WHITE PAPER

HP and SanDisk® Partner for the HP 3PAR StoreServ 7450 All-flash Array

June 2014

SanDisk®
a Western Digital brand

SanDisk®
a Western Digital brand

Western Digital Technologies, Inc.
951 SanDisk Drive, Milpitas, CA 95035

www.SanDisk.com

Table of Contents

1. Executive Summary

With all of the new technologies impacting the data center – for the enterprise and cloud providers – it's important to accelerate the performance of the data center infrastructure. Big Data analytics, Cloud Computing, Social Media and Mobility– all are pushing data center capabilities to their limits.

The sheer amount of data coming at us is at an all-time high – and growing. Flash technology is here to address this data tsunami. Flash storage delivers exceptional performance and much improved power efficiency, when compared with enterprise storage systems based on hard-disk drives (HDDs) – using 15K or 10K RPM HDDs using legacy storage controllers. Up to now, though, concerns around endurance levels of flash drives and the cost to buy them have affected consideration of all-flash arrays for some customer sites. Importantly, the search for Tier-1 data services in flash-based arrays continues: Purpose-built flash storage appliances often lack high availability features and advanced data services – and they end up being separate data silos in the data center.

IDC estimates that, by the year 2020, the world will see 44 zettabytes (ZB) of data generated per year, including structured and unstructured data[1]. Each zettabyte equals 1,000 Exabytes – or 1 billion terabytes (TB). At the same time, business managers want to address the megatrends of Big Data analytics, Cloud Computing, Social Media and Mobility – and all of the data that comes with those technologies impacting the infrastructure. IDC calls this phenomenon the "Third Platform", and Gartner calls it the "Nexus of Forces". Business professionals know that they'll need to contain the operational costs associated with the data center, focusing on "real estate" use, power, and cooling. Something needs to change.

FIGURE 1 – HP 3PAR StoreServ 7450 All-flash Array offers SanDisk's 1.92TB SAS SSD

2. The HP 3PAR StorServ 7450 All-flash Array with SanDisk Enterprise Solid State Drives (SSDs)

This paper presents an overview of the HP 3PAR StoreServ 7450 All-flash Array and the solid state drive flash technology at the heart of it. It describes how HP and SanDisk have collaborated to significantly lower the cost, improve endurance, and increase the scalability of flash-based storage. Now, there is an all-flash array that delivers all the Tier-1 data services, along with flash technology's high capacity and high performance. Customers now have the flexibility to deploy flash-based storage to a much wider range of applications.

HP 3PAR StoreServ 7450 Storage is a no-compromise all-flash array for accelerated application performance without sacrificing resiliency, efficiency, or data mobility. A flash-optimized architecture reduces the performance bottlenecks that can choke general-purpose disk arrays that have been retrofitted with SSDs. However, unlike other purpose-built flash arrays, the 3PAR StoreServ 7450 doesn't require an entirely new architecture to achieve flash-optimized performance. As a result, there are no compromises around rich, Tier-1 data services, quad-node resiliency, advanced functionality, enterprise-class efficiency, or seamless data mobility between systems.

3. Introduction: Storage Challenges in the Data Center

Flash-based storage has the potential to deliver exceptional performance and much improved power efficiency when compared to enterprise storage systems deployed with conventional spinning disks. This, in turn, can help organizations control operational costs by doing more with less. For example, 10 SSDs can potentially deliver performance equivalent to 500 hard disk drives (HDDs),[2] reducing both storage footprint and power consumption for significant operational expense (OpEx) savings.

Up until now, flash deployments have been limited to niche applications due to the relative high cost, limited scale, lack of enterprise-class resiliency, and the need to create a separate data silo for added complexity. As they are mechanical devices, HDDs do wear out over time. Similarly, flash is an electronic media that wears down with each write over time.

Some flash solutions currently targeted at enterprises come saddled with serious deficiencies. For example, one common approach that's seen in the marketplace is to take general-purpose, enterprise-class storage arrays that were never designed to accommodate flash-based storage and retrofit them with SSDs, commonly producing performance bottlenecks. This is due to controller design insufficiencies that cannot be addressed without a system redesign.

On the other hand, flash-optimized appliances require a different trade-off by asking customers to accept another completely separate and distinct storage architecture into their data centers, and one that often asks them to compromise resiliency and data services—thereby creating an additional silo and adding complexity to the storage environment.

