10 Steps to Deploying a High-Performance Fault-Tolerant SAN Using Dell EqualLogic PS Series Storage and Cisco Catalyst Network Infrastructure

What You Will Learn

This document describes how to use Dell PS Series storage arrays with Cisco Catalyst® 4900 Series Switches. With Dell PS Series storage arrays and data center-class Cisco® switches, you can set up a high-performance, fault-tolerant, and easy-to-manage Small Computer System Interface over IP (iSCSI) SAN.

Introduction to Dell PS Series Storage Arrays

The Dell EqualLogic family of iSCSI SANs is fundamentally changing the way enterprises think about purchasing and managing storage. Built on a virtualized peer storage architecture, the Dell EqualLogic PS Series simplifies the deployment and administration of consolidated storage environments. Its all-inclusive, intelligent feature set streamlines purchasing and delivers rapid SAN deployment, easy storage management, comprehensive data protection, enterprise-class performance and reliability, and easy pay-as-you grow expansion. All Dell EqualLogic PS Series arrays are completely interoperable and can be mixed and matched to build tiered storage within a single SAN or across SAN groups.

Dell EqualLogic PS6000 Series iSCSI Arrays

The Dell EqualLogic PS6000 Series (Figure 1) is designed to provide the storage foundation for the virtualized data center, supporting critical applications such as databases. Through its virtualized scale-out architecture and rich software features, the Dell PS6000 Series delivers exceptional self-optimized performance, virtualized server integration, integrated data protection for crucial business applications, consolidated management, and deployment flexibility without compromising data availability.

Figure 1. Dell EqualLogic PS6000 Series iSCSI Array

Dell EqualLogic PS5000 Series iSCSI Arrays

The Dell EqualLogic PS5000 Series (Figure 2) offers affordable, entry-level configurations as well as high-capacity configurations for data-intensive applications or highly consolidated environments. Its award-winning, modular platform includes a full suite of enterprise features and delivers end-to-end reliability and exceptional performance.

Figure 2. Dell EqualLogic PS5000 Series iSCSI Array

Introduction to Cisco Catalyst 4900 Series Data Center Switches

The Cisco Catalyst 4900 Series Switches are fixed configuration switches offering high-performance, rack-optimized server and storage switching for data centers of all sizes. They offer these benefits:

- **Exceptional Reliability:** Redundant hot-swappable internal power supplies enable nonstop operation.
- **Wire-Speed Performance:** Wire-speed throughput on all ports from 96 Gbps to 320 Gbps with low latency for data-intensive applications such as video editing and database transactions.
- **Comprehensive Management:** The Cisco Catalyst 4900 Series can be managed with Cisco Network Assistant, CiscoWorks solutions, and embedded CiscoView Software.

Cisco Catalyst 4948 Switch and Catalyst 4948 10 Gigabit Ethernet Switch

The Cisco Catalyst 4948 and Catalyst 4948 10 Gigabit Ethernet Switches offer wire-speed, low-latency, Layer 2-to-4, one-rack-unit (1 RU) fixed-configuration switching. The Cisco Catalyst 4948 offers exceptional performance and reliability for low-density, multilayer aggregation of high-performance Dell PS Series storage arrays.

The Cisco Catalyst 4948 (Figure 3) offers 48 ports of wire-speed 10/100/1000BASE-T with four alternative wired ports that can accommodate optional 1000BASE-X Small Form-Factor Pluggable (SFP) optics.

Figure 3. Cisco Catalyst 4948 Switch

The Cisco Catalyst 4948 10 Gigabit Ethernet Switch (Figure 4) offers 48 ports of wire-speed 10/100/1000BASE-T with two ports of wire-speed 10 Gigabit Ethernet (X2 optics).

Figure 4. Cisco Catalyst 4948 10 Gigabit Ethernet Switch

Exceptional reliability and serviceability are delivered with optional internal AC or DC 1+1 hot-swappable power supplies and a hot-swappable fan tray with redundant fans.

Cisco Catalyst 4900M Switch

The Cisco Catalyst 4900M (Figure 5) provides an ideal solution for space-constrained deployments that require high-performance wire-speed services, high availability, and the modular flexibility of deploying Gigabit Ethernet and 10 Gigabit Ethernet, all in a small 2RU form factor.

