



**Hewlett Packard**  
Enterprise

# HPE Nimble Storage Deployment Considerations for VMware vSphere 6

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# Introduction

The VMware vSphere platform enables customers to transform existing IT infrastructure into a private cloud. With its built-in availability, scalability, manageability, and business continuity, vSphere provides a solid foundation for the virtualization of business-critical applications. To take advantage of vSphere features such as vSphere high availability (HA), Storage Distributed Resource Scheduler (DRS), vMotion, and Storage vMotion, shared storage is a requirement. Therefore, you must carefully plan your storage design for the successful deployment of a foundational architecture that provides infrastructure as a service.

The HPE Nimble Storage solution from Hewlett Packard Enterprise (HPE) provides a complete data storage architecture that includes primary storage, intelligent caching, instant application-aware backups, and replication. It enables you to consolidate the management of primary, secondary, and off-site disaster recovery storage in a single storage environment.

HPE Nimble Storage arrays present iSCSI or Fibre Channel (FC) target volumes to VMware hosts and iSCSI target volumes to guest virtual machines (VMs). The volumes that you create on HPE Nimble Storage arrays are highly optimized for VMs. They offer the following benefits:

- **Inline compression:** Reduces storage footprint on physical disks by 50% to 70%.
- **Inline deduplication:** Further reduces footprint on HPE Nimble Storage all-flash arrays by eliminating duplicate data blocks.
- **Thin provisioning:** Efficiently stores written data rather than reserved space.
- **Snapshot backups:** Create instant point-in-time backups that eliminate backup windows.
- **Zero-copy cloning:** Preemptively eliminates the storage footprint of repetitive data.
- **WAN-optimized replication:** Dramatically reduces the bandwidth required for disaster recovery.

This guide reviews the design considerations for deploying vSphere with HPE Nimble Storage arrays. It is written for readers who have a basic understanding of vSphere and of HPE Nimble Storage technologies. It is not a replacement for the HPE Nimble Storage [VMware Integration Guide](#), which HPE highly recommends that you read as a complement to the information in this document.

# Base Connectivity for High Availability

You have two options for base connectivity to the HPE Nimble Storage arrays: iSCSI or FC. The following sections describe these options in detail.

## Base iSCSI Connectivity

For iSCSI connectivity between the vSphere environment and the HPE Nimble Storage arrays, the VMware ESXi host must have a minimum of two physical network interface cards (NICs). HPE recommends that you dedicate at least two physical NICs to iSCSI storage access. On the ESXi host, use the following NIC allocation model as a reference:

- vmnic0 and vmnic1 (for management traffic, vMotion traffic, and VM traffic)
- vmnic2 and vmnic3 (VMkernel ports for IP storage)

The VMware software iSCSI initiator is the preferred means for connecting to HPE Nimble Storage arrays by using the iSCSI protocol. You can use two connection methods to achieve HA and load distribution:

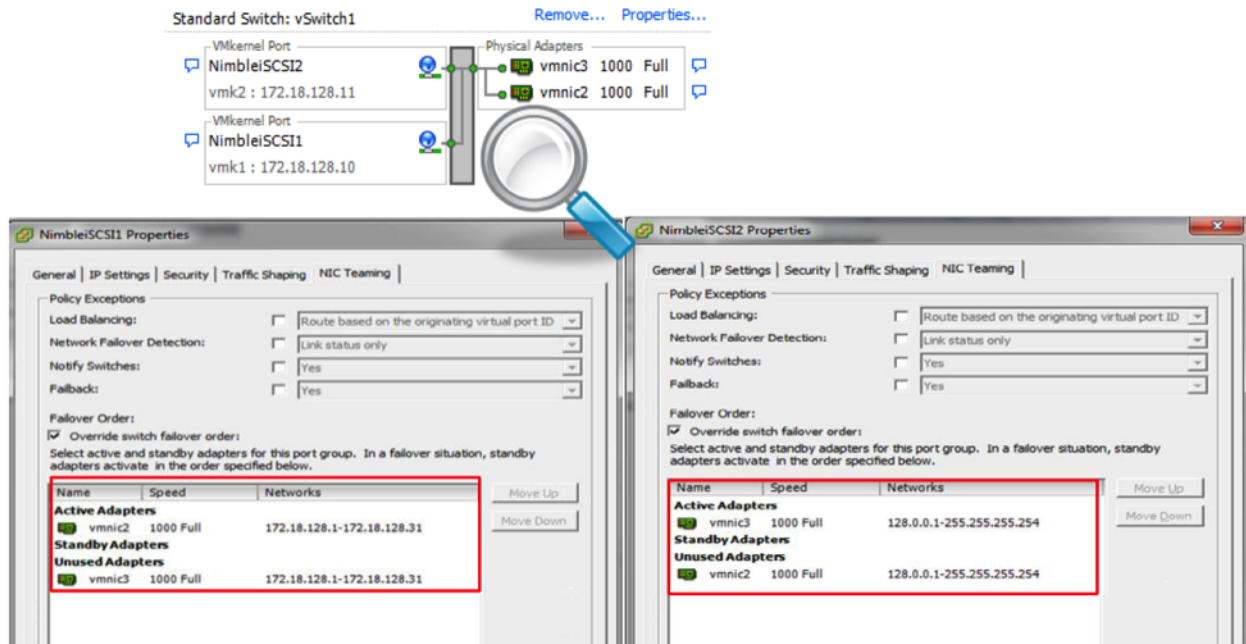
- **Method 1:** One vmnic per vSwitch, and one VMkernel port per vSwitch
- **Method 2:** Two or more vmnics per vSwitch, and one dedicated VMkernel port per vmnic

With both methods, the choice to bind VMkernel ports to the software iSCSI adapter depends on whether the ports are in the same broadcast domain and IP subnet:

- When the VMkernel ports for software iSCSI multipathing are in the same broadcast domain and IP subnet, you must bind the VMkernel ports to the software iSCSI adapter. Array target iSCSI ports must also reside in this broadcast domain and IP subnet.
- When the VMkernel ports for software iSCSI multipathing are in different broadcast domains and IP subnets, you must not bind the VMkernel ports to the software iSCSI adapter.

In addition, you must be sure to override the NIC teaming active-standby policy so that each VMkernel port is active on only a single vmnic. For detailed information about this configuration, see the HPE Nimble Storage [VMware Integration Guide](#). For more information about whether to use iSCSI port binding, see VMware [KB 2038869](#).

Although both connection methods allow ESXi iSCSI multipathing to provide high availability and load distribution for storage access, the second method has a slight advantage. It is easier to deploy and manage because only one vSwitch is required. If you use multiport NICs, ensure that iSCSI traffic spans different physical NICs instead of multiple ports on the same physical NIC. This approach prevents a single physical NIC failure from disrupting access to iSCSI storage. The following configuration illustrates this method.

**Figure 1: Sample network configuration using two VMkernel ports and a single vSwitch**

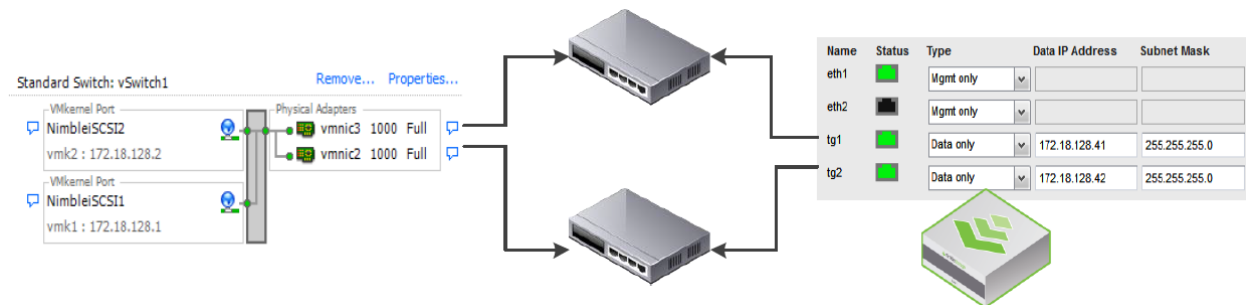
To prevent a single-switch failure that might cause a virtual infrastructure outage, HPE recommends that you use dual physical switches for the connection between the ESXi host and the HPE Nimble Storage array.

## Network Interface Types

On an HPE Nimble Storage array, you can designate separate network interfaces for management traffic and data traffic, or you can share management traffic and data traffic on the same interface. Although a single interface can serve both types of traffic, HPE recommends that you dedicate a pair of interfaces to management traffic and use the remaining interfaces to serve only data traffic.

