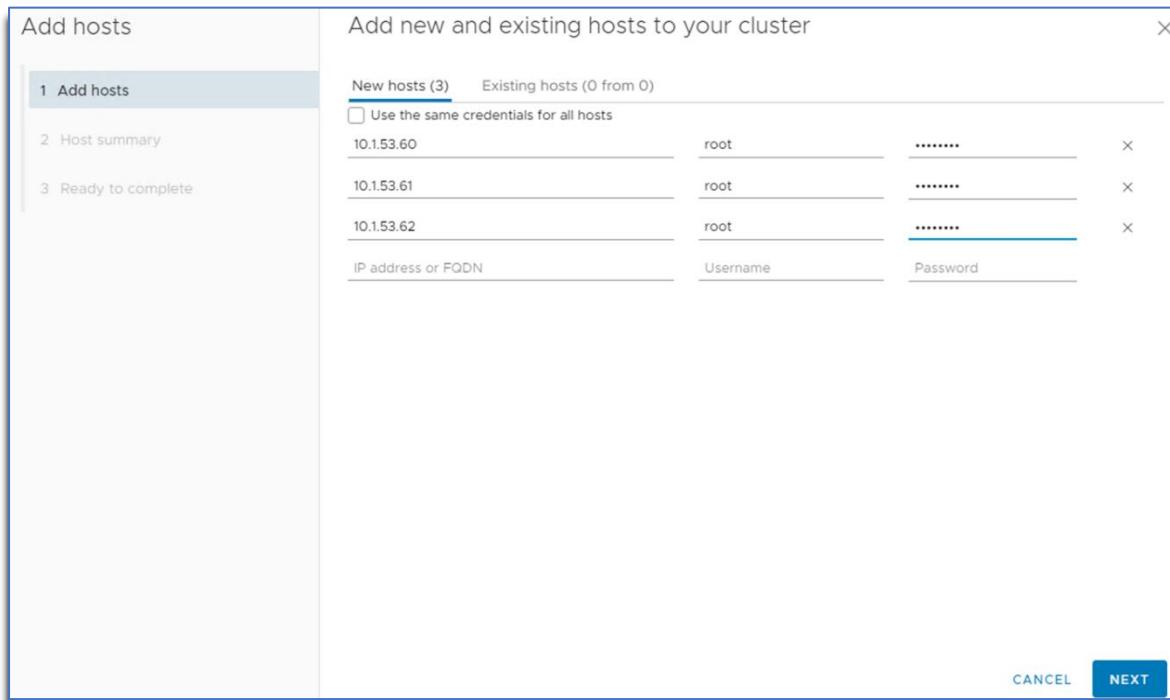
Step 6: The new **ESX cluster** created can be verified as seen in the below image:



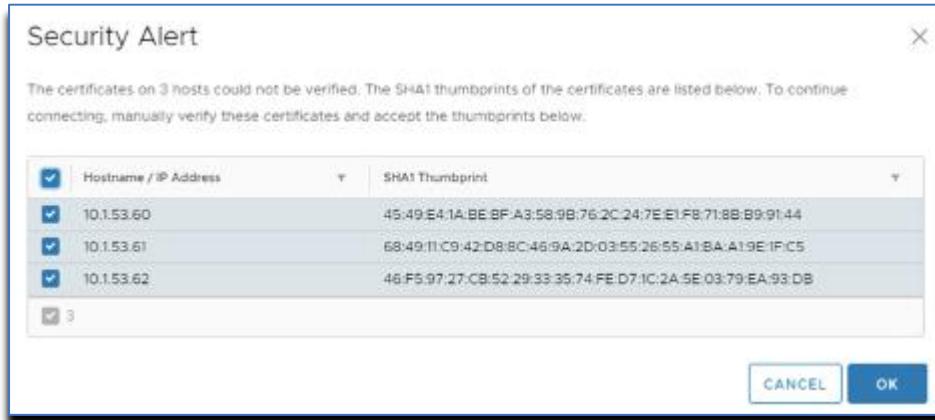
Step 7: Subsequently, user can **Add Hosts** to the ESX Cluster as seen in the below image:



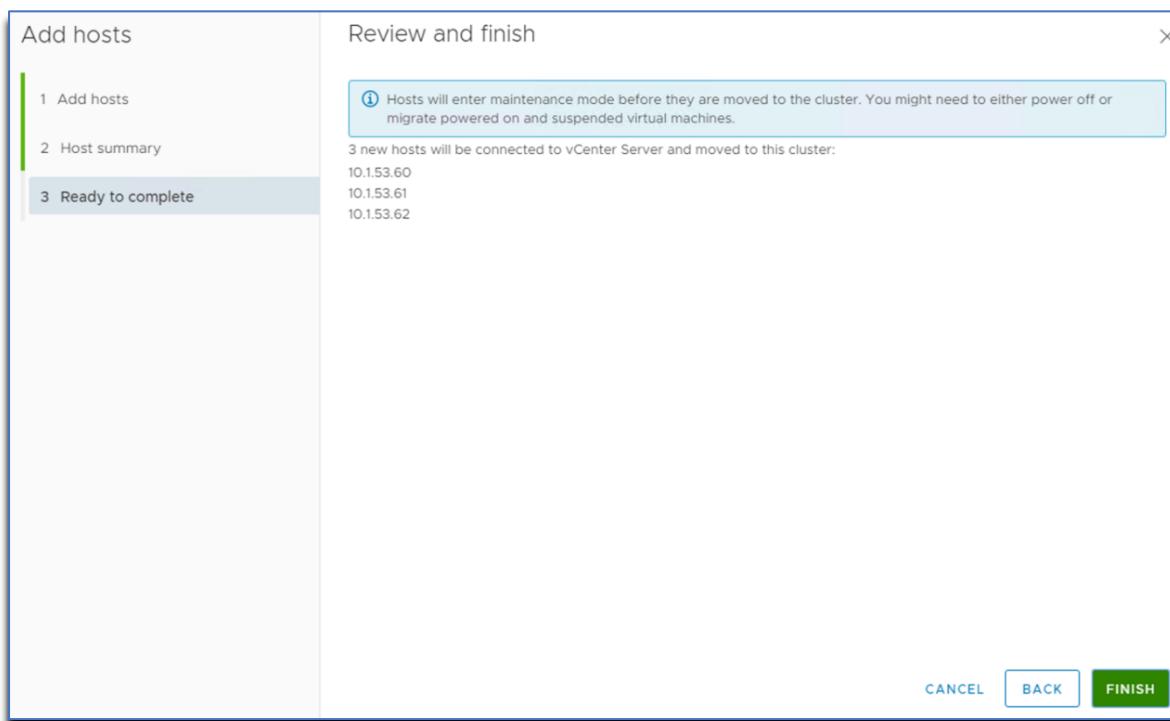
Step 8: Enter host related information, click **Next**, as seen in the below image:



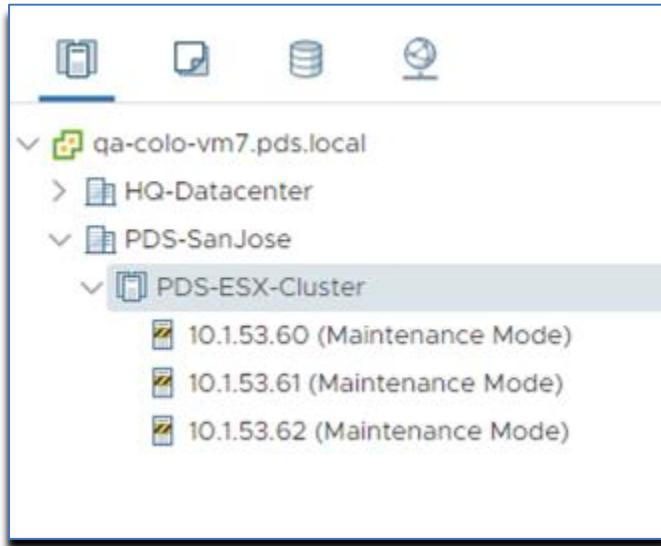
Step 9: Subsequently hosts are created, and hosts are discovered and ready to be added to the cluster as seen in the below image:



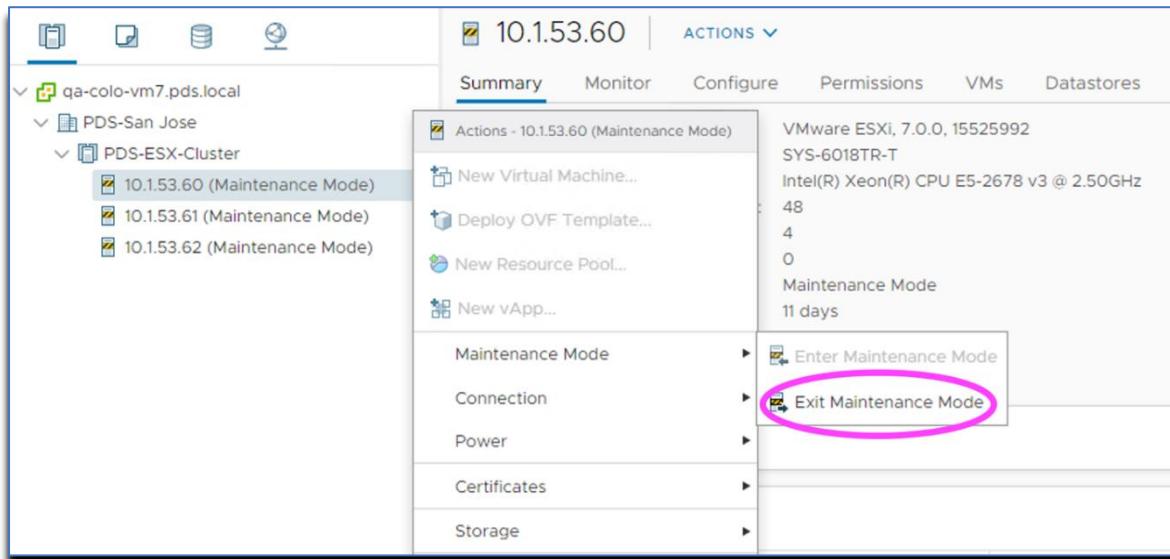
Step 10: Review the host information and click **Finish** as seen in the below image:



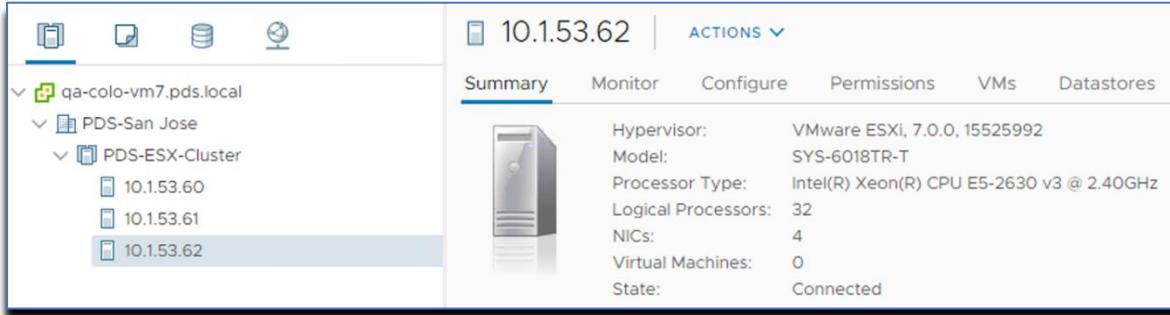
Step 11: The newly added hosts are in **Maintenance Mode** as seen in the image below:



Step 12: Select the hosts that are in maintenance mode, click on **Maintenance Mode>Exit Maintenance Mode** for each host in the cluster, as seen in the below image:



Step 13: Subsequently, the **ESXi Cluster with 3 Hosts** is created as seen in the below image:

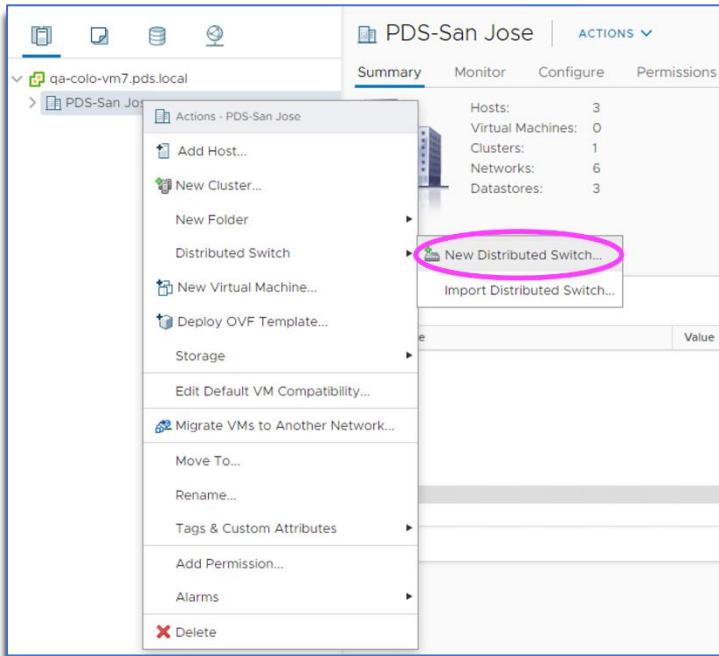


The screenshot shows the vSphere Client interface. On the left, the navigation tree displays a folder named 'qa-colo-vm7.pds.local' containing a subfolder 'PDS-San Jose' which contains a subfolder 'PDS-ESX-Cluster'. Inside 'PDS-ESX-Cluster', three hosts are listed: '10.1.53.60', '10.1.53.61', and '10.1.53.62'. The host '10.1.53.62' is highlighted with a blue selection bar at the bottom of its list item.

The main pane shows the 'Summary' tab for the selected host '10.1.53.62'. The host icon is a server rack. The summary details are as follows:

Hypervisor:	VMware ESXi, 7.0.0, 15525992
Model:	SYS-6018TR-T
Processor Type:	Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz
Logical Processors:	32
NICs:	4
Virtual Machines:	0
State:	Connected

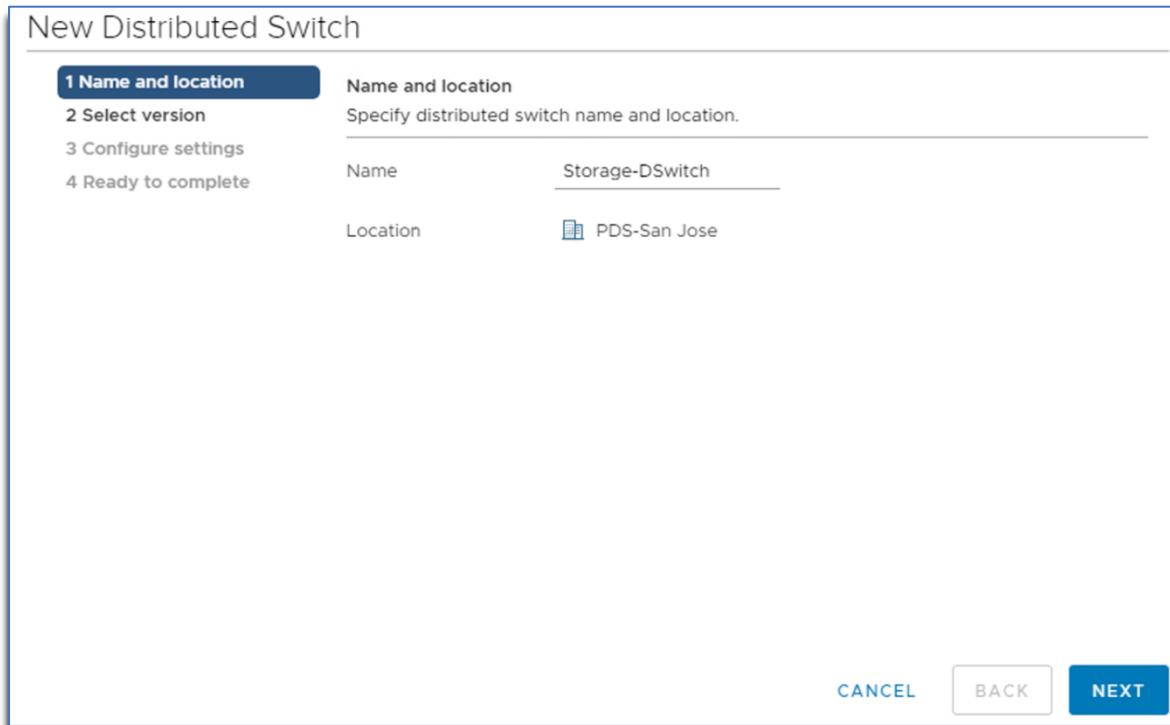
Step 14: Next step is to **Create Distributed Switch for Storage Traffic**, as seen in the below image:



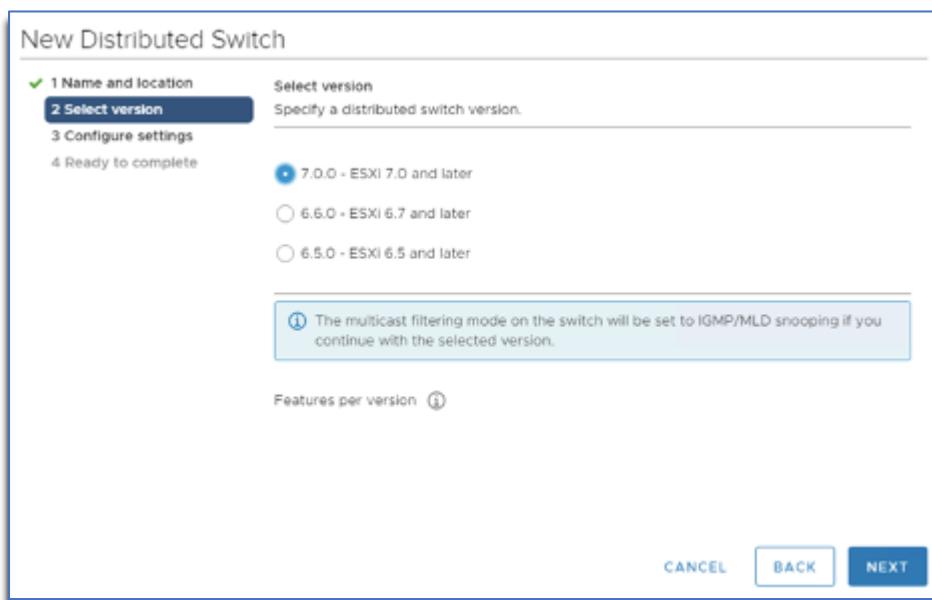
The screenshot shows the vSphere Client interface. The left navigation tree shows 'qa-colo-vm7.pds.local' and 'PDS-San Jose'. A context menu is open over 'PDS-San Jose', with the 'Actions - PDS-San Jose' option highlighted. The menu items include:

- Add Host...
- New Cluster...
- New Folder
- Distributed Switch (this item has a pink oval around it)
- New Virtual Machine...
- Deploy OVF Template...
- Storage
- Edit Default VM Compatibility...
- Migrate VMs to Another Network...
- Move To...
- Rename...
- Tags & Custom Attributes
- Add Permission...
- Alarms
- Delete

Step 15: In the **New Distributed Switch** dialog box, enter the **Name** as seen in the below image:



Step 16: Select **ESXi version 7.0.0 and later**. Click **Next**, as seen in the below image:



Step 17: Select **Number of Uplinks**. For this instance, **2 uplinks** are used. Click **Next**.

Note: Uncheck **Default Port Group**. User can create port groups later, as seen in the below image:

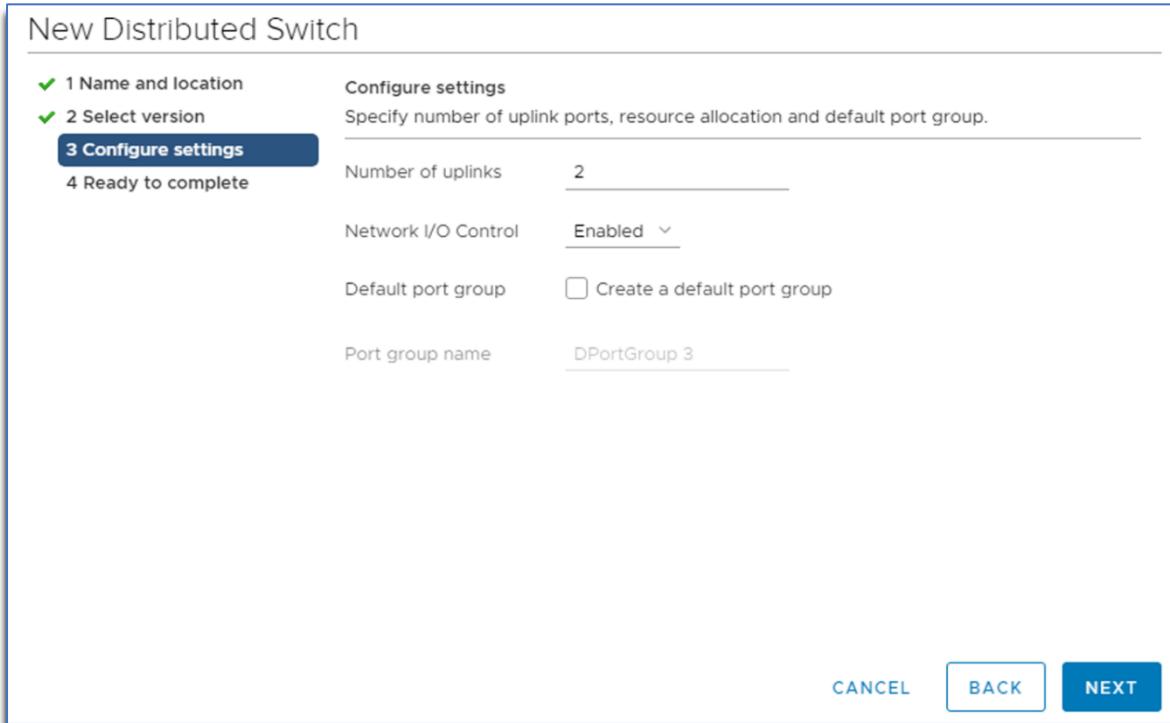
New Distributed Switch

✓ 1 Name and location
✓ 2 Select version
3 Configure settings
4 Ready to complete

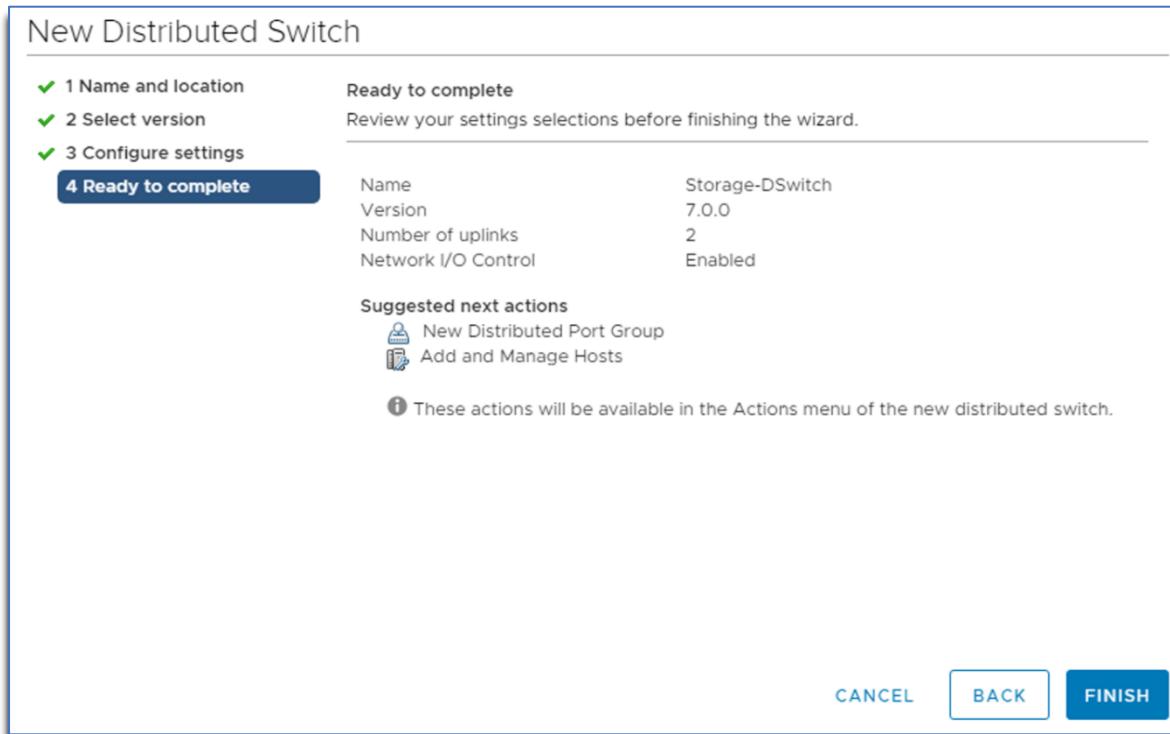
Configure settings
Specify number of uplink ports, resource allocation and default port group.

Number of uplinks	2
Network I/O Control	Enabled
Default port group	<input type="checkbox"/> Create a default port group
Port group name	DPortGroup 3

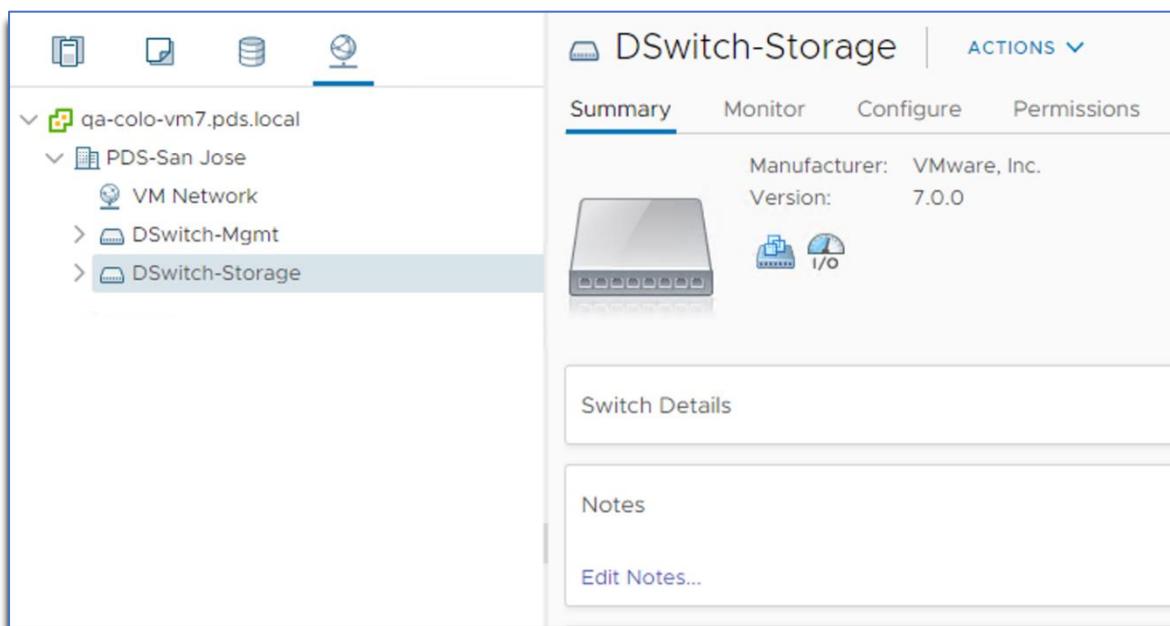
CANCEL BACK **NEXT**



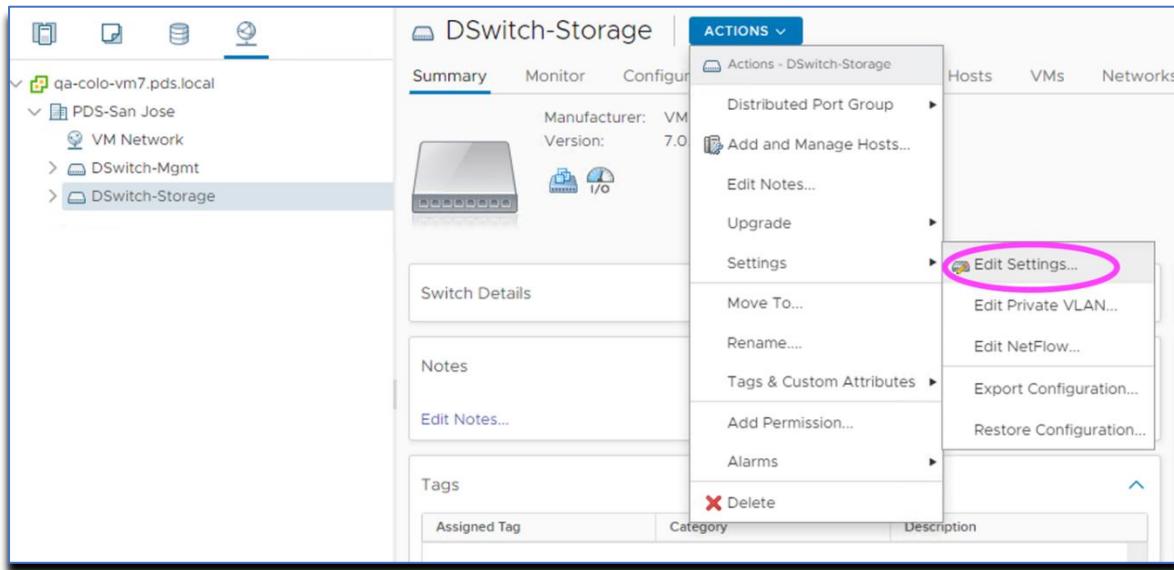
Step 18: On the **Ready to complete** dialog box, click **Finish** as seen in the below image:



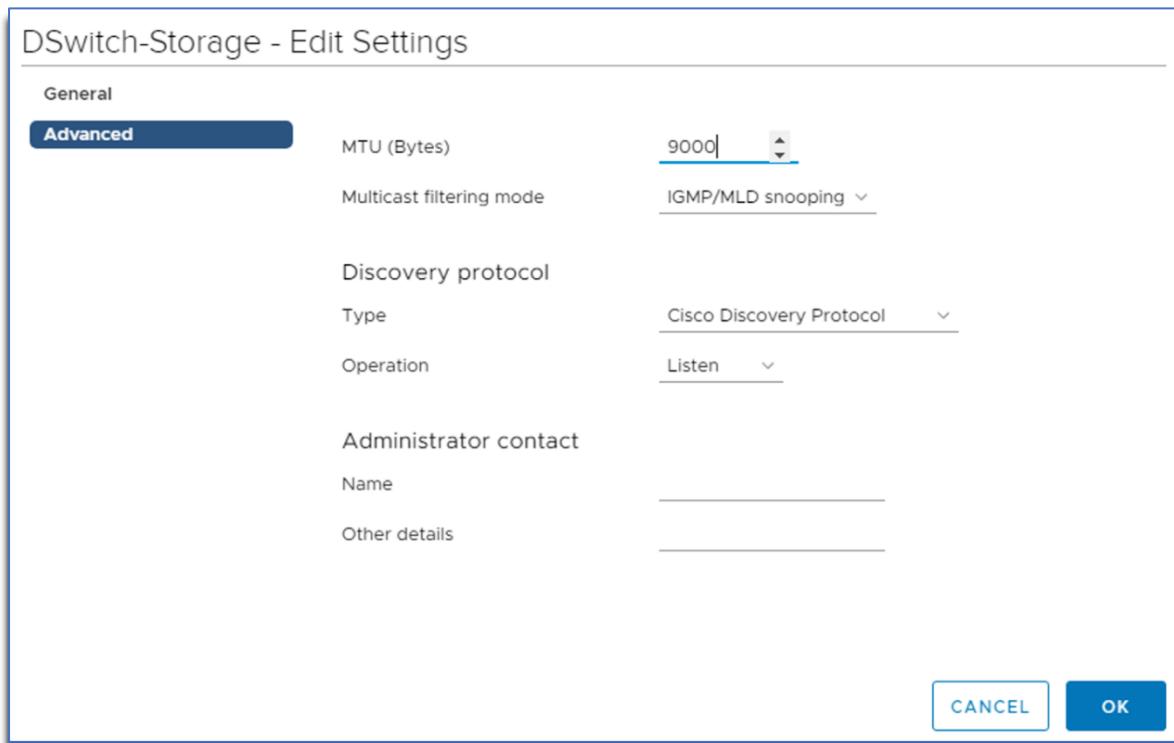
Step 19: Distributed Switch created can be viewed as seen in the below image:



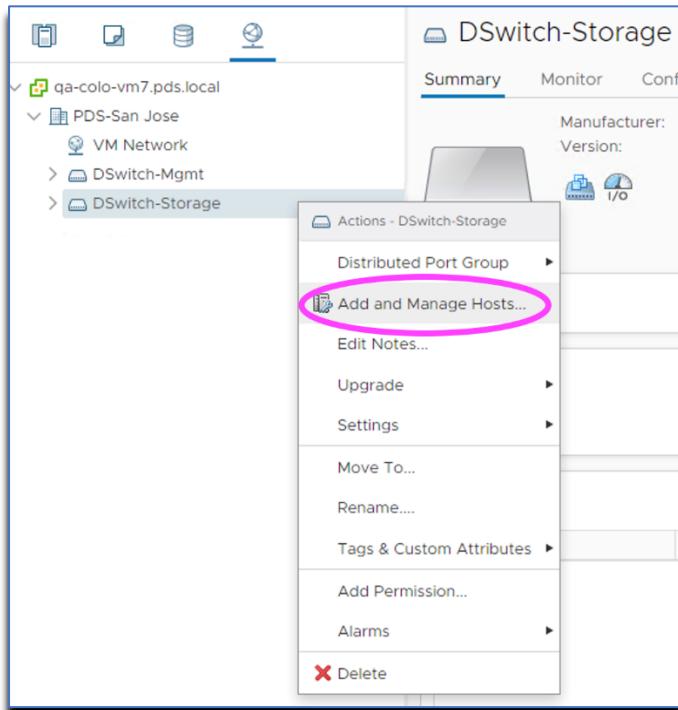
Step 20: Select the switch created, set **MTU** for the newly created distributed switch. Go to **Actions** and click **Edit Settings**, as seen in the below image:



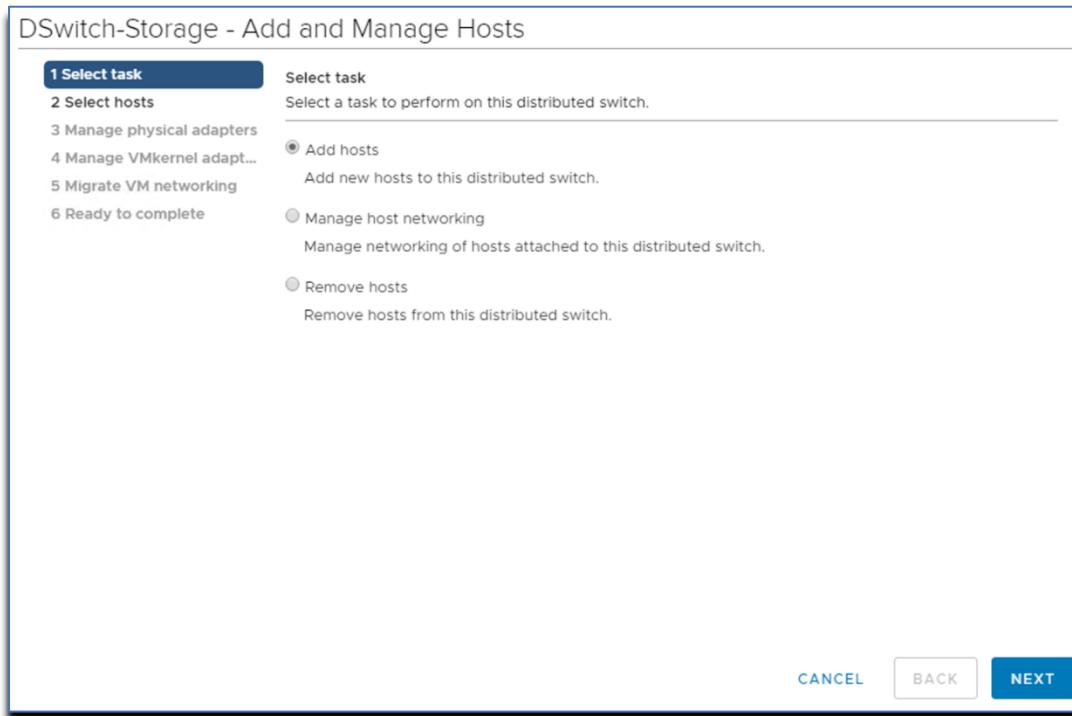
Step 21: In the **Storage-DSwitch-Edit Settings** dialog box set **MTU** to **9000**, as seen in the below image:



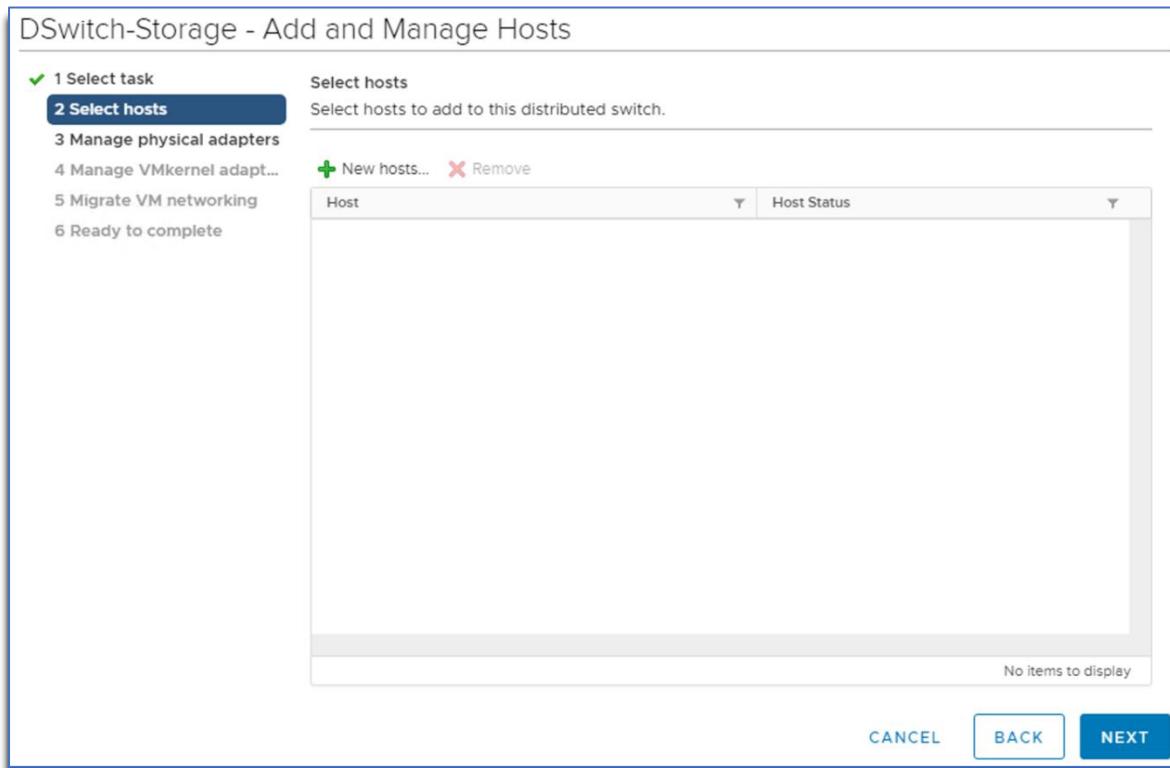
Step 22: Next step is to add **ESXi hosts** that are to use the newly created **Distributed Switch** and the **uplinks** used on those hosts. Right click on **Distributed Switch** and click **Add and Manage Hosts**, as seen in the below image:



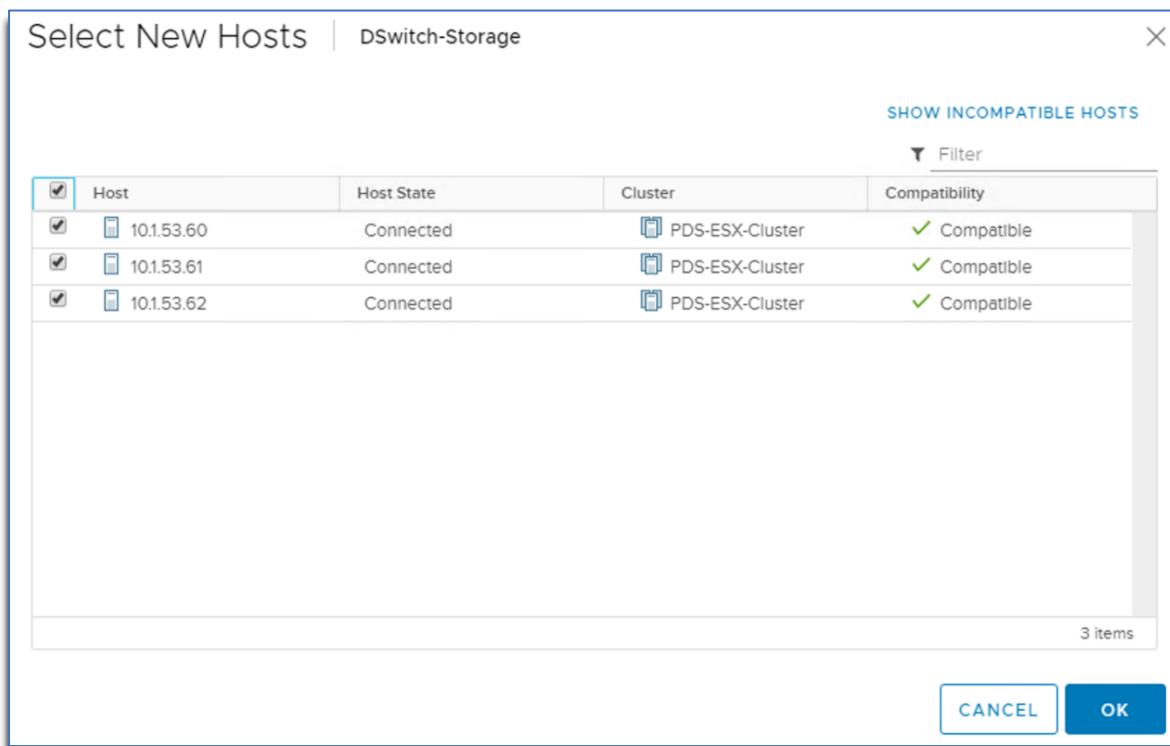
Step 23: On the **Storage-DSwitch-Add and Manage Hosts** dialog box, select **Add Hosts** as seen in the below image:



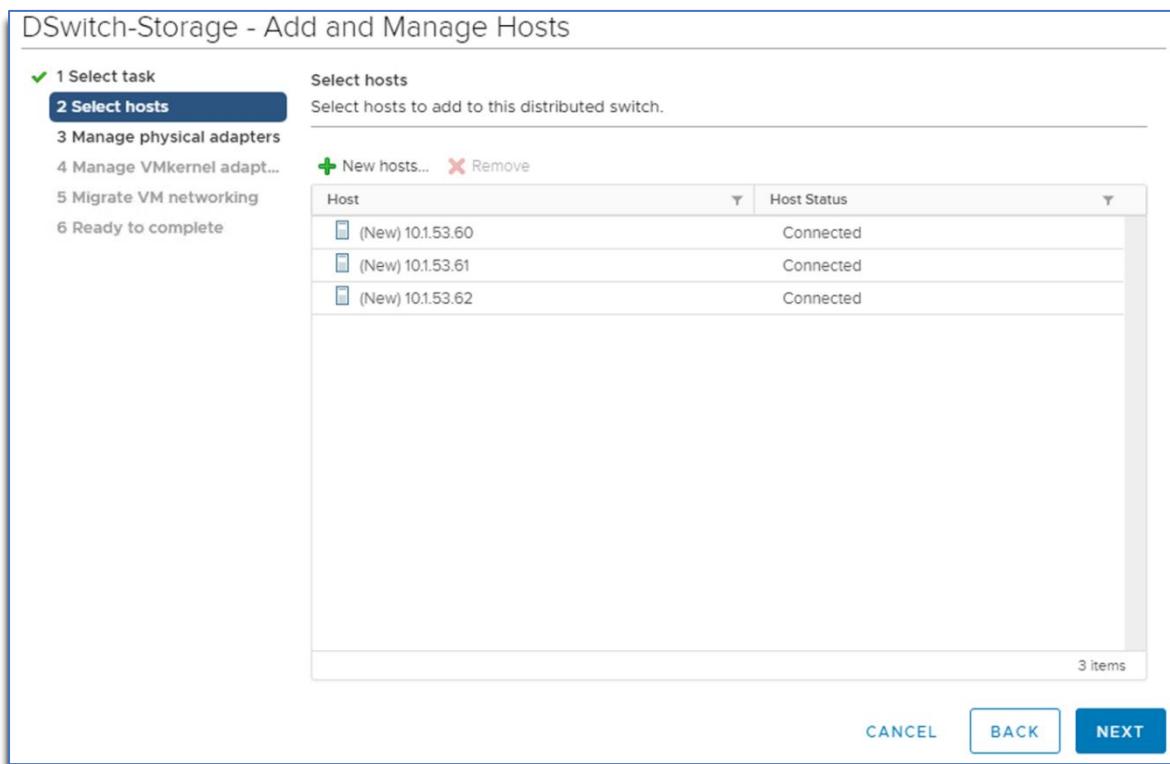
Step 24: Click **Next**. Click on **Select Hosts>New Hosts** as seen in the below image, and **add** the new hosts:



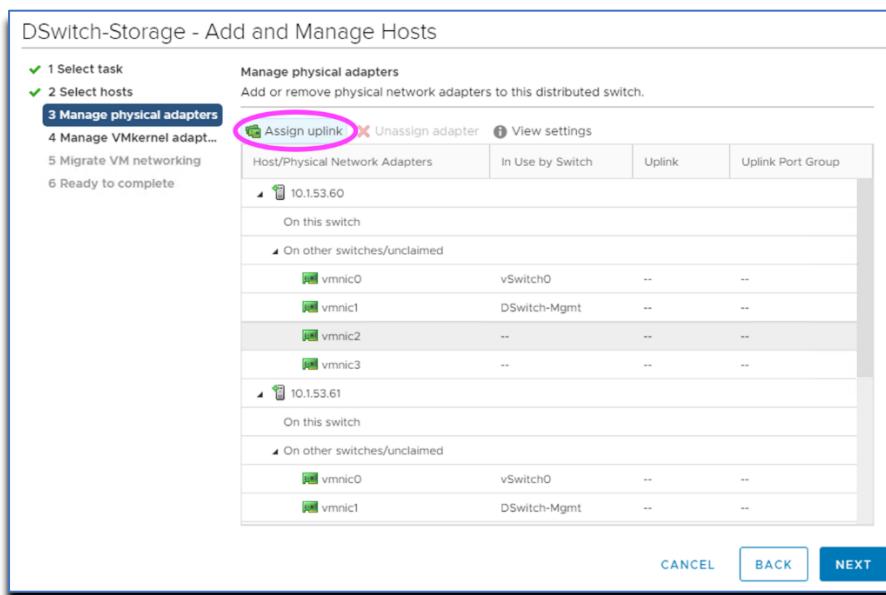
Step 25: Click **Next**. On **Select New Hosts** dialog box select the **hosts** as seen in the below image, click **OK**:



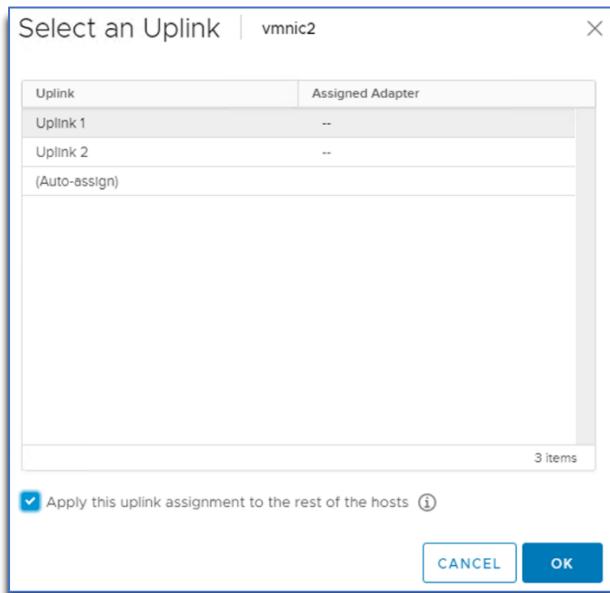
Step 26: Click **Next** as seen in the below image:



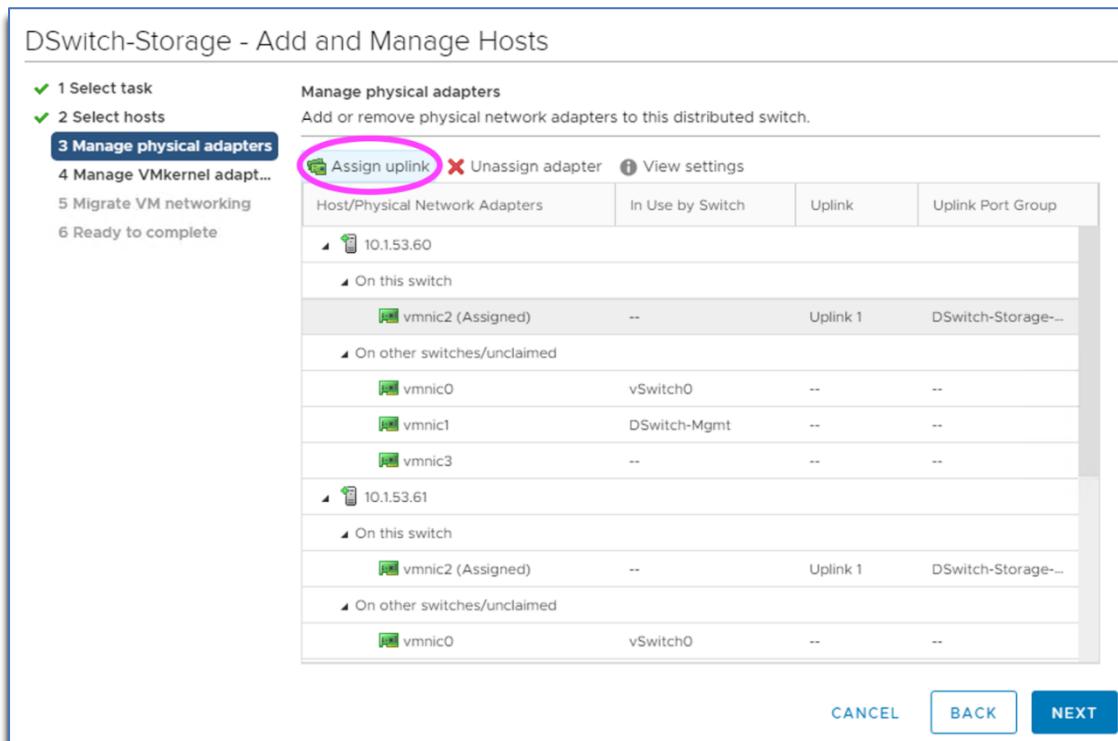
Step 27: Click on **Manage physical adapters>Assign Uplink** as seen in the below image:

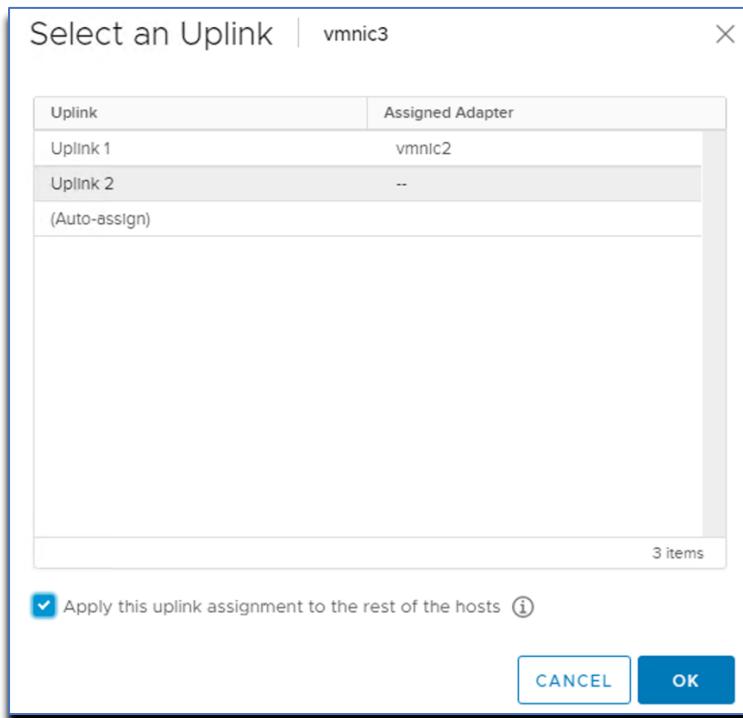


Step 28: On the **Select an Uplink** dialog box, select the **Uplink**. Make sure to check the **Apply this uplink assignment to the rest of the hosts** checkbox, as seen in the below image:



Step 29: On the **Manage physical adapters** dialog box, click **NEXT** as seen in below image:



Step 30: Configure **Uplink 2** as seen in below image:

Step 31: Verify **NICs** are assigned to **Uplinks** and click **NEXT** as seen in below image:

DSwitch-Storage - Add and Manage Hosts

✓ 1 Select task
 ✓ 2 Select hosts
 ✓ 3 Manage physical adapters
4 Manage VMkernel adapt...
 5 Migrate VM networking
 6 Ready to complete

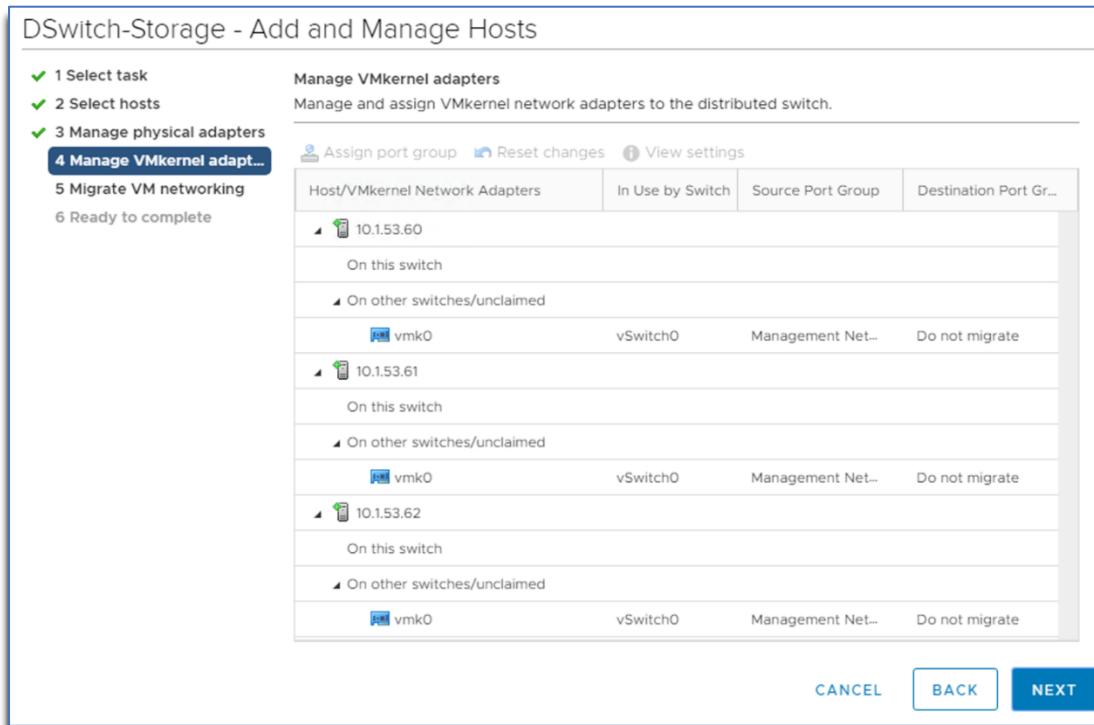
Manage VMkernel adapters
 Manage and assign VMkernel network adapters to the distributed switch.

Assign port group Reset changes View settings

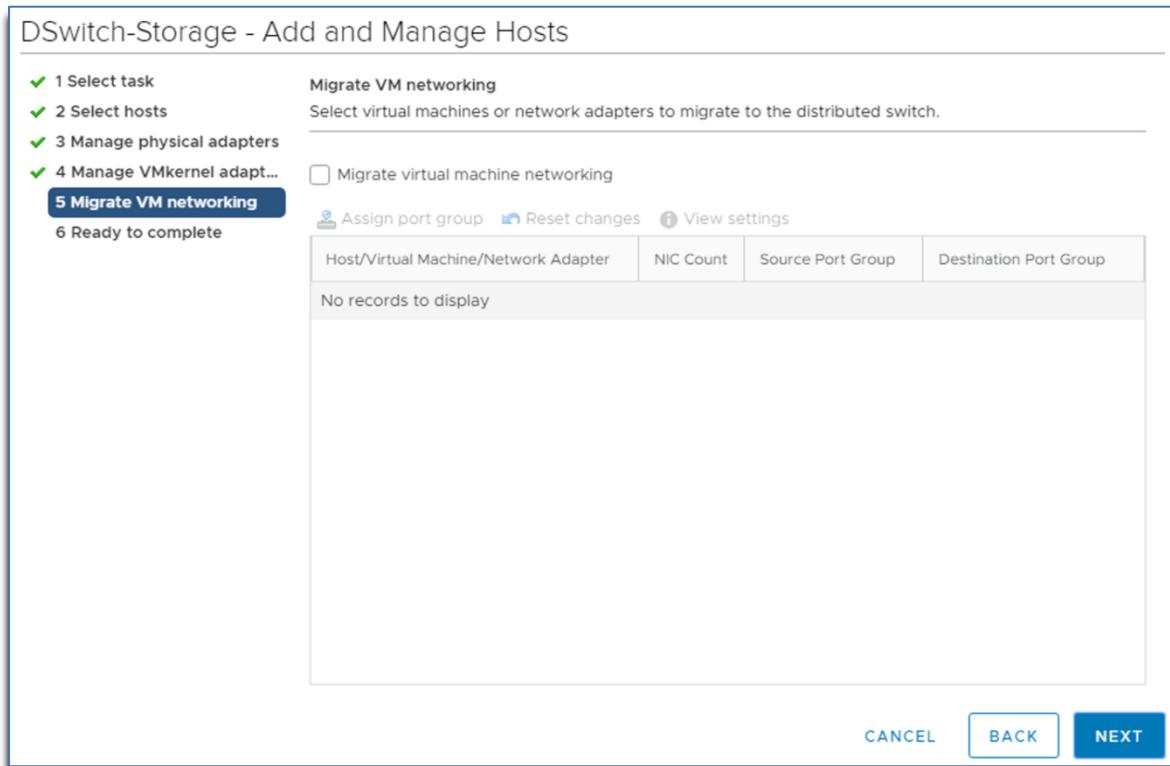
Host/VMkernel Network Adapters	In Use by Switch	Source Port Group	Destination Port Gr...
10.1.53.60			
On this switch			
On other switches/unclaimed			
vmk0	vSwitch0	Management Net...	Do not migrate
10.1.53.61			
On this switch			
On other switches/unclaimed			
vmk0	vSwitch0	Management Net...	Do not migrate
10.1.53.62			
On this switch			
On other switches/unclaimed			
vmk0	vSwitch0	Management Net...	Do not migrate

CANCEL BACK **NEXT**

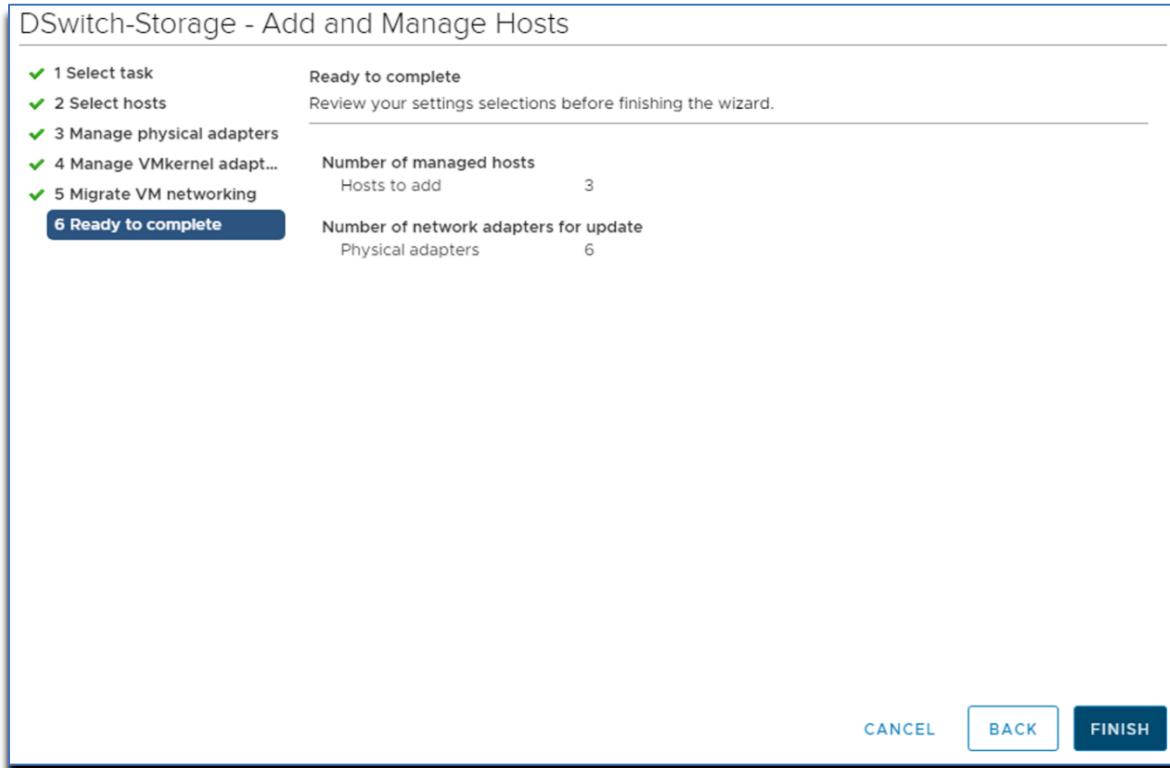
Step 32: Click **NEXT**, on the **Manage VMkernel adapters** dialog box page as seen in below image:



Step 33: Click **NEXT**, on the **Migrate VM Networking** dialog box page, as seen in below image:



Step 34: Click **FINISH** as seen in below image, with this step the user completes configuring ESXi cluster for NVMe over RoCE via vCenter.