Figure 5. Cisco Catalyst 4900M Switch

The Cisco Catalyst 4900M provides:

- High performance
- Low latency
- 10/100/1000 Ethernet
- 10 Gigabit Ethernet
- A top-of-rack access layer switching solution for rack-optimized servers

The Cisco Catalyst 4900M offers eight fixed wire-speed 10 Gigabit Ethernet ports and two half-slots that you can fill with any combination of the following:

- 20-port wire-speed 10/100/1000 (RJ-45) half-card
- 8-port (2:1) 10 Gigabit Ethernet (X2) half-card (Cisco TwinGig Converter Module compatible)
- 4-port wire-speed 10 Gigabit Ethernet (X2) half-card

10 Steps to iSCSI Success

This section describes a systematic approach to designing and implementing an iSCSI SAN. This document is not intended to be a comprehensive guide to deploying Dell PS Series storage and Cisco Catalyst 4900 Series network switches. Refer to configuration guides and installation manuals for detailed platform-specific deployment instructions.

Storage and network administrators can tune an iSCSI deployment to meet the individual business and application requirements. The goal of this document is to introduce the concepts needed for a successful iSCSI deployment using Dell PS Series storage and Cisco Catalyst networking. Successful SAN deployments require a number of trade-offs to balance application performance, data availability, and cost.

SAN performance and availability depends on a number of factors, including:

- Storage array capacity and bandwidth
- Storage group and volume configuration
- Network throughput and latency
- Network configuration
- Server connection type

Note the following architectural terminology as you read the steps here:

- **Dell PS Series Array:** An array is a high-performance block storage device that is ideal for departmental and enterprise storage. Each array contains disks, network interfaces, controllers, and power supplies.
- **Dell PS Series Group:** A group consists of a single or multiple arrays working together. The group is seen as a single, shared storage service by application servers.
- **Volumes:** Administrators create volumes from the available space in the group storage pool. The group exports volumes as iSCSI targets.

Step 1. Understand your current and future capacity requirements.
Take inventory of your current storage utilization. Pay special attention to future requirements and storage growth rates. Increased utilization of current applications and deployments of new applications can affect the amount and type of storage required.

Step 2. Segment the SAN into logical groups that have clearly defined requirements or functions.
For example, you can set up these groups:

- Group A: Finance
- Group B: Marketing
- Group C: Customer Relationship Management (CRM) database
- Group D: Video
- Group E: Backup

Dell PS Series SANs allow you to virtualize the physical storage into groups. Groups can span multiple disk volumes and storage arrays. Storage administrators can adjust the level of performance, availability, and fault tolerance at the group level and at the SAN level.

Step 3: For each group, collect the following information:

- Initial capacity required and storage growth rate
- Workload requirements: random or sequential reads and writes
- Throughput required
- Uptime requirements
- Backup requirements

Step 4: Select the RAID level that creates the best balance among all the requirements in Step 3, using Table 1.

Table 1. Workload and RAID-Level Requirements

RAID	Reads (Random/Sequential)	Writes (Random/Sequential)	Relative Cost	Relative Protection	Rebuild Performance
10	****/****	****/***	$$$$	****	****
50	****/***	***/***	$$$	***	***
5	****/***	**/***	$	**	**
6	****/***	*/**	$$	****	*

Step 5: Connect the Dell PS Series storage to the network.

