

IBM System Storage N series



Data ONTAP 8.1 SAN Configuration Guide For 7-Mode

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Preface

About this guide

This document applies to IBM N series systems running Data ONTAP, including systems with gateway functionality. If the term *7-Mode* is used in the document, it refers to Data ONTAP operating in 7-Mode, which has the same features and functionality found in the prior Data ONTAP 7.1, 7.2, and 7.3 release families.

In this document, the term *gateway* describes IBM N series storage systems that have been ordered with gateway functionality. Gateways support various types of storage, and they are used with third-party disk storage systems—for example, disk storage systems from IBM, HP®, Hitachi Data Systems®, and EMC®. In this case, disk storage for customer data and the RAID controller functionality is provided by the back-end disk storage system. A gateway might also be used with disk storage expansion units specifically designed for the IBM N series models.

The term *filer* describes IBM N series storage systems that either contain internal disk storage or attach to disk storage expansion units specifically designed for the IBM N series storage systems. Filer storage systems do not support using third-party disk storage systems.

Supported features

IBM System Storage N series storage systems are driven by NetApp Data ONTAP software. Some features described in the product software documentation are neither offered nor supported by IBM. Please contact your local IBM representative or reseller for further details.

Information about supported features can also be found on the N series support website (accessed and navigated as described in [Websites](#) on page 7).

Websites

IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates. The following web pages provide N series information:

- A listing of currently available N series products and features can be found at the following web page:
www.ibm.com/storage/nas/
- The IBM System Storage N series support website requires users to register in order to obtain access to N series support content on the web. To understand how the N series support web content is organized and navigated, and to access the N series support website, refer to the following publicly accessible web page:

www.ibm.com/storage/support/nseries/

This web page also provides links to AutoSupport information as well as other important N series product resources.

- IBM System Storage N series products attach to a variety of servers and operating systems. To determine the latest supported attachments, go to the IBM N series interoperability matrix at the following web page:

www.ibm.com/systems/storage/network/interophome.html

- For the latest N series hardware product documentation, including planning, installation and setup, and hardware monitoring, service and diagnostics, see the IBM N series Information Center at the following web page:

publib.boulder.ibm.com/infocenter/nasinfo/nseries/index.jsp

Getting information, help, and service

If you need help, service, or technical assistance or just want more information about IBM products, you will find a wide variety of sources available from IBM to assist you. This section contains information about where to go for additional information about IBM and IBM products, what to do if you experience a problem with your IBM N series product, and whom to call for service, if it is necessary.

Before you call

Before you call, make sure you have taken these steps to try to solve the problem yourself:

- Check all cables to make sure they are connected.
- Check the power switches to make sure the system is turned on.
- Use the troubleshooting information in your system documentation and use the diagnostic tools that come with your system.
- Refer to the N series support website (accessed and navigated as described in [Websites](#) on page 7) for information on known problems and limitations.

Using the documentation

The latest versions of N series software documentation, including Data ONTAP and other software products, are available on the N series support website (accessed and navigated as described in [Websites](#) on page 7).

Current N series hardware product documentation is shipped with your hardware product in printed documents or as PDF files on a documentation CD. For the latest N series hardware product documentation PDFs, go to the N series support website.

Hardware documentation, including planning, installation and setup, and hardware monitoring, service, and diagnostics, is also provided in an IBM N series Information Center at the following web page:

publib.boulder.ibm.com/infocenter/nasinfo/nseries/index.jsp

Hardware service and support

You can receive hardware service through IBM Integrated Technology Services. Visit the following web page for support telephone numbers:

www.ibm.com/planetwide/

Firmware updates

IBM N series product firmware is embedded in Data ONTAP. As with all devices, ensure that you run the latest level of firmware. Any firmware updates are posted to the N series support website (accessed and navigated as described in [Websites](#) on page 7).

Note: If you do not see new firmware updates on the N series support website, you are running the latest level of firmware.

Verify that the latest level of firmware is installed on your machine before contacting IBM for technical support.

How to send your comments

Your feedback helps us to provide the most accurate and high-quality information. If you have comments or suggestions for improving this document, please send them by email to starpubs@us.ibm.com.

Be sure to include the following:

- Exact publication title
- Publication form number (for example, GC26-1234-02)
- Page, table, or illustration numbers
- A detailed description of any information that should be changed

iSCSI configurations

Supported iSCSI configurations include direct-attached and network-attached configurations. Both single-controller and High Availability (HA) pairs are supported.

In an iSCSI environment, all methods of connecting Ethernet switches to a network approved by the switch vendor are supported. Ethernet-only switch counts are not a limitation in Ethernet iSCSI configurations. For specific recommendations and best practices, see the Ethernet switch vendor's documentation.

For Windows iSCSI multipathing options, see Technical Report 3441: *Windows Multipathing Options with Data ONTAP: FCP and iSCSI*.

Related information

IBM N series interoperability matrix: www.ibm.com/systems/storage/network/interophome.html
Technical Report 3441: Windows Multipathing Options with Data ONTAP: FCP and iSCSI

Single-network HA pair in an iSCSI SAN

You can connect hosts to HA pair controllers that use the iSCSI protocol over a single IP network. The network can consist of one or more switches. Each controller can have multiple iSCSI connections to the network. The number of ports available depends on the storage controller model.

The following figure shows two Ethernet connections to the network per storage controller. Depending on the controller model, more connections are possible.

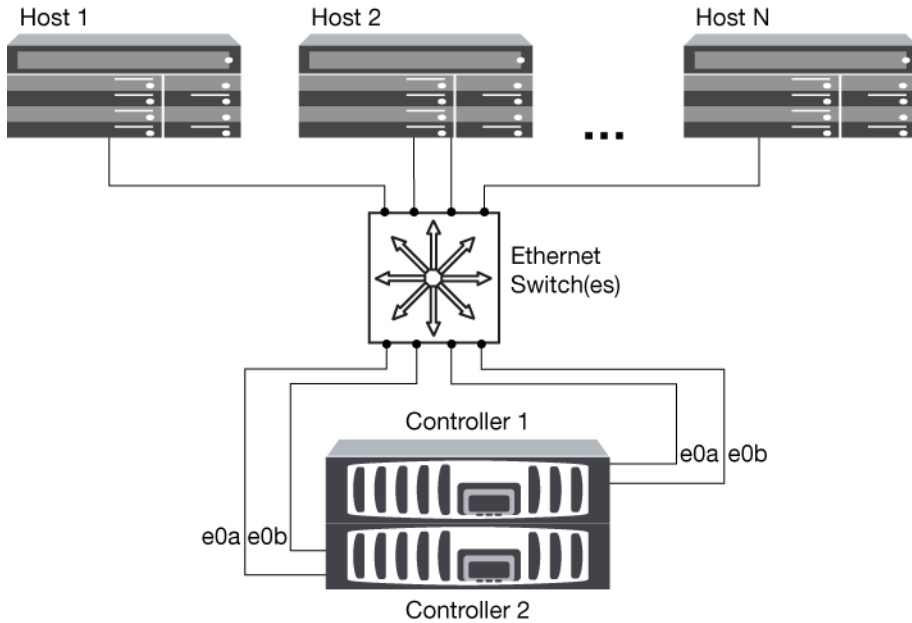


Figure 1: iSCSI single-network HA pair

Attribute	Value
Fully redundant	No, due to the single network
Type of network	Single network
Different host operating systems	Yes, with multiple-host configurations
Multipathing required	Yes
Type of configuration	HA pair

Multi-network HA pair in an iSCSI SAN

You can connect hosts to HA pair controllers that use the iSCSI protocol over multiple IP networks. To be fully redundant, a minimum of two connections to separate networks per controller is

necessary to protect against NIC, network, or cabling failure. The host will require multipathing software to be installed and configured.

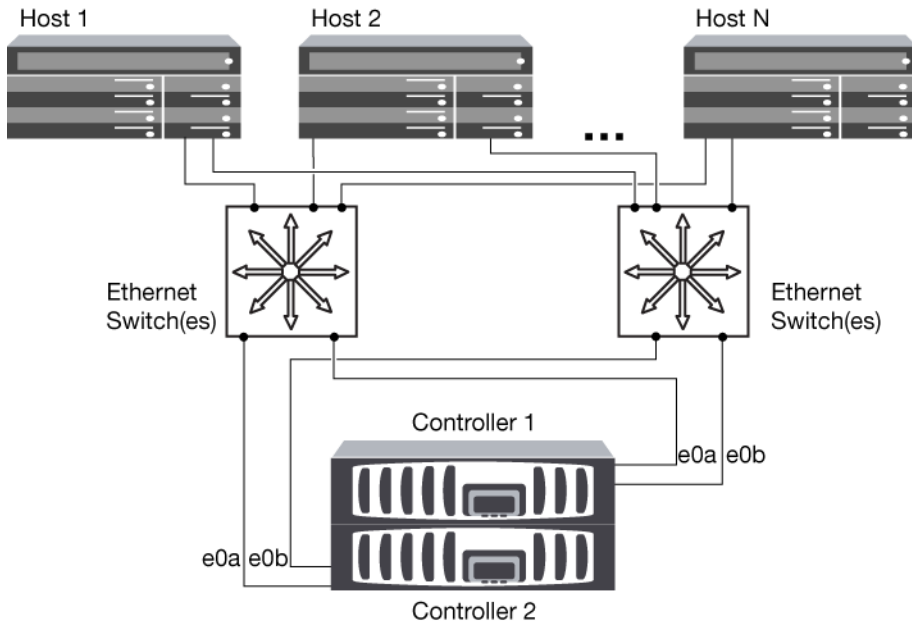


Figure 2: iSCSI multi-network HA pair

Attribute	Value
Fully redundant	Yes
Type of network	Multi-network
Different host operating systems	Yes, with multiple-host configurations
Multipathing required	Yes
Type of configuration	HA pair

Direct-attached single-controller configurations in an iSCSI SAN

You can connect hosts using iSCSI directly to controllers. The number of hosts that can be directly connected to a controller or pair of controllers depends on the number of available Ethernet ports.

Note: Direct-attached configurations are not supported in HA pairs.

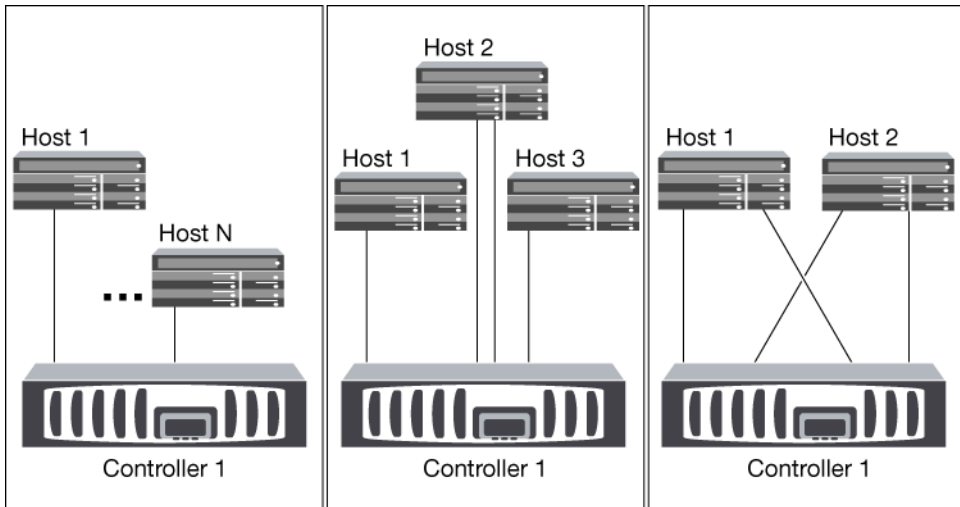


Figure 3: iSCSI direct-attached single-controller configurations

Attribute	Value
Fully redundant	No, due to the single controller
Type of network	None, direct-attached
Different host operating systems	Yes, with multiple-host configurations
Multipathing required	Yes, if multiple connections per host are configured
Type of configuration	Single controller

VLANs for iSCSI configurations

A VLAN consists of a group of switch ports grouped together into a broadcast domain. A VLAN can be on a single switch or it can span multiple switch chassis. Static and dynamic VLANs enable you to increase security, isolate problems, and limit available paths within your IP network infrastructure.

Reasons for implementing VLANs

When you implement VLANs in large IP network infrastructures, you derive the following benefits:

- Increased security. VLANs enable you to leverage existing infrastructure while still providing enhanced security because they limit access between different nodes of an Ethernet network or an IP SAN.
- Improved Ethernet network and IP SAN reliability by isolating problems.
- Reduction of problem resolution time by limiting the problem space.
- Reduction of the number of available paths to a particular iSCSI target port.

- Reduction of the maximum number of paths used by a host. Having too many paths slows reconnect times. If a host does not have a multipathing solution, you can use VLANs to allow only one path.

Static VLANs

Static VLANs are port-based. The switch and switch port are used to define the VLAN and its members.

Static VLANs offer improved security because it is not possible to breach VLANs using media access control (MAC) spoofing. However, if someone has physical access to the switch, replacing a cable and reconfiguring the network address can allow access.

In some environments, it is easier to create and manage static VLANs than dynamic VLANs. This is because static VLANs require only the switch and port identifier to be specified, instead of the 48-bit MAC address. In addition, you can label switch port ranges with the VLAN identifier.

Dynamic VLANs

Dynamic VLANs are MAC-address based. You can define a VLAN by specifying the MAC address of the members you want to include.

Dynamic VLANs provide flexibility and do not require mapping to the physical ports where the device is physically connected to the switch. You can move a cable from one port to another without reconfiguring the VLAN.

Fibre Channel configurations

Supported FC configurations include single-fabric, multi-fabric, and direct-attached configurations. Both single-controller and HA pairs are supported.

For multiple-host configurations, hosts can use different operating systems, such as Windows or UNIX.

HA pairs with multiple, physically independent storage fabrics (minimum of two) are recommended for SAN solutions. This provides redundancy at the fabric and storage system layers, which is particularly important because these layers typically support many hosts.

The use of heterogeneous FC switch fabrics is not supported, except in the case of embedded blade switches. For specific exceptions, see the N series interoperability matrix website (accessed and navigated as described in [Websites](#) on page 7).

Cascade, mesh, and core-edge fabrics are all industry-accepted methods of connecting FC switches to a fabric, and all are supported.

A fabric can consist of one or multiple switches, and the storage arrays can be connected to multiple switches.

Note: The following sections show detailed SAN configuration diagrams for each type of storage system. For simplicity, the diagrams show only a single fabric or, in the case of the dual-fabric configurations, two fabrics. However, it is possible to have multiple fabrics connected to a single storage system. In the case of dual-fabric configurations, even multiples of fabrics are supported. This is true for both HA pairs and single-controller configurations.

Related information

IBM N series interoperability matrix: www.ibm.com/systems/storage/network/interophome.html

FC onboard and expansion port combinations

You can use storage controller onboard FC ports as both initiators and targets. You can also add storage controller FC ports on expansion adapters and use them as initiators or targets.

Note: The X2056-R6 FC HBA for the N7x50T series systems is the only card that can be configured with initiators and targets on the same card.

The following table lists supported combinations.

Onboard ports	Expansion ports	Supported?
Initiator + Target	None	Yes
Initiator + Target	Target only	Yes

Onboard ports	Expansion ports	Supported?
Initiator + Target	Initiator only	Yes
Initiator + Target	Initiator + Target	Yes
Initiator only	Target only	Yes
Initiator only	Initiator + Target	Yes
Initiator only	Initiator only	Yes, but no FC SAN support
Initiator only	None	Yes, but no FC SAN support
Target only	Initiator only	Yes
Target only	Initiator + Target	Yes
Target only	Target only	Yes, but no FC disk shelf, gateway configurations, or FC tape support
Target only	None	Yes, but no FC disk shelf, gateway configurations, or FC tape support

Related concepts

[Configuration limits for FC, FCoE, and iSCSI configurations](#) on page 83

Related references

[FCoE initiator and target combinations](#) on page 68

Fibre Channel supported hop counts

The maximum supported FC hop count between a host and storage system depends on switch supplier and storage system support for FC configurations.

The hop count is defined as the number of switches in the path between the initiator (host) and target (storage system). Cisco also refers to this value as the *diameter of the SAN fabric*.

The following table lists supported hop counts:

Switch supplier	Supported hop count
Brocade	7 for FC 5 for FCoE

Switch supplier	Supported hop count
Cisco	7 Up to 3 of the switches can be FCoE switches.

Fibre Channel supported speeds

Fibre Channel target ports can be configured to run at different speeds. You should set the target port speed to match the speed of the device to which it connects.

You should set the port speed to match the speed of the device connected to the port. This is instead of using autonegotiation; a port set to autonegotiation can take longer to reconnect after a takeover/giveback or other interruption.

It is also recommended to set all ports used by a given host to the same speed.

4-Gb target ports

You can configure 4-Gb onboard ports and 4-Gb expansion adapters to run at the following speeds. Each controller and expansion adapter port can be configured individually. This allows configuration with a different speed from the other ports as needed.

- 4 Gb
- 2 Gb
- 1 Gb

8-Gb target ports

You can configure 8-Gb onboard ports and 8-Gb expansion adapters to run at the following speeds. Each controller and expansion adapter port can be configured individually. This allows configuration with a different speed from the other ports as needed.

- 8 Gb
- 4 Gb
- 2 Gb

Fibre Channel switch configuration best practices

A fixed link speed setting works best, especially for large fabrics, because it provides the best performance for fabric rebuilds. In large fabrics, fixed link speeds can create significant time savings.

Although autonegotiation provides the greatest flexibility, it does not always perform as expected. Also, it adds time to the overall fabric-build sequence because the FC port has to autonegotiate. All switches connected into the fabric have to support NPIV and have it enabled.

Note: Where supported, it works best to set the switch port topology to F (point-to-point).

Host multipathing software requirements

Multipathing software is required on a host computer whenever that computer can access a LUN through more than one path.

The multipathing software presents a single disk to the operating system for all paths to a LUN. Without multipathing software, the operating system could see each path as a separate disk, which can lead to data corruption.

Multipathing software is also known as MPIO (multipath I/O) software. Supported multipathing software for an operating system is listed in the Interoperability Matrix.

For single-fabric single-controller configurations, multipathing software is not required if you have a single path from the host to the controller. You can use zoning or portsets to limit paths.

For an HA pair, host multipathing software is required unless you use zoning or portsets to limit the host to a single path.

N7x50T series supported fibre channel configurations

N7x50T series controllers are available in single-controller and HA configurations.

The N7x50T series systems have four onboard 8-Gb FC ports per controller and each one can be configured as either a target or initiator FC port.

The N7x50T series systems also have vertical I/O slots (slots 1, 11, and 12) that can use a special 4-port 8-Gb FC adapter (Model X2056-R6). Each port on these adapters can be individually configured as either a target or initiator FC port, just like the onboard FC ports.

Each N7x50T series controller supports 4-Gb and 8-Gb FC target expansion adapters.

N7x50T series target port configuration recommendations

For best performance and highest availability, use the recommended FC target port configuration.

The port pairs on an N7x50T series controller that share an ASIC are 0a+0b and 0c+0d.

The following table shows the preferred port usage order for onboard FC target ports. For target expansion adapters, the preferred slot order is listed in the *N series Introduction and Planning Guide* for the version of Data ONTAP software that the controllers use.

