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SAN Volume Controller Second HBA Virtualization Feature

The IBM® SAN Volume Controller (SVC) software-defined storage is based on the IBM System x3550 M3 hardware platform. The original SVC design provides high performance and scalability with a single host bus adapter with four-port 8 Gbps Fibre Channel I/O.

Now, you can add a four-port 8 Gbps Fibre Channel host bus adapter (HBA) to the controller (feature code AHA7). It is commonly referred to as the *second HBA*.

This feature is supported on machine type 2145, Model CG8, and it is mutually exclusive of other supported features, such as internal solid-state drives (feature code 4500) and 10 Gbps iSCSI-FCoE (feature code 4700). The second HBA option was introduced with the Fibre Channel port masking capability in SVC Version 7.1.0.1.

In this IBM Redpaper™ publication, we describe how the second HBA is configured on the 2145-CG8 and how to use Fibre Channel port masking.

SAN Volume Controller Fibre Channel host bus adapter feature

The standard SVC hardware or “storage engine” (machine type 2145, Model CG8) provides high performance and scalability with highly specialized software. Four 8 Gbps Fibre Channel (FC) ports and 24 GB of cache are standard in each engine, and you have the option to add either two 10 Gbps Ethernet ports or up to four solid-state drives (SSDs) per SVC hardware engine. The SVC consists of storage engines that are installed in pairs.

The announcement letter that gives ordering and pricing details:

https://ibm.biz/BdRGLZ

Benefits of more Fibre Channel I/O ports and port masking

Having a second HBA provides the following benefits:

- Dedicated FC ports for use by remote copy
- Dedicated FC ports for use by a private SAN for SVC Enhanced Stretched Cluster or Stretched Cluster (or to enhance the reliability of either of those configurations)
- Connections to more than four SANs can aid in SAN migrations
- Increased I/O bandwidth is possible as a result of increased ports
- Increased resiliency through the distribution of specific port functions across redundant HBAs (host I/O, back-end storage I/O, local node communications, remote node communications functions)
- Increased flexibility in isolating I/O from selected hosts
- Hardware readiness for future increases in I/O
- Port zoning control from the SVC system
- Possible simplification of switch zoning

Installation requirements

It is important that the 2145-CG8 meets the prerequisites that are described in this section before you install the additional HBA.

Software

Confirm that the SVC cluster to which the node belongs is running SVC Version 7.1.0.1 or later. If the clustered system is not at the required level, it must be upgraded by using the normal upgrade procedures before installing the second HBA.

Confirm the SVC software from the front panel

The software version that is running on a clustered system can be checked from the front panel display of the SVC node. Press the **Down** button until the **Version** option is displayed between Node and Ethernet options.

Confirm the SVC software from the GUI

To confirm the software version from the GUI, follow these steps:

1. Using the **Monitoring** icon in the navigation menu of the Web-based GUI, access the **System** window, as shown in Figure 1.

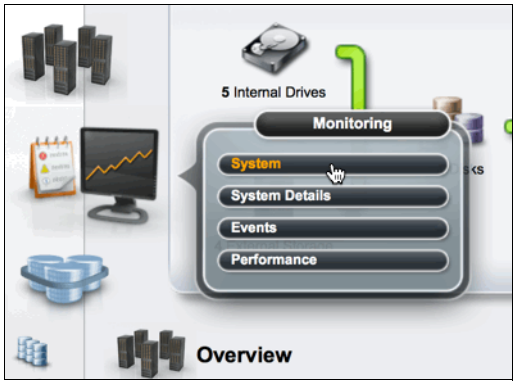

Figure 1 Accessing the System window in the web-based GUI

2. The **System** window displays the SVC cluster name, along with the software version (in parenthesis) below the drawing of the SVC system, as shown in Figure 2.

Figure 2 Confirming the SVC software version in the web-based GUI

Confirm the SVC software by using the CLI

To confirm the software version from the CLI, use the `lssystem` command, as shown in Example 1 on page 4.

Example 1 Verifying the SVC software version by using the CLI

```
IBM_2145:ITSO_Local_Cluster:superuser>lssystem
...
output lines removed for clarity
...
code_level 7.2.0.4 (build 87.6.1402270000)
...
output lines removed for clarity
...
```

Hardware

The SVC 2145-CG8 hardware node *cannot* have the Solid-State Device Attachment (feature code 4500) nor the 10 Gigabit Ethernet Attachment (feature code 4700) *concurrently* installed with the second HBA (feature code AHA7). These features use the same system board connector as the second Fibre Channel HBA. If either of these features is installed, they *must* be removed and the system must be reconfigured before feature code AHA7 can be installed.

System state

As with any other SVC hardware or software upgrades, it is strongly recommended that you resolve any existing system errors before installing the additional HBA. You can determine the system state from the front panel or from the GUI.

Determine the SVC system state from the front panel

1. Notice the value that is displayed on the panel.
2. If the node does not have any errors, the display shows *Cluster:* (followed by the cluster name) on the first line of the front panel display.
3. If the panel displays node errors, see “Resolve system errors before installing the additional HBA” on page 4 before you continue with the HBA installation.

Determine the SVC system state by using the GUI

1. Access the GUI and notice the **Health Status** bar and **Status Alerts** icon at the bottom of the window, as shown in Figure 3.

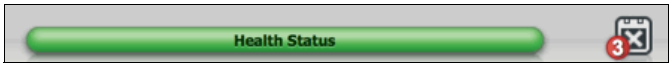

Figure 3 Determining the system status in the web-based GUI

2. If the **Health Status** bar is yellow or red, or if the **Status Alerts** icon indicates that there are unresolved status alerts, see “Resolve system errors before installing the additional HBA” on page 4 before continuing with the HBA installation.

Resolve system errors before installing the additional HBA

If system errors are encountered while checking the system state before installing the second HBA, attempt to resolve the errors by using the Directed Maintenance Procedure (DMP). It is available by clicking the **Run Fix** button on the **Monitoring** → **Events** window in the GUI, as shown in Figure 4 on page 5.

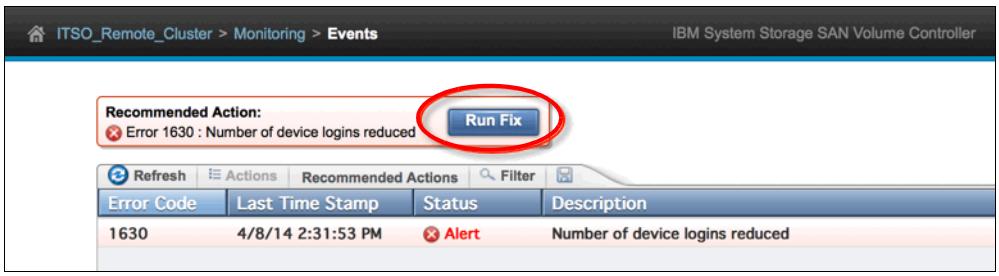

Figure 4 Resolving system errors by using DMP in the web-based GUI

Also see “Working with storage pools” in the IBM Redbooks® publication titled *Implementing the IBM System Storage SAN Volume Controller V6.3*, SG24-7933.

If you encounter errors that you cannot resolve, contact IBM Support before installing the second HBA.

Partnered cluster system requirements

Any system that is partnered with this system for replication services must be running SVC Version 6.4.0.0 or later.

