Technical white paper

HP StoreVirtual VSA design and configuration guide

For solutions based on Microsoft Hyper-V and VMware vSphere

Table of contents

Introduction........................................................................................................................................................................2
Design considerations ............................................................................................................................................................3
  Step 1: Performance, capacity, and availability requirements........................................................................................4
  Step 2: Storage options and configuration....................................................................................................................7
  Step 3: Network considerations........................................................................................................................................15
  Step 4: Server requirements...........................................................................................................................................19
  Upgrading the StoreVirtual VSA configuration..............................................................................................................21
HP StoreVirtual VSA on VMware vSphere .........................................................................................................................24
  Preparation for StoreVirtual VSA .................................................................................................................................25
  Deploying StoreVirtual VSA on vSphere........................................................................................................................29
  Advanced management..................................................................................................................................................32
HP StoreVirtual VSA on Microsoft Hyper-V......................................................................................................................33
  Enterprise remote office or medium-sized business configuration ........................................................................33
  Preparation for StoreVirtual VSA ..................................................................................................................................34
  Deploying StoreVirtual VSA on Hyper-V........................................................................................................................36
  Advanced management..................................................................................................................................................39
Summary............................................................................................................................................................................40
Frequently asked questions ...............................................................................................................................................40
Appendix A: Bill of materials ..........................................................................................................................................40
  Bill of material for three-node HP ProLiant DL380p Gen8 VSA with vSphere.................................................................41
  Bill of material for 3-node DL360p Gen8 VSA with Microsoft Hyper-V......................................................................42
Appendix B: Mass deployment of StoreVirtual VSAs on VMware vSphere..................................................................42
Convergence with HP Storage

Software-defined storage is a key component of the software-defined data center (SDDC). In an SDDC, server, storage, and networking resources are virtualized, pooled, and controlled by software. The goal is to automate the underlying infrastructure in a way that eliminates the need to configure the link between hardware and service delivery manually.

Introduction

At its core, the concept of software-defined storage refers to software applications layered on server infrastructures to deliver advanced data services, such as snapshots, thin provisioning, and multi-site disaster recovery. The flexibility of software-defined storage allows you to consolidate your storage virtual machines (VMs) onto the same servers that hold your application VMs. Along with the benefits of a fully fault-tolerant server and storage environment, you gain opportunities for substantial cost savings.

Four key factors make software-defined storage a more viable alternative to hardware-based array storage.

1. New, more powerful servers provide robust platforms that can easily handle more than just compute workloads.
2. The wide adoption of virtualization is creating the demand for highly available shared storage.
3. The current increase in disk performance and capacity now has software-based storage performing better than ever before.
4. Economic pressures have forced business leaders to analyze how they can reduce power, cooling costs, and footprint within the data center.

All these factors have shown a dramatic increase in demand for virtual storage appliances to resolve these issues better.

The software-defined primary storage offering, HP StoreVirtual VSA, is a virtual storage appliance that creates highly available shared storage from direct-attached storage in VMware® vSphere and Microsoft® Hyper-V environments. Its platform flexibility allows you to create a virtual array within and across any x86 server and non-disruptively scale capacity and performance as workload requirements evolve. The ability to use internal or external storage within your environment greatly increases storage utilization and eliminates the costs and complexity associated with dedicated external SAN storage. Storage pools based on StoreVirtual VSA are optimized for vSphere and Hyper-V and typically scale linearly from 2 up to 16 nodes (see figure 1).

Figure 1. Combining capacity and performance of individual StoreVirtual VSAs into a StoreVirtual Cluster
With the wide adoption of virtualization and the evolution of software-defined storage technologies, it is important to understand the decision points within the infrastructure that can directly influence your workloads. A key benefit of software-defined storage is the flexibility to build a system to match your workload requirements. HP offers pre-configured solutions in the form of HP ConvergedSystem 200-HC StoreVirtual System. This solution arrives pre-configured with servers, storage, networking, and VMware vSphere to enable complete deployment of a virtualized environment in 15 minutes. This document is intended to help accelerate the decision-making process when designing solutions based on StoreVirtual VSA by outlining the different components and hypervisor configurations you have to choose from.

**Target audience**
This paper is for server and storage administrators looking for guidance in deploying storage solutions based on HP StoreVirtual VSA. This paper assumes you are familiar with the architecture and feature set of the StoreVirtual portfolio.

**Design considerations**

You will find that regardless of whether your solution is based on vSphere or Hyper-V, most of the overarching design considerations presented in this section are very similar and apply to both platforms. In fact, performance and capacity sizing of the StoreVirtual VSA is the same on the two platforms. Even though the actual implementation of networking differs between those platforms, most of the general guidance applies to both.

As mentioned in the introduction, one of the major advantages of StoreVirtual VSA is its linear scalability for capacity and performance. As a direct result of this distributed and scale-out architecture, it is key that all storage nodes (i.e., the StoreVirtual VSA and its storage) provide the same capacity and performance to the storage pool—the StoreVirtual Cluster. The number of StoreVirtual VSAs and their characteristics determine the overall cluster characteristics.

Looking more closely at the storage nodes, the requirement to have similar performance and capacity per storage node translates into identical (or at least almost identical) hardware components in the servers running the StoreVirtual VSA. Three core areas that require careful planning are server platform, storage options, and the network, as shown in figure 2.

**Figure 2.** Three critical decisions in every StoreVirtual VSA design

Because storage resources are the bottleneck in most environments, StoreVirtual designs typically start out by selecting the right storage options to accommodate capacity and performance needs. The number of disks and RAID controllers on a platform (along with the CPU and memory options) dictate the server model that should host the StoreVirtual VSA and applications running in virtual machines. Because StoreVirtual uses Ethernet network as a "storage backplane" and as a way to present storage via iSCSI to servers and virtual machines, the network is another key component.

As you design a plan to build a storage pool based on StoreVirtual VSA, this section will guide you through a variety of considerations in a four-step approach:

1. **Understanding your performance, availability, and capacity requirements**
   - A. How much capacity do you need?
   - B. How much performance do you need?
   - C. How does your data need to be protected?
2. Understanding available storage options and configurations
   A. Which disk technologies can I choose from? Which type is recommended for which workload?
   B. What RAID controller technologies can benefit the solution?
   C. What are typical RAID configurations and recommended disk layout?

3. Understanding networking considerations
   A. How many network adapters should I plan for?
   B. What are the network infrastructure requirements?

4. Understanding your server requirements
   A. How many resources should I reserve for StoreVirtual VSA?
   B. How much CPU and memory do I need for StoreVirtual?

**Note**
While StoreVirtual VSA also runs on previous generations of hardware and software, most of the following sections assume that your solution with StoreVirtual VSA is on current, or at least more recent, server technology. HP Storage recommends HP ProLiant Gen8 servers or later for best performance. Validate hardware intended for StoreVirtual VSA against the appropriate hypervisor compatibility matrix.

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**Step 1: Performance, capacity, and availability requirements**

One of the strengths of StoreVirtual VSA is that it provides solution architects with countless configuration options. Users can configure clusters comprised of StoreVirtual VSA with 1 TB all SSD or with 50 TB all MDL SAS, or any number of combinations in between, based on the desired performance and capacity characteristics. This flexibility increases the importance of proper planning for the StoreVirtual VSA design, configuration, and deployment. Improper planning could lead to performance, capacity, or availability results that do not meet expectations. HP strongly advises a complete review of the target environment performance and capacity requirements.

**Performance requirements**
To best estimate the capacity and performance required, it helps to look at similar workloads in an existing environment. If you are building a platform for general-purpose server virtualization, remote/branch offices, or file serving, the performance monitoring capabilities in VMware vSphere and Microsoft Windows® help to measure performance over time (figure 3). HP strongly recommends that you look at a minimum of 24 hours of performance data that includes backup or batch jobs, and sudden spikes in performance, such as massive logins on the first day of the workweek.

**Figure 3. Performance monitoring in VMware vCenter**
Generally, different applications have different performance profiles and different performance requirements, which greatly affect the StoreVirtual VSA design. For example, an OLTP-based application typically has a small, random I/O profile (requests around 8 KB block sizes). A backup application has large, sequential read operations (request around 1 MB block sizes). From this wide spectrum, you can see that performance requirements for any storage system vary widely, based on how that storage system is used.

It is easy to sum up the I/O and throughput requirements per application (see Table 1). When looking at an existing storage system over a longer time period, pay special attention to the average and the 95th percentile for throughput and IOPS, because storage sizing is typically done for sustained performance and not for spikes. In some cases, the average I/O size can indicate the type of workload (small block size: random; large block size: sequential). Consider adding some headroom to your I/O and throughput requirements (around 20 percent for future growth). Your total will be a deciding factor when choosing storage technologies for your deployment.

Table 1. Example evaluation of performance characteristics in a branch office

<table>
<thead>
<tr>
<th>Workload</th>
<th># of instances</th>
<th>Total I/O per second</th>
<th>Total throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM: Service VMs (read-only domain controller, print server, Web proxy)</td>
<td>4</td>
<td>15</td>
<td>~2 MB/s</td>
</tr>
<tr>
<td>VM: SQL Server</td>
<td>3</td>
<td>70</td>
<td>~20 MB/s</td>
</tr>
<tr>
<td>VM: File server</td>
<td>2</td>
<td>30</td>
<td>~10 MB/s</td>
</tr>
<tr>
<td>Data: File share</td>
<td>1</td>
<td>120</td>
<td>~120 MB/s</td>
</tr>
<tr>
<td>Data: SQL database + logs</td>
<td>1</td>
<td>1,200</td>
<td>~10 MB/s</td>
</tr>
<tr>
<td>Data: User profile cache</td>
<td>30</td>
<td>20</td>
<td>~10 MB/s</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,455</strong></td>
<td></td>
<td><strong>~172 MB/s</strong></td>
</tr>
</tbody>
</table>

**Capacity requirements**

Comparable to gathering performance data in an existing environment, you should look at the capacity demand of your applications. For example, include the typical size of a virtual machine in your environment, data and log disks for your databases, and sizes of your file shares (see Table 2).

During the assessment of storage capacity in your environment, you may find underutilized file systems. In these cases, the built-in thin provisioning technology of StoreVirtual VSA can help maintain high capacity utilization in a future StoreVirtual environment. Allocating capacity on the cluster only when needed reduces stranded capacity in file systems and maintains a high capacity utilization on StoreVirtual.
Table 2. Example evaluation of capacity requirements in a branch office

<table>
<thead>
<tr>
<th>Workload</th>
<th># of instances</th>
<th>Capacity</th>
<th>Total capacity per workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM: Service VMs (read-only domain controller, print server, Web proxy)</td>
<td>4</td>
<td>30 GB</td>
<td>120 GB</td>
</tr>
<tr>
<td>VM: SQL Server</td>
<td>3</td>
<td>25 GB</td>
<td>75 GB</td>
</tr>
<tr>
<td>VM: File server</td>
<td>2</td>
<td>20 GB</td>
<td>40 GB</td>
</tr>
<tr>
<td>Data: File share</td>
<td>1</td>
<td>1,500 GB</td>
<td>1,500 GB</td>
</tr>
<tr>
<td>Data: SQL database + logs</td>
<td>1</td>
<td>500 GB</td>
<td>500 GB</td>
</tr>
<tr>
<td>Data: User profile cache</td>
<td>30</td>
<td>3 GB</td>
<td>90 GB</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>2,325 GB</td>
<td></td>
</tr>
</tbody>
</table>

Availability requirements

All virtual storage appliances (VSAs) and software-defined storage offerings that virtualize server storage resources (that is, all VSAs, not just StoreVirtual VSA) are unique, in that by themselves, they lack true high-availability capabilities.

A virtual appliance must incorporate some form of high availability in the application itself, because there is no truly highly available hardware underneath a VSA running on commodity servers. High availability must consist of a copy of the data or application running on another physical piece of hardware to prevent downtime due to the loss of a single server. Ideally, this copy of the data or application runs synchronously to protect against downtime or data loss. Anything less than synchronous replication between servers for the data or application is not considered being highly available—synchronous replication with no user intervention in the event of a server failure is a critically important requirement for storage in virtualized server deployments.