Number of target ports	Ports
1	0a
2	0a, 0c

Number of target ports	Ports
3	0a, 0c, 0b
4	0a, 0c, 0b, 0d

N7x50T series: Single-controller configurations

You can connect hosts to single controllers using a single FC fabric or with multiple FC fabrics. If you use multiple paths, multipathing software is required on the host.

FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

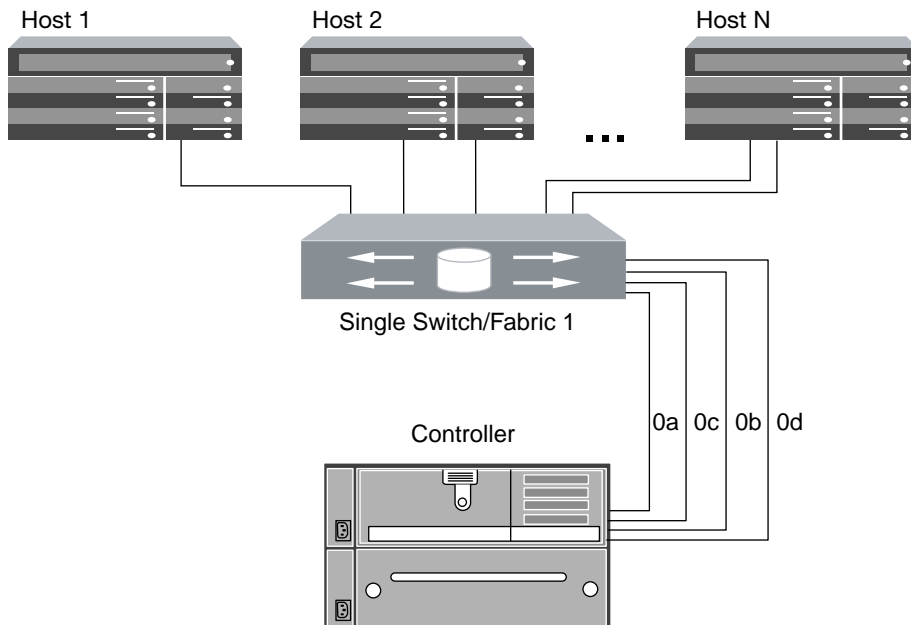


Figure 4: N7x50T series single-fabric single-controller configuration

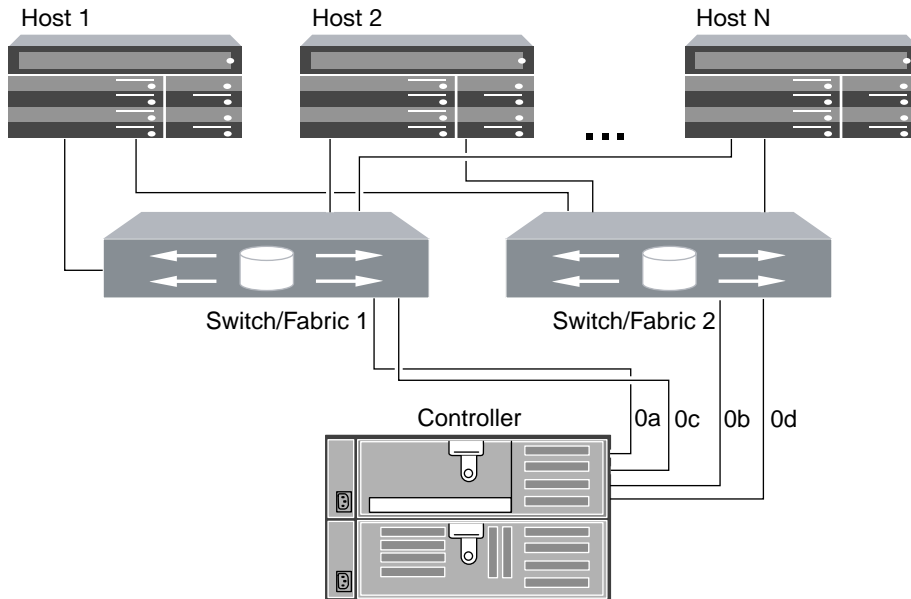


Figure 5: N7x50T series multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	Single fabric or multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

N7x50T series: Single-fabric HA configurations

You can connect hosts to both controllers in an HA configuration through a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric. Portsets should be used to help limit the paths that can be used to access LUNs on the controllers.

Note: The FC target port numbers in the following figure (0a, 0c) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion

adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

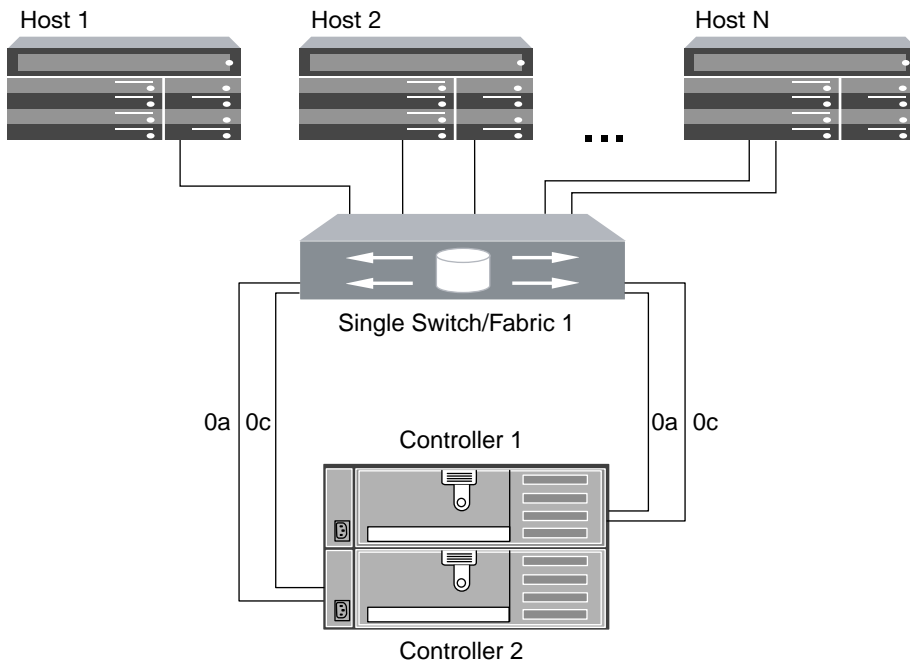


Figure 6: N7x50T series single-fabric HA configuration

Attribute	Value
Fully redundant	No, due to the single fabric
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports using target expansion adapters per controller
Type of configuration	HA configuration

N7x50T series: Multifabric HA configurations

You can connect hosts to both controllers in an HA configuration through two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric. Portsets should be used to help limit the paths that can be used to access LUNs on the controllers.

Note: The FC target port numbers in the following figure (0a, 0b, 0c, and 0d) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

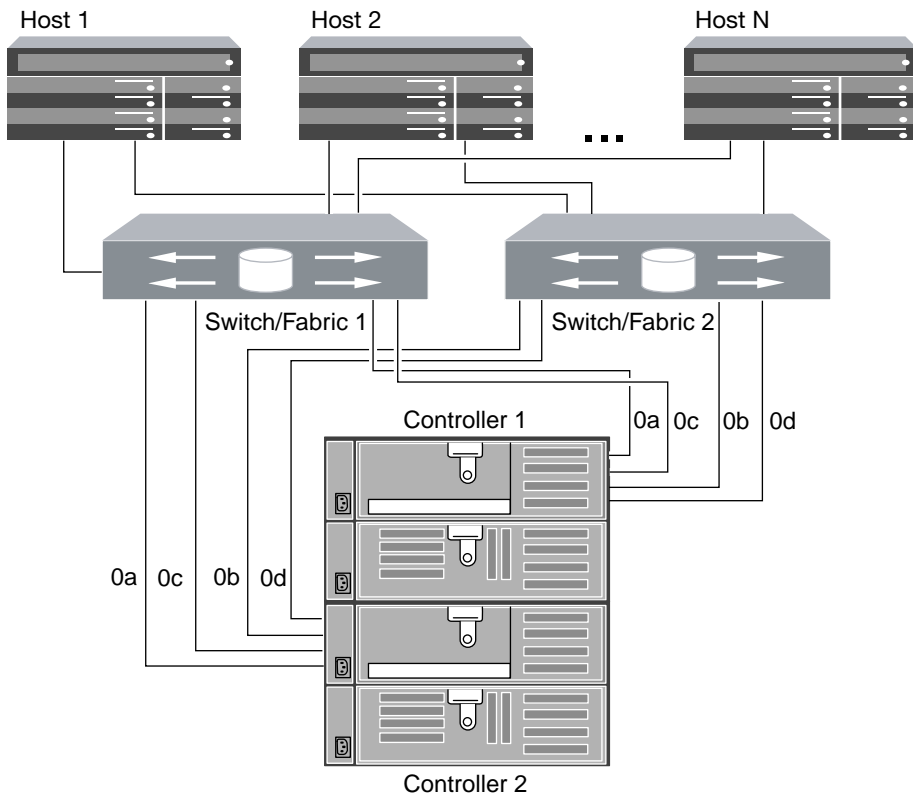


Figure 7: N7x50T series multifabric HA configurations

Attribute	Value
Fully redundant	Yes

Attribute	Value
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports using target expansion adapters per controller
Type of configuration	HA configuration

N7x50T series: Direct-attached single-controller configurations

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport` man page for more information about the command.

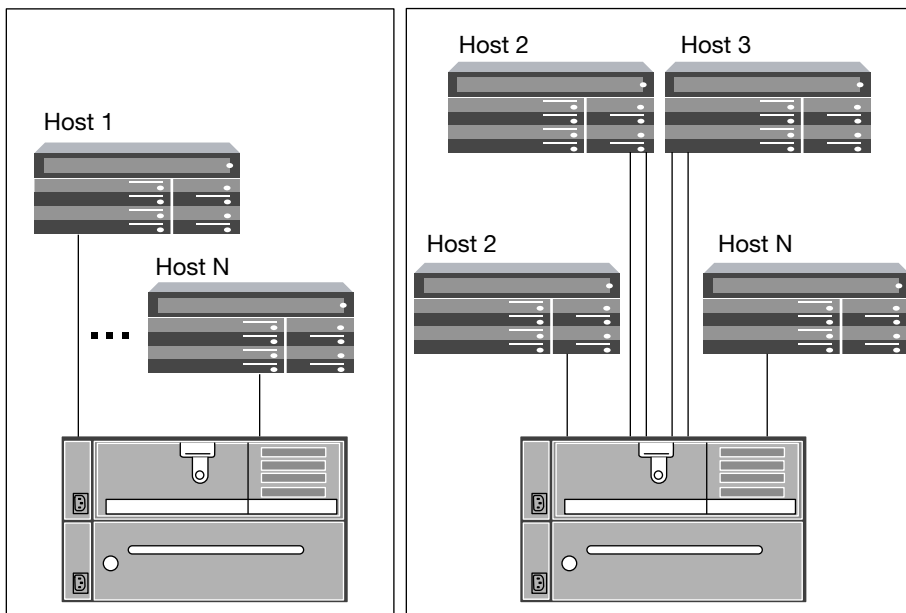


Figure 8: N7x50T series direct-attached single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

N7x50T series: Direct-attached HA configurations

You can connect hosts directly to FC target ports on both controllers in an HA configuration. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fc config mediatype` command to set the target ports; see the `fc` man page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

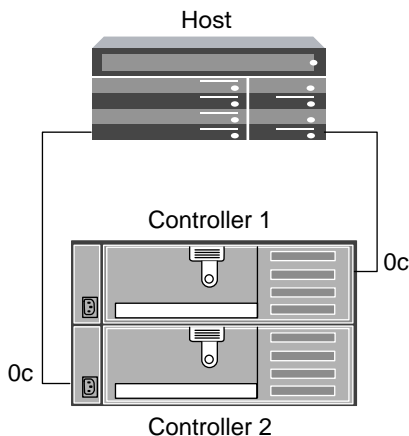


Figure 9: N7x50T series direct-attached HA configuration

Attribute	Value
Fully redundant	Yes
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA configuration

N7000 series supported configurations

N7000 series controllers are available in single-controller and HA pairs.

The N7600 and N7800 systems have eight onboard 2-Gb FC ports per controller which can be used only as initiator ports. The 2-Gb FC ports cannot be initialized if they are configured as target ports.

4-Gb and 8-Gb target connections are supported with 4-Gb and 8-Gb target expansion adapters. You cannot use both 4-Gb and 8-Gb targets on the same controller or on two different controllers in an HA pair.

The N7700 and N7900 systems have eight onboard 4-Gb FC ports per controller and each one can be configured as either a target or initiator FC port. 4-Gb target connections are supported with the onboard 4-Gb ports configured as targets.

Additional target connections can be supported using 4-Gb and 8-Gb target expansion adapters.

N7000 series target port configuration recommendations

For best performance and highest availability, use the recommended FC target port configuration.

The port pairs on an N7000 series controller that share an ASIC are 0a+0b, 0c+0d, 0e+0f, and 0g+0h.

The following table shows the preferred port usage order for onboard FC target ports. For target expansion adapters, the preferred slot order is given in the *N series Introduction and Planning Guide* for the version of Data ONTAP software being used by the controllers.

Number of target ports	Ports
1	0h
2	0h, 0d

Number of target ports	Ports
3	0h, 0d, 0f
4	0h, 0d, 0f, 0b
5	0h, 0d, 0f, 0b, 0g
6	0h, 0d, 0f, 0b, 0g, 0c
7	0h, 0d, 0f, 0b, 0g, 0c, 0e
8	0h, 0d, 0f, 0b, 0g, 0c, 0e, 0a

N7000 series: Single-controller configurations

You can connect hosts to a single controller using a single FC fabric or with multiple FC fabrics. If you use multiple paths, multipathing software is required on the host.

FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figures are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

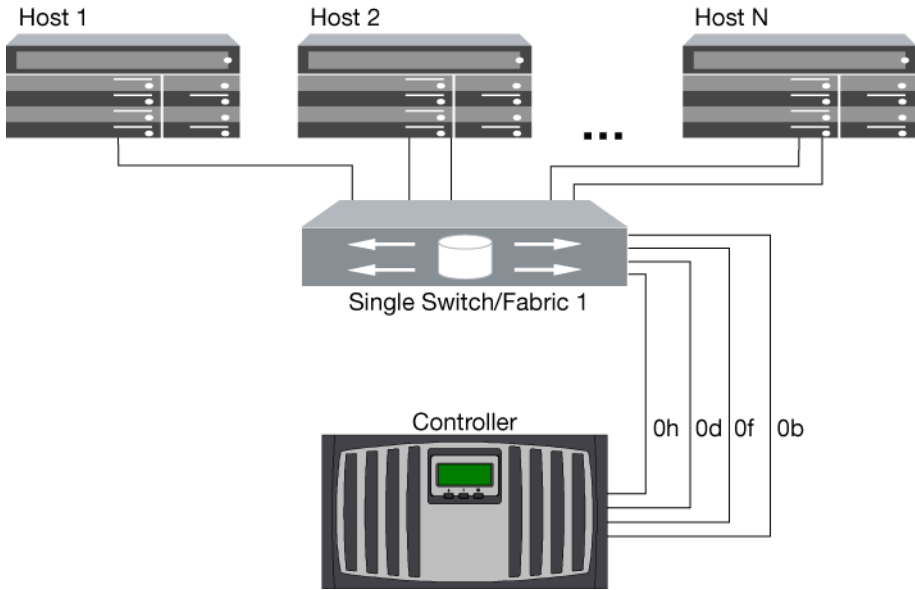


Figure 10: N7000 series single-fabric single-controller configuration

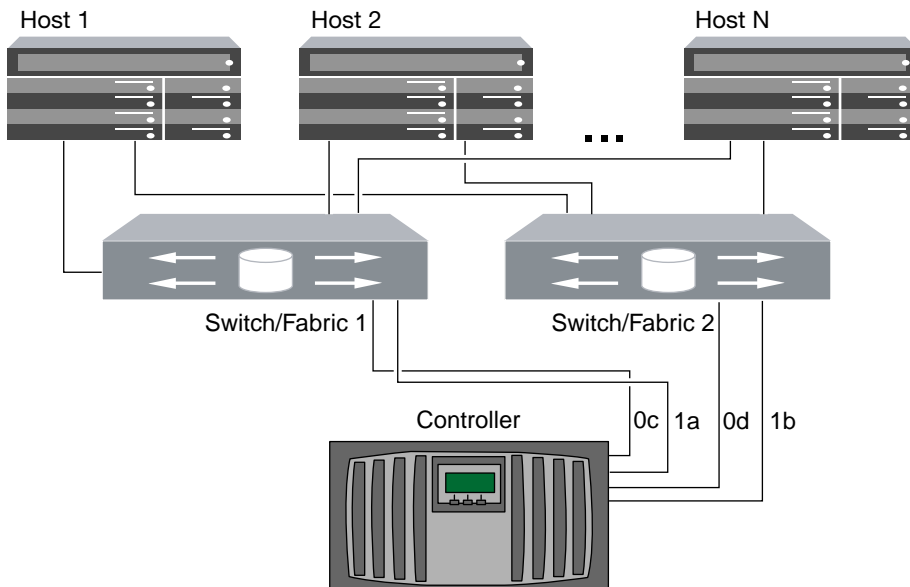


Figure 11: N7000 series multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller

Attribute	Value
Type of fabric	Single fabric or multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

Related references

[N7000 series target port configuration recommendations](#) on page 25

N7000 series: Single-fabric HA pair

You can connect hosts to both controllers in an HA pair using a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

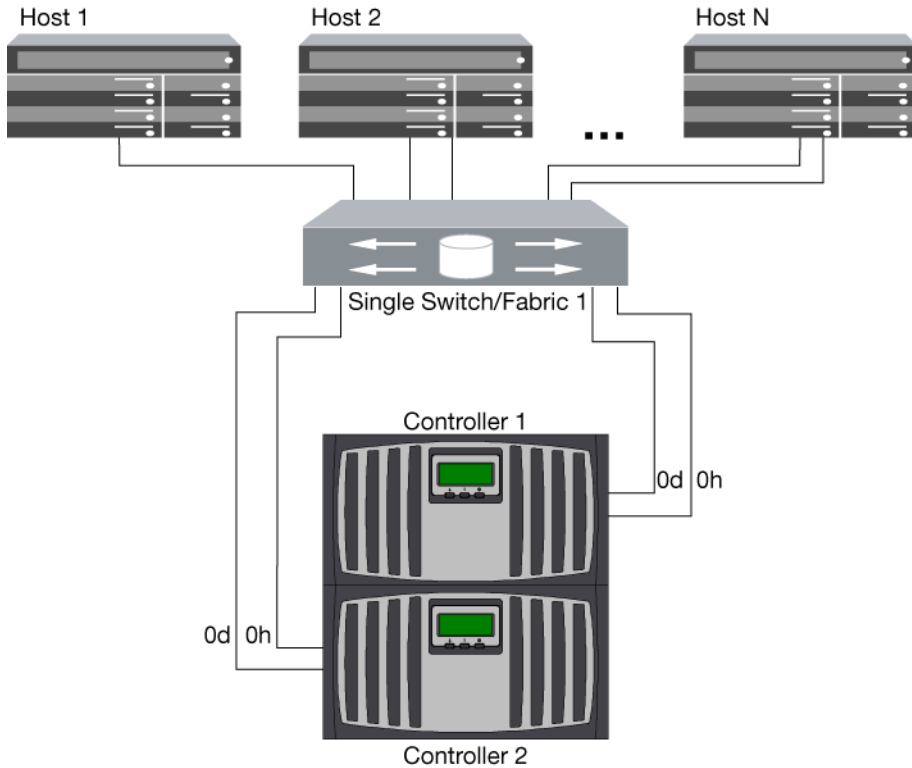


Figure 12: N7000 series single-fabric HA pair

Attribute	Value
Fully redundant	No, due to the single fabric
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports using target expansion adapters per controller
Type of configuration	HA pair