If any partnered system is not at the required level, it must be upgraded, using the normal upgrade procedures, before installing the second HBA. It is recommended that the partnered system is also upgraded to the same level as the system on which this upgrade is being installed.

Card Installation

The second HBA card is installed in PCI Slot 2 of the SVC 2145-CG8 engine. This procedure is performed by an IBM Customer Engineer.

Storage area network planning requirements

The second HBA is enabled *only* if its FC ports are connected to a target, such as a Fibre Channel switch. There is no special software control option to enable or disable the second HBA card. It is treated the same way as other cards.

In general, there are four types of services that use the Fibre Channel ports for communication:

- Host connectivity
- Back-end storage connectivity
- Local node communication (intra-cluster or node-node communication)
- Remote node communication (inter-cluster communication)

General rules and restrictions

Before applying port masking and zoning, consider the following rules and restrictions related to use of the additional HBA:

- The additional HBA cannot be used with the 10 Gbps Ethernet card option.
- The additional HBA cannot be used with the internal SSD option.
- For SVC systems that are running software earlier than Version 7.2.0, you can log in to external storage controllers only in the first six FC I/O ports for storage virtualization (physical ports 1 - 6, including Fibre Channel over Ethernet [FCoE] ports, which are known as FC I/O ports). SVC systems that are running software Version 7.2.0 or later can use all eight ports for connection to back-end storage.
- A minimum of two FC ports per node *must* be configured for local (node-node) communications (one per SAN if you have a dual SAN).
- The maximum number of node-to-node port logins cannot exceed 16.
- Keep port configurations identical in both local and remote systems.
- On SVC systems that are running software earlier than Version 7.2.0, port masking can be configured only by using the CLI. On SVC systems that are running software Version 7.2.0 or later, port masking can be configured by using the CLI or the GUI.

Table 1 shows the FC port connections that are allowed.

Table 1 Allowed Fibre Channel port connections

Physical port	Hosts	Back-end storage	Local node communication	Remote node communication
HBA 1 Port ID 1	Yes	Yes	Yes	Yes
HBA 1 Port ID 2	Yes	Yes	Yes	Yes
HBA 1 Port ID 3	Yes	Yes	Yes	Yes
HBA 1 Port ID 4	Yes	Yes	Yes	Yes
HBA 2 Port ID 5	Yes	Yes	Yes	Yes
HBA 2 Port ID 6	Yes	Yes	Yes	Yes
HBA 2 Port ID 7	Yes	Supported in v7.2.0 and later	Yes	Yes
HBA 2 Port ID 8	Yes	Supported in 7.2.0 and later	Yes	Yes

Note: *Yes* means that the physical ports can be used to connect to the services that are shown in the table.

In summary:

- Physical Ports 1-8 can be used for host traffic.
- Physical Ports 1-6 can be used for storage traffic on versions earlier than 7.2.0, and 1-8 can be used on versions 7.2.0 and later.
- Physical Ports 1-8 can be used for local node communications.
- Physical Ports 1-8 can be used for remote node communications.

Port configuration

In this section, we explain how to configure the FC port by using FC port masking.

Fibre Channel port masking

Fibre Channel port masking can be used to filter the node traffic (local or remote) that is *not* intended to travel on a specific Fibre Channel port. This way, you can choose the type of connectivity that is required on each FC port.

Port masking can be applied to both FC and FCoE port interfaces on the SVC and IBM Storwize® storage systems unless stated otherwise. It is also important to know that port masking is applied to the whole system (SVC cluster), not individual I/O groups or nodes. In other words, nodes in the same system cannot have different mask settings.

Note: Fibre Channel port masking, although available for both SVC and Storwize systems, is best used on systems with the additional HBA.

Supported service types

These two communication types can be filtered by using the Fibre Channel port masking feature:

- Local node (node-to-node) or intra-cluster communication.
- Remote node (node-to-remote node) or inter-cluster communication.

Note: Host masking is a similar but separate feature.

For more information, see page 92 in *Implementing the IBM System Storage SAN Volume Controller V6.3*, SG24-7933.

Port allocation

The allocation of ports depends on the requirements of the particular environment, but the intention is to improve the write performance of remote copy services.

There are two suggested configurations:

- Four ports can be shared by host, back-end storage, and local node traffic. The additional four ports can be dedicated to replication of services traffic.

  See Figure 5 on page 8 for a diagram of how the HBA ports are used in this configuration.

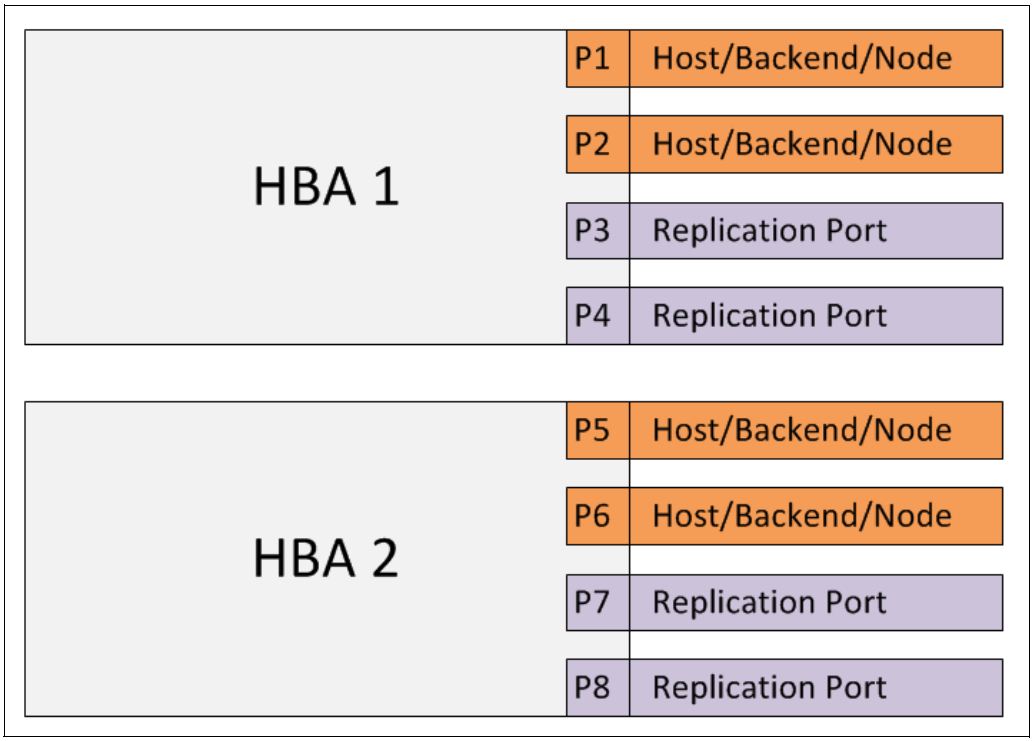

Figure 5 Connectivity of HBA cards with four ports dedicated to replication of service traffic

- Four ports can be shared by host and back-end storage traffic, two ports for local node traffic and two ports for replication services traffic.

  See Figure 6 for a diagram of how the HBA ports are used in this configuration.

