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**Introduction**

Storage Area Networks (SANs) provide a mechanism to attach a server to remote storage devices, such as disk arrays and tape libraries, through a network. SAN connected disk storage devices may be used both as data devices for application data storage or as OS boot devices for booting servers (physical and virtual). Booting from SAN connected boot devices can provide many benefits including improved disaster tolerance, boot for servers which do not have internal disks, consolidated management of boot images and application data on a storage array and faster storage repurposing.

This white paper focuses on Fibre Channel (FC) based SANs. It describes some of the key benefits and options for booting HP-UX servers from a SAN.

Note: Internet Protocol-based SCSI networks (iSCSI), and HP’s FlexFabric adapters supporting FC over Ethernet (FCoE), provide an alternative way to attach to a SAN by utilizing Ethernet networks. HP-UX 11i environments have long supported connectivity of iSCSI storage devices with the HP-UX iSCSI software initiator. While the HP-UX iSCSI software initiator does not support boot of a physical host OS, it does allow iSCSI storage to be used as backing store for an Integrity VM guest root vdisk device.

For more information on designing and implementing SANs, visit the HP Business Support Center, HP Storage Networking Blueprints and Solutions web page at: [http://h18006.www1.hp.com/products/storageworks/san](http://h18006.www1.hp.com/products/storageworks/san)

**Intended Audience**

This document is intended for customers who are familiar with:

- HP-UX boot device configuration
- HP Fibre Channel Host Bus Adapters (HBAs) for HP-UX servers
- HP Storage Disk Arrays
- HP Storage SAN switches
- HP BladeSystem interconnect modules and Virtual Connect
- HP Insight Dynamics - VSE

**Background**

Traditionally, HP-UX servers were configured to boot from directly connected internal or external parallel SCSI storage devices. Implementing boot from an external disk device improved the availability of servers needing repair by enabling a replacement server to be connected and booted from the original server’s boot device. External parallel SCSI storage devices also provided a fairly simple method to add additional disks as boot devices for multiple hard partitions (nPars) or virtual partitions (vPars) in cell-based partitionable PA-RISC and Integrity servers, assuming you had available IO slots. However, parallel SCSI solutions were limited by cable length distances and the number of devices that could be supported per SCSI bus.

As parallel SCSI solutions became obsolete, they were supplanted by other interconnect types for direct connect of small storage enclosures or storage blades for local boot devices such as Serial Attached SCSI (SAS) solutions, or in some instances direct-attach FC. New SAS switches, such as the HP Storage 3Gb SAS BL Switch interconnect module p/n AJ864A available for BladeSystem, make it possible to share SAS storage for servers blades within a blade enclosure, but not across multiple enclosures. In general, direct-attach storage solutions are still used to provide boot devices, but only
for a limited number of partitions or servers per storage enclosure or storage blade. They are not well suited for a consolidated, many-partition boot solution.

Since 1997, HP-UX servers have supported Fibre Channel (FC) HBAs which enable boot from HP Fibre Channel (FC) SAN connected online storage devices. FC SANs provide a different I/O transport that allows for greater cable distance and flexibility to allow connect and disconnect of links while the I/O adapters are still powered on. With FC SANs, boot devices are no longer restricted to short cabling distances and also provide higher availability and scalability features that enable true server and storage consolidation initiatives to be realized. FC SAN has proven to be a very reliable way to construct a large shared-data cluster configuration. HP FC HBAs are currently available in both 4Gb and 8Gb speeds.

**Why consider booting HP-UX from SAN?**

Following are some of the key decision points and advantages worth considering when evaluating whether a SAN attached boot device is appropriate for your environment:

**Server consolidation** – When using nPars, vPars or Integrity Virtual Machines, you must provide a separate boot device for each physical or virtual server. For servers which support nPars and vPars and have internal disk bays, only one of the partitions can use the available internal disks (internally connected storage) in that server as a boot device. Scale of boot devices for many partitions and virtual machines is ideal for using SAN connected storage subsystems.

**Storage consolidation** – Many large data centers reduce operating costs by consolidating the disk storage, including boot devices, to a few high-end, high-capacity storage subsystems, such as the HP 3PAR P10000 and P7000, HP XP P9500, HP EVA P6000 and HP P2000 G3 MSA storage disk array products. Storage consolidation allows centralized monitoring and maintenance to be focused on a few arrays, instead of dispersed over many small arrays or disk mechanisms throughout the data center. Additional cost reduction can be achieved by not purchasing internal disk storage or multiple direct-attach storage systems as boot devices when purchasing servers.

**Rapid infrastructure changes** – FC cables, unlike parallel SCSI cables, can be connected and disconnected without requiring the server or HBA to be powered off. Additionally, FC SANs can be easily and dynamically zoned to establish logical groups (zones) across the physically connected devices in the SAN infrastructure.

