Technical white paper

HP Smart Storage for HP ProLiant Gen9 servers

Table of contents

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Executive Summary

With the introduction of the HP ProLiant Gen9 servers, HP Smart Storage has evolved as well. HP Smart Storage for ProLiant Gen9 servers incorporates and updates several features that HP introduced later in the ProLiant Gen8 lifecycle. It also adds new features and storage choices that are available for the first time. HP Smart Storage for ProLiant Gen9 servers consists of all of the following:

• Three tiers of storage controller options, allowing you the greatest flexibility in choosing the solution that meets your needs.
• Improved storage performance due to improvements throughout the storage controller architecture, including faster controller processors, larger and faster cache memory, improved firmware and drivers, and 12 Gb/s SAS channels.
• Greater flexibility in configuring storage within HP ProLiant Gen9 servers through use of the new SAS Expander and modular backplane architecture.
• Simplified storage management through Smart Storage Administrator (HPSSA) – now the single utility for configuration, management, and monitoring of Smart Storage.

This paper provides an overview of the new generation Smart Storage for HP ProLiant Gen9 servers – including Smart Storage capabilities and performance improvements that HP introduced earlier in 2014.

HP Gen9 Smart Storage controllers

For HP ProLiant Gen9 servers, HP offers three separate sets of storage controllers – each designed to meet different usage and performance requirements. We have designed the ProLiant Gen9 storage controllers for higher performance and more efficient operation than earlier controllers while simplifying their configuration and operation at the same time.

HP Dynamic Smart Array B140i

The HP Dynamic Smart Array B140i is the standard embedded storage controller for all ProLiant Gen9 servers, replacing the B120i and B320i controllers that were on Gen8 servers. The B140i is the entry level storage controller for HP Gen9 servers, delivering a basic level of storage functionality and performance. It is ideal for use to support OS boot devices or to provide basic protection for data that does not require significant storage performance.

The B140i acts as the default controller only if you do not install the more powerful Smart SAS HBA controller or the HP Smart Array controller in the system.

The B140i supports only 6 Gb/s SATA drives using the embedded SATA ports that are part of each ProLiant Gen9 server. On Gen9 ML/DL systems it is capable of supporting the maximum of 10 SATA drives – an increase from the Gen8 embedded controllers.

Software RAID with the Smart Array B140i
In addition to supporting individually attached SATA drives as standard AHCI devices, the B140i also supports RAID operation. Using the HP Smart Storage Administrator (HPSSA), you can configure the B140i and attached SATA drives for RAID 0, RAID 1, RAID 10, or RAID 5 operation.

Unlike the more advanced HP Smart SAS HBA and HP Smart Array controllers, the B140i uses driver-based software RAID. All of the RAID functions and calculations are performed by the OS drivers using server CPU and memory resources. The B140i does not feature write cache capability, and it uses a read cache that it carves from system memory.

The B140i is also dependent on the UEFI interface and will not operate in Legacy BIOS mode. Thanks to a UEFI driver included in the system ROM, the B140i does support bootable RAID volumes.

HP Smart SAS HBA Controllers

For ProLiant Gen9 servers, HP is introducing a new generation of HP Smart SAS HBA controllers to provide high performance SAS storage connectivity. These new H-series controllers, combined with the new server infrastructure, deliver full 12 Gb SAS performance across the ProLiant Gen9 product line.

HP has designed the Smart SAS HBA controllers to provide a high performance and scalable SAS storage solution for environments that do not require the full feature set of HP Smart Array controllers.

Available HP Smart HBA Controllers

HP offers four different SAS HBA controllers for ProLiant Gen9 servers (Table 1). The H240ar is a daughterboard controller designed for HP ProLiant Gen9 300 series ML and DL servers, providing for direct attached storage without using a PCIe slot. The H244br provides the same functionality for the ProLiant Gen9 BL460c BladeSystem server. The H240 and H241 are standard low profile PCIe cards that provide internal and external SAS connections respectively.