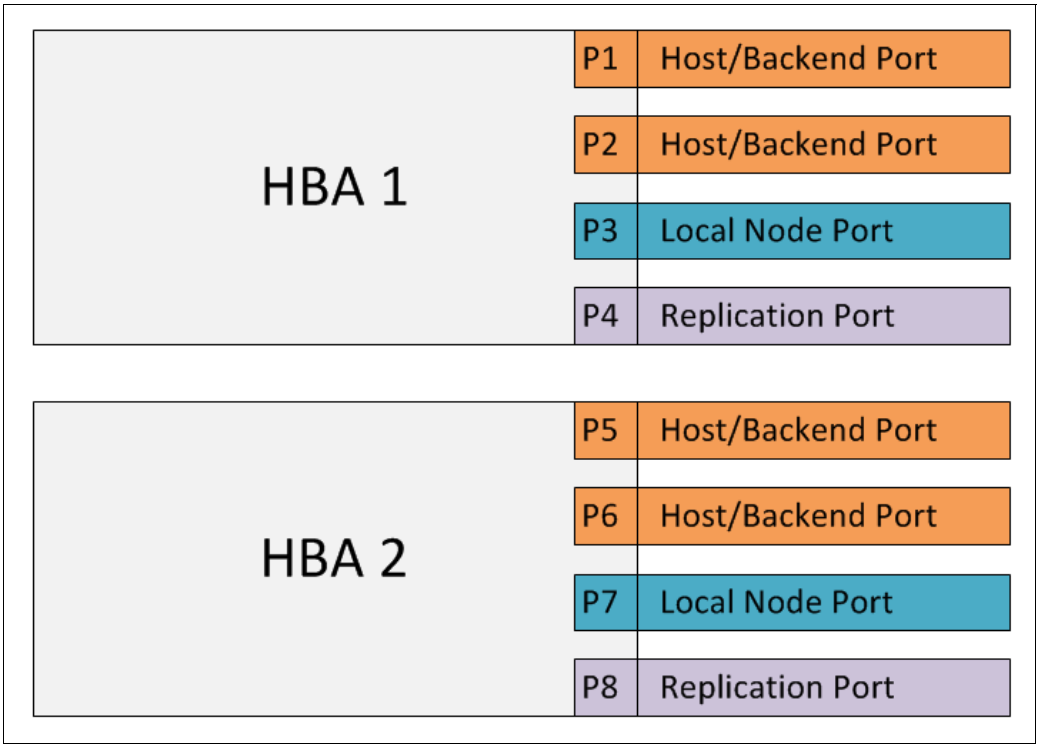

Figure 6 View of connectivity of HBA cards with only two ports dedicated to replication

Note: A rule of thumb is to allocate either two or four Fibre Channel I/O ports to any communication type unless otherwise required to maintain redundancy.

Cabling

Figure 7 shows a diagram of the rear of the 2145-CG8, with the port numbers for the two HBA cards installed. The newly installed HBA is on the right side and uses ports 5 - 8.

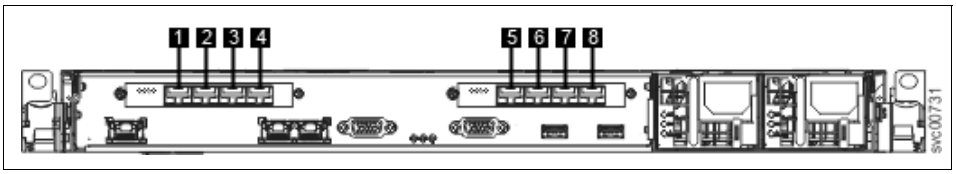

Figure 7 Rear of CG8

The Fiber Channel paths use the following port numbers:

1. Fibre Channel port 1
2. Fibre Channel port 2
3. Fibre Channel port 3
4. Fibre Channel port 4
5. Fibre Channel port 5
6. Fibre Channel port 6
7. Fibre Channel port 7
8. Fibre Channel port 8

Figure 8 on page 10 shows a connection diagram of a two-node inter-cluster environment through four FC switches.

Site A shows a two-node cluster with two HBAs per node, port IDs 1 - 8 on each node (numbered top to bottom). The remote cluster on Site B has the same configuration. All ports are evenly distributed between switches for redundancy, which is standard practice.

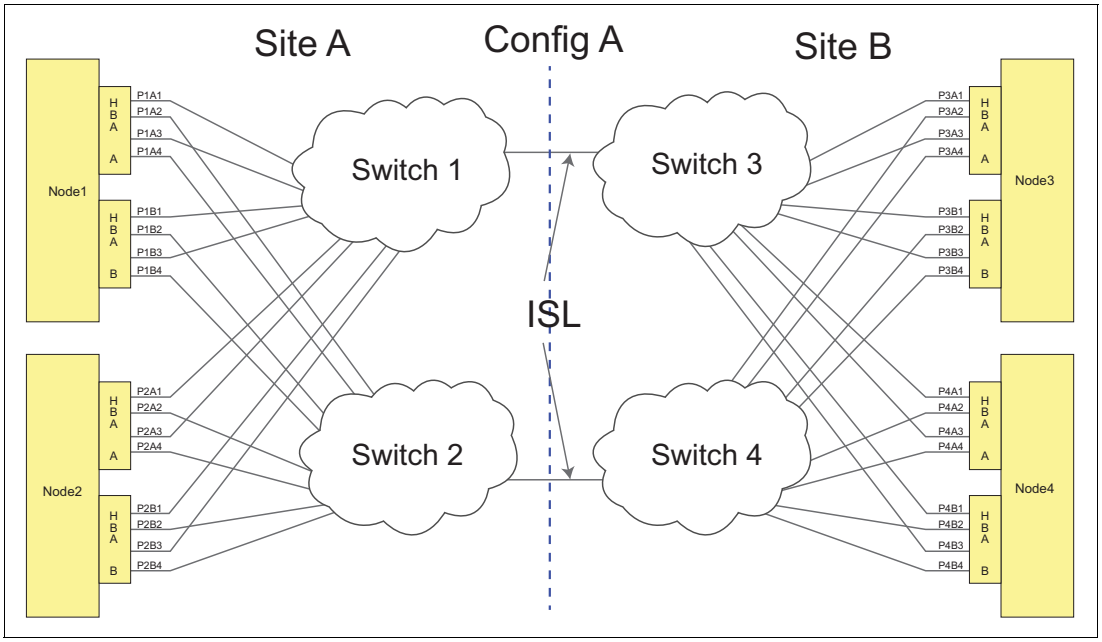

Figure 8 Two-node inter-cluster connection diagram with a second HBA

Zoning

Even with the use of port masking, traditional zoning must still be implemented. It is not recommended to change both port masking and zoning at the same time. Instead, keep one of the two methods constant. In these examples, we keep the zoning constant and change the SVC port configuration by port masking.

See “General rules and restrictions” on page 6 for more information about the number of ports that can be zoned to different I/O types.

You might see an Events log entry of 1801 (node error 888) after rezoning by using all ports. This results from exceeding the limit of local node port logins and can be resolved by using the local node port-masking feature. For more information about error 888, see the SVC Information Center:

https://ibm.biz/BdRCUE

“System view before installation: GUI” on page 11 also provides helpful information.

Host bus adapter addition use case

In this section, we describe the second HBA upgrade procedure through SVC system views.

System view before installation: GUI

By using the GUI, there are multiple areas where you can see that we have only one Fibre Channel card installed.

The first area is in **Monitoring** → **System.**

By clicking each node in the system, the VPD (Vital Product Data) tab shows the hardware that is installed (see Figure 9).

