Technical Report

VMware vSphere Virtual Volumes with ONTAP

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Abstract

NetApp worked with VMware to develop vSphere Virtual Volume support to enable policy-based management of storage at the individual VMDK level. NetApp continues to extend these capabilities, and this document describes use cases, best practices and other information to use VMware vSphere Virtual Volumes (vVols) to streamline operations and reduce errors.

Why vVols for vSphere?

NetApp ONTAP software has been a leading storage solution for VMware vSphere environments for over a decade and continues to add innovative capabilities to simplify management while reducing costs. This document covers ONTAP capabilities for VMware vSphere Virtual Volumes (vVols), including the latest product information and use cases along with best practices and other information to streamline deployment and reduce errors.

Best practices supplement other documents such as guides and compatibility lists. They are developed based on lab testing and extensive field experience by NetApp engineers and customers. They might not be the only practices that work or are supported, but they are generally the simplest solutions that meet the needs of the most customers.

This document is focused on capabilities in releases of NetApp ONTAP 9 (9.8 or later) and ONTAP tools for VMware vSphere (9.10 and later), running on vSphere 7 or later.

vVols overview

NetApp began working with VMware to support vSphere APIs for Storage Awareness (VASA) for vSphere 5. This early VASA Provider allowed for the definition of storage capabilities in a profile that could be used to filter datastores when provisioning. Over time this evolved to add new capabilities to enable more automation in provisioning, as well as the addition of Virtual Volumes or vVols, where individual storage objects (LUNs, files) are used for virtual machine (VM) files and virtual disks. NetApp worked closely with VMware as a reference partner for vVols released with vSphere 6 and continues to enhance them to take advantage of the latest capabilities in ONTAP.

There are several components to be aware of:

- **VASA Provider.** This is the software component that handles communication between VMware vCenter and the storage system. For ONTAP, the VASA Provider runs in a VM together with the Virtual Storage Console (VSC) as part of the Unified Appliance. After it is configured and registered with vCenter, there is little need to directly interact with it.
- **Protocol endpoint.** The protocol endpoint is a proxy for I/O between the ESXi hosts and the vVols datastore. The ONTAP VASA Provider creates these automatically, either one protocol endpoint LUN (4MB in size) per FlexVol volume in the vVols datastore, or one NFS mount point per NFS interface (LIF) on the storage node hosting a FlexVol volume in the datastore. The ESXi host mounts these protocol endpoints directly rather than individual vVol LUNs and virtual disk files. There is no need to manage the protocol endpoints because they are created, mounted, and deleted automatically by the VASA Provider along with any necessary interface groups or export policies.
- **Virtual Volume datastore.** The Virtual Volume datastore is a logical datastore representation of a vVols container that is created and maintained by a VASA Provider. The container represents a pool of storage capacity provisioned from storage systems managed by the VASA Provider. ONTAP tools supports allocating multiple FlexVol volumes (referred to as backing volumes) to a single Virtual Volume datastore, and these Virtual Volume datastores can span multiple nodes in an ONTAP cluster, combining flash and hybrid systems with different capabilities. They are provisioned by selecting a host or cluster in vCenter, and then selecting Provision vVols Datastore from the VASA Provider for ONTAP menu.

- **vVols.** vVols are the actual VM files and disks stored in the vVols datastore. ONTAP creates LUNs or files depending on whether a datastore uses SAN or NAS protocols. There are several different types of vVols; the most common are Config (metadata files), Data (virtual disk or VMDK), and Swap (created when VM is powered on). vVols protected by VMware VM encryption are of type Other. VMware VM encryption should not be confused with ONTAP volume or aggregate encryption.

Policy-based management

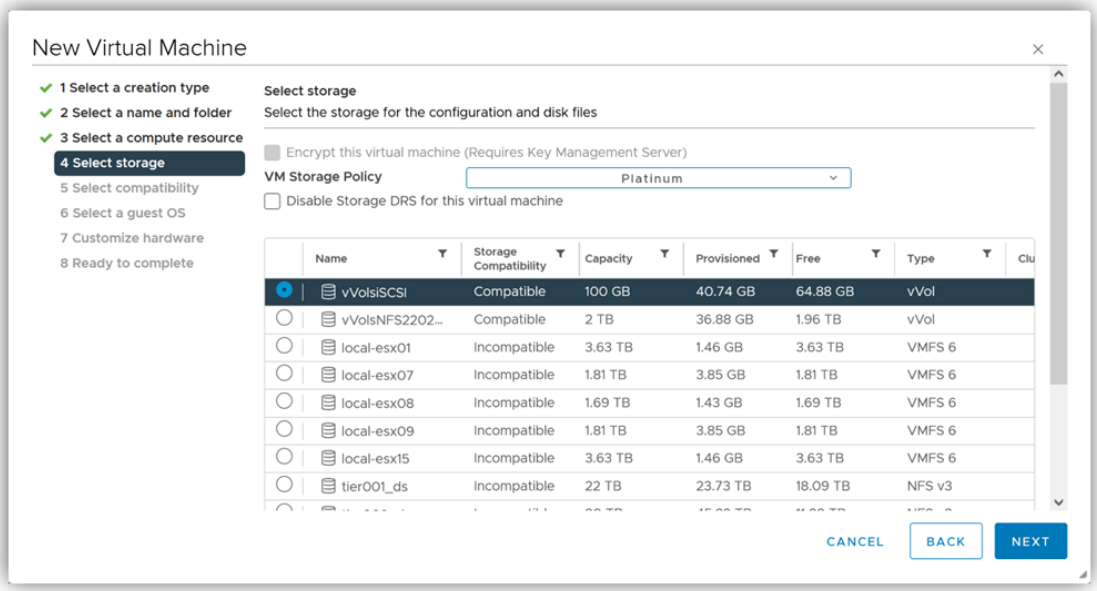
VMware vSphere APIs for Storage Awareness (VASA) make it easy for a storage administrator to configure datastores with well-defined capabilities, and they let the VM administrator use these datastores whenever needed to provision VMs without having to interact with each other. Prior to VASA, VM administrators could define VM storage policies, but they then had to work with the storage administrator to identify appropriate datastores, often by using documentation or naming conventions. With VASA, the storage administrator can define a range of storage capabilities that the VM administrator can then use to provision VMs with a storage policy that identifies its requirements. The mapping between a VM storage policy and a datastore storage capability profile allows vCenter to display a list of compatible datastores for selection. This approach is known as storage policy-based management. Although storage capability profiles and policies can also be used with traditional datastores, our focus here is on vVol datastores.

There are two elements:

- **Storage Capability Profile (SCP).** Individual capabilities of a volume or set of volumes are grouped together as a storage capability profile. These capabilities include performance, protocol, storage efficiency, and other storage features. They are created using the ONTAP tools for VMware vSphere menu within the vCenter UI. You can also use REST APIs to create SCPs. They can be manually created by selecting individual capabilities or automatically generated from existing (traditional) datastores.
- **VM storage policy.** VM storage policies are created in vCenter under Policies and Profiles. For vVols, create a ruleset using rules from the NetApp vVols storage-type provider. The easiest approach here is to directly reference an existing profile rather than specifying individual rules.

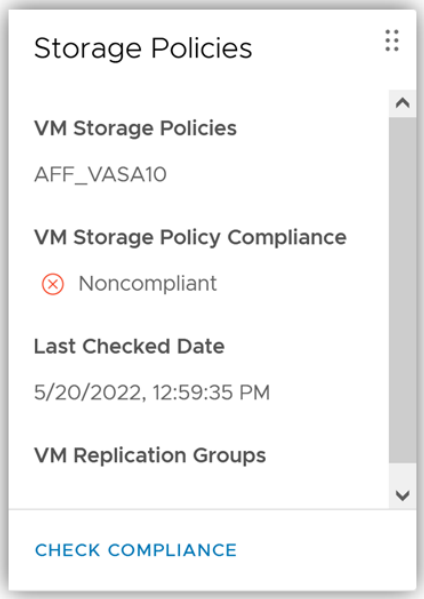
As mentioned above, using policies can help streamline the task of provisioning a volume. Select an appropriate policy, and the VASA Provider shows vVols datastores that support that policy, and then place the vVol into a compliant individual FlexVol volume, as shown in Figure 1. Provisioning a volume..

Figure 1. Provisioning a volume.



After a VM is provisioned, the VASA Provider continues to check compliance, and it alerts the VM administrator with an alarm in vCenter when the backing volume is no longer compliant with the policy, as shown in Figure 2.

Figure 2. Noncompliant storage policy.



NetApp vVols support

NetApp ONTAP has supported the VASA specification since its initial release in 2012. While other NetApp storage systems might support VASA, this document focuses on current releases of ONTAP 9.

