



**Hewlett Packard**  
Enterprise

# **HPE 3PAR StoreServ 7000 Storage for Microsoft SQL Server environments with VMware**

HPE 3PAR StoreServ 7000 enhances Microsoft SQL  
Server virtualization

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## Executive summary

In traditional data centers, Microsoft® SQL Server® instances are deployed on dedicated and frequently underutilized servers and overprovisioned storage. Although this approach may be the simplest to deploy initially, it typically requires purchasing and installing a majority of the computing and storage resources upfront. These deployments must often factor in headroom for future growth, which can go underutilized for an extended period. Traditional deployment models reduce flexibility and increase operational costs, while making it more complex to adjust to changing business needs.

Virtualization decouples applications and physical resources, thereby enabling the sharing of resources previously dedicated to individual applications and creating less provisioning complexity and greater flexibility. Thus, IT organizations have turned to virtualization as a consolidation strategy to better utilize resources and reduce the amount of physical hardware running SQL Server instances. Virtualization is now a key enabling technology for reducing costs, improving agility, and enhancing business continuity. However, to achieve these benefits, your IT infrastructure must be capable of meeting not just SQL Server requirements but also the specific demands of virtualization—such as performance, capacity efficiency, and automation—and deliver a high degree of flexibility in meeting growth demands.

Virtualizing Microsoft SQL Server 2012 workloads with HPE 3PAR StoreServ Storage and VMware vSphere 5 enables you to build a flexible, cost-effective, and highly available infrastructure, resulting in lower costs, reduced business risk, and better business agility. This white paper focuses on the HPE 3PAR StoreServ 7000, the only quad-node midrange storage platform designed to meet unpredictable workload demands. HPE 3PAR StoreServ supports file, block, and emerging object protocols, and it's affordable and easy to install, own, upgrade, and support. Features such as thin provisioning, autonomic storage tiering, wide striping, and mixed workload support enable HPE 3PAR StoreServ 7000 to be the ideal storage foundation for virtualized SQL Server deployments.

**Target audience:** The information contained in this white paper is for IT decision makers, IT support staff, and project managers involved in planning and deploying Microsoft SQL Server solutions in a virtualized environment using VMware vSphere. For more information on Microsoft SQL Server terminology and best practices, go to [hp.com/Solutions/ActiveAnswers](http://hp.com/Solutions/ActiveAnswers).

## Introduction

HPE 3PAR StoreServ is the gold standard for tier 1 storage built for IT as a service, virtualization, and the cloud. Specifically, its tightly-coupled clustered architecture, enhanced multitenancy, and mixed workload support is designed to deliver enterprise IT as a utility service simply, efficiently, and flexibly. It's the only storage platform that spans from the low end of the midrange to the high end of the enterprise market segments with a single architecture. Thus, HPE 3PAR StoreServ is an excellent choice for both SQL Server—only environments as well as heterogeneous application environments—as might be expected with VMware.

HPE 3PAR StoreServ offers an optimized storage solution that builds redundancy, performance, and breakthrough functionality on top of common components, driving a huge return on investment (ROI) as expected in a virtualized environment. Some of the breakthrough features of HPE 3PAR StoreServ include fine-grain wide striping of data on all available storage for exceptional performance, Peer Motion workload balancing and migration between storage devices, VMware vStorage application programming interface (API) integration, vCenter plug-ins, HPE 3PAR thin technologies, and storage tiering.

### **HPE 3PAR StoreServ is optimized for VMware and SQL Server**

Consolidating workloads in virtual server environments is key to driving increased savings. HPE 3PAR StoreServ offers wide striping, mixed workload support, and integration with VMware adaptive queue depth throttling algorithm and vStorage APIs, providing the performance necessary to increase virtual machine (VM) density per server by at least twofold—guaranteed—when compared to VMware deployments using traditional storage arrays.<sup>1,2</sup>

Since a VMware vSphere Server can host many different VMs, each with its own I/O patterns, the resulting I/O pattern seen by the array is generally random in nature. Random I/O generally means that the server derives less benefit from storage caching than a server with a more predictable access pattern, forcing more requests to access disks. Thus, the number of drives that make up the logical unit number (LUN) predominantly determines performance. Wide striping spreads even modestly-sized volumes across as many drives as possible in HPE 3PAR StoreServ, resulting in unmatched I/O performance, even when caching is minimally effective. *This specifically benefits SQL Server environments where even the smallest databases (DBs) benefit from the performance of all the available disks in the array.*

Combining Microsoft SQL Server workloads with VMware virtualization and HPE 3PAR StoreServ is a highly efficient way to achieve performance and increase hardware utilization throughout your data center. HPE 3PAR StoreServ 7000 provides sustained performance for SQL Server and other consolidated workloads. When SQL Server storage capacity or performance needs increase, HPE 3PAR StoreServ 7000 online storage upgrades meet the demand. The HPE 3PAR StoreServ 7000 accommodates increasing SQL Server online transaction processing (OLTP) performance demands by adding additional disk storage—up to the maximum number of configurable spindles. HPE 3PAR StoreServ, VMware virtualization, and Microsoft SQL Server provide functionality, performance, and ease of use, helping today's businesses lower costs, reduce business risk, and improve IT agility.

## **Configuration overview**

The solution uses HPE ProLiant BL460c Gen8 Server Blades configured as VMware ESXi servers and HPE 3PAR StoreServ 7000 for cluster storage.

### **VMware vSphere 5**

VMware vSphere 5 is VMware's latest generation virtualization platform providing the foundation for virtualization of the most demanding applications. With the latest release, VMware vSphere 5 VMs can scale up in order to provide compute requirements of the largest recommended SQL Server instances. This allows for very efficient, secure, and scalable use of today's powerful server hardware. VMware technologies, such as vMotion and vSphere High Availability (HA), provide increased availability, complementing HPE 3PAR StoreServ HA solution technologies such as fully redundant storage, snap and clones, remote copy, and integrated VMware management solutions.

Running SQL Server 2012 and other consolidated solutions on VMware vSphere 5 VMs offers many benefits:

#### **Server consolidation:**

- Utilize all your server processor cores
- Maintain role isolation without additional hardware expense

<sup>1</sup> 3PAR Utility Storage with VMware vSphere

<sup>2</sup> HPE 3PAR StoreServ Get Virtual Guarantee program

**Operational efficiency:**

- Design for today's workload rather than guessing about tomorrow
- Design for specific business requirements
- Rapidly provision SQL Servers with VM templates
- Enhance testing and troubleshooting using cloned production VMs

**Higher availability with less complexity:**

- Reduce planned downtime due to hardware or BIOS updates with VMware vSphere vMotion
- Reduce unplanned downtime due to hardware failure or resource constraints

**VMware vCenter Server integration with HPE Insight Control for vCenter Server:**

- **HPE Insight Control for vCenter Server** enhances both view and monitor, as well as provisioning functionality using HPE server and storage plug-ins.<sup>3</sup>
- **VASA provider** includes vSphere Storage APIs for Storage Awareness (VASA) support, which enables vCenter to query and capture the capabilities of HPE arrays and make use of the new vSphere 5 Storage Distributed Resource Scheduler (DRS) and profile-driven storage features.
- **View and monitor HPE storage**, and view volume and LUN connections to your VMS or ESX server hosts.
- **Provision HPE storage** with active management for HPE 3PAR StoreServ, including the ability to perform storage provisioning operations such as adding a new datastore, deleting or expanding an existing datastore, creating new VMs from a template, and cloning existing VMs.

<sup>3</sup> [HPE Insight Control Integrations](#)

## Microsoft Windows Server 2008 R2

Microsoft Windows® Server 2008 R2 provides OS platform for the SQL Server solution. Listed here are some feature benefits of Windows Server 2008 R2:

- Support for HPE ProLiant Gen8 servers with Windows Server 2008 R2 SP1
- Ability to implement both high availability (HA) and disaster recovery (DR) using Windows Server Failover Clustering (WSFC)
- Microsoft SQL 2012 support including Failover Cluster Instance (FCI) support

Refer to [microsoft.com](http://microsoft.com) and the [For more information](#) section of this paper for details.

## Microsoft SQL Server 2012

Microsoft SQL Server is a DB management and analysis system for e-commerce, line of business (LOB), and data warehouse solutions. Microsoft SQL Server 2012 enables a cloud-ready information platform that will help organizations unlock breakthrough insights across the organization as well as quickly build solutions and extend data across on-premises and public cloud, backed by capabilities for mission-critical confidence.

SQL Server 2012 Enterprise Edition includes all the advanced features of comparable DB products in the base product at no additional cost, significantly lowering the total cost of ownership (TCO) for enterprise customers.

