# Fibre Channel connectivity and best practices for clustered, scale-out storage

HP StoreVirtual 4000 Storage

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Executive summary

For years, HP StoreVirtual 4000 Storage (formerly HP LeftHand Storage) has been a leading high-availability storage solution in the iSCSI market. It offers a compelling combination of a clustered, scale-out storage architecture with built-in high-availability features that go beyond disk RAID inside storage nodes. HP StoreVirtual 4000 Storage offers new possibilities for server and client virtualization projects in small and medium-sized businesses as well as enterprise organizations.

With the introduction of Fibre Channel connectivity, HP StoreVirtual brings a wealth of architectural innovations to existing Fibre Channel storage environments and applications. In the past, the design of these environments created silos due to the limitations of traditional dual controller storage architectures. Now, for the first time, customers can leverage the advantages of the HP StoreVirtual architecture in Fibre Channel environments, especially when increasing availability, performance, and storage capacity over time.

This white paper provides an overview of the key architectural considerations when implementing Fibre Channel on HP StoreVirtual. It will also walk through the highly intuitive HP StoreVirtual installation process. Storage administrators familiar with Fibre Channel technology will appreciate the ease and simplicity of Fibre Channel on HP StoreVirtual.

Architectural considerations

HP StoreVirtual 4000 Storage offers a clustered and scale-out storage architecture at an unmatched level of high availability and management simplicity. With HP StoreVirtual, capacity and performance can be grown by simply adding more storage nodes to the storage cluster, as illustrated in Figure 1. This happens online and transparently to applications accessing data on the storage cluster.

![Figure 1. Grow capacity and performance through storage clustering](image)

As HP StoreVirtual clusters depend on communication among the storage nodes, a properly configured Ethernet network is a required component of every installation. The network is used as the storage cluster’s backplane. In pure iSCSI environments, cluster communication as well as iSCSI host traffic traverse the same, often dedicated, network infrastructure.

For mixed installations of iSCSI and Fibre Channel, and pure Fibre Channel installations, a 10 Gb/s Ethernet (10GbE) network has to be in place to facilitate cluster communication. Fibre Channel ports (8 Gb/s Fibre Channel) on the individual storage nodes are used for host connectivity.

Figure 2 shows a Fibre Channel environment with three Fibre Channel enabled storage nodes.
The Fibre Channel ports on HP StoreVirtual are typically connected to two independent Fibre Channel fabrics in line with general Fibre Channel storage network best practices. Please consult the HP SAN Design Reference Guide on fabrics and fabric topologies. Fibre Channel connectivity on HP StoreVirtual requires at least two storage nodes in an HP StoreVirtual management group. This is primarily to provide two paths into each Fibre Channel fabric for high availability. Additional Fibre Channel enabled nodes in the management group are supported and provide additional paths to the application volumes.

Fibre Channel connectivity is only available on HP StoreVirtual 4330 FC Storage. Existing installations can be upgraded to allow for Fibre Channel connectivity; for more information refer to the "Fibre Channel connectivity for existing installations" section. Fibre Channel becomes available for the entire management group when there are Fibre Channel nodes in the management group and all storage nodes are running LeftHand Operating System version 10.0 or higher.

A typical deployment

HP StoreVirtual 4000 Storage is using an Ethernet network for cluster communication and iSCSI traffic. In addition, two Fibre Channel fabrics are connected to the Fibre Channel ports on HP StoreVirtual 4330 FC Storage. A typical customer environment comprises at least two Ethernet switches on a fully meshed network for cluster network resiliency and two independent Fibre Channel fabrics.
In the example in Figure 3, the customer wants to connect some legacy applications via Fibre Channel to the scalable storage pool of HP StoreVirtual systems. The components of this environment are:

- 2x HP StoreVirtual 4330 FC Storage with 900 GB drives
- 2x HP SN6000 Fibre Channel Switches
- 2x HP 5920 Network Switches

HP 5920 provides the 10GbE network connectivity for cluster communication and iSCSI host connectivity. The storage nodes are connected using DAC cables to both switches for increased resiliency. The two HP 5920 network switches are interconnected using DAC cables.

Fibre Channel ports on HP StoreVirtual and application servers are connected to two HP SN6000 Fibre Channel switches (representing two independent fabrics) for affordable and scalable Fibre Channel infrastructures. Just like HP StoreVirtual, these switches allow for Fibre Channel port growth by adding more HP SN6000 switches to a so-called stack. Using stacking, the SN6000 offers 120 ports per stack and 500+ in multi-stack environments, which makes these switches ideal for both SMB and enterprise deployments. The HP SN6000 switch’s scalability protects existing investments and extends the overall lifespan of the solution. HP SN6000 switches also offer management capabilities to easily administer switch stacks through built-in management software, standalone management suites, and command-line tools.