**Disaster recovery** – Certain HP Storage arrays can be configured using the Continuous Access (CA) functionality to create and maintain a remote mirror copy of the boot LUN to enable fast roll-in server replacement style disaster recovery at a remote site. This remote mirror copy of the boot LUN can then be connected to and booted from an alternate server available at the remote site. For a local DR copy of the boot device, use DRD to create a bootable clone of the root LUN on SAN connected storage for both redundancy and also quick roll-in server replacement.

**Minimized server maintenance downtime** – Separating the boot device from the server can decrease server downtime required to perform maintenance of the internal disk devices (scheduled maintenance, firmware updates, and so on). Many of today’s high-end SAN attached disk arrays, such as the HP 3PAR P10000 and P7000, HP XP P9500, HP EVA P6000 and HP P2000 G3 MSA storage disk array products, provide online firmware updates, which further decrease server uptime disruptions for boot disk maintenance.

**Increased distance between server and storage** – In large data center environments, with tens and even hundreds of servers, it may not be possible to co-locate servers and storage devices within the cabling distance limitations imposed by parallel SCSI. FC SANs provide the distance and cabling
flexibility truly needed for these environments. SAN connected storage also plays a major role in high-availability configurations available today, such as the HP Extended Serviceguard Cluster, which allows connection distances up to 100 kilometers between servers and storage.

**Scalability of IO connectivity for boot devices** – HP Integrity servers have tremendous virtualization capabilities and can support many physical partitions (nPars), virtual partitions (vPars) or virtual machines (Integrity Virtual Machines); requiring more boot devices than can be provided from just the internal storage or smaller direct-attached storage systems. Use of SAN connected storage can provide connectivity to thousands of LUNs per FC HBA port.

**Improved availability** – Today’s SAN attached storage arrays provide much greater availability than was capable with single path parallel SCSI disk devices. Today’s storage arrays, such as the HP 3PAR P10000 and P7000, HP XP P9500, HP EVA P6000 and HP P2000 G3 MSA storage disk array products, provide striping, mirroring, and access redundancy features. External SAN storage can also be connected to multiple FC HBA ports providing redundant storage I/O paths; internal disk devices in the server typically do not have redundant I/O paths to provide for path failover if one path fails.

**Migration of virtual machines** – Migration of Integrity Virtual Machine guests requires boot devices (and data devices) to be sharable between the Integrity VM host servers. SAN based storage is ideal for fulfilling this requirement; it provides shared access for many Integrity VM host servers to connected storage arrays on the SAN.

**Virtualization of I/O ports for Integrity Blade and Blade Matrix solutions** – FC SAN connected storage is supported using HP’s Virtual Connect technology. HP’s Virtual Connect Fibre Channel modules enable servers to virtualize world-wide names and allow multiple virtual FC ports to be created on a physical FC port.

**High Availability Root Disk Mirror Copy** – it has become a best practice for High Availability configurations to have a mirrored pair of disks for the root disk with at least one of the mirror copies on the SAN; remote from the server itself. For Serviceguard cluster configurations, MirrorDisk/UX is then recommended to mirror the pair of disks for highest availability and resiliency.

**State-of-the-art technology** – Use of FC SANs enables access to today’s leading mass storage technologies, including advanced disk subsystems and tape libraries.

**Support configurations**

This section describes the hardware configurations that support booting HP-UX from a supported SAN connected boot device.

**What you need:**

- A server connected to the SAN
- A supported HBA with firmware code enabling the server to boot from the SAN
- A supported bootable disk device with an HP-UX boot image
Supported HP-UX servers

HP-UX servers can boot from SAN with supported HP FC HBAs, HP Storage disk arrays and SAN switches. The HP-UX operating system requires a unique, dedicated disk for booting the operating system. You can segment this boot disk using the HP Logical Volume Manager (LVM) or for some specific configurations, Symantec VxVM, both of which are available with HP-UX. Please contact your HP or Symantec Representative for further details.

You can also allocate swap and dump space on the root disk; however, for systems with large memory space, you should consider providing additional swap and dump space by using additional disk devices. For further information on installing HP-UX on a FC SAN connected boot LUN, please refer to the HP-UX Installation and Update Guide appropriate for your version of HP-UX available at the HP-UX collection of documents and white papers at: www.hp.com/go/hpux-core-docs.


Integrity Virtual Machines can also boot from SAN attached storage connected to the Integrity VM Host server. Integrity VM allows virtual disks to be backed by files, logical volumes and LUNs; all of which can be SAN based. Refer to the appropriate version of HP Integrity Virtual Machines Installation, Configuration and Administration guide available at: www.hp.com/go/hpux-hpvm-docs.