Ensure that all data access interfaces are connected to the physical switch that is dedicated to storage traffic. If the physical switch is shared with other traffic (such as management traffic, vMotion traffic, or VM networks), use a private (nonroutable) address set for connectivity between the ESXi VMkernel ports and the HPE Nimble Storage data access interfaces.

You must connect the management interface to the same network segment to which the VMware vCenter Server instance is connected. The HPE Nimble Storage vCenter plugin requires network connectivity between the vCenter Server and the HPE Nimble Storage array management interfaces.

**Figure 2: End-to-end network iSCSI connectivity**

You must enable flow control on the physical switch ports to which the ESXi interfaces and the HPE Nimble Storage array interfaces are connected. Failure to enable flow control on these ports might cause TCP-level packets to retransmit or iSCSI-level tasks to abort.

If the network uses jumbo frames, you must set the correct MTU size from end to end, including in these locations:

- The ESXi server VMkernel ports for iSCSI traffic
- Any physical switch ports to which the VMkernel NICs are connected
- The HPE Nimble Storage network interfaces

## HPE Nimble Storage Connection Manager

When you deploy VMware ESXi on HPE Nimble Storage arrays, you must install the HPE Nimble Storage Connection Manager (NCM) on the ESXi host. NCM consists of the HPE Nimble Storage Connection Service (NCS) and the HPE Nimble Storage path selection policy (PSP). NCS is essential for optimizing iSCSI sessions from the ESXi host to the HPE Nimble Storage storage group. The PSP optimizes I/O multipathing.

**Note** Prior to vSphere 6, VMware required enterprise-level licensing for the use of third-party multipathing solutions such as the HPE Nimble Storage PSP. For vSphere 6, this functionality is supported with the standard license.

## Base FC Connectivity

To establish base FC connectivity between an HPE Nimble Storage array and your VMware compute environment, all components must have a supported FC configuration, including:

- HPE Nimble Storage arrays
- FC switches
- ESXi installation
- Host bus adapters (HBAs)
- Drivers
- Associated cabling
- HBA utilities from Emulex or QLogic, downloaded from the respective manufacturer's site

To access ESXi configurations verified by HPE, see the [HPE InfoSight Validated Configuration Matrix](#).

### HBA Utilities

HBA manufacturers offer utilities for managing and controlling their adapters. These utilities are useful when you provision LUNs and troubleshoot connectivity because they can provide an HBA-level view of the SAN and of available targets. It is usually preferable to install these tools during initial deployment.

Emulex and QLogic installations include a Common Information Model (CIM) provider and a vCenter plugin. The CIM provider enables you to implement API integration with ESXi and to manage the HBA from the ESXi CLI.

For information about how to install and use the utilities, consult the documentation provided by the HBA manufacturer.

## Installation

You should install the components for FC connectivity in logical order, beginning with the hardware components and stepping through each piece of software. In addition to the HBA utilities, you must install the software required for storage I/O multipathing on the ESXi hosts.

### HBAs and Driver Packages

Install the HBAs and their corresponding software in the following order:



- 1 Install the physical HBAs in the server according to the HBA manufacturer's specifications and instructions.
- 2 After the hardware installation is complete, boot the system into ESXi.
- 3 Locate the driver packages on the manufacturer's website; for a list of verified HBA and driver combinations, see the [HPE InfoSight Validated Configuration Matrix](#).
- 4 Download and install the appropriate driver package according to the manufacturer's instructions.
- 5 Install the HBA utilities.

### ESXi Host Components

ESXi provides storage I/O multipathing through the VMware multipathing solution. The solution includes built-in storage array-type plugins (SATPs) as well as the ability to register additional plugins. SATPs identify the type of storage array, control how multipathing interacts with the array, and provide configurable PSPs to set behavior for load balancing and path prioritization.

The HPE Nimble Storage Connection Manager (NCM) for VMware enables installation of the HPE Nimble Storage-specific PSP on supported ESXi platforms. The correct SATP for use with HPE Nimble Storage arrays is VMW\_SATP\_ALUA; the ESXi host should detect and set the SATP automatically. After you install this SATP, the NIMBLE\_PSP\_DIRECTED PSP becomes available.

To download NCM for VMware and access installation instructions, see [HPE InfoSight Software Downloads](#).

**Note** Prior to vSphere 6, VMware required enterprise-level licensing for the use of third-party multipathing solutions such as the HPE Nimble Storage PSP. For vSphere 6, this functionality is supported with the standard license.

## Provisioning Storage

To provision storage to the host, you must perform the following tasks in order:

- 1 At the ESXi host, gather information about host initiator ports.
- 2 At the HPE Nimble Storage array, gather information about storage target ports.
- 3 At the FC switch, configure FC access to the storage.
- 4 Back at the HPE Nimble Storage array, create a volume.
- 5 At the ESXi host, discover the new device and add the storage.

**Note** Although this section describes how to perform these steps manually, HPE recommends that you use the HPE Nimble Storage vCenter plugin to provision storage.

### At the ESXi Host: Gather Initiator Port Information

You must gather information about the ports on both the ESXi host and the HPE Nimble Storage array.

First, using the HBA utilities, record the worldwide port name (WWPN) for each initiator port on the ESXi host.

Alternatively, you can obtain the WWPNs from the vSphere client:

- 1 Select the host.
- 2 Click the Configuration tab.
- 3 Select the **Storage Adapters** option.

Verify that the recorded WWPNs match what is displayed.

**Note** Do not use the worldwide node name (WWNN) for the host.

### At the HPE Nimble Storage Array: Gather Target Port Information

Using the GUI, record the WWPNs for each target port on the HPE Nimble Storage array.

You can select one of these options to find the WWPNs:

- In the GUI, navigate to **Manage > Arrays or Administration > Network Configuration > Interfaces**.
- In the CLI, use the **fc -list** command.

Record the WWPNs for both the active controllers and the standby controllers.

**Note** Do not use the WWNN for the array.

### At the FC Switch: Configure FC Access

Configuring the FC switch is the most crucial and error-prone task in the storage provisioning process. When you configure zoning, be sure to double-check all configurations. Use the tools provided by the switch vendor to configure zoning for the fabric.

Single-initiator zoning is an industry best practice. No more than one initiator port from the ESXi host should be located in each zone. All target ports from the HPE Nimble Storage array, both active and standby, should be in the zone with the single initiator. Configure a zone for each initiator port on the ESXi host.

You can assign aliases on the FC switch to give human-readable names to WWPNs. If you configure aliases, be sure to record all of them for use in the array configuration.

After zoning is complete, save and apply all configurations. Be sure that configurations are applied and active in the fabric.

### At the HPE Nimble Storage Array: Create a New Volume

On the HPE Nimble Storage array, you should create an initiator group to control host access to the FC volumes. Initiator groups must contain the WWPNs of the initiator ports on the ESXi host.

If you configured aliases on the FC switch, you may also use aliases on the HPE Nimble Storage array. Be aware that alias names must match exactly. If an alias is used, both the alias and the WWPN must match before access to volume is granted.

After you create the initiator group, you must complete the following tasks to provision a new volume:

- 1 Create a volume with the desired name, description, and performance policy.
- 2 Assign the initiator group that you created previously.
- 3 Verify that the LUN number has been set automatically or, if a specific LUN number is desired, set it manually.
- 4 Configure the desired volume size and capacity settings.
- 5 Assign a protection policy as required.
- 6 Complete the volume creation.

### At the ESXi Host: Discover and Add the New Storage

Formatting the new storage requires first discovering the new device on the ESXi host and then configuring the volume for use. You should also make sure that the timeout settings are correct.

To discover the new device on the ESXi host, a rescan is necessary. In the vSphere client, complete the following steps:

- 1 Select the host.
- 2 Click the Configuration tab.
- 3 Select the **Storage Adapters** option.
- 4 Click the **Rescan All** link.

After the rescan is complete, you must add the new storage to configure the volume for use. In the vSphere client, complete the following steps:

- 1 Select the host.
- 2 Click the Configuration tab.
- 3 Click the Storage section.
- 4 Click **Add Storage**.
- 5 Follow the prompts to add the new disk or LUN.

If you are using the volume as a datastore, be sure that all VMs residing on the datastore have an up-to-date version of VMware Tools. This sets critical timeout within the guest operating system (OS).

