sgi

SGI InfiniteStorage 4000 Series and 5000 Series Hardware Cabling Guide

(ISSM 10.86)

007-5885-002 April 2013

The information in this document supports the SGI InfiniteStorage 4000 series and 5000 series storage systems (ISSM 10.86). Refer to the table below to match your specific SGI InfiniteStorage product with the model numbers used in this document.

SGI Model #	NetApp Model
TP9600H	6091
TP9700F	6091
IS4500F	6091
TP9600F	3994 and 3992
IS4000H	3994
IS350	3992
IS220	1932 1333 DE1300
IS4100	4900
IS-DMODULE16-Z	FC4600
IS-DMODULE60	DE6900
IS4600	7091
IS-DMODULE12 & IS2212 (JBOD)	DE1600
IS-DMODULE24 & IS2224 (JBOD)	DE5600
IS-DMODULE60-SAS	DE6600
IS5012	E2600
IS5024	E2600
IS5060	E2600
IS5512	E5400
IS5524	E5400
IS5560	E5400
IS5600	E5500

Copyright information

Trademark information

NetApp, the NetApp logo, Network Appliance, the Network Appliance logo, Akorri, ApplianceWatch, ASUP, AutoSupport, BalancePoint, BalancePoint Predictor, Bycast, Campaign Express, ComplianceClock, Cryptainer, CryptoShred, Data ONTAP, DataFabric, DataFort, Decru, Decru DataFort, DenseStak, Engenio, Engenio logo, E-Stack, FAServer, FastStak, FilerView, FlexCache, FlexClone, FlexPod, FlexScale, FlexShare, FlexSuite, FlexVol, FPolicy, GetSuccessful, gFiler, Go further, faster, Imagine Virtually Anything, Lifetime Key Management, LockVault, Manage ONTAP, MetroCluster, MultiStore, NearStore, NetCache, NOW (NetApp on the Web), Onaro, OnCommand, ONTAPI, OpenKey, PerformanceStak, RAID-DP, ReplicatorX, SANscreen, SANshare, SANtricity, SecureAdmin, SecureShare, Select, Service Builder, Shadow Tape, Simplicity, Simulate ONTAP, SnapCopy, SnapDirector, SnapDrive, SnapFilter, SnapLock, SnapManager, SnapMigrator, SnapMirror, SnapMover, SnapProtect, SnapRestore, Snapshot, SnapSuite, SnapValidator, SnapVault, StorageGRID, StoreVault, the StoreVault logo, SyncMirror, Tech OnTap, The evolution of storage, Topio, vFiler, VFM, Virtual File Manager, VPolicy, WAFL, Web Filer, and XBB are trademarks or registered trademarks of NetApp, Inc. in the United States, other countries, or both.

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. A complete and current list of other IBM trademarks is available on the Web at *www.ibm.com/legal/copytrade.shtml.*

Apple is a registered trademark and QuickTime is a trademark of Apple, Inc. in the U.S.A. and/or other countries. Microsoft is a registered trademark and Windows Media is a trademark of Microsoft Corporation in the U.S.A. and/or other countries. RealAudio, RealNetworks, RealPlayer, RealSystem, RealText, and RealVideo are registered trademarks and RealMedia, RealProxy, and SureStream are trademarks of RealNetworks, Inc. in the U.S.A. and/or other countries.

All other brands or products are trademarks or registered trademarks of their respective holders and should be treated as such.

NetApp, Inc. is a licensee of the CompactFlash and CF Logo trademarks.

NetApp, Inc. NetCache is certified RealSystem compatible.

Table of Contents

Cabling Concepts and Best Practices

1

This chapter has three sections:

- The first section, "Cabling Concepts," defines terms used in this document. This section is intended primarily for reference. Read the entire section to increase your overall understanding of the storage array and help you to optimize your storage array.

- The second section, "Best Practices," contains information that might affect your choice of cabling topologies. Read this section to understand the options for cabling your storage array.

- The third section, "Common Procedures" contains procedures that you will need to perform while you are cabling the storage array. Read this section to understand tasks that might be required to cable your storage array.

Cabling Concepts

This section defines terms and concepts that are used in this document.

Fabric (Switched) Topologies Compared to Direct-Attach Topologies

Fabric topologies use a switch. Direct-attach topologies do not use a switch. A switched topology is required if the number of hosts to connect to a controller tray or controller-drive tray is greater than the number available host ports on the tray.

Host connections might be InfiniBand, SAS, Fibre Channel, iSCSI, or a mix of Fibre Channel and iSCSI. Switches must support the required connection type or types. A combination of switches of different types might be appropriate for some configurations that support a mixture of connection types.

Drive Tray

A drive tray contains drives but no controllers. Drive trays usually are attached to either a controller tray or a controller-drive tray so that the controller in the controller tray or the controller-drive tray can configure, access, and manage the storage space in the drive tray. Drive trays can be differentiated by type, which are described in the following subsections.

Switched Bunch of Disks

Switched Bunch of Disks (SBOD) is a device that takes all of the drives that are operating in a single Fibre Channel-Arbitrated Loop (FC-AL) segment and provides each drive with access to one or more controllers in a point-to-point fashion. This action is accomplished in a way that appears to be compliant with the FC-AL-2 protocol. As a result, system firmware changes are not required.

In this document, the FC2610 drive trays and the FC4600 drive trays are referred to as SBODs in the cabling diagrams. The AT2655 drive trays are identified as SATA (Serial Advanced Technology). The following figure shows an example of this type of

labeling for drive trays. The DE6900 drive trays are SBODs and can be mixed only with FC4600 drive trays. Do not mix FC2600 drive trays with other types of drive trays on the same loop.

Figure 1 SBOD Labeling in Cabling Diagrams
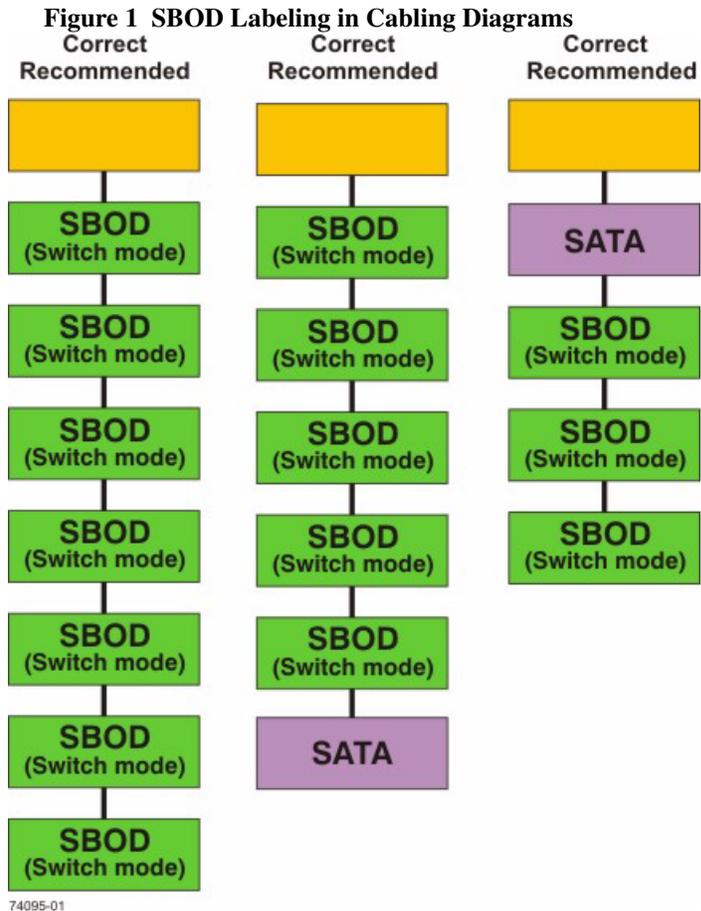
Controller Tray	A controller tray contains controllers. A controller tray does not contain drives. Controller trays configure, access, and manage the storage space of attached drive trays.
Controller-Drive Tray	A controller-drive tray contains both controllers and drives. The controllers configure, access, and manage the storage space of the drives in the controller-drive tray. A controller-drive tray might configure, access, and manage the storage space of other attached drive trays, depending upon the model.
Host Channels and Drive Channels	In this document, the term *channel* refers to a path for the transfer of data information and control information between the host and the controller, or between the drive trays and the controller trays or controller-drive trays. A data path from a host to a

controller is a *host channel*. A host channel might be Fibre Channel, InfiniBand, iSCSI, or Serial Attached SCSI (SAS). A path from a drive trays to a controller trays or a controller-drive trays is a *drive channel*. Each drive channel is defined by a single Fibre Channel-Arbitrated Loop or by a series of SAS devices connected through expanders. Controllers have between two and eight available host channels, and between one and eight available drive channels, depending upon the model. The maximum number of hosts per host channel and the maximum number of drives per drive channel depends upon the model. For model-specific information, see the topics under "Product Compatibility."

> **NOTE** When you mix different types of drive trays, you must consider the total number of drive slots that are available in the final configuration of the storage array. Your configuration must meet both the limit on the total number of drive slots and the limits on the number of drive trays of a given model.

Host Ports and Drive Ports

The ports are the physical connectors on the controller tray or the controller-drive tray that, along with the cabling, enable the transfer of data. If the port communicates with the host server, it is a *host port*. If the port communicates with a drive tray, it is a *drive port*. The figures in the topics under "Component Locations" show the connectors on the rear of each of the various trays. These figures will help you differentiate between host ports and drive ports.

Dual-Ported Drives

Each drive in a controller-drive tray or a drive tray is dual ported. Circuitry in the drive tray or the controller-drive tray connects one drive port to one channel and the other port to another channel. Therefore, if one drive port or drive channel fails, the data on the drive is accessible through the other drive port or drive channel.

SATA drives are not dual ported; however, the electronics in the AT2655 drive tray emulate the behavior of dual-ported drives. Each SATA drive is available through two paths.

Preferred Controllers and Alternate Controllers

The preferred controller is the controller that "owns" a volume or a volume group. SANtricity ES Storage Manager automatically selects the preferred controller when a volume is created, or the user can override the default selection.

Several conditions will force the preferred controller to fail over to the alternate controller. When this event occurs, ownership of the volume is shifted to the alternate controller. These conditions might initiate failover:

- The preferred controller is physically removed.
- The preferred controller is being updated with new firmware.
- The preferred controller has sustained a fatal event.

The paths used by the preferred controller to access either the drives or the host are called the preferred paths, and the redundant paths are the alternate paths. If a failure occurs that causes the preferred path to become inaccessible, the alternate path software detects the failure and automatically switches to the alternate path.

Alternate Path Software

Alternate path software or an alternate path (failover) driver is a software tool that provides redundant data path management between the host bus adapter (HBA) and the controller. This tool is installed on the host in a system that provides redundant HBAs and paths. The tool discovers and identifies multiple paths to a single logical unit number (LUN) and establishes a preferred path to that LUN. If any component in the preferred path fails, the alternate path software automatically reroutes input/output (I/O) requests to the alternate path so that the system continues to operate without interruption.

To learn how alternate path software works with SANtricity ES Storage Manager features to provide data path protection, refer to the *SANtricity ES Storage Manager Concepts* guide.

Failover

Failover is an automatic operation that switches from a failed component or failing component to an operational component. In the case of a Redundant Array of Independent Disks (RAID) controller failover, an operational controller takes over the ownership of volumes. The operational controller processes I/O from the host in place of the failing component or failed controller. Controller failover is possible only in controller trays or in controller-drive trays that contain two controllers.

In a system in which the alternate path software tool is installed on the host, the data paths through the failed HBA are replaced by data paths through the surviving HBA.

For more information, refer to the *Failover Drivers* guide.

Redundant and Non-Redundant

The term *redundant* indicates the existence of something more than what is essential to accomplish a task. In storage area network technology, redundancy means that essential services are implemented using duplicated components in such a way that if one component fails an alternative component continues to provide the service. This redundancy ensures the availability of data in case a component fails.

In most RAID systems, most of the components are redundant, but that the system might not be fully redundant. In other words, there might be one or two components whose individual failures would cause loss of access to data. Therefore, a *fully redundant system* duplicates all components and is configured to make sure that the duplicate components can be accessed in case of a failure. The manner in which the system is cabled is an essential component of creating a successfully configured redundant system.

Single Point of Failure

Any component or path that is not duplicated (redundant) or whose failure can cause loss of data access is called a potential *single point of failure*. The cabling scenarios in this document note the components that present a potential single point of failure. Choose a cabling topology that does not create a single point of failure.

SFP Transceivers, Fiber-Optic Cables, and Copper Cables

Controller-drive trays, controller trays, and drive trays use fiber-optic cables or copper cables for Fibre Channel connections. For copper Fibre Channel cables, a passive copper Small Form-factor Pluggable (SFP) transceiver is attached to each end of the cable. InfiniBand connections are made with fiber-optic cables. If your system will be connected with Fibre Channel or InfiniBand fiber-optic cables, you must install an active SFP transceiver into each port in which a fiber-optic cable will be connected before plugging in the fiber-optic cable. Connections for 1-Gb/s iSCSI use copper cables with RJ-45 connectors and do not require SFP transceivers. Connections for SAS use copper cables with SFF 8088 connectors and do not require SFP transceivers. The following figures show the two types of cables that use SFP transceivers. Note that your SFP transceivers and cables might look slightly different from the ones shown. The differences do not affect the performance of the SFP transceivers.

> **WARNING** (W03) **Risk of exposure to laser radiation** – Do not disassemble or remove any part of a Small Form-factor Pluggable (SFP) transceiver because you might be exposed to laser radiation.

Figure 2 Active SFP Transceiver with Fiber-Optic Cable

1. Active SFP Transceiver
2. Fiber-Optic Cable
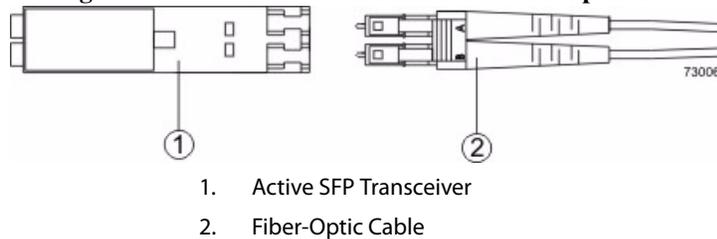
Figure 3 Passive SFP Transceiver with Copper Cable

1. Copper Cable
2. Passive SFP Transceiver
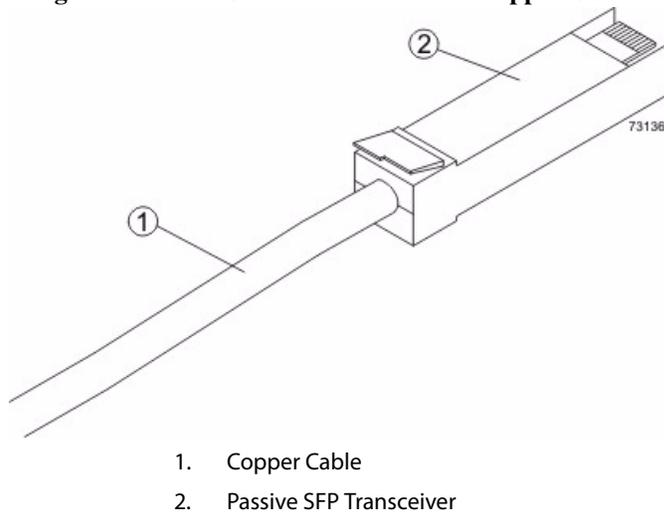
Host Adapters

Each connection from a host port on a controller tray or a controller-drive tray to a host is made through a host adapter on the host. A host adapter can be a host bus adapter (HBA) for Fibre Channel or SAS connections, a host channel adapter (HCA) for InfiniBand connections, or an Ethernet adapter for iSCSI connections. The host adapter provides the interface to the internal bus of the host. For hardware redundancy, use two host adapters in each host computer. The two host adapters must be of the same type (HBAs, HCAs, or Ethernet). For duplex controller trays or duplex controller-drive trays, connect each host adapter to a different controller in a controller tray or a controller-drive tray to make sure that the server will be accessible even if one HBA or one controller fails.

ATTENTION Possible loss of data access – Do not use a combination of HBAs from different vendors in the same storage area network (SAN). For the HBAs to perform correctly, use HBAs from only one manufacturer in a SAN.

You can obtain information about supported host adapters from the NetApp Interoperability Matrix Tool (IMT). To check for current compatibility, visit the web site at: http://now.netapp.com.

Host Interface Cards

Each controller in a CE7900 controller tray has one or two host interface cards (HICs) that contain the host ports. Each controller in a CE4900 controller-drive tray has two Fibre Channel host ports built in, as well as an optional HIC for additional host ports. Each controller in an E2600 controller-drive tray or an E2660 controller-drive tray has two SAS host ports built in, as well as an optional HIC for additional host ports. A E5400 controller-drive tray has two quad 8-Gb/s Fibre Channel ports built in and an optional HIC for additional host ports.

A HIC is cabled to a host adapter: a host bus adapter (HBA) for Fibre Channel or SAS, a host channel adapter (HCA) for InfiniBand, or an Ethernet adapter for iSCSI. The host adapter in the host must match the type of HIC to which it is cabled.

Network Interface Cards

A network interface card (NIC) is an expansion board that is installed in the host server. Some servers are equipped with an integrated NIC. The NIC supports Ethernet technology. The NIC is required for network communication. Each Ethernet cable connection for out-of-band storage array management is made through an NIC (see the topics under In-Band Management and Out-of-Band Management).

NOTE It is the responsibility of the customer to obtain the required NICs and to install them.

Switches and Zoning

A switch is an intelligent device that connects multiple devices. A switch allows data transfer between the devices, depending upon the designated source (*initiator*) and the destination (*target*) of the data. Switches can redirect traffic to ports other than the designated destination, if necessary. A switch provides full bandwidth per port and high-speed routing of data.

Zoning allows a single hardware switch to function as two or more virtual switches. In a zoned configuration, communication among devices in each zone is independent of communication among devices in another zone or zones. Zoned switches allow an administrator to restrict access to specific areas within a storage area network (SAN).

How Initiators and Targets Respond to Zoning

When an initiator first accesses the fabric, it queries the World Wide Identifier (WWID) name server for all of the attached disks and drive trays and their capabilities. Zoning is like a filter that the WWID name server applies to the query from the initiator that limits the information returned by the WWID name server to the initiator. A zone defines the WWID of the initiator and the WWID of the devices that a particular zone is allowed to access. Devices that are not part of the zone are not returned as accessible devices.

The fabric provides universal access for all initiators and targets. Any initiator can query (probe) the fabric for all targets, which can affect performance when many targets are connected to the fabric. The querying process also provides access to devices for which access is not needed. Use zoning to limit the number of devices that an initiator can access. Within your storage area network, you should zone the fabric switches so that the initiators do not "see" or communicate with each other.

How Best to Approach Zone Configuration

Some of the cabling topologies shown in this document require the use of a zoned switch. By default, the switch uses no zoning, which is not sufficiently robust for most applications. You must configure the switch before you use it.

Zone configuration is managed on a per-fabric basis. While you can administer zone configuration from any switch, use the best practice of selecting one switch for all zone administration. Give preference to the primary switches within the SAN, and choose only a switch that has the most up-to-date storage management software and switch management software installed on it.

In-Band Management and Out-of-Band Management

A system administrator manages a storage array from a storage management station, which is a workstation on which the SANtricity ES Storage Manager Client is installed. Requests and status information sent between the storage array and the storage management station are managed in one of two ways: in-band or out-of-band. A storage array that uses out-of-band management requires a different network topology from a storage array that uses in-band management.

When you use *in-band management*, a SANtricity ES Storage Manager agent running on the host receives requests from the management station. The host agent processes the requests through the host I/O interface to the storage array. The host I/O interface might be Fibre Channel, serial-attached Small Computer System Interface (SAS), InfiniBand, or Internet SCSI (iSCSI).

Figure 4 Example of In-Band Management Topology
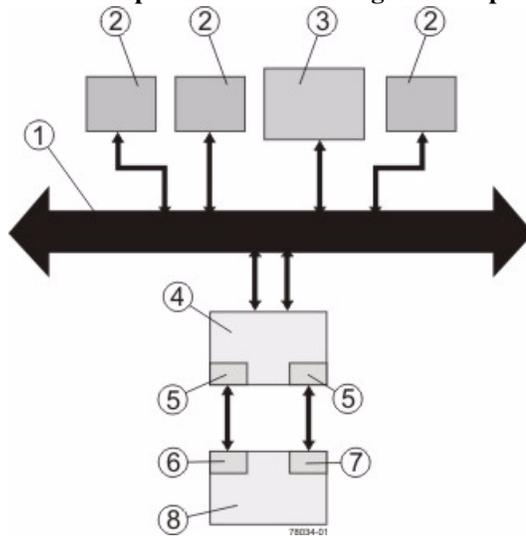
1. Ethernet Network
2. User Workstations Sending and Receiving Data
3. Storage Management Station
4. Host
5. Host Adapters
6. Controller A
7. Controller B
8. Controller Tray or Controller-Drive Tray for the Storage Array

When you use *out-of-band management*, the storage management station is connected, through an Ethernet network, to each of the controllers in the controller tray or the controller-drive tray.

Figure 5 Example of Out-of-Band Management Topology
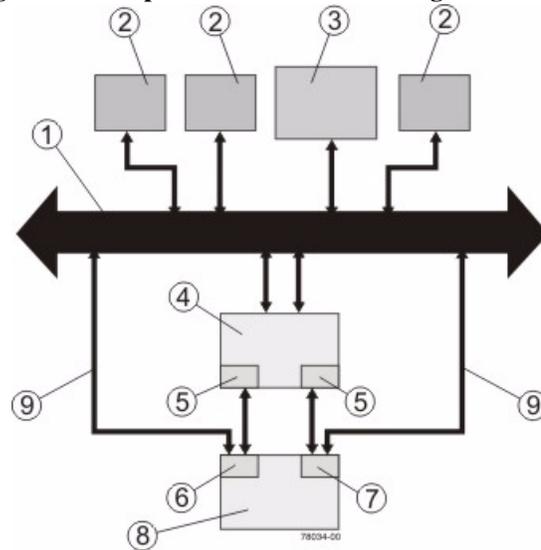
1. Ethernet Network
2. User Workstations Sending and Receiving Data
3. Storage Management Station
4. Host
5. Host Adapters
6. Controller A
7. Controller B
8. Controller Tray or Controller-Drive Tray for the Storage Array
9. Ethernet Cable from the Controllers to the Ethernet Network

When using out-of-band management, a Dynamic Host Configuration Protocol (DHCP) server is recommended for assigning Internet Protocol (IP) addresses and other network configuration settings. A DHCP server provides the network administrators the ability to manage and automatically assign IP addresses. If a DHCP server is not used, you must manually configure the controllers. For more information, refer to the Adding a Host or Storage Array online help topic in the Enterprise Management Window.

ATTENTION Risk of unauthorized access to or loss of data – If the out-of-band management method is used, connect the Ethernet ports on the controller tray or the controller-drive tray to a private network segment behind a firewall. If the Ethernet connection is not protected by a firewall, your storage array might be at risk of being accessed from outside of your network.

NOTE Where two Ethernet ports are available on each controller (four total), you can use one of the ports on each controller for out-of-band Ethernet connections. Reserve the second Ethernet port on each controller for access by your Technical Support representative.

For information about how to create a redundant out-of-band topology, see the topics under Drive Cabling.

Best Practices

This section explains recommended cabling practices. To make sure that your cabling topology results in optimal performance and reliability, familiarize yourself with these best practices.

NOTE If your existing storage array cabling does not comply with the best practices described in this section, do not re-cable your storage array unless specifically requested to do so by your Technical Support Representative.

Drive Cabling for Redundancy

When attaching the drive trays, use a cabling topology that does not create a single point of failure. A single point of failure might appear as a drive tray failure or another component failure in the middle of a grouping of drive trays. If a drive tray fails, you can no longer access the drive trays beyond the point of failure. By creating an alternate path, you make sure that the drive trays are accessible in the event of a drive tray failure.

The following figure shows a typical cabling scenario. In this example, each of the eight drive trays has two connections directly to the controller tray: one from ESM A to controller A and one from ESM B to controller B. Each redundant path pair on the controller tray connects to one drive tray. The ESM 1B ports are used for all of the connections.

Figure 6 Cabling for Eight Drive Trays

74188-08
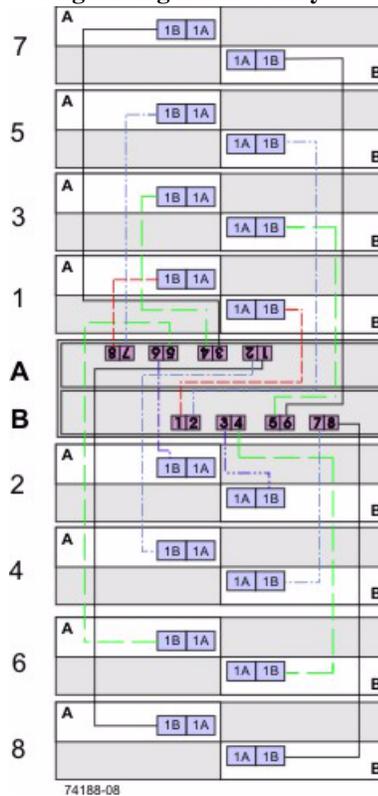
Note how the controller tray (denoted by A and B in the figure) is conveniently situated in the middle of the arrangement, which enables you to use cables that are all the same length. Positioning the controller tray near the middle of the cabinet also helps prevent the cabinet from becoming top heavy as drive trays are added.

For cabling examples, ranging from simple to complex, see the topics under Drive Cabling.

Host Cabling for Redundancy

To ensure that, in the event of a host channel failure, the storage array will stay accessible to the host, establish two physical paths from each host to the controllers, and install alternate path software on the host. This cabling topology, when used with alternate path software, makes sure that a redundant path exists from the host to the controllers.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of an HBA failure or a host channel failure.

For examples of redundant topologies, see Host Cabling.

Host Cabling for Mirroring

The Synchronous Mirroring premium feature and the Asynchronous Mirroring premium feature provide online, real-time replication of data between storage arrays in separate locations. In the event of a disaster or a catastrophic failure at one storage array, you can promote a second storage array to take over responsibility for computing services. See Hardware Installation for Synchronous Mirroring and Asynchronous Mirroring for detailed information.

NOTE When you use Fibre Channel connections for mirroring, one of the host ports on *each* controller must be dedicated for communications that occur between primary volumes on one storage array and secondary volumes on the other. If you do not use the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature, or if you use iSCSI connection with Asynchronous Mirroring, these host ports are available for ordinary host connections.

Cabling for Performance

Generally speaking, performance is enhanced by maximizing bandwidth, which is the ability to process more I/O across more channels. Therefore, a configuration that maximizes the number of host channels and the number of drive channels available to process I/O will maximize performance. Of course, faster processing speeds also maximize performance.

The DE6900 drive tray supports drive-side trunking. You can use drive-side trunking with the appropriate cabling configuration to, potentially, double the bandwidth available by making two drive channels simultaneously available to the same drive tray or loop.

In addition to planning a topology that provides maximum performance, choose a RAID level that suits the planned applications. For information on RAID levels, refer to the *SANtricity ES Storage Manager Concepts* guide.

Fibre Channel Drive-Side Trunking

Drive trays that support drive-side trunking can be cabled to a controller tray through a cabling pattern that doubles the bandwidth available to the drive trays. Trunking is possible only with drive trays that have Fibre Channel switch on a chip (SoC) loop-switch technology.

Drive-side trunking is an important feature for high-density drive trays because it enables a configuration with fewer drive trays connected to a controller tray to take advantage of the maximum bandwidth available for drive connections. For example, a storage array consisting of four DE6900 drive trays connected using drive-side trunking to a CE7900 controller tray with two controllers can take advantage of all of the available bandwidth on the controller tray. Without drive-side trunking, the four drive trays can only use half of the available bandwidth.

Each environmental services module (ESM) on a drive tray that is capable of drive-side trunking has four ports. In the previous example, two ports on each ESM would connect to each of two ports of a dual-ported drive channel on the controller tray. A new drive tray could be added to the example configuration by cabling two

ports on each ESM of the new drive tray to the two available ports on each ESM of one of the existing drive trays. The new drive tray would then share Fibre Channel loops with the drive tray to which it is cabled.

Considerations for Drive Channel Speed

When you connect multiple drive trays to the same drive channel, all of the drive trays must operate at the same speed. If you plan to combine drive trays that operate at different speeds on the same drive channel, you must set all of the drive trays to operate at the lowest common speed. The following table lists the operating speeds of each supported drive tray.

Table 1 Specifications for the Drive Trays

Model	Port Speed	Drives per Tray	Maximum Number of Drive Trays per Loop
FC4600 drive tray	4 Gb/s	16	7
FC2610 drive tray	2 Gb/s	14	8
AT2655 drive tray	2 Gb/s	14	8
DE6900 drive tray	4 Gb/s	60	2
DE6600 drive tray	6 Gb/s	60	5
DE5600 drive tray	6 Gb/s	24	7
DE1600 drive tray	6 Gb/s	12	15

Multiple Types of Drive Trays

NOTE Before you create a topology that combines multiple models of drive trays, make sure that your controller tray or controller-drive tray supports this feature. You must configure the controller tray or controller-drive tray to support multiple models of drive trays.

You can combine multiple drive tray models in a single storage array topology. Keep the following rules and guidelines in mind when you plan to cable your storage array with more than one drive tray type:

- To achieve maximum throughput performance, distribute drive trays across redundant drive channels in a controller tray or a controller-drive tray.
- Configure FC2610 drive trays and FC4600 drive trays (SBODs) in series as described in Cabling for Drive Trays That Support Loop Switch Technology.
- Do not create multiple series of FC2610 drive trays and FC4600 drive trays (SBODs) that are separated by AT2655 SATA drive trays.
- Whenever possible, and with consideration of the previously stated rules and guidelines, place all like drive trays on the same drive channel.
- When you cable drive trays to a CE7900 controller tray, do not mix multiple types of drive trays on the same loop.
- Cable only DE1600 drive trays and DE5600 drive trays to a E2600 controller-drive tray.

- Cable only DE1600 drive trays, DE5600 drive trays, and DE6600 drive trays to a E5400 controller-drive tray. E5400 controller-drive trays include the E5412, E5424, and E5460 models.

- Do not exceed the maximum number of drives that a storage array can support. When you cable drive trays to a controller-drive tray, keep in mind that the drives installed in the controller-drive tray count toward the maximum number of drives.

- Do not cable more than 15 drive trays of any type to a E5400 controller-drive tray.

The following tables summarizes the supported combinations of controller trays or controller-drive trays with drive trays.

Table 2 Drive Tray Cabling Combinations for the CE7922, CE7900, CE6998, and CE6994 Controller Trays

	DE6900 Drive Tray	**FC4600 Drive Tray**	**AT2655 Drive Tray**	**FC2610 Drive Tray**	**FC2600 Drive Tray**
CE7922 Controller Tray	■ Up to two per loop pair; eight per controller tray ■ Mixing drive tray types is not supported	Up to seven per loop pair; 28 per controller tray	Not supported	Not supported	Not supported

	DE6900 Drive Tray	FC4600 Drive Tray	AT2655 Drive Tray	FC2610 Drive Tray	FC2600 Drive Tray
CE7900 Controller Tray	■ Up to two DE6900 drive trays per loop pair; eight per controller tray ■ Up to seven FC4600 drive trays per loop pair; 28 per controller tray ■ When mixing FC4600 and DE6900 drive trays on the same loop, only one DE6900 drive tray and up to three FC4600 drive trays can share a loop.		Not supported	Not supported	Not supported
CE6998 Controller Tray	Not supported	■ Up to seven FC4600 drive trays per channel; up to 14 per controller tray			
CE6994 Controller Tray	Not supported	■ Up to eight AT2655, FC2610, or FC2600 drive trays per channel; up to 16 per controller tray ■ When a channel has a mixture of AT2655, FC2610, or FC2600 drive trays, up to seven drive trays per channel; up to 14 drive trays per controller tray ■ When a controller tray has a mixture of AT2655, FC2610, or FC2600 drive trays but each channel has only one type of drive tray, up to seven drive trays for each channel with FC4600 drive trays, up to eight drive trays for each channel with other drive tray types			

Table 3 Drive Tray Cabling Combinations for the CE4900, CDE3994, and CDE3992 Controller-Drive Trays

	DE6900 Drive Tray	FC4600 Drive Tray	AT2655 Drive Tray	FC2610 Drive Tray	FC2600 Drive Tray
CE4900 Controller-Drive Tray	Not supported	Up to six per controller-drive tray	Not supported	Not supported	Not supported
CDE3994 Controller-Drive Tray	Not supported	■ Up to seven attached drive trays if no drives are in the controller-drive tray ■ Up to six attached drive trays if no drives are in the controller-drive tray ■ MIxing different drive tray types on the same loop is supported			
CDE3992 Controller-Drive Tray	Not supported				

Table 4 Drive Tray Cabling Combinations for the E5500, E5400 and E2600 Controller-Drive Trays

	DE1600 Drive Trays	DE5600 Drive Trays	DE6600 Drive Trays
E5560 Controller-Drive Tray Standard Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 60 drives	Up to twelve per controller-drive tray when the controller-drive tray contains 60 drives	Up to five per controller-drive tray when the controller-drive tray contains 60 drives
E5524 Controller-Drive Tray Standard Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 24 drives	Up to 15 per controller-drive tray when the controller-drive tray contains 24 drives	Up to six per controller-drive tray when the controller-drive tray contains 24 drives
E5512 Controller-Drive Tray Standard Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 12 drives	Up to 15 per controller-drive tray when the controller-drive tray contains 12 drives	Up to six per controller-drive tray when the controller-drive tray contains 12 drives
E5460 Controller-Drive Tray Standard Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 60 drives	Up to twelve per controller-drive tray when the controller-drive tray contains 60 drives	Up to five per controller-drive tray when the controller-drive tray contains 60 drives
E5424 Controller-Drive Tray Standard Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 24 drives	Up to 15 per controller-drive tray when the controller-drive tray contains 24 drives	Up to six per controller-drive tray when the controller-drive tray contains 24 drives
E5412 Controller-Drive Tray Standard Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 12 drives	Up to 15 per controller-drive tray when the controller-drive tray contains 12 drives	Up to six per controller-drive tray when the controller-drive tray contains 12 drives
E5460 Controller-Drive Tray High Performance Computing Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 60 drives	Up to seven per controller-drive tray when the controller-drive tray contains 60 drives	Up to three per controller-drive tray when the controller-drive tray contains 60 drives

	DE1600 Drive Trays	DE5600 Drive Trays	DE6600 Drive Trays
E5424 Controller-Drive Tray High Performance Computing Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 24 drives	Up to nine per controller-drive tray when the controller-drive tray contains 24 drives	Up to three per controller-drive tray when the controller-drive tray contains 24 drives
E5412 Controller-Drive Tray High Performance Computing Configuration	Up to 15 per controller-drive tray when the controller-drive tray contains 12 drives	Up to nine per controller-drive tray when the controller-drive tray contains 12 drives	Up to three per controller-drive tray when the controller-drive tray contains 12 drives
E2660 Controller-Drive Tray	Not supported	Not supported	Up to two per controller-drive tray
E2624 Controller-Drive Tray	Up to 15 per controller-drive tray	Up to seven per controller-drive tray	Not supported
E2612 Controller-Drive Tray **E2612 Controller-Drive Tray**	Up to 16 per controller-drive tray	Up to eight per controller-drive tray	Not supported

Single-Controller Topologies and Dual-Controller Topologies

If you are creating a topology for a controller tray or a controller-drive tray that contains only one controller, you can attach only drive trays that contain a single environmental services module (ESM). Do not attach a drive tray that contains two ESMs to a single-controller controller tray or a single-controller controller-drive tray.

Copper Cables and Fiber-Optic Cables

You can use a combination of copper cables and fiber-optic cables to connect the drive trays to a controller tray or to a controller-drive tray. However, when a drive tray communicates with the controller tray (or the controller-drive tray) indirectly, through another drive tray, the connections between the drive tray and the controller tray (or the controller-drive tray) and between the two drive trays must use the same type of cable. Fiber-optic cables are required for host connections.

Cabling for Drive Trays That Support Loop Switch Technology

The FC2610 drive trays and the FC4600 drive trays operate internally as an array of drives that are connected in a point-to-point configuration by a Fibre Channel-Arbitrated Loop (FC-AL) loop switch. These drive trays are referred to as a Switched Bunch of Disks (SBOD). Drive trays without loop switch support operating as a string of drives on an arbitrated loop. SBOD drive trays operate more reliably than drive trays that use a traditional loop configuration. The loop switch also reduces transfer latency, which can increase performance in some configurations. To operate in Switch mode, you must cluster SBOD drive trays together when they are combined with other types of drive trays in a storage array topology.

The SBOD drive trays operate in *Switch mode* either when an SBOD drive tray is connected singly to a controller tray or a controller-drive tray, or when multiple SBOD drive trays are connected in series to a controller tray or a controller-drive tray.

An SBOD drive tray operates in *Hub mode* when a single SBOD drive tray is connected in series with other drive trays that do not support a loop switch. The SBOD drive trays also operate in *Hub mode* when multiple SBOD drive trays are interspersed in series with other drive trays that do not support a loop switch. The SBOD drive tray does not take advantage of the internal switch technology when operating in Hub mode. Some statistics that are available in switch mode are not available in Hub mode.

If SBOD drive trays are not clustered together correctly, the SANtricity ES Storage Manager software shows a Needs Attention status for the SBOD drive trays. A Needs Attention status does not prevent the SBOD drive trays from processing data; however, the Needs Attention status persists until you change the cabling topology. To maximize the performance of SBOD drive trays, always cable the SBOD drive trays in a series.

The following figure shows a simple block diagram of three recommended topologies for SBOD drive trays. All three scenarios shown in the figure are arranged to maximize performance. The scenario on the left of the figure (all SBODs) also offers the advantage of flexible drive cabling; for example, connecting two In ports or two Out ports. This flexible approach to drive cabling is enabled by the FC-AL feature.

In the figure, the FC2610 drive trays or the FC4600 drive trays are identified as SBODs. The AT2655 drive trays are identified as SATA (Serial Advanced Technology Attachment).

NOTE When you connect drive trays to the CE7922 controller tray or the CE7900 controller tray, you must not mix different types of drive trays on the same loop.

NOTE When you mix different types of drive trays, you must consider the total number of drives that are available in the final configuration of the storage array. For example, if you mix FC4600 drive trays with FC2610 drive trays, the total number of drives might be more than the maximum number that each drive channel can support.

Figure 7 Suitable Cabling Topologies for Multiple SBOD Drive Trays
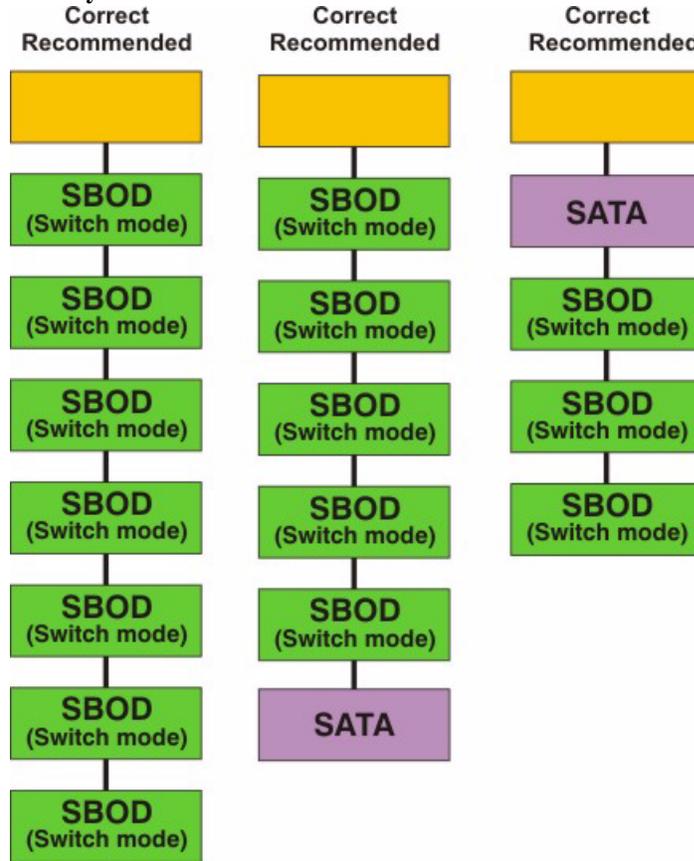
74095-01

Labeling Cables

Cabling is an important part of creating a robust storage array. Labeling the cables identifies system components, drive channels, and loops. System maintenance is easier when the cables are correctly identified. Label both ends of each cable. You can use adhesive office labels that are folded in half over the ends of each cable. Mark the labels with the port identifiers to which the cable is connected. If you use the recommended topologies in as described in the topics under Host Cabling and Drive Cabling, label each cable with the channel number noted in the table that you are following. You can provide additional information by using color-coded cable straps (or ties) to group all of the cables associated with one component, drive channel, or loop.

If a component fails, you must disconnect the cables, replace the failed component, and reattach the cables. Detailed labeling of the cables will simplify the component replacement process.

If you add a new drive tray to an existing configuration, correctly labeled cables will help you identify where to connect the new drive tray.

Cabling Information Provided by SANtricity ES Storage Manager

After you have completed your cabling topology and installed the SANtricity ES Storage Manager software, you can view cabling information through the SANtricity ES Storage Manager software. The SANtricity ES Storage Manager software shows a table that lists all of the connections in the cabling topology and identifies any incorrectly cabled drive channels or non-redundant drive channels. For more information, refer to the online help topics in the SANtricity ES Storage Manager software.

Adding New Drive Trays to an Existing Storage Array

HotScale™ technology enables you to add drive trays to an existing storage array without interrupting power or data transfer to the storage array. See the topics under Drive Cabling for the recommended cabling patterns for various numbers of attached drive trays.

For non-SAS drive connections, when the number of drive trays exceeds the number or drive ports on a controller, the cabling pattern changes significantly. At this point, you will start to use the "A" ports on the ESMs, and additional drive trays connect to the controller tray indirectly, through other drive trays.

If you are adding additional drive trays to an existing non-SAS configuration so that the total number of attached drive trays will increase from fewer than the number of drive ports per controller to a total that is greater than that number, you will need to re-cable some of the drive trays that were previously installed.

Common Procedures

This section provides procedures that are common to most cable installations.

Handling Static-Sensitive Components

Static electricity can damage dual inline memory modules (DIMMs), system boards, and other static-sensitive components. To prevent damaging the system, follow these precautions:

- Move and store all components in the static-protective packaging in which they came.
- Place components on a grounded surface before removing them from their static-protective packaging. Grounded surfaces include static-dissipating mats or grounded workstations.
- Always be properly grounded when touching a static-sensitive component. To properly ground yourself, wear a wrist strap or boot strap made for this purpose.
- Handle the component by its edges. Do not touch solder joints, pins, or printed circuitry.
- Use conductive field service tools.

Installing an SFP Transceiver and a Fiber-Optic Cable

You must install SFP transceivers into each connector to which you will connect a fiber-optic cable.

ATTENTION Potential degraded performance – To prevent degraded performance, do not twist, fold, pinch, or step on the fiber-optic cables. Many cables have a minimum bending radius. For example, do not bend fiber-optic Fibre Channel cables tighter than a 5-cm (2-in.) radius. Check the specifications for your cables and do not bend any cable more tightly than the minimum specified radius.

ATTENTION Possible hardware damage – To prevent electrostatic discharge damage to the tray, use proper antistatic protection when handling tray components.

1. Put on antistatic protection.

2. Make sure that your cables are fiber-optic cables by comparing them to the fiber-optic cable shown in the following figure. Your SFP transceivers might look slightly different from the one shown. The differences do not affect the performance of the SFP transceiver.

Figure 8 SFP Transceiver and Fiber-Optic Cable

1. SFP Transceiver
2. Fiber-Optic Cable
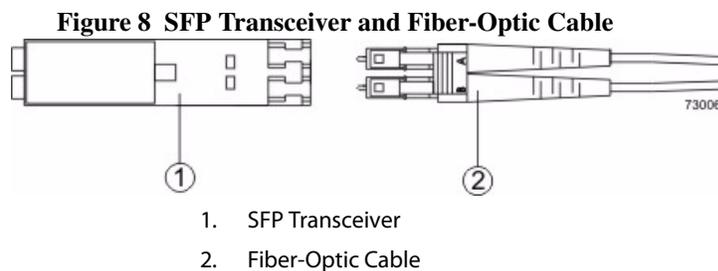
3. Insert an SFP transceiver into the port in which the fiber-optic cable will be installed.

NOTE Make sure that the SFP transceiver installs with an audible click.

Figure 9 Installing an SFP Transceiver
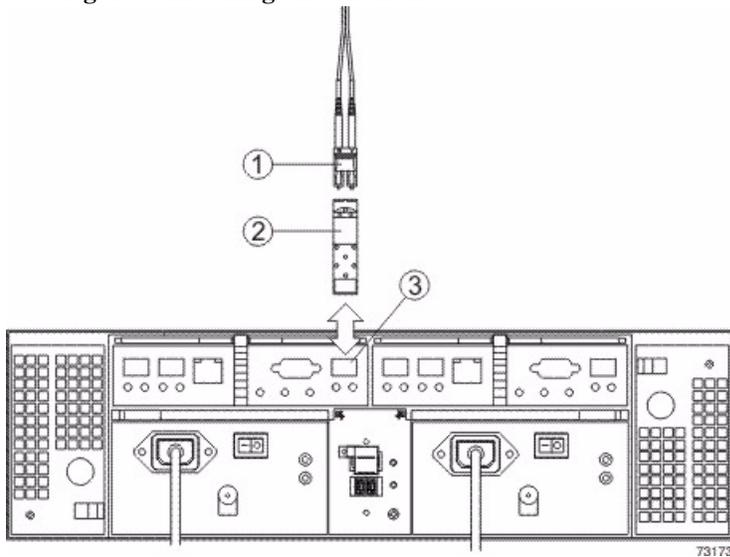
1. Fiber-Optic Cable
2. SFP Transceiver
3. Drive Tray Port

4. Install the fiber-optic cable.

Installing a Copper Cable with a Passive SFP Transceiver

ATTENTION Possible hardware damage – To prevent electrostatic discharge damage to the tray, use proper antistatic protection when handling tray components.

1. Put on antistatic protection.
2. Verify that your cables are copper cables by comparing them to the cable shown in the following figure.

   Your passive SFP transceivers might look slightly different from the one shown. The differences do not affect the performance of the SFP transceiver.

Figure 10 Passive SFP Transceiver and Copper Cable
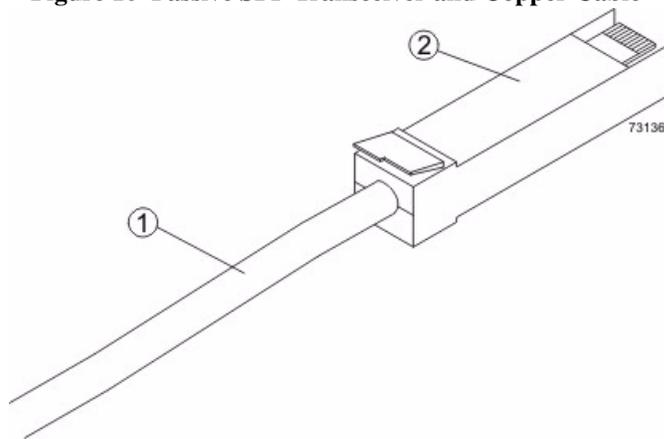
1. Copper Cable
2. Passive SFP Transceiver

NOTE Make sure that the passive SFP transceiver installs with an audible click.

---

3. Insert the passive SFP transceiver into the port in which the copper cable will be installed.

Installing an iSCSI Cable

ATTENTION Possible hardware damage – To prevent electrostatic discharge damage to the tray, use proper antistatic protection when handling tray components.

---

1. Put on antistatic protection.
2. Verify that you have the correct cables for an iSCSI connections by comparing them to the cable shown in the following figure. Cables for iSCSI connections do not require SFP transceivers.

Figure 11 iSCSI Cable with an RJ-45 Connector
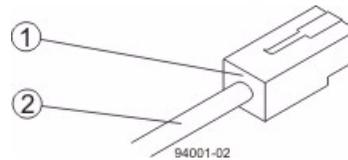
1. RJ-45 Connector
2. iSCSI Cable

3. For each cable, insert one RJ-45 connector into a host interface card port on the controller-drive tray or the controller tray and the other RJ-45 connector into a port on the host's Ethernet adapter.

