



VMware for Public Cloud

NetApp Solutions

NetApp
June 20, 2022

This PDF was generated from <https://docs.netapp.com/us-en/netapp-solutions/ehc/ehc-overview.html> on June 20, 2022. Always check docs.netapp.com for the latest.

Table of Contents

- VMware for Public Cloud 1
 - Overview of NetApp Hybrid Multi-Cloud with VMware 1
 - NetApp Solutions for VMware in Hyperscalers 5
 - Supported Configurations for NetApp Hybrid Multi-Cloud with VMware 9
 - Configuring the virtualization environment in the cloud provider 9
 - NetApp Storage options for Public Cloud Providers 38
 - Summary and Conclusion: Why NetApp Hybrid Multi-Cloud with VMware 132

VMware for Public Cloud

Overview of NetApp Hybrid Multi-Cloud with VMware

Most IT organizations follow the hybrid cloud-first approach. These organizations are in a transformation phase and customers are evaluating their current IT landscape and then migrating their workloads to the cloud based on the assessment and discovery exercise.

The factors for customers migrating to the cloud can include elasticity and burst, data center exit, data center consolidation, end-of-life scenarios, mergers, acquisitions, and so on. The reason for this migration can vary based on each organization and their respective business priorities. When moving to the hybrid cloud, choosing the right storage in the cloud is very important in order to unleash the power of cloud deployment and elasticity.

VMware Cloud options in Public Cloud

Azure VMware Solution



Azure VMware Solution is a hybrid cloud service that allows for fully functioning VMware SDDCs within the Microsoft Azure public cloud. Azure VMware Solution is a first-party solution fully managed and supported by Microsoft, verified by VMware leveraging Azure infrastructure. This means that when Azure VMware Solution is deployed, customer's get VMware's ESXi for compute virtualization, vSAN for hyper-converged storage, and NSX for networking and security, all while taking advantage of Microsoft Azure's global presence, class-leading data center facilities and proximity to the rich ecosystem of native Azure services and solutions.

VMware Cloud on AWS



VMware Cloud on AWS brings VMware's enterprise-class SDDC software to the AWS Cloud with optimized access to native AWS services. Powered by VMware Cloud Foundation, VMware Cloud on AWS integrates VMware's compute, storage, and network virtualization products (VMware vSphere, VMware vSAN, and VMware NSX) along with VMware vCenter Server management, optimized to run on dedicated, elastic, bare-metal AWS infrastructure.

Google Cloud VMware Engine



Google Cloud VMware Engine is an infrastructure-as-a-service (IaaS) offering built on Google Cloud's highly performant scalable infrastructure and VMware Cloud Foundation stack – VMware vSphere, vCenter, vSAN, and NSX-T. This service enables a fast path to the cloud, seamlessly migrating or extending existing VMware workloads from on-premises environments to Google Cloud Platform without the cost, effort, or risk of

rearchitecting applications or retooling operations. It is a service sold and supported by Google, working closely with VMware.



SDDC private cloud and NetApp Cloud Volumes colocation provides the best performance with minimal network latency.

Did you know?

Regardless of the cloud used, when a VMware SDDC is deployed, the initial cluster includes the following products:

- VMware ESXi hosts for compute virtualization with a vCenter Server appliance for management
- VMware vSAN hyper-converged storage incorporating the physical storage assets of each ESXi host
- VMware NSX for virtual networking and security with an NSX Manager cluster for management

Storage configuration

For customers planning to host storage-intensive workloads and scale out on any cloud-hosted VMware solution, the default hyper-converged infrastructure dictates that the expansion should be on both the compute and storage resources.

By integrating with NetApp Cloud Volumes, such as Azure NetApp Files, Amazon FSx for NetApp ONTAP, Cloud Volumes ONTAP (available in all three major hyperscalers), and Cloud Volumes Service for Google Cloud, customers now have options to independently scale their storage separately, and only add compute nodes to the SDDC cluster as needed.

Notes:

- VMware does not recommend unbalanced cluster configurations, hence expanding storage means adding more hosts, which implies more TCO.
- Only one vSAN environment is possible. Therefore, all storage traffic will compete directly with production workloads.
- There is no option to provide multiple performance tiers to align application requirements, performance, and cost.
- It is very easy to reach the limits of storage capacity of vSAN built on top of the cluster hosts. Use NetApp Cloud Volumes to scale storage to either host active datasets or tier cooler data to persistent storage.

Azure NetApp Files, Amazon FSx for NetApp ONTAP, Cloud Volumes ONTAP (available in all three major hyperscalers), and Cloud Volumes Service for Google Cloud can be used in conjunction with guest VMs. This hybrid storage architecture consists of a vSAN datastore that holds the guest operating system and application binary data. The application data is attached to the VM through a guest-based iSCSI initiator or the NFS/SMB mounts that communicate directly with Amazon FSx for NetApp ONTAP, Cloud Volume ONTAP, Azure NetApp Files and Cloud Volumes Service for Google Cloud respectively. This configuration allows you to easily overcome challenges with storage capacity as with vSAN, the available free space depends on the slack space and storage policies used.

Let's consider a three-node SDDC cluster on VMware Cloud on AWS:

- The total raw capacity for a three-node SDDC = 31.1TB (roughly 10TB for each node).
- The slack space to be maintained before additional hosts are added = 25% = (.25 x 31.1TB) = 7.7TB.

- The usable raw capacity after slack space deduction = 23.4TB
- The effective free space available depends on the storage policy applied.

For example:

- RAID 0 = effective free space = 23.4TB (usable raw capacity/1)
- RAID 1 = effective free space = 11.7TB (usable raw capacity/2)
- RAID 5 = effective free space = 17.5TB (usable raw capacity/1.33)

Thus, using NetApp Cloud Volumes as guest-connected storage would help in expanding the storage and optimizing the TCO while meeting the performance and data protection requirements.

NOTE:

NetApp storage as a datastore is currently available as Public preview for AWS/VMC and Azure/AVS and Private preview for GCP/GSVE. Please visit the following links for more information.

AWS press release for FSx ONTAP as a native datastore COMING SOON!