NetApp ONTAP

In addition to ONTAP 9 on AFF and FAS systems, NetApp supports VMware workloads on ONTAP Select. Access from vSphere guests to data stored in ONTAP Cloud or NetApp Private Storage is supported, but specific functionality can vary based on the service provider and available network connectivity.

Benefits of using vVols with ONTAP

When VMware introduced vVols support with VASA 2.0 in 2015, they described it as “An integration and management framework delivering a new operational model for external storage (SAN/NAS).” This operational model offers several benefits together with ONTAP storage.

Policy-based management

As covered in the section “Policy-based management,” policy-based management allows you to provision and manage VMs using predefined policies. This can help IT operations in several ways:

- **Separate storage provisioning from VM provisioning**. This allows for independent teams or independent activities by the same team.
- **Faster provisioning.** Different storage capabilities can be supported in a single datastore and selected as appropriate for a VM based on the VM policy.
- **Avoiding mistakes.** Storage and VM policies are developed in advance and applied as needed without having to customize storage each time a VM is provisioned. Compliance alarms are raised when storage capabilities drift from the defined policies.

VM granular management on SAN

SAN storage systems using FC and iSCSI were the first to be supported by VMware for ESX, but they have lacked the ability to manage individual VM files and disks from the storage system. Instead, LUNs are provisioned and VMFS manages the individual files. This makes it difficult for the storage system to directly manage individual VM storage performance, cloning, and protection. vVols bring storage granularity that customers using NFS storage already enjoy, with the robust, high-performance SAN capabilities of ONTAP.

Greater storage offload capabilities

Although VAAI offers a variety of operations that are offloaded to storage, there are some gaps that are addressed by VASA Provider. SAN VAAI is not able to offload VMware-managed snapshots to the storage system. NFS VAAI can offload VM managed snapshots, but there are limitations placed on a VM with storage-native snapshots. Since vVols use individual LUNs or files for VM disks, ONTAP can quickly and efficiently clone the files or LUNs to create VM snapshots that no longer require delta files. NFS VAAI also does not support offloading clone operations for Storage vMotion (hot) migrations. The VM must be powered off to allow offloading of the migration. The VASA Provider for ONTAP allows for nearly instant, storage-efficient clones for hot and cold migrations, and it also supports nearly instant copies for cross-volume migrations of vVols. Because of these significant storage efficiency benefits, you might be able to take full advantage of vVols workloads under the Efficiency Guarantee program.

Common use cases for vVols

In addition to these benefits, we also see these common use cases for vVol storage:

- **On-demand provisioning of temporary VMs (labs, training).** In this case, customers use vVols with additional automation software to rapidly deploy new VMs for temporary usage in training or other labs, based on clones of existing VMs or VMDKs. Offloading clones to ONTAP are near instantaneous whether within a single volume or cross-volume.

- **On-demand provisioning of VMs (private cloud with vRealize or OpenStack automation).** As with the previous use case, clones are quickly created within a single volume or across multiple volumes in an aggregate. They are also storage efficient. Clones within a volume use ONTAP file clone, which are like FlexClone volumes and only store changes from the source vVol file or LUN. Therefore, long-term VMs for production or other application purposes are created quickly, take minimal space, and can benefit from VM-level protection (using NetApp SnapCenter Plug-in for VMware vSphere, Vmware snapshots, or VADP backup) and performance management (with ONTAP QoS).

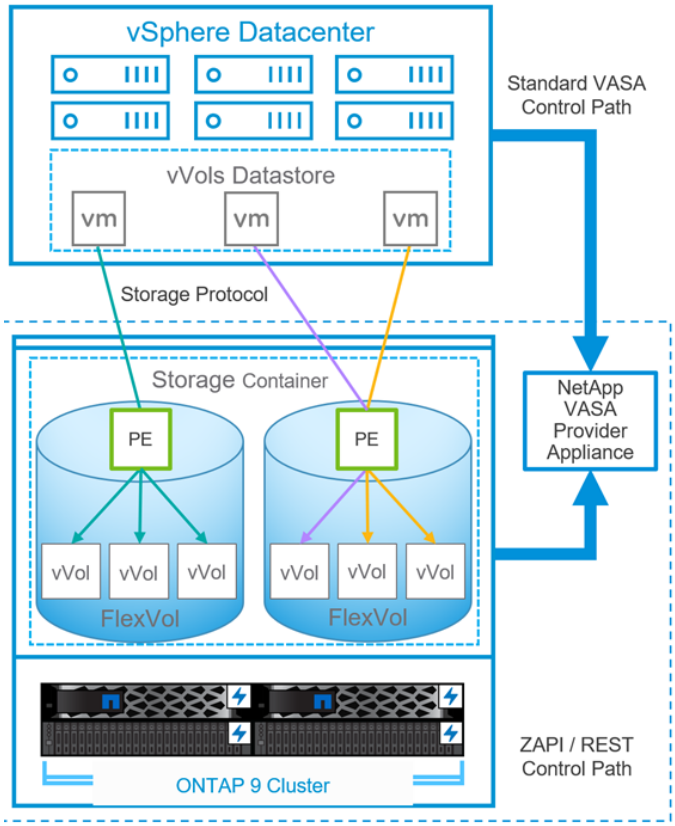
Using vVols with ONTAP

The key to using vVols with ONTAP is the VASA Provider software included as part of the ONTAP tools for VMware vSphere virtual appliance. ONTAP tools also includes vCenter UI extensions, REST API server, Storage Replication Adapter for VMware Site Recovery Manager (SRM), monitoring and host configuration tools, and an array of reports that help you to better manage your VMware environment.

Products and documentation

An ONTAP FlexClone license and the ONTAP tools appliance are the only additional products required to use vVols with NetApp ONTAP. Recent releases of ONTAP tools are supplied as a single unified appliance that runs on ESXi, providing the functionality of what formerly were three different appliances and servers. For vVols, it is important to use the ONTAP tools vCenter UI extensions or REST APIs as general management tools and user interfaces for ONTAP functions with vSphere, together with the VASA Provider, which provides specific vVols functionality. The SRA component is included for traditional datastores, but VMware SRM does not use SRA for vVols, instead implementing new services in SRM 8.3 which leverage the VASA provider for vVols replication.

Figure 3. ONTAP VASA Provider architecture.



Product installation

For new installations, deploy the virtual appliance into your vSphere environment. Current releases of ONTAP tools automatically register themselves with your vCenter instance and enable the VASA Provider by default. In addition to ESXi host and vCenter Server information, you also need the IP address configuration details for the appliance.

As previously stated, the VASA Provider requires that the ONTAP FlexClone license is already installed on any ONTAP clusters that you plan to use for vVols. The appliance has a built-in watchdog to ensure availability and, as a best practice, should be configured with the VMware High Availability and optionally Fault Tolerance features. See the section "VASA provider high availability" for additional details. Do not install or move the appliance to vVols storage because doing so can prevent the appliance from restarting.

In-place upgrades of ONTAP tools is supported by using the upgraded ISO file available for download on the NetApp Support Site (NSS). Follow the Deployment and Setup Guide instructions to upgrade the appliance.

For sizing your virtual appliance and understanding configuration limits, see the Sizing Guide for ONTAP tools for VMware vSphere.

Product documentation

The following documentation is available to help you deploy ONTAP tools. For the complete documentation repository, visit docs.netapp.com.

