Configuring NVMe-oF

NVMe over Fabrics (NVMe-oF) is an extended protocol that enables communication over a Fibre Channel fabric or an Ethernet fabric with NVMe.
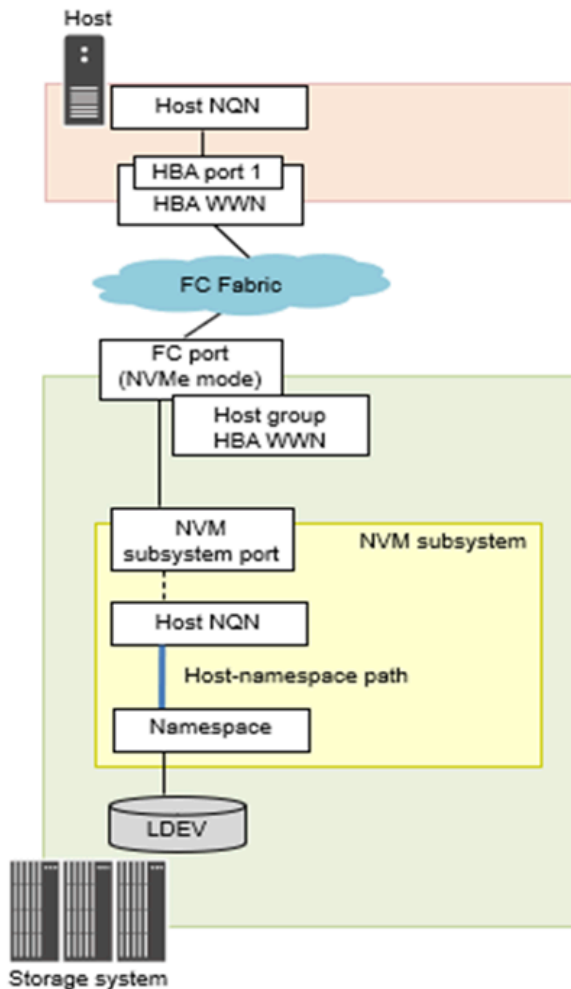
Configuration of NVMe over Fabrics in a Fibre Channel environment

In a Fibre Channel environment, NVMe-oF technology supports the NVMe-oF communication protocol on FC-SAN (Fibre Channel storage area network) using the existing Fibre Channel network devices.

To configure a system consisting of a host and a storage system using the NVMe-oF communication protocol, register a logical volume of the storage system as a namespace on the NVM subsystem, and then configure a data I/O route from the host to the logical volume.

The following configuration shows a connection between the host and the storage system using NVMe-oF.

Conventional Fibre Channel and iSCSI require an LU mapping for a port to manage an access route between the host and the logical volume. NVMe-oF, on the other hand, requires the following system components to be configured on the storage system between the host and the logical volume.

- *NVM subsystem*: A flash memory storage control system that supports the NVMe-oF communication protocol with one or more namespaces, and one or more communication ports (NVM subsystem ports).
- *Namespace*: A flash memory space formatted into a logical block.
- *NVM subsystem port*: An FC port set to NVMe mode.
- *Host identification (host NQN)*: Host name qualifier.
- *Host-namespace path*: Access permission to the namespace for each host NQN registered on the NVM subsystem.

Namespace security overview

NVMe-oF enables the use of namespace security functions instead of LUN security, which uses the conventional Fibre

Channel (FC-SCSI) connection.

The following table lists the differences between LUN security and namespace security in user operations and access from the host.

Item	LUN security **(FC-SCSI)**	Namespace security **(NVMe-oF)**
What is the security set for?	Each port	Each NVM subsystem
Default setting	Disabled	Enabled*
Host access control for logical volumes	Set a host bus adapter (HBA) WWN for a host group.	Set a host NQN defined by the host system for the NVM subsystem. In addition, set an access path (host-namespace path) between the namespace and the host NQN.
Security operations	• When the LUN security is disabled, any host can connect (log in) to the Fibre Channel port. The host can only recognize and access a logical volume of the LU for which the path is defined in the default host group (host group 0) belonging to the port. • When the LUN security is enabled, the host can only recognize and access a logical volume for which the host-namespace path is set between the namespace and the host NQN.	• When the namespace security is disabled, any host can establish the NVMe connection (connect) to the NVMe subsystem. The host can recognize and access the logical volumes of all namespaces defined on the NVM subsystem. • When the namespace security is enabled, the host can only recognize and access a logical volume of the LU defined in a host group with a WWN set.

* Namespace security is enabled by default if the namespace security setting is not specified when the NVM subsystem is created.

To use namespace security functions, you must enable the namespace security setting on the NVM subsystem. You do not need to configure the LUN security setting for a Fibre Channel port.
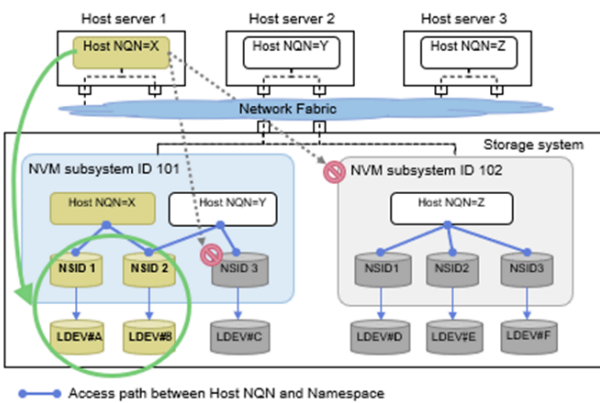
When namespace security is enabled, a logical volume that the host can access is determined by the host NQN settings for the NVM subsystem and the namespace. The host can only access a logical volume assigned to the NVM subsystem and the namespace for which the host NQN is set.
Namespace security example

The following figure shows logical volumes that the host can access when namespace security is set. The security is enabled on NVM subsystems 101 and ID 102. Host server 1 can access NVM subsystem 101, but not NVM subsystem 102. In addition, namespace ID (NSID) 1 and NSID 2 in NVM subsystem 101 can be recognized, and therefore the

logical volumes assigned to those namespaces can be accessed. The logical volume assigned to NSID 3 in NVM subsystem 101 cannot be recognized. The namespace in NVM subsystem 102 cannot be recognized, because the NVMe connection (connect) cannot be established to NVM subsystem ID 102.

Access path between Host NQN and Namespace

Requirements for NVMe over FC

VSP E1090

Item	Description
DKCMAIN microcode version	93-06-61-*xx*/*xx* or later
Maximum number of NVM subsystems	2,048 (ID range: 0 through 2,047)
Maximum number of namespaces created on the NVM subsystem	2,048 (ID range: 1 through 2,048)
Maximum number of NVM subsystem ports created on the NVM subsystem	32
Maximum number of NVM subsystem ports created on a port	255
Maximum number of namespaces for each port created when the port is shared with multiple NVM subsystems	2,048 (Total number of namespaces created on the NVM subsystem)
Maximum number of LDEVs that can be set for a namespace	1 (One LDEV can be assigned to one namespace.
LDEV that is not available for a namespace	• Journal volume • Pool volume • Logical volume for which the LU path is set • Logical volume with the T10 PI attribute

Item	Description
	• System data volume for deduplication • Volume used for a quorum disk
Usage of LDEV that is set for a namespace	The LDEV cannot be used for the following: • Remote command device • Universal Replicator Journal volume • Global-active device pair volume
Port that is available for an NVMe-oF port	Port on the channel board (FC32R CHB) for Fibre Channel[*]
Port that is not available for an NVMe-oF port	• Port for which an LU path is set • Port for which a host group other than host group 0 is set • Port for which a remote path for TrueCopy, Universal Replicator, or global-active device is set • Port for which an external path for Universal Volume Manager is set
* A Fibre Channel port can only be used for either an LU path port or an NVMe-oF port.	

Restrictions for using NVMe over FC

Storage area network configurations and settings

- NVMe-oF requires configuration of a Fibre Channel SAN. The FC switch zoning settings and the Fibre cable connections must be the same as those for conventional Fibre Channel. The existing fabric zoning functions are available at the switch level for the NVMe-oF device.
- Verify the appropriate configuration of the FC switch by following the instructions provided by the FC switch vendor.

Host server configurations and settings

- The host that connects to the target storage system must be configured with an OS and a host bus adapter (HBA) that support NVMe-oF. For more information about the combination of an OS and an HBA that support the connection to the storage system, contact customer support.
- The software required to use NVMe-oF might need to be installed on the host or the firmware, and the driver for an HBA might need to be installed. After installing the HBA, its settings might need to be changed. Follow the instructions provided by each OS and HBA vendor.
- Verifying the device recognition on the host might differ from conventional Fibre Channel (FC-SCSI) verification.

