

Dell PS Series Storage Arrays iSCSI Initiator and Operating System Considerations

Optimizing Your SAN Environment for High Availability

Dell Storage Engineering
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Table of contents

Revisions.....	2
Preface.....	5
Intended Audience	5
1 High-Availability Procedure Summary.....	6
1.1 Proactive Maintenance Support	6
1.2 Host Integration Tools	6
2 About High-Availability iSCSI Data Transfer	7
2.1 Before You Begin: Update Initiators and Drivers.....	7
3 Configure Your Hosts for High Availability	8
3.1 Host Integration Tools	8
3.2 Operating System Recommendations.....	8
3.2.1 Test Modifications in a Non-Production Environment	8
3.2.2 Increase Transmit and Receive Resource Settings	8
3.2.3 Operating System Specific Configuration Information.....	8
4 Configure Your Network for High Availability	9
4.1 General Network Requirements	9
4.1.1 Design Network for Redundancy.....	9
4.1.2 Ports	9
4.1.3 Switches	9
4.1.4 FS Series Array Switch Requirements	11
4.2 Hardware Initiators.....	11
A Configure Your Microsoft Windows Operating System.....	12
A.1 Procedure Summary.....	12
A.1.1 Install the Recommended Microsoft Hotfixes	12
A.1.2 Install the Dell HIT/Microsoft tools.....	14
B Install the Multi-extension module for VMware operating system.....	15
C Configure your Linux operating system.....	16
C.1 Configure SCSI Device Settings Using the <code>udev</code> Facility	16
C.2 Configure iSCSI Settings Using the <code>/etc/iscsi/iscsid.conf</code> File.....	16
C.3 Configure Linux Networking	17
D Configure your Oracle Solaris 10 operating system.....	19
D.1 Zero-Length Volumes	19

E	Configure your IBM AIX operating system	20
E.1	iSCSI Initiators Lose Volume Connectivity	20
F	Configure Your Citrix XenServer Operating System	21
G	Technical support and resources	22
G.1	Related resources.....	22

Preface

Dell™ PS Series arrays optimize resources by automating performance and network load balancing. Additionally, PS Series arrays offer all-inclusive array management software, host software, and free firmware updates. Dell FS Series appliances, combined with PS Series arrays, offer a high-performance, high-availability, scalable NAS solution.

This document describes configuration information, limitations, and other considerations required to architect a PS Series SAN for high availability and preparation for non-disruptive array firmware upgrades.

Intended Audience

The information in this guide is intended for experienced administrators who are responsible for managing a PS Series group. To use the information in this manual, you must have an understanding of the following topics:

- PS Series group administration
- Operating environment administration for:
 - - Windows® (or Windows Server) systems
 - - VMware®
 - - Linux® systems
- Basic network and SAN administration

1 High-Availability Procedure Summary

This chapter summarizes the procedures that you must perform to optimize your environment for high availability (HA).

1.1 Proactive Maintenance Support

If you have a Dell proactive service agreement, contact your Dell Technical Support representative, who will help you analyze your SAN environment and ensure it is correctly set up for high-availability.

1.2 Host Integration Tools

Dell has automated a portion of this process in the PS Series Host Integration Tools (HIT) kit. If installed, this software implements changes such as registry settings and configuration options on the hosts that follow Dell's recommended best practices. HIT is available for Microsoft Windows, Linux and VMWare. Downloads and more information is available at <https://eqlsupport.dell.com> (requires login).

Read the following sections in this document and perform the recommended actions:

- [About High-Availability iSCSI Data Transfer](#) - provides an overview of high-availability iSCSI data transfer.
- [Configure Your Hosts for High Availability](#) - contains general operating system recommendations and guidelines to configure settings on your servers to ensure high-availability.
- [Configure Your Network for High Availability](#) - outlines the general best practices required to configure a redundant iSCSI network.