Related references

[N7000 series target port configuration recommendations](#) on page 25

N7000 series: Multifabric HA pair

You can connect hosts to both controllers in an HA pair using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

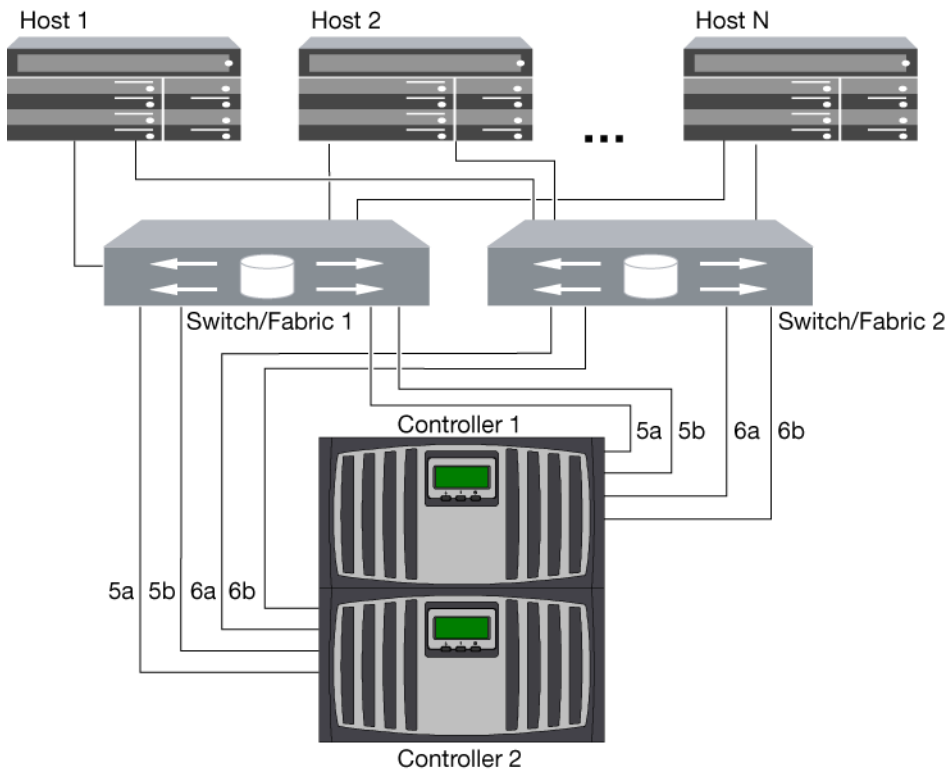


Figure 13: N7000 series multifabric HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	Multifabric

Attribute	Value
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports using target expansion adapters per controller
Type of configuration	HA pair

Related references

[N7000 series target port configuration recommendations](#) on page 25

N7000 series: Direct-attached single-controller configuration

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport man` page for more information about the command.

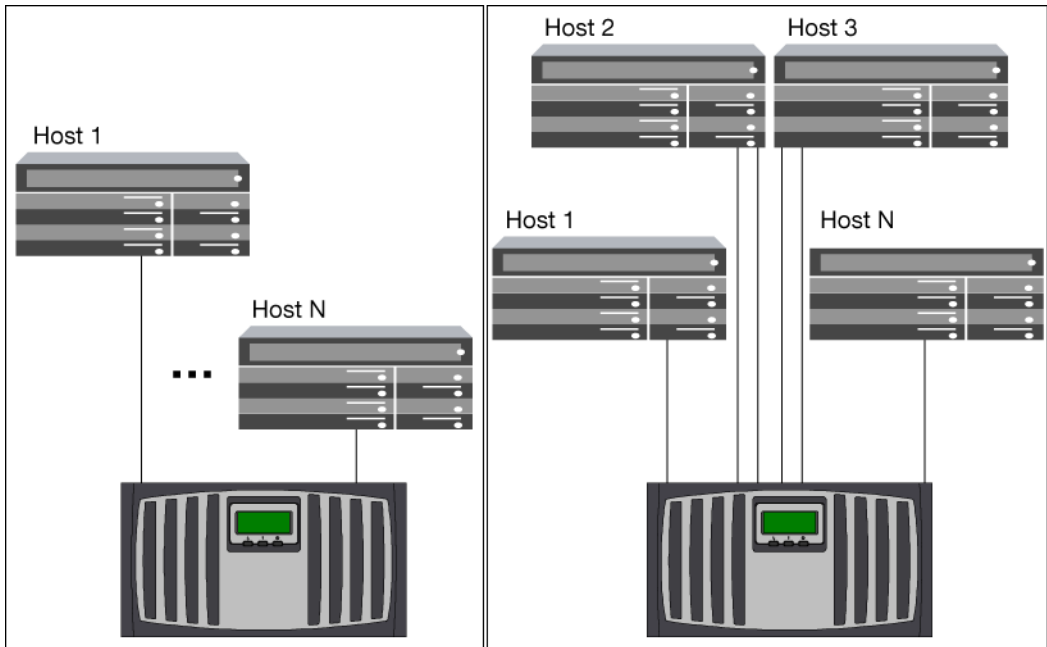


Figure 14: N7000 series direct-attached single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

Related references

[N7000 series target port configuration recommendations](#) on page 25

N7000 series: Direct-attached HA pair

You can connect hosts directly to FC target ports on both controllers in an HA pair. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport man` page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

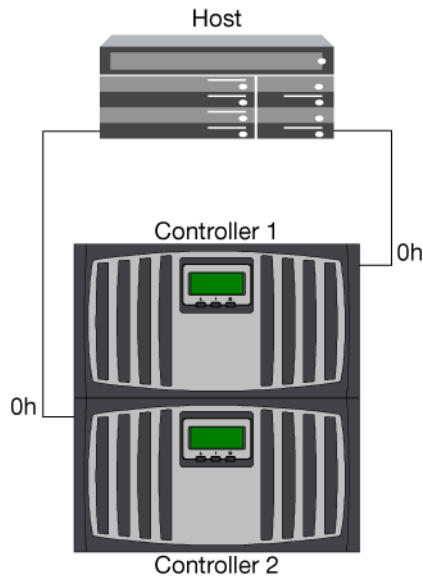


Figure 15: N7000 series direct-attached HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA pair

Related references

[N7000 series target port configuration recommendations](#) on page 25

N6200 series supported fibre channel configurations

N6200 series systems are available in HA configurations.

The N6200 series systems have two onboard 4-Gb FC ports per controller that can be configured as FC target ports. There are also two SAS ports for connecting disk shelves.

Each N6200 series controller supports 4-Gb and 8-Gb FC target expansion adapters.

N6200 series target port configuration recommendations

For best performance and highest availability, use the recommended FC target port configuration.

The following table shows the preferred port usage order for N6200 series onboard FC target ports. For target expansion adapters, the preferred slot order is given in the *N series Introduction and Planning Guide* for the version of Data ONTAP software being used by the controllers.

Number of target ports	Ports
1	0c
2	0c, 0d

N6200 series: Single-controller configurations

You can connect hosts to a single controller using a single FC fabric or with multiple FC fabrics.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figures are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

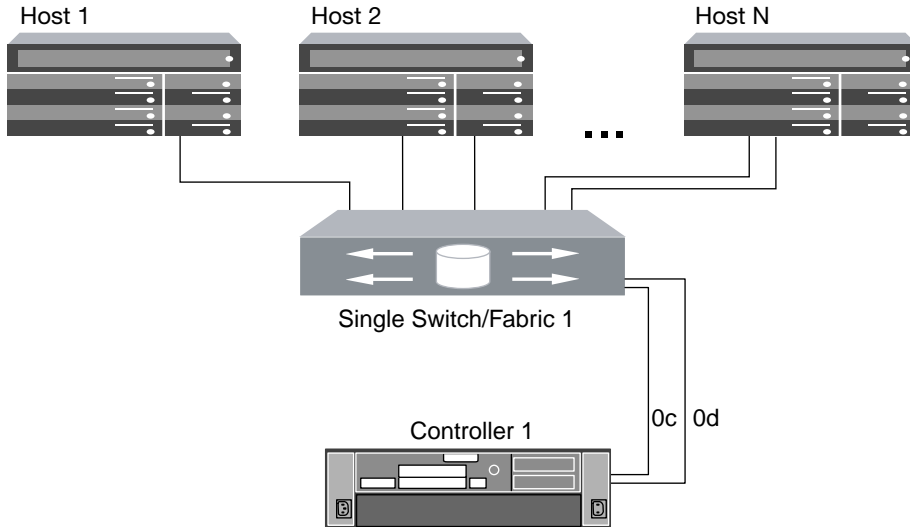


Figure 16: N6200 series single-fabric single-controller configuration

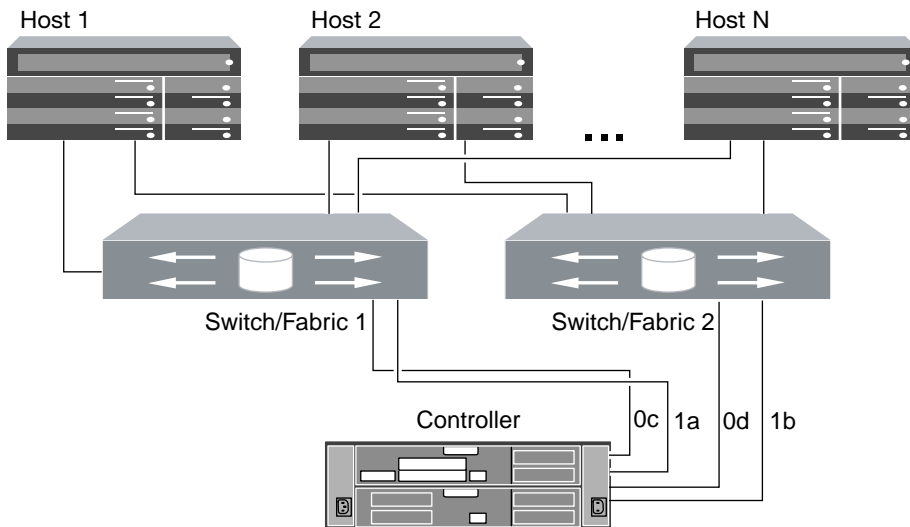


Figure 17: N6200 series multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	Single fabric or multifabric
Different host operating systems	Yes, with multiple-host configurations

Attribute	Value
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

N6200 series: Single-fabric HA configurations

You can connect hosts to both controllers in an HA configuration using a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric. Portsets should be used to help limit the paths that can be used to access LUNs on the controllers.

Note: The FC target port numbers in the following figure (0c, 0d) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

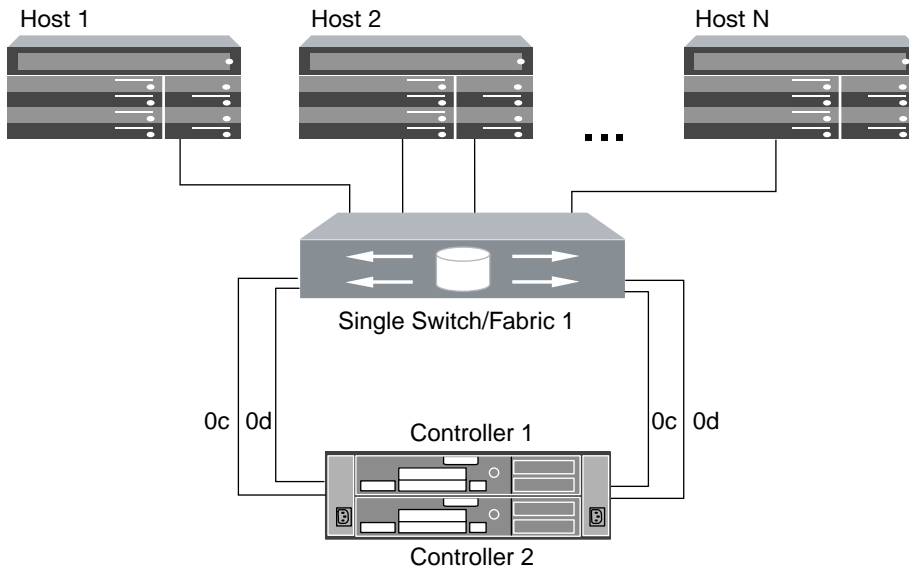


Figure 18: N6200 series single-fabric HA configuration

Attribute	Value
Fully redundant	No, due to the single fabric

Attribute	Value
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA configuration

N6200 series: Multifabric HA configurations

You can connect hosts to both controllers in an HA configuration using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric. Portsets should be used to help limit the paths that can be used to access LUNs on the controllers.

Note: The FC target port numbers in the following figure (0c, 0d, 1a, 1b) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

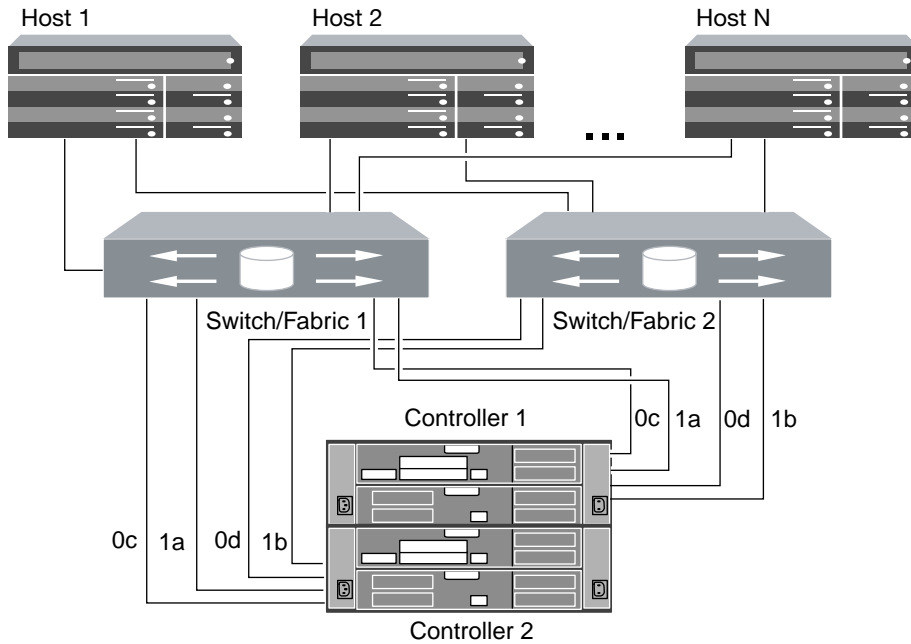


Figure 19: N6200 series multifabric HA configuration

Attribute	Value
Fully redundant	Yes
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA configuration

N6200 series: Direct-attached single-controller configurations

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fc`

`config mediatype` command to set the target ports; see the `fcip` man page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

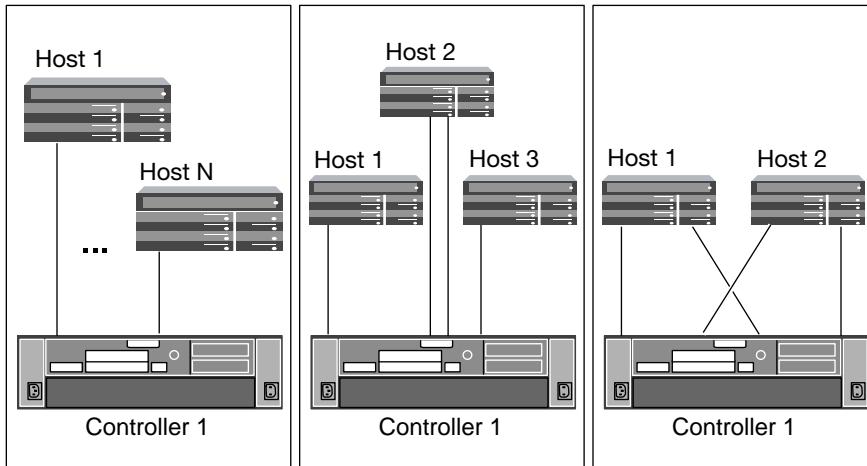


Figure 20: N6200 series direct-attached single-controller configurations

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

N6200 series: Direct-attached HA configurations

You can connect hosts directly to FC target ports on both controllers in an HA configuration. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport man` page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

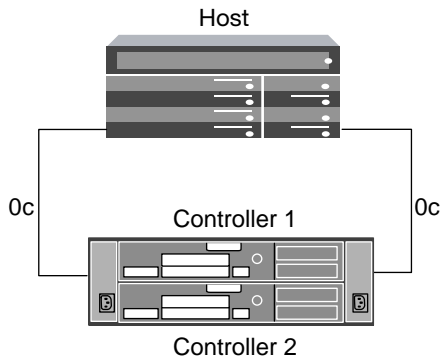


Figure 21: N6200 series direct-attached HA configuration

Attribute	Value
Fully redundant	Yes
Type of fabric	None
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA pair

N3220 and N3240 supported configurations

N3220 and N3240 systems are available in single-controller and HA configurations.

The N3220 and N3240 systems have no onboard FC ports. For FC configurations, you must add the optional 2-port 8-Gb FC adapter in slot 1. No other FC ports are available.

Each port on the optional N3220 and N3240 FC adapter can be individually configured as either a target or initiator FC port using the `fcadmin config` command, just like the onboard FC ports on other controller models.

There are also two SAS ports for connecting disk shelves.

N3220 and N3240: Single-fabric single-controller configuration

You can connect hosts to a single controller using a single FC switch. If you use multiple paths, multipathing software is required on the host.

FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The following illustration shows the storage controllers side by side, which is how they are mounted in the N3220. For the N3240, the controllers are mounted one above the other. There is no difference between the SAN configuration for the two models.

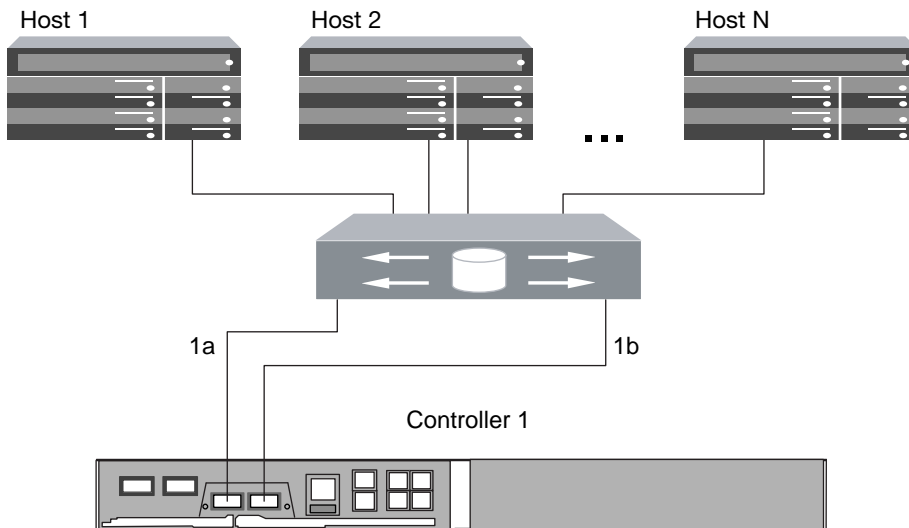


Figure 22: N3220 and N3240 single-fabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single fabric and single controller
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One or two ports on the 2-port 8-Gb FC expansion adapter configured as targets
Type of configuration	Single-controller configuration

N3220 and N3240: Single-fabric HA pair

You can connect hosts to both controllers in an HA pair using a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The following illustration shows the storage controllers side by side, which is how they are mounted in the N3220. For the N3240, the controllers are mounted one above the other. There is no difference in the SAN configuration between the two models.