Follow the guidelines for the platforms that support connections to the storage system.

NVMe-oF settings

- Provisioning operations on NVMe-oF (NVM subsystem, NVM subsystem port, namespace, host NQN settings, etc.) cannot be implemented from Device Manager - Storage Navigator and Storage Advisor Embedded. The operations must be performed using Command Control Interface.
- A Fibre Channel port for NVMe-oF cannot be used for some SCSI host settings and some Fibre Channel operations.

Operations available through HDvM - SN, Storage Advisor Embedded, or Command Control Interface

Operation	Availability		
	Storage Advisor Embedded	HDvM - SN	Command Control Interface
Setting the operation mode of a port to NVMe mode	No	No	Yes
Creating, modifying, or deleting a host group	No	No	Yes
Setting an HBA WWN	No	No	Yes
Setting a host mode and a host mode option	No	No	Yes
Setting a port security switch, data transfer speed, a topology, and a fabric switch	Yes	Yes	Yes
Viewing the operation mode setting for a port	Yes	Yes	Yes
Viewing a namespace ID assigned to LDEV	No	Yes	Yes
Viewing the attribute that indicates whether a volume is used as namespace	Yes*	No	No
Deleting a resource available in a host group from a resource group	No	No	Yes
Deleting a resource group containing a host group	No	No	Yes
Viewing a host group in a resource group	No	No	Yes

* To check whether a volume is used as a namespace, check the volume type in the volume list or volume details window in Storage Advisor Embedded. If the volume is used as a namespace, "Namespace" is displayed for the volume type.

Additional restrictions

- Before performing the following operation, verify that the host is not running the I/O operations and that no volumes are mounted. Performing the operation while an I/O operation is running or a volume is mounted disconnects the

storage system and the host:

- ◦ Enabling the namespace security.

- Before performing the following operations, verify that the host is not running the I/O operations and that no volumes are mounted:

  - ◦ Removing a namespace

  - ◦ Deleting an access path (host-namespace path) between a host NQN and a namespace

  - ◦ Removing an NVM subsystem port

  - ◦ Changing the data transfer speed for a Fibre Channel port

  - ◦ Changing the fabric switch setting

  - ◦ Changing a topology

  - ◦ Changing a host mode

  - ◦ Deleting a host group

- Before changing the operation mode of a port, verify that the following operations are not performed on the channel port:

  - ◦ Adding a remote path

  - ◦ Adding an external path

  - ◦ Connection settings between the storage system and the server registered in Storage Advisor Embedded

- Set the host queue depth so that the number of command multiple executions is 1024 or less for each channel port. A value higher than 1024 might cause a significant performance degradation on the host and then a failure such as job abend.

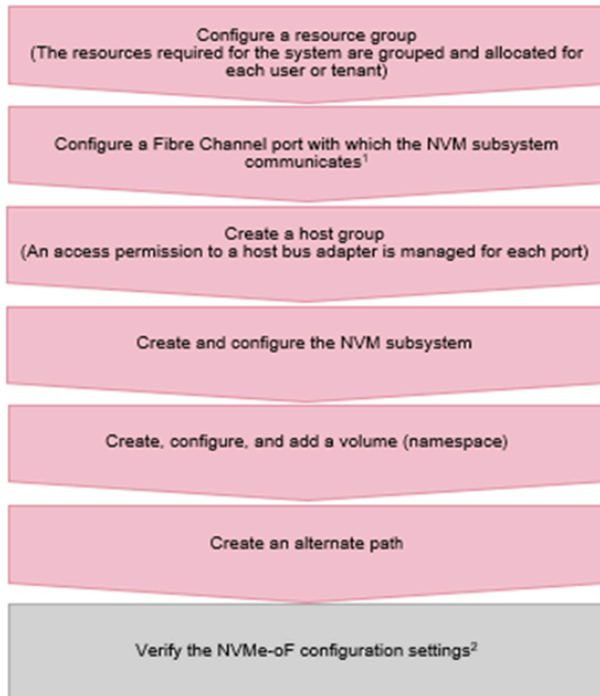# Configuring NVMe over FC for the host and the storage system

You must specify certain settings to use NVMe-oF as a communication protocol between hosts and storage systems.

If you want to create a global-active device pair, see the *Global-Active Device User Guide* as well.

NVMe over FC provisioning workflow

NVMe-oF provisioning workflow

Configure a resource group
(The resources required for the system are grouped and allocated for each user or tenant)

Configure a Fibre Channel port with which the NVM subsystem communicates[1]

Create a host group
(An access permission to a host bus adapter is managed for each port)

Create and configure the NVM subsystem

Create, configure, and add a volume (namespace)

Create an alternate path

Verify the NVMe-oF configuration settings[2]

Notes

1. Before changing the operation mode of the port to NVMe mode, verify that the host bus adapter (HBA) is disconnected (Device Lost) from the storage system port. When the operation mode of the port changes from SCSI mode to NVMe mode, the storage system resets (link down or link up) the target channel port and starts the connection as an NVMe-oF target. If you change the operation mode of the port to NVMe mode and reconnect to the HBA of the FC-SCSI target, HBA disconnection (Device Lost) might affect the connection (login) as an NVMe-oF target.

2. This step is optional.

Differences between FC-SCSI and NVMe over FC settings and operations

The following table lists the differences in the settings and the operations between conventional FC-SCSI and NVMe-oF.

FC-SCSI	NVMe-oF
• Create a host group under a Fibre Channel port and add an LDEV as a LUN. • The host logs in to the Fibre Channel port (FCP target), and then accesses the LUN. **Note:** Each setting is configured using Device Manager - Storage Navigator or Command Control Interface.	• Create the NVM subsystem and assign a Fibre Channel port. • Add an LDEV as a namespace to the NVM subsystem. • The host logs in to the Fibre Channel port (NVMe target), establishes the connection to the NVM subsystem, and then accesses the namespace. **Note:** Each setting is configured using Command

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FC-SCSI	NVMe-oF
	Control Interface.

Configuring a resource group

You can configure the resource groups to group and allocate the resources required for the system for each user or tenant:

1. Create a resource group.
2. Add a resource group for a Fibre Channel port.
3. Add a resource group for a parity group or an LDEV.
4. Add a resource group for an NVM subsystem.

Storage management resources

You can manage the resources of the storage system used for NVMe-oF by using HDvM - SN or Command Control Interface.

Storage management resource	Operation	Availability	
		HDvM - SN (Device Manager - Storage Navigator)	CCI
Port	Manages the port resources assigned to an NVM subsystem port. The management method is the same as conventional FC and iSCSI.	Yes	Yes
Logical volume	Manages the resources of a logical volume defined as a namespace. The management method is the same as conventional FC and iSCSI.	Yes	Yes
Parity group	Manages the parity groups used to create a logical volume. The management method is the same as conventional FC and iSCSI.	Yes	Yes
NVM subsystem	Manages the NVM	No	Yes

Storage management resource	Operation	Availability	
		HDvM - SN (Device Manager - Storage Navigator)	CCI
	subsystem to which a namespace is added as a resource. Specify the NVM subsystem ID.		

Guidelines for managing the NVM subsystem as a storage management resource

NVMe-oF requires the NVM subsystem, which is not used in conventional FC and iSCSI, to be registered as a storage management resource. You are responsible for creating resource groups and allocating resources according to the NVM subsystem operations, such as sharing or exclusively using the NVM subsystem by the storage user or department.

Follow these guidelines for managing the NVM subsystem as a storage resource:

- To contain the NVM subsystem in the user resource group, specify an NVM subsystem ID that is a management number of the NVM subsystem on the storage system. If the NVM subsystem ID is not moved to any resource group, the NVM subsystem is available as a resource assigned to `meta_resource` by default.
- To migrate the resources used for NVMe-oF, use the Command Control Interface raidcom add resource command.

