Document Overview

This white paper helps you understand the concepts and configuration of boot from SAN and enabling multipath features for the Root partition on SAN in deployments using Device Mapper multi-path. It includes recommendations for implementing and configuring operating system installation partitions to enable the Device Mapper multipath feature on your Linux server.

Intended Audience

This document is intended for users who would be implementing the high availability features of Boot-from-SAN and Root partition for the Linux operating system with Device Mapper multipath.

Assumptions

This document assumes that the user is familiar with the following:

- HP Fibre Channel Host Bus Adapters (HBAs) for Linux servers
- HP SAS Host Bus Adapters
- HP Smart Array Controllers
- HP StorageWorks Disk arrays
- Device Mapper multipath solution
- HP ProLiant servers
- HP ProLiant Gigabit Ethernet Multifunction server adapter

Introduction

Traditionally, servers were configured to install the operating system on internal direct attached storage device (local disk). With advances in storage technologies, and the need for storage and server consolidation, there is a need to enable booting from the Storage Area Network (SAN) and providing high availability features for the operating system.

The high availability feature for the Boot device on SAN during the boot process is provided by configuring the HBA BIOS with redundant boot paths. Many vendors refer to this feature as Boot from SAN (BFS). For more information, see "Configuring Boot from SAN".

Linux operating system vendors have incorporated the multipathing feature for the operating system installation partitions. For more information, see "Installing the operating system".

Supported Configuration

Device Mapper Multipath supports Boot-from-SAN operations on ProLiant and HP Integrity servers. This functionality is specifically HBA/BIOS centric. For BFS-supported HP StorageWorks disk arrays and HBAs, see Single Point of Connectivity Knowledge (SPOCK) at: http://www.hp.com/storage/spock. You must sign up for a HP Passport to enable access.

High availability on installation partitions is supported by the following operating systems:

- Red Hat distribution - RHEL 5 Update 2 and above
- Novell distribution - SLES 10 SP2 and above  
  SLES 11 and above

**Note:** It is recommend to have separate devices for the /boot and root (/) partitions. Enabling multipath features for the Installation partitions on SAN with HP Smart Array p700m controller is supported only on SLES 10 SP2/SLES 11 operating system and above. Refer to the product release documents for latest updates.
Configuring boot from SAN

Boot from SAN has become a de facto description for the capability of having a server boot its operating system from SAN. The HBA ROM provides this functionality. Once HBAs are configured to boot from the disk device on the SAN, the server boots as if it were a local disk.

More than one HBA can be configured for the redundant boot path for the High Availability of the Boot device. The Failover feature during boot time is provided by the HBA ROM configuration.

**Note:** Device Mapper Multipathing features are available after the kernel loads the multipathing modules from the initial RAM disk image.

Configuring the HBA/NIC ROM for High Availability of Boot device

To set up your Linux server to boot from a SAN device, complete the following steps:

### Setting up the storage arrays

1. Create two Logical units for Boot and Root devices
2. Present the Logical units to the Linux server

**Note:** For more information on configuring the Logical units, refer to the HP StorageWorks array User Guide.

### Setting up the host systems

To configure the host boot order for HP ProLiant servers with Multifunctional Gigabit Ethernet Server Adapter, complete the following steps:

1. While the system is booting, press F9 to start the BIOS Setup Utility.
2. Select Boot Controller Order.
   1. Select the HBA configured to provide the boot device and move it to Controller Order 1.
   2. In case of multiple HBAs, set to the higher Controller Order.
3. Press Escape, and press F10 to save your configuration and exit the utility.

To enable the iSCSI boot option ROM for HP ProLiant Gigabit Ethernet Multifunction server adapter in your server, complete the following steps:

1. While the system is booting, press F9 to start the BIOS Setup Utility.
2. Select System Options.
   a. Select *Embedded NICs*.
b. Select the NIC to which the boot option is to be set and press Enter twice.

c. Select \textit{iSCSI Boot} and press Enter.

d. \textit{iSCSI Boot} must be displayed as the boot option for the NIC you selected.
3. Press Escape, and then press F10 to save your configuration and exit the utility.

**Configuring HBA/NIC ROM**
This section details the steps to configure the Host Bus Adapter to boot from SAN.

- Qlogic HBA ROM configuration
- Emulex HBA ROM configuration
- HP Smart Array P700m Controller ORCA configuration
- HP SC08Ge SAS HBA configuration
- HP ProLiant Gigabit Ethernet Multifunction server adapter configuration
To configure the boot device for high availability on HP ProLiant servers, complete the following steps:

1. While the server is booting, press Ctrl+Q to enter Fast!UTIL.
2. From the Select Host Adapter menu, select the HBA you want to boot, and press Enter.
3. From the Fast!UTIL Options menu, select Configuration Settings, and press Enter.
4. From the Configuration Settings menu, select Adapter Settings, and press Enter.