Installing a SAS Cable

ATTENTION Possible hardware damage – To prevent electrostatic discharge damage to the tray, use proper antistatic protection when handling tray components.

1. Put on antistatic protection.
2. Verify that you have the correct cables for a SAS connections by comparing them to the cable shown in the following figure. Cables for SAS connections do not require SFP transceivers.

Figure 12 SAS Cable with an SFF-8088 Connector
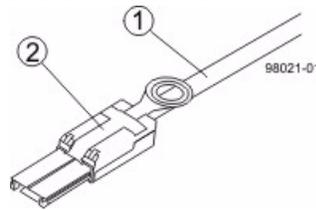
1. SAS Cable
2. SFF-8088 Connector

3. For each cable, insert one SFF-8088 connector into a host interface card port on the controller-drive tray or the controller tray and the other SFF-8088 connector into an port on the host's HBA.

Product Compatibility

2

This chapter lists all currently supported products, along with their host and drive channel specifications.

Host Channel Information by Model

The following table lists the specifications and restrictions that affect host-cabling topologies. Make sure that your planned controller tray topology or your planned controller-drive tray topology is compatible with these specifications and restrictions.

Table 1 Host Channel Information for Controller Trays and Controller-Drive Trays

Product	Host Port Type	Maximum Host Port Speed	Number of Host Ports per Controller	Maximum Number of Hosts per Cluster	Maximum Number of Hosts	Cable Type
CE7922 controller tray	InfiniBand	2 Gb/s 4 Gb/s	0, 4, or 8	16	2048	Copper or fiber-optic InfiniBand
CE7900 controller tray	Fibre Channel	8 Gb/s (with 8-Gb/s HICs)	0, 4, or 8	16	2048	Fiber-optic
	iSCSI	1 Gb/s 10 Gb/s	0, 4, or 8	16	256	Copper
	InfiniBand	20 Gb/s	0, 4, or 8	16	256	Fiber-optic InfiniBand
CE6998 controller tray	Fibre Channel	4 Gb/s	4	16	1024	Fiber-optic
E5500	SAS	6 Gb/s	Four			Active or passive copper SAS w/ MiniSAS 8088 connectors
	InfiniBand	40 Gb/s	Two			Fiber-optic or copper InfiniBand

Product	Host Port Type	Maximum Host Port Speed	Number of Host Ports per Controller	Maximum Number of Hosts per Cluster	Maximum Number of Hosts	Cable Type
E5460, E5424, and E5412 controller-drive trays	Fibre Channel	8 Gb/s	One or two quad-port adapters	16	512	Fiber-optic (Fibre Channel)
	InfiniBand	40 Gb/s	Zero or one dual-port adapter			Fiber-optic InfiniBand
	iSCSI	10 Gb/s	Zero or one dual-port adapter			
	SAS	6 Gb/s	Zero or one quad-port adapter			
CE4900 controller-drive tray	Fibre Channel	8 Gb/s	2 or 4	16	640	Fiber-optic
	iSCSI	1 Gb/s 10 Gb/s	2	16	640	Copper
CDE3994 controller-drive tray	Fibre Channel	2 Gb/s	4	16	1024	Fiber-optic
CDE3992 controller-drive tray	Fibre Channel	2 Gb/s	2 or 4	16	256	Fiber-optic
E2600 controller-drive tray and the E2660 controller-drive tray	SAS	6 Gb/s 10 Gb/s	2 or 4	16	256	Copper
	Fibre Channel	8 Gb/s	0 or 4	16	256	Fiber-optic
	iSCSI	1 Gb/s	0 or 4	16	256	Copper

Drive Channel Information by Model

The following table lists the specifications and restrictions that affect cabling between controller trays and drive trays or between controller-drive trays and drive trays. Make sure that the topology you plan for your drive trays is compatible with these specifications and restrictions.

> **NOTE** When you mix different types of drive trays, you must consider the total number of drives that are available in the final configuration of the storage array. Your configuration must meet both the limit on the total number of drive slots and the limits on the number of drive trays of a given model.

Table 2 Drive Channel Information for E5512 Controller Trays and E5524 Controller-Drive Trays

Product	Drive Port Speeds	Maximum Number of Drives	Supported Drive Trays	Cable Type	Notes
CE7922 controller tray	2 Gb/s or 4 Gb/s	480	DE6900 FC4600	Copper FC cables or fiber-optic FC cables	The 480 maximum number of drives is possible only for a configuration with eight DE6900 drive trays with no other types of drive trays. There is a limit of two expansion drive trays for each redundant pair of loops. Up to 448 drives are possible when FC4600 drive trays are used exclusively. There is a limit of seven expansion drive trays for each redundant pair of loops. Mixing drive types is not supported.
CE7900 controller tray	2 Gb/s or 4 Gb/s	480	DE6900 FC4600	Copper FC cables, fiber-optic FC cables, or copper iSCSI cables	The 480 maximum number of drives is possible only for a configuration with eight DE6900 drive trays with no other types of drive trays. There is a limit of two expansion drive trays for each redundant pair of loops. Up to 448 drives are possible when FC4600 drive trays are used exclusively. There is a limit of seven expansion drive trays for each redundant pair of loops. Mixing drive tray types is supported. The maximum number of drives for a mixed configuration is 448. With a CE7900 controller tray, FC4600 drive trays support solid-state drives (SSDs). A drive tray can have both SSDs and hard disk drives. The maximum number of SSDs for the storage array is 20.

Product	Drive Port Speeds	Maximum Number of Drives	Supported Drive Trays	Cable Type	Notes
CE6998 controller tray and CE6994 controller tray	2 Gb/s or 4 Gb/s	224	FC4600 AT2655 FC2610 FC2600	Copper FC cables or fiber-optic FC cables	If you are using the FC4600 drive tray in your configuration, design for a limit of seven expansion drive trays for each redundant pair of loops. With the AT2655, FC2610, or FC2600 expansion drive trays, the limit is eight per channel pair.
					Mixing drive types is supported. When a channel has a mix of FC4600, AT2655, FC2610, or FC2600 drive traysFC4600, AT2655, or FC2610 drive trays, up to seven drive trays per channel and up to 14 drive trays per controller tray are supported.
					When a controller tray has a mix of FC4600, AT2655, FC2610, or FC2600 drive traysFC4600, AT2655, or FC2610 drive trays but each channel has only one type of drive tray, up to seven drive trays for each channel with FC4600 drive trays and up to eight drive trays for each channel with other drive tray types are supported.
E5500	6 Gb/s	384	DE1600 DE5600 DE6600	Active or passive copper SAS cables	The E5500 controller-drive trays have 12-drive, 24-drive, and 60-drive configurations.
					The DE1600 drive tray has up to 12 drives.
					The DE5600 drive tray has up to 24 drives.
					The DE6600 has up to 60 drives.
					The maximum number of drive trays per controller-drive tray is 15.

Product	Drive Port Speeds	Maximum Number of Drives	Supported Drive Trays	Cable Type	Notes
E5460, E5424, and E5412 controller-drive trays	6 Gb/s SAS	384	DE1600 DE5600 DE6600	SAS cables	The E5400 controller-drive trays have 12-drive, 24-drive, and 60-drive configurations respectively. The DE1600 drive tray has up to 12 drives. The DE5600 drive tray has up to 24 drives. The DE6600 has up to 60 drives. The maximum number of drive trays per controller-drive tray is 15. The maximum number of drives for High Performance Computing configurations is 240.
CE4900 controller-drive tray	4 Gb/s	112	FC4600	Copper FC cables or fiber-optic FC cables Copper iSCSI cables	Design for a limit of six expansion drive trays per dual-ported drive channel.
CDE3994 controller-drive tray and CDE3992 controller-drive tray	2 Gb/s or 4 Gb/s	112	FC4600 AT2655 FC2610 FC2600	Copper FC cables or fiber-optic FC cables	Mixing different drive tray types on the same loop is supported. Up to seven attached drive trays if there are no drives in the controller-drive tray and up to six attached drive trays if there are drives in the controller-drive tray are supported.
E2600 controller-drive tray	6 Gb/s SAS	192	DE1600 DE5600 DE6600	SAS cables	The E2600 controller-drive tray has both 12-drive and 24-drive configurations. The DE1600 drive tray has up to 12 drives. The DE5600 drive tray has up to 24 drives. The DE6600 has up to 60 drives.

Product	Drive Port Speeds	Maximum Number of Drives	Supported Drive Trays	Cable Type	Notes
E2660 controller-drive tray			DE6600	SAS cables	The DE6600 has up to 60 drives.

Drive Tray Information by Model

The following tables list drive tray specifications that might affect your topology. Make sure that your planned topology is compatible with these specifications and restrictions.

NOTE When you mix different types of drive trays, you must consider the total number of drives that are available in the final configuration of the storage array. Your configuration must meet both the limit on the total number of drive slots and the limits on the number of drive trays of a given model.

NOTE The maximum number of drive slots and the maximum number of drive trays for a redundant pair of channels is the same as for a single non-redundant channel.

Table 3 Specifications for Non-SAS Drive Trays

Model	Port Speed	Drives per Tray	Maximum Number of Drive Trays per Channel
DE6900 drive tray	4 Gb/s	60	2
FC4600 drive tray	4 Gb/s	16	7
FC2610 drive tray	2 Gb/s	14	8
FC2600 drive tray	2 Gb/s	14	8
AT2655 drive tray	2 Gb/s	14	8

The E5400 controller-drive tray models are: E5412, E5424, and the E5460. For configurations of the E5400 with InfiniBand host connections, the total number of drives in the storage array, including the drives in the controller-drive tray and those in all of the attached drive trays, must not exceed 240. For all other configurations of the E5400, the total number of drives in the storage array, including the drives in the controller-drive tray and those in all of the attached drive trays, must not exceed 384. For all configurations of the E5400, the total number of trays in the storage array,

including the controller-drive tray and all of the attached drive trays, must not exceed 16. The maximum number of drive trays listed in the following table is based on a storage array where the controller-drive tray is fully populated with drives.

Table 4 Specifications for SAS Drive Trays

Model	Port Speed	Drives per Tray	Maximum Number of Drives per Channel	Maximum Number of Drive Trays per Channel
DE6600 drive tray	6 Gb/s	60	With E5400: 360 With E5400 (InfiniBand): 240 With E2660: 180	With E5400: 5 With E5400 (InfiniBand): 3 With E2660: 2
DE5600 drive tray	6 Gb/s	24	With E5400: 384 With E5400 (InfiniBand): 240 With E2600: 192	With E5400: 15 With E5400 (InfiniBand): 9 With E2600: 7
DE1600 drive tray	6 Gb/s	12	With E5400: 192 With E5400 (InfiniBand): 192 With E2600: 192	With E5400: 15 With E5400 (InfiniBand): 15 With E2600: 15

Component Locations   *3*

This chapter provides shows the rear of each controller tray, controller-drive tray, and drive tray. The figures identify the locations of controllers, environmental services modules (ESMs), host ports, drive ports, and Ethernet ports. The figures also show port identifiers.

Use the figures in the following topics to make sure that you have correctly identified the cable connection for host cabling, drive cabling and Ethernet cabling.

Port Locations on the CE7922 Controller Tray and the CE7900 Controller Tray

The CE7922 controller tray and the CE7900 controller tray have host channels that you can attach to the hosts, and drive channels that you can attach to the drive trays. The examples in this section show the CE7900 controller tray. The port locations are the same for the CE7922 controller tray.

■ Each of the two controllers in the CE7900 controller tray might have two host cards with four host ports on each card. This configuration is shown in the following figure. Some CE7900 controller trays might have controllers with only one host card each.

■ Controller A is inverted from controller B, which means that its host channels are upside-down.

Figure 1 Host Channels on the CE7922 Controller Tray and the CE7900 Controller Tray – Rear View
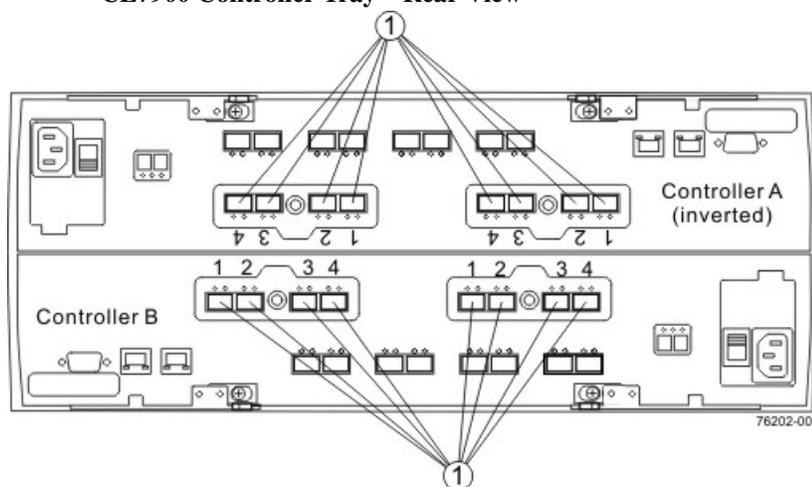
1.   Host Channel Ports

- Each controller in the CE7922 controller tray and the CE7900 controller tray has four drive channels, and each drive channel has two ports, so each controller has eight drive ports.
- Controller A is inverted from controller B, which means that its drive channels are upside-down.

Figure 2 Drive Channel Ports on the CE7922 Controller Tray and the CE7900 Controller Tray – Rear View
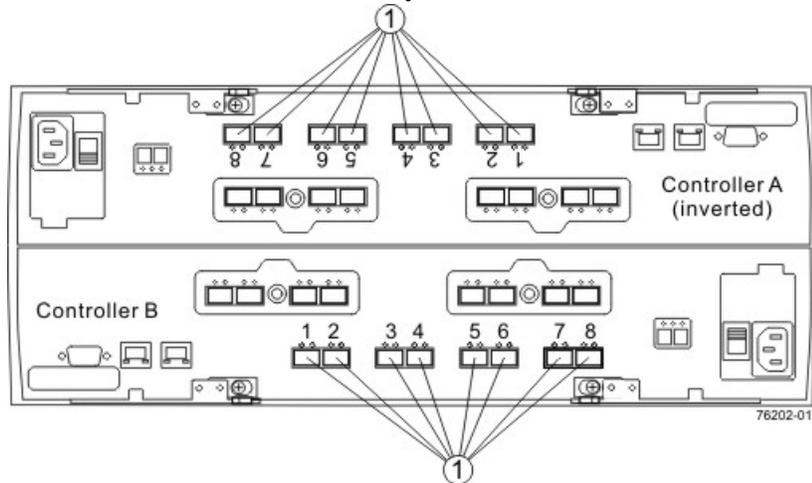
1. Drive Channel Ports

Component Locations on the CE6998 Controller Tray

Figure 3 Component Locations on the CE6998 Controller Tray – Rear View

1. Controller A (Inverted)
2. Controller B
3. Host Ports
4. Drive Ports
5. Ethernet Ports
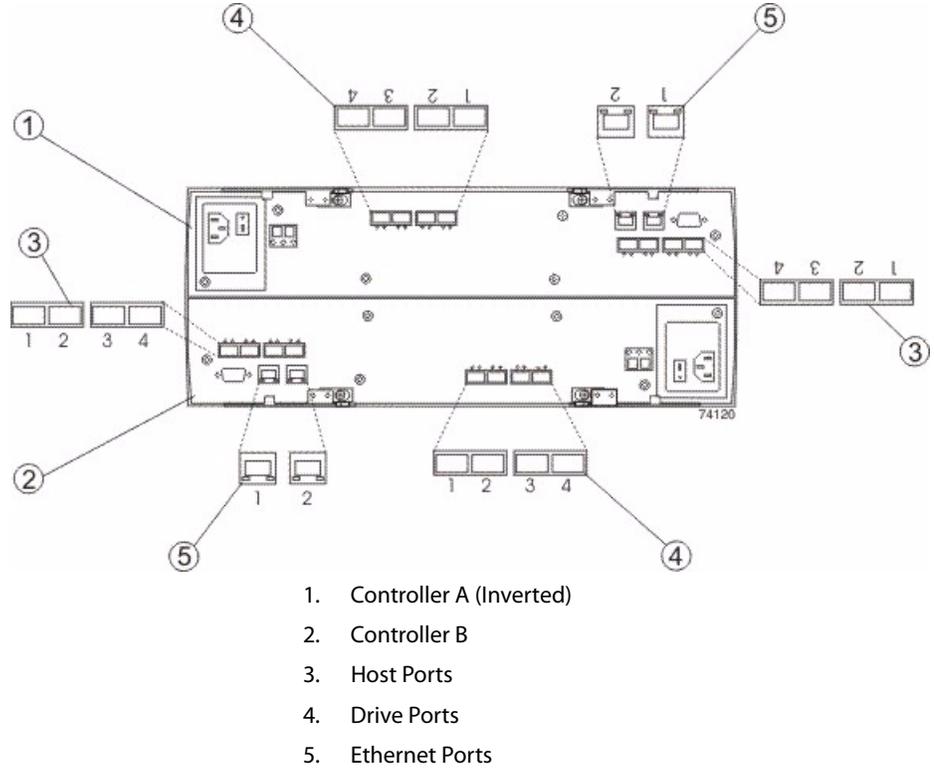
NOTE If you use remote mirroring, host port 4 on each controller of the CE6998 controller tray is reserved for that feature. If you do not use the remote mirroring feature, these host ports are available for host connections.

Table 1 Drive Ports and Drive Channels on the CE6998 Controller Tray

Drive Channel Number	Controller	Drive Port Numbers
1	A	4 and 3
2	A	2 and 1
3	B	1 and 2
4	B	3 and 4

NOTE When you cable the CE6998 controller tray, it is important to note that drive channel 1 and drive channel 3 are a redundant pair, and drive channel 2 and drive channel 4 are a redundant pair. In other words, if a failure occurred in drive channel 1, drive channel 3 would allow communication with the drives. If a failure occurred in drive channel 2, drive channel 4 would allow communication with the drives.

Component Locations on the E5500 Controller-Drive Trays

The E5500 controller-drive trays include three models: the E5560, the E5524, and the E5512. Keep these points in mind when you compare the figures in this section to your hardware.

- The top of the controller-drive tray is the side with the labels.
- The configuration of the host ports depends on which host interface card configuration is installed.
- The figures in this section show the AC power option.

Figure 4 E5560 Controller-Drive Tray – Front View with Bezel Removed
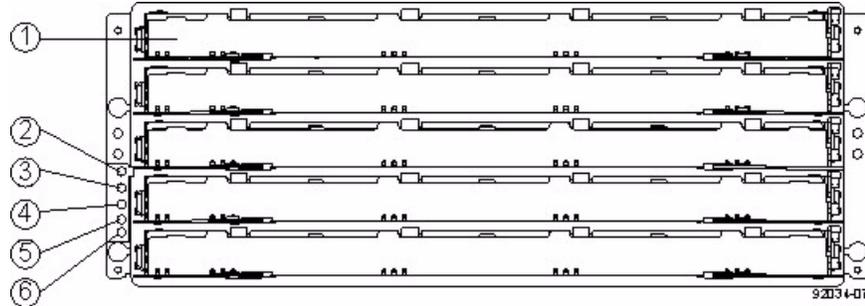
1. Drive Drawer
2. Locate LED
3. Service Action Required LED
4. Over-Temperature LED
5. Power LED
6. Standby Power LED

**Figure 5 Host Channels on the E5560 Controllers with SAS HIC –
Rear View92056**

92056-01
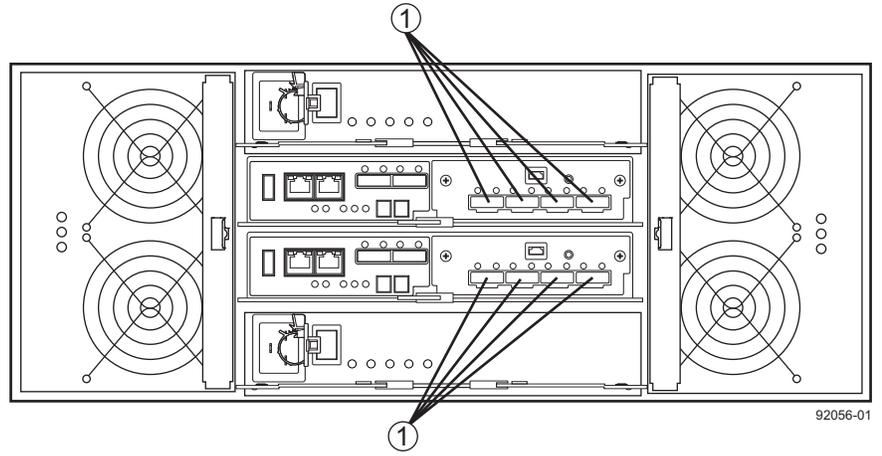
1.   SFF-8088 Host Interface Card Connectors

**Figure 6 Host Channels on the E5560 Controllers with InfiniBand
HIC – Rear View92057**

92057-01
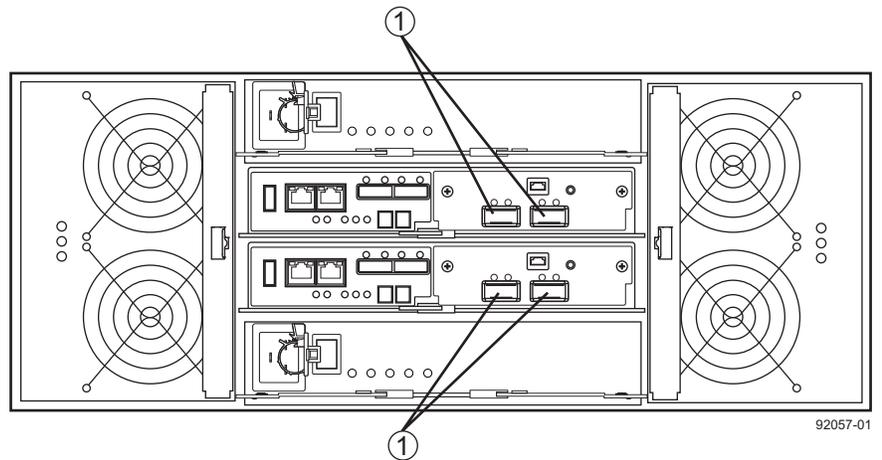
1.   IHost Interface Card QSFP Connectors

Figure 7 Drive Channel Ports on the E5560 Controller-Drive Tray
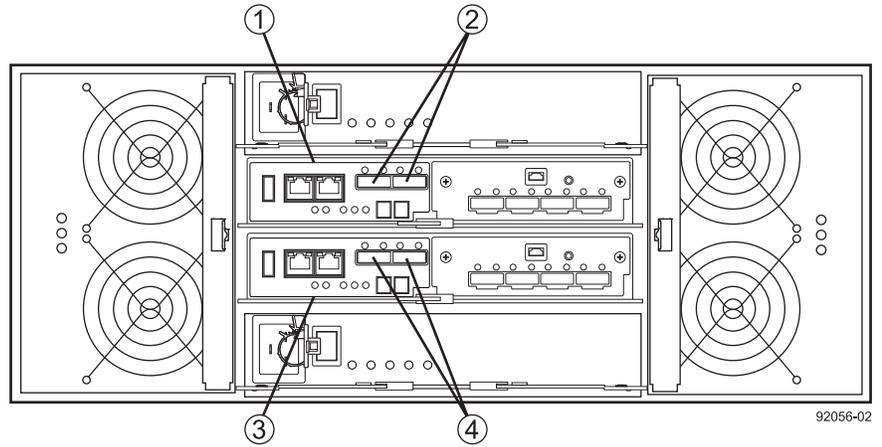
1. Controller Canister A
2. Drive Channel Port (SAS Drive Expansion Connectors)
3. Controller Canister B
4. Drive Channel Port (SAS Drive Expansion Connectors)

Figure 8 E5524 Controller-Drive Tray – Front View
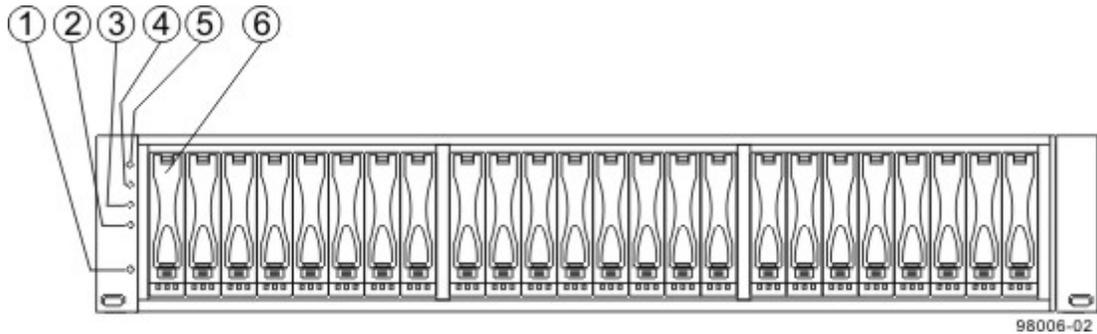
1. End Cap Standby Power LED
2. End Cap Power LED
3. End Cap Over-Temperature LED
4. End Cap Service Action Required LED
5. End Cap Locate LED
6. Drive Canister

Figure 9 E5512 Controller-Drive Tray – Front View
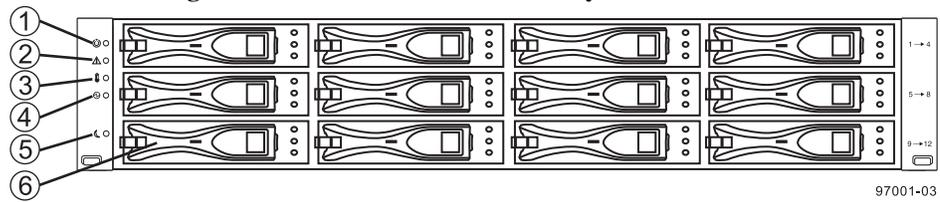
1. End Cap Standby Power LED
2. End Cap Power LED
3. End Cap Over-Temperature LED
4. End Cap Service Action Required LED
5. End Cap Locate LED
6. Drive Canister

Figure 10 E5524 Controller-Drive Tray and E5512 Controller-Drive Tray– Rear View
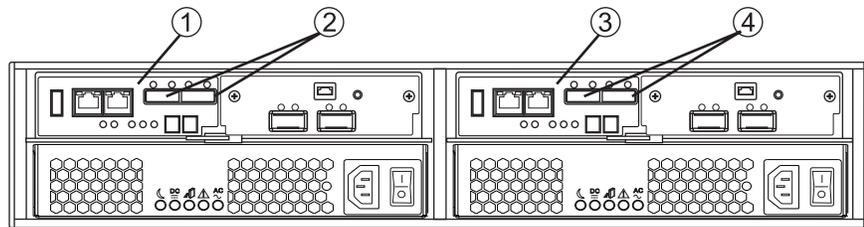
1. Controller Canister A
2. Drive Channel Port (SAS Drive Expansion Connectors)
3. Controller Canister B
4. Drive Channel Port (SAS Drive Expansion Connectors)

Figure 10 shows the controllers with infiniBand host interface cards in the right rear subplate position. Figure 11 shows the SAS host interface card which might occupy the same positions.

Figure 11 E5500 Right-Rear Subplate with an SAS Host Interface Card

51003-01
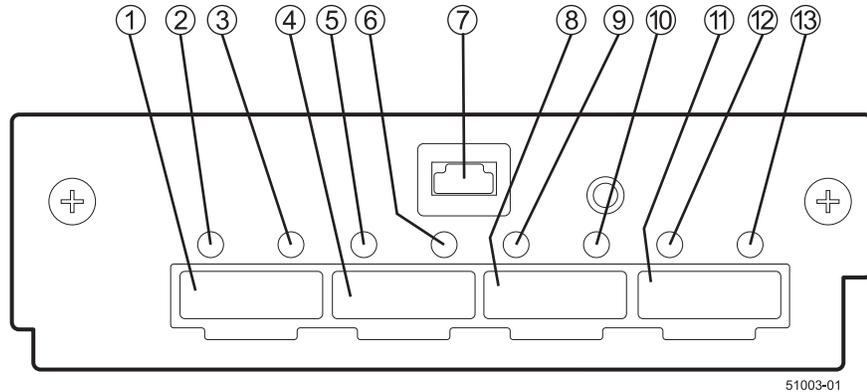
1. SFF-8088 Host Interface Card Connector 4
2. Mini-SAS Port 4 Link Fault LED
3. Mini-SAS Port 4 Link UP LED
4. SFF-8088 Host Interface Card Connector 3
5. Mini-SAS Port 4 Link Fault LED
6. Mini-SAS Port 4 Link UP LED
7. SFF-8088 Host Interface Card Connector 2
8. Mini-SAS Port 4 Link Fault LED
9. Mini-SAS Port 4 Link UP LED
10. SFF-8088 Host Interface Card Connector 1
11. Mini-SAS Port 4 Link Fault LED
12. Mini-SAS Port 4 Link UP LED

Component Locations on the E5500 Controller-Drive Trays

Component Locations on the E5400 Controller-Drive Trays

The E5400 controller-drive trays include three models: the E5460, the E5424, and the E5412. Keep these points in mind when you compare the figures in this section to your hardware.

- The top of the controller-drive tray is the side with the labels.
- The configuration of the host ports depends on which host interface card configuration is installed.
- The figures in this section show the AC power option.

Figure 12 E5460 Controller-Drive Tray – Front View with Bezel Removed
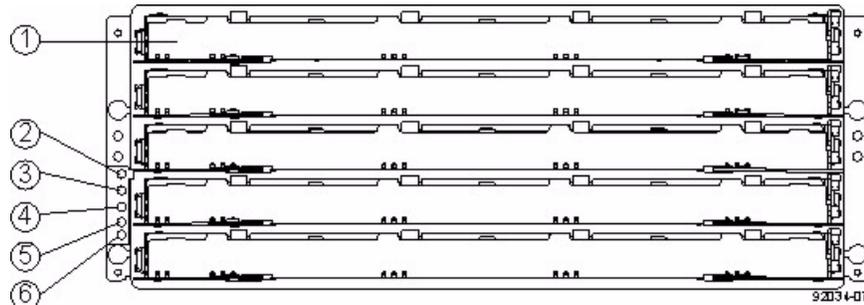
1. Drive Drawer
2. Locate LED
3. Service Action Required LED
4. Over-Temperature LED
5. Power LED
6. Standby Power LED

**Figure 13 E5460 Controller-Drive Tray – Rear View**
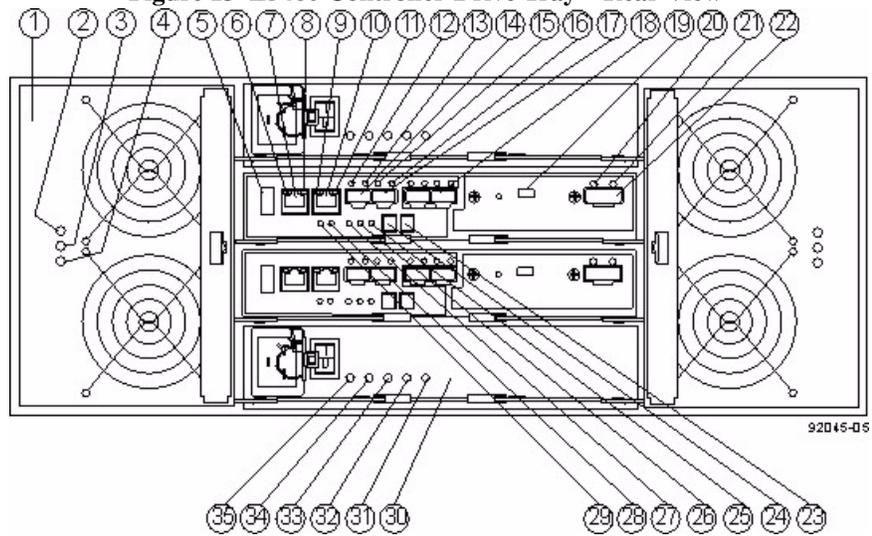
1.   Fan Canister
2.   Fan Power LED
3.   Fan Service Action Required LED
4.   Fan Service Action Allowed LED
5.   USB Connector
6.   Ethernet Link 1 Active LED
7.   Ethernet Connector 1
8.   Ethernet Link 1 Rate LED
9.   Ethernet Link 2 Active LED
10. Ethernet Connector 2
11. Ethernet Link 2 Rate LED
12. Fibre Channel Link 1 Up LED
13. Fibre Channel Link 1 Active LED
14. Fibre Channel Connector 1
15. Fibre Channel Link 2 Up LED
16. Fibre Channel Link 2 Active LED
17. Fibre Channel Connector 2
18. Fibre Channel Connector 4
19. Mini USB Connector
20. Expansion Fault LED
21. Expansion Active LED
22. Expansion SFF-8088 Port Connector
23. Second Seven-Segment Display Field

24. First Seven-Segment Display Field

25. Cache Active LED

26. Controller A Service Action Required LED

27. Controller A Service Action Allowed LED

28. Battery Charging LED

29. Battery Service Action Required LED

30. Power Canister

31. Power Canister AC Power LED

32. Power Canister Service Required Allowed LED

33. Power Canister Service Action Allowed LED

34. Power Canister DC Power LED

35. Power Canister Standby Power LED

Figure 14 E5424 Controller-Drive Tray – Front View
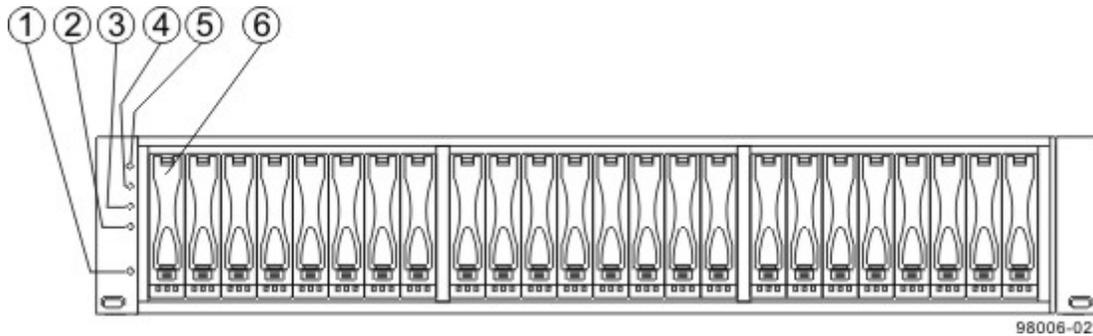
1. Standby Power LED

2. Power LED

3. Over-Temperature LED

4. Service Action Required LED

5. Locate LED

6. Drive Canister

Figure 15 E5412 Controller-Drive Tray – Front View
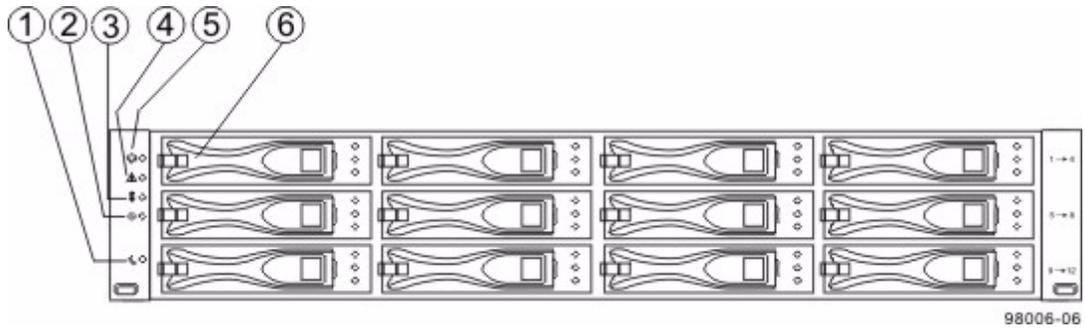
1. Standby Power LED
2. Power LED
3. Over-Temperature LED
4. Service Action Required LED
5. Locate LED
6. Drive Canister

Figure 16 E5424 Controller-Drive Tray and E5412 Controller-Drive Tray– Rear View
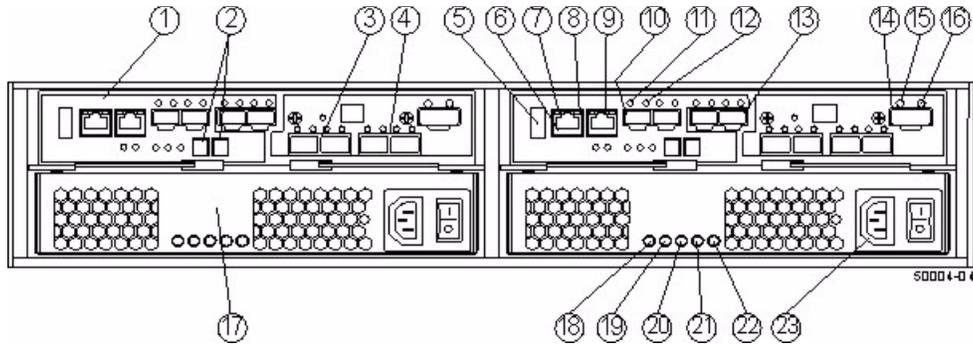
1. Controller A Canister
2. Seven-Segment Display
3. Host Interface Card Connector 1
4. Host Interface Card Connector 2
5. Serial Connector
6. Ethernet Connector 1
7. Ethernet Link Active LED
8. Ethernet Link Rate LED
9. Ethernet Connector 2
10. Host SFF-8088 Connector 2
11. Host Link 2 Fault LED
12. Host Link 2 Active LED
13. Base Host SFF-8088 Connector 1
14. ESM Expansion Fault LED
15. ESM Expansion Active LED
16. Expansion SFF-8088 Port Connector
17. Power-Fan Canister
18. Standby Power LED
19. Power-Fan DC Power LED
20. Power-Fan Service Action Allowed LED
21. Power-Fan Service Action Required LED
22. Power-Fan AC Power LED
23. AC Power Connector

Figure 17 E5400 Right-Rear Subplate with No Host Interface Card
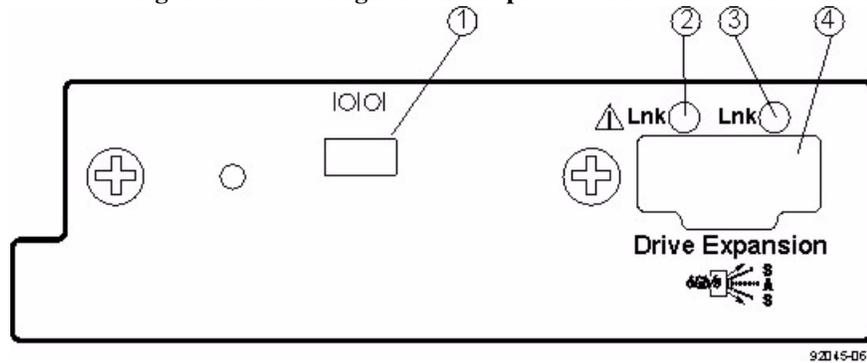
1. Mini USB Connector
2. ESM Expansion Fault LED
3. ESM Expansion Active LED
4. Expansion SFF-8088 Port Connector

Figure 18 E5400 Right-Rear Subplate with an Fibre Channel Host Interface Card
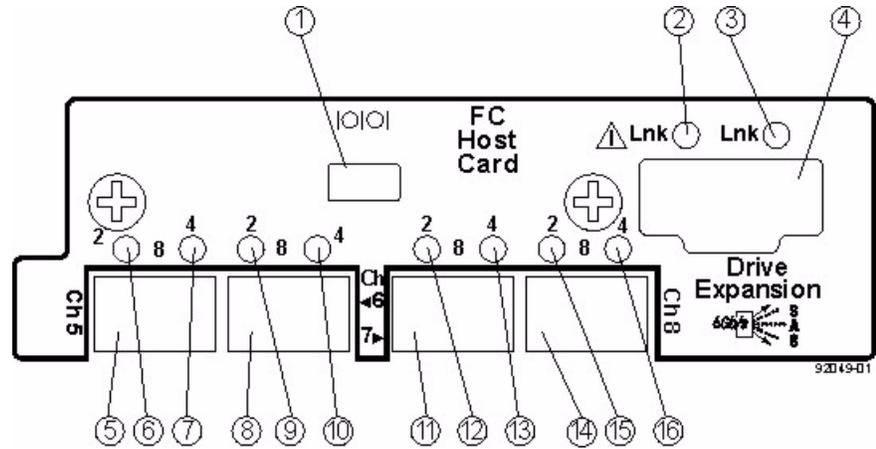
1. Mini USB Connector
2. SAS Expansion Fault LED
3. SAS Expansion Active LED
4. SAS Expansion SFF-8088 Port Connector
5. FC Host Interface Card Connector 5
6. Host Interface Card Link 5 LED 0
7. Host Interface Card Link 5 LED 1
8. FC Host Interface Card Connector 6
9. Host Interface Card Link 6 LED 0
10. Host Interface Card Link 6 LED 1
11. FC Host Interface Card Connector 7
12. Host Interface Card Link 7 LED 0
13. Host Interface Card Link 7 LED 1
14. FC Host Interface Card Connector 8
15. Host Interface Card Link 8 LED 0
16. Host Interface Card Link 8 LED 1

Figure 19 E5400 Right-Rear Subplate with an InfiniBand Host Interface Card
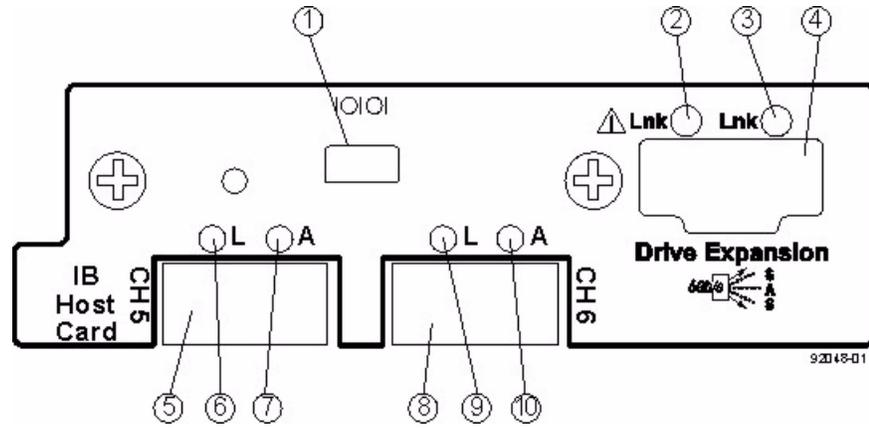
1. Mini USB Connector
2. SAS Expansion Fault LED
3. SAS Expansion Active LED
4. SAS Expansion SFF-8088 Port Connector
5. IB Host Interface Card Connector 1
6. IB Host Interface Card Physical Link 1 LED (Green)
7. IB Host Interface Card Logical Link 1 LED (Amber)
8. IB Host Interface Card Connector 2
9. IB Host Interface Card Physical Link 2 LED (Green)
10. IB Host Interface Card Logical Link 2 LED (Amber)

Component Locations on the CE4900 Controller-Drive Tray

- The top controller, controller A, is inverted from the bottom controller, controller B.
- The top of the controller-drive tray is the side with labels.
- The configuration of the host ports might appear different on your system depending on which host interface card configuration is installed.

Figure 20 CE4900 Controller-Drive Tray – Front View and Rear View
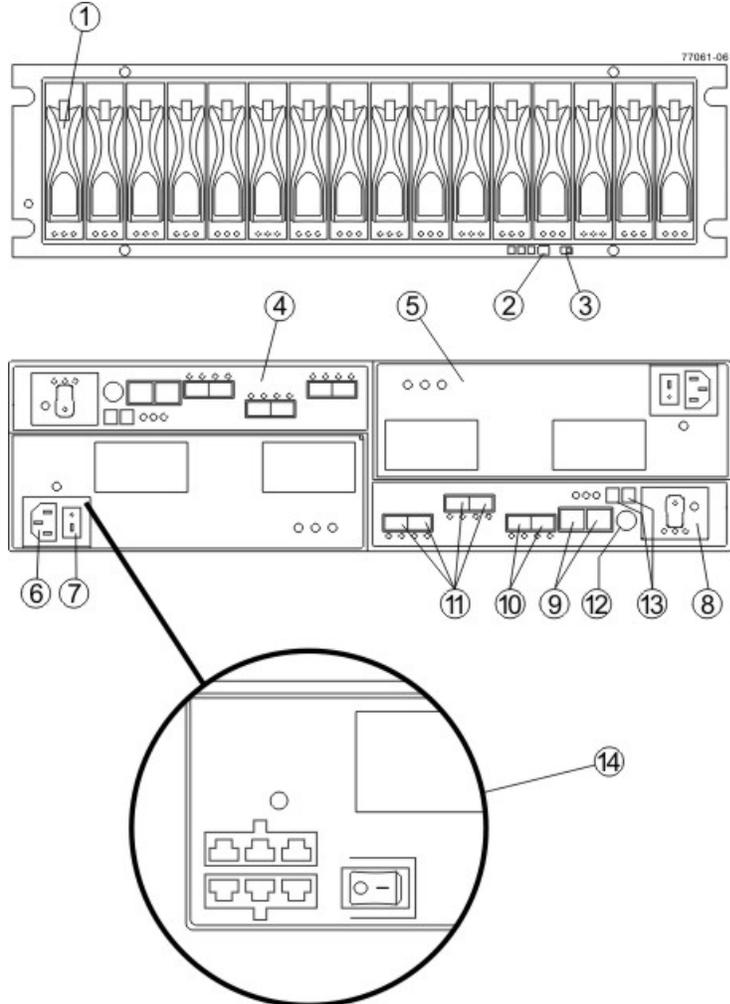
1. Drive Canister
2. Alarm Mute Switch
3. Link Rate Switch
4. Controller A (Inverted)
5. Power-Fan Canister

6.   AC Power Connector

7.   AC Power Switch

8.   Battery Canister

9.   Ethernet Ports

10. Drive Channels

11. Host Channels

12. Serial Port

13. Seven-Segment Display

14. Optional DC Power Connector and DC Power Switch

Component Locations on the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray

The following figure shows the AC power option.

Figure 21 Component Locations on the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray – Rear View
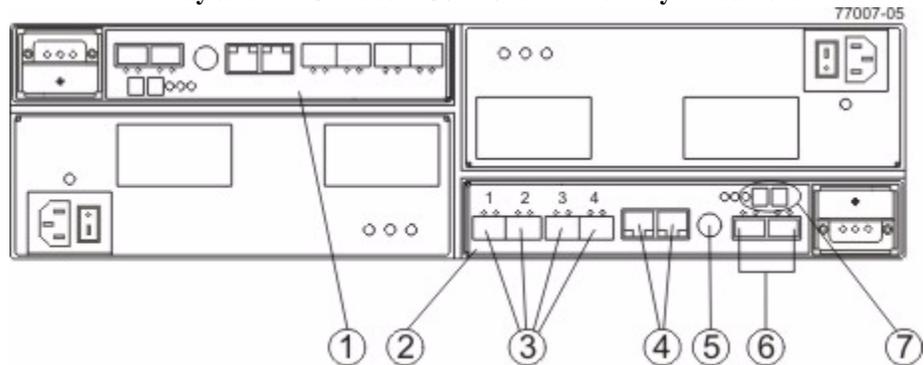
1.   Controller A (Inverted)

2.   Controller B

3.   Host Ports (2 Ports for the CDE3992 Controller-Drive Tray or 4 Ports for the CDE3994 Controller-Drive Tray)

4.   Ethernet Ports

5.   Serial Port

6.   Dual-Ported Drive Ports

7.   Seven-Segment Display

Table 2 Drive Ports and Drive Channels on the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray

Drive Channel Number	Controller	Drive Port Identifier
1	A	2 and 1
2	B	1 and 2

Component Locations on the E2600 Controller-Drive Tray

The E2600 controller-drive tray is available in two different drive configurations: one with up to twelve 3.5-in. drives and another with up to twenty-four 2.5-in. drives. With either drive configuration, the controller-drive tray is available in two different controller configurations: simplex and duplex.

Keep these points in mind when you compare the figures in this section to your hardware.

- The top of the controller-drive tray is the side with the labels.
- The configuration of the host ports depends on which host interface card configuration is installed.
- The figures in this section show the AC power option.

NOTE On the E2600 controller-drive tray, each controller has a pair of levers with handles for removing the controller from the controller-drive tray. If a controller has a HIC installed, one of these handles on the controller is located next to a host port on the HIC. The close spacing between the handle and the host port might make it difficult to remove a cable that is attached to the host port. If this problem occurs, use a flat-blade screwdriver to compress the release on the cable connector.