4. Addressing Demanding Workload Challenges with the HP 3PAR StoreServ 7450

The HP 3PAR StoreServ 7450 All-flash Array, utilizing SanDisk SSDs, addresses the challenges facing many storage administrators today. It delivers predictable lower response times at the same price as high performance spinning media without sacrificing enterprise-class storage resiliency and petabyte

scalability or the rich data services demanded by enterprise data centers. This allows the 3PAR StoreServ All-flash Array to support a wide variety of workloads running in the enterprise network, while meeting enterprise-level service level agreements (SLAs).

The introduction of HP 3PAR Thin Deduplication and Thin Clones software demonstrates how HP continues to set the gold standard for hardware-accelerated thin technologies. These technologies which added to the benefits of existing thin provisioning with zero-block deduplication reduce usable capacity requirements by more than 75 percent[3] making flash more cost-efficient. Now organizations can start thin, get thin, and stay thin with an enterprise-class solution that extends flash storage investments without compromising performance or resiliency. Also, Adaptive Sparing uniquely extends SSD usable capacity by 20 percent[4] and aids wear management within the drive, offloading this task from the storage controllers.

SanDisk's high capacity SSDs, including the 1.92TB multi-level cell (MLC), deployed in HP 3PAR StoreServ 7450 Storage, further eliminates cost and scale limitations that force compromises on competitive all-flash systems. SanDisk's advanced endurance algorithms allow customers to take advantage of less costly mid-grade MLC flash in SSDs, rather than more expensive Enterprise MLC or SLC (single-level cell) flash, yet achieve similar levels of business critical longevity and reliability.

SanDisk's innovative Guardian Technology™ Platform, complements HP's Adaptive Sparing technology, helping to support high levels of reliability and endurance. As this paper will show, both companies supply technologies that support product endurance which drive a 5-year warranty to protect a flash storage investment, along with high levels of performance, capacity and reliability.

5. Key Technical Benefits of Flash for Business Workloads

Accelerated IOPS at low latencies, made possible by flash media, means little if you don't have the right architecture in place to fully realize the performance potential of flash storage. Unless you have a storage architecture that avoids bottlenecks in the entire I/O path, which includes controllers, cache, and firmware purpose-built for the performance of flash technology, your applications won't benefit from flash.

To take advantage of the accelerated IOPS delivered by flash media, the architecture must scale beyond just dual-controller designs in order to provide greater headroom for performance scalability. And to serve hundreds of thousands of IOPS within a very small latency band, cache management for I/O operations becomes critical.

HP 3PAR StoreServ 7450 All-flash Storage is a purpose-built, flash-optimized architecture without compromising resiliency, efficiency, or data mobility.

The HP 3PAR StoreServ 7450 delivers application performance that exceeds 900,000 I/O operations per Second (IOPS) – nearly 1 million IOPS – with less than .7 milliseconds of latency.[5] At 500,000 IOPS, the array delivers an impressive .378 milliseconds of latency[6].

Unlike other purpose-built arrays on the market that solve SSD performance issues by introducing an entirely new architecture, the HP 3PAR StoreServ 7450 provides an array of Tier-1 data services, along with 4-node resiliency (quad-node resiliency), enterprise-class efficiency, and data mobility.

- Improve application response time with flash specific software optimizations like adaptive read and write optimization and autonomic cache offload which dynamically adjust the granularity of cache-to-flash operations based on demand.

- Sustain high performance with multi-tenant input/output (I/O) processing and higher-performance mesh-active clustered controllers which ensure that all application volumes are active on all disks and controllers at the same time.

- Fine-grained virtualization and system-wide striping shared by HP 3PAR StoreServ Storage delivers capacity and performance that scale automatically, even at extremely high capacity utilization levels.

- Supports mixed workloads with extremely high performance levels to alleviate legacy storage performance concerns.

HP 3PAR StoreServ 7450 allows users to consolidate additional applications on a smaller amount of infrastructure, while still delivering a predictable performance in order to meet service level requirements. HP 3PAR Priority Optimization is optional software that allows organizations to manage service levels for applications and workloads as business requirements dictate to assure quality of service (QoS). This means provisioning storage performance is now as easy and efficient as provisioning storage capacity. Reduce contention and certify that performance is delivered where it is needed most in multi-tenant environments.

A highly automated approach quickly and easily assigns a minimum goal of I/O per second, bandwidth, and latency to protect mission-critical applications in enterprise environments. Organizations also have the flexibility to assign performance thresholds on workloads with lower service level requirements.