![Figure 8](image)

5. From the Adapter Settings menu, change Host Adapter BIOS to Enabled by pressing Enter.

![Figure 9](image)

6. Press ESC to go back to the Configuration Settings menu Figure 8.

7. Select Selectable Boot Settings, and then press Enter.

8. From the Selectable Boot Settings menu, enable the Selectable Boot option by pressing Enter, move the cursor to Primary Boot Port Name, LUN, and press Enter.

![Figure 10](image)
9. From the Select Fibre Channel Device menu, select the controller Port Name of the array and press Enter.

Figure 11

10. From Select LUN menu, select the device to boot from, and press Enter.

Figure 12

Note: LUN index in the previous figure corresponds to the Lun ID of the boot device presented to the host.

11. From the Selectable Boot Settings menu, to configure the secondary boot paths, select Boot Port Name, Lun. Repeat Step 8 and Step 9 for all the other controller ports of the array.
12. Save the changes by pressing ESC twice, and then select Save Changes. This saves the configuration changes to selected HBA.

13. From the Fast!UTIL Options menu, choose Select Host Adaptor option, and press Enter. Select the other HBAs (Figure 6) and repeat the steps 2 to 12 to configure the HBA for booting the server.

**Note:** Refer to the “Booting Itanium Linux systems from a storage area network application notes” for the procedure to configure the HBA ROM on an Itanium server. You can locate this guide in the SPOCK website (http://www.hp.com/storage/spock) under Boot Guide Application Notes. You must sign up for a HP Passport to enable access.
To configure the boot device for high availability on HP ProLiant servers, complete the following steps:

1. While the server is booting, press Alt+E when the following message appears:
   **Press <Alt E> To Go To Emulex BIOS Utility.**

2. The Emulex BIOS utility displays *Emulex Adapters* in the system. At the *Enter a Selection* prompt, select the HBA index number.

3. From the HBA *configuration menu* screen, select option 2, *Configure This Adapter’s Parameters.*

4. From *Configure Adapter’s Parameters* screen, select option 1, *Enable or Disable BIOS.* Press 1 to enable the BIOS; press Esc to return to the main menu.
5. From the Configure Adapter’s Parameters screen (Figure 16) select option 4, Topology Selection, (Advanced Option).

6. From the Topology Selection menu, select option 4, Fabric Point to Point. Press Esc twice.

7. From the HBA configuration menu (), select option 1, Configure Boot Devices.

8. In the Saved Boot Devices list, select 1 as the primary boot path.

9. At the Select Two-Digit Number of the Desired Boot Device prompt, enter the index of the desired controller port.
10. Enter the LUN ID of the starting LUN at the prompt. The devices are scanned starting from the entered LUN ID.

11. At the prompt, enter the index of the Boot device from the list.
12. Select option 1, *Boot this device via WWPN*.

13. From the *Saved device list menu* (**Figure 17**), configure the alternate paths for boot devices by selecting the unused entries and repeating steps 9 to 12.

14. From *Emulex Adapters menu* (**Figure 14**), configure the other HBAs by repeating steps 2 to 13.

15. Exit from the BIOS menu and reboot the server.

**Note:** Refer to the “HP StorageWorks Booting Itanium Linux systems from a storage area network application notes” for the procedure to configure the Emulex HBA ROM on Integrity server.
To configure the boot device for high availability on HP ProLiant servers, complete the following steps:

1. While the server is booting, press F8 when the HP Smart Array P700m controller is discovered, to go to Option Rom Configuration for Arrays (ORCA).
2. At the Main Menu of the ORCA utility, select Select Boot Volume and press Enter.

3. At Boot Volume Enclosure Menu, select External and press Enter.

4. At External Boot Volume Menu, select the controller port WWID for the boot path.
5. At Menu Select Boot Volume, select the Lun to be configured as Boot partition.

6. Press F8 to save as Boot Volume.

7. Press Enter to configure alternate paths to boot device, else go to Step 9.

8. At the External Boot Volume Menu, select the other controller port WWID by repeating steps 4 to 6.

9. Press ESC to exit the ORCA.
**HP SC08Ge SAS HBA configuration**

To configure the HP SC08Ge SAS HBA as the boot controller, complete the following steps:

1. While the system is booting, press F9 to start the ROM-Based BIOS Setup Utility.
2. Select **Boot Controller Order**.
   a. Select the **SCSI Mass Storage Controller**, configured to provide the boot device and move it to Controller Order 1.
   b. Incase of multiple HBAs, set to the next higher Controller Order.
3. Press Escape, and then press F10 to save your configuration and exit the utility.