Application data should be made highly available in your future StoreVirtual VSA deployment by protecting volumes with Network RAID and built-in high availability technology StoreVirtual VSA. You are strongly advised to protect the volumes holding virtual machines, databases, or file shares with Network RAID to mitigate the effects of one StoreVirtual VSA becoming unavailable in the event of a server or component failure. Network RAID requires additional capacity on your StoreVirtual Cluster to store another copy of your data, achieving high availability using components that are not highly available.

Network RAID technology stripes and mirrors blocks of data (with the exception of a striping-only option) across all storage nodes in the cluster to achieve high availability with StoreVirtual VSA on commodity hardware. This is a synchronous operation between two or more storage nodes in the cluster. Maintaining multiple copies of your data allows volumes to stay online even after a storage node in the cluster goes offline. While it might be surprising that synchronous replication is required for high availability, keep in mind that each physical server has several single points of failure, from CPU, to backplane, to memory. Should any of those components fail, the server is down and its resources are not available to applications. With Network RAID 10's synchronous replication, the data is still available via the synchronous copy (figure 4). Any solution using virtual storage appliances or software to enable data services on top of servers requires this level of replication and data protection, especially in environments where high levels of availability and data protection are required.
You can adjust Network RAID, a per volume setting, to meet data protection and replication requirements on the fly. Choose from a variety of Network RAID levels. For most production environments, HP recommends using Network RAID 10, which stores two copies of the data on the cluster. With this setting, the volumes remain online if you lose any single node in the cluster. From a capacity standpoint, you would need to take your capacity estimate based on your assessment of the applications and workloads above and multiply it by the number of copies you want. For Network RAID 10, this is a factor of two, because you store two copies of the data on this volume. For more information on the other Network RAID levels and their respective use cases, see the current HP StoreVirtual Storage User Guide. This guide and all guides pertaining to HP StoreVirtual are located at the HP StoreVirtual 4000 Storage Support Center.

**Note**
HP recommends Network RAID 10 for most environments with high availability requirements. Network RAID 0 (stripe, no mirroring) does not provide any high availability and is not suitable for environments with availability requirements.

**Additional remarks**
Based on the performance, capacity, and availability requirements (see table 3), as well as StoreVirtual VSA licensing (4 TB, 10 TB, and 50 TB licensing), you can estimate the number of storage nodes and their capacity. Keep in mind that StoreVirtual VSA clusters can grow over time by adding storage to individual StoreVirtual VSA instances. Added capacity becomes available to the cluster after all storage nodes have the same or more capacity and by adding more StoreVirtual VSAs (with the same or higher capacity) to the cluster.

**Table 3.** Example of summary of requirements for branch office

<table>
<thead>
<tr>
<th>Workload</th>
<th># of instances</th>
<th>Total I/O per second</th>
<th>Total throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Usable space required 2,325 GB</td>
<td>With Network RAID 10 4,650 GB</td>
<td>Disk sizes, Network RAID protection</td>
</tr>
<tr>
<td>Performance</td>
<td>I/O required 1,455</td>
<td>Throughput required ~175 MB/s</td>
<td>Disk performance, network infrastructure</td>
</tr>
</tbody>
</table>

**Step 2: Storage options and configuration**
With capacity and performance storage requirements understood, look at the storage options that enable you to implement a suitable StoreVirtual VSA design. This section provides an overview of available storage options, their performance characteristics, and how RAID configurations affect performance or capacity, and probably most importantly, how to configure the storage.
Note that the StoreVirtual VSAs should not be sized for just capacity, but for performance and availability as well. For example, if a database needs 4 TB of capacity, it is easy to achieve with two 2 TB SATA drives configured as a RAID 0 set. While that might meet the capacity requirements, it is very likely that this configuration will not meet performance and availability requirements. As a general rule of thumb, reaching a capacity point based on 7,200 rpm SATA or mid-line SAS drives (sometimes also called nearline SAS) will not provide the required performance, whereas reaching a capacity point on 15K SAS drives generally provides the required performance. For example, if 20 TB of capacity are required, it can be achieved with five 4 TB drives (not factoring in RAID overhead), providing about 400 IOPS of performance. On the other hand, it could also be achieved with ~30 600 GB SAS drives, with a total of ~5,900 IOPS. Do not size only for capacity; consider performance also.

**Storage technologies**

A huge variety of storage options is available on most server platforms and each of the technologies has its respective use case. Without trying to oversimplify these technologies, three types of drive options are available, which make sense in combination with StoreVirtual VSA.

**Solid-state drives**

Solid-state drives (SSDs), based on flash technology, provide extremely high performance with very low latencies. SSDs are ideal for applications that are I/O intensive and latency sensitive, such as OLTP databases or some datastores in a VDI implementation. While SSDs offer tremendous performance, they offer lower capacities than SAS or mid-line SAS drives, and are usually used for specific applications and not as general-purpose storage. For this reason, SSDs can provide the best $ per I/O (cost for performance) value.

**SAS drives**

Drives based on SAS technology offer higher rotational speeds, low latency, and the ability to queue commands more effectively than mid-line SAS, which directly leads to higher performance in workloads with random I/O. This makes SAS optimal for workloads such as server virtualization, email servers, OLTP, and other random database type applications.

**MDL SAS drives**

Higher storage density per dollar and footprint make mid-line SAS especially good for workloads such as repositories, file shares, and as a staging area to back up data to tape. Performance sensitive applications such as email and OLTP are best suited for SAS drives. Performance may not be satisfactory if those applications are on mid-line SAS drives.

When choosing the drives for StoreVirtual VSA deployment, the type of workload should be the major consideration. Table 4 summarizes the drive option characteristics.

<table>
<thead>
<tr>
<th></th>
<th>SSD</th>
<th>SAS</th>
<th>MDL SAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational speed</td>
<td>N/A</td>
<td>10K or 15K</td>
<td>7.2K</td>
</tr>
<tr>
<td>Form factor</td>
<td>2.5” and 3.5”</td>
<td>2.5” or 3.5”</td>
<td>3.5”</td>
</tr>
<tr>
<td>Average latency</td>
<td>200 ns</td>
<td>3.4 ms</td>
<td>11 ms</td>
</tr>
<tr>
<td>Maximum I/O</td>
<td>30,000¹</td>
<td>230¹</td>
<td>100¹</td>
</tr>
<tr>
<td>Capacities</td>
<td>Up to 1 TB</td>
<td>Up to 1.2 TB</td>
<td>Up to 6 TB</td>
</tr>
<tr>
<td>$/GB</td>
<td>$$$</td>
<td>$$</td>
<td>$</td>
</tr>
<tr>
<td>$ per I/O</td>
<td>$</td>
<td>$$</td>
<td>N/A</td>
</tr>
<tr>
<td>Reliability</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Workloads</td>
<td>• OLTP databases  • Transactional workloads</td>
<td>• OLTP databases    • Server virtualization  • File shares  • Archives  • DR sites</td>
<td></td>
</tr>
</tbody>
</table>
StoreVirtual VSA can virtualize other storage options, such as PCIe-based flash (i.e., HP I/O Accelerator Cards), as long as they are supported by the server model and hypervisor.

When considering these storage options, keep in mind that StoreVirtual VSA supports two storage tiers, based on different storage technologies with Adaptive Optimization (available with 10 TB and 50 TB licenses). Additional StoreVirtual VSA environments are covered in the Adaptive Optimization section—for more information on this technology and how it can be used.

**Disk RAID options**

After selecting one or two drive types, decide on your RAID configuration. Use a dedicated RAID controller card such as the HP Smart Array Controller to configure the disk RAID. Disk RAID provides a level of protection and availability, should one or more drives fail. This allows the server and StoreVirtual VSA on that server to continue running in the event of a drive going offline for any reason. Each type of disk RAID has its advantages and disadvantages.

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**Note**

Because StoreVirtual VSA relies on hardware RAID to protect its data disks, this paper ignores JBOD or RAID 0 as impractical. A drive failure in these configurations requires a rebuild of the entire StoreVirtual VSA instance from other storage systems in the StoreVirtual Cluster when using Network RAID.

The more common types of RAID options available on common RAID controller cards include:

**RAID 5**—RAID 5 stripes data across drives with parity blocks distributed across all the drives in the RAID set. RAID 5 offers some level of protection because any drive in the set can fail and data is still available. Usable capacity is very good because RAID 5 consumes only a single drive’s capacity for parity. In a 10-drive RAID set, it is only 10 percent of the capacity. Read performance increases with the number of disks; writes however require recalculation of the parity block. A write’s speed depends on the RAID controller type and its firmware.

**RAID 6**—RAID 6 is similar to RAID 5 in which it uses distributed parity to protect against downtime. However, RAID 6 uses two parity blocks that consume two drives worth of parity. Because of the parity calculations, RAID 6 is the slowest performing of the listed RAID sets, but has an availability greater than RAID 5 because it can lose any two drives in the RAID set and stay online. Storage efficiency is similar to RAID 5, but RAID 6 consumes two drives’ capacity for parity. HP strongly recommends RAID 6 when using drives 3 TB or larger in capacity.

**RAID 10**—RAID 10 (often called RAID 1+0) is a RAID set comprised of multiple mirrors (RAID 1) that are then striped across the StoreVirtual systems (RAID 0). Each drive mirrors its data to another drive, so there is a very high level of availability. A number of drives could fail before data is unavailable, as long as they are not two drives of the same mirrored pair. Read performance is excellent because all drives are used for reads. Write performance is also very good because half of the drives are used for writes; the other half is mirroring those writes. Usable capacity is at 50 percent, which makes RAID 10 the preferred RAID level only for situations where availability and/or performance are the driving factor. A RAID 10 array with two drives is often referred to as RAID 1.

**Other nested RAID**—Other commonly used nested RAID levels, such as RAID 50 and RAID 60, concatenate two or more RAID sets together to create a larger storage pool. RAID 50, for instance, stripes across two or more RAID 5 sets. RAID 5+0 has similar storage efficiency and reliability as a RAID 5 set. Performance increases because more drives in the RAID set are serving I/O.

Modeling of availability and performance testing has shown that in most environments RAID 5 and RAID 50 can offer the best combination of performance, cost, and availability. See table 5 for a summarized overview of popular disk RAID options.
Table 5. Typical RAID configuration options in StoreVirtual VSA deployments

<table>
<thead>
<tr>
<th>RAID 10</th>
<th>RAID 5</th>
<th>RAID 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative name</td>
<td>Mirroring</td>
<td>Distributed Data Guarding</td>
</tr>
<tr>
<td>Minimum # of drives</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Useable # of drives</td>
<td>N/2</td>
<td>N-1</td>
</tr>
<tr>
<td>Percentage of useable capacity</td>
<td>50%</td>
<td>67% to 93%</td>
</tr>
<tr>
<td>Tolerates multiple drive failure</td>
<td>Yes, if second drive is part of different mirrored drive pair</td>
<td>No</td>
</tr>
<tr>
<td>Availability</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Read performance</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Write performance</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Relative cost</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

For optimal performance, HP strongly recommends that you validate that the storage configuration is the same on all servers designated to run HP StoreVirtual VSA. Confirm that the number of spindles, disk technology, disk size, and RAID type are the same. As an example, if eight drives are part of a RAID 5 array with 256 KB stripe size (ideal value for HP StoreVirtual VSA and HP Smart Array Controllers) and one logical drive on server one, this configuration should be replicated to the other servers in the environment running StoreVirtual VSAs. The resulting cluster is symmetric or balanced with predictable storage characteristics for reads and writes.

**Note**

HP Storage sees a high adoption of RAID 5 for SSD and SAS drives with StoreVirtual VSA. RAID 6 is recommended to increase the reliability of MDL SAS and enterprise SATA drives.

**Adaptive Optimization**

LeftHand OS 11.0 introduces a simple and smart sub-volume auto-tiering with Adaptive Optimization in the StoreVirtual VSA. It allows two types of storage tiers to be used in a single StoreVirtual VSA instance, moving more frequently accessed blocks to the faster storage tier (for instance SSDs), and keeping the infrequently accessed blocks on a tier with lower performance and potentially lower cost (for example SAS drives).