Get started

- Release notes
- Learn about ONTAP tools for VMware vSphere
- ONTAP tools Quick start
- Deploy ONTAP tools
- Upgrade ONTAP tools

Use ONTAP tools

- Provision traditional datastores
- Provision vVols datastores
- Configure role-based access control
- Configure remote diagnostics
- Configure high availability

Protect and manage datastores

- Protect your datastores
- Protect virtual machines
- Monitor traditional datastores and virtual machines
- Monitor vVols datastores and virtual machines

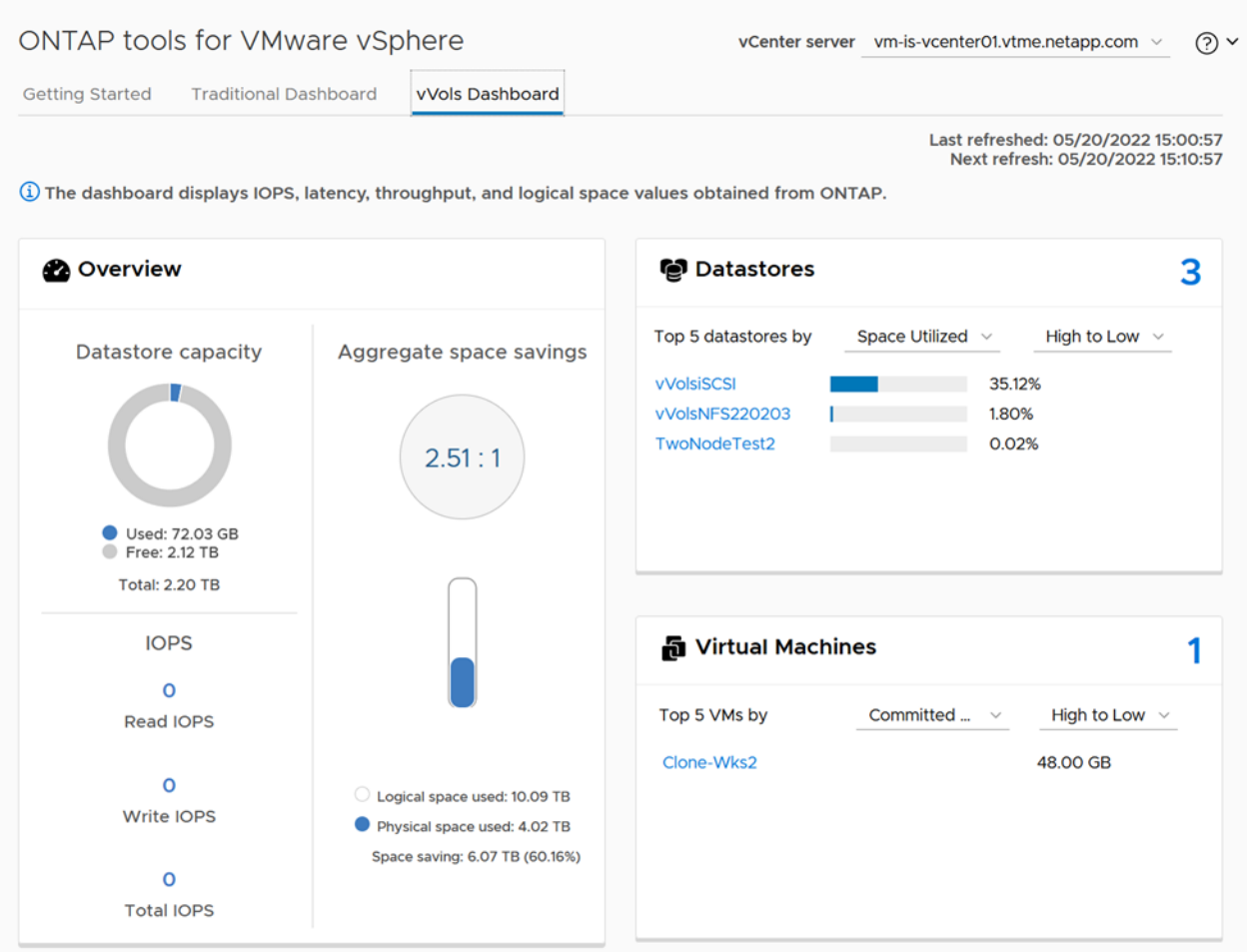
In addition to product documentation, there are various NetApp Knowledge Base articles that might be useful.

- How to perform VASA Provider Disaster Recovery

VASA Provider dashboard and OnCommand API services

The VASA Provider includes a dashboard with performance and capacity information for individual vVol VMs. This information comes directly from ONTAP for the vVol files and LUNs, including latency, IOPS, throughput, and uptime for the top five VMs and latency and IOPS for the top five datastores. It is enabled by default when using ONTAP 9.7 or later. For older versions of ONTAP, you must install and register OnCommand API Services 2.1 or later with the VASA Provider. Note that each VASA Provider requires a dedicated installation of OnCommand API Services, and it cannot be shared with multiple VASA Provider instances. Follow the installation instructions in the OnCommand API Services Installation and Setup Guide. There is no need to configure it; this is done automatically by the VASA Provider. It can take up to 30 minutes for initial data to be retrieved and displayed in the VASA Provider dashboard, as seen in Figure 4.

Figure 4. VASA Provider dashboard.



Best practices

This section contains best practices for using vVols with ONTAP along with other information.

Limits

In general, ONTAP supports vVol limits as defined by VMware (see published Configuration Maximums). The following table summarizes specific ONTAP limits in the size and number of vVols. Always check the NetApp Hardware Universe for updated limits on numbers and sizes of LUNs and files.

Capacity/feature	SAN (iSCSI or FC)	NFS
Maximum vVols size	62 TiB*	16 TiB
Maximum number of vVols per FlexVol volume	1024	2 billion
Maximum number of vVols per ONTAP node	Up to 24,576**	50 billion
Maximum number of vVols per ONTAP pair	Up to 24,576**	50 billion
Maximum number of vVols per ONTAP cluster	Up to 98,304**	No specific cluster limit
Maximum QoS objects (shared policy group and individual vVols service level)	12,000 through ONTAP 9.3; 40,000 with ONTAP 9.4 and later	

* Size limit based on large LUN-enabled ONTAP systems.

** Number of SAN vVols (LUNs) varies based on platform. Always check the NetApp Hardware Universe for updated limits on numbers and sizes of LUNs and files.

Using ONTAP vVols with vSphere is simple and follows published vSphere methods (see Working with Virtual Volumes under vSphere Storage in the VMware documentation for the ESXi Server). Here are a few additional practices to consider in conjunction with ONTAP.

- **Use ONTAP tools for VMware vSphere UI extensions or REST APIs to provision vVols datastores and protocol endpoints.** While it's possible to create vVols datastores with the general vSphere interface, using ONTAP tools automatically creates protocol endpoints as needed, and it also creates FlexVol volumes using ONTAP best practices and in compliance with your defined storage capability profiles. Right click on the host, cluster, or datacenter, and then select ONTAP Tools and Provision Datastore. From there, choose the desired vVols options in the wizard.
- **Never store the ONTAP tools appliance or vCenter Server Appliance (VCSA) on a vVols datastore that they are managing.** This can result in a chicken-and-egg situation if you need to reboot the appliances, because the appliances won't be able to rebind their own vVols while they are rebooting. However, you can use a vVols datastore from a separate vCenter and ONTAP tools instance.
- **Avoid vVols operations across different ONTAP releases.** Supported storage capabilities such as QoS, personality, and more have changed in various releases of the VASA Provider, and some properties are dependent on the ONTAP release. Using different releases in an ONTAP cluster or moving vVols between clusters with different releases can result in unexpected behavior or compliance alarms.
- **Plan your backing FlexVol volumes according to your needs.** You might want to add several backing volumes to your vVols datastore to distribute workload across the ONTAP cluster, to support different policy options, or to increase the number of allowed LUNs or files. However, if maximum storage efficiency is required, then place all your backing volumes on a single aggregate. Or if maximum cloning performance is required, then consider using a single FlexVol volume and keeping your templates or content library in the same volume.

  The VASA Provider offloads many vVol storage operations to ONTAP, including migration, cloning, and snapshots. When this is done within a single FlexVol volume, space efficient file clones are used and are almost instantly available. When this is done across FlexVol volumes, the copies are quickly available and use inline deduplication and compression, but maximum storage efficiency might not be recovered until background jobs run on volumes using background deduplication and compression. Depending on the source and destination, some efficiency can be degraded.
- **Keep Storage Capability Profiles (SCPs) simple.** Avoid specifying capabilities that aren't required by setting them to Any. This minimizes problems when selecting or creating FlexVol volumes. For example, with VASA Provider 7.1 and earlier, if compression is left at the default SCP setting of No, it attempts to disable compression, even on an AFF system.
- **Use the default SCPs as example templates to create your own.** The included SCPs are suitable for most general purposes, but your requirements might be different.
- **Consider using maximum IOPS to control unknown or test VMs.** First available in VASA Provider 7.1, Max IOPS can be used to limit IOPS to a vVol for an unknown workload to avoid affecting other more critical workloads. See the section "Performance management guidelines" for more on performance management.

Deploying vVols storage

Overview

There are several steps to creating vVols storage for your VMs. The first two steps might not be needed for an existing vSphere environment that uses ONTAP for traditional datastores.

