Pillar AxiomONE™ Path Manager 3.3

Installation Guide and Release Notes

for Oracle Linux 5.5
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Preface

Audience

This document is intended for individuals who install and maintain Pillar AxiomONE Path Manager (APM) software.

Expected experience includes:

- Understanding of storage area networks (SANs) and disk storage systems.
- Understanding of Fibre Channel or iSCSI technology
- Practical knowledge of Pillar Axiom Storage Systems.
- Basic Linux administration skills.
- Experience installing software packages on Oracle Linux systems.

Related Documentation

Refer to the following related documents:

- Pillar Axiom Customer Release Notes: Includes late-breaking important information about the installation and operation of the Pillar Axiom system.
- Pillar Axiom Administrator’s Guide: Provides detailed information on creating and managing storage resources.
- AxiomONE CLI Reference Guide (for AxiomONE CLI) or CLI Reference Guide (for pdscli): Provides detailed information about functions available in the Pillar Axiom command line interfaces (CLIs).

Access Documentation

Pillar Data Systems technical documentation (including installation, service, cabling, integration, and administration guides) are available from several sources.
Pillar Axiom GUI  After logging in to the AxiomONE Storage Services Manager on the Pilot, navigate to Support > Documentation and click on the document of interest.


After logging in to the website, click on Documents in the left navigation pane, and then click the appropriate category in the expanded list. Click on the document of interest.

Product CD-ROM  Insert the Technical Documentation CD-ROM that came with your Pillar Axiom Storage System into the CD player in a computer. Open the DocMenu PDF and click on the document of interest.

**Tip:** To search all technical documents on the CD-ROM, click the Search all PDFs icon in the top right corner. In the Search dialog, enter the word or phrase for which you would like to search.

### Typographical Conventions

**Table 1 Typography to mark certain content**

<table>
<thead>
<tr>
<th>Convention</th>
<th>Meaning</th>
</tr>
</thead>
</table>
| *italics*  | Within normal text, words in italics indicate:  
  - New terms and emphasized words.  
  - Command variables. |
| *monospace*| Indicates one of the following, depending on the context:  
  - The name of a file or the path to the file.  
  - *Output* displayed by the system on the command line. |
| *monospace* (bold) | *Input* provided by an administrator on the command line. |
### Table 1 Typography to mark certain content (continued)

<table>
<thead>
<tr>
<th>Convention</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;</td>
<td>Indicates a menu item or a navigation path in a graphical user interface (GUI). For example, “Click Storage &gt; Clone LUNs” means to click the Clone LUNs link on the Storage page in the graphical user interface (GUI).</td>
</tr>
<tr>
<td>…</td>
<td>Used within an expression of a navigation path or within a cascading menu structure. The ellipsis indicates that one or more steps have been omitted from the path or menu structure. For example, in the Groups &gt; Volume Groups &gt; Actions &gt; … &gt; Data Protection &gt; Create menu structure, the … implies that one or more menu items have been omitted.</td>
</tr>
</tbody>
</table>

### Pillar Contacts

#### Table 2 Contacts at Pillar Data Systems

<table>
<thead>
<tr>
<th>For help with...</th>
<th>Contact...</th>
</tr>
</thead>
</table>
| Error messages, usage questions, and other support issues | US and Canada: 877-4PILLAR (1-877-474-5527)  
Europe: +800 PILLAR FS (+800 74 55 27 37)  
Asia Pacific: +1-408-518-4515  
South Africa: +0 800 980 400  
Have your system serial number ready.  
support@pillardata.com  
Customer support portal (https://support.pillardata.com/login.do) |
| Training (custom or packaged) | Training and Education (http://www.pillardata.com/support-education/training/) |
| Professional services and inquiries | globalsolutions@pillardata.com  
Global Solutions (http://www.pillardata.com/support/professional-services/) |
<table>
<thead>
<tr>
<th>For help with...</th>
<th>Contact...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales and general contact information</td>
<td><a href="http://www.pillardata.com/company/contact">Company contacts</a></td>
</tr>
<tr>
<td>Documentation improvements and resources</td>
<td><a href="mailto:docs@pillardata.com">docs@pillardata.com</a></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.pillardata.com/techdocs">Technical documents</a> (Log in with your username and password, and select Documents.)</td>
</tr>
</tbody>
</table>
Introduction to AxiomONE Path Manager

AxiomONE Path Manager Requirements

Pillar Axiom systems presenting LUNs to Oracle Linux 5.5 (OL 5.5) hosts using AxiomONE Path Manager 3.3 must be running release 3.5 or higher of the Pillar Axiom software.
AxiomONE Path Manager 3.3 Features

AxiomONE Path Manager (APM) is defined as:

Optional software installed on a storage area network (SAN) host to manage multiple paths to the Pillar Axiom system.

APM performs the following primary functions:

- Routes I/O to Pillar Axiom LUNs using only the best available data paths.
- Shares traffic among the available paths and ensures that access to the LUNs is not interrupted if some paths fail.
- Automatically configures the host into the AxiomONE Storage Services Manager and updates the configuration if the host information changes.

The function described in the last bullet enables the AxiomONE Storage Services Manager to report information about APM running on the host, such as the number of working paths, and, in some environments, to configure features such as load balancing.

Each APM release provides different features, and the features provided for each platform may vary. The following table describes the specific features implemented in this release.

### Table 3 APM 3.3 for OL 5.5 features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic data path failover</td>
<td>Automatically switches to the highest priority optimized path available after a path failure or fail back.</td>
</tr>
<tr>
<td>Automatic recognition of SAN hosts by the AxiomONE Storage Services Manager</td>
<td>Sends a description of the host to each Pilot management controller on connected Pillar Axiom systems, allowing the AxiomONE Storage Services Manager GUI and CLI tools to create a definition for the host. This definition includes such information as the WWNs for each of the host's Fibre Channel ports, the IP addresses for any iSCSI ports, and the version of APM running on the host.</td>
</tr>
<tr>
<td>Call-Home log collection</td>
<td>When a Pillar Axiom administrator uses the AxiomONE Storage Services Manager to collect system information (refer to the <em>Pillar Axiom Administrator’s Guide</em> for details), the Pillar Axiom system sends a request to each connected APM host. The APM hosts collect useful</td>
</tr>
</tbody>
</table>
### Table 3 APM 3.3 for OL 5.5 features (continued)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
</table>
|         | diagnostic information and send it to the Pillar Axiom system, where it is bundled with any other requested information. The Pillar Axiom system can then transmit this information to the Pillar World Wide Customer Support Center. The information collected from each APM host includes:  
  - Logs from the APM components.  
  - Configuration and status information from the operating system.  
  - System and error logs from the operating system.  
  No customer data is transmitted. |
| Support for FC connections to FC Slammers | Makes connections to Pillar Axiom storage arrays over high-speed FC network infrastructure. |
| Support for iSCSI connections to both FC and iSCSI Slammers | Makes connections to Pillar Axiom storage arrays over long distances using IP network infrastructure.  
**Note:** iSCSI connections to FC Slammers require iSCSI-to-FC routers. |
| Support for FC clustering | Makes connections to clustered systems operating in an FC-based SAN. |
| Support for Boot from SAN | Boot from SAN is supported on QLogic and Emulex Fibre Channel host bus adapters (HBAs). |
| Fibre Channel over Ethernet (FCoE) Converged Network Adapters (CNAs) | FCoE CNAs on the host are supported, only on the Oracle Linux 5.5 Red Hat Compatible Kernel (RHCK). |
| Support for virtualization | Virtualization is not supported on OL 5.5, but it is supported on Oracle VM Server. |
| Support for static load balancing | Both static and round-robin load balancing options are supported. |
About AxiomONE Path Manager and Clustering

The AxiomONE Path Manager (APM) for Oracle Linux 5.5 (OL 5.5) can be used in a clustered environment that uses Fibre Channel connections.

The APM software must be installed and working before you set up clustering.

If the cluster function fails on the nodes, but the nodes are still running at the operating system level, data consistency can be affected. The leftover write operations from failed database instances reach the storage system after the recovery process starts. Because these write operations are no longer in the proper serial order, they can damage the consistency of the stored data. To avoid damaging the data consistency, when a cluster node fails, fence the failed node off from all the shared disk devices or disk groups.

This I/O fencing process is sometimes called *I/O fencing-exclusion, disk fencing, or failure fencing*. The purpose of I/O fencing is to:

- Prevent updates by failed instances.
- Detect failures.
- Prevent the *split-brain* effect in the cluster.

**Note:** The split-brain effect occurs when failure of a single cluster causes reconfiguration of the cluster into multiple partitions, each of which assumes ownership of the same exclusive resources, usually resulting in data corruption.

Oracle Clusterware, in association with the shared storage unit, and the Oracle Clustering File System (OCFS), are required to prevent the failed nodes from accessing shared devices.

For more information on how to set up clustering in your environment, refer to the Oracle Real Application Clusters (RAC) documentation (http://www.oracle.com/technetwork/database/clustering/overview/index-086583.html).

If you experience reboot or hang problems, we recommend setting O2CB parameters to values that are higher than Oracle’s suggested minimums. For example, we found the following settings effective for our test cluster configuration:

```bash
# O2CB_ENABLED: 'true' means to load the driver on boot.
O2CB_ENABLED=true
# O2CB_BOOTCLUSTER: If not empty, the name of a cluster to start.
O2CB_BOOTCLUSTER=ocfs2
# O2CB_HEARTBEAT_THRESHOLD: Iterations before a node is considered dead.
O2CB_HEARTBEAT_THRESHOLD=901
```
# O2CB_IDLE_TIMEOUT_MS: Time in ms before a network connection is considered dead.
O2CB_IDLE_TIMEOUT_MS=100000

# O2CB_KEEPALIVE_DELAY_MS: Max time in ms before a keepalive packet is sent
O2CB_KEEPALIVE_DELAY_MS=50000

# O2CB_RECONNECT_DELAY_MS: Min time in ms between connection attempts
O2CB_RECONNECT_DELAY_MS=20000

Note: /etc/sysconfig/o2cb is a configuration file for automatic startup of the O2CB driver. It is generated by running the following command:

/etc/init.d/o2cb configure

After generating the configuration file, use a text editor to make the following modifications:

Heartbeat dead threshold = 901
Network idle timeout: 100000
Network keepalive delay: 50000
Network reconnect delay: 20000
Checking O2CB heartbeat: Active
AxiomONE Path Manager Architecture

AxiomONE Path Manager (APM) manages the Linux multipath framework and communicates with Pillar Axiom servers on a control path, which is separate from the data path. The Linux multipath framework manages the LUN data access paths themselves.