2 About High-Availability iSCSI Data Transfer

This chapter describes how to optimize your storage area network (SAN) environment for highly available (HA) iSCSI data transfer. It contains information about how to:

- [Configure Your Hosts for High Availability](#)
- [Configure Your Network for High Availability](#)

Note: If you have a Dell proactive service agreement, your Dell Technical Support representative can help you analyze your SAN environment and ensure it is correctly set up for high availability.

For more information about Proactive Maintenance, visit dell.com/services.

When you optimize your SAN environment for HA, you increase the fault tolerance of the SAN, providing protection from component failures and minimizing service disruptions.

Many causes of service disruptions can occur in a data center. Some of the more common ones are:

- Hardware failure in servers, NICs, cables, switches, storage controllers, and disks
- Software failure such as bugs or application crashes
- Upgrades to software, drivers, or hardware firmware

In most cases, if your data center is correctly designed for redundancy, the SAN can tolerate service disruptions. In some cases, however, a redundant design is not sufficient to allow applications and operating systems to continue to operate during disruptions. For example, problems with software or updates to software and firmware can cause disruptions that redundancy cannot manage. In these cases, other best practices are typically required to tune applications and operating systems to continue to operate without being affected. This document describes the actions you can take to ensure a highly available iSCSI data transfer that minimizes the possibility of these issues with PS Series SANs.

2.1 Before You Begin: Update Initiators and Drivers

Dell recommends that you keep initiators and drivers up to date. A list of supported initiators can be found at <http://en.community.dell.com/techcenter/storage/w/wiki/2639.ps-series-configuration-guide>. Apply the recommended modifications to your operating system and iSCSI initiators specified in the following sections.

The following chapters contain configuration and performance tuning best practice recommendations for high availability and non-disruptive operation with PS Series SANs.

3 Configure Your Hosts for High Availability

3.1 Host Integration Tools

Dell has automated a portion of this process in the PS Series Host Integration Tools (HIT) kit. The PS Series HIT kits provide integrated software such as MPIO modules, enhanced data protection, automated provisioning, and alerts for Windows, VMware, and Linux hosts. If installed, this software implements changes (such as configuration options on the hosts) that follow Dell's recommended best practices.

You can download the PS Series Host Integration Tools (HIT) kit from the <https://eqsupport.dell.com> (login required) website, and install it on supported operating systems.

3.2 Operating System Recommendations

This section contains detailed information about settings and configuration options you should apply to hosts running in your PS Series iSCSI SAN to ensure high availability (HA) at the host level.

3.2.1 Test Modifications in a Non-Production Environment

If you are not running any of the operating systems or iSCSI initiators listed here, or if you are unsure of your applications' HA tolerance, Dell recommends that you first test the suggested modifications in a non-production environment.

3.2.2 Increase Transmit and Receive Resource Settings

A PS Series group might deliver more network I/O than iSCSI initiators can handle, resulting in dropped packets and retransmissions. Some iSCSI initiators, however, let you increase the transmit and receive resource settings, which can help minimize this problem.

For example, on a Windows system, you might be able to increase the initiator's network interface settings for receive and transmit descriptors. On a UNIX or Linux system, increase the transmit and receive resources for your network ports.

3.2.3 Operating System Specific Configuration Information

To view configuration information specific to your operating system, refer to the following appendixes:

A: [Configure Your Microsoft Windows Operating System](#)

B: [Configure Your VMware Operating System](#)

C: [Configure Your Linux Operating System](#)

D: [Configure Your Oracle® Solaris 10 Operating System](#)

E: [Configure Your IBM® AIX® Operating System](#)

F: [Configure Your XenServer Operating System](#)

4 Configure Your Network for High Availability

A PS Series iSCSI SAN can be operated in any network that supports the industry standards and IP subnet design guidelines described in this chapter. Because of this flexibility, many network design and configuration choices can affect SAN performance.

For more network design and configuration information to support the use of a PS Series SAN, see the Dell PS Series Configuration Guide, which can be downloaded from:

<http://en.community.dell.com/techcenter/storage/w/wiki/2639.ps-series-configuration-guide>

4.1 General Network Requirements

This section outlines the general best practices for configuring a redundant iSCSI network.

