FC-NVMe for VMware using a Hitachi VSP 5000 Series Storage System

v1.0

Configuration Guide

This document provides guidelines for configuring FC-NVMe on a VMware ESXi system using a Hitachi VSP 5000 series storage system.

Hitachi Vantara

December 2021

Feedback

Hitachi Vantara welcomes your feedback. Please share your thoughts by sending an email message to SolutionLab@hitachivantara.com. To assist with the routing of this message, use the paper number in the subject and the title of this white paper in the text.

Revision History

Revision	Changes	Date
v1.0	First Draft	12/24/2021

Contents

Executive Summary 4

Preface 5

Intended audience **5**

Revision history **5**

Document conventions **5**

Accessing product downloads **7**

Comments **7**

Host side details 8

Hardware Requirements 9

Configuration Steps 10

Overview of Hitachi Virtual Storage Platform (VSP) 5000 series 11

Storage side configuration for FC-NVMe 11

Host side configuration for FC-NVMe 17

ESXi multipathing 20

Notices and Disclaimer

This document has been reviewed for accuracy as of the date of initial publication. Hitachi Vantara may make improvements and/or changes in product and/or programs at any time without notice.

The performance data contained herein was obtained in a controlled isolated environment. Results obtained in other operating environments may vary significantly. While Hitachi Vantara has reviewed each item for accuracy, there is no guarantee that similar results can be obtained elsewhere.

All designs, specifications, statements, information, and recommendations (collectively, "designs") in this document are presented "AS IS", with all faults. Hitachi Vantara, its affiliates, and their respective suppliers disclaim all warranties, including without limitation, the warranty of merchantability, fitness for a particular purpose and non-infringement or arising from a course of dealing, usage or trade practice. In no event shall Hitachi Vantara Corporation, its affiliates or their respective suppliers be liable for any indirect, special, consequential or incidental damages, including without limitation, lost profit or loss or damage to data arising out of the use or inability to use the designs, even if Hitachi Vantara, its affiliates or their respective suppliers have been advised of the possibility of such damages.

Other company, product or service names may be trademarks or service marks of others.

Executive Summary

This document provides guidelines for configuring FC-NVMe on a VMware ESXi system using a Hitachi VSP 5000 series storage system, a brief introduction on the VMware High Performance Plugin, and steps for configuring the NVM Subsystem (NVM Subsystem, Port Parameters, Namespace configuration, and so on) using Hitachi RAID Manager.

Using this document requires a minimum knowledge of VMware ESXi systems, FC (fiber channel) SAN, Hitachi RAID Manager, and Hitachi VSP 5000 series storage systems.

Preface

About this document

This document describes the FC-NVMe configuration for Hitachi VSP 5000 series storage systems, the NVM Subsystems, and VMware ESXi system.

This document is divided into three sections:

- Hitachi VSP 5000 Series Storage NVM Subsystem configuration, Port Parameter settings, NVM Subsystem, and Namespace configuration using Hitachi RAID Manager command line interface.
- FC-NVMe configuration in VMware ESXi platform with both Emulex and QLogic HBA. This document includes steps for ESXi 7.0 update 3 environments.
- ESXi multipath details.

Release notes and Support matrix

Please read the latest release notes and support matrix documents for Hitachi VSP 5000 series storage system. It may contain requirements or restrictions that are not fully covered in this document.

Also, read the Operating Systems release documents, user guide, installation and support documents for detailed configuration steps, restrictions, updates, and corrections.

Intended audience

This guide is for users who need to configure FC-VMe for Hitachi VSP 5000 series storage systems.

Revision history

Revision	Changes	Date
1.0	First Release	December 2021

Document conventions

This document uses the following typographic conventions:

Convention	Description
Bold	▪ Indicates text in a window, including window titles, menus, menu options, buttons, fields, and labels. Example: Click **OK**. ▪ Indicates emphasized words in list items.

Italic	▪ Indicates a document title or emphasized words in text. ▪ Indicates a variable, which is a placeholder for actual text provided by the user or for output by the system. Example: pairdisplay -g *group* (For exceptions to this convention for variables, see the entry for angle brackets.)
Monospace	Indicates text that is displayed on screen or entered by the user. Example: pairdisplay -g oradb
< > angle brackets	▪ Indicates variables in the following scenarios: 1. Variables are not clearly separated from the surrounding text or from other variables. Example: Status-<*report-name*><*file-version*>.csv. 2. Variables in headings.
[ ] square brackets	Indicates optional values. Example: [a | b] indicates that you can choose a, b, or nothing.
{ } braces	Indicates required or expected values. Example: {a | b} indicates that you must choose either a or b.
vertical bar	Indicates that you have a choice between two or more options or arguments. Examples: [a | b] indicates that you can choose a, b, or nothing. {a | b} indicates that you must choose either a or b.

This document uses the following icons to draw attention to information:

Icon	Label	Description
	Note	Calls attention to important or additional information.
	Tip	Provides helpful information, guidelines, or suggestions for performing tasks more effectively.
	Caution	Warns the user of adverse conditions and/or consequences (for example, disruptive operations, data loss, or a system crash).

	WARNING	Warns the user of a hazardous situation which, if not avoided, could result in death or serious injury.

Accessing product downloads

Product user documentation is available on Hitachi Vantara Support Connect: https://knowledge.hitachivantara.com/Documents. Check this site for the most current documentation, including important updates that may have been made after the release of the product.

Comments

Hitachi Vantara welcomes your feedback. Please share your thoughts by sending an email message to SolutionLab@hitachivantara.com. To assist the routing of this message, use the paper number in the subject and the title of this white paper in the text. Thank you!

Host side details

NVMe (Non-Volatile Memory Express) is a new protocol for accessing high-speed storage media that brings many advantages compared to legacy protocols. It is the latest offering of storage access and transport protocol that caters to the ever-increasing speed, highest throughput, and fastest response times for all types of enterprise workloads. It is a much more efficient interface, providing lower latency, and is more scalable for SSDs than legacy interfaces, like serial ATA (SATA).