1. Create the SVM with either ONTAP System Manager wizards, or the command line. For protocol configuration, use either NFSv3, iSCSI, or FCP. Create at least one LIF per node for each switch or fabric connection and preferably two or more LIFs per node for SAN protocols.
2. Volumes can be created at this time, but it is simpler to let the Provision Datastore wizard create them. The only exception to this rule is if you plan to use vVols replication with VMware SRM. This is easier to set up with preexisting FlexVol volumes with existing SnapMirror relationships.
3. Deploy ONTAP tools for VMware vSphere using the OVA downloaded from the NetApp Support Site.
4. Configure ONTAP tools for your environment:
    a. Add the ONTAP cluster to ONTAP tools under Storage Systems. Although ONTAP tools and SRA support both cluster-level and SVM-level credentials, the VASA Provider supports only cluster-level credentials for storage systems. Therefore, if you plan to use vVols, you must add your ONTAP clusters using cluster-scoped credentials.
    b. If your ONTAP data LIFs are on different subnets from your VMkernel adapters, then you must add the VMkernel adapter subnets to the selected subnets list in the settings menu of ONTAP tools. By default, ONTAP tools secure your storage traffic by only allowing local subnet access.
    c. ONTAP tools comes with several predefined policies you can use, or see the section “Managing VMs with policies” for guidance on creating SCPs.
5. Use the ONTAP tools menu in vCenter to start the Provision Datastore wizard.
6. Select one or more SCPs to be supported by the vVols datastore.
7. Use the wizard to create new FlexVol volumes for each of the specified SCPs, or use existing volumes.
8. Create VM policies for each SCP to be used in the datastore.
9. Specify the Storage Capability Profile by name when creating a VM Storage Policy.
10. Create your VMs by selecting the VM Storage Policy and compatible datastore under Select Storage.

Migrating VMs from traditional datastores to vVols

Migration of VMs from traditional datastores to a vVols datastore is as simple as moving VMs within traditional datastores. Select the VM(s), select Migrate from the list of actions, and then select a migration type of Change Storage Only. Migration copy operations are offloaded with vSphere 6.0 and later for SAN VMFS to vVols migrations, but not from NAS VMDKs to vVols.

Managing VMs with policies

To automate storage provisioning with policy-based management, you need to:

- Define the capabilities of the storage (ONTAP node and FlexVol volume) with Storage Capability Profiles (SCPs).
- Create VM storage policies that map to the defined SCPs.

NetApp has simplified the capabilities and mapping beginning with VASA Provider 7.2 and continues to improve these functions in later versions. This section focuses on this new approach. Earlier releases supported a greater number of capabilities and allowed them to be mapped individually to storage policies, but this approach is no longer recommended. Table 1compares capabilities across releases.

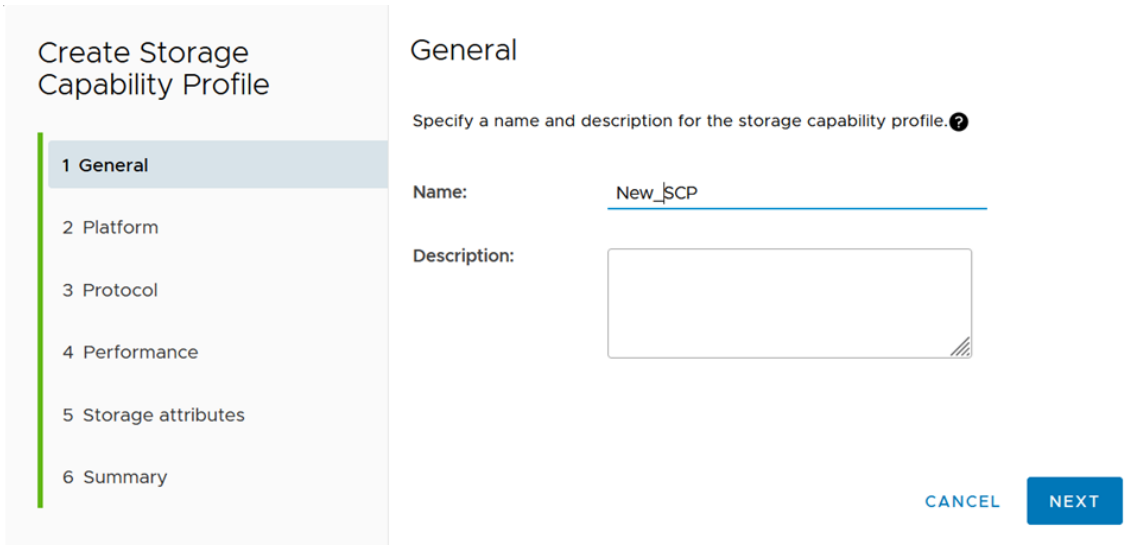
Table 1) SCP release capabilities.

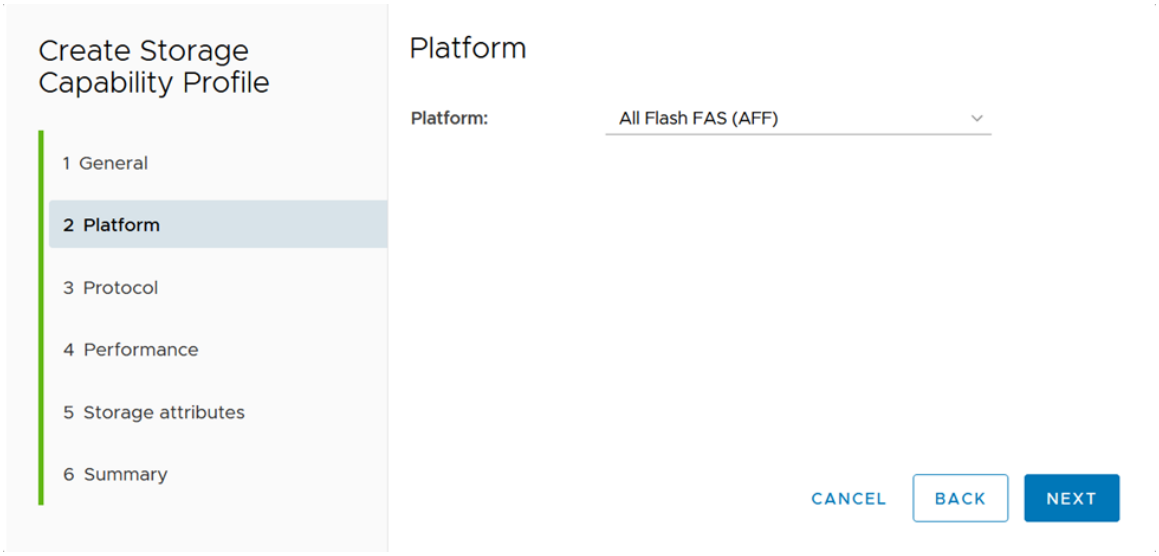
SCP Capability	Capability Values	Release Supported	Notes
Autogrow	Yes, No, Any	7.1 and earlier	Autogrow is enabled by default with 7.2 for vVols FlexVol volumes.

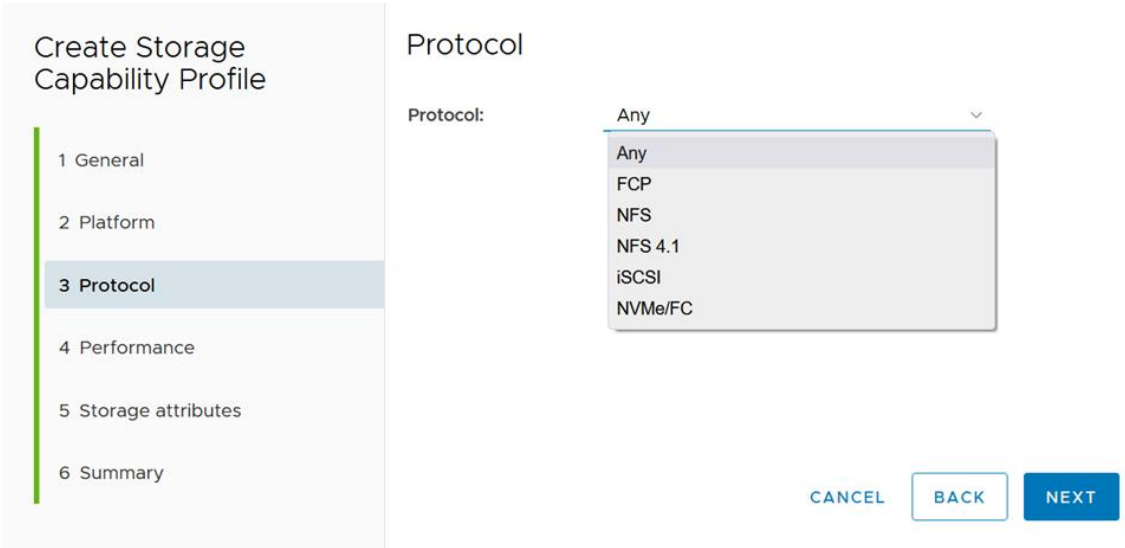
SCP Capability	Capability Values	Release Supported	Notes
Availability	HA Pair, No HA, Any	7.1 and earlier	Was not useful for provisioning FlexVol volume or vVols.
Compression	Yes, No, Any	All	Can't edit for AFF in 7.2 and later.
Deduplication	Yes, No, Any	All	Can't edit for AFF in 7.2 and later.
Disk Types	SATA, FCAL, SAS, SSD, Any	7.1 and earlier	7.2 is focused on performance/personality rather than disk type.
Encryption	Yes, No, Any	7.2 and later	Selects/creates encrypted FlexVol volume. Volume Encryption license required.
Flash Accelerated	Yes, No, Any	7.1 and earlier	7.2 is focused on performance/personality rather than specific flash features.
Max IOPS	<number>	7.1 and later, but differences	Listed under QoS Policy Group for 7.2 and later. See the section "Performance management guidelines" for more information.
ONTAP Service Level	Extreme, Performance, Value	7.2 only	Can only select Value for FAS personality. See the section "Performance management guidelines" for more information.
Personality	AFF, FAS	7.2 and later	FAS also includes other non-AFF systems, such as ONTAP Select.
Protocol	NFS, NFS 4.1, iSCSI, FCP, NVMe/FC, Any	7.1 and earlier, 9.10 and later	7.2 and later is effectively Any unless otherwise specified beginning again in 9.10. NFS 4.1 and NVMe/FC were added in 9.10.
Replication Type	Asynchronous, Synchronous, None, Any	7.1 and earlier	Replication is now handled outside of the SCP.
Space Reserve (Thin Provisioning)	Thin, Thick, (Any)	All, but differences	Called Thin Provisioning in 7.1 and earlier, which also allowed value of Any. Called Space Reserve in 7.2. All releases default to Thin.
Tiering Policy	Any, None, Snapshot, Auto	7.2 and later	Used for FabricPool – requires AFF with ONTAP 9.4 or later. Only Snapshot is recommended.

