



Using HIT/Linux and ASM/LE with Dell PS Series Storage

Dell Storage Engineering
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April 2012	Initial Release: Installation and Configuration of HIT/Linux 1.1
October 2012	Added information about HIT/Linux 1.2
February 2013	Added support for Red Hat Enterprise Linux 5.9 and wording on support for CentOS.
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Author: Randolph Nethers, Linux/UNIX Product Specialist

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Executive summary

Dell™ PS Series arrays optimize resources through automated load balancing for both volumes and networking. The arrays come with all-inclusive management software, host software and firmware updates. The Dell EqualLogic Host Integration Tools for Linux (HIT/Linux) and Auto-Snapshot Manager/Linux Edition are important software offerings that are provided with PS Series arrays.

HIT/Linux provides a collection of applications and utilities to simplify the configuration and administration of PS Series arrays, and give the Linux host the ability to access data on the array more efficiently than with native software.

File system protection and disaster recovery are vital to a sound Linux system operation. Auto-Snapshot Manager/Linux Edition (ASM/LE) is a part of the HIT/Linux suite. ASM/LE simplifies the job of protecting data and efficient disaster recovery. With ASM/LE, the administrator may create volume-based point-in-time copies of data using snapshots, clones, and replicas. The tool enables the administrator to create online, file system-consistent copies of data stored on one or more PS Series groups, resulting in a collection of reproduced data called a Smart Copy.

Audience

The information in this guide is for Linux administrators who are interested in using the Host Integration Tools for Linux as a way to better manage PS Series arrays.

The document assumes that the reader has already installed the Host Integration Tools for Linux software. For more information about installation, please see the [Dell EqualLogic Host Integration Tools for Linux Installation and User's Guide](#) (access requires a login). Extensive network or storage experience is not required however, understanding some aspects of disk and network management, basic network concepts and the existing networking environment will be helpful.

Some PS Series management tasks require administrative access.



1 HIT/Linux features

Of the many useful features provided by HIT/Linux, this document focuses on HIT/Linux Multipath I/O (MPIO) and ASM/LE.

- **Remote Setup Wizard Command Line Interface (RSWCLI):** Use the `rswcli` setup utility to:
 - Discover and initialize PS Series arrays
 - Configure and manage access to a PS Series group
 - Set configuration parameters for MPIO
 - Manage which subnets are used for MPIO
- **Dell EqualLogic iSCSI Multipathing:** A combination of user and kernel mode binaries that:
 - Automate iSCSI session management to create and maintain the optimal iSCSI session configuration for high availability and increased performance
 - Improves I/O performance by intelligently routing I/O directly to the correct PS Series array member and therefor reducing intra-group I/O forwarding.
- **EqualLogic Configuration Utility (eqlconfig):** This utility permits interactive configuration of the components of HIT/Linux, ASM/LE and MPIO.
- **EqualLogic Host Performance and Configuration Tuning Suite (eqltune):** Used to set Linux system tuning parameters to optimum levels for increased usability and performance
- **EqualLogic Log Gathering Facility (eqllog):** collects system logs and information about the current running state of the system
- **Equallogic Volume Rethinning Facility (eqlvolume):** Manages the available storage space on thin-provisioned volumes.
- **Auto-Snapshot Manager/Linux Edition (ASM/LE):** Creates a point-in-time copy of a PS Series volume as part of a backup and recovery strategy. From the ASM/LE command-line interface, the user can:
 - Create, list, and mount Smart Copies, collections, and schedules
 - Mount and unmount Smart Copies
 - Set up and manage group access files to store group names, group IP addresses, optional management IP addresses, and passwords
 - Use the ASM/LE built-in scheduler functionality to define and execute automated Smart Copy operations
 - Create a disaster tolerant storage environment by configuring your PS Series group for replication
 - Use Smart Copy replicas at a remote location for disaster recovery
 - Recover from a data loss event in the following ways:
 - > Quickly restore a file system to a point-in-time snapshot
 - > Mount file system copies to restore a Linux host
 - > Mount file system copies on a new system for testing, development, or offline processing operations

New features can be found in the *Release Notes* that come with the software or on eqlsupport.dell.com.



2 Dell PS Series MPIO

The MPIO framework uses redundant physical connections to shared storage. Having multiple host connections, switches and SAN interfaces helps to eliminate single points of failure. Using MPIO, servers can send multiple I/O streams to SAN volumes concurrently. MPIO also provides increased redundancy and can improve performance of application data hosted on the SAN.

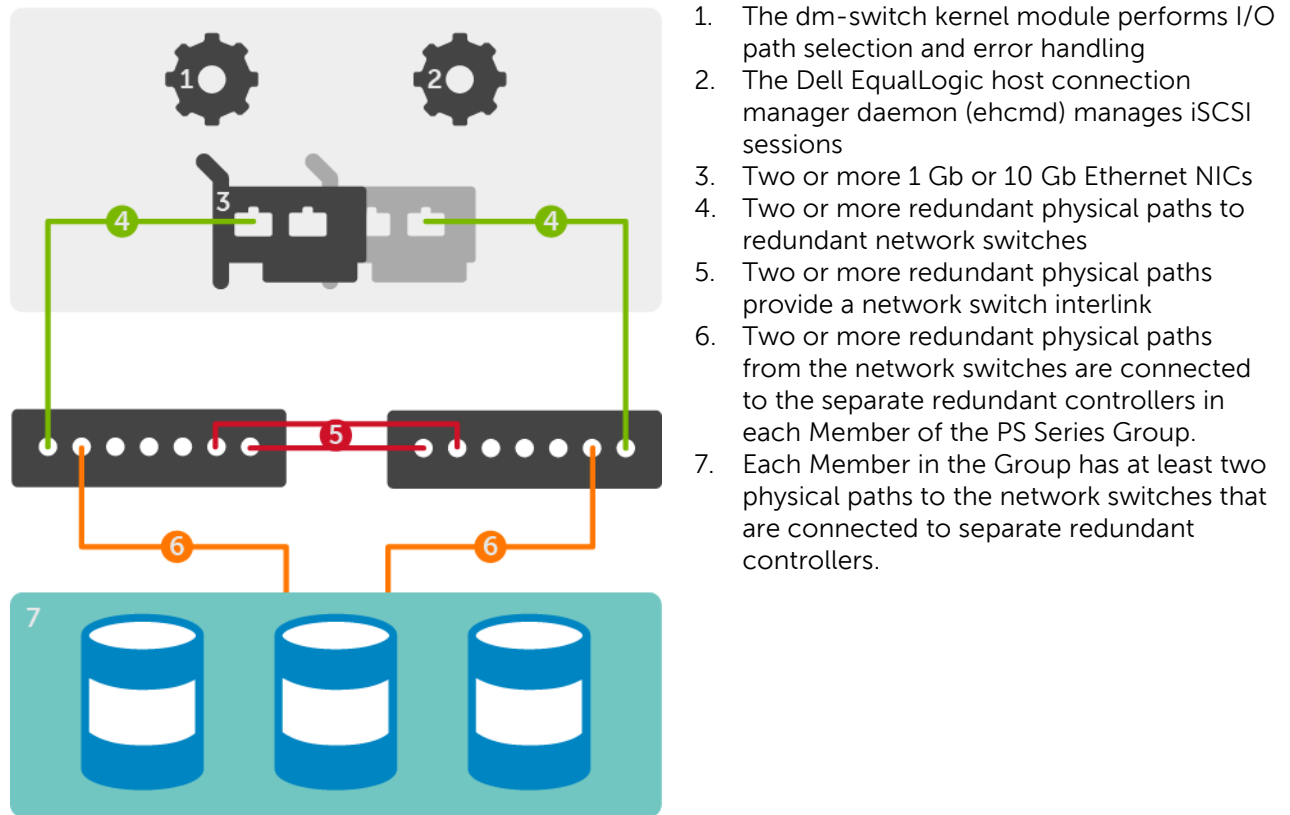


Figure 1 MPIO framework of a PS Series configuration

The Dell EqualLogic MPIO is an easy to install part of HIT/Linux and is designed to deliver:

- Automated connection management
- Automated failure detection and failover for iSCSI paths
- Automated load balancing across paths
- Support for multiple iSCSI path connections to a single iSCSI target
- Potentially increased bandwidth
- Reduced network latency
- Easy installation and management

The Dell EqualLogic HIT/Linux MPIO software consists of two components:

- The EqualLogic Host Connection Manager daemon (ehcmd) that monitors the iSCSI session state and configuration of the Linux server and PS Series Group. Running in the background, the ehcmd daemon uses the Open-iSCSI management tool (iscsiadm) to add, remove, or modify iSCSI sessions in order to maintain an optimal number of iSCSI sessions. It also gathers information on the volume layout from the PS Series Group.
- A loadable kernel module (dm-switch) that implements a new Device Mapper target to the multipath devices. Based on the volume layout on the array members, the dm-switch module routes each I/O to the optimal path in the PS Series Group.

Figure 2 shows how multiple I/O streams are concurrently routed through host iSCSI sessions directly to the member (array) in the PS Series Group servicing them. Using the Dell EqualLogic MPIO software, the best path for each I/O is selected based on knowledge about the volume layout on the PS Series Group. The Dell EqualLogic MPIO software uses iscsiadm to automatically manage these iSCSI sessions and then routes I/O directly to the member (array) where it is serviced.