4.1.1 Design Network for Redundancy

For PS Series PS arrays, follow these general SAN design requirements:

4.1.2 Ports

The arrays should be in the same subnet as the group's IP address. For all members (arrays) in a given SAN group, all ports should be connected to the same subnet. This connection allows the arrays to communicate with each other as a group of peer members.

At least two iSCSI SAN ports per host must be connected to two different switches in a SAN fabric for fully redundant SAN connectivity.

4.1.3 Switches

All switches within the SAN must be interconnected such that a path is always present from any

Ethernet port on one array to all other Ethernet ports on all other arrays in the group.

Enabling jumbo frames on all switches in the SAN is a recommended best practice as long as the rest of the infrastructure (such as initiators and NICs) supports jumbo frames as well.

Rapid Spanning Tree Protocol must be enabled if the SAN infrastructure has more than two switches in a non-stacked configuration, and portfast must be enabled on all edge device ports (hosts, and FS Series appliances and arrays).

To prevent a switch failure from also disabling all paths between a host and its connected volumes, all ports from each controller must be connected to at least two different switches. This requirement also applies to FS Series NAS appliance configurations.

For PS4100/PS4110/PS4210/PS6100/PS6210/PS6610 family arrays, split the vertical port pair connections between two switches to ensure 100% bandwidth capability is maintained in the event of a vertical port failover event, as shown in Figure 1 and Figure 2.

All switches in the SAN must have jumbo frames enabled. This requirement applies to SANs connected to either a PS Series array or an FS Series appliance.