If you are using the volume as a raw device map (RDM) to Linux guests, additional timeout settings are required on each guest. You can use the following CLI commands to set them:

```
for i in /sys/class/scsi_generic/*/device/timeout; do echo 180 > "$i"; done
echo 'for i in /sys/class/scsi_generic/*/device/timeout; do echo 180 > "$i";
done' >> /etc/rc.local
```

**Note** For RHEL Linux virtual machines, HPE recommends using the HPE Nimble Storage Connection Manager (NCM) for Linux.

## Troubleshooting

If no volumes are present on the ESXi host after you complete the provisioning steps, you should review your configuration as a whole. Pay close attention to WWPNs and to the zoning configuration.

### HPE Nimble Storage Array

Check the HPE Nimble Storage array in the following order:

- 1 Review the volume configuration by navigating to **Manage > Volumes** and selecting the volume that you created.
- 2 Verify that the proper initiator group is assigned to the volume.
- 3 Check the number of connected initiators to verify that all initiators are connected.
- 4 Click the initiator group name to verify that the WWPN is correct and that the initiators exist.

### FC Switch

Check the FC switch in the following order:

- 1 Review the zoning configuration thoroughly.
- 2 Verify that the WWPNs are correct for initiator ports and target ports.
- 3 Save and apply the zoning configuration to be sure that the configured zoning is active on the fabric.

### ESXi Host

Check the ESXi host in the following order:

- 1 Use the HBA utilities to investigate whether targets are available to the HBA.
- 2 If no targets are available, investigate the HPE Nimble Storage array or the FC switch.
- 3 If targets are available, begin troubleshooting the ESXi storage stack. If you made other changes to the configuration, rescan for devices.

# Manageability with the HPE Nimble Storage vCenter Plugin

The HPE Nimble Storage vCenter plugin offers vSphere administrators a single familiar user interface for easily managing their HPE Nimble Storage environment and their virtual compute environment. The plugin is compatible with both the vSphere web client and the vCenter thick client. It supports operational management functions such as provisioning, modifying, deleting, and cloning datastores. For installation instructions and step-by-step examples, see the HPE Nimble Storage [VMware Integration Guide](#).

**Note** Although you can perform these functions manually, HPE recommends that you install and use the HPE Nimble Storage vCenter plugin whenever possible. Automating these functions through the plugin provides greater ease of use and reduces the potential for human error.

## Provisioning a Datastore

For simplicity and consistency, provision datastores from the HPE Nimble Storage vCenter plugin. With the plugin, you can create volumes from the array side and then create a VMware virtual machine file system (VMFS) datastore for a selected group of ESXi hosts or for all ESXi hosts in a given datacenter, all in one automated workflow. Leveraging the plugin for this task greatly reduces the number of steps needed to provision storage to multiple ESXi hosts. It also eliminates the possibility of user error.

**Figure 3: Provisioning a new datastore**

**New Datastore**

**1 General**

**2 Size**

**3 Protection**

**4 Schedules**

**5 Summary**

**Datastore Name:** NewDatastore

**Description:** New Nimble Storage Datastore

**Select Hosts:**

Filter by name of host

- ▼ vCenter
  - ▼ Datacenter
    - ▼ ☒ Cluster
      - ☒ esxi5-6.sedemo.lab (v.6.0.0)
      - ☒ esxi5-7.sedemo.lab (v.6.0.0)
    - ▼ ☐ RTP AFA
      - ☐ 10.64.33.188 (v.6.0.0)

**Data Encryption:** ☐ Enabled **Cipher:** NONE

Back Next Finish | Cancel

**Note** The HPE Nimble Storage vCenter plugin applies access control records when you create new datastores so that the underlying HPE Nimble Storage volume is presented only to the hosts that you specify. If appropriate iSCSI or FC initiator groups do not already exist, the plugin creates new ones and maps the newly created volumes to those initiator groups.

## Modifying a Datastore

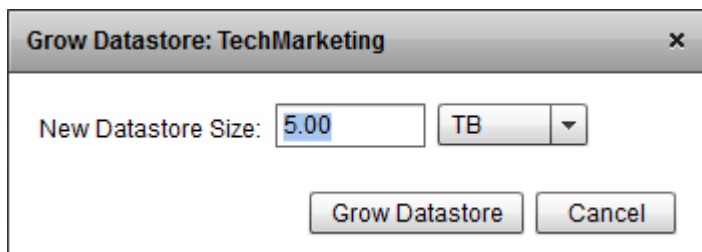
You can use the HPE Nimble Storage vCenter plugin to edit the properties of a datastore after it has been provisioned. You can change the datastore size and the data protection settings.

### Datastore Size

To change the size of a datastore, use the Grow Datastore function of the vCenter plugin. Selecting the Grow Datastore function automates the process to increase the size of the datastore. This process grows the underlying HPE Nimble Storage volume and expands the VMFS file system.

**Note** You cannot decrease the size of datastores.

**Figure 4: Growing a datastore**



### Data Protection

You can specify datastore protection settings directly in the HPE Nimble Storage vCenter plugin when you provision the datastore. If requirements change later, you can modify the protection settings by selecting the Edit Datastore option in the plugin. Define protection settings for a given datastore as either a standalone volume or part of a volume collection. If you are protecting a datastore as part of a collection, specify an existing collection name or create a new one that uses the desired settings.

**Figure 5: Defining datastore protection**

**New Datastore**

Volume collections are used to protect datastores using similar schedules. It's recommended that you choose an existing volume collection or create a new volume collection.

**1 General**  
**2 Size**  
**3 Protection**  
**4 Schedules**  
**5 Summary**

☐ None  
☒ Create new Volume Collection:   
☐ Join existing Volume Collection:   
☐ Protect as Standalone Volume

Application-consistent snapshots can be taken by enabling synchronization. To enable synchronization, please provide your vCenter credentials below.

☒ Configure synchronized snapshots

vCenter Host:  Port:   
 User Name:   
 Password:

Back Next Finish Cancel

**Figure 6: Datastore protection schedule**

**Protection**

Schedule Template:

[+ Add a Schedule](#) [Calendar View](#) [List View](#)

**1 General**  
**2 Size**  
**3 Protection**  
**4 Schedules**  
**5 Summary**

**H HOURLY**

Name: hourly Synchronization: Disabled  
 Repeat: Every 1 Hours Replication: Not replicated  
 Start Time: 12:00 AM  
 End Time: 11:59 PM  
 Days: Everyday  
 Retain: 48 local snapshots

**D DAILY**

Name: daily Synchronization: Disabled  
 Repeat: Every 1 Days Replication: Not replicated  
 Start Time: 12:00 AM  
 Days: Everyday  
 Retain: 30 local snapshots

Back Next Finish Cancel

When you create a new volume collection or choose to protect a standalone volume, you have the opportunity to enable VMware synchronized snapshots. The decision of whether to select this option depends on several factors that are covered in "When to Use Synchronized Snapshots" under [Configuring Volume Collections](#) on page 23.

To take an ad hoc datastore snapshot, select **Snapshot Datastore** in the plugin.

## Deleting a Datastore

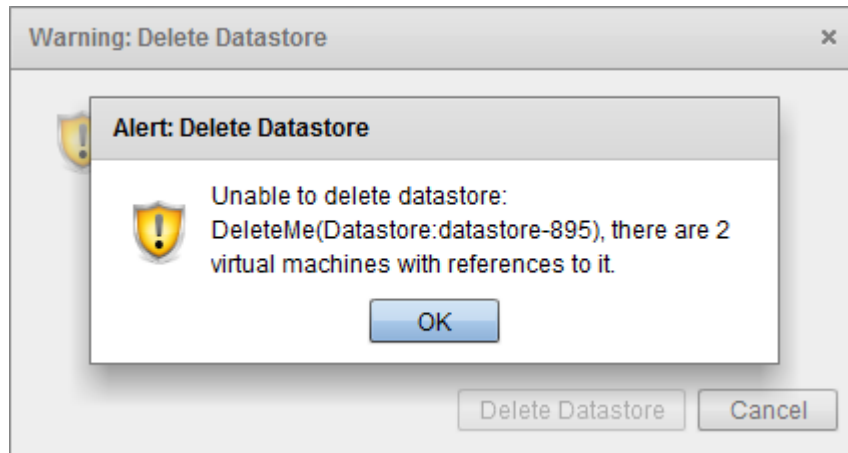
The HPE Nimble Storage vCenter plugin automates the task of datastore deletion. It first removes the datastore from vCenter and then deletes the underlying HPE Nimble Storage volume. This process is carefully orchestrated to avoid an all-paths-down condition.