**Table 1.** SQL Server 2012 capabilities

AlwaysOn FCIs	New multisubnet failover clustering architecture allows FCI clusters to span multiple subnets. FCI clusters provide HA in data centers at the instance level. When spanning data centers, it provides for disaster recovery (DR) functionality.
AlwaysOn availability groups	SQL Server 2012 provides server-side redundancy that complements HPE 3PAR data replication methods. It achieves increased application availability and data protection with options to configure active, multiple secondaries and the ability to quickly failover and recover applications.
Increased performance	A trusted platform that continuously leads in industry-relevant Transaction Processing Performance Council—Benchmark E (TPC-E), TPC-H, and real-world application performance benchmarks. It significantly boosts query performance, by up to ~10X for star join and similar queries with the new ColumnStore Index.
Remote BLOB Store	SQL Server Remote BLOB Store (RBS) is an optional add-on component that lets DB administrators store binary large objects in separate locations instead of directly on the main DB server. Storing BLOBs in the DB can consume large amounts of file space and expensive server resources. RBS efficiently transfers the BLOBs to a storage solution of your choosing, and stores references to them in the DB. This frees server storage for structured data, and frees server resources for DB operations.

## HPE ProLiant BL460c Gen8 Server Blade

The HPE ProLiant BL460c Gen8 Server Blade is a dual-socket server blade engineered for unprecedented performance, enhanced flexibility, and simplified management, making it the standard for data center computing.

The ProLiant BL460c Gen8 Server packs in more performance with a 33 percent increase in memory DIMM count, Intel® Xeon® E5-2600 Processor with added support for 130 W processors, faster I/O slots, and enhanced Smart Array Controller that now ships with 512 MB Flash Back Write Cache (FBWC) standard. In addition, it is more flexible with HPE FlexibleLOM, which provides the ability to customize server networking today and to meet future needs without overhauling server hardware.

### Key features of the HPE ProLiant BL460c Gen8 Server Blade:

- Dynamic workload acceleration delivers smarter data protection for ever-increasing drive capacities, real-time workload-aware analysis to optimize and adapt storage performance, and 6X faster solid-state performance vs. previous generation.
- HPE Active Health System provides 24x7 continuous health monitoring, 100 percent configuration change logging, and faster problem analyzing with HPE Service and Support. Start problem analysis 5X faster using unified diagnostic tools with secure data transfer to HPE Service and Support.

- HPE SmartMemory has unmatched performance, quality, and manageability advantages above industry-standard memory. It supports Unbuffered DIMM (UDIMM), Registered DIMM (RDIMM), and Load Reduced DIMM (LRDIMM) with up to 512 GB capacity and 256 GB capacity at 1600 MHz. SmartMemory in the ProLiant BL460c Gen8 Server Blade delivers up to 33 percent more memory capacity over previous generations.
- The new embedded HPE Smart Array P220i RAID controller has 512 MB Flash-Backed Write Cache (FBWC) standard with support for HPE Smart Storage and HPE SmartDrives and a choice of two 2.5-inch Small Form Factor (SFF) Serial Attached SCSI (SAS), Serial ATA (SATA), SSD drives.
- 2x16 PCIe 3.0 I/O expansion slots support the highest-performing mezzanine option cards now and into the future.
- HPE FlexibleLOM provides the ability to customize server networking today and to meet future needs without overhauling server hardware. It provides choice of bandwidth and fabric (Ethernet, FCoE, InfiniBand), supports Wake on LAN (WOL), and provides a shared Integrated Lights-Out (iLO) port for ease of use.
- Intel Xeon E5-2600 Processor family offers high performance, power efficiency, and more adaptability with Intel QuickPath, Integrated Memory Controller, Turbo Boost, and Intelligent Power Technologies.



**HPE ProLiant  
BL460c Gen8  
Blade Server**



**HPE BladeSystem c7000 Enclosure**

**Figure 1.** HPE ProLiant BL460c Gen8 Blade Server and HPE BladeSystem c7000 Enclosure

## HPE 3PAR StoreServ 7000 Storage<sup>4</sup>

HPE 3PAR StoreServ 7000 extends the innovative HPE 3PAR StoreServ product line to the midrange with industry-leading performance and features at an affordable price. Spend less time managing storage, get more features for less money, and do it all without sacrificing performance or future scalability. HPE 3PAR StoreServ is also the first product family with a common architecture that meets midrange needs and spans to the largest global enterprises, giving you access to the same features as the world's largest service providers. You can start small and grow without painful upgrades down the road.

### **Key functionality and features in the HPE 3PAR StoreServ family:**

**Cloud-ready:** Ease of maintenance, provision, and integration into current and future virtualization environments provide for easier cloud deployment and use.

**Storage virtualization:** The fine-grain virtualization and wide striping built into HPE 3PAR StoreServ drives new efficiencies in both performance and utilization without compromising either. This advanced storage virtualization technology utilizes all system resources—including disk drives, controllers, and cache—for all volumes.

**Scalable storage:** The HPE 3PAR StoreServ architecture allows customers to start small and grow as needed, adding new applications and workloads affordably and nondisruptively. The HPE 3PAR Gen4 ASIC with Thin Built In delivers a unique hardware capability that eliminates stranded capacity, alleviates the performance concerns of running mixed workloads, delivers a low entry price, and provides opportunity for massive and nondisruptive growth.

**Efficient and green storage:** HPE 3PAR StoreServ offers one of the most comprehensive thin technology suite in the industry, reducing capacity requirements by at least 50 percent, which results in lower energy consumption associated with both power and cooling.

**Storage federation:** HPE 3PAR StoreServ delivers storage federation via HPE 3PAR Peer Motion software—enabling asset management, workload balancing, and optimization of storage resources across the data center. These benefits provide the agility needed in today's unpredictable cloud and virtual data centers.

**Multi-tenancy:** HPE 3PAR StoreServ offers multi-tenancy technology that gives enterprises and service providers the ability to massively consolidate mixed workloads onto a single storage system. Enhanced security segregation protects individual users, hosts, and data, while delivering high performance and availability.

**Autonomic management:** Autonomic management features provide intelligent and simple storage provisioning and tiering that the administrator does not need to think about. It creates groups and provision storage to those groups in just seconds. Also, it maintains service levels and responds quickly to a changing environment.

**Storage tiering:** HPE 3PAR StoreServ provides a policy-driven, easy-to-use tiered storage solution that balances cost and performance to meet service-level requirements, delivered via the HPE 3PAR Optimization Suite. This storage tiering solution provides administrators with autonomic storage optimization that moves “cold” data to more economical, lower storage tiers, while escalating “hot” or frequently accessed data to the system's highest tier, without disrupting users or applications. Tiers can include SSDs, SAS HDDs, and nearline (NL) HDDs.

**Data/business protection:** HPE 3PAR StoreServ protects data with a flexible and efficient copy-on-write technology that helps maximize both recovery point objectives and recovery time objectives.

**HPE Storage Services:** HPE provides professional support for your HPE 3PAR StoreServ environment including proactive advice, performance baselines, and deep performance analysis when you don't have the expertise in-house or need an expert set of eyes to ensure sound configuration decisions.

<sup>4</sup> [HPE 3PAR StoreServ 7000 Storage QuickSpecs](#)



**HPE 3PAR StoreServ 7200**



**HPE 3PAR StoreServ 7400**

**Figure 2.** HPE 3PAR StoreServ 7000 models

**Table 2.** Technical specifications for HPE 3PAR 7200 and 7400 arrays

Category	HPE 3PAR StoreServ 7200	HPE 3PAR StoreServ 7400
Number of controller nodes	2	2 or 4
2U controller SAS drive capacity	24 SFF	24 SFF
HPE 3PAR Gen4 ASICs	4	4 or 8
Processors	2 four-core 1.8 GHz	2–4 six-core 1.8 GHz
Total cache	24 GB	32 or 64 GB
Control cache per node pair	16 GB	16 GB
Data cache per node pair	8 GB	16 GB
Host port		
Built-in Fibre Channel (FC) host ports	4	4 or 8
Additional FC host port (optional)	0–8	0–16
10 Gb/s iSCSI/FCoE host ports (optional)	0–4	0–8
Drive expansion chassis types (mixing is supported)	2U 24 SFF 4U 24 LFF	2U 24 SFF 4U 24 LFF
Number of drives	144	240 or 480
Raw capacity (approx.)	1.2–250 TB	1.2–864 TB
<b>Capacity details</b>	<b>HPE 3PAR StoreServ 7200</b>	<b>HPE 3PAR StoreServ 7400</b>
RAID levels	0, 1, 5, 6	0, 1, 5, 6
SSDs (maximum)	120	120 or 240
Drive capacities (approximate GB)	100 SSD, 200 SSD, 300 SAS, 450 SAS, 900 SAS, 2000 NL, 3000 NL	100 SSD, 200 SSD, 300 SAS, 450 SAS, 900 SAS, 2000 NL, 3000 NL

Drive chassis types	SFF and/or LFF	SFF and/or LFF
Number of drive chassis	0 to 5 enclosures	0 to 18 enclosures

**HPE 3PAR StoreServ thin technologies<sup>5</sup>**

HPE 3PAR StoreServ provides value-added thin functionality to increase ROI and ease of management and maintenance.