Table 1. HP Smart SAS HBA Controllers for ProLiant Gen9 servers

	H240ar	H244br	H240	H241
Storage Protocol Support	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA
Number of SAS/SATA Links	8	2 (2 drives maximum)	8	8
Connectors	Internal (2) x4 Mini-SAS ports	Internal 2 Embedded SAS ports	Internal (2) x4 Mini-SAS ports	Internal (2) x4 Mini-SAS HD ports

On ML and DL servers, HP Smart SAS HBAs work with the new HP 12Gb SAS Expander Card and modular backplanes to support the maximum number of internal drives for each specific server.

RAID versus HBA Modes

Using the HPSSA, you can configure an HP Smart SAS HBA Controller to operate in either RAID or HBA mode. In RAID mode, ProLiant Gen9 SAS HBAs for ProLiant ML/DL servers provide RAID 1, 10 and 5 capabilities. You must use Smart SAS HBAs in one mode or the other – they do not support mixed mode operation.

HP Smart SAS HBAs are also capable of supporting HP Secure Encryption and HP SmartPath, but only when they are used in RAID mode.

HP Smart SAS HBA Controller usage model

HP Smart SAS HBA controllers are intended for HP ProLiant server customers needing high performance non RAID storage connectivity that is also cost-effective. This includes connectivity to JBODs, the P2000 G3 MSA, or SAS Tape Libraries. Common application environments include:

• Hadoop deployment

• Database Availability Group (SQL & Exchange)

• VMware VSAN

HP Smart SAS HBA Controller Performance

In addition to 12 Gb/s SAS support, HP Smart SAS HBA Controllers for Gen9 servers include a number of other upgrades and changes designed to deliver improved performance over Gen8 controllers, including:

• Faster and more powerful RAID Controller chips

• Optimized controller firmware

• Use of 1866 MT/s DDR3 for controller memory

HP Smart Array controllers for ProLiant Gen9 servers

For Gen9, HP has incorporated Flash-backed Write Cache (FBWC) as a standard feature on all P-series Smart Array controllers. The integration of FBWC allows us to provide a simpler streamlined solution while increases in the sizes of the cache (1, 2 or 4 GiB depending on the controller) help increase overall performance – especially in write-intensive application environments.

HP has also made all of the capabilities included in the Smart Array Advanced Pack (SAAP) 2.0 a standard part of the P-series Smart Array controllers for Gen9. These include all of the following:

• RAID 6, 60, & RAID 1 Advanced Data Mirroring

• Dual Domain

• Heal Array

• Advanced Capacity Expansion

- Offline/Online Mirror split

P-series controllers are also currently the only Gen9 storage controllers to support HP SmartCache and HP Secure Encryption capabilities.

Available HP Smart Array Controllers for ProLiant Gen9 servers
HP currently offers the following Smart Array Controllers for ProLiant Gen9 servers (Table 2).

Table 2. HP P-series Smart Array Controllers for ProLiant Gen9 servers

	P440ar	P440	P441	P840	P244br
Storage Protocol Support	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA	12GB/s SAS 6 GB/s SATA
Type of Controller	Daughterboard	PCIe Standup	PCIe Standup	PCIe Standup	BladeSystem Daughterboard
Number of SAS/SATA Links	8	8	8	16	2 (2 drives max.)
Connectors	Internal (2) x4 Mini-SAS ports	Internal 1 x8 SAS port	External 2 x4 Mini-SAS HD ports	Internal 2 x8 SAS HD ports	2 Mini-SAS ports

Smart Array controllers usage model
HP Smart Array controllers are intended for use in mid-range to enterprise-level environments to provide direct attached SAS storage that maximizes performance and data availability, including the following:

- Application servers
- Messaging servers
- Database applications

HP Smart Array Controllers Performance
For Gen9, HP has made a series of refinements to P-series Smart Array controllers to deliver improved performance. These include the same improvements as those on H-series controllers as well as the addition of larger and faster FBWC compared to the Gen8 controllers. HP Smart Cache and Smart Path – which were introduced later in the Gen8 lifecycle - also contribute to improved performance for specific applications environments.