**Installation**

The following section assumes an existing and configured 10GbE network environment and two existing Fibre Channel fabrics. For detailed guidance on how to initially install HP StoreVirtual, please follow the installation instructions in HP StoreVirtual product documentation.

The basic installation steps are as follows:

1. Unpacking and racking of HP StoreVirtual 4330 FC Storage
2. Connecting Integrated Lights-Out (iLO) port to a management network
3. Connecting 10GbE ports to a dedicated HP StoreVirtual network segment
   (Please consult HP StoreVirtual Network Best Practices)
4. Connecting Fibre Channel ports to existing Fibre Channel fabrics
   (Please consult HP SAN Design Reference Guide)
5. Connecting power to HP StoreVirtual 4330 FC Storage
6. Powering on HP StoreVirtual 4330 FC Storage
7. Configuring HP iLO for remote console access (usually through Web-interface or direct attached console)
8. Configuring LeftHand OS by setting network interfaces (incl. bonding) with IP address and hostname

When all storage nodes have been configured with an IP address, the HP StoreVirtual Centralized Management Console (CMC) can be used to discover the individual nodes. This software is installed on a machine with IP connectivity to the network segment used by HP StoreVirtual. For more information, please refer to HP StoreVirtual Centralized Management Console online help.
Figure 4. Fibre Channel-capable nodes in the Centralized Management Console

All nodes should appear as available storage nodes in the CMC (see Figure 4). In this initial phase of the installation, the next step is to add all these nodes to a new management group. To create a new management group with all available nodes, right-click on one of the available nodes and select Add to New Management Group. A wizard will gather all required information to create the management group and a cluster: management group name, email and DNS settings, cluster name, and the cluster's Virtual IP address (VIP).

When clicking Finish at the end of the wizard, the settings will be applied to the storage nodes. The initial configuration of a management group may take a couple of minutes depending on the number of storage nodes joining a management group. After the management group has been created, a summary is presented (Figure 5) to the storage administrator.

Figure 5. Installation summary of a new management group and a cluster

Please note that even in environments that exclusively use Fibre Channel for host connectivity, the storage cluster will require a cluster VIP.
Connectivity

Fibre Channel connectivity on HP StoreVirtual is managed for the entire management group rather than individual cluster(s). In contrast to a cluster’s VIP, all storage nodes in a management group will be assigned with the same target worldwide node name (WWNN), which is dependent on a unique management group identifier and cannot be changed. If Fibre Channel is enabled, the Fibre Channel tab in the management group properties shows the WWNN and lists all storage nodes with Fibre Channel connectivity, including the number of active paths to the fabrics and their WWPNs (see Figure 6). Each storage node’s Fibre Channel ports will be assigned with a unique worldwide port name (WWPN) based on the management group’s WWNN.

![Figure 6. Fibre Channel properties of the management group](image)

Unless Fibre Channel is enabled on the management group level, the Fibre Channel ports on the storage nodes will not log into Fibre Channel fabrics or show up as online on the Fibre Channel switches. If the management group is created with Fibre Channel-enabled storage nodes (i.e., Fibre Channel is enabled on at least two storage nodes joining the management group), Fibre Channel is automatically activated for the entire management group. To enable or disable Fibre Channel for an entire management group, go to the Fibre Channel tab in the management group properties and select Enable Fibre Channel or Disable Fibre Channel in the Fibre Channel Tasks.

As Fibre Channel is another host connectivity protocol on HP StoreVirtual 4330 FC Storage, the Fibre Channel tab (see Figure 7) in the storage node’s Network properties will also list Fibre Channel information.

![Figure 7. Fibre Channel properties of a single storage node](image)
Fibre Channel connectivity for existing installations

Fibre Channel connectivity for existing installations can be established by adding two or more Fibre Channel-enabled storage nodes into the same management group. In some configurations, however, it may not be best practice to add new nodes to an existing cluster. Example: the new storage nodes’ capacity is significantly different from those already in the cluster, or the disk technology is not the same.

In installations where new Fibre Channel-enabled nodes cannot be part of an existing cluster, at least two Fibre Channel-enabled storage nodes may be used to form a new cluster within the same management group. When assigning server to volumes via Fibre Channel, they will use the Fibre Channel connectivity of the new storage nodes to connect to volumes in the already existing cluster.