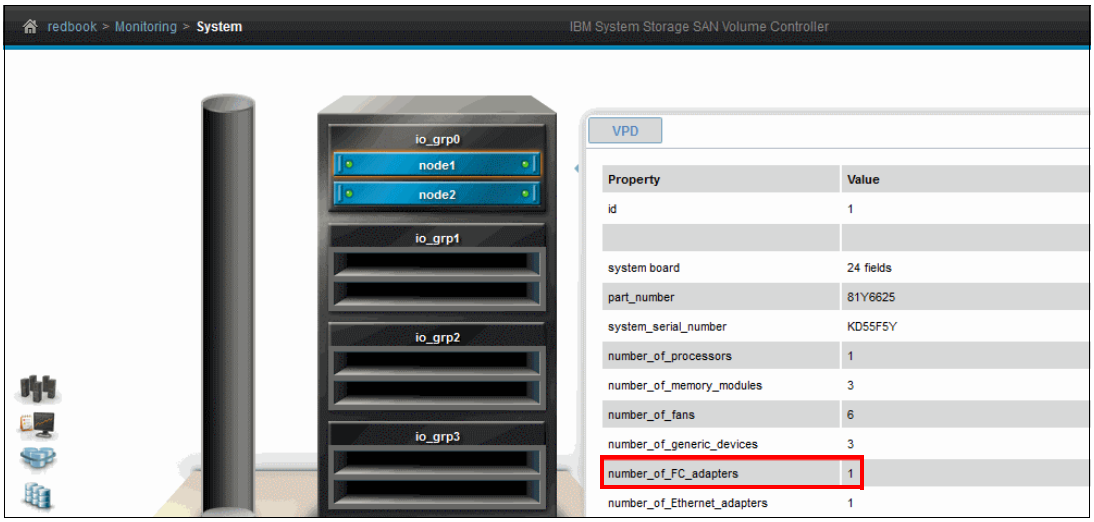

Figure 9 VPD panel in the System window, number of FC adapters highlighted

Another instance where you can see evidence of a single HBA is in **Settings** → **Network** → **Fibre Channel Ports**, as seen in Figure 10 on page 12. From here, you can see the four Fibre Channel ports and that the System Connection port shows Any. This means that there is no port masking.

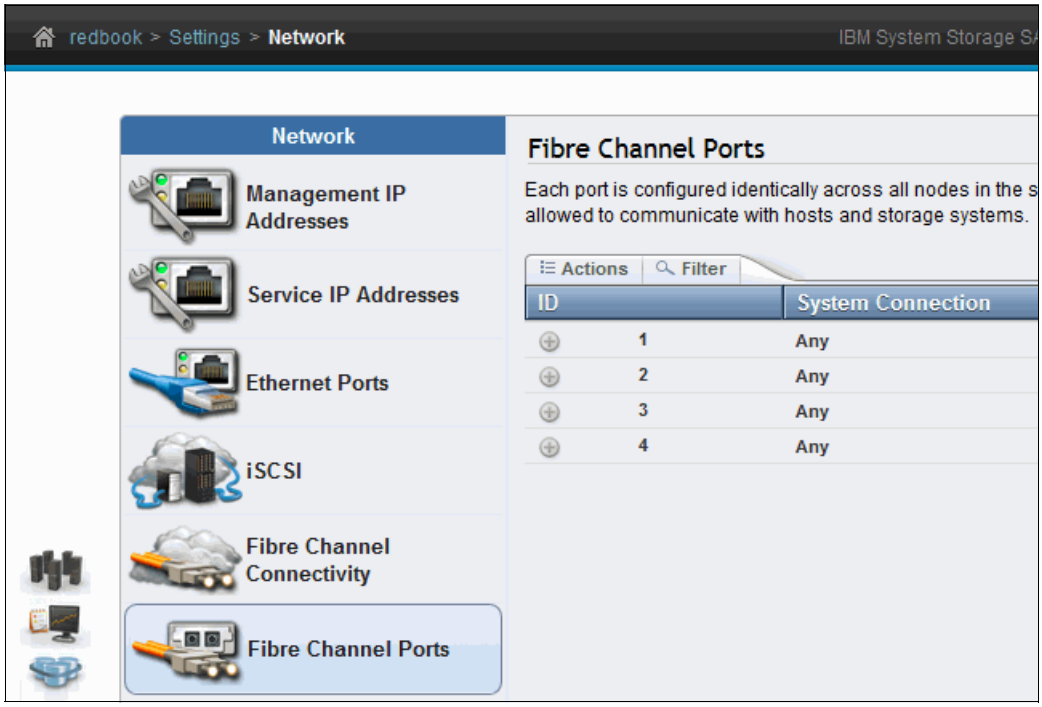

Figure 10 Fibre Channel Ports panel

System view before installation: CLI

Again, there are multiple commands that you can run from the command-line interface (CLI) to verify that only one Fibre Channel card is installed.

First, we use the **lsnodevpd** command to get the hardware information for the nodes in question. Example 2 shows the information that is returned about node `id 1`.

Example 2 Output of the lsnodevpd command for node id 1

```
IBM_2145:redbook:superuser>lsnodevpd 1
id 1

system board: 24 fields
part_number 81Y6625
system_serial_number
number_of_processors 1
number_of_memory_modules 3
number_of_fans 6
number_of_generic_devices 3
number_of_FC_adapters 1
number_of_Ethernet_adapters 1
number_of_SAS_adapters 0
...

output lines removed for clarity
```

Next, we use the **lsportfc** command to get the list of FC ports in the system, which is shown in Example 3 on page 13.

Example 3 Output of the lsportfc command

```
IBM_2145:redbook:superuser>lsportfc
id fc_io_port_id port_id type port_speed node_id node_name WWPN
nportid status               attachment cluster_use
0  1            1       fc   8Gb        1       node1     5005076801401234 010000
active               switch     local_partner
1  2            2       fc   8Gb        1       node1     5005076801301234 010100
active               switch     local_partner
2  3            3       fc   8Gb        1       node1     5005076801101234 010200
active               switch     local_partner
3  4            4       fc   8Gb        1       node1     5005076801201234 010300
active               switch     local_partner
```

Note: Certain parameters, such as `WWPN` and `nportid`, will vary from this example.

System view after installation: GUI

By using the GUI, there are multiple areas where you can see that there are now two Fibre Channel cards installed.

Click **Monitoring** and then **System**.

By clicking each node of the system, the VPD tab shows the hardware that is installed, as Figure 11 shows.