In contrast to caching solutions, the capacity of storage tiers used by Adaptive Optimization is usable capacity. This allows cost savings over implementing an all-flash solution, while boosting performance with a percentage of faster storage for frequently accessed blocks of data. Adaptive Optimization operates on a LeftHand OS page level (256 KB), making the technology very granular. It works transparently for applications accessing the storage pool.

Adaptive Optimization is especially effective for workloads that have concentrated areas of frequently accessed pages, or “hot” data. For example, certain database workloads might have tables that are accessed or updated frequently, creating a demand for more performance. A virtualized desktop environment might have some datasets that have high I/O requirements during boot storms but otherwise have a moderate performance workload during normal operation. Adaptive Optimization in the StoreVirtual VSA responds to these performance demands in near real time, moving the blocks of data with the highest performance requirements to the faster tier to provide the performance needed, while keeping other pages on the lower tier, to lower the cost of the solution.

When designing a solution based on StoreVirtual VSA with Adaptive Optimization, it is ideal to understand the percentage of frequently accessed data that would be on the faster tier, compared to the rest of the data. If it is not possible to determine the ratio of “hot” to “cold” data in your environment, a good rule of thumb is to work with 10 percent of the usable capacity of the StoreVirtual VSA (and as a result, that of the StoreVirtual Cluster) to be faster storage (called Tier 0). The remainder should be the base performance tier (Tier 1).
By default, StoreVirtual configures all volumes as “Adaptive Optimization permitted.” This allows the volumes to benefit from auto-tiering if the cluster is “Adaptive Optimization capable,” as soon as the StoreVirtual nodes have two tiers configured. It is also possible to exclude volumes from using the faster storage tier at all (“Adaptive Optimization not permitted”)—this makes sense for volumes that either do not have concentrated hot data or should not make use of it because of their workload characteristics (examples include file shares or archives).

Adaptive Optimization allows the administrator to define two different tiers of storage based on their requirements. Tier 0 storage could be SSD or SAS, while Tier 1 could be SAS or MDL SAS. However, the selection may not be based only on disk technology: a user could decide that Tier 0 could be SAS disks in RAID 10 for performance and Tier 1 could be SAS disks in RAID 5 for better capacity utilization. It is important to understand the performance characteristics of different drive configurations for different tiers to know how the system will perform.

SSD provides excellent performance, and mid-line SAS provides excellent cost per GB. However, configuring SSDs as Tier 0 and mid-line SAS as Tier 1 might not be an ideal solution because of the performance delta between the two tiers. In this example, data served out of the SSD tier will be very fast, but should data be accessed from the mid-line SAS tier, it will be much slower until it moves to the SSD tier. A better combination of drives would be SSDs as Tier 0 and SAS disks as Tier 1, so Tier 1 has sufficient performance to avoid negative effects on the entire application.

More details and sizing advice for Adaptive Optimization on HP StoreVirtual VSA is available in the Adaptive Optimization for HP StoreVirtual white paper.

**Note**

Use Adaptive Optimization on all volumes unless you do not want a volume to use Tier 0 (fastest tier) storage. It works best on volumes that have concentrated areas of frequently accessed blocks.

Manage Adaptive Optimization (AO) on an individual volume basis (figure 5), where sub-volume data is either permitted to migrate to the faster tier or is prevented from moving blocks to the faster tier.

**Figure 5.** Enable AO on individual volume

RAID controller caching

Most RAID controllers have options to use a small portion of volatile memory or flash for caching. Cache can be used to speed up and optimize read and write I/O. Cache is a bit of memory that resides on the RAID controller card. Reads that are often or recently used can reside in cache, and writes often go directly into cache to help offset some of the performance impacts of RAID 5 and 10.

If the RAID controller card provides an option for cache, HP recommends using the cache option for the performance benefit. In most cases, the larger the cache available on the card, the more performance will benefit. Workloads that benefit most from caching are sequential read operations and random and sequential writes. When using volatile memory as cache for writes, make sure that the cache on the RAID controller has battery (or capacitor) protection for data protection in the event of unexpected power loss.
Note
Whenever possible, configure flash or battery-backed cache on the RAID controller to benefit from cache and avoid lost I/O. However, disable any caching options on disk drives used by the StoreVirtual VSA because cache on the disks themselves is not protected during a power outage.

HP SmartCache for direct-attached storage
HP SmartCache is a controller-based caching solution in a DAS environment that caches the most frequently accessed data (“hot” data) onto low-latency, high-performing SSDs to accelerate application workloads dynamically. HP SmartCache is available on HP Smart Array P-Series controllers found in HP ProLiant Gen8 and Gen9 servers. HP SmartCache consists of firmware that provides the caching feature within the Smart Array Controllers and requires a license key for activation.

The direct-attached HP SmartCache solution includes the three elements of the HP SmartCache architecture: HDDs serving as bulk storage, SSDs as accelerator, and flash-backed write cache (FBWC) memory as metadata store (figure 6). For this implementation, the SmartCache control layer resides in the firmware of the on-board Smart Array Controller of the HP ProLiant Gen8 Server, below the operating system and driver. This allows caching for devices connected to a single array controller.

HP SmartCache offers flexibility in creating logical disk volumes from hard disk drives:

- The accelerator or cache volume design supports any RAID configuration supported by the Smart Array Controller.
- Each logical disk volume can have its own cache volume or none at all.
- Create and assign cache volumes dynamically without adversely influencing applications running on the server.

Only SSDs can be used for cache volumes, and a cache volume may be assigned only to a single logical disk volume. The HP SmartCache solution consumes a portion of the FBWC memory module on the Smart Array Controller for metadata. To ensure sufficient storage for accelerator and metadata, we recommend either of the following options:

- 1, 2, or 4 GB of FBWC memory
- 1 GB of metadata space for every terabyte of accelerator space

When using the HP SmartCache solution for direct-attached storage, legacy cache is still present and operational and uses the remaining space in the FBWC memory. When using HP SmartCache, we recommend setting the legacy cache for 100 percent write operation. This allows write-back support on the Smart Array Controller, which accelerates write performance. This also allows SSDs configured as HP SmartCache volumes to provide a much larger read cache.

Figure 6. HP Smart Array using SSDs to provide caching for a logical disk on SAS/MDL SAS drives

HP SmartArray Controller with SmartCache

HP SmartCache operates transparently, without any dependencies on vSphere, Hyper-V, or StoreVirtual VSA. After enabling SmartCache for a logical drive, nothing more needs to be done from a management or configuration side to benefit from an SSD cache performance boost.

The initial release of the HP SmartCache solution supports write-through caching. When an application writes data to the disk, the Smart Array Controller writes the data to the HDDs. If the data is also in the cache volume, the data is written to the SSD.
Note
When deploying two distinct storage tiers with dissimilar performance characteristics, HP recommends using StoreVirtual VSA Adaptive Optimization.

Consider using HP SmartCache for StoreVirtual VSA deployments without Adaptive Optimization or solutions deployed with SATA/MLD SAS drives. Overall performance of an SATA- or MLD-based storage solution should see benefits from the high-performance, low-latency SSD cache and HP SmartCache. A combination of Adaptive Optimization and SmartCache is not useful.

Disk layout
One of the key best practices when setting up a StoreVirtual environment is to make sure all nodes in a cluster are the same whenever possible. Because each storage node in a cluster actively participates in serving I/O and has an equal amount of the data, having consistent performance between nodes allows for linear scalability and predictable performance. By having the same host configuration for all StoreVirtual VSAs in the cluster, the performance of all StoreVirtual VSAs will be equal and performance of the cluster will be balanced across all nodes, resulting in predictable performance and linear scalability.

After you have selected the drive types and RAID levels for capacity and performance goals, the disk must be presented to the StoreVirtual VSA. Appliances in the HP StoreVirtual 4000 Storage family run LeftHand OS natively with direct communication paths to the underlying hardware, including RAID controller and drives. The LeftHand OS instance understands the type and quantity of disk drives, and can query the hardware directly for parameters such as CPU temperature, hardware component status, etc. With the StoreVirtual VSA, the hardware layer is completely abstracted by the hypervisor. This becomes apparent as the disk is presented to the StoreVirtual VSA.

The individual drives must be configured via the RAID controller card’s configuration utility (figure 7). With an HP Smart Array RAID controller, this is done via the Array Configuration Utility (ACU). ACU runs under Windows and is part of Intelligent Provisioning on HP ProLiant servers. It is used to configure arrays, logical disks, cache settings, and other parameters on HP Smart Array RAID Controllers. Other vendors provide similar management tools. Consult your server manufacturer for more information.

Figure 7. Array Configuration Utility for HP Smart Array RAID Controllers

Typically, logical disks used by the StoreVirtual VSA are on an isolated set of disks to avoid workload contingency. However, if the spindles are just shared with a light workload such as logging by the hypervisor, the StoreVirtual VSA and its data disks could be co-located with the hypervisor on the same set of disks. In this case, all disks are combined in one array for more performance. Because most RAID controllers, including HP Smart Array RAID Controllers, allow creation of more than one logical disk on one array, it is possible to configure multiple logical disks with different RAID levels on the same set of disks. This reduces stranded capacity while still achieving the performance and availability goals for StoreVirtual VSA data disks.
A typical example for a single-tier configuration is shown in figure 8, with RAID 6 for the hypervisor (Host OS) and RAID 5 for the StoreVirtual VSA data disks, which hold the user data.

Figure 8. Typical RAID configuration on HP Smart Array with one tier of storage

For configurations that use two storage tiers, the hypervisor and the StoreVirtual VSA are placed on the lower storage tier (SAS drives in an SAS/SSD configuration). The resulting RAID configuration typically comprises two arrays and a total of three logical drives. Two of the logical disks are used for the data disks of the StoreVirtual VSA, and one is used for the hypervisor. In the example in figure 9, the second array with SSDs has one logical disk with RAID 5 protection.

Figure 9. Typical RAID configuration on HP Smart Array with two tiers of storage for use with Adaptive Optimization

StoreVirtual VSA can consume and virtualize storage resources using two methods available in the hypervisor:

1. Virtual disk (VMDK or VHD/VHDX) on a file system (VMFS or NTFS)
2. Physical disk (raw device mapping in “Physical compatibility mode” or physical disk)

In concept, this is similar to how StoreVirtual 4000 Storage uses the hard drives to virtualize the disk resources and make their capacity and performance available to the StoreVirtual Cluster.

While there is only a negligible performance difference between these two options, the amount of storage that can be presented to the StoreVirtual VSA varies and may be an important consideration. Whether the StoreVirtual VSA base image (disk that holds LeftHand OS) and data disks (disks that contain the data of volumes, snapshots, and SmartClones that are created on the StoreVirtual Cluster) are placed on the same logical disks depends on the use of Adaptive Optimization and the amount of storage capacity that should be virtualized by the StoreVirtual VSA.

To configure larger StoreVirtual VSAs in environments using a current version of vSphere and Hyper-V, it is possible to virtualize up to 50 TB capacity in one virtual disk and present it to the StoreVirtual VSA. That virtual disk can be configured and placed on the same logical disk as the StoreVirtual VSA. See the first option in figure 10.
In previous versions of vSphere and Hyper-V, which do not support virtual disks larger than 2 TB, it may not be possible to present all the capacity using the seven slots in the StoreVirtual VSA (SCSI 1:0 to SCSI 1:6). When virtualizing larger storage resources and wanting to preserve the ability to add more storage to the StoreVirtual VSA in the future, HP recommends collocating the StoreVirtual VSA with the hypervisor on the same logical disk. The StoreVirtual VSA can then use logical disks as data disks that are attached to it using a physical disk (see second option in figure 10).

When using JBODs for additional external storage, the disks in the external enclosures are configured in one or more separate arrays and logical disks via a RAID controller. Especially in combination with internal disks, a JBOD can be the perfect addition for environments that require more capacity than possible with internal drives.

See the vSphere and Hyper-V sections for more information on presenting storage to the StoreVirtual VSA.

### External storage arrays

With StoreVirtual VSA, it is also possible to virtualize portions of an external disk array. Even though the StoreVirtual VSA primary use case is to turn direct-attached storage into shared, highly available storage, there are use cases where turning a third-party array into StoreVirtual Storage makes sense. For instance, using the StoreVirtual VSA on top of an array can turn the array into a Remote Copy target in remote/branch office deployments. The virtualized array must be listed as supported block storage (iSCSI/FC/SAS) on the VMware Hardware Compatibility List or Microsoft Certified Products List.