![Diagram showing Fibre Channel connectivity for existing storage clusters.](image)

**Figure 8.** Enabling Fibre Channel connectivity for existing storage clusters

In Figure 8, cluster 1, which is based on HP StoreVirtual 4330 FC Storage, provides paths into two Fibre Channel fabrics, while cluster 2 does not have any Fibre Channel connectivity. Due to the Fibre Channel target architecture in HP StoreVirtual, volumes on cluster 2 can be made available through the Fibre Channel connectivity on cluster 1.

Alternatively, **HP Peer Motion** on HP StoreVirtual 4000 Storage may be used for online and transparent movement of application data: volume migration (online migration of volumes between two clusters in a management group) or cluster swap (parallel replacement of old storage nodes with new storage nodes).

**Zoning**

As previously mentioned, all nodes in a management group share the same target name (WWNN). Individual ports on storage nodes have WWPNs, which are dependent on the management group’s target name.

Single initiator zoning based on WWPNs is recommended for use with Fibre Channel on HP StoreVirtual. Alternatively, zoning can be based on domain ID and port number, or the target WWNN of the management group. Regardless of which information zoning is based on, all Fibre Channel ports on HP StoreVirtual must be zoned to the Fibre Channel ports on a server (see Figure 9). Should more Fibre Channel enabled storage nodes be joined to a management group, the zoning configuration needs to be updated to include these new ports.
When zoning is required before any devices are connected to the customer environment, enable Fibre Channel on HP StoreVirtual by adding them to a management group before connecting any Fibre Channel ports to the fabrics. After the WWNN for the management group and WWPN for the ports have been generated, the WWPNs for the nodes can be used to create the zoning configuration in the customer fabrics. After all zoning preparations are completed and the changes to the zone configuration have been applied to the fabric, connect all ports of the HP StoreVirtual storage nodes to the fabrics.

### Connecting servers

As soon as Fibre Channel has been enabled successfully and all ports have been properly zoned to Fibre Channel initiator ports, two steps need to be performed before a server can access volumes on HP StoreVirtual using Fibre Channel:

1. A server connection with Fibre Channel information needs to be created in the management group
2. A volume needs to be assigned to the server connection using connection type Fibre Channel

A server connection may consist of iSCSI and Fibre Channel initiator information. When creating a new server connection for a server with Fibre Channel and iSCSI connectivity:

- fill in the appropriate iSCSI information; and
- add the server’s Fibre Channel ports to the list of assigned ports

A server connection with iSCSI and Fibre Channel initiator information is shown in Figure 10. For servers that are only connected to HP StoreVirtual using Fibre Channel, disable iSCSI by unchecking **Allow iSCSI access** when creating the server connection.

If the server is not yet connected to the fabric or not properly zoned, the Fibre Channel ports will not appear in the list of automatically discovered Fibre Channel initiator ports. Verify the server and fabric configurations; alternatively, Fibre Channel initiator ports may be added manually. Automatically discovered and manually added ports will appear in the list of available WWNNs and can be assigned to the server connection.
To assign this newly created server connection to a volume, right-click on the server connection and select **Assign and Unassign Volumes and Snapshots** from the context menu. As shown in Figure 11, make sure you check the **Assigned** checkbox for the desired volume and select **Fibre Channel** as the connection type. The LUN ID field is prepopulated with the next free LUN ID for this server connection. If required, the LUN ID can be adjusted in the dialog. Please note that if the LUN ID is already in use by this server connection for another volume on HP StoreVirtual, the LUN ID cannot be reused for the volume in this step.

To complete the volume assignment, click **OK** to save the changes to the assignment. The volume should now be visible through all ports on server ports that are configured in the server connection. Typically, a rescan of volumes needs to be performed on the application server.

When assigning a volume to servers, a volume can only be assigned via Fibre Channel or iSCSI; mixed operation is not possible for the same volume or snapshot. However, a volume may be accessed via Fibre Channel, and snapshots of the same volume can be assigned to servers through iSCSI, or vice versa.
Enabling multipathing

If the same volume is visible through multiple paths, the host will display all instances of the volume. For example, if a volume is visible on six Fibre Channel ports on HP StoreVirtual (three storage nodes with two ports each), the operating system on server will typically report six instances of the volume (see Figure 12). It is best practice to enable a multipathing driver to handle the volume and its paths.

![Image of Disk Management](image)

**Figure 12.** Multipathing is not activated for this volume yet

In Microsoft® Windows® Server 2008, 2008 R2, and 2012, the built-in multipath support needs to be enabled by installing the MPIO feature. This can be done using Server Manager. After the MPIO feature has been installed successfully, MPIO needs to be enabled for HP StoreVirtual volumes. For MPIO settings, open the MPIO settings in Control Panel.