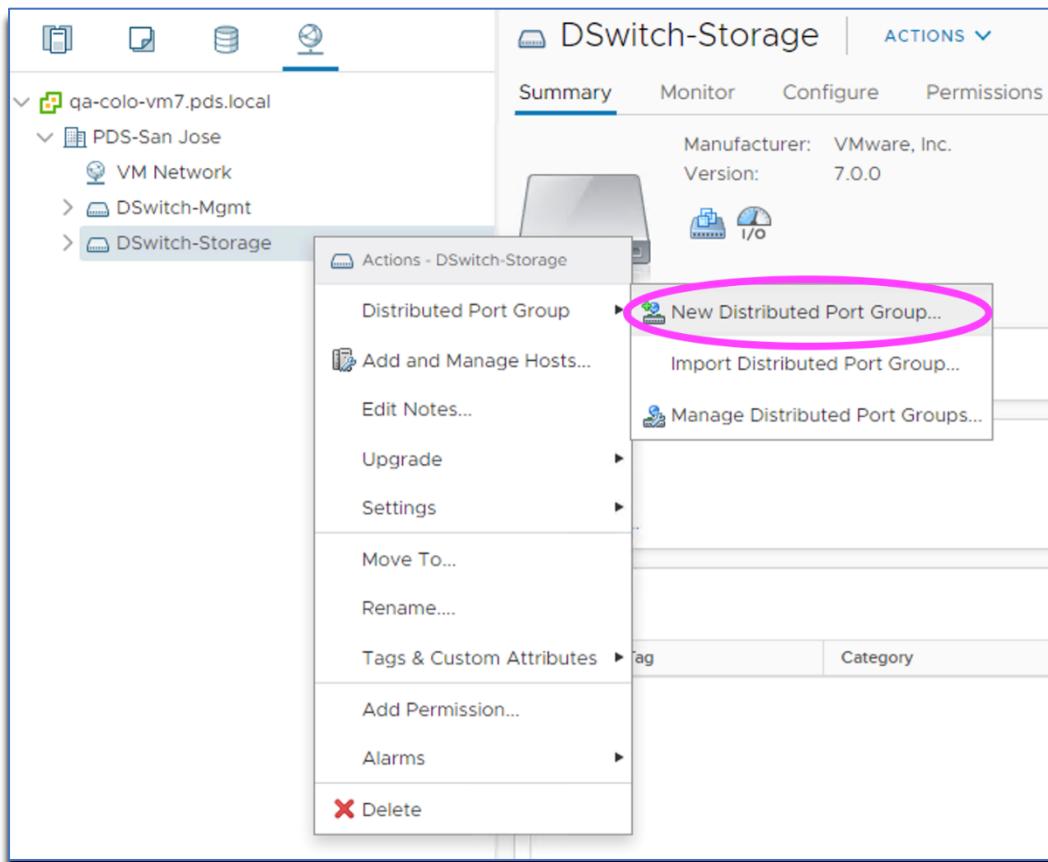


8. Creating Distributed Port Groups for Storage Traffic

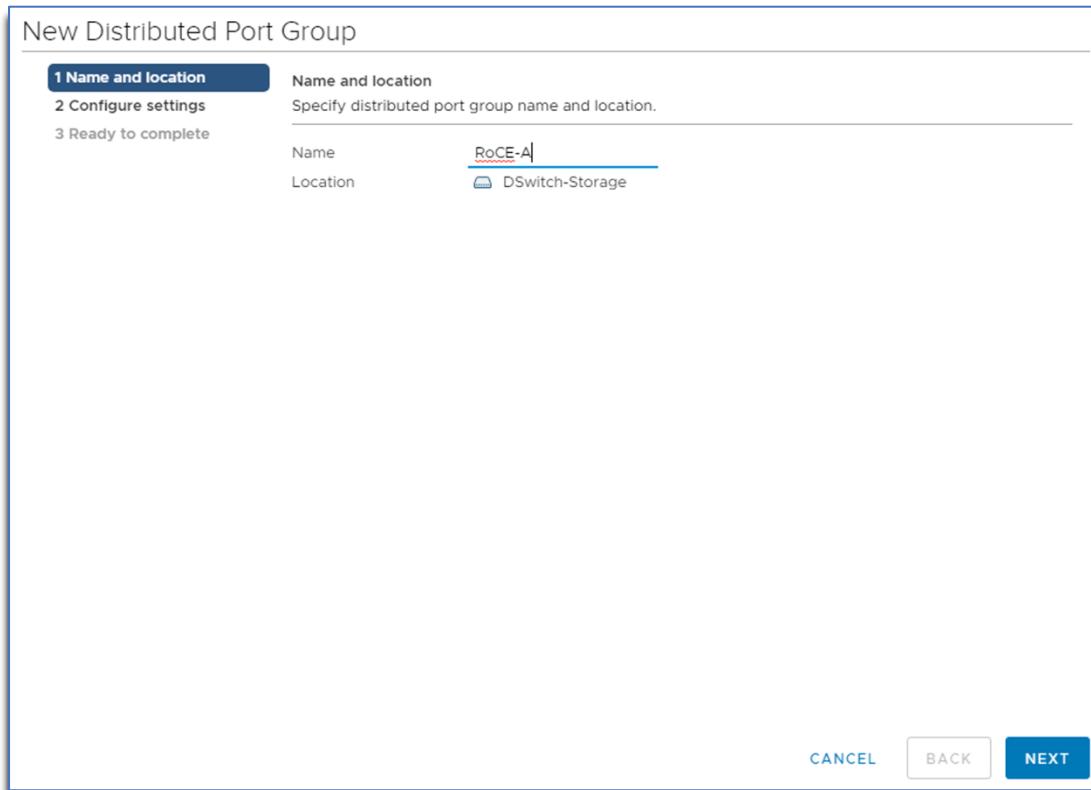
This section lists the steps required to **create 2 distributed port groups** with one **Active** and **Standby** uplink.

Note: The **2 port groups** should be created in such a way that each uplink is **Active** on one port group and **Passive** on the peer port group. This enables using both the RDMA storage adapters which can act as 2 paths to the storage.

Step 1: Right click on **Distributed switch** and select **Distributed Port Group>New Distributed Port Group** as seen in the below image:



Step 2: On the **New Distributed Port Group** dialog box, enter **Name** as <RoCE-A> and click on **Next** as seen in the below image:



Step 3: Check **Customize default policies configuration** checkbox and click **Next** as seen in the below image:

New Distributed Port Group

✓ 1 Name and location
2 Configure settings
 3 Security
 4 Traffic shaping
 5 Teaming and failover
 6 Monitoring
 7 Miscellaneous
 8 Ready to complete

Configure settings
Set general properties of the new port group.

Port binding	Static binding
Port allocation	Elastic
Number of ports	8
Network resource pool	(default)

VLAN

VLAN type	None
-----------	------

Advanced

Customize default policies configuration

CANCEL BACK NEXT

Step 4: Navigate to **Security**, on the **Security** dialog box, click **NEXT**, as seen in the below image:

New Distributed Port Group

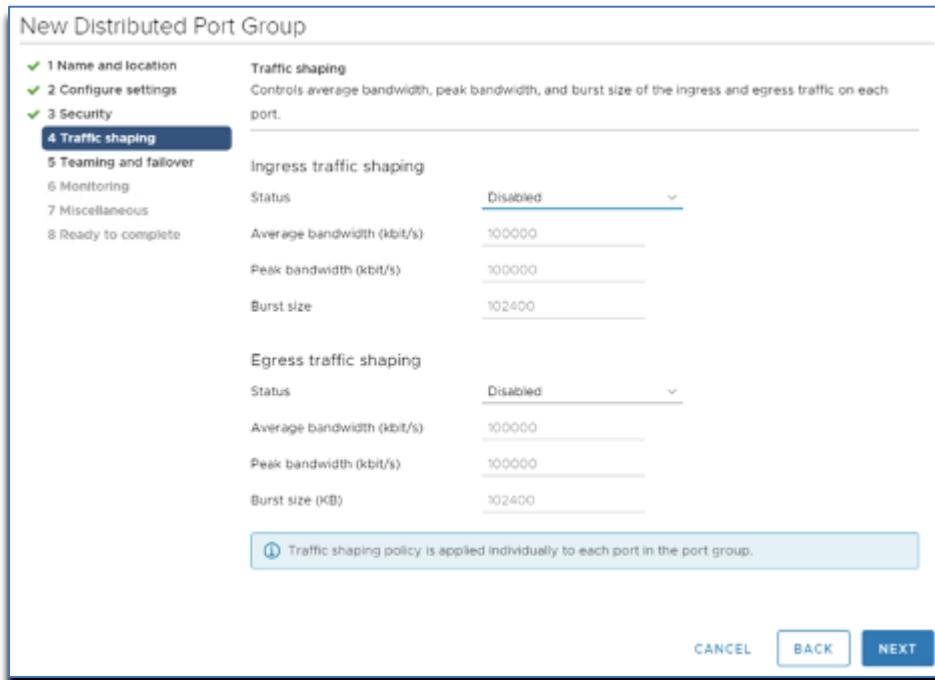
✓ 1 Name and location
 ✓ 2 Configure settings
3 Security
 4 Traffic shaping
 5 Teaming and failover
 6 Monitoring
 7 Miscellaneous
 8 Ready to complete

Security
Controls promiscuous mode, MAC address changes, and forged transmits.

Promiscuous mode	Reject
MAC address changes	Reject
Forged transmits	Reject

CANCEL BACK NEXT

Step 5: Navigate to **Traffic shaping**, on the **Traffic shaping** dialog box, click **NEXT**, as seen in the below image:



Step 6: Navigate to **Teaming and failover**, on the **Teaming and failover** dialog box select **Uplink 1** as **active** uplink and set **Uplink 2** to **standby** uplink. Click **NEXT**, as seen in the below image:

New Distributed Port Group

<ul style="list-style-type: none"> ✓ 1 Name and location ✓ 2 Configure settings ✓ 3 Security ✓ 4 Traffic shaping 5 Teaming and failover 6 Monitoring 7 Miscellaneous 8 Ready to complete 	Teaming and failover Controls load balancing, network failure detection, switches notification, fallback, and uplink failover order.
	Load balancing Use explicit failover order
	Network failure detection Link status only
	Notify switches Yes
	Fallback Yes
Failover order ⓘ	
↑ ↓	
Active uplinks  Uplink 1 Standby uplinks  Uplink 2 Unused uplinks	

[CANCEL](#) [NEXT](#)

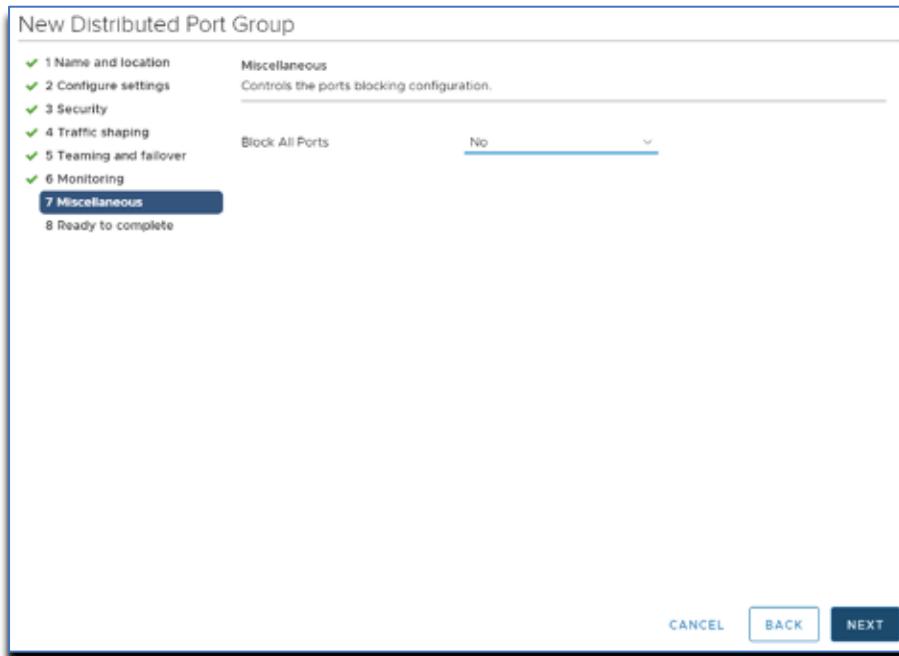
Step 7: Navigate to **Monitoring**, on the **Monitoring** dialog box set **NetFlow** to **Disabled**, click **NEXT**, as seen in the below image:

New Distributed Port Group

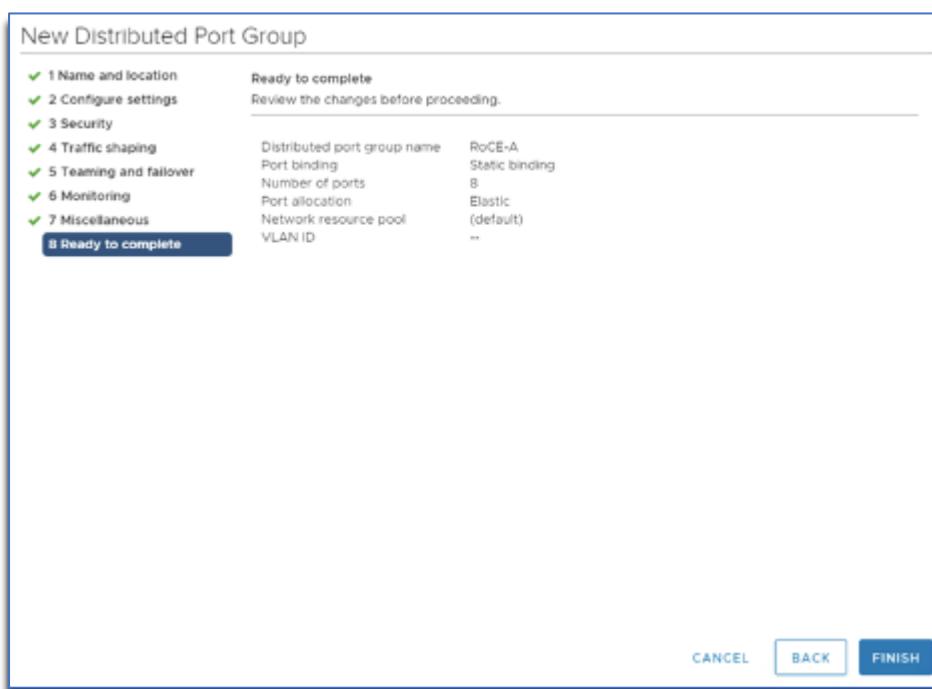
<ul style="list-style-type: none"> ✓ 1 Name and location ✓ 2 Configure settings ✓ 3 Security ✓ 4 Traffic shaping ✓ 5 Teaming and failover 6 Monitoring 7 Miscellaneous 8 Ready to complete 	Monitoring Controls NetFlow configuration.
	NetFlow <u>Disabled</u>

[CANCEL](#) [NEXT](#)

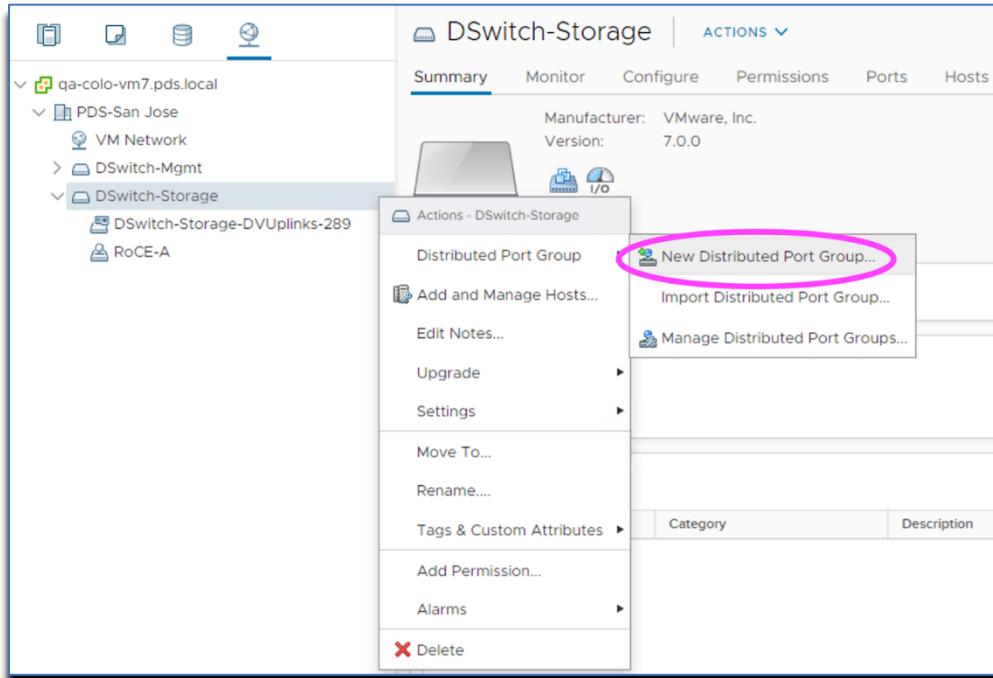
Step 8: Navigate to **Miscellaneous**, on the **Miscellaneous** dialog box set **Block All Ports** to **No**, click **NEXT**, as seen in the below image:



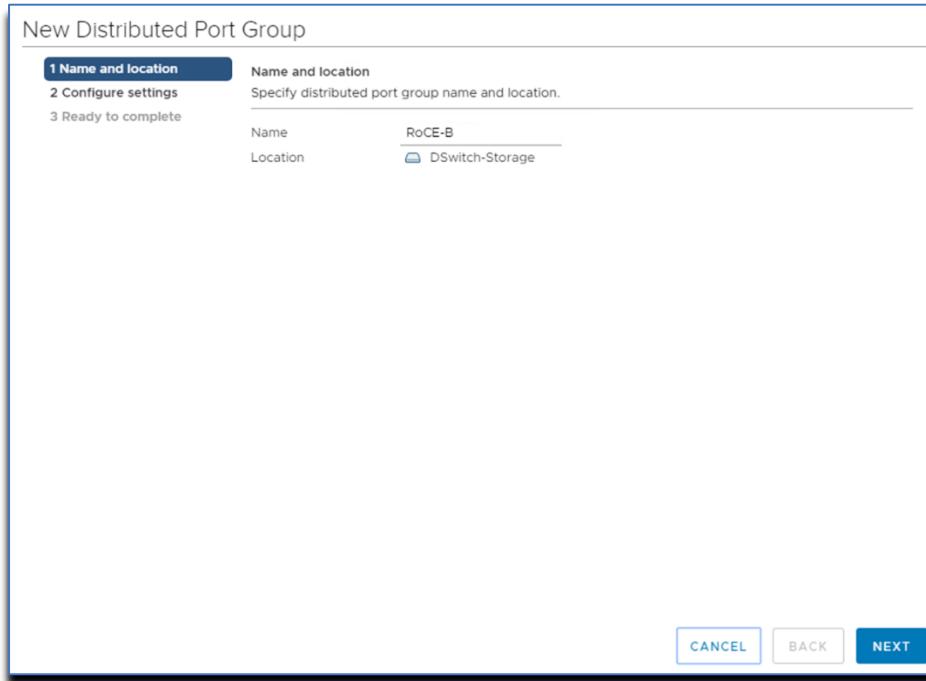
Step 9: Navigate to **Ready to complete**, on the **Ready to complete** dialog box review all the changes before you click **Finish**, as seen in the below image:



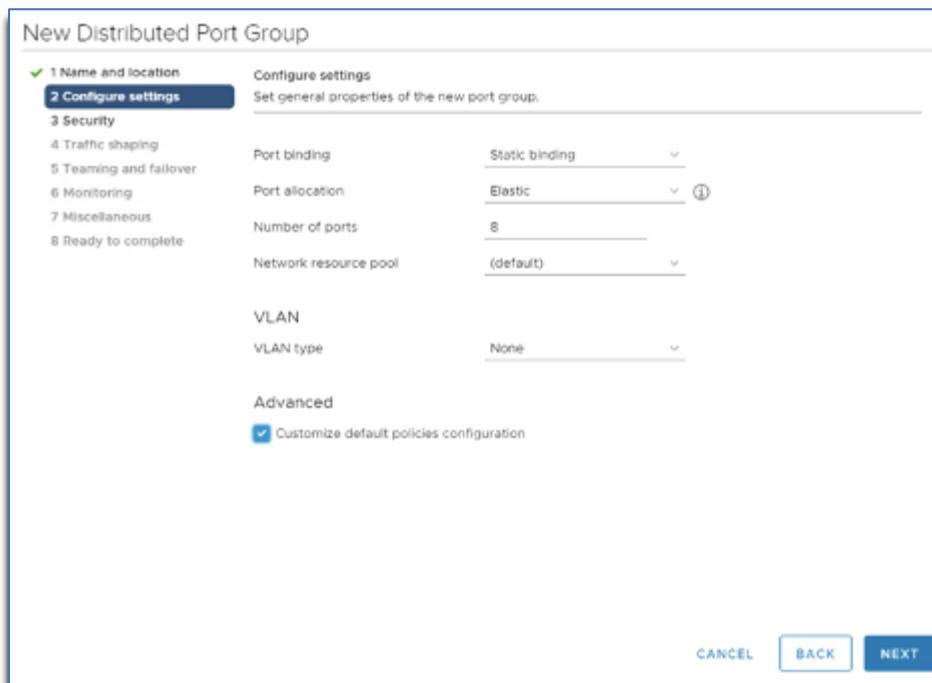
Step 10: As a next step, click on **Distributed Port Group> New Distributed Port Group** to create the second port group, as seen in the below image:



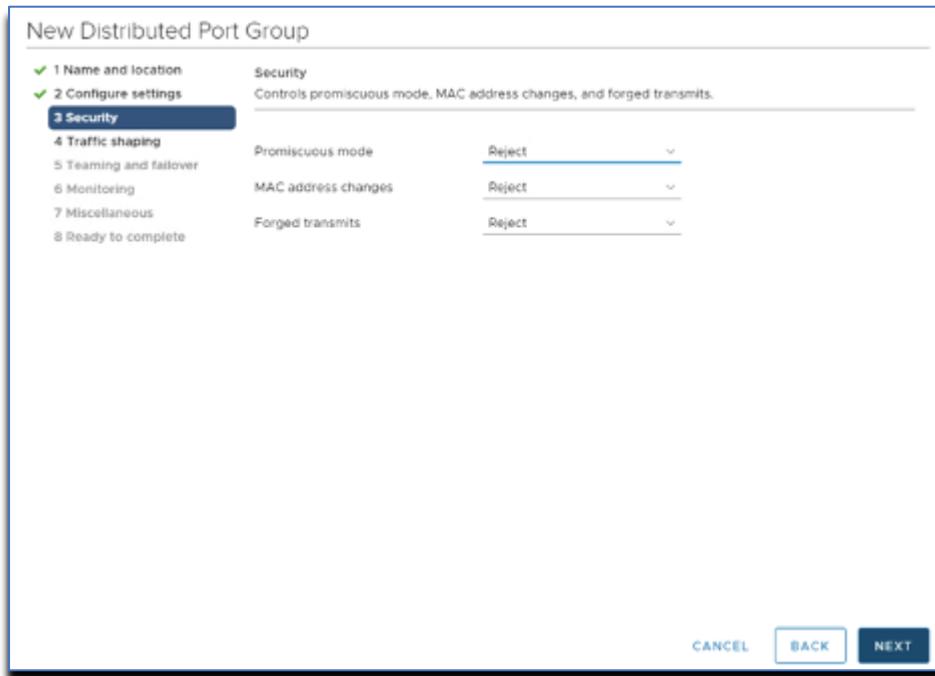
Step 11: On the **New Distributed Port Group** dialog box for the second port enter **Name <RoCE B>** and click **NEXT**, as seen in the below image:



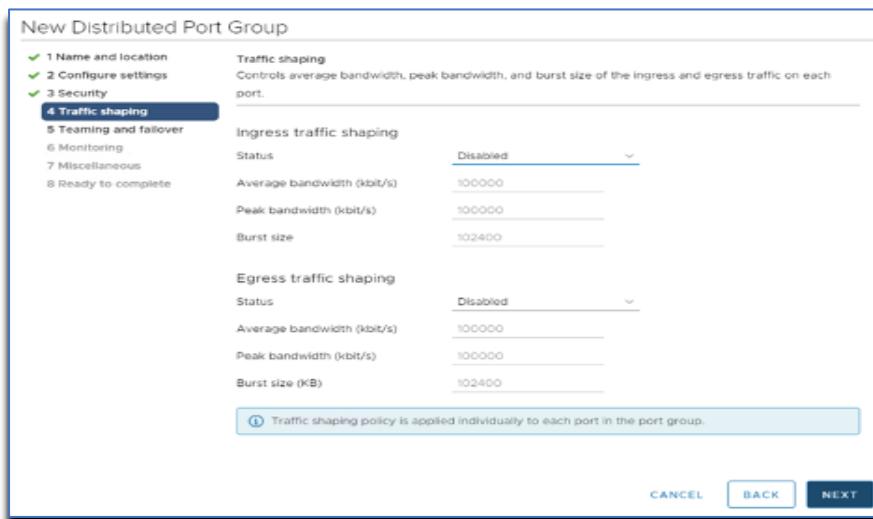
Step 12: Navigate to **Configure Settings**, on the **Configure Settings** dialog box, check the **Customize default policies configuration** checkbox and click **Next**, as seen in the below image:



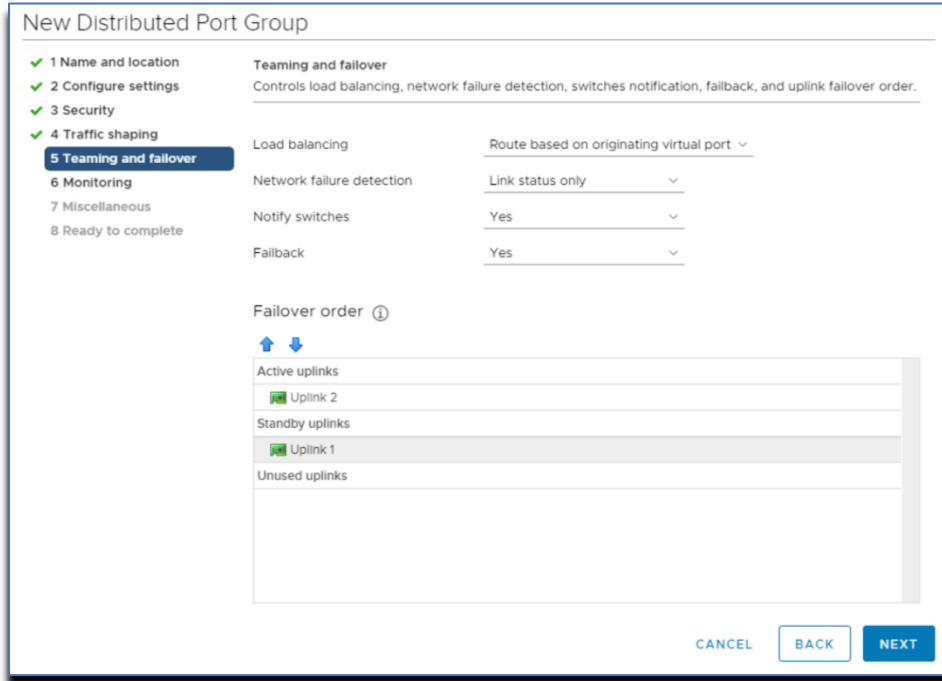
Step 13: Navigate to **Security**, on the **Security** dialog box, set the values as required and click **Next**, as seen in the below image:



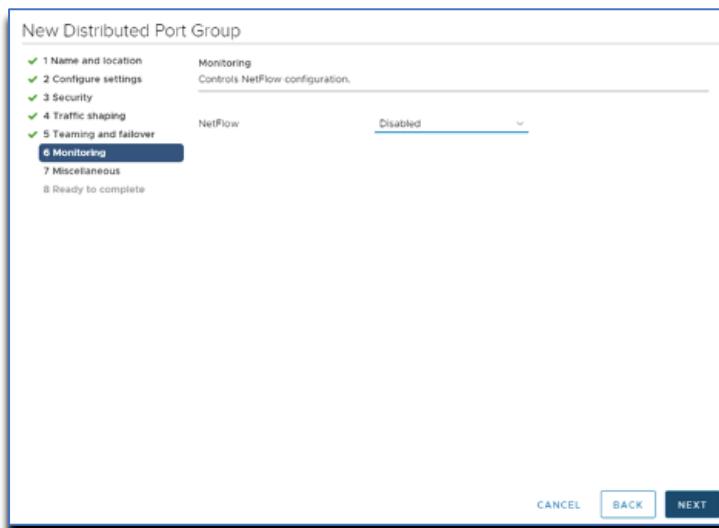
Step 14: Navigate to **Traffic Shaping**, on the **Traffic Shaping** dialog box, set the values as required and click **Next**, as seen in the below image:



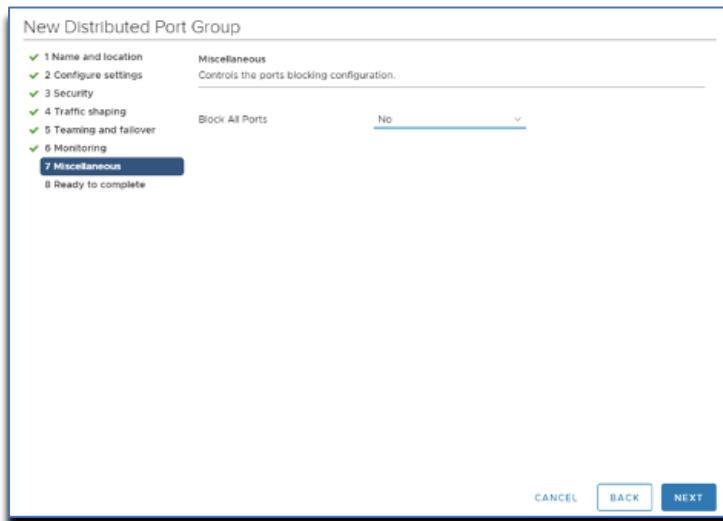
Step 15: Navigate to **Teaming and failover**, on the **Teaming and failover** dialog box, set **Uplink 2** as **active** uplink and **Uplink 1** to **standby** uplink, as seen in the below image:



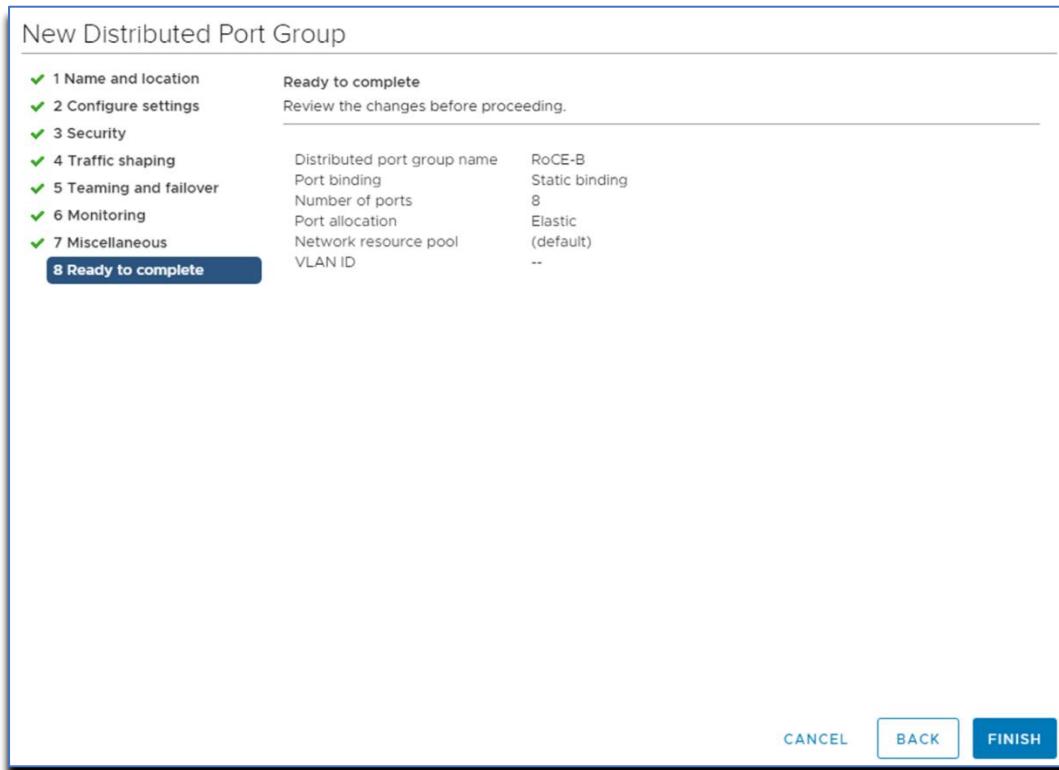
Step 16: Navigate to **Monitoring**, on the **Monitoring** dialog box, set **NetFlow** as **Disabled** as seen in the below image:



Step 17: Navigate to **Miscellaneous**, on the **Miscellaneous** dialog box, set **Block All Ports** as **No** as seen in the below image:



Step 18: Navigate to **Ready to complete**, on the **Ready to complete** dialog box, verify all the information, and click **Finish**, seen in the below image:



Note: Subsequently, port group for <RoCE-B> is created.

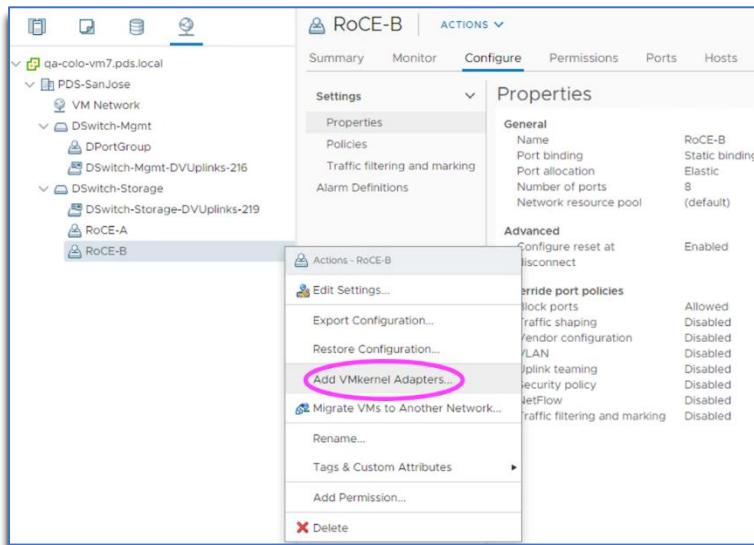
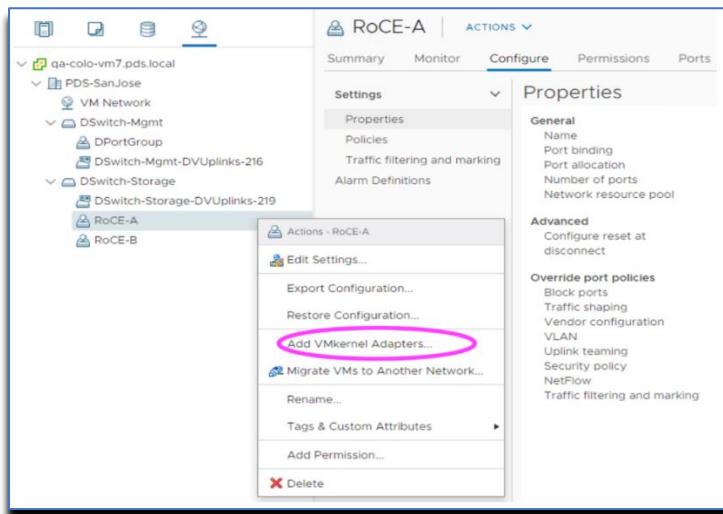
9. Adding VMkernel Adapters for Distributed Port Groups

This section lists the steps required to add **VMkernel Adapters** for distributed port groups.

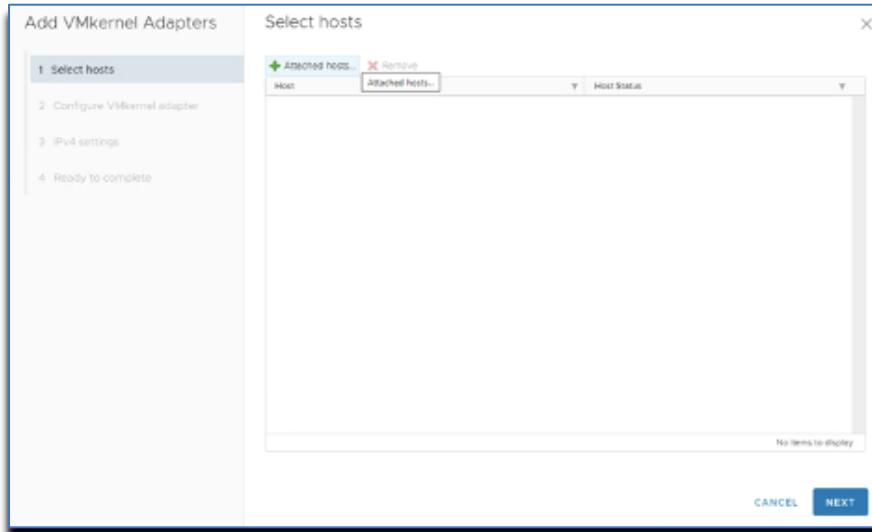
Note: The same steps are applicable for both the port groups <RoCE-A> and <RoCE-B> created as seen in the above section *Creating Distributed Port Groups for Storage Traffic*.

Step 1: As seen in the below image, right click the distributed port group and select **Add VMkernel Adapters**:

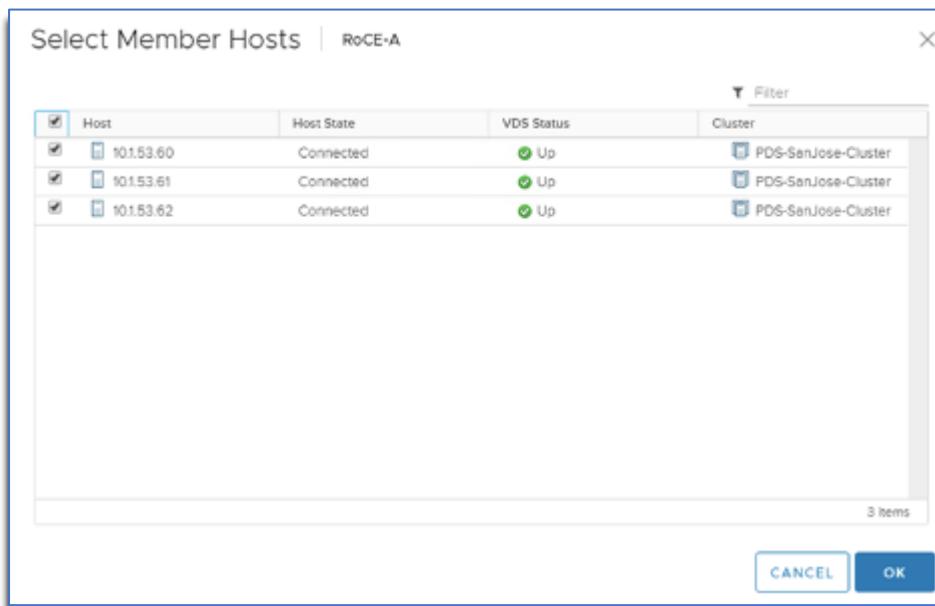
Sample Images: Adding VMkernel Adapters



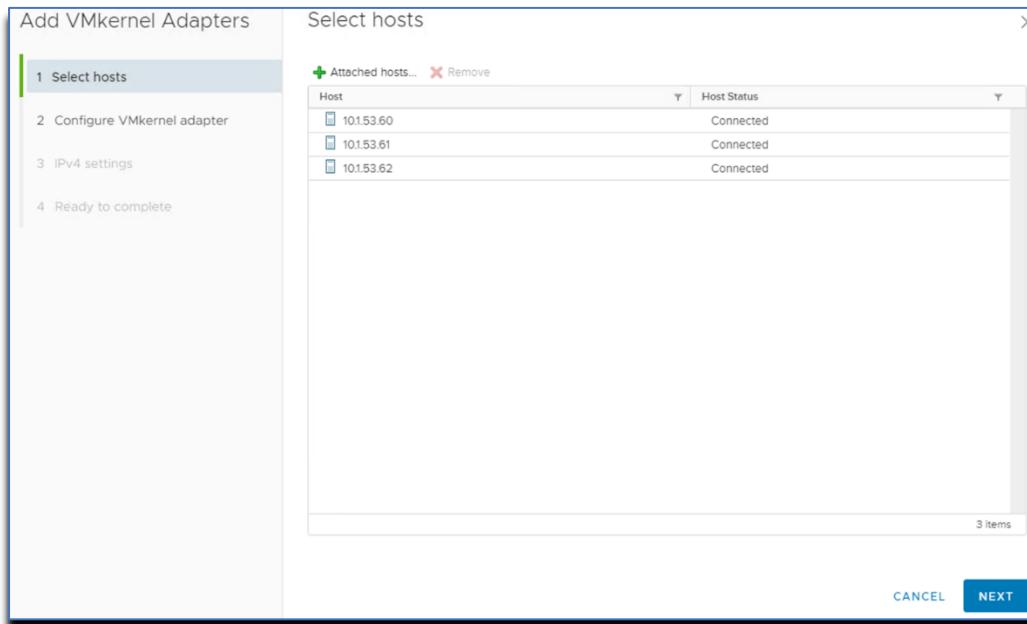
Step 2: Subsequently, navigate to **Select hosts** and click **Add Hosts** as seen in the below image:



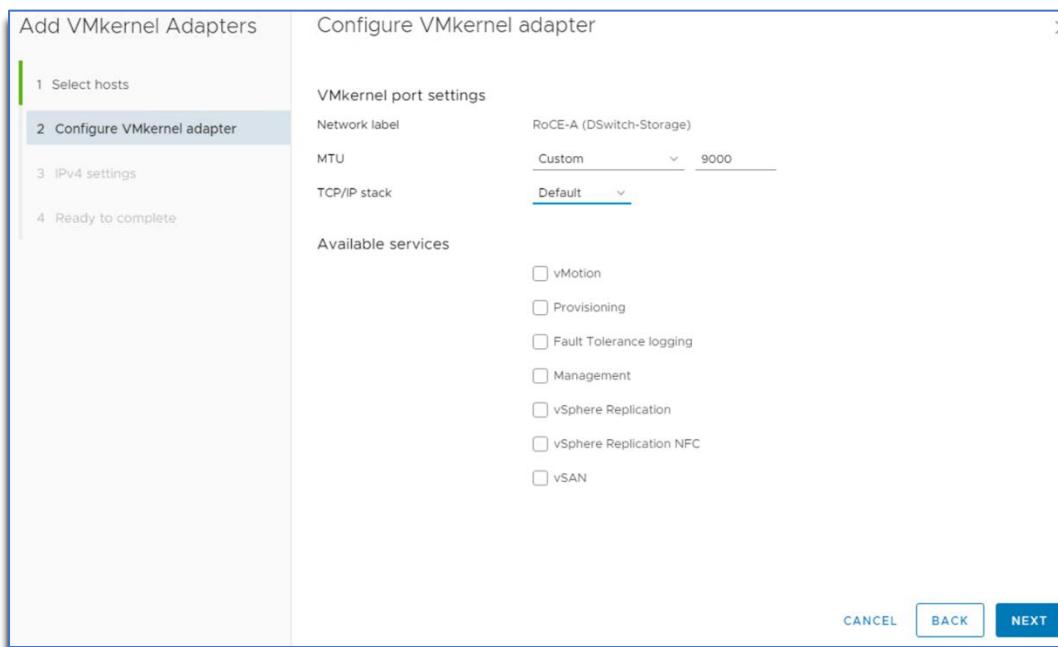
Step 3: As a next step, select the hosts and click **OK**.



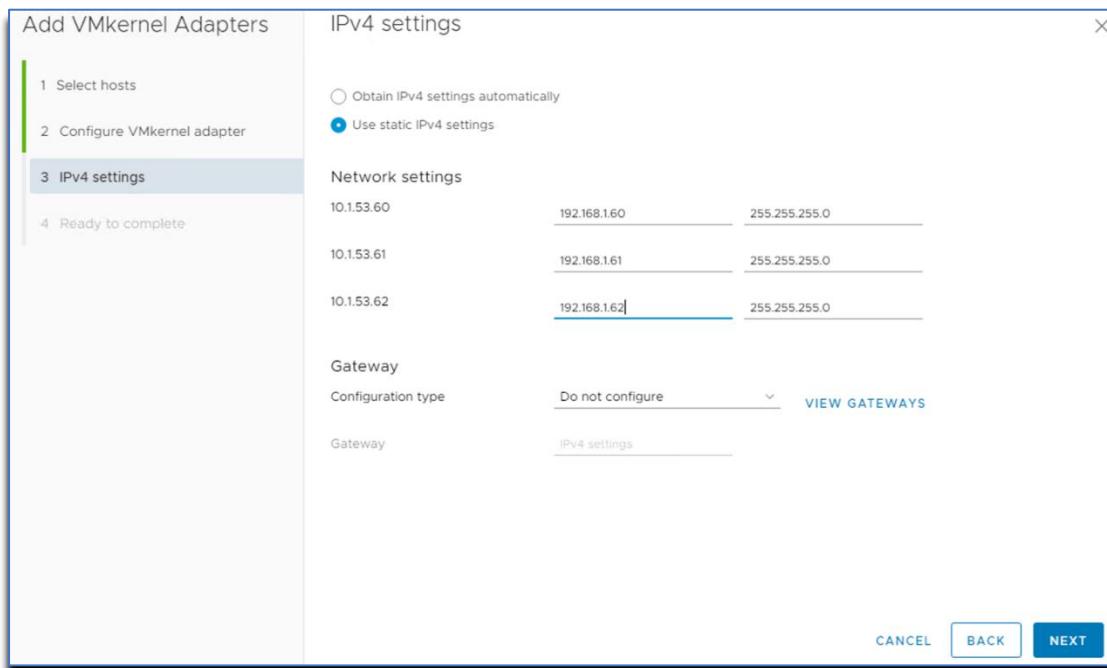
Step 4: Then click **NEXT** on the **Select hosts** dialog box.



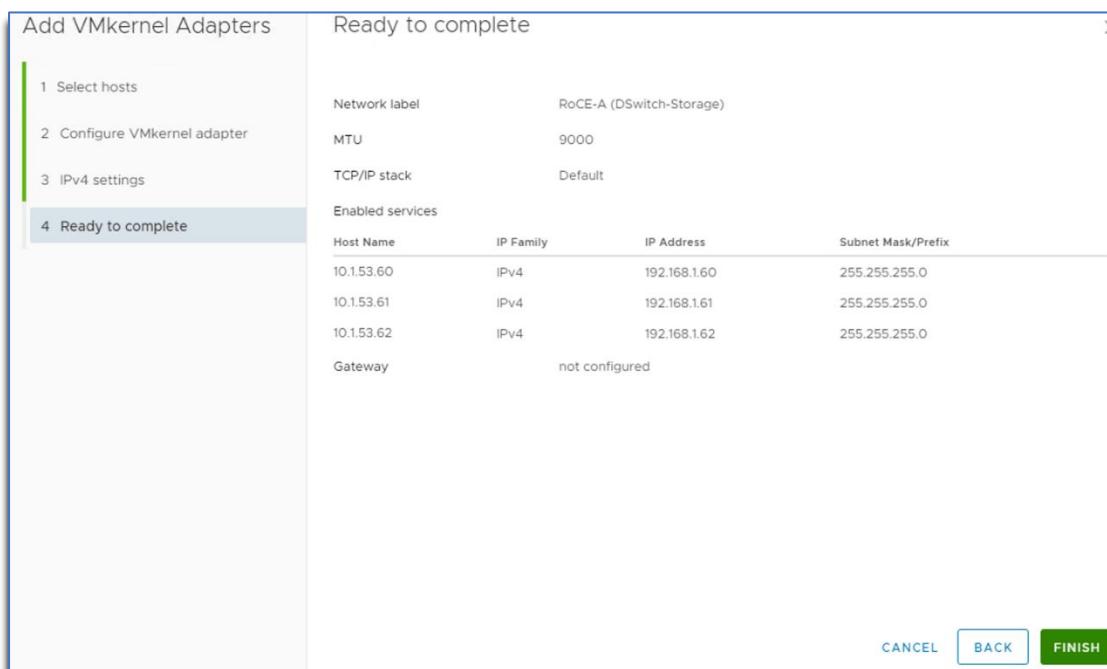
Step 5: Navigate to **Configure VMkernel adapter**, Set **MTU** to **9000** and click **NEXT** as seen in below image:



Step 6: Navigate to **IPv4** settings, enter the **Network Settings** and **Gateway** details, and click **NEXT** as seen in below image:

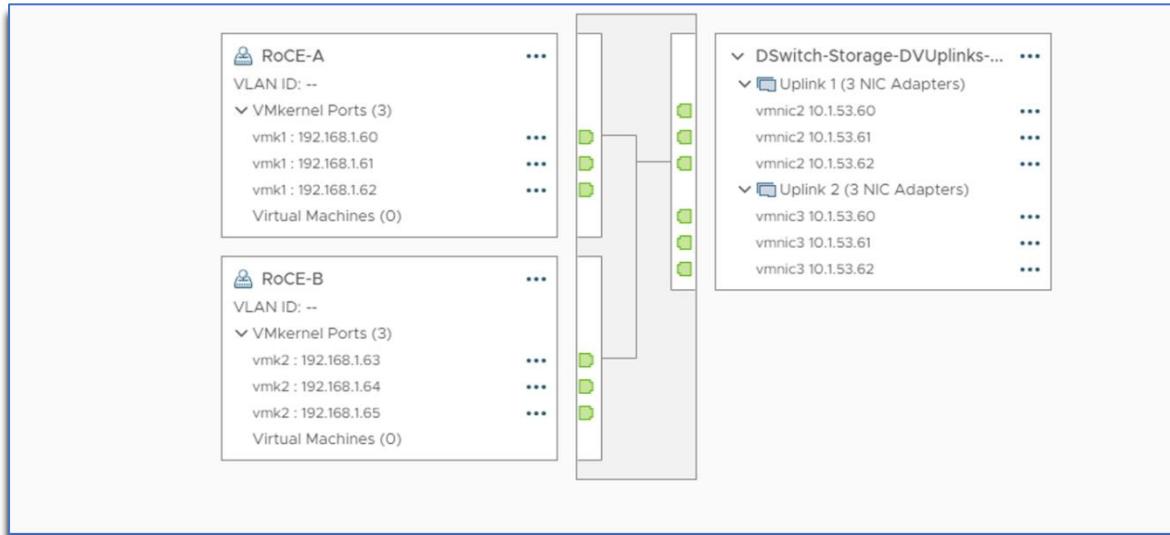


Step 7: Navigate to **Ready to complete** to verify the settings, and click **FINISH** as seen in the below image:



Note: Execute **Step 2** through **Step 7** to add VMkernel Adapters.

Step 8: After all the ESXi Cluster Networking configuration is complete, the configuration can be verified under the **Distributed Switch>Configure>Topology** tab, the topology is seen in the below image:



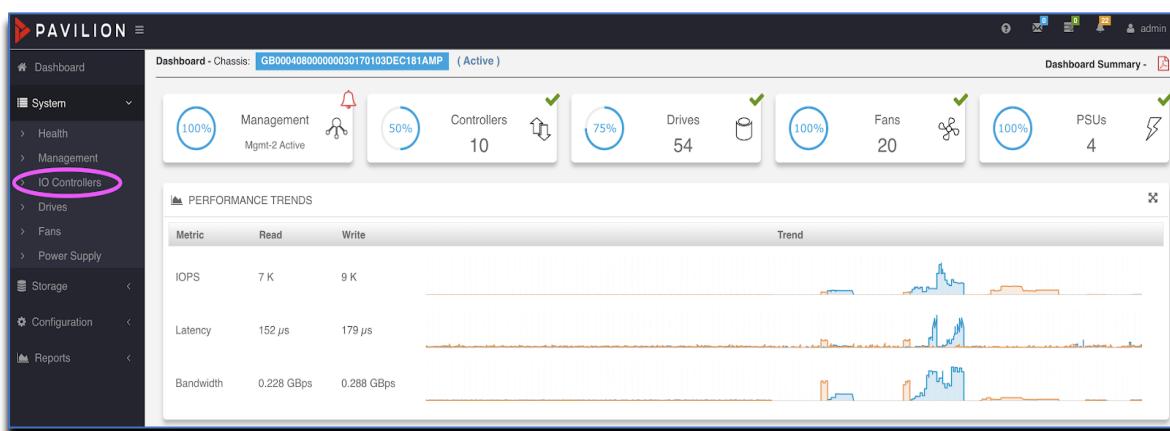
10. Configuring NVMe over RoCE in Pavilion HFA

This section lists the steps required to configure **Pavilion Controller** for NVMe over RoCE using GUI.

Step 1: Login to the **Pavilion** GUI as seen in below image:

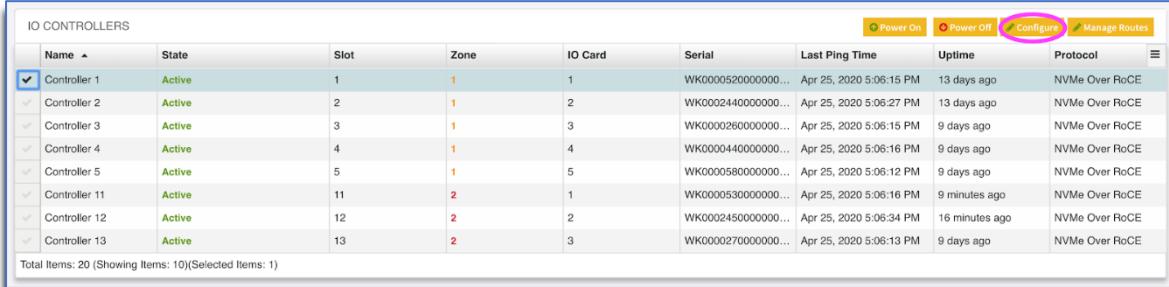


Step 2: Navigate to **System>IO Controller** as seen in below image:



Step 3: Configure controllers 1 and 2 for NVMe Over RoCE.

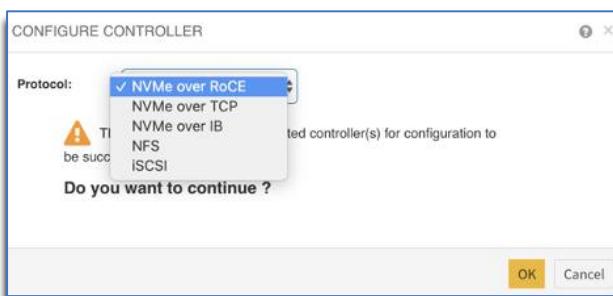
Note: All controllers by default are configured for **NVMe Over RoCE**. To change protocol type for a controller, select the controller and click on **Configure** button displayed at the top-right corner of the page as seen in the image below:



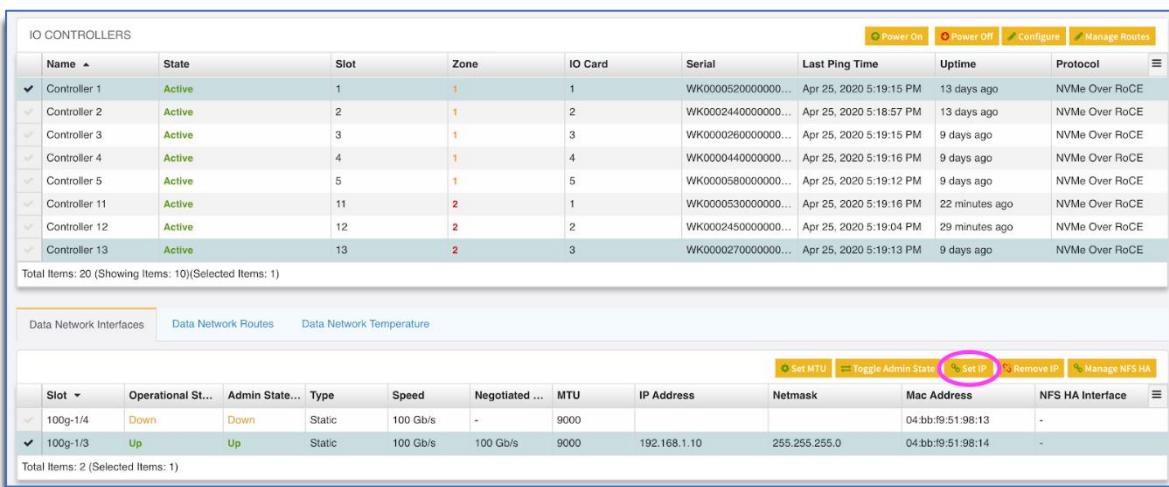
IO CONTROLLERS									
Name	State	Slot	Zone	IO Card	Serial	Last Ping Time	Uptime	Protocol	
Controller 1	Active	1	1	1	WK000052000000...	Apr 25, 2020 5:06:15 PM	13 days ago	NVMe Over RoCE	
Controller 2	Active	2	1	2	WK000244000000...	Apr 25, 2020 5:06:27 PM	13 days ago	NVMe Over RoCE	
Controller 3	Active	3	1	3	WK00002440000000...	Apr 25, 2020 5:06:15 PM	9 days ago	NVMe Over RoCE	
Controller 4	Active	4	1	4	WK00004400000000...	Apr 25, 2020 5:06:16 PM	9 days ago	NVMe Over RoCE	
Controller 5	Active	5	1	5	WK00005800000000...	Apr 25, 2020 5:06:12 PM	9 days ago	NVMe Over RoCE	
Controller 11	Active	11	2	1	WK00005300000000...	Apr 25, 2020 5:06:16 PM	9 minutes ago	NVMe Over RoCE	
Controller 12	Active	12	2	2	WK00024500000000...	Apr 25, 2020 5:06:34 PM	16 minutes ago	NVMe Over RoCE	
Controller 13	Active	13	2	3	WK00002700000000...	Apr 25, 2020 5:06:13 PM	9 days ago	NVMe Over RoCE	

Total Items: 20 (Showing Items: 10)(Selected Items: 1)

Step 4: Select the Protocol as NVMe over RoCE and click OK, as seen in the below image:



Step 5: As a next step assign a dataport IP address for Pavilion controller. Select any available dataport slot for controller 1 and click Set IP.