6. Addressing Endurance Concerns with HP and SanDisk Technologies

Flash-based storage has the potential to deliver exceptional performance and much improved power efficiency when compared to enterprise storage systems deployed with conventional spinning disks. Even so, there are lingering concerns in the IT community about SSDs endurance, and its cost, in $/GB. These types of concerns are seen in the evaluation process for flash-based technologies. However, HP 3PAR StoreServ 7450 with SanDisk SSDs provides the performance, density and endurance technologies to overcome these concerns. With 3PAR StoreServ's Flash Optimized architecture and superior performance, and the increased capacity and reliability of SanDisk SSDs comparing favorably against HDD-based arrays, customers can buy fewer overall arrays. Thus, the number of enclosures, power supplies, host bus adapters (HBAs), cables and other hardware is reduced, which results in lowering the up-front total cost of acquisition (TCA).

HP 3PAR StoreServ 7450 Storage and SanDisk offer flash-based innovations to deliver additional media endurance that enables you to extend the life of your SSDs to get the most out of every dollar and I/O for increased storage return on investment (ROI).

HP 3PAR StoreServ Storage and SanDisk, working together, are applying multiple technologies to ensure that a five-year product life warranty is met – and that performance promises are kept over time.

The following features help maximize the efficiency of HP 3PAR StoreServ 7450 Storage to drive down the overall cost of flash performance and protect your critical investments:

- **HP 3PAR Thin Deduplication:** ASIC-assisted block-level deduplication on the array happens 'inline'—upon ingest—which carries multiple benefits, including increasing capacity efficiency, protecting system performance, and extending flash media life span. Thin Deduplication supports the new HP 3PAR Express Indexing feature that accelerates hash signature comparison, detecting duplicate write requests and preventing duplicate data from being written.

- **Fine-grained allocation unit:** With its 16KB write allocation unit, the HP 3PAR StoreServ Storage platform has long been known for pioneering innovation in storage capacity efficiency. This granular allocation size enables only the right amount of flash media to be allocated, avoiding waste due to unused allocated capacity.

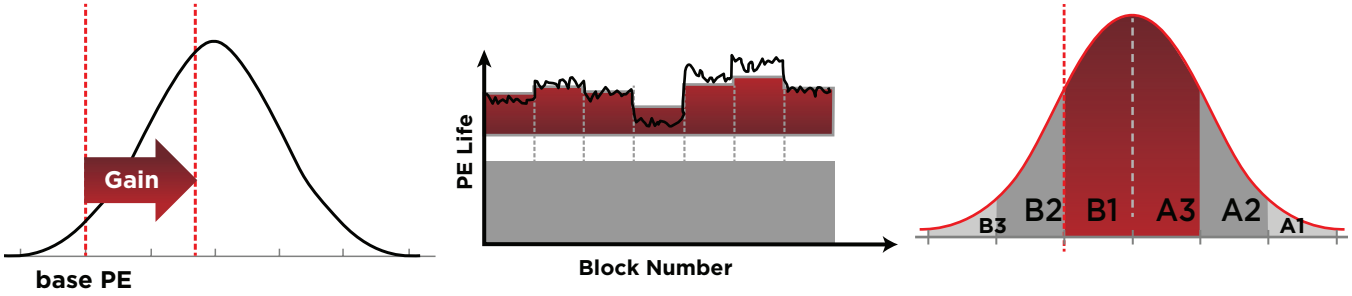
- **System-wide striping:** The HP 3PAR StoreServ architecture stripes data across all system resources (controllers, ports, cache, and drives). This system-wide striping enables the array to simultaneously deliver uniquely high capacity utilization (no silos of any kind) and performance levels (all resources supporting each volume). This drives uniform I/O patterns across all media resources by spreading wear evenly across the entire system. Because the system automatically manages this system-wide load balancing, no extra time or complexity is required to create or maintain optimally better configured system.

Finally, 3PAR StoreServ's Adaptive Sparing is an example of HP and SanDisk joining forces to extend flash based media endurance by lowering the internal over-provisioned capacity in SSDs. While other architectures generally reserve entire drives to use as spares, in the 3PAR architecture, the system reserves spare "chunklets" within each drive. When using flash-based media, Adaptive Sparing adjusts sparing policies on the fly to avoid using SSDs for sparing and therefore lengthens flash media lifespan and drives down the cost of flash performance. Also, HP now offers a standard 5-year SSD warranty on new 1.92TB MLC SSD, 480GB and 920GB SSDs to protect investments in flash storage.