In a VMware ESXi environment, the NVMe Express controller was supported from ESXi 6.5 and VM hardware version 13 as a logical device interface specification for accessing nonvolatile storage media attached through a PCI Express (PCIe) bus in real and virtual hardware. Virtual NVMe devices reduce guest I/O processing overhead, which allows more VDI VMs per host and more transactions per minute.

VMware vSphere 7.0 introduces support for NVMe over Fabrics (NVMeoF), a protocol specification that connects hosts to high-speed flash storage using a fabric network and the NVMe protocol. The NVMe-oF fabrics that vSphere 7.0 supports include Fibre Channel (FC-NVMe) and RDMA (RoCE v2).

NVMe Transport	ESXi Support
NVMe over PCIe	Local storage
NVMe over RDMA	Shared NVMe-oF storage (with the RoCE v2 technology)
NVMe over Fibre Channel (FC-NVMe)	Shared NVMe-oF storage

In this document, NVMe over Fibre Channel configuration steps are documented for ESXi 7.0 update 3 environments.

The ESXi host uses a PCIe storage adapter to access one or more local NVMe storage devices. After the adapter is installed on the host, the host discovers available NVMe devices, and they appear in the list of storage devices in the vSphere Client.

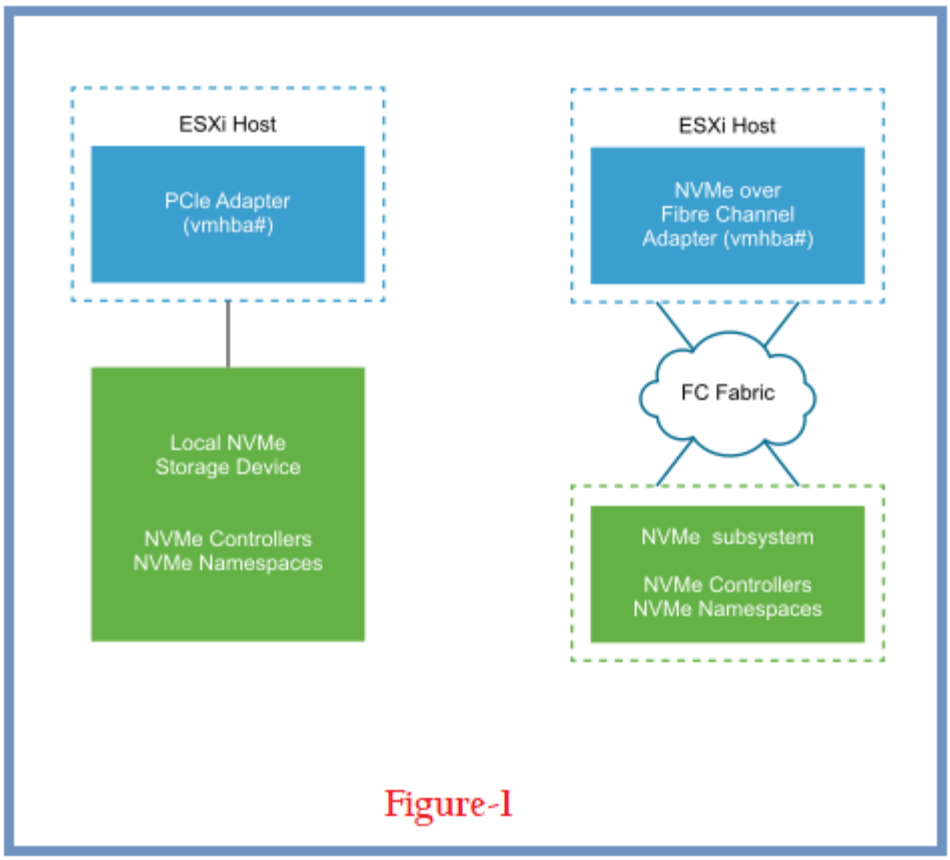


Figure-1

In the case of an NVMe over Fibre Channel Network, you must install a NVMe over Fibre channel adapter on the ESXI host to connect to Fibre Channel Storage using the NVMe protocol. In this document, Emulex and QLogic HBAs are used.

Hardware Requirements

- A Fibre Channel storage system that supports NVMe.
- A Compatible ESXi host. For OS and Server support, refer to: https://www.vmware.com/resources/compatibility/search.php
- A hardware NVMe adapter (Fibre Channel HBA that supports NVMe).
  For the Emulex HBA support and driver download, see: https://www.broadcom.com/support/emulex
  For the QLogic HBA support and driver download, see: https://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Defaultnewsearch.aspx
- An NVMe controller. After the required hardware NVMe adapter is installed, it automatically connects to all targets and controllers that are reachable at that moment.