Tables 3 and 4 show the relative performance of the original Gen8 Smart Array controllers versus the Gen9 P440ar Flexible Smart Array controller using the new 12 Gb/s SAS drives. HP made changes and improvements to the Smart Array controllers throughout the Gen8 lifecycle. These numbers represent the cumulative performance improvement from the original Gen8 controllers to the new Gen9 controllers.

Table 3. Relative Performance of HP Smart Array controllers for Random IOPs – Gen8 vs. Gen9.

	Gen8 P420i	Gen9 P440ar
Random Read IOPs[1]	405,000 IOPs 1.26 ms avg. latency	930,000 IOPs .55 ms avg. latency
Random Write IOPs[2]	102,000 IOPs 3.20 ms avg. latency	490,000 IOPs .43 ms avg. latency

[1] Iometer 4 KiB random reads using 8 SAS SSDs configured as 8 RAID 0 logical drives with HP SSD SmartPath enabled
[2] Iometer 4 KiB random writes using 8 SAS SSDs configured as 8 RAID 0 logical drives with HP SSD SmartPath enabled

Table 4. Relative Performance of HP Smart Array controllers for sequential operations – Gen8 vs. Gen9.

	Gen8 P420i	Gen9 P440ar
Sequential Read IO Throughput[3]	3,050 MB/s	6,816 MB/s
Sequential Write IO Throughput[4]	1,625 MB/s	4,981 MB/s

The new generation HP Smart Array controllers have also reached an important milestone in storage performance. The HP P840 Smart Array controller, with 8 SSDs attached, has been able to achieve over 1 million random IOPs operation using 4 Kib random reads.

Gen9 Storage and HP Gen9 ProLiant server infrastructure

For the ProLiant Gen9 servers, HP has implemented a storage architecture that gives you maximum flexibility in designing your direct attached storage solution. While the Dynamic Smart Array B140i provides a good entry level storage controller that is embedded across the entire Gen9 server product line, it is limited in both performance and in the number of internal drives it supports. The HP Smart SAS HBA and HP Smart Array Controllers provide more scalable solutions.

Flexible internal storage configuration

For higher performing and more scalable solutions, HP offers the both the Smart SAS HBA Controller H240ar and the HP Flexible Smart Array Controller P440ar. These daughter card controllers work on selected HP ProLiant Gen9 300 series ML and DL servers without using up a PCIe slot – giving you the ability to choose your base storage controller for each server. With two x4 mini-SAS ports, either of these controllers is capable of supporting up to 8 SFF drives in a ProLiant Gen9 server.

To support more than 8 internal drives, you can pair these controllers with the HP 12 Gb SAS Expander Card. The SAS Expander card allows you to configure any of the ProLiant Gen9 DL servers with their maximum number of drives. Figure 1 shows the internal storage architecture for the ProLiant DL380 Gen9 server with the 12 Gb SAS Expander Card installed. The DL380 server supports up to 26 SFF drives internally – 24 on the storage backplane and 2 more in the back of the server.

[3] Iometer 256 KiB sequential reads using 8 SAS SSDs configured as 8 RAID 0 logical drives with HP SSD SmartPath enabled
[4] Iometer 256 KiB sequential writes using 8 SAS SSDs configured as 8 RAID 0 logical drives with HP SSD SmartPath enabled