Independent of HP, SanDisk has solely developed the technology that makes up the Guardian Technology™ Platform. This platform consists of three technologies: FlashGuard™ Technology, DataGuard™ Technology and EverGuard™ Technology that can be found in the SanDisk 1.92TB SSD. For endurance at the drive level, SanDisk offers the Guardian Technology Platform - a suite of enterprise features and endurance enhancement technologies that make the most cost-effective NAND (MLC) fully usable for enterprise application and database workloads. SanDisk's vertical integration and ownership of the flash intellectual property (IP) ensures that the Guardian Technology Platform and the NAND work seamlessly with each other, enhancing endurance, performance, and reliability capabilities that this platform provides.

Three key technologies are included with the Guardian Technology Platform:

- **FlashGuard™ Technology:** uses aggregate flash management and advanced signal processing combined with a mix of flash grades to ensure longer usable product life from MLC NAND than other flash products.



Aggregated Flash Management

- Utilizes average endurance of all die within the SSD
- SSD flash population endurance is greater than the sum of individual components

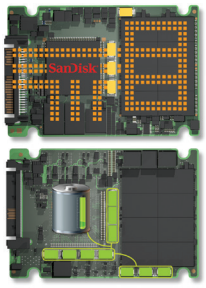
Advanced Signal Processing

- Provides adaptive programming of flash parameters throughout the life of the device
- Includes algorithms for adaptive programming developed based on extensive flash characterization
- Ensures each flash block is used to its maximum endurance capability

Intelligent Flash Mixing

- Takes advantage of fab data
- Provides intelligent mixing of "graded" die/wafer
- Ensures each drive has right mix of grades

FIGURE 2 – The Building Blocks of FlashGuard Technology



- **DataGuard™ Technology:** provides full end-to-end data-path protection (T10 DIF support), ensuring that the data will be safe throughout the entire data path, providing the ability to recover data for failed page and NAND blocks.

- **EverGuard™ Technology:** prevents the loss and corruption of user data during unexpected power interruption.

All of these Guardian Technology Platform capabilities are built into HP 3PAR StoreServ 7450 All-flash Array. The ability to use less expensive NAND technologies, while ensuring data integrity and protecting against data loss, are valuable assets in any mission-critical storage system solution.

7. Transforming the Economics of Flash

More energy efficient, more compact, and more predictable than spinning drives, flash-based media is the future of high performance storage. Solid state drive technology is both mature and capable of giving you incredible performance in a superbly efficient package. However, there is still a significant cost difference between SSDs and spinning media—meaning that, now more than ever, efficiency mechanisms like thin provisioning, block-level deduplication, and space reclamation are essential to getting the most out of SSD capacity.

The introduction of HP 3PAR Thin Deduplication and Thin Clones software demonstrates how HP continues to set the gold standard for hardware-accelerated thin technologies. This, added to the benefits of existing Thin Provisioning with zero-block deduplication, reduce usable capacity requirements by over 75 percent[7].

HP 3PAR StoreServ 7450 when deployed with SanDisk's new high-density 1.92TB MLC SSD, and combined with HP 3PAR compaction technologies, lowers the cost of storage to below $2 per usable gigabyte. This is the same cost as systems using performance-oriented spinning HDDs today.

For the first time, HP and SanDisk are working together to enable customers to deploy all-flash arrays for a much wider range of applications by scaling to 460 terabytes (TB) raw capacity and more than 1.3 petabytes of equivalent usable capacity. This industry leading, all-flash scalability is six times that of typical raw and usable capacities provided on first-generation all-flash systems.