Configuration Diagram

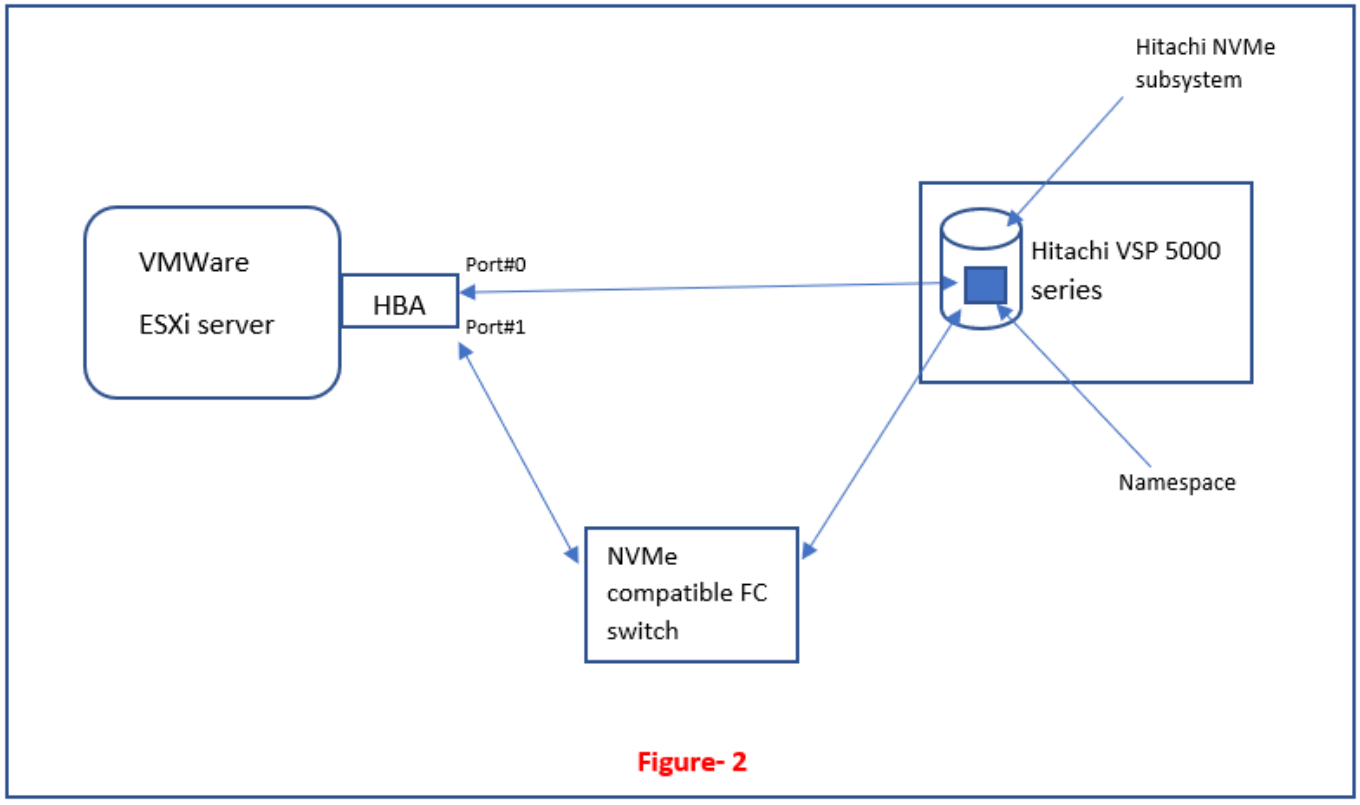


Figure- 2

For illustration purpose, port 0 is connected to the NVM subsystem as a Direct path (without a switch) and port 1 is connected using an NVMe supported switch.

Configuration Steps

1. Complete the connectivity by installing a NVMe supported dual port FC HBA into a supported server. One port of the HBA is directly connected to a Hitachi VSP 5000 series storage system port and the other HBA port is connected to another port of the storage through the FC SAN Switch.

   ESXi 7.0 update 3 was installed on an NVMe supported server and an Emulux or QLogic FC-HBA with an NVMe supported adapter installed on the ESXi host.

2. Install the NVMe supported HBA driver on the ESXi 7.0 update3 host.
   - For an Emulex HBA, the ESXi 7.0 update 3 bundled lpfc driver supports NVMe.
   - For a QLogic HBA, install an out-of-box NVMe supported driver downloaded from the QLogic/VMware website. For a supported driver list, see the VMware vCG page as mentioned earlier.

3. Configure Fibre channel zoning with the HBA and Storage port WWN on the Fibre channel switch.

4. Enable the NVMe module on the ESXi host:
   - For a QLogic HBA, go to Step b.
   - For an Emulex HBA, go to the next step.

a. For an Emulex HBA, run the following command to change the FC4 type to FCP and NVMe:

```
esxcli system module parameters set -p lpfc_enable_fc4_type=3 -m lpfc
```

where valid values for type are:

- 0 = Register FCP only (for LPe32000-series adapters); Register both FCP and NVMe (for LPe35000-series adapters)
- 1 = Register FCP only
- 3 = Register both FCP and NVMe. This parameter requires a system reboot or quick boot.

```
esxcli system module parameters set -p lpfc_enable_fc4_type=3 -m lpfc
```

Note: For QLogic HBA, this step is not required. NVMe module for QLogic HBA is by default enabled in ESXi 7.0 onwards hosts.

b. For both Emulex and QLogic HBAs, run the following command to generate the NVMe Qualified Name (NQN) of the adapter:

```
esxcfg-module -s 'vmknvme_hostnqn_format=0' vmknvme
```

5. For the changes to take effect, restart the ESXi host.

Note the Host NQN information by running the following command:

```
esxcli nvme info get
```

The output will be similar to the following:

```
Host NQN: nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
```

Note: The Host adapter NQN does not change for host restarts or driver updates, but it changes with the new Host OS installation.

Overview of Hitachi Virtual Storage Platform (VSP) 5000 series

Hitachi Virtual Storage Platform (VSP) 5000 series, powered by Hitachi Storage Virtualization Operating System (SVOS) RF, is designed to deliver the foundation for data-driven infrastructures, faster than any other storage system. VSP 5000 Series can deliver data in real time, even as datasets grow to multi-petabyte scale. It's agile enough to handle any data type and can be integrated into application-optimized converged solutions. It enables you to adopt new technologies when they become available and when you're ready. It scales to store more data to power your business operations and insights. And it offers unparalleled levels of protection to ensure data is always available and accessible to the right people and never available to those who shouldn't have it.

Storage side configuration for FC-NVMe

This section describes the process for configuring the Hitachi VSP 5000 series storage NVM Subsystem with RAID Manager (CCI).

For detailed information on installation, configuration, and CCI commands, see the RAID Manager manuals.

- **CCI Configuration:**

1. Update the CCI management server to the latest release:

```
Model  : RAID-Manager/Linux
Ver&Rev: 01-64-03/00
Usage  : raidcom <action> <object> [options]
```

2. Configure the HORCM configuration file for the NVMe storage as shown in the following example:

```
cat /etc/horcm6715.conf
HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
127.0.0.1 horcm6715 1000 3000
HORCM_CMD
#dev_name dev_name
\\.\IPCMD-172.23.67.15-31001
[root@local-boot ~]#

[root@local-boot ~]# horcmstart.sh 6715
starting HORCM inst 6715
HORCM inst 6715 starts successfully.
```

In this example, `horcm6715.conf` is the storage horcm configuration file and 172.23.67.15 is the SVP IP.