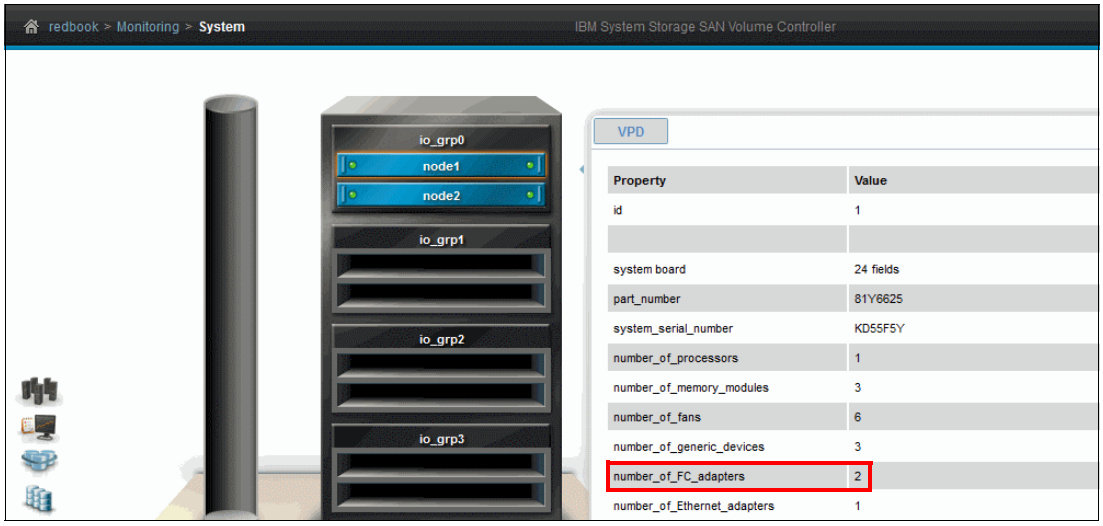

Figure 11 VPD panel in the System window, number_of_HC_adapters highlighted

Another instance where you can see evidence of both HBAs is by selecting **Settings** → **Network** → **Fibre Channel Ports**, as shown in Figure 12 on page 14. From here, you can see that there are eight Fibre Channel ports and that the System Connection is listed as Any. This means that there is no port masking.

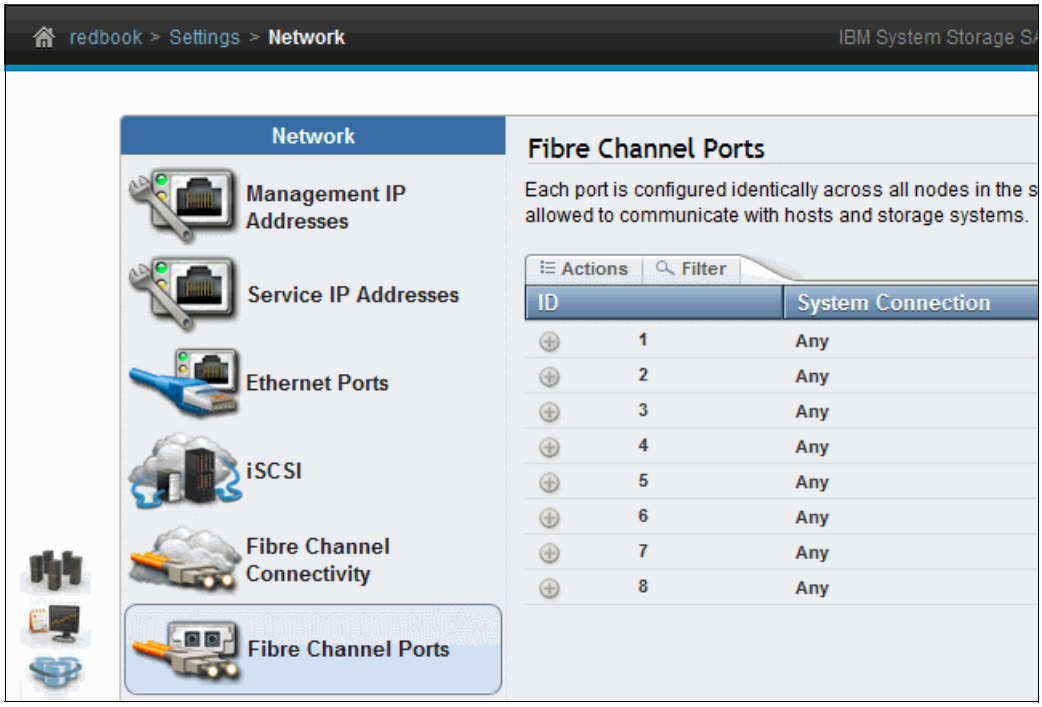

Figure 12 Fibre Channel Ports panel

System view after installation: CLI

There are multiple commands that can be run to verify that only one Fibre Channel card is installed.

First, we use **`lsnodevp`** to get the hardware information about the nodes in question. Example 4 shows the information returned about node `id 1`.

Example 4 Output of the lsnodevpd command

```
IBM_2145:redbook:superuser>lsnodevpd 1
id 1

system board: 24 fields
part_number 81Y6625
system_serial_number
number_of_processors 1
number_of_memory_modules 3
number_of_fans 6
number_of_generic_devices 3
number_of_FC_adapters 2
number_of_Ethernet_adapters 1
number_of_SAS_adapters 0
...

output lines removed for clarity
```

Next, we use the **`lsportfc`** command to get the list of FC ports in the system, as shown in Example 5 on page 15.

Example 5 Output of the lsportfc command

```
IBM_2145:redbook:superuser>lsportfc
id fc_io_port_id port_id type port_speed node_id node_name WWPN
nportid status               attachment cluster_use
0  1            1       fc   8Gb        1       node1     5005076801401234 010000
active               switch     local_partner
1  2            2       fc   8Gb        1       node1     5005076801301234 010100
active               switch     local_partner
2  3            3       fc   8Gb        1       node1     5005076801101234 010200
active               switch     local_partner
3  4            4       fc   8Gb        1       node1     5005076801201234 010300
active               switch     local_partner
4  5            5       fc   8Gb        1       node1     5005076801501234 010400
active               switch     local_partner
5  6            6       fc   8Gb        1       node1     5005076801601234 010500
active               switch     local_partner
6  7            7       fc   8Gb        1       node1     5005076801701234 010600
active               switch     local_partner
7  8            8       fc   8Gb        1       node1     5005076801801234 010700
active               switch     local_partner
```

New CLI parameters for port masking

There are new attributes in the lssystem command and new parameters in the chsystem command that have been introduced to assist in FC port masking.

For **`lssystem`**, these are the new attributes:

- `local_fc_port_mask`
- `partner_fc_port_mask`

These attributes show the Port Masking setting on the current cluster for local and partner communication, respectively.

For **`chsystem`**, these are the new parameters:

- `localfcportmask`
- `partnerfcportmask`

These parameters are used to configure the Port Masking setting on the current cluster for local and partner communication, respectively.

Note: Port masking is applied to the whole system, not individual nodes or I/O groups. This means that you cannot have different mask settings for specific nodes or I/O groups in an SVC system.

Port masking explanation and configuration

As noted in “Fibre Channel port masking” on page 7, port masking is used to filter traffic from particular ports in a system. This is done by applying a 64-bit mask across the FC ports. To better understand this, see Example 6 on page 16, which shows the output of the **`lssystem`** command.

Example 6 Output of the lssystem command

```
IBM_2145:redbook:superuser>lssystem

output lines removed for clarity
...
local_fc_port_mask
1111111111111111111111111111111111111111111111111111111111111111
partner_fc_port_mask
1111111111111111111111111111111111111111111111111111111111111111
...

output lines removed for clarity
```

This is the 64-bit mask. Notice that each bit value is set to 1. This denotes that the particular port is *unmasked*. The alternative is a bit value of 0, denoting that the particular port is *masked*. In this example, all ports can be used for all functions.

Read the mask from right to left, with the least-significant bit denoting port 1 and the most-significant bit denoting port 64, if there is one. With the 2145-CG8 node and the second HBA, there are a total of eight ports, so we focus on the final 8 bits of the mask, again reading from right to left. In Example 6, these are denoted in red.

Set port masking by using the CLI

For this example, we use the CLI to set the port masking as Example 6 shows. We use the commands that are shown in Example 7.

