Abstract

Solid-state drives (SSDs) allow your data center—and your storage system in particular—to meet high performance goals. However, some RAID controllers are not designed to take full advantage of SSD speed—or of your investment in SSD technology. To ensure you get the most value from your SSDs, choose an HP Smart Array Controller that includes HP SSD Smart Path. This advanced technology improves the RAID efficiency of your HP Smart Array Controller, enabling it to better match SSD performance.

This paper:
• Describes HP SSD Smart Path technology
• Shows you how to configure and use HP SSD Smart Path
• Discusses suggested environments and applications for HP SSD Smart Path

HP SSD Smart Path overview

RAID controller operations involve device driver and firmware layers that process all I/O requests from an application or operating system. These controller processes do not usually hinder the performance of hard disk drive (HDD)-based systems because HDDs seek and access capabilities that can keep pace with firmware processing that occurs on the controller. SSDs, however, have such low latency (i.e., fast response to requests) that the RAID controller can become a storage bottleneck. If the RAID controller firmware must process numerous small read requests, the SSD must wait for the RAID controller to process those requests.

HP SSD Smart Path improves the performance of select HP Smart Array Controllers in SSD-based HP ProLiant Gen8 servers. HP SSD Smart Path technology allows I/O requests that meet certain requirements to bypass the normal I/O path involving firmware layers, and instead use an accelerated I/O operation called HP SSD Smart Path (seen in figure 1). This process accelerates reads for all RAID levels and writes for RAID 0.

Figure 1. HP SSD Smart Path bypasses the Smart Array firmware and accesses SSDs directly
With HP SSD Smart Path, the Smart Array controller device driver analyzes each I/O request for the following Smart Path eligibility requirements:

- Read requests for all supported RAID levels
- Write requests for RAID 0 volumes
- Size and location parameters, resulting in an operation that can be satisfied by a single physical disk I/O (parameters will vary according to system configuration)

The HP SSD Smart Path and the normal I/O path are both active simultaneously. The Smart Array device driver coordinates with the Smart Array firmware and keeps an up-to-date map of the disk and volume layout so that qualified requests can bypass the Smart Array firmware and use the Smart Path instead. Typically, requests are handled as follows:

- HP SSD Smart Path handles small requests meeting the eligibility requirements, which generally includes small read requests for volumes of any RAID level and small write requests to RAID 0.
- The normal I/O path handles large requests and most writes.
- If a request goes through HP SSD Smart Path and results in an error, the request is retried through the normal I/O path.
- If volume expansions, rebuilds, reconfigurations, or RAID-level migrations are in progress, all requests use the normal I/O path.

**Suggested environments**

HP SSD Smart Path offers significant performance gains for storage environments where data is read repeatedly from a large number of drives. Such environments might include:

- High-frequency trading
- Online transaction processing

Other types of environments might not benefit as much from HP SSD Smart Path, including environments characterized by non-repetitive or write-heavy I/O transactions. Systems handling backup duties, benchmark utilities, and database logging will not benefit from HP SSD Smart Path because their disk access patterns are either more random or write-intensive.

**System requirements**

To use HP SSD Smart Path, your system must meet the following requirements:

- HP ProLiant Gen8 or newer server with logical volumes created from a RAID array of SSDs
- Any of the following HP Smart Array controllers supporting HP SSD Smart Path:
  - HP Smart Array P220i Controller
  - HP Smart Array P222 Controller
  - HP Smart Array P420 Controller
  - HP Smart Array P420i Controller
  - HP Smart Array P421 Controller
  - HP Smart Array P822 Controller
  - HP Smart Array P721m Controller
  - HP Smart Array P430 Controller
  - HP Smart Array P431 Controller
  - HP Smart Array P731m Controller
  - HP Smart Array P830 Controller
- The latest Smart Array controller firmware for your controller on [hp.com](http://hp.com)
• Updated Smart Array device driver software installed on your server:
  – HpCISSs3.sys drivers, available for current versions of Microsoft® Windows® releases
  – hpsa driver updates, available for current versions of Linux distributions
• HP Smart Storage Administrator (SSA) for configuring the array and enabling HP SSD Smart Path
  For details visit: hp.com/go/hpssa