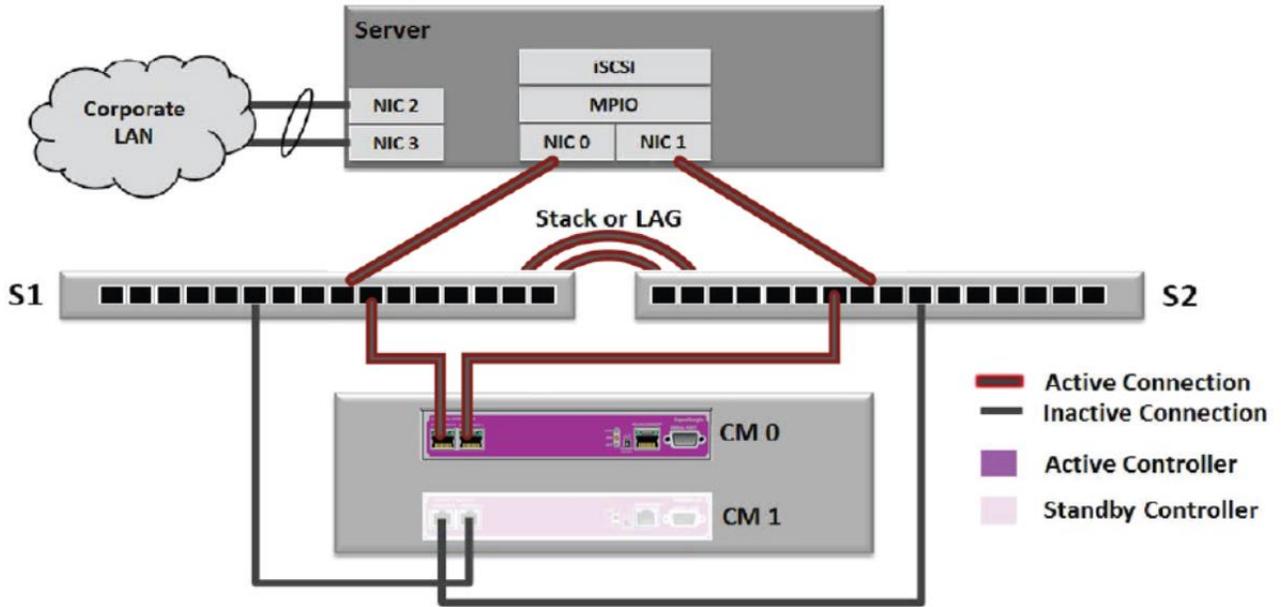


Figure 1 Redundant SAN PS4100

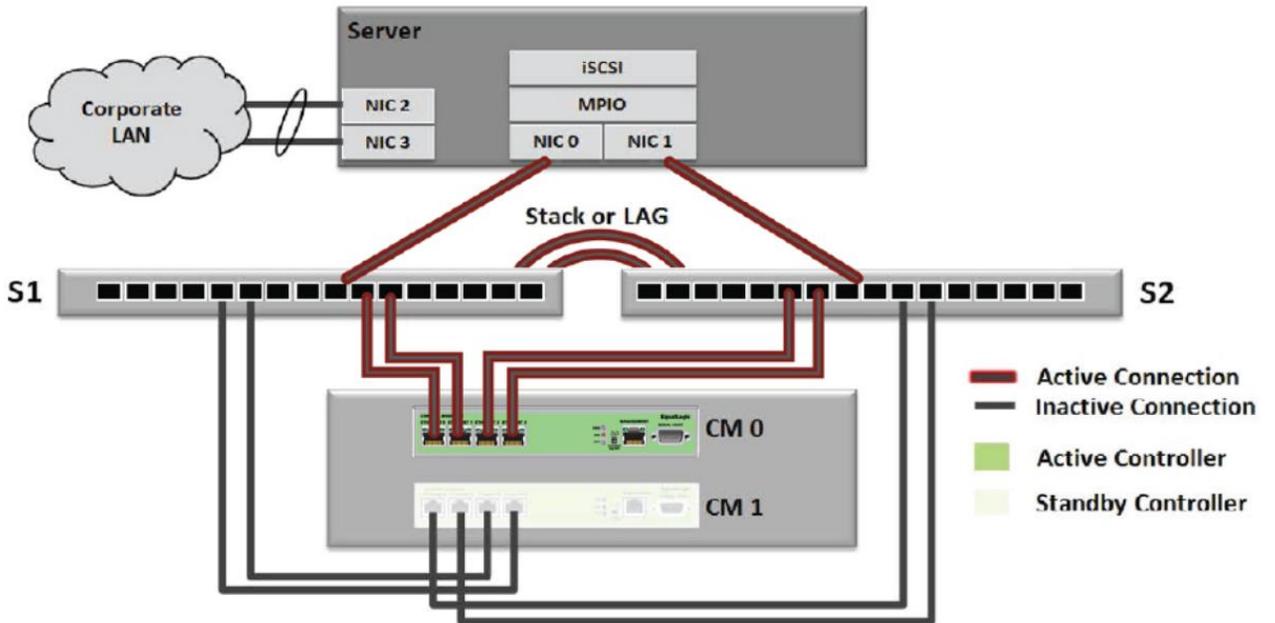


Figure 2 Redundant SAN PS6100

- Both LAG or Stacking interconnects can be used as the bridging mechanism between redundant switches in the PS Series SAN, but each method has a different set of considerations that might make one approach more preferable than the other. For more information about LAG and Stacking considerations, see the Dell PS Series Configuration Guide at: en.community.dell.com/techcenter/storage/w/wiki/2639.equallogic-configuration-guide.aspx
- Any PS Series SAN group that is required to send or receive replication traffic to or from another SAN group must have an uninterrupted communications path (such as "visibility") between each group.

See Dell's Switch Configuration Guides for specific switch vendor and model settings and best practices. Examples and detailed instructions about configuring SAN network switches and hosts can be obtained through the Rapid PS Series Configuration Portal or by reviewing sample SAN reference architectures on the Dell TechCenter website: en.community.dell.com/techcenter/storage/w/wiki/4250.switch-configuration-guides-by-sis.aspx

4.1.4 FS Series Array Switch Requirements

- Keep the client and SAN side networks physically separate, and deploy two switches on each side to protect against a switch failure.
- Do not block IPv6 traffic on your SAN/internal switches if you have FS series appliances attached.

