NetApp

Technical Report

VMware vSphere Virtual Volumes for SolidFire storage configuration guide
Concepts and quality of service policy configuration and usage

Aaron Patten and Andy Banta, NetApp

Abstract

This technical report explains how to configure and use the VMware vSphere Virtual Volumes (vVols) feature with SolidFire® storage and specifically with NetApp® HCI SolidFire storage systems.

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Introduction

This document addresses the configuration of the vVols feature for use on NetApp HCI SolidFire storage systems. Basic concepts about vVols and how it can be used on SolidFire storage are also covered. See the glossary for vVols-related terminology.

Note: This document assumes an intermediate level of knowledge of the VMware vSphere platform.

Related documents

The documents listed in Table 1 provide additional essential information about the management and configuration of vVols for SolidFire and should be used to supplement the information provided in this configuration guide.

Table 1) Related documents.

Document title	Description
TR-4806 VMware vSphere for Element Software Configuration Guide	Describes how to configure and connect a VMware vSphere host to a SolidFire iSCSI target. It also provides best practices for design and implementation, including disk alignment procedures, network load balancing configuration, network failover, and performance control.
SolidFire Element OS User documents	Describes how to use the SolidFire Element® OS UI for vVols-related storage-side tasks.

vVols use cases

vSphere vVols is a storage paradigm for VMware that moves much of the storage management for vSphere from the storage system to VMware vCenter. Instead of the vSphere administrator consuming LUNs assigned by a storage administrator, they can now have a hands-on view of the available storage resources. They also have automatic control over how those resources are provisioned to virtual workloads through VMware Storage Policy-Based Management (SPBM).

Starting in the vSphere 6.0 release, the following workloads and target use cases are more suitable for vVols implementation than others:

- General virtual machine (VM) consolidation and a true mixed workload on one storage system
- Database consolidation
- Cloud-based service offerings

Use cases that require replication (not supported by NetApp at this time) or very high VM density are not currently ideal for vVols deployments.

vVols is a framework provided to storage vendors for integration, and each vendor's implementation is different in terms of features and maturity. Storage vendors implement or adapt their features to work within this framework. For example, a snapshot of a VM running on vVols is different for a vendor that keeps data structures on disk rather than one that keeps metadata in memory.

By extension, vendors can expose the value of their storage capabilities with vVols, allowing vSphere to consume them automatically with SPBM. For example, SolidFire exposes QoS profiles through the VM API for the Storage Awareness (VASA) provider, which can be used to provide a per-virtual disk level of guaranteed performance for the volume's minimum, maximum, and burst IOPS settings.

Figure 1) vVols implementation on SolidFire.
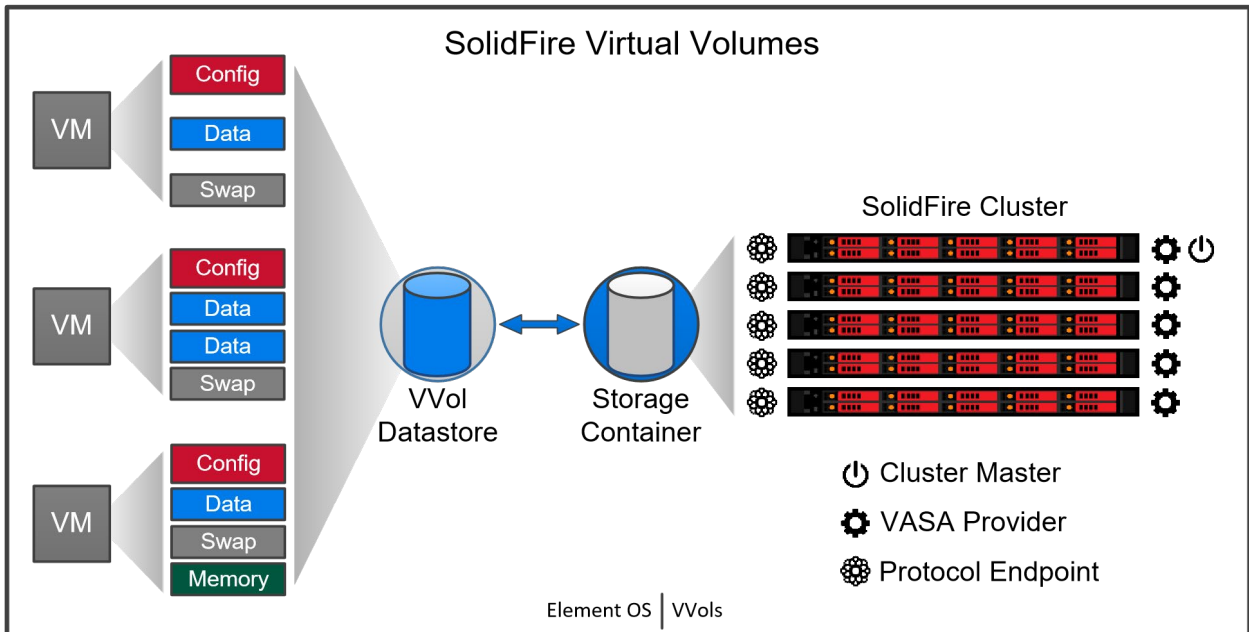
This document is not intended to be a vVols or SPBM tutorial. For an overview of the SPBM and vVols features, see the VMware documentation.

Benefits of VMware vSphere vVols on SolidFire storage

Deploying VMs in vVols provides multiple benefits to virtual infrastructure administrators. Table 2 compares some of the features of vSphere vVols with those of a traditional VM file system (VMFS).

Table 2) Benefits of vVols.

Feature	vVols	VMFS	Benefits of use
Quality of service (QoS)	Per virtual machine disk (VMDK)	Per volume	VM-level and VMDK-level performance control. No data movement is needed to change performance. Eliminates interVM contention.
Deduplication	Native format on array	VMDK files in VMFS	Higher deduplication ratio delivers higher effective capacity.
UNMAP	Automatic	Semi-automatic*	Space is returned to the storage array when the guest OS deletes data or when a VM is deleted.
Snapshots	Offload to array	No offload	Instant operation that is more space efficient with no data to copy. Also eliminates the performance degradation seen with VMware snapshots.
Clones	Offload to array	Partial offload**	Instant operation that is more space efficient with no data to copy.
Volumes: VMware ESXi	64,000	256	Removes the traditional LUN limitation.

Feature	vVols	VMFS	Benefits of use
Datastore capacity	Full array capacity	Limited by LUN	"Unlimited" scale for datastores.
VMs per datastore	No hard limit	Maximum 2,048; <20 is typical	Removes limits on the number of VMs per datastore by eliminating VMFS locking issues.
New storage allocation for VMs	Autocreation of vVols.	Might require SAN admin to provision new LUNs	The scope of VM deployment is solely in the domain of the virtual infrastructure administrator. Eliminates the steps required to provision new SAN resources.
VM I/O requirements change	Update SPBM policy	Manually change volume QoS	Allows for faster response to new I/O requirements.

*This property depends on the VMware vSphere version, guest OS type, disk type, and `VMFS3.EnableBlockDelete` value.

**VMware vSphere Storage APIs for Array Integration (VAAI) XCOPY operations issue I/O commands to copy the VM. There is no I/O with vSphere vVols. The operation is fully offloaded to the array.

Getting started with vSphere vVols

The SolidFire storage system ships with the vVols feature disabled. To start provisioning vVols-backed VMs, complete the following high-level steps:

1. Enable the vVols feature on the SolidFire cluster with the SolidFire Element UI. See the section "Enable vSphere Virtual Volumes."

2. Install the vCenter Plug-In (VCP) for NetApp SolidFire. See section 4.3, "Install the NetApp SolidFire vCenter Plug-In." It might already be installed during the original install of the NetApp HCI gear.