3. Login to the storage system using the following command:

```
[root@local-boot ~]# raidcom -login <username> <password> -IH6715
[root@local-boot ~]# ps -ef | grep horcm
root      2630     1  0 05:28 ?        00:00:00 horcmd_06715
root      2690  2668  0 05:34 pts/3    00:00:00 grep horcm
```

- **Storage Port Configuration**

1. Check current settings for the Storage Ports and remove any FC-SCSI settings that exist on the ports. Verify the Port mode using the RAID Manager command as follows:

```
[root@local-boot ~]# raidcom get port -key detail -I6715
PORT   TYPE  ATTR   SPD  LPID  FAB  CONN  SSW   SL   Serial#  WWN               PHY_PORT PORT_MODE
CL1-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL1-C  FIBRE TAR    AUT    E1  N    PtoP  Y      0    530008  50060e8008753802  -        SCSI
CL1-D  FIBRE TAR    AUT    D3  Y    PtoP  Y      0    530008  50060e8008753803  -        SCSI
CL1-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL1-G  FIBRE TAR    AUT    AC  Y    PtoP  Y      0    530008  50060e8008753806  -        SCSI
CL1-H  FIBRE TAR    AUT    9F  Y    PtoP  Y      0    530008  50060e8008753807  -        SCSI
CL2-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL2-C  FIBRE TAR    AUT    C9  Y    PtoP  Y      0    530008  50060e8008753812  -        SCSI
CL2-D  FIBRE TAR    AUT    B6  Y    PtoP  Y      0    530008  50060e8008753813  -        SCSI
CL2-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL2-G  FIBRE TAR    AUT    88  Y    PtoP  Y      0    530008  50060e8008753816  -        SCSI
CL2-H  FIBRE TAR    AUT    76  Y    PtoP  Y      0    530008  50060e8008753817  -        SCSI
CL3-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL3-C  FIBRE TAR    AUT    E0  Y    PtoP  Y      0    530008  50060e8008753822  -        SCSI
CL3-D  FIBRE TAR    AUT    D2  Y    PtoP  Y      0    530008  50060e8008753823  -        SCSI
CL3-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL3-G  FIBRE TAR    AUT    AB  Y    PtoP  Y      0    530008  50060e8008753826  -        SCSI
CL3-H  FIBRE TAR    AUT    9E  Y    PtoP  Y      0    530008  50060e8008753827  -        SCSI
CL4-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL4-C  FIBRE TAR    AUT    C7  Y    PtoP  Y      0    530008  50060e8008753832  -        SCSI
CL4-D  FIBRE TAR    AUT    B5  Y    PtoP  Y      0    530008  50060e8008753833  -        SCSI
CL4-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL4-G  FIBRE TAR    AUT    84  Y    PtoP  Y      0    530008  50060e8008753836  -        SCSI
CL4-H  FIBRE TAR    AUT    75  Y    PtoP  Y      0    530008  50060e8008753837  -        SCSI
CL5-C  FIBRE TAR    AUT    DC  Y    PtoP  Y      0    530008  50060e8008753842  -        SCSI
CL5-D  FIBRE TAR    AUT    D1  Y    PtoP  Y      0    530008  50060e8008753843  -        SCSI
CL5-G  FIBRE TAR    AUT    AA  Y    PtoP  Y      0    530008  50060e8008753846  -        SCSI
CL5-H  FIBRE TAR    AUT    9D  Y    PtoP  Y      0    530008  50060e8008753847  -        SCSI
CL6-C  FIBRE TAR    AUT    C6  Y    PtoP  Y      0    530008  50060e8008753852  -        SCSI
CL6-D  FIBRE TAR    AUT    B4  Y    PtoP  Y      0    530008  50060e8008753853  -        SCSI
CL6-G  FIBRE TAR    AUT    82  Y    PtoP  Y      0    530008  50060e8008753856  -        SCSI
CL6-H  FIBRE TAR    AUT    74  Y    PtoP  Y      0    530008  50060e8008753857  -        SCSI
```

```
CL7-C  FIBRE TAR    AUT    DA  Y    PtoP  Y      0    530008  50060e8008753862  -        SCSI
CL7-D  FIBRE TAR    AUT    CE  Y    PtoP  Y      0    530008  50060e8008753863  -        SCSI
CL7-G  FIBRE TAR    AUT    A9  Y    PtoP  Y      0    530008  50060e8008753866  -        SCSI
CL7-H  FIBRE TAR    AUT    9B  Y    PtoP  Y      0    530008  50060e8008753867  -        SCSI
CL8-C  FIBRE TAR    AUT    C5  Y    PtoP  Y      0    530008  50060e8008753872  -        SCSI
CL8-D  FIBRE TAR    AUT    B3  Y    PtoP  Y      0    530008  50060e8008753873  -        SCSI
CL8-G  FIBRE TAR    AUT    81  Y    PtoP  Y      0    530008  50060e8008753876  -        SCSI
CL8-H  FIBRE TAR    AUT    73  Y    PtoP  Y      0    530008  50060e8008753877  -        SCSI
```

2. Change the Port mode of the CL1-C and CL2-C ports using the RAID Manager command as follows:

```
[root@local-boot ~]# raidcom modify port -port CL1-C -port_mode nvme -request_id auto -IH6715
[root@local-boot ~]# raidcom modify port -port CL2-C -port_mode nvme -request_id auto -IH6715
```