**HPE 3PAR Thin Provisioning software**

Use HPE 3PAR Thin Provisioning software when configuring storage for your application needs, as it eliminates the stranded storage dilemma plaguing many storage implementations. VMware vSphere support for Microsoft clustering solutions on VMware requires raw device mapping (RDM) for shared storage across physical machines.<sup>6</sup> Use Thin Provisioning software for all your storage needs including RDM devices, since this enables one of the most cost-effective storage while easing administrative effort.

When implementing HPE 3PAR thin-provisioned virtual volumes (TPVVs), administrators often ask whether implementing vSphere Thin Provisioning for virtual machine disk (VMDK) files makes sense. In general, thin provisioning with HPE 3PAR and vSphere accomplish the same end-result, albeit at different logical layers. With VMware vSphere Thin Provisioning, administrators realize greater VM density in the virtual machine file system (VMFS) layer, but at the cost of CPU and disk I/O overhead as the volume incrementally increases on ESXi hosts. By implementing HPE 3PAR TPVVs, the same VM density levels are achieved; however, the thin provisioning CPU work is offloaded to HPE 3PAR ASIC. If the goals are to reduce storage costs, increase storage utilization, and maintain performance, then use HPE 3PAR Thin Provisioning software to provision virtual volumes. If performance is not a concern, but overprovisioning VMs at the VMFS layer is important, then implement both the thin provisioning solutions. However, there are no additional storage savings realized by using VMware Thin Provisioning on top of HPE 3PAR TPVVs and, in fact, implementing both the solutions add more management complexity to the environment. *HPE recommends using only HPE 3PAR Thin Provisioning, which reduces management complexity and enables greater performance and efficiency.*

**Zero detection**

HPE 3PAR StoreServ includes a Zero Detection feature which allows zeroed out blocks to be recognized and not written to disks, thereby saving space and time. Zero Detection also achieves space reclamation of zeroed data during copy operations, which can have a large space-saving impact. It is advisable to enable Zero Detection on HPE 3PAR TPVVs.

**HPE 3PAR Thin Conversion software**

HPE 3PAR Thin Conversion software is a feature that converts a fully provisioned volume to a TPVV. Volumes with large amounts of allocated but unused space are converted to TPVVs that are much smaller than the original volume. During the conversion process, allocated but unused space is discarded, and the result is a TPVV that uses less space than the original volume. The space is recovered by zeroing free space prior to the conversion process. The more free space there is, the greater the realized cost savings. As production environments are consolidated with VMware vSphere, HPE 3PAR Thin Conversion should be implemented to produce the cost savings and other benefits of going thin and virtual.

**HPE 3PAR Thin Persistence software**

HPE 3PAR Thin Persistence software is a feature that keeps TPVVs and read/write (R/W) snapshots of TPVVs small by detecting pages of zeros during data transfers and not allocating space for those pages. This feature works in real time and analyzes the data before it is written to the source TPVV or R/W snapshot of the TPVV. Freed blocks of 16 KB of contiguous space are returned to the source volume, and freed blocks of 128 MB of contiguous space are returned to the common provisioning group (CPG) for use by other volumes. HPE 3PAR Thin Copy Reclamation

<sup>5</sup> [HPE 3PAR StoreServ 7000 Storage](#)

<sup>6</sup> [Microsoft Clustering on VMware vSphere: Guidelines for Supported Configurations](#)

software is a feature that reclaims space when snapshots are deleted from a system. As snapshots are deleted, the snapshot space is reclaimed and returned to the CPG free space. Deleted snapshot space can be reclaimed from virtual copies, physical copies, or remote copies.

An example of thin persistence is when an administrator deletes a VMDK file that existed on an HPE 3PAR TPVV, the array detects the delete operation (ESXi 5.0 and greater), and the zeroed space (small computer system interface [SCSI] WRITE\_SAME) is reclaimed.

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**Note**

Reclaiming space when snapshots are deleted with the Thin Copy Reclamation feature requires the Virtual Copy, Remote Copy, or Thin Provisioning license.

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**HPE 3PAR Recovery Manager****HPE 3PAR Recovery Manager for VMware vSphere**

HPE 3PAR Recovery Manager for VMware vSphere allows VMware administrators to create hundreds of VM-aware snapshots and initiate rapid online recovery directly from within the VMware vCenter Server virtualization management console.

**HPE 3PAR Plug-in for VMware vCenter**

HPE 3PAR Plug-in for VMware vCenter gives VMware administrators enhanced visibility into storage resources and precise insight into how individual VMs are mapped onto datastores and individual storage volumes. When used in conjunction with HPE 3PAR Recovery Manager for VMware vSphere, this plug-in gives administrators the power of seamless, rapid online recovery from within the vCenter Server virtualization management console.

**HPE 3PAR Recovery Manager for Microsoft SQL Server**

HPE 3PAR Recovery Manager for Microsoft SQL Server is another extension to HPE 3PAR Virtual Copy that eases costs and administration. It provides rapid, affordable online recovery of SQL Server DBs from multiple, highly granular point-in-time snapshots that allow quick recovery of a DB to a known point in time. This expedites a variety of operations including rapid recovery of the production SQL Server.<sup>7</sup>

**HPE 3PAR Peer Motion software**

HPE 3PAR Peer Motion software is the first nondisruptive, do-it-yourself data migration tool for enterprise block storage. With Peer Motion software, you can load balance I/O workloads across systems at will, perform technology refresh seamlessly, cost-optimize asset lifecycle management, and lower technology refresh capital expenditures. Unlike traditional block migration approaches, the software enables you to migrate storage volumes between any HPE 3PAR StoreServ products online, nondisruptively, and without complex planning or dependency on extra tools. Peer Motion leverages HPE 3PAR Thin Built In technology to power the simple and rapid inline conversion of inefficient, “fat” volumes on source arrays (for example, Enterprise Virtual Array [EVA], HPE 3PAR) to more efficient, higher-utilization “thin” volumes on the destination HPE 3PAR StoreServ. HPE 3PAR Peer Motion Manager is an add-on application that orchestrates all stages of the data migration lifecycle to simplify and automate it.

In a Windows Server-only environment (without VMware integration), different storage devices might use different multipath target devices. In such situations, this will require a reboot for the migration to complete properly. However, this reboot is not required in a VMware environment. VMware allows for a migration that is completely transparent and online. Peer Motion software migrations from HPE 3PAR StoreServ to HPE 3PAR StoreServ in Windows Server are also completely online and transparent in operations since they use the same target device settings. Lastly, HPE 3PAR Peer Motion software can be used to migrate SQL Server DBs in a VMware environment nondisruptively.

<sup>7</sup> As of the publication of this document, HPE 3PAR Recovery Manager support of SQL Server 2012 is in development.

## Reference configuration and sizing

### Solution layout

This paper focuses predominantly on the use of VMs that are running on VMware vSphere clients; however, HA and DR concepts are often just as applicable whether involving a VM or a physical machine. Additionally, by including other OS into the mix (such as Linux), the HPE 3PAR StoreServ can provide greater benefits as consolidation efforts are increased in scope to all areas of storage in the data center. Virtualizing SQL Server 2012 with HPE 3PAR StoreServ reduces stranded resources and increases raw utilization of equipment. *Combining virtual and nonvirtual storage requirements into a single HPE 3PAR StoreServ enables easier management and increased performance due to HPE 3PAR thin technologies and wide striping of data on an increased number of drives, which provides higher random I/O performance.*

### VM layout<sup>8</sup>

#### VM across physical hosts

There are several ways to configure VMs across physical machines when Microsoft Cluster Services (MSCS) is involved. One method involves clustering VMs that reside across two separate physical hosts. This is a common method documented by VMware and described here. This clustering method in its most basic configuration consists of two VMs on two separate physical machines clustered together as shown in figure 3. Two VMs can be clustered around a single host; however, this would be a single point of failure (SPOF) and would not provide the benefits and flexibility VMware offers when servicing the physical machines. Use the configuration in figure 3 for Windows Failover Cluster (WFC) configuration with SQL Server FCIs. This type of HA configuration provides server-level redundancy in the cluster with storage HA being provided by the shared SAN HPE 3PAR storage device.