**HP ProLiant Gigabit Ethernet Multifunction server adapter configuration**

Upgrade to the latest iSCSI Boot Option ROM image using:

- HP NC-Series Broadcom Online Firmware Upgrade Utility for Linux (CP00xxxx.scexe).

To download and use the HP NC-Series Broadcom Online Firmware Upgrade Utility for Linux (CP00xxxx.scexe), complete the following steps:

2. Click **Software & Driver Downloads**.
3. Enter the product name (for example, NC373i) in the product box and begin the search.
4. Select an operating system.
5. Click HP NC-Series Broadcom Online Firmware Upgrade Utility.
6. Click Download and save the CP00xxxx.scexe and CP00xxxx.txt file to a directory on your hard drive.

The SCEXE (Smart Component Executable) components are self-extracting executable file.

**Updating iSCSI option ROM**

HP NC-Series Broadcom Online Firmware Upgrade Utility for Linux must be used on the system that needs the iSCSI boot option ROM to be updated from a Linux operating system or a Linux operating system live CD.

To update to latest iSCSI boot option ROM image, complete the following steps:

1. The firmware utility requires the adapter interface to be up and running. Bring up a network adapter interface using the following command:
   
   ```
   # ifup ethx
   Or
   # ifconfig ethx up
   ```

2. Update the firmware using the following command:
   
   ```
   #./CPXXXXXX.scexe
   ```

   The upgrade installation activity is written to a common installation log file called ./nicfwupg.log.

**Setting up iSCSI boot LUN**

The `ev` utility present in the HP ProLiant iSCSI Boot Package for Linux can be downloaded from the software download page of [HP ProLiant iSCSI Boot Package for Linux](http://www.hp.com/support).

1. Create the configuration file `evinput.txt`. A sample configuration file is shown below.

   Following is a sample configuration file.

   ```
   ###
   # Copyright 2006 Hewlett-Packard Development Company, L.P.
   # All Rights Reserved
   ```
Name of the iSCSI Target. Must match what the target offers.
# Hard coded Target IP .. No DNS support
# 
# TargetName= iqn.1986-03.abc.as:asddfrt.dsa23243
TargetIP=12.234.45.123
TargetPort=3260
TargetIP2=12.234.45.124
TargetPort2=3260
#

local name the iSCSI client will present to the Target
# and local IP settings. No DNS or DHCP support
# 
# InitiatorName=iqn.1234-98.com.asfd:19.23456ghg12:name
InitiatorIP=12.234.34.543
InitiatorNetmask=255.255.255.0
InitiatorRoute=12.234.34.1
#

Locally Admin Address (MAC address) and VLAN (Enabled/Disabled)
# 
# LAA=0000000000000000
VLAN=Disabled
#

LUN Mapping
# 
# LUN=1
## Make this persistent BIOS int 13 IPL routine. Replaces Embedded HD C:\ (if present).
# ForceBoot=True
## Digest (Checksum) data or Headers. Must match target setting.
# 
# DataDigest=False
HeaderDigest=False
## Account Login information
# . The AuthMethod values are: None,CHAP, and (TwoWay) MutualCHAP,
# 
# AuthMethod=None
CHAPSecret=Some12day123
CHAPMSecret=BetterThanThat

2. Write the boot path to the target server. The boot path configuration file may be written to the
server with the ev DOS utility or written using the ibootcfg utility.
   a. To write the boot path using the ev DOS utility, boot to DOS and change directories
to the ev DOS utility. The ev DOS utility is packaged with the HP iSCSI boot feature.
   b. Execute the following on the server with the option ROM.
       ev -c <evinput.txt

For more information on configuring the HP ProLiant Gigabit Ethernet Multifunction server adapter,
see the HP ProLiant iSCSI Boot for Linux User Guide.
Installing the operating systems

Root partition on SAN has become popular with blade systems and virtualization technologies. Multipath feature support for operating system installation partitions was introduced with the latest operating system distributions. OS vendors have provided the feature for enabling high availability for the installation partitions on the SAN.

To enable the high availability feature in RHEL and SLES operating system, complete the following steps:

Enabling the Device Mapper multipath feature

**Recommended configuration on RHEL operating system**

Ensure that there are multiple paths to the LUNS before starting the installation process. If there is only one path to the LUNS, Anaconda installs the operating system on the SCSI device even if mpath is specified as a kernel parameter. Enabling multipath features for the installation partitions on iSCSI SAN devices is supported in RHEL 5.3 and later.