3. Register the VASA provider with vCenter. See section 4.2, "Register the SolidFire VASA Provider."

4. Create one or more storage containers. See the "Create a Storage Container and Discover a Virtual Volumes Datastore" section.

The storage administrator must perform the one-time task of enabling the vVols feature. This step is performed with the Element UI. Enabling the vVols feature immediately initializes the SolidFire VASA provider, which the vSphere admin must register with vCenter. Other required Element configuration processes, including creating protocol endpoints (PEs), creating accounts for storage containers, starting the VASA provider service, and opening port 8444 for VASA traffic, are all performed automatically. After the storage administrator has enabled the vVols feature, no additional configuration is required in the SolidFire Element UI. All additional configuration can be completed through the vSphere client.

To make vSphere aware of the vVols feature on the SolidFire cluster, the vSphere admin must register the SolidFire VASA provider with vCenter. The VASA provider is the out-of-band control path between vSphere and the SolidFire cluster. It is responsible for executing requests on the SolidFire cluster on behalf of vSphere, such as creating VMs, making VMs available to vSphere, and advertising storage capabilities to vSphere.

The VASA provider runs as part of the SolidFire cluster master in the Element OS. The cluster master is a highly available service that fails over to any node in the cluster as needed. If the cluster master fails over, the VASA provider moves with it, making sure of high availability for the VASA provider. All provisioning and storage management tasks use the VASA provider, which handles any changes needed on the SolidFire cluster.

To take full advantage of SolidFire vVols integration with vCenter, install and register the most recent vCenter Plug-In (VCP) from NetApp SolidFire into your vCenter. The VCP provides the capabilities to examine existing vVols and storage containers and create new storage containers as needed for new projects or new tenants of the SolidFire storage. Without the VCP, management and monitoring of vVols and storage containers must be performed through the SolidFire UI or APIs.

To provision VMs to a vVols datastore, an administrator must also create one or more storage containers. Each storage container represents a vVols datastore in vSphere. After creation, a vSphere administrator can freely configure any resources made available from the storage container. The storage container is a logical construct mapped to a SolidFire account that can be used for reporting and resource allocation purposes. A single storage container has all available resources from the SolidFire cluster. If a single storage container is created, all vVols are bound to that storage container. If more granular management or multitenancy is required, an administrator can create multiple storage containers.

Appendix D describes the procedures for creating storage containers and discovering vVols datastores in the absence of the VCP.

While logically very similar, a vVols datastore is functionally different than a VMFS-based datastore. A datastore is not a formatted VMFS file system. Every VM on a vVol datastore is backed by at least two vVols. At a minimum, every VM created has a config and data vVols. Additional vVols are created on demand as vCenter requires. For more information about vVols types, see Appendix B.

After vVols datastores have been created, VMs can be provisioned and associated with the datastores. See the SPBM Policies and vSphere Tags section.

Enable vSphere vVols

You must manually enable vSphere functionality through the SolidFire Element UI. SolidFire system functionality is disabled by default, and it is not automatically enabled as part of a new installation or upgrade. Enabling the vVols feature is a one-time configuration task.

Note: After being enabled, vSphere vVols functionality cannot be disabled. Enabling vVols functionality permanently changes the Element configuration. You should only enable vVols functionality if your cluster is connected to a VMware ESXi vVols-compatible environment. You can only disable the vVols feature and restore the default settings by returning the cluster to the factory image.

Prerequisites

- The SolidFire cluster must be running Element OS version 9.2 (Fluorine) or later.
- The SolidFire cluster must be connected to an ESXi 6.0 or later environment that is compatible with vVols.

Procedure

1. In the Element UI, go to Clusters > Settings.
2. Find the cluster-specific settings for vSphere vVols.
3. Click Enable Virtual Volumes.
4. Click Yes to confirm the vSphere vVols configuration change.

   The vVols tab displays in the Element OS UI.

   Note: When vVols functionality is enabled, the SolidFire cluster starts the VASA provider, opens port 8444 for VASA traffic, and creates protocol endpoints (PEs) that can be discovered by vCenter and all ESXi hosts.

5. Copy the VASA provider URL from the vSphere vVols settings in Clusters > Settings. You use this URL to register the VASA provider in vCenter. See section 4.2, "Register the SolidFire VASA Provider."
6. Create a storage container. See section 4.4, "Create a Storage Container and Discover a Virtual

Volumes Datastore."

Note: You must create at least one storage container so that VMs can be provisioned to a vVols datastore.

1. Go to vVols > Protocol Endpoints.

2. Verify that a PE has been created for each storage node in the cluster.

Note: Additional configuration tasks are required in vSphere. See the sections "Register the SolidFire VASA Provider," "Create a Storage Container and Discover a Virtual Volumes Datastore," and "Create SPBM Policy."

Register the SolidFire VASA provider

You must register the SolidFire VASA provider with vCenter so that vCenter is aware of vVols functionality on the cluster. Registering the VASA provider with vCenter is a one-time configuration task.

Prerequisites

- SolidFire Element OS version 9.2 (Fluorine) or later.
- You have enabled the vVols feature on a SolidFire cluster. See the "Enable vSphere Virtual Volumes" section.
- vCenter version 6.x., 7.x
- ESXi hosts version 6.x, 7.x

Caution: Do not register a SolidFire VASA provider to more than one vCenter instance unless it is with Element 12, in which case you can. The SolidFire VASA provider can only be registered to a single vCenter due to limitations with how vCenter handles SSL.

Procedure

1. Select the vCenter instance for which you want to register the SolidFire VASA provider.

2. Select Configure > Storage Providers.

3. From Storage Providers, click Add.

The New Storage Provider dialog box displays.

4. Enter the following information:

   a. The VASA provider name

   b. The VASA provider URL

   Note: The VASA provider URL is available in the vVols settings in Clusters > Settings in the Element OS UI. Use the IP address in the URL as seen below.

a. The administrative account user name for the SolidFire cluster

b. The administrative account password for the SolidFire cluster 5. Click OK to add the VASA provider.

5. Click Yes to install the SolidFire SSL cert when prompted.

The SolidFire VASA provider should now be registered with a status of Connected (or Active depending on your vSphere version).

Refresh the storage provider, if necessary, to show the current status of the provider after registering the provider for the first time.

Install the NetApp SolidFire vCenter Plug-In

The NetApp SolidFire configuration plug-in for vCenter makes most SolidFire management functions available through the vSphere Web Client.

Prerequisites

- SolidFire Element version 9.2 (Fluorine) or later
- vCenter version 6.x, 7.x
- ESXi hosts version 6.x, 7.x

Procedure

Download a management node (mNode) open virtualization appliance (OVA) with VCP in the name from your NetApp Support portal or contact your NetApp support representative. Upon publication of this document, the most recent plug-in version was VCP 4.4.0. Examples in this document include the VCP

4.3.0 display and explain VCP 4.3.0 procedures. Later releases might have a different appearance and more features than described here.

Note: If you are using NetApp HCI, the vCenter plug-in is installed automatically when you configure the system.