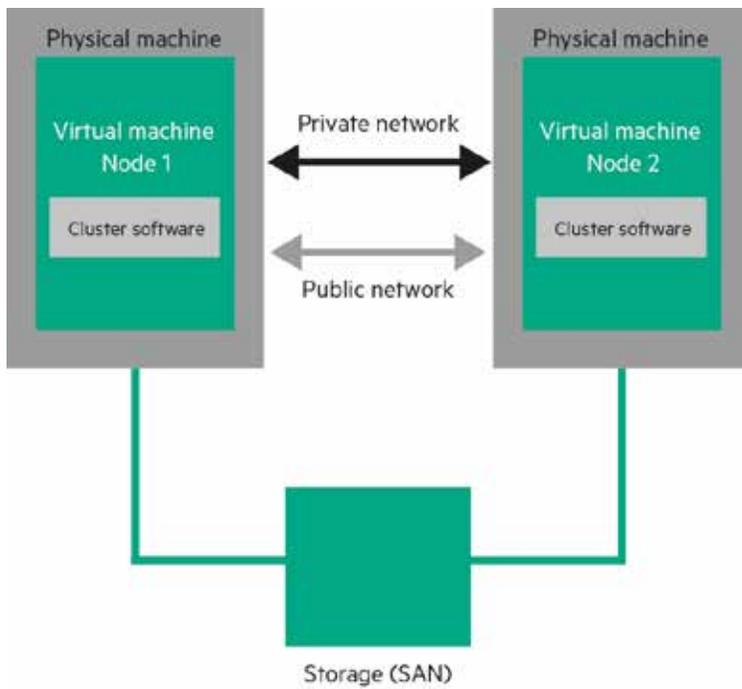


Figure 3. VMs clustered across physical hosts—basic configuration

<sup>8</sup> Setup for Failover Clustering and Microsoft Cluster Service

VMware currently supports up to two VMs (two nodes in the FCI) in the cluster with shared storage; however, multiple 2-node clusters are supported on the vSphere client machines as shown in figure 4. With multiple clusters sharing the same hosts, increased flexibility and consolidation is achieved. When configuring such FCIs, ensure VMware affinity/anti-affinity rules are applied so the VMs do not migrate onto the same physical machine, which would defeat the purpose of the cluster and expose the environment to a SPOF.

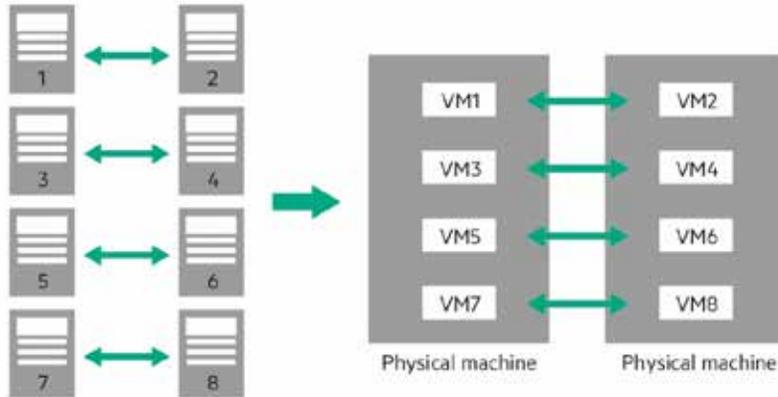


Figure 4. Multiple clusters of VMs across physical hosts—shared configuration

## SQL Server 2012 HA and DR

### VMs using SQL Server AlwaysOn availability groups

Another way to configure VMs is across separate hosts using SQL Server AlwaysOn functionality, which uses the MSCS, but does not cluster the server nodes. Instead, availability groups of single installed instances of SQL Server 2012 are created to provide copies of the instance and data either locally or remotely. This type of solution does not use a shared LUN. VMware has no restriction to the number of nodes in a Microsoft Failover Cluster (MSFC) with nonshared storage. When using SQL Server AlwaysOn, it is advisable to provide another HPE 3PAR StoreServ for remote copy. While AlwaysOn availability groups provide HA and DR for SQL Server 2012 solutions, it does not provide HA and DR for other applications. *Leverage HPE 3PAR Peer Persistence software to provide multisite DR protection of user data in mixed application environments.*

### SQL AlwaysOn FCI<sup>9</sup>

An AlwaysOn FCI is a SQL Server instance installed across nodes in a WSFC cluster. In the event of a failover, the WSFC service transfers ownership of instance resources to a designated failover node. The SQL Server instance is then restarted on the failover node, and DBs are recovered as usual. At any given moment, only a single node in the cluster can host the FCI and underlying resources. FCI nodes existing in the same data center provide local HA. FCI can provide HA and DR by having nodes in a remote data center and combining the solution with storage replication.

<sup>9</sup> [Windows Server Failover Clustering \(WSFC\) with SQL Server](#)

**Table 3.** Special considerations for storage used for failover clustering and MSCS

Item	Recommendation/best practice/advisable
Shared RDM storage	Storage must be on a SAN (HPE 3PAR FC connect meets this requirement)
FC SAN zoning	A single initiator for multiple targets per zone (shared HPE FC storage environment for ease of management)
Eager zeroed thick (EZT) for HPE 3PAR LUNs	EZT format used for all VMware VMSF disks using HPE 3PAR storage (not applicable for RDMs)
Multipath policy = fixed	“Fixed” is required for volumes used with MSCS. Manually configure the preferred path for evenly distributed path usage.
RDM compatibility mode	Physical compatibility mode required for sharing between VMs on any server
SCSI controller for RDMs not 0	Use SCSI 1 for example, not the default 0
SCSI bus sharing = physical	Allows sharing between VM on any server
Storage I/O control (SIOC)	Yes (enable) for data LUNs

## Microsoft SQL Server 2012 guidance

### Microsoft Assessment and Planning Toolkit (MAP)

The MAP toolkit is available to assist in the evaluation of existing SQL Server workloads to understand the current SQL Server sizing requirements and ease migration planning. Use the MAP tool with planning and growth estimates for new SQL Server 2012 workloads to help form the total sizing requirements for the array. Use the MAP tool to help inventory-different environments for planning, such as VMware, MySQL, Oracle, and servers running various versions of the Windows Server OS.

### SQL AlwaysOn alternatives and considerations

SQL Server Availability Groups provide HA and DR benefits for Microsoft SQL Server 2012 unavailable in earlier SQL Server releases. Availability Group functionality applies to a SQL Server 2012-only environment and does not provide full user data protection in a consolidated mixed application environment. Use of Availability Groups for SQL Server 2012 instances in a mixed application environment and with earlier SQL Server versions is not recommended. One benefit of using HPE 3PAR StoreServ-based replication is the ability to protect all workloads on the array against an outage. HPE recommends that HPE 3PAR Remote Copy and Recovery Manager<sup>9</sup> be used to provide multisite DR protection for enterprises requiring a multisite DR solution.

### HPE 3PAR StoreServ 7000 Storage guidance

While this paper provides sizing information, it is not a sizing guide, nor does it suggest the maximum capabilities of the equipment used. One aspect of planning a virtualized environment is correctly sizing the equipment; however, this is not as critical as it is for a standalone environment. Virtual environments are more forgiving of sizing issues as VMs can be created, grown, and migrated more easily than standalone environments. The HPE 3PAR StoreServ, with thin provisioning technology built in, can be configured for volumes that are larger than anticipated need. Physical storage may be added at a later date as need arises.

Converting a physical server to a VM is a convenient method of replacing aging hardware. Also, converting multiple servers to VMs and consolidating them to fewer physical hosts creates significant savings in equipment, power, cooling, and real estate. When sizing the host servers that contain the VMs, remember this simple best practice: host servers should have at least as many resources as the sum of used resources on the physical servers being converted to VMs, plus overhead for the host OS.

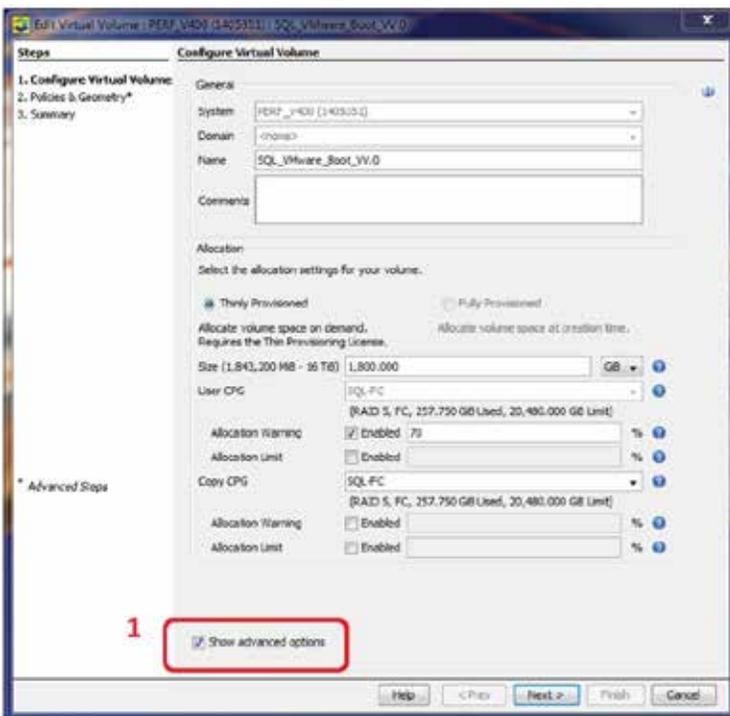
Refer to the [For more information](#) section of this paper for sizing tools and resources.