Figure 1. Internal Storage architecture for an ProLiant DL380 Gen9 server using the HP 12 Gb SAS Expander Card
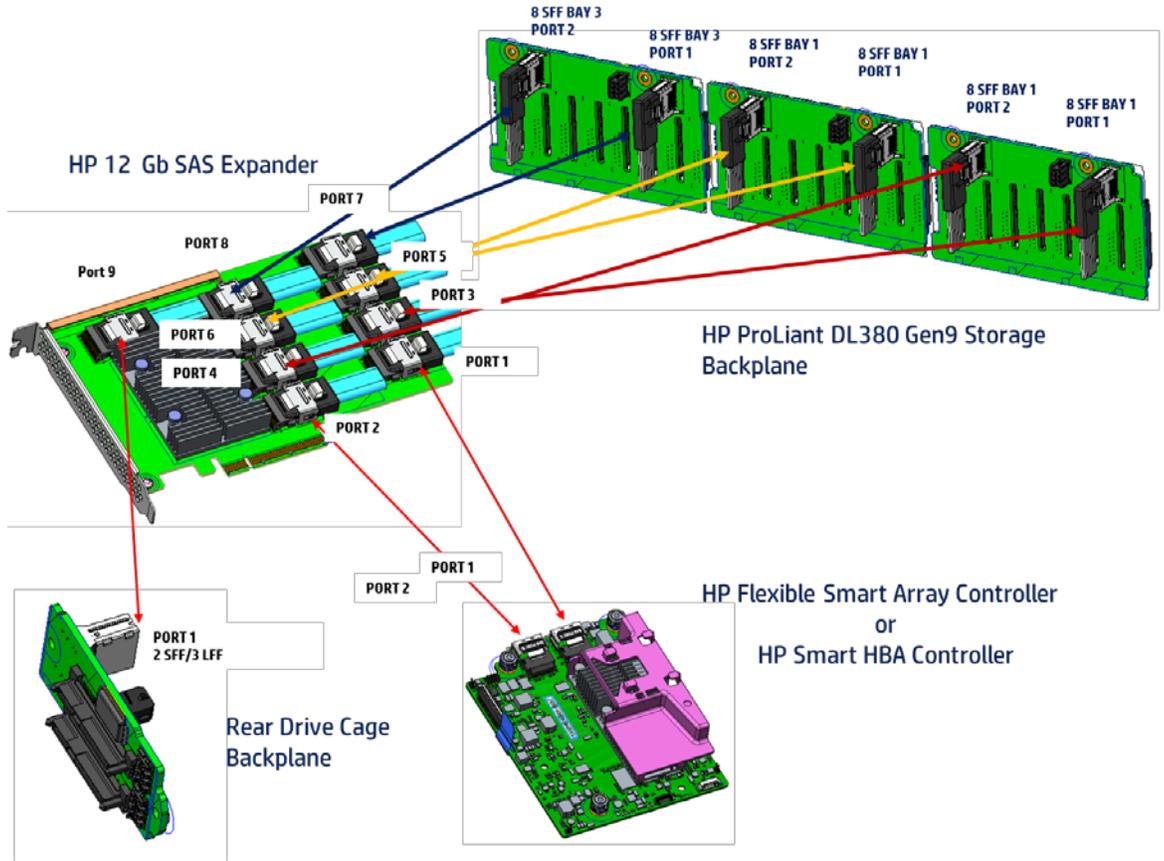

Table 5 shows the maximum number of internal drives supported in each of the ProLiant Gen9 servers. The ProLiant ML350 Gen 9 can support up to 48 SFF drives. This would require the use of two SAS Expander Cards and possibly two storage controllers.

Table 5. Internal storage capacities of HP ProLiant Gen9 ML and DL servers

	Number of Small Form Factor (SFF) drives supported	Number of Large Form Factor (LFF) drives supported
ProLiant DL380	24 SFF (Storage backplane) +2 SFF (rear bay)	12 LFF (Storage backplane) +3 LFF (rear bay)
ProLiant DL180	16 SFF (Storage backplane) 2 SFF (rear)	12 LFF
ProLiant DL360	8 SFF (Storage backplane) 2 SFF (rear)	4 LFF
ProLiant DL160	8 SFF (Storage backplane)	4 LFF
ProLiant ML350	48 SFF	24 LFF
ProLiant ML150	16 SFF	8 LFF
ProLiant BL460c	2 SFF	Not Supported

HP Smart Storage Battery

With the introduction of ProLiant Gen9 servers, HP has made a significant change to how Gen9 Smart Array controllers support their flash-backed write cache (FBWC). In Gen9 servers, a single HP Smart Storage Battery connected to the system board provides the backup battery power to all of the Smart Array controllers in the system that use FBWC. The HP Smart Storage Battery (Figure 2) for ProLiant ML and DL servers is a single Lithium ION battery pack capable of supporting multiple devices – replacing the individual SuperCaps used with each controller in Gen8 systems. A smaller Smart Storage Battery provides the same functionality for ProLiant Gen9 BladeSystem servers.