### Step 3: Network considerations

The network is a key component in every HP StoreVirtual deployment. It is critical to the communication among storage nodes as well as for hosts accessing volumes via iSCSI. The network segment for StoreVirtual VSA should be isolated from other networks (user network) and network services (hypervisor cluster network) using a separate VLAN that is dedicated for StoreVirtual VSA and iSCSI. Administrators designing an Ethernet network for storage payloads should plan for sufficient bandwidth and low latency.

**Note**

HP recommends isolating the network segment used for StoreVirtual VSA and iSCSI from other networks by implementing a separate VLAN.
**1 Gb Ethernet vs. 10 Gb Ethernet**
Targeting primary virtualization and databases that are characterized by highly random workloads, the disks typically become the bottleneck in StoreVirtual solutions—well before the network does. StoreVirtual technology is optimized for these random workloads with its wide striping across all storage nodes in the cluster; it traditionally uses 1 Gb Ethernet networks. However, certain workloads and configurations (or large sequential I/O—as referenced in the next paragraph) benefit from higher bandwidth in 10 Gb Ethernet networks.

In 10 Gb Ethernet networks, bandwidth-related performance concerns diminish. As 10 Gb Ethernet becomes more prevalent, using 10 Gb Ethernet should be seriously considered, especially in server virtualization environments with large sequential I/O requirements, such as virtual machine migration, streaming services, or performing large backups.

Depending on the network resource intensity of other applications running on your environment, it is possible to mix 1 Gb Ethernet for virtual machines and 10 Gb Ethernet networks for storage to balance cost per port and required bandwidth.

**Host-side networking**
Based on the assumption that the network for StoreVirtual is separate from other networks, a minimum of four network interfaces is recommended on your hypervisor hosts. Having more networks allows for further separation of network traffic and increases infrastructure reliability.

On Hyper-V and vSphere, the StoreVirtual VSA uses a virtual network switch (vSwitch), which is typically connected to two or more physical network interfaces on the server. While the StoreVirtual VSA supports two network interfaces, bonding these virtual interfaces is not supported. The second interface can be used for management operations via the StoreVirtual management tools and to communicate with other network services, such as email servers and SNMP trap receivers on other network segments.

**Four network interfaces**
With four NICs on the server, the recommended configuration is to dedicate two NICs to a vSwitch for StoreVirtual. In addition, this vSwitch can be shared by the host to access volumes via iSCSI. The remaining two NICs on a second vSwitch are used for application traffic (user network) and hypervisor management traffic. Configurations with four network interfaces, as shown in figure 11, are considered the minimum configuration in terms of host-side networking.

![Figure 11. Host with four network interfaces](image)

**Six or more network interfaces**
Six or more network interfaces per server are the ideal configuration. This allows for segregation of iSCSI traffic, application traffic, and management traffic, including network services, such as vSphere or Windows cluster communication, and advanced features, such as vMotion. With six network interfaces, three virtual switches should be created; one vSwitch for iSCSI traffic, one vSwitch for management traffic, and one vSwitch for application traffic (see figure 12).

![Figure 12. Host with six network interfaces](image)
Note
On the hypervisor host, HP recommends you follow best practices around network aggregation and network load balancing. Network bonding of the virtual network adapters in the StoreVirtual VSA is not supported.

For solutions based on Hyper-V, it may be required to add more network connectivity to accommodate iSCSI connectivity for host, guest, and the StoreVirtual VSA itself. Per best practices, it is recommended to use individual network interfaces for multi-path I/O to connect to iSCSI targets, instead of teaming network interfaces. Even though solutions using teamed adapters have not reported any problems, these configurations have not been fully qualified by either Microsoft or HP. For more details, see the Hyper-V section in this document.

Switching infrastructure
As with solutions based on HP StoreVirtual 4000 Storage, there are no StoreVirtual VSA certified switches or networking solutions. However, there is general guidance around the capabilities and specifications of network switches used for StoreVirtual VSA solutions. In all cases, the key design criteria for networks should address two areas:

• Performance and low latency
  The switches should have non-blocking backplane, port buffer > 256 KB per port used for iSCSI, and wire speed throughput.

• Reliability and high availability
  The network should be built out as a resilient and meshed network fabric.

Depending on the availability requirements for the StoreVirtual VSA solution, HP recommends using two redundant switches at the core of the StoreVirtual VSA network. To address the two design criteria above, HP recommends selecting switches that support the following features:

• Link aggregation
  Aggregating multiple physical links to one logical interface increases available bandwidth and resiliency for the link between two devices, e.g., combining two 1 Gb Ethernet links. While there are a variety of technologies available, a commonly used standardized protocol is the Link Aggregation Control Protocol (LACP, IEEE 802.1AX or previously IEEE 802.3ad) between switches.

• Ethernet flow control
  To prevent dropped packets, enable flow control on all switch ports that handle StoreVirtual and iSCSI traffic. It is a temporary means of congestion management by generating and honoring the so-called PAUSE frames, as defined in IEEE 802.3x standard. It is not a resolution for switch or network oversubscription. Flow control uses the buffer of the sending device for a brief period to manage the switch device of the receiving switch during periods of congestion.

• Loop detection
  Building meshed Ethernet networks typically requires the use of some form of loop detection mechanism to avoid packet storms. To avoid negative side effects of improperly or not-yet configured switches and other devices, HP recommends implementing a loop detection and prevention protocol that re-acts quickly to changes in the network topology, such as the Rapid Spanning Tree Protocol (IEEE 802.1w). Because there are variants of the Spanning Tree Protocol and other loop detection protocols available, implement a protocol that works across the entire StoreVirtual deployment.

• Virtual LANs (VLANs)
  Use VLANs to create multiple network segments on the same physical switch, separating one switch into multiple broadcast domains. In StoreVirtual deployments, this can be used to separate StoreVirtual and iSCSI traffic from other services on the network. Note that StoreVirtual VSA does not natively support VLAN tagging. When using VLANs, make sure that the physical network adapters and the virtual switches on the hypervisor hosts are properly configured and present only the iSCSI network to the StoreVirtual VSA.

• Jumbo frames (optional)
  When using jumbo frames for the StoreVirtual and iSCSI network, all switch and server ports and virtual switches on the network segment must be configured with the same frame size. Frame size may also be referred to as maximum transmission unit (MTU). Typical examples are 4,000 or 9,000 bytes (Some devices have frame size limitations). If the ports are not properly configured, the switches or devices might discard frames. This may cause connectivity and performance issues, which are difficult to troubleshoot.
• Routing (optional)

In environments where a group of StoreVirtual VSAs is used to replicate to another StoreVirtual installation (remote office replicating to a data center or vice versa) or if the StoreVirtual VSA needs to communicate with other services that are not on the same network or subnet, routing can bridge the gap between these separate networks. Even though routing is often taken care of by dedicated equipment, some switches offer dynamic and static routing capabilities to facilitate the communication between network segments and networks.

Note

Not all of the above listed features need to be supported or implemented on the switches in your solution. However, HP recommends implementing link aggregation, Ethernet flow control, loop detection and prevention, and VLANs in most StoreVirtual VSA environments.

For more detailed information on StoreVirtual network best practices, consult the HP StoreVirtual Storage network design considerations and best practices guide, which also lists some recommended switches from HP Networking.

Multi-site configurations

A single logical cluster can span different physical locations, as shown in figure 13. With Network RAID 10, two copies of the data are in each volume in the cluster. If the cluster is physically split between two sites such that each site has a complete copy of the data, which means the storage is now site protected. A complete site or location could go offline for any reason, and a complete, live copy of the data on the StoreVirtual VSA is still accessible by hosts and applications. When combined with hypervisor features such as VMware’s High Availability, vSphere Metro Storage Cluster, or Windows Failover Cluster for Hyper-V VMs, this is a powerful and highly available solution.

High-availability features require shared storage so that the hypervisor servers can access the virtual machines. If the storage (and therefore the virtual machines) is unavailable, these features cannot work as designed. With the multi-site cluster configuration of the StoreVirtual VSA, one set of storage and physical servers can be at one location and another set of storage and physical servers can be at a second location. Should either site go down, the storage remains online with no user intervention, and the hypervisor can access the virtual machines’ files, pause briefly, and then resume the work of the virtual machines.

When planning for a multi-site implementation, take advantage of the networking requirements that will help ensure that performance and availability meet expectations. At a high level, you should plan for 50 MB/s of bandwidth for each storage system per site when using 1 Gb Ethernet. For instance, if each site contains five storage systems, then you need 250 MB/s of bandwidth.

In this case, it translates into two Gigabit Ethernet links or more. In environments with 10 Gb Ethernet, plan for 250 MB/s for each storage node per site. Network links should have low latency (2 ms or less is recommended). For more details around planning and implementing multi-site configurations, refer to the HP StoreVirtual Storage multi-site configuration guide.

Figure 13. Multi-site configuration: stretched StoreVirtual Cluster that matches a stretched compute cluster configuration
Remote Copy
For remote and branch offices, StoreVirtual VSA can replicate to other StoreVirtual VSAs or StoreVirtual 4000 Storage. StoreVirtual VSA supports any transparent network technology as long as there is a TCP/IP link: VPNs over the Internet and WAN accelerators with compression are fully supported.

Step 4: Server requirements
HP StoreVirtual VSA requires system resources to virtualize the storage resources defined in step 2. Like traditional storage controllers, the VSA requires server CPU and memory resources. Based on that and on the networking requirements revisited in step 3, the next step is to select the server platform. In addition to the StoreVirtual VSA, the vSphere or Hyper-V host is virtualizing applications; these resources need to be added on top of the StoreVirtual VSA requirements. This section focuses on considerations for the right server platform for StoreVirtual VSA.

Note
The hypervisor must fully support servers and storage using HP StoreVirtual VSA. To be sure that you are running a supported configuration, check to see if the server model is on the VMware Compatibility Guide or in the Microsoft Windows Server® Catalog (see links listed in section Resources).

External storage
Another driving factor when choosing the server platform is the option to connect external storage shelves as additional direct-attached storage. An example could be that if you landed on a mixed configuration of SAS and MDL SAS, based on performance and capacity requirements, you might want to use eight SFF SAS drives in a 1U chassis and attach an additional disk shelf with 12 LFF MDL SAS drives to the server.

HP offers two disk shelves with 12 Gb SAS connectivity, which are commonly found in larger StoreVirtual VSA installations.

- HP D3600 12 Gb SAS enclosures with up to 12 LFF drives
- HP D3700 12 Gb SAS enclosures with up to 25 SFF drives

HP D3000 Enclosures 12 Gb SAS enables a higher and faster data transfer rate doubling the current transfer rate of 6 Gb solutions providing crucial bandwidth. These disk shelves can be populated with SSDs, SAS, MDL SAS, and Enterprise SATA drives to match your performance and availability requirements for this StoreVirtual solution.

Choosing a server platform
The server and its RAID controller primarily need to support the defined amount of drives. The HP ProLiant Server portfolio offers a variety of storage controllers and form factors to support your network and compute requirements.

Figure 14. HP ProLiant Server family at a glance

Figure 14 shows the HP ProLiant Server family from high-density rack-mount servers (DL series), to towers (ML series), to blades (BL series). For most StoreVirtual VSA installations, the new HP ProLiant Gen9 rack portfolio, with flexible choices and versatile design, is the ideal choice because of their options for CPUs, memory, network, and storage. Testing for this paper was done on Gen8; however, the solution is fully supported on ProLiant Gen9 servers.

- HP ProLiant DL360p Gen8 with support for 2 Intel® Xeon® CPUs, up to 768 GB and up to 10 SFF or 4 LFF drives
- HP ProLiant DL380p Gen8 with support for 2 Intel Xeon CPUs, up to 768 GB and up to 25 SFF or 12 LFF drives
Note
When configuring CPU and memory, refer to your server manufacturer’s documentation on optimal configurations to achieve best performance.

For both models, the on-board HP Smart Array Controller supports all internal drive options offered with this server. An additional HP Smart Array RAID Controller is required to add external storage shelves.