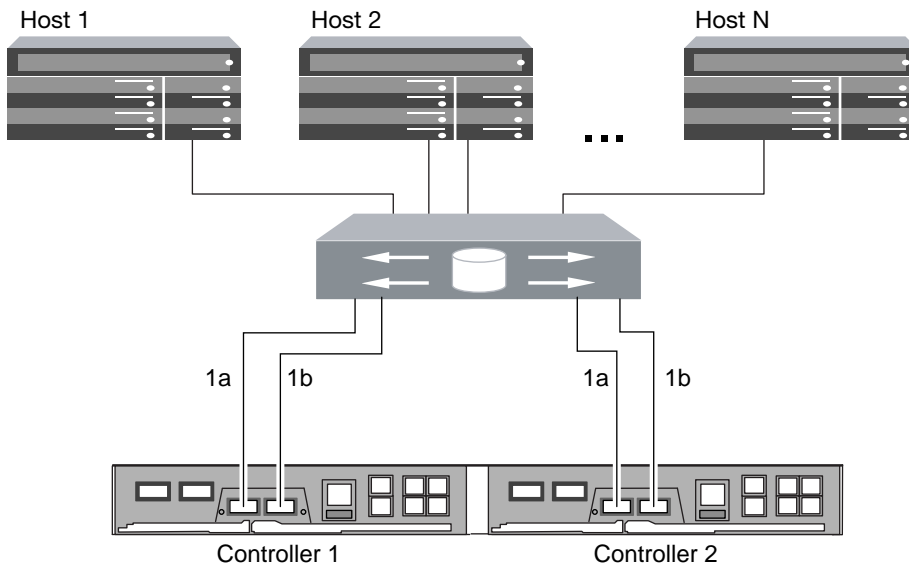


Figure 23: N3220 and N3240 single-fabric HA pair

Attribute	Value
Fully redundant	No, due to the single fabric
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One or two ports on the 2-port 8-Gb FC expansion adapter configured as targets on each controller
Type of configuration	HA pair

N3220 and N3240: Multifabric single-controller configuration

You can connect hosts to one controller using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The following illustration shows the storage controllers side by side, which is how they are mounted in the N3220. For the N3240, the controllers are mounted one above the other. There is no difference in the SAN configuration between the two models.

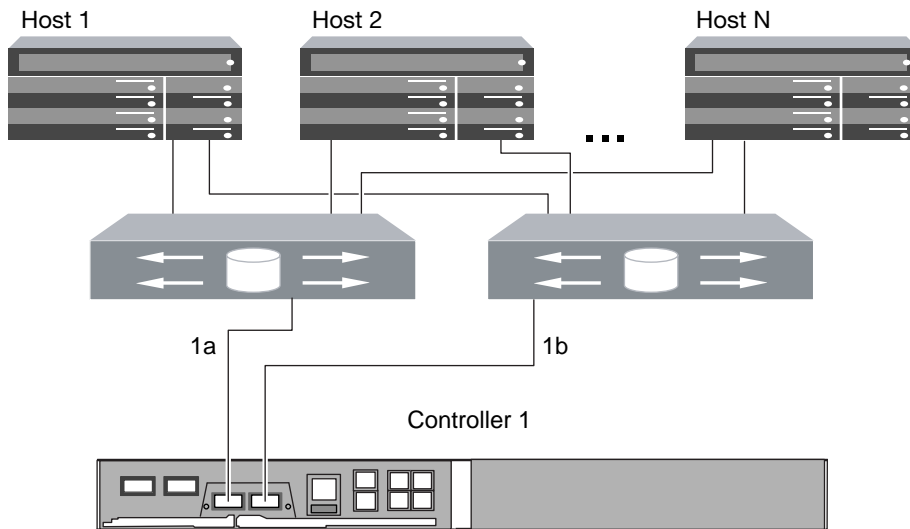


Figure 24: N3220 and N3240 multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	Both ports on the supported 2-port 8-Gb FC expansion adapter configured as targets
Type of configuration	Single-controller configuration

N3220 and N3240: Multifabric HA pair

You can connect hosts to both controllers in an HA pair using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning or portsets are recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The following illustration shows the storage controllers side by side, which is how they are mounted in the N3220. For the N3240, the controllers are mounted one above the other. There is no difference in the SAN configuration between the two models.

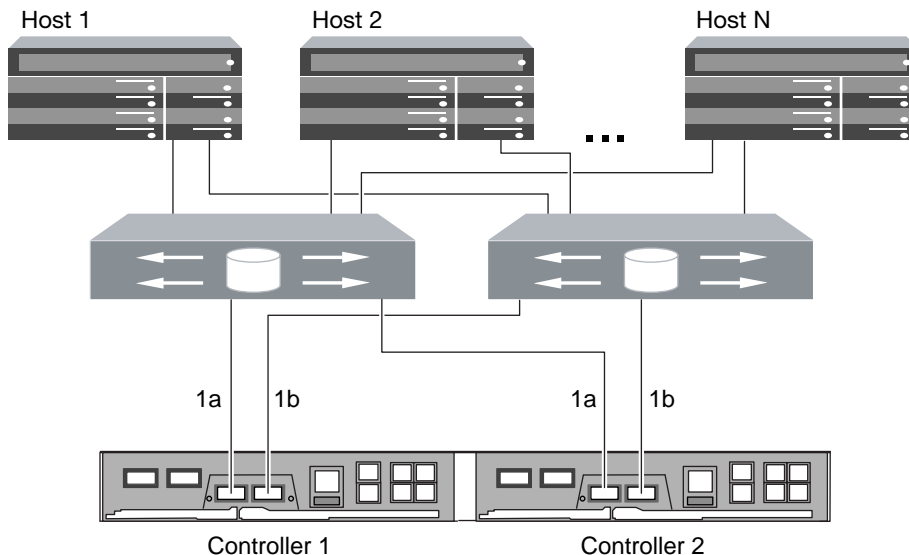


Figure 25: N3220 and N3240 multifabric HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	Both ports on the supported 2-port 8-Gb FC expansion adapter configured as targets on each controller
Type of configuration	HA pair

N3220 and N3240: Direct-attached single-controller configurations

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport` man page for more information about the command.

Note: The following illustration shows the storage controllers side by side, which is how they are mounted in the N3220. For the N3240, the controllers are mounted one above the other. There is no difference in the SAN configuration between the two models.

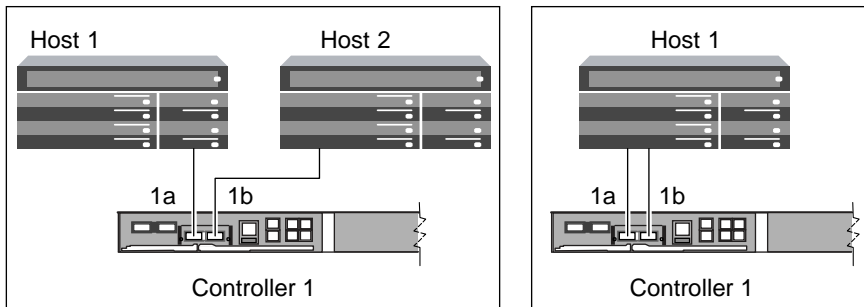


Figure 26: N3220 and N3240 direct-attached single-controller configurations

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One or two ports on the 2-port 8-Gb FC expansion adapter configured as targets
Type of configuration	Single-controller configuration

N3220 and N3240: Direct-attached HA pair

You can connect hosts directly to FC target ports on both controllers in an HA pair. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fc config mediatype` command to set the target ports; see the `fc` man page for more information about the command.

Note: The following illustration shows the storage controllers side by side, which is how they are mounted in the N3220. For the N3240, the controllers are mounted one above the other. There is no difference in the SAN configuration for the two models.

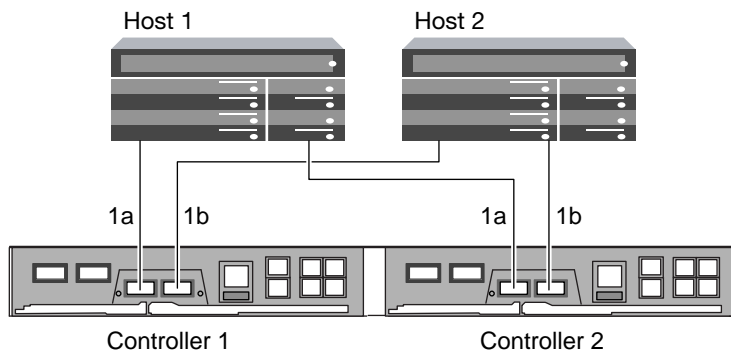


Figure 27: N3220 and N3240 direct-attached HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One or two ports on the 2-port 8-Gb FC expansion adapter configured as targets on each controller
Type of configuration	HA pair

N6000 series supported fibre channel configurations

N6000 series systems are available in HA pairs.

The N6000 series systems have four onboard 4-Gb FC ports per controller and each port can be configured as either an FC target port or an initiator port. For example, you can configure two ports as SAN targets and two ports as initiators for disk shelves.

Each N6000 series controller supports 4-Gb and 8-Gb FC target expansion adapters.

N6000 series target port configuration recommendations

For best performance and highest availability, use the recommended FC target port configuration.

The port pairs on an N6000 series controller that share an ASIC are 0a+0b and 0c+0d.

The following table shows the preferred port usage order for onboard FC target ports. For target expansion adapters, the preferred slot order is given in the *N series Introduction and Planning Guide* for the version of Data ONTAP software being used by the controllers.

Number of target ports	Ports
1	0d
2	0d, 0b
3	0d, 0b, 0c
4	0d, 0b, 0c, 0a

N6000 series: Single-controller configurations

You can connect hosts to a single controller using a single FC fabric or with multiple FC fabrics. If you use multiple paths, multipathing software is required on the host.

FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figures are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

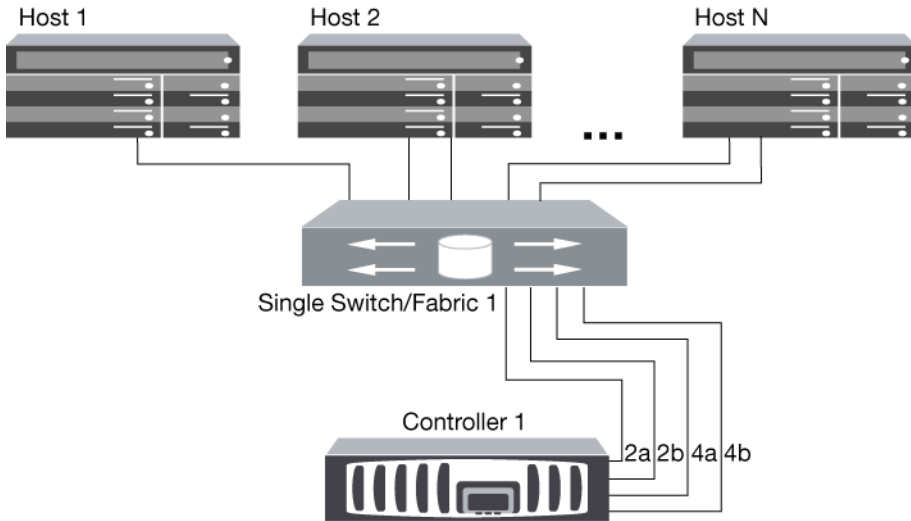


Figure 28: N6000 series single-fabric single-controller configuration

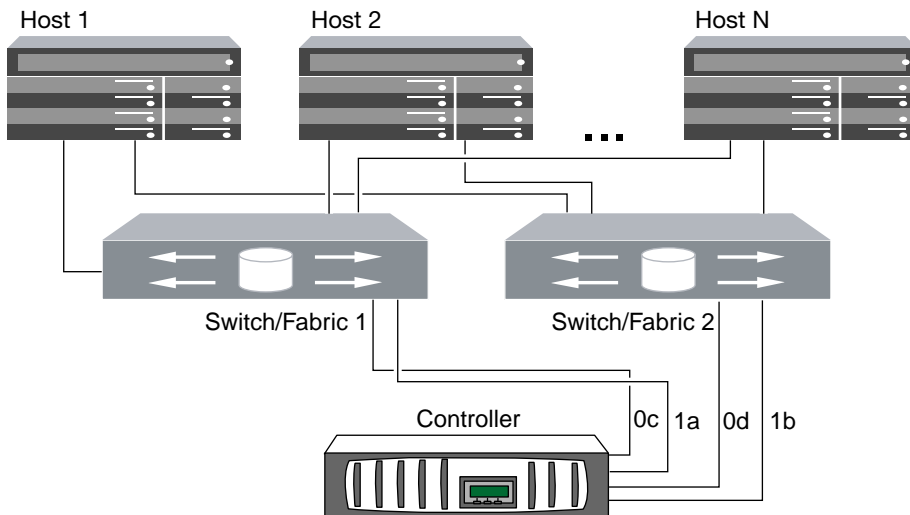


Figure 29: N6000 series multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	Single fabric or multifabric
Different host operating systems	Yes, with multiple-host configurations

Attribute	Value
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

Related references

[N6000 series target port configuration recommendations](#) on page 47

N6000 series: Single-fabric HA pair

You can connect hosts to both controllers in an HA pair using a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric. Portsets should be used to help limit the paths that can be used to access LUNs on the controllers.

Note: The FC target port numbers in the following figure (0b and 0d) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

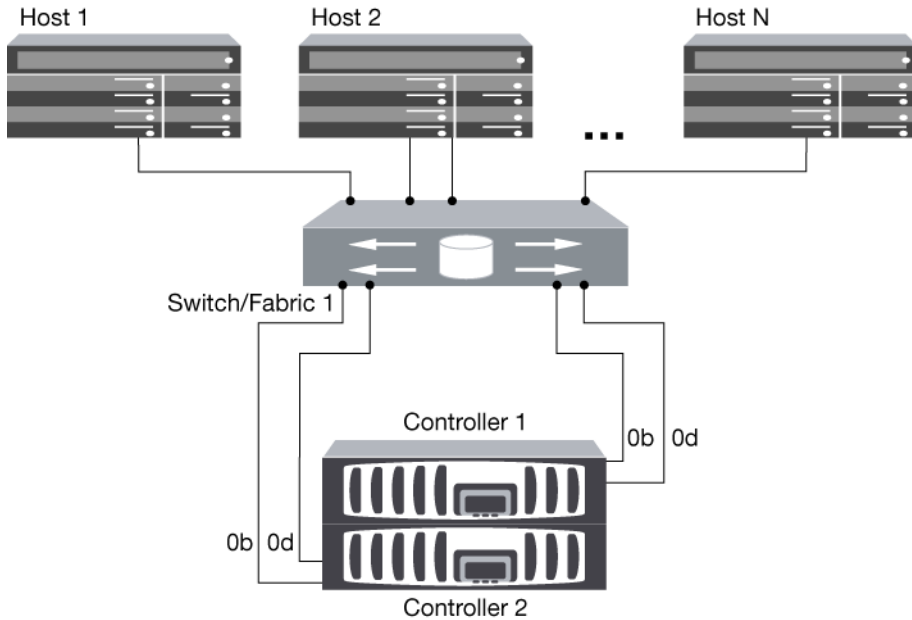


Figure 30: N6000 series single-fabric HA pair

Attribute	Value
Fully redundant	No, due to the single fabric
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA pair

Related references

[N6000 series target port configuration recommendations](#) on page 47

N6000 series: Multifabric HA pair

You can connect hosts to both controllers in an HA pair using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric. Portsets should be used to help limit the paths that can be used to access LUNs on the controllers.

Note: The FC target port numbers in the following figure (0a, 0b, 0c, and 0d) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

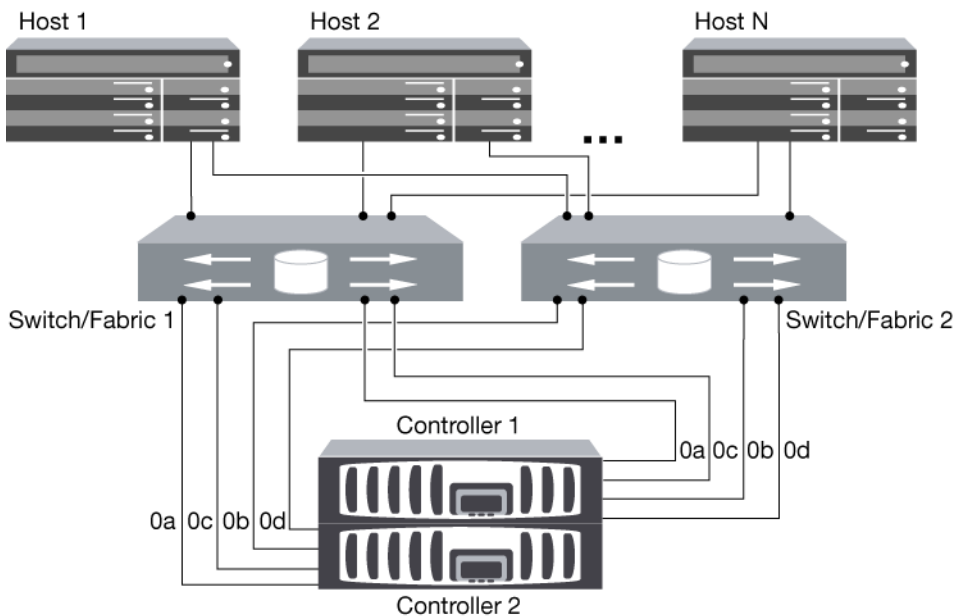


Figure 31: N6000 series multifabric HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations

Attribute	Value
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA pair

Related references

[N6000 series target port configuration recommendations](#) on page 47

N6000 series: Direct-attached single-controller configurations

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcpcfg mediatype` command to set the target ports; see the `fcpcfg` man page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

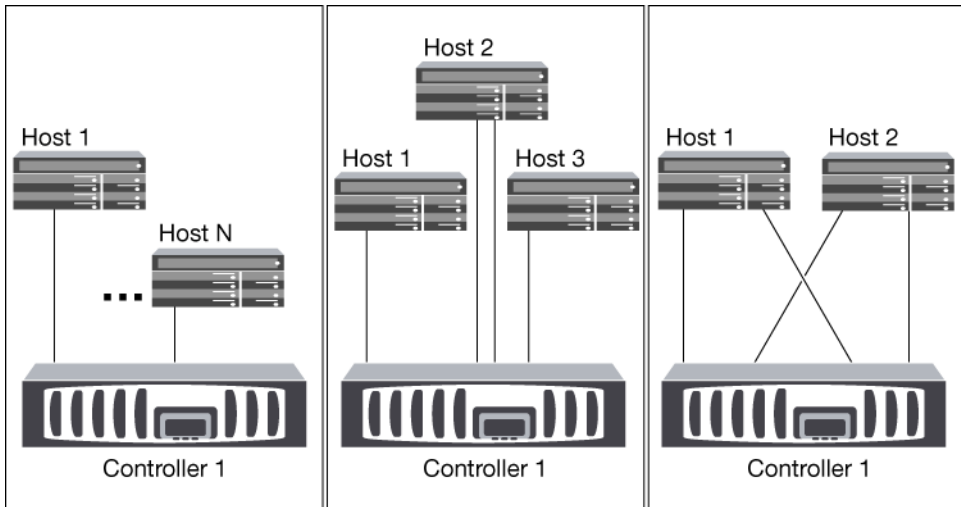


Figure 32: N6000 series direct-attached single-controller configurations

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

Related references

[N6000 series blue port configuration recommendations](#) on page 47

N6000 series: Direct-attached HA pair

You can connect hosts directly to FC target ports on both controllers in an HA pair. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fc cp`

`config mediatype` command to set the target ports; see the `fc` man page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

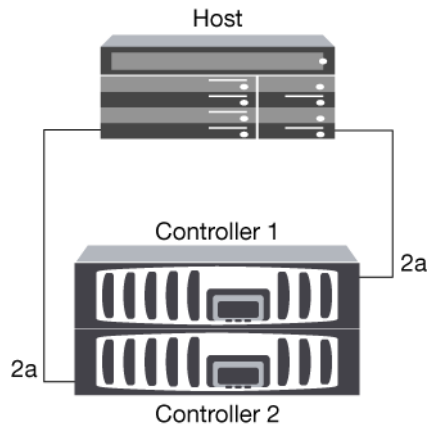


Figure 33: N6000 series direct-attached HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	None
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA pair

Related references

[N6000 series target port configuration recommendations](#) on page 47

N5000 series supported configurations

N5000 series systems are available in single-controller and HA pairs.