Datastore deletion requires only two steps:

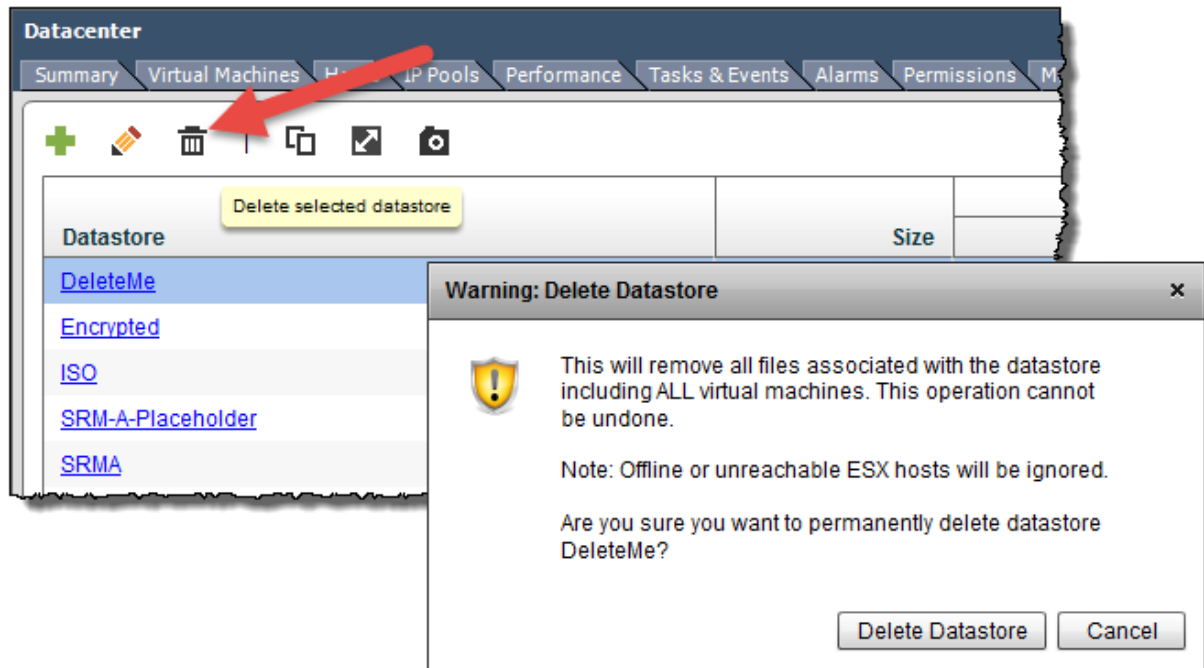
- 1 Unregister, remove, or migrate all VMs from the datastore that you will remove.

**Note** You cannot proceed with datastore deletion without first completing this step.

**Figure 7: Datastore deletion warning**



- 2 In the HPE Nimble Storage vCenter plug-in, select the datastore to be deleted and then click the waste bin icon to delete the selected datastore.

**Figure 8: Deleting a datastore with the HPE Nimble Storage vCenter plug-in**

## Cloning a Datastore

The HPE Nimble Storage vCenter plugin can also automate the task of cloning a datastore. With this functionality, you can create one or more clones based on an existing snapshot, or you can create a new ad hoc snapshot on which to base the clone.

The plugin automates the workflow of creating the space-efficient and time-efficient zero-copy clone on the HPE Nimble Storage array, mapping it to the ESXi hosts, resignaturing the VMFS volume, and renaming the datastore. You can then import VMs into inventory or attach individual virtual disks to existing VMs. In addition to populating development or test environments, this functionality can be very useful for data recovery.



Figure 9: Cloning a datastore

Clone Datastore: TechMarketing

Clone Name \*

TM-Clone

Description

Number of clones

1

Choose Snapshot

Take new snapshot

Use existing snapshot

New Snapshot Name \*

ad-hoc-clone

Clone

Cancel

Datastore Performance Overview

When you use the thick client, two primary views of storage are available:

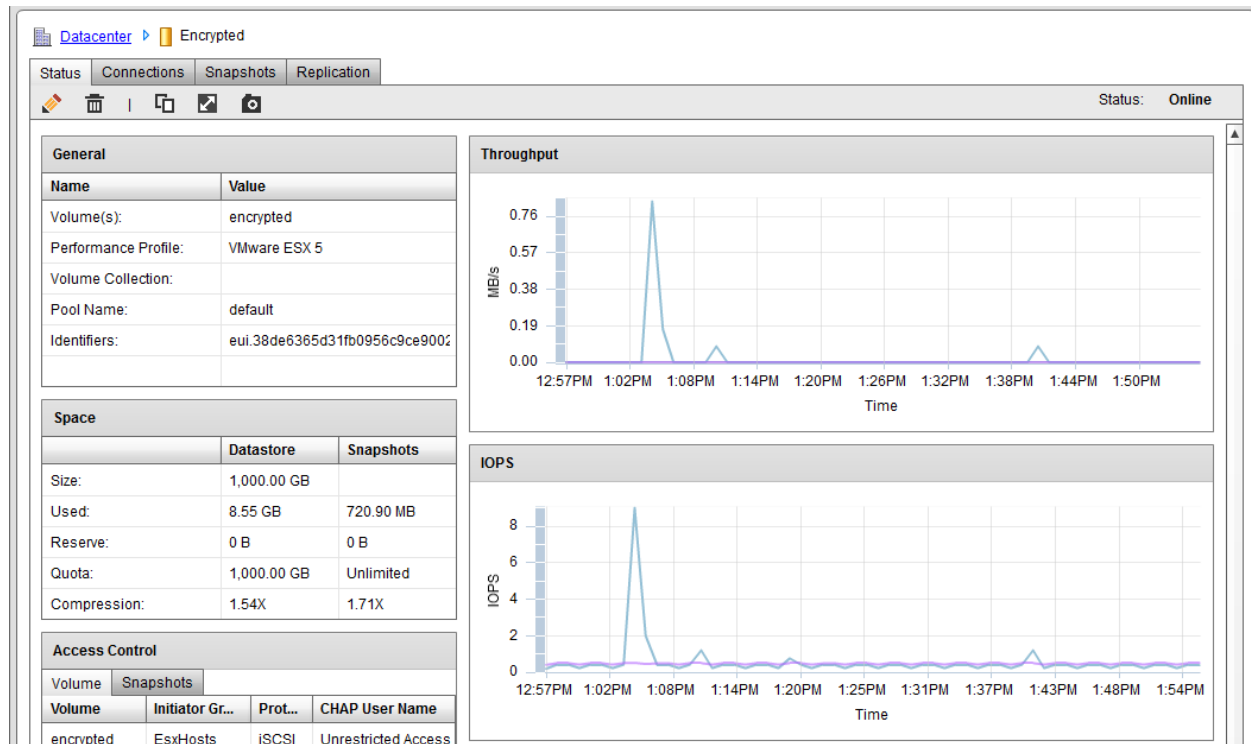
- The datacenter view
- The datastore view

The datacenter view shows all storage associated with the site.

Figure 10: Datacenter view

Datastore	Size	IOPS		Throughput (MB/s)		Optimizations		Total Usage
		Read	Write	Read	Write	Compression	Backup	
<a href="#">DedupeTest</a>	500.00 GB	0.43	1.2	0	0	1.37X	1.36X	19.13 GB <div></div>
<a href="#">DeleteMe</a>	600.00 GB	0.33	0.47	0	0	15.37X	15.33X	689.38 KB <div></div>
<a href="#">Encrypted</a>	999.75 GB	0.33	0.47	0	0	1.54X	1.71X	9.26 GB <div></div>
<a href="#">ISO</a>	2.00 TB	0.7	0.93	0	0	1.03X	1.03X	24.50 GB <div></div>
<a href="#">SRM-A-Placeholder</a>	10.00 GB	0.7	0.93	0	0	15.32X	15.34X	481.25 KB <div></div>
<a href="#">SRMA</a>	2.00 TB	0.7	0.93	0	0	1.54X	2.53X	14.26 GB <div></div>

The datastore view provides a fine-grained view of individual HPE Nimble Storage volumes that are attached as datastores.