IO CONTROLLERS									
Name	State	Slot	Zone	IO Card	Serial	Last Ping Time	Uptime	Protocol	
Controller 1	Active	1	1	1	WK000052000000...	Apr 25, 2020 5:19:15 PM	13 days ago	NVMe Over RoCE	
Controller 2	Active	2	1	2	WK00024400000000...	Apr 25, 2020 5:18:57 PM	13 days ago	NVMe Over RoCE	
Controller 3	Active	3	1	3	WK00002600000000...	Apr 25, 2020 5:19:15 PM	9 days ago	NVMe Over RoCE	
Controller 4	Active	4	1	4	WK00004400000000...	Apr 25, 2020 5:19:16 PM	9 days ago	NVMe Over RoCE	
Controller 5	Active	5	1	5	WK00005800000000...	Apr 25, 2020 5:19:12 PM	9 days ago	NVMe Over RoCE	
Controller 11	Active	11	2	1	WK00005300000000...	Apr 25, 2020 5:19:16 PM	22 minutes ago	NVMe Over RoCE	
Controller 12	Active	12	2	2	WK00024500000000...	Apr 25, 2020 5:19:04 PM	29 minutes ago	NVMe Over RoCE	
Controller 13	Active	13	2	3	WK00002700000000...	Apr 25, 2020 5:19:13 PM	9 days ago	NVMe Over RoCE	

Total Items: 20 (Showing Items: 10)(Selected Items: 1)

Data Network Interfaces									
Slot	Operational St...	Admin State...	Type	Speed	Negotiated ...	MTU	IP Address	Netmask	Mac Address
100g-1/4	Down	Down	Static	100 Gb/s	-	9000			04:bb:f9:51:98:13
100g-1/3	Up	Up	Static	100 Gb/s	100 Gb/s	9000	192.168.1.10	255.255.255.0	04:bb:f9:51:98:14

Total Items: 2 (Selected Items: 1)

Step 6: On the Set DataPort IP dialog box set **IP address** and **Netmask** as seen in below image:



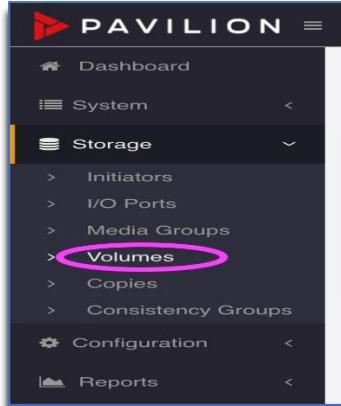
Step 7: Repeat the above steps to configure protocol and assign IP address for all the controllers.

Note: It is recommended that you refer to *Pavilion GUI Reference Guide* for more information.

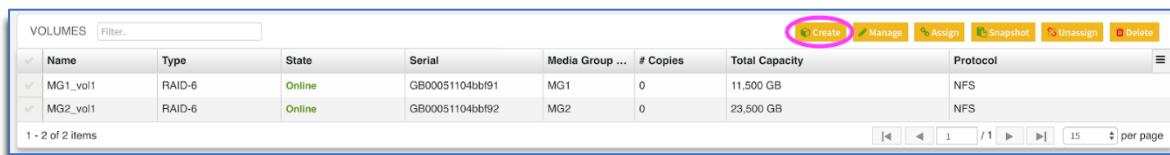
11. Creating Datastore Volumes on the Pavilion HFA

Note: Before creating volumes, ensure that controllers are configured for RoCE and media groups are created. It is recommended that you refer to *Pavilion GUI Reference Guide* for more information.

Step 1: To create volumes navigate to **Storage>Volumes>Create Volume**.

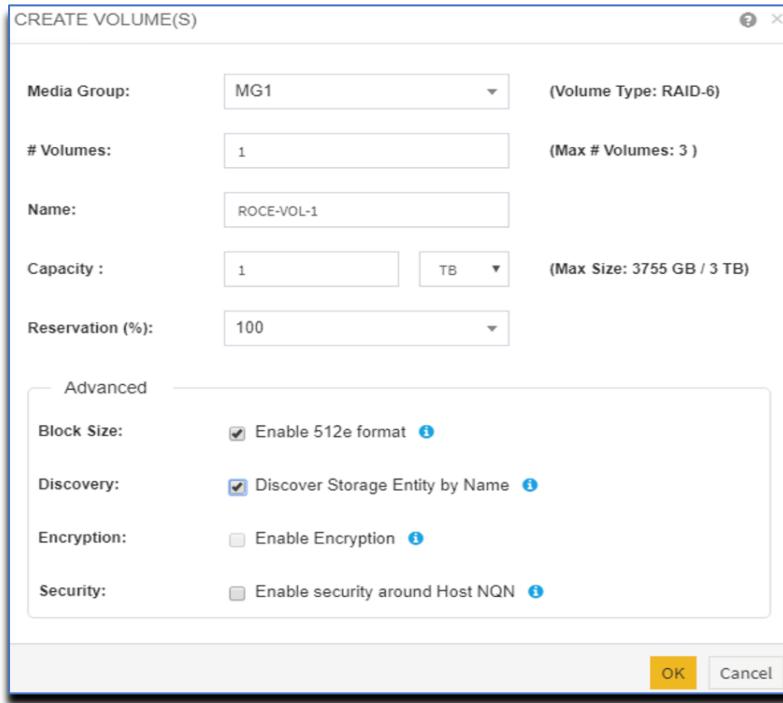


Step 2: On the **Volumes** page, click **Create** button to create a volume as seen in the below image:

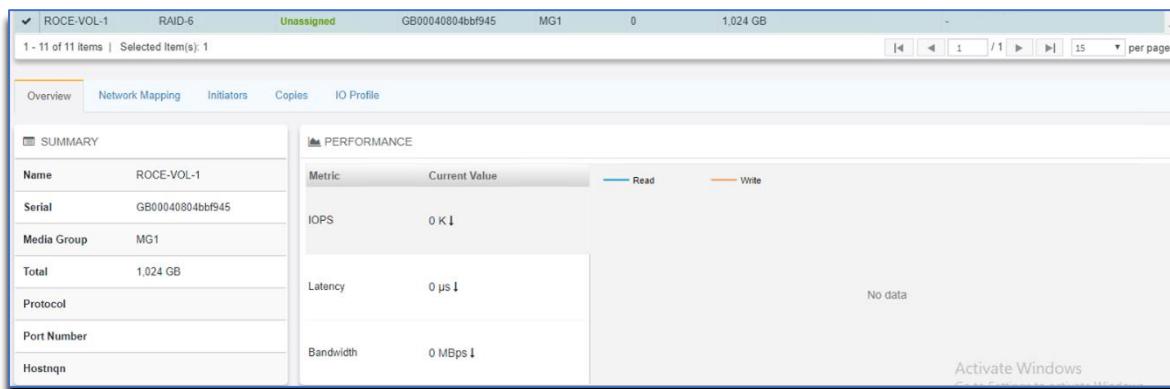


Step 3: Fill in the details in the **Create Volumes** page.

! Check the **Enable 512e format** and **Discover storage entity by name** checkbox. As, **VMFS** requires **512-byte** emulated sectors to function, as seen in the below image:



Step 4: Subsequently, new volume <ROCE-VOL-1> is created, as seen in the below image:

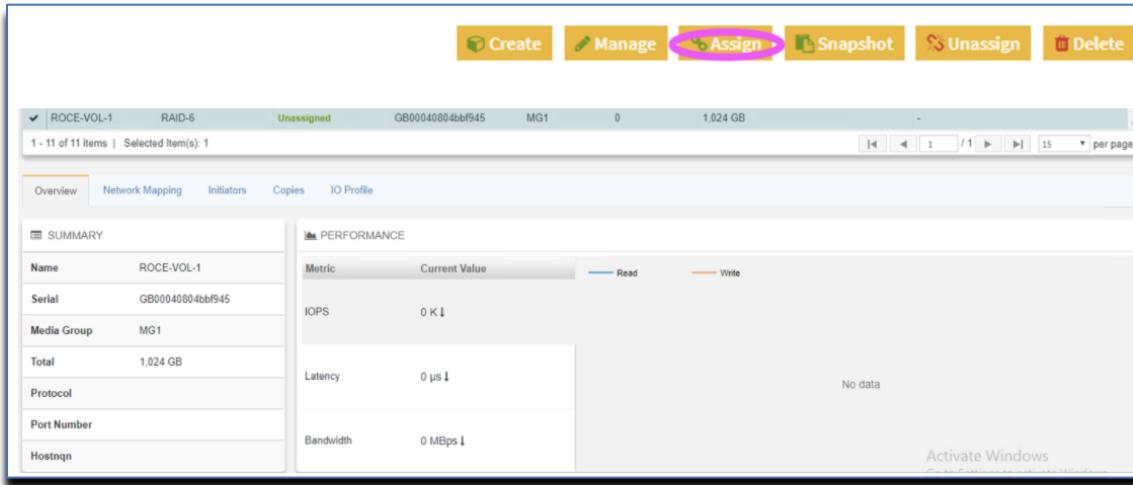


12. Assigning the Datastore Volumes for High Availability

Once the volume is created, it needs to be assigned to a pair of controllers to serve as **active** and **passive** controllers for **High Availability**.

Note: It is recommended that you refer to *Pavilion GUI Reference Guide* for more information.

Step 1: Select the volume just created and use the **Pavilion GUI** navigate to: **Storage>Volumes>Assign**.



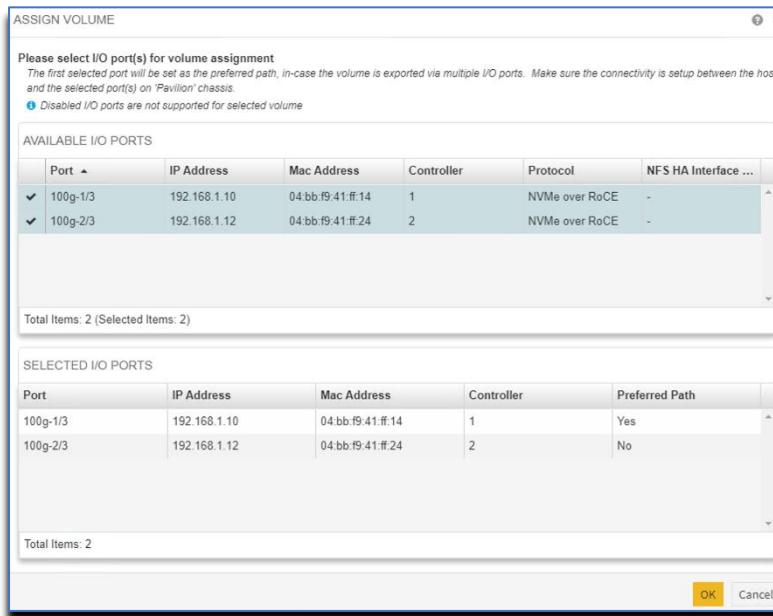
The screenshot shows the Pavilion GUI interface for managing volumes. At the top, there is a toolbar with several buttons: Create, Manage, Assign (which is highlighted with a pink oval), Snapshot, Unassign, and Delete. Below the toolbar, there is a header bar displaying volume details: ROCE-VOL-1, RAID-6, Unassigned, GB00040804bbfb945, MG1, 0, 1.024 GB. The main area is divided into two sections: SUMMARY and PERFORMANCE. The SUMMARY section contains a table with the following data:

Name	ROCE-VOL-1
Serial	GB00040804bbfb945
Media Group	MG1
Total	1,024 GB
Protocol	
Port Number	
Hostnqn	

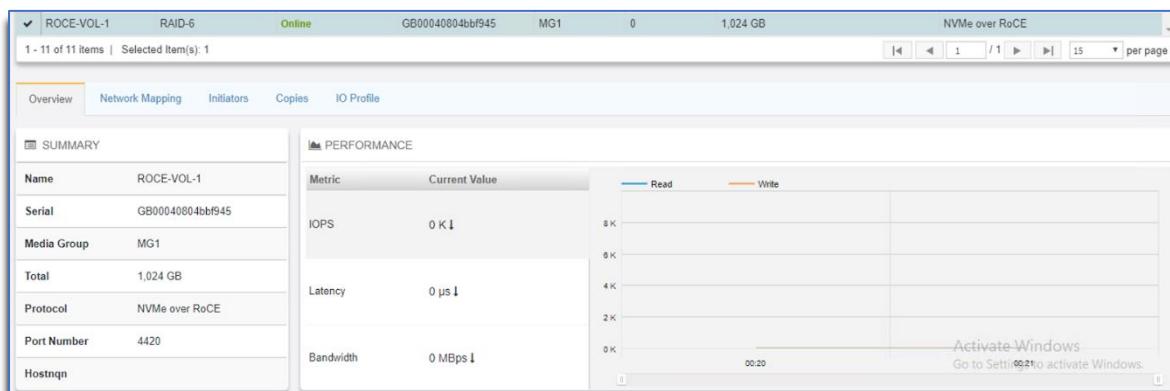
The PERFORMANCE section displays metrics for Read and Write operations. The current values are: IOPS (0 K↓), Latency (0 µs↓), and Bandwidth (0 MBps↓). A message "No data" is shown next to the latency and bandwidth metrics. At the bottom right of the interface, there is a link "Activate Windows".

Step 2: On the **Assign Volumes** dialog box, select **OK**.

Note: Make a note of the two IP addresses present (one from each controller), as these are required to configure the **ESXi server**, see image below for reference:



Step 3: As a next step, the volume is assigned, and volume state is changed from **unassigned** to **online**.



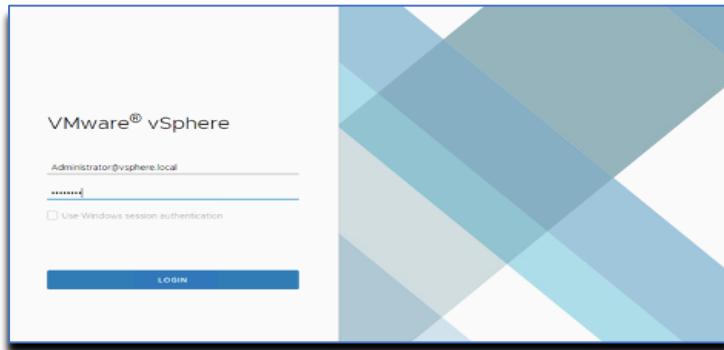
Step 4: At this point the volume will be visible on the network via two different IPs and the **ESXi servers** can be set up.

13. VMware RDMA Client Mounting and Options

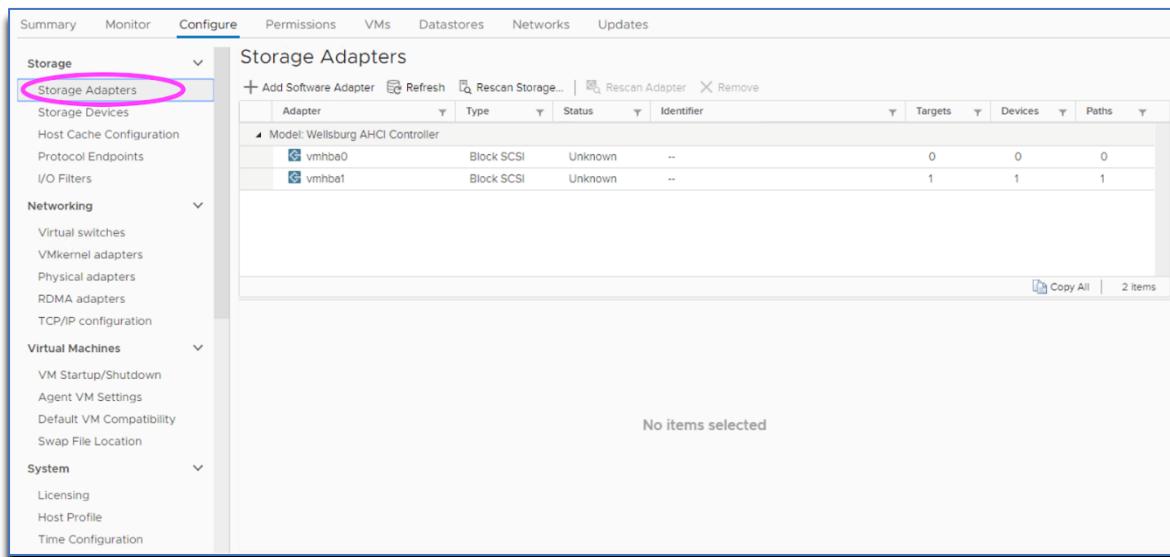
Note: To access **Pavilion** volumes user needs to create the software **NVMe-RDMA Storage Adapters**.

This section lists the steps required to do so.

Step 1: Log in to the **VMware® vSphere™** Client as seen in below image:

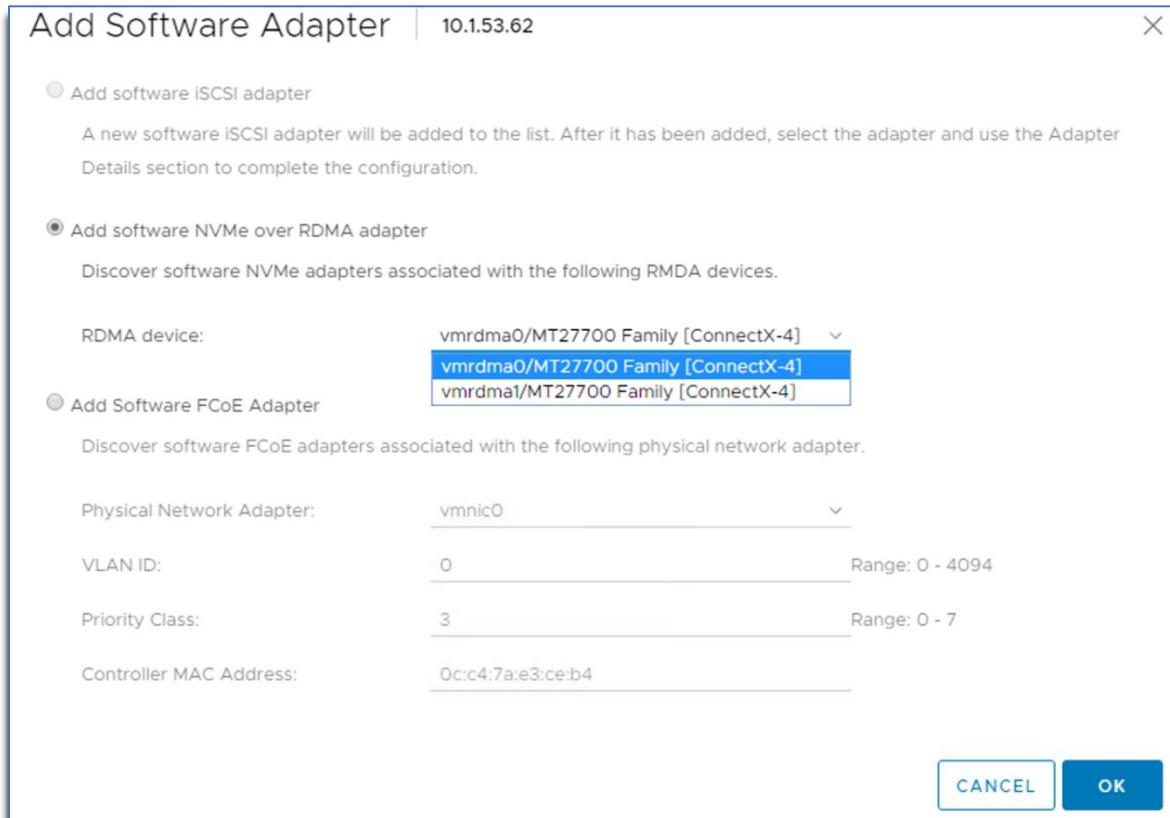


Step 2: Navigate to **Host and Clusters** and select the **ESXi host**, select the **Configure** tab, locate the **Storage** section, and select **Storage Adapters**. Click **Add Software Adapter** as seen in below image:

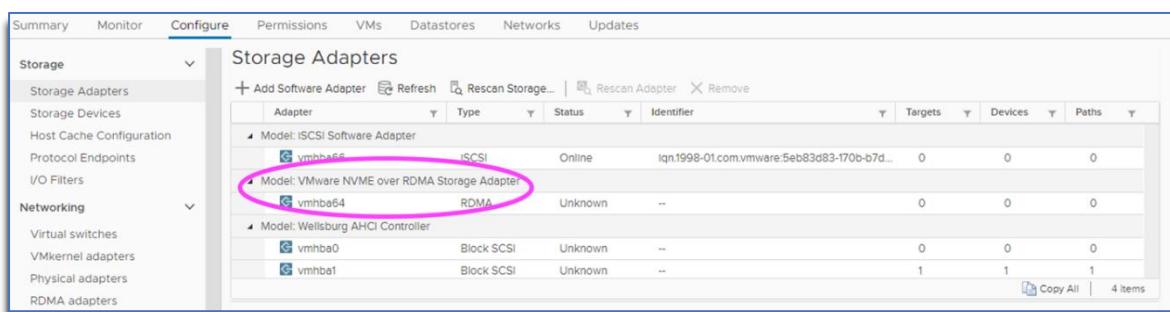


Adapter	Type	Status	Identifier	Targets	Devices	Paths
vmhba0	Block SCSI	Unknown	--	0	0	0
vmhba1	Block SCSI	Unknown	--	1	1	1

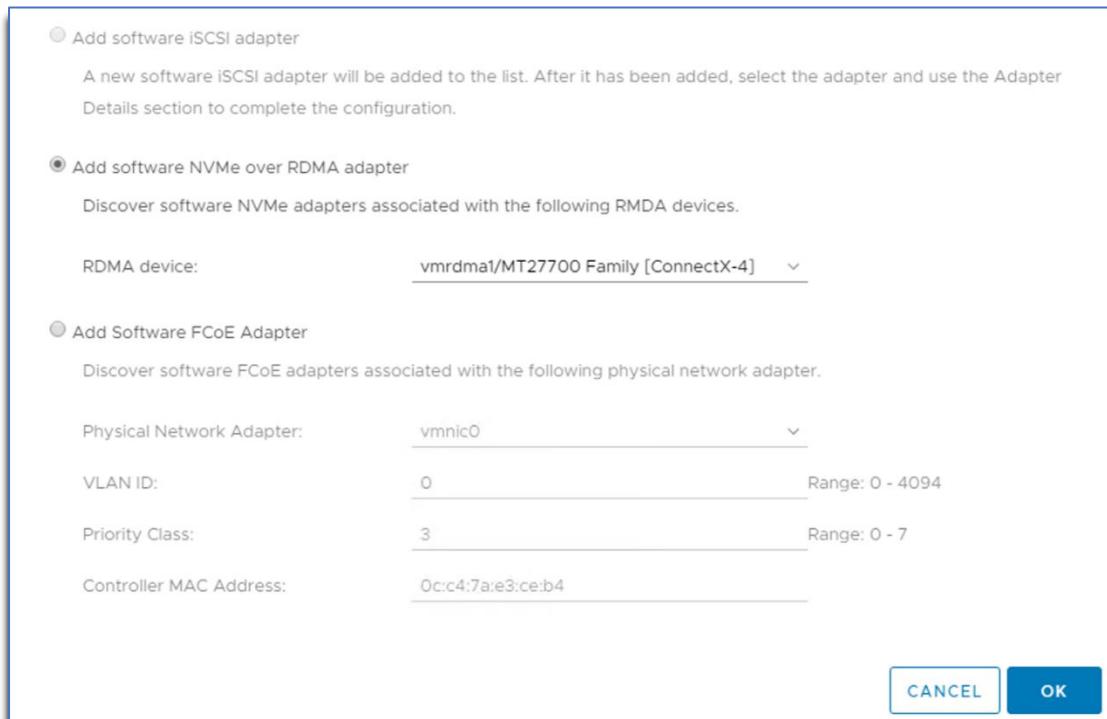
Step 3: On the **Add Software Adapter** dialog box, select **Add software NVMe over RDMA adapter** and select **RDMA device** as **vmrdma0** as seen in the below image:



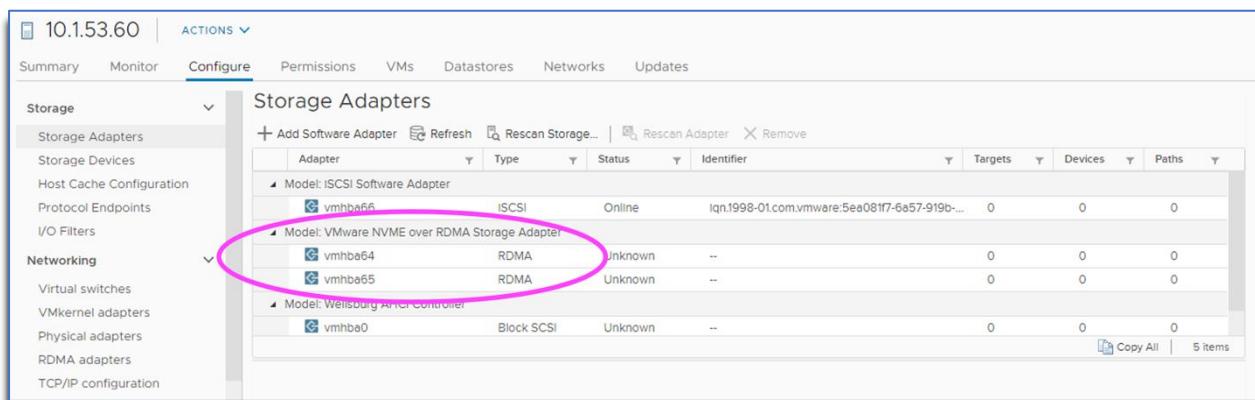
Step 4: Click OK. As a next step, verify on the **Storage Adapters>Configure** tab, that DMA storage adapter **vmhba64** has been added, as seen in the below image:



Step 5: As a next step, select **Add Software NVMe over RDMA adapter** to add the **second RDMA adapter (vmrdma1)** as seen in the below image:



Step 6: As a next step, verify on the **Storage Adapters>Configure** tab, that DMA storage adapter **vmhba65** has been added, as seen in the below image:



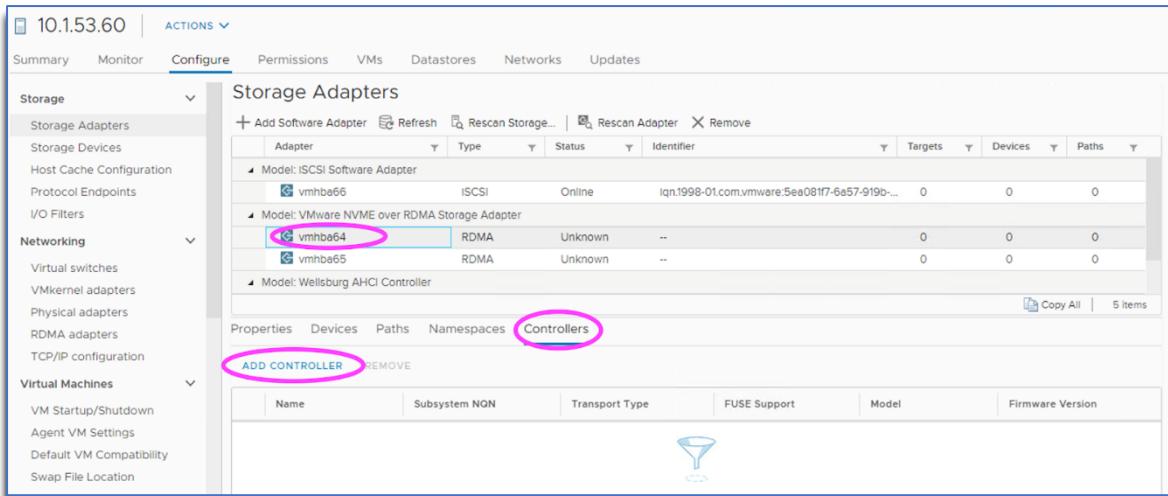
Adapter	Type	Status	Identifier	Targets	Devices	Paths
vmhba66	iSCSI	Online	iqn.1998-01.com.vmware:5ea08f17-6a57-919b-...	0	0	0
vmhba64	RDMA	Unknown	--	0	0	0
vmhba65	RDMA	Unknown	--	0	0	0
vmhba0	Block SCSI	Unknown	--	0	0	0

Note: Repeat Step 3 through Step 6 to configure VMware NVMe over RDMA Storage Adapter for all the hosts in the cluster.

15 Connecting to a NVMe-oF Volume

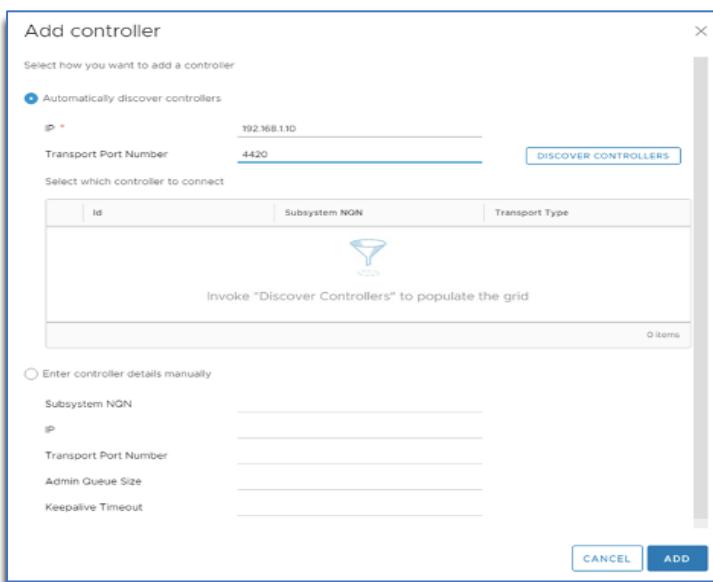
This section lists the steps required to configure NVMe-oF volume.