System resources
For StoreVirtual VSAs running on LeftHand OS 12.0 or later, HP recommends reserving two virtual CPUs with 2,000 MHz and a quantity of virtual machine memory based on the amount of server storage capacity dedicated to StoreVirtual VSA (see table 6). This is especially important for planning purposes; the installers for HP StoreVirtual VSA automatically configures the amount of virtual memory according to table 6.

Table 6. Virtual memory requirements for StoreVirtual VSA

<table>
<thead>
<tr>
<th>StoreVirtual VSA capacity (total of all storage devices)</th>
<th>Memory required (GB) not using Adaptive Optimization or Space Reclamation</th>
<th>Memory required (GB) when using Adaptive Optimization and/or Space Reclamation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 1 TB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1 - &lt;= 4 TB</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4 - &lt;= 10 TB</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>10 - &lt;= 20 TB</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>20 - &lt;= 30 TB</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>30 - &lt;= 40 TB</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>40 - &lt;= 50 TB</td>
<td>18</td>
<td>26</td>
</tr>
</tbody>
</table>

Refer to the HP StoreVirtual Storage VSA Installation and Configuration Guide to determine the most recent hardware requirements for the version of StoreVirtual VSA that you are going to deploy. Adding more virtual machine resources than specified in the HP StoreVirtual Storage VSA Installation and Configuration Guide will not increase performance; an exception to this rule is deployments of StoreVirtual VSA with large flash tiers (or all flash). Adding up to four vCPUs in these environments helps to deliver more I/O per second from these tiers.

Hardware monitoring
When using StoreVirtual VSA, HP recommends using hardware monitoring capabilities as provided by the server vendor. In the event of hardware issues, especially disk failures, the server monitoring software notifies the administrator about failure and prefailure conditions. For HP ProLiant servers, agents for Microsoft Windows and VMware vSphere enable active monitoring. In the custom HP Image of vSphere Hypervisor (VMware ESXi Server), these agents come preinstalled. HP ProLiant servers also come with Systems Insight Manager that allows monitoring of the system components. Even more advanced is HP Insight Remote Support that can be configured to automatically open support incidents in cases of component failures.

Upgrading the StoreVirtual VSA configuration

Reasons for upgrading a StoreVirtual VSA may involve some combination of the products, features, and requirements listed here:

- HP StoreVirtual Multipathing Extension Module for VMware vSphere
- Space Reclamation (T10 SCSI UNMAP) feature in LeftHand OS 12.0
- Increase storage capacity by adding more storage to a StoreVirtual VSA
- Increase performance
- Add additional sites for high availability and disaster recovery purposes
- Licensing for capacity and features

Upgrades take careful planning to mitigate downtime or loss of data availability. Some upgrade operations may trigger StoreVirtual resynchronization and restripe operations that do not effect availability but may cause temporary performance changes during an operation. Validate that the cluster is normal before initiating any of the upgrades.

Note

Upgrades to server hardware or host operating systems are outside the scope of this document.

HP StoreVirtual Multi-path Extension Module for vSphere

HP StoreVirtual Multi-path Extension Module (MEM) for vSphere is a new feature with LeftHand OS 12.0. MEM provides and manages additional iSCSI sessions between ESX hosts and the HP VSA nodes that may increase application performance. Figure 15 is an example of a vSphere host running MEM with two iSCSI paths to a single StoreVirtual volume in a three-node StoreVirtual Cluster. This storage volume has eight paths between host and cluster.

MEM is not installable via the CMC. The administrator seamlessly installs the MEM component on the host using a vSphere VIB or via VMware Update Manager, using an Offline Bundle available from the HP StoreVirtual downloads page.

Figure 15. HP StoreVirtual MEM-enabled iSCSI paths

Space Reclamation

LeftHand OS 12.0 delivers Space Reclamation, a new StoreVirtual Storage feature that recovers space released by vSphere 5 and later or Windows Server 2012 and later. Space Reclamation uses the T10 SCSI UNMAP command issued by a storage host to signal a storage array that a block on a volume is no longer needed, for example, after files are deleted by user. HP StoreVirtual reclaims the freed capacity that, in thin-provisioned environments, results in a reduction of provisioned space on the array and an increase in available storage capacity.

VMware disables UNMAP operations by default in vSphere 5.5 (KB 2014849). VMware provides an esxcli command that manually reclaims unused storage blocks on a thin-provisioned VMFS datastore. The following VMware esxcli command initiates the UNMAP operation (KB 2057513).

```
# esxcli storage vmfs unmap
```

After a management group is running LeftHand OS 12.0, right-click on a management group in the CMC and select Enable Space Reclamation to enable the feature. When the LeftHand OS enables the feature for the first time, it runs a memory size check on all storage systems in the management group. If any of the storage systems have insufficient memory (e.g., StoreVirtual VSAs or certain HP P4000 G2 systems), the CMC informs you of the issue. If the CMC does not flag any issues, all the storage systems in the management group are properly equipped for Space Reclamation. View Space Reclamation status from the CMC cluster details view shown in figure 16. Once enabled, Space Reclamation cannot be disabled.

**Figure 16.** Space Reclamation

The HP document titled HP StoreVirtual Storage User Guide p/n AX696-96359 contains a good section on managing storage space using Space Reclamation. The Ongoing Capacity Management section details requirements and maintenance of Space Reclamation.

**Increase storage capacity**

Increase storage capacity by adding StoreVirtual systems to an existing cluster. Additional storage systems may also increase cluster performance.

**Licensing**

StoreVirtual VSA functions during an evaluation period of 60 days without a license. During the 60-day evaluation period, StoreVirtual is fully functional and all features are available for trial purposes. As the evaluation period progresses, alarm indications (example shown in figure 17) in the CMC remind the administrator of the amount of time available in the remaining period. Beginning with LeftHand OS 12.0, HP StoreVirtual enforces the licensing agreement so at the expiration of the period, specific StoreVirtual features become unavailable to the cluster.

**Note**

Volume data and snapshots will become inaccessible to the cluster but not deleted from the array. Licensing the cluster restores access to volumes and snapshots.

Shut down applications and then back up application data before clusters become unavailable.
Figure 17. Example of registration alarm in CMC as 60-day trial VSA license period winds down

<table>
<thead>
<tr>
<th>Event</th>
<th>E0000024: HP LICENSE STATUS LIMITED CMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>CRITICAL</td>
</tr>
<tr>
<td>Date and Time</td>
<td>1/10/15 5:10:23 AM PST</td>
</tr>
<tr>
<td>Component</td>
<td>SANIO</td>
</tr>
<tr>
<td>User</td>
<td>System</td>
</tr>
<tr>
<td>Object Type</td>
<td>Management Group</td>
</tr>
<tr>
<td>Object Name</td>
<td>Gp1/VSA</td>
</tr>
<tr>
<td>Management Group</td>
<td>Gp1/VSA</td>
</tr>
<tr>
<td>Cluster</td>
<td>Ostr/VSA</td>
</tr>
<tr>
<td>IP Hostname</td>
<td>vsa50</td>
</tr>
<tr>
<td>Resolution</td>
<td>Online Event Resolution Help</td>
</tr>
</tbody>
</table>

The management group ‘Gp1/VSA’ license type is ‘Time Limited’ licensed, volumes offline in less than 15 days. You must register your storage system now.

The StoreVirtual VSA licensing interaction with myhplicensing.hp.com, HP’s software licensing portal for managing entitlements, requires three pieces of information to complete the process for each installed VSA.

- **EON or certificate ID**—Sent to the customer after purchasing a key for each VSA.
- **Email address**—HP licensing requires a customer email address to help register new keys and to manage existing VSA keys and certificate IDs. HP distributes new license keys using this email address.
- **MAC address of VSA**—VSA MAC addresses are system generated by the hypervisor during VSA deployment. The administrator can also manually configure MAC addresses to the VSA. Either way, the address is available for viewing from the CMC after VSA discovery.

The easiest way to install keys is through the CMC Import License function, which licenses all VSAs in a cluster at one time. Each license file arrives as an attachment via separate emails. Archive the attachments for safekeeping and save copies of the attachments in a folder that is accessible from the CMC. Use the minimum naming format when saving the copies used by the Import License function. Figure 18 demonstrates one context sensitive help message to correct an incorrectly formatted file name. The minimum file name string consists of numeric and upper case only characters of the MAC address, followed by file type dat. Separate the MAC address by periods into character pairs. Note the additional lowercase “x” characters. This represents optional free form text and is useful for identifying or managing key usage. File name examples include:

- `00.15.5D.E2.91.06.dat`
- `Clusterxyz00.15.5D.E2.91.06.dat`
- `Cloud2_RowA_00.15.5D.E2.91.06.dat`

Figure 18. Context-sensitive help example of incorrectly formatted license key file name
Note
HP recommends using optional free form text to help identify and manage key usage.

The state of entitlement for a given storage system is viewable through the CMC and validates that the network MAC address (feature key) for this VSA is correctly associated with a license key from myhplicensing.hp.com and the StoreVirtual features set (figure 19).

Figure 19. Feature key validation

Standardizing on building blocks
Because HP StoreVirtual is a clustered storage system, it is advisable to define building blocks for your environments. Common components simplify support for your environment and the extensibility of an installation. This is not only true for the StoreVirtual VSA part of your installation, but for all virtualized server environments using storage resources. Common CPU and memory configurations allow you to take full advantage of your hypervisors, including migration between hosts and Fault Tolerance on vSphere. Defining blocks are also very useful when designing solutions for remote and branch offices because the above-mentioned benefits scale with the number of environments.

Next steps
Now that you have defined your server configuration, it is time to set up the server, configure the storage options, and deploy the StoreVirtual VSA on vSphere or Hyper-V. You can now continue to the individual VMware or Microsoft implementation sections to learn about specific steps for the two supported hypervisors.

To avoid reconfiguration after the StoreVirtual VSA is deployed on the server, verify that the server hardware configuration is final and that all drivers and firmware versions are up to date. On HP ProLiant servers, the HP Software Update Manager helps with the assessment and update procedure.

HP StoreVirtual VSA on VMware vSphere
Based on the considerations covered earlier in this document, StoreVirtual VSA on vSphere performance is determined by the storage and network setup. This section covers the implementation level considerations for deployments on VMware vSphere.

Although StoreVirtual VSA runs on any server on the VMware Hardware Compatibility List capable of running VMware vSphere, HP Storage recommends HP ProLiant servers for optimal performance and management software like HP StoreFront Analytics for VMware vRealize Operations Manager adapter and HP OneView for VMware vCenter.

Table 7 demonstrates one suggested configuration for a medium-sized business solution. The solution achieved over 21 thousand random IOPS running an OLTP workload profile with Adaptive Optimization managing the hot data in Tier 0 space. The result for the large block sequential reads is also from Tier 0 space after AO has migrated data between tiers.
### Table 7. VMware vSphere example configuration

<table>
<thead>
<tr>
<th><strong>Server model</strong></th>
<th>ProLiant DL family</th>
<th>DL380p Gen8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU</strong></td>
<td>Intel Xeon E5-2660 v2</td>
<td></td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>160 GB</td>
<td>Dual rank x4 PC3-12,800R (DDR3-1,600)</td>
</tr>
<tr>
<td><strong>Storage media</strong></td>
<td>10 x 900 GB/HDD, 4 x 200 GB/SSD</td>
<td>SSD and HDD 6 Gb SAS, 10K rpm, AO-enabled</td>
</tr>
<tr>
<td><strong>Useable network RAID 10 capacity</strong></td>
<td>Tier 0 (SSD capacity)</td>
<td>- 497 GB (per storage node)</td>
</tr>
<tr>
<td></td>
<td>Tier 1 (SAS capacity)</td>
<td>- 7.1 TB (per storage node)</td>
</tr>
<tr>
<td><strong>Network interfaces</strong></td>
<td>4 x 10 Gb Ethernet ports</td>
<td>HP NC523SFP 10Gb 2-port Server Adapter</td>
</tr>
<tr>
<td><strong>Random performance (Tier 0)</strong></td>
<td>21,464 IOPS</td>
<td>Performance of a three-node cluster as determined by HP Storage load-generating tools for 8K 60% reads @ 30 ms</td>
</tr>
<tr>
<td><strong>Sequential performance (Tier 0)</strong></td>
<td>1,830 MB/s</td>
<td>Performance of a three-node cluster as determined by HP Storage load-generating tools for 256,000, 100% reads @ 30 ms</td>
</tr>
<tr>
<td><strong>Hypervisor</strong></td>
<td>VMware</td>
<td>ESXi 5.5 U2</td>
</tr>
</tbody>
</table>

**Note**
Refer to the following white paper for detailed review of StoreVirtual Adaptive Optimization, [h20195.www2.hp.com/v2/GetPDF.aspx/4AA4-9000ENW.pdf](h20195.www2.hp.com/v2/GetPDF.aspx/4AA4-9000ENW.pdf).