**Figure 11: Datastore view**

The vSphere web client provides performance information contextually within each datastore. To see the information, select **Monitor > Performance > Nimble Volume Performance**. The datastore summary contains configuration information for each datastore, including HPE Nimble Storage volume information, space information, HPE Nimble Storage protection policy, and HPE Nimble Storage volume access control.

# Virtual Storage Access Considerations

You can connect networked storage to vSphere in four primary ways:

- Create a VMFS datastore on an HPE Nimble Storage volume.
- Attach VMs directly to HPE Nimble Storage volumes by using an iSCSI initiator in the guest OS.
- Create an RDM (in either physical or virtual compatibility mode) to the HPE Nimble Storage volume.
- Store VMs in VMware Virtual Volumes (VVols) directly on the HPE Nimble Storage array.

By planning your HPE Nimble Storage volume creation carefully, you can maximize the benefits of the HPE Nimble Storage array. Each storage attachment method has its own use cases and benefits, and each requires planning considerations.

## VMDK in VMFS Datastore

The simplest way to configure HPE Nimble Storage arrays with vSphere is to mount an HPE Nimble Storage volume as a VMFS datastore. At a minimum, VMFS datastores are used to hold the VM configuration and the OS volume.

For application-aware quiescing, HPE Nimble Storage arrays are integrated in VMware Tools with the VMware VSS Provider for Microsoft Volume Shadow Copy Service (VSS). This integration makes VMFS volumes suitable for storing transactional data from applications such as SQL Server or Microsoft Exchange.

Using VMFS datastores reduces the management burden because this approach does not require you to install additional tools. It also avoids the maintenance that would otherwise be required on each guest to properly quiesce applications or databases. In addition, VMFS datastores make it possible to keep the entire VM together on the same protected volume.

VMFS datastores provide a convenient method of mounting storage to the VMware platform. However, this method does have tradeoffs that must be considered.

### Use Cases

VMFS datastores are appropriate if you want to take advantage of the following features:

- Both VM OS disk and application disks configured as virtual machine disks (VMDKs) on VMFS
- Application-consistent quiescing through the VMware Tools VSS driver
- Item-level recovery

### Benefits

VMFS datastores offer significant advantages:

- They are simple to configure, with no in-guest iSCSI initiator to install or maintain.
- They can be fully integrated into VMware Site Recovery Manager for VM protection, test failover, failover, and failback.

### Planning Considerations

If you plan to use VMFS datastores, it is important to consider the following points:

- Microsoft Exchange backup through the VMware VSS driver does not truncate log files. Ensure that a third-party Exchange truncation backup solution is in place.
- If all VMs in a VMFS volume host applications that are stateless in nature (such as a web server, a file server, or a print server), VMware VSS-quiesced snapshots are not required. In this case, ensure that the volume collection synchronization setting is set to `None`.

- Running multiple virtual disks on a VMFS volume requires additional time for VMware VSS-quieted snapshots to be created on the given datastore.
- You should create the datastore with the HPE Nimble Storage vCenter plugin to ensure that the correct performance policy is selected.
- You must ensure that the VM guest OS partition is block-aligned (specifically for Windows XP and Windows 2003).
- You can perform item-level recovery by cloning the VMFS datastore from the target snapshot and attaching virtual disks to a recovery VM.

## Guest-Connected, Direct-Attached iSCSI Volumes

The guest-connected method provides integrity for the application data during snapshot backup operations. It also provides quick item-level recovery. This hybrid storage architecture consists of a VMFS datastore that holds the guest OS and application binary data. The application data, such as database and database log volumes, is attached to the VM through a guest-based iSCSI initiator that communicates directly with the HPE Nimble Storage array.

The tradeoff for using this connection method is the additional configuration and maintenance required for the software iSCSI initiator inside the VM guest OS. In addition, you must implement a custom script to use with Site Recovery Manager so that the VMs can access their guest-connected storage during test recovery, recovery, or failover.

### Use Cases

This method is appropriate to use if you have:

- A VM OS disk (VMDK on VMFS)
- VM application disks (NTFS/ext3)
- Guest-connected application-consistent quiescing through HPE Nimble Storage Windows Toolkit VSS integration
- Item-level recovery

### Benefits

This method offers the following benefits:

- Log truncation for Microsoft Exchange logs with HPE Nimble Storage Windows Toolkit VSS integration
- Simplicity of management with one-to-one mapping between array volume and application data volume
- Ease of interchange between virtual and physical environments without VMDK conversion
- Ability to tune volume block size to match application-data block size

### Planning Considerations

If you plan to use this method, consider the following points:

- For data volumes that contain Microsoft Exchange or SQL Server data, consider protecting the data by using a volume collection that is configured to use application-specific VSS synchronization policies.
- Site Recovery Manager requires a custom script (customer defined, not created or maintained by HPE) for mounting guest-connected storage during test failover and actual failover.
- Be sure to select the correct performance policy during volume creation. If a custom policy does not already exist for the application, create one using appropriate settings.
- Ensure that in-guest MPIO, firewall, and disk timeout registry settings are configured properly inside the VM. For step-by-step instructions, see the HPE Nimble Storage [VMware Integration Guide](#).
- Ensure that the VM guest OS partition is aligned (specifically for Windows XP and Windows 2003).

## RDM in Physical Compatibility Mode

Raw device mapping (RDM) enables you to give a VM direct access to an HPE Nimble Storage volume that has been presented to the host that contains the VM.

### Use Cases

This method is appropriate if you are using VMDK for OS and application binaries and RDM in physical compatibility mode for application data.

### Benefits

The RDM method offers the following benefits:

- Provides a means for guest VMs to control the entire volume when connected to HPE Nimble Storage FC arrays
- Provides full integration with VMware Site Recovery Manager without the need for additional scripts

### Planning Considerations

If you plan to use RDM, consider the following points:

- There is typically no performance benefit from using RDMs as opposed to VMDKs or guest-connected iSCSI.
- When HPE Nimble Storage VSS integration is used, snapshots are verified through guest-connected iSCSI, even when RDMs are used.

## vSphere VVols

The vSphere Virtual Volumes (VVols) framework is a much-anticipated storage technology introduced in vSphere 6 and supported by NimbleOS 3. With VVols, VMDKs are treated as first-class citizens directly on the storage array without being abstracted behind a VMFS datastore. On an HPE Nimble Storage array, a VMDK that was created as a VVol exists as a native HPE Nimble Storage volume. It can be tuned through the use of performance policies for the specific application type that runs on the VM. For example, a VM running Microsoft SQL Server might have three data disks: one for the OS and application binaries, one for the database data, and one for the database logs. Each would have attributes, such as block size, caching policy, data reduction policy, and encryption algorithm, that are optimized for that specific disk rather than being grouped in a datastore with a generic VMFS performance policy.

In addition to data VVols that correspond to each VMDK, a configuration VVol is also created for the VM to store information about that VM. A VVol for swap space is dynamically created and destroyed as the VM is powered on or off. Because the number of HPE Nimble Storage volumes created with VVols might be quite large, it is important to note the number of volumes required and ensure that this number is well within the volume maximum for your HPE Nimble Storage array.

Because data VVols are native HPE Nimble Storage volumes, you can take advantage of native HPE Nimble Storage features that work at the volume level. For example, you can take a VM snapshot by using highly efficient HPE Nimble Storage volume snapshots, grouped in a snapshot collection for consistency across all of the VMDKs in the VM. Creating a VM clone from the vSphere web client invokes an HPE Nimble Storage zero-copy cloning operation to instantly provision highly space-efficient clones, regardless of the size of the VM. No data is copied, and these clones are extremely fast.

Unlike VMs in a VMFS datastore, deleting a VM on VVols causes the deletion of the HPE Nimble Storage volume on which it is stored. To protect against accidental deletion, HPE has implemented a deferred deletion feature. With default settings, which can be adjusted to suit user preference, the volumes for a deleted VM are taken offline and hidden from the vCenter environment. Without further action, the volumes are deleted

after a period of 24 hours. To recover the VM from this state, use the **vm --restore** command. To force immediate deletion of the VM, use the **vm --destroy** command.

**Note** By default, the deferred deletion period is 24 hours. The HPE Nimble Storage support team can assist if you require an alternate length of time for deferred deletion.

**Important** For the configuration VVol to be recovered, it must be part of a volume collection, and there must be at least one snapshot. A configuration VVol becomes part of a volume collection when a protection schedule is part of the storage policy-based management (SPBM) policy.