  The following example migrates the NVM subsystem ID 1 to the resource group `sql_srv`.
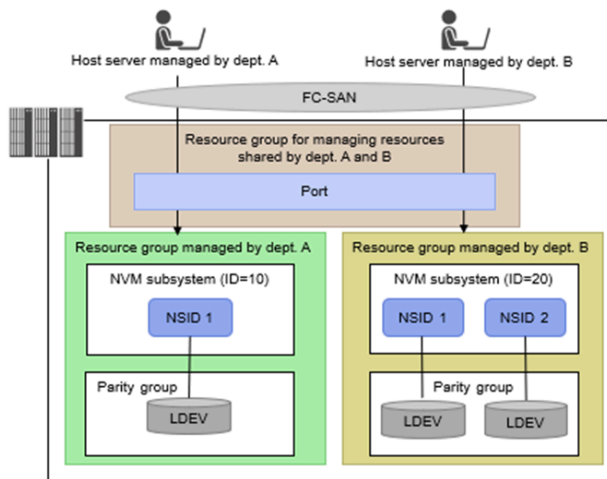
  ```
  # raidcom add resource -resource_name sql_srv -nvm_subsystem_id 1
  ```

  For more information about how to run the Command Control Interface command and specify the option, see the Command Control Interface User and Reference Guide and the Command Control Interface Command Reference.
- Virtual storage machines do not support the NVMe-oF protocol. Resources used for NVMe-oF cannot be moved to the resource group for which the virtual ID is set as a virtual storage machine.

The following figure is an example configuration of two departments in a company sharing a virtual private storage system. Departments A and B can use the parity groups, logical volumes, and NVM subsystems assigned for each department, however the port is shared by both the departments.

Configuring a Fibre Channel port with which the NVM subsystem communicates

You can configure a Fibre Channel port with which the NVM subsystem communicates:

1. Verify the disconnection between the host and the target channel port.
2. Set the operation mode of the port to NVMe mode.
3. Set the topology and the channel speed of the port.

Setting the operation mode of a Fibre Channel port to NVMe mode

You can set the NVMe mode to enable communication on a Fibre Channel port using the NVMe-oF protocol, and then set the Fibre Channel port as an NVM subsystem port on the NVM subsystem.
Note The default operation mode of the port is the SCSI mode. If you change the operation mode of the port to NVMe mode, the following settings cannot be configured. Make sure to set the NVMe mode after satisfying the prerequisites.

• Connection to a host bus adapter port that operates with the FC-SCSI protocol or to an external port on the storage system.

• Define a SCSI path (add an LU path).

• Change the host group settings using Device Manager - Storage Navigator

• Add a remote path.

• Add an external path.

• Connection settings between the storage system and the server registered in Storage Advisor Embedded.

Before you begin

• The Storage Administrator (Provisioning) role is required to perform this task.

• The channel board (FC32R CHB) of Fibre Channel that supports the NVMe protocol must be installed.

• The following devices are not connected to the port:
NoteDisconnect from a host port running with FC-SCSI, an external port on the storage system, or Initiator port, or RCU Target port on the remote storage system, and then verify that there are no connections.

- ◦ SCSI host
- ◦ External storage system
- ◦ Storage system connected using a remote path
- No host groups or LU paths for SCSI hosts have been set under the port.
- No host groups other than the host group 0 have been set.

Procedure

1. Set the operation mode of a Fibre Channel port (CL1-A) to NVMe mode by using the raidcom modify port command.
   Example

   ```
   # raidcom modify port -port CL1-A -port_mode nvme -request_id auto
   ```

2. Verify that the setting is complete by using the raidcom get command_status command. The pre-run configuration command Request ID must be specified in the argument of the -request_id option.
   Example

   ```
   C:\HORCM\etc>raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID  Description
   00000001 -   -     -    700001     0 -
   ```

3. Verify that the operation mode of the port (CL1-A) is set to NVMe mode by using the raidcom get port option.
   Example

   ```
   # raidcom get port -key detail
   PORT  TYPE ATTR  SPD  LPID FAB  CONN  SSW  SL  Serial#  WWN PHY_PORT PORT_MODE
   CL1-A FIBRE TAR   -    EF  Y   PtoP  N    0   700001   50060e8023000100 -      NVME
   CL2-A FIBRE TAR   -    D9  Y   PtoP  N    0   700001   50060e8023000110 -      SCSI
   . . .
   ```

Creating a host group

The host that accesses a logical volume using NVMe-oF is identified by a host NQN defined on the host instead of by a host bus adapter (HBA) WWN. Therefore, managing the HBA WWN is not required for verifying the security of host access to the logical volume.

- If you want to control the host (HBA WWN) that permits the port to log in using the LUN security function of the port. NoteUse the zoning function of the fabric switch to manage the access restrictions between the storage target port and the HBA with the fabric connection. When the FC switch zoning is used for NVMe-oF, setting the host WWN is not required for the access restrictions.
- If you must set a host mode option to support a connected host and an HBA configuration.

You can create a host group and configure an HBA:

1. Enable a security switch of a port.
2. Create a host group, and set a HBA WWN.

3. Set a host group mode and a host mode option.

Setting a host group and a host WWN

You can configure a security switch, a host group, and a host WWN on a port set to NVMe mode. Then you can perform the host group operations for the port.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the following items:
  - Port name of a channel port to be used
  - Host bus adapter WWN

Procedure

1. Enable a security switch on the port (CL4-E) by using the raidcom modify port command.
   Example

   ```
   # raidcom modify port -port CL4-E -security_switch y
   ```

2. Create a host group (host group ID 3, host group name: `Win_export`) on the port (CL4-E) by using the raidcom add host_grp command.
   Example

   ```
   # raidcom add host_grp -port CL4-E-3 -host_grp_name Win_export
   ```

3. Verify the information about the host group created by using the raidcom get host_grp command.
   Example

   ```
   # raidcom get host_grp -port CL4-E
   PORT  GID  GROUP_NAME   Serial# HMD      HMO_BITs
   (Omitted)
   CL4-E  3    Win_export   700001 WIN_EX
   ```

4. Register the host WWN to the host group created by using the raidcom add hba_wwn command.
   Example

   ```
   # raidcom add hba_wwn -port CL4-E-3 -hba_wwn 210000e0,8b0256f8
   ```

5. Verify that the WWN is registered by using the raidcom get hba_wwn command.
   Example

   ```
   # raidcom get hba_wwn -port CL4-E-3
   PORT  GID GROUP_NAME   HWWN           Serial#  NICK_NAME
   CL4-E  3  Linux_x86   210000e08b0256f8   700001
   ```

Setting a host mode option for a port

You can set a host mode option (HMO) to change the operations for each Fibre Channel port. Set the HMO required for a host group on a port.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the following items:
  - Host mode option to be set
  - Port name of a channel port to be set

Procedure

1. Set HMO (HMO 13) for the host group (host group ID 3) belonging to the port (CL4-E) by using the raidcom modify host_grp command.
   Example

   ```
   # raidcom modify host_grp -port CL4-E-3 -host_mode LINUX -set_host_mode_opt 13
   ```

2. Verify that the information about HMO that is set in the host group by using the raidcom get host_grp command.
   Example

   ```
   # raidcom get host_grp -port CL4-E
   PORT   GID   GROUP_NAME   Serial# HMD        HMO_BITs
   (Omitted)
   CL4-E  3     Linux_x86    700001 LINUX       13
   ```

Creating and configuring the NVM subsystem

You can create the NVM subsystem as a resource that logically organizes the system components on the storage system required to connect to the NVMe host:

1. Create the NVM subsystem.
2. Set the host mode and the host mode option for the NVM subsystem.
3. Set the namespace security for the NVM subsystem.
4. Register an NVM subsystem port (Fibre Channel port).
5. Register a host NQN on the NVM subsystem.
6. Connect the host port to the channel port, and then verify that the host recognizes the NVM subsystem.

Creating the NVM subsystem

NVMe-oF requires creation of the NVM subsystem to manage a path between the host and a logical volume. You can manage and configure the relationships between a Fibre Channel port (subsystem port) that connects to the host, a logical volume (namespace) assigned to the host, a host device (host NQN), and the volume access for each NVM subsystem.

When you create an NVM subsystem, you can also configure the following settings by specifying the corresponding options:

- Host mode of the NVM subsystem
- Namespace security of the NVM subsystem

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Determine an NVM subsystem ID that you use (an NVM subsystem ID is not automatically numbered).