### Preparation for StoreVirtual VSA
For ideal performance, the underlying hardware on each vSphere host should be similar when used in the same StoreVirtual VSA cluster. This is especially true for the storage and networking configuration.

#### Configuring the storage subsystem
An equal amount of storage, dedicated to StoreVirtual VSA, is required in any individual server participating in a StoreVirtual Cluster. The storage can be directly attached to internal drives or external drives (DAS) or can be part of some external storage array. As long as the hardware is on the VMware Hardware Compatibility List for the version of vSphere that is installed, the hardware is supported in turn by the StoreVirtual VSA.

In addition to the storage configurations described previously, vSphere provides one additional storage configuration option. Given vSphere’s low storage footprint and the option to use Secure Digital (SD) cards on some servers, it is possible to install and boot the vSphere Hypervisor (ESXi) on an SD card (see figure 202). This setup leaves all drive capacity and performance to the StoreVirtual VSA; while drafting this document, this option is only available for vSphere Hypervisor (ESXi).

As mentioned in the Disk layout section, the StoreVirtual VSA does not directly see the individual drives, LUNs, or volumes for external arrays. Instead, the storage is first presented to the hypervisor, either through the RAID controller card or from the external storage array. Decisions about disk RAID protection, number of drives, and type of drives are made and managed at a layer below the hypervisor. The LUNs or volumes from the storage devices are then presented to vSphere for use by StoreVirtual VSA.

**Presenting storage to StoreVirtual VSA**

In vSphere, storage is presented in two ways: virtual machine disk (VMDK) or Raw Device Mapping (RDM) (see figure 21). VMDKs reside in a VMware Virtual Machine File System (VMFS) datastore and are storage collection of files that reside on a VMFS datastore. Format a storage resource with VMFS before placing VMDK files on this datastore. An RDM, on the other hand, is essentially a pass-through of raw disk from the storage controller to a VM, without an elaborate abstraction layer.

Traditionally, a VMDK datastore has provided many advantages for virtual machines. VMDKs allow advanced functionality such as vMotion, DRS, and virtual machine snapshots. VMDKs are limited in size to 2 TB per VMDK in vSphere 5.1 and previous versions, but this limit increases to 62 TB in vSphere 5.5.

**Figure 21.** RDM and VMDK in vSphere’s storage stack

StoreVirtual VSA VMs are not like traditional virtual machines, in that you do not use vMotion or DRS or take snapshots of the StoreVirtual VSA and its data disks. As compared to other virtual machines running Linux®, Windows, or other guest operating systems, the StoreVirtual VSAs are very static. Because StoreVirtual VSA does not use the advanced features of vSphere, using RDMs is a viable option for the StoreVirtual VSA data disks. There is no real performance difference between the two formats. However, RDMs allow larger storage allocations in versions of vSphere earlier than 5.5.
The following best practices apply to VMFS datastores for the StoreVirtual VSA:

- VMDKs can be only 2 TB with vSphere 5.1, and only 7 VMDKs can be presented to the StoreVirtual VSA. For total capacity higher than 14 TB per StoreVirtual VSA, upgrade to vSphere 5.5 or use RDMs.
- Regardless of using VMDKs or RDMs, make sure each of the VMDKs or RDMs in a set is equal in capacity and configuration for each StoreVirtual VSA to ensure predictable performance.

**Note**
Depending on the amount of storage presented to vSphere, and consequently to the StoreVirtual VSA as VMDK, it may be necessary to increase the heap size in the host configuration for vSphere 5.1 and earlier (see VMware KB 1004424 for more detail).

**Networking configuration on vSphere**
Enabling iSCSI connectivity via the iSCSI Software Initiator in vSphere requires specific network configuration. Starting with vSphere 4, you can use multiple adapters with the iSCSI Software Initiator. Each physical network interface (vmnic) used for iSCSI has its own VMkernel with exactly one active adapter. These VMkernel instances are then bound to the iSCSI Software Initiator (vmhba) that uses all underlying network interfaces.

The ideal networking configuration for iSCSI depends on the number of Gigabit network connections available to a vSphere Server. The most common configurations, four or six ports, are outlined here for reference. HP does not recommend using fewer than four ports, because adapters would need to be shared for iSCSI and other services. Figure 22 shows a vSphere screenshot of a four-port configuration.

The vSphere servers with four Ethernet network ports are capable of performing better by separating management and virtual machine traffic from iSCSI and vMotion traffic.

**Figure 22.** Typical configuration with four physical network interfaces

In this configuration, typically two virtual switches are configured with two network interfaces. If possible, one port from two separate network adapters should be used. For example, if using two on-board network interfaces and a dual port PCI adapter, use port 0 from the on board and port 0 from the adapter on one virtual switch. Then, use port 1 from the on board and port 1 from the adapter on the other virtual switch. This provides protection from some bus or card failures.
The vSphere servers with four 1 Gb Ethernet network ports should be configured as follows:

- The first virtual switch should have:
  - A virtual machine network
  - A VMkernel port for management and vMotion
- The second virtual switch should have:
  - A virtual machine network for StoreVirtual VSA and guests that need direct access to iSCSI
  - Two VMkernel instances for iSCSI (individually mapped to one vmnic interface) for iSCSI connectivity of the vSphere host

**Note**
Use at least two 1 Gb Ethernet network adapters for iSCSI connectivity for performance and failover.

The vSphere servers with six 1 Gb Ethernet network interfaces are ideal for delivering performance with the iSCSI Software Initiator (figure 23). The improvement over four ports is achieved by segmenting vMotion traffic and iSCSI traffic, so they do not have to share bandwidth. Both iSCSI and vMotion will perform better in this environment. Figure 23 shows a screenshot of this configuration.

**Figure 23.** Typical configuration with six or more physical network interfaces

In this configuration, typically three virtual switches are configured with two network interfaces per virtual switch. If possible, one port from separate Gigabit adapters should be used on each virtual switch to prevent some bus or card failures from affecting an entire virtual switch.

- The first virtual switch should have:
  - A virtual machine network
  - A VMkernel port for management
• The second virtual switch should have:
  – A virtual machine network for StoreVirtual VSA and guests that need direct access to iSCSI
  – Two VMkernel instances for iSCSI (individually mapped to one vmnic interface) for iSCSI connectivity of the vSphere host
• The third virtual switch should have:
  – VMkernel instances with vMotion and Fault Tolerance enabled on a separate VLAN

For more detailed information on how to configure and connect vSphere to StoreVirtual Storage, consult the HP LeftHand Storage with VMware vSphere: design considerations and best practices white paper.

Note
For best performance, VMkernel networks used for iSCSI should be separate from any other VMkernel networks (used for management, vMotion, and Fault Tolerance) or networks for virtual machines.

Deploying StoreVirtual VSA on vSphere
HP provides choices for deploying VSA depending on the size of the environment and the skill set of the data center administrator. The IT generalist or remote administrator will benefit from using the deployment and storage management features contained in HP OneView for VMware vCenter.

HP OneView for VMware vCenter
HP OneView for VMware vCenter simplifies the deployment and management of StoreVirtual VSA. HP OneView for VMware vCenter integrates as a plug-in with the vSphere Web Client software as shown in figure 24. The VMware administrator accesses HP StoreVirtual deployment and management capabilities using the vSphere Web Client. Learn more and download software at hp.com/go/ov4vc.

Figure 24. vSphere Web Client with HP OneView for VMware vCenter plug-in
Traditional HP StoreVirtual VSA deployment

HP continues to support HP StoreVirtual VSA installation with individual installers available through the HP StoreVirtual Storage website. The HP StoreVirtual Storage VSA Installation and Configuration Guide (HP part number TA688-96141) contains detailed installation and configuration steps for HP StoreVirtual VSA for VMware vSphere and HP StoreVirtual VSA for Microsoft Hyper-V. The guide includes network configuration best practices to help achieve the best performance for the SAN using the StoreVirtual VSAs.

Datastores must be present in vSphere and configured as VMFS or RDM before the StoreVirtual VSA can be installed to use the storage. HP StoreVirtual VSA Installer for VMware vSphere allows for deployments of StoreVirtual VSA on standalone vSphere hosts and vSphere hosts managed by VMware vCenter. Administrators can deploy multiple StoreVirtual VSAs in an environment.

The installation wizard prompts for host names, network configuration, and the name of the virtual machine. It will also help to define the storage and tiering configuration for the StoreVirtual VSA instance (see figure 25).

Figure 25. HP StoreVirtual VSA 2014 and StoreVirtual FOM Installer for VMware vSphere

After successful deployment using the installation wizard, the StoreVirtual VSA instance will be available on the designated network. Make sure that the StoreVirtual VSA is listed as an available system in the HP StoreVirtual Centralized Management Console.

When all StoreVirtual VSAs have been deployed on the network, the next step is to create a management group, with the first cluster and volumes provisioned to hosts. HP recommends volumes on the cluster be protected with Network RAID 10 for best performance and high availability. For more information on working with management groups and clusters, refer to the chapters in the current version of the HP StoreVirtual Storage User Guide. The example shown in figure 26 shows three VSAs in a group labeled GrpESXVSA.

Using the network interfaces of the vSphere host, the iSCSI Software Initiator can now access the volumes on the StoreVirtual VSA cluster.
The vSphere clusters require shared storage to make virtual machines highly available on the cluster and to move virtual machines transparently between hosts using vMotion. Figure 27 shows how a vSphere cluster uses iSCSI storage presented by the StoreVirtual Cluster, running on the same hardware and without external shared arrays.

**ESXi boot and iSCSI storage availability**

During the ESXi boot process, the hypervisor scans for storage devices, and then mounts the devices to the datastores, followed by the startup of virtual machines. The iSCSI devices from HP StoreVirtual are not discovered during the ESX boot process because the hypervisor has not brought the HP VSAs online and the HP StoreVirtual volumes are not available. Once all servers are booted, HP StoreVirtual VSA achieves quorum and presents volumes for ESX must scan the storage adapters again and then mount the iSCSI storage devices to the datastores.

HP recommends rescanning the storage adapters for known iSCSI targets after the boot process completes until all targets are discovered using a simple VIB available from the HP vibsdepot Download and install the VIB `hp-iscsi-rescan` offline bundle/VIB from the StoreVirtual directory on vibsdepot.hp.com (AKA HP Online Depot). It is available for ESX version 5.0/5.1 and 5.5. Version 1.0.0 is thoroughly tested by the converged systems team.
Advanced management

StoreVirtual administrators may choose to manage HP StoreVirtual Storage from the vSphere Web Client in addition to using HP StoreVirtual Centralized Management Console. HP OneView for VMware vCenter (HP OV4VC) adds the HP Management feature set and new Actions dropdown items to the vSphere Web Client. HP OV4VC lets the administrator deploy VSAs, create StoreVirtual Clusters, and provision new datastores from the vSphere Web Client. Without using the Centralized Management Console and manually mounting and formatting new volumes in vCenter, this plug-in automates datastore provisioning and decommissioning. It also provides an overview of available and provisioned storage, and space savings with thin provisioning.

For information on HP OneView for VMware vCenter, including add-in download or documentation, refer to HP OneView for VMware vCenter.

HP OneView for VMware vCenter

Figures 28 and 29 highlight StoreVirtual management tasks available from the vSphere Web Client. The HP OneView for VMware vCenter plug-in provides robust integration for fully automated vSphere cluster deployment, monitoring, and streamlined firmware updates.

**Figure 28.** Example of HP OneView for VMware vCenter functionality
Provision HP StoreVirtual Storage to datastores with the intuitive five-step wizard. Figure 29 shows one of the five steps that leads the administrator or IT generalist through the creation of three new datastores.