Figure 1: APM interaction with a Pillar Axiom server illustrates how the APM software installed on a storage area network (SAN) host interacts with a Pillar Axiom system. Refer to the table below to determine the significance of the lines and colors in the figure.

Table 4 Line and color key for APM interaction diagram

<table>
<thead>
<tr>
<th>Graphic element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>Data path</td>
</tr>
<tr>
<td>___</td>
<td>Control path</td>
</tr>
<tr>
<td>![Pillar-supplied]</td>
<td>Pillar-supplied hardware and software</td>
</tr>
<tr>
<td>![Non-Pillar]</td>
<td>Non-Pillar hardware and software</td>
</tr>
<tr>
<td>![SAN host kernel space]</td>
<td>SAN host kernel space</td>
</tr>
<tr>
<td>![SAN host user space]</td>
<td>SAN host user space</td>
</tr>
</tbody>
</table>
Legend

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User</td>
</tr>
<tr>
<td>2</td>
<td>User application</td>
</tr>
<tr>
<td>3</td>
<td>SAN host</td>
</tr>
<tr>
<td>4</td>
<td>APM daemon</td>
</tr>
<tr>
<td>5</td>
<td>Control paths (all dashed lines)</td>
</tr>
<tr>
<td>6</td>
<td>Pillar Axiom administrator</td>
</tr>
<tr>
<td>7</td>
<td>Pillar Axiom command line interface (CLI) or graphical user interface (GUI)</td>
</tr>
<tr>
<td>8</td>
<td>Encrypted XML over TCP/IP</td>
</tr>
<tr>
<td>9</td>
<td>Network card</td>
</tr>
<tr>
<td>10</td>
<td>Linux multipath framework</td>
</tr>
<tr>
<td>11</td>
<td>iSCSI software initiator (iSCSI)</td>
</tr>
<tr>
<td>12</td>
<td>TCP/IP driver (iSCSI)</td>
</tr>
<tr>
<td>13</td>
<td>HBA driver (FC) or NIC driver (iSCSI)</td>
</tr>
<tr>
<td>14</td>
<td>HBA (FC) or NIC (iSCSI)</td>
</tr>
<tr>
<td>15</td>
<td>SCSI over Fibre Channel (FC) or iSCSI over IP (iSCSI)</td>
</tr>
<tr>
<td>16</td>
<td>Data path (all solid lines)</td>
</tr>
<tr>
<td>17</td>
<td>Pillar Axiom server</td>
</tr>
<tr>
<td>18</td>
<td>Brick storage enclosure pool</td>
</tr>
</tbody>
</table>
About the AxiomONE Path Manager Control Path

The AxiomONE Path Manager (APM) control path provides a path separate from the data path to manage multipathing and communication.

The APM software uses a daemon running in the background to control multipathing and communication. The APM daemon uses the control path to:

- Get path information from the HBA drivers.
- Configure the Linux multipath framework.
- Send information such as host attributes and statistics to the Pilot management controller, and collect logs from the host on request.

The APM daemon sends a description of the host to the Pilot on each connected Pillar Axiom system. This description creates a definition for the host in the AxiomONE Storage Services Manager. The definition includes any Fibre Channel (FC) ports in the host, and the name of the host's iSCSI initiator, if Internet Small Computer System Interface (iSCSI) is configured. The graphical user interface (GUI) and command line interface (CLI) list the port World Wide Names (WWNs) of the FC ports in the host and the Internet Protocol (IP) addresses that are used to make iSCSI connections to the Pillar Axiom system.

To establish the control path to a Pillar Axiom host, that host must be able to connect to the Pillar Axiom system over the data path. The Slammer returns the IP address of its Pilot to the APM host over the data path as part of the connection sequence.

If you use iSCSI on the host to connect to a FC Slammer storage controller through an iSCSI-to-FC router, these connections are described as FC. The connections will appear to originate from the FC ports that are assigned on the switch to the host's iSCSI initiator. The WWNs of these ports are displayed as Fibre Channel HBA ports on the host. The HBA model associated with these ports is reported as iSCSI-FC router.

About the AxiomONE Path Manager Data Path

AxiomONE Path Manager (APM) uses the Linux device-mapper to provide paths for reading and writing data to LUNs on the Pillar Axiom system.

See Figure 1: APM interaction with a Pillar Axiom server for an illustration of how data flows from the host to the Pillar Axiom system.
The Linux multipath framework:

- Controls and manages all data paths to Pillar Axiom LUNs.
- Groups multiple data paths to a Pillar Axiom LUN and presents this group to the operating system as a single LUN or drive.
- Identifies and uses optimized data paths when possible. An optimized path provides the best performance and is the preferred path for data transfer.
- Determines which data paths to use.
- Handles data path failover.
- Manages data path errors.

About Multipathing and Device Mapper Automation

AxiomONE Path Manager (APM) uses the standard Linux 2.6 device-mapper functionality to provide multipathing services. APM consists of a daemon that monitors the state of the device-mapper and communicates with the Pillar Axiom software. APM presents the multipathed LUNs as virtual block devices in the Linux 2.6 device-mapper framework.

Note: You can use device-mapper and multipath-tools for many purposes other than managing multipathing for Pillar Axiom systems.

Pillar Data Systems provides a package containing an updated version of the multipath-tools component of device-mapper, along with additional bug fixes, as part of APM.

Important! Unless you are using the Unbreakable Enterprise Kernel (UEK) version of Oracle Linux 5.5, you must use this Pillar Data Systems version of multipath-tools instead of the one supplied as part of the operating system in order to use APM. See Install (or Update) the AxiomONE Path Manager Software.

In addition, APM provides installation and start up scripts that automate several of the manual integration and configuration tasks usually required by device-mapper. The automation includes:

- Correcting functional deficiencies in the HBA driver installers.
- Bringing partitions on multipath devices online automatically.
- Reordering startup scripts for optimum operation.
Note: To determine how the Linux startup scripts have been altered, refer to the comments in the following Pillar-provided files:

- `/etc/init.d/multipathd`
- `/etc/init.d/axiompmid`
Supported Oracle Linux 5.5 Distributions

AxiomONE Path Manager (APM) is supported on Oracle Linux 5.5 (OL 5.5) platforms.

APM supports OL 5.5 distributions for the following architectures:

- x86-32 (32-bit x86 platforms)
- x86-64 (64-bit AMD and Intel platforms)

To determine the hardware platform on which your distribution is running, run the following command:

```
# uname -i
```

Compare the output of this command with the information in the following table:

<table>
<thead>
<tr>
<th>Hardware platform</th>
<th>Output from <code>uname -i</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>x86</td>
<td>i386</td>
</tr>
<tr>
<td>AMD64/Intel EM64T</td>
<td>x86_64</td>
</tr>
</tbody>
</table>

To determine the Linux kernel installed on your system, run the following command:

```
# uname -r
```

Verify that the kernel identifier in the output of this command begins with the following value:

<table>
<thead>
<tr>
<th>Red Hat Compatible Kernel (RHCK)</th>
<th>Unbreakable Enterprise Kernel (UEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6.18-194</td>
<td>2.6.32-100.0.19.el5</td>
</tr>
</tbody>
</table>
Operating Limits

AxiomONE Path Manager (APM) provides access over multiple data paths to LUNs defined on a Pillar Axiom system. APM, the device-mapper, Linux, and the Pillar Axiom software limit the following aspects of this access.

**Table 7 APM operating limits**

<table>
<thead>
<tr>
<th>APM capabilities</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Pillar Axiom systems</td>
<td>Eight for each SAN host</td>
</tr>
<tr>
<td>Connect to SAN Slammer storage controllers</td>
<td>Four for each Pillar Axiom system</td>
</tr>
<tr>
<td>Connect to LUNs</td>
<td>256</td>
</tr>
<tr>
<td>Handle data paths</td>
<td>32 to each LUN</td>
</tr>
<tr>
<td>Handle FC HBA ports</td>
<td>32 for each SAN host</td>
</tr>
</tbody>
</table>

The Linux device-mapper has a limitation of 1024 paths to all devices, including Pillar Axiom LUNs. If you use the maximum of 256 LUNs, you will have a maximum of four paths to each LUN.

**Important!** The Linux device-mapper does not gracefully handle more than 1024 visible paths and may fail in a variety of ways if that limit is exceeded.

**Important!** Not all combinations of the limits shown have been tested. Use care when operating a system that has been configured to run at or near these limits. The system may exhibit anomalies when all limits are exercised concurrently.
Chapter 2

Install AxiomONE Path Manager

Prepare to Install the AxiomONE Path Manager

To ensure a successful installation of AxiomONE Path Manager (APM), perform the following tasks in sequence:

1. Read AxiomONE Path Manager Release Notes.

2. Ensure that the Pillar Axiom system is running release 3.5 or higher of the Pillar Axiom software.

3. If you are using Fibre Channel (FC) connections, verify that your FC storage area network (SAN) components and host bus adapters (HBAs) are supported. See: Supported Fibre Channel SAN Hardware Components.

4. If you are using FC connections, confirm that your HBAs are installed according to our instructions. See one of:
   - Install Emulex Host Bus Adapters and Drivers
   - Install QLogic Host Bus Adapters and Drivers

5. If you are using Internet Small Computer System Interface (iSCSI) connections, verify that your network is configured for iSCSI multipathing, and that you have configured the iSCSI software initiator correctly. See About Network Configuration for iSCSI Multipathing, Configure the iSCSI Initiator, and Start the iSCSI Software Initiator Service.