Step 1: To connect to NVMe-oF volumes, select any hosts in the cluster and select the newly generated **vmhba** and use the **Controllers** tab at the bottom of the page to **Add Controller**, seen in the below image:



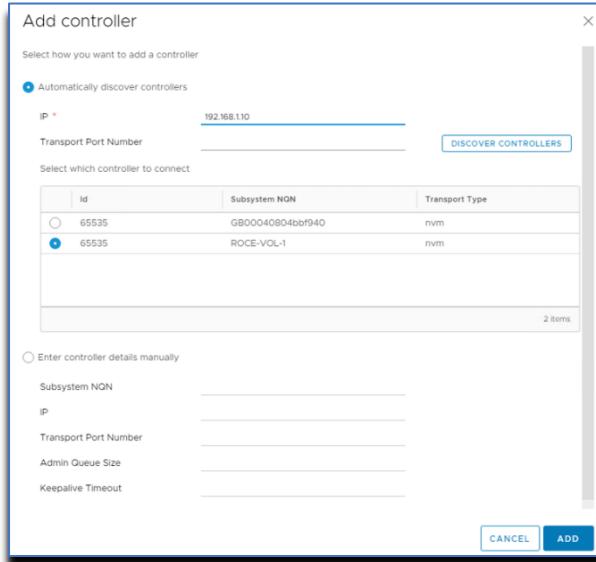
The screenshot shows the vSphere Web Client interface for host 10.1.53.60. The left sidebar is collapsed. The main navigation bar includes Summary, Monitor, Configure (selected), Permissions, VMs, Datastores, Networks, and Updates. Under the Storage category in the left sidebar, Storage Adapters is selected. The main content area displays a table of storage adapters. One adapter, 'vmhba64', is highlighted with a blue selection bar and circled in pink. The table has columns for Adapter, Type, Status, Identifier, Targets, Devices, and Paths. Below the table, tabs for Properties, Devices, Paths, Namespaces, and Controllers are shown. The Controllers tab is also circled in pink. At the bottom of the table area, there are 'ADD CONTROLLER' and 'REMOVE' buttons, both of which are circled in pink.

Step 2: Note: You can Automatically discover controllers or Enter controller details manually. For this instance, the controller is discovered automatically. Enter controller IP, Port and click **Discover Controllers** as seen in the below image:

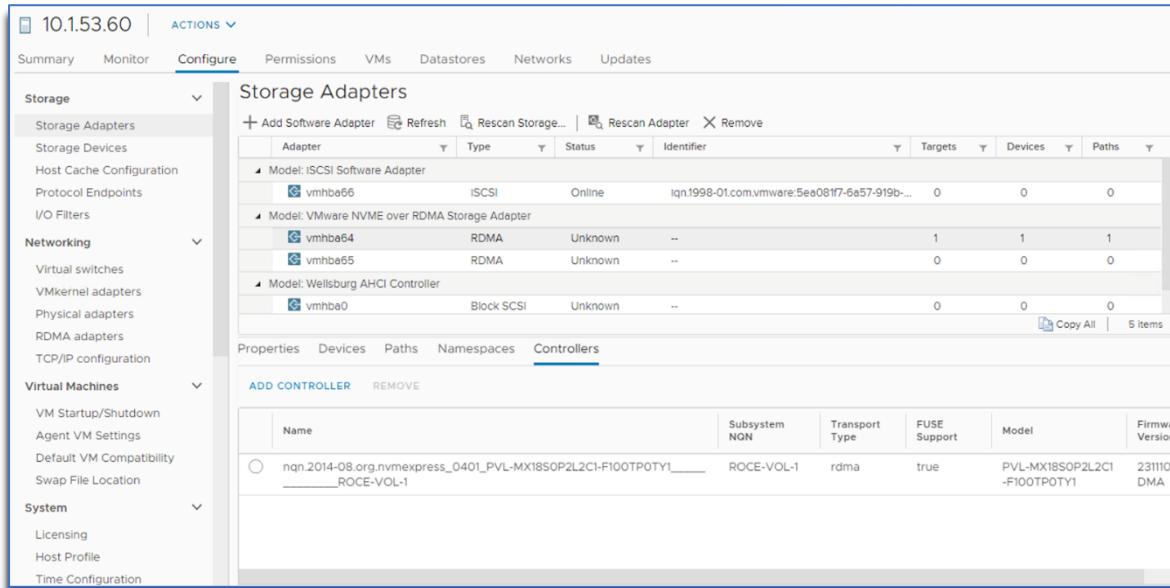


The screenshot shows the 'Add controller' dialog box. At the top, it says 'Select how you want to add a controller'. There are two options: 'Automatically discover controllers' (selected) and 'Enter controller details manually'. Under 'Automatically discover controllers', fields for 'IP' (192.168.1.10) and 'Transport Port Number' (4420) are filled in, along with a 'DISCOVER CONTROLLERS' button. Below this, a table titled 'Select which controller to connect' is shown with one row, which is empty. A note says 'Invoke "Discover Controllers" to populate the grid'. At the bottom, there is a note 'Enter controller details manually' followed by fields for 'Subsystem NQN', 'IP', 'Transport Port Number', 'Admin Queue Size', and 'Keepalive Timeout'. At the very bottom are 'CANCEL' and 'ADD' buttons.

Step 3: On the **Add Controller dialog box** select NQN ROCE-VOL-1 and click **ADD** as seen in the below image:



Step 4: As a next step, you can verify that Connectivity through the controller with IP address 192.168.1.10 has been established, as seen in the below image:



Adapter	Type	Status	Identifier	Targets	Devices	Paths
vmhba66	iSCSI	Online	iqn.1998-01.com.vmware:5ea081f7-6a57-919b-...	0	0	0
vmhba64	RDMA	Unknown	--	1	1	1
vmhba65	RDMA	Unknown	--	0	0	0
vmhba0	Block SCSI	Unknown	--	0	0	0

Step 5: Now Connect through the other controller IP address. Select NQN and click **ADD**, as seen in the below image:

Add controller

Select how you want to add a controller

Automatically discover controllers

IP *

Transport Port Number

Select which controller to connect

	Id	Subsystem NQN	Transport Type
<input type="radio"/>	65535	GB00040804bbf941	nvm
<input checked="" type="radio"/>	65535	ROCE-VOL-1	nvm

2 items

Enter controller details manually

Subsystem NQN

IP

Transport Port Number

Admin Queue Size

Keepalive Timeout

Step 6: Connectivity through Active and Standby controllers is established, as seen in the below image:

10.1.53.60 | ACTIONS ▾

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

Storage Adapters

+ Add Software Adapter | Refresh | Rescan Storage... | Rescan Adapter | Remove

Adapter	Type	Status	Identifier	Targets	Devices	Paths
Model: iSCSI Software Adapter vmhba66	iSCSI	Online	lqn.1998-01.com.vmware:Sea081f7-6a57-919b-...	0	0	0
Model: VMware NVMe over RDMA Storage Adapter vmhba64 vmhba65	RDMA	Unknown	--	2	1	2
Model: Wellsburg AHCI Controller vmhba0	Block SCSI	Unknown	--	0	0	0

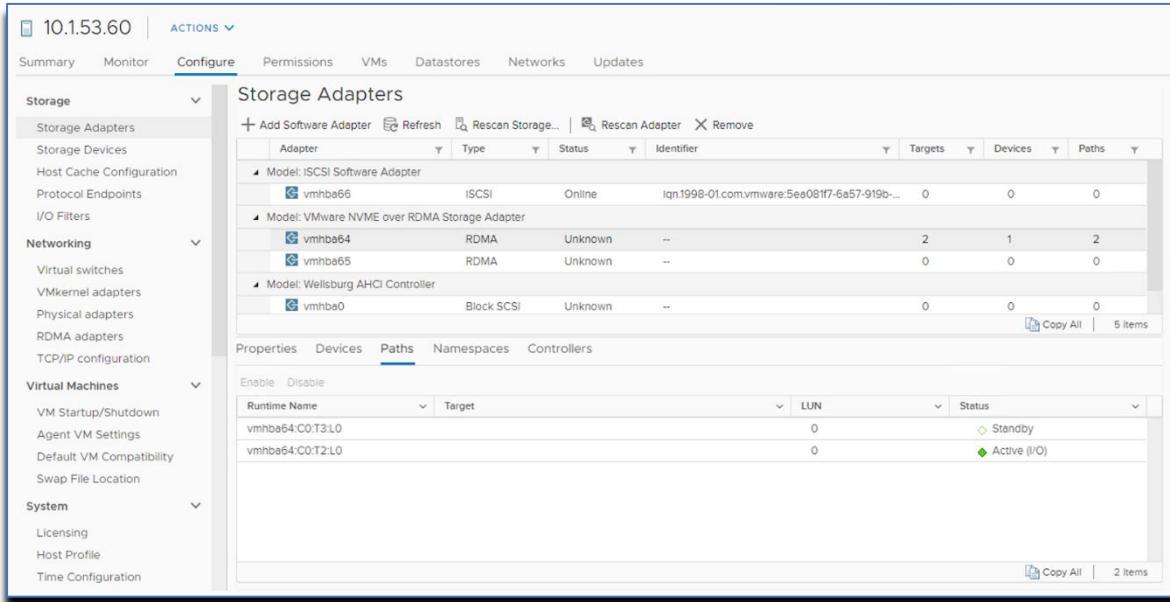
Copy All | 5 items

Properties | Devices | Paths | Namespaces | Controllers

ADD CONTROLLER | REMOVE

Name	Subsystem NQN	Transport Type	FUSE Support	Model	Firmware Version
nqn.2014-08.org.nvmeexpress_0401_PVL-MX18S0P2L2C1-F100TP0TY1 ROCE-VOL-1	ROCE-VOL-1	rdma	true	PVL-MX18S0P2L2C1-F100TP0TY1	231107-DMA
nqn.2014-08.org.nvmeexpress_0802_PVL-MX18S0P2L2C1-F100TP0TY1 ROCE-VOL-1	ROCE-VOL-1	rdma	true	PVL-MX18S0P2L2C1-F100TP0TY1	231107-DMA

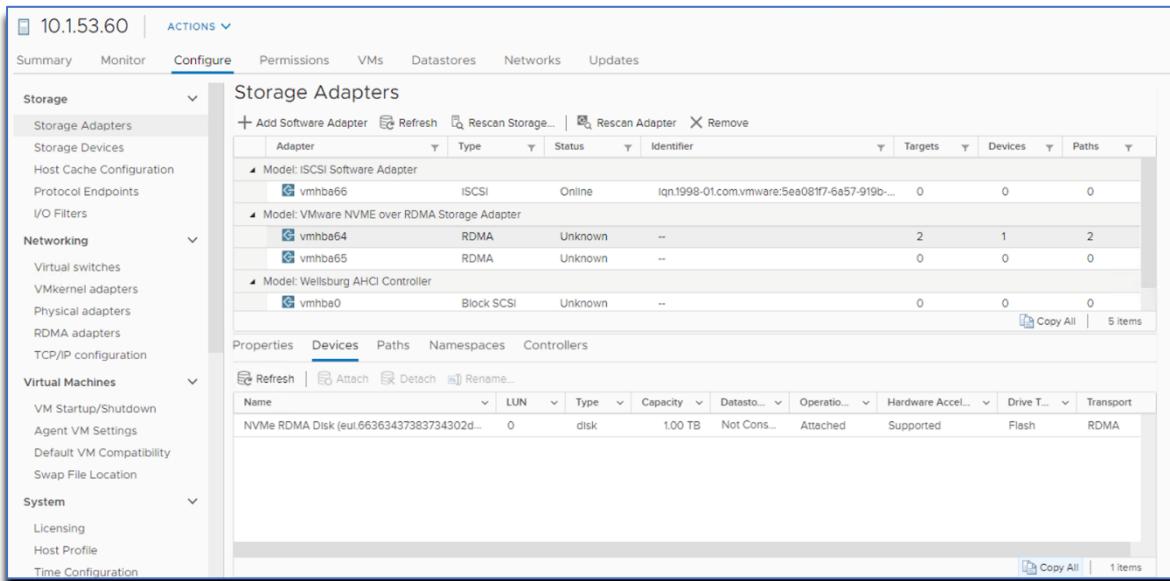
Step 7: As a next step, verify **Paths** as seen in the below image:



Adapter	Type	Status	Identifier	Targets	Devices	Paths
vmhba66	ISCSI	Online	iqn.1998-01.com.vmware:5ea081f7-6a57-919b-...	0	0	0
vmhba64	RDMA	Unknown	--	2	1	2
vmhba65	RDMA	Unknown	--	0	0	0
vmhba0	Block SCSI	Unknown	--	0	0	0

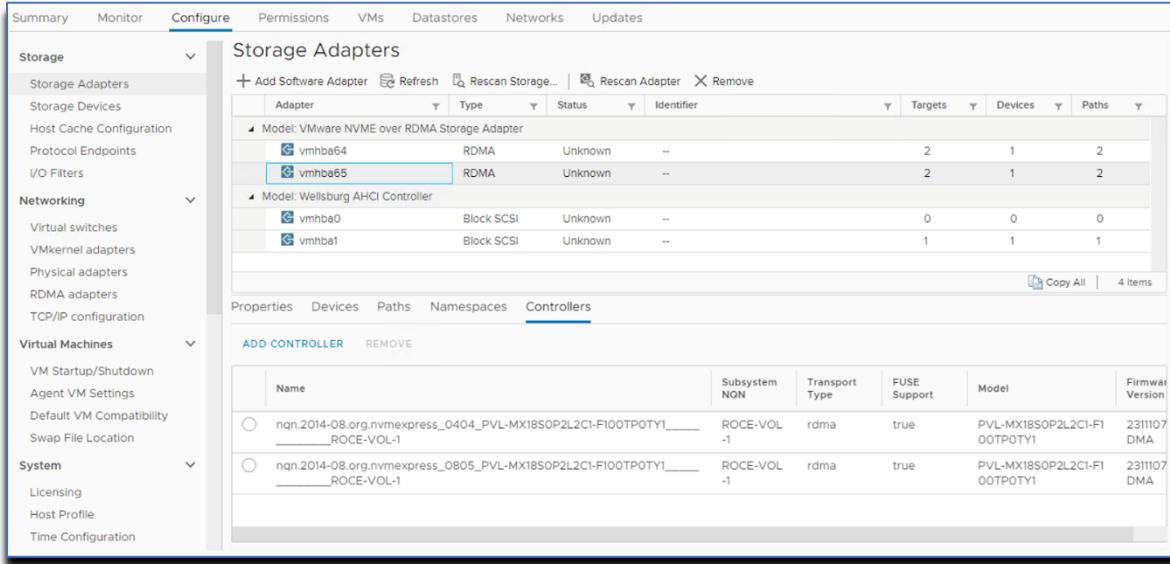
Runtime Name	Target	LUN	Status
vmhba64:C0:T3.L0		0	Standby
vmhba64:C0:T2.L0		0	Active (I/O)

Step 8: Verify **Host** to the NVMe Device as seen in the below image:



Name	LUN	Type	Capacity	Datasto...	Operatio...	Hardware Accel...	Drive T...	Transport
NVMe RDMA Disk (eui.6636343738734302d...)	0	disk	1.00 TB	Not Cons...	Attached	Supported	Flash	RDMA

Step 9: Repeat the connectivity process for the second adapter **vmhba65** on the host, as seen in the below image:



The screenshot shows the vSphere 7.0 interface under the 'Configure' tab. The left sidebar is expanded to show 'Storage' and 'Networking' sections. In the main pane, the 'Storage Adapters' section is selected. A table lists storage adapters, with 'vmhba65' highlighted. Below the table, there are tabs for 'Properties', 'Devices', 'Paths', 'Namespaces', and 'Controllers'. The 'Controllers' tab is selected, showing a list of controllers associated with the selected adapter. Two entries are listed, both labeled 'nqn.2014-08.org.nvmeexpress_0404_PVL-MX18S0P2L2C1-F100TPOTY1'.

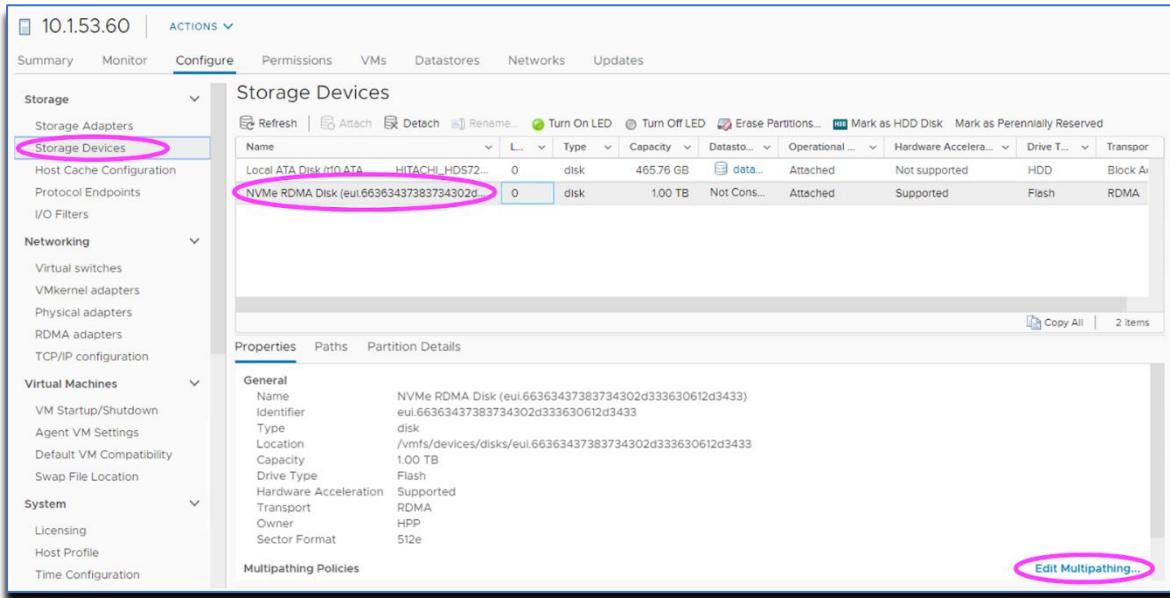
Name	Subsystem	Transport Type	FUSE Support	Model	Firmware Version
nqn.2014-08.org.nvmeexpress_0404_PVL-MX18S0P2L2C1-F100TPOTY1 ____ROCE-VOL-1	NON -1	rdma	true	PVL-MX18S0P2L2C1-F1 00TPOTY1	2311107 DMA
nqn.2014-08.org.nvmeexpress_0805_PVL-MX18S0P2L2C1-F100TPOTY1 ____ROCE-VOL-1	NON -1	rdma	true	PVL-MX18S0P2L2C1-F1 00TPOTY1	2311107 DMA

Note: In a similar manner you can connect to all the hosts in the ESX cluster and verify that the hosts can see the NVMe device.

14. Configuring Multipathing

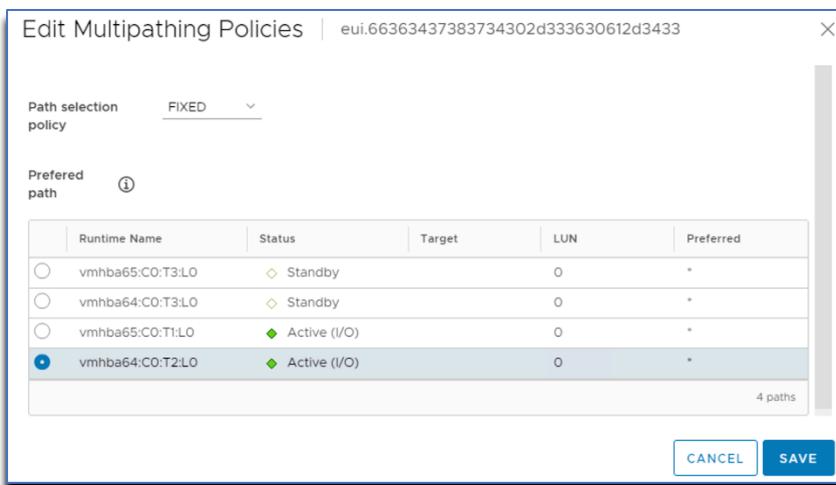
This section lists the steps required to configure multipath.

Step 1: After adding controllers, navigate to **Storage>Storage devices** and then after selecting the NVME device click **Edit Multipathing** as can be seen at the bottom-right corner of the page in the image:



The screenshot shows the vSphere Web Client interface. The left sidebar is collapsed. The main area displays the 'Storage Devices' list. A single row for 'NVMe RDMA Disk' is selected. At the bottom right of the list, there is a blue button labeled 'Edit Multipathing...'. This button is circled in pink.

Step 2: Select **vhmba** with **Active (I/O)** and set **Path selection policy** to **FIXED**, as seen in the below image:



The screenshot shows the 'Edit Multipathing Policies' dialog box. The top section shows the 'Path selection policy' dropdown set to 'FIXED'. Below it is a table titled 'Preferred path' with four entries. The last two entries have a blue dot next to them, indicating they are active. At the bottom right of the dialog are 'CANCEL' and 'SAVE' buttons, with 'SAVE' being highlighted with a blue box.

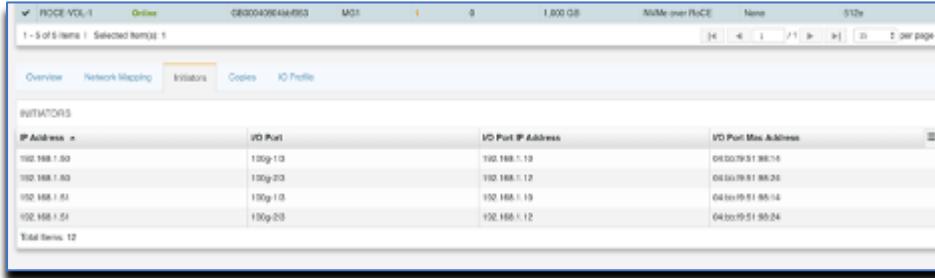
Runtime Name	Status	Target	LUN	Preferred
vmhba65:CO:T3:LO	Standby	0	*	
vmhba64:CO:T3:LO	Standby	0	*	
vmhba65:CO:T1:LO	Active (I/O)	0	*	
vmhba64:CO:T2:LO	Active (I/O)	0	*	

Step 3: In a similar manner, configure multipathing for all the hosts in the ESX cluster.

15. Verifying Initiators in Pavilion

This section lists the steps required to verify **Pavilion** initiators.

Step 1: Login to **Pavilion** GUI, navigate to **Storage>Volumes** and verify **Initiators** tab displayed at the bottom of the page, when you select a volume, as seen in the below image:



The screenshot shows the Pavilion GUI interface for managing volumes. A specific volume, 'RoCE VOL-1', is selected and displayed in the top navigation bar. The main content area shows the 'Initiators' tab selected, listing five initiators with their respective IP addresses, iD Port, and iD Port IP Address. The table includes columns for IP Address, iD Port, iD Port IP Address, and iD Port Max Address. The total number of items listed is 12.

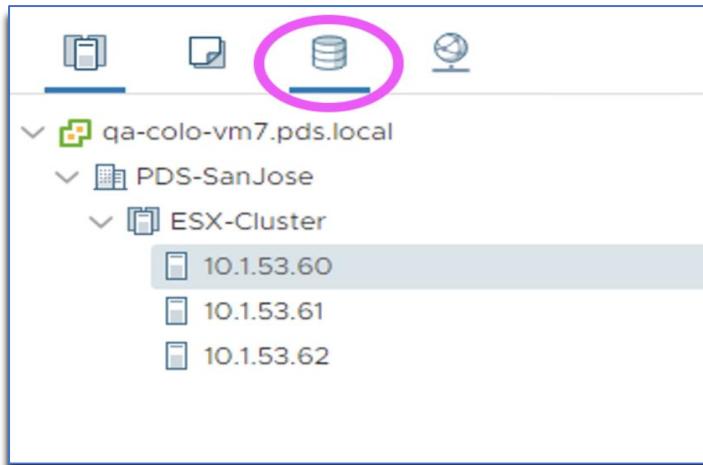
IP Address	iD Port	iD Port IP Address	iD Port Max Address
192.168.1.80	190g-10	192.168.1.10	04:00:79:81:88:16
192.168.1.80	190g-20	192.168.1.12	04:00:79:81:88:20
192.168.1.81	190g-10	192.168.1.19	04:00:79:81:88:14
192.168.1.81	190g-20	192.168.1.12	04:00:79:81:88:24

16. Creating VMFS Filesystem and Datastore

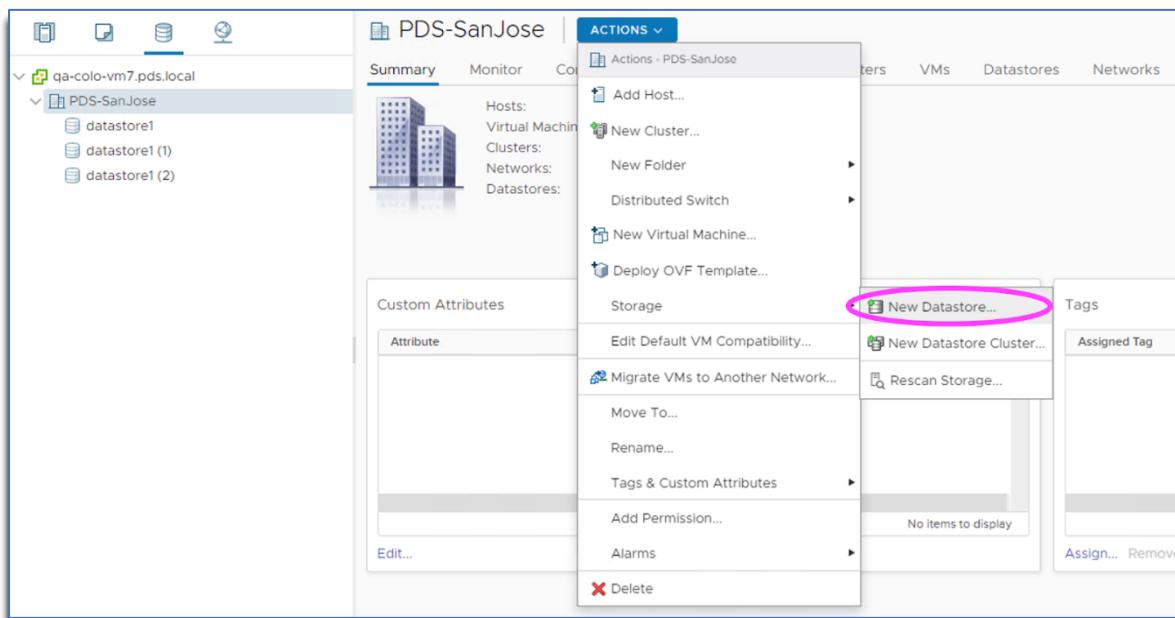
This section lists the steps required to create datastore and VMFS filesystem.

Step 1: Log in to the **VMware® vSphere™ Client**.