[Azure NetApp Files \(ANF\) as a native datastore for Azure](#)
[Cloud Volumes Service \(CVS\) as a native datastore for GCP](#)

Points to Remember

- In hybrid storage models, place tier 1 or high priority workloads on vSAN datastore to address any specific latency requirements because they are part of the host itself and within proximity. Use in-guest mechanisms for any workload VMs for which transactional latencies are acceptable.
- Use NetApp SnapMirror® technology to replicate the workload data from the on-premises ONTAP system to Cloud Volumes ONTAP or Amazon FSx for NetApp ONTAP to ease migration using block-level mechanisms. This does not apply to Azure NetApp Files and Cloud Volumes Services. For migrating data to Azure NetApp Files or Cloud Volumes Services, use NetApp XCP, Cloud sync, rysnc or robocopy depending on the file protocol used.
- Testing shows 2-4ms additional latency while accessing storage from the respective SDDCs. Factor this additional latency into the application requirements when mapping the storage.
- For mounting guest-connected storage during test failover and actual failover, make sure iSCSI initiators are reconfigured, DNS is updated for SMB shares, and NFS mount points are updated in fstab.
- Make sure that in-guest Microsoft Multipath I/O (MPIO), firewall, and disk timeout registry settings are configured properly inside the VM.



This applies to guest connected storage only.

Benefits of NetApp cloud storage

NetApp cloud storage offers the following benefits:

- Improves compute-to-storage density by scaling storage independently of compute.
- Allows you to reduce the host count, thus reducing the overall TCO.
- Compute node failure does not impact storage performance.
- The volume reshaping and dynamic service-level capability of Azure NetApp Files allows you to optimize cost by sizing for steady-state workloads, and thus preventing over provisioning.

- The storage efficiencies, cloud tiering, and instance-type modification capabilities of Cloud Volumes ONTAP allow optimal ways of adding and scaling storage.
- Prevents over provisioning storage resources are added only when needed.
- Efficient Snapshot copies and clones allow you to rapidly create copies without any performance impact.
- Helps address ransomware attacks by using quick recovery from Snapshot copies.
- Provides efficient incremental block transfer-based regional disaster recovery and integrated backup block level across regions provides better RPO and RTOs.

Assumptions

- SnapMirror technology or other relevant data migration mechanisms are enabled. There are many connectivity options, from on-premises to any hyperscaler cloud. Use the appropriate path and work with the relevant networking teams.
- In-guest storage was the only available option at the time this document was written.

NOTE:

NetApp storage as a datastore is currently available as Public preview for AWS/VMC and Azure/AVS and Private preview for GCP/GSVE. Please visit the following links for more information.

[AWS press release for FSx ONTAP as a native datastore COMING SOON!](#)

[Azure NetApp Files \(ANF\) as a native datastore for Azure](#)
[Cloud Volumes Service \(CVS\) as a native datastore for GCP](#)



Engage NetApp solution architects and respective hyperscaler cloud architects for planning and sizing of storage and the required number of hosts. NetApp recommends identifying the storage performance requirements before using the Cloud Volumes ONTAP sizer to finalize the storage instance type or the appropriate service level with the right throughput.

Detailed architecture

From a high-level perspective, this architecture (shown in the figure below) covers how to achieve hybrid multi-cloud connectivity and app portability across multiple cloud providers using NetApp Cloud Volumes ONTAP, Cloud Volumes Service for Google Cloud and Azure NetApp Files as an additional in-guest storage option.



NetApp Solutions for VMware in Hyperscalers

Learn more about the capabilities that NetApp brings to the three (3) primary hyperscalers - from NetApp as a guest connected storage device or a native datastore to migrating workflows, extending/bursting to the cloud, backup/restore and disaster recovery.

Pick your cloud and let NetApp do the rest!



To see the capabilities for a specific hyperscaler, click on the appropriate tab for that hyperscaler.

Jump to the section for the desired content by selecting from the following options:

- [VMware in the Hyperscalers Configuration](#)

- [NetApp Storage Options](#)
- [NetApp / VMware Cloud Solutions](#)

VMware in the Hyperscalers Configuration

As with on-premises, planning a cloud based virtualization environment is critical for a successful production-ready environment for creating VMs and migration.

AWS / VMC

This section describes how to set up and manage VMware Cloud on AWS SDDC and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting FSx ONTAP and Cloud Volumes ONTAP to AWS VMC.

The setup process can be broken down into the following steps:

- Deploy and Configure VMware Cloud for AWS
- Connect VMware Cloud to FSx ONTAP

View the detailed [configuration steps for VMC](#).

Azure / AVS

This section describes how to set up and manage Azure VMware Solution and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting Azure NetApp Files and Cloud Volumes ONTAP to Azure VMware Solution.

The setup process can be broken down into the following steps:

- Register the resource provider and create a private cloud
- Connect to a new or existing ExpressRoute virtual network gateway
- Validate the network connectivity and access the private cloud

View the detailed [configuration steps for AVS](#).

GCP / GCVE

This section describes how to set up and manage GCVE and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting Cloud Volumes ONTAP and Cloud Volumes Services to GCVE.

The setup process can be broken down into the following steps:

- Deploy and Configure GCVE
- Enable Private Access to GCVE

View the detailed [configuration steps for GCVE](#).

NetApp Storage Options

NetApp storage can be utilized in several ways - either as guest connected or as a native datastore - within each of the 3 major hyperscalers.

Please visit [Supported NetApp Storage Options](#) for more information.

AWS / VMC

AWS supports NetApp storage in the following configurations:

- FSx ONTAP as guest connected storage
- Cloud Volumes ONTAP (CVO) as guest connected storage
- FSx ONTAP as a native datastore¹

View the detailed [guest connect storage options for VMC](#).

Read more about FSx ONTAP as a native datastore public preview from the AWS Press Release (COMING SOON!).

Azure / AVS

Azure supports NetApp storage in the following configurations:

- Azure NetApp Files (ANF) as guest connected storage
- Cloud Volumes ONTAP (CVO) as guest connected storage
- Azure NetApp Files (ANF) as a native datastore¹

View the detailed [guest connect storage options for AVS](#).

Read more about [Azure NetApp Files \(ANF\) as a native datastore - Public Preview](#).

GCP / GCVE

Google Cloud supports NetApp storage in the following configurations:

- Cloud Volumes ONTAP (CVO) as guest connected storage
- Cloud Volumes Service (CVS) as guest connected storage
- Cloud Volumes Service (CVS) as a native datastore¹

View the detailed [guest connect storage options for GCVE](#).

Read more about [Cloud Volumes Service \(CVS\) as a native datastore¹](#).



1 - Currently in Private Preview

NetApp / VMware Cloud Solutions

With NetApp and VMware cloud solutions, many use cases are simple to deploy in your hyperscaler of choice. VMware defines the primary cloud workload use-cases as:

- Protect (includes both Disaster Recovery and Backup / Restore)
- Migrate
- Extend

AWS / VMC

[Browse the NetApp solutions for AWS / VMC](#)

Azure / AVS

[Browse the NetApp solutions for Azure / AVS](#)

GCP / GCVE

[Browse the NetApp solutions for Google Cloud Platform \(GCP\) / GCVE](#)

Supported Configurations for NetApp Hybrid Multi-Cloud with VMware

Understanding the combinations for NetApp storage support in the major hyperscalers.