6. If you are using iSCSI connections, confirm that any iSCSI-to-FC routers and IP switches you have installed are supported. See Supported iSCSI Routers and Switches.

7. Pre-Configure the SAN Host for Pillar Axiom Integration.

8. Verify Installation of the Device Mapper.
Supported SAN Protocols

AxiomONE Path Manager (APM) 3.3 supports Fibre Channel and software-based Internet Small Computer System Interface (iSCSI) connections to the Pillar Axiom system.

Supported Fibre Channel SAN Hardware Components

AxiomONE Path Manager (APM) supports a variety of Fibre Channel host bus adapters (HBAs) and storage area network (SAN) routers and switches.

Approved HBAs and switches that are compatible with the Pillar Axiom system are listed in:

- Supported Emulex Host Bus Adapters and Drivers
- Supported QLogic Host Bus Adapters and Drivers
- Supported Fibre Channel and Fibre Channel over Ethernet Switches

Supported Fibre Channel Topologies

AxiomONE Path Manager (APM) supports the Point-to-Point (FC-P2P) and Switched Fabric (FC-SW) topologies. APM does not support Arbitrated Loop (FC-AL).

Maximum Queue Depth

The recommended maximum queue depth for all SAN hosts attached to a Pillar Axiom system is 64. This value is the maximum number of outstanding I/O requests to the Pillar Axiom system. Exceeding the maximum I/O queue depth may cause errors.

This value is typically set in the BIOS or similar firmware configuration of the HBA on the SAN host. Consult your HBA documentation for the setting that controls the maximum I/O queue depth for your HBA and for configuration instructions.
Supported Emulex Host Bus Adapters and Drivers

AxiomONE Path Manager (APM) supports the following Emulex host bus adapters (HBAs) and HBA drivers:

- LP10000
- LP10000DC
- LP10000ExDC-E
- LP11000
- LP11002
- LPe11000
- LPe11002
- LPe11004
- LPe12000
- LPe12002
- LPe12004

APM also supports the following Emulex Fibre Channel over Ethernet (FCoE) converged network adapter (CNA):

OCe10102–F

Note: This FCoE CNA can also be used concurrently as an Ethernet network interface controller (NIC).

Important! Because Emulex has not supplied an HBA API suitable for the Unbreakable Enterprise Kernel (OEK) as of this writing, APM supports Emulex HBAs and CNAs only on the Red Hat Compatible Kernel (RHEK) version of Oracle Linux 5.5 (OL 5.5).

The above HBAs and CNAs require Emulex driver version 8.2.0.63 (comes with the Linux distribution) or later. In addition, the applications kit for your driver version is required. The drivers are included in the OL 5.5 distribution, but the applications kit must be downloaded from the Emulex Open Source Driver Version 8.2.0.63 page (http://www.emulex.com/downloads/emulex/cnas-and-hbas/drivers/linux/82063-driver-and-enterprise-application-kits.html).

Note: Refer to the Emulex website for requirements for the OCe10102–F FCoE CNA.

Recommended Settings for Emulex Host Bus Adapters

We recommend the following settings for Emulex host bus adapters (HBAs):
### Table 8 Emulex HBA settings

<table>
<thead>
<tr>
<th>HBA settings</th>
<th>Recommended value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Queue Depth (lpfc_lun_queue_depth)</td>
<td>64</td>
</tr>
<tr>
<td>lpfc_nodev_tmo</td>
<td>60</td>
</tr>
<tr>
<td>lpfc_discovery_threads</td>
<td>32</td>
</tr>
</tbody>
</table>

**Note:** You can use the Emulex HBA management utility to set the `lpfc_nodev_tmo` and `lpfc_discovery_threads` parameters. Refer to the Emulex documentation for details.

### Install Emulex Host Bus Adapters and Drivers

To ensure compatibility between AxiomONE Path Manager (APM) and your Emulex host bus adapters (HBAs), be sure to follow the instructions in this section for installing the supported Emulex HBAs and drivers.

1. Install Emulex HBAs according to the instructions at the Emulex support download page (currently http://www.emulex.com/downloads).

2. Verify that you have the Emulex version 8.2.0.63 or later driver installed.

   To determine your driver version, run the following command:

   ```
   modprobe lpfc
   ``

   If the driver version returned does not match the supported version, download the driver from the Open Source Driver Version 8.2.0.63 page (http://www.emulex.com/downloads/emulex/cnas-and-hbas/drivers/linux/82063-driver-and-enterprise-application-kits.html), and follow the Emulex instructions for installing the driver.

3. Download the Emulex applications kit appropriate for your Linux operating system, and follow the Emulex instructions for installing the applications kit.

   The required HBA drivers are supplied as part of the Oracle Linux 5.5 (OL 5.5) operating system, but you must download the applications kit from the Emulex Open Source Driver Version 8.2.0.63 page (http://www.emulex.com/downloads/emulex/cnas-and-hbas/drivers/linux/82063-driver-and-enterprise-application-kits.html). The applications kit is required for the APM daemon to communicate with the Pillar Axiom system.

4. Use the HBA management utility to set the HBA settings to the recommended values.
See Table 8: Emulex HBA settings.

5 If you have replaced the driver, or made any modifications to the driver configuration file, rebuild the kernel to ensure that any changes to the driver are picked up.

Use the following command:

```
# /sbin/new-kernel-pkg --mkinitrd --depmod --install
`uname -r`
```

Supported QLogic Host Bus Adapters and Drivers

The AxiomONE Path Manager (APM) software supports the following QLogic Fibre Channel host bus adapters (HBAs) on x86-32 and x86-64 platforms:

- QLA2310F, QLA2310FL
- QLA2340, QLA2340L
- QLA2342, QLA2342L
- QLA2344
- QLA2460
- QLA2462
- QLA2464
- QLA2560
- QLE2460
- QLE2462
- QLE2464
- QLE2560
- QLE2562
- QLE2564

The above HBAs require one of the following QLogic driver versions that come with the Linux distribution:

<table>
<thead>
<tr>
<th>Red Hat Compatible Kernel (RHCK)</th>
<th>Unbreakable Enterprise Kernel (UEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.03.01.04.05.05-k or later</td>
<td>8.03.01.01.32.1-k9 or later</td>
</tr>
</tbody>
</table>

In addition, the latest HBA API libraries for these drivers are required. Download the SNIA API for Linux Drivers libraries, qlapi-v6.00build8–rel or later, from the QLogic Driver Downloads/Documentation page (http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI) for your hardware platform.

Recommended Settings for QLogic Host Bus Adapters

We recommend the following settings for QLogic host bus adapters (HBAs):
Table 10 QLogic HBA settings

<table>
<thead>
<tr>
<th>HBA setting</th>
<th>Recommended value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link Down Timeout</td>
<td>30</td>
</tr>
<tr>
<td>Execution Throttle</td>
<td>64</td>
</tr>
<tr>
<td>LUNs per Target</td>
<td>256</td>
</tr>
<tr>
<td>Port Down Retry Count</td>
<td>45</td>
</tr>
<tr>
<td>Max Queue Depth (ql2xmaxqdepth)</td>
<td>64</td>
</tr>
</tbody>
</table>

Install QLogic Host Bus Adapters and Drivers

To ensure compatibility between AxiomONE Path Manager (APM) and your QLogic host bus adapters (HBAs), be sure to follow the instructions in this section for installing the supported QLogic HBAs and drivers.

1. Install QLogic HBAs according to the instructions at the QLogic support download page (currently http://support.qlogic.com/support).

2. Verify that you have the QLogic version 8.03.01.04.05.05-k or 8.03.01.01.32.1-k9, or later, driver installed.

   (The driver comes with the Linux distribution.) To determine your driver version, run the following command:

   ```
   modprobe qla2xxx
   ```

   If the driver version returned does not match the supported version, download the SANSurfer Linux Driver Installer from the QLogic Driver Downloads/Documentation page (http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI) for your hardware platform, and follow the QLogic instructions for installing the driver.

3. Download the QLogic HBA API libraries appropriate for your hardware platform, and follow the QLogic instructions for installing the libraries.

   The required HBA drivers are supplied as part of the Oracle Linux 5.5 (OL 5.5) operating system, but you must download the latest SNIA API for Linux Drivers libraries, qlapi-v6.00build8-rel or later, from the QLogic Driver Downloads/Documentation page (http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI) for your hardware platform. The HBA API
libraries are required for the APM daemon to communicate with the Pillar Axiom system.

4 Download and install the SANSsurfer CLI (optional).

If you have not already installed the SANSsurfer CLI as part of the SANSsurfer Linux Driver Installer package, download version 1.7.3 build 20 of the QLogic SANSsurfer FC HBA CLI from the QLogic Driver Downloads/Documentation page (http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI), and follow the QLogic installation instructions.

**Note:** If you use the SANSsurfer CLI to change the settings in Steps 5 and 6, you will not need to rebuild the kernel for the changes to go into effect.

5 Set the HBA settings in the `/etc/modprobe.conf.local` configuration file to the recommended values.

See Table 10: QLogic HBA settings.

6 Disable QLogic's multipathing to ensure recovery from path failures.

Ensure that the `/etc/modprobe.conf.local` file has the following settings:

```bash
options qla2xxx ql2xfailover=0 ConfigRequired=0
MaxRetriesPerPath=15
ql2xlogintimeout=60
ql2xloginretrycount=90 qlport_down_retry=45
ql2xretrycount=30
```

7 Rebuild the kernel to ensure that any changes to the driver are picked up.

Use the following command:

```
# /sbin/new-kernel-pkg --mkinitrd --depmod --install `uname -r`
```

**Note:** If you used the SANSsurfer CLI to change these settings, it is not necessary to rebuild the kernel.

---

**Supported Fibre Channel and Fibre Channel over Ethernet Switches**

For a list of supported Fibre Channel and Fibre Channel over Ethernet switches, choose one of:

- Call the Pillar World Wide Customer Support Center at the number listed in Pillar Contacts.
- Refer to the *Pillar Axiom Support and Interoperability Guide*, which can be found on the Technical Documents website (http://www.pillardata.com/techdocs).
Note: Refer to the switch vendor's website for the most recent installation instructions, patches, and firmware.

Supported iSCSI Software and Hardware

AxiomONE Path Manager (APM) for Oracle Linux 5.5 (OL 5.5) supports the following Internet Small Computer System Interface (iSCSI) software and hardware:

- The iSCSI software initiator included in the OL 5.5 distribution.
- The iSCSI-to-Fibre Channel routing features of the Cisco MDS 9000 family of routers and switches.

Note: APM for OL 5.5 does not support iSCSI host bus adapters (HBAs).

About Network Configuration for iSCSI Multipathing

You can reduce the impact of failures in your Internet Small Computer System Interface (iSCSI) network by ensuring that iSCSI connections are made through several network interface cards (NICs) on the host.

We recommend using the normal IP configuration facilities to route connections to different Slammer storage controller ports through different host NICs. For example, if the host has two NICs available for iSCSI connections to a Slammer, you can set up routing to send all traffic to one port on each Slammer control unit (CU) through one NIC, and traffic to the other port on each Slammer CU through the other NIC.

The best way to ensure that your iSCSI paths use different physical connections depends on factors such as the number of available NICs in the host and the existing configuration of your IP network. We recommend using normal IP routing configuration techniques such as subnet configuration and explicit route configuration to distribute connections over multiple NICs. You can also use NIC bonding to provide redundancy on Ethernet connections between the host and the switch.

About Subnet Configuration

Groups of host network interface cards (NICs) and Slammer ports can be configured into different subnets. Whenever the iSCSI initiator opens a connection to a Slammer port, that connection will automatically be routed
through the host NIC in the same subnet as the Slammer port. For example, if a
host has two NIC ports on the Internet Small Computer Systems Interface
(iSCSI) network, one of the host NIC ports connected to one of the Slammer
control unit (CU) ports could be placed in one subnet, and another host NIC port
connected to the other Slammer CU port could be placed in a different subnet.

Configure Explicit Routing

If two or more NICs on the host are configured into the same subnet, you should
explicitly configure Internet Protocol (IP) routing to route connections to different
destination ports through different host NICs.

1. Create or edit the routing configuration file for each NIC, and add entries for
each destination IP address that you want to route through this NIC.

   The name of the routing configuration file is /etc/sysconfig/network-
scripts/route-NIC, where NIC is the name used by the OS for the NIC.
   Add a line for each Slammer port for which access is to be routed through
   this NIC. The format of the line should be:

   **Slammer_port_IP_address** via **NIC_IP_address** src **NIC_IP_address**

   Example:
   If the NIC eth0 has been configured with IP address 192.168.2.39, and you
   want to use this NIC to access Slammer ports 192.168.2.10 and
   192.168.2.12, then you would create or edit the file /etc/sysconfig/
   network-scripts/route-eth0 and add the following lines:

   192.168.2.10 via 192.168.2.39 src 192.168.2.39
   192.168.2.12 via 192.168.2.39 src 192.168.2.39

   You can also use the `ip route add` command to temporarily set up routes
   from the command line by using lines of the form described above as
   parameters.

   Example:
   The following command sets up a route for the first Slammer port described
   above:

   ```
   # ip route add 192.168.2.10 via 192.168.2.39 src 192.168.2.39
   ```

2. If the host has more than one NIC in a broadcast domain, you must modify
the configuration to prevent a condition known as address resolution
protocol (ARP) flux, which can prevent routing from operating correctly.
To prevent ARP flux, edit the file `/etc/sysctl.conf`, and modify or add entries for the following parameters:

```shell
net.ipv4.conf.all.arp_ignore=1
net.ipv4.conf.all.arp_announce=2
```

You can also temporarily prevent ARP flux by using lines of this form as parameters to `sysctl -w` commands.

Example:
The following commands temporarily prevent ARP flux:

```shell
# sysctl -w net.ipv4.conf.all.arp_ignore=1
# sysctl -w net.ipv4.conf.all.arp_announce=2
```

Changes to the configuration files will take effect after you reboot the host.

---

**About NIC Bonding**

Network interface card (NIC) bonding is another way to add redundancy to Ethernet networks.

With *NIC bonding*, also known as *channel bonding*, two or more NICs and their physical connections to the switches are logically bonded together and presented to the Internet Protocol (IP) as a single virtual NIC. If one of the physical connections fails, the traffic is transferred to another NIC without the IP layer or the layers above it knowing about the transfer.

This approach protects against low-level Ethernet failures, such as a faulty NIC or cable, between the host and its local IP switch. Because the redundancy is at a very low level in the protocol stack, the higher layers such as Transmission Control Protocol/Internet Protocol (TCP/IP), Internet Small Computer System Interface (iSCSI), and `device-mapper` are not aware that a transfer to a different NIC has taken place. To the IP protocol, the virtual bonded NIC appears as a single physical connection. To iSCSI, it appears as a single connection to each target port.

In short, the iSCSI, `device-mapper`, and APM layers are not aware of the physical path redundancy provided at the NIC bonding level and do not treat this redundancy as providing multiple paths to the Slammer storage controller. Multiple paths created by NIC bonding will not be reported as multiple paths by `device-mapper` or in the AxiomONE Storage Services Manager.
Configure the iSCSI Initiator

To support iSCSI connections, AxiomONE Path Manager (APM) for Oracle Linux 5.5 (OL 5.5) requires the 6.2.0.871-0.16.el5 version of the iSCSI software initiator included in the OL 5.5 distribution.

For complete installation and configuration instructions, refer to: /usr/share/doc/iscsi-initiator-utils-*/README. The following procedure is an overview of the instructions in the README file.

Important! You must ensure that each iSCSI initiator on the iSCSI SAN has a unique name, and set this host's initiator name in the /etc/iscsi/initiatorname.iscsi file.

1. Set up IP addresses and network parameters on Slammer iSCSI ports.
   This may include setting up Challenge Handshake Authentication Protocol (CHAP) on your system.

2. Configure iSCSI accordingly.
   Example:
   If you are using CHAP to communicate with the Slammer iSCSI ports, you may need to modify the /etc/iscsi/iscsid.conf file accordingly.

3. Start the iSCSI initiator.
   
   # service iscsi start

4. Discover the Slammer iSCSI target ports.
   Examples:

   • # iscsiadm -m discovery -t sendtargets -p 172.20.191.11:3260
   • # iscsi_discovery 10.0.0.22

5. Discover the other ports, depending on the desired design (optional).

6. Restart the iscsi service to log in to the discovered target ports:
   
   # service iscsi restart

7. Use chkconfig to configure the iscsi service to start up at various run levels.
   See Start the iSCSI Software Initiator Service.
Start the iSCSI Software Initiator Service

After you have configured the iSCSI software initiator, set the iSCSI initiator to start at startup time and confirm that your Internet Small Computer System Interface (iSCSI) devices are visible.

1. Start the `iscsi` service.

   Run the following command:
   ```bash
   # service iscsi start
   ```

2. Configure the `iscsi` service to start at boot time.

   Run the following commands:
   ```bash
   # chkconfig --add iscsi
   # chkconfig iscsi on
   ```

   The first command checks that the scripts necessary to start and stop the service are available. The second command sets the service to start at the appropriate run levels.

3. Verify that the `iscsi` service is configured to start at boot time.

   Run the following command:
   ```bash
   # chkconfig --list iscsi
   ```

   Result:
   The following is a sample of the output of this command when the service is not configured to start at boot time:
   ```
   iscsi 0:off 1:off 2:off 3:off 4:off 5:off 6:off
   ```

   The following is a sample of the output of this command when the service is configured to start at boot time:
   ```
   iscsi 0:off 1:off 2:on 3:on 4:on 5:on 6:off
   ```

Supported iSCSI Routers and Switches

AxiomONE Path Manager (APM) supports the iSCSI-to-Fibre Channel routing features of the Cisco MDS 9000 family of multi-layer directors and fabric switches.

The iSCSI-to-Fibre Channel routing features enable a host to use Internet Small Computer System Interface (iSCSI) to access LUNs on Pillar Axiom Fibre Channel Slammer storage controllers. Pillar Data Systems tested this APM...
release on Cisco MDS SAN-OS Release 3.0 (2a). Refer to the Cisco documentation (http://www.cisco.com/univercd/cc/td/doc/product/sn5000/mds9000/3_0/fmcfg/index.htm) for more information on these features.

In this release, Pillar Data Systems supports only the iSCSI-to-Fibre Channel routing capabilities provided by this Cisco switch.

The switch requires certain configuration steps to work with APM and the Pillar Axiom system as an iSCSI-to-Fibre Channel router. See Configure the iSCSI-to-Fibre Channel Router for configuration information.

Configure the iSCSI-to-Fibre Channel Router

The iSCSI-to-Fibre Channel routing features of the Cisco MDS 9000 family of multi-layer directors and fabric switches require configuration to work with the AxiomONE Path Manager (APM) and the Pillar Axiom system.

For more information on these features, refer to the Cisco documentation (http://www.cisco.com/univercd/cc/td/doc/product/sn5000/mds9000/3_0/fmcfg/index.htm).

1. Present the Pillar Axiom Slammer storage controller ports as Internet Small Computer System Interface (iSCSI) targets.

   Choose Dynamic Mapping or Static Mapping. However, we recommend that you use dynamic mapping because the main Cisco features for static mapping requirements are supplied by APM and the AxiomONE Storage Services Manager.

2. Present the iSCSI hosts as virtual Fibre Channel hosts.

   The hosts must be presented in transparent initiator mode (not in proxy-initiator mode). When you assign World Wide Names (WWNs) for the iSCSI initiators, use the static mapping mechanism.

After you configure the switch, APM on the iSCSI hosts interacts with the Pillar Axiom systems in exactly the same way as when both hosts and Slammers use the same SAN protocol.

Pre-Configure the SAN Host for Pillar Axiom Integration

Before you install the AxiomONE Path Manager (APM) software, you need to prepare your storage area network (SAN) host connections with the Pillar Axiom system.

Prerequisites:
Verify that your system has:

- LUNs configured on your Pillar Axiom system.
- At least one SAN Slammer storage controller that has Fibre Channel (FC) or Internet Small Computer System Interface (iSCSI) ports.
- An FC or iSCSI protocol license.
- Supported host bus adapter (HBA) drivers and API libraries.
- Ethernet connections to the management ports on the Pilot management controller.
- A network configuration that allows an application on the SAN host to connect to TCP port 26004 on the Pilot.

**Tip:** To check network connectivity, issue a simple `pdscli` or `axiomcli` request from the host to the Pillar Axiom system. Both `pdscli` and `axiomcli` use the same port and protocols as those used by APM. Refer to the *Pillar Axiom CLI Reference Guide* or *Pillar AxiomONE CLI Reference Guide* for details.

1. Verify that all FC and iSCSI components and software are installed on the SAN host according to the instructions in this guide.

2. Set up the physical connectivity and any required switch zoning for the SAN. Proper setup is needed so all required host ports can access the Slammer ports on the Pillar Axiom server.

3. If you are using iSCSI connections, choose one or more of the following:
   - **About Network Configuration for iSCSI Multipathing.**
   - **Configure the iSCSI Initiator.**
   - **Configure the iSCSI-to-Fibre Channel Router.**

4. Launch the AxiomONE Storage Services Manager and navigate to the Storage > SAN > Hosts page.

5. Verify the SAN connections.
   - Each host port should display individually as follows:
Table 11 Characteristics of SAN connections to host ports

<table>
<thead>
<tr>
<th>Column label</th>
<th>Port type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FC</td>
</tr>
<tr>
<td></td>
<td>iSCSI</td>
</tr>
<tr>
<td>Host Name:</td>
<td>Hostname Unknown</td>
</tr>
<tr>
<td></td>
<td>IQN (iSCSI Qualified Name)</td>
</tr>
<tr>
<td>Host Port:</td>
<td>WWN</td>
</tr>
<tr>
<td></td>
<td>IP address</td>
</tr>
</tbody>
</table>

See Figure 2: Example host ports before APM installation for an illustration.

6 If the host is using only iSCSI to connect to Slammers, choose one of:

- Install the sg3-utils packages.
- Ensure that at least one LUN on the Pillar Axiom system is visible to the host.

The sg3-utils-libs-* and sg3-utils-* packages are required for automatic discovery of the Pillar Axiom system over iSCSI when no iSCSI LUNs are visible to the host. An alternative is to make a LUN visible to the host by either creating a global LUN or mapping one to the host iSCSI software initiator IQN.

**Note:** If you mapped a LUN to the initiator IQN, it will automatically be remapped to the host name after APM is installed. If the LUN is temporary, delete it after you install the software.

---

**Verify Installation of the Device Mapper**

The Linux 2.6 device-mapper, among other uses, maps a logical block device on the SAN host into a Pillar Axiom LUN. The AxiomONE Path Manager (APM) daemon monitors the device-mapper and uses it to provide multipathing.

APM requires device-mapper version 1.02.39-1.el5 or later.

1 Verify that device-mapper is installed.

Run the following command:

```
# rpm -qa | grep device-mapper | grep -v multipath
```

Result:

If device-mapper is installed, this command returns the version of device-mapper and your operating system.
2 If `device-mapper` version 1.02.39–1.el5 or later is not installed, install this version.

Install `device-mapper` from your Linux installation CDs or operating system vendor website.
Download and Install the AxiomONE Path Manager Software

The AxiomONE Path Manager (APM) installation for Oracle Enterprise Linux 5.5 (OEL 5.5) requires that you download both the APM package and the Multipath Tools package from the Pillar Support website. Then you need to install both packages on your system.

If you are using the Unbreakable Enterprise Kernel (UEK) version of Oracle Linux 5.5, you can download and install either the Pillar version of multipath-tools or the latest device-mapper-multipath package available from the Oracle Unbreakable Linux Network.

1. Download the AxiomONE Path Manager Software.
2. Install (or Update) the AxiomONE Path Manager Software.
3. Configure the Pillar Axiom System for LUN Access.

To remove the AxiomONE Path Manager software from your SAN host, see Remove AxiomONE Path Manager Software (Optional).

Download the AxiomONE Path Manager Software

Download the AxiomONE Path Manager (APM) software from the Pillar Support website.

The APM 3.3 software consists of two packages that you will need to download:

- **APM**: Contains the APM daemon
- **Multipath Tools**: Contains an updated version of the multipath-tools component of device-mapper

The Multipath Tools component also contains bug fixes. When using APM, the Pillar version of multipath-tools must be used in place of the one supplied with the Linux operating system.

**Note**: If you are using the Unbreakable Enterprise Kernel (UEK) version of Oracle Linux 5.5, you can use either the Pillar version of multipath-tools or the latest device-mapper-multipath package available from the Oracle Unbreakable Linux Network.

2 Click **Software Downloads > AxiomONE Path Manager** in the left-hand navigation pane.

3 Navigate to the name of the installation package for your hardware platform in the right-hand content pane.

4 For each package (APM or Multipath Tools), click the name of the package to download for your hardware platform (x86, or AMD64/Intel EM64T).

5 Click the green arrow in the **Software Download Details** pane below, and follow the download prompts.

6 Choose the **Save** option to download the package to your SAN host.

---

**Install (or Update) the AxiomONE Path Manager Software**

After you download the AxiomONE Path Manager (APM) software and Multipath Tools packages, you can install them on your host system.

Before you install the APM software, verify that your system meets the prerequisites outlined in **Supported Fibre Channel SAN Hardware Components** and **Pre-Configure the SAN Host for Pillar Axiom Integration**.

Two steps in the installation process enable you to keep your original multipath configuration file (**/etc/multipath.conf**) so that you can continue to use your specific configurations for managing devices other than APM-managed Pillar Axiom LUNs:

- Because the configuration file will be deleted, Step 1 asks you to save a copy of that file before you begin the APM installation or update task.
- Step 5 asks you to merge any changes you made to the original configuration file into the new file.

**Tip:** We strongly recommend that you follow these two steps when you have previously added or modified entries in **/etc/multipath.conf**.

1 If you previously configured **multipath-tools** on your system, save a copy of the current **/etc/multipath.conf** file.

   Saving a copy allows you to merge the changes into the new file that will be created.

2 Remove any previous versions of APM on your system using the following command:

   ```shell
   # rpm -e axiompm
   ```
3 Do one of:

- Uninstall any previously installed versions of `multipath-tools`, and install the Pillar Multipath Tools package.

  The name of the `multipath-tools` Red Hat Package Manager (RPM) package varies (depending on its source). The name usually begins with one of the following strings:

  `multipath-tools`

  `device-mapper-multipath`

  Use one of the following example commands, depending on the name of the `multipath-tools` RPM package, to uninstall the previous version:

  ```sh
  # rpm -e multipath-tools
  or
  # rpm -e --nodeps device-mapper-multipath
  ```

  **Important!** Other packages associated with `device-mapper` that begin with the string `device-mapper` may exist on the SAN host. Do not remove these packages. Remove only those packages that begin with the string `multipath-tools` or `device-mapper-multipath`.

  Use the following command to install the Multipath Tools package:

  ```sh
  # rpm -ivh multipath-tools-version.rpm
  ```

  **Note:** In the command above, `version` is the name of the release version you downloaded.

- *(UEK only)* Install the latest `device-mapper-multipath` package from the Oracle Unbreakable Linux Network (OULN).

4 Install the APM package using the following command:

```sh
# rpm -ivh axiompm-version.rpm
```

**Note:** In the command above, `version` is the name of the release version you downloaded.

APM files and scripts are installed in the `/opt/pillar` directory.

5 After the new `/etc/multipath.conf` is installed, merge in any previous configuration data for `device-mapper` from the copy of the configuration file you saved in Step 1.
Merging those changes allows you to retain previous configuration settings to manage devices other than APM.

6 Restart the host.

After you install the software, follow the instructions in Configure the Pillar Axiom System for LUN Access. You must complete that task for the software to function correctly.
Configure the Pillar Axiom System for LUN Access

The LUN configuration procedure provides the storage area network (SAN) host with access to Pillar Axiom LUNs. Refer to the *Pillar Axiom Administrator’s Guide* for instructions on how to create LUNs.

Prerequisites:

- **Pre-Configure the SAN Host for Pillar Axiom Integration.**
- **Install (or Update) the AxiomONE Path Manager Software.**

1. In the AxiomONE Storage Services Manager, navigate to the *Storage > SAN > Hosts* page.

2. Verify that the individual entries for the host ports have been replaced with a single entry under the host name.

Examples:

**Figure 2 Example host ports before APM installation**

<table>
<thead>
<tr>
<th>Host Name</th>
<th>Host Port</th>
<th>Type</th>
<th>AxiomONE Path Manager</th>
<th>Number of LUNs</th>
<th>Host Port Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x9:36:94:5e</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x8:36:94:9f</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x9:36:94:20</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x8:41:32:3c</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x8:41:32:4c</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>iam.1987-63.com.01.ea39960551</td>
<td>192.168.2.83</td>
<td>ISCSI</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>iam.1987-63.com.01.ea39960551</td>
<td>192.168.2.84</td>
<td>ISCSI</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
</tbody>
</table>

**Figure 3 Example host ports after APM installation**

<table>
<thead>
<tr>
<th>Host Name</th>
<th>Host Port</th>
<th>Type</th>
<th>AxiomONE Path Manager</th>
<th>Number of LUNs</th>
<th>Host Port Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>iame</td>
<td>10:00:00:00:x9:39:84:5a</td>
<td>FC</td>
<td>Communicating</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>iame</td>
<td>10:00:00:00:x9:39:84:6f</td>
<td>FC</td>
<td>Communicating</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>iame</td>
<td>192.168.2.93</td>
<td>ISCSI</td>
<td></td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>iame</td>
<td>192.168.2.94</td>
<td>ISCSI</td>
<td></td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x8:36:95:20</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x8:41:32:23</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
<tr>
<td>Hostname Unknown</td>
<td>10:00:00:00:x8:41:32:24</td>
<td>FC</td>
<td>Not Registered</td>
<td>0</td>
<td>Connected</td>
</tr>
</tbody>
</table>
Note: The Hosts page may display differently in your version of AxiomONE Storage Services Manager.

You will see one or more of the following AxiomONE Path Manager Status and Host Port Status messages on the Hosts page:

**APM Status**

- **Communicating**: The host control path is currently logged into the Pilot.
  
  **Note**: Communicating status is required for the APM control path to report path status, configure load balancing, and use the Pillar Axiom system to collect APM diagnostic logs.

- **Not Registered**: A control path from an APM host with this name has never logged into the Pilot.

- **Not Communicating**: The APM host control path has previously logged into the Pilot, but it is not currently logged in.

**Host Port Status**

- **Connected**: The host SAN connection is logged in to the SAN Slammer.
  
  **Not connected**: The host SAN connection is not logged in to the SAN Slammer.

See the AxiomONE Storage Services Manager Help for information about the remaining fields on the Hosts page.

3 As needed, create new LUNs on the Pillar Axiom server for the SAN hosts.

**Note**: In a clustered environment, LUNs shared in a cluster should be mapped to all host nodes in the cluster.

4 As needed, set up mappings of the LUNs to the new host entries.

5 Follow the recommendations in SAN Dynamic Reconfiguration to make any changes visible to the SAN host.

6 Run the following commands to list the multipath devices (optional):

   # /sbin/multipath -v3
   # /sbin/multipath -ll

   The first command (multipath -v3) populates the path information, and the second command (multipath -ll, lower-case letters L) lists the state of the paths.

7 In the AxiomONE Storage Services Manager, navigate to the Storage > SAN > Hosts page.

8 Click the name of the new host and, on the Host Information page, verify the APM software version.
9  Click the **LUN Connections** tab and verify that the host and LUN connections are as expected.

   The column titled **LUN Name on Host** should show the Linux disk names that APM allocates to each LUN.

   **Important!** With a few exceptions (such as when you partition and format the LUN on the SAN host), you should use only these Linux disk names to access and configure the LUNs on the host. Linux creates device names for each individual path to a LUN, but almost all configuration and administration tasks should be done using the `/dev/mapper` name shown in the AxiomONE Storage Services Manager.

10  If you plan to partition and format the LUN on the SAN host, see **Partition and Format the LUN Disk (Optional)**.
Partition and Format the LUN Disk (Optional)

Follow these instructions if you plan to use the Linux fdisk or parted utilities to partition and format the disk on which a LUN resides.

The fdisk utility cannot be used with devices listed in the /dev/mapper directory. Instead, use fdisk on one of the underlying paths, and then run the scripts to restart the multipath-tools and APM daemons to notify device-mapper that a /dev/mapper device has a new partition.

1 Identify one of the highest priority paths to the LUN using the output of the multipath -ll command.

Example:
In the output below, you could identify either the /dev/sdd or the /dev/sdh path:

```
2000b08008e001305 dm-0 Pillar,Axiom 500
  size=50G features='1 queue_if_no_path' hwhandler='0' wp=rw
    +- policy='round-robin 0' prio=4000000 status=active
       | - 4:0:1:1 sdd 8:48 active ready running
       |   `- 5:0:1:1 sdt 65:48 active ready running
    +- policy='round-robin 0' prio=3000000 status=enabled
       | - 8:0:0:1 sdj 8:144 active ready running
       |   `- 6:0:0:1 sdk 8:160 active ready running
    +- policy='round-robin 0' prio=2000000 status=enabled
       | - 4:0:0:1 sdb 8:16 active ready running
       |   `- 5:0:0:1 sdf 8:80 active ready running
     `-+- policy='round-robin 0' prio=1000000 status=enabled
        | - 9:0:0:1 sdl 8:176 active ready running
        |   `- 7:0:0:1 sdp 8:240 active ready running
```

2 Use fdisk to partition one of the highest priority paths identified in Step 1.

3 Run the following command to restart the device-mapper:

```
# /etc/init.d/multipathd restart
```

4 Run the following command to restart the APM daemon:

```
# /etc/init.d/axiompmd restart
```

5 Verify that the new partitions are listed as:

```
/dev/mapper/LUNpX
```

Where LUN is the LUN identifier, and x is the partition number used in Step 2.
Note: The letter \( p \) appears between the LUN identifier and the partition number.

Example:
In the example above, if only partition 1 were created with `fdisk`, it would appear as follows:

```
localhost$ ls -l /dev/mapper/2000b080002001395*
brw-rw----  1 root disk 253,  2 Jul  7 12:02
2000b080002001395
brw-rw----  1 root disk 253,  3 Jul  7 15:12
2000b080002001395p1
```

6 Format the new partition.

Example:
To format the partition created in the example above, you might run the following command:

```
# mke2fs -j /dev/mapper/2000b080002001395p1
```

7 Mount the filesystem.

For detailed information, refer to your Linux documentation.
About Load Balancing Configurations

AxiomONE Path Manager (APM) can be configured for static or round-robin load balancing. You can configure load balancing separately for each LUN.

In static load balancing, the software selects the best available path and all commands are sent over that path until the path is no longer operational. Then, a failover to another appropriate path is initiated.

In round-robin load balancing, commands are sent by turn over the best available paths. This ensures that LUN commands are evenly distributed over any path that is available to access the LUNs.

Load balancing allows the paths to share load in different ways:

- Balances access to a LUN across all optimized Slammer ports available for that LUN
- Balances access from a host across the host's HBA channels

To configure round-robin or static load balancing through the AxiomONE Storage Services Manager, refer to the Pillar Axiom Administrator's Guide.
About Path Selection

AxiomONE Path Manager (APM) supports access to LUNs using Internet Small Computer System Interface (iSCSI) and Fibre Channel (FC) protocol at the same time, as well as individually.

Paths to a LUN may have different performance characteristics. Paths to the Slammer control unit where the LUN resides are considered *optimized paths*; other paths to the LUN are considered *non-optimized paths*. When both FC and iSCSI access to a LUN are available, FC access generally performs better.

APM divides the paths to each LUN into four groups with different performance characteristics, in this order of precedence:

- First, FC optimized
- Next, iSCSI optimized
- Next, FC non-optimized
- Finally, iSCSI non-optimized

At any given time, the *device-mapper* framework only uses paths from the most preferred group that has paths available.

**Note:** When an active path fails, and I/O traffic is transferred to a different path, I/O performance will be reduced for a short time while the operating system recognizes the failure and makes the path transfer. If the failing path was optimized and the new path is non-optimized, I/O performance may remain lower than before since it is now using a lower-performance path. Within a few minutes of traffic being transferred to a non-optimized path, the Pillar Axiom system will reconfigure the LUNs to use an optimized path, if possible. I/O performance will improve.
Remove AxiomONE Path Manager Software (Optional)

When you uninstall AxiomONE Path Manager (APM), support for multiple paths to Pillar Axiom LUNs is removed.

Before you uninstall APM, if you do not want to access Pillar Axiom LUNs, we recommend that you disconnect the storage area network (SAN) host from the Pillar Axiom system.

Sometimes, the uninstall process may take longer than expected, and the process may appear to be hanging. Allow the process to run for at least an hour before attempting to restart the process.

1. Run the following commands to stop and remove the APM daemon:
   
   ```
   # /etc/init.d/axiompm stop
   # rpm -e axiompm
   ```

2. Run the following command to remove the version of multipath-tools supplied by Pillar Data Systems:

   ```
   # rpm -e multipath-tools
   ```

3. Reinstall the multipath-tools that came with your Linux software (optional).

After the APM software (both axiompm and multipath-tools) has been removed, the host appears not to be communicating in the AxiomONE Storage Services Manager, and the multipath behavior stops working.

**Important!** If you want to continue LUN access without multipathing, we recommend that you reconfigure the SAN so that only a single path exists from the host to each Pillar Axiom Slammer storage controller. You may need to reconfigure LUN mapping on the Pillar Axiom system to map the LUNs to the host port or iSCSI Qualified Name (IQN), and you may need to reconfigure the host to access the LUNs through new device names.
AxiomONE Path Manager (APM) 3.3 supports:

- **Oracle Linux 5.5 (OL 5.5)**
  The version of `multipath-tools` included in OL 5.5 fixes Red Hat Bugzilla defect 518575: Multipath UID/GID/MODE settings not always taking effect. APM 3.3 contains the first version of the Pillar `multipath-tools` to support the UID/GID permissions feature.

- Fibre Channel over Ethernet (FCoE) connections from converged network adapters (CNAs) through a switch to a Fibre Channel (FC) SAN on Red Hat Compatible Kernel versions of OL 5.5 only.

- Both static and round-robin load balancing.
Known APM Issues

The following AxiomONE Path Manager (APM) issues are known in this release.

Table 12 Known issues

<table>
<thead>
<tr>
<th>Issue</th>
<th>Workaround or planned fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Updates not displayed in GUI. Updates to the host path or optimization state are not displayed in the AxiomONE Storage Services Manager (GUI).</td>
<td>It may be necessary to restart the APM daemon to update the GUI after host path and optimization changes.</td>
</tr>
</tbody>
</table>
## Known Pillar Axiom Issues

The following issues might be associated with the version of the Pillar Axiom software you are using.

### Table 13 Known Pillar Axiom issues

<table>
<thead>
<tr>
<th>Issue</th>
<th>Workaround or planned fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>When a Fibre Channel HBA is removed from a host running APM, it remains associated with that host. If the HBA is moved to a host that is either not running APM or on which APM is shown as not communicating with the Pillar Axiom Pilot, any LUNs mapped to the host will continue to be accessible through the HBA ports. The GUI and CLI will continue to report the HBA as being present in the original host. If the HBA is moved to a host where APM is running and communicating with the Pilot, its association and mappings for the old host will be removed, and the mappings for the new host will be applied.</td>
<td>This issue is fixed in release 4.0 of the Pillar Axiom software.</td>
</tr>
<tr>
<td>If you use the GUI or CLI to change the default configured Slammer control unit (CU) of a LUN to the other CU on the Slammer, the Slammer port mask for the LUN will be reversed. For example, if CU0 Port 0 is enabled and Port 1 is excluded, and the LUN is moved to CU1, then CU1 Port 0 will become excluded and CU1 Port 1 will become enabled.</td>
<td>After you change the default configured Slammer CU for a LUN, be sure to update the LUN port mask to the required value. This issue is fixed in release 4.0.0 of the Pillar Axiom software.</td>
</tr>
<tr>
<td>If an APM host uses iSCSI to connect to a Pillar Axiom system, and it uses an iSCSI initiator name that is the same as its host name, then the entry for that host in the AxiomONE Storage Services Manager will be continually deleted and recreated, causing the host</td>
<td>Ensure that the iSCSI initiator names configured on hosts that use iSCSI to connect to a Pillar Axiom system are different from all host names used by APM hosts, including virtual machine hosts, connected to that Pillar Axiom system. The iSCSI standards require</td>
</tr>
</tbody>
</table>
Table 13 Known Pillar Axiom issues (continued)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Workaround or planned fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>entry to disappear and reappear intermittently.</td>
<td>that iSCSI names follow particular formats, as specified in RFC 3720: (<a href="http://tools.ietf.org/html/rfc3720#section-3.2.6">http://tools.ietf.org/html/rfc3720#section-3.2.6</a>). If hosts are configured to use iSCSI initiator names that conform to these requirements, it is extremely unlikely that they will be the same as any host name. This issue is fixed in release 4.1 of the Pillar Axiom software.</td>
</tr>
<tr>
<td>If all paths to a LUN's configured Slammer control unit (CU) fail, APM will re-route all traffic through the non-optimized paths to the LUN's alternate CU. In response, the Pillar Axiom system will initially log events indicating non-optimized access, then when this traffic continues it will temporarily move the LUN to the alternate CU. This process leaves the host using optimized paths to the LUN, but the LUN is resident on a CU other than its configured home. Normally, the system will attempt to move the LUN back to its configured CU from time to time, and if the paths to the other CU have recovered the traffic will transfer back and the system returns to its normal configured state. However, if the Pilot software is restarted while a LUN is in this temporary state, as might happen during a software update that includes the option to update the Pilot software, two problems occur: 1 The graphical user interface (GUI) and command line interface (CLI) wrongly report that the LUN's current CU is its configured CU.</td>
<td>This issue is fixed in release 4.0 of the Pillar Axiom software.</td>
</tr>
</tbody>
</table>
Table 13 Known Pillar Axiom issues (continued)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Workaround or planned fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Non-optimized access events are no longer logged for the LUN, and the system does not attempt to move the LUN back to its configured CU. If subsequent path failures and recoveries cause traffic to be sent to the CU on which the LUN is not resident, the system will not move the LUN to the CU receiving the traffic. This means that all traffic to the LUN would have non-optimized access, which decreases performance, and this non-optimized access would not be logged.</td>
<td>This issue is fixed in Pillar Axiom software release 4.0. If the Pillar Axiom system is running a release earlier than 4.0, check that the load balancing attribute for the LUN is still set to the desired value after APM on the host has detected the LUN and its LUN name on Host has been reported in the GUI. If the setting has changed, change it back to the desired value, which can then be correctly saved.</td>
</tr>
<tr>
<td>When a LUN is created on a Pillar Axiom system, its load balancing attribute is set to round-robin by default. If the LUN is then mapped to a host running APM, the load balancing attribute setting can change to static when APM on the host first communicates with the Pillar Axiom system after detecting the LUN. Instead, this attribute should be set to round-robin when the LUN is first created, and should change only if an administrator changes it using the GUI or CLI.</td>
<td>This issue is fixed in Pillar Axiom software release 4.0. If the Pillar Axiom system is running a release earlier than 4.0, check that the load balancing attribute for the LUN is still set to the desired value after APM on the host has detected the LUN and its LUN name on Host has been reported in the GUI. If the setting has changed, change it back to the desired value, which can then be correctly saved.</td>
</tr>
<tr>
<td>If an iSCSI initiator is added to a SAN host that has authentication enabled, authentication will not be enabled for that initiator. Also, if an iSCSI initiator with authentication enabled on a previous SAN host is moved to another host with or without authentication enabled, the initiator will retain its original configuration.</td>
<td>This issue is fixed in Pillar Axiom software release 4.0. If the Pillar Axiom system is running a release earlier than 4.0, disable then re-enable authentication for the host after iSCSI initiators are added to or moved between SAN hosts.</td>
</tr>
<tr>
<td>The GUI and CLI may show incorrect link speeds for SAN hosts with 8 Gb/s HBAs.</td>
<td>This issue is fixed in release 4.1 of the Pillar Axiom software.</td>
</tr>
</tbody>
</table>
### Table 13 Known Pillar Axiom Issues (continued)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Workaround or planned fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>After recovery from a Slammer control unit (CU) failure, the Pillar Axiom system may become incapable of automatically moving LUNs between the CUs on that Slammer. When the system attempts to move the LUNs automatically in response to non-optimized access from a host, the attempts fail, and non-optimized access persists.</td>
<td>Use the GUI or CLI to re-assign the LUNs to the CUs through which access is currently taking place. Alternatively, restart the Pillar Axiom system to restore optimized access. This issue is fixed in release 4.1 of the Pillar Axiom software.</td>
</tr>
<tr>
<td>When an iSCSI initiator name is changed or removed on an APM host, the GUI and CLI may continue to associate the old name with the host.</td>
<td>1. Stop the APM daemon on the host. 2. When the Pillar Axiom system reports the host as Not Connected, delete the host. This will preserve LUN mappings to the initiators. 3. Restart the APM daemon. This issue is fixed in release 4.2 of the Pillar Axiom software.</td>
</tr>
<tr>
<td>When a Pilot restart occurs on a Pillar Axiom system running release 4.0 (4.0.4 or later) or release 4.1 (4.1.0 or later) of the Pillar Axiom software, all LUNs on the system move from their current Slammer control unit (CU) to the other Slammer CU. As a result, the optimization of all paths to the LUNs changes.</td>
<td>If all relevant SAN hosts have paths to both CUs on the Slammers, and those paths are managed by an ALUA-aware path management system such as AxiomONE Path Manager, it should not be necessary to take any action. The LUNs will remain balanced across the CUs, and the path management software will ensure that only optimized paths to the LUNs are used. Be aware that traffic may be moved to alternate paths when a Pilot restart occurs. Other hosts may need their path configuration to be changed to ensure that they access each LUN through its new current home CU. Alternatively, all LUNs can be moved back to their default configured CU by restarting the Pillar Axiom system. This issue is fixed in release 4.1.4 of the Pillar Axiom software.</td>
</tr>
</tbody>
</table>
Table 13 Known Pillar Axiom issues (continued)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Workaround or planned fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>The load balancing configuration displayed in the GUI or CLI can be different from the load balancing setting that the Pillar Axiom system sends to APM on the SAN host. This happens because, occasionally in the course of updating its configuration records to describe the new host, the Pillar Axiom system creates duplicate internal records.</td>
<td>This issue is fixed in Release 4.2.3 and later of the Pillar Axiom software.</td>
</tr>
<tr>
<td>A change in the number of reported iSCSI initiator IQNs can cause the loss of all SAN Zonings.</td>
<td>If something causes an APM host to report two or more iSCSI initiator IQNs, and there is a subsequent change that causes that APM host to report one less iSCSI initiator, all zonings in the storage area network (SAN) to all iSCSI initiators for that host will be lost. MCC-core will still show mappings to the host, but these mappings will not be zoned in the SAN and will be unavailable to the host. This issue is fixed in release 4.3 of the Pillar Axiom software.</td>
</tr>
<tr>
<td>In the GUI, LUN host connections in a disconnected state display Protocol Disabled instead of Not Connected status in the View Connections screen.</td>
<td>This issue is fixed in release 4.3 of the Pillar Axiom software.</td>
</tr>
</tbody>
</table>
**Known Operating System Issues**

The following operating system issues may have an impact on running APM on Linux platforms.

**Access to LUNs**

In most cases, you should only access LUNs through `device-mapper` or individual partition paths.

The Linux `device-mapper` creates paths of the form `/dev/mapper/2000b08003d001321` to represent multipath Pillar Axiom LUNs. Individual partitions on a LUN have names of the form `/dev/mapper/2000b08003d001321p3`. With the exception of the situation described in Partition and Format the LUN Disk (Optional), you should access multipath LUNs and their partitions exclusively through these paths.

If a multipath partition is configured into `/etc/fstab`, omit the sixth field of its entry (`fs_passno`), or set it to 0 to prevent `fsck` from running automatically on the partition during a system boot. This is because `device-mapper` is not yet configured at the time `fsck` runs during boot, so the multipath devices are not accessible.

**Important!** Failure to disable `fs_passno` will cause host boot failure.

**SAN Dynamic Reconfiguration**

Linux does not automatically detect storage LUNs after a dynamic reconfiguration. Dynamic reconfiguration is the addition, deletion, growing, resizing, or cloning of one or more LUNs attached to a host.

Follow the instructions for dynamic reconfiguration in the Online Storage Reconfiguration Guide (http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/5/html/Online_Storage_Reconfiguration_Guide/). If you continue to have problems with dynamic reconfiguration, the following steps will help you handle exceptions.

Linux requires a series of steps, including a potential host reboot, when a LUN is dynamically reconfigured. After Linux detects the new LUNs, you must restart AxiomONE Path Manager (APM) to update the Pillar Axiom system with the new LUN status.
LUNs Added Dynamically

In most systems, a newly added LUN is immediately visible on the host without a rescan. However, due to inconsistent device driver behavior on some hosts, if the added LUN is not visible, a rescan usually makes it visible. A rescan normally involves an I/O reset.

If, after creating a new LUN on the Pillar Axiom system and assigning it to the host, running the rescan script does not bring up the LUNs. This may have happened because Linux incorrectly believes that the LUN number is already in use. To correct this situation, modify the host LUN number in the AxiomONE Storage Services Manager. Give it a new, unique value that falls within the range of permitted values. If necessary, rescan to add the LUN.

Both Emulex and QLogic provide rescan scripts that may help in dynamically configuring LUNs.

- The Emulex HBA driver for Linux enables you to dynamically add or delete LUNs and targets without unloading or reloading the lpfc module and without resetting the adapter. Use the Emulex lun_scan script in /usr/sbin. Refer to the Emulex Driver for Linux User Manual (http://www-dl.emulex.com/support/linux/82022/manual.pdf) for details.

- For QLogic HBAs, use the Dynamic Target and LUN Discovery script ql-dynamic-tgt-LUN-disc.sh, available from the QLogic Downloads page (http://driverdownloads.QLogic.com).

LUNs Deleted Dynamically

Deleting a LUN prevents the LUN from being visible from the host. This includes deleting LUN mapping and LUN masking. In general, LUN deletion disrupts normal function of the Linux multipath framework and must be planned.

If a LUN is deleted, it may appear as either a 2000000000000 entry or as the original LUID with Path down messages. These entries may persist until the host is rebooted.

To avoid disruption, you may blacklist the LUN. Refer to your Linux documentation.

The host usually picks up the deleted LUN, and it is deleted from the /dev/mapper table. However, this may not occur on all platforms consistently. If you want to view the device-mapper LUN mapping table, start the multipathd shell by running the following command:

```bash
# /sbin/multipathd -k
```

To delete a LUN, we recommend shutting down the host, deleting the LUN or LUN mapping from the Pillar Axiom system, and then restarting the host. If this procedure is not possible, you may want to run the following procedure.
Important! The following procedure will interrupt I/O and may require an immediate reboot of your host. In some cases, this may require a power cycle of the host to recover.

1 Copy the following and run it as a script:

```bash
#!/bin/bash
# Must be run as root
/etc/init.d/axiompmd stop
/sbin/multipath -F
/etc/init.d/multipathd stop
# RESCAN SCRIPT FROM QLOGIC / EMULEX
# Please modify the following line based on your rescan script location
/usr/bin/ql-dynamic-tgt-lun-disc.sh -s -r
/etc/init.d/multipathd start
/etc/init.d/axiompmd start
/sbin/multipath –v3 -ll
```

Tip: The rescan script might require your interaction.

2 Be prepared to reboot the host as soon as possible after deleting LUNs in case something goes wrong.

If a LUN that is visible to a Linux 2.6 host is deleted from the Pillar Axiom system, and the `/sbin/multipath -F` or `/sbin/multipath -f` command is run before rebooting the host, the device-mapper configuration map may become unusable and all access to LUNs may be lost due to a bug in the Linux device-mapper code. If this occurs, the only way to recover is to reboot the host.

After LUN deletion, you may see a message similar to the following while the Pillar Axiom system is restarting the daemon:

```
error calling out /sbin/scsi_id -g -u -s /block/sd*
```

This message indicates that entries for the deleted LUNs still exist in the device-mapper device table. Rebooting the host will flush these deleted path entries from the device table.

### LUNs Resized Dynamically

When you resize a LUN, a host reboot is necessary due to the constraints in the Linux device-mapper. You must stop the iSCSI services before you reboot the host.

However, if you follow the procedures documented in the Online Storage Reconfiguration Guide (http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/5/html/Online_Storage_Reconfiguration_Guide/) to force your device drivers to recognize the resized LUN, the device-mapper may recognize the resized LUN without a host reboot. The ability to use the resized LUN is a function of the host filesystem.
Clone LUNs Added or Deleted Dynamically

The procedures for adding or deleting LUNs described above also apply for Clone LUNs.

Restore Paths After Path Failure

Due to a Linux limitation, SCSI device paths may be marked offline after path failure.

1. Open the `/etc/modprobe.conf` file in a text editor, and set the options as follows:

   ```
   options qla2xxx ql2xfailover=0 MaxRetriesPerPath=3
   ql2xloginretrycount=30 ql2xlogintimeout=30
   ql2xretrycount=90 qlport_down_retry=45
   ```

2. Run the following command to rebuild the kernel:

   ```
   # /sbin/new-kernel-pkg --mkinitrd --depmod --install `uname -r`
   ```

3. Reboot the host.

Multipath Failed Path Errors

The multipath command may return errors that indicate only that there are failed paths.

If paths are in a failed state, the `multipath` command returns the following error messages:

```
multipath -ll 2000b08005c001259
9:0:0:3: sg_io failed status 0x8 0x1 0x0 0x0
9:0:0:3: Unable to get INQUIRY vpd 1 page 0x0.
error calling out /sbin/scsi_id -g -u -s /block/sdaf
8:0:0:3: sg_io failed status 0x8 0x1 0x0 0x0
```

These error messages indicate only that there are failed paths in the multipath device map. The multipath device map shows paths that are failed and active, and `sg_io failed` refers to the fact that SCSI generic (`sg`) devices do not exist for iSCSI device paths that are failed. These errors indicate that the system is responding correctly.

You must fix the failed paths or, if these errors occur during failover testing, recognize that this is normal and expected Linux multipath behavior.
Note: The multipath command can be invoked automatically by the system at various times, so it is possible for messages like these to be seen whenever paths are in an unusual state, such as during dynamic reconfiguration.

Reconfigure Oracle Cluster Parameter to Prevent Hangs

Restoring ports in a cluster during failback after a failover creates a potential split-brain condition. By design, Linux clustering reboots nodes as part of I/O fencing to avoid data corruption.

In addition, losing all paths to a node may cause the cluster host to hang because the Oracle hang check timer is exercised.

If you experience reboot problems, we recommend setting O2CB parameters to values that are higher than Oracle’s suggested minimums. For example, we found the following settings effective for our test cluster configuration:

```
# O2CB_ENABLED: 'true' means to load the driver on boot.
 O2CB_ENABLED=true
# O2CB_BOOTCLUSTER: If not empty, the name of a cluster to start.
 O2CB_BOOTCLUSTER=ocfs2
# O2CB_HEARTBEAT_THRESHOLD: Iterations before a node is considered dead.
 O2CB_HEARTBEAT_THRESHOLD=901
# O2CB_IDLE_TIMEOUT_MS: Time in ms before a network connection is considered dead.
 O2CB_IDLE_TIMEOUT_MS=100000
# O2CB_KEEPALIVE_DELAY_MS: Max time in ms before a keepalive packet is sent
 O2CB_KEEPALIVE_DELAY_MS=50000
# O2CB_RECONNECT_DELAY_MS: Min time in ms between connection attempts
 O2CB_RECONNECT_DELAY_MS=20000
```

/etc/sysconfig/o2cb is a configuration file for automatic startup of the O2CB driver. It is generated by running the following command:

```
/etc/init.d/o2cb configure
```

After generating the configuration file, use a text editor to make the following modifications:

```
Heartbeat dead threshold = 901
Network idle timeout: 100000
Network keepalive delay: 50000
Network reconnect delay: 20000
Checking O2CB heartbeat: Active
```
RHCK to UEK Upgrade Fails

Upgrading from the Red Hat Compatible Kernel (RHCK) to the Unbreakable Enterprise Kernel (UEK) version of Oracle Linux 5.5 (OL 5.5) fails on boot-from-SAN systems because of a UEK limitation.

The UEK kernel fails to load the device-mapper driver at boot time. This is a known problem with the OL 5.5 release. Contact Oracle technical support for assistance.

Unable to Update Path States

After loss and restore of paths, it may be necessary to manually refresh device-mapper to update the host path state.

Because of a Linux defect, it may be necessary to run the multipathd reconfigure command to restore the path state after a loss and restore of paths on an OL 5.5 host. Run the multipathd show maps topology command to show the state of the LUNs as seen by the kernel.
Resolved Issues

There are no resolved issues for this release.
Additional Notes

Mount iSCSI Filesystems

We recommend that iSCSI filesystems be auto-mounted with the `_netdev` option. If the iSCSI filesystem is manually mounted, it must be unmounted manually before a reboot to avoid hangs.

Filesystems installed on iSCSI devices cannot be automatically mounted at system reboot because the IP network is not yet configured at mount time. However, the driver provides a method to auto-mount these filesystems as soon as the iSCSI devices become available, after the IP network is configured.

To auto-mount a filesystem installed on an iSCSI device:

1. List the iSCSI partitions to be automatically mounted in `/etc/fstab`.
2. For each filesystem on each iSCSI device, enter the logical volume on which the filesystem resides.
   - The mount points must exist for the filesystems to be mounted. For example, the following `/etc/fstab` entry will mount the iSCSI devices with partition `p1` specified by the LUID `20000121390p1`:
     ```
     LABEL=/ / ext3 defaults 1 1
     LABEL=/boot /boot ext3 defaults 1 2
     /dev/mapper/20000121390p1 ext2 _netdev 0 0
     ```
3. Restart the system.
   - Result: The `netfs` initialization script mounts all filesystems with the `_netdev` mount option. Run this initialization script after the networking and iSCSI scripts to ensure that the system is ready to mount these devices.

Due to variable network delays, targets may not always become available in the same order from one boot to the next. Thus, the order in which iSCSI devices are mounted may vary and may not match the order the devices are listed in `/etc/fstab`. You should not assume mounts of iSCSI devices will occur in any particular order.
Incorrect Adapter Speed

The AxiomONE Storage Services Manager may report the adapter speeds of Brocade and QLogic host adapter ports that are connected at speeds of 4 Gb/s or higher as Unknown.

This occurs because of a limitation in the current vendor HBA API implementation.
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