4.2 Hardware Initiators

Most hardware initiators are referred to as Converged Network Adapters (CNAs). CNAs support a variety of enhancements such as iSCSI Offload, DCB, and so on, making them more than just a hardware initiator. Of the major CNAs supported by PS Series, the most common ones are QLogic®, Broadcom®, Emulex®, and Intel®.

A Configure Your Microsoft Windows Operating System

The following sections describe how to configure settings on your Microsoft® Windows servers to ensure high availability.

A.1 Procedure Summary

To ensure high availability, configure the settings on your Microsoft® Windows servers as follows. If you have installed the HIT kit, skip step 3.

1. Install the recommended Microsoft hotfixes.
2. Install the HIT kit and proceed to step 4.
3. (Optional) Set the registry entries if the HIT kit is not installed.
4. Check the Microsoft guidelines.

A.1.1 Install the Recommended Microsoft Hotfixes

Note: Not all hotfixes are necessary for all versions of Windows. Dell recommends that you install the latest Microsoft recommended hotfixes.

For Windows Server 2012, Windows Server 2012 R2 a few hotfixes are listed here as examples, please check the Microsoft sites for the complete list of appropriate hotfixes.

- Microsoft has released a KB Rollup for Windows Server 2012 R2 MPIO LUN loss on storage controller failover causing the Server to lose its Storage connection.

Assume that you have a Windows Server 2012 R2-based computer connected to a storage device through multiple paths by using Multipath I/O (MPIO). When multiple paths fail over concurrently or in quick succession, the I/O operation may fail, and the computer may lose its connection to the storage device.

Recommendation: To resolve this issue, install the May 2016 update rollup for Windows RT 8.1, Windows 8.1, and Windows Server 2012 R2 (KB3156418).

Related Link: (Microsoft Support Website – Article ID: 3156418

<https://support.microsoft.com/en-us/kb/3156418>

- Windows Server 2012 R2 connecting to an iSCSI SAN where the server unexpectedly restarts on a high-speed network.

Note: To apply this update, you must first have update 2919355 installed in Windows 8.1 or Windows Server 2012 R2. Recommendation: To resolve this issue, install the update rollup that is dated November 2014. Microsoft has released hotfix KB2851144 to correct a LUNs tracking after a path failover occurs between storage controllers in Windows Server 2008 R2 or Windows Server 2012.

- LUN not appearing in Disk Management after path failover.

You configure a Windows Server 2008 R2-based or Windows Server 2012-based computer to use Microsoft Multipath I/O (MPIO) and Microsoft Device Specific Module (MDSM) or the Dell

HIT/Microsoft toolkit. A path failover occurs between storage controllers. In this scenario, the system loses track of one or more logical unit numbers (LUNs). Therefore, not all the LUNs appear in the Device Manager. Additionally, the system no longer sends out I/O requests to the missing LUNs.

Note: To resolve this issue in Windows Server 2012, install update rollup 2889784

Recommendation: Microsoft has released 2851144 hotfix to address this issue. If you have questions regarding the 2851144 solution, please contact Microsoft Support.

Related Link: (Microsoft Support Website – Article ID: 2851144)

<https://support.microsoft.com/en-us/kb/2851144>

For Windows Server 2008 R2, visit the Microsoft website and then install the following hotfixes:

Note: The Dell HIT/Microsoft 4.8 and above does not support Windows Server 2008 or Windows Server 2008 R2.

- Update Windows Server 2008 R2 Clusters

If your environment contains Microsoft Windows Server 2008 R2 clusters, apply the hotfix specified in Microsoft Knowledge Base article 978562, support.microsoft.com/kb/978562, to each cluster node before upgrading group members.

- During a Failover or Load Balance Event, Volumes May Become Unavailable

If you are running multipath I/O in a Windows Server 2008 or Windows Server 2008 R2 environment (might also affect clusters), and the server must disconnect and then reconnect to the volume (such as for failover or load balance), the volume might become unavailable. If this situation occurs, refer to Microsoft Knowledge Base article 2718576, support.microsoft.com/kb/2718576, for detailed information on how to proceed.