	Guest Connected	Native Datastore
AWS	CVO FSx ONTAP Details	FSx ONTAP Press Release coming soon!
Azure	CVO ANF Details	ANF Details ¹
GCP	CVO CVS Details	CVS Details ²

NOTE:

1 - Currently in Public Preview

2 - Currently in Private Preview

Configuring the virtualization environment in the cloud provider

Details for how to configure the virtualization environment in each of the supported hyperscalers are covered here.

AWS / VMC

This section describes how to set up and manage VMware Cloud on AWS SDDC and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting FSx ONTAP and Cloud Volumes ONTAP to AWS VMC.

The setup process can be broken down into the following steps:

- Deploy and Configure VMware Cloud for AWS
- Connect VMware Cloud to FSx ONTAP

View the detailed [configuration steps for VMC](#).

Azure / AVS

This section describes how to set up and manage Azure VMware Solution and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting Azure NetApp Files and Cloud Volumes ONTAP to Azure VMware Solution.

The setup process can be broken down into the following steps:

- Register the resource provider and create a private cloud
- Connect to a new or existing ExpressRoute virtual network gateway
- Validate the network connectivity and access the private cloud

View the detailed [configuration steps for AVS](#).

GCP / GCVE

This section describes how to set up and manage GCVE and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting Cloud Volumes ONTAP and Cloud Volumes Services to GCVE.

The setup process can be broken down into the following steps:

- Deploy and Configure GCVE
- Enable Private Access to GCVE

View the detailed [configuration steps for GCVE](#).

Deploy and configure the Virtualization Environment on AWS

As with on-premises, planning VMware Cloud on AWS is critical for a successful production-ready environment for creating VMs and migration.

This section describes how to set up and manage VMware Cloud on AWS SDDC and use it in combination with the available options for connecting NetApp storage.



In-guest storage is currently the only supported method of connecting FSx ONTAP and Cloud Volumes ONTAP to AWS VMC.

The setup process can be broken down into the following steps:

Deploy and configure VMware Cloud for AWS

[VMware Cloud on AWS](#) provides for a cloud native experience for VMware based workloads in the AWS ecosystem. Each VMware Software-Defined Data Center (SDDC) runs in an Amazon Virtual Private Cloud (VPC) and provides a full VMware stack (including vCenter Server), NSX-T software-defined networking, vSAN software-defined storage, and one or more ESXi hosts that provide compute and storage resources to your workloads.

This section describes how to set up and manage VMware Cloud on AWS and use it in combination with Amazon FSx for NetApp ONTAP and/or Cloud Volumes ONTAP on AWS with in-guest storage.



In-guest storage is the only supported method of connecting Amazon FSx for NetApp ONTAP and Cloud Volumes ONTAP to VMware Cloud on AWS.

The setup process can be broken down into three parts:

Register for an AWS Account

Register for an [Amazon Web Services Account](#).

You need an AWS account to get started, assuming there isn't one created already. New or existing, you need administrative privileges in the account for many steps in this procedure. See this [link](#) for more information regarding AWS credentials.

Register for a My VMware Account

Register for a [My VMware](#) account.

For access to VMware's cloud portfolio (including VMware Cloud on AWS), you need a VMware customer account or a My VMware account. If you have not already done so, create a VMware account [here](#).



Provision SDDC in VMware Cloud

After the VMware account is configured and proper sizing is performed, deploying a Software-Defined Data Center is the obvious next step for using the VMware Cloud on AWS service. To create an SDDC, pick an AWS region to host it, give the SDDC a name, and specify how many ESXi hosts you want the SDDC to contain. If you don't already have an AWS account, you can still create a starter configuration SDDC that contains a single ESXi host.

1. Log into the VMware Cloud Console using your existing or newly created VMware credentials.



2. Configure the AWS region, deployment, and host type and the SDDC name:



3. Connect to the desired AWS account and execute the AWS Cloud Formation stack.

CloudFormation > Stacks > Create stack

Quick create stack

Template

Template URL
<https://vmware-sddc.s3.us-west-2.amazonaws.com/1eb9d184-a706-4488-abb8-652aad0a25d0/mq5lqhtclleoh8l5o75ntegq9kcc4bdd7lffq07nv7v16fk36>

Stack description
 This template is created by VMware Cloud on AWS for SDDC deployment and maintenance. Please do not remove.

Stack name

Stack name

Stack name can include letters (A-Z and a-z), numbers (0-9), and dashes (-).

Parameters

Parameters are defined in your template and allow you to input custom values when you create or update a stack.

Feedback English (US) © 2018–2021, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use Cookie preferences

CloudFormation > Stacks > Create stack

Quick create stack

Stack name

Stack name

Stack name can include letters (A-Z and a-z), numbers (0-9), and dashes (-).

Parameters

Parameters are defined in your template and allow you to input custom values when you create or update a stack.

No parameters
 There are no parameters defined in your template.

Capabilities

The following resource(s) require capabilities: [AWS::IAM::Role]
 This template contains Identity and Access Management (IAM) resources that might provide entities access to make changes to your AWS account. Check that you want to create each of these resources and that they have the minimum required permissions. [Learn more](#)

☐ I acknowledge that AWS CloudFormation might create IAM resources.

Cancel Create change set **Create stack**

Feedback English (US) © 2018–2021, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use Cookie preferences



Single-host configuration is used in this validation.