Procedure

1. Create the NVM subsystem (NVM subsystem ID 1, NVM subsystem name: `my_nvm_subsystem`, host mode: `VMWARE_EX`) by using the raidcom add nvm_subsystem command.
   Example

   ```
   # raidcom add nvm_subsystem -nvm_subsystem_id 1 -nvm_subsystem_name
   my_nvm_subsystem -host_mode VMWARE_EX -request_id auto
   ```

   Note
   - If specifying the namespace security is omitted, the security function is enabled by default. In a fabric connection environment, multiple hosts and NVM subsystem ports share the same fabric, and therefore it is recommended to enable the security settings to prevent the NVM subsystem and the namespace (logical volume) from being accessed by any hosts. For more information about the namespace security, see Namespace security overview.
   - When creating the NVM subsystem, specify a host mode that corresponds to the NVM subsystem and the host OS to which the namespace is allocated. For more information about the host mode that can be set on the NVM subsystem, see Host modes and a host mode option for the NVM subsystem.
   - The following characters cannot be used for the NVM subsystem name: \ /:,; *?" <> | `
   - If specifying the NVM subsystem name is omitted, the system automatically defines a default name. The default name that is automatically defined by the system cannot be specified.

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID Description
   00000001 -   -    -    700001     0 -
   ```

3. Verify the settings of the created NVM subsystem (NVM subsystem ID 1) and the NVM subsystem NQN by using the raidcom get nvm_subsystem command.
   Example

   Displays the setting information about the created NVM subsystem (NVM subsystem ID 1):

   ```
   # raidcom get nvm_subsystem -nvm_subsystem_id 1
   NVMSS_ID RGID NVMSS_NAME              SECURITY T10PI   HMD       HMO_BITs
       1    0 my_nvm_subsystem        ENABLE  DISABLE VMWARE_EX  -
   ```

Example

Displays the NVM subsystem NQN (NVMSS_NQN) with the NVM subsystem ID 1:

```
# raidcom get nvm_subsystem -nvm_subsystem_id 1 -key opt
NVMSS_ID  NVMSS_NAME              NVMSS_NQN
     1  my_nvm_subsystem        nqn.1994-04.jp.co.hitachi:
 nvme:storage-subsystem-sn.7-00001-nvmssid.00001
・  ・  ・
```

Setting an NVM subsystem port

You can set an NVM subsystem port to the NVM subsystem. For the NVM subsystem port, specify a channel port to establish the network connection with the host bus adapter for the host. By setting the NVM subsystem port, the communication path between the host, the NVM subsystem, and the logical volume is configured through the channel port.

To make the data I/O path between the NVM subsystem and the host redundant, define multiple channel ports as the NVM subsystem ports to configure an alternate path.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- The NVM subsystem must be created.
- The channel port specified for the NVM subsystem port meets the following conditions:
    ◦ The channel port is a channel adapter port that supports NVMe-oF.
    ◦ The port operation mode is set to NVMe mode.
- Verify the following items:
    ◦ NVM subsystem ID to be used.
    ◦ Port name of a channel port to be used.

Procedure

1. Create the NVM subsystem port by defining a channel port (CL1-A) on the NVM subsystem (NVM subsystem ID 1) by using the raidcom add nvm_subsystem_port command.
   Example

   ```
   # raidcom add nvm_subsystem_port -nvm_subsystem_id 1
   -port CL1-A -request_id auto
   ```

   You can define one channel port for an NVM subsystem port for each command. When creating an alternate path configuration, repeat running the command the same number of times as the number of channel ports to be used.

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   ```

```
REQID    R SSB1   SSB2   Serial#    ID  Description
00000001 -   -     -    700001     0 -
```

3. Verify the information about all NVM subsystem ports on the NVM subsystem (NVM subsystem ID 1) by using the raidcom get nvm_subsystem_port command.
Example

```
# raidcom get nvm_subsystem_port -nvm_subsystem_id 1
PORT   NVMSS_ID  NVMSS_NAME
CL1-A       1  my_nvm_subsystem
```

Registering a host with access permissions on the NVM subsystem

The storage system identifies a host that is permitted to access the NVM subsystem and the namespace by using a host NQN. Set the host NQN defined by the host to be used for the NVM subsystem to enable the host to discover the NVM subsystem and the namespace to be added to the NVM subsystem.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- The NVM subsystem must be created.
- Verify the following items:
  ◦ NVM subsystem ID to be used.
  ◦ Host NQN for the host that is permitted to access the NVM subsystem.
    NoteThe procedure to verify the host NQN defined on the host depends on the host OS. The following is an example of the confirmation procedure. For more information about how to verify on the host not described below and how to take actions if the host NQN cannot be verified, follow the host NQN confirmation procedure provided by the vendor of each host OS.
    - Red Hat Enterprise Linux 8 or SuSE Linux Enterprise Server 15: Verify the NQN string from the `hostnqn` file generated in the directory: /etc/nvme/

      Example:

      ```
      # cat /etc/nvme/hostnqn
      nqn.2014-08.org.nvmexpress:uuid:cd41cd3f-5630-46dc-b7df-345fead93868
      ```

    - VMware ESXi 7: Run the following command provided by the host, and then verify the output NQN string:`# esxcli nvme info get`

      Example:

      ```
      :~] esxcli nvme info get
         Host NQN: nqn.2014-08.net.test.storage.clp.:nvme:server-55
      ```

    - IBM AIX® 7: Run the following command provided by the host by specifying the management name of the NVMe-oF protocol device on the host (`fcnvme0` in the following command example), and then verify the NQN string: `# lsattr -El fcnvme0`

Procedure

1. Set the host NQN (`nqn.2014-08.com.example:nvme.host.sys.xyz`) on the NVM subsystem (NVM subsystem ID 1) by using the raidcom add host_nqn command.
   Example

   ```
   # raidcom add host_nqn -nvm_subsystem_id 1
   -host_nqn nqn.2014-08.com.example:nvme.host.sys.xyz
   -request_id auto
   ```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID  Description
   00000001 -   -    -    700001    - -
   ```

3. Verify the information about the host NQN on the NVM subsystem (NVM subsystem ID 1) by using the raidcom get host_nqn command.
   Example

   ```
   # raidcom get host_nqn -nvm_subsystem_id 1
   NVMSS_ID  NVMSS_NAME              HOST_NQN
        1  my_nvm_subsystem        nqn.2014-08.com.example:nvme.host.sys.xyz
   ```

Verifying that a host recognizes the NVM subsystem

You can verify that a host recognizes the NVM subsystems:

1. Verify the subsystem NQN for the NVM subsystem.
2. Verify the subsystem NQN for the NVMe controller that the host recognizes the connection.

Verifying the subsystem NQN for the NVM subsystem

The NVM subsystem NQN (subsystem NQN) created on the storage system is automatically defined by the storage system when you create the NVM subsystem. You can verify the subsystem NQN.

Before you begin
Verify the NVM subsystem ID to be used.

Procedure

1. Display the NVM subsystem (NVM subsystem ID 1) by using the raidcom get nvm_subsystem command.

   Example

   ```
   # raidcom get nvm_subsystem -nvm_subsystem_id 1 -key opt
   ```

2. Verify that the subsystem NQN is displayed in the `NVMSS_NQN` column.
   Example

```
# raidcom get nvm_subsystem -nvm_subsystem_id 1 -key opt
NVMSS_ID  NVMSS_NAME           NVMSS_NQN
    1  my_nvm_subsystem       nqn.1994-04.jp.co.hitachi:nvme:
storage-subsystem-sn.7-00001-nvmssid.00001
```

Verifying the subsystem NQN for the NVMe controller to which the host recognizes the connection (Linux)

Verifying the subsystem NQN for the NVMe controller from the host management interface depends on the host operating system. For more information about how to verify on the host not described below and about how to take actions if the subsystem NQN cannot be verified, follow the confirmation procedure provided by the vendor of each host OS.

This procedure is for Red Hat Enterprise Linux 8 and SuSE Linux Enterprise Server 15.

Procedure

1. Run the following command provided by the `nvme-cli` package.
    Example

    > # nvme list-subsys

2. Verify the output NQN string of the NVMe controller.

Verifying the subsystem NQN for the NVMe controller to which the host recognizes the connection (VMware ESXi)

Verifying the subsystem NQN for the NVMe controller from the host management interface depends on the host operating system. For more information about how to verify on the host not described below and about how to take actions if the subsystem NQN cannot be verified, follow the confirmation procedure provided by the vendor of each host OS.

Procedure

1. Run the following command provided by the host.
    Example

    > # esxcli nvme controller list

2. Verify the subsystem NQN from the character string displayed in `Name` in the output NVMe controller list.

Verifying the subsystem NQN for the NVMe controller to which the host recognizes the connection (IBM AIX® 7)

Verifying the subsystem NQN for the NVMe controller from the host management interface depends on the host operating system. For more information about how to verify on the host not described below and about how to take

actions if the subsystem NQN cannot be verified, follow the confirmation procedure provided by the vendor of each host OS.