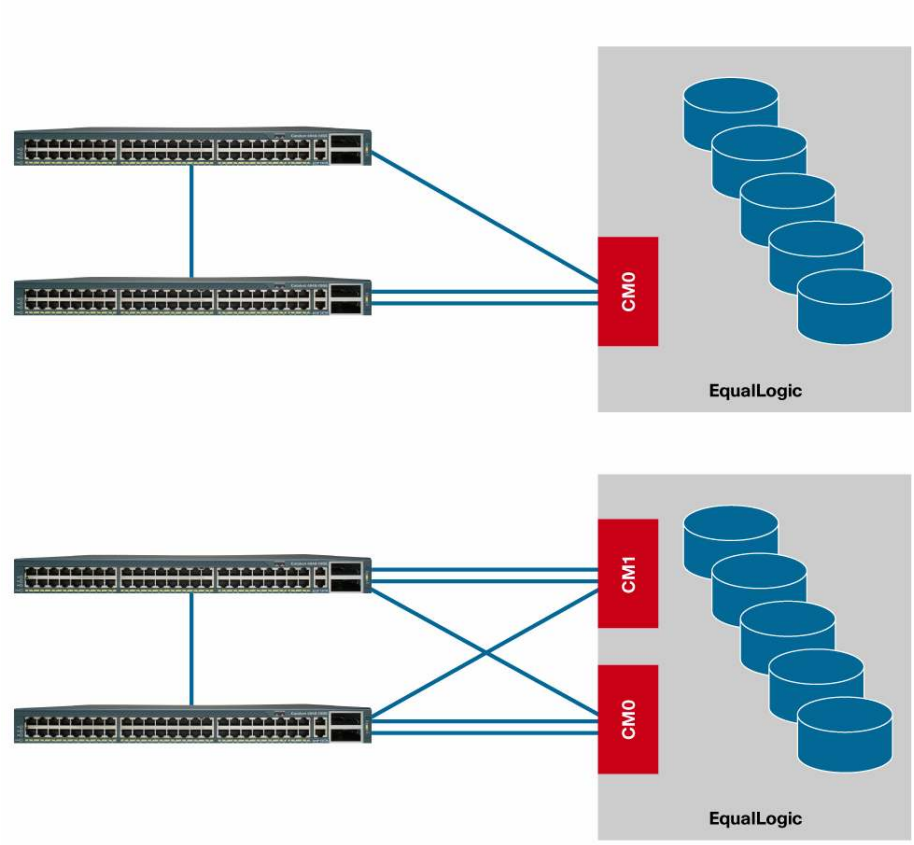
In this step, you can adjust the network bandwidth allocated to each storage array and the level of hardware redundancy within the SAN.

Dell PS Series arrays have multiple high-performance network connections. A group can be spread over several physical arrays, each with *n* connections to the network. For best performance, connect all available network connections to a data center-class Cisco Catalyst 4900 Series Switch. For additional performance at the group level, span the group across several physical storage arrays.

Table 2. Storage to Network Connection Requirements

Requirement	Description
Appropriate Network Cable	For copper-based networks, use Cat 5E or Cat 6 cables with RJ-45 connectors. You can also use Cat 5 cables if they adhere to the TIA/EIA TSB95 standard. For fiber-optic networks, use cables with LC connectors. Fiber optic networks also require SFP connectors.
Network Connection	Each array must have at least one active network connection and can have a maximum of three.
Network Access to the Group IP Address	Each array must have at least one network interface configured on the same subnet as the group IP address.
Connectivity between Switches	In a single-subnet group in which the arrays configured on the network interface are connected to multiple switches, there must be network connectivity between the switches.

Figure 6. PS Series Single and Dual Controller Network Connections



When adjusting network bandwidth, for best performance you should select network devices that provide non-blocking data access between the storage array and the application server.

You can create a multi- or single-tier SAN:

- **Single Tier:** Storage array and application servers are connected to a single network device
- **Two Tier:** Storage and servers are connected to an access-layer switch. The access-layer switches are aggregated at a distribution layer or core layer.