4. Select the desired AWS VPC to connect the VMC environment with.



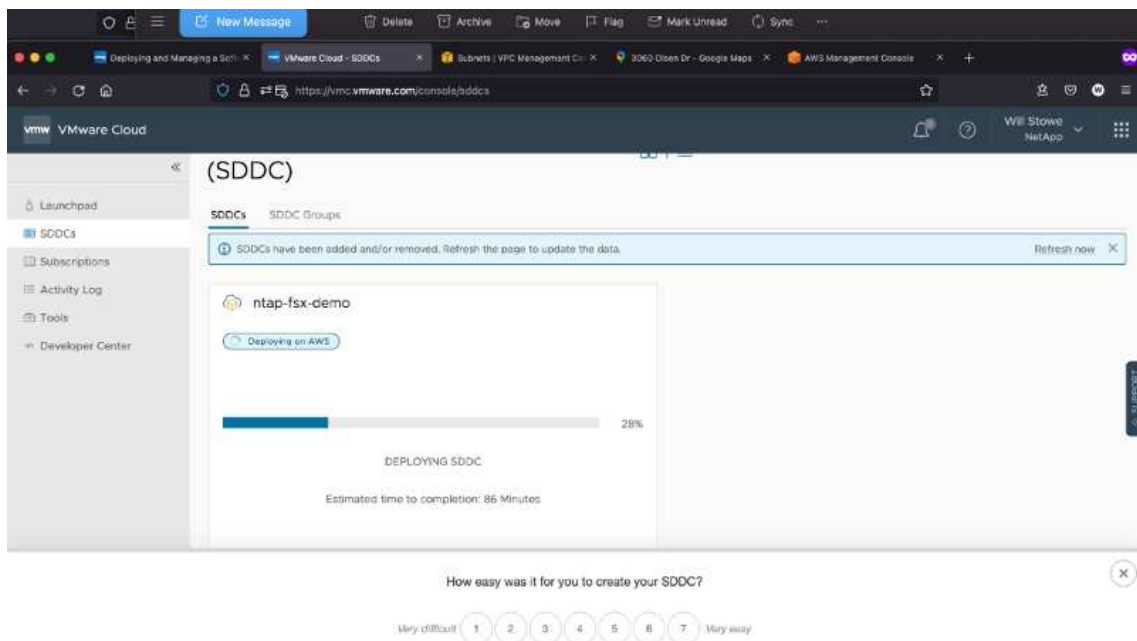
5. Configure the VMC Management Subnet; this subnet contains VMC-managed services like vCenter, NSX, and so on. Do not choose an overlapping address space with any other networks that need connectivity to the SDDC environment. Finally, follow the recommendations for CIDR size notated below.



6. Review and acknowledge the SDDC configuration, and then click deploy the SDDC.



The deployment process typically takes approximately two hours to complete.



7. After completion, the SDDC is ready for use.

The screenshot shows the VMware Cloud console interface. On the left is a navigation sidebar with options like Launchpad, SDDCs, Subscriptions, Activity Log, Tools, and Developer Center. The main header area displays 'Software-Defined Data Centers (SDDC)' with a 'CREATE SDDC' button and an 'ACTIONS' dropdown. Below this, a table lists SDDC groups. The 'ntap-fsx-demo' group is highlighted, showing its status as 'Ready' and 'Expires in 60 days'. A detailed view of this group shows the following resources:

Resource	Value
CPU	82.8 GHz
Memory	512 GiB
Storage	10.37 TiB

At the bottom of the detailed view, there are links for 'VIEW DETAILS', 'OPEN VCENTER', and 'ACTIONS'. The page also includes a 'BACK TO TOP' and 'GO TO GRID VIEW' link at the bottom right.

For a step-by-step guide on SDDC deployment, see [Deploy an SDDC from the VMC Console](#).

Connect VMware Cloud to FSx ONTAP

To connect VMware Cloud to FSx ONTAP, complete the following steps:

1. With VMware Cloud deployment completed and connected to AWS VPC, you must deploy Amazon FSx for NetApp ONTAP into a new VPC rather than the original connected VPC (see the screenshot below). FSx (NFS and SMB floating IPs) is not accessible if it is deployed in the connected VPC. Keep in mind that iSCSI endpoints like Cloud Volumes ONTAP work just fine from the connected VPC.



2. Deploy an additional VPC in the same region, and then deploy Amazon FSx for NetApp ONTAP into the new VPC.

Configuration of an SDDC group in the VMware Cloud console enables the networking configuration options required to connect to the new VPC where FSx is deployed. In step 3, verify that “Configuring VMware Transit Connect for your group will incur charges per attachment and data transfers” is checked, and then choose Create Group. The process can take a few minutes to complete.



3. Attach the newly created VPC to the just created SDDC group. Select the External VPC tab and follow the [instructions for attaching an External VPC](#) to the group. This process can take 10 to 15 minutes to complete.





- As part of the external VPC process, you are prompted through the AWS console to a new shared resource via the Resource Access Manager. The shared resource is the [AWS Transit Gateway](#) managed by VMware Transit Connect.





5. Create the Transit Gateway Attachment.



6. Back on the VMC Console, Accept the VPC attachment. This process can take approximately 10 minutes to complete.



7. While in the External VPC tab, click the edit icon in the Routes column and add in the following required routes:

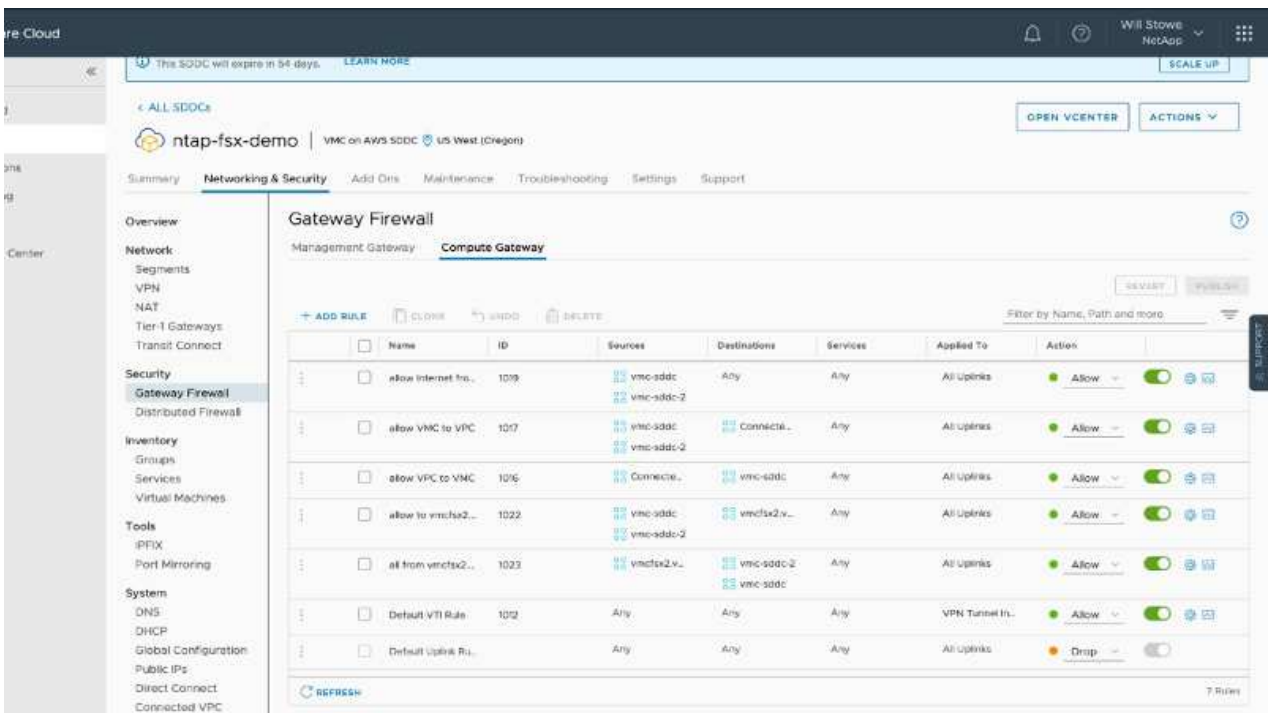
- A route for the floating IP range for Amazon FSx for NetApp ONTAP [floating IPs](#).
- A route for the floating IP range for Cloud Volumes ONTAP (if applicable).
- A route for the newly created external VPC address space.