Procedure

1. Run the following command provided by the host by specifying the management name of the NVMe controller on the storage system (`nvme1` in the following command example).

   > # lsattr -El nvme1

2. Verify the subsystem NQN from the character string displayed in `Name` in the output NVMe controller list.

Creating, configuring, and adding a volume (namespace)

You can enable the host to perform the data I/O operations from the host to the storage system:

1. Create an LDEV in the same way as FC-SCSI.
2. Specify the LDEV and create a namespace on the NVM subsystem.
3. Assign the namespace to a host NQN registered on the NVM subsystem (host-namespace path setting).
4. Verify that the logical volume is recognized from the host as the namespace.

Creating a namespace

You can add a namespace to the NVMe subsystem to enable the host to recognize the available the NVMe data volumes and to perform the data I/O operations. When creating a namespace, assign a logical volume created in advance on the storage system as a namespace.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- The NVM subsystem must be created.
- A logical volume must be created.
  NoteFor the requirements for a logical volume to be set for a namespace, see Requirements for NVMe over FC.
- Verify the following items:
  ◦ NVM subsystem ID to be used.
  ◦ LDEV ID of a logical volume to be used.

Procedure

1. Assign an LDEV (LDEV ID 10) on the NVM subsystem (NVM subsystem ID 1) by using the raidcom add namespace command, and then create a namespace by setting the namespace ID numbering to `auto`.
   Example

   > # raidcom add namespace -nvm_subsystem_id 1 -ns_id auto
   > -ldev_id 10 -request_id auto

Note

The `-ns_id` option is required.

2. Verify that the setting is complete by using the raidcom get command_status command.
Example

```
# raidcom get command_status -request_id 1
REQID   R SSB1   SSB2   Serial#    ID  Description
00000001 -   -     -   700001    0 -
```

3. Verify that the information about all namespaces created on the NVM subsystem (NVM subsystem ID 1) is displayed by using the `raidcom get namespace` command.
Example

```
# raidcom get namespace -nvm_subsystem_id 1
NVMSS_ID NVMSS_NAME            NSID LDEV# CAPACITY(BLK)
   1 nvmss_id_00001(default_name)  1   10   1677721
```

Setting the host access permission to a namespace (host-namespace path)

You can set the host access permission (set a host-namespace path) to a namespace using the host NQN that has been set for the NVM subsystem. A specific host can access a specific namespace by specifying whether the host can access the namespace. When multiple hosts share the NVM subsystem, you can set the allocation of the namespace to the hosts in detail.

When the namespace security for the NVM subsystem is enabled, the host cannot access the logical volume even if a logical volume is added to the NVM subsystem as a namespace. Specify the host NQN and the namespace that are set on the NVM subsystem, and then configure the host-namespace path.

When the namespace security for the NVM subsystem is disabled, any host can access all namespaces on the NVM subsystem regardless of the access settings for the host in the namespace.

Before you begin

• The Storage Administrator (Provisioning) role is required to perform this task.
• The NVM subsystem must be created.
• A host NQN must be created on the NVM subsystem.
• A namespace must be created on the NVM subsystem.
• Verify the following items:
  ◦ NVM subsystem ID to be used.
  ◦ Namespace ID of a logical volume used by the host.

Procedure

1. Set the host-namespace path from the host (host NQN:

`nqn.2014-08.com.example:nvme.host.sys.xyz`) to the namespace (namespace ID 1) on the NVM subsystem (NVM subsystem ID 1) by using the raidcom add namespace_path command.
Example

```
# raidcom add namespace_path -nvm_subsystem_id 1 -ns_id 1
-host_nqn nqn.2014-08.com.example:nvme.host.sys.xyz -request_id auto
```

2. Verify that the setting is complete by using the raidcom get command_status command.
Example

```
# raidcom get command_status -request_id 1
REQID   R SSB1   SSB2   Serial#     ID Description
00000001 -   -    -    700001     0 -
```

3. Verify that the host NQN (`nqn.2014-08.com.example:nvme.host.sys.xyz`) are set for the namespace (namespace ID 1) on the NVM subsystem (NVM subsystem ID 1) by using the raidcom get namespace_path command.
Example

```
# raidcom get namespace_path -nvm_subsystem_id 1
NVMSS_ID NVMSS_NAME              NSID LDEV# HOST_NQN
      1 nvmss_id_00001(default_name)  1    10 nqn.2014-08.com.example:nvme.host.sys.xyz
```

Verifying that a host recognizes a logical volume as a namespace

You can verify that a logical volume is recognized from the host as a namespace:

1. Verify the namespace globally unique identifier (NGUID) of the logical volume.
2. Verify the NGUID of the namespace recognized by the host.

Verifying the namespace globally unique identifier of a logical volume

You can verify the namespace globally unique identifier (NGUID) defined in a namespace to which a logical volume is assigned.

Before you begin

- Verify the LDEV ID of a logical volume to be used.

Procedure

1. Specify the LDEV ID of a logical volume to be used by using the raidcom get ldev command with the `-ldev_id` option.
Example

```
# raidcom get ldev -ldev_id <LDEV ID> -key nguid
```

2. Verify that an LDEV_NGUID is displayed in the `NGUID` line.

Example

```
# raidcom get ldev -ldev_id 256 -key nguid
Serial#  : 700001
LDEV : 256
SL : 0
CL : 0
VOL_TYPE : OPEN-V-CVS
VOL_Capacity(BLK) : 16777216
NUM_PORT : 0
PORTs : -
NVM_NUM_PORT : 2
NVM_PORTs : CL1-A CL2-B
NSID : 1
NVMSS_ID : 111
LDEV_NGUID : 50700001000000000060e82300010100
…
```

Verifying the NGUID of a namespace recognized by a host (Linux)

Verifying an NGUID of a namespace from the host management interface depends on the host operating system. The following is an example of the confirmation procedure. For more information about how to verify on the host not described below and about how to take actions if the NGUID cannot be verified, follow the confirmation procedure provided by the vendor of each host operating system.

This procedure is for Red Hat Enterprise Linux 8 and SuSE Linux Enterprise Server 15.

Procedure

1. Run the following command provided by the `nvme-cli` package.
   Example

   > # nvme id-ns <namespace device file path(example/dev/nvme0n1)>

2. Verify the output `nguid.`

Verifying the NGUID of a namespace recognized by a host (VMware ESXi)

Verifying an NGUID of a namespace from the host management interface depends on the host operating system. The following is an example of the confirmation procedure. For more information about how to verify on the host not described below and how to take actions if the NGUID cannot be verified, follow the confirmation procedure provided by the vendor of each host operating system.

This procedure is for VMware ESXi 7.

Procedure

1. Run the following command provided by the host.
   Example

   > # esxcli nvme namespace list

2. Verify an NGUID from the character string following `eui.` displayed in `Name` in the output namespace list.

Verifying the NGUID of a namespace recognized by a host (IBM AIX® 7)

Verifying an NGUID of a namespace from the host management interface depends on the host operating system. The following is an example of the confirmation procedure. For more information about how to verify on the host not described below and how to take actions if the NGUID cannot be verified, follow the confirmation procedure provided by the vendor of each host operating system.

This procedure is for IBM AIX® 7.

Procedure

1. Run the following command provided by the host by specifying the physical disk number recognized by the host (`hdisk1` in the following command example).

   > # lsattr -El hdisk1

2. Verify the NGUID from the character string output for `unique_id` (unique device identifier) on the output screen. The NGUID is the lower 32 bytes of the hexadecimal numbers output in the left of the character string `nvme`.

Creating an alternate path

You can create an alternate path by defining multiple channel ports to use for a data I/O route to a logical volume, in case the data I/O operations cannot be performed on a specific port due to a failure on a Fibre Channel route.

NVMe-oF enables you to create an alternate path by setting multiple NVM subsystem ports on the NVM subsystem that contains a namespace to which the logical volume is assigned.

Storage system

1. Set the operation mode of the port used for an alternate path to NVMe mode.
2. Set the topology and the channel speed of the port.
3. Add a communication port (Fibre Channel port) to the NVM subsystem.

Verifying the NVMe over FC configuration settings

You can verify the NVMe-oF configuration settings on the storage system.

The following table lists whether HDvM - SN or Command Control Interface is available for performing each procedure.