Each N5300 and N5600 controller supports 4-Gb and 8-Gb FC target expansion adapters.

N5000 series target port configuration recommendations

For best performance and highest availability, use the recommended FC target port configuration.

The port pairs on an N5000 series controller that share an ASIC are 0a+0b, 0c+0d.

The following table shows the preferred port usage order for onboard FC target ports. For target expansion adapters, the preferred slot order is given in the *N series Introduction and Planning Guide* for the version of Data ONTAP software being used by the controllers.

Number of target ports	Ports
1	0d
2	0d, 0b
3	0d, 0b, 0c
4	0d, 0b, 0c, 0a

N5300 and N5600 supported configurations

N5300 and N5600 systems are available in single-controller and HA pairs.

The N5300 and N5600 controllers have four onboard 4-Gb FC ports per controller and each port can be configured as either an FC target port or an initiator port. For example, you can configure two ports as SAN targets and two ports as initiators for disk shelves.

N5300 and N5600: Single-controller configurations

You can connect hosts to single controllers using a single FC fabric or with multiple FC fabrics. If you use multiple paths, multipathing software is required on the host.

FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figure (2a, 2b, 4a, 4b) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

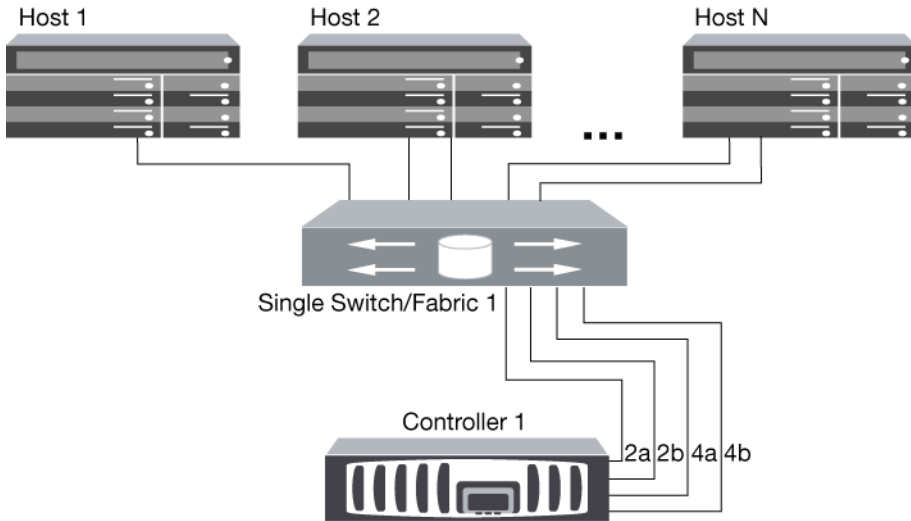


Figure 34: N5300 and N5600 single-fabric single-controller configuration

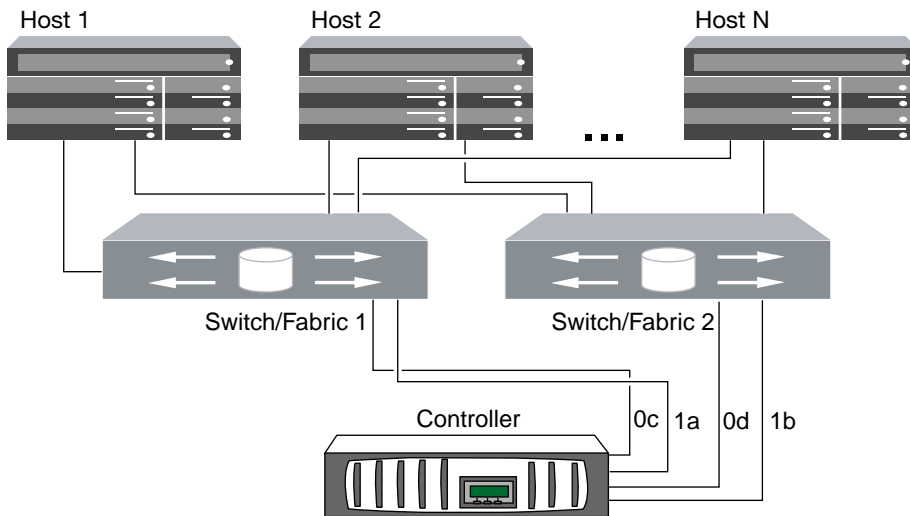


Figure 35: N5300 and N5600 multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	Single fabric or multifabric
Different host operating systems	Yes, with multiple-host configurations

Attribute	Value
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

Related references

[N5000 series target port configuration recommendations](#) on page 55

N5300 and N5600: Single-fabric HA pair

You can connect hosts to both controllers in an HA pair using a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figure (0b, 0d) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

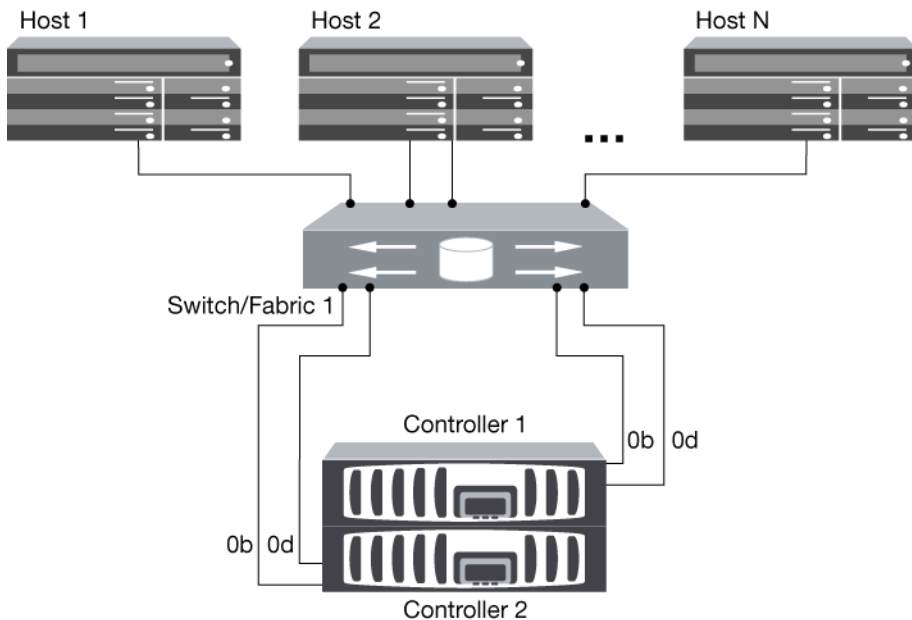


Figure 36: N5300 and N5600 single-fabric HA pair

Attribute	Value
Fully redundant	No, due to the single fabric
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports using target expansion adapters per controller
Type of configuration	HA pair

Related references

[N5000 series target port configuration recommendations](#) on page 55

N5300 and N5600: Multifabric HA pair

You can connect hosts to both controllers in an HA pair using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following figure (0a, 0b, 0c, 0d) are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

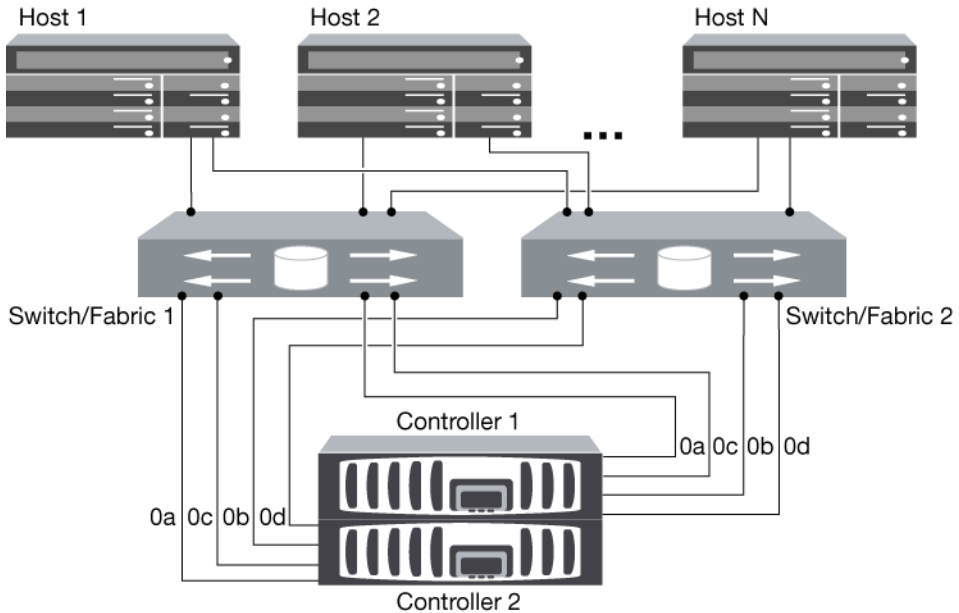


Figure 37: N5300 and N5600 multifabric HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports using target expansion adapters per controller
Type of configuration	HA pair

Related references

[N5000 series target port configuration recommendations](#) on page 55

N5300 and N5600: Direct-attached single-controller configurations

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport` man page for more information about the command.

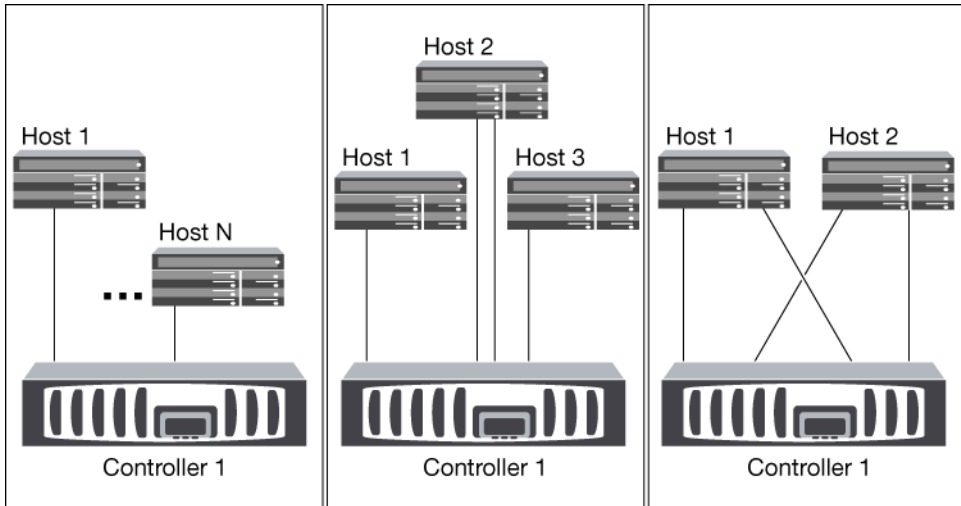


Figure 38: N5300 and N5600 direct-attached single-controller configurations

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	Single-controller configuration

Related references

[N5000 series target port configuration recommendations](#) on page 55

N5300 and N5600: Direct-attached HA pair

You can connect hosts directly to FC target ports on both controllers in an HA pair. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport` man page for more information about the command.

Note: The FC target port numbers in the following figure are examples. The actual port numbers might vary depending on whether you are using onboard ports or FC target expansion adapters. If you are using FC target expansion adapters, the target port numbers also depend on the expansion slots into which your target expansion adapters are installed.

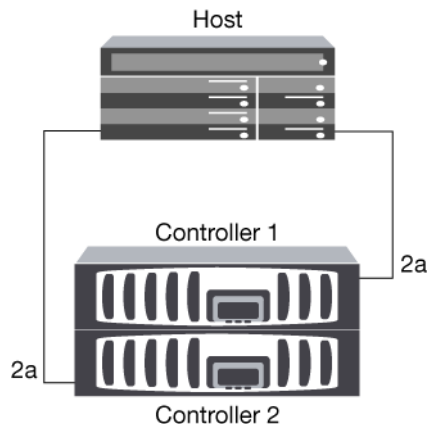


Figure 39: N5300 and N5600 direct-attached HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	None
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC target expansion adapters
Type of configuration	HA pair

Related references

[N5000 series target port configuration recommendations](#) on page 55

N3400 supported configurations

N3400 systems are available in single-controller and HA pairs.

The N3400 have two onboard 4-Gb FC ports per controller. You can configure these ports as either target ports for FC SANs or initiator ports for connecting to disk shelves.

N3400: Single-fabric single-controller configuration

You can connect hosts to a single controller using a single FC switch. If you use multiple paths, multipathing software is required on the host.

FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following illustration (0a, 0b) are examples.

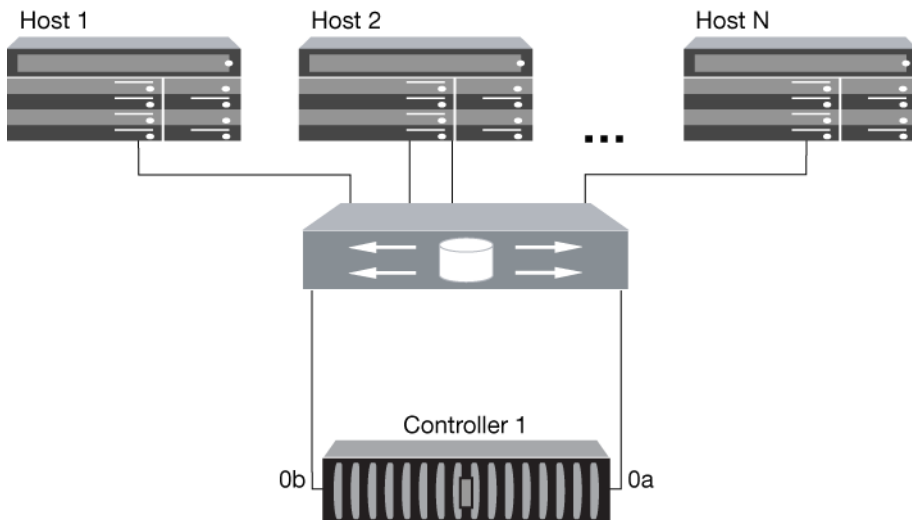


Figure 40: N3400 single-fabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single fabric and single controller
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations

Attribute	Value
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller
Type of configuration	Single-controller configuration

N3400: Single-fabric HA pair

You can connect hosts to both controllers in an HA pair using a single FC switch.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following illustration (0a, 0b) are examples.

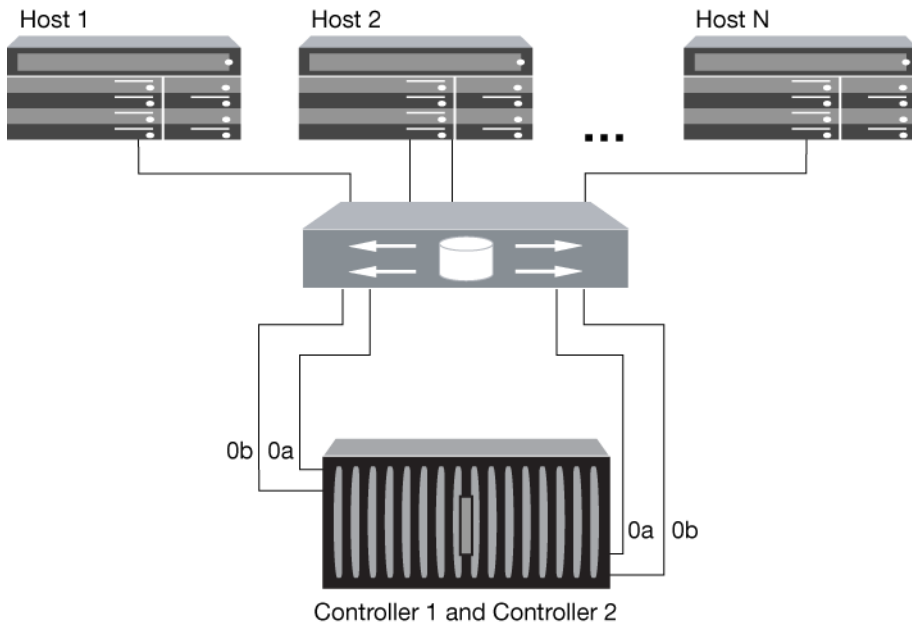


Figure 41: N3400 single-fabric HA pair

Attribute	Value
Fully redundant	No, due to the single fabric
Type of fabric	Single fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller

Attribute	Value
Type of configuration	HA pair

N3400: Multifabric single-controller configuration

You can connect hosts to one controller using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following illustration (0a, 0b) are examples.

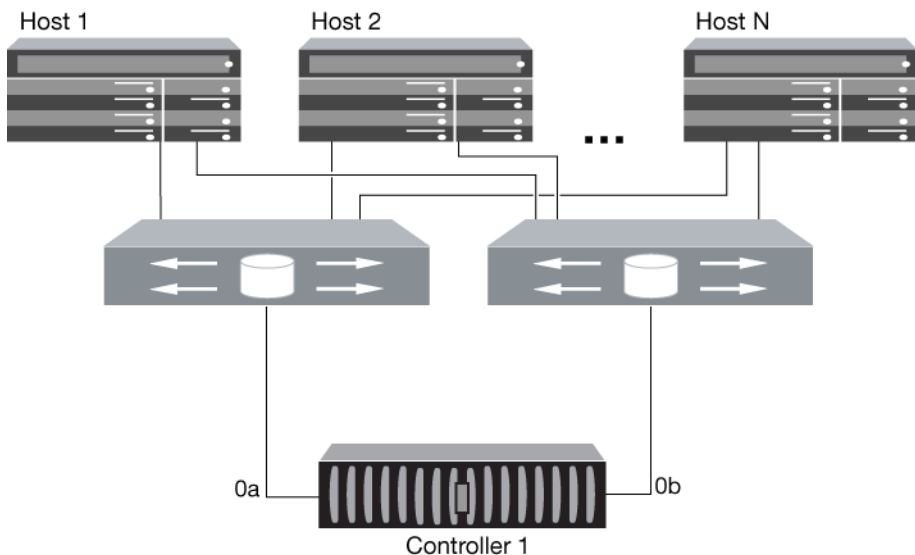


Figure 42: N3400 multifabric single-controller configuration

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller
Type of configuration	Single-controller configuration

N3400: Multifabric HA pair

You can connect hosts to both controllers in an HA pair using two or more FC switch fabrics for redundancy.