### Use Cases

This method is appropriate if you want separate, optimized volumes for OS, data files, and log files. Each VMDK is represented by a unique HPE Nimble Storage volume.

### Benefits

The VVols method offers the following benefits:

- Block size and performance policies are tuned for the type of data stored on the VVol.
- VM snapshots are native HPE Nimble Storage snapshots.
- VM clones use native HPE Nimble Storage zero-copy cloning.

### Planning Considerations

If you plan to use this method, consider the following points:

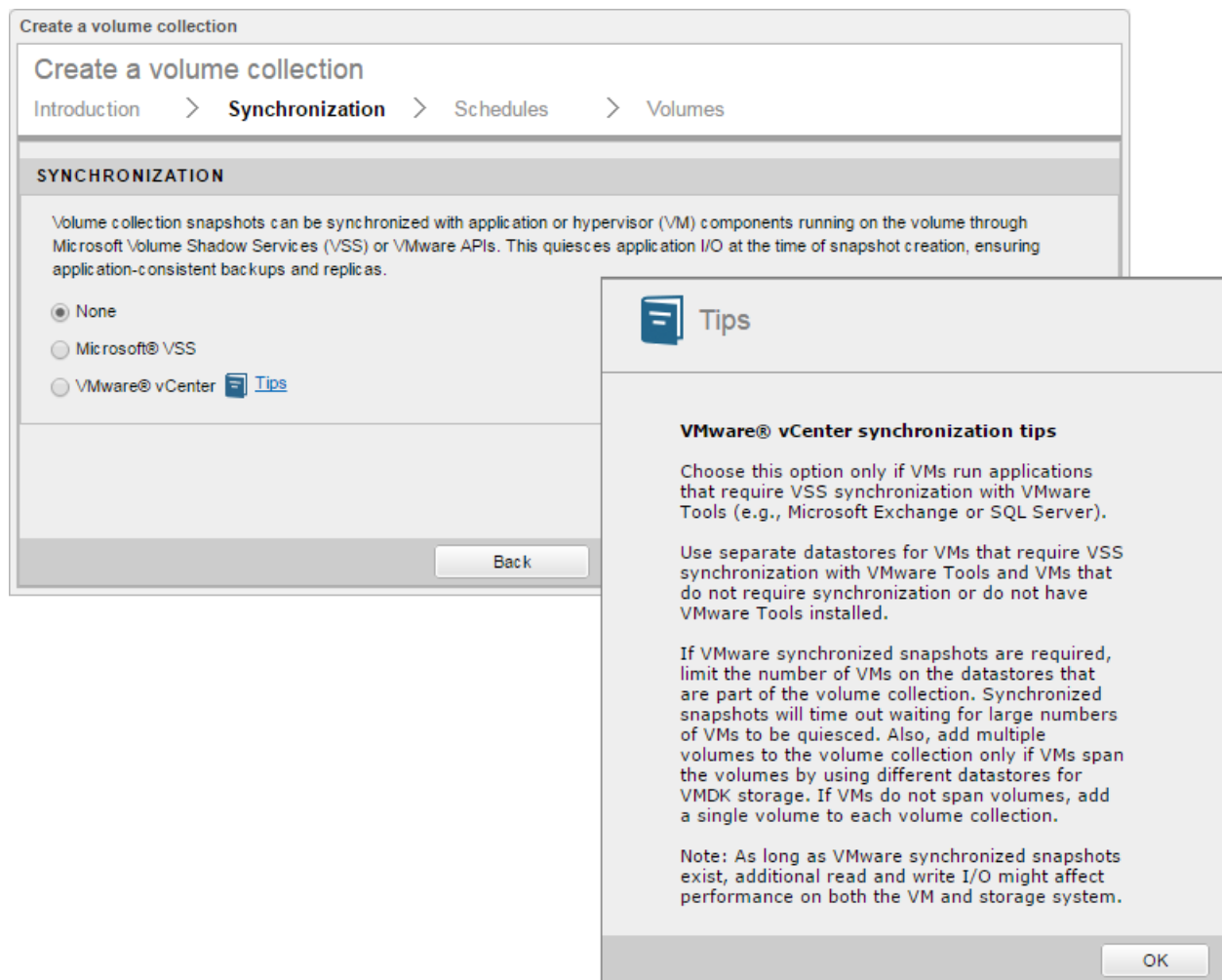
- Configure VMware storage policies to use HPE Nimble Storage array capabilities as advertised by the HPE Nimble Storage VASA provider.
- Each VM consumes one HPE Nimble Storage volume for configuration data, one for swap space, and one for each data VMDK. Plan accordingly to stay within the maximum HPE Nimble Storage volume count.

# Configuring Volume Collections

Volume collections are used to configure data protection for volumes on HPE Nimble Storage arrays. They determine the frequency with which volume snapshots are taken, whether the snapshots should be replicated to a downstream replication partner, and how many snapshots should be retained on both the source and the replica. Volume collections contain one or more HPE Nimble Storage volumes, and the protection policies defined for the volume collection apply to all volumes in the collection as a group.

For HPE Nimble Storage volumes that are used as VMware datastores, you have the option of configuring VMware synchronized snapshots for the volume collection. It is important to understand what this option entails and when it is appropriate for you to select it.

**Figure 12: Configuring volume synchronization settings**



## VMware Synchronized Snapshots

You can use VMware synchronized snapshots to quiesce VMs by creating VMware VM-level snapshots before creating an array-level snapshot. Selecting this option for a given volume collection adds several steps to the process of creating snapshots of the member volumes.

When the HPE Nimble Storage array triggers a scheduled snapshot, it first passes the request to vCenter, which uses VMware Tools to coordinate snapshots for every VM in the datastore. The VMware Tools VSS driver triggers an application quiesce on a VSS-enabled application in the VM. When the data files are in a consistent state, it sends a response back to vCenter.

After the VMware snapshots are created for all VMs in the datastore, NimbleOS creates an array-based snapshot for the HPE Nimble Storage volume associated with the datastore. After the array snapshot is in place, NimbleOS signals vCenter to remove each of the individual VMware snapshots. These VM snapshots are no longer needed because their quiesced state is preserved in the HPE Nimble Storage volume-level snapshot.

**Important** Before an array-level snapshot can be created, every VM on every datastore in the volume collection must first be quiesced. This process can take a long time if there are many VMs or if the VMs are generating a lot of I/O. Therefore, HPE recommends that you limit both the number of VMs in a datastore that use VMware synchronized snapshots and the number of datastores that belong to a single HPE Nimble Storage volume collection.

### When to Use VMware Synchronized Snapshots

If a VM hosts applications that are stateless in nature (such as a web server, a file server, or a print server), then an array-based snapshot is generally sufficient. If the VM hosts applications such as Microsoft Exchange, SQL Server, SharePoint, or Oracle Database, then HPE recommends using the VSS framework to quiesce the application properly.

If a given VMFS volume contains only VMs that run stateless applications without the need for VSS quiescing, HPE generally recommends that you set the HPE Nimble Storage volume synchronization to `None`. This setting streamlines the backup of the datastore by eliminating the step of coordinating VMware VM-level snapshots in addition to the HPE Nimble Storage snapshot that is being created. If a given VMFS volume contains at least one VM running an application that requires VSS quiescing, then the HPE Nimble Storage volume must have `VMware vCenter` checked for the synchronization setting.

VMware Synchronized Snapshots should not be configured on volume collections containing vSphere Virtual Volumes.

**Note** The VSS implementation in VMware Tools does not truncate logs for applications such as Microsoft Exchange. Therefore, you must ensure that the environment has an application-aware backup solution if this method is used.



# Thin, Zero Thick, and Eager-Zeroed Thick Considerations

A key characteristic of storage provisioning originated from the need to estimate the amount of data space required over the lifetime of applications. The attempt at estimating frequently resulted in an underestimation of storage requirements, which led to downtime while administrators searched for available storage resources and attached them to the production server. Overestimating storage resources became the norm to avoid the penalty of downtime associated with underestimating. The result was unused space that still had to be paid for up front. Therefore, SAN storage provisioning has adapted over the years to include more provisioning options that make data center management an easier process.

VMware provides three primary provisioning features for VMDK files on VMFS volumes:

- Thin
- Zeroed thick (sometimes referred to as "lazy" zeroed thick)
- Eager-zeroed thick

The provisioning model that you select for your datastores affects the density of VMs contained on your storage array, and it can affect the runtime of VMs. It can also ensure that critical VMs will always have access to provisioned space and that they will continue to run if the storage array reaches full capacity. The following table lists the provisioning models.