3. Verify that the Port mode is changed to NVME:

```
[root@local-boot ~]# raidcom get port -key detail -I6715
PORT   TYPE  ATTR   SPD  LPID  FAB  CONN  SSW   SL   Serial#  WWN               PHY_PORT PORT_MODE
CL1-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL1-C  FIBRE TAR    AUT    E1  N    PtoP  Y      0    530008  50060e8008753802  -        NVME
CL1-D  FIBRE TAR    AUT    D3  Y    PtoP  Y      0    530008  50060e8008753803  -        SCSI
CL1-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL1-G  FIBRE TAR    AUT    AC  Y    PtoP  Y      0    530008  50060e8008753806  -        SCSI
CL1-H  FIBRE TAR    AUT    9F  Y    PtoP  Y      0    530008  50060e8008753807  -        SCSI
CL2-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL2-C  FIBRE TAR    AUT    C9  Y    PtoP  Y      0    530008  50060e8008753812  -        NVME
CL2-D  FIBRE TAR    AUT    B6  Y    PtoP  Y      0    530008  50060e8008753813  -        SCSI
CL2-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL2-G  FIBRE TAR    AUT    88  Y    PtoP  Y      0    530008  50060e8008753816  -        SCSI
CL2-H  FIBRE TAR    AUT    76  Y    PtoP  Y      0    530008  50060e8008753817  -        SCSI
CL3-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL3-C  FIBRE TAR    AUT    E0  Y    PtoP  Y      0    530008  50060e8008753822  -        SCSI
CL3-D  FIBRE TAR    AUT    D2  Y    PtoP  Y      0    530008  50060e8008753823  -        SCSI
CL3-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL3-G  FIBRE TAR    AUT    AB  Y    PtoP  Y      0    530008  50060e8008753826  -        SCSI
CL3-H  FIBRE TAR    AUT    9E  Y    PtoP  Y      0    530008  50060e8008753827  -        SCSI
CL4-A  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL4-C  FIBRE TAR    AUT    C7  Y    PtoP  Y      0    530008  50060e8008753832  -        SCSI
CL4-D  FIBRE TAR    AUT    B5  Y    PtoP  Y      0    530008  50060e8008753833  -        SCSI
CL4-E  ISCSI TAR    10G    00  N    UNKN  Y      0    530008  -                 -        -
CL4-G  FIBRE TAR    AUT    84  Y    PtoP  Y      0    530008  50060e8008753836  -        SCSI
CL4-H  FIBRE TAR    AUT    75  Y    PtoP  Y      0    530008  50060e8008753837  -        SCSI
CL5-C  FIBRE TAR    AUT    DC  Y    PtoP  Y      0    530008  50060e8008753842  -        SCSI
CL5-D  FIBRE TAR    AUT    D1  Y    PtoP  Y      0    530008  50060e8008753843  -        SCSI
CL5-G  FIBRE TAR    AUT    AA  Y    PtoP  Y      0    530008  50060e8008753846  -        SCSI
CL5-H  FIBRE TAR    AUT    9D  Y    PtoP  Y      0    530008  50060e8008753847  -        SCSI
CL6-C  FIBRE TAR    AUT    C6  Y    PtoP  Y      0    530008  50060e8008753852  -        SCSI
CL6-D  FIBRE TAR    AUT    B4  Y    PtoP  Y      0    530008  50060e8008753853  -        SCSI
CL6-G  FIBRE TAR    AUT    82  Y    PtoP  Y      0    530008  50060e8008753856  -        SCSI
CL6-H  FIBRE TAR    AUT    74  Y    PtoP  Y      0    530008  50060e8008753857  -        SCSI
CL7-C  FIBRE TAR    AUT    DA  Y    PtoP  Y      0    530008  50060e8008753862  -        SCSI
CL7-D  FIBRE TAR    AUT    CE  Y    PtoP  Y      0    530008  50060e8008753863  -        SCSI
CL7-G  FIBRE TAR    AUT    A9  Y    PtoP  Y      0    530008  50060e8008753866  -        SCSI
CL7-H  FIBRE TAR    AUT    9B  Y    PtoP  Y      0    530008  50060e8008753867  -        SCSI
CL8-C  FIBRE TAR    AUT    C5  Y    PtoP  Y      0    530008  50060e8008753872  -        SCSI
CL8-D  FIBRE TAR    AUT    B3  Y    PtoP  Y      0    530008  50060e8008753873  -        SCSI
CL8-G  FIBRE TAR    AUT    81  Y    PtoP  Y      0    530008  50060e8008753876  -        SCSI
CL8-H  FIBRE TAR    AUT    73  Y    PtoP  Y      0    530008  50060e8008753877  -        SCSI
```

4. Configure the topology settings.

    a. Set the port topology:
        - For direct connectivity between the HBA and the Storage port, set the port topology to Fabric OFF and “Point to Point”.
        - For direct connectivity between the HBA and the Storage port, set the port topology to Fabric OFF and “Point to Point”.

- When FC connectivity between the HBA and the Storage port is through SAN Switch, set the port topology to Fabric ON and “Point to Point”.

b. For port CL1-C, set Fabric OFF and PtoP; for port CL2-C, set Fabric ON and PtoP:

```
[root@local-boot ~]# raidcom get port -key detail -I6715
PORT   TYPE  ATTR   SPD  LPID  FAB  CONN  SSW   SL   Serial#  WWN               PHY_PORT PORT_MODE
CL1-C  FIBRE TAR    AUT    E1  N    PtoP  Y      0    530008  50060e8008753802  -        NVME
.
.
.
CL2-C  FIBRE TAR    AUT    C9  Y    PtoP  Y      0    530008  50060e8008753812  -        NVME
```

5. Configure WWN security settings.

a. Set the port security switch to enable and register the HBA WWN with the Storage ports.
b. Enable WWN security switch for Port CL1-C and CL2-C:

```
[root@local-boot ~]# raidcom modify port -port CL1-C -security_switch y -I6715
[root@local-boot ~]# raidcom modify port -port CL2-C -security_switch y -I6715
```

c. Check the WWN of the HBA from the host or the Fibre Channel Switch and register the HBA WWN on these ports to allow access with the RAID Manager:

```
[root@local-boot ~]# raidcom add hba_wwn -port CL1-C -hba_wwn 100000109b56ffa3 -I6715
[root@local-boot ~]# raidcom add hba_wwn -port CL2-C -hba_wwn 100000109b56ffa4 -I6715
```

d. Verify the HBA WWN with CL1-C and 2-C:

```
[root@local-boot etc]# raidcom get hba_wwn -port CL1-C -I6715
PORT   GID GROUP_NAME                  HWWN  Serial# NICK_NAME
CL1-C    0 1C-G00           100000109b56ffa3   530008 -
[root@local-boot etc]#
[root@local-boot etc]# raidcom get hba_wwn -port CL2-C -I6715
PORT   GID GROUP_NAME                  HWWN  Serial# NICK_NAME
CL2-C    0 2C-G00           100000109b56ffa4   530008 -
[root@local-boot etc]#
```

NVM Subsystem configuration

1. Create the NVM Subsystem.

Create an NVM subsystem on the storage system based on the operating system host mode option using the RAID Manager command. Verify whether there are any existing NVM Subsystems, then create an NVM Subsystem with an available ID.