If you use multiple paths to a LUN, multipathing software is required on the host. FC switch zoning is recommended to limit the number of paths between hosts and LUNs in configurations with multiple target ports connected to the same fabric.

Note: The FC target port numbers in the following illustration (0a, 0b) are examples.

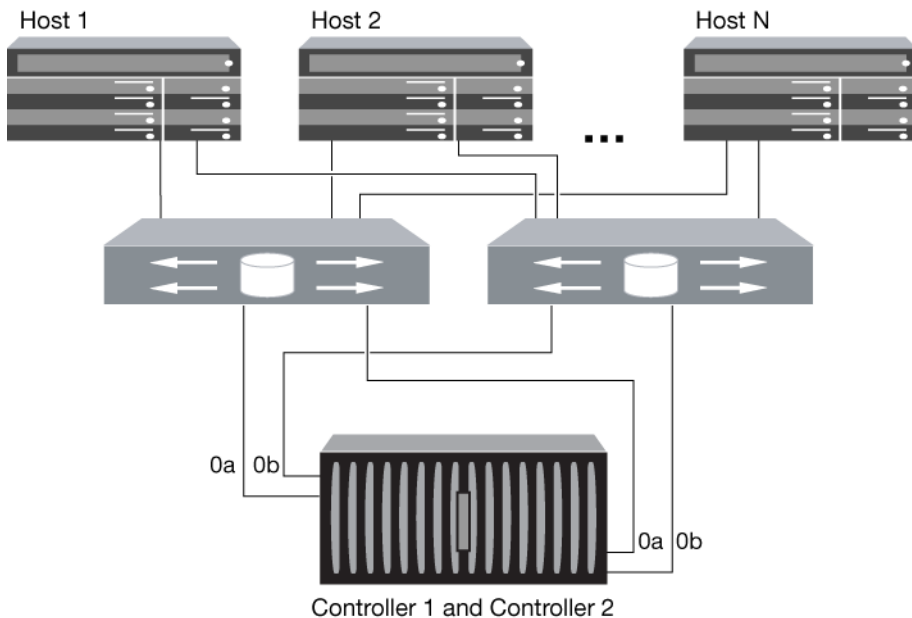


Figure 43: N3400 multifabric HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	Multifabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller
Type of configuration	HA pair

N3400: Direct-attached single-controller configurations

You can connect hosts directly to FC target ports on a single controller. Each host can connect to one port, or to two ports for redundancy. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fc config mediatype` command to set the target ports; see the `fc` man page for more information about this command.

Note: The FC target port numbers in the following illustration (0a, 0b) are examples.

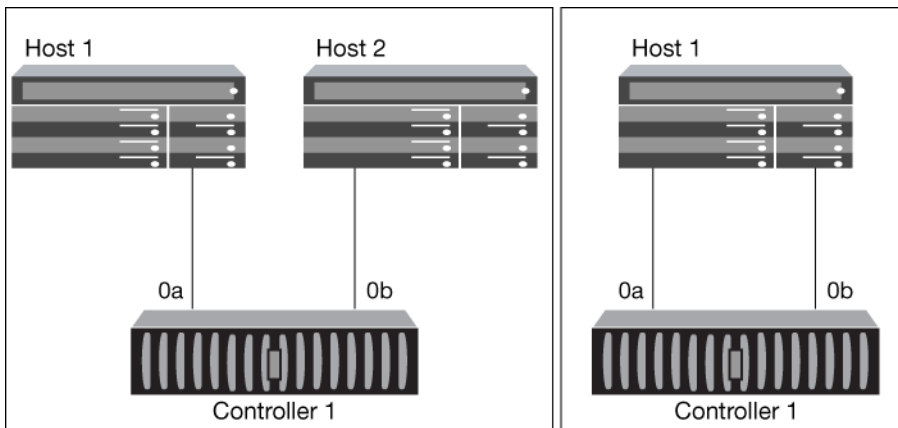


Figure 44: N3400 direct-attached single-controller configurations

Attribute	Value
Fully redundant	No, due to the single controller
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller
Type of configuration	Single-controller configuration

N3400: Direct-attached HA pair

You can connect hosts directly to FC target ports on both controllers in an HA pair. The number of hosts is limited by the number of available target ports.

If you use multiple paths to a LUN, multipathing software is required on the host.

Direct-attached configurations typically need the FC ports set to loop mode. Be sure to follow the recommendation of your host operating system provider for FC port settings. You can use the `fcport config mediatype` command to set the target ports; see the `fcport man` page for more information about the command.

Note: The FC target port numbers in the following illustration (0a, 0b) are examples.

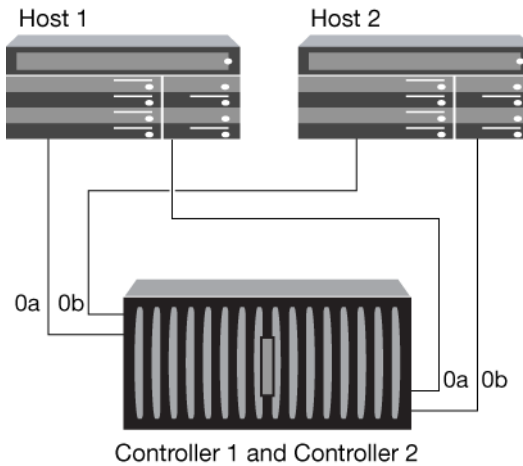


Figure 45: N3400 direct-attached HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	None
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller
Type of configuration	HA pair

Fibre Channel over Ethernet overview

Fibre Channel over Ethernet (FCoE) is a model for connecting hosts to storage systems. As with Fibre Channel (FC), FCoE maintains existing FC management and controls. However, the hardware transport is a lossless 10-Gb Ethernet network.

Setting up an FCoE connection on the host requires one or more supported converged network adapters (CNAs) in the host, connected to a supported FCoE switch. The CNA is a consolidation point and effectively serves as both an FC HBA and an Ethernet adapter.

The CNA is presented to the host as both an FCoE Initiator HBA and a 10-Gb Ethernet adapter. The FCoE Initiator HBA portion of the CNA handles the FCoE traffic when traffic is sent and received as FC frames mapped into Ethernet packets (FC over Ethernet). The Ethernet adapter portion of the CNA handles the standard Ethernet host IP traffic, such as iSCSI, CIFS, NFS, and HTTP, for the host. Both the FCoE and standard Ethernet portions of the CNA communicate over the same Ethernet port, which connects to the FCoE switch.

The FCoE target adapter is also called a "unified target adapter" or UTA. Like the CNA in the host, the UTA supports both FCoE and regular Ethernet traffic.

You should configure jumbo frames (MTU = 9000) for the Ethernet adapter portion of the CNA. You cannot change the MTU for the FCoE portion of the adapter.

Note: Unified target adapters (UTAs) are 10-Gb converged network adapters (CNAs) that you install in your storage systems.

In general, you configure and use FCoE connections just like traditional FC connections. You can use UTAs for non-FCoE IP traffic such as NFS, CIFS, or iSCSI.

Note: For detailed information about how to set up and configure your host to run FCoE, see your host documentation.

FCoE initiator and target combinations

Certain combinations of FCoE and traditional FC initiators and targets are supported.

FCoE initiators

You can use FCoE initiators in host computers with both FCoE and traditional FC targets in storage controllers. The host FCoE initiator must connect to an FCoE DCB (data center bridging) switch; direct connection to a target is not supported.

The following table lists the supported combinations.

Initiator	Target	Supported?
FC	FC	Yes
FC	FCoE	Yes
FCoE	FC	Yes
FCoE	FCoE	Yes

FCoE targets

You can mix FCoE target ports with 4-Gb or 8-Gb FC ports on the storage controller regardless of whether the FC ports are add-in target adapters or onboard ports. You can have both FCoE and FC target adapters in the same storage controller.

Note: The rules for combining onboard and expansion FC ports still apply.

Related references

[Rules for combining onboard and expansion FC ports](#) on page 15

Fibre Channel over Ethernet supported hop count

The maximum supported FCoE hop count between a host and storage system depends on the switch supplier and storage system support for FCoE configurations.

The hop count is defined as the number of switches in the path between the initiator (host) and target (storage system). Documentation from Cisco Systems also refers to this value as the *diameter of the SAN fabric*.

For FCoE, you can have FCoE switches connected to FC switches.

For end-to-end FCoE connections, the FCoE switches must be running a firmware version that supports Ethernet inter-switch links (ISLs).

The following table lists the maximum supported hop counts:

Switch supplier	Supported hop count
Brocade	7 for FC 5 for FCoE
Cisco	7 Up to 3 of the switches can be FCoE switches.

Fibre Channel over Ethernet supported configurations

Supported FCoE native configurations include single-fabric and multifabric configurations. Both single-controller and HA configurations are supported.

Supported storage systems with native FCoE target expansion adapters (called unified target adapters or UTAs) are the N7x50T series, N7000 series, N6200 series, N6000 series, N5300, and the N5600.

The host FCoE initiator with FC target configuration is also supported on all storage systems using an FCoE/DCB switch. Direct-attached configurations are not supported in iSCSI, FC or FCoE using UTAs.

Note: While iSCSI configurations allow any number of Ethernet switches, there must be no additional Ethernet switches in FCoE configurations. The CNA must connect directly to the FCoE switch.

FCoE initiator to FC target configuration

You can connect hosts to both controllers in an HA pair using host FCoE initiators (CNAs) through FCoE switches to FC target ports. This requires an FCoE switch that also has FC ports.

The host FCoE initiator always connects to a supported FCoE switch. The FCoE switch can connect directly to an FC target, or can connect through FC switches to the FC target.

Note: The FC target expansion adapter port numbers (0b and 0d) in the following figure are examples. The actual port numbers might vary, depending on the expansion slot in which the FC target expansion adapter is installed.

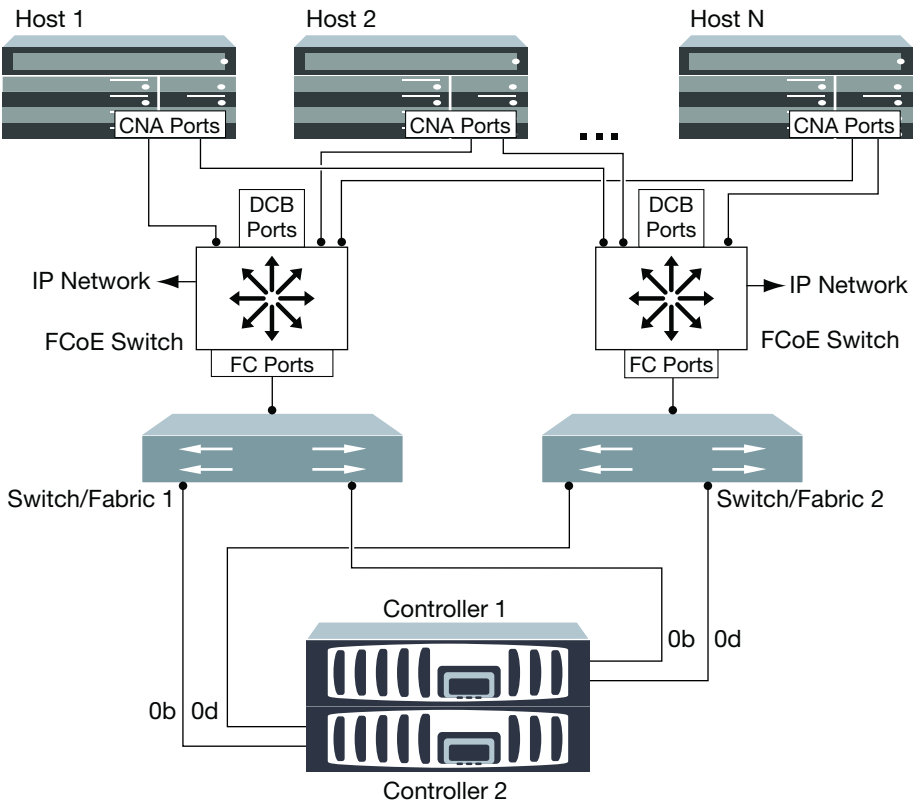


Figure 46: FCoE initiator to FC dual-fabric HA pair

Attribute	Value
Fully redundant	Yes
Type of fabric	Dual fabric
Different host operating systems	Yes, with multiple-host configurations
FC ports or adapters	One to the maximum number of supported onboard FC ports per controller One to the maximum number of supported 4-Gb or 8-Gb FC ports per controller using FC target expansion adapters
Multipathing required	Yes
Type of configuration	HA pair

FCoE end-to-end configuration

You can connect hosts to both controllers in an HA pair. This connection is achieved host using FCoE initiators (CNAs) through DCB switches to FCoE target ports.

The FCoE target adapter is also called a unified target adapter or UTA. Like the CNA in a host, the UTA supports both FCoE and regular Ethernet traffic.

You can have multiple FCoE and FC switches in the path between the initiator and target, up to the maximum hop count limit. To connect FCoE switches to each other, the switches must run a firmware version that supports Ethernet ISLs.

Note: The FCoE target expansion adapter port numbers (2a and 2b) in the following figure are examples. The actual port numbers might vary, depending on the expansion slot in which the FCoE target expansion adapter is installed.

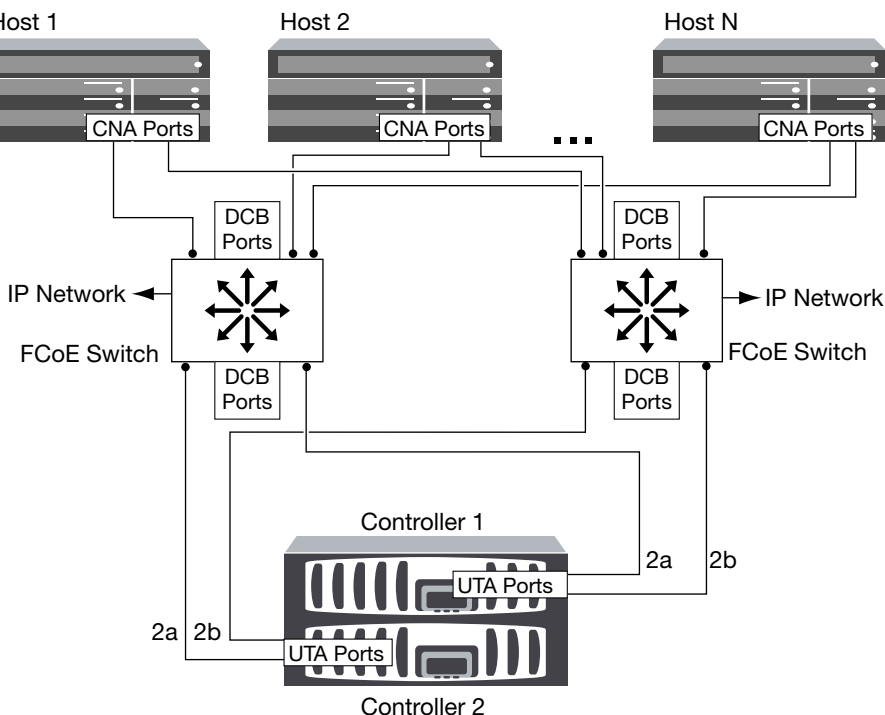


Figure 47: FCoE end-to-end

Attribute	Value
Fully redundant	Yes
Type of fabric	Dual fabric
Different host operating systems	Yes, with multiple host-configurations

Attribute	Value
FCoE ports or adapters	One or more FCoE target expansion adapters per controller
Multipathing required	Yes
Type of configuration	HA pair

FCoE mixed with FC

You can connect hosts to both controllers in an HA pair. This connection is achieved using host FCoE initiators (CNAs) through FCoE switches to FCoE and FC mixed target ports.

The FCoE target adapter is also called a unified target adapter or UTA. Like the CNA in a host, the UTA supports both FCoE and regular Ethernet traffic.

You can have multiple FCoE and FC switches in the path between the initiator and target, up to the maximum hop count limit. To connect FCoE switches to each other, the switches must run a firmware version that supports Ethernet ISLs.

Note: The FCoE target expansion adapter port numbers (2a and 2b) and FC target port numbers (0b and 0d) are examples. The actual port numbers might vary, depending on the expansion slots in which the FCoE target expansion adapter and FC target expansion adapter are installed.

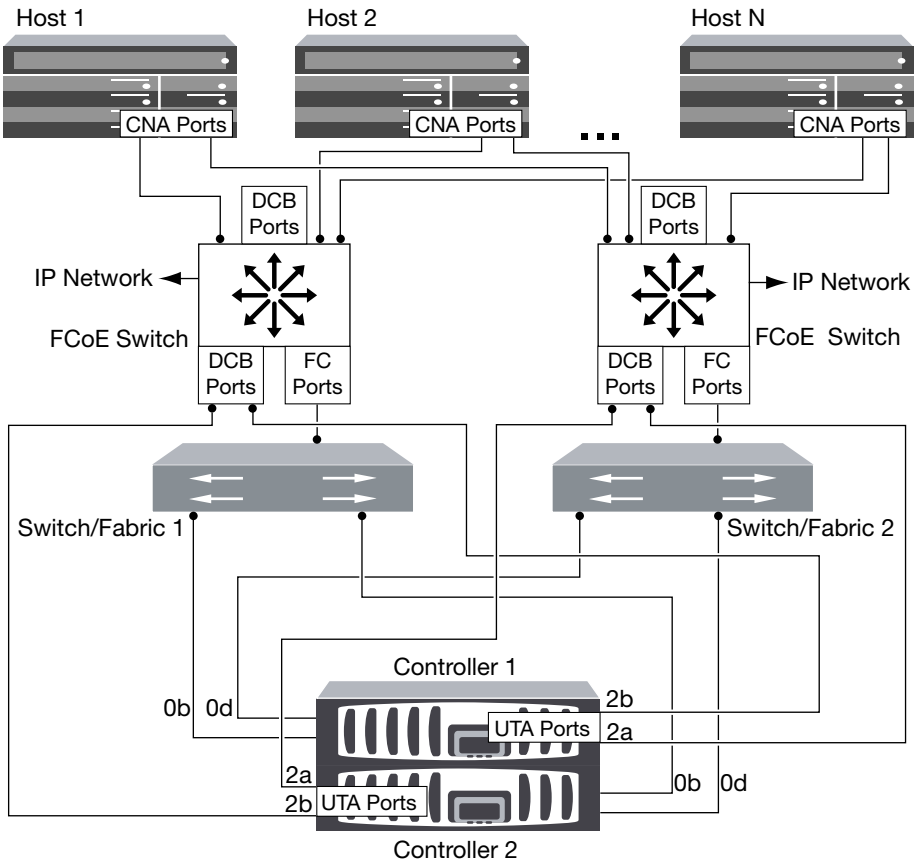


Figure 48: FCoE mixed with FC

Attribute	Value
Fully redundant	Yes
Type of fabric	Dual fabric
Different host operating systems	Yes, with multiple-host configurations
FC/FCoE ports or adapters	One to the maximum number of supported onboard FC ports per controller One or more FCoE target expansion adapters per controller At least one 4-Gb or 8-Gb FC target expansion adapter per controller
Multipathing required	Yes
Type of configuration	HA pair

FCoE mixed with IP storage protocols

You can connect hosts to both controllers in an HA pair using host FCoE initiators (CNAs) through FCoE switches to FCoE target ports. You can also run non-FCoE Ethernet traffic through the same switches.