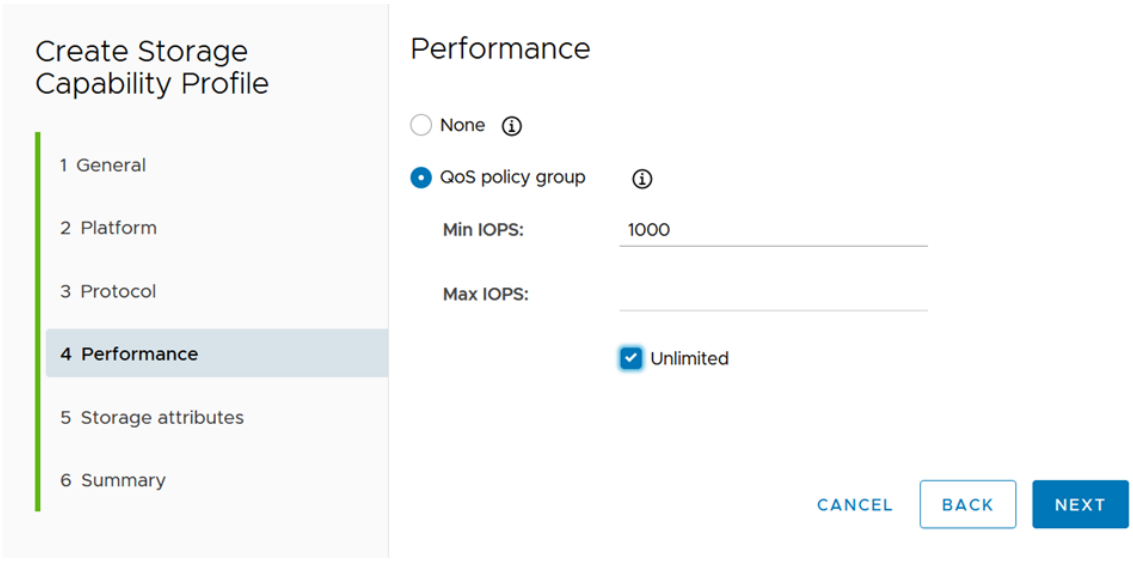
Creating storage capability profiles

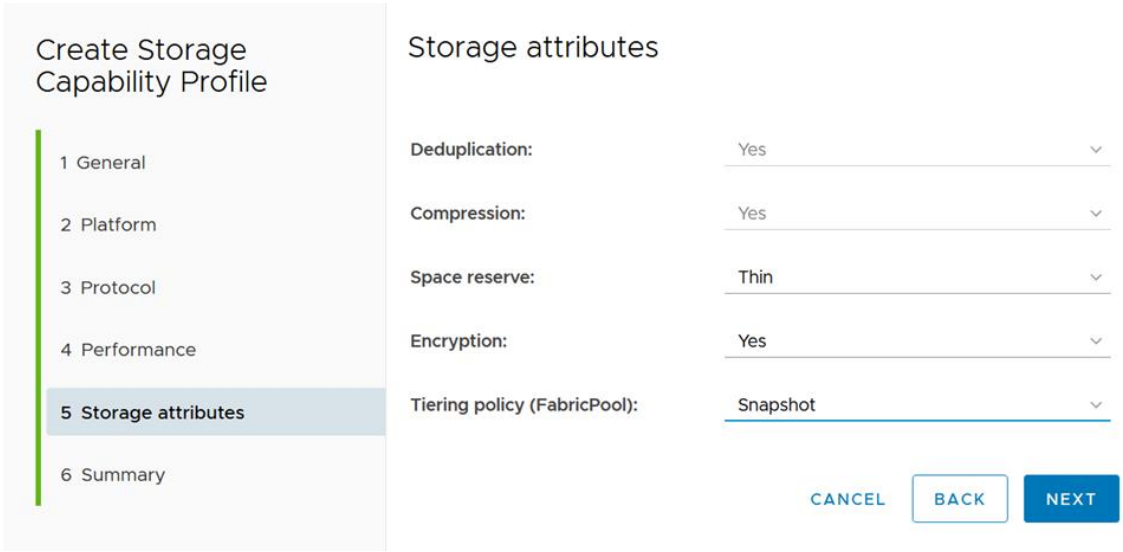
The NetApp VASA Provider comes with several predefined SCPs. New SCPs can be created manually using the vCenter UI or via automation using REST APIs. This can be done by specifying capabilities in a new profile, cloning an existing profile, or by auto-generating profiles from existing traditional datastores using the menus under ONTAP tools. Use Storage Capability Profiles to create or clone a profile and Storage Mapping to auto-generate a profile. The following images shows the capabilities that can be specified with ONTAP tools 9.10.


Create Storage Capability Profile
1 General
2 Platform
3 Protocol
4 Performance
5 Storage attributes
6 Summary
General
Specify a name and description for the storage capability profile.
Name:
New_SCP
Description:
CANCEL
NEXT


Create Storage Capability Profile
1 General
2 Platform
3 Protocol
4 Performance
5 Storage attributes
6 Summary
Platform
Platform:
All Flash FAS (AFF)
CANCEL
BACK
NEXT


Create Storage Capability Profile
1 General
2 Platform
3 Protocol
4 Performance
5 Storage attributes
6 Summary
Protocol
Protocol:
Any
Any
FCP
NFS
NFS 4.1
iSCSI
NVMe/FC
CANCEL
BACK
NEXT