To deploy vCenter Plug-In to manage the NetApp SolidFire nodes, an mNode OVA with OVA in the name (for example, `2020_cert_solidfire-fdva-sodium-patch7-11.7.0.76.ova`) must be deployed. To deploy an mNode with the ability to manage NetApp SolidFire nodes from vCenter, complete the following steps:

1. Navigate to vCenter and deploy the mNode OVA with VCP in the name.
2. Power on the mNode VM you just deployed and assign it an IP address.
3. Navigate to mNode IP:9443.
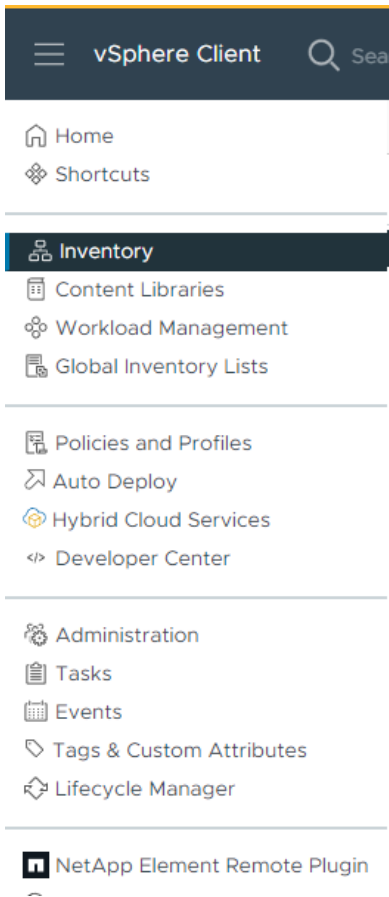4. Click vCenter Plug-in Registration.

5. On the Register Plug-in page, enter information about the vCenter. Click Register.
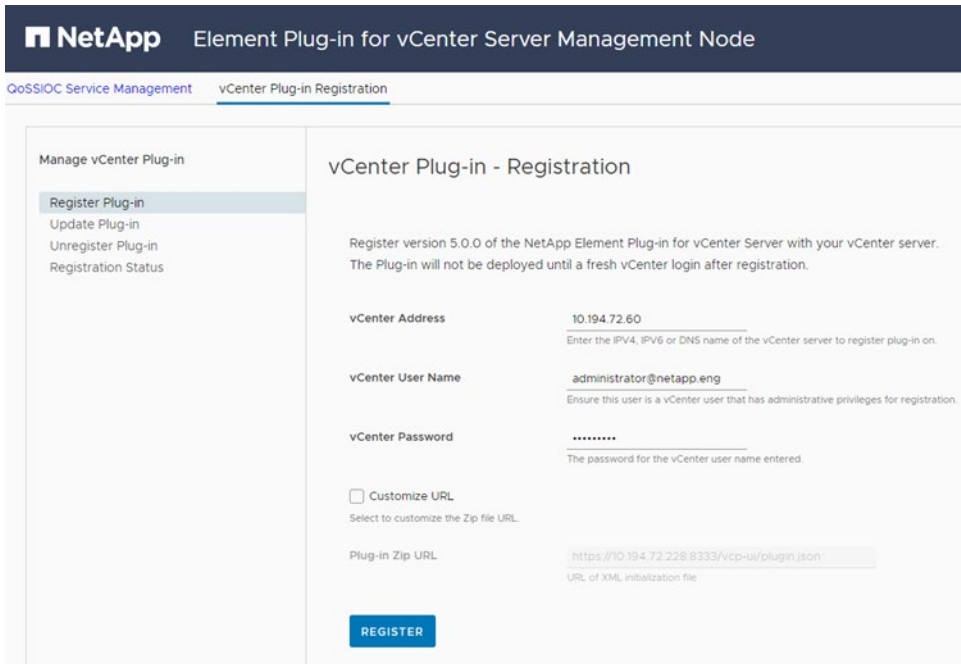
If the registration is successful, a message displays on the page.

6. Log in to vCenter and verify that the plug-in is successfully installed. The following NetApp Element Remote Plugin will appear in the 3-stack menu.

7. Click the Configuration tab. In the Clusters tab, click Add Cluster. On the Add Cluster popup, enter a FQDN or management virtual IP address (MVIP) of the storage cluster. Click OK.

8. The Clusters table displays the new cluster.

Create a storage container and discover a vVols datastore

After the vCenter plug-in has been installed, use the NetApp SolidFire Management item from the selection list to create storage containers and discover datastores.

Prerequisites

- SolidFire Element version 9.2 (Flourine) or later.
  - VSphere 8 requires 12.7 or later
- You have enabled the vVols feature on a SolidFire cluster. See the "Enable vSphere Virtual Volumes" section.
  - vCenter version 6.x., 7.x, 8.x
  - ESXi hosts version 6.x, 7.x, 8.x
  - NetApp SolidFire VCP 4.0 or later.

  Note: If you do not have the NetApp SolidFire vCenter Plug-In installed, see Appendix D for the procedure to manually create a storage container and discover a datastore.

Procedure

1. In vCenter, select NetApp Element Remote Plugin > Management > vVols.
2. Go to the Storage Containers tab. Any existing storage containers are displayed.
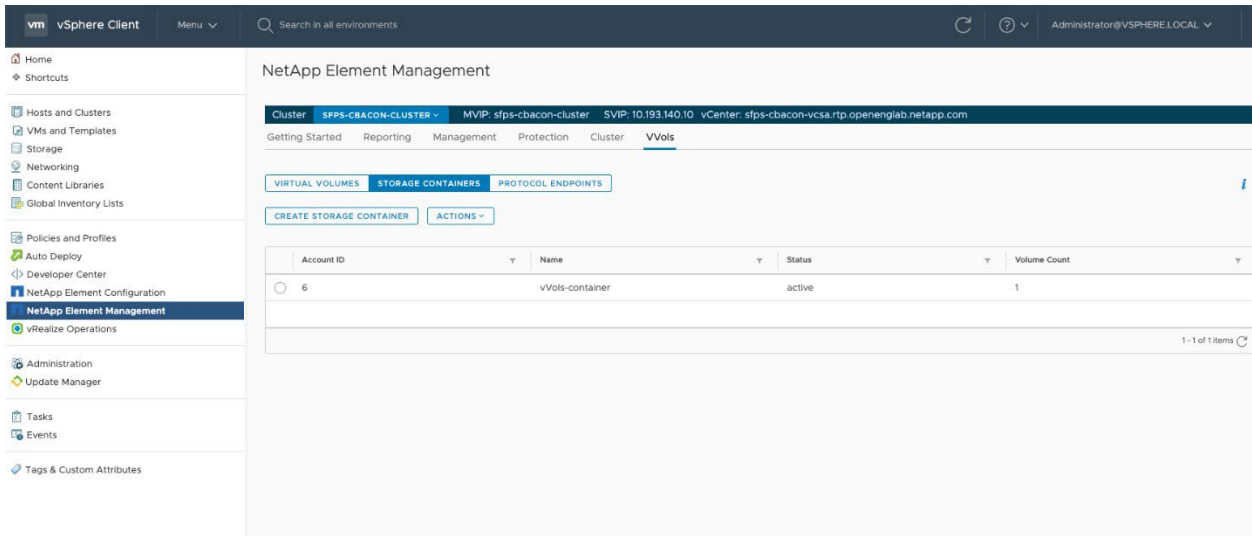
3. Click Create Storage Container.

4. Enter a name for the storage container.

> **Best practice**
>
> Leave the CHAP Settings fields blank to automatically generate secrets.

5. The name used for the storage container is automatically used for the datastore name. You can use any name to replace the datastore name.

6. Select the hosts that can access the datastore.
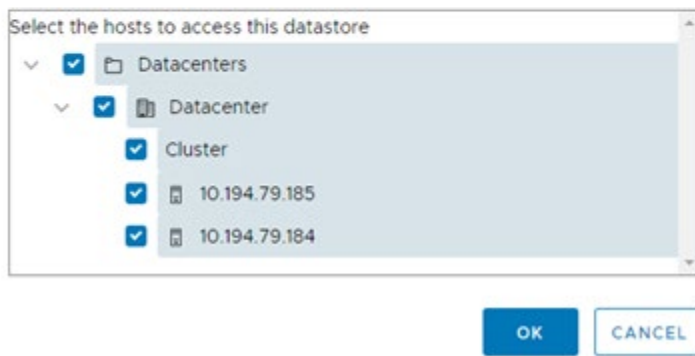
Create Storage Container

Storage Container Name *   vvol-ds1

Initiator Secret   CHAP authentication for initiat·

Target Secret   CHAP authentication for targe·

☑ Create a datastore

Datastore Name *   vvol-ds1

Select the hosts to access this datastore

- ☑ 🗀 Datacenters
  - ☑ 🏢 Datacenter
    - ☑ Cluster
      - ☑ 🖥 10.194.79.185
      - ☑ 🖥 10.194.79.184

OK   CANCEL

7. Click OK to finish creating the storage container and the vVols datastore.

Note: The storage container is created on the SolidFire storage immediately. However, it takes a minute or two for vSphere to discover the datastores for all hosts. Check the vSphere Client tasklog to gauge the discovery progress.