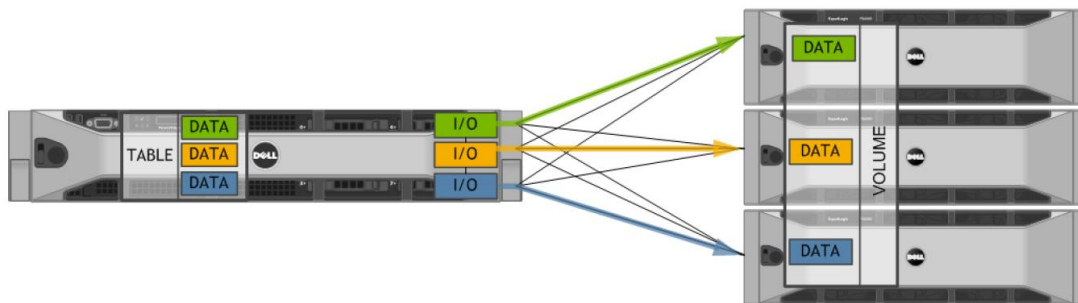


Figure 2 MPIO streams

For more information about HIT/Linux MPIO, refer to the [Dell EqualLogic Host Integration Tools for Linux Installation and User's Guide](#). Specifically, Chapter 4 addresses configuring MPIO devices.

3 Getting started

Dell EqualLogic Host Integration Tools for Linux greatly simplifies MPIO setup and configuration by completely eliminating the multipath configuration steps and automatically managing multiple iSCSI sessions. The software also optimizes the operation of a PS Series array by using knowledge about volume layouts on a PS Series group and routing I/O directly to the PS Series arrays that service requests. The EqualLogic Host Performance and Configuration Tuning Suite (eqltune) enables you to verify a Linux system for optimal iSCSI performance configuration by analyzing a large number of system settings for compliance with Dell recommended practices. There are four categories: Critical, Warning, Suggestion and OK. Eqlvolume manages recovery of disk space that has become available and makes more efficient use of disk capacity in storage volumes.

Before starting with HIT/Linux and the PS Series, Dell recommends:

- Two network interfaces available for iSCSI traffic on the Linux host separate from LAN traffic
- SAN traffic is segmented from LAN traffic, preferably on different switch infrastructure

Following these recommendations ensure optimal performance and a redundant, robust configuration.

3.1 Installation

Detailed installation steps are available in the [Dell EqualLogic Host Integration Tools for Linux Version 1.5 Installation and User's Guide](#).

The software is available at eqlsupport.dell.com and is provided for Linux as an ISO file.

- The file needs to be downloaded and mounted locally
- The RPM public key needs to be imported
- Install the software, beginning with accepting the End User License Agreement
- Run the install script, which will permit entering IP address information for the PS Series array, and login credentials for accessing volumes assigned to the Linux host
- The HIT/Linux tools will optimize the Linux system to work with the PS Series array

3.1.1 A few things to note during installation

Preview the installation procedure that is well documented in the *HIT/Linux Installation and User's Guide*.

During the installation, HIT/Linux should be used to manage MPIO and iSCSI sessions. Of course, it is important to pay attention to what interfaces are used for iSCSI sessions.

```
=====
Configuring MPIO Parameters
=====

Would you like ehcmd to actively manage MPIO and iSCSI sessions (Yes/No)
[Yes] ?
```



Choose address protocol (IPv4/IPv6) [IPv4]:

Found the following subnets for MPIO:

- 1.) 10.1.1.0/23
- 2.) 10.2.0.0/16
- 3.) Choose individual NICs

Enter a comma-separated list of subnets that you want to use for MPIO, e.g., 1, 2 or select individual NICs (1, 2, 3) [1, 2]: 2

For optimal performance, permit eqltune to fix any errors it finds in the host configuration.

```
=====
Running 'eqltune' to check system settings
=====
```

Dell EqualLogic 'eqltune' version 1.5.0
Copyright (c) 2010-2014 Dell Inc.

Checking your Linux system for optimal iSCSI performance...

Sysctl Tunables	Critical	Warnings	Suggestions	Ok
ARP Flux	2	0	0	0
RP Filter	1	0	0	0
Network Buffers	0	0	10	0
Scheduler	0	1	0	0
Ethernet Devices				
eno33559296	1	0	2	0
iSCSI Settings				
iscsid.conf defaults	1	4	1	1
External Utility Settings				
Blacklists	1	0	0	0
EqualLogic Host Tools				
Running system checks	0	0	0	2
eqlvolume checks	0	0	0	3

Run in verbose mode (eqltune -v) for more details and instructions on how



to adjust your settings.

Run in fix mode (eqltune fix) to automatically repair all Critical issues.

Critical errors detected. Eqltune can fix these automatically.

How would you like to proceed (Fix/List/Ignore) [Fix]? Fix

3.1.2 Gathering diagnostic data to show status

The ehcmcli program shows two Ethernet interfaces and their IP addresses in the following example. These two interfaces are used to connect to the PS Series array.

```
[root@rhel7 ~]# ehcmcli status
Generating diagnostic data, please wait...

=====
Adapter List
=====
  Name: eno33559296
    IP Address: 10.2.1.151
    HW addr: 00:50:56:8F:BB:E5

  Name: eno50338560
    IP Address: 10.2.1.150
    HW addr: 00:50:56:8F:4C:84

=====
Volume list
=====

Summary
=====
  Adapters:          2
  Managed Volumes:   0
  iSCSI Sessions:    0
  Errors:             0
  Warnings:          0
  Suggestions:       0
```

There are no volumes or iSCSI sessions immediately following installation and configuration. The steps to creating iSCSI sessions and using volumes are detailed below.



3.2 Accessing volumes using MPIO

To access volumes assigned to the host using the HIT/Linux MPIO:

1. Create the volume and provide it with the correct permissions (see the [Dell EqualLogic Group Manager Administrator's Guide](#) for information on provisioning volumes).
2. Verify connectivity to the PS Series array.
3. Discover the targets.
4. Log in to the iSCSI volume.
5. Create a file system on the volume.
6. Create a mount point and mount the volume.

3.2.1 Verify SAN connectivity

Verify that each network interface on the SAN network has access to the PS Series Group IP address (for example: 10.2.1.50).

```
[root@rhel7 ~]# ping -I eno50338560 -c 1 10.2.1.50
PING 10.2.1.50 (10.2.1.50) from 10.2.1.150 eno50338560: 56(84) bytes of data.
64 bytes from 10.2.1.50: icmp_seq=1 ttl=255 time=0.528 ms

--- 10.2.1.50 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.528/0.528/0.528/0.000 ms
[root@rhel7 ~]# ping -I eno33559296 -c 1 10.2.1.50
PING 10.2.1.50 (10.2.1.50) from 10.2.1.151 eno33559296: 56(84) bytes of data.
64 bytes from 10.2.1.50: icmp_seq=1 ttl=255 time=0.570 ms

--- 10.2.1.50 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.570/0.570/0.570/0.000 ms
```

Tests for each of the two example interfaces show connectivity. For the ping command, `-I` identifies interface to use, so that particular interface is tested. The `-c` switch tells the ping command to send only one ping. The above test demonstrates connectivity between the host and group iSCSI address on the PS Series array.

3.2.2 Discovering targets

Here, targets correspond to volumes that the Linux host can access. The `iscsiadm` command is used to discover those targets on the PS Series array that are available for use.

```
[root@rhel7 ~]# iscsiadm -m discoverydb -p 10.2.1.50 -t st -o new -D
10.2.1.50:3260 via sendtargets

[root@rhel7 ~]# iscsiadm -m discovery -t st -p 10.2.1.50
10.2.1.50:3260,1 iqn.2001-05.com.equallogic:0-af1ff6-2339a23e4-3e7b0d0cc335314d-
hit1
```



```
10.2.1.50:3260,1 iqn.2001-05.com.equallogic:0-af1ff6-2ff9a23e4-b3db0d0cc355314d-hit2
10.2.1.50:3260,1 iqn.2001-05.com.equallogic:0-af1ff6-2339a23e4-3e7b0d0cc355314d-hit1
10.2.1.50:3260,1 iqn.2001-05.com.equallogic:0-af1ff6-2ff9a23e4-b3db0d0cc355314d-hit2
```

There are two paths to each hit volume (hit1 and hit2) because two host Ethernet interfaces are connected to the SAN network.

3.2.3 Logging in to the volume

Typically, the `iscsiadm` command is used for logging in to an iSCSI volume. However, the `ehcmcli` command, which is part of HIT/Linux, is much more versatile.

```
[root@rhel7 ~]# ehcmcli login --target hit1 --portal 10.2.1.50
Looking up volume by name (hit1)
  Found: iqn.2001-05.com.equallogic:0-af1ff6-2339a23e4-3e7b0d0cc355314d-hit1
(10.2.1.50)
Login succeeded.  Device to mount:
/dev/eql/hit1
[root@rhel7 ~]# ehcmcli login --target hit2 --portal 10.2.1.50
Looking up volume by name (hit2)
  Found: iqn.2001-05.com.equallogic:0-af1ff6-2ff9a23e4-b3db0d0cc355314d-hit2
(10.2.1.50)
Login succeeded.  Device to mount:
/dev/eql/hit2
```

Note: At the end of each volume login, the `ehcmcli` command displays the device name. This device name is the one to use for file system creation and mounting the volume. However, devices under `/dev/mapper` are still present.