**HPE 3PAR StoreServ and VMware vSphere hardware—accelerated block zeroing and zero detection**

VMware has several file system configuration options. For the virtual servers that will host SQL Server or other applications in the shared environment where the VMFS will be implemented, use EZT volumes. Eager zeroed disks provide performance and security benefits over lazy zeroed thick disks whose blocks are zeroed on demand the first time a block has data written to it. When utilizing the EZT format during virtual disk creation, all the space is preallocated and prezeroed from the VMware perspective, which would be both time-consuming and resource-intensive; however, not for HPE 3PAR StoreServ. The VMware block-zeroing primitive uses the SCSI WRITE\_SAME command to write zeros, which allows HPE 3PAR StoreServ to keep volumes thin while speeding up the provisioning of VMs. *HPE recommends that VMFS volumes should use EZT along with HPE 3PAR Zero Detect to help maximize performance and space savings in TPVVs.*

HPE 3PAR zero detection may be enabled with HPE 3PAR InForm management console (figure 5) by using the “Advanced options” checkbox of the “Create Virtual Volume” wizard or the “Edit Virtual Volume” wizard.

1. Check the “Show advanced options panel(s)” box.



2. Check the “Zero detect” box.

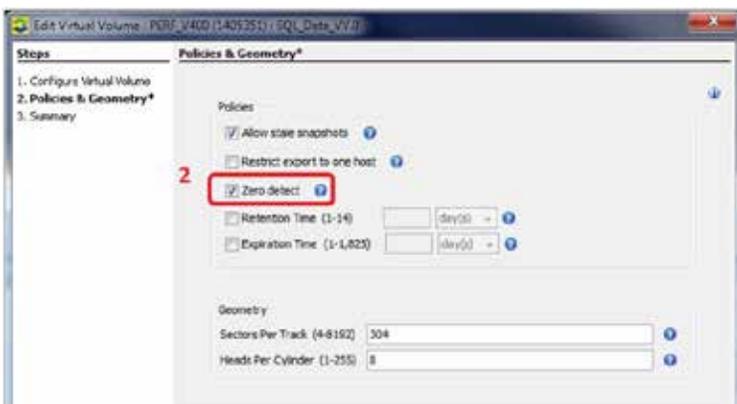


Figure 5. Configure “Zero Detect” on HPE 3PAR StoreServ within “Create Virtual Volume” or “Edit Virtual Volume” wizards.

## HPE 3PAR StoreServ 7000 Storage sizing considerations

### Array performance planning

Performance in the HPE 3PAR StoreServ 7000 family scales very well from HPE 3PAR StoreServ 7200 to HPE 3PAR StoreServ 7400. Figure 6 shows how various drive types and RAID configurations play a part in performance sizing of the arrays for a random 8k rpm mixed 80/20 R/W block workload. This R/W ratio was chosen to provide a more realistic idea of how the array can perform in a real data center environment since the array can perform better with a strictly read workload.

For greater performance and power savings, configure HPE 3PAR StoreServ 7400 with SSD devices configured in RAID 1 groups. Projected estimates of random 8k rpm 80/20 workloads on SSD CPGs show a performance boost greater than 100 percent when using RAID 1 over a RAID 5 configuration; however, there is loss of usable capacity. Another consideration when using SSDs is whether the applications using the storage can really benefit from the extra performance available. For extremely hot localized I/O data access patterns seen at the array, a RAID 1 configuration might be warranted. *Thankfully, HPE 3PAR StoreServ can reconfigure volumes from one RAID level to another without taking the volume offline.*

If using SSDs with a 100 percent small block random read workload, the array can service about another 30 percent additional I/O over that as shown in figure 6. Another benefit of SSDs is the extremely fast response times. Testing has shown that I/O performance of SSDs in HPE 3PAR StoreServ remains fairly constant from a response time of around 3 ms on up, which HDDs can never do. Decision points for choosing SSDs include greater performance, power savings, and response times.

HPE 3PAR Inform Management Console has performance analysis tools that can help pinpoint whether or not data access patterns have localized hot data, which might warrant an SSD tiered environment. HPE Storage Services assist customers in analyzing their performance data and understanding the options they might want to consider.

For HDD devices, the small form factor (SFF) devices tend to consume less power and provide slightly better performance than large form factor (LFF) devices. The SFF HDDs perform better with a random workload environment due to the reduced seek distance. For business intelligence types of workloads with large sequential I/O, LFF drives may provide similar performance to smaller disks, but they will consume more power.

For large block sequential transactional workloads, consolidation considerations are handled differently than for small block random workloads, which are usually measured in IOPS. Sequential workloads are typically measured in MB/s and do not necessarily scale beyond a certain point, no matter how many disk spindles are added to the system. HPE 3PAR StoreServ handles mixed sequential and random I/O workloads very well; however, when sizing the array for sequential workloads, do not assume that merely adding spindle count can increase performance. Storage array controllers have a finite bandwidth capability, and increasing the spindle count beyond this capability may not provide increased bandwidth. HPE 3PAR StoreServ performs very well with sequential I/Os in a mixed sequential and random I/O workload environment; therefore, this aspect of workload planning must always be considered. In addition, as environments are virtualized and consolidated on a single storage platform, the I/O pattern seen by the storage device tends to appear more random in nature than might otherwise be the case, which is yet another reason that HPE 3PAR StoreServ, with its wide-striping, is a great choice for virtualization and consolidation.

For the configurations in this paper, NL 7.2k revolutions per minute (rpm) disk performance capabilities were not considered since they are not intended for sustained SQL Server workloads and can rarely meet the response times needed. However, for a tiered storage environment, they can provide storage capacity for data that is rarely accessed, thereby freeing up space on faster devices for active data.

**To optimize SQL Server performance on HPE 3PAR StoreServ, consider the following:**

- FC spindles provide about 3X the performance of NL spindles. The SQL Server DB performance goals are addressed prior to adding NL disks. Do not count NL spindles towards performance goals. NL disks are for storing relatively inactive data. Add NL disks and allow HPE Adaptive Optimization software to monitor and migrate data for peak DB performance.
- Keep tempdb data on faster spindles by including it in an Adaptive Optimization software configuration with NL disks. Use a CPG that shares its disks with the other SQL data files on FC storage.
- If possible, use HPE 3PAR System Reporter to analyze the workload characteristics of your SQL Server DB. System Reporter can help when planning future upgrades and looking for performance issues.
- If using Adaptive Optimization software, use the “Performance” mode setting for SQL Server 2012 and plan for migrations to occur during non-peak usage times since any I/O to the disks can affect performance, as expected, and migrations do incur disk I/Os.
- For OLTP type workloads dominated by mostly reads, if System Reporter shows “hot” enough regions that cannot be adequately serviced by HDD (spindled) devices, consider using Adaptive Optimization software with SSDs. SSDs can provide a tremendous boost in performance with little additional power consumption.
- If using Adaptive Optimization software, create the initial default CPG from the FC disks. As capacity utilization increases in an AO configuration, new IOs will be directed to the default CPG. If either an NL CPG or an SSD CPG were the default, performance or capacity problems might result.
- HPE 3PAR StoreServ can be initially deployed in a minimal configuration and upgraded later to handle increased demands (for example, HPE 3PAR StoreServ 7400<sup>10</sup> can be upgraded from a 2-node configuration with no drive chassis to 4 nodes and up to 18 disk chassis).
- When using RAID 5 for 80/20 R/W OLTP-type workloads, a fully loaded HPE 3PAR StoreServ 7400 can provide more than double the performance of HPE 3PAR StoreServ 7200 at 12 ms response times. If additional performance is needed, consider SSDs or RAID 1 configurations. For SQL Server OLTP workloads, the benefit of RAID 1 performance increases as response times drop; conversely, as response times rise towards 20 ms, the performance benefit of using RAID 1 diminishes. HPE 3PAR StoreServ allows the migration of LUNs from one RAID type to another, so your solution may be tuned over time.
- If power or cooling utilization is important, consider using SSDs in the array configuration. SSDs provide significant savings in power utilization along with the additional performance capability over HDD devices.
- In a mixed workload environment, ensure that the HPE 3PAR StoreServ is sized correctly from both a capacity as well as a workload perspective. Having sufficient capacity does not mean performance objectives can be met—for example, when considering the capability of 15k rpm disks vs. 7.2k rpm disks.

<sup>10</sup> The HPE 3PAR StoreServ 7200 is a 2-node model. The HPE 3PAR StoreServ 7400 is upgradable from a 2-node base configuration to a 4-node configuration.