Figure 7. Single Tier Network Design

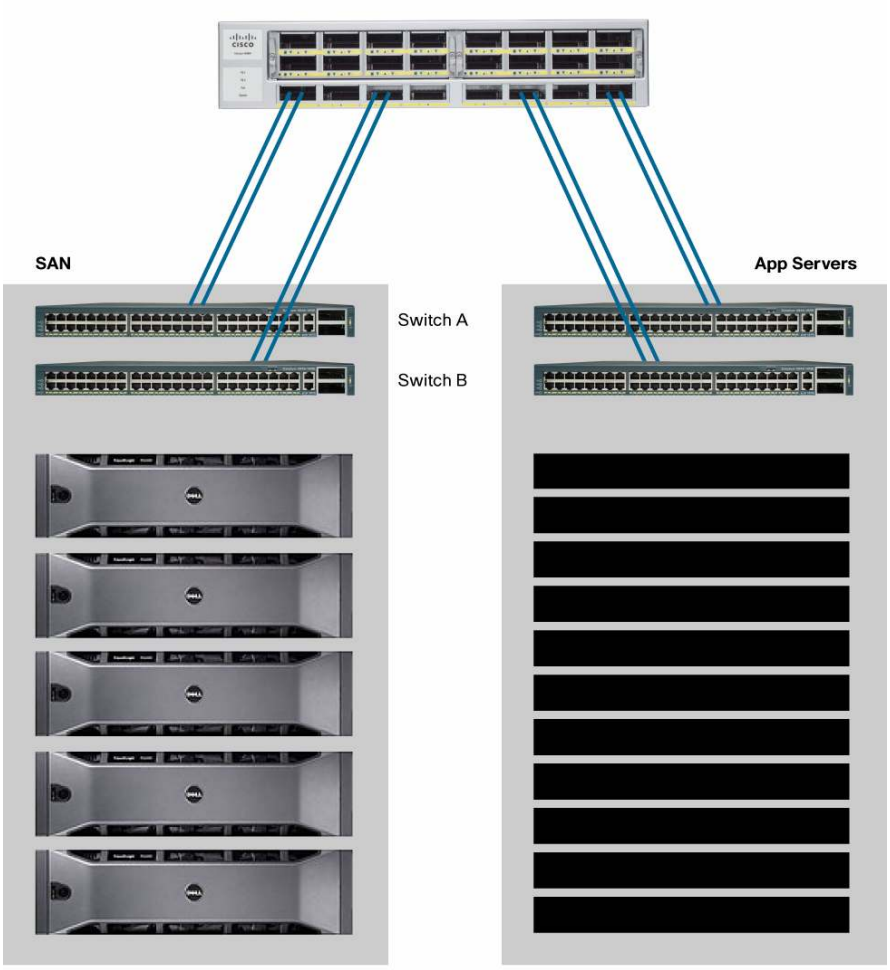


Table 3. Application-Based RAID Selection

Group Attribute	Implementation
High-Performance Sequential Data Access (Video)	RAID-50
High-Performance Random Data Access (Database)	RAID-10
System Backup	RAID-5, RAID-6; the backup group should be located in a remote location with high-bandwidth network connections to the centralized SAN
Security and Availability (Finance)	RAID-10; this group should be segmented on a private VLAN within the switch

Step 6: Specify network settings, described in Table 4.