8. Finally, allow bidirectional traffic [firewall rules](#) for access to FSx/CVO. Follow these [detailed steps](#) for compute gateway firewall rules for SDDC workload connectivity.



9. After the firewall groups are configured for both the Management and Compute gateway, the vCenter can be accessed as follows:



The next step is to verify that Amazon FSx ONTAP or Cloud Volumes ONTAP is configured depending on your requirements and that the volumes are provisioned to offload storage components from vSAN to optimize the deployment.

Deploy and configure the Virtualization Environment on Azure

As with on-premises, planning Azure VMware Solution is critical for a successful production-ready environment for creating VMs and migration.

This section describes how to set up and manage Azure VMware Solution and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting Azure NetApp Files and Cloud Volumes ONTAP to Azure VMware Solution.

The setup process can be broken down into the following steps:

Register the resource provider and create a private cloud

To use Azure VMware Solution, first register the resource provider within the identified subscription:

1. Sign in to the Azure portal.
2. On the Azure portal menu, select All Services.
3. In the All Services dialog box, enter the subscription and then select Subscriptions.
4. To view, select the subscription from the subscription list.
5. Select Resource Providers and enter Microsoft.AVS into the search.
6. If the resource provider is not registered, select Register.



Provider	Status
Microsoft.OperationsManagement	✓ Registered
Microsoft.Compute	✓ Registered
Microsoft.ContainerService	✓ Registered
Microsoft.ManagedIdentity	✓ Registered
Microsoft.AVS	✓ Registered
Microsoft.Operationallnsights	✓ Registered
Microsoft.GuestConfiguration	✓ Registered

7. After the resource provider is registered, create an Azure VMware Solution private cloud by using the Azure portal.
8. Sign in to the Azure portal.
9. Select Create a New Resource.
10. In the Search the Marketplace text box, enter Azure VMware Solution and select it from the results.
11. On the Azure VMware Solution page, select Create.
12. From the Basics tab, enter the values in the fields and select Review + Create.

Notes:

- For a quick start, gather the required information during the planning phase.
- Select an existing resource group or create a new resource group for the private cloud. A resource group is a logical container in which the Azure resources are deployed and managed.
- Make sure the CIDR address is unique and does not overlap with other Azure Virtual Networks or on-premises networks. The CIDR represents the private cloud management network and is used for the cluster management services, such as vCenter Server and NSX-T Manager. NetApp recommends using a /22 address space. In this example, 10.21.0.0/22 is used.

Create a private cloud ...

Prerequisites * Basics Tags Review and Create

Project details

Subscription *

Resource group * [Create new](#)

Private cloud details

Resource name *

Location *

Size of host *

Number of hosts * [Find out how many hosts you need](#)

CIDR address block

Provide IP address for private cloud for cluster management. Make sure these are unique and do not overlap with any other Azure vnets or on-premise networks.

Address block for private cloud *

[Review and Create](#) [Previous](#) [Next : Tags >](#)

The provisioning process takes approximately 4–5 hours. After the process is complete, verify that the deployment was successful by accessing the private cloud from the Azure portal. A status of Succeeded is displayed when the deployment is complete.

An Azure VMware Solution private cloud requires an Azure Virtual Network. Because Azure VMware Solution doesn't support on-premises vCenter, additional steps are required to integrate with an existing on-premises environment. Setting up an ExpressRoute circuit and a virtual network gateway is also required. While waiting for the cluster provisioning to complete, create a new virtual network or use an existing one to connect to Azure VMware Solution.

[Home >](#)

 **nimoavspriv**  
AVS Private cloud

 Delete

 Overview

 Activity log

 Access control (IAM)

 Tags

 Diagnose and solve problems

Settings

 Locks

Manage

 Connectivity

 Identity

 Clusters

Essentials

Resource group [\(change\)](#)
[NimoAVSDemo](#)

Status
Succeeded

Location
East US 2

Subscription [\(change\)](#)
[SaaS Backup Production](#)

Subscription ID
b58a041a-e464-4497-8be9-9048369ee8e1

Tags [\(change\)](#)
[Click here to add tags](#)

Address block for private cloud
10.21.0.0/22

Primary peering subnet
10.21.0.232/30

Secondary peering subnet
10.21.0.236/30

Private Cloud Management network
10.21.0.0/26

vMotion network
10.21.1.128/25

Number of hosts
3

Connect to a new or existing ExpressRoute virtual network gateway

To create a new Azure Virtual Network (VNet), select the Azure VNet Connect tab. Alternatively, you can create one manually from the Azure portal by using the Create Virtual Network wizard:

1. Go to Azure VMware Solution private cloud and access Connectivity under the Manage option.
2. Select Azure VNet Connect.
3. To create a new VNet, select the Create New option.

This feature allows a VNet to be connected to the Azure VMware Solution private cloud. The VNet enables communication between workloads in this virtual network by automatically creating required components (for example, jump box, shared services such as Azure NetApp Files, and Cloud Volume ONTAP) to the private cloud created in Azure VMware Solution over ExpressRoute.

Note: The VNet address space should not overlap with the private cloud CIDR.



4. Provide or update the information for the new VNet and select OK.

Create virtual network



This virtual network enables the communication between workloads in this virtual network (e.g. a JumpHost) to the private cloud created in Azure VMware Solution over an Express route. A default address range and a subnet is selected for this virtual network. For changing the default address range and subnet of this virtual network, follow these steps: Step 1: Change the "Address Range" to desired range (e.g. 172.16.0.0/16). Step 2: Add a subnet under "Subnets" with the name as "GatewaySubnet" and provide subnet's address range in CIDR notation (e.g. 172.16.1.0/24). [Learn more about virtual networks](#)

Name *

Address space

The virtual network's address space specified as one or more address prefixes in CIDR notation (e.g. 10.0.0.0/16).