Figure 22 E2600 Controller-Drive Tray with 12 Drives – Front View
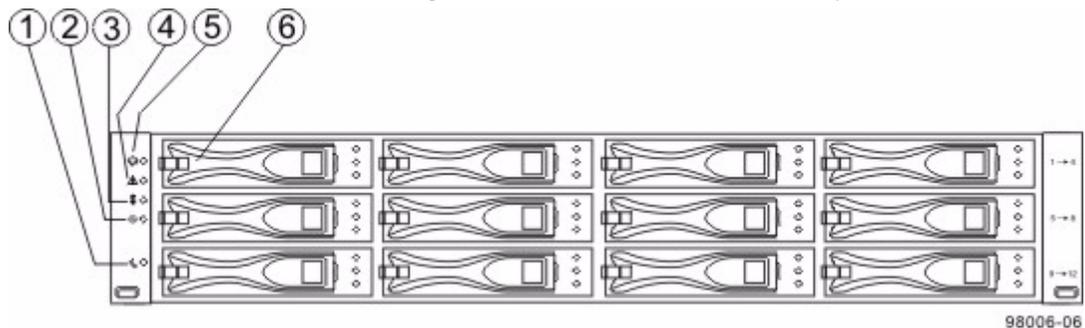
1. Standby Power LED
2. Power LED
3. Over-Temperature LED
4. Service Action Required LED
5. Locate LED
6. Drive Canister

Figure 23 E2600 Controller-Drive Tray with 24 Drives – Front View
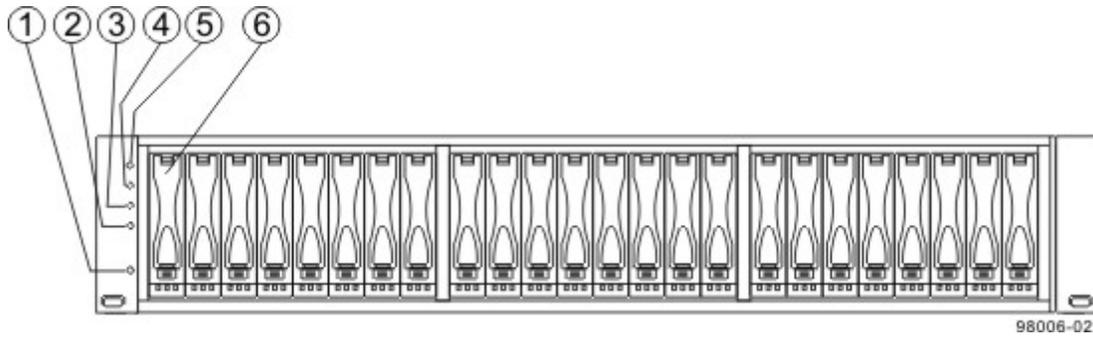
1. Standby Power LED
2. Power LED
3. Over-Temperature LED
4. Service Action Required LED
5. Locate LED
6. Drive Canister

**Figure 24 E2600 Controller-Drive Tray Duplex Configuration –
Rear View**
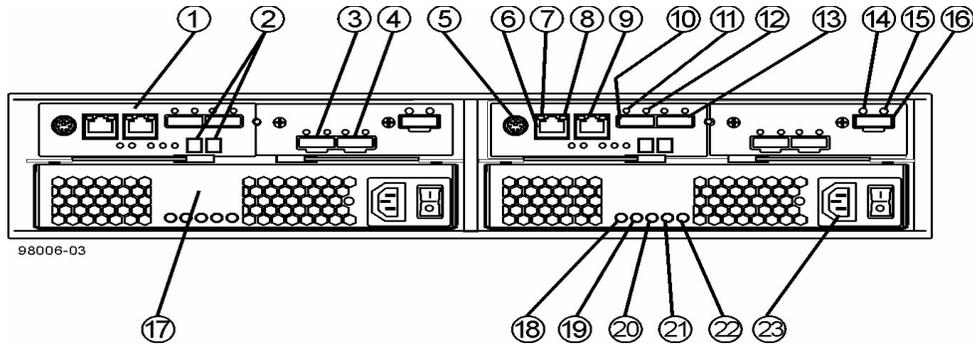
1. Controller A Canister
2. Seven-Segment Display
3. Host Interface Card Connector 1
4. Host Interface Card Connector 2
5. Serial Connector
6. Ethernet Connector 1
7. Ethernet Link Active LED
8. Ethernet Link Rate LED
9. Ethernet Connector 2
10. Host SFF-8088 Connector 2
11. Host Link 2 Fault LED
12. Host Link 2 Active LED
13. Base Host SFF-8088 Connector 1
14. ESM Expansion Fault LED
15. ESM Expansion Active LED
16. Expansion SFF-8088 Port Connector
17. Power-Fan Canister
18. Standby Power LED
19. Power-Fan DC Power LED
20. Power-Fan Service Action Allowed LED
21. Power-Fan Service Action Required LED
22. Power-Fan AC Power LED
23. AC Power Connector

Figure 25 E2600 Right-Rear Subplate with No Host Interface Card

1. ESM Expansion Fault LED
2. ESM Expansion Active LED
3. Expansion SFF-8088 Port Connector

Figure 26 E2600 Right-Rear Subplate with a SAS Host Interface Card
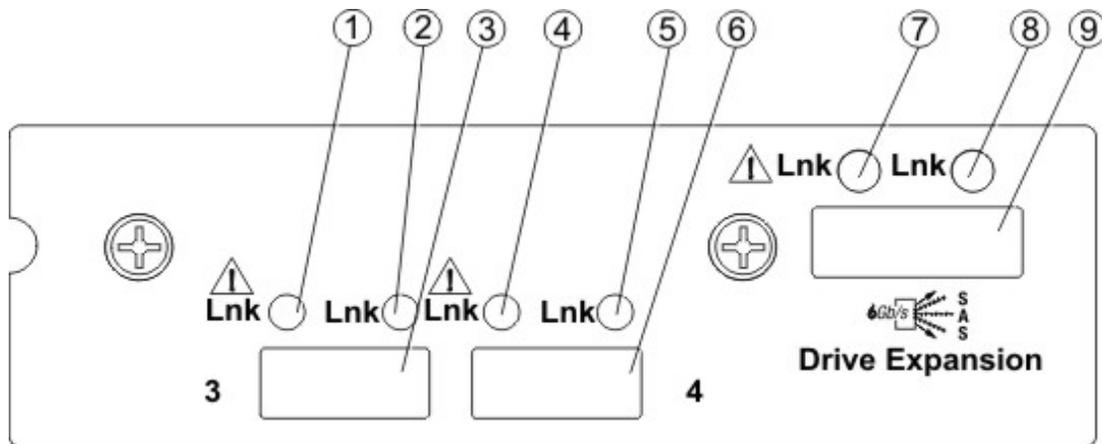
1. Host Interface Card Link 3 Up LED
2. Host Interface Card Link 3 Active LED
3. SFF-8088 Host Interface Card Connector 3
4. Host Interface Card Link 4 Up LED
5. Host Interface Card Link 4 Active LED
6. SFF-8088 Host Interface Card Connector 4
7. ESM Expansion Fault LED
8. ESM Expansion Active LED
9. Expansion SFF-8088 Port Connector

Figure 27 E2600 Right-Rear Subplate with an FC Host Interface Card
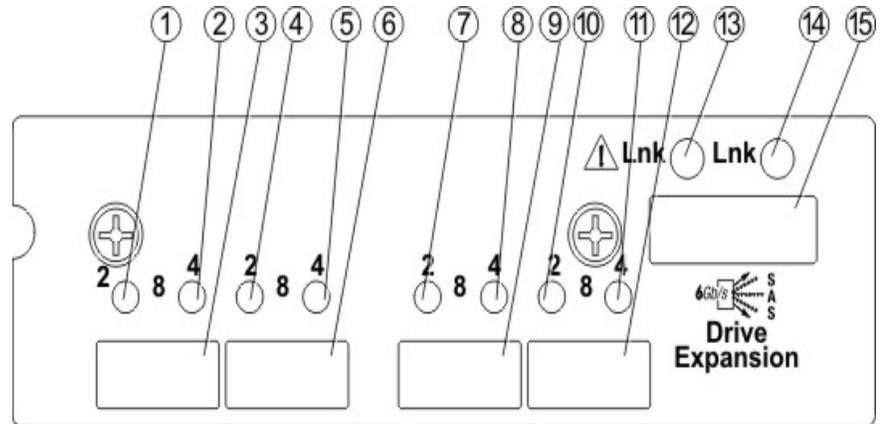
1. Host Interface Card Link 3 Up LED
2. Host Interface Card Link 3 Active LED
3. FC Host Interface Card Connector 3
4. Host Interface Card Link 4 Up LED
5. Host Interface Card Link 4 Active LED
6. FC Host Interface Card Connector 4
7. Host Interface Card Link 5 Up LED
8. Host Interface Card Link 5 Active LED
9. FC Host Interface Card Connector 5
10. Host Interface Card Link 6 Up LED
11. Host Interface Card Link 6 Active LED
12. FC Host Interface Card Connector 6
13. ESM Expansion Fault LED
14. ESM Expansion Active LED
15. Expansion SFF-8088 Port Connector

Figure 28 E2600 Right-Rear Subplate with an iSCSI Host Interface Card
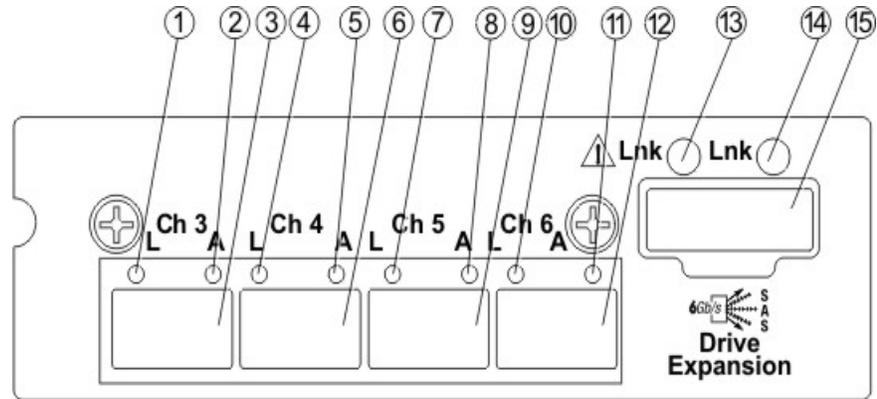
1. Host Interface Card Link 3 Up LED
2. Host Interface Card Link 3 Active LED
3. iSCSI Host Interface Card Connector 3
4. Host Interface Card Link 4 Up LED
5. Host Interface Card Link 4 Active LED
6. iSCSI Host Interface Card Connector 4
7. Host Interface Card Link 5 Up LED
8. Host Interface Card Link 5 Active LED
9. iSCSI Host Interface Card Connector 5
10. Host Interface Card Link 6 Up LED
11. Host Interface Card Link 6 Active LED
12. iSCSI Host Interface Card Connector 6
13. ESM Expansion Fault LED
14. ESM Expansion Active LED
15. Expansion SFF-8088 Port Connector

**Figure 29 E2600 Controller-Drive Tray Simplex Configuration –
Rear View**
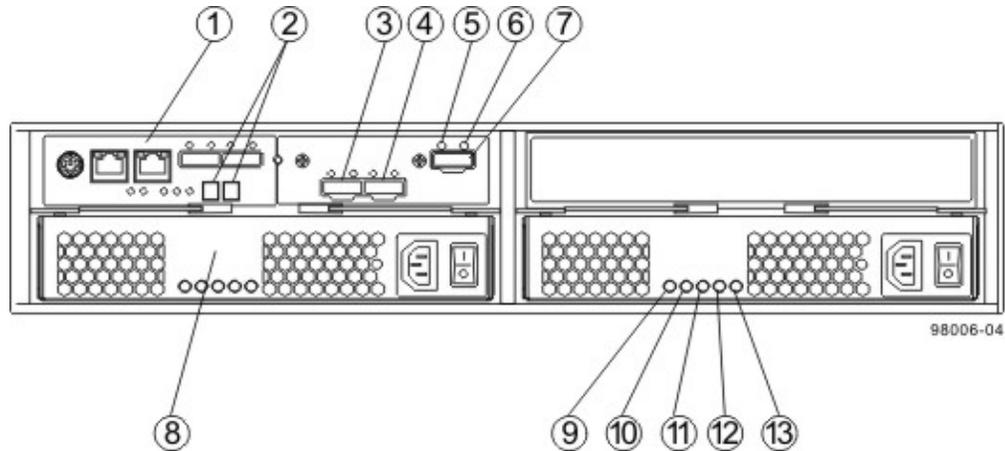
1. Controller A Canister
2. Seven-Segment Display
3. Host Interface Card Connector 1
4. Host Interface Card Connector 2
5. ESM Expansion Fault LED
6. ESM Expansion Active LED
7. Expansion Port SFF-8088 Connector
8. Power-Fan A Canister
9. Standby Power LED
10. Power-Fan DC Power LED
11. Power-Fan Service Action Allowed LED
12. Power-Fan Service Action Required LED
13. Power-Fan AC Power LED

Component Locations on the E2660 Controller-Drive Tray

The E2660 controller-drive tray is available in two different controller configurations: simplex and duplex.

Keep these points in mind when you compare the figures in this section to your hardware.

- The top of the controller-drive tray is the side with the labels.
- The configuration of the host ports depends on which host interface card configuration is installed.
- The figures in this section show the AC power option.

NOTE On the E2660 controller-drive tray, each controller has a pair of levers with handles for removing the controller from the controller-drive tray. If a controller has a HIC installed, one of these handles on the controller is located next to a host port on the HIC. The close spacing between the handle and the host port might make it difficult to remove a cable that is attached to the host port. If this problem occurs, use a flat-blade screwdriver to compress the release on the cable connector.

Figure 30 E2660 Controller-Drive Tray – Front View
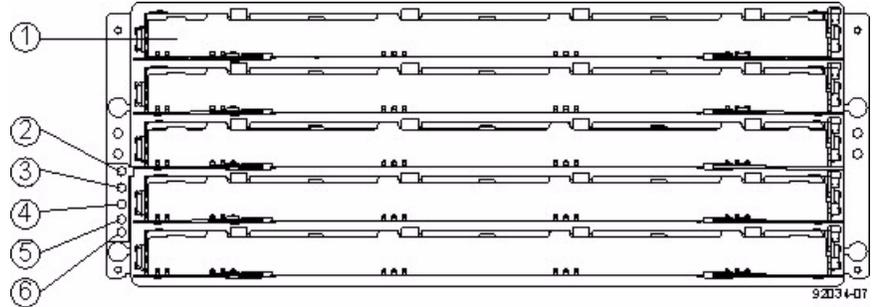
1. Drive Drawer
2. Standby Power LED
3. Power LED
4. Over-Temperature LED
5. Service Action Required LED
6. Locate LED

Figure 31 E2660 Controller-Drive Tray – Rear View
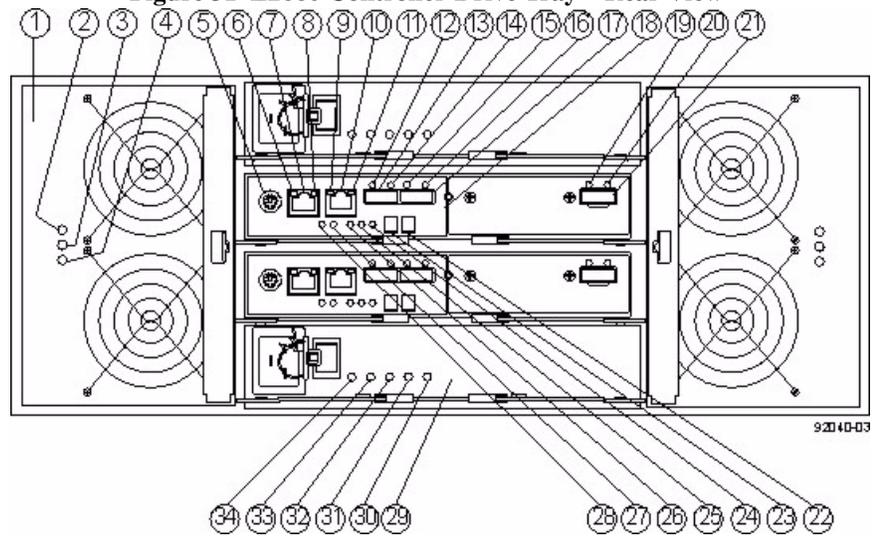
1. Fan Canister
2. Fan Power LED
3. Fan Service Action Required LED
4. Fan Service Action Allowed LED
5. Serial Connector
6. Ethernet Link 1 Active LED
7. Ethernet Connector 1
8. Ethernet Link 1 Rate LED
9. Ethernet Link 2 Active LED
10. Ethernet Connector 2
11. Ethernet Link 2 Rate LED
12. Host Link 2 Fault LED
13. Base Host SFF-8088 Connector 2
14. Host Link 2 Active LED
15. Host Link 1 Fault LED
16. Host Link 1 Active LED
17. Base Host SFF-8088 Connector 1
18. Controller A Canister
19. ESM Expansion Fault LED
20. ESM Expansion Active LED
21. Expansion SFF-8088 Port Connector
22. Second Seven-Segment Display
23. First Seven-Segment Display

24. Cache Active LED

25. Controller A Service Action Required LED

26. Controller A Service Action Allowed LED

27. Battery Service Action Required LED

28. Battery Charging LED

29. Power Canister

30. Power AC Power LED

31. Power Service Action Required LED

32. Power Service Action Allowed LED

33. Power DC Power LED

34. Power Standby Power LED

Figure 32 E2660 Right-Rear Subplate with No Host Interface Card
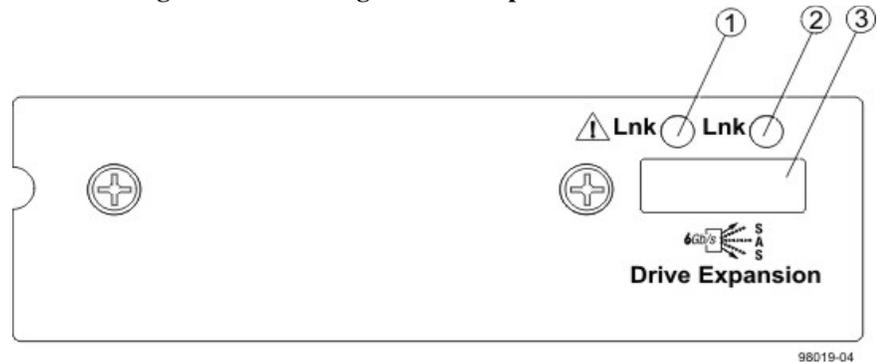
1. ESM Expansion Fault LED

2. ESM Expansion Active LED

3. Expansion SFF-8088 Port Connector

Figure 33 E2660 Right-Rear Subplate with a SAS Host Interface Card
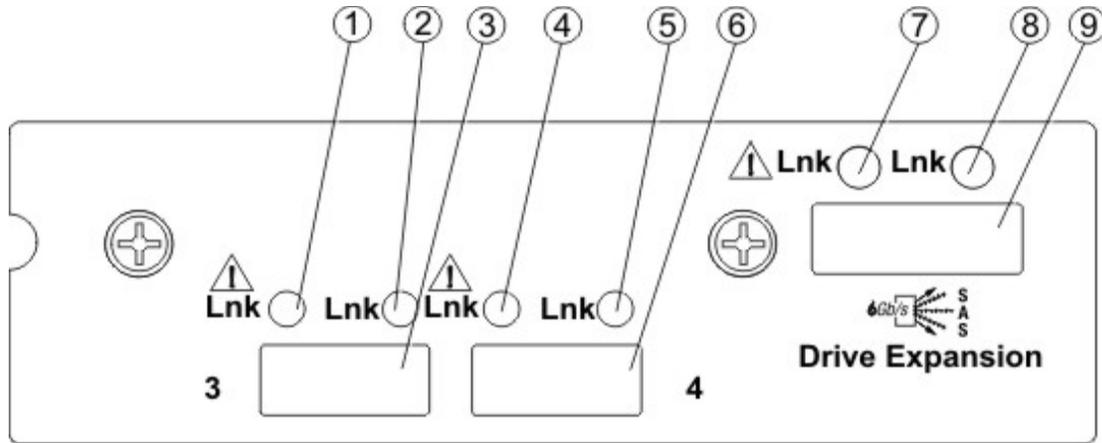
1. Host Interface Card Link 3 Up LED
2. Host Interface Card Link 3 Active LED
3. SFF-8088 Host Interface Card Connector 3
4. Host Interface Card Link 4 Up LED
5. Host Interface Card Link 4 Active LED
6. SFF-8088 Host Interface Card Connector 4
7. ESM Expansion Fault LED
8. ESM Expansion Active LED
9. Expansion SFF-8088 Port Connector

Component Locations on the DE6900 Drive Tray

Figure 34 DE6900 Drive Tray – Front View with the Bezel

Figure 35 DE6900 Drive Tray – Front View with the Bezel Removed
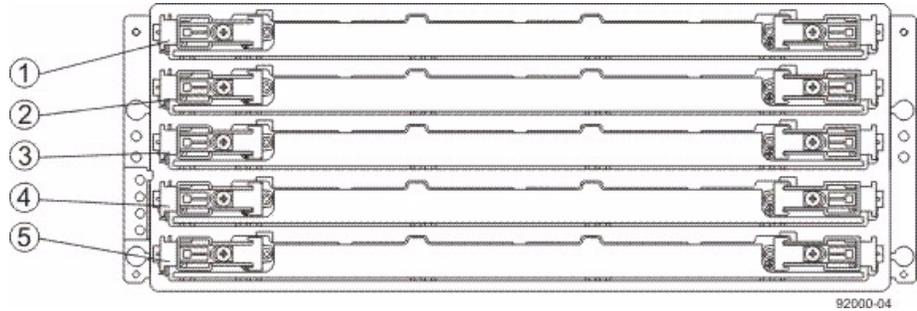
1. Drive Drawer 1
2. Drive Drawer 2
3. Drive Drawer 3
4. Drive Drawer 4
5. Drive Drawer 5

Figure 36 DE6900 Drive Tray – Rear View
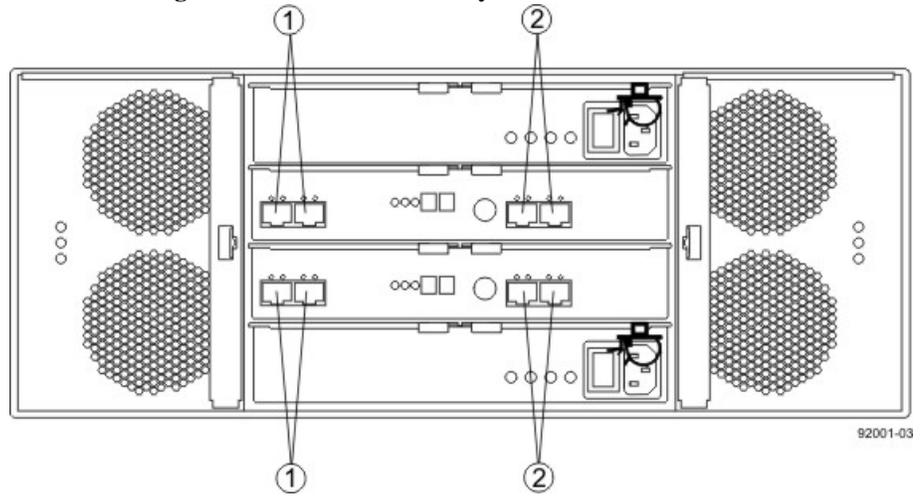
1. Standard Expansion Connectors
2. Drive-Side Trunking Expansion Connectors

Component Locations on the DE6600 Drive Tray

Figure 37 DE6600 Drive Tray – Front View with the Bezel
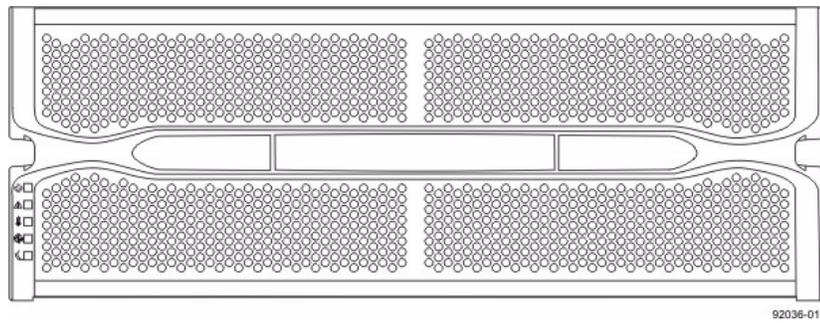
Figure 38 DE6600 Drive Tray – Front View with the Bezel Removed
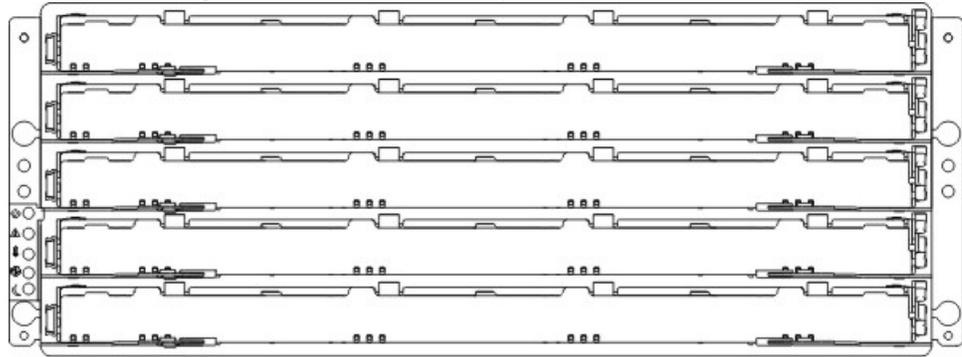
92034-04

Figure 39 DE6600 Drive Tray – Rear View
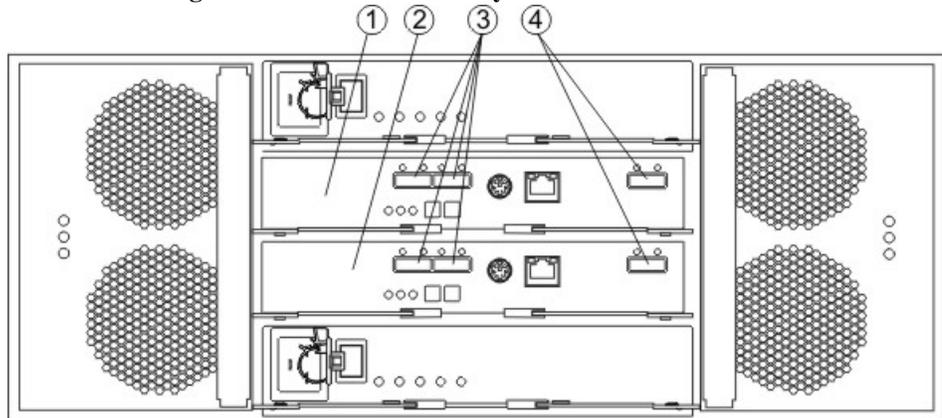
92033-01

1.   ESM A
2.   ESM B
3.   SAS In Connectors
4.   Expansion Connectors

Component Locations on the FC4600 Drive Tray

Figure 40 Component Locations on the FC4600 Drive Tray – Rear View
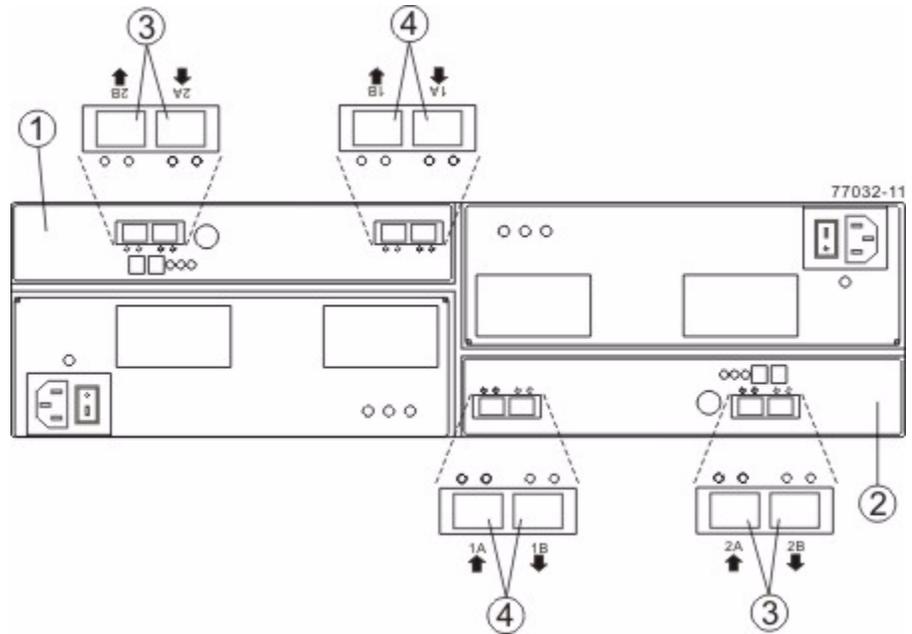
1.   Left ESM
2.   Right ESM
3.   Secondary SFP Ports
4.   Primary SFP Ports

The ESM on the FC4600 drive tray has four SFP ports. The two primary ports are active. The secondary ports are reserved for future use. If SFP transceivers are placed in the secondary ports, the SFP Port LEDs blink, as a reminder that these ports are not functioning.

Component Locations on the AT2655 Drive Tray

Figure 41 Component Locations on the AT2655 Drive Tray – Rear View
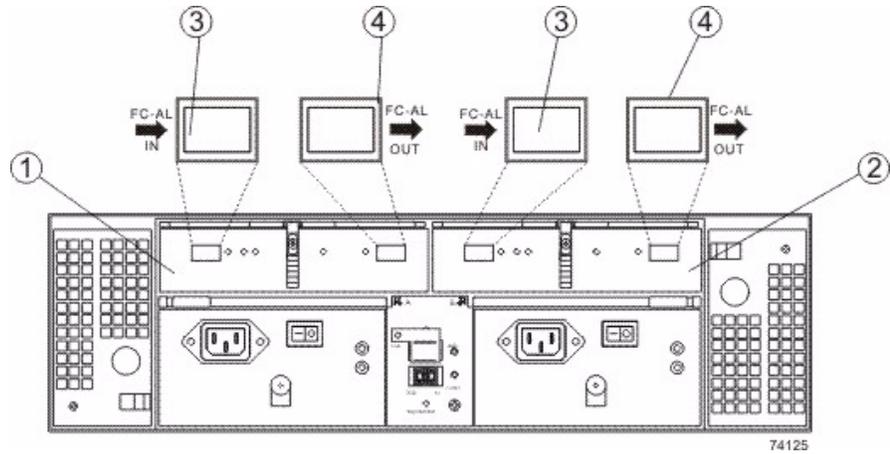
1. Left ESM
2. Right ESM
3. In Ports
4. Out Ports

Component Locations on the FC2610 Drive Tray

Figure 42 Component Locations on the FC2610 Drive Tray – Rear View
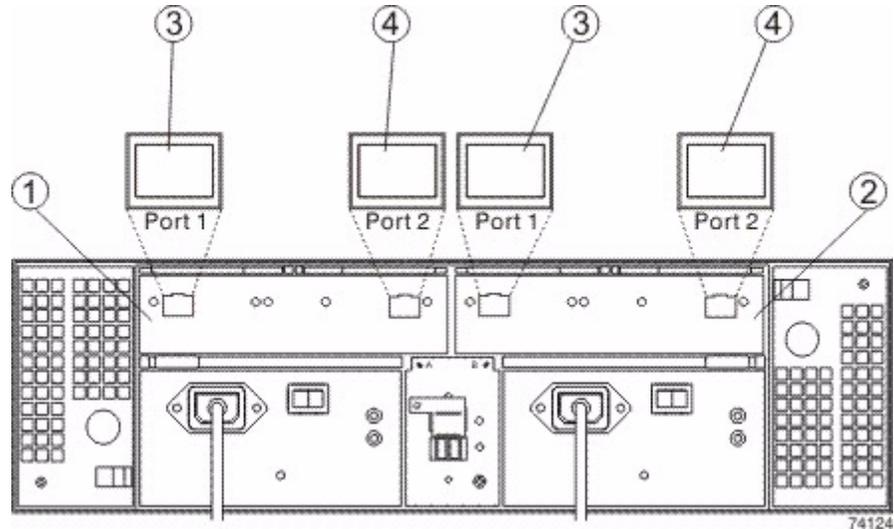
1. Left ESM
2. Right ESM
3. In Ports
4. Out Ports

Component Locations on the FC2600 Drive Tray

Figure 43 Component Locations on the FC2600 Drive Tray – Rear View
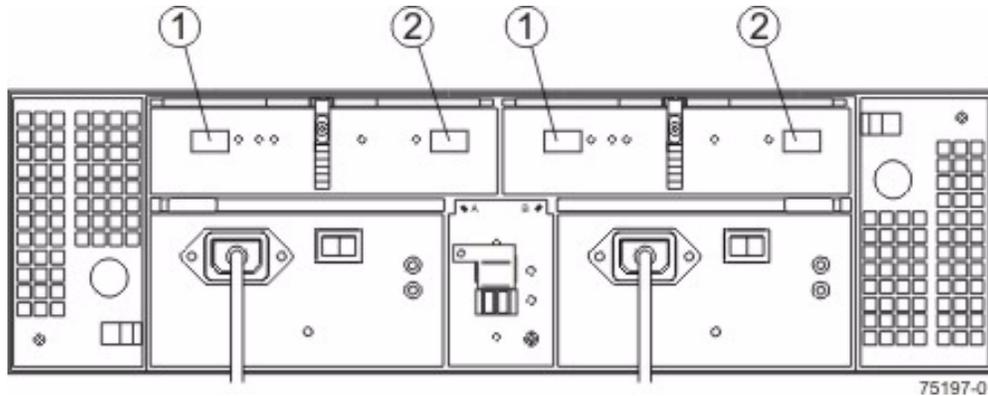
1. In Ports
2. Out Ports

Component Locations on the DE1600 Drive Tray and the DE5600 Drive Tray

The DE1600 drive tray can have two to twelve 3.5-in. drives. The DE5600 drive tray can have two to twenty-four 2.5-in. drives. The component locations on the rear of these drive trays are the same. The following figures show the AC power option.

Figure 44 DE1600 Drive Tray – Front View
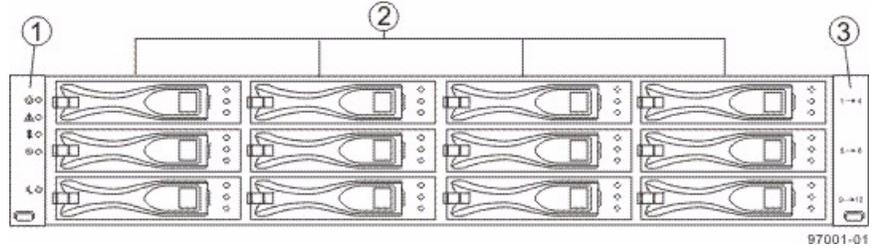
1. Left End Cap (Has the Drive Tray LEDs)
2. Drives
3. Right End Cap

Figure 45 DE5600 Drive Tray – Front View
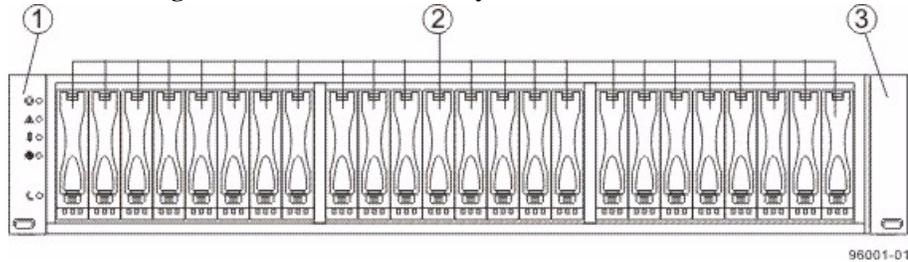
1. Left End Cap (Has the Drive Tray LEDs)
2. Drives
3. Right End Cap

Figure 46 DE1600 Drive Tray or DE5600 Drive Tray – Rear View
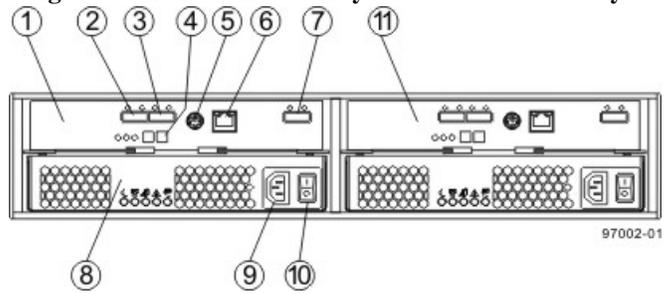
1. ESM A Canister
2. Host Connector 1
3. Host Connector 2
4. Seven-Segment Display Indicators
5. Serial Connector
6. Ethernet Connector
7. Expansion Port SFF-8088 Connector
8. Power-Fan Canister
9. Power Connector
10. Power Switch
11. ESM B Canister

Host Cabling *4*

This chapter provides examples of possible cabling topologies between one or more hosts and a controller tray or a controller-drive tray. Direct-attach topologies, fabric topologies, and mixed topologies are addressed. You are not limited to using only these topologies. Examples are provided to show basic concepts to help you define an optimal host-cabling topology. A table that lists the maximum supported number of hosts is included.

For host port locations on the specific controller tray model or controller-drive tray model that you are installing, see "Component Locations."

NOTE If you are using the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature, see "Hardware Installation for Synchronous Mirroring and Asynchronous Mirroring" for information on cabling for these features.

NOTE iSCSI or Infiniband host ports do not support the Data Assurance (DA) feature.

Host Interface Connections

The CE7900 controller trays and the CE7922 controller trays connect to hosts through one or two host interface cards (HICs). The E5500 controller-drive trays connect to hosts through one HIC which has either 4 SAS ports or two Fibre Channel ports. The C5400 controller-drive trays connect to hosts through one HIC. The CE4900 controller-drive tray has built-in (base) Fibre Channel (FC) connectors for host connections and might also have an optional HIC. The E2600 controller-drive tray and the E2660 controller-drive tray have built-in (base) SAS connectors for host connections and might also have an optional HIC. The E5400 controller-drive trays (E5412, E5424, and E5460) have built-in (base) Fibre Channel, and might also have an optional HIC for Fibre Channel connections or InfiniBand connections. All other supported controller trays and controller-drive trays connect through built-in ports.

**Table 1 Types of Host Port Configurations and HICs for Controller Trays and
Controller-Drive Trays**

Controller Type	Base Ports	HIC 1	HIC 2
CE7900	None	Quad 4-Gb/s FC, Quad 8-Gb/s FC, Dual 1-Gb/s iSCSI, or Dual 10-Gb/s iSCSI	None, Quad 4-Gb/s FC, Quad 8-Gb/s FC, Dual 1-Gb/s iSCSI, or Dual 10-Gb/s iSCSI
E5500	none	Quad 6-Gb/s SAS Dual 40-Gb/s InfiniBand	none
E5412, E5424, and E5460	Quad 8-Gb/s FC	None, Quad 8-Gb/s FC, or Dual 40-Gb/s InfiniBand	None
CE4900	Dual 8-Gb/s FC	None, Dual 8-Gb/s FC, or Dual 1-Gb/s iSCSI	None
E2600 E2660	Dual 6-Gb/2 SAS	None, Dual 6-Gb/2 SAS, Quad 8-Gb/s FC, Quad 1-Gb/s iSCSI, or Dual 10-Gb/s iSCSI	None

NOTE When a E2600 controller-drive tray or a E2660 controller-drive tray has a
10-Gb/s iSCSI HIC, some restrictions apply to the types of cables you can use for host
cabling. The following table shows the types and lengths of cables you can use. Do not
use Category 5e cables or Category 6 cables.

Table 2 Supported Cables for 10-Gb/s iSCSI Host Connections

Cable Type	Length
Category 6a unshielded	up to 50 meters
Category 6a shielded	up to 100 meters
Category 7	up to 100 meters

The following trays can, with some restrictions, mix host interfaces of different types:

- CE7900 controller trays
- E5400 controller-drive trays
- CE4900 controller-drive trays
- E2600 controller-drive trays
- E2660 controller-drive trays

In all cases, when host interface types are mixed, both controllers in a duplex tray must have the same arrangement of HICs. Each controller must have the same type of HIC in the same relative position as the other controller.

NOTE For a E5400 controller-drive tray with an InfiniBand HIC, use only InfiniBand host connections. Do not mix Fibre Channel host connections with InfiniBand host connections.

NOTE On the E2600 controller-drive tray, each controller has a pair of levers with handles for removing the controller from the controller-drive tray. If a controller has a HIC installed, one of these handles on the controller is located next to a host port on the HIC. The close spacing between the handle and the host port might make it difficult to remove a cable that is attached to the host port. If this problem occurs, use a flat-blade screwdriver to compress the release on the cable connector.

A HIC is connected to a host adapter: a host bus adapter (HBA) for Fibre Channel or SAS, a host channel adapter (HCA) for InfiniBand, or an Ethernet adapter for iSCSI. The host adapter in the host must match the type of HIC to which it is connected.

For best performance, connect an 8-Gb/s Fibre Channel HIC to an 8-Gb/s HBA. If the data rate for the HBA is lower, the data transfer rate will be at the lower rate. For instance, if you connect an 8-Gb/s Fibre Channel HIC to a 4-Gb/s HBA, the data transfer rate is 4 Gb/s.

It is possible for a host to have both iSCSI and Fibre Channel adapters for connections to a storage array that has a mix of HICs. Several restrictions apply to such configurations:

- The root boot feature is not supported for hosts with mixed connections to one storage array.
- Cluster configurations are supported for hosts with mixed connections to one storage array.
- When the host operating system is VMware, mixing connection types within a storage partition is not supported.
- When the host operating system is Windows, mixing connection types within a storage partition is not supported. A single server that attaches to multiple storage partitions on a single storage array must not have any overlap in LUN number assignments given to the volumes.
- For other operating systems, mixed connection types from a host to a single storage array are not supported.

Maximum Number of Host Connections

Table 3 Maximum Number of Host Connections by Model to a Controller Tray or a Controller-Drive Tray

Model	Maximum Number of Hosts
CE7922 controller tray and CE7900 controller tray	2048
CE6998 controller tray and CE6994 controller tray	1024
E5500 controller-drive trays	512
E5460, E5424, and E5412 controller-drive trays	512
CE4900 controller-drive tray	640
CDE3994 controller-drive tray and	1024
CDE3992 controller-drive tray	256
E2600 controller-drive tray	256
E2660 controller-drive tray	256

ATTENTION Possible loss of data access – Do not use a combination of HBAs from different vendors in the same storage area network (SAN). For the HBAs to perform correctly, use only HBAs from one manufacturer in a SAN.

Direct-Attach Topologies

The host-to-controller tray topologies presented in this section do not use switches. The host adapters might be HBAs for Fibre Channel or SAS, HCAs for InfiniBand, or Ethernet for iSCSI. Some controller trays and controller-drive trays support more direct host connections than the examples shown. To cable more host connections, follow the pattern established by the examples in this section.

When a host is cabled to a dual-controller controller-drive tray or a dual-controller controller tray, each attached host should have two host adapters installed. For redundancy, connect one host adapter to controller A and the other to controller B.

One Host to a Controller Tray or a Controller-Drive Tray

The following table lists the components in this topology that are non-redundant and present a risk of a single point of failure. The following figure shows an example of a direct-attach topology with one host and a dual-controller controller tray or a dual-controller controller-drive tray.

The example in the figure identifies HBA1 and HBA2 as connecting points on the host. For other configurations, these connecting points might be host channel adapters (HCAs) for InfiniBand connections, Ethernet adapters for iSCSI connections, or a combination of one HBA and one iSCSI Ethernet adapter.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of an HBA, an HCA, or an iSCSI Ethernet adapter failure or a host channel failure.

Table 4 Redundant and Non-Redundant Components in a Direct-Attached Configuration with One Host and a Controller Tray or a Controller-Drive Tray

Component	Redundant	Non-Redundant
Host/server		Non-redundant
HBA, HCA, or iSCSI Ethernet adapter	Redundant	
Host-to-controller cable	Redundant	
Controller	Redundant	

Figure 1 Direct-Attach Topology – One Host and a Controller Tray or a Controller-Drive Tray
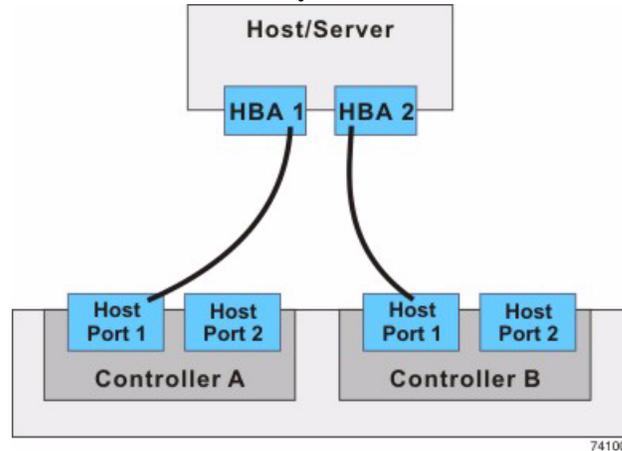
Two Hosts to a Controller Tray or a Controller-Drive Tray

The following table lists the components in this topology which are non-redundant and present a risk of a single point of failure. The following figure shows an example of a direct-attach topology with two hosts and a dual-controller controller tray or a dual-controller controller-drive tray.

The example in the figure shows HBA1 and HBA2 as connecting points on the host. For other configurations, these connecting points might be host channel adapters (HCAs) for InfiniBand connections, Ethernet adapters for iSCSI connections, or a combination of one HBA and one iSCSI Ethernet adapter.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of an HBA, HCA, or iSCSI Ethernet adapter failure or a host channel failure.

Table 5 Redundant and Non-Redundant Components in a Direct-Attached Configuration with Two Hosts and a Controller Tray or a Controller-Drive Tray

Component	Redundant	Non-Redundant
Host/server (see note)	Redundant	
iSCSI Ethernet adapter, HBA, HCA, or SAS	Redundant	
Host-to-controller cable	Redundant	
Controller	Redundant	
Note – The hosts/servers in this example must be clustered to be redundant.		

Figure 2 Direct-Attach Topology – Two Hosts and a Controller Tray or a Controller-Drive Tray
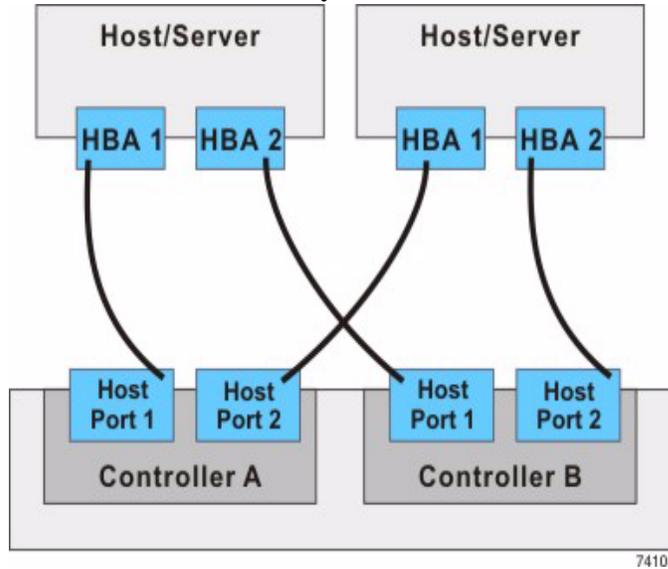
One Hosts with Direct SAS Connections to Four Controller-Drive Trays

The following table lists the components in this topology that are non-redundant and present a risk of a single point of failure. The following figure shows an example of a direct-attach topology with one host and a dual-controller controller-drive tray.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of a SAS HBA failure or a host channel failure.