**Figure 29. Creating datastores with HP OneView**

![Create Datastores Figure]

For configuration details on HP OneView for VMware vCenter, refer to the current version of the HP OneView for VMware vCenter User Guide in the HP Support Center.

**HP StoreVirtual VSA on Microsoft Hyper-V**

HP StoreVirtual VSA can be deployed on all Windows Server editions that run Hyper-V, including the standalone Microsoft Hyper-V Server product. As a best practice, all servers in the setup should run the same edition of Windows Server. In addition to updating all firmware and driver components, plan ahead and install all Windows Server roles and features (Windows Failover Clustering, MPIO, etc.) required for your solution before starting the deployment of StoreVirtual VSA. Doing so reduces any further server interruption after StoreVirtual Storage is active.

Although StoreVirtual VSA runs on any server in the Windows Server Catalog capable of running the Hyper-V role, HP Storage recommends HP ProLiant servers.

**Enterprise remote office or medium-sized business configuration**

After gathering all capacity and performance requirements, and after selecting the server platform based on supported network interfaces and drives, you can now define the configuration for your StoreVirtual VSA environment.

Table 8 shows the components for a remote office Microsoft Hyper-V Server configuration in a StoreVirtual VSA deployment. Performance numbers are based on a three-node StoreVirtual Cluster.
Table 8. Typical configuration for StoreVirtual VSA remote office deployment

<table>
<thead>
<tr>
<th>Remote or branch office solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Server model</strong></td>
</tr>
<tr>
<td><strong>CPU</strong></td>
</tr>
<tr>
<td><strong>Memory</strong></td>
</tr>
<tr>
<td><strong>Storage media</strong></td>
</tr>
<tr>
<td><strong>Useable network RAID 10 capacity</strong></td>
</tr>
<tr>
<td><strong>RAID controller</strong></td>
</tr>
<tr>
<td><strong>Network interfaces</strong></td>
</tr>
<tr>
<td><strong>Random performance</strong></td>
</tr>
<tr>
<td><strong>Sequential performance</strong></td>
</tr>
<tr>
<td><strong>Hypervisor</strong></td>
</tr>
</tbody>
</table>

Note

These numbers can be affected by many configuration and application variables, such as the number of volumes on the StoreVirtual and queue depth (number of requests) to keep the drives busy.

Preparation for StoreVirtual VSA

For ideal performance, the underlying hardware on each Hyper-V host should be similar when used in the same StoreVirtual VSA cluster. This is especially true for the storage and networking configuration.

Configuring the storage subsystem

The disk capacity virtualized by the StoreVirtual VSA can be either pass-through disks or logical disks presented to the VSA from the server’s array controller or from an external array controller. Determine the appropriate RAID level for the logical disks based on the requirements of the applications that will consume the StoreVirtual VSA presented volumes.

The StoreVirtual VSA Installer for Hyper-V presents two options for configuring StoreVirtual VSA a single tier (no tiering) or two tiers (Adaptive Optimization). More storage and a second tier can be added at a later date as an online operation; for more information, consult the current version of the HP StoreVirtual Storage User Guide.

RAID sets used for the StoreVirtual VSA data disks should not be shared with other workloads. On a Hyper-V host, the base image of the StoreVirtual VSA is typically stored on the server’s local boot device, along with the installation of Windows Server. Alternatively, it can be stored on the lower performing tier when virtual hard disk files (VHDX) are used. The option to store the VHDX file on a lower performing tier is not available when using pass-through disks or if the StoreVirtual VSA is stored on the boot drive of the server.

Presenting storage to the StoreVirtual VSA

Server storage capacity can be presented to the StoreVirtual VSA as virtual hard disks (VHDX, up to 64 TB) or directly as pass-through disks (see figure 30). The StoreVirtual VSA can now present the storage capacity to application hosts through the CMC.
Because there are only marginal performance differences between the two options, choose your storage based on supported capacity and your storage management preferences. For the majority of customers, virtual machine disk (VHDX) files are typically easier to manage.

**Network configuration on Hyper-V**

As shown in figures 31 and 32, the ideal networking configuration for StoreVirtual VSA in Hyper-V environments typically requires four or more network interfaces. Service level planning should drive the requirement for the number of network interfaces contained in the solution. The number is determined by the level of resiliency and the desired storage connectivity by host and virtual machines (guest operating systems). All interfaces used for connectivity among StoreVirtual VSAs or to the StoreVirtual VSA cluster connect to the same network segment. Regardless of the available network bandwidth, the StoreVirtual VSA will always report “Unavailable” in the CMC TCP status tab. The available bandwidth value can be found from the Windows Network and Sharing Center view.

**Two network ports for StoreVirtual VSA**

On Windows Server 2012, ideally two network interfaces should be teamed to provide resilient network connectivity for the StoreVirtual VSA (Team 2 and Network 2 in figure 31). The teamed interface used for communication between the StoreVirtual VSAs on the network (replication, management) should be used by the StoreVirtual VSA and should not be used by other virtual machines or the Hyper-V host itself. For previous versions of Windows, consult the server documentation on how to create network teams or bonds. Install these drivers before installing the Hyper-V role.

**Two network ports for iSCSI Initiator of the host OS**

To allow the iSCSI Initiator on the Hyper-V host to access storage on the StoreVirtual VSA cluster, ideally two independent interfaces (a and b; each with their own IP address) should be available to iSCSI Initiator software and the StoreVirtual Centralized Management Console for management purposes. The adapters should not be shared with virtual machines or used for other functionality (Windows Failover Cluster communication, etc.). When using multiple adapters with the iSCSI Initiator software adapters, the MPIO framework in Windows will use multiple paths to the
volumes on the StoreVirtual VSA cluster. Instead of using the built-in multi-path support for iSCSI, install the HP StoreVirtual DSM for Microsoft MPIO in these environments.

**Figure 32.** Expanded networking configuration for StoreVirtual VSA on Hyper-V with iSCSI initiator in the guest OS

Two network ports for iSCSI Initiator in the guest OS (optional)

Similar to the consideration on the host side, ideally two interfaces (Team 3 in figure 32) are mapped to a virtual switch (Network 3 in figure 32) in Hyper-V. Alternatively, individual network interfaces (not teamed) could be exposed to the guest operating systems to access storage using the iSCSI Initiator and MPIO (built-in multi-path for iSCSI in Windows, or HP StoreVirtual DSM for Microsoft MPIO). These interfaces should not be used for any other purpose other than iSCSI traffic between a virtual machine and StoreVirtual VSAs.

For each of these functions, HP recommends using more than one network interface for resiliency and performance. Consider using the same guidelines for the virtual machine network and management network on the Hyper-V host.

HP StoreVirtual DSM for MPIO can also be used to improve sequential throughput and lower latency when connecting to volumes on an HP StoreVirtual Cluster. By establishing an iSCSI session with each StoreVirtual VSA in the cluster, blocks of data can be efficiently retrieved from the StoreVirtual VSAs where the block actually resides. The software can be used on the Hyper-V host, as well as in guests running Windows Server 2008 and higher. For more information on StoreVirtual Multi-path and the HP StoreVirtual DSM for MPIO, consult the HP StoreVirtual Storage Multipathing Deployment Guide p/n AX696-96377 and the HP StoreVirtual Storage VSA Installation and Configuration Guide.

For more information on how to configure and connect Microsoft Windows to StoreVirtual Storage, please consult the Configuring HP StoreVirtual Storage with Microsoft Windows Server white paper.

### Deploying StoreVirtual VSA on Hyper-V

After storage and networks are configured on all Hyper-V hosts that will run the StoreVirtual VSA, the next step is to start the software deployment on each of the servers using one of the two following methods:

**HP Storage UI Add-in for Microsoft System Center Virtual Machine Manager**

Deploy HP StoreVirtual VSA for Microsoft through Microsoft System Center Virtual Machine Manager (SCVMM) with the HP Storage UI Add-in version 2.2 or later, available from HP OneView for Microsoft System Center (see figure 33). The UI Add-in interface leads the administrator through a sequence of steps to deploy VSA instances to the Hyper-V servers managed by SCVMM.

Additionally, the SCVMM Add-in contains a link-launch button, which opens the HP StoreVirtual CMC management application.
Further information on HP StoreFront Manager for Microsoft System Center is available at h20392.www2.hp.com/portal/swdepot/displayProductInfo.do?productNumber=System_Center.

**Traditional VSA deployment**

HP StoreVirtual VSA Installer for Microsoft Hyper-V helps to install and configure the StoreVirtual VSA on the local server. This means that the installer needs to be executed on the Hyper-V hosts individually.

Like the StoreVirtual VSA Installer for vSphere, the Installer for Hyper-V presents a wizard to configure the virtual machine and its networking and storage configuration (including multiple storage tiers for Adaptive Optimization). To match the similar hardware configuration of the Hyper-V hosts, the configuration of each StoreVirtual VSA will be very similar, if not identical, except for its host name and IP address.

When the wizard completes, before the actual installation starts, the installer presents a summary page of the settings. Review this page carefully and compare it with your planning guides. As shown in figure 34, the summary lists all details of the to-be-installed StoreVirtual VSA, including network and storage configuration. If parameters need adjustments, return to the wizard and make the desired changes to the installation options.

After deploying the StoreVirtual VSA, most settings can be altered using Hyper-V Manager (connected network) or HP StoreVirtual Centralized Management Console (tier assignment, IP address).
After the successful deployment using the installation wizard, the StoreVirtual VSA instance is available on the designated network. Make sure the CMC lists the StoreVirtual VSA as an available system. Run Find Systems from the CMC to discover available StoreVirtual systems.

After deploying all StoreVirtual VSAs on the network, the next step is to create a management group and the first cluster. Protect volumes on the cluster with Network RAID 10 for best performance and high availability. For more information on working with management groups and clusters, refer to the current version of the HP StoreVirtual Storage User Guide.

Using the Hyper-V Server network interfaces, the iSCSI Initiator can now access the volumes on the StoreVirtual VSA cluster. To create highly available virtual machines on these volumes, connect to volumes, add them to a Windows Failover Cluster, and create highly available virtual machines using Failover Cluster Manager.

Note that StoreVirtual VSAs are not visible in Failover Cluster Manager and are not marked as highly available because they stay local to each machine.

Windows Failover Cluster requires shared storage to make virtual machines highly available on the cluster and to move virtual machines transparently between hosts using Live Migration. Figure 35 shows how hosts in the Windows Failover Cluster use iSCSI storage presented by the StoreVirtual Cluster running on the same hardware and without external shared storage arrays.
Advanced management

For streamlined workflows in Hyper-V environments, the storage presented by StoreVirtual VSA can be managed from within the Microsoft System Center Virtual Machine Manager 2012 SP1 (SCVMM). Use SCVMM to provision new storage for a virtual machine or rapid deployment of a virtual machine template with SAN copy. HP StoreVirtual does not require a proxy agent. Instead, SCVMM communicates directly with the StoreVirtual Cluster.

After you set up the StoreVirtual Cluster, you can add the cluster virtual IP address as a storage provider into Virtual Machine Manager (see figure 36). When adding StoreVirtual, make sure you use SSL encryption for the communication, default port (TCP 5989), and protocol SMI-S CIM-XML. Storage resources need to be associated with a storage classification (administrator-defined) such as bronze, silver, or gold.

After adding the provider successfully, all clusters in your StoreVirtual management group are available in the classification and pools list. New volumes can be provisioned from the available storage pools, used by new virtual machines, and presented to Hyper-V hosts that are managed by Virtual Machine Manager via iSCSI.

For virtual machine templates that reside on StoreVirtual volumes and are available in Virtual Machine Manager Library, you can also rapidly provision multiple instances from this template. These instances are spun up from SmartClones that are created on the basis of the StoreVirtual volume that contains the virtual machine template.

For more information and details on using System Center Virtual Machine Manager, refer to Microsoft System Center main page.
Summary

StoreVirtual VSA provides a robust, feature-rich primary storage platform that also provides the flexibility to adapt to your changing business needs. Its scale-out, distributed architecture makes it easy to grow capacity and performance linearly. With its all-inclusive software package, it is easy to accommodate availability and business continuity requirements in both the data center and smart remote offices.