Operation	Availability	
	HDvM - SN	Command Control Interface
Verifying the operation mode of a	Yes	Yes

Operation	Availability	
	HDvM - SN	Command Control Interface
port		
Verifying a logical volume that uses a channel port operating in the NVMe mode as a route	No	Yes
Verifying that a logical volume is set to a namespace	Yes	Yes
Verifying the NVM subsystem for which a logical volume is set	No	Yes
Verifying a port configured as data I/O paths of a logical volume	No	Yes
Verifying the namespace security setting for the NVM subsystem	No	Yes
Verifying that a host NQN is set for the NVM subsystem	No	Yes
Verifying a host NQN that can access a namespace	No	Yes

Verifying the port operation mode (HDvM - SN)

You can verify the operation mode (SCSI mode or NVMe mode) setting of a Fibre Channel port.

Procedure

1. From the Storage Systems tree, select Ports/Host Groups/iSCSI Targets.

2. Select the Port tab.
   The operation mode of a Fibre Channel port is displayed in Mode of the Port tab.
   - SCSI: port operating in the SCSI mode
   - NVMe: port operating in the mode

Verifying the port operation mode (Command Control Interface)

You can verify the operation mode (SCSI mode or NVMe mode) setting of a Fibre Channel port.

Procedure

1. Display the port information by using the raidcom get port command.

Example

> # raidcom get port -key detail

2. Verify that the operation mode of a Fibre Channel port is displayed in the `PORT MODE` column.
   Example

```
# raidcom get port -key detail
PORT  TYPE  ATTR  SPD  LPID  FAB  CONN  SSW  SL  Serial#  WWN            PHY_PORT  PORT_
MODE
CL1-A  FIBRE  TAR   -    EF   Y    PtoP  N    0   700001   50060e8023000100  -      NVME
CL2-A  FIBRE  TAR   -    D9   Y    PtoP  N    0   700001   50060e8023000110  -      SCSI
CL2-A  FIBRE  MCU   -    D9   Y    PtoP  N    0   700001   50060e8023000110  -      SCSI
CL2-A  FIBRE  RCU   -    D9   Y    PtoP  N    0   700001   50060e8023000110  -      SCSI
CL2-A  FIBRE  ELUN  -    D9   Y    PtoP  N    0   700001   50060e8023000110  -      SCSI
…
```

Verifying a logical volume that uses a channel port operating in NVMe mode as a route

You can verify a logical volume that uses a Fibre Channel port operating in NVMe mode as a route. Verify the NVM subsystem containing the NVM subsystem port with the target channel port set, and then verify the logical volume assigned to the namespace on the NVM subsystem.

Before you begin
Verify the port name of the channel port to be used.

Procedure

1. Specify the target channel port for the `-port` option of the raidcom get nvm_subsystem_port command and run the command.
   Example

   > # raidcom get nvm_subsystem_port -port <port name>

2. Verify that the NVMS subsystem ID displayed in the `NVMSS_ID` column.
   Example

   ```
   # raidcom get nvm_subsystem_port -port CL1-A
   PORT  NVMSS_ID  NVMSS_NAME
   CL1-A      1  nvmss_id_00001(default_name)
   CL1-A      2  NVMSS_2
   ```

3. Specifying the NVM subsystem ID displayed in step 2 by using the raidcom get namespace command with the `-nvm_subsystem_id` option.
   Example

   > # raidcom get namespace -nvm_subsysem_id <NVM subsystem ID>

4. Verify that the LDEV ID is displayed in the `LDEV#` column, and then verify a logical volume that uses the target Fibre Channel port as a route.

Example

```
# raidcom get namespace -nvm_subsystem_id 1
NVMSS_ID NVMSS_NAME              NSID  LDEV#  CAPACITY(BLK)
       1 nvmss_id_00001(default_name)  1   10    16777216
       1 nvmss_id_00001(default_name)  2   11    16777216
```

Verifying that a logical volume is set to a namespace (HDvM - SN)

1. From the Storage Systems tree, select Logical Devices, and click the LDEV tab.

2. Verify that a namespace ID is displayed in the Namespace ID column in the line of the target LDEV ID on the LDEV tab. If a hyphen (-) is displayed, the logical volume has not been set in the namespace.

Verifying that a logical volume is set to a namespace (Command Control Interface)

1. Specify a logical volume assigned to a namespace by using the raidcom get ldev command with the `-ldev_id` option.
   Example

   ```
   # raidcom get ldev -ldev_id <LDEV ID> -key front_end_nvme
   ```

2. Verify that the namespace ID is displayed in the `NS_ID` column in the line of the target LDEV ID. If a hyphen (-) is displayed, the logical volume has not been set for the namespace.
   Example

   ```
   # raidcom get ldev -ldev_id 577 -key front_end_nvme
   Serial# LDEV# SL CL VOL_TYPE     VOL_Cap(BLK)    PID ATTRIBUTE NVMSS_ID NS_ID
   Ports   PORT_No
   700001    577 0   0 OPEN-V-CVS   2181120    -   CVS       1   1   2    CL2-E CL2-F
   ```

Verifying the NVM subsystem for which a logical volume is set

You can verify the NVM subsystem that contains a namespace to which a logical volume is assigned.

Procedure

1. Specify a logical volume that is assigned to a namespace by using the raidcom get ldev command with the `-ldev_id` option.
   Example

   ```
   # raidcom get ldev -ldev_id <LDEV ID> -key front_end_nvme
   ```

2. Verify that the NVM subsystem ID is displayed in the `NVMSS_ID` column.
   Example

   ```
   # raidcom get ldev -ldev_id 577 -key front_end_nvme
   Serial# LDEV# SL CL VOL_TYPE     VOL_Cap(BLK)    PID ATTRIBUTE NVMSS_ID NS_ID
   ```

```
 Ports   PORT_No
700001      577 0   0 OPEN-V-CVS    2181120      -    CVS        1    1   2     CL2-E CL2-F
```

Verifying a port configured as a data I/O path for a logical volume

You can verify an NVM subsystem port that is configured as a data I/O path for a logical volume.

Procedure

1. Specify a logical volume assigned to a namespace by using the raidcom get ldev with the `-ldev_id` option.
    Example

    > # raidcom get ldev -ldev_id <LDEV ID> -key front_end_nvme

2. Verify that the NVM subsystem port number is displayed in the `PORT_No` column.
    Example

    > # raidcom get ldev -ldev_id 577 -key front_end_nvme
    > Serial# LDEV# SL CL VOL_TYPE   VOL_Cap(BLK)   PID ATTRIBUTE NVMSS_ID NS_ID Ports PORT_
    > No
    > 700001   577 0 0 OPEN-V-CVS 2181120   -   CVS   1   1   2   CL2-E CL2-F

Viewing the namespace security setting for the NVM subsystem

You can view the namespace security setting that is configured for the NVM subsystem.

Procedure

1. Specify a namespace ID for which you want to view the namespace security setting by using the raidcom get nvm_subsystem with the `-nvm_subsystem_id` option.
    Example

    > # raidcom get nvm_subsystem -nvm_subsystem_id <NVM subsystem ID>

2. Verify that the namespace security setting is displayed in the `SECURITY` column.
    Example

    > # raidcom get nvm_subsystem -nvm_subsystem_id 1
    > NVMSS_ID RGID NVMSS_NAME   SECURITY T10PI   HMD   HMO_BITs
    >   1   0 nvmss_id_00001(default_name) ENABLE   DISABLE VMWARE   -

    ◦ ENABLE: Namespace security is enabled.
    ◦ DISABLE: Namespace security is disabled.

Verifying that a host NQN is set for the NVM subsystem

You can verify that a host NQN is set for the NVM subsystem.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the host NQN that is defined on the host to be used.

Procedure

1. Display the host NQN information by using the raidcom get host_nqn command.
   Example

   ```
   # raidcom get host_nqn -nvm_subsystem_id <NVM subsystem ID>
   ```

2. Verify that the host NQN of the host to be used is displayed in the `HOST_NQN` column.
   Example

   ```
   # raidcom get host_nqn -nvm_subsystem_id 1
   NVMSS_ID  NVMSS_NAME              HOST_NQN
        1  my_nvm_subsystem        nqn.2014-08.com.example:nvme.host.sys.xyz
   ```

   NoteIf the namespace security for the NVM subsystem is enabled, the host cannot recognize the NVM subsystem unless the host NQN of the host is set for the NVM subsystem. In this case, set the host NQN of the host for the NVM subsystem.

Verifying a host NQN that can access a namespace

You can verify a host NQN that is permitted to access a namespace.

Before you begin

Verify the following items:

- Host NQN that is defined on the host that is used.
- Namespace ID of a logical volume that is assigned to a host.