Table 6 Redundant and Non-Redundant Components in a Direct-Attached Configuration with One Host and Four Controller-Drive Trays

Component	Redundant	Non-Redundant
Host/server (see note)		Non-Redundant
HIC (SAS)	Redundant	
Host-to-controller cables	Redundant	
Controllers	Redundant	

**Figure 3 Direct-Attach Topology – One Host and Four
Controller-Drive Trays with SAS Connections**
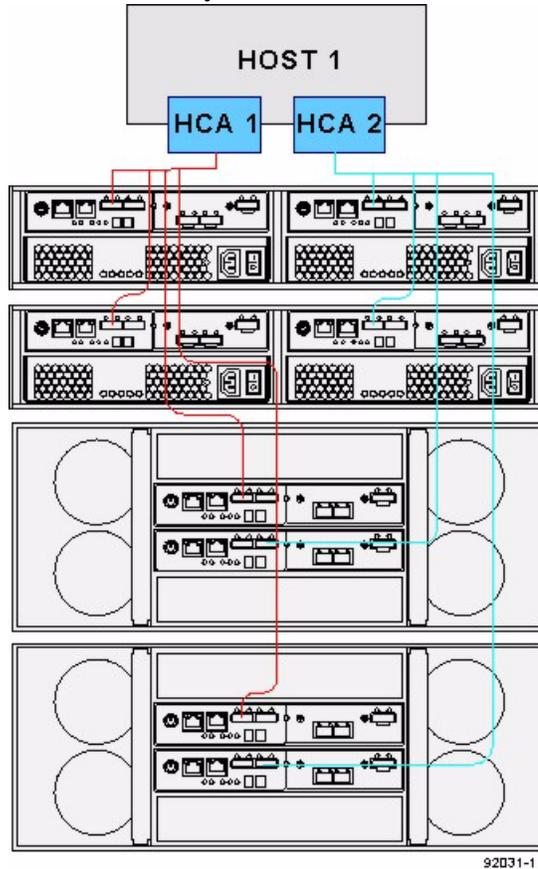
**One Single-HBA
Host to a
Single-Controller
Controller Tray or a
Single-Controller
Controller-Drive
Tray**

The following figure shows an example of a direct-attach topology with one host and
a single-controller controller tray or a single-controller controller-drive tray. The
following table describes which of the components in this topology are non-redundant
and present a risk of a single point of failure.

**Table 7 Direct-Attach Topology – One Host and a Single-Controller Controller
Tray or a Single-Controller Controller-Drive Tray**

Component	Redundant	Non-Redundant
Host/server		Non-redundant
HBA		Non-redundant
Host-to-controller cable		Non-redundant
Controller		Non-redundant

Direct-Attach Topologies

Figure 4 Single-HBA Host to a Single-Controller Controller Tray or a Single-Controller Controller-Drive Tray
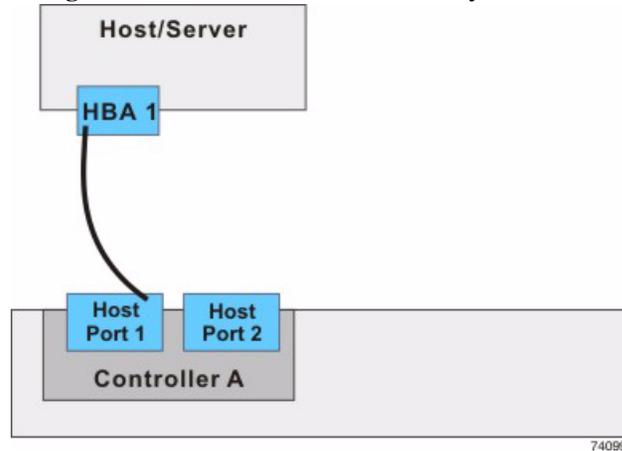
Switch Topologies

The host-to-controller tray topologies or host-to-controller-drive tray topologies presented in this section include one or more switches. The host adapters in the hosts might be HBAs for Fibre Channel, HCAs for InfiniBand, or Ethernet for iSCSI. Switches are not supported for SAS host connections.

When a host is cabled to a dual-controller controller-drive tray or a dual-controller controller tray, each attached host should have two host adapters installed. For redundancy, attach each of the host adapters to a different switch (or switch zone) so that one switch (or zone) connects to controller A and the other to controller B in the controller tray or the controller-drive tray. In the case where a host has one HBA and one iSCSI Ethernet adapter, the two connections might require two different types of switches.

One Host to a Controller Tray or a Controller-Drive Tray

The following figure shows an example of a switch topology with one host, a controller tray or a controller-drive tray, and a zoned switch. The following table describes which of the components in this topology are non-redundant and present a risk of a single point of failure.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of an HBA failure or a host channel failure.

Component	Redundant	Non-Redundant
Host/server		Non-redundant
Host adapter	Redundant	
Host-to-controller cable	Redundant	
Switch		Non-redundant
Controller	Redundant	

In the following figure, each outlined group of ports represents a zone.

**Figure 5 Switch Topology – One Host and a Controller Tray or a
Controller-Drive Tray with a Switch**
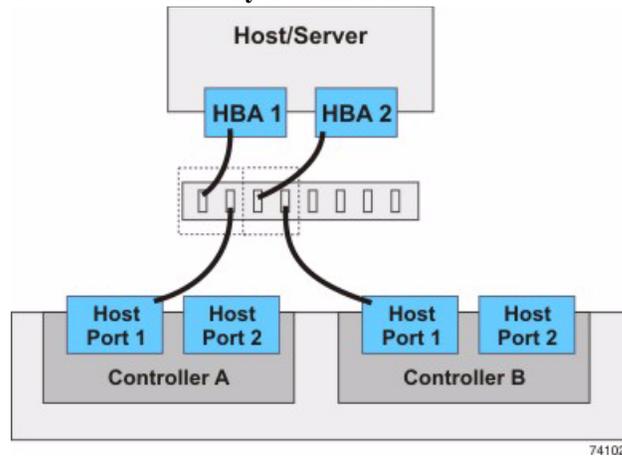
**Two Hosts to a
Controller Tray or a
Controller-Drive
Tray**

The following figure shows an example of a switch topology with two hosts, a
controller tray or a controller-drive tray, and a zoned switch. The following table
describes which of the components in this topology are non-redundant and present a
risk of a single point of failure.

ATTENTION Possible loss of data access – You must install alternate path software
or an alternate path (failover) driver on the host to support failover in the event of an
HBA failure or a host channel failure.

**Table 9 Redundant and Non-Redundant Components in a Switched
Configuration with Two Hosts and a Controller Tray or a Controller-Drive Tray**

Component	Redundant	Non-Redundant
Host/server (see note)	Redundant	
Host adapter	Redundant	
Host-to-controller cable	Redundant	
Switch		Non-redundant
Controller	Redundant	
Note – The hosts/servers in this example must be clustered to be redundant.		

In the following figure, each outlined group of ports represents a zone.

**Figure 6 Switch Topology – Two Hosts and a Controller Tray or a
Controller-Drive Tray with a Zoned Switch**
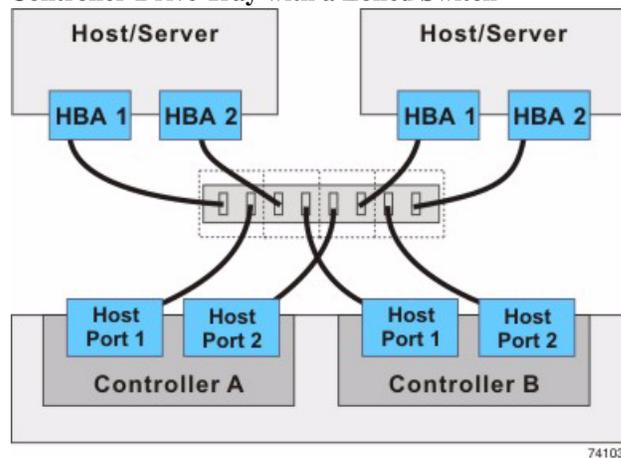
**Two Hosts to a
Controller-Drive
Tray with Switched
SAS Connections**

The following figure shows an example of a switch topology with two hosts, a
controller-drive tray, and two SAS switches. The following table describes which of
the components in this topology are non-redundant and present a risk of a single point
of failure.

ATTENTION Possible loss of data access – You must install alternate path software
or an alternate path (failover) driver on the host to support failover in the event of an
HBA failure or a host channel failure.

Table 10 Redundant and Non-Redundant Components in a Switched Configuration with two Hosts and a E2600 Controller-Drive Tray or a E2660 Controller-Drive Tray

Component	Redundant	Non-Redundant
Hosts/servers (see note)	Redundant	
Host adapters	Redundant	
Host-to-switch cables	Redundant	
Switches	Redundant	
Controllers	Redundant	

Note – The hosts/servers in this example must be clustered to be redundant.

Figure 7 Switch Topology – Two Hosts and a E2600 Controller-Drive Tray with SAS Connections
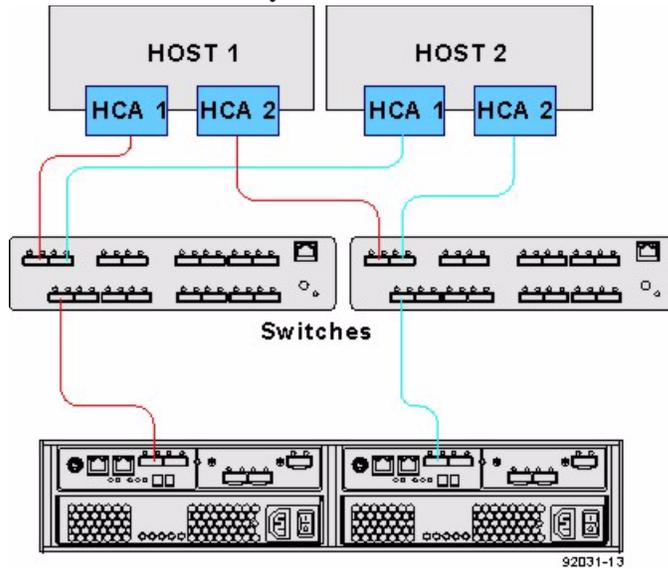
Figure 8 Switch Topology – Two Hosts and a E2660 Controller-Drive Tray with SAS Connections
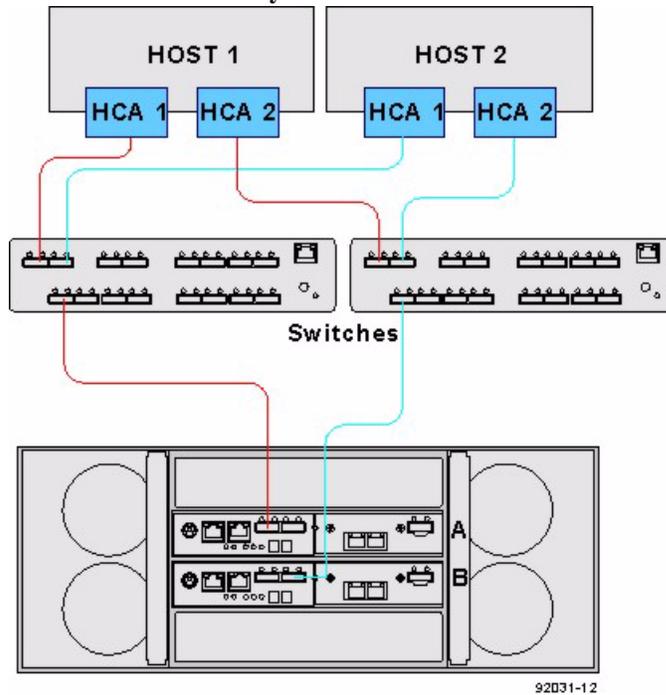
Four Hosts to a Controller Tray or a Controller-Drive Tray

The following figure shows an example of a switch topology with four hosts, a controller tray or a controller-drive tray, and two zoned switches. The following table describes which of the components in this topology are non-redundant and present a risk of a single point of failure.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of an HBA failure or a host channel failure.

Table 11 Redundant and Non-Redundant Components in a Switched Configuration with Four Hosts and a Controller Tray or a Controller-Drive Tray

Component	Redundant	Non-Redundant
Host/server (see note)	Redundant	
Host adapter	Redundant	
Host-to-controller cable	Redundant	

Component	Redundant	Non-Redundant
Switch	Redundant	
Controller	Redundant	
Note – The hosts/servers in this example must be clustered to be redundant.		

In the following figure, each outlined group of ports represents a zone.

Figure 9 Switch Topology – Four Hosts and a Controller Tray or a Controller-Drive Tray with Two Zoned Switches
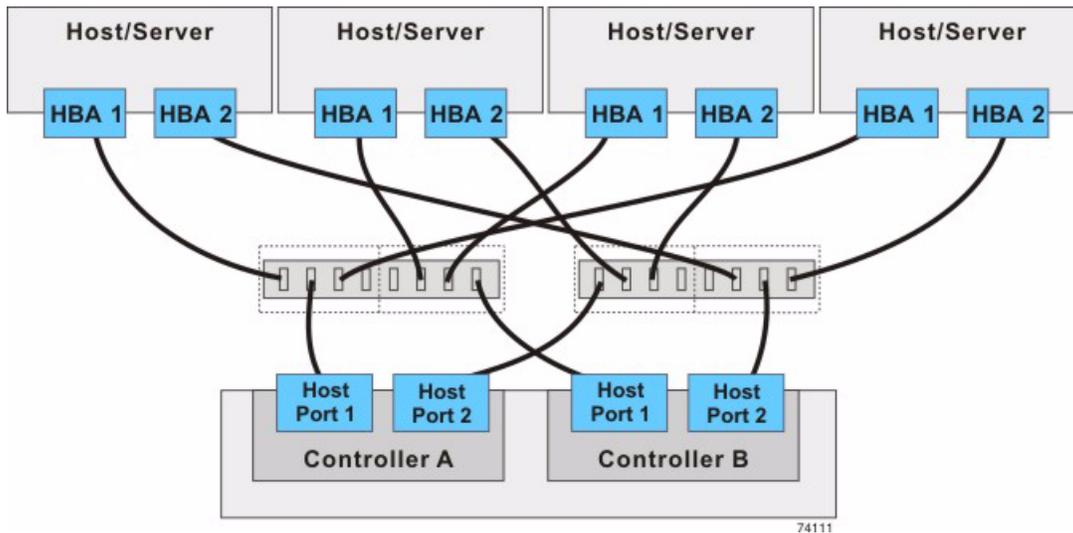
Mixed Topologies

The following table describes which of the components in this topology are non-redundant and present a risk of a single point of failure. The following figure shows an example of a mixed topology; that is, a topology that combines both switch topology and direct-attach topology. This example shows three hosts, a controller tray, and two switches.

The example in the figure identifies HBA1 and HBA2 on each host as connecting points. For other configurations, these connecting points might be Ethernet adapters for iSCSI connections, or a combination of one HBA and one iSCSI Ethernet adapter. Switches are not supported for SAS host connections.

When a host is cabled to a dual-controller controller-drive tray or a dual-controller controller tray, each attached host should have two host adapters installed. The host adapters might be HBAs for Fibre Channel or SAS, or Ethernet for iSCSI. For redundancy, attach each of the host adapters that connects through a switch to a different switch (or switch zone) so that one switch (or zone) connects to controller A and the other to controller B in the controller tray or the controller-drive tray. In the

case where a host has one HBA and one iSCSI Ethernet adapter, the two connections might require two different types of switches. Redundancy for a host that attaches directly to a controller tray or a controller-drive tray requires that each host adapter attach to a different controller.

ATTENTION Possible loss of data access – You must install alternate path software or an alternate path (failover) driver on the host to support failover in the event of an HBA failure or a host channel failure.

Table 12 Redundant and Non-Redundant Components in a Mixed Configuration with Three Hosts and a Controller Tray or a Controller-Drive Tray

Component	Redundant	Non-Redundant
Host/servers 1 and 2 (see note)	Redundant	
Host/server 3		Non-redundant
HBA or Ethernet iSCSI adapter	Redundant	
Host-to-controller cable	Redundant	
Switch	Redundant	
Controller	Redundant	

Note – The hosts/servers in this example must be clustered to be redundant.

Figure 10 Mixed Topology – Three Hosts and a Controller Tray
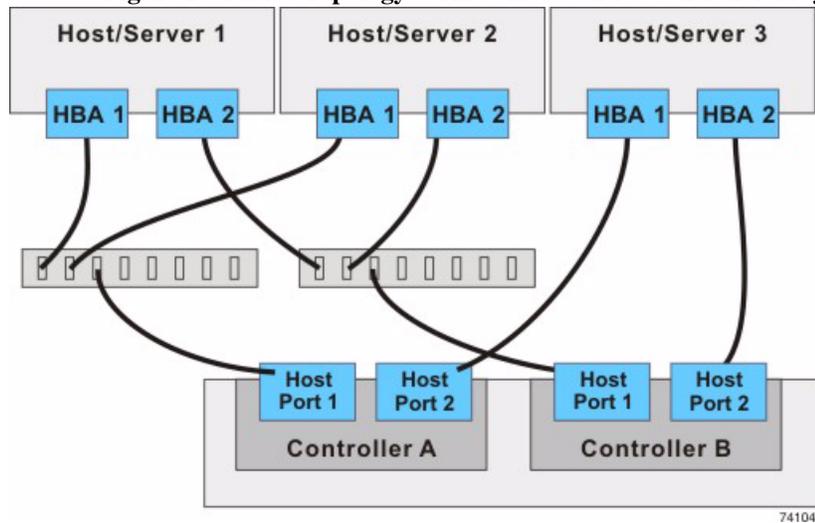
Drive Cabling 5

This chapter provides examples of cabling between a controller tray or a controller-drive tray and the environmental services modules (ESMs) of one or more expansion drive trays. This chapter also shows potential combinations of these products in storage array configurations.

NOTE Every example in this chapter provides redundant access to each drive.

See the topics under Component Locations for drive port locations on the specified controller tray or controller-drive tray and drive tray models that you are installing.

Refer to the section that applies to the controller tray or controller-drive tray to which you are cabling the drive trays.

Drive Channel Redundancy for the CE7900 Controller Tray and the CE7922 Controller Tray

Each controller has four drive channels, and each drive channel has two ports. Therefore, each controller has eight drive ports. A controller tray has eight redundant path pairs that are formed using one drive channel of controller A and one drive channel of controller B. The following figure shows the redundant pairs in a controller tray. The following table lists the numbers of the redundant path pairs and the drive ports of the drive channels from which the redundant path pairs are formed.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or multiple drive trays on a loop to both drive channels on a redundant path pair.

NOTE If you are connecting DE6900 drive trays and you plan to use the drive-side trunking capability, you must connect each drive tray (or multiple drive trays on a loop) to both drive channels on each of two redundant path pairs to maintain hardware redundancy.

Figure 1 Redundant Path Pairs on the CE7900 Controller Tray and the CE7922 Controller Tray
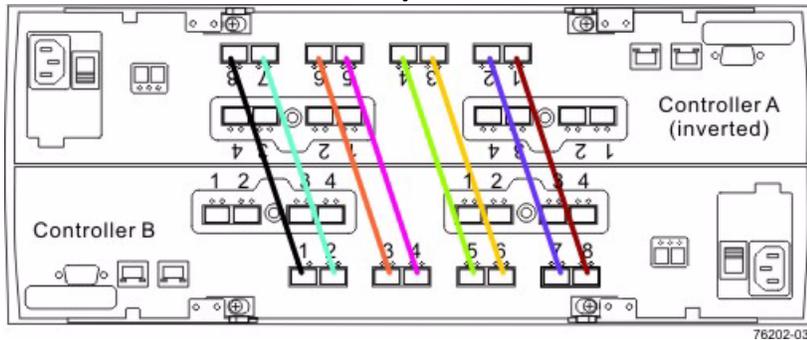
Table 1 Redundant Path Pairs on the CE7900 Controller Tray and the CE7922 Controller Tray

Drive Ports on Controller A	Drive Channels on Controller A	Ports on Controller B	Drive Channels on Controller B
Port 8	Channel 1	Port 1	Channel 5
Port 7	Channel 1	Port 2	Channel 5
Port 6	Channel 2	Port 3	Channel 6
Port 5	Channel 2	Port 4	Channel 6
Port 4	Channel 3	Port 5	Channel 7
Port 3	Channel 3	Port 6	Channel 7
Port 2	Channel 4	Port 7	Channel 8
Port 1	Channel 4	Port 8	Channel 8

Drive Channel Redundancy for the CE6998 Controller Tray

Each controller has two drive channels, and each drive channel has two ports. Therefore, each controller has four drive ports. A controller tray has four redundant path pairs that are formed using one drive channel of controller A and one drive channel of controller B. The following figure shows the redundant pairs in a controller tray. The following table lists the numbers of the redundant path pairs and the drive ports of the drive channels from which the redundant path pairs are formed.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive channels on a redundant path pair.

Figure 2 Redundant Path Pairs on the CE6998 Controller Tray

76010-01
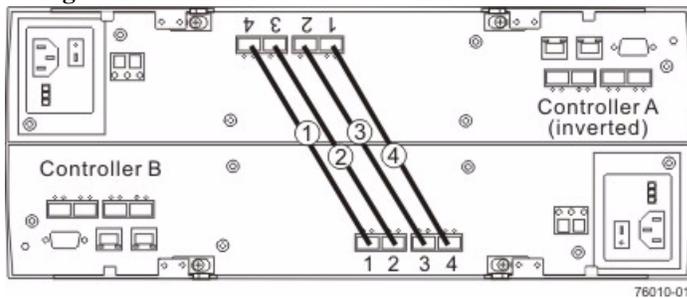
Table 2 Redundant Path Pairs on the CE6998 Controller Tray

Redundant Path Pairs	Drive Ports on Controller A	Drive Channels on Controller A	Ports on Controller B	Drive Channels on Controller B
1	Port 4	Channel 1	Port 1	Channel 3
2	Port 3	Channel 1	Port 2	Channel 3
3	Port 2	Channel 2	Port 3	Channel 4
4	Port 1	Channel 2	Port 4	Channel 4

Drive Channel Redundancy for the E5560 Controller-Drive Tray

Each controller in a E5560 has two drive ports. A redundant path pair consists of one drive port from controller A and one drive port from Controller B.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to at least one drive ports on each controller.

Figure 3 Redundant Path Pair on the E5560 Controller-Drive Tray
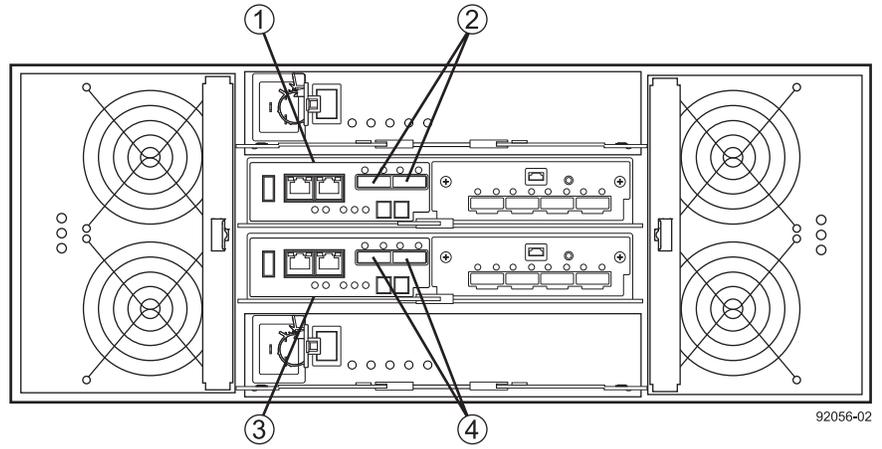
1. Controller Canister A
2. Drive Expansion Ports (SAS Drive Expansion Connectors)
3. Controller Canister B
4. Drive Expansion Ports (SAS Drive Expansion Connectors)

Drive Channel Redundancy for the E5512 Controller-Drive Tray and the E5524 Controller-Drive Tray

Each controller in a E5512 or a E5524 has two drive ports. The drive ports on controller A and the drive ports on controller B form redundant pairs.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive ports on a dual-controller configuration.

Figure 4 Redundant Path Pair on the E5512 Controller-Drive Tray or the E5524 Controller-Drive Tray
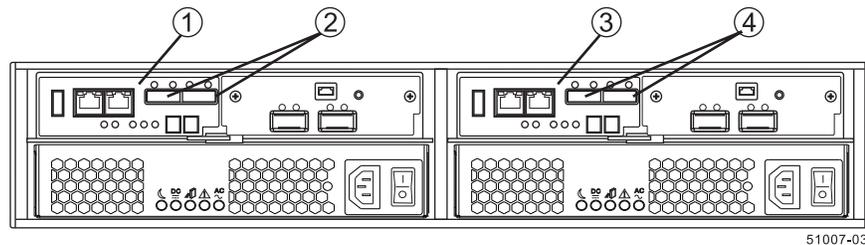
51007-03

1. Controller Canister A
2. Drive Channel Ports (SAS Drive Expansion Connectors)
3. Controller Canister B
4. Drive Channel Ports (SAS Drive Expansion Connectors)

Drive Channel Redundancy for the E5460 Controller-Drive Tray

Each controller in a E5460 has one drive port. When a controller-drive tray has two controllers, the drive port on controller A and the drive port on controller B form a redundant pair. The following figure shows the drive ports on a dual-controller configuration.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive ports on a dual-controller configuration.

Figure 5 Redundant Path Pair on the E5460 Controller-Drive Tray
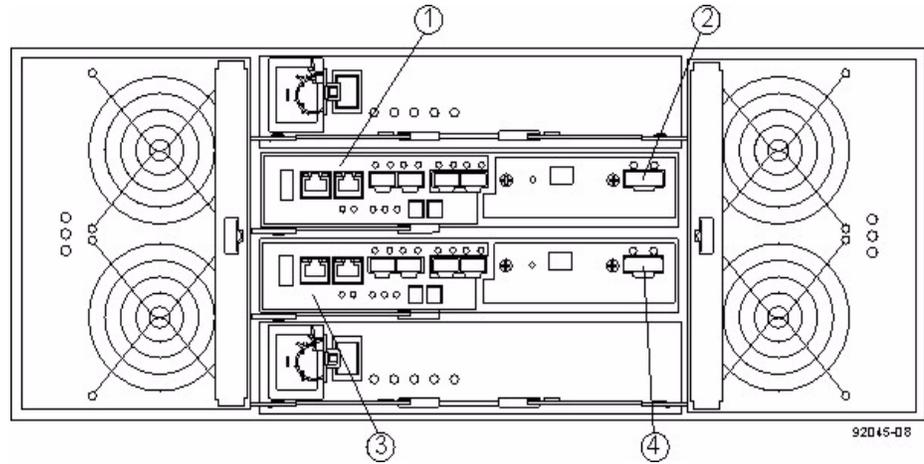
1. Controller Canister A
2. Drive Expansion Connector (Connectors 2 and 4 comprise a redundant path pair.)
3. Controller Canister B
4. Drive Expansion Connector (Connectors 2 and 4 comprise a redundant path pair.)

Drive Channel Redundancy for the E5412 Controller-Drive Tray and the E5424 Controller-Drive Tray

Each controller in a E5412 or a E5424 has one drive port. When a controller-drive tray has two controllers, the drive port on controller A and the drive port on controller B form a redundant pair. The following figure shows the drive ports on a dual-controller configuration.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive ports on a dual-controller configuration.

Figure 6 Redundant Path Pair on the E5424 Controller-Drive Tray or the E5412 Controller-Drive Tray
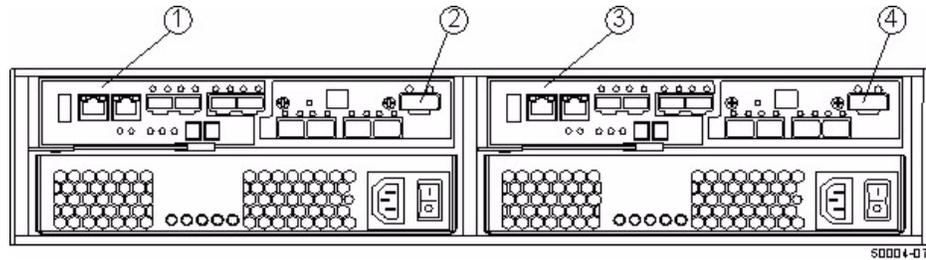
1. Controller Canister A
2. Drive Expansion Connector (Connectors 2 and 4 comprise a redundant path pair.)
3. Controller Canister B
4. Drive Expansion Connector (Connectors 2 and 4 comprise a redundant path pair.)

Drive Channel Redundancy for the CE4900 Controller-Drive Tray

Each controller has one drive channel, and each drive channel has two ports. Therefore, each controller has two drive ports. A controller-drive tray has two redundant path pairs that are formed using one drive channel of controller A and one drive channel of controller B. The following figure shows the redundant pairs in a controller-drive tray. The following table lists the numbers of the redundant path pairs and the drive ports of the drive channels from which the redundant path pairs are formed.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive channels on a redundant path pair.

Figure 7 Redundant Path Pairs on the CE4900 Controller-Drive Tray

Table 3 Redundant Path Pairs on the CE4900 Controller-Drive Tray

Redundant Path Pairs	Drive Ports on Controller A	Drive Channels on Controller A	Ports on Controller B	Drive Channels on Controller B
1	Port 2	Channel 1	Port 1	Channel 2
2	Port 1	Channel 1	Port 2	Channel 2

Drive Channel Redundancy for the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray

Each controller has one drive channel, and each drive channel has two ports. Therefore, each controller has two drive ports. A controller-drive tray has two redundant path pairs that are formed using one drive channel of controller A and one drive channel of controller B. The following figure shows the redundant pairs in a controller-drive tray. The following table lists the numbers of the redundant path pairs and the drive ports of the drive channels from which the redundant path pairs are formed.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive channels on a redundant path pair.

Figure 8 Redundant Path Pairs on the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray

Table 4 Redundant Path Pairs on the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray

Redundant Path Pairs	Drive Ports on Controller A	Drive Channels on Controller A	Ports on Controller B	Drive Channels on Controller B
1	Port 2	Channel 1	Port 1	Channel 2
2	Port 1	Channel 1	Port 2	Channel 2

Drive Channel Redundancy for the E2600 Controller-Drive Tray

Each controller in a E2600 has one drive port. When a controller-drive tray has two controllers, the drive port on controller A and the drive port on controller B form a redundant pair. The following figure shows the drive ports on a dual-controller configuration.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive ports on a dual-controller configuration.

**Figure 9 Redundant Path Pair on the E2600 Controller-Drive Tray**
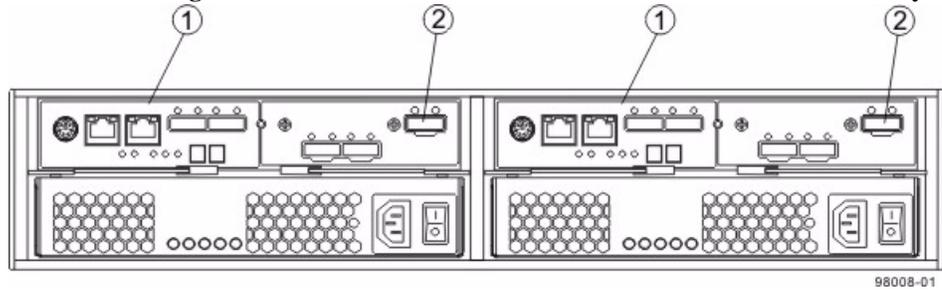
1. Controller Canisters
2. Drive Expansion Connectors (Redundant Path Pair)

Drive Channel Redundancy for the E2660 Controller-Drive Tray

Each controller in a E2660 controller-drive tray has one drive port. When a controller-drive tray has two controllers, the drive port on controller A and the drive port on controller B form a redundant pair. The following figure shows the drive ports on a dual-controller configuration.

NOTE To maintain data access in the event of the failure of a controller, an ESM, or a drive channel, you must connect a drive tray or a string of drive trays to both drive expansion ports on a dual-controller configuration.

Figure 10 Redundant Path Pair on the E2660 Controller-Drive Tray
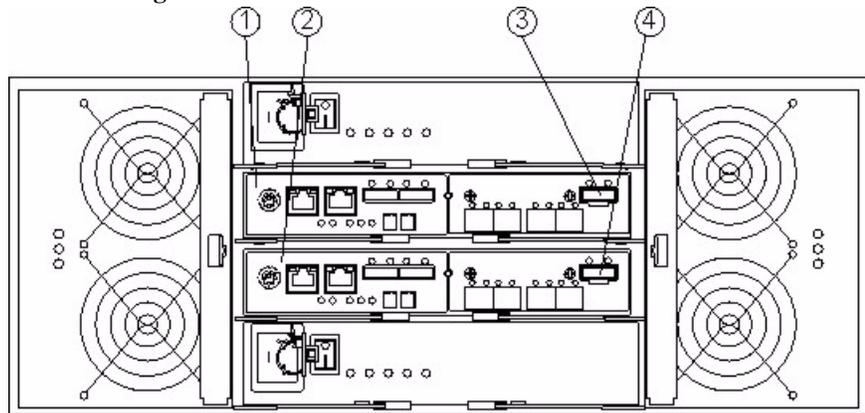
1. Controller A
2. Controller B
3. SAS Drive Expansion Connector (Connectors 3 and 4 comprise a redundant path pair)
4. SAS Drive Expansion Connector (Connectors 3 and 4 comprise a redundant path pair)

ESM Canister Arrangements

Many of the figures in topics for drive cabling topologies show storage arrays that use drive trays with side-by-side ESMs. Each ESM canister has one In port and one Out port (for Fibre Channel) or two SAS In ports and one SAS Expansion port (SAS). The canisters are located adjacent to one another, as shown in the following figures.

Figure 11 Drive Tray with Side-by-Side ESMs (Fibre Channel)
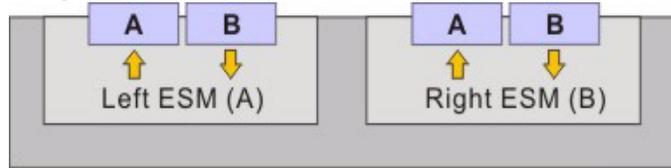
The following figure shows a drive tray with side-by-side ESMs and SAS ports.

Figure 12 Drive Tray with Side-by-Side ESMs (SAS)
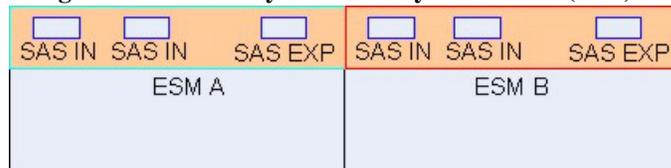
The following figure shows another type of drive tray. This type of drive tray has inverted ESM canisters. Other figures in this chapter show this type of drive tray.

Figure 13 Drive Tray with Inverted ESMs
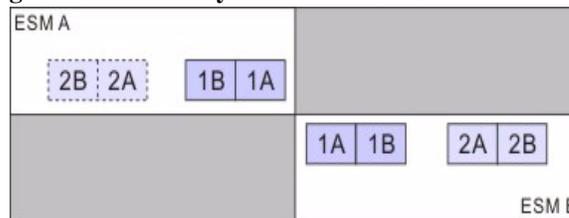
The following figure shows a drive tray with ESM canisters one above the other.

Figure 14 Drive Tray with Stacked ESMs
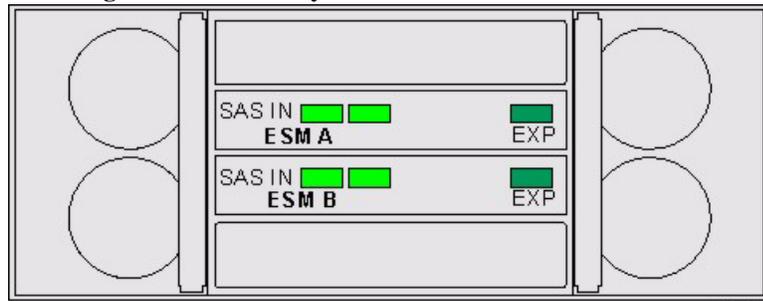
Drive Cabling Topologies for the CE7900 Controller Tray and the CE7922 Controller Tray

You can cable the CE7922 controller tray only to FC4600 drive trays. No more than seven drive trays may be cabled to one loop pair and no more than 28 total drive trays may be cabled to the controller tray.

You can cable the CE7900 controller tray to DE6900 drive trays, FC4600 drive trays, or a combination of the two. No more than seven FC4600 drive trays may be cabled to any one loop pair and no more than two DE6900 drive trays may be cabled to any one loop pair. When a mix of FC4600 drive trays and DE6900 drive trays is cabled to the controller tray, the total number of drives must not exceed 448. The following table shows the allowed combinations of drive trays.

Table 5 Drive Tray Combinations

DE6900 Drive Trays per Loop Pair	FC4600 Drive Trays per Loop Pair							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
0	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1	Yes	Yes	Yes	Yes	No	No	No	No
2	Yes	No	No	No	No	No	No	No

With a CE7900 controller tray, FC4600 drive trays support solid-state drives (SSDs). A drive tray may have both SSDs and hard disk drives. The maximum number of SSDs for the storage array is 20.

Cabling for the CE7922 Controller Tray or the CE7900 Controller Tray and One to Four FC4600 Drive Trays

The figures and tables in this section show representative configurations for redundant cabling.

Figure 15 One CE7922 Controller Tray or CE7900 Controller Tray and Two Drive Trays

74188-02
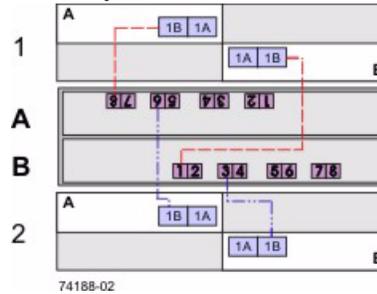
Figure 16 One CE7922 Controller Tray or CE7900 Controller Tray and Four Drive Trays
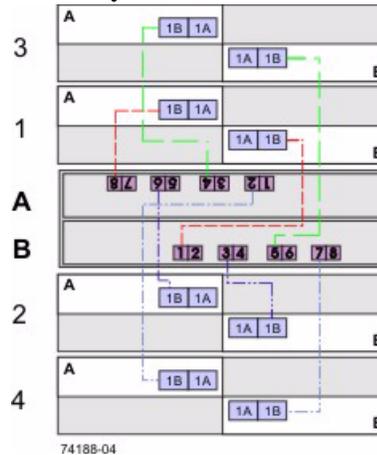
74188-04

The following table specifies the cabling pattern for a controller tray that is attached to one to four drive trays. The "Cable" column indicates that two cables are used for each drive tray. In the rows for cable 1 and cable 2, for example, the "Xs" indicate that the cables are connected to controller A, channel 1, port 8 and controller B, channel 5, port 1 respectively. The "Bs" in these rows indicate that the other ends of cable 1 and cable 2 are connected to port 1B of the left ESM (ESM A) and port 1B of the right ESM (ESM B) of drive tray 1 respectively. This pattern continues, using even-numbered ports on controller A and odd-numbered ports on controller B for the first four drive trays.

Table 6 One CE7922 Controller Tray or CE7900 Controller Tray and One to Four Drive Trays

| Cable | Controller A Channel Number / Port Number | | | | | | | | Controller B Channel Number / Port Number | | | | | | | | Drive Trays ESMs (Left or Right) | | | | | | | |
| | Ch1 | Ch2 | Ch2 | Ch2 | Ch3 | Ch3 | Ch4 | Ch4 | Ch5 | Ch5 | Ch6 | Ch6 | Ch7 | Ch7 | Ch8 | Ch8 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	L	R	L	R	L	R	L	R
1	X																B							
2									X									B						
3			X																B					
4											X									B				
5					X																B			
6													X									B		
7							X																B	
8															X									B

Drive Cabling Topologies for the CE7900 Controller Tray and the CE7922 Controller Tray

Cabling for the CE7922 Controller Tray or the CE7900 Controller Tray and Five to Eight FC4600 Drive Trays

The figures and tables in this section show representative configurations for redundant cabling. Use the information in the previous topic to cable the first four drive trays, and then continue with this topic to cable up to eight additional drive trays.

Figure 17 One CE7922 Controller Tray or CE7900 Controller Tray and Eight Drive Trays
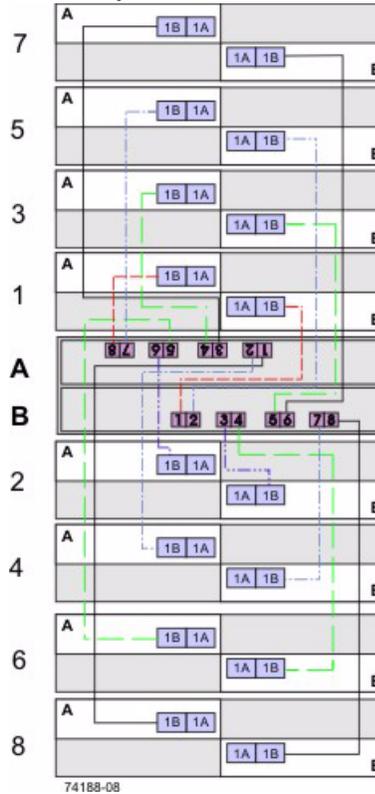
74188-08

The following table specifies the cabling pattern for a controller tray that is attached to five to eight drive trays. The "Cable" column indicates that two cables are used for each drive tray. In the rows for cable 9 and cable 10, for example, the "Xs" indicate that the cables are connected to controller A, channel 1, port 7 and controller B, channel 5, port 2 respectively. The "Bs" in these rows indicate that the other ends of cable 9 and cable 10 are connected to port 1B of the left ESM1 and port 1B of the right ESM of drive tray 5 respectively. This pattern continues, using odd-numbered ports on controller A and even-numbered ports on controller B for up to eight drive trays.

Table 7 One CE7922 Controller Tray or CE7900 Controller Tray and Five to Eight Drive Trays

Cable	Controller A								Controller B								Drive Trays							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		5		6		7		8	
	\\ Port Number								Port Number								ESMs (Left or Right)							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	L	R	L	R	L	R	L	R
9		X															B							
10									X									B						
11				X															B					
12												X								B				
13						X															B			
14														X								B		
15								X															B	
16																X								B

One CE7922 Controller Tray or CE7900 Controller Tray and Nine to 16 FC4600 Drive Trays

When the number of drive trays exceeds eight, the cabling pattern changes significantly. From this point, you will begin to use the "A" ports on the ESMs, and connect the drive trays beyond the eighth one to another drive tray.

If you add drive trays to an existing configuration so that the total number of drive trays attached to one controller tray increases from eight or fewer to a total of more than eight, you must re-cable some of the drive trays that were previously cabled to that controller tray. For each new drive tray beyond the eighth one, in addition to adding two cables to attach the new drive tray, you must move one cable on a previously installed drive tray.

The following figure and table show an example where a ninth and tenth drive tray have been added to a controller tray that previously had eight drive trays. Cable 1 remains the same as in the previous configuration. The end of cable 2 that was previously connected to drive tray 1 now connects to drive tray 9. Cables 17 and 18 are added between drive tray 1 and drive tray 9 so that they now connect in series. Drive tray 10 is added using connections to drive tray 2 that follow the pattern of the connections between drive tray 1 and drive tray 9. Drive tray 3 is not connected to another drive tray, so its cabling remains the same (as it does for drive trays 4 to 8, which do not appear in the table).

You can cable up to 16 drive trays by following the pattern shown in this example.

Drive Cabling Topologies for the CE7900 Controller Tray and the CE7922 Controller Tray

Figure 18 One CE7922 Controller Tray or CE7900 Controller Tray and 10 Drive Trays

74188-10

Table 8 One CE7922 Controller Tray or CE7900 Controller Tray and 10 Drive Trays

Cable	Controller A — Channel Number — Port Number								Controller B — Channel Number — Port Number								Drive Trays — ESMs (Left or Right)									
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		1		2		3		9		10	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	L	R	L	R	L	R	L	R	L	R
1	X																B									
2									X															B		
17																	A						B			
18																		B						A		
3			X																B							
4											X															B
19																			A						B	
20																				B						A
5					X																B					
6													X									B				

One CE7922 Controller Tray or CE7900 Controller Tray and 17 to 28 FC4600 Drive Trays

You can add drive trays in series to each redundant pair of drive ports up to 28 drive trays. In a configuration with 28 drive trays, four of the port pairs will have four drive trays each, while the other four will have three drive trays each. The following figure shows this arrangement schematically. The physical arrangement of the drive trays in cabinets will depend on your particular installation.

The following table shows an example cabling pattern for adding three drive trays (drive trays 9, 17, and 25) in series with drive tray 1. Add drive trays in series to each redundant pair of drive ports so that the number of drive trays for each pair of drive ports remains balanced, to the extent possible. For example, do not add a third drive tray in series with drive tray 1 on ports 8 and 1 if another pair of drive ports has only one drive tray connected.

Table 9 One CE7922 Controller Tray or CE7900 Controller Tray and Ten Drive Trays

| Cable	Controller A								Controller B								Drive Trays							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		1		9		17		25	
	Port Number								Port Number								ESMs (Left or Right)							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	L	R	L	R	L	R	L	R
1	X																B							
2									X															B
17																	A		B					
18																		B		A				
33																			A		B			
34																				B		A		
49																					A		B	
50																						B		A

Figure 19 One CE7922 or CE7900 Controller Tray and 28 Drive Trays
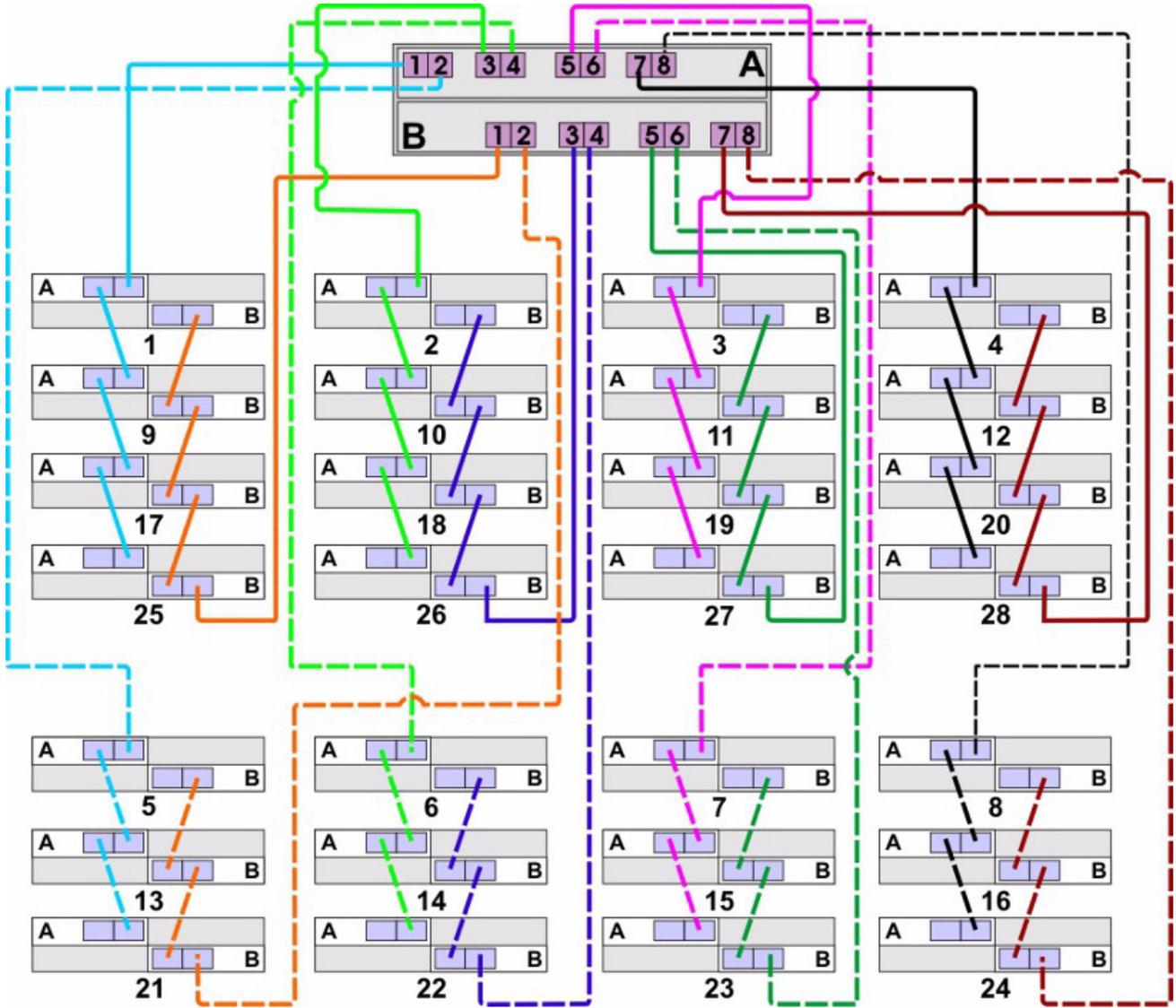
One CE7922 Controller Tray or CE7900 Controller Tray and One to Four DE6900 Drive Trays without Trunking

In the cabling configuration figures that follow, the controller tray is placed on top, and the controllers are labeled as A and B. Because the DE6900 drive trays are very heavy, they are installed starting at the bottom of the cabinet. The drive trays are labeled from the bottom upward as 1, 2, 3, and so on. The figures in this section show representative configurations for cabling.