1. Start the installation of the operating system.
2. Provide the parameter “linux mpath” to the kernel boot line.

3. To add the iSCSI devices to the installation, complete the following steps, else go to **Step 4**:
   a. Click **Advanced storage configuration**.
b. Select Add iSCSI targets and click **Add drive**.

c. Enable network Interface for the currently used NIC.
d. Enter the target IP address.

e. Repeat step a to d to add more iSCSI targets.

4. While creating partitions during the installation process, you will see multipath devices (/dev/mapper/mpath*). Create the installation partitions using multipath devices. Multipathing feature will be enabled for all the operating system partitions created on multipath device during installation.
5. Ensure that iscsi-initiator-utils and device-mapper-multipath packages are selected in the package list.
6. Complete the installation and reboot the server.

Note:
- If the installation partitions are on a XP array, comment the following line in "defaults section" in the /etc/multipath.conf file:
  `prio_callout       
  
  - If the installation partitions are on a MSA2xxxsa array, comment the following line in "device section" of the MSA2xxxsa array in the /etc/multipath.conf file:
    `getuid_callout    

Recommended configuration on SLES operating system

- It is recommended to have a single path to the logical units while installing SLES10 operating systems and multiple paths to the logical units while installing SLES11 systems.
- It is also recommended to mount the installation partitions using “by-label” fstab option.
- If you are choosing to mount the installation partitions by device-id, ensure that you set the "user_friendly_names" to "no" in /etc/multipath.conf file to avoid boot failures after rebuilding the initrd image.

Note: For iSCSI SAN devices in SLES10SP2, use only “by-id” fstab option to mount the installation partitions.

1. Start the installation of the operating system. For iSCSI SAN boot, complete the following step, else go to Step 3:
   a. Provide the parameters “withiscsi=1 netsetup=1” to the kernel boot line for SLES10SP2.
b. Provide the parameters “withiscsi=1” to the kernel boot line for SLES11.

2. To add the iSCSI devices for installation, complete the following step, else go to Step 3:
   a. Select the currently used network device (NIC)
b. Configure the IP information.

c. Ensure that the “Initiator Name” is correct.

d. Setting up the target IP:
   - For SLES10 operating systems ensure that only one target IP is connected and the Start-Up is set to automatic.
For SLES11 operating systems ensure that more than one target IP set. By default only one target IP is connected. Add new target IPs using the “Add” button under the Connected Targets tab.

Enter the Target IP address and click Next.
3. Select the device for installing the operating system:
   - For SLES11 operating systems, complete the following steps:
     a. Select the DM devices to create installation partitions.
     b. By default, DM devices are not listed. To list the DM devices select Hard Disks.
c. Click Configure > Configure Multipath > Yes > Yes.
d. Select the DM devices to create installation partitions.

4. While creating the installation partitions, select either of the following options:
   - If you intend to use the “user_friendly_names” with device mapper multipath devices select “by-label” fstab option.
   - If you do not intend to use the “user_friendly_names” with device mapper multipath devices, select “by device-id” fstab option.

5. Complete the installation and reboot.
6. Ensure that the latest supported Device mapper multipath tools package is installed.
7. If you have chosen to mount the installation partitions by device-id, ensure that you set the "user_friendly_names" to "no" in /etc/multipath.conf file.
8. For boot volumes mounted using “by-id” fstab options, configured on Smart Array Controllers, perform the following steps, else go to Step 9.
9. Enable multipath services to start at boot time by running the following commands:
   ~foo# chkconfig boot.multipath on
   ~foo# chkconfig multipathd on

10. Add device mapper multipath kernel module to initrd image by completing the following steps:
    a. Edit the file /etc/sysconfig/kernel and add "dm-multipath" to "INITRD_MODULES"
    b. Create a new initrd image, which include device mapper kernel modules
       ~foo# mkinitrd -k <kernel> -i <initrd>
    c. Edit the value for default parameter in /boot/grub/menu.lst file to boot with the new
       initrd image.

11. Reboot the server.
Additional Information

For detailed information about HBAs, switches, storage arrays, and storage software, go to the following websites:

<table>
<thead>
<tr>
<th>Topic</th>
<th>HP website</th>
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<tbody>
<tr>
<td>HBAs and switches</td>
<td><a href="http://h18006.www1.hp.com/storage/saninfrastructure.html">http://h18006.www1.hp.com/storage/saninfrastructure.html</a></td>
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<tr>
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<tr>
<td>Multipath software</td>
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<tr>
<td>Integrity servers</td>
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To make comments and suggestions about this document, please send a message to multipathfeedback@hp.com.