3.2.4 The Benefits of using ehcmcli

The HIT/Linux `ehcmcli` command provides similar functionality as `iscsiadm` for logging into a volume, but there are some advantages.

- The volume name can be used for logging in rather than the target IQN string to reduce the likelihood of mistyping an IQN string.
- In the time it takes the `ehcmcli login` command to return successfully, a session is established and the device symbolic link is available. With `iscsiadm`, there is a wait for the device file to be available.
- The `ehcmcli` enables leading-login support that enables one session to start and fall back across multiple interfaces. Other MPIO sessions will be set up at a later time by `ehcmd`.
- The `--login-at-boot` command can be used to automatically log in to each volume at boot time.



3.2.5 Gather diagnostic data to show status

With the volumes configured, the output correctly shows the two SAN Ethernet adapters, IP addresses and volume list. Notice under **Summary** there is one volume being managed with two iSCSI sessions from the Linux host to the volume on the PS Series Group.

```
[root@rhel7 ~]# ehcmcli status
Generating diagnostic data, please wait...

=====
Adapter List
=====
Name: eno33559296
  IP Address: 10.2.1.151
  HW addr: 00:50:56:8F:BB:E5

Name: eno50338560
  IP Address: 10.2.1.150
  HW addr: 00:50:56:8F:4C:84

=====
Volume list
=====
Volume: hit1
  Target name: iqn.2001-05.com.equallogic:0-af1ff6-2339a23e4-3e7b0d0cc335314d-hit1
  Device to mount: /dev/eql/hit1
  Status: Normal: Per-member session count reduced due to number of available
host and array NICs
    Session: 1      /dev/sdb   10.2.1.151    ->    10.2.1.65    00:11:19
    Session: 3      /dev/sdd   10.2.1.150    ->    10.2.1.57    00:07:13

Volume: hit2
  Target name: iqn.2001-05.com.equallogic:0-af1ff6-2ff9a23e4-b3db0d0cc335314d-hit2
  Device to mount: /dev/eql/hit2
  Status: Normal: Per-member session count reduced due to number of available
host and array NICs
    Session: 4      /dev/sde   10.2.1.150    ->    10.2.1.57    00:07:05
    Session: 5      /dev/sdc   10.2.1.151    ->    10.2.1.65    00:03:04

=====
Summary
=====
Adapters:          2
Managed Volumes:  2
iSCSI Sessions:    4
```



```
Errors:          0
Warnings:       0
Suggestions:    0
```

3.2.6 Create mount points and file systems

To use the available volumes, create mount points for them, file systems on them and mount them for use.

```
[root@rhel7 ~]# mkdir -pv /mnt/hit{1,2}
mkdir: created directory '/mnt/hit1'
mkdir: created directory '/mnt/hit2'
Create file systems on the devices corresponding to each volume. [root@rhel7 ~]#
mkfs.xfs /dev/eql/hit1
meta-data=/dev/eql/hit1      isize=256    agcount=4, agsize=655680 blks
                             =               sectsz=512   attr=2, projid32bit=1
                             =               crc=0        finobt=0
data      =                   bsize=4096   blocks=2622720, imaxpct=25
                             =               sunit=0      swidth=0 blks
naming    =version 2         bsize=4096   ascii-ci=0 ftype=0
log       =internal log     bsize=4096   blocks=2560, version=2
                             =               sectsz=512   sunit=0 blks, lazy-count=1
realtime  =none             extsz=4096   blocks=0, rtextents=0
[root@rhel7 ~]# mkfs.xfs /dev/eql/hit2
meta-data=/dev/eql/hit2      isize=256    agcount=4, agsize=655680 blks
                             =               sectsz=512   attr=2, projid32bit=1
                             =               crc=0        finobt=0
data      =                   bsize=4096   blocks=2622720, imaxpct=25
                             =               sunit=0      swidth=0 blks
naming    =version 2         bsize=4096   ascii-ci=0 ftype=0
log       =internal log     bsize=4096   blocks=2560, version=2
                             =               sectsz=512   sunit=0 blks, lazy-count=1
realtime  =none             extsz=4096   blocks=0, rtextents=0
```



3.2.7 Mount volumes

Mount the created file systems. The devices `/dev/eql/hit1` and `/dev/eql/hit2` are mounted on `/mnt/hit1` and `/mnt/hit2`, respectively.

```
[root@rhel7 ~]# mount /dev/eql/hit1 /mnt/hit1
[root@rhel7 ~]# mount /dev/eql/hit2 /mnt/hit2
```

The `df` command demonstrates the availability of `/mnt/hit1` and `/mnt/hit2`.

```
[root@rhel7 ~]# df
Filesystem                                1K-blocks      Used
Available Use% Mounted on
<truncated to show only 'hit' volumes>
/dev/eql/hit1 10480640    32928 10447712    1% /mnt/hit1
/dev/eql/hit2 10480640    32928 10447712    1% /mnt/hit2
```

Note: The PS Series volumes can be mounted automatically at boot by making the appropriate entries in the host's file system table (`/etc/fstab`). For example, for the `hit1` volume:

```
/dev/eql/hit1 /mnt/hit1 xfs _netdev,defaults 0 0
```

Adding the `'_netdev'` option is important in this case, because the PS Series volume is an iSCSI volume. The `_netdev` option tells the operating system to wait for network availability before attempting to mount the iSCSI volume.



4 HIT/Linux with ASM/LE

Disaster recovery and protecting the file system are key to information system operation. Maintaining the availability and integrity of systems and information is a driving force in the information industry. The shortest possible time to recovery and minimized data loss in disaster situations require solutions balanced against cost. PS Series arrays with ASM/LE and the ability to create volume-based point-in-time copies of data using snapshots, clones, and replicas greatly reduces the cost of achieving ever increasing demands for data and system availability and integrity.

ASM/LE functionality in HIT/Linux enables online creation of file system consistent copies of data stored on one or more PS Series groups. The resulting collection of copied data is called a Smart Copy. ASM/LE offers consistent Smart Copies using the built-in snapshot, clone and replication facilities in PS Series arrays. With ASM/LE a Linux server administrator can:

- Create and manage Smart Copy operations using the Auto-Snapshot Manager Command Line Interface (ASMCLI) command syntax interactively and in scripts
- Use the ASM/LE built-in scheduler functionality to define and execute automated Smart Copy operations
- Recover from a data loss event in the following ways:
 - Quickly restore a file system to a point-in-time snapshot
 - Mount file system copies to restore a Linux host
 - Mount file system copies on a new system for testing, development, or offline processing operations
 - Use Smart Copy replicas at a remote location for disaster recovery
- Create a disaster tolerant storage environment by configuring your PS Series group for replication

The capabilities of ASM/LE extend the use of PS Series Smart Copy technology and snapshot facilities to server administrators. The productivity of server administrators increases and allows the efficient use of SAN copy capabilities without requiring SAN privileges. By automating these data protection operations, the headaches and time-consuming day-to-day operations of managing and maintaining volume uptime are minimized, while substantially decreasing the risk of data loss. Data availability can be sustained at a high level of assurance using Auto-Snapshot Manager and Smart Copy technologies with PS Series arrays.

HIT/Linux Auto-Snapshot Manager coordinates Linux host file system I/O operations and PS Series SAN copy operations. ASM/LE uses Linux file system I/O freeze functionality to provide host integration with PS Series SAN copy operations. Quieting the file system on the Linux host temporarily suspends I/O operations. With the quiet file system, consistent copies of volumes can be created on the PS Series Group. The hardware-based Smart Copy operation completes very quickly, after which I/O operations resume to the file system. The result is a data-consistent point-in-time Smart Copy of the volume(s). Smart Copies can then be used to restore a volume fully, or any file system element within that Smart Copy set. ASM/LE automates Linux host file system restores and mounts, iSCSI login/logout operations and associated PS Series SAN operations.



Only particular versions of Linux are supported as mentioned above and in the *Dell EqualLogic Host Integration Tools for Linux Installation and User's Guide*. ASM/LE is unable to create file system consistent Smart Copies for Linux host kernel versions earlier than 2.6.29. ASM/LE supports file systems that support freeze and thaw operations. Supported file systems include ext3, ext4, xfs and gfs2.

4.1 ASM/LE with Linux I/O

ASM/LE coordinates Linux host file system I/O operations and PS Series SAN copy operations. ASM/LE uses Linux file system freezing functionality to provide host integration with PS Series SAN copy operations. Quiescing the file system on the Linux host temporarily suspends I/O operations, enabling file system consistent copies of volumes to be created on the PS Series group. The hardware-based Smart Copy operation completes very quickly, after which I/O operations resume to the file system. The end result is a data-consistent point-in-time Smart Copy of the volume(s). Smart Copies can then be used to fully restore a volume or any file system element within that Smart Copy set. ASM/LE automates Linux host file system restores and mounts, iSCSI login/logout operations and associated PS Series SAN operations.