Figure 2. HP Smart Storage Battery for ProLiant Gen9 servers

This new approach for supporting FBWC has several advantages over the use of individual SuperCaps. The HP Smart Storage Battery delivers more power for backup. Each 96 watt Smart Storage Battery in ML/DL servers is capable of providing enough power to support backing up the larger cache sizes (4 GB) found in HP Gen9 Smart Array controllers. Backing up 4 GB of cache to the flash modules can take up to 1 minute, which is too close to the maximum capabilities of SuperCaps. The Smart Storage Battery is also capable of supporting up to 24 separate devices in the system.

The HP Smart Storage Battery also simplifies cabling by delivering its power to the motherboard via a single connection. Daughterboard–based Smart Array controllers that use FBWC then draw their battery power directly though their connection to the motherboard. For the new standup P-series controllers, a single cable from the riser card to the controller provides the connection to the battery.

Finally, the Smart Storage battery should provide a longer life expectancy than earlier solutions. By positioning the battery pack in an area of the servers that will keep it at a temperature below 50 degrees Celsius, HP has engineered a design that maximizes the lifespan of the HP Smart Storage Battery, which is fully warrantied for 3 years.

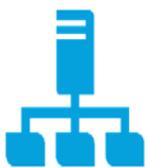## HP Smart Storage Administrator

For Gen9, The HP Smart Storage Administrator continues to evolve as the single control point for configuration, management and monitoring of HP Smart Storage (Figure 3). In addition to a simplified and more intuitive user interface, HP has incorporated the following into HPSSA for Gen9 Smart Storage:

• Array Diagnostics (ADU)

• Support for the HP Smart Wear Gauge for SSDs across all Gen9 storage controllers (including AHCI attached drives)

• Configuration and management of advanced Smart Storage functionality - including HP SmartCache, HP Secure Encryption and Power Management

Figure 3. Overview of HP Smart Storage Administrator

HP Smart Storage Administrator (HP SSA)

Innovation designed around business workloads

- Present a simplified and seamless customer experience for Smart Storage configuration.
- Replicate configuration from host to host (Via Scripting HP SSACLI and HP SSAScripting
- HP SSD Smart Path (on/off switch; no performance monitor)
- RAID
- Raid Transformation (Advanced Capacity Expansion)
- Video on Demand

- Verification (mismatched of same drives) of latest firmware for SSDs and HDDs devices
- Heal Array (allows hands off drive movement w/in the system of spare drives)
- Move Logical Drives/or Replace Array – take any logical drive and move anywhere else you want – hardware drive type agnostic

- Intelligent drives with enhanced serviceability
- HP Smart Wear Gauge Utility, provides visibility to more devices: Smart Array, HBAs, integrated controllers, and I/O Accelerators
- Audit storage configuration
- Report and measure progress against rebuilds, surface scans, parity initialization
- Capacity utilization (SmartSSDWear Gauge)
- Potential data loss indicator (prefailure warning)
- HP SmartCache

For ProLiant Gen9 servers, the SSA is the sole method for configuring and managing any of the Gen9 storage controllers. Configuration using the RBSU is no longer available. You can access the HPSSA through the UEFI System Maintenance menu or through Intelligent Provisioning.

UEFI and Gen9 Storage

HP ProLiant Gen9 servers are the first generation of HP servers to fully support the Unified Extensible Firmware Interface (UEFI) in addition to traditional ROM BIOS. With Gen9 servers UEFI is now the default firmware mode. ROM BIOS mode is still supported, but it is not recommended.

The transition to UEFI also brings numerous important changes and improvements for storage as well. The new Smart Array B140i requires UEFI mode and will not operate in ROM BIOS mode. More importantly, UEFI mode removes several longstanding restrictions for storage volumes as well as adding support for additional features. These Include:

- The ability to have boot volumes over 2.2 TB in size
- Ability to support more than 4 disk partitions supported
- Flexible boot order – boot from any drive on any storage controller
- Support for 4 KB Sectors

Advanced Smart Storage features

For Gen9, HP has continued to add features to Smart Storage. We introduced some of these features in the latter stages of the Gen8 lifecycle. Others are new for the Gen9 storage controllers.