SPBM policies and vSphere tags

After one or more vVols datastores have been created, you can provision VMs associated with those datastores. The provisioning process works the same as creating a VM in a VMFS datastore.

To take full advantage of vVols on SolidFire, you can create VM storage policies that drive initial placement and control QoS policies on the VMs. For example, a vSphere environment might require storage consumption reporting for the four business units it supports. To meet this requirement, the business decides to segment VMs based on the business unit (BU) they support with each BU assigned a dedicated vVols datastore. Table 3 illustrates this structure.

Note: Storage policies are always applied to vVols. If a specific policy is not chosen, VMware assigns a No Requirement Policy to any vVols that is created during the deployment of a VM.

Table 3) Business unit organization.

Business unit	Datastore name	Tags	SPBM policies
Finance	INF-FIN-01	Finance	FIN-POL-APPSRV; FINPOL-WS

Business unit	Datastore name	Tags	SPBM policies
Engineering	INF-ENG-01	Engineering	ENG-POL-WS-2Disk; ENG-POL- QA-High
Support	ING-SUP-01	Support	SUP-POL-VDI-Default; SUP- POL-VDI-Maint
Sales	INF-SAP-01	Sales	SAL-POL-WS; SAL-POLDT

In addition to SPBM policies, vSphere tags can be used to automatically guide placement of new VMs.

This two-tier arrangement of tags and policies means that the tags determine which vVols datastores are compatible for VM placement, and the SPBM policies determine the performance profiles of those VMs. This arrangement provides granular reporting from both vCenter and SolidFire as well as a per-VMDK storage performance SLA that can be dynamically updated without requiring any data movement.

Additionally, you can create granular storage profiles for VMs that serve a specific purpose. For example, a vSphere administrator can provision specific performance profiles for a SQL database for each disk so that the database, log, backup, and tempdb disks all have individual QoS policies applied. These policies can be set at deployment and then monitored with compatibility checks.

Configure vSphere tags

Optionally, you can use tags for granular control over VM placement if there are multiple vVols datastores in the vCenter inventory.

Procedure

1. In vCenter, go to Menu > Tags & Custom Attributes.
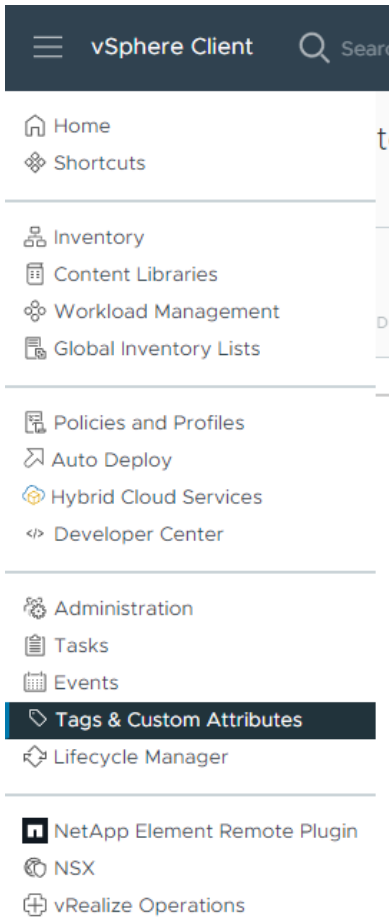
2. Select the Categories tab.
3. Click New.
4. Configure the following details:
   a. Enter a name for the category in the Category Name field.
   b. Enter a description in the Description field.
   c. Select the Many Tags Per Object option in the Cardinality field.
   d. Select the following items from the Associable Object Types list:
   – Datastore
   – Datastore Cluster (only select if using datastore clusters). Click OK.

Add Category

Category Name:	SolidFire
Description:	Tags for SolidFire storage provisioning

Tags Per Object: ○ One tag   ● Many tags

Associable Object Types:

☐ All objects

☐ Folder	☐ Cluster	☐ Datacenter
☑ Datastore	☑ Datastore Cluster	☐ Distributed Port Group
☐ Distributed Switch	☐ Host	☐ Content Library
☐ Library Item	☐ Network	☐ Resource Pool
☐ vApp	☐ Virtual Machine	

CANCEL   OK

5. Click Tags.

6. Click New.

7. In the New Tag dialog box, enter the following information:

    a. Provide a name for the tag in the Name field.

    b. Provide a description for the tag in the Description field.

    c. Choose SolidFire from the Category list.

    d. Click OK.

Create Tag

Name:	New Tag
Description:	Tag for ....
Category:	test

Create New Category

CANCEL   CREATE

8. (Optional) Follow steps 6 through 7 to create additional tags as needed.
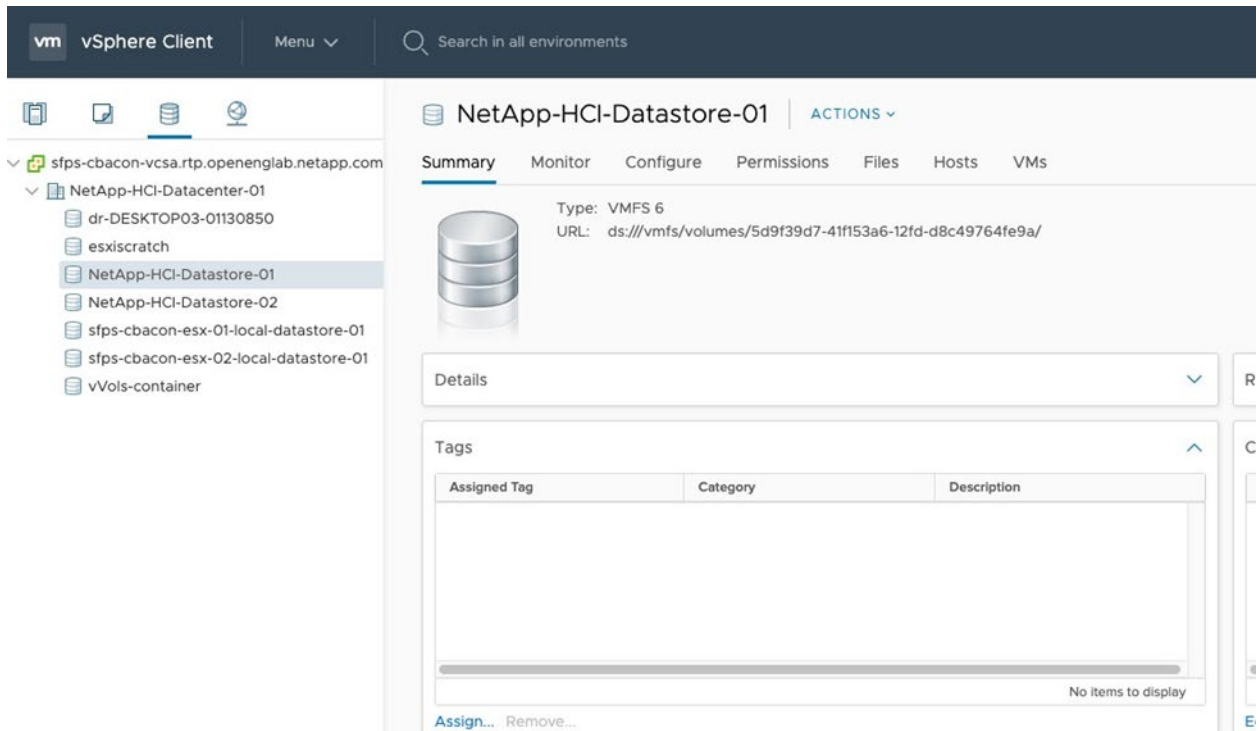
Apply tags to vVols datastores