NOTE The controller tray and the drive trays do not have to be stacked in this exact order, and there is no requirement that you label the drive trays in this particular sequence. Just make sure that the DE6900 drive trays are at the bottom of the cabinet.

Figure 20 One CE7900 Controller Tray or CE7922 Controller Tray and Four DE6900 Drive Trays without Trunking

74190-04

The following table specifies the cabling pattern for a controller tray that is attached to one to four drive trays. The "Cable" column indicates that two cables are used for each drive tray. In the rows for cable 1 and cable 2, for example, the "Xs" indicate that the cables are connected to controller A, channel 1, port 8 and controller B, channel 5, port 1 respectively. The "Bs" in these rows indicate that the other ends of cable 1 and cable 2 are connected to port 1B of the top ESM (ESM A) and port 1B of the bottom ESM (ESM B) of drive tray 1 respectively. This pattern continues, using even-numbered ports on controller A and odd-numbered ports on controller B for the first four drive trays.

Table 10 One CE7900 Controller Tray or CE7922 Controller Tray and One to Four Drive Trays without Trunking

Cable	Controller A Channel Number Ch1		Ch2		Ch3		Ch4		Controller B Channel Number Ch5		Ch6		Ch7		Ch8		Drive Trays 1		2		3		4	
	Port Number								Port Number								ESMs (Left or Right)							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	L	R	L	R	L	R	L	R
1	X																B							
2									X									B						
3			X																B					
4											X									B				
5					X																B			
6													X									B		
7							X																B	
8															X									B

One CE7922 Controller Tray or CE7900 Controller Tray Five to Eight DE6900 Drive Trays without Trunking

In the cabling configuration shown in the following figure, the controller tray is placed on top, and the controllers are labeled as A and B. Because the DE6900 drive trays are very heavy, they are installed starting at the bottom of the cabinet. The drive trays are labeled from the bottom upward as 1, 2, 3, and so on.

NOTE The controller tray and the drive trays do not have to be stacked in this exact order, and there is no requirement that you label the drive trays in this particular sequence. Just make sure the DE6900 drive trays are at the bottom of the cabinet.

The figure and table in this topic show a representative configuration for redundant drive cabling. Use the information in the previous topic to cable the first four drive trays, and then continue with this topic to cable up to four additional drive trays.

Drive Cabling Topologies for the CE7900 Controller Tray and the CE7922 Controller Tray

Figure 21 One CE7922 Controller Tray CE7900 Controller Tray and Eight DE6900 Drive Trays without Trunking

The following table specifies the cabling pattern for a controller tray that is attached to five to eight drive trays. The "Cable" column indicates that two cables are used for each drive tray. In the rows for cable 9 and cable 10, for example, the "Xs" indicate that the cables are connected to controller A, channel 1, port 7 and controller B, channel 5, port 2 respectively. The "Bs" in these rows indicate that the other ends of cable 1 and cable 2 are connected to port 1B of the top ESM (ESM A) and port 1B of the bottom ESM (ESM B) of drive tray 5 respectively. This pattern continues, using odd-numbered ports on controller A and even-numbered ports on controller B for drive trays five through eight.

Table 11 One CE7922 Controller Tray CE7900 Controller Tray and Five to Eight DE6900 Drive Trays without Trunking

Cable	Controller A								Controller B								Drive Tray							
	Channel								Channel								5		6		7		8	
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8									
	Port Number								Port Number								ESM (Top or Bottom)							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	T	B	T	B	T	B	T	B
9		X															B							
10									X									B						
11				X															B					
12											X									B				
13						X															B			
14														X								B		
15								X															B	
16																X								B

In the figures that follow, the controller tray is shown on top, and the controllers are labeled as A and B. Because the DE6900 drive trays are very heavy, they are installed starting at the bottom of the cabinet. The drive trays are labeled from the bottom upward as 1, 2, 3, and so on.

NOTE The CE7900 controller tray and the DE6900 drive trays do not have to be stacked in this exact order, and there is no requirement that you label the drive trays in this particular sequence. Just make sure the DE6900 drive trays are at the bottom of the cabinet.

Use the configuration examples in this section as a guide to configure your storage array to receive the benefits of drive-side trunking cabling. Drive-side trunking uses the right side of the expansion ports on the rear of the drive trays to allow the full bandwidth potential of the CE7900 controller tray.

Drive-side trunking requires that the ESMs have four ports to support trunked cascading connections to other drive trays. These cascading connections only apply when eight DE6900 drive trays are connected to a single controller tray.

The figures in this section show representative configurations for cabling.

Figure 22 One CE7922 Controller Tray or CE7900 Controller Tray and One DE6900 Drive Tray with Drive-Side Trunking
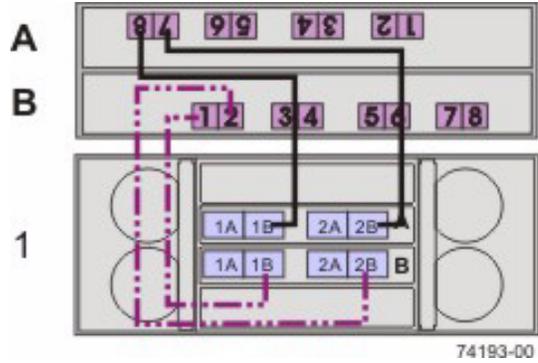

Figure 23 One CE7922 Controller Tray or CE7900 Controller Tray and Two DE6900 Drive Trays with Drive-Side Trunking
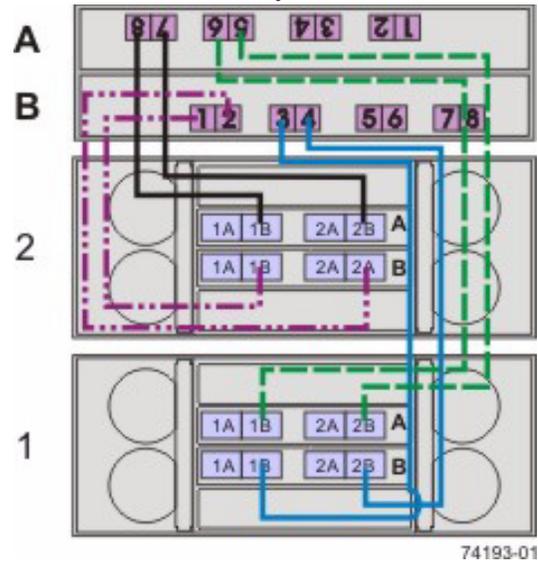
Figure 24 One CE7922 Controller Tray or CE7900 Controller Tray and Four DE6900 Drive Trays with Drive-Side Trunking
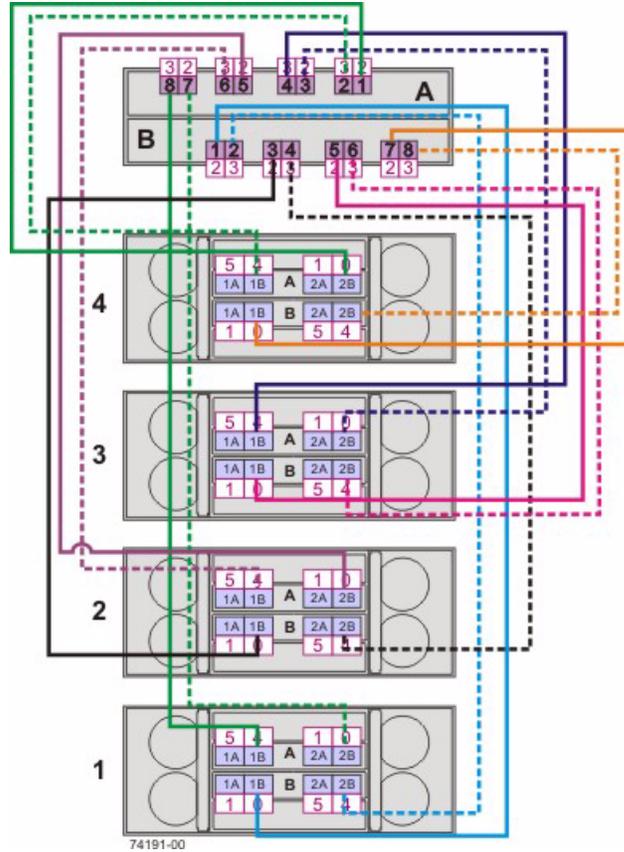
Table 12 One CE7922 Controller Tray or CE7900 Controller Tray and DE6900 Drive Tray 1 with Drive-Side Trunking

| Cable	Controller A								Controller B								Drive Tray 1							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1	X																	X						
2		X																		X				
3									X														X	
4										X														X

Table 13 One CE7922 Controller Tray or CE7900 Controller Tray and DE6900 Drive Tray 2 with Drive-Side Trunking

Cable	Controller A								Controller B								Drive Tray 2							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1			X															X						
2				X																X				
3											X												X	
4												X												X

Table 14 One CE7922 Controller Tray or CE7900 Controller Tray and DE6900 Drive Tray 3 with Drive-Side Trunking

Cable	Controller A								Controller B								Drive Tray 3							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1					X													X						
2						X														X				
3													X										X	
4														X										X

Table 15 One CE7922 Controller Tray or CE7900 Controller Tray and DE6900 Drive Tray 4 with Drive-Side Trunking

Cable	Controller A								Controller B								Drive Tray 4							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1							X											X						
2								X												X				
3															X								X	
4																X								X

One CE7922 Controller Tray or CE7900 Controller Tray and Five to Eight DE6900 Drive Trays with Drive-Side Trunking

In the cabling configuration figure that follows, the controller tray is placed on top, and the controllers are labeled as A and B. Because the DE6900 drive trays are very heavy, they are installed starting at the bottom of the cabinet. The drive trays are labeled from the bottom upward as 1, 2, 3, and so on.

NOTE The controller tray and the drive trays do not have to be stacked in this exact order, and there is no requirement that you label the drive trays in this particular sequence. Just make sure the DE6900 drive trays are at the bottom of the cabinet.

Use the configuration examples in this section as a guide to configure your storage array to receive the benefits of drive-side trunking cabling. Drive-side trunking uses the right side of the expansion ports on the rear of the drive trays to allow the full bandwidth potential of the controller tray.

Drive-side trunking requires that the ESMs have four ports to support trunked cascading connections to other drive trays. These cascading connections only apply when eight DE6900 drive trays are connected to a single controller tray.

The figure in this section shows a representative configuration for cabling. Use the tables in this section to see specific cabling patterns for other configurations.

Figure 25   One CE7922 Controller Tray or CE7900 Controller Tray and Eight DE6900 Drive Trays with Drive-Side Trunking

74193-03

Cable	Controller A								Controller B								Drive Tray 1							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1									X													X		
2										X														X

Cable	Drive Tray 1								Drive Tray 2							
	Top ESM				Bottom ESM				Top ESM				Bottom ESM			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3		X							X							
4				X							X					
5					X										X	
6							X									X

Cable	Controller A								Controller B								Drive Tray 2							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7	X																	X						
8		X																		X				

Cable	Controller A								Controller B								Drive Tray 3							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1											X											X		
2												X												X

Cable	Drive Tray 3 Top ESM				Drive Tray 3 Bottom ESM				Drive Tray 4 Top ESM				Drive Tray 4 Bottom ESM			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3					X									X		
4							X									X
5		X							X							
6				X							X					

Cable	Controller A Ch1		Ch2		Ch3		Ch4		Controller B Ch5		Ch6		Ch7		Ch8		Drive Tray 4 Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7					X													X						
8						X														X				

Table 18 One CE7922 Controller Tray or CE7900 Controller Tray and DE6900 Drive Trays 5 and 6 with Drive-Side Trunking

Cable	Controller A Ch1		Ch2		Ch3		Ch4		Controller B Ch5		Ch6		Ch7		Ch8		Drive Tray 5 Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1			X															X						
2				X																X				

Cable	Drive Tray 5 Top ESM				Drive Tray 5 Bottom ESM				Drive Tray 6 Top ESM				Drive Tray 6 Bottom ESM			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3	X								X							

Cable	Drive Tray 5								Drive Tray 6							
	Top ESM				Bottom ESM				Top ESM				Bottom ESM			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
4			X									X				
5						X							X			
6								X							X	

Cable	Controller A								Controller B								Drive Tray 6							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7											X											X		
8												X												X

Table 19 One CE7922 Controller Tray or CE7900 Controller Tray and DE6900 Drive Trays 7 and 8 with Drive-Side Trunking

Cable	Controller A								Controller B								Drive Tray 7							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1							X										X							
2								X											X					

Cable	Drive Tray 7								Drive Tray 8							
	Top ESM				Bottom ESM				Top ESM				Bottom ESM			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3	X									X						
4			X									X				
5						X							X			
6								X							X	

Drive Cabling Topologies for the CE7900 Controller Tray and the CE7922 Controller Tray

Cable	Controller A								Controller B								Drive Tray 8							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		Top ESM				Bottom ESM			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7															X						X			
8																X								X

One CE7900 Controller Tray and Multiple Types of Drive Trays

If you are cabling a mix of DE6900 drive trays and FC4600 drive trays, the following restrictions apply:

- Connect no more than two DE6900 drive trays per loop pair and no more than eight DE6900 drive trays per controller tray.

- Connect no more than seven FC4600 drive trays per loop pair and no more than 28 FC4600 drive trays per controller tray. In configurations that contain one DE6900 drive tray, connect no more than 21 FC4600 drive trays per controller tray.

- When FC4600 and DE6900 drive trays are mixed on the same loop, only one DE6900 drive tray and up to three FC4600 drive trays can share a loop.

- When FC4600 and DE6900 drive trays are mixed, the total number of drives must not exceed 448.

Drive Cabling Topologies for the CE6998 Controller Tray

One CE6998 Controller Tray and One Drive Tray

If you are cabling one CE6998 controller tray to one drive tray, use the cabling topology shown in the following table and figure.

Figure 26 One CE6998 Controller Tray and One Drive Tray
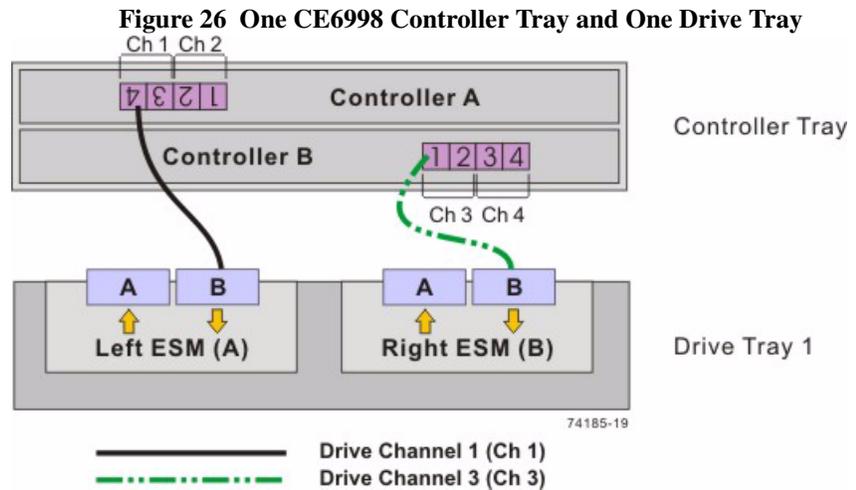
Table 20 One CE6998 Controller Tray and One Drive Tray

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	4	Drive tray 1	Left ESM, port B
3	Controller B	1	Drive tray 1	Right ESM, port B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

**One CE6998
Controller Tray and
Two Drive Trays**

If you are cabling one CE6998 controller tray to two drive trays, use the cabling topology described in the following table and figure.

Figure 27 One CE6998 Controller Tray and Two Drive Trays
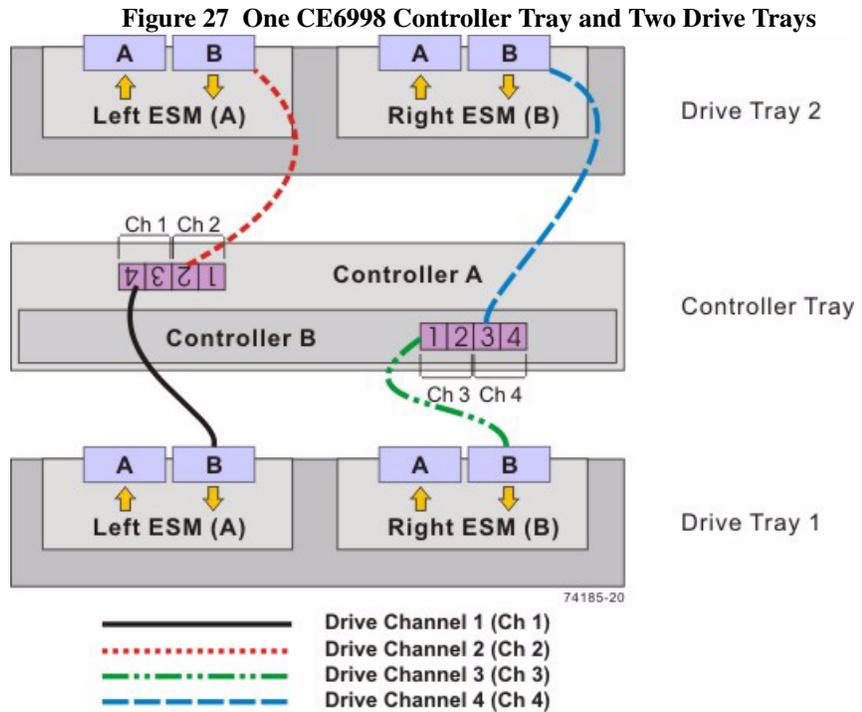
Table 21 One CE6998 Controller Tray and Two Drive Trays

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	4	Drive tray 1	Left ESM, port B
2	Controller A	2	Drive tray 2	Left ESM, port B
3	Controller B	1	Drive tray 1	Right ESM, port B
4	Controller B	3	Drive tray 2	Right ESM, port B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CE6998 Controller Tray and Four Drive Trays

If you are cabling one CE6998 controller tray to four drive trays, use the cabling topology shown in the following figure and table.

Figure 28 One CE6998 Controller Tray and Four Drive Trays
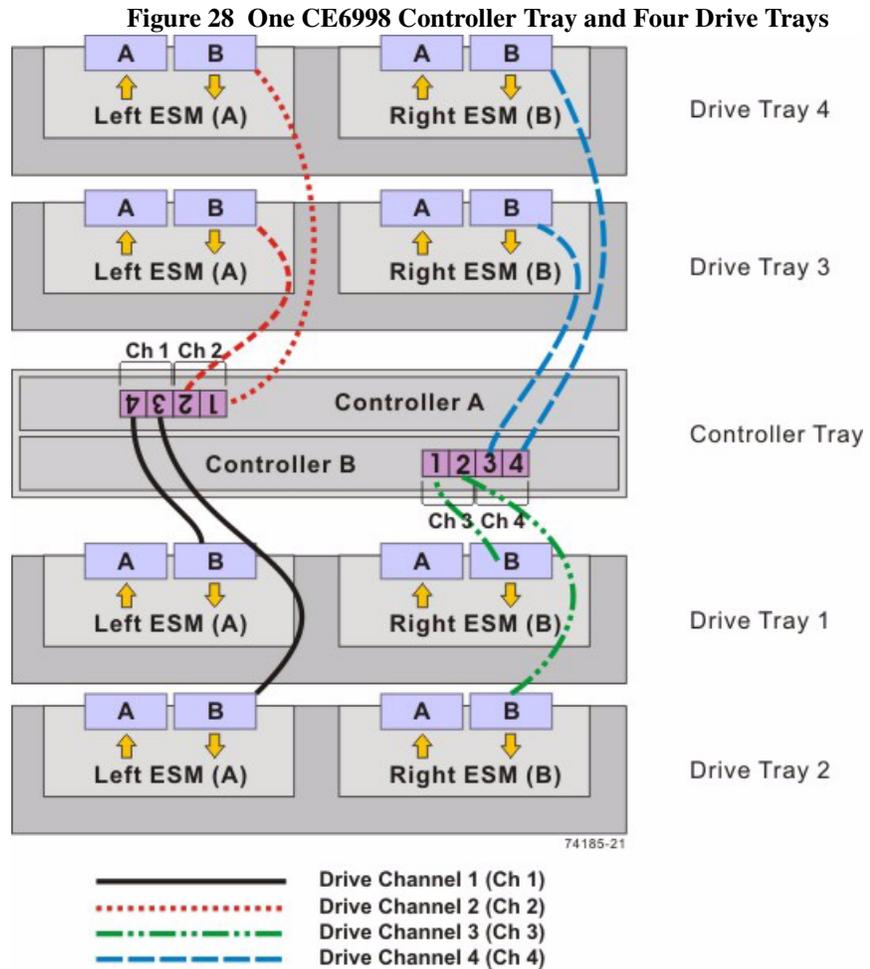
Table 22 One CE6998 Controller Tray and Four Drive Trays

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	4	Drive tray 1	Left ESM, port B
	Controller A	3	Drive tray 2	Left ESM, port B
2	Controller A	2	Drive tray 3	Left ESM, port B
	Controller A	1	Drive tray 4	Left ESM, port B

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
3	Controller B	1	Drive tray 1	Right ESM, port B
	Controller B	2	Drive tray 2	Right ESM, port B
4	Controller B	3	Drive tray 3	Right ESM, port B
	Controller B	4	Drive tray 4	Right ESM, port B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CE6998 Controller Tray and Eight Drive Trays

If you are cabling one CE6998 controller tray to eight drive trays, use the cabling topology described in the following table and figure.

Figure 29 One CE6998 Controller Tray and Eight Drive Trays

Drive Cabling Topologies for the CE6998 Controller Tray
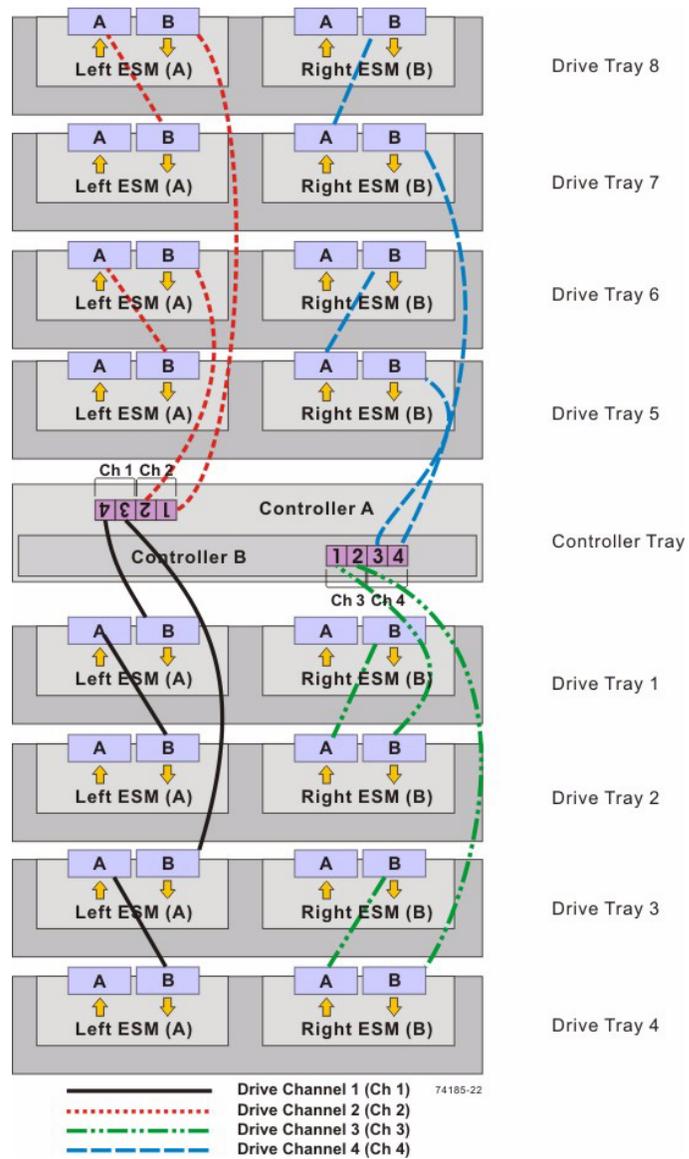
Table 23 One CE6998 Controller Tray and Eight Drive Trays

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	4	Drive tray 1	Left ESM, port B
	Drive tray 1		Drive tray 2	Left ESM, port B
	Controller A	3	Drive tray 3	Left ESM, port B
	Drive tray 3		Drive tray 4	Left ESM, port B
2	Controller A	2	Drive tray 6	Left ESM, port B
	Drive tray 6		Drive tray 5	Left ESM, port B
	Controller A	1	Drive tray 8	Left ESM, port B
	Drive tray 8		Drive tray 7	Left ESM, port B
3	Controller B	1	Drive tray 2	Right ESM, port B
	Drive tray 2		Drive tray 1	Right ESM, port B
	Controller B	2	Drive tray 4	Right ESM, port B
	Drive tray 4		Drive tray 3	Right ESM, port B
4	Controller B	3	Drive tray 5	Right ESM, port B
	Drive tray 5		Drive tray 6	Right ESM, port B
	Controller B	4	Drive tray 7	Right ESM, port B
	Drive tray 7		Drive tray 8	Right ESM, port B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CE6998 Controller Tray and Multiple Types of Drive Trays

If you are cabling more than one type of drive tray to the CE6998 controller tray, read these topics before you choose a cabling topology:

■   Guidelines for Cabling FC2610 Drive Trays or FC4600 Drive Trays

■   Guidelines for Cabling AT2655 Drive Trays

Follow these guidelines for cabling multiple types of drive trays to maximize performance and accessibility.

Guidelines for Cabling FC2610 Drive Trays or FC4600 Drive Trays

Follow these guidelines for cabling a topology with multiple types of drive trays, including the FC2610 drive trays or the FC4600 drive trays.

- If your storage array includes FC2610 drive trays or FC4600 drive trays, cable the FC2610 drive trays or the FC4600 drive trays so that they are the first devices on the drive channel (after controller A). The first device on the drive channel is distinguished by the fact that the left ESM of the first device is cabled directly to controller A of the controller tray. Because an optimal redundant cabling topology requires that the redundant drive channel be cabled in the opposite order, this same device will be the last in the drive channel when cabled to controller B.

- Evenly distribute the FC2610 drive trays or the FC4600 drive trays in pairs or multiples across redundant pairs of the available drive channels.

- Do not cable a single FC2610 drive tray or a single FC4600 drive tray on a drive channel unless it is the only FC2610 drive tray or FC4600 drive tray in the storage array.

Guidelines for Cabling AT2655 Drive Trays

Follow these guidelines for cabling a topology with multiple drive tray types, including AT2655 drive trays.

- If your storage array includes AT2655 drive trays, cable the AT2655 drive trays so that they are the last devices on the drive channel (from a top-down cabling perspective).

- Distribute AT2655 drive trays across redundant pairs of drive channels to equalize the number of drive trays on the available channels.

In the following figure, the FC2610 drive trays and the FC4600 drive trays are identified as SBODs (Switched Bunch of Disks). The AT2655 drive tray is identified as SATA (Serial Advanced Technology Attachment).

NOTE When you mix different types of drive trays, you must consider the total number of drives that are available in the final configuration of the storage array. For example, if you mix FC4600 drive trays with FC2610 drive trays, the total number of drives might be more than the maximum number that each drive channel can support.

Figure 30 One CE6998 Controller Tray and Multiple Types of Drive Trays
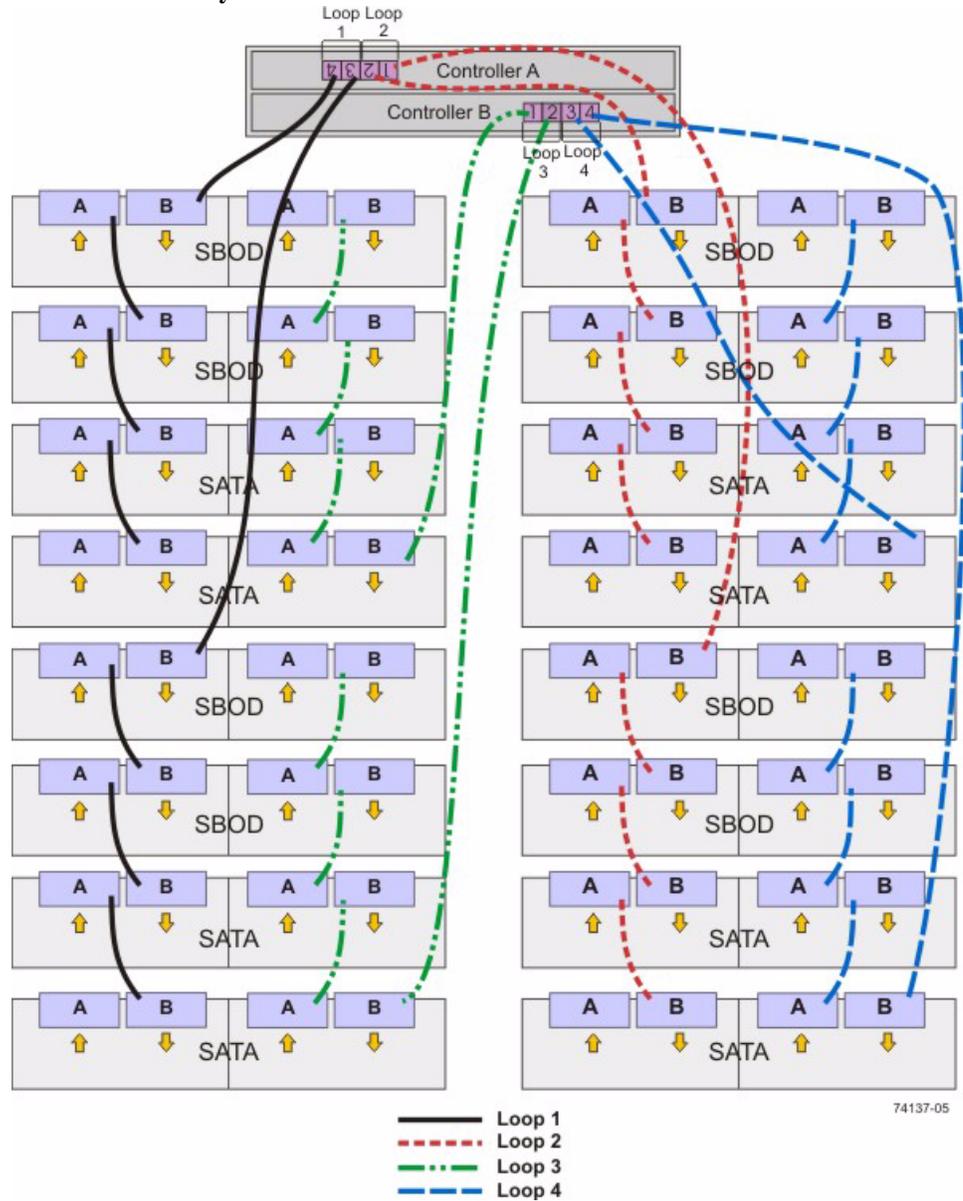
NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

Drive Cabling Topologies for the E5500 Controller-Drive Trays

This section provides examples of drive cabling topologies for the E5500 controller-drive trays. The E5500 controller-drive tray models are: E5512, E5524, and the E5560.

The E5500 controller-drive trays can be cabled to DE1600 drive trays, DE5600 drive trays, DE6600 drive trays, or combinations of these three types of drive trays The drive slot limit for configurations with InfiniBand host connections is 240 drive slots. For all other configurations, the limit is 384 drive slots. The drive limit includes drive slots in the controller-drive tray. For all configurations of the E5500, the total number of trays in the storage array, including the controller-drive tray and all of the attached drive trays, must not exceed 16.

Drive Cabling Topologies for the E5524 Controller-Drive Tray and the E5512 Controller-Drive Tray

The figures in this section show representative cabling configurations. The configurations shown guarantee that redundant data paths exist between the controller-drive tray and all attached drive trays in a storage array. The E5524 controller-drive tray and the E5512 controller-drive tray can be cabled to DE1600 drive trays, DE5600 drive trays, DE6600 drive trays, or various combinations of those three models of drive tray.

For any one controller-drive tray, you must not exceed the limit of 15 connected drive trays or the limit for the total number of drive slots in the storage array. The drive slot limit for a controller-drive tray with InfiniBand host connections is 240 drive slots. For other configurations, the limit is up to 384 drives. The drive slot limits include drive slots in the controller-drive tray.

NOTE The drive slot limit might be lower than 384 for some sub-models of the E5524 controller-drive tray and the E5512 controller-drive tray. You are notified through the Major Event Log (MEL) if you attempt to install drive slots in excess of the limit for your storage array. Contact Technical Support if this occurs.

The following figure show the SAS ports on a DE1600 drive tray or a DE5600 drive tray. Each environmental services module (ESM) has two SAS IN ports and one SAS expansion (out) port. You may connect the SAS IN ports to the SAS expansion port on another drive tray or to a SAS expansion port on a controller-drive tray. Follow the cabling pattern shown in the figures in this topic.

Figure 31 SAS Ports on a DE1600 Drive Tray or a DE5600 Drive Tray
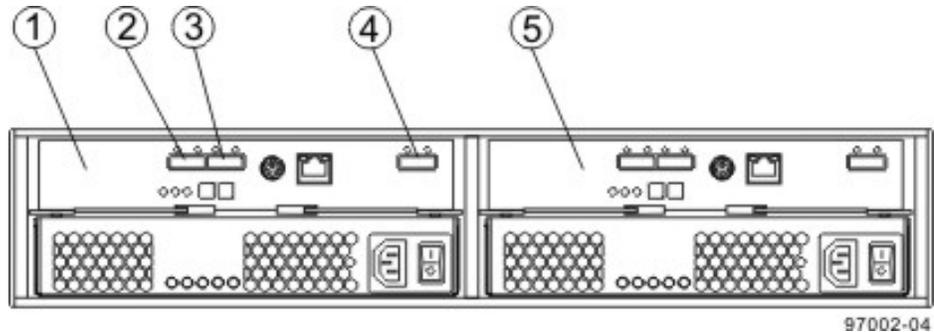
97002-04

1. ESM A
2. SAS IN Connector
3. SAS IN Connector
4. SAS Expansion (Out) Connector
5. ESM B

When you cable the storage array, keep these points in mind:

■ To connect an ESM to a controller-drive tray, use both of the SAS IN ports on the ESM. Connect one SAS IN port to a SAS expansion port on controller A and the other SAS IN port a SAS expansion port on controller B in the controller-drive tray.

■ To connect two drive trays, connect the SAS expansion port on an ESM in one drive tray to one of the SAS IN ports on an ESM in the other drive tray. Do not connect both SAS IN ports on one ESM to other drive trays.

Figure 32 One E5524 Controller-Drive Tray or E5512 Controller-Drive Tray and One Drive Tray
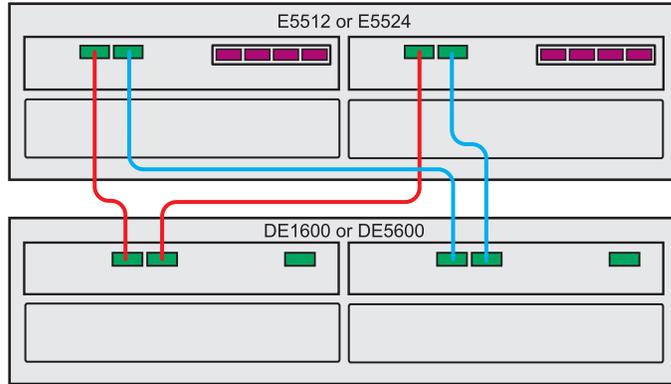
74198-08

Figure 33 One E5524 Controller-Drive Tray or E5512 Controller-Drive Tray and Three Drive Trays
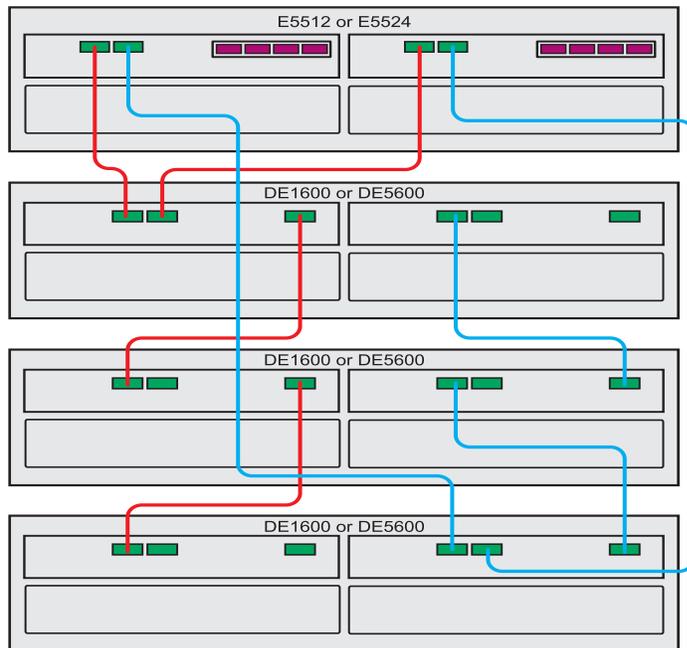
74198-02

**Figure 34 One E5524 Controller-Drive Tray or E5512
Controller-Drive Tray and up to 15 Drive Trays**
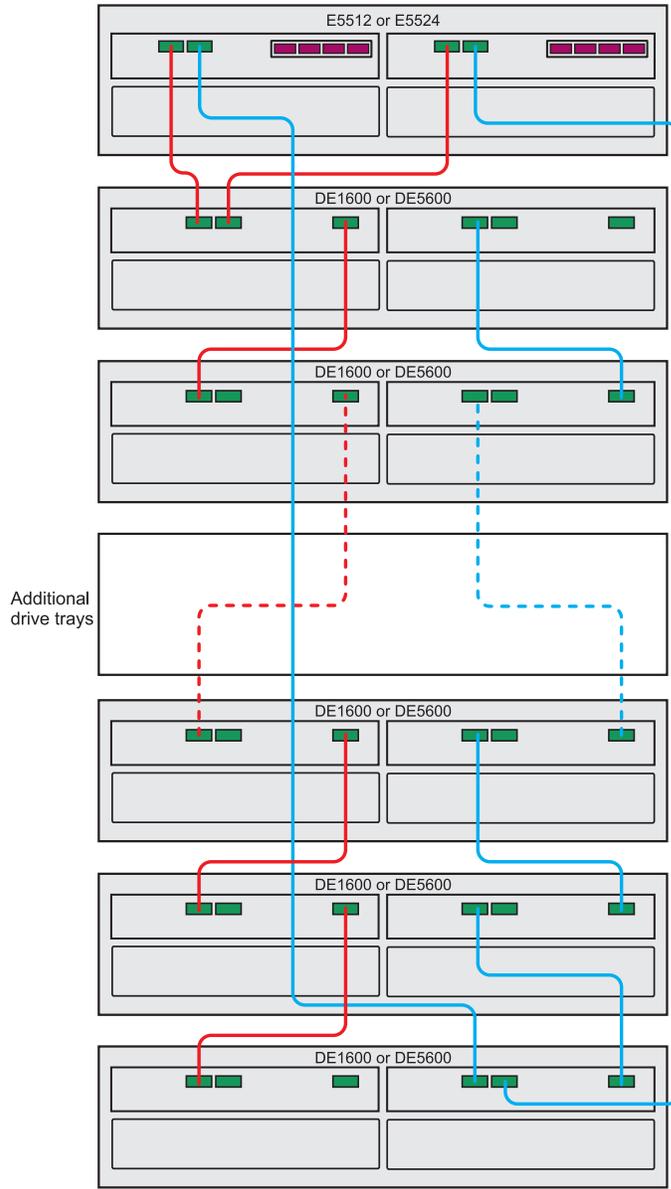
The figures above show storage arrays with DE1600 drive trays or DE5600 drive
trays. A storage array with an E5524 controller-drive tray or an E5512
controller-drive tray might also include DE6600 drive trays. The cabling pattern

remains the same, although the ESMs are arranged differently in a DE6600 drive tray. Drive Cabling Topologies for the E5560 Controller-Drive Tray on page 132 shows the arrangement of ESMs and the location of ports on the DE6600 drive tray.

> **NOTE** The cabling pattern is independent of the physical location of the trays in the cabinet. If the controller-drive tray is installed in the middle of the cabinet, the physical cabling pattern will be different from what is shown in Figure 34, although the topology will be consistent. If the storage array includes DE6600 drive trays, install those drive trays beginning from the bottom of the cabinet so that the cabinet does not become top-heavy. A top-heavy cabinet has a greater risk of falling over.

Drive Cabling Topologies for the E5560 Controller-Drive Tray

The figures in this section show representative cabling configurations. The configurations shown guarantee that redundant data paths exist between the controller-drive tray and all attached drive trays in a storage array. The E5560 controller-drive tray can be cabled to DE1600 drive trays, DE5600 drive trays, DE6600 drive trays, or various combinations of those three models of drive tray.

> **WARNING** (W15) **Risk of bodily injury** – An empty E5560 controller-drive tray weighs approximately 56.7 kg (125 lb). Three persons are required to safely move an empty tray. If the tray is populated with components, a mechanized lift is required to safely move the tray.

> **NOTE** To ensure cabinet stability and guarantee the lowest possible center of gravity, install only 60-drive trays (E5560 controller-drive trays or DE6600 drive trays) at the bottom of the cabinet, and install any 12-drive trays or any 24-drive trays above all 60-drive trays, with no empty space. A top-heavy cabinet has a greater risk of falling over.

For any one controller-drive tray, you must not exceed the limit of 15 connected drive trays or the limit for the total number of drive slots in the storage array. The drive slot limit for a controller-drive tray with InfiniBand host connections is 240 drives. For other configurations, the limit is up to 384 drive slots. The drive slot limits include drive slots in the controller-drive tray.

NOTE The drive slot limit might be lower than 384 for some sub-models of the E5560 controller-drive tray. You are notified through the Major Event Log (MEL) if you attempt to install drive slots in excess of the limit for your storage array. Contact Technical Support if this occurs.

The following figures show the SAS ports on a DE6600 drive tray. Each environmental services module (ESM) has two SAS IN ports and one SAS expansion (out) port. You may connect the SAS IN ports to the SAS expansion port on another drive tray or to a SAS expansion port on a controller-drive tray. Follow the cabling pattern shown in the figures in this topic.

Figure 35 SAS Ports on a DE6600 Drive Tray
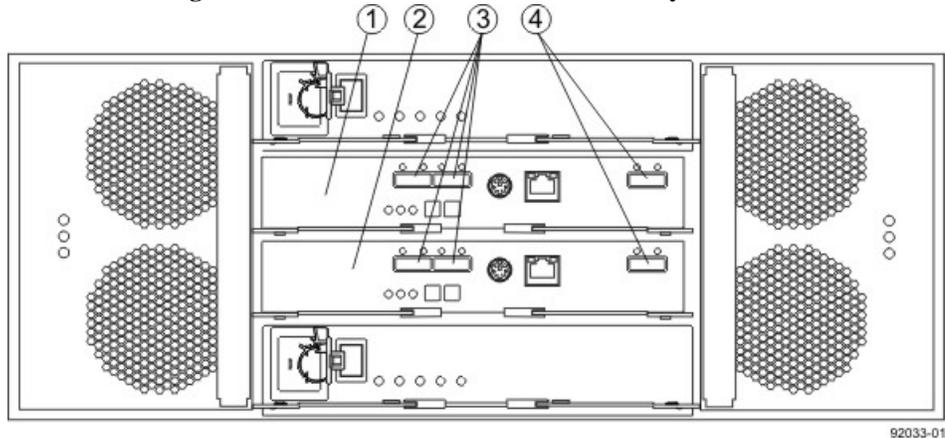
1. ESM A
2. ESM B
3. SAS IN Connectors
4. SAS Expansion (Out) Connectors

When you cable the storage array, keep these points in mind:

■   To connect an ESM to a controller-drive tray, use both of the SAS IN ports on the ESM. Connect one SAS IN port to a SAS expansion port on controller A and the other SAS IN port a SAS expansion port on controller B in the controller-drive tray.

■   To connect two drive trays, connect the SAS expansion port on an ESM in one drive tray to one of the SAS IN ports on an ESM in the other drive tray. Do not connect both SAS IN ports on one ESM to other drive trays.

Figure 36 One E5560 Controller-Drive Tray and One DE6600 Drive Tray

74198-05

Drive Cabling Topologies for the E5500 Controller-Drive Trays
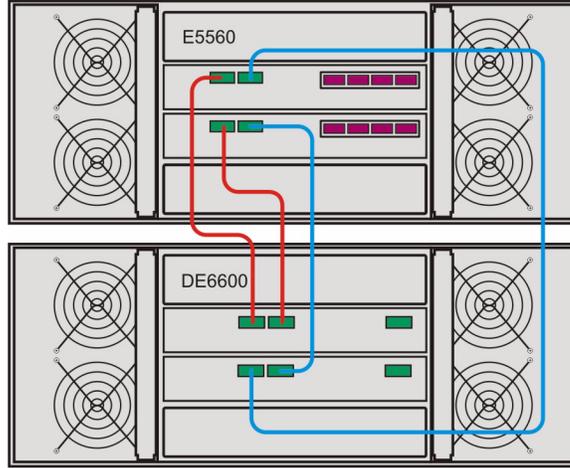
Figure 37 One E5560 Controller-Drive Tray and Three DE6600 Drive Trays
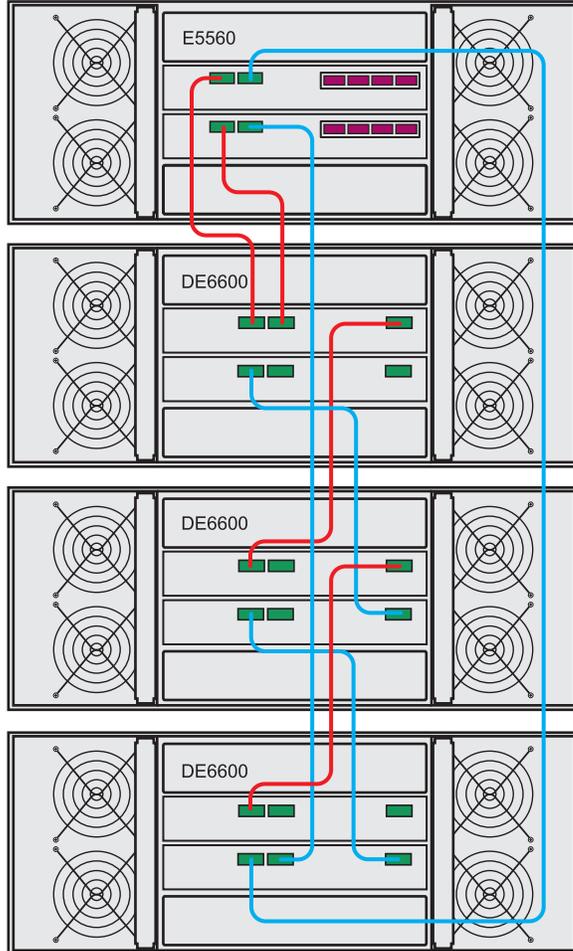
74198-01

Figure 38 One E5460 Controller-Drive Tray and Five DE6600 Drive Trays
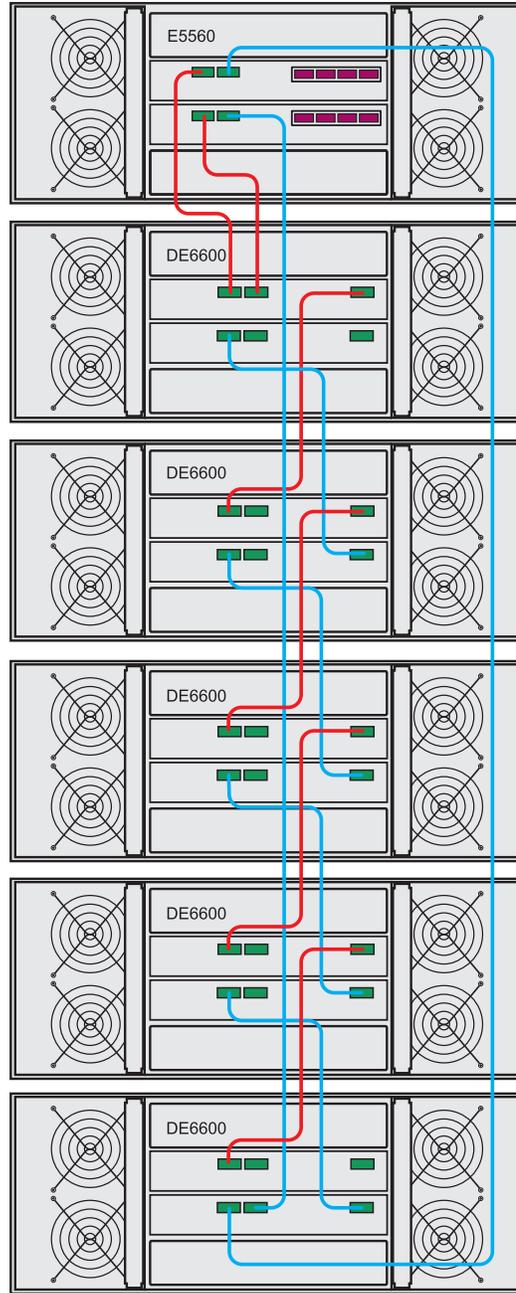
The figures above show storage arrays with DE6600 drive trays. A storage array with an E5560 controller-drive tray might also include DE1600 drive trays or DE5600

drive trays. The cabling pattern remains the same, although the ESMs are arranged differently in DE1600 drive trays and DE5600 drive trays. Drive Cabling Topologies for the E5524 Controller-Drive Tray and the E5512 Controller-Drive Tray on page 128 shows the arrangement of ESMs and the location of ports on the DE1600 drive trays and DE5600 drive trays.