Smart Storage Power Management

Smart Storage Power Management is a new feature for Gen9 Smart Storage controllers. It allows you to optimize the power consumption of the controller based on both its array configuration and workload. In many cases, Smart Storage Power Management can save several watts on storage controller power consumption without greatly impacting overall storage performance.

How Smart Storage Power Management works

Smart Storage Power Management reduces the overall power consumption of the controller by intelligently managing the settings for basic functions within the storage controller. These can include some or all of the following:

• Number of PCIe lanes enabled and their speed of operation

• Speed of SAS connections to the drives

• Operating frequency of the Storage Controller's CPU

• Operating frequency and refresh mode of the Storage Controller's DDR3 Memory

Some of these settings, such as the PCIe lanes and speeds are static – they can only be changed by the controller firmware following a reboot. Others such as the controller CPU frequency are dynamic – the controller firmware can change them while the server is running.

Available Power Modes

HP currently offers three different power modes for Gen9 Storage controllers. You can set these power modes in the HPSSA.

• **Minimum Power**. The controller configures the static settings for the lowest possible power consumption and may reduce dynamic settings based on workload.

• **Balanced**. The controller configures the static settings based on configuration of the arrays attached to the controller. During operation, it may also reduce power consumption based on the workload by changing those settings that are dynamically controllable.

• **Max Performance**. The controller configures the static settings for the highest possible performance and power consumption. This remains fixed, with no dynamic adjustments made during operation.

Power modes and performance

The Minimum Power mode can have large performance impacts and is not recommended for most situations. Balanced mode should be able to save several watts of power while impacting the performance of most workloads by 5% or less. It does this by analyzing the array configuration and using those static settings that can save power without significantly affecting performance. For example, a controller that is configured with a smaller number of arrayed drives may not need all of its PCIe lanes enabled since the attached drives cannot saturate the available PCIe bandwidth.

As a general guideline, use of Balanced power mode will typically have a low impact on throughput oriented workloads with high queue depths. The performance impact is greater for low queue depth workloads, including a significant impact on latencies.

Dynamic Power Throttling

HP Gen9 Smart Array controllers also use the dynamic settings to throttle their power consumption if temperatures inside the server exceed certain thresholds. These thresholds are high enough that dynamic power throttling should only occur in fan failure cases.

HP Secure Encryption

HP Secure Encryption delivers new levels of data security in your IT environment by encrypting the data stored on the storage devices locally attached to HP Smart Array controllers. Encryption of all data written to the storage devices is performed by the controller itself using an encryption key that can be stored locally in the controller and administered through the HPSSA.

This is known encryption protection for data at rest, since it protects data when it is "at rest" on the storage devices themselves – or in the cache module of the controller. HP Secure Encryption helps you meet Government data protection compliance regulations by ensuring that data on any storage devices remains unreadable if they are removed from their native environment. HP has engineered Secure Encryption to be compliant with level 2 of the Federal Information Processing Standard (FIPS-2).

HP Secure Encryption can also be managed in Remote mode, where the encryption keys are stored on an HP Secure Key Manager (ESKM) your network. Remote mode allows for central management and backup of encryption keys for multiple storage systems in an enterprise environment. With Remote mode, encrypted storage assets can also be re-deployed as needed within server groups within a data center.

Secure Encryption is only available for P-series Smart Array controllers and requires the purchase of an additional Encryption SKU.

HP SSD Smart Path

HP SSD Smart Path is a newer technology that HP introduced for Smart Array controllers during the Gen8 lifecycle and is continuing to refine as part of Gen9 Storage. It is designed specifically to deliver performance gains for logical drives using Solid State Drives (SSDs) on HP Smart Array controllers.

With HP SSD Smart Path, the HP Smart Storage device drivers analyze each IO request to decide whether it can be executed more quickly through the driver itself, or whether it should be passed to the Smart Array firmware for execution as normal IO. Because SSDs have such low latencies, many simpler IO requests are handled more quickly using HP SSD Smart Path in the driver than using normal IO through the Smart Array firmware. In general, the Smart Array driver will handle IO requests in the following manner:

• HP SSD Smart Path handles the Read requests for all RAID levels and the write requests for RAID 0 volumes.