NOTE: Beginning with the HP-UX 11i v3 March 2013 Update release, the maximum boot disk size supported with LVM boot layout has been enhanced from 2 Terabytes (TB) to 16 TB on HP Integrity systems. This means that HP-UX can now be installed on disks up to 16 TB in size with LVM boot layout. Refer to the LVM whitepaper for more details at: http://www.hp.com/go/hpux-LVM-VxVM-docs

Supported HP Host Bus Adapters (HBAs)

The following table shows the currently shipping PCIe HP Host Bus Adapters (HBAs) that are supported for boot from SAN for each HP-UX server family.

<table>
<thead>
<tr>
<th>Integrity</th>
<th>Blade Servers</th>
<th>Rackmount Servers or Superdome 2 IOX (PCIe I/O cards)</th>
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<tbody>
<tr>
<td>i4 Servers</td>
<td>NC553i FCoE embedded LOM (2 Port 10Gb)</td>
<td>QMH 2562 (2 port 8Gb)</td>
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<tr>
<td>Superdome 2</td>
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<tr>
<td>BL860c i4</td>
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<td>BL870c i4</td>
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<td>BL890c i4</td>
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<td>rx2800 i4</td>
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## i2 Servers

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<td>Superdome 2</td>
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<td>BL860c i2</td>
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<td>BL890c i2</td>
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<td>rx2800 i2</td>
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</table>

## Legacy servers

(with PCIe + PCI-X I/O options)

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<tbody>
<tr>
<td>Integrity Superdome sx2000, rx8640, rx7640</td>
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<tr>
<td>rx6600, rx3600, rx2660</td>
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<td>BL860c</td>
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<td>BL870c</td>
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### NOTE:
Legacy Integrity and HP 9000 servers also support these PCIe cards for boot from SAN:
- AH402A (1 port 8Gb) and AH403A (2 port 8Gb) PCIe
- AD355A (2 port 4Gb) PCIe and AD299A (1 port 4Gb) PCIe

Additional information about FC HBA support with current server products can be found in the [HP-UX FC (fcd, fclp) and FlexFabric FCoE (fcoc) Host Bus Adapter Support Matrix](http://www.hp.com/go/fibre-channel-HBA-docs) at:

For detailed information on FC HBAs for legacy servers with PCI-X I/O busses, please search for documents which match your specific HBA product number, such as AD194A, at the following location: [http://www.hp.com/go/hpux-iocards-docs](http://www.hp.com/go/hpux-iocards-docs)

For HBAs with multiple FC ports, such as the AH401A, AH403A and AD222A adapters, each port appears to the system as a separate FC port. Each port on a multi-port HBA adapter card is considered a separate I/O path. It is recommended for high availability to use ports on separate HBA adapters to provide multiple paths to LUNs.

For information regarding the number of disk devices or LUNs that can be connected to an HBA port on a server for each version of HP-UX 11i, please refer to the [Maximum LUN Configuration and Considerations for HP-UX white paper](http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c02029814/c02029814.pdf)

### NOTE:
HP FC HBAs support boot in Direct Fabric Attach (DFA, a.k.a. switched fabric) and Private/Public Loop modes. However, not all storage devices support these FC connection modes. Refer to the specific configuration guidelines and limitations appropriate for your storage array.
**Where to get more information on I/O cards**

Refer to the HBA user documentation for the system firmware version required to support boot for the appropriate model of server and version of HP-UX. You can obtain Installation Guides and Release Notes by searching for the HBA product number (for example, AH400A) at the HP Technical Documentation Web site at the HP Business Support Center, HP-UX I/O Cards:

http://www.hp.com/go/hpux-iocards-docs

The HP-UX Fibre Channel (fcd, fclp) and FlexFabric FCoE (fcoc) Host Bus Adapter Support Matrix is available at:

http://www.hp.com/go/fibre-channel-HBA-docs

**Supported HP Storage SAN switches**

HP Storage B-Series, C-Series, and H-Series Fibre Channel switch products support booting from the SAN. General Boot from SAN information from HP Storage is available here at http://h18006.www1.hp.com/storage/networking/bootsan.html

Please refer to the HPSAN Design Reference Guide for the current list of supported switch models along with any topology and configuration recommendations. This guide is available at:


**Supported SAN attached HP Storage Disk Array systems**

The supported HP storage arrays for HP-UX boot from FC SAN include:

- HP 3PAR F-class and T-class Storage
- HP 3PAR StoreServ 10000 and 7000 Storage
- HP XP P9500 Storage
- HP EVA P6000 Storage
- HP P2000 G3 and MSA G2 FC Storage

Refer to the user reference guide for your selected HP Storage array for further information and guidelines regarding configuration and use of the array as a HP-UX SAN boot device.