You can use tags to help with provisioning new or existing VMs that are being migrated into vVols. Only appropriately tagged vVol datastores display as compatible storage.
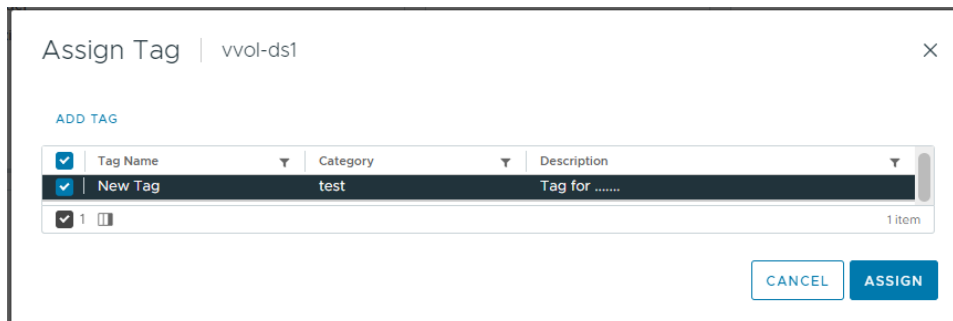
Prerequisites

- Existing tags
- Existing vVols datastores

Procedure

1. In vCenter, select a vVols datastore in the Navigator pane.

2. Click Assign at the bottom of the Tags widget.
3. Select the appropriate tags to apply to the datastore and click Assign.
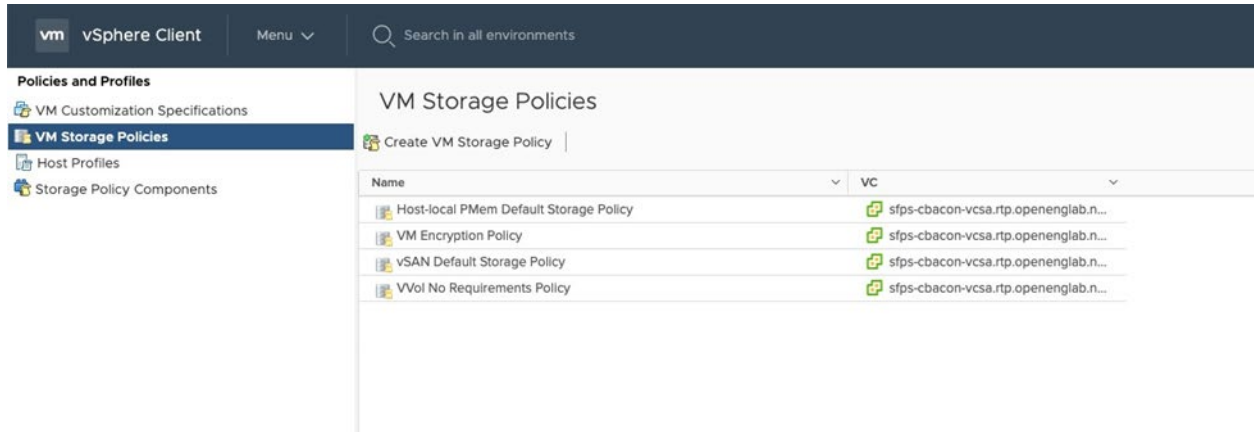

Create an SPBM policy

You can create SPBM policies to set QoS metrics for VM virtual disks.
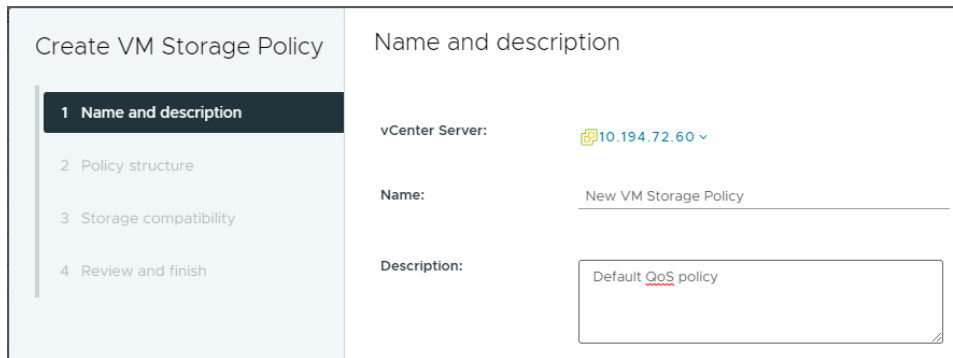
Prerequisites

The SolidFire VASA provider must be registered with vCenter.

Procedure

1. In vCenter, go to Policies and Profiles.

2. Click VM Storage Policies.
3. Click Create.
4. In the Create New VM Storage Policy dialog box, enter the following information:
   a. Select a vCenter server.
   b. Enter a name for the policy.
   c. Enter a description of the policy.
   d. Click Next.

5. Click Next to move through the Policy Structure page.
6. Under Datastore Specific rules, complete the following steps:
   a. Enable rules for "com.solidfire.vasa..." (enable both if there are two).
   b. Select Next.
   c. Set a guaranteed minimum IOPS value for VMDKs using this policy in the Data vVols Minimum IOPS field.
   d. Set a maximum IOPS value for VMDKs using this policy in the Data vVols Maximum IOPS field.
   e. Set a burst IOPS value for VMDKs using this policy in the Data vVols Burst IOPS field.
   f. Use the default values for the following fields:

- Config vVols Minimum IOPS
- Config vVols Maximum IOPS
- Config vVols Burst IOPS

Caution: Specifying a higher value for Config vVols Minimum IOPS unnecessarily consumes a portion of the cluster IOPS budget for each VM created.

7. Verify that the desired storage is listed as Compatible and click Finish.

Apply policies to VM templates

You can apply an SPBM template to make sure that VMs deployed from those templates are guided to the correct vVols datastores and have a predetermined QoS profile applied to them.

Note: Applying SPBM policies to VM templates is optional. As an alternative, you can apply SPBM policies during the provisioning of the VM with vSphere.
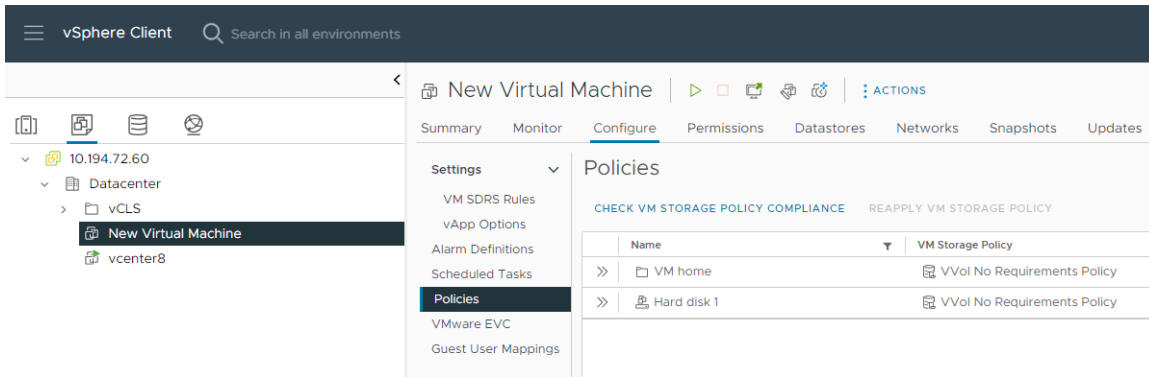
Prerequisites

- SPBM policies must already be defined.
- Templates must be converted to standard VMs.