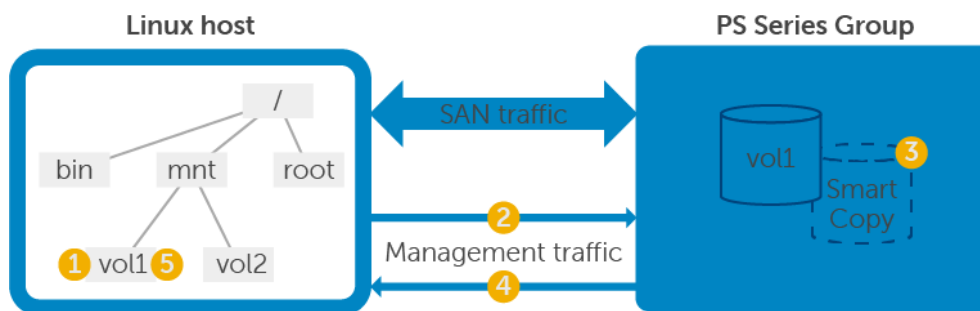


Figure 3 Smart Copy creation

The steps numbered in Figure 3 are:

1. The file system (`/mnt/vol1`) is frozen on the Linux host, temporarily suspending I/O to `vol1` on the PS Series group.
2. A request is sent from the Linux host to the PS Series Group to create the Smart Copy using the PS Series hardware copy functionality.
3. The PS Series Group creates a smart copy of `vol1`.
4. A response is sent from the PS Series Group to the Linux host confirming that the Smart Copy operation has been completed.
5. The file system (`/mnt/vol1`) is thawed on the Linux host, which resumes I/O to `vol1` on the PS Series Group.

Note: ASM/LE quiets the file system(s) associated with the volume(s) in a Smart Copy set. Some applications may require application-specific coordination steps to create an application consistent copy. (For example, database applications require the database itself to quiet first before stopping I/O to the volume.) If an application software offers methods for quieting the application, ASM/LE operations can be incorporated into those procedures and scripts.

4.2 General command syntax

The ASM command line interface (ASMCLI) provides Smart Copy creation and management commands that can be entered at the Linux shell prompt. The general ASMCLI command syntax is:

```
# asmcli command-verb command-noun [--parameter [argument] ]
```

Complete ASMCLI commands include both a command-verb and a command-noun. For example, `asmcli create smart-copy` includes the verb `create` and the noun `smart-copy`. The [Dell EqualLogic Host Integration Tools for Linux Version 1.5 Installation and User's Guide](#) provides a concise summary of all ASMCLI commands along with the <verb> and <noun> pairs that are supported.

ASM/LE includes the following internal help facilities:

- Linux man page # `man asmcli`
- `asmcli help overview` # `asmcli help`
- `asmcli help specific command` # `asmcli < verb > < noun > -- help`

Note: Command line interfaces in HIT/Linux, including ASMCLI, are integrated with a Bash programmable command completion facility. This feature can make entering ASMCLI commands easier and faster by greatly reducing the amount of typing that is required to issue ASM/LE operations. Simply type part of a command and hit the <tab> key, and if the part of the command already typed is unique, the shell will automatically fill in the rest, or if there are two or more alternatives, they will be displayed. Type enough of the command to make it unique, and hit <tab> again, and the shell will fill in the rest of the command.

4.3 A basic usage example

Prior to covering all the concepts and functionality available in ASM/LE, it may be helpful to provide the procedure for a basic usage example. In this example, a Smart Copy is created, then mounted and deleted. One volume named `hit1` is already connected and mounted on the Linux host and multipath I/O is managed over two iSCSI connections.

The output from the HIT/Linux `ehcmcli status` command, along with a list of the mounted file systems (**df**), is shown here:

```
[root@rhel7 ~]# ehcmcli status
Generating diagnostic data, please wait...
```

```
=====
Adapter List
=====
Name: eno33559296
  IP Address: 10.2.1.151
  HW addr: 00:50:56:8F:BB:E5
```



Name: eno50338560
IP Address: 10.2.1.150
HW addr: 00:50:56:8F:4C:84

=====

Volume list

=====

Volume: hit1
Target name: iqn.2001-05.com.equallogic:0-af1ff6-2339a23e4-3e7b0d0cc335314d-hit1
Device to mount: /dev/eql/hit1
Status: Normal: Per-member session count reduced due to number of available host and array NICs
Session: 1 /dev/sdb 10.2.1.151 -> 10.2.1.65 22:09:27
Session: 3 /dev/sdd 10.2.1.150 -> 10.2.1.57 22:05:21

Volume: hit2
Target name: iqn.2001-05.com.equallogic:0-af1ff6-2ff9a23e4-b3db0d0cc335314d-hit2
Device to mount: /dev/eql/hit2
Status: Normal: Per-member session count reduced due to number of available host and array NICs
Session: 4 /dev/sde 10.2.1.150 -> 10.2.1.57 22:05:13
Session: 5 /dev/sdc 10.2.1.151 -> 10.2.1.65 22:01:12

=====

Summary

=====

Adapters: 2
Managed Volumes: 2
iSCSI Sessions: 4
Errors: 0
Warnings: 0
Suggestions: 0

The df command demonstrates the availability of the new volumes.

```
[root@rhel7 ~]# df
(showing only the hit1 and hit2 volumes)
Filesystem        1K-blocks    Used   Available   Use%   Mounted on
/dev/eql/hit1    10480640    32928   10447712    1%   /mnt/hit1
/dev/eql/hit2    10480640    32928   10447712    1%   /mnt/hit2
```

Assuming this is the first time ASM/LE has been used between the Linux host and PS Series group, ASM Group Access Credentials must be established before Smart Copy operations are performed. Established group access credentials are cached on the Linux host for future use.



The following steps for a basic scenario demonstrate the command syntax for ASMCLI.

1. Create Group access credentials. This is required once to establish group access and create cached credentials. See the section 5, "Group access credentials" for more information.

```
[root@rhel7 ~]# asmcli create group-access --name EQLGROUP1 --ip-address
10.2.1.50 --user-name pooladmin
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

Using Management IP 10.1.1.30 to contact EQLGROUP1.
Password for user pooladmin on EQLGROUP1: *****
Successfully created credentials record in file /etc/equallogic/asm-group-
access.
```

2. Create a Smart Copy as needed. In this example, a Smart Copy of /mnt/hit1 is created.

```
[root@rhel7 ~]# asmcli create smart-copy --source /mnt/hit1
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

The mount point has been frozen.
Created snapshot hit1-2016-05-06-12:15:43.369554.1 on EQLGROUP1
The mount point has been thawed.
Successfully created a Smart Copy from 1 target.
```

3. Use the command line tool to mount the newly created Smart Copy snapshot and to unmount it (on /mnt/SNAP in this example).

```
[root@rhel7 ~]# mkdir /mnt/SNAP
[root@rhel7 ~]# asmcli mount smart-copy --latest --destination /mnt/SNAP
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

Logging in 1 Smart Copy target.
Logged in hit1-2016-05-06-12:15:43.369554.1 on EQLGROUP1
Mounted /mnt/SNAP/mnt/hit1
Successfully mounted 1 file system from 1 Smart Copy target.

[root@rhel7 ~]# asmcli unmount smart-copy --latest
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

Unmounted /mnt/SNAP/mnt/hit1
Removing sessions to hit1-2016-05-06-12:15:43.369554.1 on EQLGROUP1

Successfully unmounted 1 file system and logged out 1 target.
```



4. Use the ASMCLI command to delete the smart copy.

```
[root@rhel7 ~]# asmcli delete smart-copy --latest
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
Deleted Smart Copy: 1-e32649-774abb0ac-fd9527f9766b79bd
Successfully removed the Smart Copy.
```

The example above demonstrates issuing ASM/LE commands in an interactive shell. These same commands can be imbedded in shell scripts that permit scripting. Scheduling makes unattended creation of Smart Copies possible.

4.4 Backup documents

Backup documents permit ASM/LE recovery operations and are vital to the Smart Copy restore process. Backup documents are XML documents that contain the metadata for the Smart Copy set and are by default stored in a local directory. In order for ASM/LE to perform a volume recovery operation, it needs the backup document associated for that Smart Copy set. Without the backup document, recovery operations cannot be performed by ASM/LE.

The location of the backup document directory is a configurable item within ASM/LE and can be modified by either running the eqlconfig utility or by editing the SmartCopyDirectory value in the /etc/equallogic/eql.conf HIT/Linux configuration file. The default value is /var/lib/equallogic/asm/smart-copies/.

For cluster environments, the ASM/LE backup document folder can be set to the same location on every node. This allows every node to read and access the backup docs created from other nodes within the cluster.

Best practice: The location for the ASM/LE backup document directory should be managed on a central file resource that can be backed up regularly. If PS Series replication is configured, the backup document directory location should be reachable by the primary and remote groups and ideally, replicated either through automated means or manually transported to the remote site. The following three figures show protection options for backup documents.

In Figure 4, the protection scenario uses a volume share located on the PS Series group. By using a SAN volume for the backup document directory location, data protection can be handled using standard PS Series snapshots or any other supported backup application. Using this protection scenario, the backup document path can be mounted on one host and shared among multiple hosts that may need access to the backup documents for restore options.