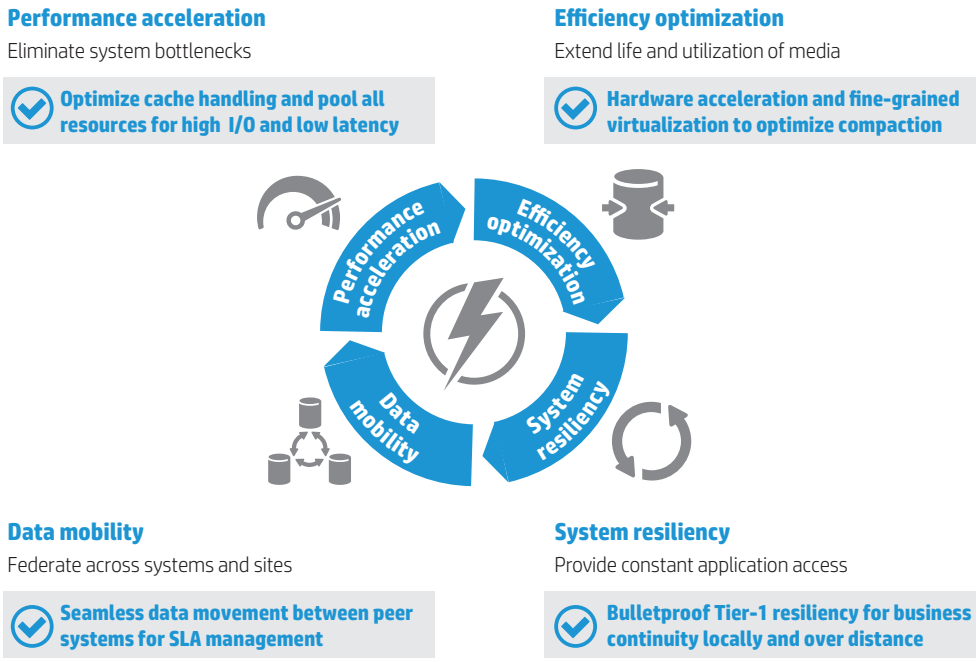


FIGURE 3 – The Benefits of the HP 3PAR StoreServ Flash-optimized Architecture

8. A Storage System Designed to Meet Business Requirements

Budgetary considerations are key to any new system acquisition – whether it is purchased or leased. Systems that cannot provide their utility and their operational efficiency should not be included on the short-list for acquisition.

Here are the key business attributes that the HP 3PAR StoreServ 7450 All-flash Storage brings to the data center customer.

- **Workload Acceleration.** HP 3PAR StoreServ Storage removes the bottlenecks that prevent legacy storage from taking full advantage of flash-based media. This is the driving force that allows the HP 3PAR StoreServ 7450 all-flash array to deliver accelerated performance that is six times greater[8] than traditional platforms using hard disk drives (HDDs) while also delivering extremely low latency.

- **Reliability Features.** In order to meet service level demands for performance-critical applications, high availability and uncompromising data protection are must-haves. HP 3PAR StoreServ 7450 Storage decreases downtime while dramatically reducing the cost of remote data replication and disaster recovery (DR) with highly efficient, multi-mode replication across all HP 3PAR StoreServ models.

- **Efficiency.** Customers often shop for flash-based systems by evaluating the cost per gigabyte, compared with HDDs usually in comparison with 15K RPM HDDs. However, the entire cost equation must be examined – by considering the total amount of data center space required to host the storage capacity, and the amount of power and cooling needed to keep the system running within its operational specifications. HP 3PAR StoreServ 7450 Storage with Sandisk SSDs radically improve efficiency, making an all-flash storage array more affordable for a wider range of applications than ever before.

- **Data Mobility.** In the age of distributed data, important business information may be located in many places across an enterprise network. Depending on frequency of access, and the location where the data originated, that data may need to be migrated, and re-hosted, in new locations closer to the business units that access the data most frequently. Delays in accessing data can ripple out across the organization, if data is not properly placed. That's why data mobility in the data center is key to operational efficiency for the business. With HP 3PAR StoreServ Storage, you can simply and non-disruptively shift data between the HP 3PAR StoreServ 7450 All-flash Array and any other HP 3PAR StoreServ array without additional management layers or appliances.

9. Key Business Benefits of the HP 3PAR StoreServ 7450 Storage

Now, let's take a step back from the product details, and look at the business value that the 3PAR StoreServ 7450 All-flash Array brings to the storage marketplace. This solution is built to deal with the data tsunami that is posed by the four big megatrends of our time: Big Data analytics, Cloud Computing, Social Media and Mobility.

These trends are reshaping the data center's infrastructure – and demanding higher levels of performance, capacity and flexibility from storage systems than ever before. That combination provides powerful price/performance in a smaller data center space, resulting in a highly adaptable and useful flash-based array solution for our times.

[1] Digital Universe with Research and Analysis by IDC, The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things, April 2014.
[2] As compared to not using data compaction technologies. HP internal tests demonstrated a 4:1 data compaction with the 3PAR StoreServ 7450.
[3] Based on HP Internal Testing.
[4] Based on HP Internal Testing.
[5] Source: HP 3PAR StoreveServ 7450 All-flash Array Datasheet.
[6] Based on HP Internal Testing.
[7] As compared to not using data compaction technologies. HP internal tests demonstrated a 4:1 data compaction with the 3PAR StoreServ 7450.
[8] Based on HP Internal Testing.