**Table 1: Provisioning models for datastores**

VMDK Format	Space Dedicated	Zeroed-Out Blocks	HPE Nimble Storage Provisioning
Thin	As needed	As needed	Default (thin)
Zero thick	At creation	As needed	Use volume reservation
Eager-zeroed thick	At creation	At creation	Use volume reservation

By default, HPE Nimble Storage arrays use the thin-provisioned model to allocate physical space. You should typically match HPE Nimble Storage provisioning to your VMFS provisioning. For example, if you choose VMware thick provisioning, then you can override the HPE Nimble Storage default thin provisioning by reserving space during HPE Nimble Storage volume creation. If you reserve less than 100% of the HPE Nimble Storage provisioned volume space, the remainder of the volume continues to be thin provisioned. The guidelines in the following sections can help you decide which VMware VMDK format to use with HPE Nimble Storage arrays.

## Thin Provisioning

Thin-provisioned virtual disks on vSphere enable you to overcommit space at the datastore level. Overcommitting space means that you can provision more space to VMs than the actual capacity of the datastore allows. If the environment has a large number of VM deployments with unpredictable space growth, using thin-provisioned virtual disks on thin-provisioned VMFS volumes might be a viable solution. However, you must exercise caution to prevent space overcommitment at the VMFS datastore level from causing out-of-space conditions for VMs.

If you do not use thin-provisioned virtual disks, ensure that the `Datastore usage on disk alarm` is enabled at the highest level of the vSphere infrastructure. Also make sure that the alarm has an acceptable value range for the warning and alert triggers. In vSphere, the predefined default value for warnings is 75% of disk space usage; the value for alerts is 85%.

When you receive a warning or alert, you can use the HPE Nimble Storage vCenter plugin to resize datastores. In addition, in a VMFS datastore that contains both thin-provisioned and thick-provisioned virtual disks, you

can correct the out-of-space condition by converting thick-provisioned virtual disks to a thin format. You can convert them through a storage vMotion migration to another datastore, followed by a migration back to the source datastore.

## Thick Provisioning and Eager-Zeroed Thick Provisioning

For lazy-zeroed thick virtual disks, the datastore is zeroed out on demand as data is written. In contrast, eager-zeroed thick virtual disks are zeroed out fully at creation time. Because of this difference, eager-zeroed thick virtual disks are generally considered to offer superior performance.

Traditionally, the downside has been the space and time required to write all of the zeroes when provisioning. On HPE Nimble Storage arrays, however, data reduction technologies intercept the zero writes. Therefore, the provisioning jobs return very quickly and do not consume additional capacity on the array.

For best performance, HPE recommends that you use the eager-zeroed thick VMDK format.

# HPE InfoSight VMVision

The [HPE InfoSight](#) analytics portal includes a powerful feature that enables you to analyze your VMware virtual environment along with your HPE Nimble Storage environment. You can choose to include vSphere performance details as part of the data collection packages that are constantly being sent from HPE Nimble Storage arrays. The virtualized infrastructure performance data is correlated and displayed in an easy-to-understand visualization that enables you to quickly analyze potential issues.

## Dashboards

VMVision provides several dashboard views. When you look at the overall performance picture of your virtualized environment, these views are a good place to start. Dashboard views are scoped to the currently selected vCenter instance.

The following sections describe the key dashboard views:

- Top VMs
- Host activity
- Datastore treemap
- Inactive VMs
- HPE Nimble Storage arrays

### Top VMs

The Top VMs dashboard provides two lists of top VMs:

- Those that have received the highest number of I/Os over the last 24 hours
- Those that have the highest average latency over the same time period

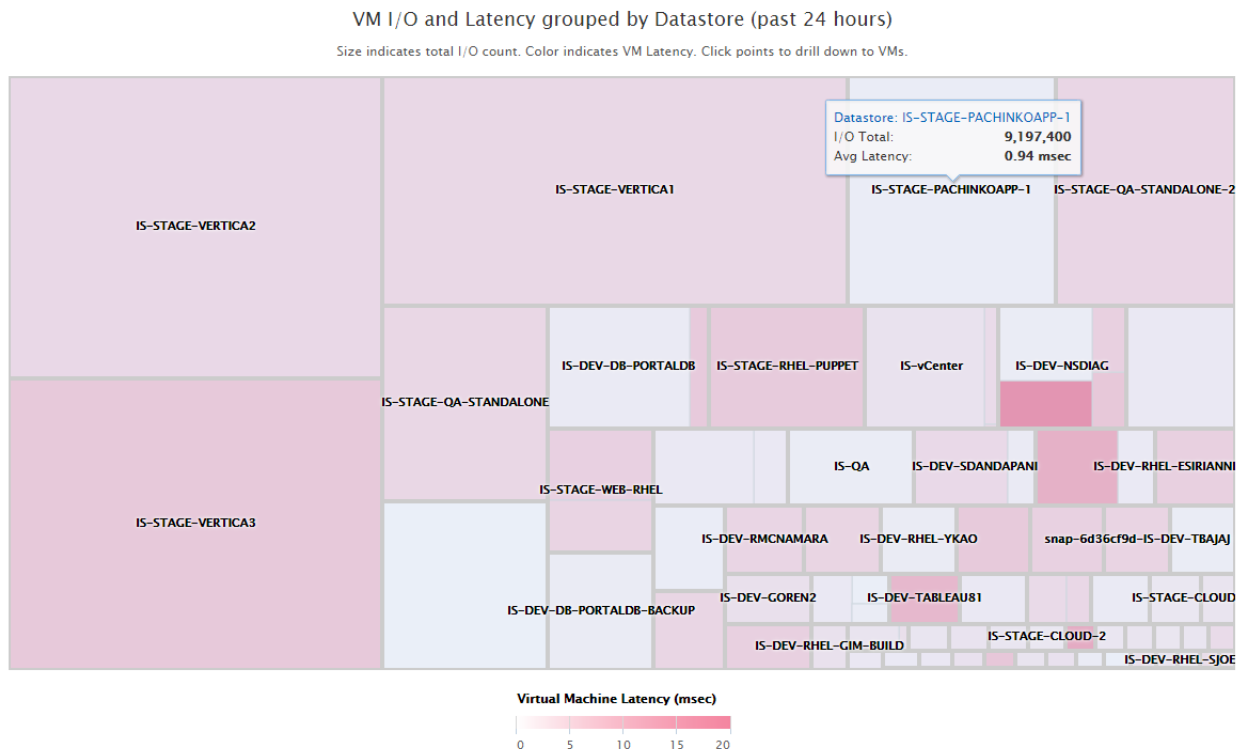
### Host Activity

The Host Activity dashboard shows CPU and memory statistics for all of the virtualization hosts that are managed by the selected vCenter instance.

### Datastore Treemap

The Datastore Treemap dashboard provides a quick and easy way to visualize the performance of all datastores in the vCenter environment. Datastores are represented by rectangles of varying size and color. The larger the rectangle, the more I/Os the datastore has performed over the past 24 hours. The color of the rectangle indicates latency, with darkness increasing as average latency increases.

To display absolute values for both size and latency, you can hover your cursor over the datastore name. To zoom in to the VM view, you can click a particular datastore. All VMs in that datastore are displayed with the same size and color scheme used for the datastores.

**Figure 13: Datastore treemap**

## Inactive VMs

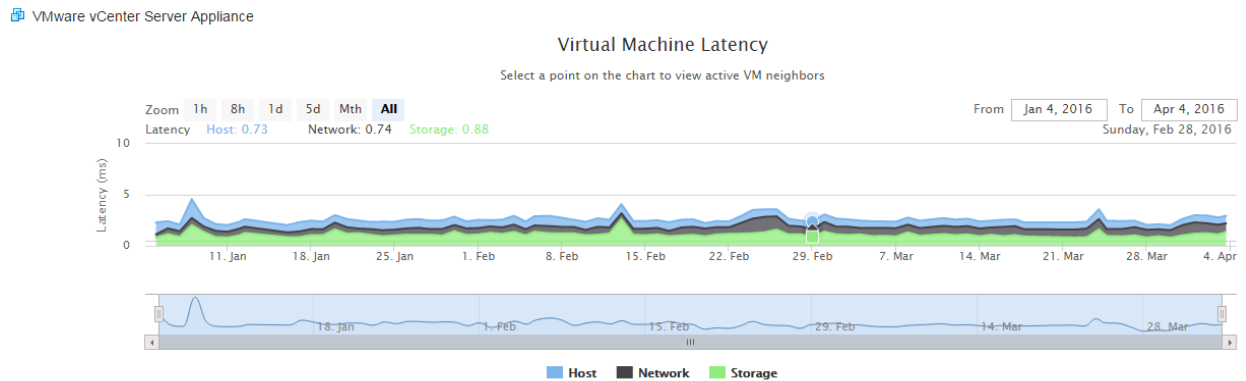
If a VM has had no I/O operations over the past seven days, it appears in the Inactive VMs dashboard. This dashboard helps you identify VMs that are no longer in use and whose resources can potentially be reclaimed for use elsewhere.