Procedure

1. In vCenter, click Inventory > VMs and Templates
2. Select the target VM for the policy.
3. Convert the template to a VM if needed.

    Note: You can only apply policies to standard VMs. Templates are read-only.

4. Select the Configure tab.
5. Click the Policies tab.

6. Click Edit VM Storage Policies and complete the following steps:

   a. In the VM Storage Policies dialog box, select the policy to apply from the VM storage policy list.

   b. Click OK.
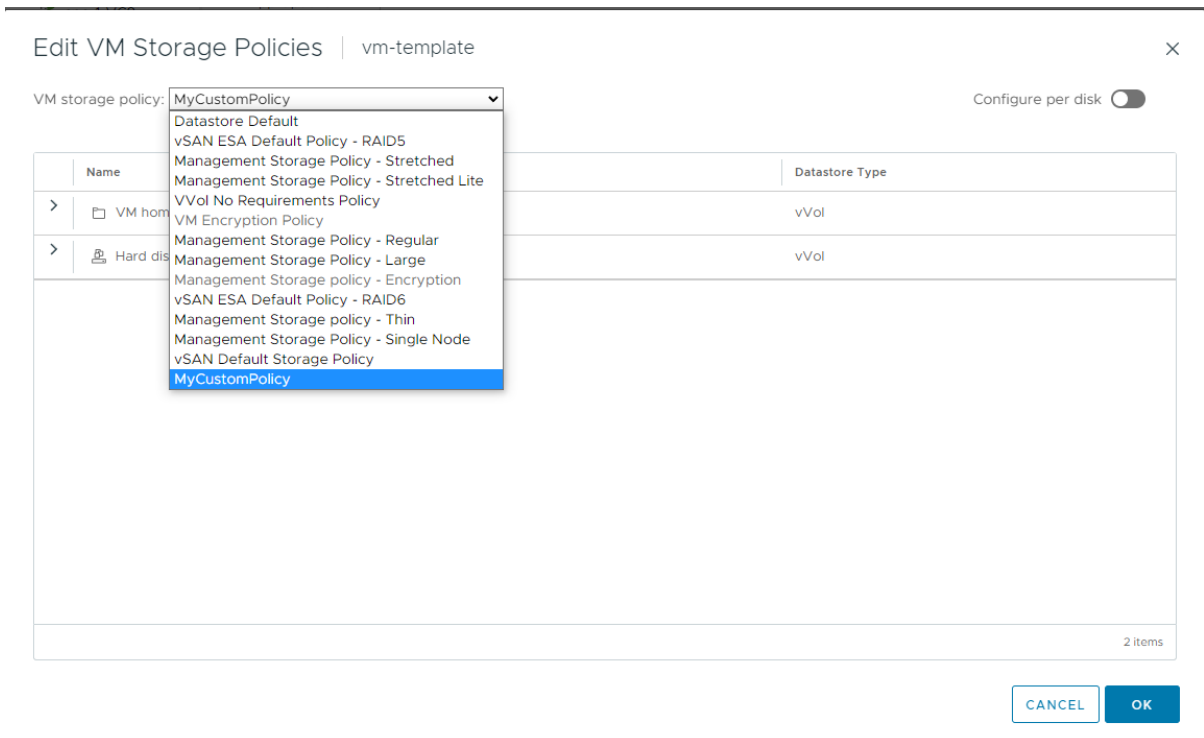
   c. Click OK to apply the policy.

   Note: If the target VM template is stored on a VMFS datastore, the SPBM policy has no effect until you deploy a VM from the template to a vVols datastore. Until this happens, the compliance status appears as Not Applicable.

7. Convert the VM back to a template by right-clicking the VM and selecting Template > Convert to Template.

Deploy VMs

You can deploy a VM from a VM template that contains both an SPBM policy (rules that are based on data services) and a vSphere tag (rules that are based on tags). The data services component of the

SPBM policy controls the QoS profile to be configured for the VM, and the tag component controls which datastores are compliant.

Starting with Element 12, and vSphere 6.7 you can use vVols to create a cluster that allows SCSI-3 reservations. You would create a VM as you normally would, but multiple VMs could use the same disk. This is the VMware-recommended way to avoid using raw device mappings (RDMs).

Prerequisites

The SPBM policy must be configured and applied to the VM template.

Procedure

1. In vCenter, select the VM template to deploy.
2. Right-click the VM and select New VM from This Template.
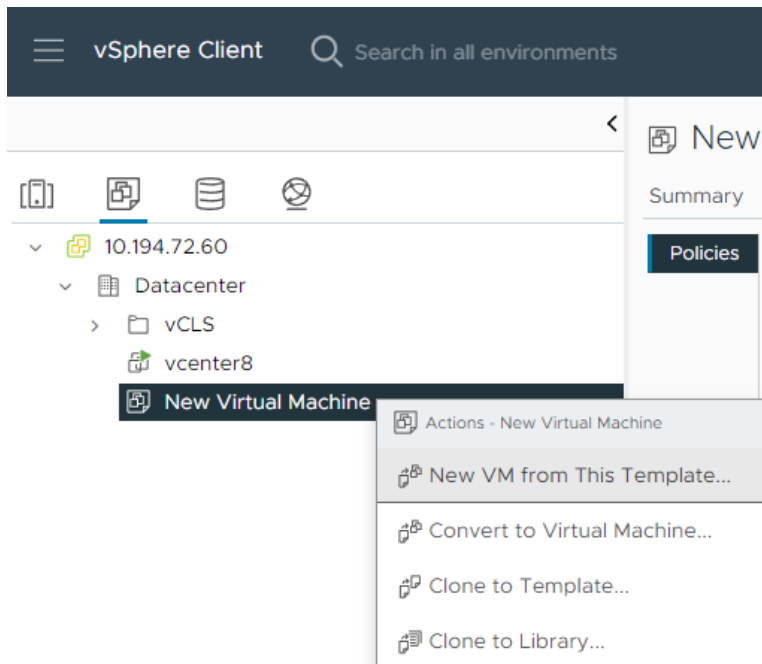
3. In the Deploy from Template wizard, complete the following steps:
   a. Provide a name for the VM.
   b. Select a folder for the VM.
   c. Select the vSphere cluster for the VM.
   d. Select storage for the VM. The SPBM policy and tags applied to the VM control which vVols datastores appears as compatible.

Select storage

Select the storage for the configuration and disk files

BATCH CONFIGURE | CONFIGURE PER DISK

☐ Encrypt this virtual machine (Requires Key Management Server)

Select virtual disk format   Thin Provision ⌄

VM Storage Policy   New VM Storage Policy ⌄

☐ Disable Storage DRS for this virtual machine

	Name ▼	Storage Compatibility ▼	Capacity ▼	Provisioned ▼	Free ▼	Type ▼	
●	🗄 vvol-ds1	Compatible	502.95 TB	88.18 GB	502.91 TB	vVol	
○	🗄 datastore1 …	Incompatible	216 GB	6.01 GB	209.99 GB	VMFS 6	

Items per page   10 ⌄

     e.   Select clone options and click Next.

     f.   Click Finish.