When designing a software-defined storage solution based on StoreVirtual VSA, always be sure to understand the performance and capacity requirements of the environment, especially during peak activity. After the storage requirements are understood, a solution can be designed with the right disk drives, server platforms, and network infrastructure.

By following the best practices and design considerations in this document, your software-defined storage implementation can provide excellent performance, availability, and value.

Frequently asked questions

1. What does 4, 10, or 50 TB license mean? How much usable capacity will each StoreVirtual VSA have?
The licensed capacity reflects the amount of capacity that can be presented and virtualized by a single StoreVirtual VSA instance, after considering all RAID overhead. For example, with a 10 TB license, a customer can have six 2 TB drives, for a total of 12 TB. After applying disk RAID 5, there is 10 TB that is usable. All 10 TB would be available with the 10 TB license, even though the sum of all disks is greater than 10 TB.

A capacity license cannot be split into multiple StoreVirtual VSA instances.

2. Can I upgrade my 4 TB StoreVirtual VSA license to a 10 TB or 50 TB license?
Yes, you can purchase a license to upgrade a smaller capacity license to a larger capacity license. Applying a license upgrade or adding more storage to a StoreVirtual VSA is an online process.

3. What happens at the end of the 60-day StoreVirtual VSA trial period?
At the end of the 60-day trial period, access to the data on the StoreVirtual VSAs will be disrupted. All data remains intact; however, access is simply denied. Applying a valid license key to the StoreVirtual VSAs in the management group allows continued access to the data with no reinstallation or reconfiguration required. The StoreVirtual Centralized Management Console continually notifies the user when a management group is in a trial or unlicensed state.

4. Why does the RAID status shows as “Off” on the StoreVirtual VSA?
Generally, this indicates a failure of the RAID controller card to present volumes to the hypervisor, which in turn makes the volumes unavailable to the StoreVirtual VSA. Check the disk management section of the hypervisor to make sure the volumes presented by the RAID controller are online. If they are not, check to see if there is an underlying hardware issue through hardware monitoring of your servers.

5. Why can I not ping or communicate with my StoreVirtual VSA even though I can see that it is up and running in vSphere Web Client or Hyper-V Manager?
Generally, this is a simple networking issue. Make sure that the virtual NIC on the StoreVirtual VSA is properly configured and is connected to the correct virtual switch. This can be verified by connecting to the StoreVirtual VSA using the hypervisor tools. Also, make sure that the virtual switch is properly mapped to the physical NIC that is connected to the iSCSI network segment, and that all IPs, VLAN settings, frame sizes, and routing information are correct.

6. Why does it say my license is going to expire or is expired?
StoreVirtual VSA comes with a 60-day, fully functioning trial license. At the end of the 60 days, access to the volumes is denied (although the data remains safe). If a license has not been purchased, contact your preferred HP reseller to obtain permanent licenses. If a license has already been purchased and applied, contact the My HP Licensing portal (myhplicensing.hp.com) to resolve any licensing issues.

7. Why is it not possible to install my StoreVirtual VSA using the software’s base VMDK and VHDX file?
The HP StoreVirtual VSA Installer greatly simplifies the installation of the StoreVirtual VSA by offering an easy-to-use interface that streamlines the deployment of multiple VSAs across multiple physical servers. The StoreVirtual VSA Installer
for vSphere and Hyper-V are the preferred method of installing the StoreVirtual VSA because they offer more flexibility and customization and save time.

For vSphere installations, the StoreVirtual VSA is also available as an OVF template. This method is going to be deprecated in one of the next releases of LeftHand OS.

8. How can I troubleshoot the hardware used by StoreVirtual VSA?

One of the strengths of the StoreVirtual VSA is that it is supported to run on any hardware that is supported by the hypervisor. Because of the sheer number of hardware options available, the best way to get support for a hardware issue is to contact the manufacturer of the hardware directly.

Appendix A: Bill of materials

Bill of material for three-node HP ProLiant DL380p Gen8 VSA with vSphere

Hardware

This paper uses the hardware components listed in table 8 for the VMware-based, medium-sized business solution. SSD technology continues to evolve with increased capacity and lifespan and a corresponding reduction in cost per GB. Because of this evolution, the 200 GB SSD devices used in this solution may be supplanted by larger capacity SSD devices with better performance per GB.

<p>| Table 9. Hardware bill of materials for medium-sized business environment |
|-----------------------------------------------|--------------------------|</p>
<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HP NC365T 1Gb 4-port Ethernet Server Adapter (593722-B21)</td>
</tr>
<tr>
<td>3</td>
<td>HP NC552SFP 100b 2-port Server Adapter (614203-B21)</td>
</tr>
<tr>
<td>3</td>
<td>HP NC523SFP 100b 2-port Server Adapter (593717-B21)</td>
</tr>
<tr>
<td>12</td>
<td>HP 200GB 6G SATA Mainstream Endurance SFF 2.5-in SC Enterprise Mainstream SSD</td>
</tr>
<tr>
<td>30</td>
<td>HP 900GB 6G SAS 10K rpm SFF (2.5-inch) SC Enterprise HDD</td>
</tr>
<tr>
<td>2</td>
<td>5900AF-48XG-4QSFP+ Switch (JC772A)</td>
</tr>
<tr>
<td>2</td>
<td>HP 58x0AF Back (power side) to Front (port side) Airflow Fan Tray (JC682A)</td>
</tr>
</tbody>
</table>

HP Networking

| 1         | HP rack and KVM switch with keyboard and monitor |
| 12        | HP X240 10G SFP+ to SFP+ Direct Attach Copper Cable |
| 1         | HP 3800 Switch (J9575A) |
| 2         | HP X240 40G QSFP+ to QSFP+ 1m Direct Attach Copper Cable (JG126A) |
Software

Table 10. Solution-tested software

<table>
<thead>
<tr>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP StoreVirtual VSA 2014 and StoreVirtual FOM Installer for VMware vSphere</td>
</tr>
<tr>
<td>HP StoreVirtual Centralized Management Console</td>
</tr>
<tr>
<td>HP StoreVirtual Multi-Path Extension Module (MEM) for vSphere</td>
</tr>
<tr>
<td>VMware vSphere ESXi 5.5 U2 (HP build)</td>
</tr>
</tbody>
</table>

Bill of material for 3-node DL360p Gen8 VSA with Microsoft Hyper-V

This paper used the hardware components listed in Table 10 for the Windows-based remote office solution.

Hardware

Table 11. Hardware bill of materials

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HP ProLiant servers</td>
</tr>
<tr>
<td>3</td>
<td>HP ProLiant DL360p Gen8 E5-2650 2P 32GB-R P420i SFF 460W PS Performance Server 646904-001</td>
</tr>
<tr>
<td>24</td>
<td>HP 300GB 6G SAS 10K rpm SFF (2.5-inch) SC Enterprise HDD</td>
</tr>
<tr>
<td>3</td>
<td>HP Ethernet 1Gb 4-port 331FLR Adapter</td>
</tr>
<tr>
<td></td>
<td>HP Networks</td>
</tr>
<tr>
<td>1</td>
<td>HP Networks 3800 Switch (J9575A)</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous hardware</td>
</tr>
<tr>
<td>1</td>
<td>HP rack and KVM switch with keyboard and monitor</td>
</tr>
</tbody>
</table>

Software

Table 12. Tested software

<table>
<thead>
<tr>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP StoreVirtual VSA for Hyper-V with LeftHand OS 12.0</td>
</tr>
<tr>
<td>HP StoreVirtual Centralized Management Console 12.0</td>
</tr>
<tr>
<td>Microsoft Windows Server 2012 R2</td>
</tr>
</tbody>
</table>

Appendix B: Mass deployment of StoreVirtual VSAs on VMware vSphere

The StoreVirtual VSA for vSphere Installer works best in scenarios when deploying a few StoreVirtual VSAs interactively. For instance, a new medium-sized business deployment with three instances of the StoreVirtual is easily deployed using the installation wizard. The “Configure another” option located in the installer allows administrators to define additional instances of the StoreVirtual VSAs that are deployed all at once.

HP OneView for VMware vSphere and HP StoreFront Manager both offer VSA deployment automation opportunities for enterprise businesses planning large deployments.
However, when scaling out very large numbers of StoreVirtual VSAs repeatedly (prestaging of remote office deployments or in a data center), it is desirable to deploy StoreVirtual VSA in a more automated fashion. The installer can deploy StoreVirtual VSA according to an "answer file" for the installation wizard. The XML-based deployment manifest method shown in the code example below installs StoreVirtual VSA as follows:

- On one standalone vSphere host
- On multiple vCenter-managed vSphere hosts

To generate an XML deployment manifest, unzip the entire HP StoreVirtual VSA 2014 and StoreVirtual FOM Installer for VMware vSphere (TA688-10528.exe) package (self-extracting archive) and execute VSACL1.EXE from a command-line prompt. The text-based wizard guides you through all StoreVirtual VSA settings, including networking, storage, and tier definition. Save all answers to an XML file. Use the XML file to start the deployment at a later time, or use as a template for a larger, scripted installation of StoreVirtual VSAs.

The following code is an example of a StoreVirtual deployment manifest for two VSAs on two ESXi hosts.

```xml
<?xml version="1.0" encoding="utf-8"?>
<Zero2VSA>
  <VSA_Source path="VSA_OVF_12.0.00.0725\VSA.ovf" />
  <ConfigDisk path="Config_Disk" />
  <VCInfo ip="esxsvr1.corp.loc" user="root" pass="TG2KGNBHonONmE/sTQLyfg==" Encrypted="true">
    <HostSystem ip="esxsvr1.corp.loc">
      <VSA name="VSA100" DSPath="datastore_esxsvr1" type="VSA">
        <Network_Mappings name="VSA100.corp.loc" SANiQ_Pref="1">
          <Network name="eth0" ip="DHCP" interface="VSA Net" />
        </Network_Mappings>
        <Disk_Mappings type="VMDK">
          <Disk name="HardDisk1" Datastore="Datastore_esx1lh1" size="5" spaceReclaim="True" tier="Tier 0" />
        </Disk_Mappings>
      </VSA>
    </HostSystem>
    <HostSystem ip="esxsvr2.corp.loc">
      <VSA name="VSA200" DSPath="datastore_esxsvr2" type="VSA">
        <Network_Mappings name="VSA200.corp.loc" SANiQ_Pref="1">
          <Network name="eth0" ip="DHCP" interface="VSA Net" />
        </Network_Mappings>
      </VSA>
    </HostSystem>
</Zero2VSA>
```
The example above deploys two StoreVirtual VSAs (networking configured with DHCP) with 5 GB of storage on two vSphere hosts (10.0.108.251, 10.0.108.252) managed by one vCenter instance (10.0.108.250). To add more vSphere hosts in this example, simply copy the <HostSystem/> section and modify the content to represent the configuration of the other VSAs, until all VSAs being installed have the correct deployment settings in the XML file.

**Note**
HP does not recommend using DHCP for VSA IP addresses unless addresses are static DHCP.

To start the deployment, call VSACLI.EXE with the answer file as sole argument. See the following example.

```bash
VSACLI.EXE vsa-deployment-manifest.xml
```

This command immediately starts the installation of the StoreVirtual VSA instances as specified in the deployment manifest.

**Note**
When deploying multiple StoreVirtual VSAs to standalone vSphere hosts, use one deployment manifest per vSphere host and use Windows command line or PowerShell scripting to serialize (or parallelize) the installation. Avoid concurrent deployments of StoreVirtual VSAs with the same name to one vSphere host.
Resources
HP StoreVirtual VSA product page
HP StoreVirtual VSA QuickSpecs
HP StoreVirtual support manuals and user guides
HP LeftHand OS Version 12.0 Release Notes
HP StoreVirtual downloads
HP StoreVirtual Compatibility Matrix (on HP SPOCK)
HP OneView for VMware vCenter
HP OneView for Microsoft System Center
HP StoreVirtual Multi-Site Best Practices
Adaptive Optimization for HP StoreVirtual
HP StoreVirtual Storage network design considerations and best practices
Selecting Storage Controllers for HP ProLiant Gen8 Servers
HP SmartCache technology white paper
HP Systems Insight Manager 7.4.1 QuickSpecs
Microsoft Windows Server Catalog
VMware Compatibility Guide (hardware compatibility list)

Learn more at
hp.com/go/storevirtual