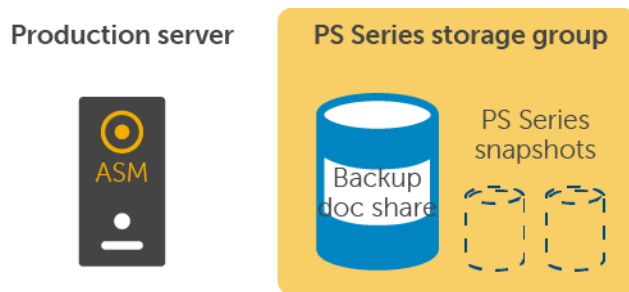


Figure 4 First protection option

Figure 5 shows the protection scenario that includes the use of standard PS Series volume snapshots on the local SAN as well as volume replication to a remote PS Series group. By replicating the backup document directory to a replication partner, the backup document files can be incrementally sent to the remote group. Make sure that the backup document replication occurs regularly to ensure restore capabilities at the remote location.

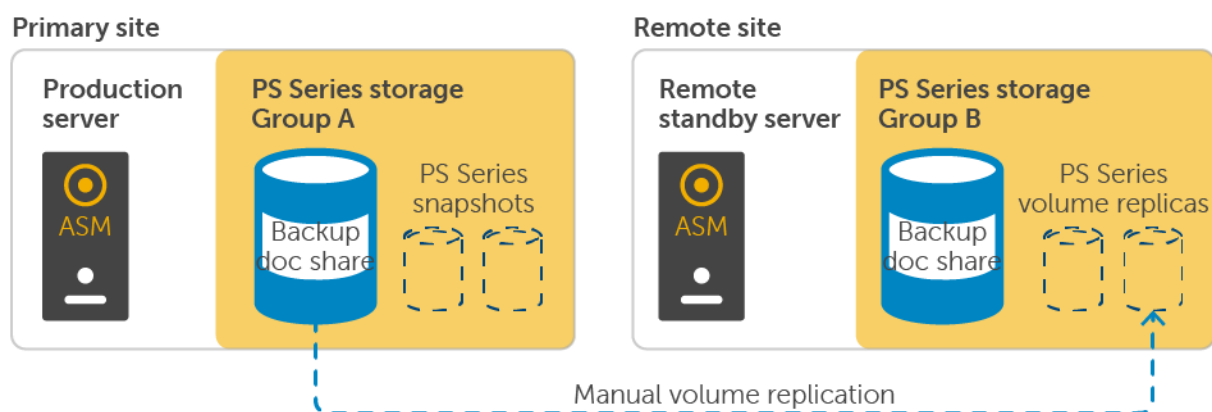


Figure 5 Second protection option

Backup documents reside on a PS Series volume at the remote site and the remote site volume is being accessed by the primary site over the WAN. In the event of a primary site disaster, the volume can be accessed by a remote site server and the backup documents remains intact. This example assumes that the volume is being accessed by one host at a time and the backup document path is being shared to additional hosts.

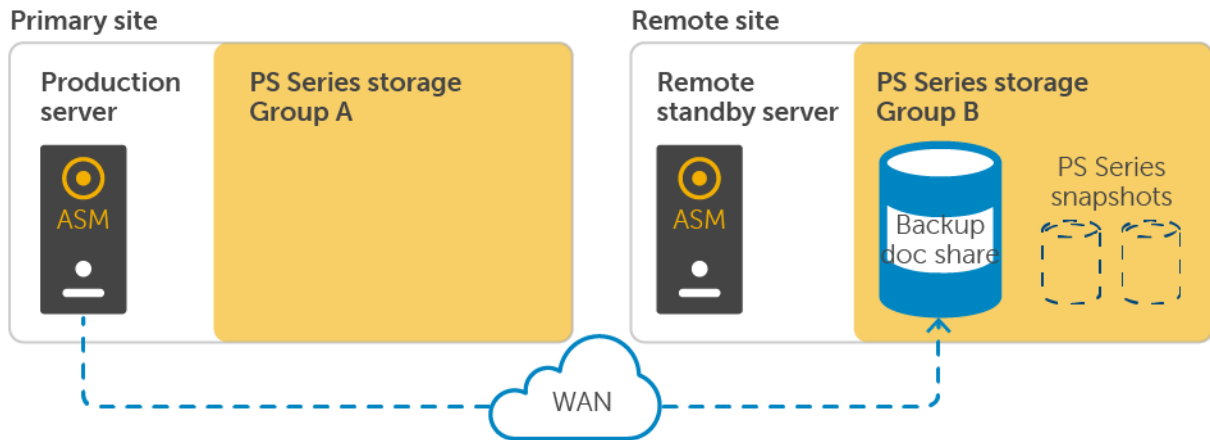


Figure 6 Third protection option

All three backup document protection scenarios vary by configuration and complexity. As with any data protection scenario, you should test and verify your solution before putting it into a production environment. Everyone involved should be aware of and comfortable with the recovery procedures in the event of data disaster.

ASM/LE lets you validate all backup documents known by a Linux host with the command:

```
# asmcli list smart-copy --broken
```

This operation makes sure that there are valid Smart Copies located on the PS Series SAN for every backup document contained in the backup document location directory. If ASM/LE determines there are broken backup documents or backup documents that do not associate with any Smart Copies, they can be removed with the command:

```
# asmcli delete smart-copy --broken
```

In some cases, the `--force` option is required for the delete operation to succeed. Refer to the *Host Integration Tools for Linux Installation and User's Guide* for more information about managing backup documents and broken Smart Copies.

Best practice: Remove broken Smart Copies and associated backup documents. This ensures that all the Smart Copies listed are valid and usable for restore and recovery operations.

5 Group access credentials

Group access credentials are used by ASM/LE to connect to PS Series groups and perform ASM operations. The credentials are stored in group-access files on the Linux host and contain encrypted usernames and passwords for the corresponding administration accounts on the PS Series group. An error occurs if ASM/LE attempts to perform an ASM operation on a PS Series group to which the Linux host does not have group access credentials established.

Establishing ASM/LE group access credentials involves configuration steps on the Linux host(s) and PS Series group. Specifically, an administration account must exist on the PS Series group that matches the group access credentials created on the Linux host. Dell recommends using pool or volume administrative accounts rather than the default group administrator account (grpadmin). The examples in this document use an administrative account named **pooladmin**, previously created on the PS Series Group. The **Administration** tab within the **Group Configuration** section of the PS Series Group Manager GUI allows management of administration accounts.

Best practice: When establishing group access credentials, avoid using the default group administrator (grpadmin) account that provides all privileges on the entire group. Instead, configure pool and volume administrators on the PS Series Group and use those for Linux host group access credentials. This approach provides sufficient privileges for ASM/LE while restricting access to the entire group.

With the administration account configured, the `asmcli create group-access` command syntax is used on the Linux host to create and save the group access credentials on the Linux host.

```
[root@rhel7 ~]# asmcli list group-access
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
=====
Group Access
=====
```

0 Groups defined.

There is no group access defined. Below, the **pooladmin** administration account is created, and then listed. The `asmcli create group-access` command creates the **pooladmin** access on the **EQLGROUP1** group. The `asmcli list group-access` command lists the newly created access. `[root@rhel7 ~]# asmcli create group-access --name EQLGROUP1 --ip-address 10.2.1.50 --user-name pooladmin`

```
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
Password for user pooladmin on EQLGROUP1: *****
Successfully created credentials record in file /etc/equallogic/asm-group-access.
```

```
[root@rhel7 ~]# asmcli list group-access
```



```
=====
Group Access
=====
```

```
Group name:      EQLGROUP1
IP address:      10.2.1.50
Management IP:   10.1.1.30
User names:      pooladmin
```

1 Group defined.

Group Access credentials only need to be configured once, afterwards the credentials are retained on the Linux host. The default group access file location is `/etc/equallogic/asm-group-access`. Using ASM/LE, credentials can be created, updated and deleted from group access files.

5.1 Managing multiple identities

ASM/LE supports the creation and management of multiple group access credentials for a PS Series group. When multiple user names are stored on a Linux host for a single PS Series group, ASM/LE needs to know which credentials should be used for the requested operation. Use the `--user-name <name>` parameter to specify the appropriate credentials.

```
# asmcli create smart-copy --source <mount point> --user-name <name>
```

Note: ASM/LE requires that the proper group access privileges exist between the group access username provided by the Linux host and the object/volume being accessed on a PS Series group. If the group access user credentials being provided by the Linux host do not have sufficient permissions to perform an operation on a PS Series group object, an error is returned. For security purposes, the error message returned by ASMCLI may indicate that the object on the PS Series group does not exist, because it is not available to that user.

ASM/LE supports the management of multiple group access credentials through two techniques. First, the `asmcli create group-access--user-name` syntax can be used to save multiple user names on the Linux host in the default group access file location. Second, the `asmcli create group-access --file` syntax is available for creating user defined group access file(s) somewhere other than the default file location. Referencing a user created group access file is accomplished through the use of the `--group-access-file <path>` syntax.

```
# asmcli create smart-copy --source <mount point> --group-access-file <path>
```

6 Smart Copy types and operations

ASM creates Smart Copies using the built-in PS Series SAN protection capabilities of volume snapshots, clones, and replicas. The Smart Copies created by ASM/LE are visible in the PS Group Manager GUI and CLI. A Smart Copy consists of:

- One or more snapshot, replica or clone (depending on the type of Smart Copy operation and the original operation)
- A backup document describing the Smart Copy that is required for operations later, such as a restore operation

All Smart Copies can be transported and can be mounted on any Linux host, whether the originator of the data, or another, provided the host mounting the Smart Copy has iSCSI access privileges and group access.