Configuring and using HP SSD Smart Path

Servers that meet the hardware and firmware requirements defined in the previous section will automatically be enabled for HP SSD Smart Path for any logical volume configured on an array of SSDs. The controller’s host also requires the Smart Path-ready Smart Array device driver HpCISSs3.sys for Windows platforms or the hpsa driver for Linux distributions.

**Enabling or disabling HP SSD Smart Path on Microsoft Windows**

Enable or disable HP SSD Smart Path with HP Smart Storage Administrator.

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**Important:**

Enabling or disabling HP SSD Smart Path for a logical volume on an array will have the same effect on all other logical volumes on that array sharing the same set of physical disks. HP SSD Smart Path is automatically and temporarily disabled any time the disk array is in degraded mode due to a drive failure, rebuild operation, expansion, or migration.

We highly recommend you halt I/O loads before running configuration utilities that change the array configuration (i.e., deleting or adding LUNs).

Using HP SSD Smart Path in the Microsoft Windows environment requires the HpCISSs3.sys driver, available at hp.com. Once the driver is loaded, use the HP SSA utility to disable or enable HP SSD Smart Path.

Figure 2 shows the HP SSA screens for creating an array and a logical drive with HP SSD Smart Path enabled.

**Figure 2.** Enabling HP SSD Smart Path in the HP SSA GUI
Enabling or disabling HP SSD Smart Path on Linux

Enable or disable HP SSD Smart Path with HP Smart Storage Administrator.

Using HP SSD Smart Path in Linux environments requires the hpsa device driver for the appropriate distribution, available at hp.com. Once the driver is loaded, use the HP SSA utility to disable or enable HP SSD Smart Path as shown in the Microsoft Windows section.

Configuring a controller

By installing the latest controller firmware, HP SSD Smart Path is automatically enabled for the controller.

Configuring a logical volume

After installing the supported controllers and firmware, HP SSD Smart Path will automatically be enabled for any newly created logical volumes configured on an array composed of solid-state disks. You can enable, disable, and re-enable the functionality using HP SSA or hpssacli.

Important:

When HP SSD Smart Path is enabled (or disabled) for any logical volume on an array, it will also be enabled (or disabled) for all other logical volumes on that array sharing the same set of physical disks.

The following example shows use of hpssacli to create a new RAID 5 volume with HP SSD Smart Path enabled:

- hpssacli controller slot=0 create type=ld size=5000 raid=5 drives=2I:1:2-2I:1:7 ssdsmartpath=enable

The following shows use of hpssacli to disable HP SSD Smart Path on array A:

- hpssacli controller slot=0 array a modify ssdsmartpath=disable

Configuring a device driver

While not typically done, you can disable or re-enable HP SSD Smart Path mode at the device driver level on Linux systems.

To disable HP SSD Smart Path in the hpsa driver:

- echo 0 > /sys/class/scsi_host/host<id>/hp_ssd_smart_path_status

HP SSD Smart Path will remain disabled for the specified controller until the next reboot or until it is re-enabled manually.

To re-enable HP SSD Smart Path in hpsa driver:

- echo 1 > /sys/class/scsi_host/host<id>/ hp_ssd_smart_path_status
Checking HP SSD Smart Path status on Microsoft Windows systems

You can also check the status of HP SSD Smart Path through the Microsoft Windows event log (as in figure 3):

Start > Administrators Tools > Event Viewer > Windows Logs > System

Figure 3. The Event Properties window of the Windows event viewer shows the SSD Smart Path status.