Check the existing NVM subsystem information as follows:

```
[root@local-boot ~]# raidcom get nvm_subsystem -key opt -I6715
NVMSS_ID  NVMSS_NAME                 NVMSS_NQN
       1  vmw_nvme_sub                nqn.1994-04.jp.co.hitachi:nvme:storage-subsystem-sn.5-30008-
nvmssid.00001
```

In the following example, the NVM Subsystem (host mode 21: vmware_ex) is created with NVM Subsystem ID 2:

```
[root@local-boot ~]# raidcom add nvm_subsystem -nvm_subsystem_id 2 -nvm_subsystem_name vmw_nvme_sub_em -
host_mode VMWARE_EX -request_id auto -I6715
REQID : e
```

Command status can be checked with this command:

```
[root@local-boot HORCM]# raidcom get command_status -request_id e -I6715
REQID    R SSB1    SSB2    Serial#      ID  Description
0000000e -    -       -     530008       2  -
```

Check the details of newly created NVM Subsystem ID 2:

```
[root@local-boot ~]# raidcom get nvm_subsystem -nvm_subsystem_id 2 -I6715
NVMSS_ID  RGID  NVMSS_NAME                  SECURITY T10PI    HMD         HMO_BITs
       2     0  vmw_nvme_sub_em             ENABLE   DISABLE  VMWARE_EX   -
[root@local-boot ~]# raidcom get nvm_subsystem -key opt -I6715
NVMSS_ID  NVMSS_NAME                  NVMSS_NQN
       1  vmw_nvme_sub                nqn.1994-04.jp.co.hitachi:nvme:storage-subsystem-sn.5-30008-
nvmssid.00001
       2  vmw_nvme_sub_em             nqn.1994-04.jp.co.hitachi:nvme:storage-subsystem-sn.5-30008-
nvmssid.00002
[root@local-boot ~]#
```

Note the NQN of NVM Subsystem ID 2 for future use.

2. Register the NVM Subsystem port.

   Register the Storage FC Ports that are connected to the ESXi hosts with the NVM subsystem using the following command:

   In the following example, Storage Ports CL1-C and CL2-C are registered with NVM Subsystem ID 2.

```
[root@local-boot ~]# raidcom add nvm_subsystem_port -nvm_subsystem_id 2 -port CL1-C -request_id auto -I6715
REQID : f
[root@local-boot ~]# raidcom add nvm_subsystem_port -nvm_subsystem_id 2 -port CL2-C -request_id auto -I6715
REQID : g

[root@local-boot ~]# raidcom get nvm_subsystem_port -nvm_subsystem_id 2 -I6715
PORT   NVMSS_ID  NVMSS_NAME
CL1-C         2  vmw_nvme_sub_em
CL2-C         2  vmw_nvme_sub_em
```

3. Configure Namespace security settings.

   Check the Host NQN and note it for the Host NQN settings in the NVM Subsystem.
   Host NQN for VMware host:

```
esxcli nvme info get
Host NQN: nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
```

   Set the Host NQN to allow access to the NVM subsystem with the RAID Manager command as follows:

```
[root@local-boot ~]# raidcom add host_nqn -nvm_subsystem_id 2 -host_nqn nqn.2014-
08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280 -request_id auto -I6715
REQID : 10
[root@local-boot ~]# raidcom get host_nqn -nvm_subsystem_id 2 -I6715

NVMSS_ID  NVMSS_NAME                  HOST_NQN
       2  vmw_nvme_sub_em             nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
```

4. Create a Namespace.

   Create a Namespace by registering the LDEV with the NVM Subsystem. After registering an LDEV with the NVM Subsystem, a Namespace is created for that LDEV with a Namespace ID.

   Check whether there is a free LDEV to assign; if not, create new LDEVs.

In the following example, an ldev of ldev ID 00:60 is created with 10 GB capacity on parity group 1-1, and then the LDEV is formatted.

```
[root@local-boot HORCM]# raidcom add ldev -parity_grp_id 1-1 -ldev_id 60 -capacity 10G -I6715
[root@local-boot HORCM]# raidcom initialize ldev -operation fmt -ldev_id 60 -I6715
```

Create a Namespace for the newly created LDEVs and register it with Storage Subsystem ID as follows:

```
root@local-boot HORCM]# raidcom add namespace -nvm_subsystem_id 2 -ns_id auto -ldev_id 60 -request_id auto
-I6715
REQID : b
```

Verify that the Namespaces are created for the LDEVs in the Storage Subsystem:

```
[root@local-boot HORCM]# raidcom get namespace -nvm_subsystem_id 2 -I6715
NVMSS_ID  NVMSS_NAME                  NSID  LDEVID  CAPACITY(BLK)
       2  vmw_nvme_sub_em                1      60       20971520
```

5. Configure the Namespace path settings.

   Register the Host NQN to the Namespace ID to allow access to the namespace for the ESXi Host. Set the Host NQN-Namespace Path with the following RAID Manager command:

```
[root@local-boot HORCM]# raidcom add namespace_path -nvm_subsystem_id 2 -ns_id 1 -host_nqn nqn.2014-
08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280 -request_id auto -I6715
REQID : d
```

   Verify the Namespace Path information with the following RAID Manager [raidcom get namespace_path] command:

```
[root@local-boot HORCM]# raidcom get namespace_path -nvm_subsystem_id 2 -I6715
NVMSS_ID  NVMSS_NAME                  NSID  LDEV#  HOST_NQN
       2  vmw_nvme_sub_em                1     60  nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-
1522-000e1e540280
```

6. Check host nqn login information on the storage ports:

```
[root@local-boot ~]# raidcom get port -port CL1-C -key login_host_nqn -I6715
PORT    LOGIN_STATUS   HOST_NQN
CL1-C   LOGOUT         nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
[root@local-boot ~]#

[root@local-boot ~]# raidcom get port -port CL2-C -key login_host_nqn -I6715
PORT    LOGIN_STATUS   HOST_NQN
CL2-C   LOGOUT         nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
[root@local-boot ~]#
```

   Here, the host nqn will show in the respective storage ports login information, but the status will be logout. Restarting the ESXi host will change the status to login if all the connectivity and configurations are done correctly.