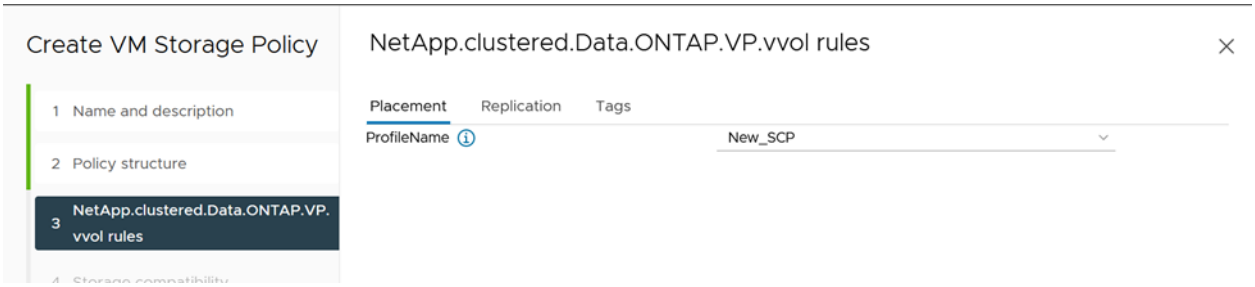


Creating vVols datastores

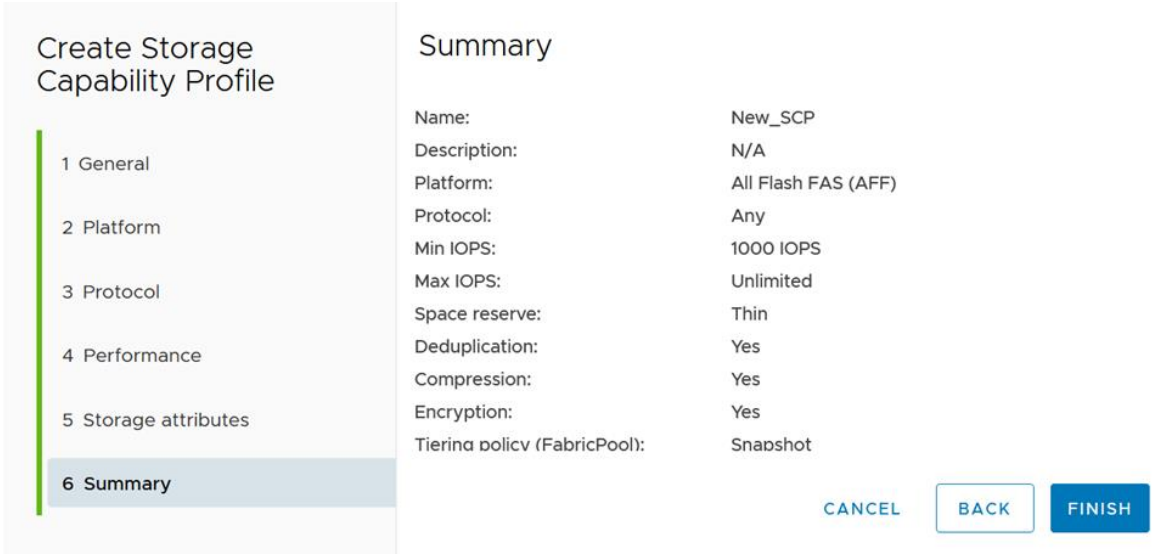
After the necessary SCPs have been created, they can be used to create the vVols datastore and, optionally, FlexVol volumes for the datastore. Right-click on the host, cluster, or datacenter on which you want to create the vVols datastore, and then select ONTAP tools > Provision Datastore. Select one or more SCPs to be supported by the datastore, and then select from existing FlexVol volumes and/or provision new FlexVol volumes for the datastore. Finally, specify the default SCP for the datastore, which is used for VMs that do not have an SCP specified by policy and for swap vVols (these do not require high performance storage).

Creating VM storage policies

VM storage policies are used in vSphere to manage optional features such as Storage I/O Control or vSphere Encryption. They are also used with vVols to apply specific storage capabilities to the VM. Use the `NetApp.clustered.Data.ONTAP.VP.vvol` storage type and `ProfileName` rule to apply a specific SCP to VMs through use of the policy. See the following figure for an example of this with VASA Provider.



Rules for `NetApp.clustered.Data.ONTAP.VP.VASA10` storage are used with non-vVols-based datastores.



Earlier releases are similar, but your options might vary, as is discussed in the table from the section "Managing VMs with policies."

After you create the storage policy, you can use it when provisioning new VMs (see Figure 1). Guidelines for using performance management capabilities with VASA Provider 7.2 are covered in the following section.

Performance management with VASA Provider 9.10.

ONTAP tools 9.10 uses its own balanced placement algorithm to place a new vVol in the best FlexVol volume within a vVols datastore. Placement is based on the specified SCP and matching FlexVol volumes. This makes sure that the datastore and backing storage can meet the specified performance requirements.

Changing performance capabilities such as Min and Max IOPS requires some attention to the specific configuration.

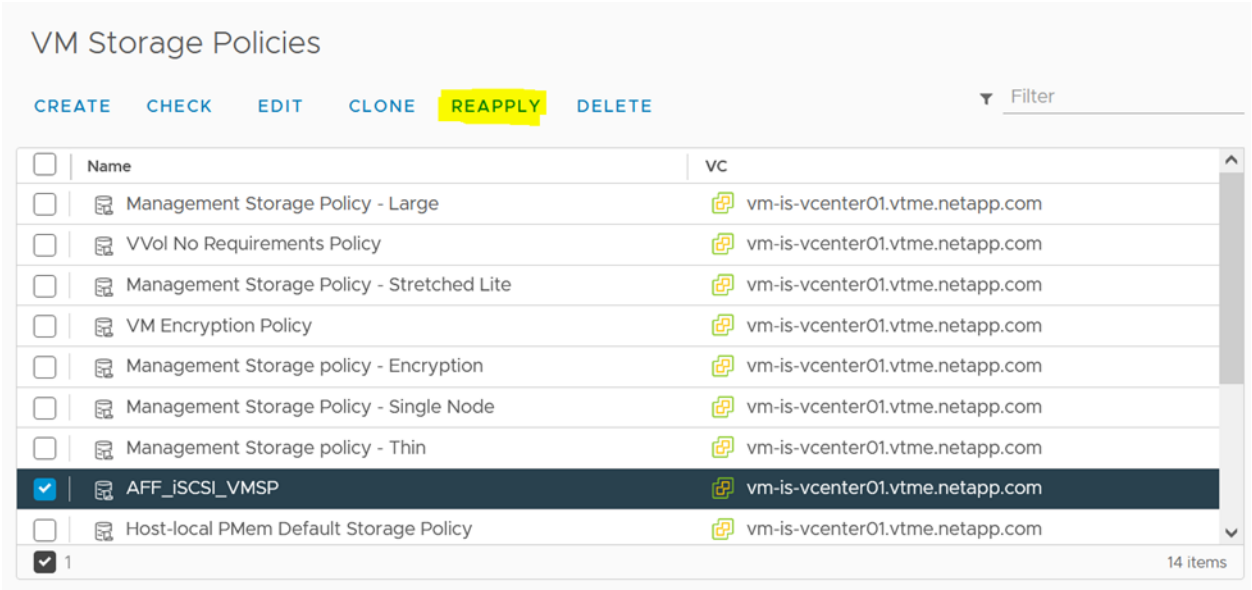
- Minimum and maximum IOPS can be specified in an SCP and used in a VM policy.
- Changing the IOPS in the SCP does not change QoS on the vVols until the VM policy is edited and then reapplied to the VMs that use it (see the following figure). You can also create a new SCP with the desired IOPS and change the policy to use it (and reapply to VMs). NetApp typically recommends defining separate SCPs and VM storage policies for different tiers of service and changing the VM storage policy on the VM.

- AFF and FAS personalities have different IOPs settings. Both Min and Max are available on AFF. However non-AFF systems can only use Max IOPs settings.

In some cases, a vVol might need to be migrated after a policy change, either manually, or automatically by VASA Provider and ONTAP:

- Some changes require no migration (such as changing Max IOPS, which can be applied immediately to the VM as outlined above).
- If the policy change cannot be supported by the current FlexVol volume that stores the vVol (for example, the platform does not support the encryption or tiering policy requested), you must manually migrate the VM in vCenter.

ONTAP tools creates individual non-shared QoS policies with currently supported versions of ONTAP. Therefore, each individual VMDK receives its own allocation of IOPs.



Protecting vVols

VASA provider high availability

The NetApp VASA Provider runs as part of the virtual appliance together with the vCenter plugin and REST API server (formerly known as the Virtual Storage Console [VSC]) and Storage Replication Adapter. If the VASA Provider is not available, VMs using vVols continue to run. However, new vVols datastores and vVols cannot be created by vSphere. This means that VMs using vVols cannot be powered on, because vCenter is not able to request the creation of the swap vVol.

VASA Provider 7.1 and later support new capabilities to make sure that services are available when needed. It includes new watchdog processes that monitor VASA Provider and integrated database services. If it detects a failure, it updates the log files and then restarts the services automatically.