- Some iSCSI Initiator Sessions Not Being Deleted

If you are running a large cluster configuration using Windows Server 2008 R2 without SP1 installed, some iSCSI attempts to log out iSCSI sessions in the iSCSI initiator GUI might fail with an error message indicating that the session cannot be logged out. In addition, if you are using the Host Integration Toolkit, this can result in a higher than expected total iSCSI session count.

To fix the issue, install the hotfix specified in Microsoft Knowledge Base article 979710 to each cluster node. See support.microsoft.com/kb/979710 for more information.

- Bugcheck 0x0000000A Returned After Control Module Failover

If you are running a large cluster configuration using Windows Server 2008 R2 without SP1 installed, you might encounter bugcheck 0x0000000a after an array control module failover:

0x0000000A

(<parameter1>, <parameter2>, <parameter3>, <parameter4>IRQL_NOT_LESS_OR_EQUAL

To fix this problem, apply the hotfix specified in Microsoft Knowledge Base article [979711](https://support.microsoft.com/kb/979711), support.microsoft.com/kb/979711, to each cluster node.

- Performance Degradation When Heavy Disk I/O Load

The performance of a computer that is running Windows Server 2008 R2 or Windows 7 decreases by 20 percent under a heavy disk I/O load. Apply the hotfix specified in Microsoft Knowledge Base article [982383](https://support.microsoft.com/kb/982383), support.microsoft.com/kb/982383.

- MPIO Driver Fails Over All Paths

The MPIO driver incorrectly fails over all paths when a transient single failure occurs in Windows Server 2008 or in Windows Server 2008 R2. Apply the hotfix specified in Microsoft Knowledge Base article [2522766](https://support.microsoft.com/kb/2522766), support.microsoft.com/kb/2522766.

- MPIO Does Not Fail Over Correctly

MPIO failover fails on a system that is running Windows Server 2008 R2 system and the path failover process fails, any application that tries to access the storage device might stop responding. Therefore, the MPIO path does not fail over. Apply the hotfix specified in Microsoft Knowledge Base article [2460971](https://support.microsoft.com/kb/2460971), support.microsoft.com/kb/2460971.

- MPIO.sys Driver Error in Windows Server 2008 R2

If you connect a storage device that is controlled by MPIO to a Windows Server 2008 R2 system, and if the system is under heavy backup workload, Windows Server 2008 R2 crashes. Apply the hotfix specified in Microsoft Knowledge Base article [2511962](https://support.microsoft.com/kb/2511962).

A.1.2 Install the Dell HIT/Microsoft tools.

Dell has automated a portion of this process in the PS Series Host Integration Tools (HIT) kit. You can download the PS Series HIT kit from the <https://eqsupport.dell.com> website, and install it on supported operating systems.

The PS Series HIT kit provides integrated software such as MPIO modules, enhanced data protection, automated provisioning, and alerting. If installed, this software implements changes that follow Dell's recommended best practices for the following registry values:

- Disk timeout
- EQL DSM SCSI timeout
- EQL DSM path verification enabled
- EQL DSM path verification period
- Link downtime
- Enable iSCSI NOP Out
- MPIO path recovery interval
- MSISCSI IO timeout

B Install the Multi-extension module for VMware operating system

VMware vSphere provides the Pluggable Storage Architecture (PSA), which enables multipath configuration for high availability and increased performance. The modular design of the architecture accepts third-party multipathing plugins that enable enhanced functionality specific to storage device models.

The Dell PS Series Multipathing Extension Module (MEM) provides the following enhancements to the existing VMware multipathing functionality:

- Increased bandwidth
- Reduced network latency
- Automatic connection management
- Automatic load balancing across multiple active paths

For these reasons Dell highly recommends that the MEM be downloaded and installed on the VMware servers. The MEM and other VMware integration tools such as Virtual Storage Manager for VMware, Storage Replication Adapter for VMware Site Recovery Manager and Adapter for VMware vRealize Operations Manager from <https://eqsupport.dell.com>.