• The Smart Array firmware handles larger requests as well as most Write requests for volumes using higher RAID levels (for example, RAID 5).

Figure 3. HP SSD Smart Path architecture
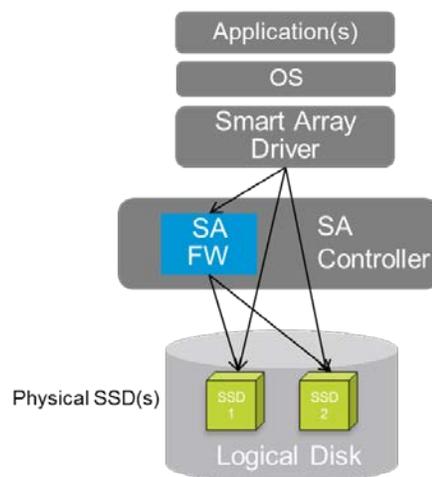
• High performance option for SSD traffic
• Smart Array driver chooses optimum path to SSD
  • Reads for all RAID levels
  • RAID 0 writes
• Smart Array controller cache disabled
• Smart Array firmware handles error conditions
• Configurable through HP Smart Storage Administrator
• Media surface scans by Smart Array firmware

HP SSD Smart Path is capable of delivering significant performance gains (2X to 4X improvement) when used in environments where data is being repeatedly read from volumes with larger numbers of drives. These may include applications such as high-frequency trading and online transaction processing (OLTP) among others.

You can enable HP SSD Smart Path on a volume by volume basis using HPSSA. Smart Path will not run in conjunction with FBWC or HP Smart Cache enabled and is not designed to operate with HDD-based Volumes.

For a deeper examination of HP SSD Smart Path, please consult the HP Technical white paper located at hp.com/V2/GetDocument.aspx?docname=4AA4-8144ENW&cc=us&lc=en.

HP SmartCache

HP has improved and expanded HP SmartCache for Gen9 as well. In Direct Attached Storage (DAS) environments, HP SmartCache uses one or more SSDs as dedicated caching devices for other volumes – increasing storage performance by copying the most frequently accessed data to the low latency SSD(s) for quicker access that is completely transparent to host applications.

HP SmartCache originally only supported write-through cache capabilities. This allowed it to deliver improved performance for read operations to Smart Array volumes, but not for write operations. Write-intensive application such as virtualization did not see significant performance gains with SmartCache.

For Gen9 HP SmartCache has added write-back cache capabilities as well. Write-back caching allows writes to Smart Array volumes to be stored in the low latency SSD cache and completed to the Smart Array volume at a later point in time. With write-back caching, HP SmartCache can now improve the performance of applications with heavy write workloads.

SSD Cache RAID Levels
Additionally, HP SmartCache for Gen9 supports the creation of RAID 1 and RAID 5 SSD cache array volumes for the first time. This new capability delivers greater data reliability for Smart Array volumes using SmartCache by allowing you to configure the cache array with its own data redundancy. Smart Array volumes configured for Write-through SmartCache can use SSD

cache LUNs configured as RAID 0 or RAID 1. Smart Array volumes configured for write-back SmartCache can use SSD cache LUNSs that are RAID 0, 1 or 5. Using a RAID 0 SSD cache LUN with volumes configured for write-back SmartCache is not recommended since it does not provide redundancy for the cached data.

Additional SmartCache refinements

For Gen9, HP has removed one of the restrictions from earlier versions of SmartCache that prevented performing transformations on all LUNs on a storage controller that was configured with an SSD SmartCache array. With Gen9 controllers, you can now perform transformations on non-cached LUNs that are on the controller. You still cannot perform transformations on primary LUNs that have a cache LUN associated with them. SmartCache is able to operate with HP Secure Encryption enabled.

HP SmartCache is one of the advanced features that are only available on HP Smart Array storage controllers. It is not supported for the Smart SAS HBA Controllers or the B140i.