Further protection must be configured by the vSphere administrator using the same availability features used to protect vSphere VMs from faults in software, host hardware, and networking. No additional configuration is required on the virtual appliance to use these features; just configure them using standard vSphere approaches. These approaches have been tested and are supported by NetApp.

vSphere High Availability is easily configured to restart a VM on another host in the host cluster in the event of failure. vSphere Fault Tolerance provides higher availability by creating a secondary VM that is

continuously replicated and can take over at any point. Additional information on these features is available in the ONTAP tools for VMware vSphere documentation (Configure high availability for ONTAP tools), as well as VMware vSphere documentation (look for vSphere Availability under ESXi and vCenter Server).

vVols replication

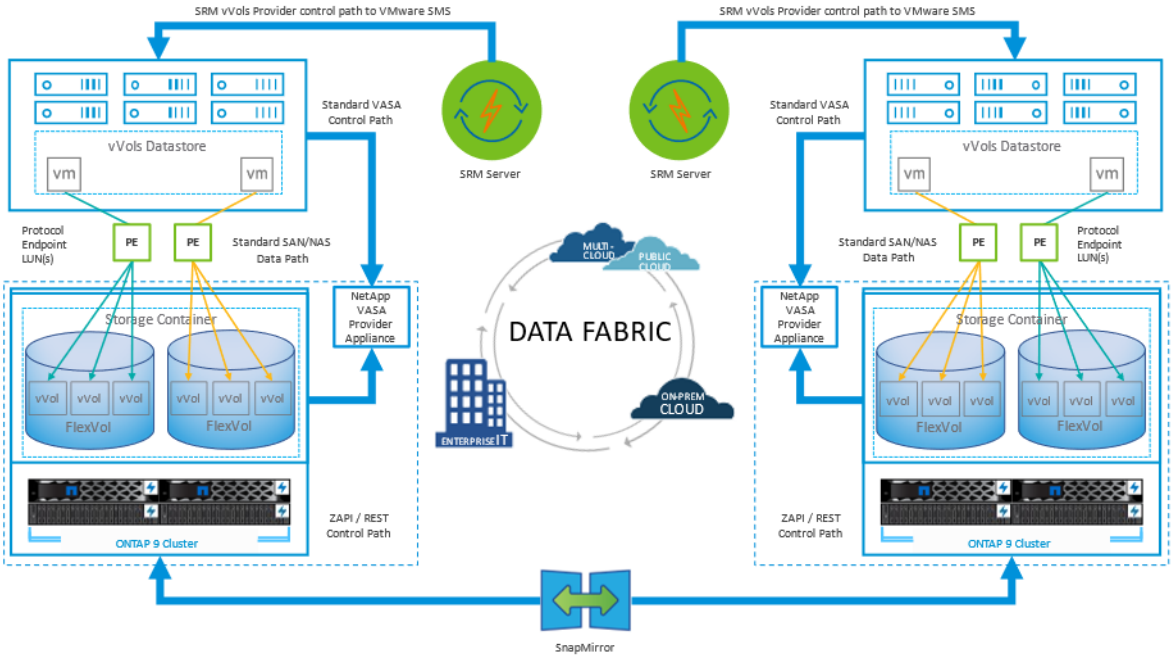
Many ONTAP customers replicate their traditional datastores to secondary storage systems using SnapMirror and SnapVault and then use the secondary system to recover individual VMs or an entire site in the event of a disaster. In most cases, customers use a software tool to manage this, such as a backup software product like the NetApp SnapCenter Plug-in for VMware vSphere or VMware's SRM together with NetApp Storage Replication Adapter.

This requirement for a software tool is even more important to manage vVols replication. Although some aspects can be managed by native capabilities (for example, VMware-managed snapshots of vVols are offloaded to ONTAP, which uses quick and efficient file or LUN clones), in general orchestration is needed to manage replication and recovery. Metadata about vVols is protected within ONTAP as well as the VASA Provider, but additional processing is needed to use the vVols at a secondary site.

ONTAP tools 9.7.1 used in conjunction with the VMware SRM 8.3 release added support for disaster recovery and migration workflow orchestration taking advantage of NetApp SnapMirror technology.

In the initial release of SRM support with ONTAP tools 9.7.1, it was a requirement to precreate FlexVol volumes and enable SnapMirror protection before using them as backing volumes for a vVols datastore. Beginning in ONTAP tools 9.10 that is no longer required. You can now add SnapMirror protection to existing backing volumes and update your VM storage policies to take advantage of policy-based management with disaster recovery, migration orchestration, and automation integrated with SRM.

Currently, VMware SRM is the only disaster recovery and migration automation solution for vVols supported by NetApp, although it is possible to leverage the ONTAP tools REST APIs to create your own services.



vVols backup overview

There are several approaches to protecting VMs, such as using in-guest backup agents, attaching VM data files to a backup proxy, or using defined APIs such as VMware VADP. vVols can be protected using most of the same mechanisms, and many NetApp partners support VM backups, including vVols.

As mentioned earlier, VMware vCenter-managed snapshots are offloaded to space-efficient and fast ONTAP file/LUN clones. These can be used for quick, manual backups, but they are limited by vCenter to a maximum of 32 snapshots. You can use vCenter to take snapshots and revert as needed.

SnapCenter Plug-in for VMware vSphere (SCV) 4.6 when used in conjunction with ONTAP tools 9.10 or later adds support for crash-consistent backup and recovery of vVols based VMs leveraging ONTAP FlexVol volume snapshots with support for SnapMirror and SnapVault replication.

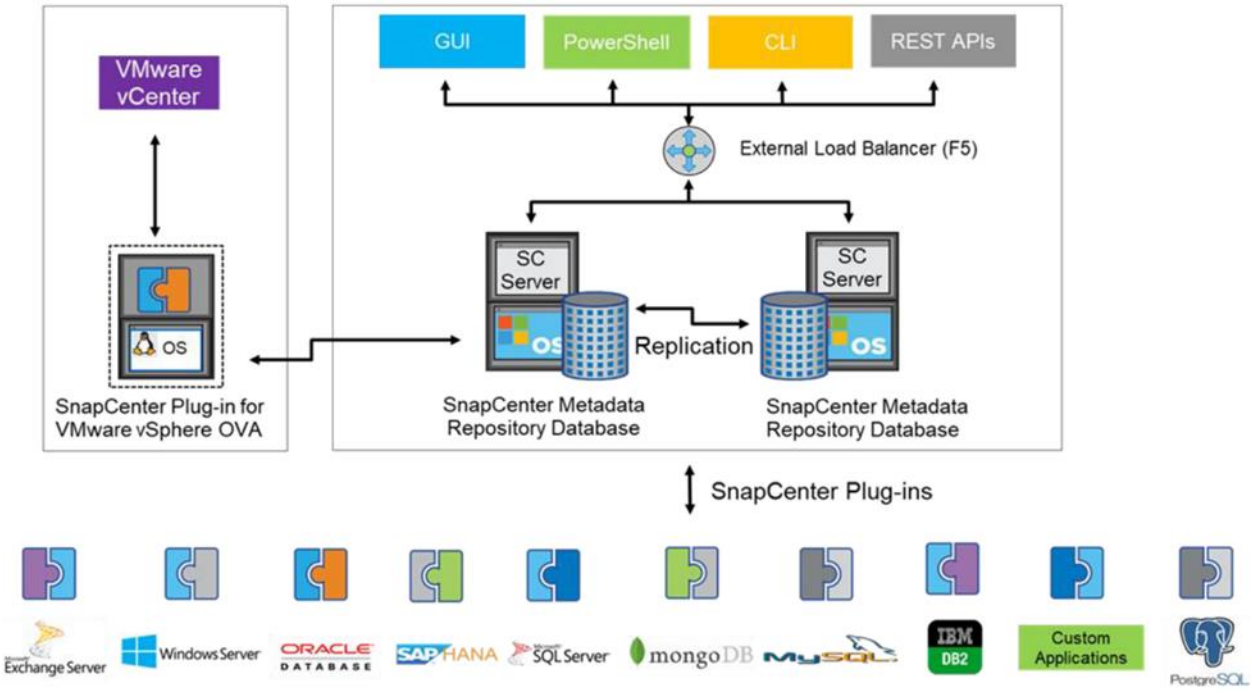
vVols backup with SnapCenter Plug-in for VMware vSphere

With SnapCenter, you can now create resource groups based on tags and/or folders in additional to previous resource types to automatically take advantage of ONTAP FlexVol-based snapshots for vVol-based VMs. This allows you to define backup and recovery services that protect VMs automatically as they are dynamically provisioned within your environment.

There are two deployment models for SnapCenter Plug-in for VMware vSphere.

- A standalone appliance registered as a vCenter extension, managed through the vCenter UI for operational simplicity, or via REST APIs for backup and recovery service automation.
- As a plugin with SnapCenter Server. The SnapCenter Server provides a centralized HTML5-based user interface, PowerShell cmdlets, and REST APIs as a highly available and scalable single-user interface.

The following graphic shows the SnapCenter architecture.



Because the other SnapCenter Plug-ins don't support vVols at the time of this writing, we focus on the standalone deployment model in this document.