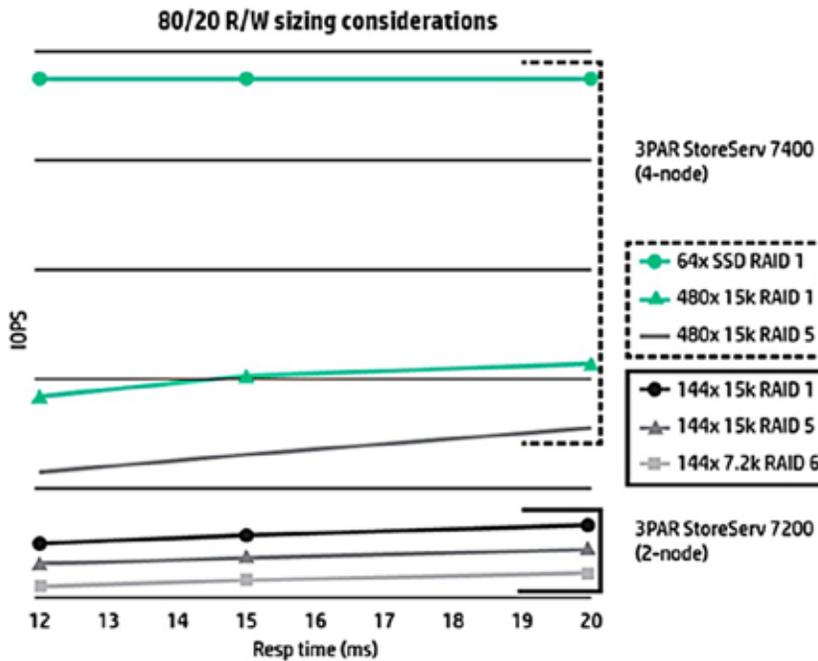


Figure 6. Random 8k rpm mixed 80/20 R/W block IOPS for HPE 3PAR StoreServ 7000 performance sizing and scaling

**Storage tiering with HPE 3PAR Adaptive Optimization software**

Storage tiering can provide a benefit over a purely homogenous storage tier. HPE 3PAR StoreServ is already tuned for single tier performance by wide striping data across all devices possible thereby reducing hot spots. However, by mixing device types in the array, additional performance and cost benefits can be enabled. With Adaptive Optimization software, sub LUN regions of data are monitored for performance characteristics and moved to the appropriate tier based on user selectable configuration choices such as sampling period and the LUNs to monitor.

Use Adaptive Optimization software to create an economical boost to performance for virtualized SQL environments by mixing SAS and SSD devices in a tiered environment. If the most active regions are hot enough to warrant SSDs, then using SSDs instead of HDDs can provide a performance boost without the additional costs associated with HDDs, and with a faster response time. An SSD solution is more cost-effective than HDDs for a number of reasons (also, see the sizing examples later in the paper):

- HDDs have a higher cost and IOPS compared to SSDs.
- HDDs cannot provide the response times available in SSDs.
- More capacity is needed to house the additional HDDs.
- Much more power and cooling is needed for HDDs.
- Sometimes an array’s performance potential cannot be reached with HDDs.

The bottom line is that SSDs are a cost-effective solution for persistent, hot-read regions.

In some enterprise virtualization deployments, there are a number of SQL VM instances that end up having very little I/O resource utilization. With the HPE 3PAR StoreServ architecture, you can leverage a multitiered storage deployment approach with SSD, FC, and NL devices coupled with Adaptive Optimization software capabilities to move these “permafrost” workloads to more economical storage, freeing up the FC and SSD tiers for more active workloads.

HPE Storage Services can help decide the optimum configuration for a specific environment. Size the tiers so that basic performance objectives are met. For example, if a two-tier environment of SSDs and FC HDDs is implemented, size the FC disks to handle the bulk of the capacity, ensure that basic I/O needs can be met by the number of spindles being purchased, and then size the SSDs to handle the hot spots. Using different RAID levels within the same policy is acceptable.

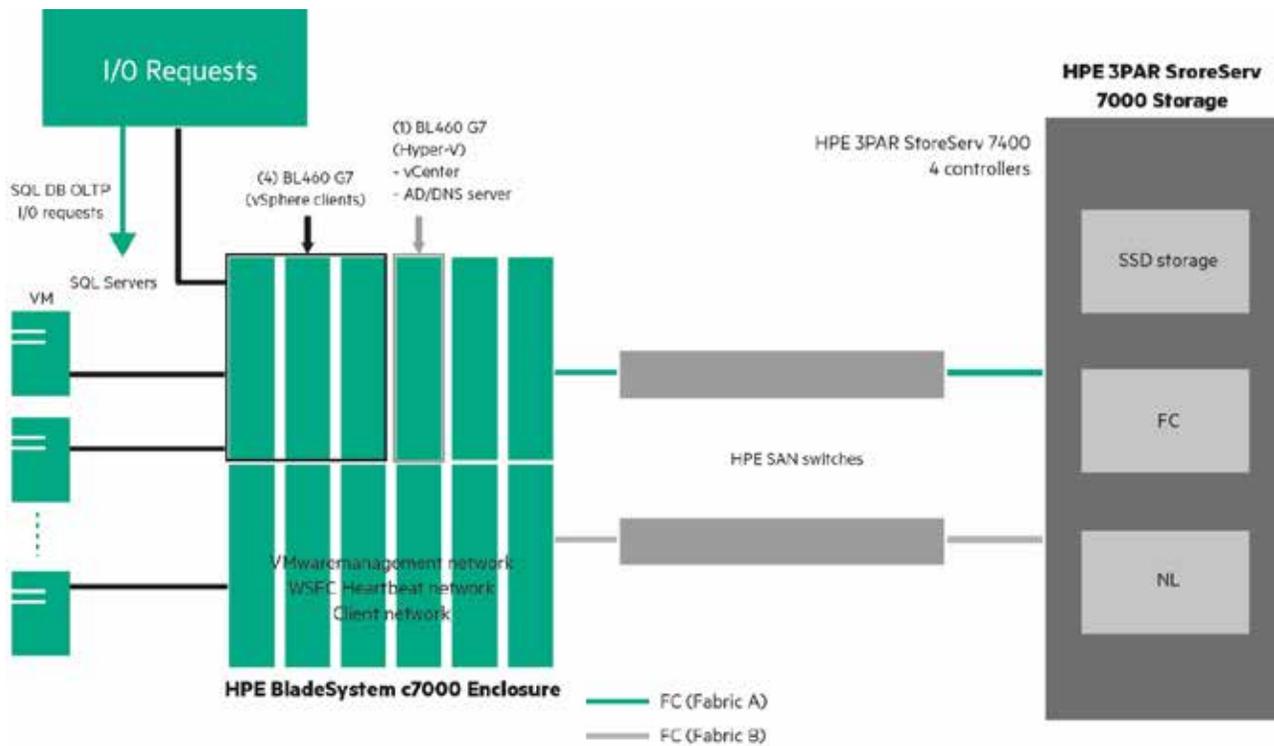
Table 4 shows examples of tiering option possibilities with HPE 3PAR Adaptive Optimization software. The first listing shows an obvious option of SSD, FC, and NL devices all tiered together; however, as the other rows show, a two-tier configuration is possible, and it is possible to create a configuration based on the RAID type used.

**Table 4.** Examples of acceptable Adaptive Optimization software tier configurations

Tier 1	Tier 2	Tier 3
SSD	FC	NL
SSD	FC	--
FC	NL	--
SSD	FC RAID 1	FC RAID 6
FC RAID 1	FC RAID 6	NL

### Hardware and DB layout

Figure 7 shows the HPE 3PAR StoreServ 7400 solution. There is a single HPE c7000 Blade Enclosure containing four ProLiant BL460c G8 blade servers for vSphere clients and one ProLiant BL460c G7 blade servers running a Hyper-V environment for the DNS server and for the vCenter server. Networking is self-contained in the BladeSystem c7000 Enclosures for VMkernel and WFC heartbeat network with a single external network coming out of the enclosure to help minimize cable clutter.



**Figure 7.** Hardware layout

CPGs are created in HPE 3PAR StoreServ, which are used for DB user data and tempdb. The user DB layout and tempdb configuration are similar to that shown in figure 8.



Figure 8. Typical DB instance layout created from HPE 3PAR Virtual Volumes

## HPE 3PAR StoreServ 7000 Storage sizing examples

### HPE 3PAR StoreServ 7200 upgrade sizing example

Some arrays might be able to use SSDs, but their controllers cannot benefit from SSD performance capabilities since they do not have the performance headroom. It is not the case with the HPE 3PAR StoreServ 7000. The HPE 3PAR StoreServ 7200 array is a good starting platform when considering an array that incorporates a mix of HDDs and SSDs because it has ample controller performance headroom. In the following sizing example, an HPE 3PAR StoreServ 7200 with a certain capacity is given a performance boost with SSDs.