C Configure your Linux operating system

If you do not have the HIT kit installed, the following sections describe the configuration settings you need to apply on your Linux hosts to ensure high availability. See Table 1 for a summary of the recommended settings.

C.1 Configure SCSI Device Settings Using the `udev` Facility

The Linux `udev` utility can be used to dynamically modify device settings every time a new device is added or changed. The following examples show ways that the HIT/Linux kit achieves the following settings with `udev` rules:

- Increase SCSI Device Timeout Value to Avoid Disk I/O Timeouts

The default disk timeout should be increased to 60 seconds. The specific `udev` rule implemented by HIT/Linux is installed in the file named `/lib/udev/rules.d/99-eqlsd.rules`:

```
ACTION!="remove", SUBSYSTEM=="block", ENV{ID_VENDOR}=="EQLLOGIC",  
RUN+="/bin/sh -c 'echo 60 >/sys/%p/device/timeout'"
```

- Increase SCSI Device Read-Ahead Buffer Size

The default SCSI device read-ahead buffer setting of 128KB is increased to 1024KB. The specific `udev` rule implemented by HIT/Linux is installed in the file named `/lib/udev/rules.d/38-equallogic.rules`: `ATTR{queue/read_ahead_kb}="1024"`

- Change SCSI Device I/O Scheduler Algorithm

The default SCSI device I/O scheduler algorithm of CFQ (Completely Fair Queuing) is set to `noop`. The specific `udev` rule implemented by HIT/Linux is installed in the file named `/lib/udev/rules.d/38-equallogic.rules`: `ATTR{queue/scheduler}="noop"`

C.2 Configure iSCSI Settings Using the `/etc/iscsi/iscsid.conf` File

The following changes should be made in the Linux iSCSI configuration file `/etc/iscsi/iscsid.conf`. Any settings in this file are propagated to iSCSI targets on discovery or rediscovery.

- Change `FastAbort` Setting in iSCSI Configuration File

The default iSCSI initiator setting for `FastAbort` is set to `Yes`. PS Series targets prefer this iSCSI configuration parameter be set to `No`. The HIT/Linux software automatically implements this change: `node.session.iscsi.FastAbort = No`

- Change `node.startup` Setting to Avoid Login Storms

The default iSCSI initiator setting for `node.startup` is set to `automatic`, which means that all previously discovered iSCSI targets will be logged in to at system boot. This behavior can cause a surge of iSCSI login activity during system reboots, which can place a resource burden on both the PS Series

arrays and the Linux host. Dell recommends that you change the setting to manual. The HIT/Linux `eqltune` utility recommends this change, but does not automatically implement it:
`node.startup = manual`

C.3 Configure Linux Networking

Dell's best practice recommendation is to configure multipathing for Ethernet interfaces on a Linux host to connect to a PS Series group. This multiple NIC per subnet configuration requires that several Linux networking parameters be modified from default values for reliable implementation. The HIT/Linux `eqltune` utility, when run in fix mode, automatically configures the Linux operating system to operate correctly with the multiple NIC per subnet configuration.

Note: Apply these commands, changes, and settings to each Ethernet interface (for example: `eth1`, `eth2`).

- Disable Generic Receive Offload

The Generic Receive Offload (GRO) feature, implemented by some Linux network drivers, causes poor read performance results. This feature can be disabled using the `ethtool` utility:

```
#ethtool ethX -K gro off
```

- Enable Flow Control

Flow control is often negotiated properly, but a network that supports full flow control (RX and TX pause names on) is recommended. If your network infrastructure is set up to support flow control, you could benefit from forcing flow control to be on. The HIT/Linux `eqltune` utility recommends this change, but does not automatically implement it:

```
#ethtool -pause ethX autoneg off rx on tx on
```

To make this change persistent across reboots, add the command to the `/etc/rc.local` directory.