The following section covers several Smart Copy types and options that are supported. A complete list of the Smart Copy types supported by ASM/LE is located in the [Dell EqualLogic Host Integration Tools for Linux Installation and User's Guide](#).

6.1 Snapshot Smart Copy

A snapshot Smart Copy is a point-in-time copy of a volume at the time of the Smart Copy operation. Snapshots are the most space-efficient form of a volume Smart Copy, therefore multiple copies of snapshots can be retained on a PS Series group with minimal storage resource consumption. Snapshots can be used for in-place file system recovery operations. By default, ASM/LE creates snapshot Smart Copies, unless a different type is specified by the `asmcli` command.

In the PS Series Group Manager GUI, snapshot Smart Copies are shown under each base volume from where they were created.

Using ASM/LE, Smart Copy snapshots can be created and applied to:

- Restore the current volume by rolling back the source volumes to the point in time of the Smart Copy (restore in place).
- Mount the snapshot to allow manual, selective recovery of file system data (side-by-side recovery).
- Restore a volume to a new physical location, even on a different Linux host.

Smart Copy snapshots can be created by using the `asmcli create smart-copy` command syntax, as seen earlier. Here a snapshot is created and then listed. In this example, the user-name was specified **pooladmin**, and a comment was added to the description using the `--comment` syntax:

```
[root@rhel7 ~]# asmcli create smart-copy --source /mnt/hit1 --user-name
pooladmin --comment 'asmcli test'
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```



```
The mount point has been frozen.  
Created snapshot hit1-2016-05-06-14:22:05.2394 on EQLGROUP1  
The mount point has been thawed.
```

```
[root@rhel7 ~]# asmcli list smart-copy  
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0  
Copyright (c) 2010-2016 Inc.
```

```
=====
```

```
Smart Copy
```

```
=====
```

```
Source          rhel7. : /mnt/hit1  
Snapshot:       06-May-2016 14:22:05.128176  
Description:    asmcli test  
ObjectID:       8-e5f21a-6752cfe45-1291ed81409ae43f  
hit1 --> hit1-2016-05-06-14:22:05.2394 on EQLGROUP1
```

The ObjectID is a value that can be used in various ASM/LE operations (such as delete, list and mount) using the `--object ObjectID` syntax to specify a particular Smart Copy.

6.2 Clone Smart Copy

Clone Smart Copies are exact duplicates of the original volume(s) including all the data of each volume included in the Smart Copy. Clones are treated and shown as separate volumes in the PS Series Group Manager GUI. Since creating a clone creates a new, independent volume, clone Smart Copies cannot be used in ASM/LE restore operations. Clone Smart Copies are most useful when recreating the original volume environment, either on that Linux host or another one.

With ASM/LE, Smart Copy clones can be used to duplicate production environments or create exact copies of environments for testing and development scenarios. In addition, these copies can also be used to offload operations from the production server, such as reporting or data mining.

Smart Copy clones can be created through use of the `asmcli create smart-copy --type clone --source /mnt/hit1` syntax. In this example the first command creates the clone and the second command lists the Smart Copies of type clone:

```
[root@rhel7 ~]# asmcli create smart-copy --type clone --source /mnt/hit1  
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0  
Copyright (c) 2010-2016 Inc.
```

```
The mount point has been frozen.  
Created snapshot hit1-clone-2016-05-06-15:03:46.306 on EQLGROUP1  
The mount point has been thawed.  
Successfully created a Smart Copy from 1 target.
```



```
[root@rhel7 ~]# asmcli create smart-copy --type clone
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
=====
Smart Copies
=====
```

```
Source          rhel7. : /mnt/hit1
Snapshot:       06-May-2016 15:03:46.272560
ObjectId:       7-768a31-81a00e414-0e34adfe8b7231ab
hit1 --> hit1-clone-2016-05-06-15:03:46.306 on EQLGROUP1
```

```
1 Smart Copy found.
```

6.3 Replica Smart Copy

Replica Smart Copy options are available if replication is configured in the PS Series group for the volume or volumes. Replicas are snapshots that are sent from one PS Series group and stored at another PS Series group. They only hold the changed data from the last replica operation. When using replica Smart Copies, it is important to manage the Smart Copy backup documents so that they can be accessed and used to recover replicas on the remote site or replication partner group.

To replicate many volumes, make sure to configure sufficient replication space. Also, the time required to replicate data can vary based on the amount of data being replicated and the bandwidth of the network between the partner groups.

Replica Smart Copies can be used to recover primary site data at a remote site or to offload reporting or data mining operations to the remote site. Smart Copy replicas are created using the `asmcli create smart-copy replica` command syntax, as shown here:

```
[root@rhel7 ~]# asmcli create smart-copy --type replica --source /mnt/hit1
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
The mount point has been frozen.
The replica was started successfully.
The mount point has been thawed.
Getting remote replica information, please wait ...
Created replica hit1.6-2016-05-06-15:52:11.375581.1 on EQLGROUP1
Successfully created a Smart Copy from 1 target.
```

When performing replica operations, ASM/LE will only freeze the file system long enough to quiet the file system and initiate the replication. This approach allows file system operations to proceed during the actual replication process, which may take a while to complete. Upon completion of the create replica operation, the PS Group Manager displays the remote replicas for the volume.



6.4 Smart Copy object collections

Smart Copy collections can be configured to create Smart Copies of a group of volumes. Volumes can be combined into a collection so that snapshot, clone, or replica Smart Copies can be made of a group of volumes while issuing one ASMCLI command. This is especially useful for scheduling Smart Copy operations of similar components sharing the same set of volumes. Collections can be created by using the `asmcli create collection` command syntax.

Collections can be accessed by specifying the collection name within an `asmcli` command using the `--collection` syntax. Collections can be created, listed and modified in ASM/LE. The following screenshot captures these steps, highlighting the step numbers next to the corresponding command lines:

1. List existing collections (there are none).

```
[root@rhel7 ~]# asmcli list collection
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
0 collections found
```

2. Create a collection with two mount points: hit1 & hit2.

```
[root@rhel7 ~]# asmcli create collection --name hit-collection --source
/mnt/hit1 /mnt/hit2
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
Successfully created collection "hit-collection".
```

3. List the collection.

```
[root@rhel7 ~]# asmcli list collection
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
=====
Collections
=====
```

```
Name:                hit-collection
Mount point:         /mnt/hit1
Mount point:         /mnt/hit2
```

4. Create a Smart Copy snapshot of the collection.

```
[root@rhel7 ~]# asmcli create collection --name hit-collection --source
/mnt/hit1 /mnt/hit2
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```



```

All mount points (2) have been frozen.
Created snapshot hit1-2016-05-09-09:41:46.2227 on EQLGROUP1
Created snapshot hit2-2016-05-09-09:41:47.2228 on EQLGROUP1
All mount points (2) have been thawed.
Successfully created a Smart Copy from 2 targets.

```

6.5 Smart Copy schedules

ASM/LE includes scheduler functionality to define ongoing Smart Copy protection at various intervals. ASM/LE scheduler functionality relies on a Linux scheduler service (cron) and supports Smart Copy schedule frequencies as low as five minutes. The scheduler supports a **keep count** parameter (`asmcli create schedule -keep <count>`) that retains only the specified number of active Smart Copies for an object. This ensures that storage resources are conserved while data recovery remains highly available. Note that schedules can be used to create either snapshot or replica Smart Copies, but not clones.

The recommended procedure for defining, verifying and registering a schedule requires these steps:

1. Create a schedule by using the `asmcli create schedule` command.
2. Verify the schedule syntax using the `asmcli do schedule` command.
3. Register the schedule with a Linux scheduler service such as cron.

The steps are demonstrated here:

```

[root@rhel7 ~]# asmcli create schedule --name hourly --source /mnt/hit1 -retry-
count 12
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

```

Successfully created schedule "hourly".

```

[root@rhel7 ~]# asmcli do schedule --name hourly
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

```

```

The mount point has been frozen.
Created snapshot hit1-2016-05-09-11:43:29.2230 on EQLGROUP1
The mount point has been thawed.
Successfully created a Smart Copy from 1 target.

```

```

[root@rhel7 ~]# asmcli list schedule
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.

```

```

=====
Schedules
=====

```



```
Name:          hourly
Source:        /mnt/hit1
Type:          snapshot
Count:         1 (limit 12)
Last Ran:      09-May-2016 11:42:38
```

```
1 schedule found.
```

The example above demonstrates a new schedule named **hourly**, which takes a snapshot of the file system mounted at /mnt/hit1 using a retry-count of 12. Then the schedule syntax is verified by interactively performing the schedule with the `asmcli do schedule --name hourly` command. Lastly, the schedule is listed using the `asmcli list schedule` command.

Next the schedule is registered with the scheduler service, in this case cron, by editing the crontab using the `crontab -e` command. Note the crontab syntax used. First, the full pathname to the `asmcli` command is used. Cron syntax requires that either the `PATH` variable is updated or full pathnames be provided. Also, the output of the `asmcli do schedule` command is redirected to /dev/null. This syntax discards output for normal, successful executions of the schedule. If however there is an error, cron will send email to the root account. The specific syntax used in the crontab is:

```
[root@rhel7 ~]# crontab -l
# Run this schedule every 60 minutes
*/60 * * * * /sbin/asmcli do schedule --name hourly > /dev/null 2>&1
```

Dell recommends developing ASM/LE schedules in stages, starting with an `asmcli create smart-copy` command that has been verified prior to registering the operation with a scheduling service. This approach provides a convenient way to test scheduled operations before adding them to a scheduler service.