4. Click the Configure tab for the newly deployed VM.

5. Click Policies and make sure the applied policy is listed as compliant.

🖥 vm2   ▷ ☐ 🖥 🖥 🖥   ⋮ ACTIONS

Summary   Monitor   **Configure**   Permissions   Datastores   Networks   Snapshots   Updates

Settings ⌄   **Policies**

VM SDRS Rules   CHECK VM STORAGE POLICY COMPLIANCE   REAPPLY VM STORAGE POLICY

vApp Options

Alarm Definitions

Scheduled Tasks

Policies

Guest User Mappings

	Name ▼	VM Storage Policy ▼	Compliance Status
»	📁 VM home	🖥 New VM Storage Policy	✓ Compliant
»	🖥 Hard disk 1	🖥 New VM Storage Policy	✓ Compliant

6. To verify the QoS settings for the VM, complete the following steps:

     a.   Browse to the SolidFire Element UI.

     b.   Click the vVols tab.

     c.   Verify the QoS settings for the new vVols.

Snapshots

vVols significantly changes how snapshots are handled on shared storage. vVols enables a complete offload of the VM snapshot workflow to the storage system. SolidFire storage supports VMware snapshots through a combination of SolidFire read-only snapshots and writable clones.

Fully offloaded snapshots on SolidFire storage include the following benefits:

- Snapshots are faster to take and delete.
- All snapshots are fully independent and can be used as a basis for clones.
- Snapshots are very space efficient.
- There is no performance penalty for nested snapshots.
- There is no I/O traffic on the storage network.

VMware enables two options for snapshots of VMs:

- **Snapshot of the VM's memory (VMware default).** This is a read-only snapshot that captures both the state of the VM memory and disk contents. This type of snapshot is typically used as a quick save of the machine state to roll back to in case of a failed driver install or failed software management task. A snapshot revert operation restores the VM to its exact state at the time the snapshot was created. Table 4 summarizes the SolidFire operations performed for memory snapshots.

Table 4) Memory snapshots.

Type	Create SolidFire Snapshot?	Creates new SolidFire volume?
Data	Yes, one per data vVols per snapshot	No
Config	No	No
Memory	No	Yes, one per snapshot
Swap	No	No

- **Quiesce guest file system.** This is a writable snapshot of the VM state that quiesces (flushes and stops operations to) the file system contents to disk for backup. The VM must have VMware Tools installed on the guest operating system to take this type of snapshot. A snapshot revert operation restores the VM to a crash-consistent and powered-off state. Table 5 summarizes the SolidFire operations performed for quiesced snapshots.

Table 5) Quiesced snapshots.

| Type	Create SolidFire Snapshot?	Creates New SolidFire volume?
Data	No	Yes, one per data vVols per snapshot
Snapshot config	No	No
Memory	No	No
Swap	No	No

Create a VM Snapshot

You can create a VM snapshot using the vCenter interface.

Prerequisites

VMware Tools must be installed on the guest operating system if you plan to create a quiesced snapshot.

Procedure

1. In vCenter, go to the VMs and Templates tab.
2. Right-click the VM that you want to create a snapshot for and select Snapshots > Take Snapshot.
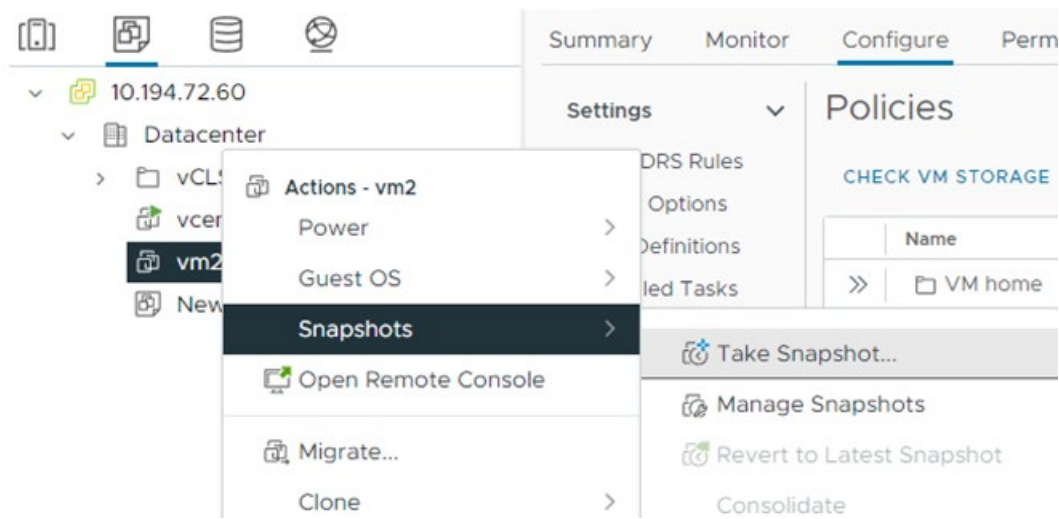
3. In the Take VM Snapshot for `<VM Name>` window, do one of the following:

   a. Select Snapshot the VM's Memory (default) for a read-only snapshot of the VM to use for rollback purposes.

   b. Clear the Snapshot the VM's Memory checkbox and select Quiesce Guest File System for a writable snapshot for VM backup purposes.

4. Enter a name for the snapshot in the Name field.

5. Enter a description for the snapshot in the Description field.

6. Click OK to create the snapshot of the VM.

Revert to a VM Snapshot

You can revert a VM to a snapshot, effectively rolling back the VM to the state at the time the snapshot was created.

Prerequisites

You must have an existing snapshot of a VM.

Procedure

1. In vCenter, open the VMs and Templates tab.

2. Right-click a VM and select Snapshots > Manage Snapshots.

3. In the Manage VM Snapshots for `<VM Name>` window, select the snapshot to revert the VM to and click Revert.
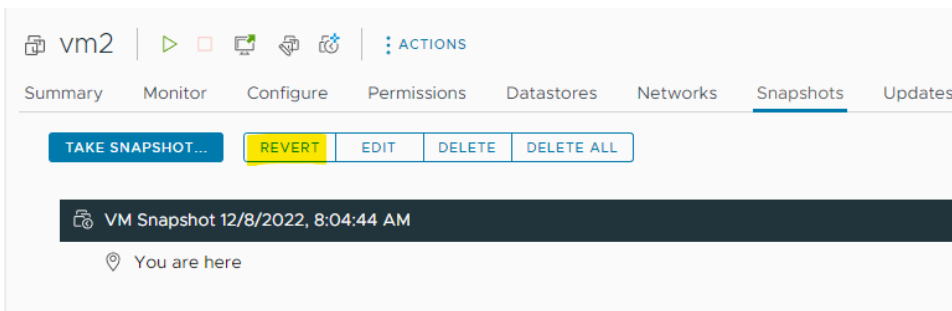
4. Click Yes to confirm the action.

Appendix A: VMware vSphere storage APIs for array integration

Prior to the vVols feature, vSphere allowed host-orchestrated offloads for certain storage tasks. This meant that a host could instruct the array to move or copy data on its behalf. However, this required the host to send SCSI commands to the array over the network or SAN fabric. With vVols, VAAI tasks are fully offloaded to the array using the VASA provider.

Fundamental VAAI operations

Table 2 describes the fundamental VAAI operations.

Table 2) Fundamental VAAI operations.

Operation	Description
ATS (atomic test and set)	The config vVols (VM home object) is formatted with VMFS and requires ATS for locking purposes, similar to standard, shared VMFS datastores.
Block zeroing (write same)	Block zeroing is fully offloaded to the array with VASA. Zero offload does not write any block data to SolidFire but does allocate metadata space.
Thin provisioning out of space (OOS)	Storage container out-of-space warnings are sent to vSphere when space allocation fails.
UNMAP	Without the VMFS layer to manage UNMAP, commands generated by the guest OS are now sent directly to the array. The supporting TRIM or UNMAP of the guest OS immediately releases space to the array.
XCOPY (extended copy)	vSphere copy commands are fully offloaded to the array using VASA for all operations, except in the case of vVols to VMFS. This is due to a limitation in the VMware data mover.

Appendix B: vVols object types

With vVols, VMs are no longer encapsulated in folders on a VMFS. Instead, each VM is built across at least two distinct vVols types (config and data).