<input type="checkbox"/> Address range	Addresses	Overlap	
<input type="checkbox"/> 172.24.0.0/16	172.24.0.4 - 172.24.255.254 (65531 addresses)	None	
<input type="text"/>	(0 Addresses)	None	

Subnets

The subnet's address range in CIDR notation (e.g. 10.0.0.0/24). It must be contained by the address space of the virtual network.

<input type="checkbox"/> Subnet name	Address range	Addresses	
<input type="checkbox"/> GatewaySubnet	172.24.0.0/24	172.24.0.4 - 172.24.0.254 (251 addresses)	
<input type="text"/>	<input type="text"/>	(0 Addresses)	

The VNet with the provided address range and gateway subnet is created in the designated subscription and resource group.



If you create a VNet manually, create a virtual network gateway with the appropriate SKU and ExpressRoute as the gateway type. After the deployment is complete, connect the ExpressRoute connection to the virtual network gateway containing Azure VMware Solution private cloud using the authorization key. For more information, see [Configure networking for your VMware private cloud in Azure](#).

Validate the network connect and access to Azure VMware Solution private cloud

Azure VMware Solution does not allow you to manage a private cloud with on-premises VMware vCenter. Instead, jump host is required to connect to the Azure VMware Solution vCenter instance. Create a jump host in the designated resource group and sign in to the Azure VMware Solution vCenter. This jump host should be a Windows VM on the same virtual network that was created for connectivity and should provide access to both vCenter and the NSX Manager.

Create a virtual machine

Basics Disks Networking Management Advanced Tags Review + create

Create a virtual machine that runs Linux or Windows. Select an image from Azure marketplace or use your own customized image. Complete the Basics tab then Review + create to provision a virtual machine with default parameters or review each tab for full customization. [Learn more](#)

Project details

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription *	SaaS Backup Production
Resource group *	NimoAVSDemo
	Create new

Instance details

Virtual machine name *	nimAVS.R1
Region *	(US) East US 2
Availability options	No infrastructure redundancy required
Image *	Windows Server 2012 R2 Datacenter - Gen2
	See all images
Azure Spot instance	<input type="checkbox"/>
Size *	Standard_D2s_v3 - 2 vcpus, 8 GiB memory (\$130.67/month)
	See all sizes

After the virtual machine is provisioned, use the Connect option to access RDP.

nimAVSJH | Connect

Virtual machine

Search (Ctrl+/)

- Overview
- Activity log
- Access control (IAM)
- Tags
- Diagnose and solve problems

Settings

- Networking
- Connect
- Disks
- Size

To improve security, enable just-in-time access on this VM. →

RDP SSH BASTION

Connect with RDP

To connect to your virtual machine via RDP, select an IP address, optionally change the port number, and download the RDP file.

IP address *

Public IP address (52.138.103.135)

Port number *

3389

Download RDP File

Sign in to vCenter from this newly created jump host virtual machine by using the cloud admin user . To access the credentials, go to the Azure portal and navigate to Identity (under the Manage option within the private cloud). The URLs and user credentials for the private cloud vCenter and NSX-T Manager can be copied from here.

nimoavspriv | Identity

AWS Private cloud

Search (Ctrl+/)

- Access control (IAM)
- Tags
- Diagnose and solve problems

Settings

Locks

Manage

- Connectivity
- Identity
- Clusters
- Placement policies (preview)
- Add-ons

Login credentials

vCenter credentials

Web client URL ⓘ

https://10.21.0.2/

Admin username ⓘ

cloudadmin@vsphere.local

Admin password ⓘ

Certificate thumbprint ⓘ

AE26B15A5CE38DC069D35F045F088CA6343475EC

NSX-T Manager credentials

Web client URL ⓘ

https://10.21.0.3/

Admin username ⓘ

admin

Admin password ⓘ

Certificate thumbprint ⓘ

B2B722EA683958283EE159007246D5166D0509D3

In the Windows virtual machine, open a browser and navigate to the vCenter web client URL (<https://10.21.0.2/>) and use the admin user name as **cloudadmin@vsphere.local** and paste the copied password. Similarly, NSX-T manager can also be accessed using the web client URL (<https://10.21.0.3/>) and use the admin user name and paste the copied password to create new segments or modify the existing tier gateways.



The web client URLs are different for each SDDC provisioned.



The image shows two screenshots related to VMware vSphere. The top screenshot is the vSphere login page, displaying the VMware logo and a login form with fields for username (cloudadmin@vsphere.local) and password. A 'LOGIN' button is at the bottom. The bottom screenshot is the vSphere Client interface. The top bar shows the vSphere Client logo and a search bar. The main content area displays the vSphere inventory tree on the left, showing a folder named 'SDDC-Datacenter'. The right pane shows the summary of the selected folder, including statistics for Virtual Machines (0) and Hosts (3). Below the summary, there are sections for Custom Attributes and Tags. At the bottom, a 'Recent Tasks' table is visible, showing a task named 'Undeploy plug-in' for the target 'vc.beeb9fd29eab4cbea81e62.eastus2.av...' with a status of 'Completed'.

The Azure VMware Solution SDDC is now deployed and configured. Leverage ExpressRoute Global Reach to connect the on-premises environment to Azure VMware Solution private cloud. For more information, see [Peer on-premises environments to Azure VMware Solution](#).

Deploy and configure the Virtualization Environment on Google Cloud Platform (GCP)

As with on-premises, planning Google Cloud VMware Engine (GCVE) is critical for a successful production-ready environment for creating VMs and migration.

This section describes how to set up and manage GCVE and use it in combination with the available options for connecting NetApp storage.



In-guest storage is the only supported method of connecting Cloud Volumes ONTAP and Cloud Volumes Services to GCVE.

The setup process can be broken down into the following steps:

Deploy and configure GCVE

To configure a GCVE environment on GCP, login to the GCP console and access the VMware Engine portal.

Click on the “New Private Cloud” button and enter the desired configuration for the GCVE Private Cloud. On “Location”, make sure to deploy the private cloud in the same Region/Zone where CVS/CVO is deployed, to ensure the best performance and lowest latency.

Pre-requisites:

- Setup VMware Engine Service Admin IAM role
- [Enable VMWare Engine API access and node quota](#)
- Make sure that the CIDR range doesn't overlap with any of your on-premises or cloud subnets. The CIDR range must be /27 or higher.