The FCoE target adapter is also called a unified target adapter or UTA. Like the CNA in a host, the UTA supports both FCoE and regular Ethernet traffic.

You can have multiple FCoE and FC switches in the path between the initiator and target, up to the maximum hop count limit. To connect FCoE switches to each other over Ethernet, the switches must run a firmware version that supports Ethernet ISLs. You can also connect switches using FC ISLs.

The FCoE ports are connected to DCB ports on the FCoE switches. FCoE ports cannot use traditional link aggregation to a single switch. Cisco switches support a special type of link aggregation called *Virtual Port Channel* that does support FCoE. A Virtual Port Channel aggregates individual links to two switches. You can also use the Virtual Port Channel for other Ethernet traffic. For more information about configuring Virtual Port Channels, see Technical Report TR-3800: *Fibre Channel over Ethernet (FCoE) End-to-End Deployment Guide* or your Cisco switch documentation.

Note: This technical report contains information about NetApp products that IBM licenses and in some cases customizes. Technical reports might contain information about models and features that are not supported by IBM.

Ports used for traffic other than FCoE, including NFS, CIFS, iSCSI, and other Ethernet traffic, can use regular Ethernet ports on the FCoE switches.

Note: The FCoE target expansion adapter port numbers (2a and 2b) and the Ethernet port numbers (e0a and e0b) in the following figure are examples. The actual port numbers might vary, depending on the expansion slots in which the FCoE target expansion adapters are installed.

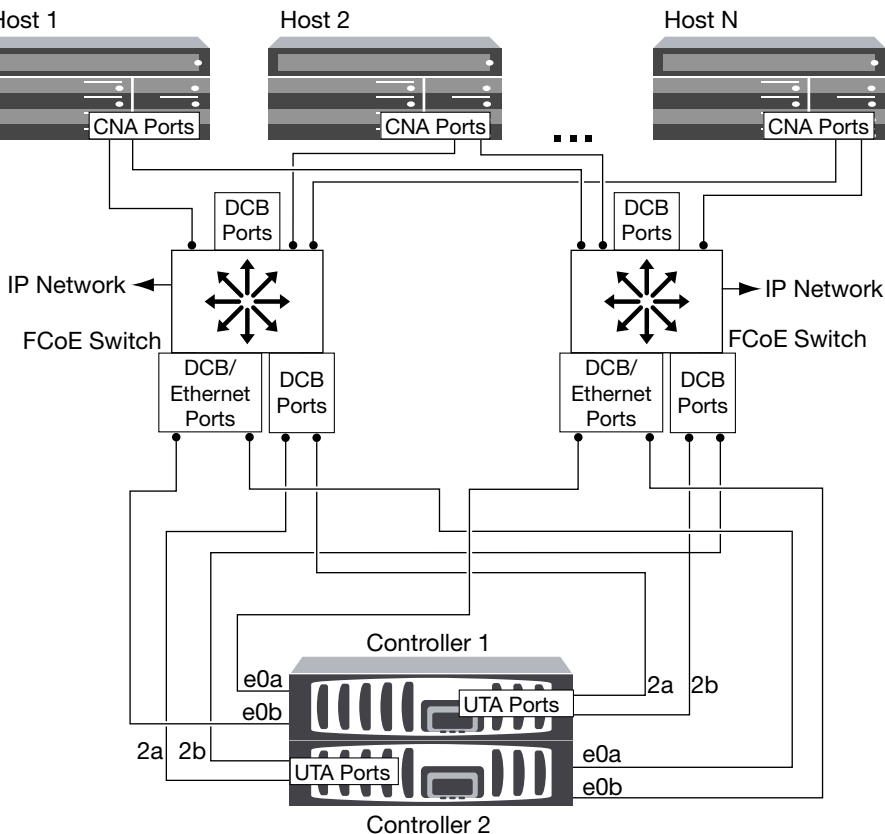


Figure 49: FCoE mixed with IP storage protocols

Attribute	Value
Fully redundant	Yes
Type of fabric	Dual fabric
Different host operating systems	Yes, with multiple-host configurations
FCoE ports or adapters	One or more FCoE target expansion adapters per controller
Multipathing required	Yes
Type of configuration	HA pair

Related information

Technical Report 3800: Fibre Channel over Ethernet (FCoE) End-to-End Deployment Guide

Fibre Channel and FCoE zoning

An FC or FCoE zone is a subset of the fabric that consists of a group of FC or FCoE ports or nodes that can communicate with each other. You must contain the nodes within the same zone to allow communication.

Reasons for zoning

- Zoning reduces or eliminates *cross talk* between initiator HBAs. This occurs even in small environments and is one of the best arguments for implementing zoning. The logical fabric subsets created by zoning eliminate crosstalk problems.
- Zoning reduces the number of available paths to a particular FC or FCoE port and reduces the number of paths between a host and a particular LUN that is visible. For example, some host OS multipathing solutions have a limit on the number of paths they can manage. Zoning can reduce the number of paths that an OS multipathing driver sees. If a host does not have a multipathing solution installed, you need to verify that only one path to a LUN is visible.
- Zoning increases security because there is limited access between different nodes of a SAN.
- Zoning improves SAN reliability by isolating problems that occur and helps to reduce problem resolution time by limiting the problem space.

Recommendations for zoning

- You should implement zoning anytime four or more hosts are connected to a SAN.
- Although World Wide Node Name zoning is possible with some switch vendors, World Wide Port Name zoning is recommended.
- You should limit the zone size while still maintaining manageability. Multiple zones can overlap to limit size. Ideally, a zone is defined for each host or host cluster.
- You should use single-initiator zoning to eliminate crosstalk between initiator HBAs.

Port zoning

Port zoning, also referred to as “hard zoning”, specifies the unique fabric N_port IDs of the ports to be included within the zone. The switch and switch port are used to define the zone members.

Port zoning provides the following advantages:

- Port zoning offers improved security because it is not possible to breach the zoning by using WWN spoofing. However, if someone has physical access to the switch, replacing a cable can allow access.
- In some environments, port zoning is easier to create and manage because you only work with the switch or switch domain and port number.

World Wide Name-based zoning

Zoning based on World Wide Name (WWN) specifies the WWN of the members to be included within the zone. Depending on the switch vendor, either World Wide Node Names or World Wide Port Names can be used. You should always use World Wide Port Name zoning.

WWN zoning provides flexibility because access is not determined by where the device is physically connected to the fabric. You can move a cable from one port to another without reconfiguring zones.

Individual zones

In the recommended zoning configuration, there is one host initiator per zone. The zone consists of the host initiator port and one or more target ports on each storage controller up to the desired number of paths per target. This means that hosts accessing the same controllers cannot see each other's ports, but each initiator can access both controllers.

Single-fabric zoning

In a single-fabric configuration, you can still connect each host initiator to each storage controller. Multipathing software is required on the host to manage multiple paths. Each host should have two initiators for multipathing to provide resiliency in the solution.

Each initiator can access a target port on both storage controllers in an HA configuration, but should only be zoned to the storage controllers that are providing the paths used for connectivity. This means that each initiator on the host might only have one target port per storage controller in its zone configuration. If there is a requirement for multipathing to the same storage controller, then each storage controller will have multiple ports per initiator in its zone configuration. This enables the host to still access its LUNs if a controller fails.

Single-fabric configurations are supported, but are not considered highly available. The failure of a single component can cause loss of access to data.

In the following figure, the host has two initiators and is running multipathing software. There are two zones:

- Zone 1: HBA 0, port 0b on Controller 1, and port 0b on Controller 2
- Zone 2: HBA 1, port 0d on Controller 1, and port 0d on Controller 2

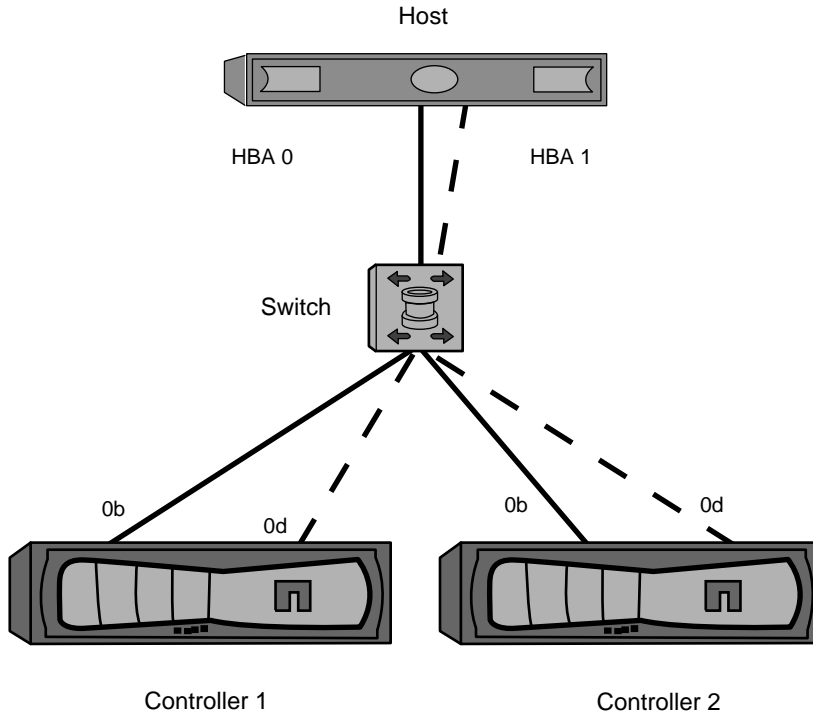


Figure 50: Single-fabric zoning

In this example, you could also have all four ports in each zone. In that case, the zones would be:

- Zone 1: HBA 0, ports 0b and 0d on Controller 1, and ports 0b and 0d on Controller 2
- Zone 2: HBA 1, ports 0b and 0d on Controller 1, and ports 0b and 0d on Controller 2

Note: The host Operating System and multipathing software have to support the number of supported paths that are being used to access the LUNs on the storage controllers. The number of paths can be verified by using configuration limits at the end of this document.

Dual-fabric HA pair zoning

In dual fabric configurations, you can connect each host initiator to each storage controller. Each host initiator uses a different switch to access the storage controllers. Multipathing software is required on the host to manage multiple paths.

Dual fabric configurations are considered high availability because access to data is maintained in the event of a single component failure.

In the following figure, the host has two initiators and is running multipathing software. There are two zones:

- Zone 1: HBA 0, port 0b on Controller 1, and port 0b on Controller 2

- Zone 2: HBA 1, port 0d on Controller 1, and port 0d on Controller 2

Each host initiator is zoned through a different switch. Zone 1 is accessed through Switch 1. Zone 2 is accessed through Switch 2.

Because each host initiator is zoned to a port on each controller, the host can still access its LUNs if a controller fails.

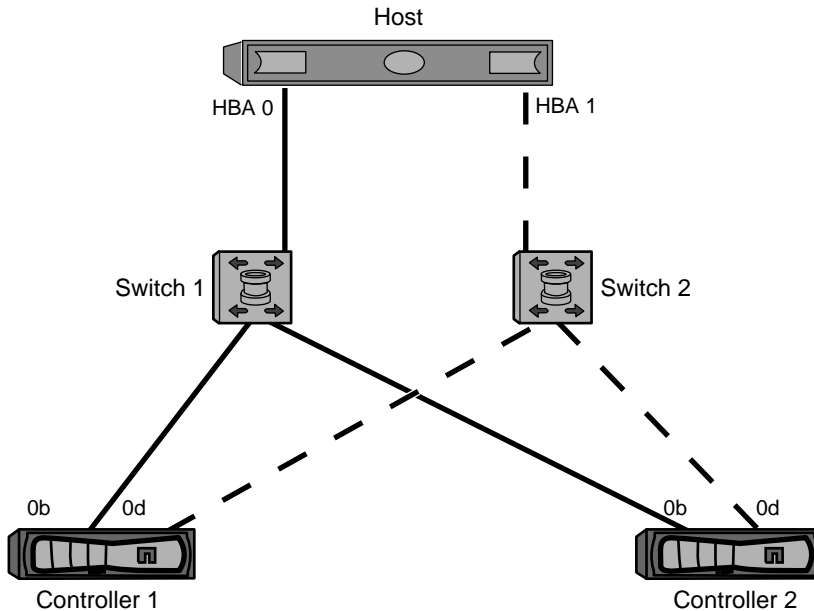


Figure 51: Dual-fabric zoning

In this example, you could also have all four ports in each zone. In that case, the zones would be:

- Zone 1: HBA 0, ports 0b and 0d on Controller 1, and ports 0b and 0d on Controller 2
- Zone 2: HBA 1, ports 0b and 0d on Controller 1, and ports 0b and 0d on Controller 2

Note: The host operating system and multipathing software have to support the number of paths that are being used to access the LUNs on the storage controllers. Information on supported path and LUN limitations can be verified by using the configuration limits at the end of this document.

Shared SAN configurations

Shared SAN configurations are defined as hosts that are attached to both N series and non-N series storage systems. Accessing N series storage systems and other vendors' storage systems (including IBM) from a single host is supported as long as several requirements are met.

To access N series storage systems and other vendors' storage systems from a single host requires:

- Native Host OS multipathing or VERITAS DMP is used for multipathing (see exception for EMC PowerPath co-existence below)
- IBM configuration requirements (such as timeout settings) as specified in the appropriate IBM Host Utilities documents have been met

Native Host OS multipathing in combination with EMC PowerPath is supported for the following configurations. For configurations that do meet these requirements, an RPQ is required to determine supportability.

Host	Supported configuration
Windows	EMC CX3, CX4, and VNX arrays with PowerPath 4.5 or later connected to an N series storage system using Data ONTAP DSM for Windows MPIO
Solaris	EMC CX3, CX4, and VNX arrays PowerPath 5 or later connected to an N series storage system using MPxIO
AIX	EMC CX3, CX4, and VNX arrays PowerPath 5 or later connected to an N series storage system using AIX MPIO

ALUA configurations

Asymmetric logical unit access (ALUA) is supported for certain combinations of host operating systems and host multipathing software.

ALUA is an industry standard protocol for identifying optimized paths between a storage system and a host computer. The administrator of the host computer does not need to manually select the paths to use.

You should use ALUA whenever the host configuration supports it. For information about which specific configurations support ALUA, see the Interoperability Matrix and the Host Utilities *Installation and Setup Guide* for your host operating system.

ALUA is enabled or disabled on the igroup to which the LUN is mapped. The default ALUA setting in Data ONTAP depends on the igroup type. ALUA is not supported for iSCSI paths.

For information about enabling ALUA on the storage system, see the *Data ONTAP SAN Administration Guide for 7-Mode*.

Related information

IBM N series interoperability matrix: www.ibm.com/systems/storage/network/interophome.html

Configuration limits for FC, FCoE, and iSCSI configurations

Configuration limits are available for FC, FCoE, and iSCSI configurations. In some cases, theoretical limits might be higher, but the published limits are tested and supported.

SAN Configuration limit parameters and definitions

There are a number of parameters and definitions related to FC, FCoE, and iSCSI configuration limits.

Parameter	Definition
Visible target ports per host (iSCSI)	The maximum number of target iSCSI Ethernet ports that a host can see or access on iSCSI-attached controllers.
Visible target ports per host (FC)	The maximum number of FC adapters that a host can see or access on the attached Fibre Channel controllers.
LUNs per host	The maximum number of LUNs that you can map from the controllers to a single host.
Paths per LUN	The maximum number of accessible paths that a host has to a LUN. Note: Using the maximum number of paths is not recommended.
Maximum LUN size	The maximum size of an individual LUN on the respective operating system.
LUNs per controller or node	The maximum number of LUNs that you can configure per controller, including cloned LUNs and LUNs contained within cloned volumes. LUNs contained in Snapshot copies do not count in this limit and there is no limit on the number of LUNs that can be contained within Snapshot copies.
LUNs per volume	The maximum number of LUNs that you can configure within a single volume. LUNs contained in Snapshot copies do not count in this limit and there is no limit on the number of LUNs that can be contained within Snapshot copies.
FC port fan-in	The maximum number of hosts that can connect to a single FC port on a controller. Connecting the maximum number of hosts is generally not recommended, and you might need to tune the FC queue depths on the host to achieve this maximum value.

Parameter	Definition
FC port fan-out	The maximum number of LUNs mapped to a host through a FC target port on a controller.
iSCSI sessions per controller or node	The recommended maximum number of iSCSI sessions that you can connect to a single controller. The general formula to calculate this is as follows: Maximum sessions = 8 * System Memory divided by 512 MB.
Hosts per controller (FC)	The maximum number of hosts that you can connect to a controller. Connecting the maximum number of hosts is generally not recommended, and you might need to tune the FC queue depths on the host to achieve this maximum value. This value assumes two initiators per host. Note: Virtualized hosts, using NPIV to access the fabric with virtual WWPNs, count as additional hosts for the purpose of this limitation.
igroups per controller	The maximum number of initiator groups that you can configure per controller.
Initiators per igroup	The maximum number of FC initiators (HBA WWNs) or iSCSI initiators (host iqn/eui node names) that you can include in a single igroup.
LUN mappings per controller	The maximum number of LUN mappings per controller. For example, a LUN mapped to two igroups counts as two mappings.
LUN path name length	The maximum number of characters in a full LUN name. For example, /vol/abc/def has 12 characters.
LUN size	The maximum capacity of an individual LUN on a controller.
FC queue depth available per port	The usable queue depth capacity of each FC target port. The number of LUNs is limited by available FC queue depth.
FC target ports per controller or node	The maximum number of supported FC target ports per controller. FC initiator ports used for back-end disk connections, for example, connections to disk shelves, are not included in this number.

Related tasks

[Calculating queue depth](#) on page 98

Host operating system limits for SAN configurations

Each host operating system has host-based configuration limits for FC, FCoE, and iSCSI.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Note: AIX 6.0 Host Utilities do not support iSCSI.

Note: The values listed are the maximum supported by IBM. The operating system vendor might support a different value. For best performance, do not configure your system at the maximum values.