Note that the `asmcli update schedule --name` syntax can be used to modify the properties of an existing schedule, while `asmcli delete schedule --name` will remove schedules. Ensure that schedules are removed from the scheduler service (for example, cron) prior to deleting them. Otherwise the Linux scheduler service will encounter errors when attempting to execute missing schedules. Also, to ensure reliable performance in production environments, avoid scheduling frequencies of less than 10 minutes.

ASM/LE implements schedules that perform Smart Copy operations repeatedly at user defined intervals. Snapshot and replica Smart Copies are limited by the available snapshot reserve and replica reserve configured on the PS Series group.

Best practices: Use the `--keep` option when creating schedules to manage the number of objects retained to limit the amount of reserve space consumed on the PS Series group.

Use the `--retry-count` option when creating schedules to accommodate recovery from failed operations. If an intermittent failure occurs, ASM/LE will try as many times as indicated, increasing the



likelihood of success. The `--retry-wait` option determines how long to pause between retries (the default value is 10 seconds).

Avoid creating too many schedules and schedules that execute too frequently, both of which can adversely affect performance. Dell recommends specifying a frequency of no fewer than 10 minutes for jobs that run a Smart Copy schedule.

6.6 Choosing a Smart Copy type

The needs of the business will determine what type of Smart Copy to create by using ASM/LE.

A snapshot Smart Copy can be used for fast recovery and the most efficient use of storage resources. Snapshot Smart Copies use minimal amounts of storage resource and are sufficient for a complete recovery strategy.

Clone Smart Copies create a mirror of the original volume structure, creating a standalone copy, independent of the original volume. A clone is good for application or user data.

If there is a remote site available and you want the ability to bring the latest version of application or user data online in the event of a disaster at the primary site, use replica Smart Copies. These also enable the ability to offload reporting or data mining operations from the production site. Choose the Smart Copy type and the behavior based on the planned usage of the Smart Copy (for example, file system restore, test environment and development).

6.7 Smart Copy selection

ASM/LE offers a number of methods for selecting Smart Copies in `asmcli` command syntax. By default, the `asmcli list smart-copy` command lists all available Smart Copies but a flexible array of qualifiers can be applied to filter the output list (or example, `--latest`, `--earliest`, `--hostname`, `--schedule`, and `--object`). These qualifiers can also be used for other ASM/LE operations such as restoring and mounting Smart Copies.

Best practice: Dell recommends using the `asmcli list smart-copy` command to ensure that the resulting smart copy list selects the expected Smart Copy. Once the Smart Copy selection is verified, replace the list verb with the desired verb (for example, delete). Be especially careful when using the `--latest` parameter with `asmcli` to select a Smart Copy. The most recent Smart Copy object created by an ASM/LE operation will be selected, including those built by scheduled operations. Dell recommends selecting by `ObjectId` to ensure the specific, desired Smart Copy is chosen.



6.8 Storage resource management

Snapshot Smart Copies use the snapshot reserve space allocated to the volume. The amount of snapshot reserve can be monitored and changed for each volume by viewing and modifying reserve allocations in the PS Series Group Manager.

When a snapshot Smart Copy is restored, the snapshot continues to exist and continues to use the snapshot reserve for the volumes that make up the Smart Copy. Any writes to these snapshots while they are mounted on a host will consume additional snapshot reserve.

Best practice: Maintain keep counts for Smart Copy schedules to minimize overuse of snapshot reserve. If storage resources are overcommitted, snapshots can be deleted. For long term use of a Smart Copy, it is recommended to use Clone type Smart Copies. Also, a snapshot Smart Copy can be converted to a volume through the PS Series Group Manager.

Clone Smart Copies use the same amount of storage as the original volume or volumes. When you create a clone Smart Copy, a new volume appears in the Group Manager GUI with the date and timestamp of the Smart Copy operation. Clone Smart Copies can be mounted on a Linux host through ASM/LE by using the `asmcli mount smart-copy -t clone` command syntax. Once the clone Smart Copy is brought online to a host, it is treated as a normal volume.

Best practice: Clone Smart Copies are complete copies of objects and should be cleaned up after use to avoid storage resource consumption.

Replica Smart Copies can be created if replication is configured for a volume or volumes. Replication requires a replication partner PS Series Group to store the replica set and must be set up on both PS Series groups prior to creating a Smart Copy replica. The first replication always replicates the total volume data. Each subsequent replication operation only replicates the data that changed for the volume or volumes since the last replication operation. You can monitor and increase the replication reserve through the PS Group Manager GUI at any time.

Note that mounting a Smart Copy with the `--read-only` option halts all replication activity on that Smart Copy replica set until the replica is unmounted and demoted.

The time it takes to replicate data can vary due to the amount of data being replicated and the bandwidth of the network between the partner groups. For more information on replication, see the [PS Series Technical Documentation on Dell TechCenter](#).

Best practice: Size replication space and network bandwidth according to your network needs. Only mount using the `--read-only` option for temporary use and be sure to unmount and demote when finished to allow replication to continue on the Smart Copy set.

Thin Clone Smart Copies and template volumes allow PS Series volumes to be designated as template volumes where a standard volume can be converted into a template volume that holds a read-only locked configuration of the volume data. The template volume can be used to create highly space efficient and



distributable thin clones that reference the read-only configuration data of the template volume. Thin clones have an advantage over snapshots because they do not consume snapshot reserve and only new writes are applied to the storage pool. Thin clone Smart Copies are supported by ASM/LE through the use of the `--type thin-clone` argument. For more information on template volumes and thin-clones see the latest *PS Series Firmware Group Administration Guide*.

Best practice: Thin clones can be useful to quickly distribute a large numbers of volume copies to test and development teams without using valuable storage space. In a test and development environment, this would mean any new builds or tests on a thin-clone volume take up very minimal storage space and if a build does not work or breaks, the volume can be easily reverted back to the state of the template volume.



7 Restoring volumes with Smart Copies

There are various methods to restore and recover volumes and smart copy collections using Smart Copies. ASM/LE can either restore a volume from a Smart Copy or mount a Smart Copy to a Linux host. Mounting a Smart Copy makes the file system contents available to the Linux host. Restoring from a Smart Copy rolls back all of the data on the volumes to the point in time when the snapshot was created.

7.1 Smart Copy restore options

Depending on the Smart Copy type, there are two restore options available in ASM/LE:

- **Mount:** Mounts the Smart Copy set on specified mount points. It does not restore the contents of the file system. Users can use the mounted Smart Copy for archiving or perform manual steps to recover data.
- **Restore:** Performs an in-place restore of all the data in the Smart Copy and brings the file systems online. If there are multiple objects included in the Smart Copy set, for example, in a collection, all the file systems are restored to the point in time of the Smart Copy and brought online.

7.2 Restoring from a snapshot Smart Copy

The snapshot Smart Copy supports both the mount and restore options. The ASM/LE usage for both approaches is illustrated in the next two screenshots. First, list the Smart Copies.

```
[root@rhel7 ~]# asmcli list smart-copy
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
=====
Smart Copy
=====
```

```
Source          rhel7. : /mnt/hit1
Snapshot:       06-May-2016 14:22:05.128176
Description:    asmcli test
ObjectId:       8-e5f21a-6752cfe45-1291ed81409ae43f
hit1 --> hit1-2016-05-06-14:22:05.2394 on EQLGROUP1
```

The Smart Copy snapshot is mounted using the objected on /mnt/SNAP using the asmcli command, using the specific Object ID listed above. .

```
[root@rhel7 ~]# asmcli mount smart-copy -object 8-e5f21a-6752cfe45-
1291ed81409ae43f -destination /mnt/SNAP --verbose
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

Connecting to destination PS Groups.



```

Logged into PS Series group 10.2.1.50 (EQLGROUP1) as username pooladmin
(PoolAdmin)
Logging in 1 Smart Copy target.
Logged into target iqn.2001-05.com.equallogic:0-af1ff6-2339a23e4-
3e7b0d0cc335314d-hit1-2016-05-06-14:22:05.2394 (10.2.1.50)
Mounted /mnt/hit1 : eql-8-e5f21a-6752cfe45-1291ed81409ae43f+hit1
Successfully mounted 1 file system from 1 Smart Copy target.

```

The `df` command shows the Smart Copy snapshot is mounted on `/mnt/SNAP`.

```

[root@rhel7 ~]# df

```

Filesystem	1K-blocks	Used
Available Use% Mounted on		
/dev/mapper/eql-8-e5f21a-6752cfe45-1291ed81409ae43f+hit1	10480640	32928
10447712 1% /mnt/SNAP/mnt/hit1		

Note: The mount point where the Smart Copy snapshot is mounted must exist prior to mounting. For this example, the mount directory (`/mnt/SNAP`) was created prior to use. Otherwise the mount operation would terminate and advise the user to create the mount point.

The next example demonstrates restoring a volume in place from a snapshot Smart Copy with ASM/LE. In this scenario a file (`criticalFile`) is placed on the file system, and a snapshot is created of the file system. Then a data loss occurs (for example, `criticalFile` is deleted). The `asmcli restore smart-copy` syntax is used to perform an in-place restore of all data in the Smart Copy. As seen below, the ASM/LE restore operation automates three steps.

1. Unmounts the existing filesystem (`/mnt/hit1`).
2. Restores the target filesystem from the Smart Copy snapshot.
3. Mounts the restored filesystem (`mnt/hit1`).

Once completed, the `/mnt/hit1` filesystem is restored to the file system that was created by the `asmcli create smart-copy` operation that took place prior to the data loss. The deleted file (`criticalFile`) is once again available in the newly restored file system, as seen below.