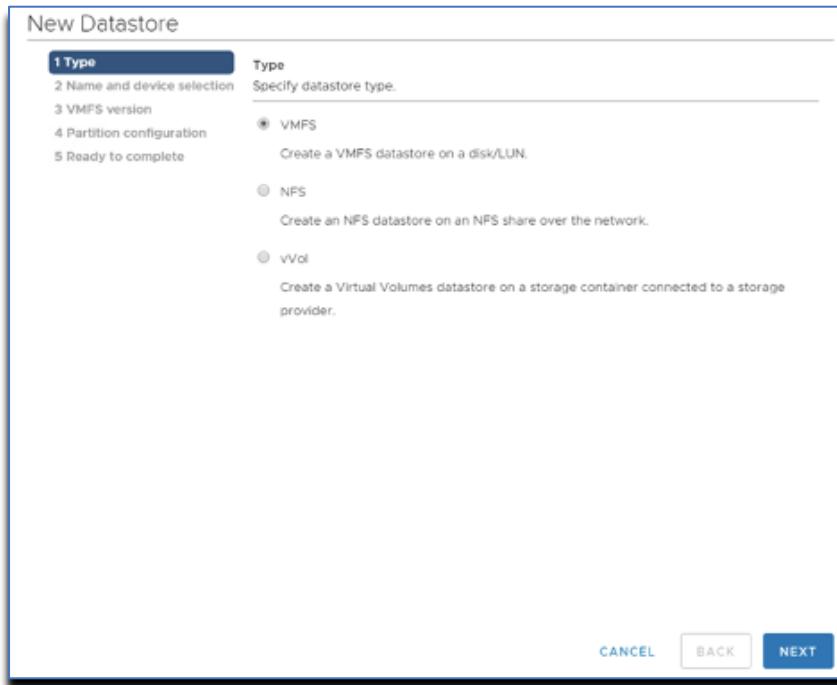
Step 2: At vCenter, click **storage** icon as seen in below image:



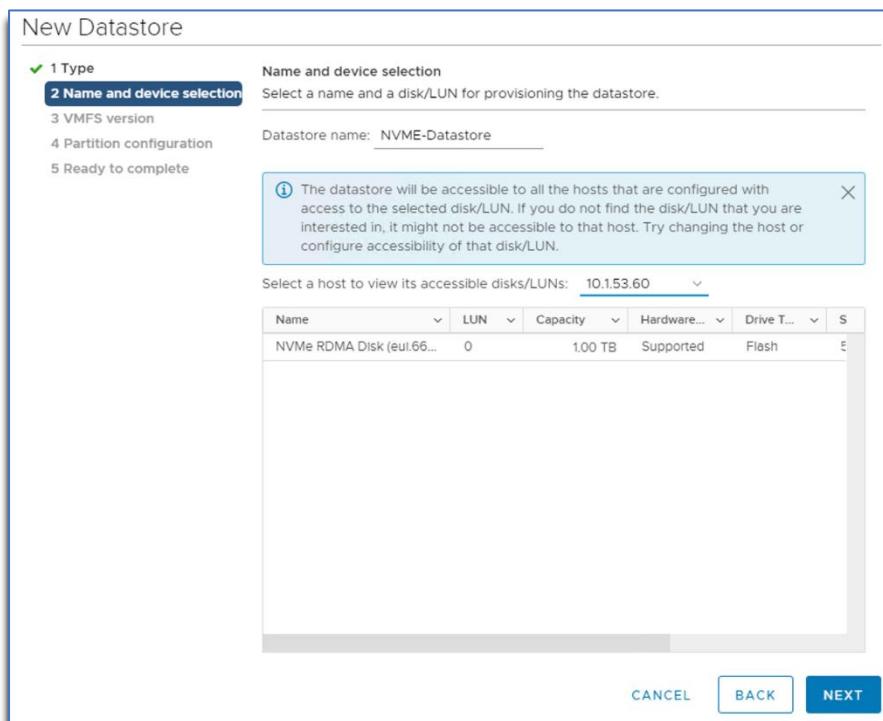
Step 3: Navigate to **Actions>Storage>New Datastore** as seen in below image:



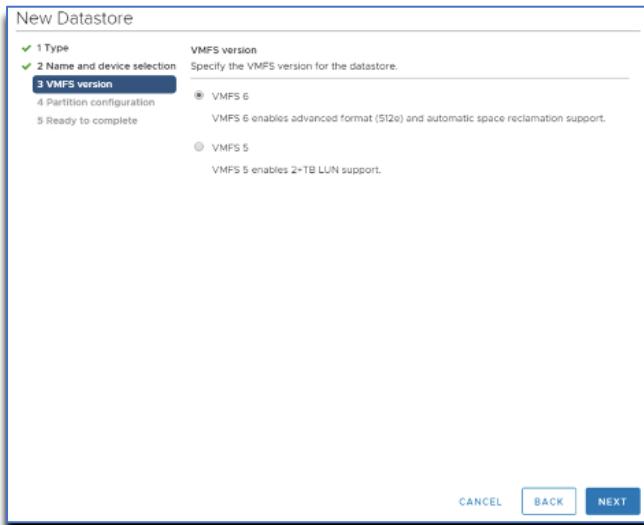
Step 4: On the New Datastore dialog box, select Type, **Select Datastore Type as VMFS** and click **NEXT** as seen in below image:



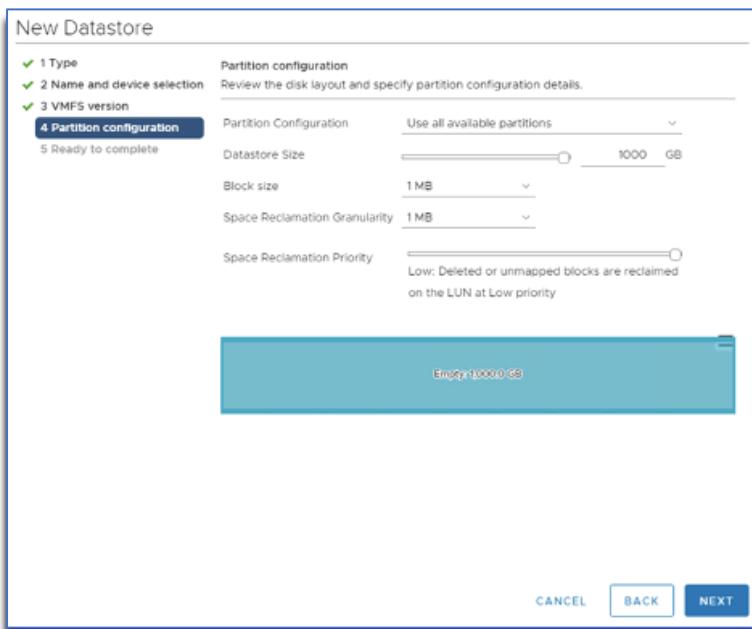
Step 5: Navigate to Name and device selection, enter the Datastore name, and click **NEXT** as seen in below image:



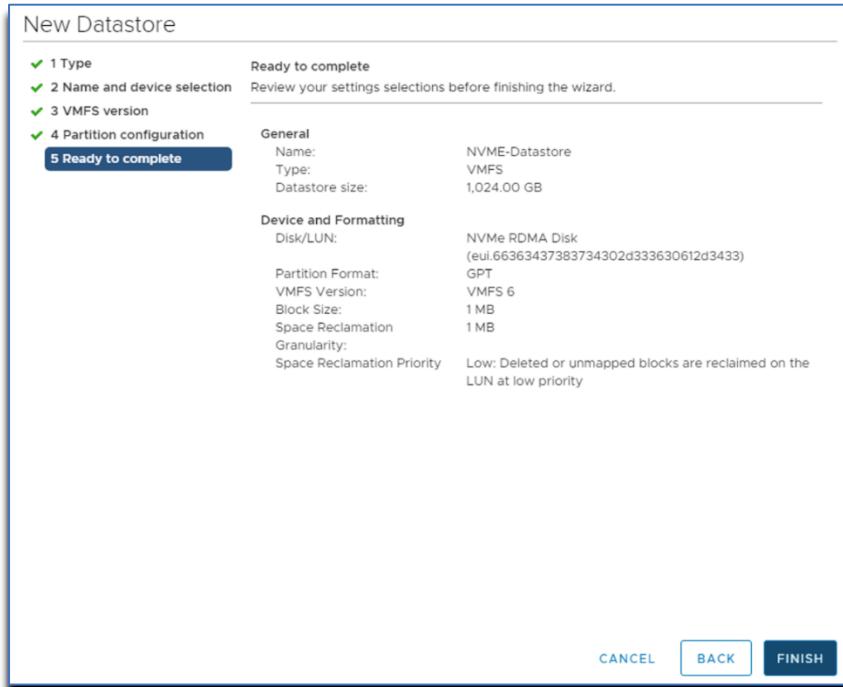
Step 6: Navigate to VMFS version, Select **VMFS Version** and click NEXT as seen in below image:



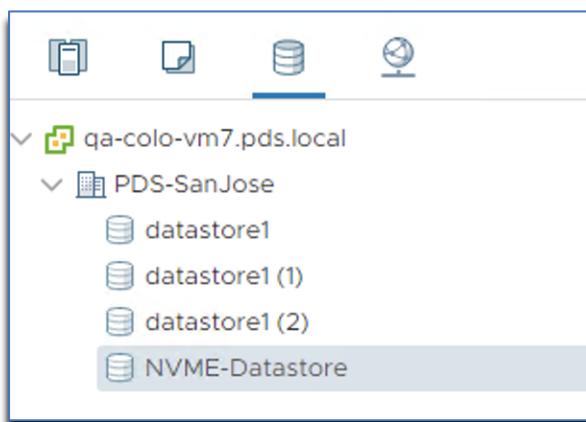
Step 7: Navigate **Partition configuration**, specify Partition configuration and click **NEXT** as seen in below image:



Step 8: Navigate to Ready to complete page, verify datastore information and click **Finish** as seen in below image:



Step 9: As a next step you can verify that new datastore **NVME-Datastore** is created and is ready for use as seen in below image:



17. Optimizing VMs for NVMe-oF Datastores

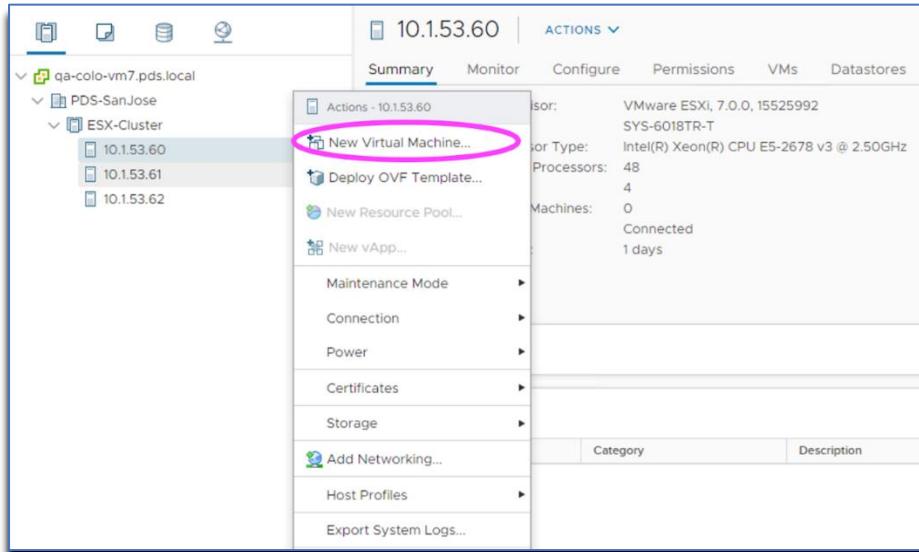
A datastore using the **Pavilion HFA** can be managed in the same manner as any other datastore on other storage media. However, because **Pavilion HFA** can provide I/O performance much higher than other technologies, it is important that any VMs using **Pavilion HFA** datastore is configured properly.

As a thumb rule, for I/O intensive workloads, VMs should have their virtual disks connected using the **VMware vNVMe Controller** and not the standard VMware SCSI or SATA controllers, as long as the client operating system supports NVMe technology.

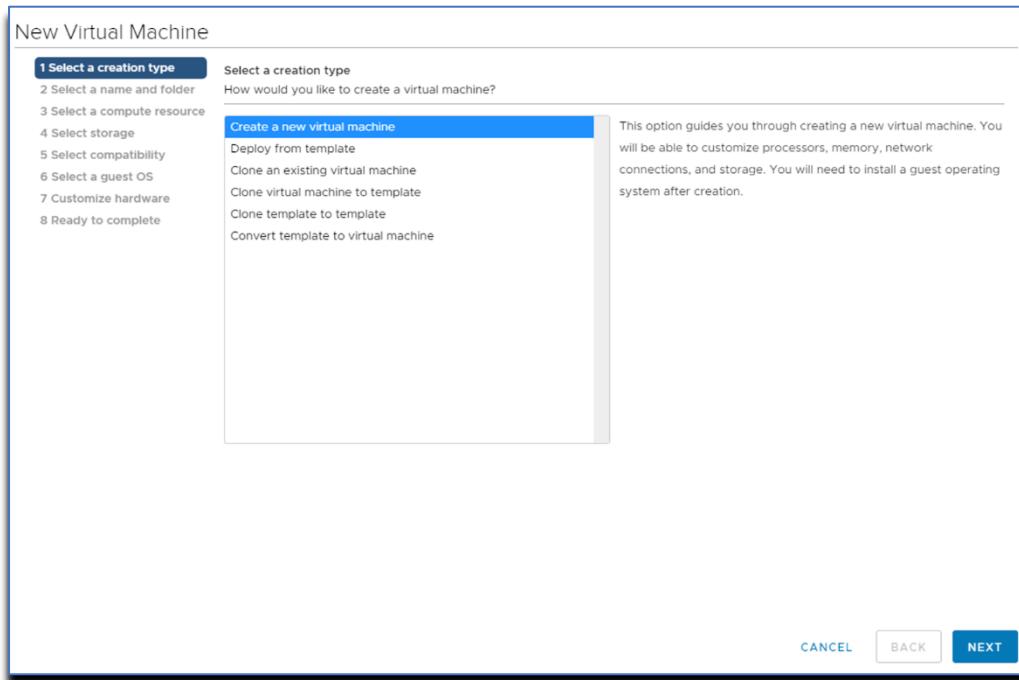
Modern Microsoft Windows Server and Linux distributions all natively support NVMe, so for new deployments this is not an issue. However, for older Microsoft Windows Server distributions which do not natively support NVMe, the VMware paravirtualized SCSI or SATA, or even emulates LSI SATA controllers will still function, albeit at reduced performance potential.

Note: To proceed with **VM** creation, ensure that you select the **Pavilion** datastore. This section lists the steps to perform the transaction.

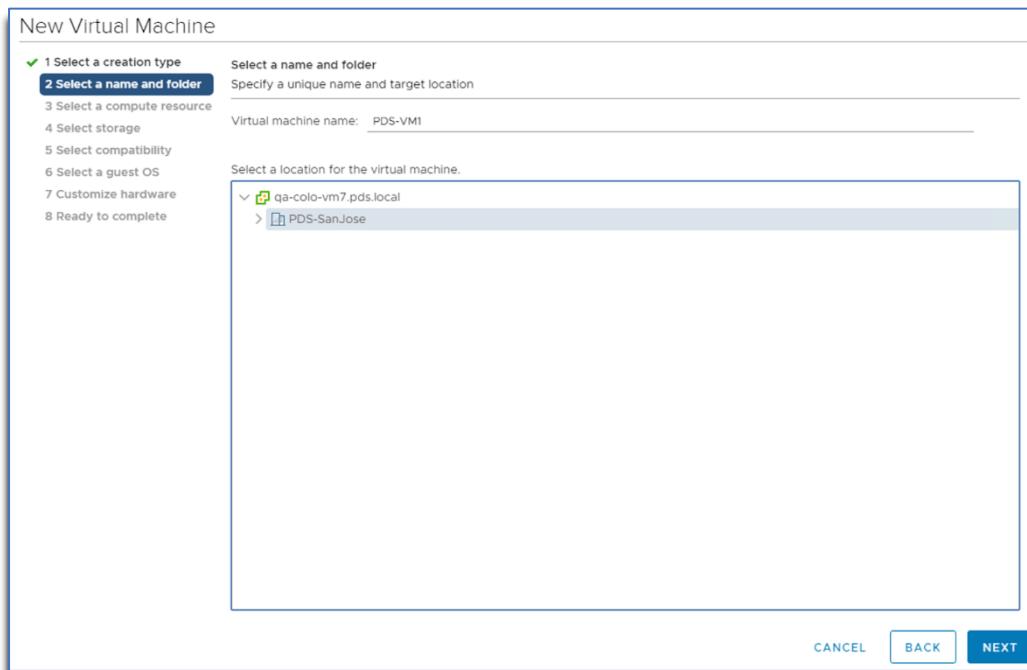
Step 1: Navigate back to **Host and Clusters** in **VMware® vSphere™**. Right click on any hosts in your ESX cluster and select **New Virtual Machine** as seen in the below image:



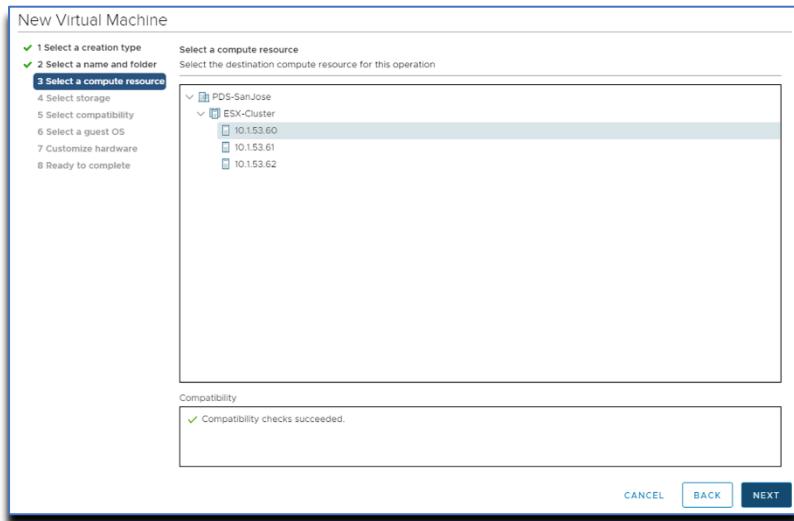
Step 2. Navigate to **Select Creation type>Create a new virtual machine**, and click **NEXT** as seen in below image:



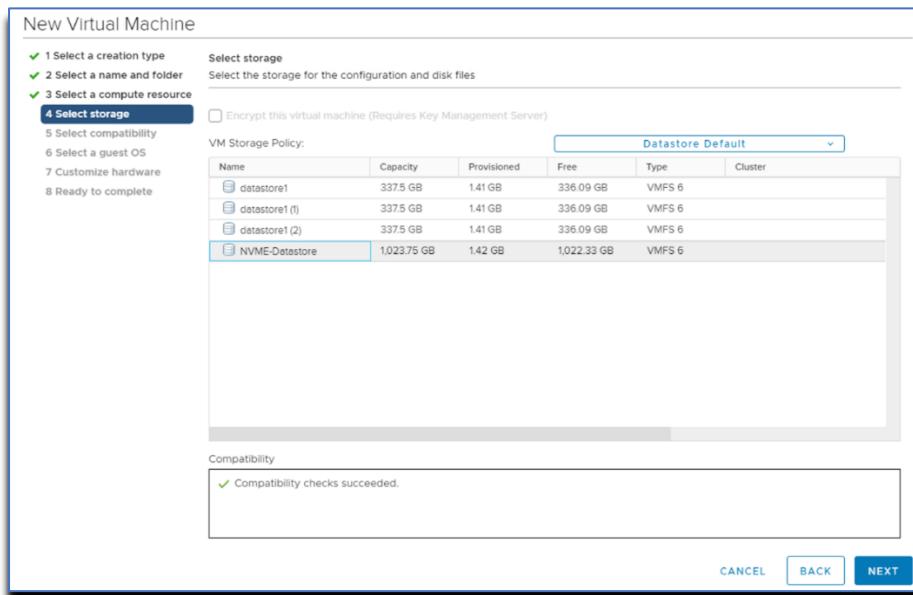
Step 3. Specify **Virtual Machine Name** and click **NEXT** as seen in below image:



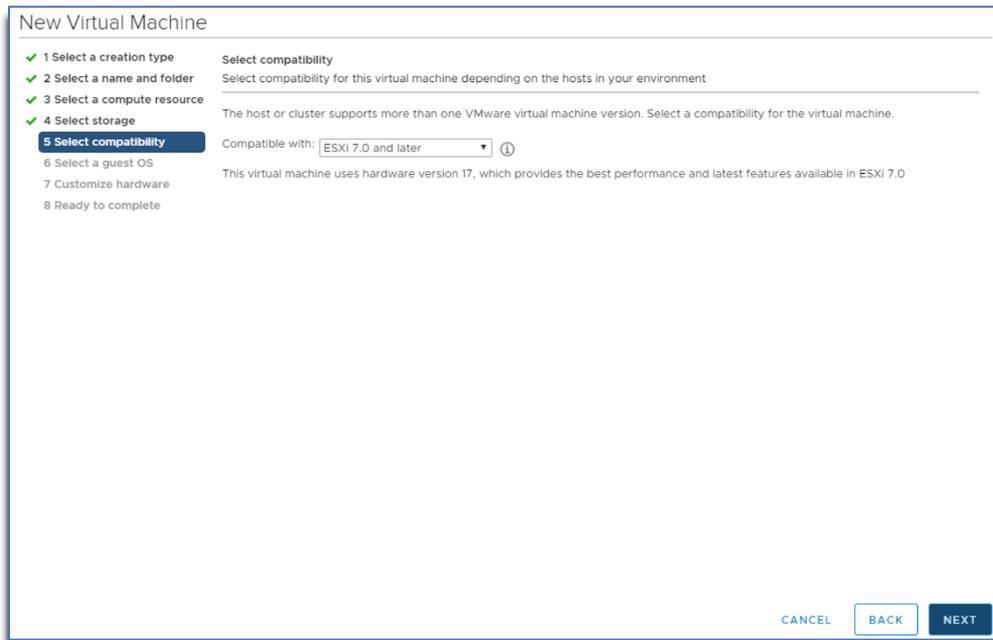
Step 4. Navigate to **Select a computer resource**, select primary host for the virtual machine and click **NEXT** as seen in below image:



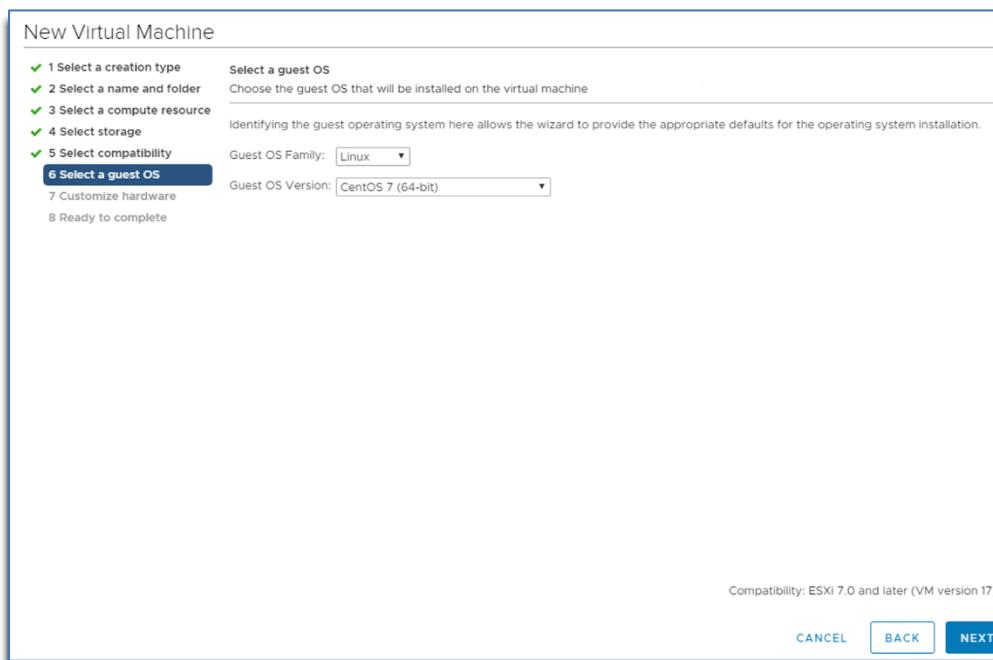
Step 5. Navigate to **Select Storage**, select datastore for the virtual machine and click **NEXT** as seen in below image:



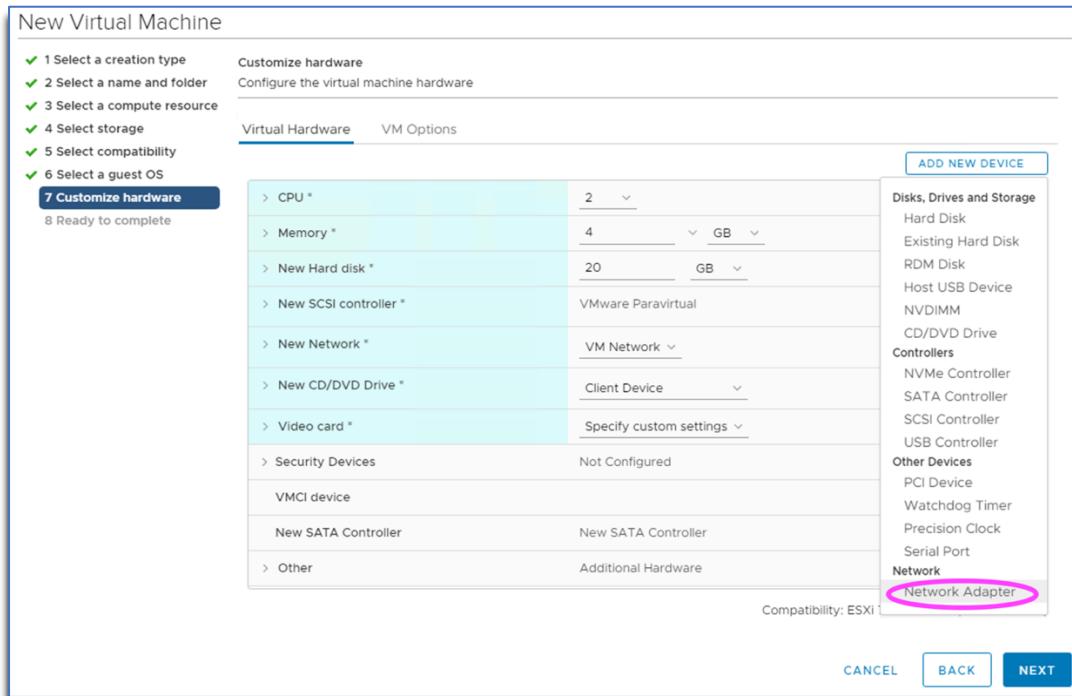
Step 6: Navigate to **Select Compatibility**, select **Compatibility with** and click **NEXT** as seen in below image:



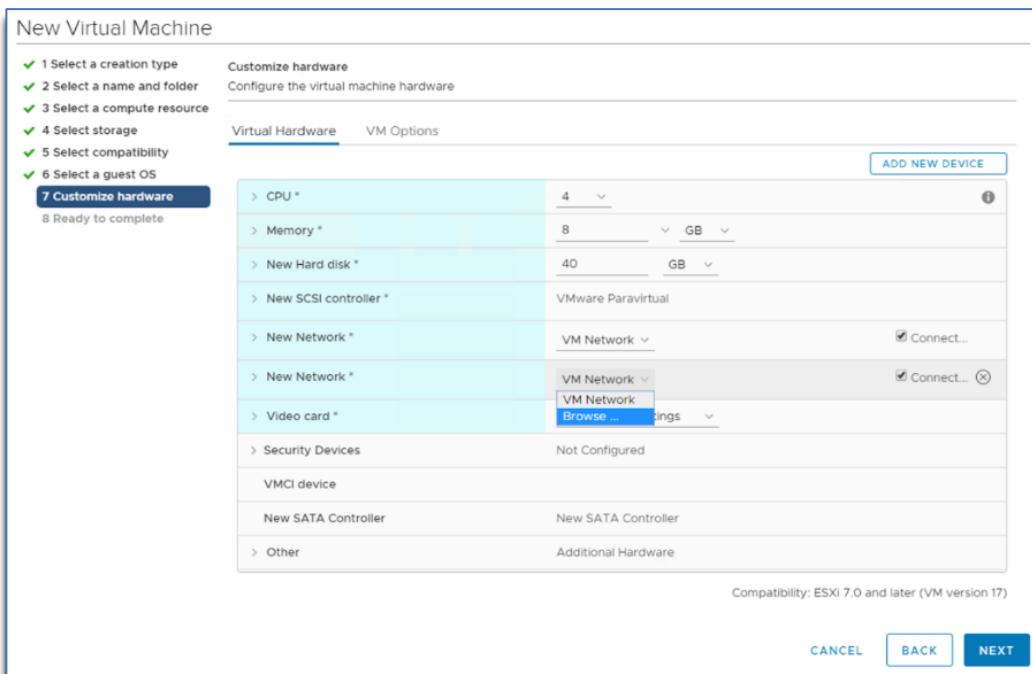
Step 7: Navigate to **Select a guest OS**, select **Guest OS Family** and **Guest OS Version** and click **NEXT** as seen in below image:



Step 8: Navigate to **Customize hardware>Virtual Hardware**, and add new network adapter and click **NEXT** as seen in below image:



Step 9: As seen in the below *images*, set the **New Network to Browse**, select **Network** and click **NEXT** as seen in below image:



New Virtual Machine

✓ 1 Select a creation type
 ✓ 2 Select a name and folder
 ✓ 3 Select a compute resource
 ✓ 4 Select storage
 ✓ 5 Select compatibility
 ✓ 6 Select a guest OS
7 Customize hardware
 8 Ready to complete

Customize hardware
Configure the virtual machine hardware

Virtual Hardware VM Options

ADD NEW DEVICE

> CPU *	4
> Memory *	8 GB
> New Hard disk *	40 GB
> New SCSI controller *	VMware Paravirtual
> New Network *	VM Network
> New Network *	RoCE-A
> Video card *	Auto-detect settings
> Security Devices	Not Configured
VMCI device	
New SATA Controller	New SATA Controller
> Other	Additional Hardware

Compatibility: ESXi 7.0 and later (VM version 17)

CANCEL **BACK** **NEXT**

Step 10: Add new Hard Disk and specify the size, as seen in the below image:

New Virtual Machine

✓ 1 Select a creation type
 ✓ 2 Select a name and folder
 ✓ 3 Select a compute resource
 ✓ 4 Select storage
 ✓ 5 Select compatibility
 ✓ 6 Select a guest OS
7 Customize hardware
 8 Ready to complete

Customize hardware
Configure the virtual machine hardware

Virtual Hardware VM Options

ADD NEW DEVICE

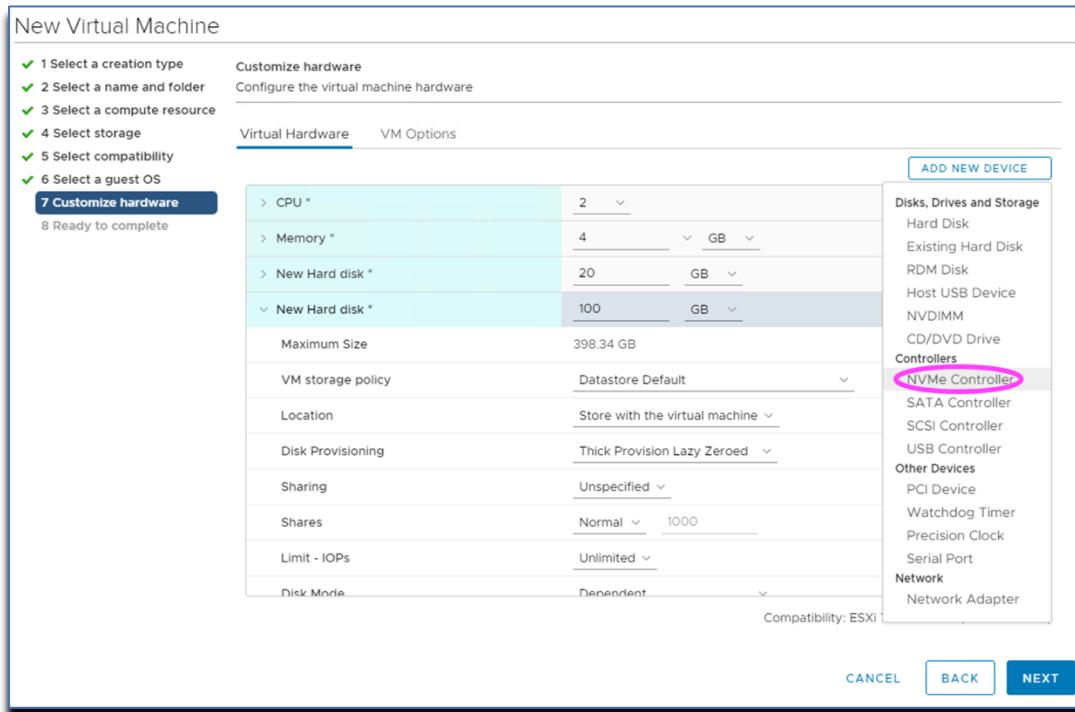
> CPU *	2
> Memory *	4 GB
> New Hard disk *	20 GB
> New SCSI controller *	VMware Paravirtual
> New Network *	VM Network
> New Network *	RoCE-A
> Video card *	Specify custom settings
> Security Devices	Not Configured
VMCI device	
New SATA Controller	New SATA Controller
> Other	Additional Hardware