Drive Cabling Topologies for the E5400 Controller-Drive Trays

This section provides examples of drive cabling topologies for the E5400 controller-drive trays. The E5400 controller-drive tray models are: E5412, E5424, and the E5460.

The E5400 controller-drive trays can be cabled to DE1600 drive trays, DE5600 drive trays, DE6600 drive trays, or combinations of these three types of drive trays DE5600 drive trays, DE6600 drive trays, or combinations of these two types of drive trays. For configurations of the E5400 with InfiniBand host connections, the total number of drives in the storage array, including the drives in the controller-drive tray and those in all of the attached drive trays, must not exceed 240. For all other configurations of the E5400, the total number of drives in the storage array, including the drives in the controller-drive tray and those in all of the attached drive trays, must not exceed 384. For all configurations of the E5400, the total number of trays in the storage array, including the controller-drive tray and all of the attached drive trays, must not exceed 16.

Drive Cabling Topologies for the E5424 Controller-Drive Tray and the E5412 Controller-Drive Tray

The figures in this section show representative cabling configurations. The configurations shown guarantee that redundant data paths exist between the controller-drive tray and all attached drive trays in a storage array. The E5424 controller-drive tray and the E5412 controller-drive tray can be cabled to DE1600 drive trays, DE5600 drive trays, DE6600 drive trays, or various combinations of those three models of drive tray.

For any one controller-drive tray, you must not exceed the limit of 15 connected drive trays or the limit for the total number of drive slots in the storage array. The drive slot limit for a controller-drive tray with InfiniBand host connections 240 drive slots. For all other configurations, the limit is 384 drive slots. The drive limits includes drive slots in the controller-drive tray.

The following figure show the SAS ports on a DE1600 drive tray or a DE5600 drive tray. You may connect either of the SAS ports labeled SAS 1 and SAS 2 to the SAS expansion port on another drive tray or on a controller-drive tray. Do not make connections to both the SAS 1 port and the SAS 2 port on the same ESM.

Figure 39 SAS Ports on a DE1600 Drive Tray or a DE5600 Drive Tray
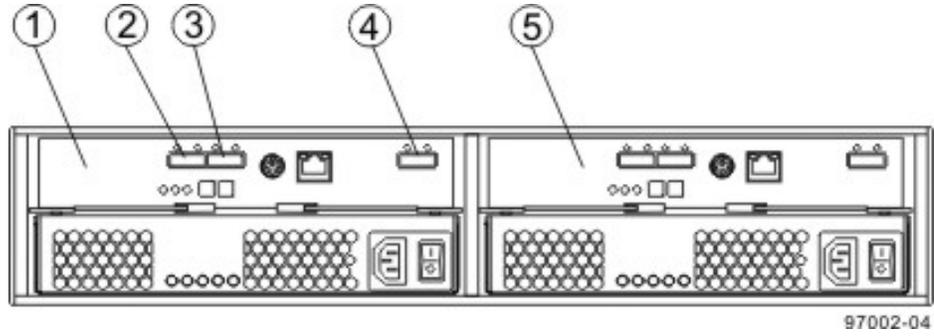

1. ESM A
2. SAS Port 1
3. SAS Port 2
4. SAS Expansion Port
5. ESM B

Figure 40 One E5424 Controller-Drive Tray or E5412 Controller-Drive Tray and One DE1600 Drive Tray or DE5600 Drive Tray

Drive Cabling Topologies for the E5400 Controller-Drive Trays
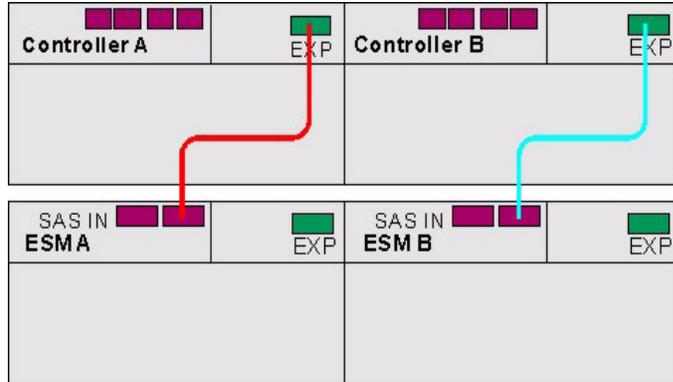
Figure 41 One E5424 Controller-Drive Tray or E5412 Controller-Drive Tray and Two DE1600 Drive Trays or DE5600 Drive Trays
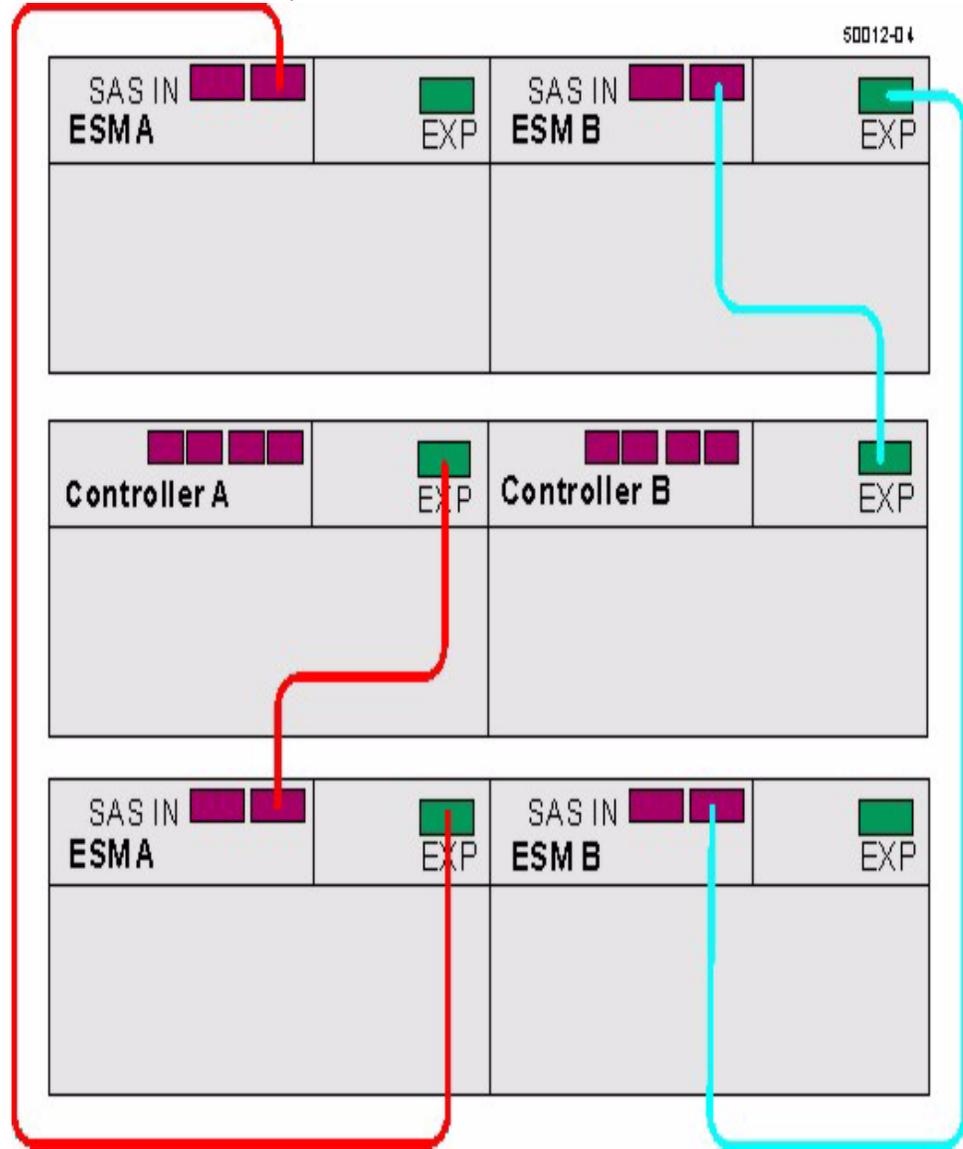
The following figures show the SAS ports on a DE6600 drive tray. You may connect either the left or right SAS port on an ESM to the SAS expansion port on another drive tray or on a controller-drive tray. Do not make connections to both the left and right SAS ports on the same ESM.

Figure 42 SAS Ports on a DE6600 Drive Tray
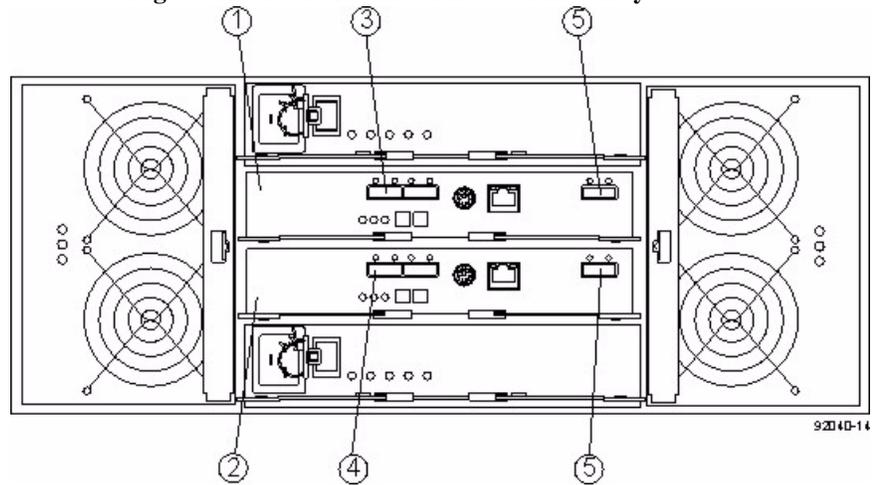
1. ESM A
2. ESM B
3. SAS In Ports
4. SAS In Ports
5. SAS Expansion Ports

WARNING (W15) **Risk of bodily injury** – An empty tray weighs approximately 56.7 kg (125 lb). Three persons are required to safely move an empty tray. If the tray is populated with components, a mechanized lift is required to safely move the tray.

NOTE The cabling pattern is independent of the physical location of the trays in the cabinet. If the storage array includes DE6600 drive trays, install those drive trays beginning from the bottom of the cabinet so that the cabinet does not become top-heavy. A top-heavy cabinet has a greater risk of falling over.

**Figure 43 One E5424 Controller-Drive Tray or E5412
Controller-Drive Tray and One DE6600 Drive Tray**
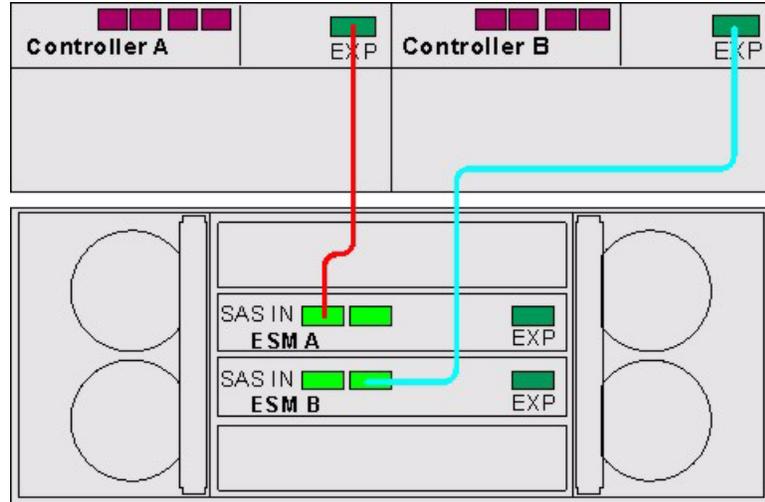
**Figure 44 One E5424 Controller-Drive Tray or E5412
Controller-Drive Tray and Two DE6600 Drive Trays**

The following figure shows how the cabling pattern can be continued for additional
drive trays until the 15 drive tray limit or the limit on the total number of drive slots in
the storage array is reached. The figure uses the schematic representation for DE1600
drive trays or DE5600 drive trays. However, DE6600 drive trays can be included in
the storage array as long as the same cabling pattern, connecting SAS expansion ports
to SAS In ports, is followed.

> **NOTE** The cabling pattern is independent of the physical location of the
> trays in the cabinet. If the storage array includes DE6600 drive trays,
> install those drive trays beginning from the bottom of the cabinet so that
> the cabinet does not become top-heavy. A top-heavy cabinet has a greater
> risk of falling over.

**Figure 45 One E5424 Controller-Drive Tray or E5412
Controller-Drive Tray and Seven or More Drive Trays**

The number of drive trays
may vary as long as the
maximum number of drives
is not exceeded.

98002-00

Drive Cabling Topologies for the E5460 Controller-Drive Tray

The figures in this section show representative cabling configurations. The configurations shown guarantee that redundant data paths exist between the controller-drive tray and all attached drive trays in a storage array. The E5460 controller-drive tray can be cabled to DE1600 drive trays, DE5600 drive trays, DE6600 drive trays, or various combinations of those three models of drive tray.

WARNING (W15) **Risk of bodily injury** – An empty tray weighs approximately 56.7 kg (125 lb). Three persons are required to safely move an empty tray. If the tray is populated with components, a mechanized lift is required to safely move the tray.

NOTE Install the E5460 controller-drive tray at the bottom of the cabinet so that the cabinet does not become top-heavy. A top-heavy cabinet has a greater risk of falling over.

For any one controller-drive tray, you must not exceed the limit of 15 connected drive trays or the limit for the total number of drive slots in the storage array. The drive slot limit for a controller-drive tray with InfiniBand host connections is 240 drive slots. For all other configurations, the limit is 384 drive slots. The drive slot limits includes drive slots in the controller-drive tray.

The following figures show the SAS ports on a DE1600 drive tray or a DE5600 drive tray. You may connect either the left or right SAS port on an ESM to the SAS expansion port on another drive tray or on a controller-drive tray. Do not make connections to both the left and right SAS ports on the same ESM.

Figure 46 SAS Ports on a DE1600 Drive Tray or a DE5600 Drive Tray
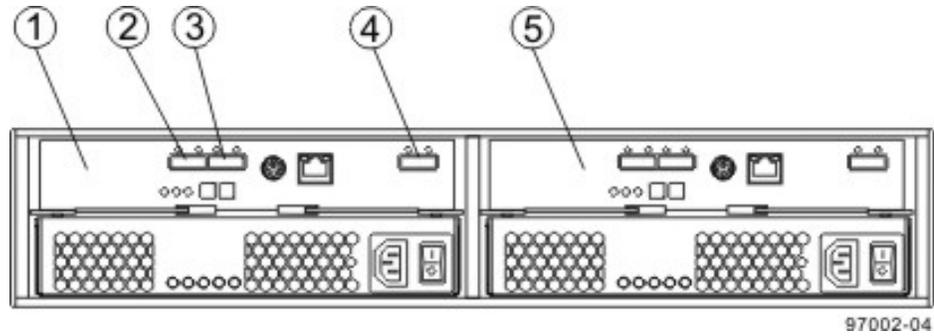
1. ESM A
2. SAS Port 1
3. SAS Port 2
4. SAS Expansion Port
5. ESM B

**Figure 47 One E5460 Controller-Drive Tray and One DE1600 Drive Tray or DE5600 Drive Tray**
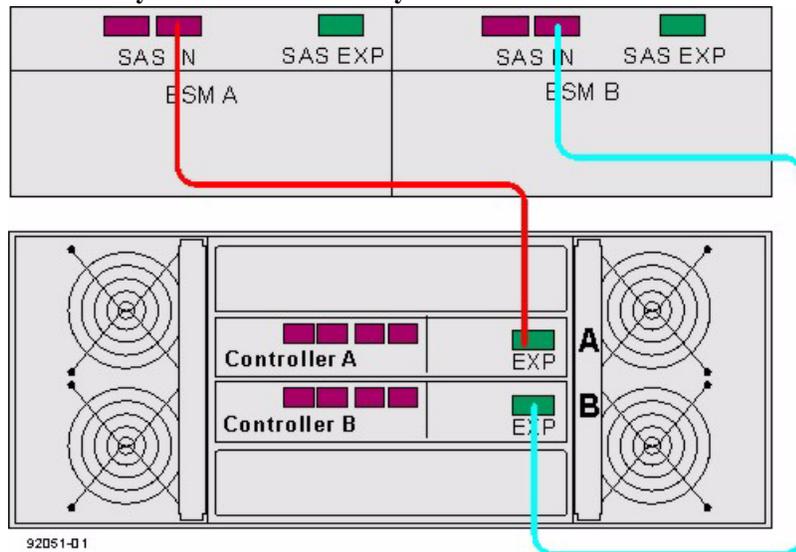
Figure 48 One E5460 Controller-Drive Tray and Two DE1600 Drive Trays or DE5600 Drive Trays
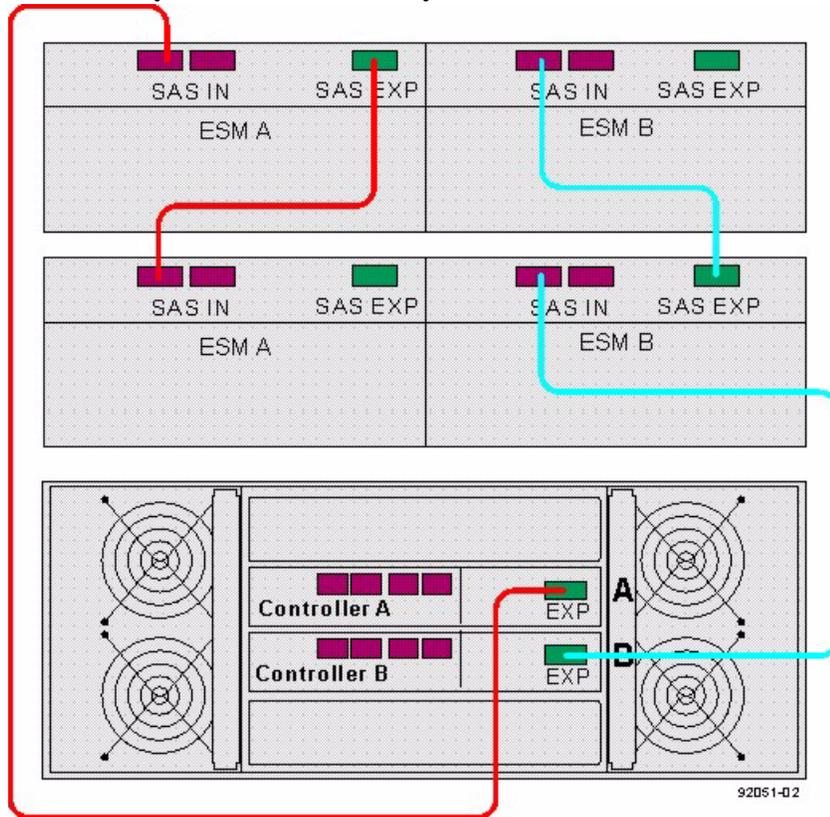
The following figures show the SAS ports on a DE6600 drive tray. You may connect either of the SAS ports labeled SAS 1 and SAS 2 to the SAS expansion port on another drive tray or on a controller-drive tray. Do not make connections to both the SAS 1 port and the SAS 2 port on the same ESM.

WARNING (W15) **Risk of bodily injury** – An empty tray weighs approximately 56.7 kg (125 lb). Three persons are required to safely move an empty tray. If the tray is populated with components, a mechanized lift is required to safely move the tray.

NOTE   If the storage array includes DE6600 drive trays, install those drive trays beginning from the bottom of the cabinet so that the cabinet does not become top-heavy. A top-heavy cabinet has a greater risk of falling over.

Figure 49 SAS Ports on a DE6600 Drive Tray
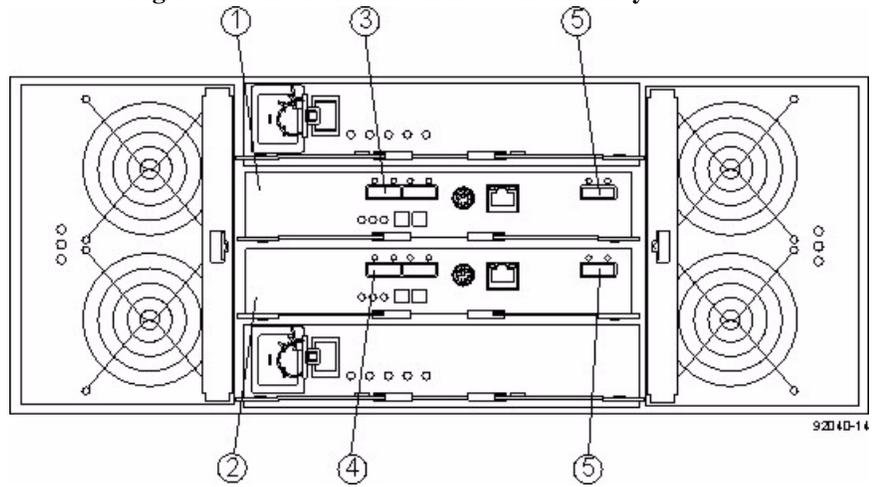
1. ESM A
2. ESM B
3. SAS In Port
4. SAS In Port
5. SAS Expansion Ports

Figure 50 One E5460 Controller-Drive Tray and One DE6600 Drive Tray

Drive Cabling Topologies for the E5400 Controller-Drive Trays
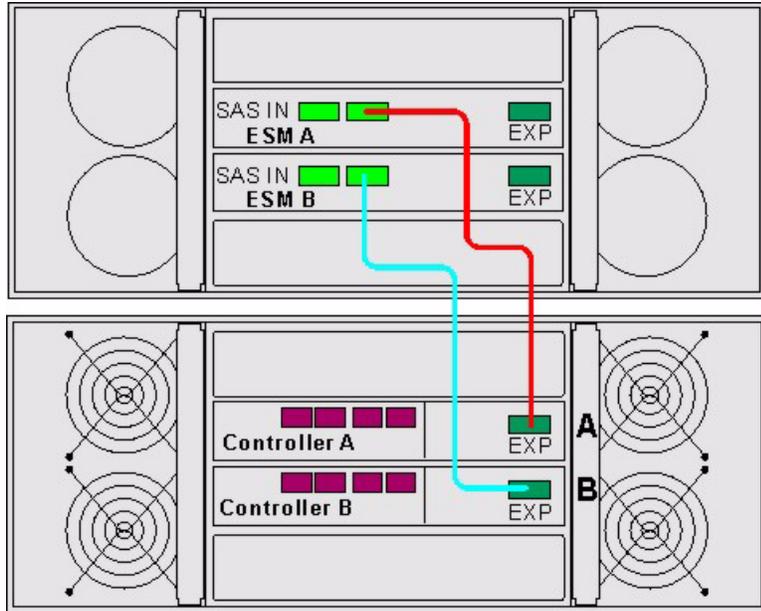
Figure 51 One E5460 Controller-Drive Tray and Two DE6600 Drive Trays

The following figure shows how the cabling pattern can be continued for additional drive trays until the 15 drive tray limit or the limit on the total number of drives in the storage array is reached. The figure uses the schematic representation for DE1600 drive trays or DE5600 drive trays. However, DE6600 drive trays can be included in the storage array as long as the same cabling pattern, connecting SAS expansion ports to SAS In ports, is followed.

NOTE The cabling pattern is independent of the physical location of the trays in the cabinet. If the storage array includes DE6600 drive trays, install those drive trays beginning from the bottom of the cabinet so that the cabinet does not become top-heavy. A top-heavy cabinet has a greater risk of falling over.

Figure 52 One E5460 Controller-Drive Tray and Seven or More Drive Trays
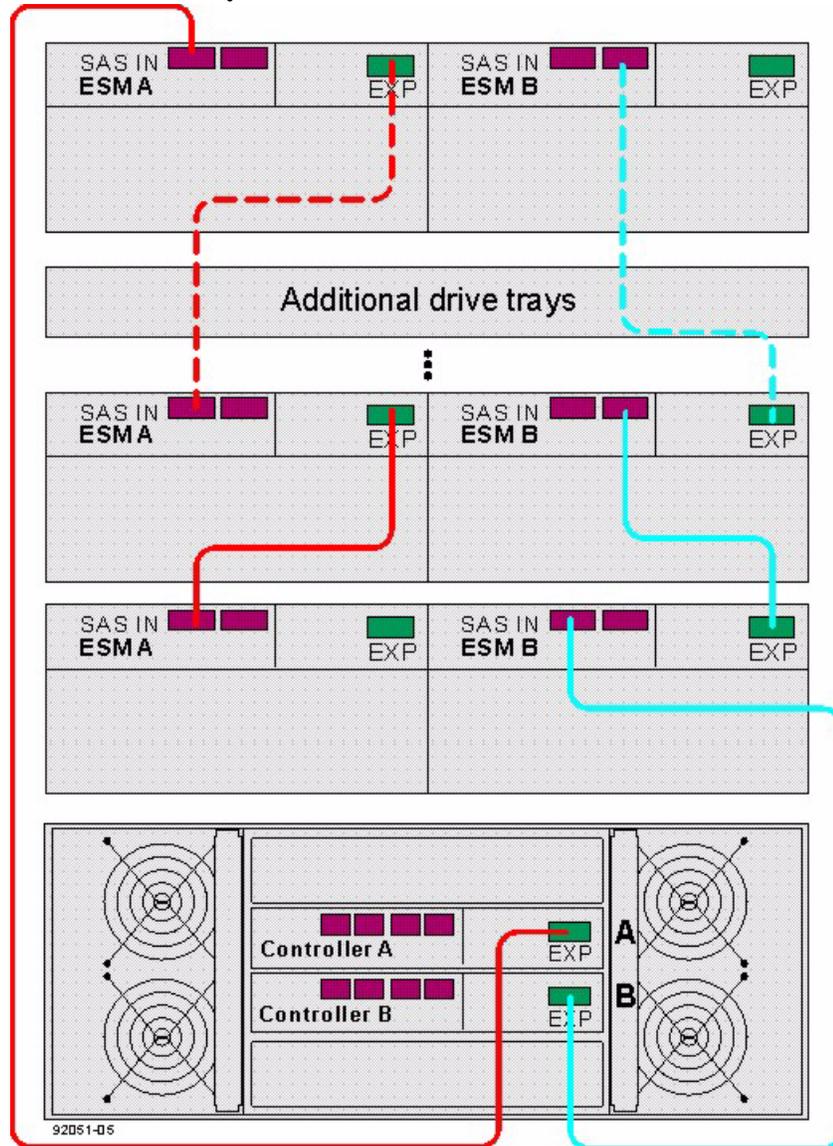
The following figure shows cabling for a storage array with the capacity for 384 drives, the maximum number. The storage array consists of a E5460 controller-drive tray with five DE6600 drive trays and one DE5600 drive tray. The maximum capacity can also be achieved by replacing the DE5600 drive tray in this example with two DE1600 drive trays. When the E5460 controller-drive tray uses InfiniBand host connections, the maximum supported number of drive slots is 240.

Figure 53 A Storage Array with the Capacity for 384 Drives Using a E5460 Controller-Drive Tray
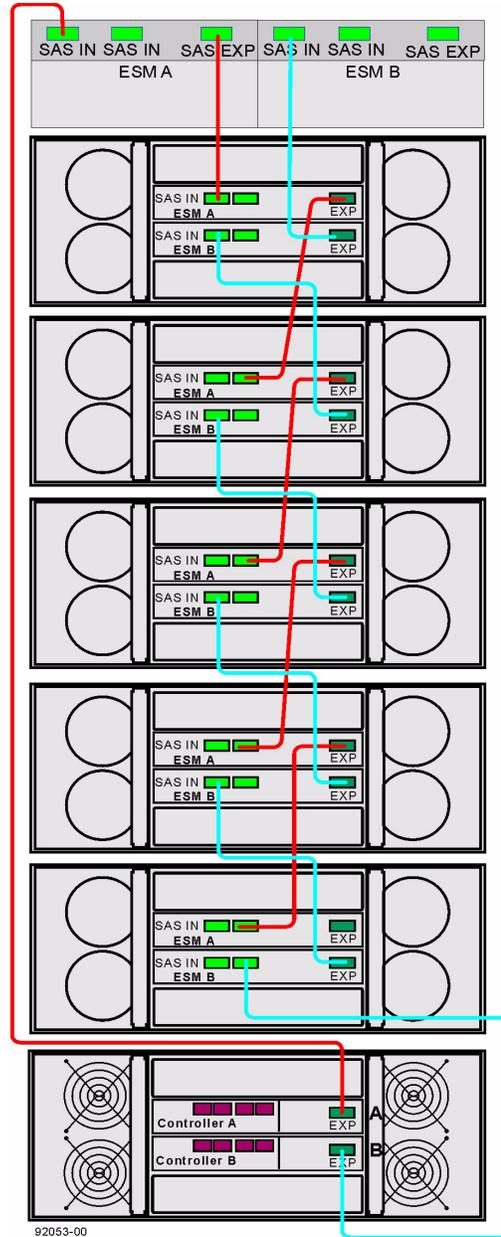
Drive Cabling Topologies for the E5400 Controller-Drive Trays

Drive Cabling Topologies for the CE4900 Controller-Drive Tray

This section provides examples of drive cabling topologies that can be used for cabling the CE4900 controller-drive tray to FC4600 drive trays. Depending on the number of drive trays that you need to connect, see the applicable figure for a cabling configuration. Each example provides redundant paths to the drives. The total number of drives in the storage array, including the drives in the controller-drive tray and those in the drive trays, must not exceed 112.

Figure 54 One CE4900 Controller-Drive Tray and One FC4600 Drive Tray
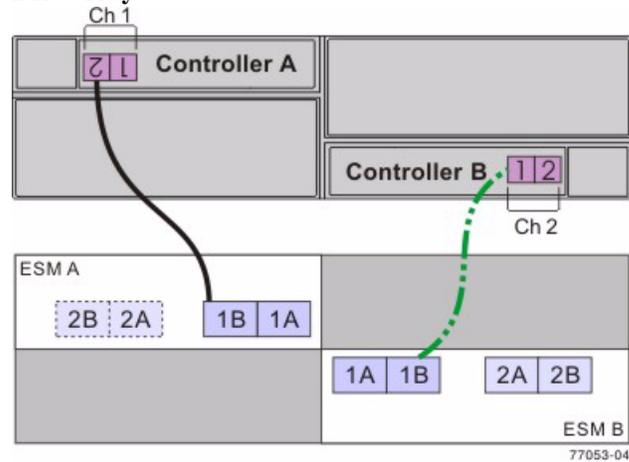
**Figure 55 One CE4900 Controller-Drive Tray and Two FC4600 Drive Trays**

Drive Channel 1 (Ch 1)
Drive Channel 2 (Ch 2)

Drive Cabling Topologies for the CE4900 Controller-Drive Tray

Figure 56 One CE4900 Controller-Drive Tray and Three FC4600 Drive Trays
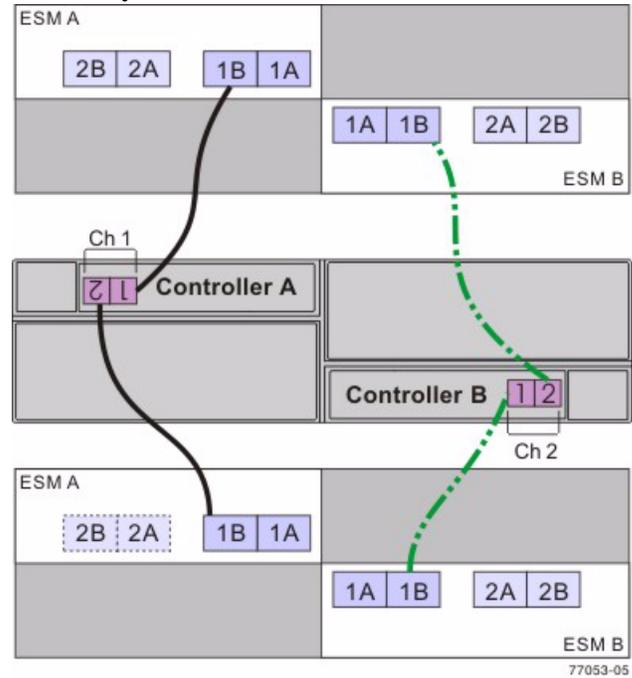
Drive Channel 1 (Ch 1)
Drive Channel 2 (Ch 2)
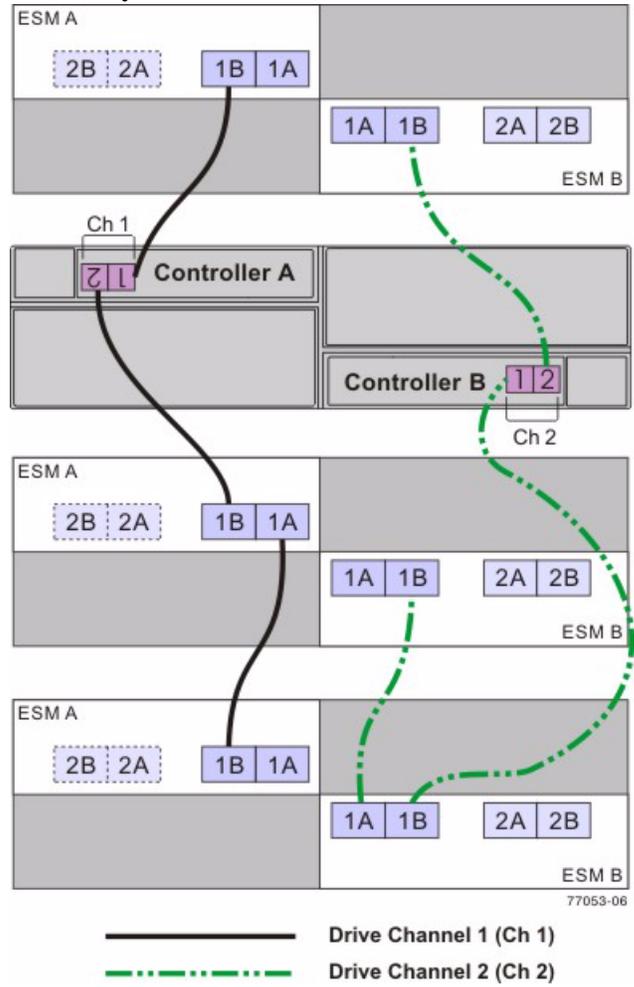
Figure 57 One CE4900 Controller-Drive Tray and Four FC4600 Drive Trays

Drive Channel 1 (Ch 1)
Drive Channel 2 (Ch 2)

Drive Cabling Topologies for the CE4900 Controller-Drive Tray
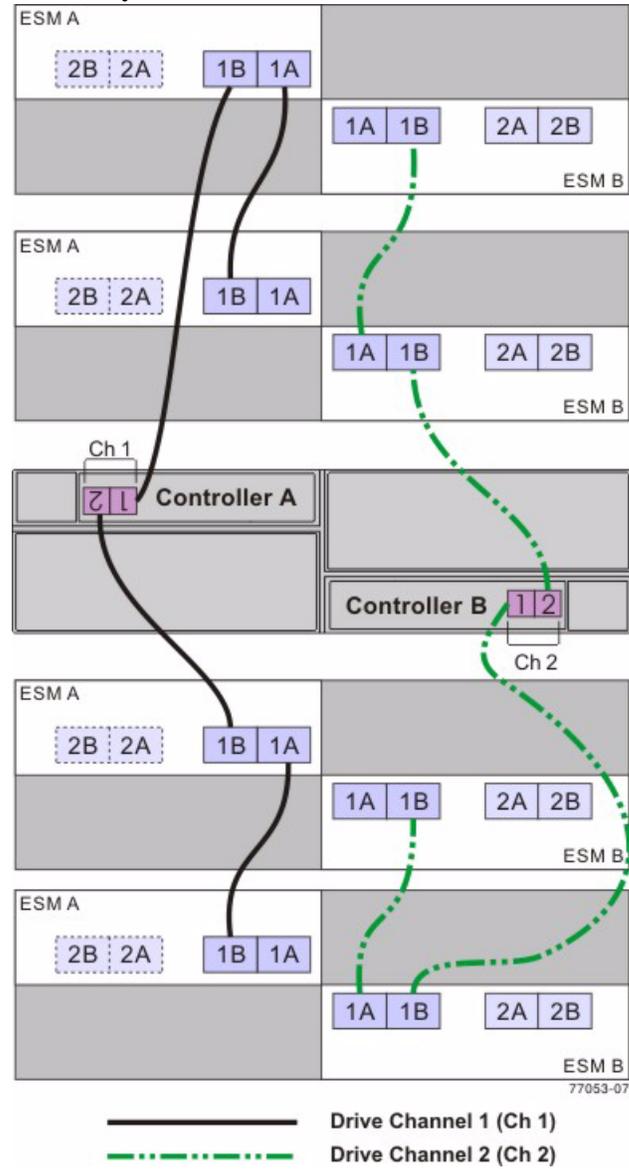
Figure 58 One CE4900 Controller-Drive Tray and Five FC4600 Drive Trays
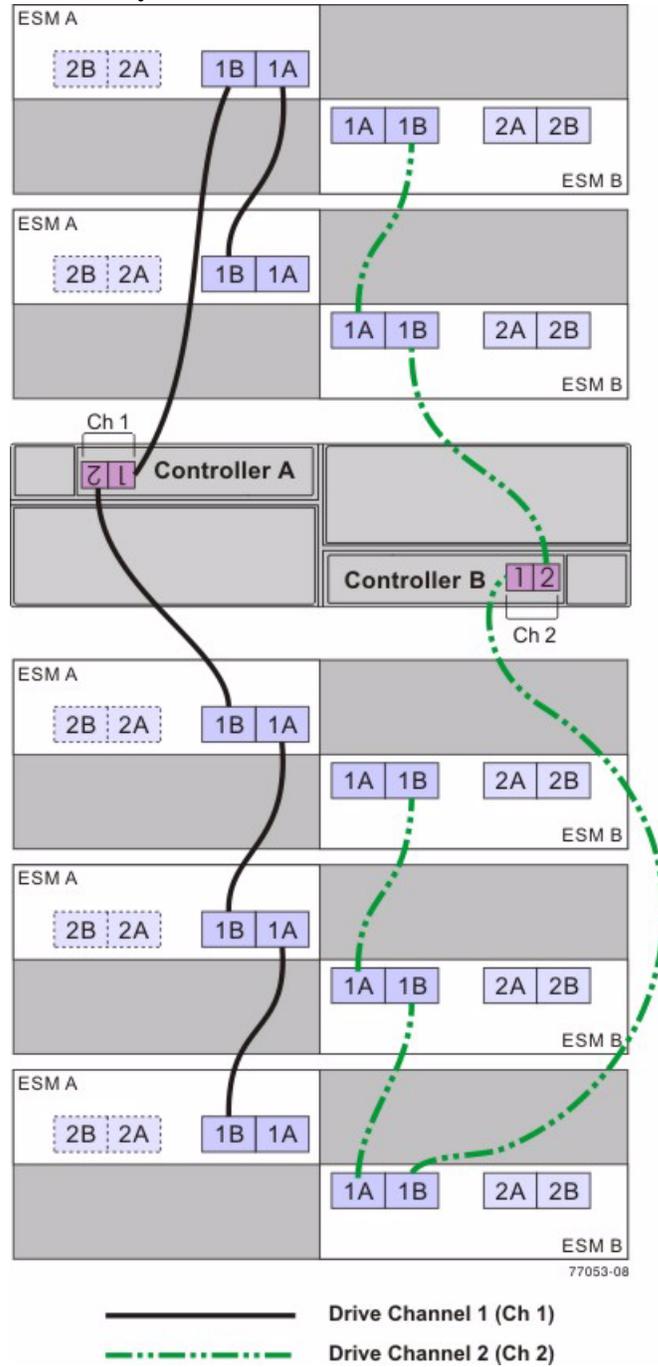
Figure 59 One CE4900 Controller-Drive Tray and Six FC4600 Drive Trays
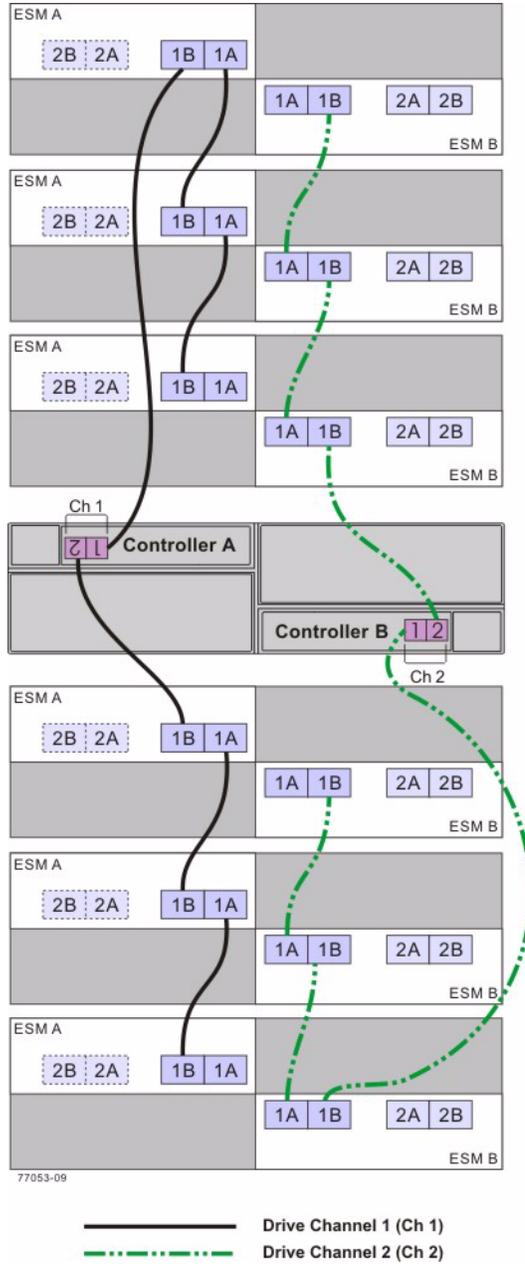
## Drive Cabling Topologies for the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray

This section provides examples of drive cabling topologies that can be used for the CDE3994 controller-drive tray. The controllers on the lower-cost CDE3992 controller-drive tray have two host ports and two drive ports. The controllers on the higher-cost CDE3994 controller-drive tray have four host ports and two drive ports.

Each example provides redundant paths to the drives. If one of these examples is suitable for your hardware and application, complete the cabling connections as described by the tables. However you decide to implement your cabling, follow the recommendations in Best Practices to make sure that data has full availability.

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and One Drive Tray

If you are cabling one CDE3994 controller-drive tray to one drive tray, and that drive tray has inverted ESM canisters, use the cabling topology described in the following table and figure.

**Figure 60 One CDE3994 Controller-Drive Tray and One Drive Tray with Inverted ESMs**
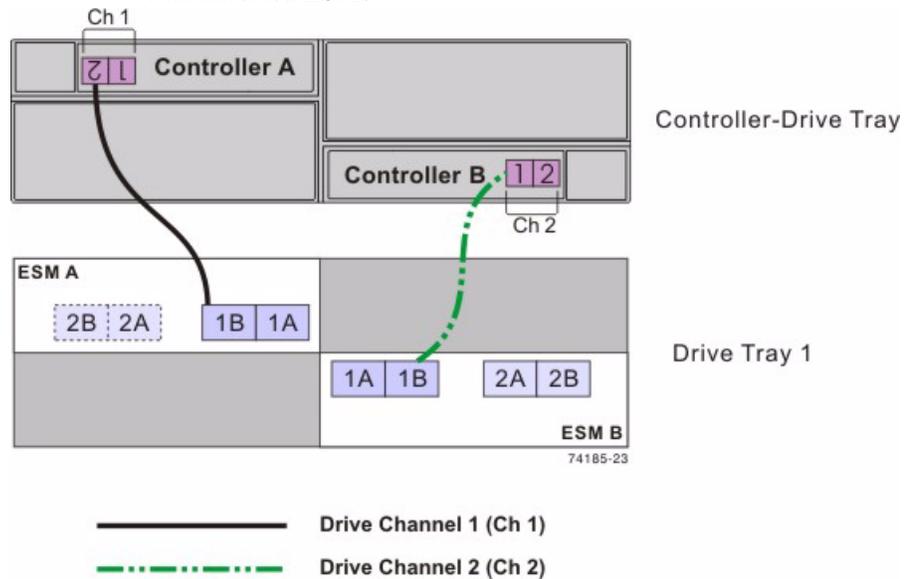
Table 24 One CDE3994 Controller-Drive Tray and One Drive Tray with Inverted ESMs

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	2	Drive tray 1	ESM A, port 1B
2	Controller B	1	Drive tray 1	ESM B, port 1B

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and Two Drive Trays

If you are cabling one CDE3994 controller-drive tray to two drive trays, and those drive trays have inverted ESM canisters, use the cabling topology shown in the following table and figure.

Figure 61 One CDE3994 Controller-Drive Tray and Two Drive Trays with Inverted ESMs
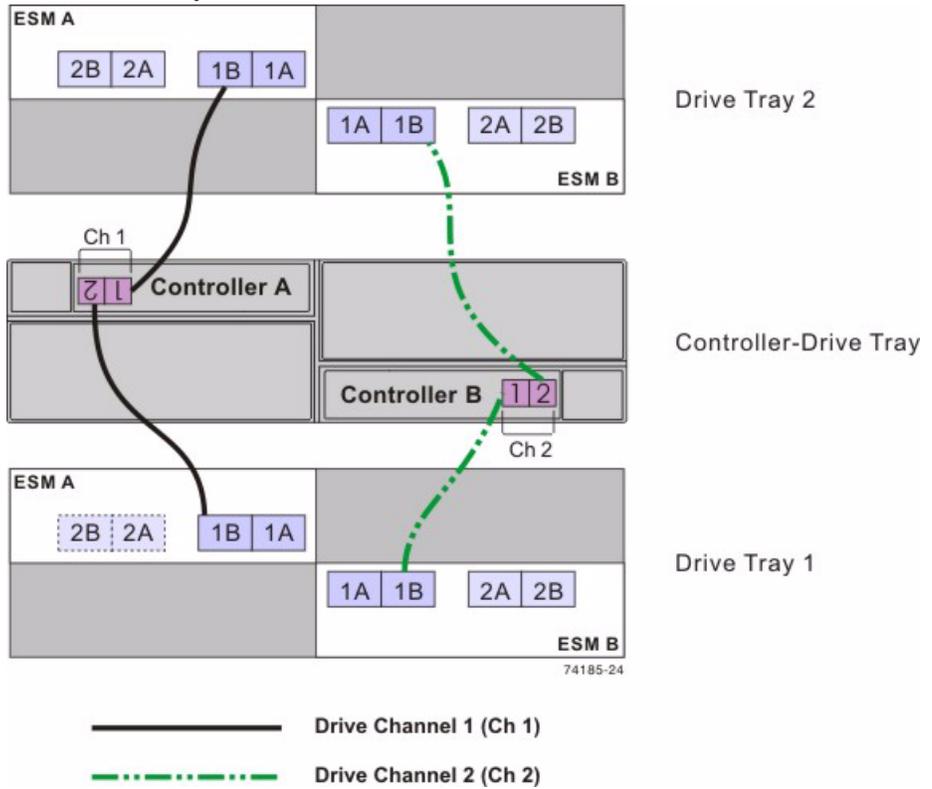
Table 25 One CDE3994 Controller-Drive Tray and Two Drive Trays with Inverted ESMs

Drive Channel	Connection Point		Connection Point	
	Tray or Component	**Port Number and Location**	**Tray or Component**	**Port Number and Location**
1	Controller A	1	Drive tray 2	ESM A, port 1B
	Controller A	2	Drive tray 1	ESM A, port 1B
2	Controller B	1	Drive tray 1	ESM B, port 1B
	Controller B	2	Drive tray 2	ESM B, port 1B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and Three Drive Trays

If you are cabling one CDE3994 controller-drive tray to three drive trays, and those drive trays have inverted ESM canisters, use the cabling topology described in the following table and figure.