## HPE Nimble Storage Arrays

The HPE Nimble Storage Arrays dashboard view lists all of the HPE Nimble Storage arrays that are providing storage to the selected vCenter instance. It also provides links to them on [HPE InfoSight](#) to enable further detailed analysis.

## VM Latency Analysis

VMVision gives you the ability to examine individual VMs and to analyze their respective latencies, breaking them down by host, network, and storage.

**Figure 14: Virtual machine latency**

VM latency can be easily correlated with activity on the host, on any datastores used by the VM, and at the level of the individual VMDK. The graph shows neighboring VMs that share a datastore with the VM under examination, together with thumbnail graphs of all their IOPS, throughput, and latency. You can click any point in the VM latency graph to display neighboring VM activity at exactly that moment, making it easy to identify and remedy noisy-neighbor scenarios.

# vSphere Storage Feature Usage Considerations

The usage considerations related to vSphere storage fall into three categories:

- Storage I/O control (SIOC)
- vSphere Storage DRS
- Storage policy-based management

## SIOC

SIOC enables quality of service (QoS) for shared storage access between VMs. It is designed to address the noisy-neighbor problem that is common in shared services environments. It enables you to define shares and IOPS limits at the level of each VMDK to ensure that critical VMs are treated as first-class citizens.

### HPE Nimble Storage Considerations

No additional configuration is required on the HPE Nimble Storage array side to take advantage of this feature. Simply set higher share values and IOPS limits for mission-critical VMs, and the I/O QoS enforcement is adjusted accordingly.

## vSphere Storage DRS

VMware vSphere 5 introduced a new object called a datastore cluster, which is a collection of datastores that are aggregated into a single logical unit of consumption from the administrator's perspective. When a datastore cluster is enabled with Storage DRS, the VMDKs can be balanced nondisruptively across a group of datastores in the datastore cluster through storage vMotion migration. The concept is analogous to DRS for compute resources. The Storage DRS feature leverages the datastore cluster construct to perform the following key functions:

- Placing the initial VM on the datastore with the lowest space utilization
- Balancing the load based on capacity usage
- Balancing the load based on I/O load

Storage DRS provides value for automating storage resource management. If you use datastore clusters on HPE Nimble Storage arrays, be sure to consider the backup-and-restore aspects in relation to the infrastructure. The following scenarios provide examples.

### Scenario 1: VMs with OS in VMDK on a VMFS Volume and Application Data Disk on a Guest-Connected HPE Nimble Storage Volume

If multiple VMFS volumes are used to store the VMDK for the VM's OS disk, then you can create a datastore cluster for all of the VMFS volumes with the Storage DRS feature enabled. Because the guest-connected storage is treated as network traffic in ESXi, the Storage DRS operation does not affect the application data volumes. You should place all datastores that belong to the datastore cluster in the same volume collection, along with the guest-connected volumes, for the creation of crash-consistent OS snapshots.

### Scenario 2: VMs with Both OS and Application Data Disk in VMDK on a VMFS Volume

If OS and application VMDKs are on separate VMFS volumes, it is best to create two separate datastore clusters so that different types of VMDKs do not end up together on the same datastore.

If both OS and application data disks are on the same VMFS volume, and there are multiple VMFS volumes serving VMs in the same fashion, then you can group the VMFS volumes together on the same datastore cluster to take advantage of the VM placement and of migration between datastores to balance the load.

Consider using VM and VMDK affinity rules to ensure that the VMDKs for the VMs stay together on the datastore. Keeping the VMDKs together is especially important when an HPE Nimble Storage array is used to back up the virtual infrastructure.

### **HPE Recommendations**

The following recommendations apply to both types of deployment scenarios:

- HPE recommends that you place Storage DRS in manual mode so that the end user can review the generated recommendation and determine whether the storage vMotion migration should take place.
- It is imperative to keep track of the recommendations that have been applied. This means noting when a VM's VMDK is migrated from one datastore to another in a given datastore cluster. Tracking the individual VMs simplifies the restore process by identifying the specific HPE Nimble Storage array snapshot that contains the snapshot image of the VM in need of a restore.

## **Storage Policy–Based Management**

The storage policy–based management (SPBM) feature enables administrators to predefine storage requirements for VMs. Policies are built from storage array capabilities made known to vSphere through the HPE Nimble Storage array's vSphere Storage APIs for Storage Awareness (VASA) provider. When provisioning a new VM, the administrator selects a storage policy to apply to the VM and optionally selects additional storage policies to apply to individual virtual disks within the VM.

### **HPE Nimble Storage VASA Provider**

The HPE Nimble Storage VASA provider runs directly on the HPE Nimble Storage array. This arrangement makes the provider highly available and eliminates the need to maintain additional infrastructure for it. The following figure shows the window where you register the provider with vSphere. For a step-by-step guide to registering the provider, see the HPE Nimble Storage [VMware Integration Guide](#).

**Figure 15: Registering the HPE Nimble Storage VASA provider**

## VMware Integration

**Register a vCenter**

vCenter Name:

Subnet:

vCenter Host:  Port:

Description:

Credentials: (on file)

**Register the following: (Optional)**

☒ Web Client

☒ Thick Client

☒ VASA Provider (VVols)

**Storage Policies**

Using the capabilities advertised to vSphere through the HPE Nimble Storage VASA provider, administrators create custom storage policies that define the attributes of the HPE Nimble Storage volumes to be created as vSphere VVols. These storage policies can implement one or more of the rules listed in the following table. The figure following the table shows the window in which these rules are entered.

**Table 2: HPE Nimble Storage SPBM rules**

Rule	Function
All-flash	Allows the VVol to be placed in an all-flash storage pool.
Application policy	Optimizes the VVol based on the expected characteristics of the application that uses the volume. Application policies are tied to HPE Nimble Storage array application-specific performance policies. They control attributes such as block size, data reduction, caching, and behavior if the quota is exceeded.
Deduplication	Although deduplication is typically configured based on the selected application policy, this rule can override the application policy so that you can enable or disable deduplication as desired.



Rule	Function
Protection schedule	<p>This option enables the administrator to configure data protection as part of the storage policy. Schedules can be by the minute or hourly, daily, or weekly. The rule defines these settings:</p> <ul style="list-style-type: none"> <li>• When snapshots should be taken</li> <li>• How many should be retained locally</li> <li>• How frequently they should be replicated to an optional downstream replication partner</li> <li>• How many snapshots should be retained remotely</li> <li>• Whether the replicated volumes should be deleted when the source volume is deleted</li> </ul>
Data encryption cipher	This rule defines whether the volume should be unencrypted or encrypted with AES-256.

**Figure 16: Entering HPE Nimble Storage SPBM rules**

**Create New VM Storage Policy**

1 Name and description  
2 Rule-Sets  
3 Storage compatibility  
4 Ready to complete

**2a Rule-Set 1**

Select rules specific for a datastore type. Rules can be based on data services provided by datastore or based on tags. The VM storage policy will match datastores that satisfy all the rules in at least one of the rule-sets.

**Rules based on data services** NimbleStorage

All-Flash *i* No

Application policy *i* SQL Server 2012

Deduplication *i* Yes

Protection schedule (hourly) *i*

Start time *i* 0:00

End time *i* 23:00

Day(s) *i* ☒ Monday ☒ Tuesday ☒ Wednesday ☒ Thursday

Snapshots to retain locally *i* 32

Replication partner *i* cs7-lab2

Replication frequency *i* 1

Snapshots to retain on replica *i* 48

Delete replicas from partner *i* No

Data encryption cipher *i* AES-256-XTS

<Add rule>

**Rules based on tags**

Add tag-based rule...

Add another rule set Remove this rule set

Back Next Finish Cancel

## Version History

Version	Release Date	Description
1.0	November 2016	Initial release