Compatibility: ESXi

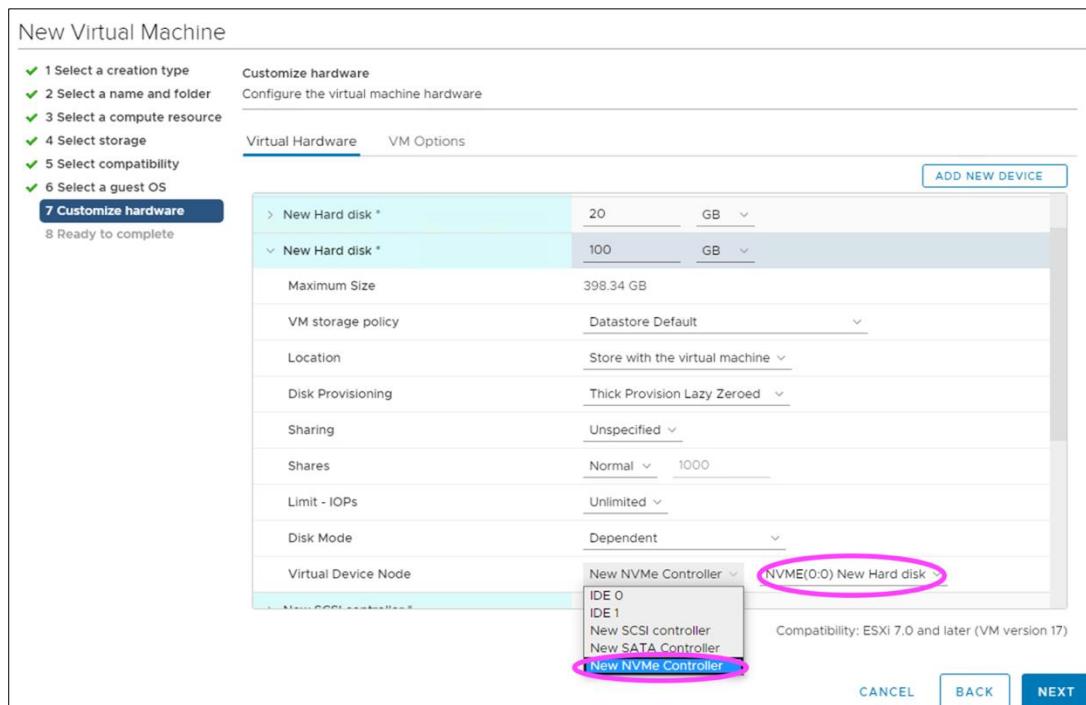
Disks, Drives and Storage
Hard Disk (highlighted with a red circle)
 Existing Hard Disk
 RDM Disk
 Host USB Device
 NVDIMM
 CD/DVD Drive
Controllers
 NVMe Controller
 SATA Controller
 SCSI Controller
 USB Controller
Other Devices
 PCI Device
 Watchdog Timer
 Precision Clock
 Serial Port
Network
 Network Adapter

CANCEL **BACK** **NEXT**

Step 11: In the customization panel, select the **ADD NEW DEVICE** button and select **NVMe Controller** as seen in the below image:



Step 12: Open the **New Hard Disk** line item and select the new NVMe controller just added as seen in the below images:



New Virtual Machine

✓ 1 Select a creation type
 ✓ 2 Select a name and folder
 ✓ 3 Select a compute resource
 ✓ 4 Select storage
 ✓ 5 Select compatibility
 ✓ 6 Select a guest OS
7 Customize hardware
 8 Ready to complete

Customize hardware
Configure the virtual machine hardware

Virtual Hardware VM Options

ADD NEW DEVICE

New Hard disk *	100 GB
Maximum Size	398.34 GB
VM storage policy	Datastore Default
Location	Store with the virtual machine
Disk Provisioning	Thick Provision Lazy Zeroed
Sharing	Unspecified
Shares	Normal 1000
Limit - IOPS	Unlimited
Disk Mode	Dependent
Virtual Device Node	New NVMe Controller NVME(0:0) New Hard disk
> New SCSI controller *	VMware Paravirtual

Compatibility: ESXi 7.0 and later (VM version 17)

CANCEL BACK **NEXT**

Step 13: Navigate to **Ready to complete**, verify the VM configuration and click **FINISH** as seen in below image:

New Virtual Machine

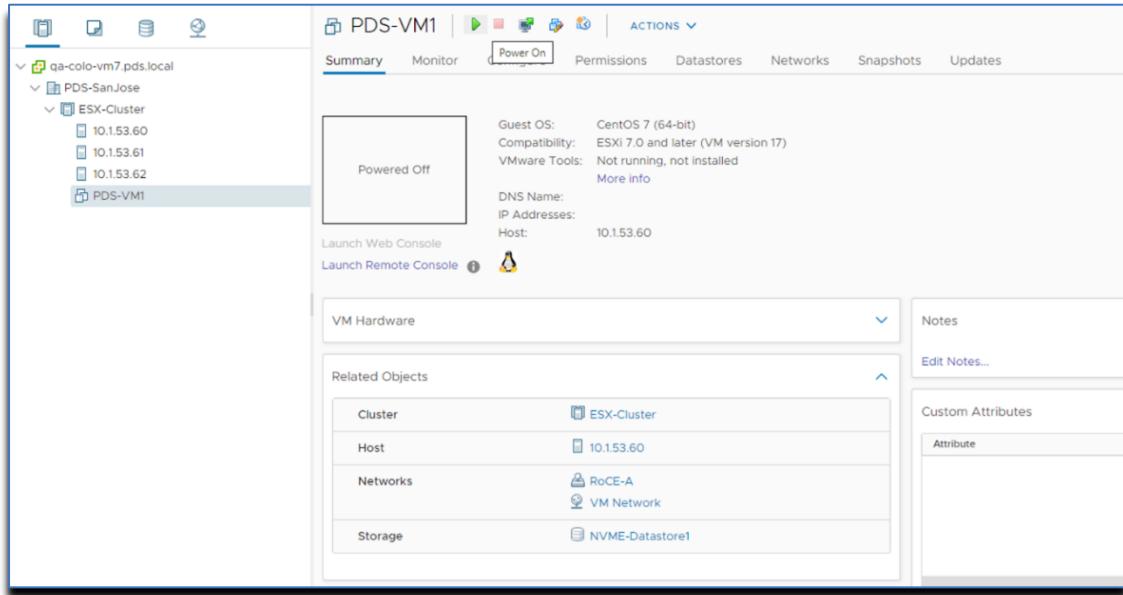
✓ 1 Select a creation type Ready to complete
Click Finish to start creation.

✓ 2 Select a name and folder
 ✓ 3 Select a compute resource
 ✓ 4 Select storage
 ✓ 5 Select compatibility
 ✓ 6 Select a guest OS
 ✓ 7 Customize hardware
8 Ready to complete

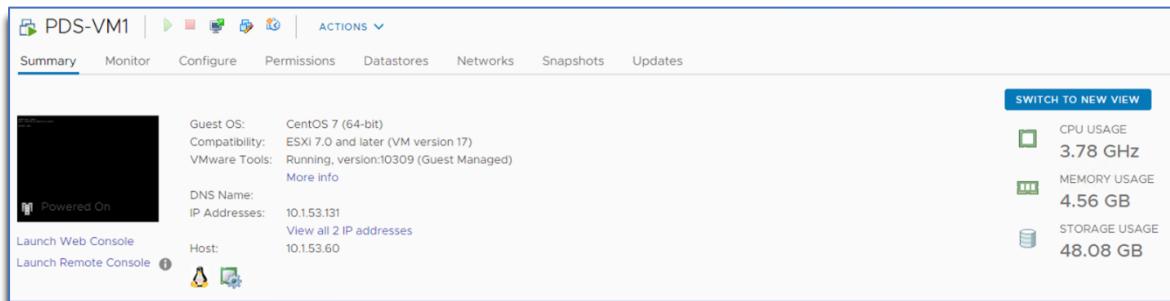
Virtual machine name	PDS-VM1
Folder	PDS-San Jose
Cluster	PDS-ESX-Cluster
Datastore	NVME-Datastore1
Guest OS name	CentOS 7 (64-bit)
Virtualization Based Security	Disabled
CPUs	2
Memory	4 GB
NICs	2
NIC 1 network	VM Network
NIC 1 type	VMXNET 3
NIC 2 network	RoCE-A (DSwitch-Storage)
NIC 2 type	VMXNET 3
SCSI controller 1	VMware Paravirtual
Create hard disk 1	New virtual disk

CANCEL BACK **FINISH**

Step 14: As a next step, **Power On** the newly created VM and **install OS** as seen in below image:



Step 15: Newly created VM is ready for use as can be seen in the below image:



Note: With the **virtual NVMe controller**, the hard drives will not appear in Linux under the typical `/dev/sd[a-z]` or `/dev/hd[a-z]` device nodes. Instead, they appear under the new device nodes `/dev/nvme0n1`

To verify the same, enter the following command:

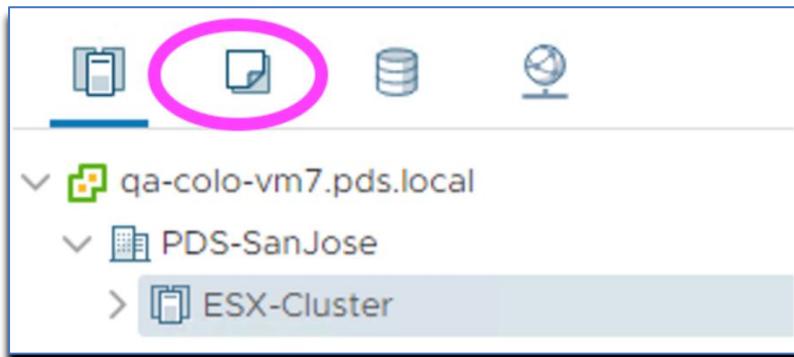
```
# nvme list
```

Node	SN	Model	Format	FW Rev
Namespace	Usage			
<code>/dev/nvme0n1</code>	VMWare NVME_0000	VMware Virtual NVMe Disk		
1	107.37 GB / 107.37 GB	512 B + 0 B		

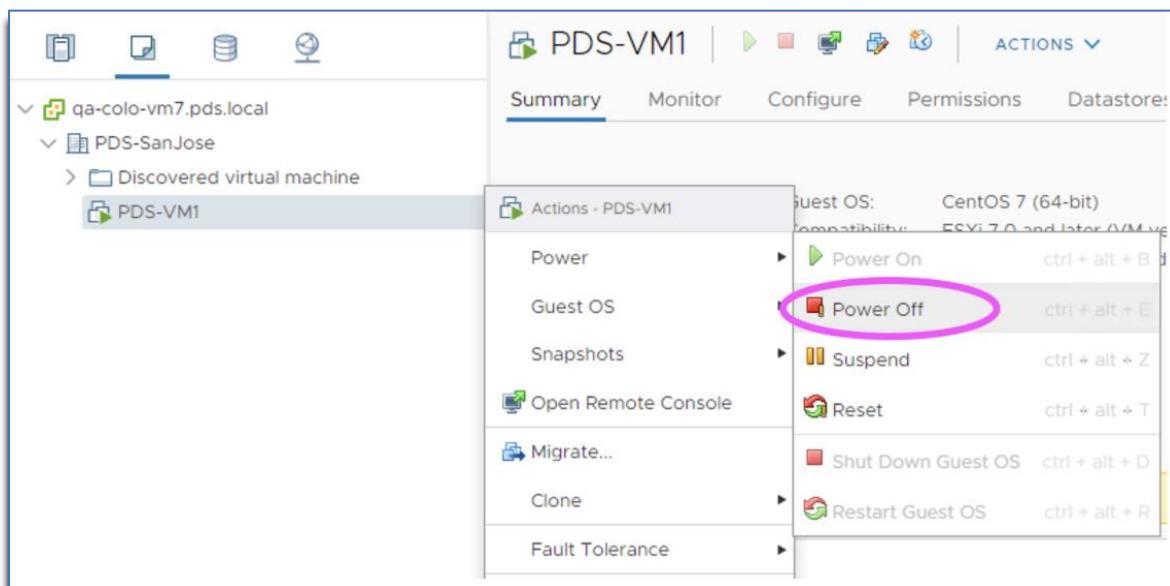
18. Disconnecting from a NVMe Datastore

This section lists the steps required to disconnect from a NVMe datastore:

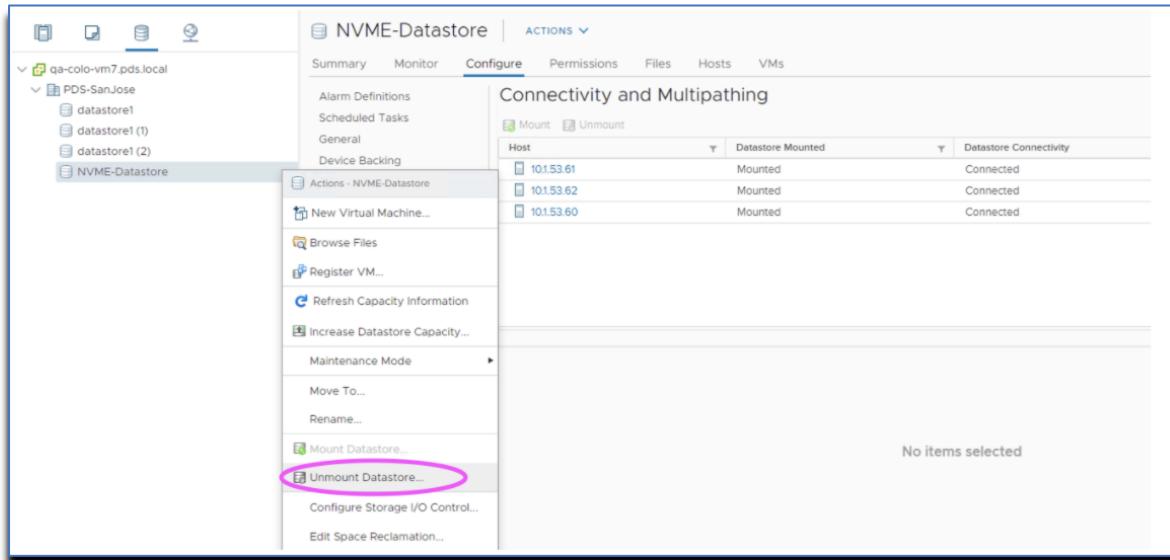
Step 1: Login to vCenter and navigate to **VMs and Templates** as seen in the below image:



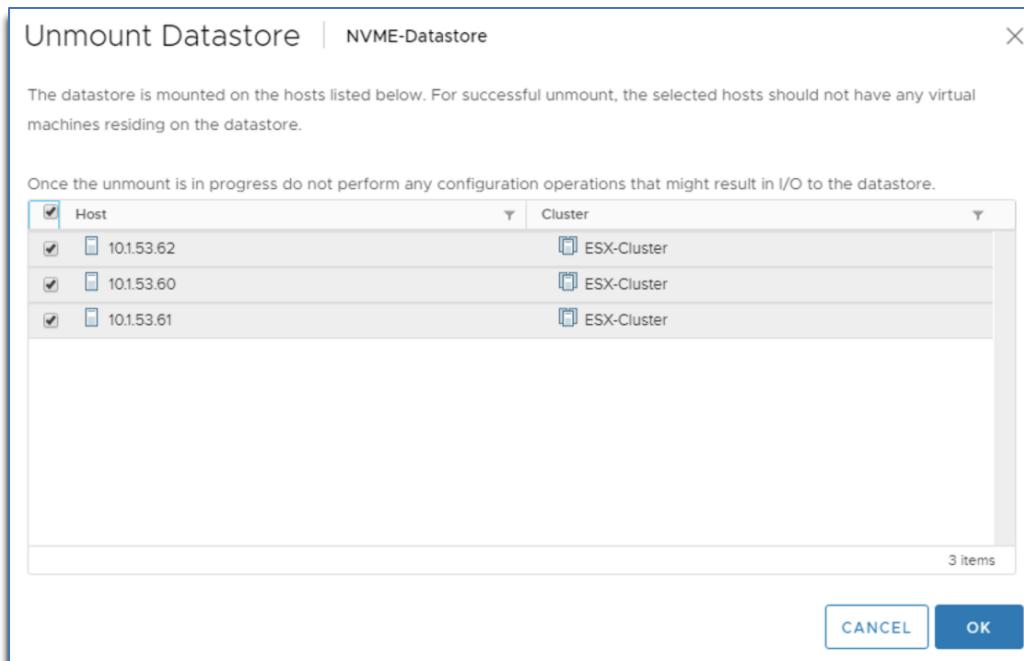
Step 2: Power Off all the VMs. Delete the VMs or move storage to different datastore as seen in the below image:



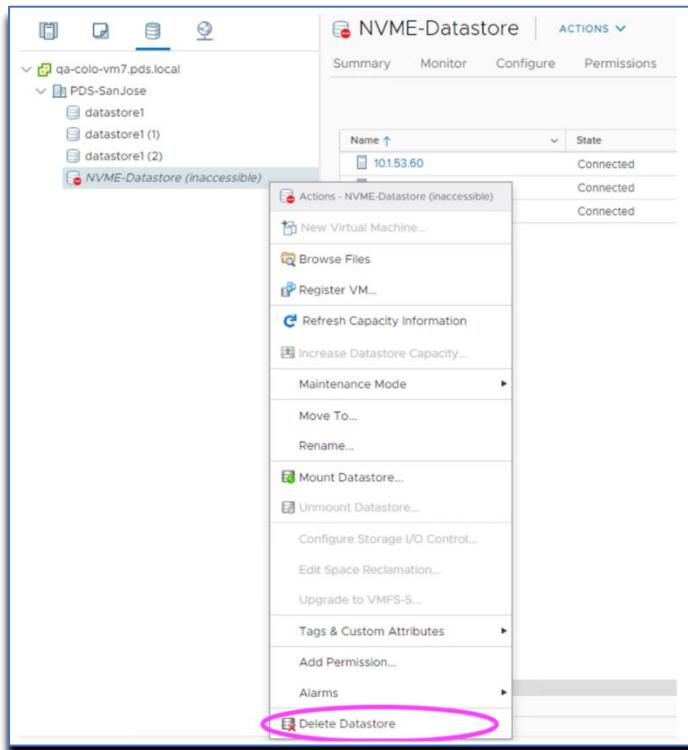
Step 3: Right click the datastore and select **Unmount Datastore** as seen in the below image:



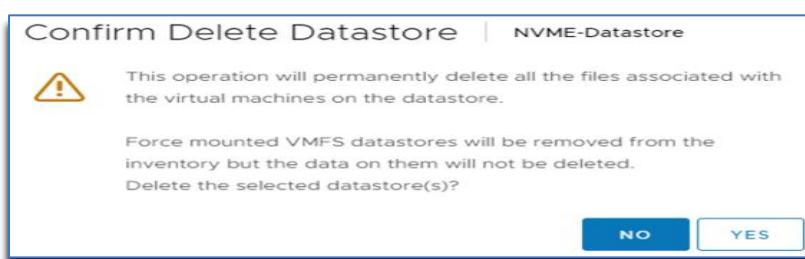
Step 4: Select all the Hosts in the cluster and click OK, as seen in the below image:



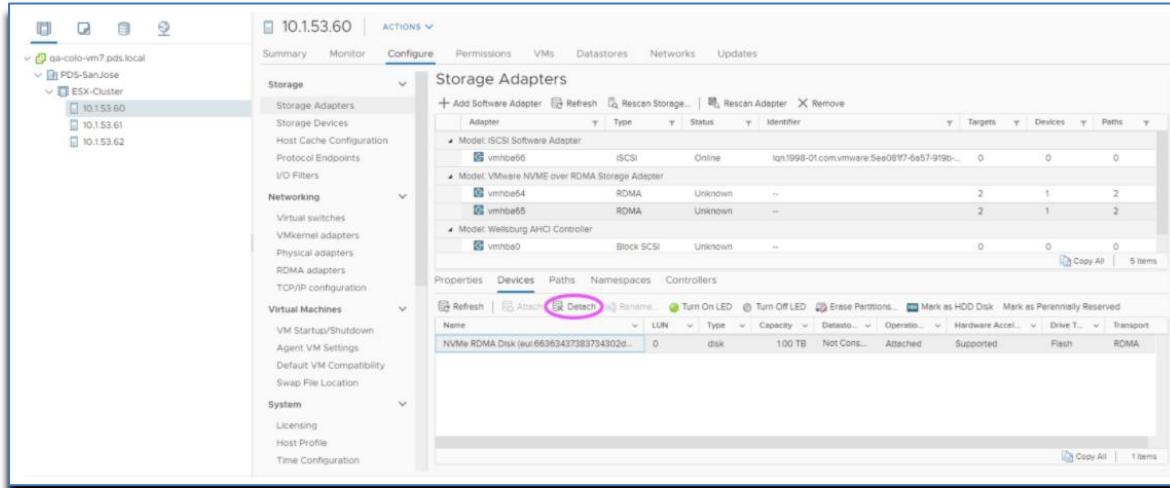
Step 5: Select the datastore and right click to **Delete Datastore**, as seen in the below image:



Step 6:  Make sure VMs are migrated to another datastore before you click YES as seen in the below image:

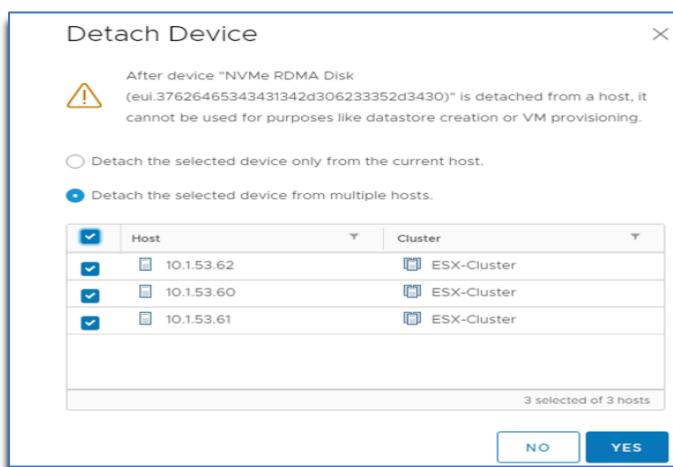


Step 7: As a next step, detach the NVMe device from the ESXi Hosts. From any hosts in the cluster navigate to **Storage Adapters**, select the NVMe device and click **Detach** as seen in the below image:

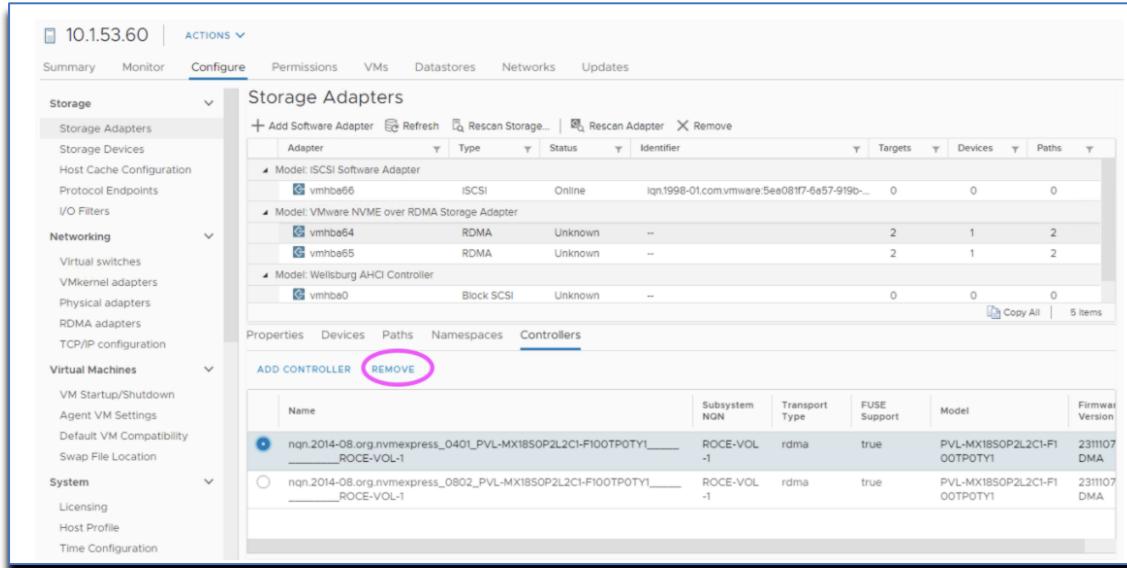


Step 8:  Be cautious before you proceed with the step.

On the Detach Device dialog box, select all the hosts in the ESXi Cluster as seen in the below image:

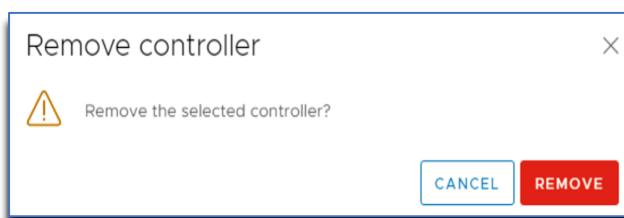


Step 9: Next step is to remove controllers to remove NQN from the RDMA storage adapters. For each **vmhba** select the controllers and click **Remove**, as seen in the below image:

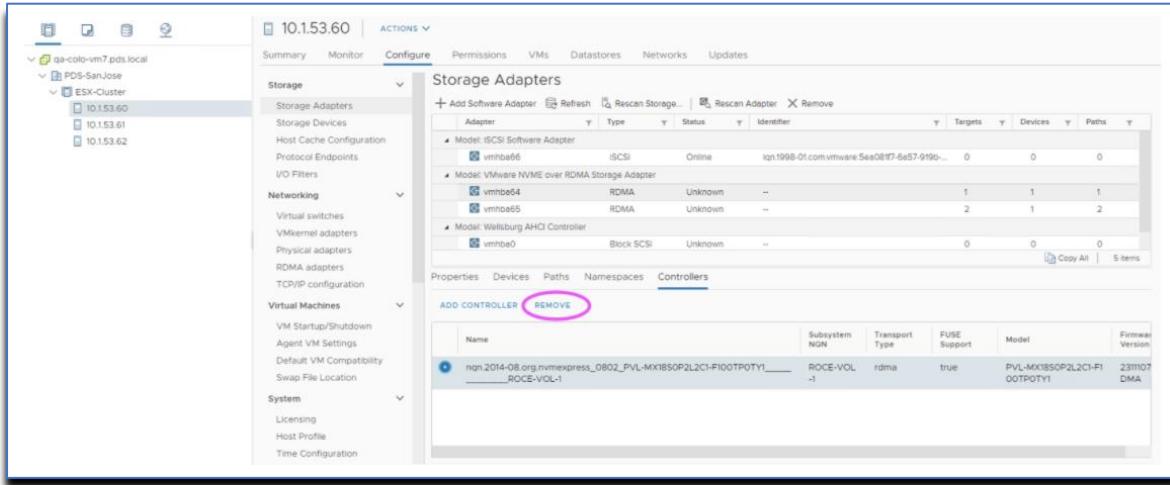


Name	Subsystem NQN	Transport Type	FUSE Support	Model	Firmware Version
nqn.2014-08.org.nvmeexpress_0401_PVL-MX18S0P2L2C1-F100TPOTY1_____ROCE-VOL-1	-1	rdma	true	PVL-MX18S0P2L2C1-F1	231107 OOTPOTY1 DMA
nqn.2014-08.org.nvmeexpress_0802_PVL-MX18S0P2L2C1-F100TPOTY1_____ROCE-VOL-1	-1	rdma	true	PVL-MX18S0P2L2C1-F1	231107 OOTPOTY1 DMA

Step 10:  Be cautious before you proceed with the step. Click **REMOVE** as seen in below image:

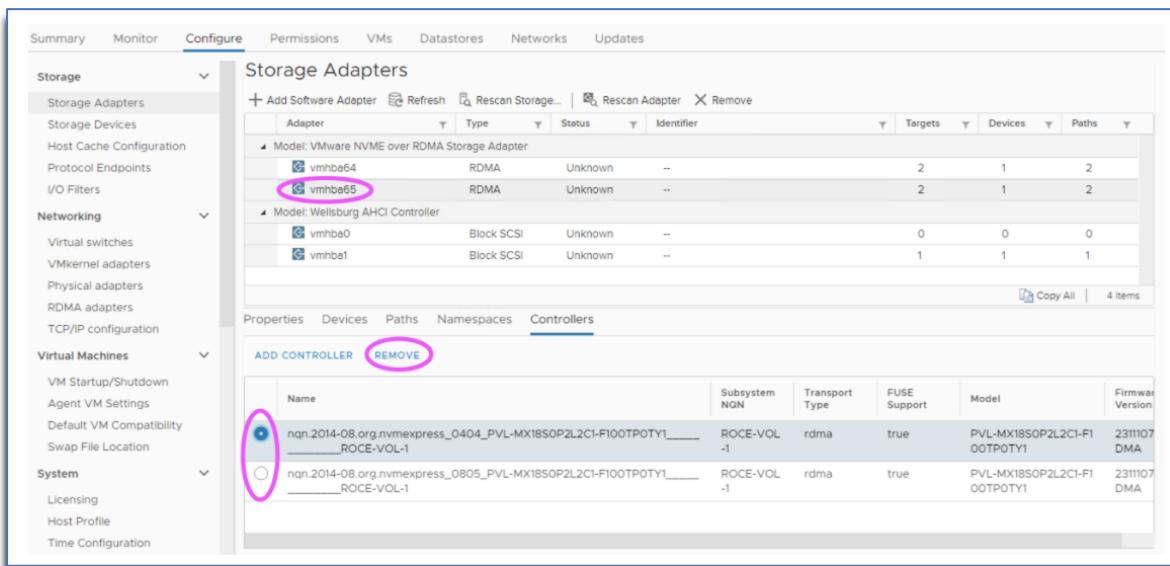


Step 11: As a next step **Remove** all the Controllers as seen in below image:



Name	Subsystem	Transport Type	FUSE Support	Model	Firmware Version
qnn.2014-08.org.nvmeexpress_0802_PVL-MX18S0P2L2C1-F100TPOTY1_____ROCE-VOL-1	NON	rdma	true	PVL-MX18S0P2L2C1-F100TPOTY1	23H107 DMA

Step 12: Perform above steps to **Remove** controllers for the second adapter **vmhba65**, as seen in below image:



Name	Subsystem	Transport Type	FUSE Support	Model	Firmware Version
qnn.2014-08.org.nvmeexpress_0404_PVL-MX18S0P2L2C1-F100TPOTY1_____ROCE-VOL-1	NON	rdma	true	PVL-MX18S0P2L2C1-F100TPOTY1	23H107 DMA
qnn.2014-08.org.nvmeexpress_0805_PVL-MX18S0P2L2C1-F100TPOTY1_____ROCE-VOL-1	NON	rdma	true	PVL-MX18S0P2L2C1-F100TPOTY1	23H107 DMA

Step 13: In a similar manner, **Remove Controllers** from all hosts in the **ESX cluster**.