Example 7 chsystem commands

```
chsystem -localfcportmask 01000100
chsystem -partnerfcportmask 10001000
```

Note: The entire 64-bit mask does not need to be typed because the command fills in the zeros for the rest of the mask.

Running **`lssystem`** returns the output that is shown in Example 8.

Example 8 lssystem output

```
IBM_2145:redbook:superuser>lssystem

output lines removed for clarity
...
local_fc_port_mask
0000000000000000000000000000000000000000000000000000000001000100
partner_fc_port_mask
0000000000000000000000000000000000000000000000000000000010001000
...

output lines removed for clarity
```

In Example 8, you can see the results of the change. Now, ports 1, 2, 4, 5, 6, and 8 (again reading right to left) will *not* be used for local node communication, and ports 1, 2, 3, 5, 6, and 7 will *not* be used for remote node communication.

Note: There must be a minimum of two valid paths that are set for node-to-node communication, regardless of whether that communication is in a single or second HBA configured system.

Set port masking by using the GUI

Note: On SVC systems that are running software versions earlier than 7.2.0, port masking can be configured only by using the CLI. On SVC systems that are running software Version 7.2.0 or later, port masking can be configured by using either the CLI or the GUI.

In this example, we set up port masking as shown previously in Example 6 on page 16.

The ports can be changed in the same area where they can be viewed: **Settings** → **Network** → **Fibre Channel Ports**. From there, you can select either a single port or multiple ports (by holding down the **Ctrl** key and clicking each port). In this example, only one port is changed at a time.

After right-clicking a port, select **Modify Connection** from the options, as Figure 13 shows.

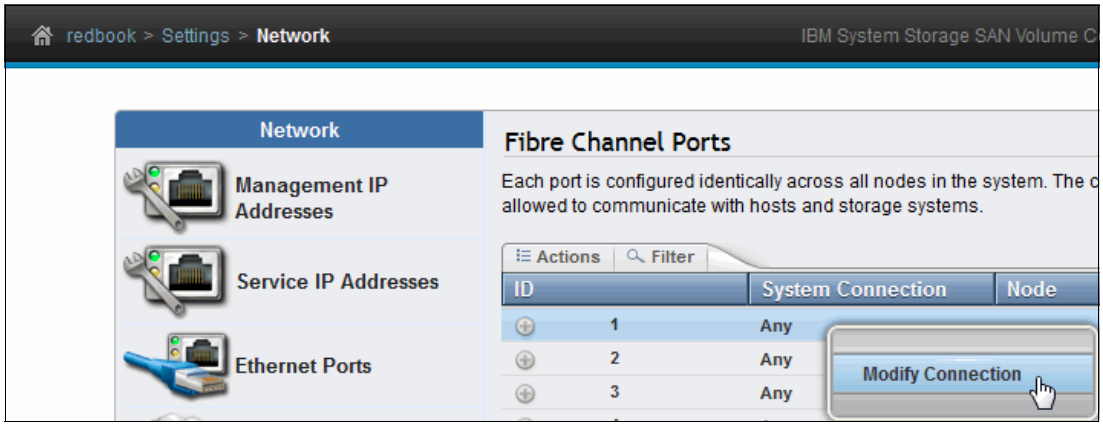

Figure 13 Modify connection

From the Modify Connection window (Figure 14), select what type of node communication to use for this port. You have four choices: **Any** (default), **Local**, **Remote**, or **None**.

- **Any** allows the port to be used for host, back-end storage, local, or remote I/O.
- **Local** allows the port to be used for local node I/O.
- **Remote** allows the port to be used for remote node I/O.
- **None** allows the port to be used for host and back-end storage I/O.

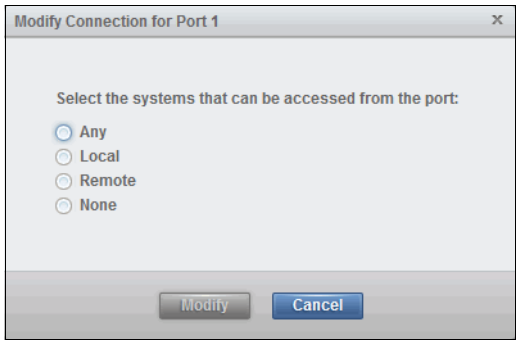

Figure 14 Modify connection

Following the earlier example, port 1 will not be used for either local or remote node I/O, so we change this to None, as shown in Figure 15.

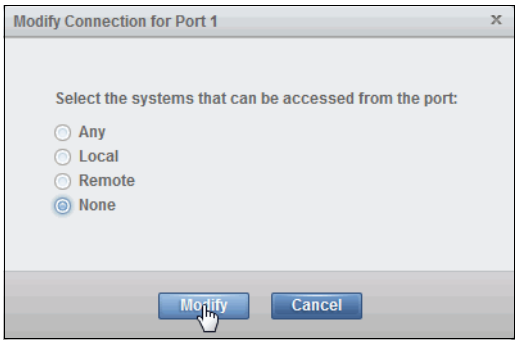

Figure 15 “Modify” button is selected

In Figure 16, you can see the commands that are being generated and run. Using both **`chsystem -localfcportmask 11111110`** and **`chsystem -partnerfcportmask 11111110`** denotes that the port will not be used for either local or remote node I/O.

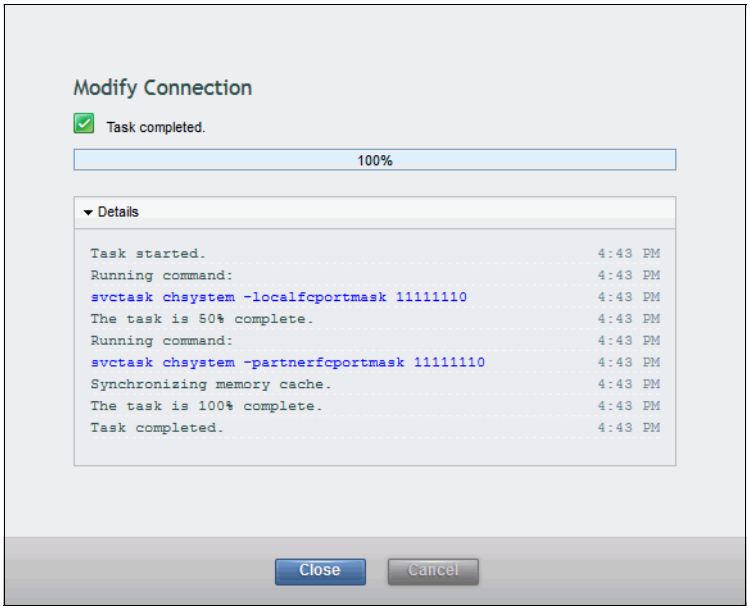

Figure 16 CLI commands in GUI

Looking back at the **Fibre Channel Ports** window, you see that the ports have been updated, as shown in Figure 17 on page 19. Port 1 now shows None under System Connection.