Table 3 lists the vVols object types which each map to a unique and specific VM file.

Table 3) vVols object types

Type	Description
Config	A config vVols contains all the configuration information for a VM, including log files and the VMX file for the VM. There is always one 4GB config vVols per VM that is formatted with VMFS.

Type	Description
Data	A data vVols contains all data for a VMDK and varies in size based on VMDK capacity. There is a 1:1 mapping between VM disks and data vVols.
Swap	A swap vVol contains the swap file space for a VM and is only created and bound at runtime for the VM. It is destroyed when the VM is powered off. There is always one swap vVols per powered-on VM.
Memory	This vVols is created whenever a snapshot containing the VM memory is created. There is always one memory vVols per snapshot and its size depends on memory size.
Other	A vSphere solution-specific object.

Appendix C: Glossary

Table 4) Glossary of terms

Term	Definition
C	
Challenge-Handshake Authentication Protocol	Authenticates a user or network to an authenticating entity.
CHAP	See Challenge-Handshake Authentication Protocol.
Cluster	A contiguous group of nodes on a storage system.
I	
Internet Small Computer System Interface	Internet Protocol (IP)–based storage networking standard for linking data storage facilities. iSCSI carries SCSI commands over an IP network to facilitate data transfers over the internet, LANs, or WANs.
iSCSI	See Internet Small Computer System Interface.
N	
Node	A SolidFire node is a physical group of SSD drives. Each node in a cluster has CPU capability and storage resources and can connect to a network.
P	
PE	See protocol endpoint.
Protocol endpoint	A protocol endpoint (PE) is the access point used by a host to address storage on a SolidFire cluster. A SolidFire cluster automatically creates one protocol endpoint per storage node in the cluster. Therefore, a six-node SolidFire array has six PEs that are mapped to each ESXi host. PEs are dynamically managed by SolidFire and are created, moved, or destroyed as needed without any intervention. PEs are the target for multipathing and act as an I/O proxy for subsidiary (or sub) LUNs. Each PE consumes an available SCSI address, just like a standard iSCSI target. Protocol endpoints appear as a single-block (512-byte) storage device in the vSphere client, but this storage device is not available to be formatted or used as storage.
S	

Term	Definition
SPBM	See storage policy-based management.
Storage container	A storage container is a datastore representation created on a SolidFire cluster. Storage containers are created and tied to accounts on SolidFire. A storage container created on SolidFire storage appears as a vSphere datastore in vCenter and ESXi. Storage containers do not allocate any space on SolidFire storage. They are simply used to logically associate vVols.
Storage policy-based management	Storage policy-based management (SPBM) is a policy-based framework for provisioning storage for VMs. SPBM enables the creation of storage policies with specific QoS values for entire VMs or for individual virtual disks (VMDKs). When an SPBM policy is applied to a VM or VMDK, the policy automatically guides the creation or modification of storage objects to meet the policy requirements.
Subsidiary LUN	Sub LUNs map to vVols and are used to address SCSI commands to a particular vVol. Sub LUNs do not show up as storage devices in the vCenter inventory.
T	
Thin provisioning	Thin provisioning is used to provide the right amount of storage at the time it is needed. This eliminates capacity consumption due to overprovisioning volumes or underutilized volumes.
V	
VASA	Virtual machine API for storage awareness. SolidFire supports all of VASA version 2.0.
VASA provider	The software component that provides storage awareness services and can manage multiple arrays. The VASA provider creates vVols. The VASA provider is a highly available service that runs internally to the SolidFire cluster as part of the cluster master service. It is responsible for managing VM storage requests from vCenter and ESXi, including creating, modifying, and deleting vVols and its attributes as dictated by SPBM policies that have been applied to those VMs. The VASA provider is also used by ESXi to gain access to the vVols. The VASA provider must be running and accessible to power on VMs and perform other VM operations.
Virtual Volume	The equivalent of a virtual machine disk (VMDK), but now addressable as a volume with no datastore required.
VMFS	Virtual machine file system. A high-performance cluster file system that provides storage virtualization that is optimized for VMs.
vSphere tags	Attributes that can be attached to vCenter inventory objects for purposes of filtering. See Virtual Volume.

Appendix D: Create a storage container through the SolidFire UI and discover it through vCenter

Create a storage container

You can create storage containers in the Element OS UI and discover them in vCenter. You must create at least one storage container to begin provisioning -backed VMs.

Prerequisites

You have enabled the vVols functionality in the Element OS for the cluster.

Procedure

1. In the Element OS UI, go to vVols > Storage Containers.
2. Click Create Storage Containers.
   a. Enter the following storage container information in the Create a New Storage Container dialog box: a. Enter a name for the storage container.
   b. Configure initiator and target secrets for the Challenge-Handshake Authentication Protocol (CHAP).

Best practice

Leave the CHAP Settings fields blank to automatically generate secrets.

   c. Click Create Storage Container.
3. Verify that the new storage container appears in the list from the Storage Containers tab.

Because a SolidFire account ID is automatically created and assigned to the storage container, you do not need to manually create an account.

Create a vVols datastore

You must create a vVols datastore that represents the storage container on the SolidFire cluster in vCenter. You must create at least one vVols datastore to begin provisioning vVols-backed VMs.
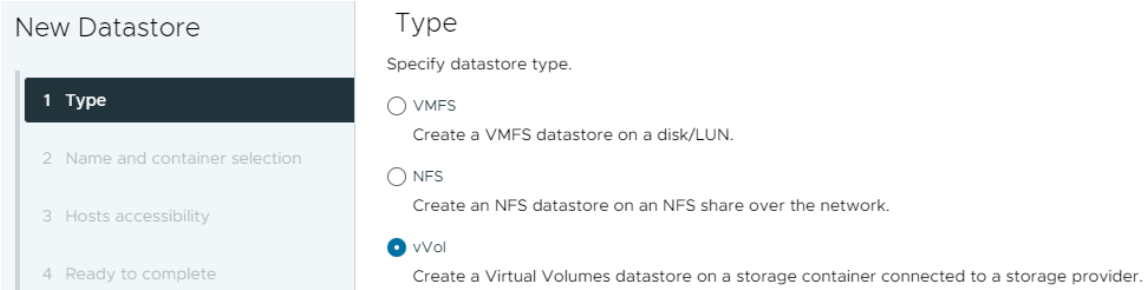
Prerequisites

- A SolidFire cluster that has the vVols functionality enabled.
- A storage container exists in the virtual environment.
- The VASA provider is registered with vCenter.

   Note: You might need to rescan SolidFire storage in vCenter to discover storage containers.

Procedure

1. In vCenter, click Storage and select the Datastores tab.
2. Right-click the Datacenter > Storage > New Datastore.
3. Select vVols as the type of datastore to create.

4. Provide a name for the datastore in the Datastore Name field.
5. Select the SolidFire storage container from the Backing Storage Container list.

Note: You do not need to manually create PE LUNs. They are automatically mapped to the ESXi hosts when the datastore is created.

6. Click Next.
7. Select the hosts you want to have access to the vVols datastore.
8. Click Finish to create the vVols datastore and map it to the selected hosts.

Where to find additional information

To learn more about the information described in this document, refer to the following documents and/or websites:

- NetApp SolidFire Resources
  https://mysupport.netapp.com/info/web/ECMLP2740378.html
- NetApp Element Plug-in for VMware vCenter Server documentation
  NetApp Element Plug-in for VMware vCenter Server documentation-117/index.jsp

Version history

Version	Date	Document version history
Version 1.2	January 2023	Updates for vSphere 7 and 8 by Adam Kittel and Michael White
Version 1.1	March 2020	Updates to cover VMware and vVols updates.
Version 1.0	October 2017	Initial release.

Refer to the on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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