Figure 62 One CDE3994 Controller-Drive Tray and Three Drive Trays with Inverted ESMs

Drive Cabling Topologies for the CDE3994 Controller-Drive Tray and the CDE3992 Controller-Drive Tray
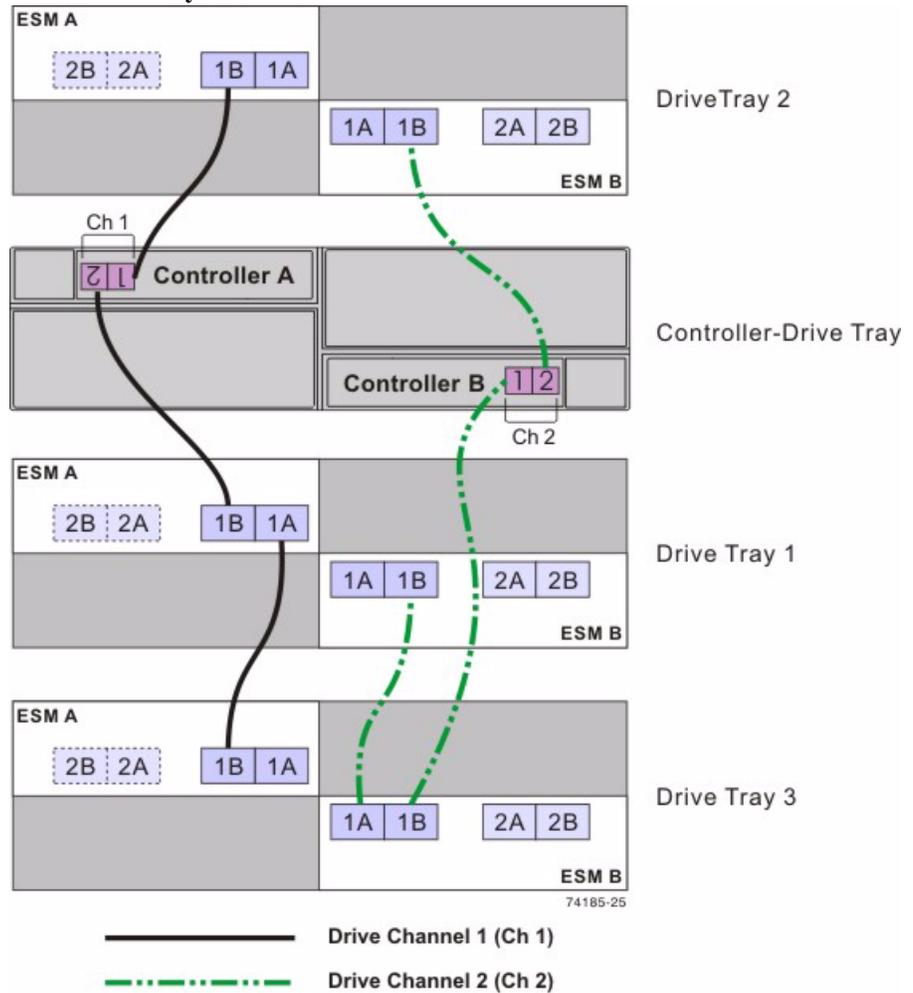
Table 26 One CDE3994 Controller-Drive Tray and Three Drive Trays with Inverted ESMs

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	1	Drive tray 2	ESM A, Port 1B
	Controller A	2	Drive tray 1	ESM A, Port 1B
	Drive tray 1	ESM B, Port 1A	Drive tray 3	ESM A, Port 1B
2	Controller B	1	Drive tray 3	ESM B, Port 1B
	Drive tray 3	ESM B, Port 1A	Drive tray 1	ESM B, Port 1B
	Controller B	2	Drive tray 2	ESM B, Port 1B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and Four Drive Trays

If you are cabling one CDE3994 controller-drive tray to four drive trays, and those drive trays have inverted ESM canisters, use the cabling topology described in the following figure and table.

Figure 63 One CDE3994 Controller-Drive Tray and Four Drive Trays with Inverted ESMs
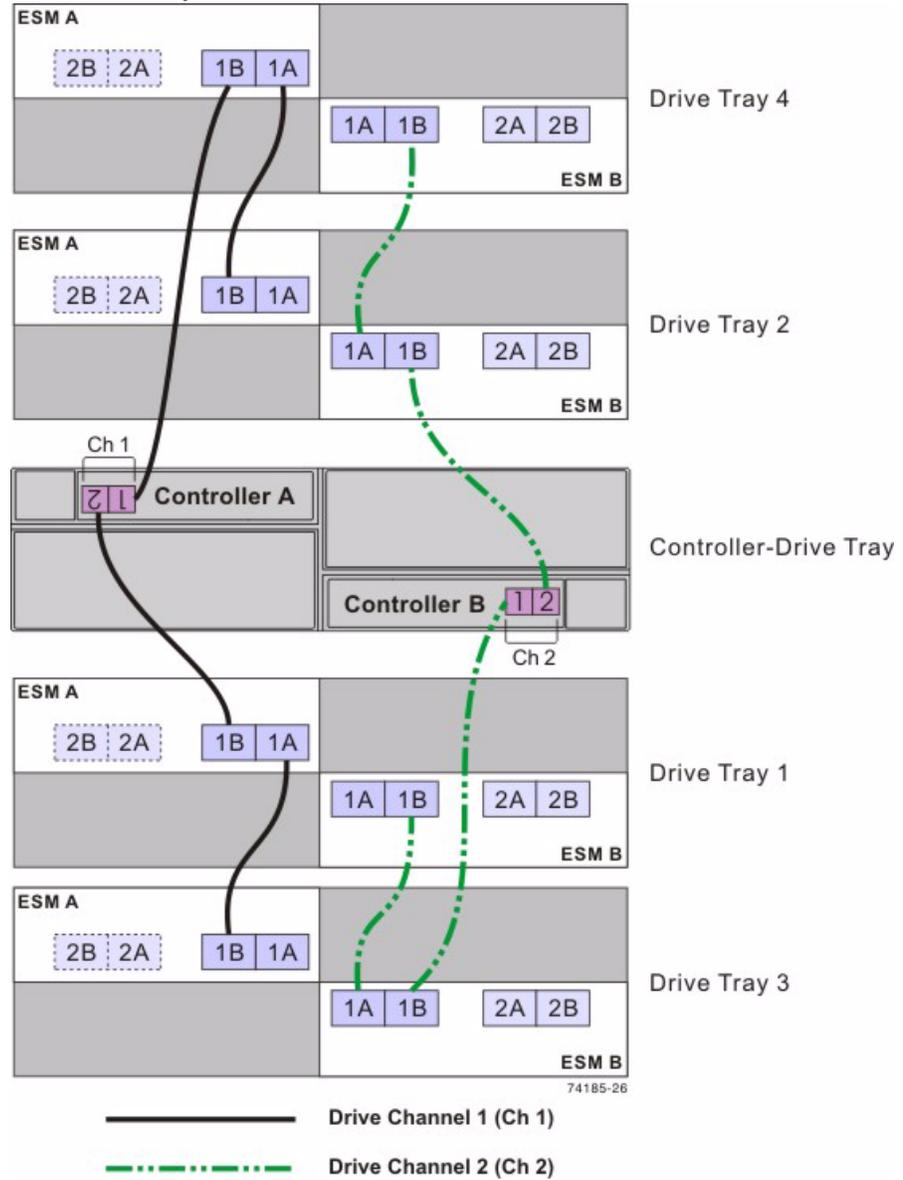
Table 27 One CDE3994 Controller-Drive Tray and Four Drive Trays with Inverted ESMs

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	1	Drive tray 4*	ESM A, port 1B
	Drive tray 4*	ESM A, port 1A	Drive tray 2*	ESM A, port 1B
	Controller A	2	Drive tray 1*	ESM A, port 1B
	Drive tray 1*	ESM A, port 1A	Drive tray 3*	ESM A, port 1B
2	Controller B	1	Drive tray 3*	ESM B, port 1B
	Drive tray 3*	ESM B, port 1A	Drive tray 1*	ESM B, port 1B
	Controller B	2	Drive tray 2*	ESM B, port 1B
	Drive tray 2*	ESM B, port 1A	Drive tray 4*	ESM B, port 1B

*The firmware that controls the controller-drive tray automatically assigns drive tray tray IDs to the FC4600 drive trays that will usually not match the drive tray numbers shown in this table and preceding figure. The cabling is not affected by the assignment of drive tray tray IDs by the firmware.

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and Five Drive Trays

If you are cabling one CDE3994 controller-drive tray to five drive trays, and those drive trays have inverted ESM canisters, use the cabling topology described in the following figure and table.

Figure 64 One CDE3994 Controller-Drive Tray and Five Drive Trays with Inverted ESMs
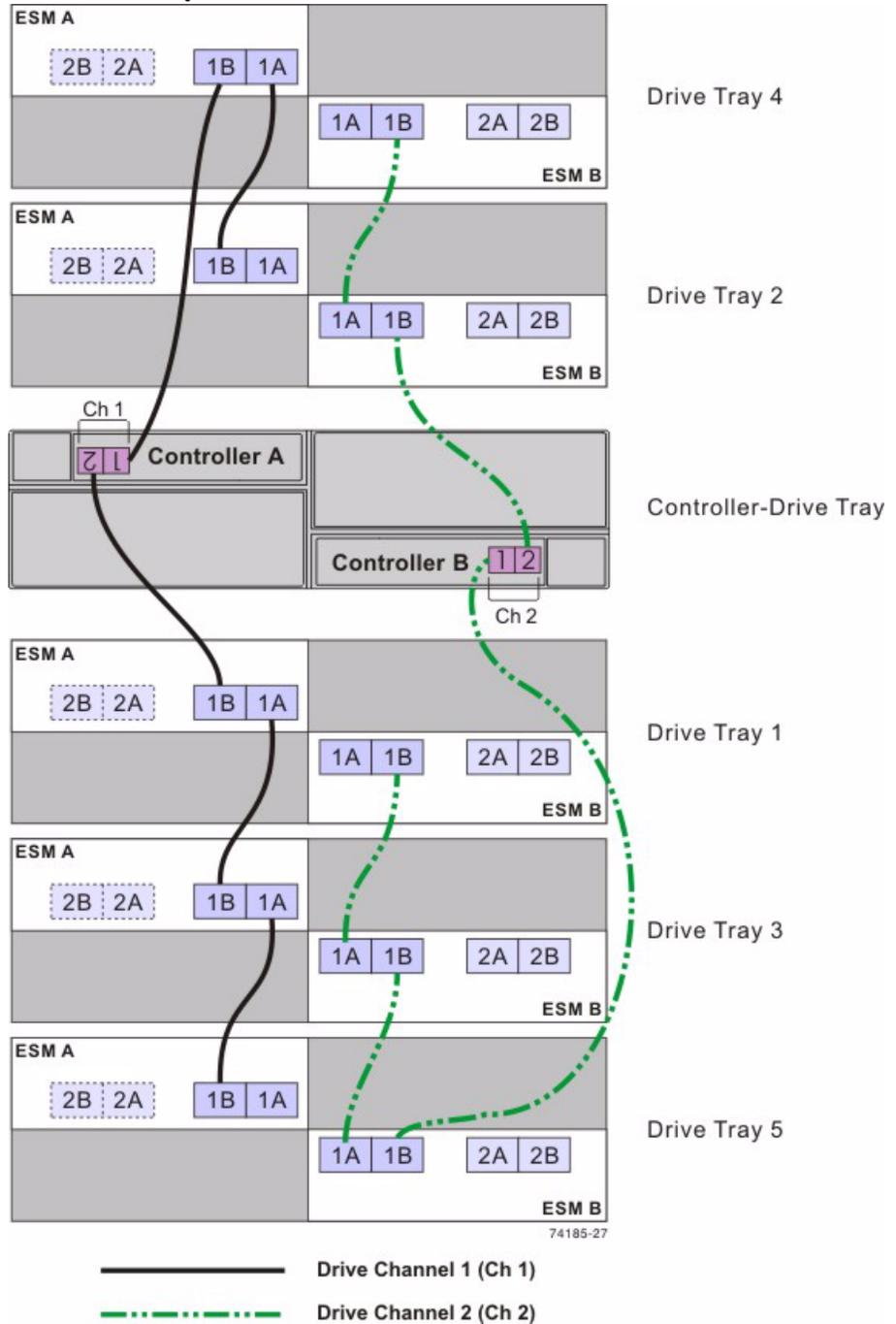
Table 28 One CDE3994 Controller-Drive Tray and Five Drive Trays with Inverted ESMs

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	1	Drive tray 4	ESM A, port 1B
	Drive tray 4	ESM A, port 1A	Drive tray 2	ESM A, port 1B
	Controller A	2	Drive tray 1	ESM A, port 1B
	Drive tray 1	ESM A, port 1A	Drive tray 3	ESM A, port 1B
	Drive tray 3	ESM A, port 1A	Drive tray 5	ESM A, port 1B
2	Controller B	1	Drive tray 5	ESM B, port 1B
	Drive tray 5	ESM B, port 1A	Drive tray 3	ESM B, port 1B
	Drive tray 3	ESM B, port 1A	Drive tray 1	ESM B, port 1B
	Controller B	2	Drive tray 2	ESM B, port 1B
	Drive tray 2	ESM B, port 1A	Drive tray 4	ESM B, port 1B

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and Six Drive Trays

If you are cabling one CDE3994 controller-drive tray to six drive trays, and those drive trays have inverted ESM canisters, use the cabling topology shown in the following table and figure.

NOTE The CDE3994 controller-drive tray supports a maximum of seven drive trays. However, if you are using the FC4600 drive tray in your configuration, plan for a limit of six FC4600 drive trays. Seven FC4600 drive trays exceed the maximum number of drive slots supported on a single drive channel.

Figure 65 One CDE3994 Controller-Drive Tray and Six Drive Trays with Inverted ESMs
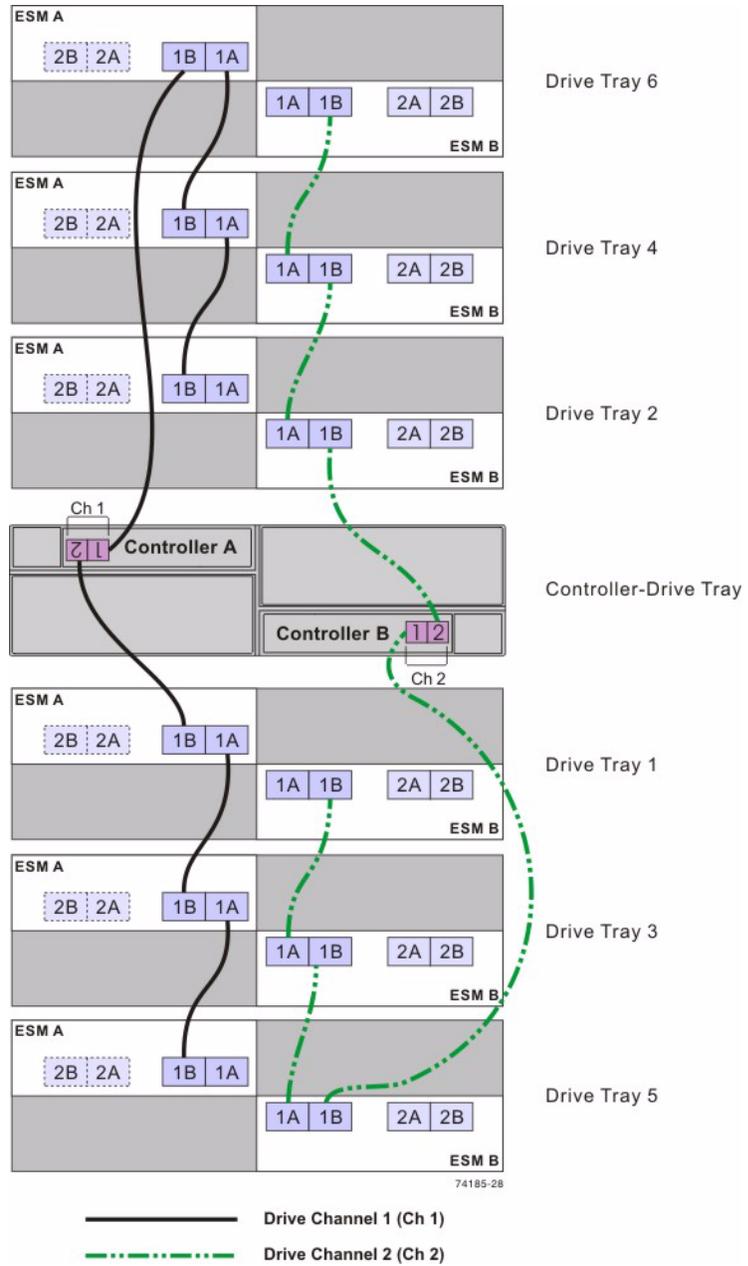
Table 29 One CDE3994 Controller-Drive Tray and Six Drive Trays with Inverted ESMs

Drive Channel	Connection Point		Connection Point	
	Tray or Component	Port Number and Location	Tray or Component	Port Number and Location
1	Controller A	1	Drive tray 6*	ESM A, port 1B
	Drive tray 6*	ESM A, port 1A	Drive tray 4*	ESM A, port 1B
	Drive tray 4*	ESM A, port 1A	Drive tray 2*	ESM A, port 1B
	Controller A	2	Drive tray 1*	ESM A, port 1B
	Drive tray 1*	ESM A, port 1A	Drive tray 3*	ESM A, port 1B
	Drive tray 3*	ESM A, port 1A	Drive tray 5*	ESM A, port 1B
2	Controller B	1	Drive tray 5*	ESM B, port 1B
	Drive tray 5*	ESM B, port 1A	Drive tray 3*	ESM B, port 1B
	Drive tray 3*	ESM B, port 1A	Drive tray 1*	ESM B, port 1B
	Controller B	2	Drive tray 2*	ESM B, port 1B
	Drive tray 2*	ESM B, port 1A	Drive tray 4*	ESM B, port 1B
	Drive tray 4*	ESM B, port 1A	Drive tray 6*	ESM B, port 1B

*The firmware for the controller-drive tray automatically assigns tray IDs to the FC4600 drive trays. Those tray IDs usually will not match the drive tray numbers shown in this table and in the preceding figure. The cabling pattern is not affected by the assignment of drive tray tray IDs by the firmware.

NOTE If you have drive trays with inverted ESM canisters, see ESM Canister Arrangements.

One CDE3994 Controller-Drive Tray or CDE3992 Controller-Drive Tray and Multiple Types of Drive Trays

If you are cabling more than one type of drive tray to the CDE3994 controller-drive tray, be sure to read Cabling for Drive Trays That Support Loop Switch Technology.

Follow these guidelines for cabling multiple types of drive trays to maximize performance and accessibility. (The first device on the drive channel is distinguished by the fact that the left ESM of the first device is cabled directly to controller A of the controller tray or controller-drive tray. Because an optimal redundant cabling topology requires that the redundant drive channel be cabled in the opposite order, this same device will be the last in the drive channel when cabled to controller B.)

The following figure provides an example of how flexible the cabling can be when you use a CDE3994 controller-drive tray as the controller. The firmware is able to detect, and correctly handle, combinations of drive trays with both side-by-side ESMs

and inverted ESMs. This feature allows you to easily add new drive trays to your storage environment, while continuing to take advantage of pre-existing drive trays that you own.

If your storage array includes AT2655 drive trays, it is still advisable to cable the AT2655 drive trays so that they are the last devices on the drive channel (farthest from controller A).

NOTE When you mix different types of drive trays, you must consider the total number of drives that are available in the final configuration of the storage array. For example, if you mix FC4600 drive trays with FC2610 drive trays, the total number of drives might be more than the maximum number that each drive channel can support.

Figure 66 One CDE3994 Controller-Drive Tray and Multiple Types of Drive Trays
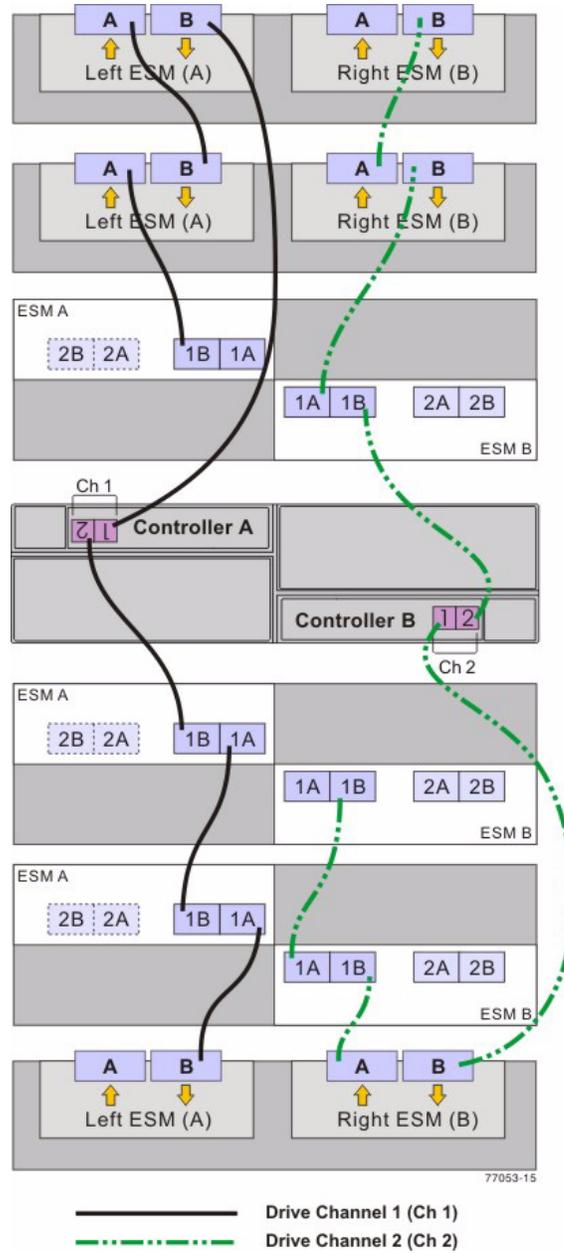
Drive Channel 1 (Ch 1)
Drive Channel 2 (Ch 2)

## Drive Cabling Topologies for the E2600 Controller-Drive Tray

This section provides examples of drive cabling topologies for the E2600 controller-drive tray. The E2600 controller-drive tray can be cabled to DE1600 drive trays, DE5600 drive trays, or combinations of these two drive trays. The total number of drives in the storage array, including the drives in the controller-drive tray and those in the drive trays, must not exceed 192.

NOTE Simplex systems do not provide redundant connections to drive trays. If a connection or an environmental services module (ESM) fails, all drive trays that connect to the controller-drive tray indirectly through the failed connection or drive tray will become inaccessible.

Drive Cabling Topologies for the E2600 Controller-Drive Tray With DE1600 Drive Trays or DE5600 Drive Trays

Depending on the number of drive trays that you need to connect, see the applicable figure for a cabling topology. Each example shows a duplex controller-drive tray configuration with redundant paths to the drive trays. For a simplex controller-drive tray configuration, use the cabling topology shown for controller A in the applicable figure.

NOTE The following figures shows the SAS ports on a DE1600 drive tray or a DE5600 drive tray. You may connect either of the SAS ports labeled SAS 1 and SAS 2 to the SAS expansion port on another drive tray or on a controller-drive tray. You should not make connections to both the SAS 1 port and the SAS 2 port on the same ESM.

**Figure 67 SAS Ports on a DE1600 Drive Tray or a DE5600 Drive Tray**
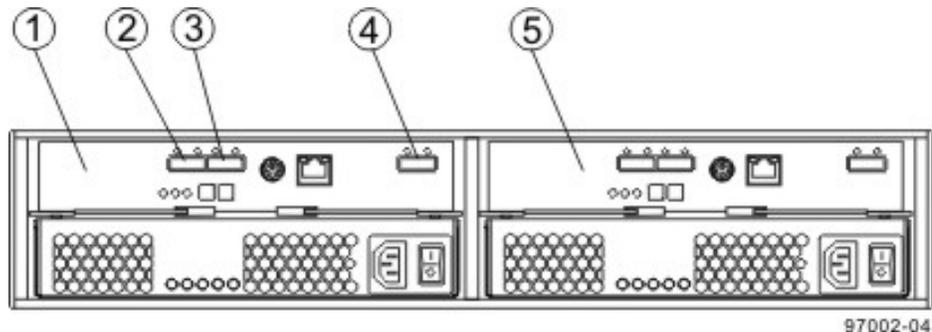
1. ESM A
2. SAS Port 1
3. SAS Port 2
4. SAS Expansion Port
5. ESM B

Figure 68 One E2600 Controller-Drive Tray and One Drive Tray
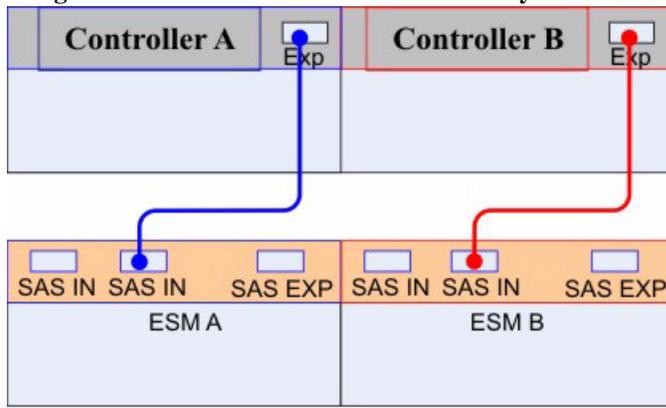
**Figure 69 One E2600 Controller-Drive Tray and Two Drive Trays**
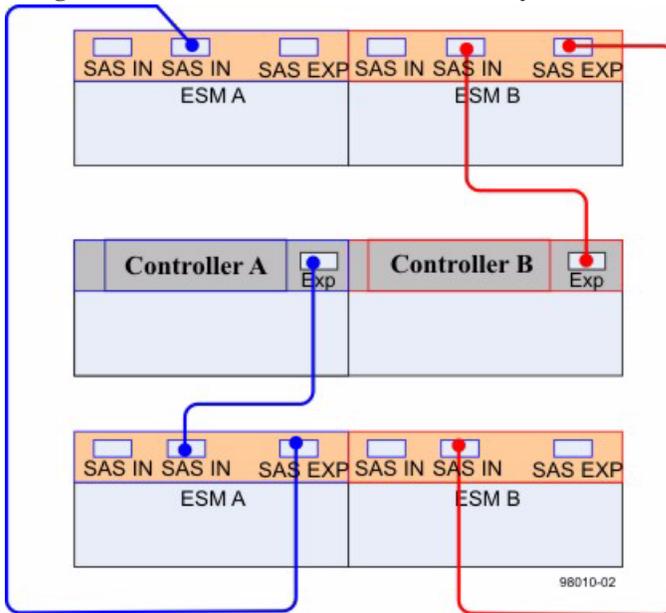
**Figure 70 One E2600 Controller-Drive Tray and Three Drive Trays**
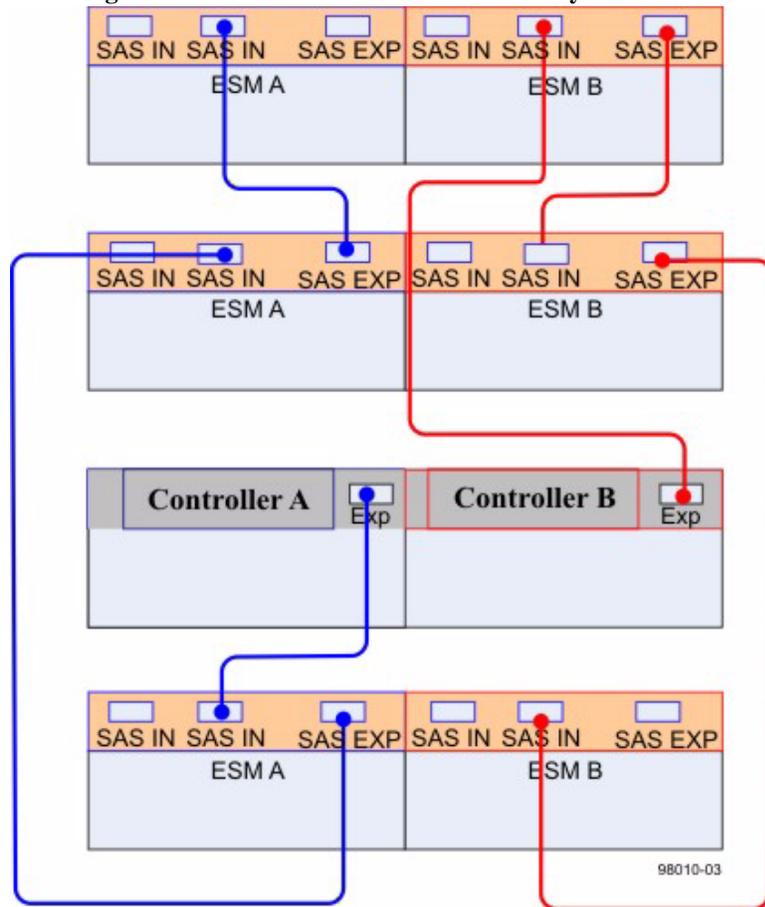
Figure 71 One E2600 Controller-Drive Tray and Eight Drive Trays
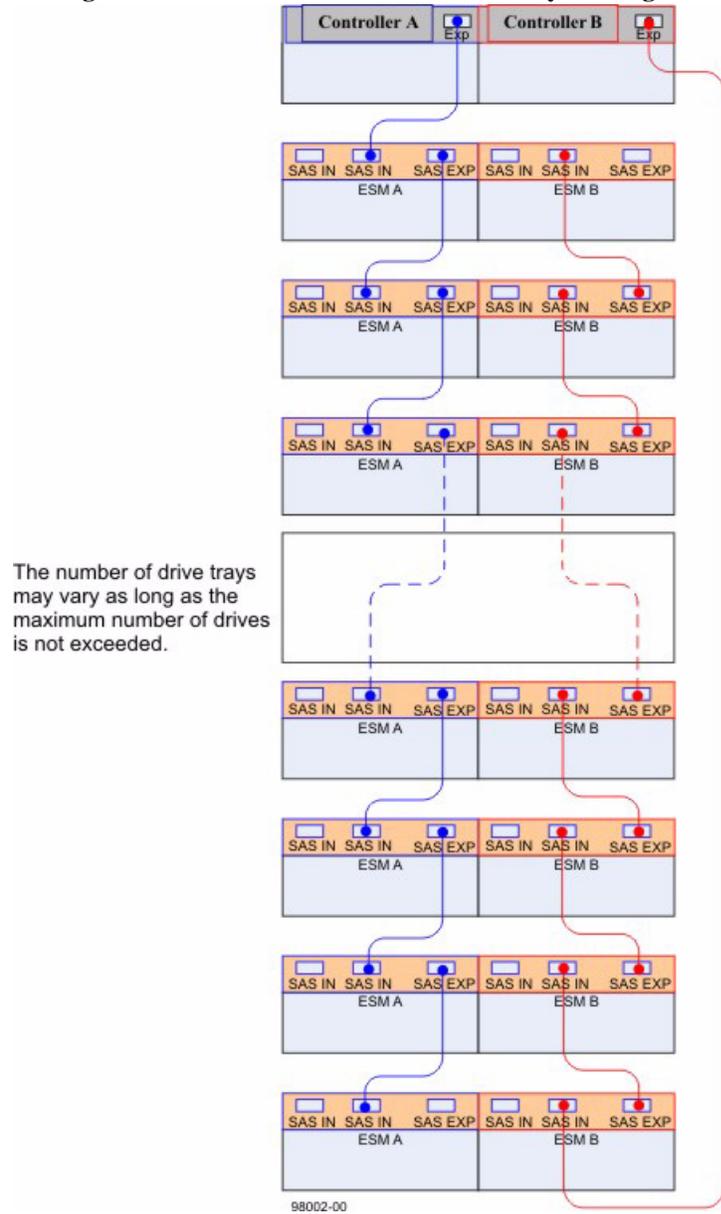
The number of drive trays may vary as long as the maximum number of drives is not exceeded.

98002-00

Drive Cabling Topologies for the E2600 Controller-Drive Tray

Drive Cabling Topologies for the E2660 Controller-Drive Tray

This section provides examples of drive cabling topologies for the E2660 controller-drive tray. The E2660 controller-drive tray can be cabled only to DE6600 drive trays. The total number of drives in the storage array, including the drives in the controller-drive tray and those in the drive trays, must not exceed 192.

NOTE Simplex systems do not provide redundant connections to drive trays. If a connection or an environmental services module (ESM) fails, all drive trays that connect to the controller-drive tray indirectly through the failed connection or drive tray will become inaccessible.

Drive Cabling Topologies for the E2660 Controller-Drive Tray With DE6600 Drive Trays

Depending on the number of drive trays that you need to connect, see the applicable figure for a cabling topology. Each example shows a duplex controller-drive tray configuration with redundant paths to the drive trays. For a simplex controller-drive tray configuration, use the cabling topology shown for controller A in the applicable figure.

WARNING (W15) **Risk of bodily injury** – An empty tray weighs approximately 56.7 kg (125 lb). Three persons are required to safely move an empty tray. If the tray is populated with components, a mechanized lift is required to safely move the tray.

NOTE Install trays beginning from the bottom of the cabinet so that the cabinet does not become top-heavy. A top-heavy cabinet has a greater risk of falling over.

The following figures show the SAS ports on a DE6600 drive tray. You may connect either of the SAS ports labeled SAS 1 and SAS 2 to the SAS expansion port on another drive tray or on a controller-drive tray. Do not make connections to both the SAS 1 port and the SAS 2 port on the same ESM.

Figure 72 SAS Ports on a DE6600 Drive Tray
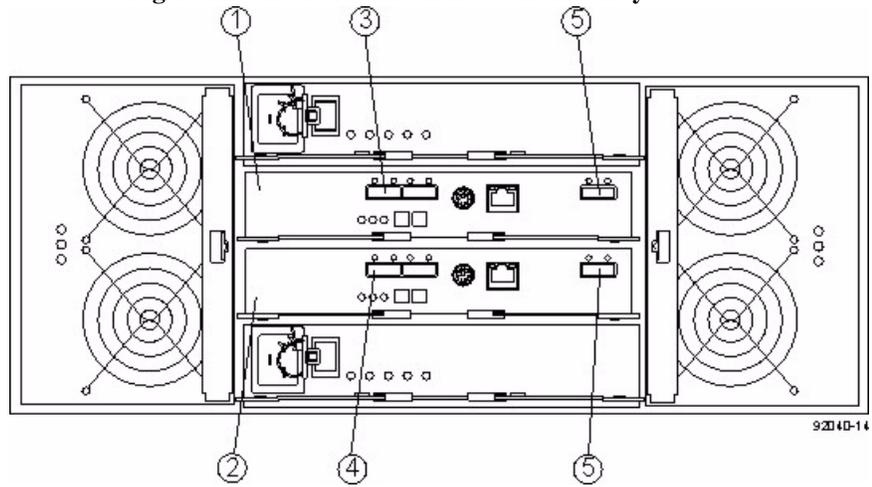
1. ESM A
2. ESM B
3. SAS In Port
4. SAS In Port
5. SAS Expansion Ports

Figure 73 One E2660 Controller-Drive Tray and One Drive Tray
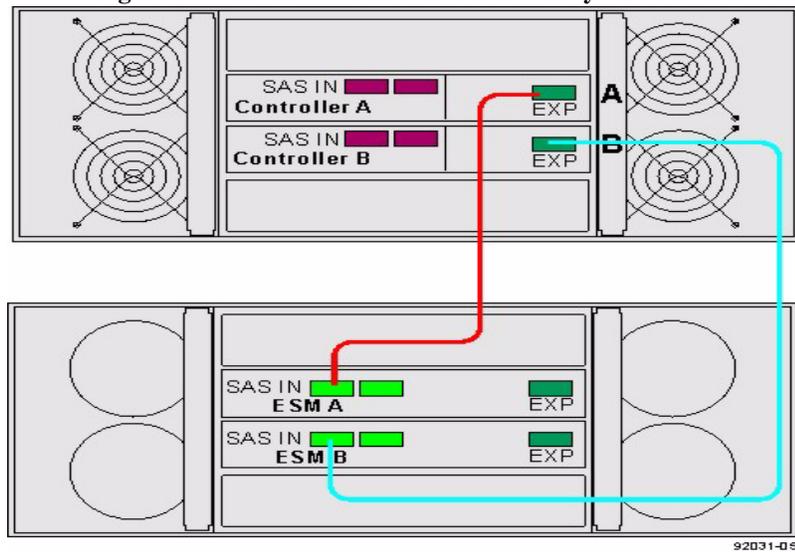
**Figure 74 One E2660 Controller-Drive Tray and Two Drive Trays**

Drive Cabling Topologies for the E2660 Controller-Drive Tray
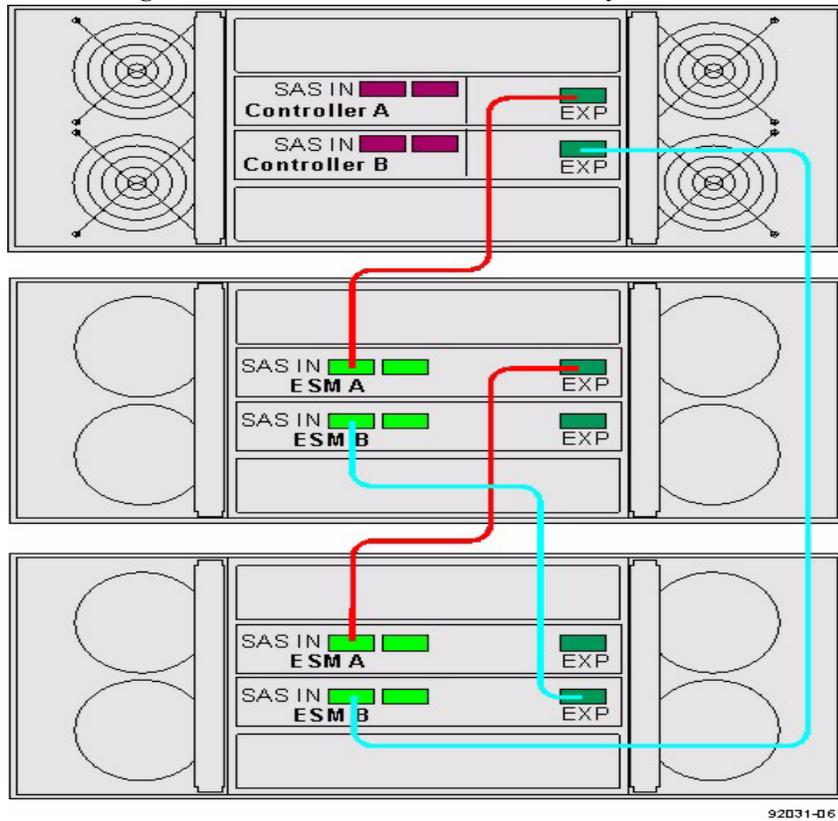
Ethernet Cabling 6

This chapter provides examples of how to connect your storage array to an Ethernet network for out-of-band storage array management. If you plan to use in-band storage array management, Ethernet cabling might not be necessary for management connections.

For illustrations showing the Ethernet port locations on the specific controller tray model or controller-drive tray model that you are installing, see the topics under Component Locations.

ATTENTION Possible loss of data access – If you use out-of-band management, connect the Ethernet ports on the controller tray or the controller-drive tray to a private network segment behind a firewall. If the Ethernet connection is not protected by a firewall, your storage array might be at risk of being accessed from outside of your network.

Direct Out-of-Band Ethernet Topology

The following figure shows storage array management connections from the controller tray or controller-drive tray to the Ethernet. In this topology, you must install a network interface card (NIC) in the storage management station in which the client software resides. For dual controllers, you must install two NICs in the storage management station.

NOTE For more information about NICs, see Network Interface Cards .

Figure 1 Network Out-of-Band Ethernet Topology
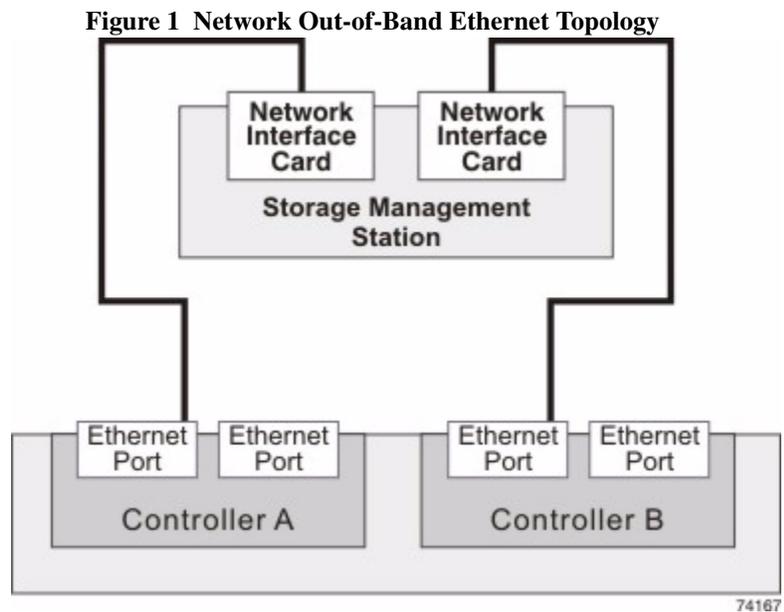
NOTE In limited situations where the storage management station is connected directly to the controller tray or the controller-drive tray, you must use an Ethernet crossover cable to connect the storage management station to the Ethernet port. An Ethernet crossover cable is a special cable that reverses the pin contacts between the two ends of the cable.

Fabric Out-of-Band Ethernet Topology

The following figure shows two storage array management connections from the controller tray or the controller-drive tray to two ports on an Ethernet switch. In this topology, you must install a NIC in the storage management station where the client software resides. You must use Ethernet cables for all storage array management connections.

Figure 2 Fabric Redundant Out-of-Band Ethernet Topology
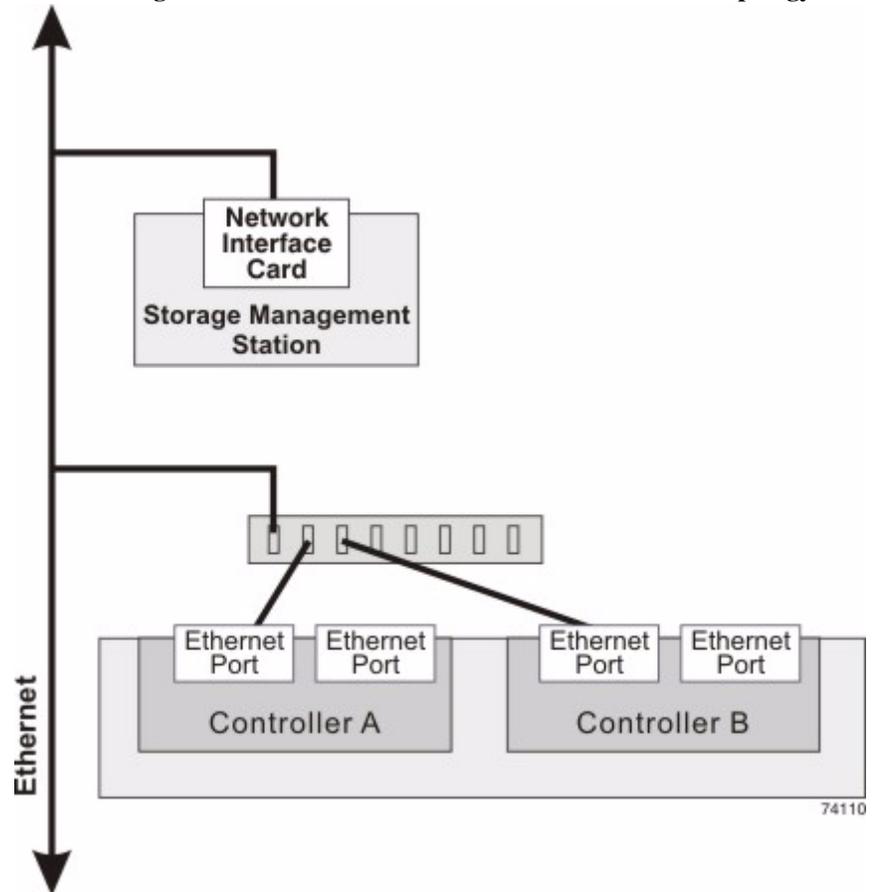
For more information, see In-Band Management and Out-of-Band Management

NOTE If you have two available Ethernet ports on each controller, reserve one port on each controller for access to the storage array by your Technical Support Representative.

Adding a Drive Tray to an Existing System 7

This chapter provides information about adding a drive tray to an existing system.

Getting Ready

If you need to add another drive tray to an existing storage array, contact your Technical Support Representative before proceeding. Your Technical Support Representative might direct you to complete preparatory tasks before installing and cabling the new drive tray. Some of these tasks might include:

- Creating, saving, and printing a storage array profile for all of the storage arrays that will be affected by the upgrade
- Performing a complete backup of all of the drives in the storage array
- Making sure that the volume groups and associated volumes on the storage array have an Optimal status

ATTENTION Possible loss of data access – Contact your Technical Support Representative if you plan to add a drive tray to an existing storage array under either of the following conditions: The power is not turned off to the controller tray or the controller-drive tray or data transfer continues to the storage array.

HotScale Technology

HotScale™ technology lets you configure, reconfigure, add, or relocate storage array capacity without interrupting user access to data.

Port bypass technology automatically opens ports and closes ports when drive trays are added to or removed from your storage array. Fibre Channel loops stay intact so that system integrity is maintained throughout the process of adding and reconfiguring your storage array.

For more information about using the HotScale technology, contact your Technical Support Representative.

Adding Redundant Drive Channels

If you are working with a storage array that has redundant drive channels, it is easy to add drive trays. Make sure that you always maintain communication between a functioning controller and the existing drive trays by only interrupting the continuity of a single drive channel at any one point in time. This precaution avoids interruption of data availability.

Your Technical Support Representative can provide assistance in maintaining access to data during the upgrade of your storage array.

Adding One Non-Redundant Drive Channel

If you are working with a storage array that has only one drive channel, add the drive tray to the end of the series of drive trays in the storage array. You do so while power is still applied to the other drive trays.

ATTENTION Risk of equipment damage – If your FC4600 drive tray, DE1600 drive tray, or DE5600 drive tray uses the optional DC power connection, a different procedure exists for turning on and turning off the power to a DC-powered drive tray. Refer to the *Storage Array Installation* guide PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's website.

---

1. Add the new drive tray to the end of the series of existing drive trays.
2. Install the additional cable.
3. Turn on the power to the new drive tray.

Hardware Installation for Synchronous Mirroring and Asynchronous Mirroring

A

This appendix provides information about these topics:

- Site preparation
- Hardware requirements
- Cabling

The Asynchronous Mirroring (AM) premium feature uses a remote point-in-time replication method. AM differs from Synchronous Mirroring (SM) in one essential way: it captures the state of the source volume at a particular point in time and includes just the data that has changed since the last image capture. With AM, the remote storage array is not fully synchronized with the local storage array, so if the operation needs to transition to the remote storage array due to a loss of the local storage array, some transactions could be lost.