- Enable Jumbo Frames

If supported by your networking infrastructure, enabling jumbo frames (that is, an MTU of 9000) enhances iSCSI throughput under heavy load. The HIT/Linux `eqltune` utility recommends this change, but does not automatically implement it:

In `/etc/sysconfig/networking/devices/ifcfg-ethX` (where X is the Ethernet port) add this line:

```
MTU=9000
```

- Avoid ARP Flux

The default value of 0 (zero) allows NICs to reply to ARP requests on any other NIC, which can provide false positives to externally originating ping tests, as well as unexpected ARP resets. This condition is known as ARP Flux. To avoid ARP Flux in a multiple NIC per subnet configuration, apply the following parameters in `/etc/sysctl.conf`:

```
net.ipv4.conf.ethX.arp_ignore = 1  
net.ipv4.conf.ethX.arp_announce = 2
```

- Loosen IPv4 Reverse Path Filtering

To allow multiple iSCSI connections in a multiple NIC per subnet configuration, reverse path filtering must be loosened. Use this setting:

```
net.ipv4.conf.ethX.rp_filter=2
```

Table 1 Summary of Recommended Changes

Area	Setting	Default Value	Recommended Value ¹ (PS Series)
SCSI block devices	Device timeout	30 seconds	60 seconds
Per SCSI device	read-ahead buffer	128KB	1024KB
Per SCSI device	I/O scheduler	CFQ	noop
iSCSI settings	node.session.iscsi.FastAbort	Yes	No
iSCSI settings	node.startup	manual	automatic
Ethernet devices	Generic Receive Offload	on	off
Ethernet devices ¹	flow control ¹	auto-negotiate	on
Ethernet devices ¹	jumbo frames ¹ (MTU size)	1500	9000
Sysctl tunable - ARP	net.ipv4.conf.ethX.atp_ignore	0	1
Sysctl tunable - ARP	net.ipv4.conf.ethX.atp announce	0	2
Sysctl tunable - ARP	net.ipv4.conf.ethX.atp filter	0	2

¹ Verify the network infrastructure supports these two settings (flow control and jumbo frames) before implementing them.

D Configure your Oracle Solaris 10 operating system

You can use the default initiator configuration for Oracle® Solaris® 10 operating systems. No changes are required. However, you might experience the following issue.

D.1 Zero-Length Volumes

By default, the Solaris 10 initiator automatically connects to all volumes it discovers. If it connects to a zero-length volume (such as the vss-control volume), it panics. To avoid this issue, make sure the vss-control volume on the group has access control records configured to prevent the Solaris initiator from discovering it. In other words, make sure the volume does not allow unrestricted access.

E Configure your IBM AIX operating system

The AIX native iSCSI controller does not perform device discovery, so you will need to know your iSCSI IQN target names specifically. In addition IBM® AIX® systems might experience the following issue.

E.1 iSCSI Initiators Lose Volume Connectivity

In some cases, after a load-balancing operation completes, AIX iSCSI initiators lose volume connectivity. This issue can be corrected by applying a patch to your AIX system. For more information, contact your IBM customer support provider and reference incident number IZ90885, or visit ibm.com/support/docview.wss?uid=isg1IZ90885&crawler=1.

Note: As a short-term workaround, before applying the patch, disable the PS Series group's load-balancing feature.

F Configure Your Citrix XenServer Operating System

You may use the Citrix XenServer Open-iSCSI multipathing software initiator to provide native MPIO support and discovery. More information is available on TechCenter (login required):

http://en.community.dell.com/techcenter/extras/m/white_papers/20442325.

G Technical support and resources

[Dell.com/support](https://dell.com/support) is focused on meeting customer needs with proven services and support.

[Dell TechCenter](#) is an online technical community where IT professionals have access to numerous resources for Dell EMC software, hardware and services.

[Storage Solutions Technical Documents](#) on Dell TechCenter provide expertise that helps to ensure customer success on Dell EMC Storage platforms.

G.1 Related resources

Provide a list of documents and other assets that are referenced in the paper; include other resources that may be helpful.