Google Cloud VMware Engine

← Create Private Cloud ⓘ

Private Cloud name *

NIMoGCVE

Location *

us-east4 > v-zone-a > VE Placement Group 2

Node type *

ve1-standard-72
2x2.6 GHz, 36 Cores (72 HT), 768 GB RAM
19.2 TB Raw, 3.2 TB Cache (All-Flash)

Node count *

3
(3 to 3)

vSphere/vSAN subnets CIDR range *

192.168.100.0 / 22

IP Range: 192.168.100.0 - 192.168.103.255

HCX Deployment Network CIDR range

192.168.104.0 / 26

IP Range: 192.168.104.0 - 192.168.104.63

Note: Private cloud creation can take between 30 minutes to 2 hours.

Enable Private Access to GCVE

Once the Private Cloud is provisioned, configure private access to the Private Cloud for high-throughput and low-latency data-path connection.

This will ensure that the VPC network where Cloud Volumes ONTAP instances are running is able to communicate with the GCVE Private Cloud. To do so, follow the [GCP documentation](#). For the Cloud Volume Service, establish a connection between VMware Engine and Cloud Volumes Service by performing a one-time peering between the tenant host projects. For detailed steps, follow this [link](#).

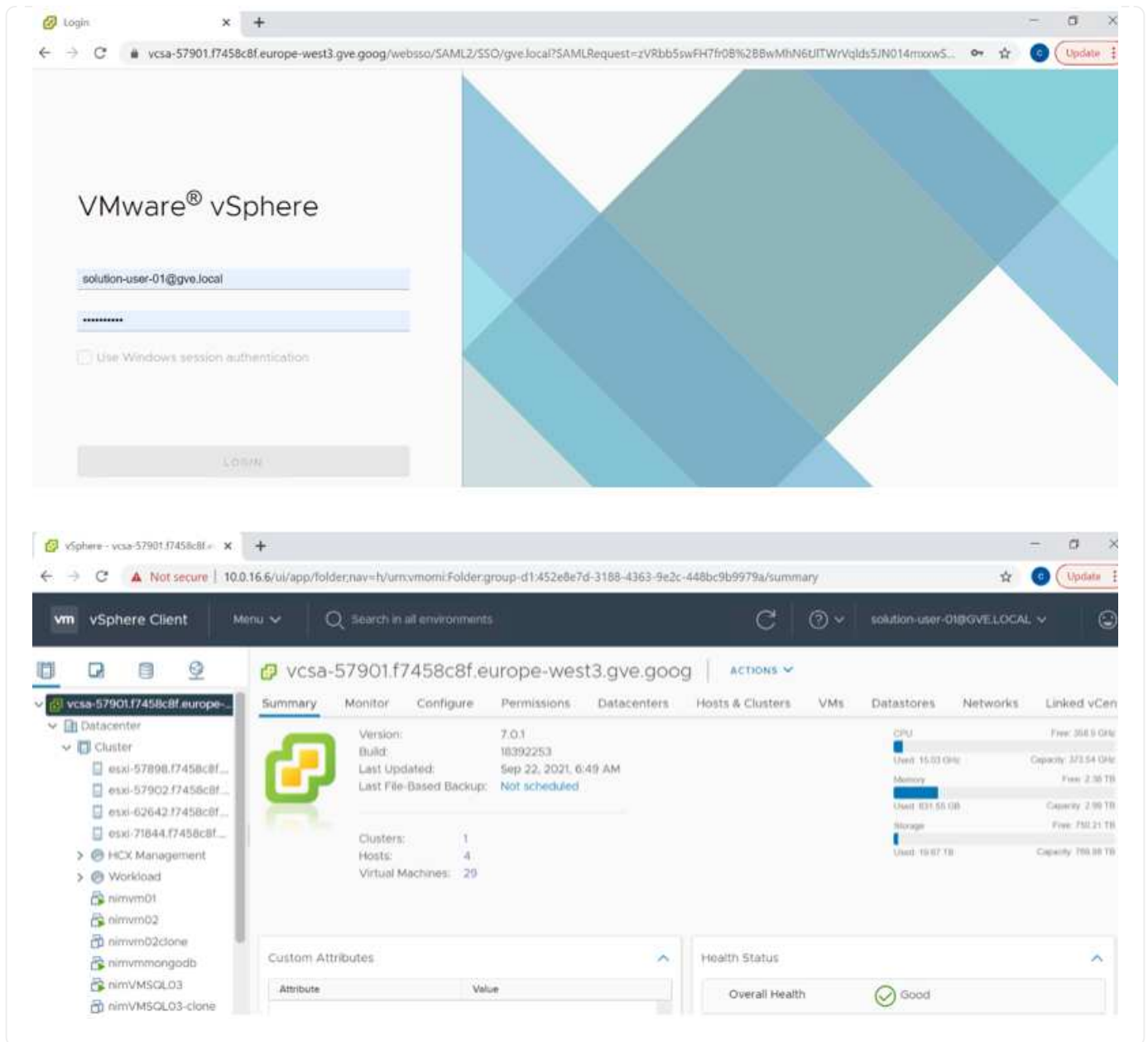
Tenant P	Service	Region	Routing Mode	Peered Project ID	Peered VPC	VPC Peering Sta...	Region Status
ke841388caa56b...	VPC Network	europe-west3	Global	cy-performance-te...	cloud-volumes-vpc	Active	Connected
jbd729510b3ebbf...	NetApp CVS	europe-west3	Global	y2b6c17202af6dc...	netapp-tenant-vpc	Active	Connected

Sign in to vcenter using the [CloudOwner@gve.local](#) user. To access the credentials, go to the VMware Engine portal, Go to Resources, and select the appropriate private cloud. In the Basic info section, click the View link for either vCenter login info (vCenter Server, HCX Manager) or NSX-T login info (NSX Manager).

The screenshot shows the Google Cloud VMware Engine (GCVE) console. The top navigation bar is blue with the 'Google Cloud VMware Engine' logo and several icons. The left sidebar contains a 'Resources' section with icons for Home, Resources, Network, Activity, and Account. The main content area is titled 'Resources' and shows a list of private clouds. The selected cloud is 'gcve-cvs-hw-eu-west3'. Below the cloud name, there are tabs for 'SUMMARY', 'CLUSTERS', 'SUBNETS', 'ACTIVITY', 'VSPHERE MANAGEMENT NETWORK', 'ADVANCED VCENTER SETTINGS', and 'DNS CONFIGURATION'. The 'SUMMARY' tab is active, showing a table with columns for Name, Status, Location, Expandable, vCenter login info, NSX-T login info, Cloud Monitoring, Private Cloud DNS Servers, and Upgradeable. The table shows that the cloud is 'Operational' and provides links to view vCenter and NSX-T login info. Below the table, there is a 'Capacity' section showing 'Total nodes: 4', 'Total CPU capacity: 144 cores', and 'Total RAM: 3072 GB'.