For a deeper examination of HP SmartCache, please consult the HP Technical white paper located at hp.com/V2/GetDocument.aspx?docname=4AA5-1706ENW&cc=us&lc=en.

Rapid Rebuild

Rapid Rebuild represents a re-engineering of the rebuild functionality and performance for RAID volumes with failed drives on HP Smart Array controllers. Rapid Rebuild still uses the rebuild priority settings that you set in HPSSA to manage RAID rebuilds. However, the rebuild scheduling algorithms have been completely re-engineered to provide significant improvements in rebuild times while minimizing the impact on operating host IO performance as much as possible.

With Rapid Rebuild, the Smart Array firmware/driver uses a new two-pronged approach to improving rebuild performance. First, the rebuild algorithms attempt to give the rebuild activity more bandwidth by lowering the allowed queue depths on host IOs. In low host IO activity environments, this is usually enough to guarantee good rebuild times without impacting operating performance. In heavy host IO environments, the new rebuild algorithms also add a built-in time window in each second that is set aside for rebuild operations. In the High rebuild priority setting, this window can be as large as 20%. Although it does affect performance, this allows the rebuild process to complete in a reasonable amount of time. HPSSA has also added an additional rebuild priority setting of Medium-High to give you more granular control over the rebuild time versus performance trade-off.

Table 6 is illustrative of the type of rebuild performance improvements that are possible with the new Rapid Rebuild functionality. As always, the actual performance is dependent on the specific IO profile of your application environment.

Table 6. Relative performance changes with new Rapid Rebuild priorities (using six 4TB SAS drives at RAID 5) Iometer tests

Rebuild Priority (Gen9 controllers)	Heavy Sequential Write Operations		Heavy Random Read Operations	
	Rebuild Performance (Versus old Medium priority)	Host IO Performance during rebuild (Versus non-rebuild activity)	Rebuild Performance (Versus old Medium priority)	Host IO Performance during rebuild (Versus non-rebuild activity)
Low	Same	99% of normal	Same	95% of normal
Medium	5X improvement	80% of normal	3X improvement	80% of normal
Medium-High	15X improvement	75% of normal	6X improvement	75% of normal
High	25X improvement	55% or normal	9X improvement	60% of normal

Rapid Rebuild is designed primarily to improve rebuild performance for RAID volumes composed of SAS/SATA disk drives. It is not designed for SSD RAID volumes.

HP implemented Rapid Rebuild and the new rebuild priorities in the latter part of the Gen8 lifecycle. These capabilities are now a standard feature for all Gen9 Smart Array controllers, including the B140i embedded controller. The new rebuild processes still do not allow multiple RAID volumes to rebuild simultaneously.

Summary

HP has designed Smart Storage for to offer our customers a wide range of storage options for ProLiant Gen9 servers – from the basic storage of the B140i to the higher performance scale out capabilities of the Smart SAS HBA controllers. HP Smart Array Controllers for Gen9 deliver the best performance, scalability and resiliency through advanced Smart Storage features such as HP SmartCache, Rapid Rebuild, and advanced RAID modes.

At the same time, we have endeavored to simplify the Smart Storage management experience as well. The Smart SAS HBA controllers and the HP Smart Array controllers for Gen9 use the same device drivers. The HP Smart Storage Administrator is now the single point of control for all Smart Storage management – including array configuration, storage maintenance and storage monitoring and diagnosis.

As data storage and accessibility requirements grow, your storage solutions need to meet a variety of needs. HP Smart Storage solutions for ProLiant Gen9 improve your storage utilization and performance while delivering the scalability, reliability, and accessibility you require and helping you deal with data privacy challenges.

Resources, contacts, or additional links

HP Smart Array controllers on hp.com
hp.com/go/smartarray

HP ProLiant servers on HP.com
hp.com/go/proliant

Technical white paper - Optimized solid-state drive performance with HP SSD Smart Path
hp.com/V2/GetDocument.aspx?docname=4AA4-8144ENW&cc=us&lc=en

Technical white paper – HP SmartCache technology
hp.com/V2/GetDocument.aspx?docname=4AA5-1706ENW&cc=us&lc=en

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