Parameter	Windows	Linux	HP-UX	Solaris	AIX	ESX
Visible target ports per host	32	16	16	16	16	16
LUNs per host	255 (Windows 2003) 255 (Windows 2008)	1,024 devices max (where each path to a LUN is a device)	11iv2: 512 11iv3: 1024	512	1,024	4.x: 256 Local drives, CD-ROM, and so on count against this value.
Paths per LUN	8 (max of 1,024 per host)	8 (max of 1,024 per host)	11iv2: 8 11iv3: 32	16	16	4.x: 8 (max of 1,024 per host)
Max LUN size	2 TB (MBR) 16 TB (GPT) Server 2003 SP2 and later	16 TB	11iv2: 2 TB 11iv3: 16 TB	16 TB	16 TB	16 TB (VMFS-5 and pass through RDM) 2 TB (VMFS-3 and non-pass through RDM)

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

N7x50T series single-controller limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N7950T
LUNs per controller	2,048
FC queue depth available per port	2,048
LUNs per volume	2,048
Port fan-in	64
Connected hosts per storage controller (FC)	256
iSCSI sessions per controller	512
igroups per controller	1,024
Initiators per igroup	256
LUN mappings per controller	8,192
LUN path name length	255
LUN size	16 TB
FC target ports per controller	32
Ethernet ports per controller	48

Related tasks

[Calculating queue depth](#) on page 98

N7x50T series HA configuration limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Limits for HA configuration systems are *NOT* double the limits for single-controller systems. This is because one controller in the HA configuration must be able to handle the entire system load during failover.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system with the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N7950T
LUNs per HA pair	4,096
FC queue depth available per port	2,048
LUNs per volume	2,048
FC port fan-in	64
Connected hosts per HA pair (FC)	512
iSCSI sessions per HA pair	1,024
igroups per HA pair	2,048
Initiators per igroup	256
LUN mappings per HA pair	8,192
LUN path name length	255
LUN size	16 TB
FC target ports per HA pair	64
Ethernet ports per HA pair	96

Related tasks

[Calculating queue depth](#) on page 98

N6200 series single-controller limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system with the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N6200 series
LUNs per controller	2,048
FC queue depth available per port	2,048
LUNs per volume	2,048
Port fan-in	64
Connected hosts per storage controller (FC)	256
iSCSI sessions per controller	256 512 (N6270)
igroups per controller	256 512 (N6270)
Initiators per igroup	256
LUN mappings per controller	4,096
LUN path name length	255
LUN size	16 TB
FC target ports per controller	10 (without I/O expansion module) 24 (with I/O expansion module)
Ethernet ports per controller	10 (without I/O expansion module) 26 (with I/O expansion module)

Related tasks

[Calculating queue depth](#) on page 98

N6200 series HA configuration limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Limits for HA configuration systems are *NOT* double the limits for single-controller systems. This is because one controller in the HA configuration must be able to handle the entire system load of the other controller during failover.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system with the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N6200 series
LUNs per HA configuration	2,048
FC queue depth available per port	2,048
LUNs per volume	2,048
FC port fan-in	64
Connected hosts per HA configuration (FC)	256 512 (with RPQ approval)
iSCSI sessions per HA configuration	512 1,024 (N6270)
igroups per HA configuration	512 1,024 (N6270)
Initiators per igroup	256
LUN mappings per HA configuration	4,096
LUN path name length	255
LUN size	16 TB
FC target ports per HA configuration	20 (without I/O expansion module) 48 (with I/O expansion module)
Ethernet ports per controller	20 (without I/O expansion module) 52 (with I/O expansion module)

Related tasks

[Calculating queue depth](#) on page 98

N3150, N3220 and N3240 single-controller limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC and iSCSI unless otherwise noted.

Note: The N3150 configuration does not support FC but does support iSCSI. The values listed are the maximum that can be supported. For best performance, do not configure your system with the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N3220 and N3240	N3150
LUNs per controller	1,024	1,024
FC queue depth available per port	2,048	n/a
LUNs per volume	1,024	1,024
FC port fan-in	64	n/a
Connected hosts per controller (FC)	128	n/a
iSCSI sessions per controller	128	128
igroups per controller	256	256
Initiators per igroup	256	256
LUN mappings per controller	4,096	4,096
LUN path name length	255	255
LUN size	16 TB	16 TB
FC target ports per controller	2	n/a
Ethernet ports per controller	4	n/a

Related tasks

[Calculating queue depth](#) on page 98

N3150, N3220 and N3240 HA configuration limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC and iSCSI unless otherwise noted.

Limits for HA pair systems are *NOT* double the limits for single-controller systems. This is because one controller in the HA pair must be able to handle the entire system load during failover.

Note: The N3150 configuration does not support FC but does support iSCSI. The values listed for both configurations are the maximum that can be supported. For best performance, do not configure your system with the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N3220 and N3240	N3150
LUNs per HA pair	1,024	1,024
FC queue depth available per port	2,048	n/a
LUNs per volume	1,024	1,024
FC port fan-in	64	n/a
Connected hosts per HA pair (FC)	128	n/a
iSCSI sessions per HA pair	128	128
igroups per HA pair	256	256
Initiators per igroup	256	256
LUN mappings per HA pair	4,096	4,096
LUN path name length	255	255
LUN size	16 TB	16 TB
FC target ports per HA pair	4	n/a
Ethernet ports per HA pair	8	n/a

Related tasks

[Calculating queue depth](#) on page 98

N7000 series and N6000 series single-controller limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N6000 series	N7600 or N7700	N7800 or N7900
LUNs per controller	2,048	2,048	2,048
FC queue depth available per port	2,048	2,048	2,048
LUNs per volume	2,048	2,048	2,048
Port fan-in	64	64	64
Connected hosts per storage controller (FC)	256	256	256
iSCSI sessions per controller	256	256	512
igroups per controller	256	1,024	1,024
Initiators per igroup	256	256	256
LUN mappings per controller	4,096	8,192	8,192
LUN path name length	255	255	255
LUN size	16 TB	16 TB	16 TB
FC target ports per controller	20	16	16
Ethernet ports per controller	18	26	26

Related tasks

[Calculating queue depth](#) on page 98

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

N7000 series and N6000 series HA pair limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Limits for HA pair systems are *NOT* double the limits for single-controller systems. This is because one controller in the HA pair must be able to handle the entire system load during failover.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N6000 series	N7600 or N7700	N7800 or N7900
LUNs per HA pair	2,048 4,096 (available on the N6060 and N6070 with RPQ approval)	2,048 4,096 (with RPQ approval)	4,096
FC queue depth available per port	2,048	2,048	2,048
LUNs per volume	2,048	2,048	2,048
FC port fan-in	64	64	64
Connected hosts per HA pair (FC)	256 512 (available on the N6060 and N6070 with RPQ approval)	256 512 (with RPQ approval)	256 512 (with RPQ approval)
iSCSI sessions per HA pair	512	512	1,024
igroups per HA pair	512	2,048	2,048
Initiators per igroup	256	256	256
LUN mappings per HA pair	4,096 8,192 (available on the N6060 and N6070 with RPQ approval)	8,192	8,192

Parameter	N6000 series	N7600 or N7700	N7800 or N7900
LUN path name length	255	255	255
LUN size	16 TB	16 TB	16 TB
FC target ports per HA pair	32	32	32
Ethernet ports per HA pair	36	52	52

Related tasks

[Calculating queue depth](#) on page 98

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

N5000 series single-controller limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless noted.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N5300 and N5600
LUNs per controller	2,048
FC queue depth available per port	2,048
LUNs per volume	2,048
Port fan-in	64
Connected hosts per storage controller (FC)	256
iSCSI sessions per controller	256
igroups per controller	256
Initiators per igroup	256

Parameter	N5300 and N5600
LUN mappings per controller	4,096
LUN path name length	255
LUN size	16 TB
FC target ports per controller	12
Ethernet ports per controller	16

Related tasks

[Calculating queue depth](#) on page 98

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

N5000 series HA pair limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless noted.

Limits for HA pair systems are *NOT* double the limits for single-controller systems. This is because one controller in the HA pair must be able to handle the entire system load during failover.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N5300 and N5600
LUNs per HA pair	2,048
FC queue depth available per port	2,048
LUNs per volume	2,048
FC port fan-in	64
Connected hosts per HA pair (FC)	256
iSCSI sessions per HA pair	512
igroups per HA pair	256

Parameter	N5300 and N5600
Initiators per igroup	256
LUN mappings per HA pair	4,096
LUN path name length	255
LUN size	16 TB
FC target ports per HA pair	24
Ethernet ports per HA pair	32

Related tasks

[Calculating queue depth](#) on page 98

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

N3400 single-controller limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N3400
LUNs per controller	1,024
FC queue depth available per port	2,048
LUNs per volume	1,024
FC port fan-in	64
Connected hosts per controller (FC)	128
iSCSI sessions per controller	128
igroups per controller	256

Parameter	N3400
Initiators per igroup	256
LUN mappings per controller	4,096
LUN path name length	255
LUN size	16 TB
FC target ports per controller	2
Ethernet target ports per controller	4

Related tasks

[Calculating queue depth](#) on page 98

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

N3400 HA pair configuration limits

Each system model has configuration limits for reliable operation. Do not exceed the tested limits.

The following table lists the maximum supported value for each parameter based on testing. All values are for FC, FCoE, and iSCSI unless otherwise noted.

Limits for HA pair systems are *NOT* double the limits for single-controller systems. This is because one controller in the HA pair must be able to handle the entire system load during failover.

Note: The values listed are the maximum that can be supported. For best performance, do not configure your system at the maximum values.

The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

Parameter	N3400
LUNs per HA pair	1,024
FC queue depth available per port	2,048
LUNs per volume	1,024
FC port fan-in	64
Connected hosts per HA pair (FC)	128
iSCSI sessions per HA pair	128

Parameter	N3400
igroups per HA pair	256
Initiators per igroup	256
LUN mappings per HA pair	4,096
LUN path name length	255
LUN size	16 TB
FC target ports per HA pair	4
Ethernet target ports per HA pair	8

Related tasks

[Calculating queue depth](#) on page 98

Related references

[SAN Configuration limit parameters and definitions](#) on page 83

Calculating queue depth

You might need to tune your FC queue depth on the host to achieve the maximum values for hosts per controller and FC port fan-in. The maximum number of LUNs and the number of HBAs that can connect to an FC port are limited by the available queue depth on the FC target ports.

About this task

Queue depth is the number of I/O requests (SCSI commands) that can be queued at one time on a storage controller. Each I/O request from the host's initiator HBA to the storage controller's target adapter consumes a queue entry. Typically, a higher queue depth equates to better performance. However, if the storage controller's maximum queue depth is reached, that storage controller rejects incoming commands by returning a QFULL response to them. If a large number of hosts are accessing a storage controller, plan carefully to avoid QFULL conditions, which significantly degrade system performance and can lead to errors on some systems.

In a configuration with multiple initiators (hosts), all hosts should have similar queue depths. This prevents hosts with small queue depths from being starved by hosts with large queue depths.

The following general recommendations can be made about "tuning" queue depths.

- For small to mid-size systems, use a HBA queue depth of 32.
- For large systems, use a HBA queue depth of 128.
- For exception cases or performance testing, use a queue depth of 256 to avoid possible queuing problems.

- All hosts should have the queue depths set to similar values to give equal access to all hosts.
- Ensure that the storage controller target FC port queue depth is not exceeded to avoid performance penalties or errors.

Steps

1. Count the total number of FC initiators in all the hosts that connect to one FC target port.
2. Multiply by 128.
 - If the result is less than 2,048, set the queue depth for all initiators to 128.

Example

Example: You have 15 hosts with one initiator connected to each of two target ports on the storage controller. $15 \times 128 = 1,920$. 1,920 is less than the total queue depth limit of 2,048, so you can set the queue depth for all your initiators to 128.

- If the result is greater than 2,048, go to step 3.

Example

Example: You have 30 hosts with one initiator connected to each of two target ports on the storage controller. $30 \times 128 = 3,840$. 3,840 is greater than the total queue depth limit of 2,048, so you should choose one of the options under step 3 for remediation.

3. Choose one of the following options.
 - Option 1:
 - a. Add more FC target ports.
 - b. Redistribute your FC initiators.
 - c. Repeat steps 1 and 2.

Example

Example: The desired queue depth of 3,840 exceeds the available queue depth per port. To remedy this, you can add a two-port FC target adapter to each controller; then rezone your FC switches so that 15 of your 30 hosts connect to one set of ports, and the remaining 15 hosts connect to a second set of ports. The queue depth per port is then reduced to $15 \times 128 = 1,920$.

- Option 2:
 - a. Designate each host as "large" or "small" based on its expected I/O need.
 - b. Multiply the number of large initiators by 128.
 - c. Multiply the number of small initiators by 32.
 - d. Add the two results together.

- e. If the result is less than 2,048, set the queue depth for "large" host to 128 and the queue depth for "small" host to 32.
- f. If the result is still greater than 2,048 per port, reduce the queue depth per initiator until the total queue depth is less than or equal to 2,048.

Note: To estimate the queue depth needed to achieve a certain I/O per second throughput, use this formula.

Needed queue depth = (Number of I/O per second) x (Response time)

For example, if you need 40,000 I/O per second with a response time of 3 milliseconds, the needed queue depth = 40,000 x (.003) = 120.

Example

Example: The desired queue depth of 3,840 exceeds the available queue depth per port. You have 10 "large" hosts that have high storage I/O needs, and 20 "small" hosts that have low I/O needs. Set the initiator queue depth on the "large" hosts to 128 and the initiator queue depth on the "small" hosts to 32.

Your resulting total queue depth is $(10 \times 128) + (20 \times 32) = 1,920$.

Example

You can spread the available queue depth equally across each initiator.

Your resulting queue depth per initiator is $2,048/30 = 68$

Setting queue depths on AIX hosts

You can change the queue depth on AIX hosts using the `chdev` command. Changes made using the `chdev` command are persistent across reboots.

Examples:

- To change the queue depth for the `hdisk7` device, use the following command.
`chdev -l hdisk7 -a queue_depth=32`
- To change the queue depth for the `fcs0` HBA, use the following command.
`chdev -l fcs0 -a num_cmd_elems=128`

The default value for `num_cmd_elems` is 200. The maximum value is 2,048.

Note: It might be necessary to take the HBA offline to change `num_cmd_elems` and then bring it back online using the `rmdev -l fcs0 -R` and `makdev -l fcs0 -P` commands.

Setting queue depths on HP-UX hosts

You can change the LUN or device queue depth on HP-UX hosts using the kernel parameter `scsi_max_qdepth`. You can change the HBA queue depth using the kernel parameter `max_fcp_reqs`.

- The default value for `scsi_max_qdepth` is 8. The maximum value is 255.

`scsi_max_qdepth` can be dynamically changed on a running system using the `-u` option on the `kmtune` command. The change will be effective for all devices on the system. For example, use the following command to increase the LUN queue depth to 64.

```
kmtune -u -s scsi_max_qdepth=64
```

It is possible to change queue depth for individual device files using the `scsictl` command. Changes using the `scsictl` command are not persistent across system reboots. To view and change the queue depth for a particular device file, the following command can be executed.

```
scsictl -a /dev/rdisk/c2t2d0
```

```
scsictl -m queue_depth=16 /dev/rdisk/c2t2d0
```

- The default value for `max_fcp_reqs` is 512. The maximum value is 1024.

The kernel must be rebuilt and the system must be rebooted for changes to `max_fcp_reqs` to take effect. To change the HBA queue depth to 256, for example, use the following command.

```
kmtune -u -s max_fcp_reqs=256
```

Setting queue depths on LINUX hosts

You can modify the `/etc/modprobe.conf` or `etc/modprobe.conf.local` file to change the queue depth on LINUX hosts. You will also need to modify certain parameters depending on the type of card you have installed in your host.

- For an EMuleX HBA with default settings, the respective minimum and maximum values on relevant parameters are:
 - `lpfc_lun_queue_depth` (30, 1, 128)
 - `Lpfc-hba_queue_depth` (8192, 32, 8192)

HBAnyware or `hbacmd` can also be used to change the parameters.

- For a Qlogic HBA, the relevant parameter is:
 - `Ql2xmaxdepth`. The default value for `Ql2xmaxdepth` is 32.

Note: You must reload the driver and build a new ramdisk image for changes to parameters to take effect.

Setting queue depths on Solaris hosts

You can set the LUN and HBA queue depth for your Solaris hosts.

About this task

- For LUN queue depth, the number of LUNs in use on a host multiplied by the per-LUN throttle (`lun-queue-depth`) must be less than or equal to the `tgt-queue-depth` value on the host.
- For queue depth in Sun stack: The native drivers do not allow for per LUN or per target `max_throttle` settings at the HBA level. The recommended method for setting the `max_throttle` value for native drivers is on a per device type (`VID_PID`) level in the `/kernel/drv/sd.conf` and `/kernel/drv/ssd.conf` files. The host utility sets this value to 64 for MPxIO configurations and 8 for Veritas DMP configurations.

HBA Queue Depth

To update the queue depth for the Emulex HBA, execute the following commands:

Steps

1. # cd/kernel/drv
2. # vi lpfc.conf
3. Search for /tft-queue (/tgt-queue)
tgt-queue-depth=32

Note: The default value is set to 32 at install.

4. Set the desired value based on the configuration of you environment.
5. Save the file.
6. Reboot the host using the `sync; sync; sync; reboot -- -r` command.

Setting queue depths on VMWARE hosts

Use the `esxcfg-module` command to change the HBA timeout settings. Manually updating the `esx.conf` file is not recommended.

About this task

To set maximum queue depth for a QLogic HBA

Steps

1. Log on to the service console as the root user.
2. Use the `#vmkload_mod -l` command to verify which Qlogic HBA module is currently loaded.
3. For a single instance of a Qlogic HBA, run the following command: `#esxcfg-module -s ql2xmaxqdepth=64 qla2300_707`

Note: This example uses `qla2300_707` module. Use the appropriate module based on the output of `vmkload_mod -l`.

4. Save your changes using the following command: `#/usr/sbin/esxcfg-boot -b`
5. Reboot the server using the following command: `#reboot`
6. Confirm the changes using the following commands:
 - a) `#esxcfg-module -g qla2300_707`
 - b) `qla2300_707 enabled = 1 options = 'ql2xmaxqdepth=64'`

To change the queue depth of an Emulex HBA

Steps

1. Log on to the service console as the root user.
2. Use the `#vmkload_mod -l grep lpfcdd` command to verify which Emulex HBA is currently loaded.
3. For a single instance of an Emulex HBA, run the following command: `#esxcfg-module -s lpfc0_lun_queue_depth=16 lpfcdd_7xx`

Note: Depending on the model of the HBA, the module can be either `lpfcdd_7xx` or `lpfcdd_732`. The above command uses the `lpfcdd_7xx` module. You should use the appropriate module based on the outcome of `vmkload_mod -l`.

Running this command will set the LUN queue depth to 16 for the HBA represented by `lpfc0`.

4. For multiple instances of an Emulex HBA, run the following command: `a esxcfg-module -s "lpfc0_lun_queue_depth=16 lpfc1_lun_queue_depth=16" lpfcdd_7xx`

The LUN queue depth for `lpfc0` and the LUN queue depth for `lpfc1` is set to 16.

5. Run the following command: `#esxcfg-boot -b`
6. Reboot using `#reboot`.

Setting queue depths on Windows hosts

On Windows hosts, you can use the `LPUTILNT` utility to update the queue depth for Emulex HBAs and the `SANsurfer` HBA manager utility to update the queue depths for Qlogic HBAs.

To update Emulex HBA queue depths

Steps

1. Run the `LPUTILNT` utility located in the `c:\WINNT\system32` directory.
2. Select **Drive Parameters** from the pull down menu on the right side.
3. Scroll down and double-click **QueueDepth**.

If you are setting **QueueDepth** greater than 150, the following Windows Registry value also need to be increased appropriately: `HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\lpxnnds\Parameters\Device\NumberOfRequests`

To update Qlogic HBA queue depths

Steps

1. Run the `SANsurfer` HBA manager utility.

2. Click on **HBA port > Settings**
3. Click **Advanced HBA port settings** in the drop down list box.
4. Update the Execution Throttle parameter.

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