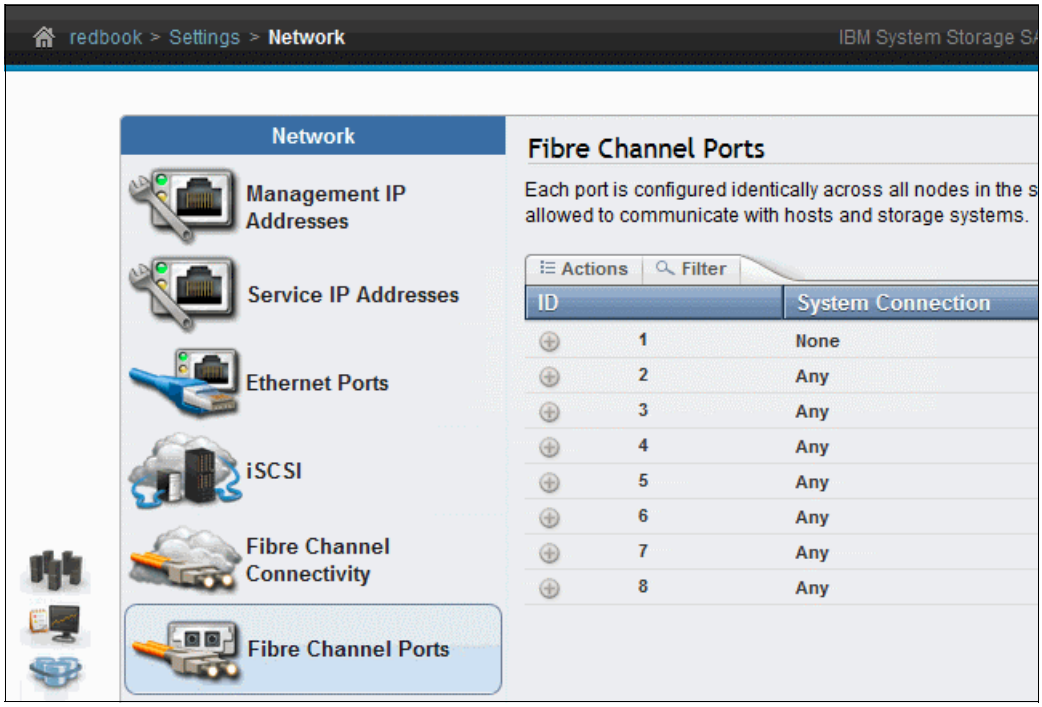

Figure 17 New Fibre Channel settings

To finish the rest of the ports, Figure 18 shows the last command that we run in the GUI.

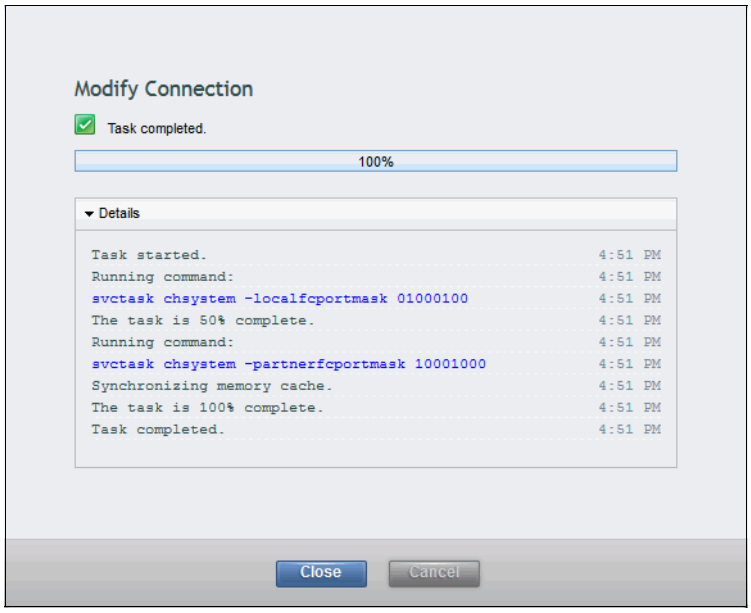

Figure 18 Last command in the GUI

The final update to the Fibre Channel Ports window is shown in Figure 19 on page 20.

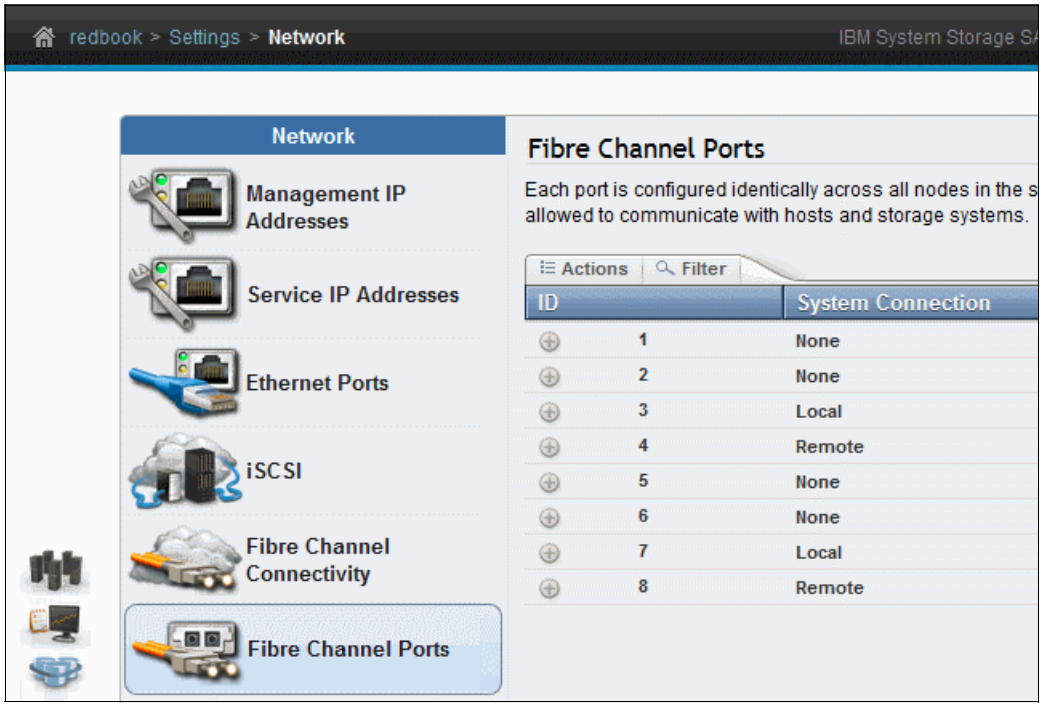

Figure 19 Final update

To remove port masking, simply set all ports to **Any**.

Troubleshooting port masking

With the second HBA installed, new events can be raised on either of the Fibre Channel adapters. To support this, a node error and alert are introduced with the second HBA.

Non-critical node error 888, alert 1801

A new, non-critical, node error 888 is reported when the system determines that there are too many Fibre Channel connections between two nodes. Alert 1801 is raised in the system Events log when this node error is reported. The explanation and service action are the same in either case.

Explanation

The system determines that the Fibre Channel network is zoned or unmasked, so error or alert reports indicate that the node has received more than 16 Fibre Channel logins that originated from another node. The node that the connection comes from might be another SVC node or it might be an IBM Storwize or IBM Flex System® V7000 node canister.

An I/O port on a node receives a login from every port that can connect to it over the Fibre Channel network. The zoning configuration of the Fibre Channel switch determines the number of other ports that can connect to a node's I/O port. Therefore, with an open zone, where every port can connect to every other port, an SVC node with a single Fibre Channel adapter has 16 logins to another similar SVC node (four logins on each of the four ports).

However, if a second Fibre Channel adapter is added to a node, it receives 32 logins from a four-FC port SVC node and 64 from an eight-FC port SVC node.