**Third-party storage devices**

The EMC Symmetrix DMX and VMAX storage arrays are also supported for HP-UX boot from SAN. Other third-party storage devices have passed interoperability validation for HP-UX boot from SAN. You can find additional information about interoperable third-party storage devices at:


**SAN boot device general guidelines**

This section summarizes general recommendations for configuring a SAN boot device in your computing environment. Refer to the user reference guide for your selected storage device for further information and guidelines regarding device specific configuration recommendations and use as a HP-UX SAN boot device.
SAN Boot Device Configuration Recommendations

Specific SAN boot device configuration recommendations and limitations are unique to each storage device. The following are offered as recommended subjects to review for your selected storage device.

**Multiple I/O path recommendations**

Providing multiple I/O paths to the boot disk increases overall availability of the server and applications running on it by eliminating a single point of lunpath failure to the boot disk. When possible, cable storage array controllers to separate switches to further reduce single points of failure.

**Protection group or disk group recommendations**

Protection groups or disk groups are groupings of physical disk mechanisms into a storage pool in which virtual LUNs are created and the data is striped across with designated RAID protection. Refer to the documentation for your storage device for the recommended size (number of LUNs) that should be in a protection group or disk group that has a boot LUN. Following are some general guidelines to consider:

- Do not configure a boot LUN in a protection group or disk group that contains only a few disks and also has high application data activity
- For arrays that are not capable of creating protection groups or disk groups with a large number of disks included, create a protection group or disk group for boot LUNs which is separate from protection groups or disk groups that contain heavily used application data.

**RAID level recommendations**

Both RAID Level 1 and Level 5 are frequently used for boot LUNs with satisfactory results. Recently, the newer RAID levels 0+1 and 10 have been gaining popularity for use with boot LUNs. If your storage array provides hardware-assisted RAID protection, it is recommended to use the hardware RAID protection available with the array and not use the software RAID utilities available with volume managers. Using a software RAID utility takes processor cycles away from applications and can be quite excessive if there is a lot of data movement to the associated LUNs.

**Array port loading recommendations**

Refer to the documentation for your selected SAN storage array for specific guidelines on controller port loading recommendations, such as:

- Maximum number of LUNs per controller port
- Maximum number of boot LUNs per controller port
- Sharing disk spindles that have a boot LUN

It is highly recommended that you do not configure boot LUNs to be on array controllers which have continuous high application data activity.

**High availability cluster boot device recommendations**

If the server is part of a Serviceguard high-availability cluster, it is highly recommended that the boot LUN have a software mirrored copy using MirrorDisk/UX for additional availability. Also, when using internal boot LUNs within a Serviceguard high-availability cluster, it is highly recommended that you use software mirroring to create a mirror copy of the boot LUN in an external disk enclosure or disk array for higher availability.

For additional information, refer to the section titled “Creating Mirrors of Root Logical Volumes” in the manual titled *Managing Serviceguard Seventeenth Edition*, available at:

Additional recommendations

**HBA replacement**

If you use some form of LUN security within the SAN and you replace an FC HBA in the server, you might need to reconfigure your LUN security mechanism to allow access of appropriate LUNs to this new HBA. Most LUN security mechanisms use the host HBA World Wide Port Name (WWPN or pWWN) to determine which HBA can access which LUNs in the storage array. When you change or replace a host HBA, the WWPN of the new HBA will be different and so LUNs will not be visible to this new HBA until the LUN security is changed. It is recommended to delete the WWPN of the HBA being removed from the storage LUN security mechanism and SAN switch zoning so that if it is reused, you do not have accidental security access issues from previous configuration.

**Server replacement**

If you replace a failed server, it is often advisable to retain all the FC HBAs from the server being removed and install them in the replacement server. Using the old HBAs, and their assigned WWPN and WWN, in the replacement server can save valuable time because you eliminate the need to reconfigure your LUN security mechanism and SAN zoning to remove old HBAs and add new HBAs to all the existing LUNs. Additionally, it is further recommended that you try to install the HBA that was configured for SAN boot in the same I/O slot of the replacement server.
For more information

HP Integrity Superdome 2 – www.hp.com/go/integrity
HP-UX servers – www.hp.com/go/hpux
Fibre Channel HBAs – www.hp.com/go/hpux-iocards-docs
Fibre Channel switches – www.hp.com/go/san

HP Storage Boot from SAN - http://h18006.www1.hp.com/storage/disk_storage
HP Storage SAN Design Reference Guide -

Call to action

Please contact your HP representative or visit: www.hp.com/go/superdome2