Procedure

1. Retrieve the namespace path by using the raidcom get namespace_path command with the following options:

   - `-nvm_subsystem_id`: NVM subsystem ID of the namespace for which you want to verify the host access permissions
   - `-ns_id:` Namespace for which you want to verify the host access permissions

   Example

   ```
   # raidcom get namespace_path -nvm_subsystem_id <NVM subsystem ID>
   -ns_id <namespace ID>
   ```

2. Verify that a host NQN that is permitted to access a namespace is displayed in the `HOST_NQN` column.
   Example

```
# raidcom get namespace_path -nvm_subsystem_id 1
NVMSS_ID  NVMSS_NAME             NSID  LDEV#  HOST_NQN
      1 nvmss_id_00001(default_name)   1    10  nqn.2014-08.com.example:
nvme.host.sys.xyz
```

NoteIf the namespace security for the NVM subsystem is enabled, the host cannot recognize the namespace unless the host NQN of the host is set for the namespace path. Set the host-namespace path by specifying the namespace on the NVM subsystem and the host NQN of the host.

Host modes and host mode options available for NVMe over FC

You can set a host mode and a host mode option (HMO) for the host group for the NVM subsystems and the ports when using NVMe-oF.

Host modes and a host mode option for the NVM subsystem

Host modes

The following host modes can be selected for the NVM subsystem.

Host mode	When to select this host mode
LINUX	When connecting a host using a Linux OS such as Red Hat or SuSE to the NVM subsystem
VMWARE	When connecting a VMware server host to the NVM subsystem (Specify VMWARE_EX unless otherwise specified.)
VMWARE_EX	When connecting a VMware server host to the NVM subsystem
AIX®	When connecting an AIX® host to the NVM subsystem

If you connect to a host that is not listed in the table above, contact customer support for more information about the host mode specified for the NVM subsystem.
Host mode option (HMO)

No HMOs are available on the NVM subsystem.

Host mode and host mode option for a port host group

Host modes

For the host group containing the Fibre Channel port used for NVMe-oF set to NVMe mode, you can select from the available host modes.
Host mode option (HMO)

HMO	Function	When to select this HMO
13	SIM report at link failure	Use this HMO when you want SIMs (service information messages) to be issued if the number of link failures detected between the ports exceeds the threshold. **Note**: Enable HMO 13 only when requested to do so. HMO 13 is enabled for each port. Set HMO 13 for the host group 00 of the target port.

Managing the NVM subsystem and a namespace

You can manage the NVM subsystem and a namespace:

1. Change the NVM subsystem name.
2. Change the host mode for the NVM subsystem.
3. Change the security switch for the NVM subsystem.
4. Change a host NQN name.
5. Add a host NQN.
6. Delete a host NQN.
7. Change a namespace name.
8. Add a namespace and a host-namespace path.
9. Delete a host-namespace path.
10. Remove a namespace.
11. Remove an NVM subsystem port.
12. Remove an NVM subsystem.

Changing the NVM subsystem name

You can change the NVM subsystem management name that is created on the storage system.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the NVM subsystem ID whose setting is changed.

Procedure

1. Change the NVM subsystem name of the NVM subsystem (NVM subsystem ID 1) to `test_srv_1` by using the raidcom modify nvm_subsystem command.
   Example

   ```
   # raidcom modify nvm_subsystem -nvm_subsystem_id 1
   -rename_nvm_subsystem_name test_srv_1 -request_id auto
   ```

   Note
   - The following characters cannot be used for the NVM subsystem name: \ /:,; *?" <> | `
   - The default name that is automatically defined by the system cannot be specified.

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID    R SSB1   SSB2   Serial#    ID Description
   00000001 -   -     -    700001     0 -
   ```

3. Verify that the NVM subsystem name of the NVM subsystem (NVM subsystem ID 1) has been changed by using the raidcom modify nvm_subsystem command.
   Example

   ```
   # raidcom get nvm_subsystem -nvm_subsystem_id 1
   NVMSS_ID RGID NVMSS_NAME              SECURITY T10PI   HMD       HMO_BITs
       1    0  test_srv_1              ENABLE   DISABLE VMWARE    -
   ```

Changing the host mode for the NVM subsystem

You can change the host mode for the NVM subsystem that is created on the storage system.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the NVM subsystem ID whose setting is changed.

Procedure

1. Change the host mode for the NVM subsystem (NVM subsystem ID 1) to `LINUX` by using the raidcom modify nvm_subsystem command.
   Example

   ```
   # raidcom modify nvm_subsystem -nvm_subsystem_id 1
   -host_mode LINUX -request_id auto
   ```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID    R SSB1   SSB2   Serial#    ID  Description
   ```

```
00000001 -    -    -    700001     0 -
```

3. Verify that the host mode for the NVM subsystem (NVM subsystem ID 1) has been changed to `LINUX` by using the raidcom get nvm_subsystem command.
   Example

   ```
   # raidcom get nvm_subsystem -nvm_subsystem_id 1
   NVMSS_ID RGID NVMSS_NAME          SECURITY T10PI   HMD      HMO_BITs
       1    0 test_srv_1           ENABLE  DISABLE  LINUX     -
   ```

Changing the security switch for the NVM subsystem

You can enable or disable the namespace security for the NVM subsystems that is created on the storage system. The namespace security is enabled by default if the namespace security (`-namespace_security`) is not specified when the NVM subsystem is created.

Changing the namespace security setting causes the following effects:

- When the namespace security is changed from Enable to Disable, any hosts that can access the NVM subsystem port in the Fibre Channel network level are permitted to access the NVM subsystem and the namespace to be changed.
- When the namespace security is changed from Disable to Enable, if a host NQN and a host-namespace path are not set for a host, the accesses from the host to the NVM subsystem and the namespace are disconnected and rejected.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify that the NVM subsystem ID whose setting is changed.

Procedure

1. Change the namespace security setting on the NVM subsystem by using the raidcom modify nvm_subsystem command.

   ◦ When the namespace security is enabled:

     Example

     ```
     # raidcom modify nvm_subsystem -nvm_subsystem_id 1
     -namespace_security enable -request_id auto
     ```

   ◦ When the namespace security is disabled:

     Example

     ```
     # raidcom modify nvm_subsystem -nvm_subsystem_id 1
     -namespace_security disable -request_id auto
     ```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID  Description
   00000001 -   -     -    700001     0 -
   ```

3. Verify that the namespace security setting has been changed by using the raidcom get nvm_subsystem command.
   Example

   ```
   # raidcom get nvm_subsystem -nvm_subsystem_id 1
   NVMSS_ID  RGID  NVMSS_NAME              SECURITY  T10PI    HMD       HMO_BITs
       1     0 test_srv_1              ENABLE  DISABLE  LINUX      -
   ```

Setting a host NQN nickname

You can set a user management nickname of a host NQN that is set for the NVM subsystem.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the following items:
  - NVM subsystem ID on which a target host NQN is registered.
  - Host NQN whose nickname is set.

Procedure

1. Set the nickname of the host NQN (nqn.2014-08.com.example:nvme.host.sys.xyz) to `my_host` by using the raidcom modify host_nqn command.
   Example

   ```
   # raidcom modify host_nqn -host_nqn nqn.2014-08.com.example:nvme.host.sys.xyz
   -nvm_subsystem_id 1 -set_host_name my_host -request_id auto
   ```

   Note
   - If the specified host NQN is registered on multiple NVM subsystems, the setting is applied to all NVM subsystems.
   - The following characters cannot be used for a host NQN nickname: \ /:,; *?" <> | `

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID  Description
   00000001 -   -     -    700001     0 -
   ```

3. Verify that the host NQN nickname has been set to `my_host` by using the raidcom get host_nqn command.
   Example

```
# raidcom get host_nqn -nvm_subsystem_id 1 -key opt
NVMSS_ID  NVMSS_NAME       NICK_NAME    HOST_NQN
     1 my_nvm_subsystem    my_host      nqn.2014-08.com.example:
nvme.host.sys.xyz
```

Adding a host NQN

You can add a host NQN that is permitted to access on the NVM subsystem created on the storage system. For more information, see Registering a host with access permissions on the NVM subsystem.

Deleting a host NQN

You can delete the host NQN that is registered on the NVM subsystem.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the NVM subsystem ID to which the host NQN to be deleted is registered.
- The target host must have accessed and unmounted the NVM subsystem and the namespace.

NoteIf you release the host NQN registration from the NVM subsystem, the following problems are caused. Therefore, verify that the host NQN whose registration is released from the NVM subsystem, and verify that all connections from the host identified by the target host NQN to the NVM subsystem are disconnected.