![Image of MPIO Settings](image)

**Figure 13.** Activating multipathing automatically on Microsoft Windows Server
To enable multipathing after volumes on HP StoreVirtual have been assigned to the server, click Add in the SPC-3-compliant section of the Discover MPIO tab (Figure 13). The server will need to be restarted after enabling MPIO.

If MPIO happens to be configured before any volumes on HP StoreVirtual are attached, the device ID “LEFTHANDP4000 disk” can be manually added to the list of MPIO devices (on the MPIO Devices tab in the MPIO settings).

After the server reboot, only one instance per volume on HP StoreVirtual appears in Windows Disk Management. To view more detailed information about the paths (Figure 14), please select Properties from the context menu of the volume and select the MPIO tab.

![Figure 14. Path properties for volumes on HP StoreVirtual](image)

Asymmetrical Local Unit Access (ALUA) is used to negotiate which paths are actively used to access the volume. Two paths are shown as Active/Optimized; the rest of the available paths are listed as Standby/Optimized. In case of a path failure (HBA port failure or storage node failure), another set of paths is made available as Active/Optimized. Round-robin with subset (default) is the preferred load-balancing policy.

For Fibre Channel and multipathing support on other operating systems, please refer to the HP StoreVirtual compatibility information on HP Single Point of Connectivity Knowledge (SPOCK).

**Fibre Channel Campus Cluster**

HP StoreVirtual 4000 FC Storage may be deployed as clusters, which are stretched across two racks (Figure 15), data rooms or data centers. These installations require:

- two stretched Fibre Channel fabrics, and
- a stretched 10GbE Ethernet network

Please note that 500 MB/s of bandwidth per storage node pair needs to be allocated on the network between the two locations. As an example, a cluster of four storage nodes with two storage nodes in each location requires 1000 MB/s between the two sites. Network latency among storage nodes may not exceed 1 ms.

The installation of a Failover Manager (FOM) in the same management group is highly recommended for automated and transparent storage failovers. It is advisable to use the Best Practice Analyzer in the HP StoreVirtual Centralized Management Console to verify the configuration of managers. Additionally, there should not be any quorum-related alarms in the management group.

The two Fibre Channel fabrics between the two sites may be stretched using any native and transparent fabric extension technology, such as long-range optics and DWDM. SAN extensions using other intermediate protocols, like IP, are not supported in campus cluster configurations. Please refer to the HP SAN Design Reference Guide for more information on SAN extensions.
To set up the campus cluster functionality, create a multi-site cluster by assigning storage nodes to sites. Please refer to HP StoreVirtual documentation for more information on how to configure multi-site clusters and how to work with sites. Note that server connections, which are assigned to sites in the management group and are configured for volume access via Fibre Channel, will not honor the site preference.

All ports of HP StoreVirtual 4000 FC Storage must be visible to servers connecting via Fibre Channel to ensure connectivity in case of port, node, or site failures. See the Zoning section of this document for more information.

If Fibre Channel connectivity is used to access volumes on another cluster in the same management group, the other cluster must have an identical site configuration.

Figure 15. Campus cluster for automated, transparent site failovers

Figure 15 shows a Campus Cluster configuration with a FOM in a third location. Best practices for FOM deployments also apply to Campus Cluster installations: at a minimum, Fast Ethernet connectivity is required between the FOM and the regular managers in the management group. The latency on that connection must not be higher than 50 ms.

Summary

This paper provided an overview of Fibre Channel connectivity on HP StoreVirtual 4330 FC Storage. Fibre Channel is now available to connect legacy applications and services, as well as servers with exclusive Fibre Channel connectivity to HP StoreVirtual.

The architectural benefits of HP StoreVirtual over traditional dual-controller designs help customers mitigate the risk of creating isolated silos and inefficiencies of storage in the enterprise. With iSCSI and Fibre Channel connectivity to the same storage pools based on flexible and scale-out storage clusters, application data is never trapped. By using various disk technologies such as MDL SAS, SAS, and SSD in separate clusters in a management group, customers can realize different storage tiers more easily than ever before. Furthermore, the high availability with Network RAID protects data beyond individual HP StoreVirtual storage nodes.
For more information

For more general information on HP StoreVirtual 4000 Storage, white papers, and best practices, please visit hp.com/go/storevirtual.

For more detailed information on the installation and operation of HP StoreVirtual 4000 Storage, please refer to the product documentation.

For more information on storage networking design, please download the latest revision of the HP SAN Design Reference Guide for up-to-date design recommendations and compatibility.

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