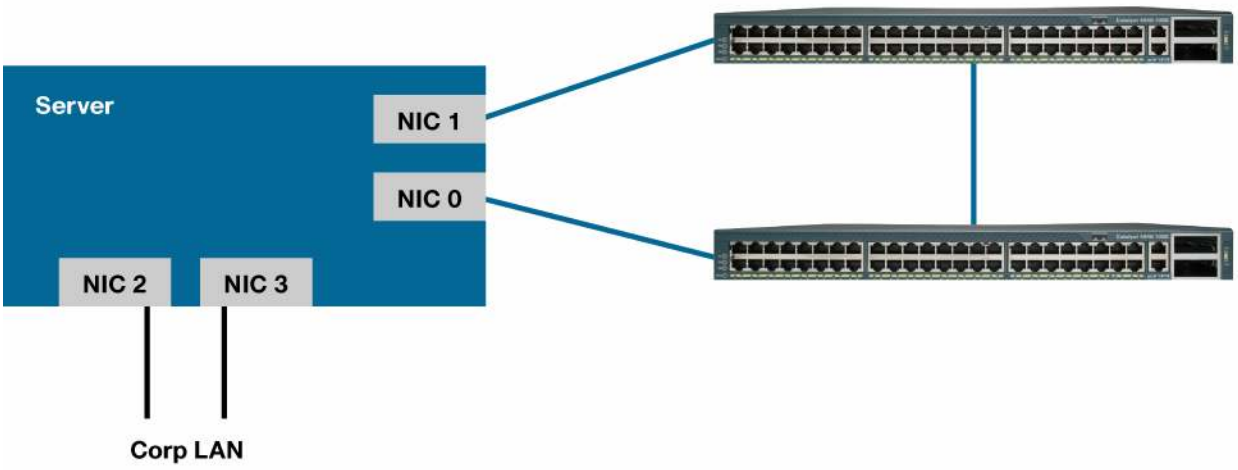
Table 4. Network Settings

Feature	Description
Spanning Tree	Spanning tree is not required on storage array network ports.
Jumbo Frames	Enable jumbo frames on each switch that handles iSCSI traffic. If your server is using a software iSCSI initiator and network interface card (NIC) combination, you must also enable jumbo frames on the NICs that handle iSCSI traffic to obtain any performance benefit and help ensure consistent behavior.
Flow Control	You should enable flow control on each switch port that handles iSCSI traffic. If your server is using a software iSCSI initiator and NIC combination to handle iSCSI traffic, you must also enable flow control on the NICs to obtain any performance benefit. Dell PS Series storage arrays will correctly respond to flow control.
VLAN	Configure VLANs on switches to separate iSCSI traffic from other network traffic.
PortChannel	In multi-tier designs, use PortChannels to combine uplink ports to increase the total bandwidth.

Step 7: Specify server connections.

Host computers should be configured with one or more network connections dedicated to iSCSI SAN communication. NICs or iSCSI host bus adapters (HBAs) can be used (Figure 8). NICs used for iSCSI communication require the use of a software-based iSCSI initiator.

Figure 8. Server to Network Connection



Step 8: Design the SAN for fault tolerance and storage availability.

Availability, including storage availability, should always be a critical design consideration for any SAN.

Consolidated storage increases the need for availability in the storage infrastructure. The availability model used by the Dell PS Series architecture essentially eliminates single points of failure and enables an array to survive multiple, simultaneous failures:

- Each Dell PS Series array is composed of redundant components: disks, controllers with mirrored write-back caches, network interfaces, power supplies, and cooling fans.
- Hot-swappable hardware components help reduce downtime.
- Faults are well isolated; loss of controllers does not cause loss of RAID protection. This feature applies to all supported RAID types.

- Disks are automatically configured with RAID, and hot spares are reserved to help ensure that no data is unprotected.
- Hot sparing and data recovery require no user intervention.
- Volume replication can provide site-level disaster protection.
- Group member hardware upgrades can be performed while a group is online; simply add the upgraded array to the group.
- A member can be decommissioned while a group is online; simply remove the array from the group.

Feature	Description
RAID	Select the RAID level that provides the level of performance and availability required.
Dual-Controller Arrays	To eliminate the controller as a single point of failure, deploy dual-controller arrays and connect all three network connections.
Hot Spares	Allocate at least one spare disk for each group.

Step 9: Design the SAN for Network availability.

Table 5. Requirements for Network Availability

Requirement	Description
Configure Multiple Network Connections on an Array	Connecting multiple network interfaces on an array (assigning each interface an IP address and net mask) improves performance and availability. Connect the cables to different switches, if possible, for high availability.
In a Multiple-Subnet Group, Help Ensure Access to the Group IP Address	In a multiple-subnet group, the arrays' configured network interface should be able to access the subnet on which the group IP address resides.
Use High-Bandwidth Switch Connections	For the best performance, you should connect arrays and hosts to a switched network and make sure that all network connections between hosts and arrays are Gigabit Ethernet. An array can operate at 10 and 100 Mbps, but performance will be significantly degraded.
Use Redundant Network Paths Between Hosts and Arrays	A multipathing solution helps ensure that no single point of failure exists between hosts and arrays.
For Replication, Use a Reliable, Adequately-Sized Network Link	For effective and predictable replication, be sure that the network link between the primary and secondary groups is reliable and provides sufficient bandwidth for copying data.

Step 10: Use host-based tools to protect your applications.

Two utilities within the PS Series—Auto-Snapshot Manager/VMware Edition (ASM/VE) and Auto-Snapshot Manager/Microsoft Edition (ASM/ME)—help enable fast online backups and quick restores of VMware ESX and Microsoft Hyper-V virtual machines. ASM/ME also helps administrators simply and easily create clean, application-consistent, hardware-based snapshots of Microsoft SQL and Exchange datasets that are quickly and easily recoverable to prior points in time.

ASM/ME and ASM/VE host-based tools enable fast online backups and quick restores of virtual machines and file systems on the Dell EqualLogic SAN arrays. ASM capabilities provide easy-to-use graphical interfaces that coordinate the creation, recovery and scheduling of PS Series snapshots with VirtualCenter and native snapshotting technology.

For More Information

For more information, visit:

- http://www.cisco.com/go/4900
- http://www.dell.com

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV
Amsterdam, The Netherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at www.cisco.com/go/offices.

Printed in USA C11-540141-00 06/09