SVC supports a maximum of 512 logins per port. This must be shared among other SVC nodes and on other storage systems and host systems. Therefore, only 16 logins are supported from another SVC node or an IBM Storwize or Flex System V7000 node canister.

If a 10 Gbps Ethernet adapter that is running FCoE is installed in a node, it also has FC I/O ports that can be in the same zone as the Fibre Channel ports. The count includes both FC and FCoE logins from a node. Therefore, the 10 Gbps Ethernet adapter could cause the permissible limit to another node's port to be exceeded.

The system continues to operate while in this condition. It is possible that the event alert indicates why connections to other nodes or systems on the storage area network (SAN) are missing.

Events log information

When this error appears, the Events log shows an event alert, such as the one shown in Figure 20.

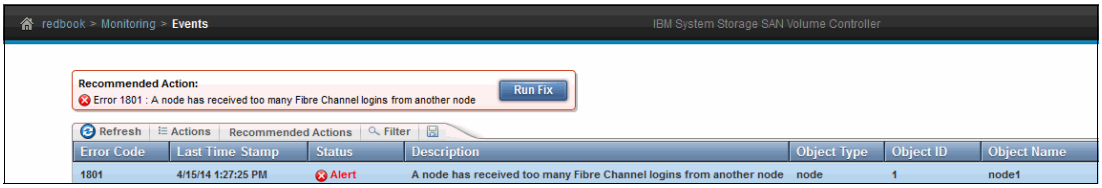

Figure 20 Events log with 1801 error

The Events log entry shows the ID of the node that received too many logins, which is `id 1` in this example.

When the DMP is run for this event, more information is provided, as seen in Figure 21.

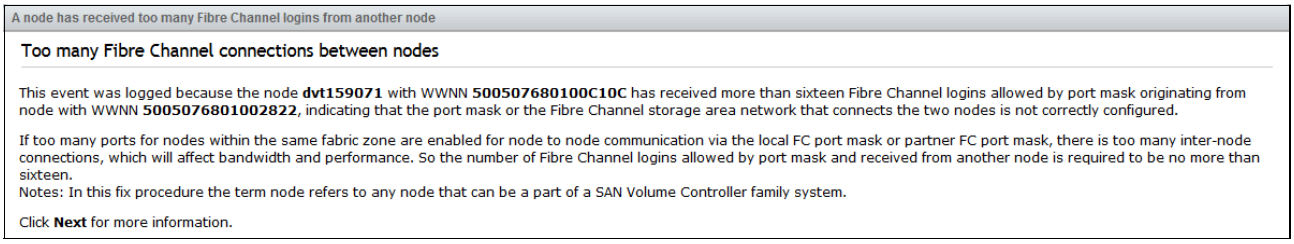

Figure 21 DMP information

This shows more information:

- The name and WWNN of the node with greater than 16 logins
- The name and WWNN of the originating node

Proceeding through the DMP, there is another window with more port information and information about how to fix the error, as shown in Figure 22 on page 22.

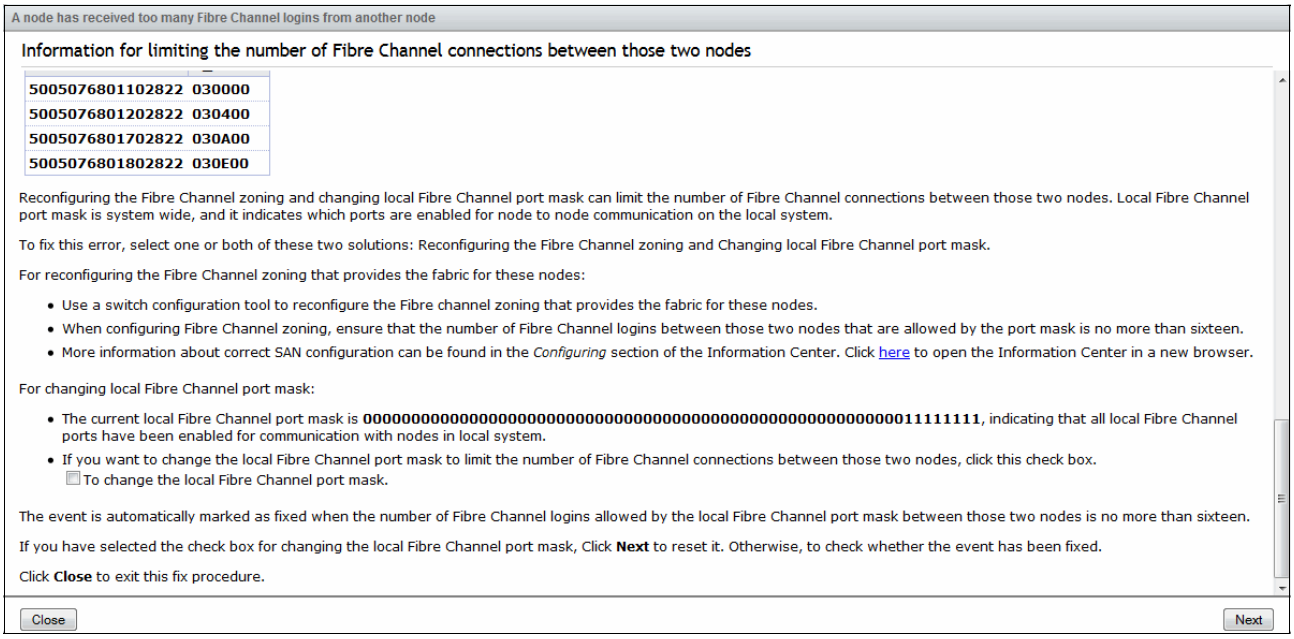

Figure 22 More DMP information

Corrective action

The Fibre Channel port masking or zoning must be modified to reduce the number of logins to the ports on the reporting node. In Figure 22, a check box can be seen that can be checked to allow the port masking to be changed by using a method different from what was described previously. Figure 23 shows an example of this.

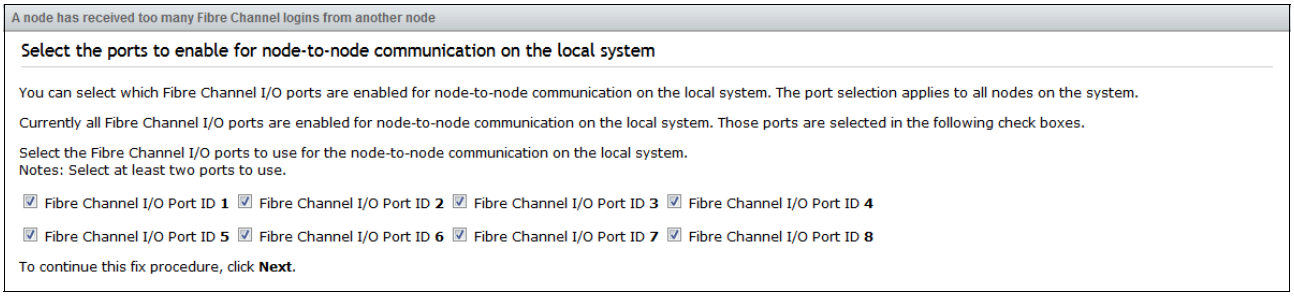

Figure 23 DMP port mask change

This action is equivalent to using **`chsystem -localfcportmask`** and selecting which ports are used for only local node communication.

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