### Sizing example of a tiered HDD/SSD storage solution—adding SSDs to an existing HDD solution

This example shows how it is possible to use SSDs to boost the performance of an existing HPE 3PAR StoreServ 7200 for a reduced cost compared to an all-HDD solution providing similar performance. This example starts with a base HDD configuration and then adds SSDs.

**Caveat:** This example is based on early test data and is for a random 8k 80/20 R/W workload with 15 ms response times for HDDs. Cost information is normalized in an effort to standardize the data for various changing cost factors. A ratio of one to seven was calculated for the difference in cost between 450 GB HDDs and 200 GB Single Level Cell (SLC) SSDs based on currently available cost information. This example assumes the workload can benefit from the higher tier.

The base configuration in this example consists of 64 450 GB 6G SAS 10k 2.5-in. HDDs. This storage configuration can provide around 7,500 IOPS.

Table 5. Base HDD configuration

Device type	Capacity (GB)	Qty.	Total capacity (GB)	RAID level	Performance estimated from sizer (IOPS)	Estimated unit cost (normalized)	Total costs (normalized)
HDD	450	64	28,800	5	7,529	1	64

Next, six SSDs are added to the base configuration, which more than doubles the existing available system performance.

As a comparison, in order to achieve this performance boost using HDDs, it would take an additional 82 HDDs in more than three additional drive enclosures. Additionally, 82 HDDs would cost 95 percent more than the SSDs without considering the cost of the additional disk enclosures or power consumption. For access to tools that can help in array sizing efforts, refer to sizing links in the [For more information](#) section of this paper. In this case, the six SSDs installed in the HPE 3PAR StoreServ 7200, configured with RAID 5 protection, can provide 9,188 IOPS. Refer to table 6.

Table 6. Base HDD configuration with additional SSDs added

Device type	Capacity (GB)	Qty.	Capacity (GB)	RAID level	Performance estimated from sizer (IOPS)	Estimated unit cost (normalized)	Total costs (normalized)
HDD	450	64	28,800	5	7,529	1	64
SSD	200	6	12,00	5	9,188	7	42
			Total capacity = 30,000			Total=16,717	Total = 106

Table 7 is similar to table 6, but it shows information for an HDD upgrade rather than the earlier SSD upgrade. Overall performance is comparable for the two upgrade paths; however, the overall cost is less with the SSD upgrade.

**Table 7.** Base HDD configuration with additional HDDs added to match mixed HDD/SSD performance

Device type	Capacity (GB)	Qty.	Capacity (GB)	RAID level	Performance estimated from sizer (IOPS)	Estimated unit cost (normalized)	Total costs (normalized)
HDD	450	64	28,800	5	7,529	1	64
HDD	450	82	36,900	5	9,188	1	82
			Total capacity = 65,700			Total=16,717	Total = 146

Table 8 shows a comparison of costs and the benefit of selecting the SSD upgrade path over the HDD upgrade when upgrading for performance reasons. The first row shows the cost of the base solution prior to the upgrade. The next two rows show the cost of the two possible upgrade paths. The final two rows show the cost benefit.

**Table 8.** Summary of upgrade results

Normalized cost of base HDD-only solution	64
Normalized cost of upgraded mixed HDD/SSD solution	106
Normalized cost of upgraded HDD-only solution	146
Overall device cost savings of the mixed HDD/SSD solution over the HDD-only solution. <sup>11</sup> $([146 - 99]/146) \times 100 = 32\%$	<b>32%</b>
Cost savings of just the upgrade (SSD vs. HDD) for the same performance benefit. SSDs cost less. $([82 - 42]/42) \times 100 = 95\%$	<b>95%</b>

In this sizing example, upgrading with SSDs rather than HDDs actually costs 95 percent less than an HDD upgrade path. *For SQL Server environments that currently have adequate storage capacity, but are looking for increased performance, SSDs provide the most economical growth path.*

### HPE 3PAR StoreServ 7400 HDD vs. HDD/SSD sizing example

HPE 3PAR StoreServ 7400 is a better platform choice for a shared resource or private cloud solution incorporating a SQL Server environment that requires greater capacity or performance than is available in an HPE 3PAR StoreServ 7200 array. HPE 3PAR StoreServ 7400 expects to scale up to 480 drives, providing higher IOPS in a multitrack configuration. With an extra set of controllers and additional storage devices (SSD or HDD), the array can provide more than twice the throughput of the smaller model.

### Sizing example of a tiered HDD/SSD storage solution with 28 percent cost savings over a purely HDD solution

This example shows how it is possible to use SSDs to maintain available performance of HPE 3PAR StoreServ 7400 while reducing the storage purchase costs. Additionally, by using SSDs, recurring expenses such as power, cooling, and floor space are reduced. This example starts with a base HDD configuration, and then sizes a tiered storage environment based on performance goals.

<sup>11</sup> The original formula for the cost savings of the mixed HDD/SSD solution over the HDD only solution is  $([146 - 106]/146) \times 100$ ; however, since three of the disk enclosures are not needed, which is about the cost of 1 SSD, the new normalized SSD cost is reduced from 106 to 99.

**Caveat:** This example is based on early test data and is for a random 8k 80/20 R/W workload with 15 ms response times for HDDs. Cost information is normalized in an effort to standardize the data for various changing cost factors. A ratio of one to seven was calculated for the difference in cost between HDDs and SSDs based on currently available cost information. This example assumes the workload can benefit from the higher tier.

The base configuration in this example consists of (404) 450 GB 6G SAS 10k 2.5 in. HDDs. This storage configuration can provide 40,000 IOPS. Table 9 lists information for the base configuration.

**Table 9.** HPE 3PAR StoreServ 7400 base HDD configuration

Device type	Capacity (GB)	Qty.	Capacity (GB)	RAID level	Performance estimated from sizer (IOPS)	Estimated unit cost (normalized)	Total costs (normalized)
HDD	450	404	181,800	5	40,014	1	404

Using the same base performance goal of 40,000 IOPS, SSDs are used to take over some of the I/O demand so that the HDD count can be reduced. The number of HDDs that may be reduced is not an exact ratio of the change in the I/O workload taken over by the SSDs, so test sizer data is used to find what the new HDD count should be. Refer to the [For more information](#) section of this paper for sizing tools and resources. In this case, eight SSDs installed in the HPE 3PAR StoreServ 7400 system, configured with RAID 5 protection, can provide 12,250 IOPS, which allows the HDD count to be reduced by 148 to 256. If additional performance is desired from the SSDs, using RAID 1 instead of RAID 5 can provide a significant boost in performance for SSDs (as shown earlier). Table 10 shows information about this sizing example.

**Table 10.** Base HDD configuration

Device type	Capacity (GB)	Qty.	Capacity (GB)	RAID level	Performance estimated from sizer (IOPS)	Estimated unit cost (normalized)	Total costs (normalized)
HDD	450	256	115,200	5	27,773	1	256
SSD	200	8	1,600	5	12,250	7	56
Total=40,023							Total = 312

Table 11 shows the comparison cost information and benefit of the mixed HDD/SSD solution (keeping performance constant). *Implementing the mixed HDD/SSD solution can cost 28 percent less in enclosure and device costs over the HDD-only solution.*

**Table 11.** Summary of alternative configuration

Normalized cost of base HDD-only solution	404
Normalized cost of mixed HDD/SSD solution	312
Cost savings of mixed HDD/SSD solution over the HDD-only solution <sup>12</sup>	<b>28%</b>

<sup>12</sup> The original formula for cost savings of the mixed HDD/SSD solution over the HDD-only solution is  $[(404 - 312)/404] \times 100$ ; however, with the mixed solution, six disk enclosures are also not needed, which roughly covers the cost of three SSDs. Considering that the cost of three of the eight SSDs is paid for by the savings from the disk enclosures, the cost saving is now calculated as  $[(404 - 291)/404] \times 100$ .

## Conclusion

Today's dynamic business world ups the ante for virtualized solutions, and HPE 3PAR StoreServ 7000 delivers. It provides a triple whammy of storage efficiency, effortless management, and unsurpassed performance in unpredictable heterogeneous environments. Teaming HPE 3PAR StoreServ with SQL Server in virtualized environments provides the competitive edge that organizations hunger for today.

## Solution components

### HPE customized ESXi 5 installation images<sup>13</sup>

HPE ProLiant Gen8 servers require the use of HPE customized ESXi 5 images for a successful installation. The drivers for the new network and storage controllers in the ProLiant Gen8 servers are integrated into the HPE customized image and are not part of the generic ESXi image distributed by VMware.

Table 12 shows VMware virtual switch configuration information for the solution environment, which includes MSFC network requirements.