The Synchronous Mirroring premium feature is also used for online, real-time data replication between storage arrays over a remote distance. The storage array controllers manage the mirror operation. You create one or more mirrored pairs consisting of a primary volume at the local site and a secondary volume at a secondary, remote site. However, instead of batching the synchronization process using point-in-time snapshot images like in AM, the primary volume copies all of the data from the primary volume to the secondary volume in a single operation. This full synchronization process takes longer to complete, but creates a complete copy of the mirrored data. While this process is ideal for certain operations, make sure you fully understand both data mirror options before selecting one over the other.

Refer to the online help system for background information on the Synchronous Mirroring (SM) premium feature and the Asynchronous Mirroring (AM) premium feature, and for software-related procedures to set the configuration of these features and use them.

Planning and Site Preparation

The Asynchronous Mirroring premium feature can be used with either Fibre Channel or iSCSI host connections. Asynchronous Mirroring requires a duplex controller configuration. The Synchronous Mirroring premium feature can be used only with Fibre Channel connections. For Fibre Channel connections, you *must* have Fibre Channel switches to create a fabric environment for data replication. For iSCSI connections, switches are optional. The following restrictions apply to connections for Asynchronous Mirroring or Synchronous Mirroring.

- SAS and InfiniBand connections are not supported.
- Fibre Channel Arbitrated Loop (FC-AL), or point-to-point configurations are not supported.

- iSCSI connections must use a host-connect port and not the management Ethernet port.

With the Asynchronous Mirroring premium feature, the following considerations apply for combining Fibre Channel and iSCSI connections:

- If two storage arrays are connected through both Fibre Channel and iSCSI connections, only one connection type is used for a given asynchronous mirror group. However, if there are multiple asynchronous mirror groups, some asynchronous mirror group can use Fibre Channel connections while others use iSCSI connections.

- Failover from a Fibre Channel connection to an iSCSI connection (or vice versa) is not supported.

Switches require only minimal additional site preparation beyond basic storage array operation. For additional site preparation considerations for switches, including power requirements and physical dimensions, refer to the documentation that is provided by the switch manufacturer.

iSCSI Connections for Asynchronous Mirroring

You can use iSCSI connections for the Asynchronous Mirroring premium feature. Connect one iSCSI port on each controller of the local (primary) storage array to the corresponding controller on the remote (secondary) storage array. You can make connect ions through a switched fabric or directly between controllers. During asynchronous mirror group creation, the source storage array attempts to connect to the target storage array. The source storage array scans the IPv4 iSCSI ports in order until it finds a connection. If the source storage array fails to find an IPv4 connection, it repeats the process using IPv6.

NOTE To improve performance, connect the lowest numbered iSCSI port on each controller of the local storage array to the corresponding controller on the remote storage array. This reduces delay in asynchronous mirror group creation.

NOTE Make sure that Internet Control Message Protocol (ICMP) response is enabled on storage arrays used with the Asynchronous Mirroring premium feature. Refer to the SANtricity ES online help topic "Set Storage Array ICMP Response."

Fibre Channel Configurations Overview

Because of possible restrictions at the host level, the supported Synchronous Mirroring and Asynchronous Mirroring configurations contain Fibre Channel switches. These Fibre Channel switches are zoned so that a single host adapter can access only one controller per storage array. Additionally, all configurations use a separate zone for the ports that are reserved for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

> **NOTE** Do not zone the uplink port (E_port) that connects (cascades) switches within a fabric.

Switch zoning configurations are typically set up by using the switch management software that is provided by the manufacturer of the Fibre Channel switch. This software should have been included with the materials that are provided when the switch was purchased.

When two or more Fibre Channel switches are cascaded together, the switch management software combines the ports for all of the switches that are linked. For example, if two 16-port Fibre Channel switches are cascaded with a physical connection using a Fibre Channel cable, the switch management software shows ports 0 through 31 participating in the fabric rather than two switches each with ports 0 through 15. Therefore, a zone that is created containing any of these ports can exist on multiple cascaded switches.

The following figure shows both cascaded and non-cascaded switches. The top-half of the figure shows a set of cascaded switches that are on the same network. Therefore, Zone 1 is the same zone on Switch 1A as Zone 1 is on Switch 1B. In a single-mode Fibre Channel environment, the two switches are connected by a single port on each switch that is designated as an E_port, which is not in a zone.

The set of switches in the bottom half of the following figure is on the same network but is not cascaded. Although both sets contain a Zone 1 (shown as Zone A in Switch 2), these zones are independent of each other.

Figure 1 Switch Zoning in Cascaded and non-Cascaded Fibre Channel Switches
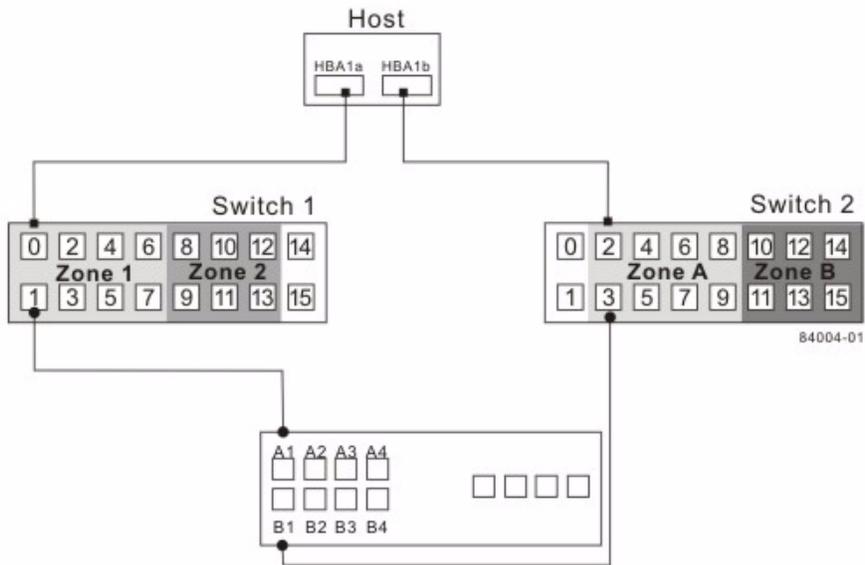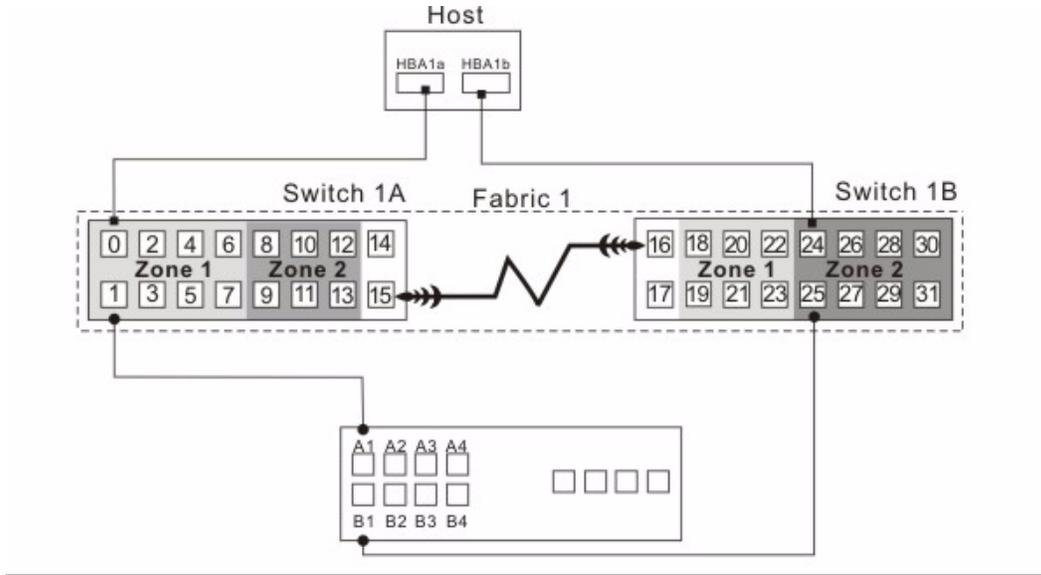
For more information about Fibre Channel switch zoning or setting up a zone configuration, refer to the manufacturer's documentation that is provided with the switch.

Because of the varying Synchronous Mirroring configurations, the switch zone settings are presented preceding each configuration in this appendix.

Select one of the following configuration options to connect and configure one or more storage arrays for use with the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

Table 1 Fibre Channel Configuration Options for Synchronous Mirroring or Asynchronous Mirroring

Configuration	Description
Highest availability campus configuration (recommended)	This configuration has the greatest redundancy. It is the most stable of the three configurations. ■ Two Fibre Channel switches (for a total of four) at both the primary site and the secondary site provide for complete failover and redundancy in the Fibre Channel switches and fabrics, in addition to all storage array components and hosts. ■ A single point of failure does not exist in this configuration, and it is the recommended configuration. See Highest Availability Campus Configuration – Recommended on page 192.
Campus configuration	The campus configuration is a lower-cost configuration than the highest availability campus configuration. Only one Fibre Channel switch at the primary site and one at the secondary site exist, for a total of two switches. This configuration essentially allows the minimum required components to successfully operate between two sites. ■ The number of Fibre Channel switches is reduced from four to two and the number of fabrics from two to one. ■ This configuration is redundant for host bus adapters, controllers, and Synchronous Mirroring ports, but it has a single point of failure for switches and fabric. ■ A switch failure does not usually result in a loss of data, but it does affect data synchronization until the error is corrected. Therefore, the highest availability campus configuration is the recommended configuration, because data synchronization can continue for any single switch failure. See Campus Configuration on page 188.

Configuration	Description
Intra-site configuration	The intra-site configuration is the lowest-cost configuration of all three configurations. It is used in environments where a long-distance fabric is not required because of the close proximity of the hosts and storage arrays. ■ Because the intra-site configuration only has two switches, it is similar to the campus configuration. However, multiple-switch fabrics do not exist in this configuration. ■ The configuration is redundant for host bus adapters, controllers, Synchronous Mirroring ports, and switches but is a single point of failure for the site because all of the equipment can be destroyed by the same disaster. ■ The highest availability campus configuration is the recommended configuration, because it is fully redundant, which makes disaster recovery easier. See Intra-Site Configuration204.

Highest Availability Campus Configuration – Recommended

NOTE The highest availability campus configuration is the recommended Fibre Channel configuration for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

This configuration has two Fibre Channel switches at the primary site and two Fibre Channel switches at the secondary site (four switches total), which provide for complete failover and redundancy. Failures could involve Fibre Channel switches, Fibre Channel cables, and any host or storage array. Two Fibre Channel switches at each site also provide redundancy to the local site in addition to a fully redundant remote configuration. No single point of failure exists in the hardware components.

The following figure shows the highest availability campus configuration. The controller trays are shown schematically with four host ports on each of two controllers in each controller tray. In this configuration, use the A4 connection and the B4 connection for remote mirroring traffic instead of the A2 connection and the B2 connection. You can use controller ports A2, A3, B2, and B3 for additional host access if needed.

Figure 2 Highest Availability Campus Configuration
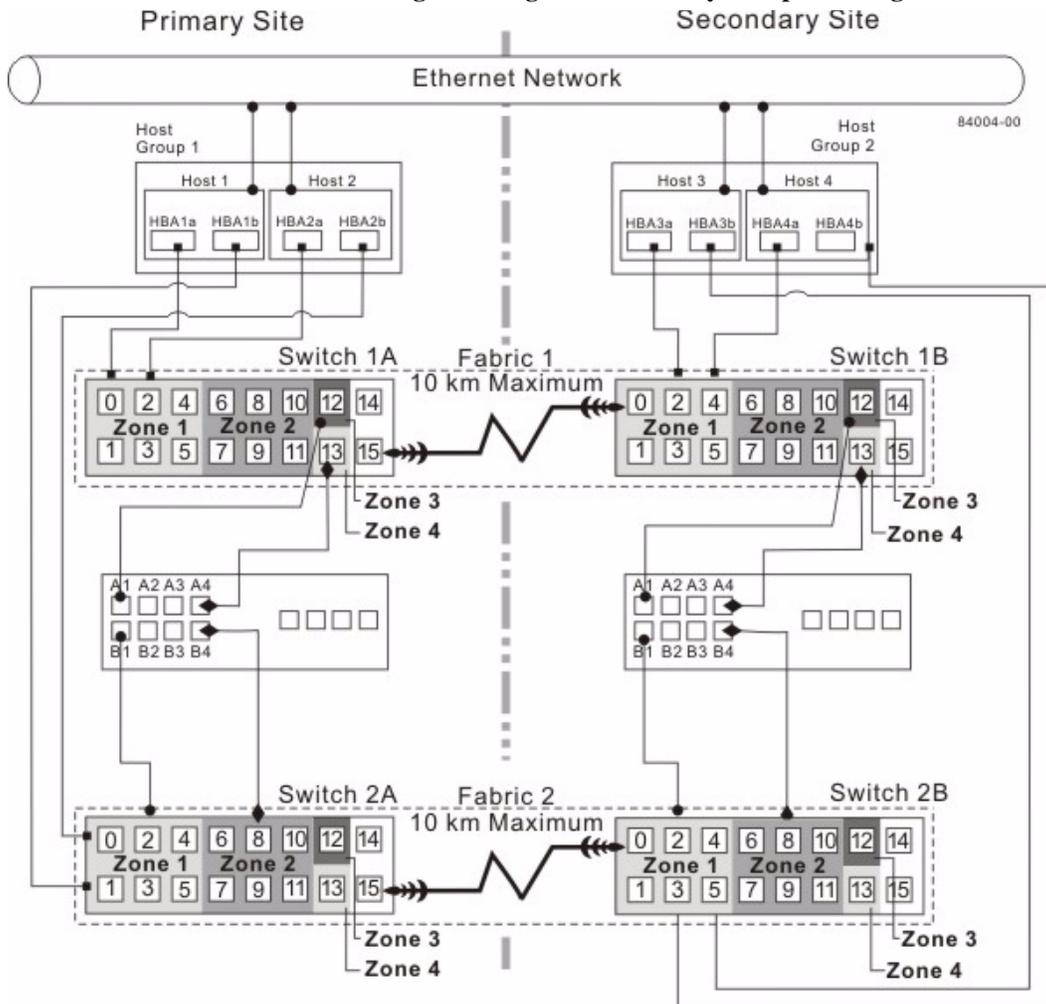
1. Host Fibre Channel Cable
2. Storage Array Fibre Channel Cable
3. Fibre Channel Cable Dedicated for mirroring
4. Fabric Uplink Cable

Switch Zoning for Highest Availability Campus Configuration

The highest availability campus configuration provides a separate zone for each reserved port for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

The switches do not need to be zoned exactly as presented in this configuration. However, you must meet the following requirements when zoning switches for the highest availability campus configuration.

There are a total of four zones in this configuration.

- Zone 1 and zone 3 are on fabric 1 (switch 1A at the primary site, and switch 1B at the secondary site).
- Zone 2 and zone 4 are on fabric 2 (switch 2A at the primary site, and switch 2B at the secondary site).

Configure the zones on the switch so that there is one port per zone for a storage array connection and one port per zone for each host. Switches are zoned so that a single host bus adapter port can access only one controller per storage array.

Switches are zoned so that a single host bus adapter port can access only one controller for each storage array.

NOTE Do not zone the uplink ports (E_ports) on any of the Fibre Channel switches.

The following figure shows how the four switches are zoned for the highest availability campus configuration.

The switches have 16 ports each, which leaves unused ports on each switch when following the preceding requirements. The remaining ports can be distributed among the other zones. It is recommended, however, that most of the remaining ports be assigned to the zones containing the host connections: zone 1 and zone 2. This port assignment allows easy setup for additional hosts to connect to the environment.

Figure 3 Switch Zoning for the Highest Availability Campus Configuration
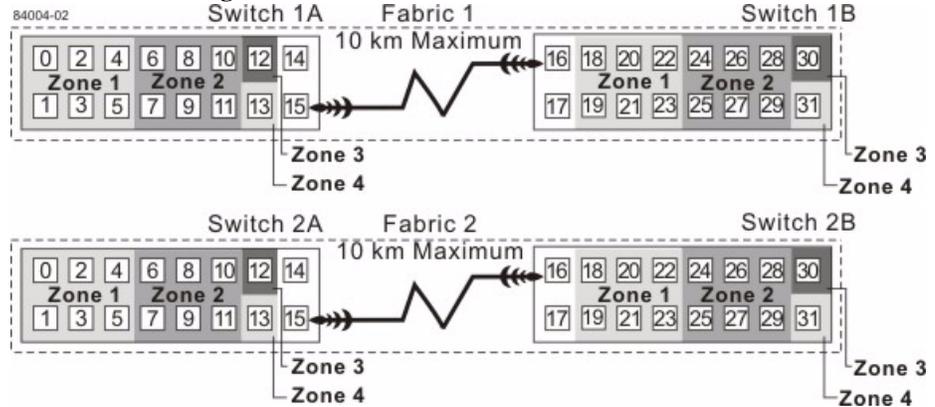
Before you proceed, review the requirements listed in this section and the zoning shown in the figure to make sure that all four switches are correctly zoned. For more information, see the Fibre Channel Configurations Overview.

Cabling for the Highest Availability Campus Configuration

NOTE Start the installation at the primary site. Repeat these steps for the secondary site when instructed to do so.

After the four Fibre Channel switches are correctly zoned, complete this procedure to set up the highest availability campus configuration for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

NOTE Complete all connections by using Fibre Channel cables of the correct length.

1. Are you adding equipment to an existing storage array environment?
    — **Yes** – Stop I/O activity from all hosts before proceeding. Go to step 2.
    — **No** – The storage array installation is new. Go to step 3.

ATTENTION Possible hardware damage – DC-powered controller-drive trays and drive trays have special power procedures that you *must* follow beyond the procedures for AC-powered trays. To get specific power-off and power-on procedures, refer to the corresponding PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's web site.

2. Turn off the power to all storage arrays, hosts, Fibre Channel switches, and any other equipment in the storage array environment.
3. Make sure that cabling between all of the controller trays or controller-drive trays and the drive trays is complete.

4. Connect the primary host bus adapter for each local host to an available port in zone 1 of switch 1.

   The following figure shows the cabling that is described in step 4 and step 5.

Figure 4 Host Bus Adapter Connections to Fibre Channel Switches

5. Connect the secondary host bus adapter for each host at this site to an available port in zone 1 of switch 2.
6. Connect controller port A1 of the storage array to an available port in zone 1 of switch 1.

   The figure following step 9 shows the cabling for CE6998 controller trays.
7. Connect controller port B1 of the storage array to an available port in zone 1 of switch 2.

8. Connect controller port A2 of the storage array to an available port in zone 2 of switch 1. In a four-host-port system, connect controller port A4 to an available port in zone 2 of switch 1.

9. Connect controller port B2 of the storage array to an available port in zone 2 of switch 2. In a four-host-port system, connect controller port B4 to an available port in zone 2 of switch 2.

Figure 5 Storage Array Connections to Fibre Channel Switches in the CE6998 Controller Tray
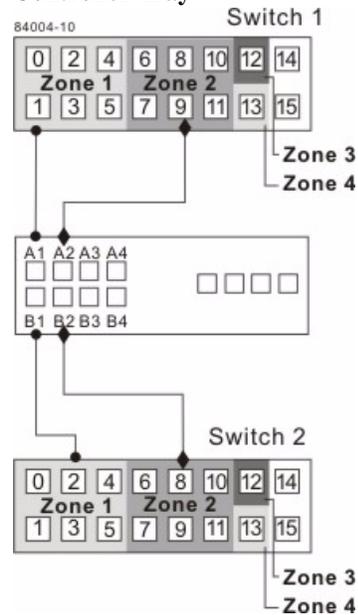

NOTE Controller port A2 and controller port B2 are reserved for mirror relationship synchronization upon activation of the Synchronous Mirroring premium feature. In a four-host-port system, controller port A4 and controller port B4 are reserved.

---

10. The primary site cabling is now complete. Is the secondary site cabling complete?

    — **No** – Repeat step 1 through step 9 for the secondary site.

    — **Yes** – Go to step 11.

11. Complete the fabric environment for switch 1 by connecting switch 1A to switch 1B.

The following figure shows the cabling that is described in step 11 and step 12.

Figure 6 Connecting Remote Switches to Complete Fabric Environments
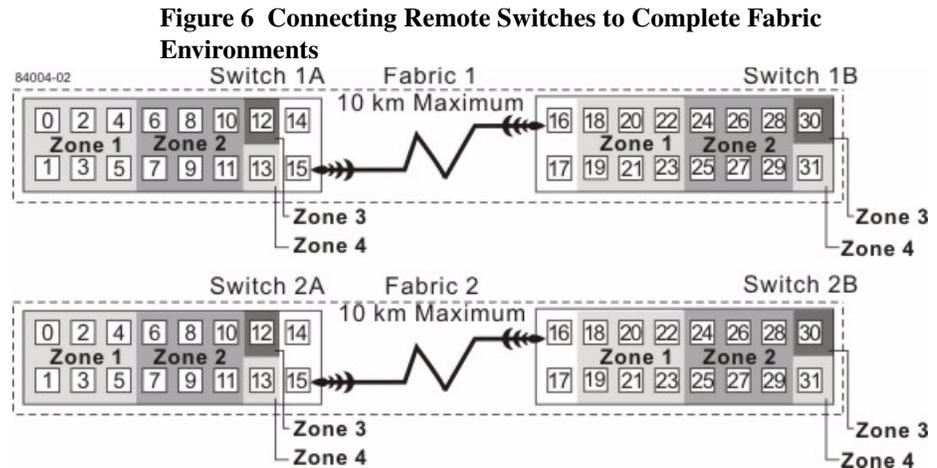
12. Repeat step 11 for switch 2A and switch 2B to complete the fabric environment for switch 2.

13. Cabling for the highest availability campus configuration is complete. Repeat step 4 through step 10 for other storage arrays that exist in the same cabinet that use the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

ATTENTION Possible hardware damage – DC-powered controller-drive trays and drive trays have special power procedures that you *must* follow beyond the procedures for AC-powered trays. To get specific power-off and power-on procedures, refer to *Storage Array Installation Guide* PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's website.

---

14. Turn on the power to all of the storage array hosts, Fibre Channel switches, and any other hardware at both sites where the power was turned off.

The hardware installation is complete. To configure the storage management software to support mirror relationships, refer to the online help topics.

Campus Configuration

The campus configuration offers the same functionality as the highest availability campus configuration, but the campus configuration contains only one switch at each site, rather than two. The configuration is still redundant for host bus adapters, controllers, and remote mirroring ports, but the configuration has a single point of failure for switches. If a switch at either site fails, the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature cannot operate. For this reason, the highest availability campus configuration is highly recommended for total environment redundancy.

The following figure shows a complete campus configuration. The controller trays are shown schematically with four host ports on each of two controllers in each controller tray.

**Figure 7 Campus Configuration**

1. Host Fibre Channel Cable
2. Storage Array Fibre Channel Cable
3. Fibre Channel Cable Dedicated for Mirroring
4. Fabric Uplink Cable
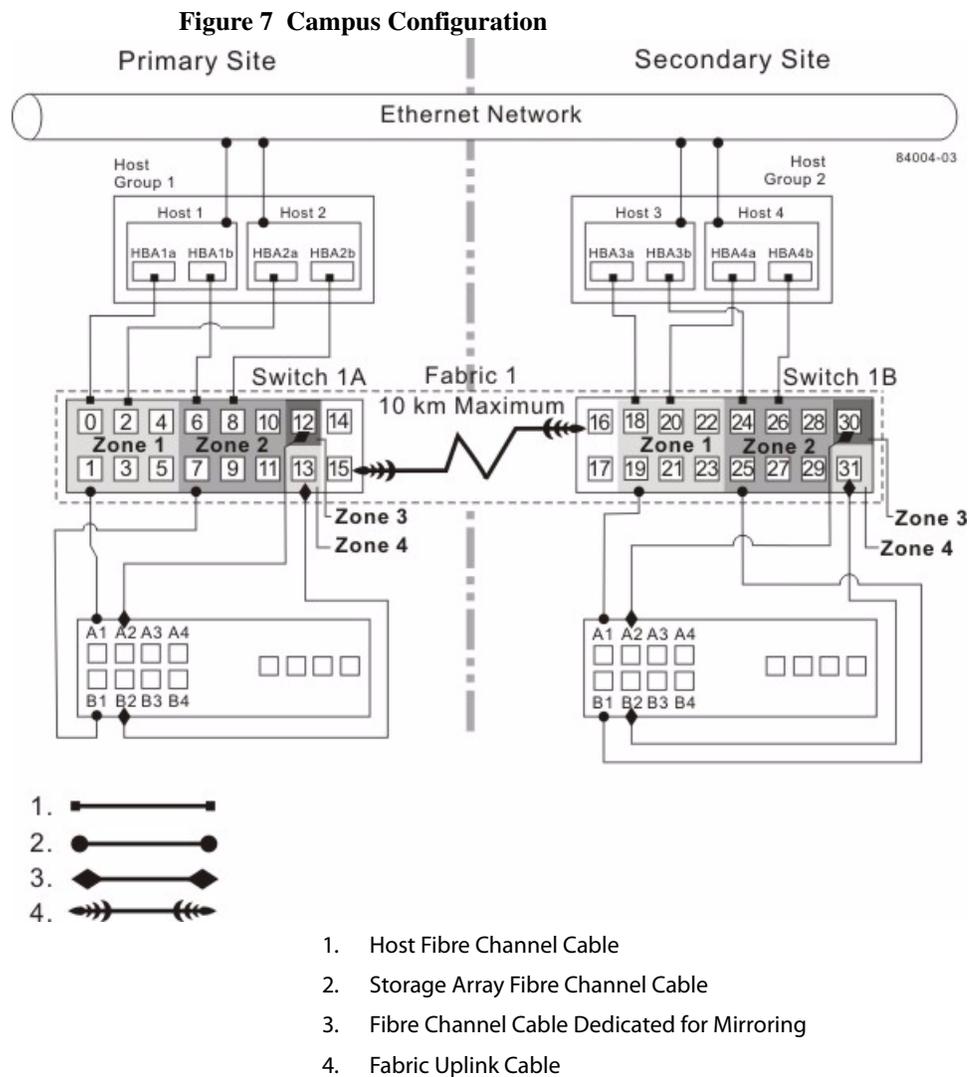
Switch Zoning for the Campus Configuration

The campus configuration allows for a separate zone for each reserved port for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

The switches do not need to be zoned exactly as presented in this configuration. However, you must meet the following requirements when you zone switches for the campus configuration.

NOTE Do not zone the uplink ports (E_ports) on any of the Fibre Channel switches.

You must have a total of four zones in this configuration.

- All zones exist on fabric 1 (switch 1A at the primary site, and switch 1B at the secondary site).
- Zone 3 and zone 4 are reserved for the dedicated Synchronous Mirroring premium feature connections.

You must configure the zones on the switches so that there is one port per zone for a storage array connection and one port per zone for each host.

You must zone the switches so that a single host adapter can access only one controller per storage array.

The switches in the following figure contain 16 ports each, which leaves many unused ports per switch. The remaining ports can be distributed among the other zones. However, it is recommended that most remaining ports be assigned to the zones that contain the host connections (zone 1). This setup allows connections for additional hosts.

The following figure shows how the two switches are zoned for the campus configuration.

Figure 8 Switch Zoning for the Campus Configuration
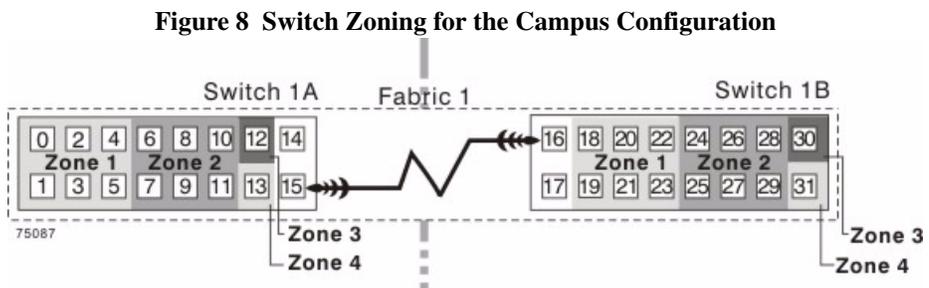
Review the requirements in this section and the zoning example in the figure above to make sure that both switches are correctly zoned before proceeding. For more information, see Fibre Channel Configurations Overview.

Cabling for the Campus Configuration

NOTE Start the installation at the primary site. Repeat these steps for the secondary site when instructed to do so.

After both Fibre Channel switches are correctly zoned, complete this procedure to set up the campus configuration for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

NOTE Complete all connections by using Fibre Channel cables of the correct length.

1. Are you adding equipment for mirroring to an existing storage array environment?

    — **Yes** – Stop I/O activity from all hosts before proceeding. Go to step 2.

    — **No** – This is a new storage array installation. Go to step 3.

ATTENTION Possible hardware damage – DC-powered controller-drive trays and drive trays have special power procedures that you *must* follow beyond the procedures for AC-powered trays. To get specific power-off and power-on procedures, refer to *Storage Array Installation Guide* PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's website.

2. Turn off the power to all storage arrays, hosts, Fibre Channel switches, and any other equipment in the storage array environment.

3. Make sure that basic cabling between all of the controller trays or controller-drive trays and the drive trays on both storage arrays is complete.

NOTE Depending on which site is being configured, switch 1 represents switch 1A for the primary site and switch 1B for the secondary site.

NOTE You can connect the cables to any port in the correct zone of the switch.

4. Connect the primary host bus adapter for each host at this site to an available port in zone 1 of switch 1A.

    The following figure shows the cabling that is described in step 4 and step 5.

5. Connect the secondary host bus adapter for each host at this site to an available port in zone 2 of switch 1A.

Figure 9 Host Bus Adapter Connections to Fibre Channel Switches
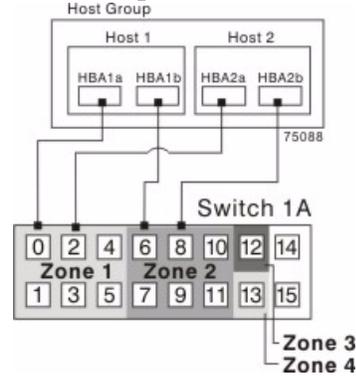
6. Connect controller port A1 of the storage array to an available port in zone 1 of switch 1A.

    The first figure following step 9 shows the storage array connected to Fibre Channel switches that is described in step 6 through step 9. The second figure following step 9 shows the cabling configuration schematically with four host ports on each of two controllers in each controller tray.

7. Connect controller port B1 of the storage array to an available port in zone 2 of switch 1A.

8. Connect controller port A2 of the storage array to an available port in zone 3 of switch 1A. In a four-host-port system, connect controller port A4.

9. Connect controller port B2 of the storage array to an available port in zone 4 of switch 1A. In a four-host-port system, connect controller port B4.

NOTE Controller ports A2 and B2 are reserved for mirror relationship synchronization upon activation of the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature. In a four-host-port system, controller port A4 and controller port B4 are reserved.

**Figure 10 Storage Array Connections to Fibre Channel Switches**
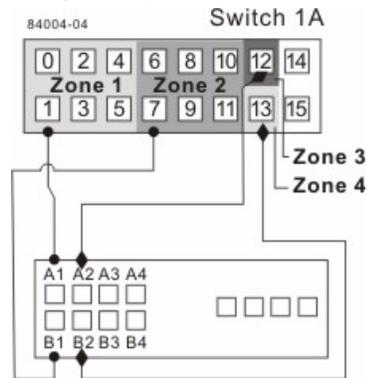
Figure 11 Storage Array Connections to Fibre Channel Switches
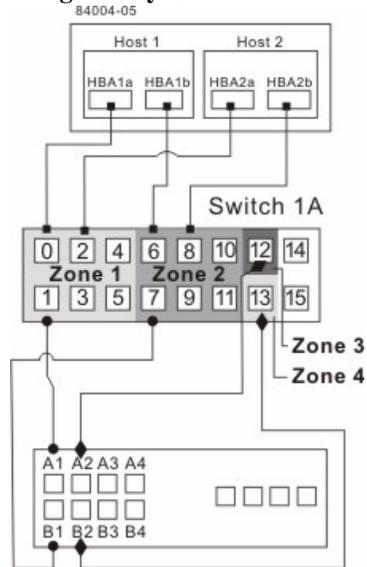
10. The primary site cabling is now complete. Is the secondary site cabling complete?

   — **No** – Repeat step 1 through step 9 for the secondary site.

   — **Yes** – Go to step 11.

11. Complete fabric 1 by connecting switch 1A to switch 1B.

The following figure shows the cabling that is described in this step.

Figure 12 Connecting Remote Switches to Complete the Fabric Environment
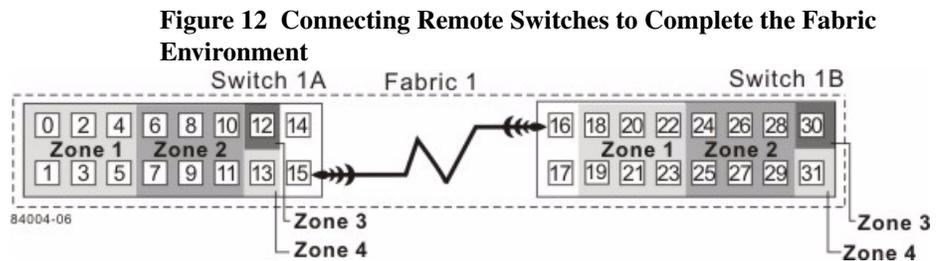
12. Cabling for the campus configuration is complete. Repeat step 4 through step 10 for any additional storage arrays that exist in the same cabinet that will use the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

ATTENTION Possible hardware damage – DC-powered controller-drive trays and drive trays have special power procedures that you *must* follow beyond the procedures for AC-powered trays. To get specific power-off and power-on procedures, refer to *Storage Array Installation Guide* PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's website.

---

13. Turn on the power to all storage arrays, hosts, Fibre Channel switches, and any other hardware at both sites where the power was turned off.

14. Hardware installation is complete. Refer to the online help topics for procedures to configure the storage management software to support mirror relationships.

Intra-Site Configuration

The intra-site configuration is used in environments where a long-distance fabric is not required because of the close proximity of the hosts and storage arrays. The configuration is still redundant for host bus adapters, controllers, remote mirroring ports, and switches, but the configuration is a single point of failure for the site because all of the equipment can be destroyed by the same disaster. For this reason, the highest availability campus configuration is highly recommended for total environment redundancy.

The following figure shows a complete installation of the intra-site configuration.

NOTE A switch failure in this configuration does not affect data access; however, as a result, an Unsynchronized state might occur for all of the mirror relationships on both the primary storage arrays and the secondary storage arrays.

**Figure 13 Intra-Site Configuration Following a Complete Installation**

1.   Host Fibre Channel Cable
2.   Storage Array Fibre Channel Cable
3.   Fibre Channel Cable Dedicated for mirroring
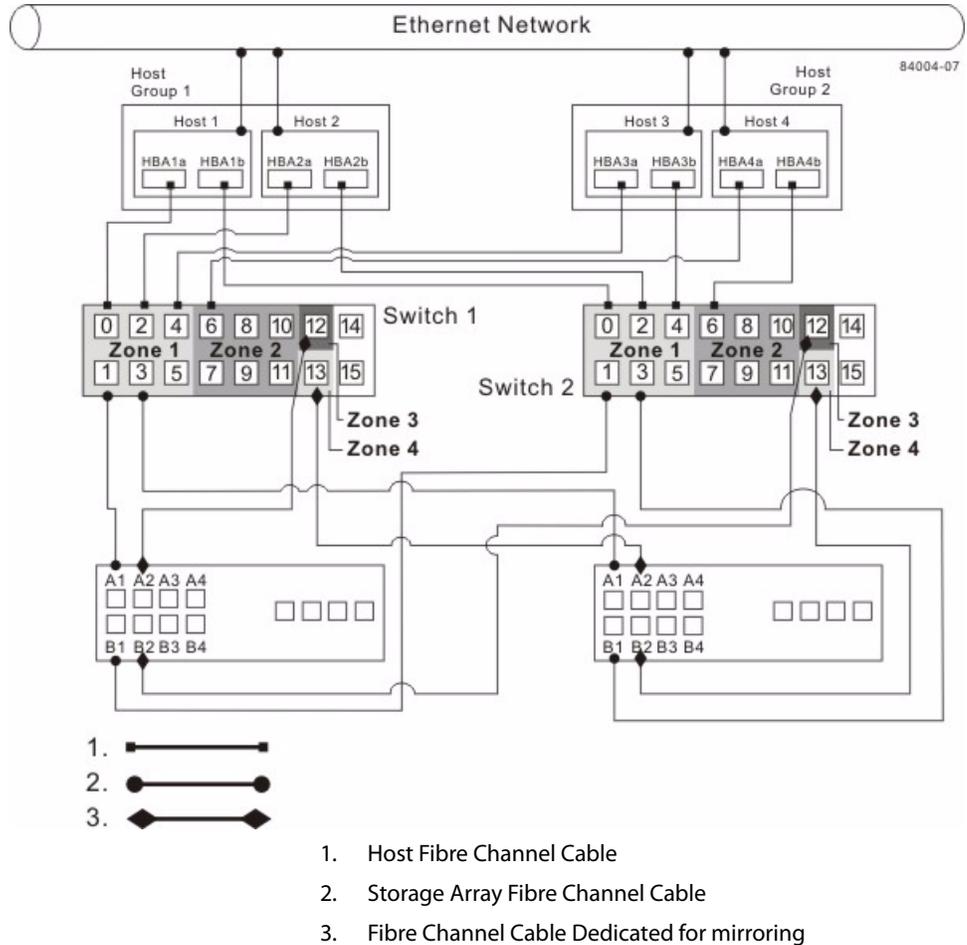
Switch Zoning for the Intra-Site Configuration

The intra-site configuration provides switch redundancy, but the switches are not cascaded and are independent of each other.

NOTE The switches do not need to be zoned exactly as presented in this configuration. However, you must meet the following requirements when zoning switches for the intra-site configuration.

You must have a total of four zones on each controller in this configuration.

You must configure the zones on the switch so that there is one port per zone for a storage array connection and one port per zone for each host.

You must zone the switches so that a single host adapter can only access one controller per storage array.

The switches in the following figure contain 16 ports each, which leaves many unused ports per switch. The remaining ports can be distributed among the other zones. However, it is recommended that most of the remaining ports be assigned to the zones that contain the host connections: zone 1 and zone 2. This assignment allows for easy setup for connecting additional hosts.

For simplicity, in this example, the switches use one-half of the ports for each zone, although zone 3 and zone 4 require fewer ports.

Figure 14 Switch Zoning for the Intra-Site Configuration

Before proceeding, review the requirements in this section and the zoning example in the figures to make sure that both switches are correctly zoned. For more information, see Fibre Channel Configurations Overview.

Cabling for the Intra-Site Configuration

After both Fibre Channel switches are correctly zoned, complete this procedure to set up the intra-site configuration for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

NOTE Complete all connections by using Fibre Channel cables of the correct length.

---

1. Are you adding equipment for the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature to an existing storage array environment?

    — **Yes** – Stop I/O activity from all hosts before proceeding. Go to step 2.

    — **No** – This is a new storage array installation. Go to step 3.

ATTENTION Possible hardware damage – DC-powered controller-drive trays and drive trays have special power procedures that you *must* follow beyond the procedures for AC-powered trays. To get specific power-off and power-on procedures, refer to *Storage Array Installation Guide* PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's website.

---

2. Turn off the power to all storage arrays, hosts, Fibre Channel switches, and any other equipment in the storage array environment.

3. Make sure that basic cabling between all of the controller trays or controller-drive trays and the drive trays is complete on both storage arrays as described in this document.

4. Connect the primary host bus adapter for each host to an available port in zone 1 of switch 1.

The following figure shows the cabling that is described in step 4.

NOTE You can connect the cables to any port in the correct zone of the switch.


Figure 15 Primary Host Bus Adapter Connections to Fibre Channel Switches

5. Connect the secondary host bus adapter for each host to an available port in zone 1 of switch 2.

The following figure shows the cabling that is described in this step.

Figure 16 Secondary Host Bus Adapter Connections to Fibre Channel Switches
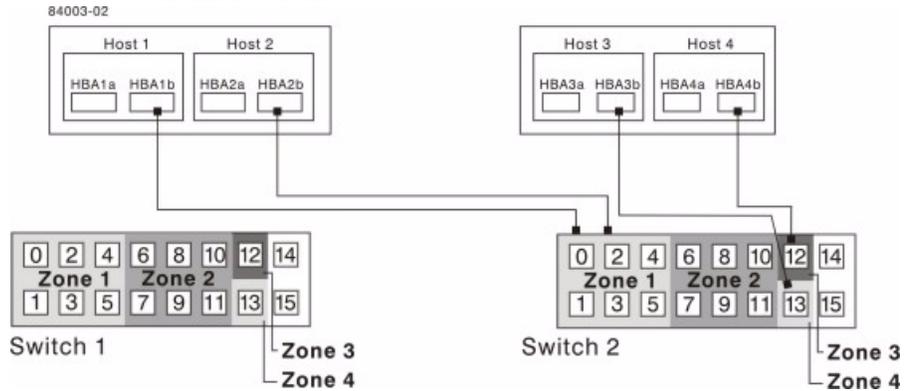
6. Connect controller port A1 of the primary storage array to an available port in zone 1 of switch 1.

   The following figure shows the cabling that is described in step 6 through step 9.

Figure 17 Primary Storage Array Connections to Fibre Channel Switches
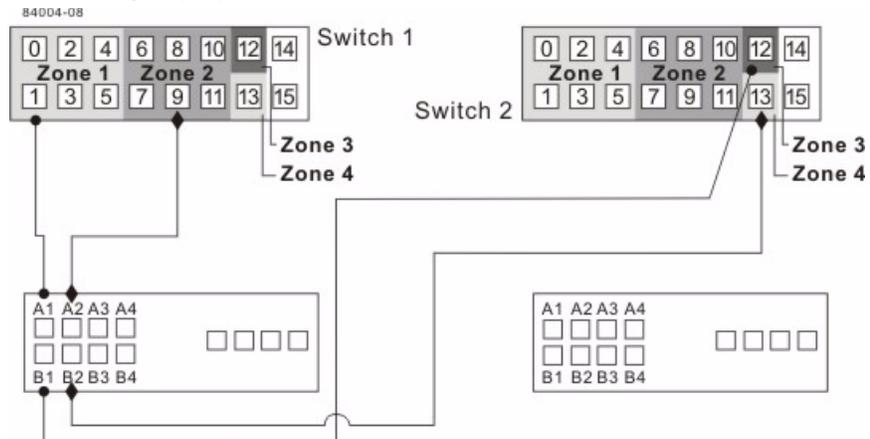
7. Connect controller port B1 of the primary storage array to an available port in zone 3 of switch 2.
8. Connect controller port A2 of the primary storage array to an available port in zone 2 of switch 1. In a four-host-port system, connect controller port A4 to an available port in zone 2 of switch 1.
9. Connect controller port B2 of the primary storage array to an available port in zone 4 of switch 2. In a four-host-port system, connect controller port B4 to an available port in zone 4 of switch 2.

NOTE Upon activation of the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature, controller port A2 and controller port B2 are reserved for mirror relationship synchronization. In a four-host-port system, controller port A4 and controller port B4 are reserved.

---

10. Connect controller port A1 of the secondary storage array to an available port in zone 1 of switch 1.

    The figure following step 13 shows the cabling described in step 10 through step 13.

11. Connect controller port B1 of the secondary storage array to an available port in zone 3 of switch 2.
12. Connect controller port A2 of the secondary storage array to an available port in zone 2 of switch 1. In a four-host-port system, connect controller port A4 to an available port in zone 2 of switch 1.

13. Connect controller port B2 of the secondary storage array to an available port in zone 4 of switch 2. In a four-host-port system, connect controller port B4 to an available port in zone 4 of switch 2.

Figure 18 Secondary Storage Array Connections to Fibre Channel Switches
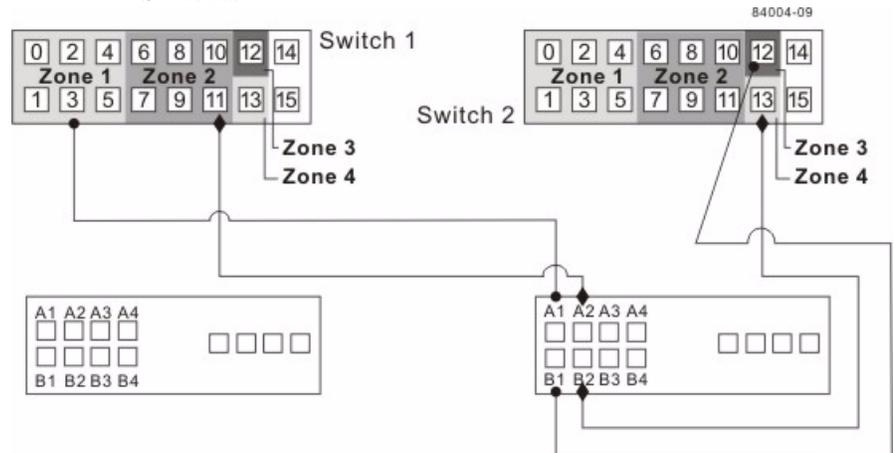
14. Cabling for the intra-site configuration is complete. Repeat step 4 through step 13 for any additional storage arrays that exist in the same cabinet that will use the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature.

ATTENTION Possible hardware damage – DC-powered controller-drive trays and drive trays have special power procedures that you *must* follow beyond the procedures for AC-powered trays. To get specific power-off and power-on procedures, refer to *Storage Array Installation Guide* PDF document on the SANtricity ES Storage Manager Installation DVD or on your storage vendor's website.

---

15. Turn on the power to all storage arrays, hosts, Fibre Channel switches, and any other hardware where power was turned off.

16. The hardware installation is complete. Refer to the online help topics for procedures to configure the storage management software to support mirror relationships.

Installing and Using Mirroring with a Wide Area Network

When installing and using the Synchronous Mirroring premium feature or the Asynchronous Mirroring premium feature over a wide area network (WAN), keep these guidelines in mind:

- If you are setting up an FCIP router to perform mirroring, go to the Compatibility Matrix. Select **Router-FCIP** in the **Product** field, and select the release of the storage management software that you use in the **Software Release** field. Verify that the maximum latency and distance are supported by referring to the vendor specifications for your router and by checking the NetApp Interoperability Matrix Tool (IMT) site at http://now.netapp.com.

- FCIP router vendors and telecommunication vendors are responsible for setting up routing.

- The smaller the bandwidth on the WAN, the longer it takes an mirror to synchronize.

- If the bandwidth does not exceed the average rate, you might not be able to synchronize the data at all. For example, if the system writes at 1 Mb/s, it needs 2 Mb/s of bandwidth available.

- If the mirroring is lagging far behind during production hours, suspend the mirror. During off-peak hours, resume the mirror.

- If you need to keep the Synchronous Mirroring on at all times, keep the mirror physically as close as possible to the production site.

- To determine the average write rate, you should use the available system utilities and should take measurements during peak times.

- If you anticipate adding any applications, determine the bandwidth needs for any future applications.

- Acceptable lag times vary depending on the environment and should be determined on an individual basis.

Line Capacities

Table 2 Line Capacities and Line Speeds

Line Type	Capacity in Mb/s	Speed in MB/s
T-1	1.544	0.193
T-3	43.232	5.404
OC-3	155.6352	19.454
OC-12	622.5408	77.8176
OC-48	2490.1632	311.27
OC-192	9960.6528	1245.085

The following table shows average write operations in Mb/s with corresponding line capacity calculations. When the line capacity calculation is below 50 percent, the result is an adequate response-time performance and a limited need for delta logging

(when the mirror lags behind the data). When the line capacity calculation is above 50 percent, the mirror can never catch up. Any transfers above 50 percent will start to lag.

Table 3 Line Capacity Calculation for Various Write I/O Rates

Average Write Time in Mb/s	T-1	T-3	OC-3	OC-12	OC-18	OC-192
0.01	5.2%	0.2%	0.1%	0.0%	0.0%	0.0%
0.1	51.8%	1.9%	0.5%	0.1%	0.0%	0.0%
1	518.1%	18.5%	5.1%	1.3%	0.3%	0.1%
10	5181.3%	185.3%	51.4%	12.9%	3.2%	0.8%

Please
Recycle

210- 05838_A0