- The I/O operations with the host identified by the host NQN to be deleted are stopped.
- All connections between the host identified by the host NQN to be deleted and all NVMe controllers for the NVM subsystem are disconnected.
- The new command or the connection request from the host identified by the host NQN to be deleted is rejected.

Procedure

1. Delete the host NQN (nqn.2014-08.com.example:nvme.host.sys.xyz) that is set for the NVM subsystem (NVM subsystem ID 1) by using the raidcom delete host_nqn command.
   Example

   ```
   # raidcom delete host_nqn -host_nqn nqn.2014-08.com.example:nvme.host.sys.xyz
   -nvm_subsystem_id 1 -request_id auto
   ```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID Description
   00000001 -   -    -    700001    0 -
   ```

3. Display the information about the host NQN that is set for the NVM subsystem (NVM subsystem ID 1) by using the raidcom get host_nqn command, and then verify that the deleted host NQN is not displayed.

Setting a namespace nickname

You can set a user management nickname of a namespace created on the NVM subsystem.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the following items:
  - NVM subsystem ID on which a target namespace is registered
  - Namespace ID whose nickname is set

Procedure

1. Set the nickname of the namespace (namespace ID 1) that is defined on the NVM subsystem (NVM subsystem ID 1) to `my_namespace` by using the raidcom modify namespace command.
   Example

   ```
   # raidcom modify namespace -nvm_subsystem_id 1 -ns_id 1
   -set_namespace_name my_namespace -request_id auto
   ```

   NoteThe following characters cannot be used for the NVM subsystem name: \ /:,; *?" <> | `

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID Description
   00000001 -   -     -    700001      0 -
   ```

3. Verify that the nickname of the namespace (namespace ID 1) that is defined on the NVM subsystem (NVM subsystem ID 1) has been set to `my_namespace` by using the raidcom get namespace command.
   Example

   ```
   # raidcom get namespace -nvm_subsystem_id 1 -key opt
   NVMSS_ID NVMSS_NAME              NSID LDEV# CAPACITY(BLK) NS_NAME
       1 nvmss_id_00001(default_name)   1   10    16777216  my_namespace
   ```

Adding a namespace and a host-namespace path

You can assign a new namespace to a host:

1. Create a namespace on the NVM subsystem.
2. Establish a host-namespace path.

When the namespace and the host-namespace path configurations are changed, the storage system uses the asynchronous event notification for the NVMe-oF communication protocol to issue a notification to the host connecting to the NVM subsystem whose configuration is to be changed.

If the host supports the asynchronous event notifications for the NVMe-oF communication protocol, the new namespace can be recognized without a host reboot. Verify that the host recognizes a device in the namespace after adding the namespace and the host-namespace path. For the procedure to verify the added namespace, see the manual provided for each operating system.

Deleting a host-namespace path

You can delete a host-namespace path to release the host access permission to the namespace.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the following items:
  - NVM subsystem ID to which a host-namespace path to be deleted is registered.
  - Host NQN and namespace ID from which a namespace assignment is released.
- You must stop the I/O operations from the target host whose setting will be changed to a namespace, and then release the mounted status.

NoteIf a host-namespace path is deleted, the command from the host for which the path is set to the namespace is rejected. Verify that all connections from the host to the namespace are disconnected.

Procedure

1. Delete a host-namespace path between the namespace (namespace ID 1) on the NVM subsystem (NVM subsystem ID 1) and the host NQN (nqn.2014-08.com.example:nvme.host.sys.xyz) by using the raidcom delete namespace_path command.
   Example

   ```
   # raidcom delete namespace_path -nvm_subsystem_id 1 -ns_id 1
   -host_nqn nqn.2014-08.com.example:nvme.host.sys.xyz -request_id auto
   ```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#    ID Description
   00000001 -   -    -    700001     0 -
   ```

3. Verify that the host-namespace path has been deleted by using the raidcom get namespace_path command.

Removing a namespace

You can remove the namespace created on the NVM subsystem, and then release the logical volume assignment of the namespace.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- Verify the following items:
    - NVM subsystem ID on which a namespace to be removed is registered.
    - Namespace ID to be deleted.
- You must stop the I/O operations from the target host whose setting is to be changed to a namespace and release the mounted status.

Procedure

1. Delete the namespace (namespace ID 1) on the NVM subsystem (NVM subsystem ID 1) by using the raidcom delete namespace command.
   Example

   > # raidcom delete namespace -nvm_subsystem_id 1 -ns_id 1 -request_id auto

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   > # raidcom get command_status -request_id 1
   > REQID   R SSB1   SSB2   Serial#   ID Description
   > 00000001 -   -   -   700001   0 -

3. Verify that the namespace (namespace ID 1) has been deleted by using the raidcom get namespace command.

Removing an NVM subsystem port

You can remove an NVM subsystem port added to the NVM subsystem then release the assignment of the channel port on the storage system. If host I/O operations are running to the namespace that uses a channel port assigned to the NVM subsystem port as a route, the NVM subsystem port cannot be deleted. In this case, stop the I/O operations from the host first, and then delete the NVM subsystem port.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- You must stop the I/O operations from the host to the namespace defined on the NVM subsystem that uses the NVM subsystem port to be deleted.
- Verify the following items:
    - NVM subsystem ID of the NVM subsystem port to be deleted
    - Channel port name to which the NVM subsystem port to be deleted is assigned

Procedure

1. Delete the channel port (CL1A) that is assigned to the NVM subsystem port on the NVM subsystem (NVM subsystem ID 1) by using the raidcom delete nvm_subsystem_port command.
   Example

```
# raidcom delete nvm_subsystem_port -nvm_subsystem_id 1
-port CL1-A -request_id auto
```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#     ID Description
   00000001 -   -     -    700001      0 -
   ```

3. Verify the setting for the NVM subsystem port by using the raidcom get nvm_subsystem_port command.

Removing an NVM subsystem

You can remove an unnecessary NVM subsystem from the storage system. If you delete the NVM subsystem, the NVM subsystem port and the host NQN registration that are set for the target NVM subsystem are also removed.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.
- There are no namespaces on the NVM subsystem to be deleted.
  Note If a namespaces exists on the NVM subsystem to be deleted, the NVM subsystem cannot be deleted.
- Verify the NVM subsystem ID to be deleted.

Procedure

1. Delete the NVM subsystem (NVM subsystem ID 1) by using the raidcom delete nvm_subsystem command.
   Example

   ```
   # raidcom delete nvm_subsystem -nvm_subsystem_id 1 -request_id auto
   ```

2. Verify that the setting is complete by using the raidcom get command_status command.
   Example

   ```
   # raidcom get command_status -request_id 1
   REQID   R SSB1   SSB2   Serial#     ID Description
   00000001 -   -     -    700001      0 -
   ```

3. Verify that the NVM subsystem (namespace ID 1) has been deleted by using the raidcom get nvm_subsystem command.

Replacing a host bus adapter for the NVMe over FC connection

If a host bus adapter (HBA) WWN is registered in the host group with the NVMe-oF connection, you must change the WWN setting for the HBA when the HBA is replaced for maintenance.

If you set an HBA WWN to a Fibre Channel port for which NVMe mode is enabled in an NVMe-over FC environment,

use CCI. You cannot use HDvM - SN for WWW setting.

Before you begin

- The Storage Administrator (Provisioning) role is required to perform this task.

Procedure

1. Verify the HBA WWN you have used. For more information about how to verify the WWN, follow the procedure for each host.

2. Stop the host.

3. Replace the HBA.

4. Restart the host.

5. Verify the HBA WWN after the replacement.

6. Delete the HBA WWN (210000e0,8b039800) before the replacement from the port (CL4-E) and the host group (host group #0).
   Example

   > # raidcom delete hba_wwn -port CL4-E-0 -hba_wwn 210000e0,8b039800

7. Set the HBA WWN (210000e0, 8b0256f8) after the replacement on the port (CL4-E) to be connected and the host group (host group #0).
   Example

   > # raidcom add hba_wwn -port CL4-E-0 -hba_wwn 210000e0,8b0256f8

8. Verify that the HBA WWN has been set on the port (CL4-E) and the host group (host group #0).
   Example

   > # raidcom get hba_wwn -port CL4-E-0
   > PORT GID GROUP_NAME HWWN   Serial# NICK_NAME
   > CL4-E 0   Linux_x86 210000e08b0256f8   700001   ORA_NODE0_CTL_0

9. Connect the HBA to a fabric switch or a Fibre Channel port.