Because SnapCenter uses ONTAP FlexVol Snapshot copies, there is no overhead placed on vSphere, nor is there any performance penalty as one might see with traditional VMs using vCenter-managed snapshots. Furthermore, because SCV's functionality is exposed via REST APIs, it makes it easy to create automated workflows using tools like VMware vRealize Automation.

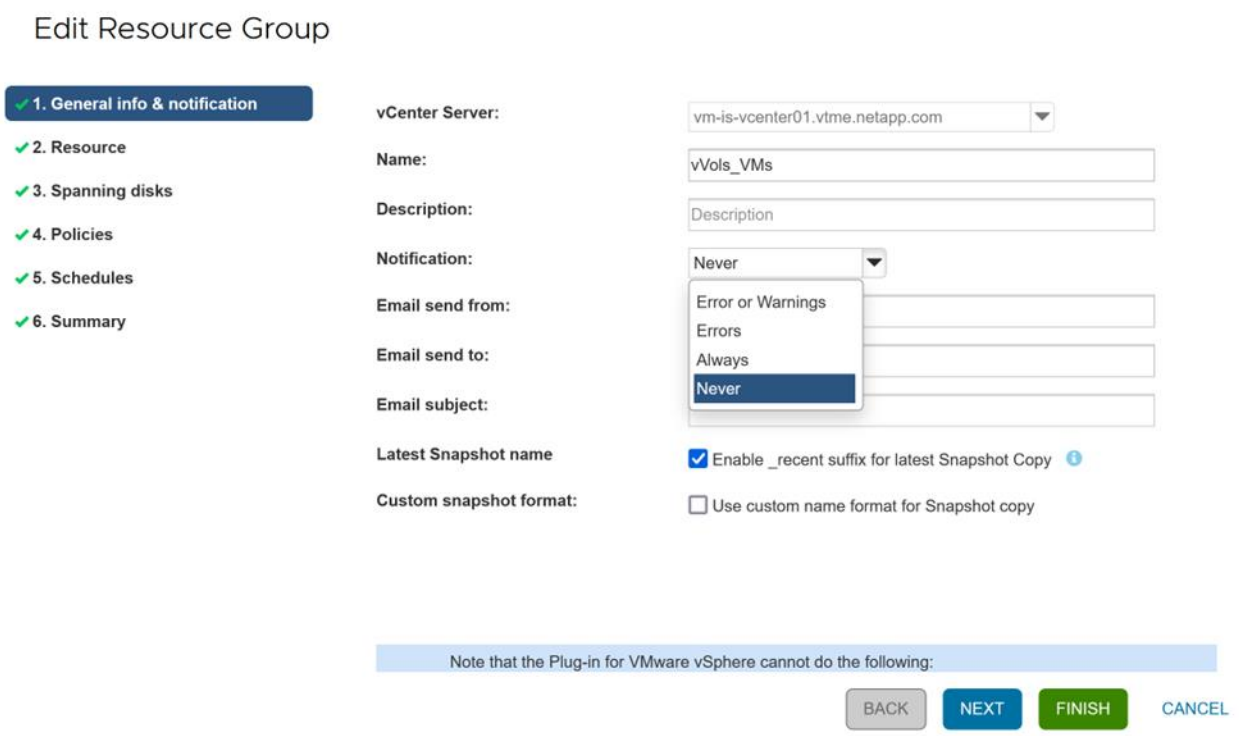
For information on SnapCenter REST APIs, see this Overview of REST APIs.

For information on the SnapCenter Plug-in for VMware vSphere REST APIs, see the SnapCenter Plug-in for VMware vSphere REST APIs.

The following best practices can help you get the most out of your SnapCenter deployment.

- SCV supports both vCenter Server RBAC and Data ONTAP RBAC and includes predefined vCenter roles. You can read more about the supported types of RBAC here.
  - Use the vCenter UI to assign least privileged account access using the predefined roles described here.
  - If you use SCV with SnapCenter Server, you must assign the SnapCenterAdmin role.
  - ONTAP RBAC refers to the user account used to add and manage the storage systems used by SCV. ONTAP RBAC doesn't apply to vVols-based backups. Read more about ONTAP RBAC and SCV here.
- Replicate your backup datasets to a second system using SnapMirror for complete replicas of source volumes or SnapVault for longer term retention of backup data independent of source volume snapshot retention settings. Both mechanisms are supported with vVols, although only SnapMirror is used with VMware SRM.
- Design your backup policies with retention settings that meet your organizations defined recovery point objectives (RPOs).

Configure notification settings on your resource groups to be notified of the status when backups run (see the following figure).



Get started with SCV by using these documents:

- Learn about SnapCenter Plug-in for VMware vSphere
- Deploy SnapCenter Plug-in for VMware vSphere

Troubleshooting

There are several troubleshooting resources available with additional information.

NetApp Support Site

In addition to a variety of NetApp Knowledge Base articles for NetApp virtualization products, the NetApp Support site also offers a Guided Problem Solving portal for VMware Solutions - Virtual Storage Console. This portal provides links to articles, videos, technical reports, and VMware Solutions Discussions on NetApp Community.

Product troubleshooting

The various components of ONTAP tools, such as the Virtual Storage Console, VASA Provider, and Storage Replication Adapter, are all documented together in the NetApp documents repository. However, each has a separate subsection of the Knowledge Base repository and might have specific troubleshooting procedures. These procedures address the most common issues that might be encountered with the VASA Provider.

VASA Provider UI problems

Occasionally, the vCenter vSphere Web Client encounters problems with the Serenity components, causing the VASA Provider for ONTAP menu items to not display. See Resolving VASA Provider registration issues in the Deployment Guide or this NetApp Knowledge Base article.

vVols Datastore provisioning fails

Occasionally vCenter services can timeout when creating the vVols datastore. To correct this issue, restart the vmware-sps service, and remount the vVols datastore using the vCenter menus (Storage > New Datastore). This process is covered under vVols datastore provisioning fails with vCenter Server 6.5 in the Administration Guide.

Upgrading Unified Appliance fails to mount ISO

Due to a bug in vCenter, the ISO used to upgrade the Unified Appliance from one release to the next might fail to mount. If the ISO can be attached to the appliance in vCenter, follow the process in this NetApp Knowledge Base article to resolve the issue.

Where to find additional information and version history

To learn more about the information that is described in this document, review the following documents and/or websites:

Getting started

- Release notes
  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/release_notes.html
- Learn about ONTAP tools for VMware vSphere

https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/concepts/concept_virtual_storage_console_overview.html

- ONTAP tools Quick start

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/qsg.html

- Deploy ONTAP tools

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/deploy/task_deploy_ontap_tools.html

- Upgrade ONTAP tools

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/deploy/task_upgrade_to_the_9_8_ontap_tools_for_vmware_vsphere.html

Use ONTAP tools

- Provision traditional datastores

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/configure/task_provision_datastores.html

- Provision vVols datastores

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/configure/task_provision_vvols_datastores.html

- Configure role-based access control

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/concepts/concept_vcenter_server_role_based_access_control_features_in_vsc_for_vmware_vsphere.html

- Configure remote diagnostics

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/manage/task_configure_vasa_provider_to_use_ssh_for_remote_diag_access.html

- Configure high availability

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/concepts/concept_configure_high_availability_for_ontap_tools_for_vmware_vsphere.html

Protect and manage datastores

- Protect your datastores

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/protect/task_enable_storage_replication_adapter.html

- Protect virtual machines

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/protect/concept_configure_replication_for_vvols_datastore.html

- Monitor traditional datastores and virtual machines

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/manage/task_monitor_datastores_using_the_traditional_dashboard.html

- Monitor vVols datastores and virtual machines

  https://docs.netapp.com/us-en/ontap-tools-vmware-vsphere/manage/task_monitor_vvols_datastores_and_virtual_machines_using_vvols_dashboard.html

In addition to product documentation, there are NetApp Knowledge Base articles that might be useful.

- How to perform a VASA Provider Disaster Recovery

  https://kb.netapp.com/Advice_and_Troubleshooting/Data_Storage_Software/VSC_and_VASA_Provider/How_to_perform_a_VASA_Provider_Disaster_Recovery_-_Resolution_Guide

Version history

Version	Date	Details
Version 3.0	August 2022	Chance Bingen. Updated to reflect changes in ONTAP tools 9.10 and SnapCenter 4.6. Removed third-party backup references as those are now documented by partners.
Version 2.0	June 2018	Karl Konnerth. Updated to reflect current ONTAP and VASA Provider releases. Changed focus from how to set up and use vVols, which is covered in other product documentation, to benefits of vVols, best practices, and related areas such as migration, protection and troubleshooting.
Version 1.0	April 2015	Eric Wagar. Initial release.

Refer to the Interoperability Matrix Tool (IMT) 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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