**Table 12.** Basic VMware network description

Network	Item	Description
vnic0	vSphere standard switch	VMware vCenter management
Production	vSphere standard switch	Production
vMotion	vSphere distributed switch	VMware vMotion
MSFC Heartbeat	vSphere distributed switch	MSFC heartbeat

Table 13 contains HPE ProLiant BL460c Gen8 Server Blade information. The ProLiant BL460c Gen8 server blades are used as vSphere servers for the VMs in the solution. The VMs created on these clients provide base servers for the virtualized Windows Server 2008 R2 clustered environment.

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### Note

Use the HPE-provided VMware ESXi media when installing vSphere on these servers since it includes the required drivers to run ESXi on HPE ProLiant servers.

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<sup>13</sup> [Customize VMware ESXi Images for HPE ProLiant Servers](#)

**Table 13.** HPE c7000 blade server hardware configuration [per server]

HPE ProLiant BL460c Gen8 Server	Item	Description
Processor type	Two Intel Xeon Processors E5-2658	8-Core 2100 MHz, 20 MB, 95 W, DDR3-12800
Memory	192 GB	Twelve 16-GB DIMMs Dual Rank x 4 PC3 - 12800R (DDR3 - 1600) Registered DIMMs at 1.5 V
Internal storage	Two 146 GB	Boot disks
Internal storage controller	P220i	HPE Smart Array P220i Controller with 512 MB FBWC (Flash-Backed Write Cache)
Network (FlexibleLOM)	554 Flash-Backed (FLB)	HPE FlexFabric 10 Gb 2-port 554 FLB FlexibleLOM

Table 14 provides the basic configuration used in the highly available HPE 3PAR StoreServ 7200 system for the Microsoft SQL Server DBs and DB backups. Table 15 provides the same type of information for HPE 3PAR StoreServ 7400, which provides an additional tier and greater performance headroom for a more demanding storage need.

**Table 14.** Basic HPE 3PAR StoreServ 7200 hardware and software

7200 array	Description
Controller	2-node, 24 GB Cache
Storage	8 each 200 GB SSDs 64 each 450 GB 10k rpm 6 Gb SAS disks
Adaptive optimization	For 2 Tiers
VMware vSphere Storage API for Array Integration (VAAI) support	HPE Insight Control with Storage Module for VMware vCenter <a href="http://h18004.www1.hp.com/products/servers/management/unified/infolibraryicv.html">http://h18004.www1.hp.com/products/servers/management/unified/infolibraryicv.html</a>

**Table 15.** Basic HPE 3PAR StoreServ 7400 hardware and software

7400 array	Description
Controller	4-node, 64 GB Cache
Storage	8 each 200 GB SSDs 256 each 450 GB 10k rpm 6 Gb SAS disks 24 each 2 TB 7.2k rpm 6 Gb SAS disks
Adaptive Optimization	For 3 Tiers
VMware VAAI support	HPE Insight Control Storage Module for VMware vCenter <a href="http://h18004.www1.hp.com/products/servers/management/unified/infolibraryicv.html">http://h18004.www1.hp.com/products/servers/management/unified/infolibraryicv.html</a>

## Bill of materials

The following bill of materials lists key hardware configuration options. For more information, please contact an HPE Sales Representative or HPE Reseller.

For the HPE 3PAR 7200 utility storage solution, refer to configuration table 16.

**Table 16.** Key hardware bill of materials for HPE 3PAR StoreServ 7200 configuration

Quantity	Description	Part Number
4 (4-blade servers)	HPE ProLiant BL460c Gen8 10 Gb FlexibleLOM Configure-to-order Blade Server	641016-B21
4 (1 per server)	HPE BL460c Gen8 E5-2658 FIO Kit 8-Core Intel Xeon, 2100 MHz (2.10 GHz/8-core/20 MB/95 W)	662080-L21
4 (1 per server)	HPE BL460c Gen8 E5-2658 Kit 8-Core Intel Xeon, 2100 MHz (2.10 GHz/8-core/20 MB/95 W)	662080-B21
48 (12 per server)	HPE 16 GB Dual Rank x 4 PC3-12800R-11 Memory Kit	672631-B21
4 (1 per server)	HPE FC 8 Gb QMH2572 Adapter FC host bus adapter (HBA) for HPE BladeSystem, c-Class	651281-B21
8 (2 per server)	HPE 146 GB 6G SAS 15K SFF HDD	652605-B21
4 (1 per server)	HPE FlexFabric 10 Gb 2P 554-FLB FIO Adapter	684212-B21
1 (holds up to 24 SFF drives)	HPE 3PAR StoreServ 7200 2-N Storage Base	QR482A
2	HPE M6710 2.5 in. 2U SAS Drive Enclosure	QR490A
1	HPE M6720 3.5 in. 4U SAS Drive Enclosure	QR491A
6	HPE M6710 200 GB 6G SAS 2.5 in. SLC SSD	QR503A
64	HPE M6710 450 GB 6G SAS 10K 2.5 in. HDD	QR494A

For the HPE 3PAR 7400 utility storage solution, refer to configuration table 17.

**Table 17.** Key hardware bill of materials for HPE 3PAR StoreServ 7400 configuration

Quantity	Description	Part Number
4 (4-blade servers)	HPE ProLiant BL460c Gen8 10 Gb FlexibleLOM Configure-to-order Blade Server	641016-B21
4 (1 per server)	HPE BL460c Gen8 E5-2658 FIO Kit 8-Core Intel Xeon, 2100 MHz (2.10 GHz/8-core/20 MB/95 W)	662080-L21
4 (1 per server)	HPE BL460c Gen8 E5-2658 Kit 8-Core Intel Xeon, 2100 MHz (2.10 GHz/8-core/20 MB/95 W)	662080-B21
48 (12 per server)	HPE 16 GB Dual Rank x 4 PC3-12800R-11 Memory Kit	672631-B21
4 (1 per server)	HPE FC 8 Gb QMH2572 Adapter FC HBA for HPE BladeSystem, c-Class	651281-B21
8 (2 per server)	HPE 146 GB 6G SAS 15K SFF HDD	652605-B21
4 (1 per server)	HPE FlexFabric 10 Gb 2P 554-FLB FIO Adapter	684212-B21
1 (holds up to 48 SFF drives)	HPE 3PAR StoreServ 7400 4-N Storage Base	QR485A
9	HPE M6710 2.5 in. 2U SAS Drive Enclosure	QR490A
1	HPE M6720 3.5 in. 4U SAS Drive Enclosure	QR491A
8	HPE M6710 200 GB 6G SAS 2.5 in. SLC SSD	QR503A
256	HPE M6710 450 GB 6G SAS 10K 2.5 in. HDD	QR494A
24	HPE M6720 2 TB 6G SAS 7.2K 3.5 in. NL HDD	QR499A

**Note**

HPE 3PAR StoreServ 7000 can be purchased in scalable capacity SAN solution packages with either the HPE 3PAR StoreServ 7200 2-node or the HPE 3PAR StoreServ 7400 4-node option. Storage options include various disk capacities and speeds, as well as SSDs.<sup>14</sup>

<sup>14</sup> [HPE 3PAR StoreServ 7000 Storage QuickSpecs](#)

## Important reference documentation

When referring to reference documentation, it is important to be aware that there are special configuration considerations for the VMware environment for Failover Clustering and MSCS, which supplement other information—pay special attention to such documentation.

**Table 18.** Important documentation and considerations

Document Title	Comment
3PAR Utility Storage with VMware vSphere	Optimize, simplify, and save in VMware vSphere environments with HPE 3PAR Storage Systems. <a href="http://vmware.com/files/pdf/techpaper/vmw-vsphere-3par-utility-storage.pdf">vmware.com/files/pdf/techpaper/vmw-vsphere-3par-utility-storage.pdf</a>
HPE 3PAR VMware ESX Implementation Guide	Refer to the latest HPE 3PAR Implementation Guide (see links in the back of this document).
Microsoft Cluster Service (MSCS) support on ESX/ESXi	KB: 1004617
Microsoft Clustering on VMware vSphere: Guidelines for Supported Configurations	KB: 1037959
ESX/ESXi hosts with visibility to RDM LUNs being used by MSCS nodes with RDMs may take a long time to boot	KB: 1016106
HPE 3PAR Storage and VMware vSphere 5 best practices	<a href="http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-3286ENW&amp;cc=us&amp;lc=en">http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-3286ENW&amp;cc=us&amp;lc=en</a>
Setup for Failover Clustering and Microsoft Cluster Service (subtitle ESXi 5.0, vCenter Server 5.0)	<a href="http://pubs.vmware.com/vsphere-50/topic/com.vmware.ICbase/PDF/vsphere-esxi-vcenter-server-50-mscs-guide.pdf">http://pubs.vmware.com/vsphere-50/topic/com.vmware.ICbase/PDF/vsphere-esxi-vcenter-server-50-mscs-guide.pdf</a>

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