Checking HP SSD Smart Path status on Linux systems

Checking for HP SSD Smart Path capability on a driver

Check the current state of HP SSD Smart Path availability in the driver using the following command:

- **cat /sys/class/scsi_host/host<id>/hp_ssd_smart_path_status**
- **Output:** No such file or directory: Driver does not have HP SSD Smart Path capability, and needs to be upgraded to use HP SSD Smart Path.
- **Output:** HP SSD Smart Path enabled: Driver has active HP SSD Smart Path capabilities.
- **Output:** HP SSD Smart Path disabled: Driver has HP SSD Smart Path capabilities, but they are currently disabled by user command.

Checking for HP SSD Smart Path enablement on a volume or array

Use the HP Smart Storage Administrator to verify whether HP SSD Smart Path mode has been enabled for a particular volume or array.

Using command line:

- **hpssacli controller slot=0 show config detail**
- **Examine output of array subsection(s) on line labeled HP SSD Smart Path, as shown below:**
  - HP SSD Smart Path: enable
- **Examine output of logical drive (LD) subsection(s) on line labeled LD Acceleration Method, as shown below:**
  - LD Acceleration Method: HP SSD Smart Path
Checking HP SSD Smart Path activation on a volume

As mentioned in previous section, even when HP SSD Smart Path is enabled for a volume, certain conditions can prompt the controller to temporarily turn off the feature for one or more volumes. These conditions include arrays in degraded mode, undergoing a rebuild operation, or when performing RAID-level migrations. The Linux hpsa driver tracks the state of activation of the feature in a /sysfs attribute file.

On Red Hat® Enterprise Linux (RHEL) 6.x:

Use the lsscsi command (or cat /proc/scsi/scsi) to see the IDs and name assignments of the devices on the controller:

- Isscsi
  - [6:0:0:0]  storage  HP  P420i  3.41
  - [6:0:0:1]  disk       HP  LOGICAL VOLUME  3.41
    /dev/sdc
  - [6:0:0:2]  disk       HP  LOGICAL VOLUME  3.41
    /dev/sdd

Assume /dev/sdd is the device configured to use HP SSD Smart Path.

Use the cat command to show the status of HP SSD Smart Path:

- cat /sys/block/sdd/device/ hp_ssd_smart_path_enabled

Output: 1

Return value of “1” indicates that HP SSD Smart Path is enabled and active on the volume.

Return value of “0” indicates that HP SSD Smart Path is not enabled or is inactive on the volume.

Performance expectations

HP SSD Smart Path can yield substantial throughput improvements for SSD-based systems. However, several factors affect the degree of performance realized, including:

- Number of logical drives
- Number of SSDs (and SSD drive speed) in each logical drive
- Type of RAID fault tolerance
- Stripe size
- System processor

Figure 4 compares the performance of 8x and 16x 6 Gb SAS with a Smart Array P421 and Smart Array P822 controllers with HP SSD Smart Path disabled and enabled. The comparison used SAS SSDs with Single Level Cell (SLC) NAND technology. The graph illustrates that HP SSD Smart Path offers little advantage for systems using only a few drives, but scales appreciably with large numbers of SSDs—with as much as a 3.5X input/output per second (IOPS) improvement, as compared to normal I/O transactions. Performance results are based on a Microsoft Windows configuration.
Figure 4. SSD Smart Path performance comparison between 8x and 16x 6 Gb SAS SLC SSDs with Smart Array P421 and Smart Array P822 controllers.

The following system configurations were used in the performance comparison.

Figure 5. 8x and 16x 6 Gb SAS configurations
Summary

Free your enterprise SSD-based servers from storage I/O bottlenecks. Realize the full performance benefit of SSDs in your data center using HP SSD Smart Path. With no additional licensing required, HP SSD Smart Path is available for free with the latest HP Smart Array controllers, firmware, and drivers.

Resources
HP Smart Array Controllers for HP ProLiant Servers User Guide
hp.com/bc/docs/support/SupportManual/c01608507/c01608507.pdf

HP D2600/D2700 Disk Enclosure User Guide
hp.com/bc/docs/support/SupportManual/c02212004/c02212004.pdf