```

[root@rhel7 ~]# ls -la /mnt/hit1
total 0
drwxr-xr-x. 2 root root 6 May 06 12:38 .
drwxr-xr-x. 9 root root 82 Apr 27 12:15 ..
[root@rhel7 ~]# touch /mnt/hit1/criticalFile
[root@rhel7 ~]# ls -la /mnt/hit1
total 0
drwxr-xr-x. 2 root root 25 May 12 13:25 .
drwxr-xr-x. 9 root root 82 Apr 27 12:15 ..
-rw-r--r--. 1 root root 0 May 12 13:25 criticalFile

[root@rhel7 ~]# asmcli create smart-copy --source /mnt/hit1
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0

```



Copyright (c) 2010-2016 Inc.

The mount point has been frozen.
Created snapshot hit1-2016-05-12-13:45:02.2294 on EQLGROUP1
The mount point has been thawed.
Successfully created a Smart Copy from 1 target.

```
[root@rhel7 ~]# rm -f /mnt/hit/criticalFile
[root@rhel7 ~]# ls -la /mnt/hit1
total 0
drwxr-xr-x. 2 root root  6 May 12 13:47 .
drwxr-xr-x. 9 root root 82 Apr 27 12:15 ..
```

```
[root@rhel7 ~]# asmcli restore smart-copy --source /mnt/hit1 --latest
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
Unmounted /mnt/hit1
Target restored from hit1-2016-05-12-13:45:02.2294
Mounted /mnt/hit1
Restore operation completed successfully.
```

```
[root@rhel7 ~]# ls -la /mnt/hit1
total 0
drwxr-xr-x. 2 root root 25 May 12 13:25 .
drwxr-xr-x. 9 root root 82 Apr 27 12:15 ..
-rw-r--r--. 1 root root  0 May 12 13:25 criticalFile
```

7.3 Restoring from a Clone Smart Copy

The Clone Smart Copy supports the mount option, but not the restore option.

The following example lists existing Smart Copies of type clone and mounts the one and only existing Smart Copy clone specified by the smart copy type. The destination mount point `--destination` is a required parameter. As noted earlier, the mount directory (`/mnt/CLONE`) must already exist.

```
[root@rhel7 ~]# asmcli create smart-copy --type clone
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
=====
Smart Copies
=====
```

```
Source          rhel7. : /mnt/hit1
Snapshot:       06-May-2016 15:03:46.272560
ObjectId:       7-768a31-81a00e414-0e34adfe8b7231ab
```



```
hit1 --> hit1-clone-2016-05-06-15:03:46.306 on EQLGROUP1
```

1 Smart Copy found.

The clone is mounted on /mnt/CLONE using asmcli.

```
[root@rhel7 ~]# asmcli mount smart-copy --type clone --destination /mnt/CLONE
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

Logging in 1 Smart Copy target.

Logged in hit1-clone-2016-05-06-15:03:46.306 on EQLGROUP1

Mounted /mnt/CLONE/mnt/hit1

Successfully mounted 1 file system from 1 Smart Copy target.

Output from the df command demonstrates the Smart Copy snapshot is mounted on /mnt/SNAP, and the clone is mounted on /mnt/CLONE.

```
[root@rhel7 ~]# df
Filesystem                                1K-blocks      Used
Available Use% Mounted on
/dev/mapper/eql-8-e5f21a-6752cfe45-1291ed81409ae43f+hit1 10480640    32928
10447712   1% /mnt/SNAP/mnt/hit1
/dev/mapper/eql-7-768a31-81a00e414-0e34adfe8b7231ab+hit1 10480640    32928
10447712   1% /mnt/CLONE/mnt/hit1
```

7.4 Restoring from a Replica Smart Copy

The Replica Smart Copy supports both the mount and restore options.

The following example lists existing Smart Copies of type replica, and mounts the one and only existing Smart Copy replica specified by the type. The destination mount point `--destination` is a required parameter. As noted earlier, a mount directory must already exist. For the example below, /mnt/REPLICA was chosen.

```
[root@rhel7 ~]# asmcli list smart-copy --type replica
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

```
=====
Smart Copy
=====
```

```
Source          rhel7. : /mnt/hit1
Snapshot:       06-May-2016 15:52:11.365834
ObjectId:       f-90d11b-8792de46-1551ab11229e8431
hit1 on EQLGROUP1 --> hit1-2016-05-06-15:52:11.375581.1 on EQLGROUP1
```



1 Smart Copy found.

The replica is mounted on /mnt/REPLICA.

```
[root@rhel7 ~]# asmcli mount smart-copy --type replica --destination
/mnt/REPLICA
Dell EqualLogic Auto-Snapshot Manager CLI Version 1.5.0
Copyright (c) 2010-2016 Inc.
```

Logging in 1 Smart Copy target.

Logged in hit1-2016-05-06-15:52:11.375581.1 on EQLGROUP1

Mounted /mnt/REPLICA/mnt/hit1

Successfully mounted 1 file system from 1 Smart Copy target.

The df command demonstrates the replica is available on /mnt/REPLICA.

```
[root@rhel7 ~]# df
Filesystem                                1K-blocks    Used
Available Use% Mounted on
/dev/mapper/eql-8-e5f21a-6752cfe45-1291ed81409ae43f+hit1 10480640    32928
10447712    1% /mnt/SNAP/mnt/hit1
/dev/mapper/eql-7-768a31-81a00e414-0e34adfe8b7231ab+hit1 10480640    32928
10447712    1% /mnt/CLONE/mnt/hit1
/dev/mapper/eql-f-90d11b-8792de46-1551ab11229e8431+hit1 10480640    32928
10447712    1% /mnt/REPLICA/mnt/hit1
```



8 Operations in a Linux cluster

ASM/LE supports Smart Copies of clustered file systems. In order for ASM/LE to operate correctly in a failover cluster, the following criteria must be met.

- HIT/Linux is installed on each node of the failover cluster
- ASM/LE is configured on each node of the failover cluster
- The ASM/LE backup document location is shared and reachable by all nodes in the cluster
- All PS Series volumes must have shared access enabled before adding to a cluster

Once these criteria are met, ASM/LE protection and recovery operations can begin. All protection and recovery operations must take place from the active node hosting the file system resources in the cluster. If nodes failover, ASM/LE will follow the failover process so that schedules and other Smart Copy operations always take place on the active cluster node.

Best practice: Set the ASM/LE backup document location to a directory that is reachable by all nodes at all times. It is recommended not to use a cluster disk as the backup document location since passive nodes will not be aware of the Smart Copies until the nodes failover.



9 Summary

Dell PS Series arrays come with the Host Integration Tools for Linux software, which simplifies MPIO setup and configuration by eliminating the multipath configuration steps and automatically managing multiple iSCSI sessions. The software also optimizes the operation of a PS Series array by using knowledge about volume layouts on a PS Series group and routing I/O directly to the PS Series arrays that will be servicing requests.

The Host Performance and Configuration Tuning Suite (eqltune) enables the administrator to verify a Linux system for optimal iSCSI performance configuration by analyzing a large number of system settings for compliance with Dell recommended practices, in four categories: Critical, Warning, Suggestion and OK.

Eqlvolume manages recovery of disk space that has become available and makes more efficient use of disk capacity in storage volumes.

Auto-Snapshot Manager functionality within HIT/Linux can substantially increase Linux server data availability by using PS Series array protection technologies. Snapshot, Clone, and Replica Smart Copies all play a vital role in robust protection scenarios for on-demand data recovery and restores, as well as providing instant point-in-time copies for scalable distribution of PS Series volume data.

Although using ASM/LE can increase volume data protection and availability, it is not considered an alternative to long-term backup methods. ASM/LE and Smart Copies should be used in conjunction with a normal backup schedule for a higher level of data protection and shorter file system recovery times.

Auto-Snapshot Manager is a valuable tool for maintaining point-in-time copies of application data that can be recovered easily and quickly but it is not positioned as a long term data retention backup solution. Therefore it is a best practice to incorporate a backup and recovery solution for long term data retention purposes.

By using ASM/LE in conjunction with regular backup methods, you can ensure your Linux server data is protected and available at all times.

A Additional resources

This appendix provides contact information and additional documentation available to assist with administering

A.1 Dell Technical support and resources

Dell.com/support is focused on meeting customer needs with proven services and support.

For additional support information on specific array models, see the following table.

Dell Storage	Online support	Email	Phone support (US only)
PS Series (EqualLogic)	http://eqlsupport.dell.com	eqlx-customer-service@dell.com	800-945-3355

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

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

Dell Resource
Host Integration (HIT) Kit Guide for Linux
Dell EqualLogic Group Manager Administrator's Guide (Login required)
Best practices for sharing an iSCSI SAN Infrastructure with Dell PS Series and Dell SC Series Storage using Linux Hosts

A.2 Red Hat Enterprise Linux support

Linux specific support can be obtained from the [Red Hat Customer Portal](#).