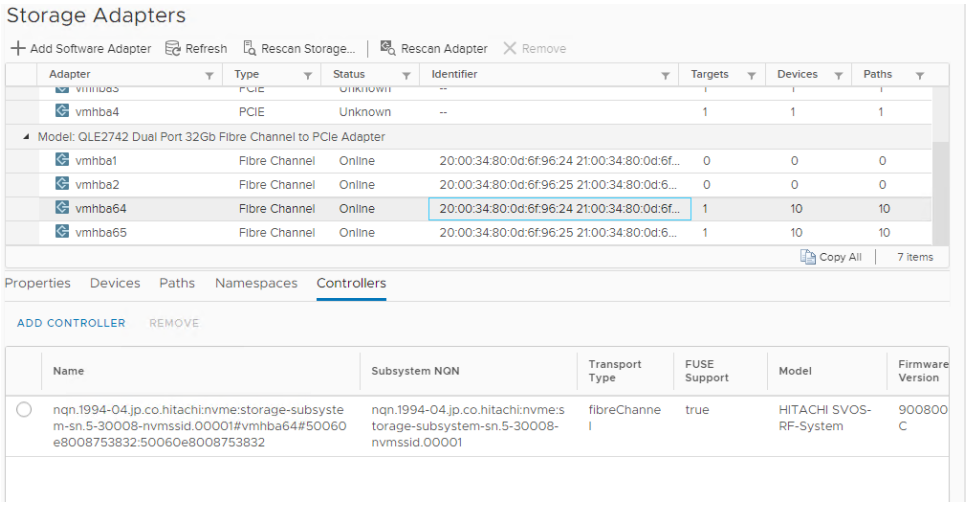
   After restarting the host, the status of the host NQN login on the storage ports will be as follows:

```
[root@local-boot ~]# raidcom get port -port CL1-C -key login_host_nqn -I6715
PORT    LOGIN_STATUS   HOST_NQN
CL1-C   LOGIN          nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
[root@local-boot ~]#

[root@local-boot ~]# raidcom get port -port CL2-C -key login_host_nqn -I6715
PORT    LOGIN_STATUS   HOST_NQN
CL2-C   LOGIN          nqn.2014-08.org.nvmexpress:uuid:606fd4fb-3570-3bd6-1522-000e1e540280
[root@local-boot ~]#
```

Host side configuration for FC-NVMe

After completing the storage side configuration through CCI and restarting the host, the NVMe controller should appear under the storage adapter tab of the ESXi host.

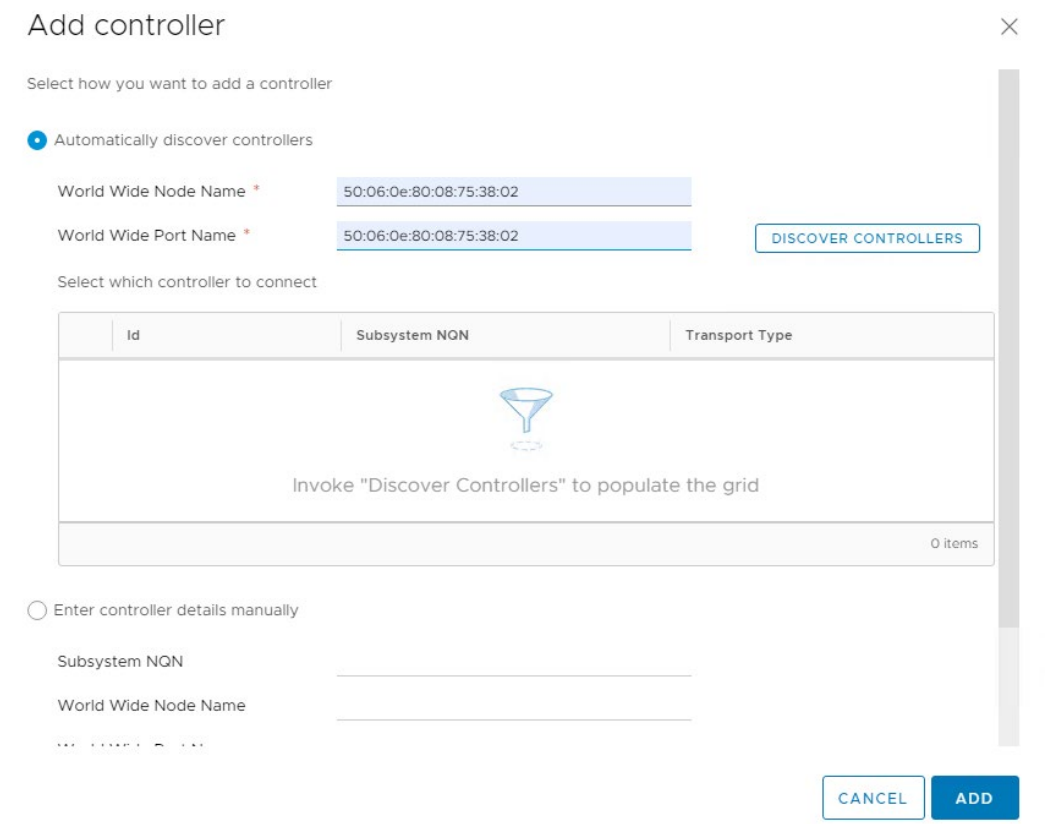


Alternatively, if the NVMe controller is not present under storage adapter tab of the ESXi host, it can be added by using one of the following methods:

- Automatic add controller method:

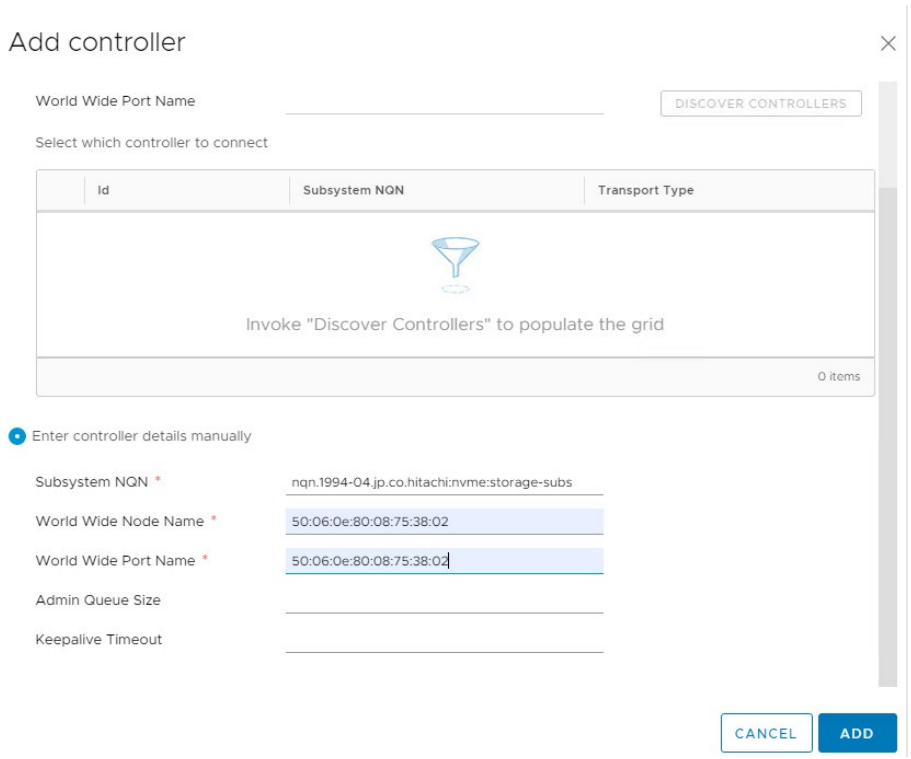
  Using this method, you only need the WWPN and WWNN of the storage ports to register the NVMe controller to this host.

  In the following example, the WWPN and WWNN information for storage NVMe port 1C is added and the discover controller operation is performed. If the connectivity and configuration settings are done correctly, the NVMe controller should appear as seen in the previous image.



- Manual add controller method:

  In this method, along with the WWPN and WWNN information of the storage port, the NVM subsystem NQN information must also be provided:



After adding the NVMe controller to the ESXi hosts, the namespaces associated with that NVMe controller should appear in the ESXi host as follows:

```
[root@localhost:~] esxcfg-mpath -b
mpx.vmhba1:C0:T7:L0 : Local PLDS CD-ROM (mpx.vmhba1:C0:T7:L0)
   vmhba1:C0:T7:L0 LUN:0 state:active Local HBA vmhba1 channel 0 target 7

naa.64cd98f06b05460024b02bfa54885f8c : Local DELL Disk (naa.64cd98f06b05460024b02bfa54885f8c)
   vmhba6:C2:T0:L0 LUN:0 state:active sas Adapter: 54cd98f06b054600  Target: 60b02bfa54885f8c

mpx.vmhba32:C0:T0:L0 : Local USB CD-ROM (mpx.vmhba32:C0:T0:L0)
   vmhba32:C0:T0:L0 LUN:0 state:active Local HBA vmhba32 channel 0 target 0

mpx.vmhba32:C0:T0:L1 : Local USB Direct-Access (mpx.vmhba32:C0:T0:L1)
   vmhba32:C0:T0:L1 LUN:1 state:active Local HBA vmhba32 channel 0 target 0

eui.0050753800000000060e80875380a00 : NVMe Fibre Channel Disk (eui.0050753800000000060e80875380a00)
   vmhba64:C0:T0:L0 LUN:0 state:active fc Adapter: WWNN: 20:00:00:10:9b:56:ff:a3 WWPN:
10:00:00:10:9b:56:ff:a3  Target: WWNN: 50:06:0e:80:08:75:38:12 WWPN: 50:06:0e:80:08:75:38:12

[root@localhost:~]
```

ESXi multipathing

For high-speed devices like NVMe, VMware introduced new multipath plugin from ESXi 7.0. The High Performance Plugin (HPP) replaces NMP (Native Multipath Plugin) for NVMe-oF devices as the default plugin. Unlike the Path Selection Policy (PSP) used by NMP, HPP uses Path Selection Schemes (PSS) to select paths for IO devices. By default, LB-RR (Load Balance – Round Robin) is selected as PSS by HPP, but this can be changed to FIXED or other LB PSS using esxcli commands.

For additional information on the VMware High Performance Plugin, see:

https://docs.vmware.com/en/VMware-vSphere/7.0/com.vmware.vsphere.storage.doc/GUID-F7B60A5A-D077-4E37-8CA7-8CB912173D24.html

The following provides some of the esxcli commands that you can use to get more information on the ESXi host for NVMe devices:

- To list the paths currently claimed by HPP:

```
[root@localhost:/vmfs/volumes/61271846-fd2d484c-10d9-d4f5ef4f1008] esxcli storage hpp path list
fc.200034800d6f9624:210034800d6f9624-fc.50060e8008753832:50060e8008753832-eui.0050753800000000060e80875380b00
   Runtime Name: vmhba64:C0:T0:L0
   Device: eui.0050753800000000060e80875380b00
   Device Display Name: NVMe Fibre Channel Disk (eui.0050753800000000060e80875380b00)
   Path State: dead
   Path Config:
```

- To list the devices currently controlled by HPP:

```
[root@localhost:/vmfs/volumes/61271846-fd2d484c-10d9-d4f5ef4f1008] esxcli storage hpp device list
eui.0050753800000000060e80875380b00
   Device Display Name: NVMe Fibre Channel Disk (eui.0050753800000000060e80875380b00)
   Path Selection Scheme: LB-RR
   Path Selection Scheme Config: {iops=1000,bytes=10485760;}
   Current Path: vmhba65:C0:T0:L0
   Working Path Set: vmhba65:C0:T0:L0
   Is SSD: true
   Is Local: false
   Paths: vmhba64:C0:T0:L0, vmhba65:C0:T0:L0
```

```
   Use ANO: fals
```


December 2021 .