In a Windows virtual machine, open a browser and navigate to the vCenter web client URL (<https://10.0.16.6/>) and use the admin user name as [CloudOwner@gve.local](#) and paste the copied password. Similarly, NSX-T manager can also be accessed using the web client URL (<https://10.0.16.11/>) and use the admin user name and paste the copied password to create new segments or modify the existing tier gateways.

For connecting from an on-premises network to VMware Engine private cloud, leverage cloud VPN or Cloud Interconnect for appropriate connectivity and make sure the required ports are open. For detailed steps, follow this [link](#).



NetApp Storage options for Public Cloud Providers

Explore the options for NetApp as storage in the three major hyperscalers.

AWS / VMC

AWS supports NetApp storage in the following configurations:

- FSx ONTAP as guest connected storage
- Cloud Volumes ONTAP (CVO) as guest connected storage
- FSx ONTAP as a native datastore¹

View the detailed [guest connect storage options for VMC](#).

Read more about FSx ONTAP as a native datastore public preview from the AWS Press Release (COMING SOON!).

Azure / AVS

Azure supports NetApp storage in the following configurations:

- Azure NetApp Files (ANF) as guest connected storage
- Cloud Volumes ONTAP (CVO) as guest connected storage
- Azure NetApp Files (ANF) as a native datastore¹

View the detailed [guest connect storage options for AVS](#).

Read more about [Azure NetApp Files \(ANF\) as a native datastore - Public Preview](#).

GCP / GCVE

Google Cloud supports NetApp storage in the following configurations:

- Cloud Volumes ONTAP (CVO) as guest connected storage
- Cloud Volumes Service (CVS) as guest connected storage
- Cloud Volumes Service (CVS) as a native datastore¹

View the detailed [guest connect storage options for GCVE](#).

Read more about [Cloud Volumes Service \(CVS\) as a native datastore¹](#).



1 - Currently in Private Preview

NetApp Guest Connected Storage Options for AWS

AWS supports guest connected NetApp storage with the native FSx service (FSx ONTAP) or with Cloud Volumes ONTAP (CVO).

FSx ONTAP

Amazon FSx for NetApp ONTAP is a fully managed service that provides highly reliable, scalable, high-performing, and feature-rich file storage built on NetApp's popular ONTAP file system. FSx for ONTAP combines the familiar features, performance, capabilities, and API operations of NetApp file systems with the agility, scalability, and simplicity of a fully managed AWS service.

FSx for ONTAP provides feature-rich, fast, and flexible shared file storage that's broadly accessible from Linux,

Windows, and macOS compute instances running in AWS or on premises. FSx for ONTAP offers high-performance solid state drive (SSD) storage with submillisecond latencies. With FSx for ONTAP, you can achieve SSD levels of performance for your workload while paying for SSD storage for only a small fraction of your data.

Managing your data with FSx for ONTAP is easier because you can snapshot, clone, and replicate your files with the click of a button. In addition, FSx for ONTAP automatically tiers your data to lower-cost, elastic storage, lessening the need for you to provision or manage capacity.

FSx for ONTAP also provides highly available and durable storage with fully managed backups and support for cross-Region disaster recovery. To make it easier to protect and secure your data, FSx for ONTAP supports popular data security and antivirus applications.

FSx ONTAP as guest connected storage

Configure Amazon FSx for NetApp ONTAP with VMware Cloud on AWS

Amazon FSx for NetApp ONTAP files shares and LUNs can be mounted from VMs that are created within the VMware SDDC environment at VMware Cloud on AWS. The volumes can also be mounted on the Linux client and mapped on the Windows client using the NFS or SMB protocol, and LUNS can be accessed on Linux or Windows clients as block devices when mounted over iSCSI. Amazon FSx for the NetApp ONTAP file system can be set up quickly with the following steps.



Amazon FSx for NetApp ONTAP and VMware Cloud on AWS must be in the same availability zone to achieve better performance and avoid data transfer charges between availability zones.



Create and mount Amazon FSx for ONTAP volumes

To create and mount Amazon FSx for NetApp ONTAP file system, complete the following steps:

1. Open the [Amazon FSx console](#) and choose Create file system to start the file system creation wizard.
2. On the Select File System Type page, choose Amazon FSx for NetApp ONTAP, and then choose Next. The Create File System page appears.



3. In the Networking section, for Virtual Private Cloud (VPC), choose the appropriate VPC and preferred subnets along with the route table. In this case, vmcfsx2.vpc is selected from the dropdown.

Create file system

Creation method

☐ Quick create
Use recommended best-practice configurations. Most configuration options can be changed after the file system is created.

☒ Standard create
You set all of the configuration options, including specifying performance, networking, security, backups, and maintenance.

4. For the creation method, choose Standard Create. You can also choose Quick Create, but this document uses the Standard create option.

File system details

File system name - optional [Info](#)

vmcfsxval2

Maximum of 256 Unicode letters, whitespace, and numbers, plus + - = . _ : /

SSD storage capacity [Info](#)

1024

Minimum 1024 GB; Maximum 192 TB.

Provisioned SSD IOPS

Amazon FSx provides 3 IOPS per GB of storage capacity. You can also provision additional SSD IOPS as needed.

☒ Automatic (3 IOPS per GB of SSD storage)

☐ User-provisioned

Throughput capacity [Info](#)

The sustained speed at which the file server hosting your file system can serve data. The file server can also burst to higher speeds for periods of time.

512 MB/s (Recommended)

5. In the Networking section, for Virtual Private Cloud (VPC), choose the appropriate VPC and preferred subnets along with the route table. In this case, vmcfsx2.vpc is selected from the dropdown.

Network & security

Virtual Private Cloud (VPC) [Info](#)

Specify the VPC from which your file system is accessible.

vmcfsx2.vpc | vpc-0d1c764bcc495e805

VPC Security Groups [Info](#)

Specify VPC Security Groups to associate with your file system's network interface.

Choose VPC security group(s)

sg-018896ea218164ccb (default) X

Preferred subnet [Info](#)

Specify the preferred subnet for your file system.

subnet02.sn | subnet-013675849a5b99b3c (us-west-2b)

Standby subnet

subnet01.sn | subnet-0ef956cebf539f970 (us-west-2a)

VPC route tables

Specify the VPC route tables associated with your file system.

☒ VPC's default route table

☐ Select one or more VPC route tables

Endpoint IP address range

Specify the IP address range in which the endpoints to access your file system will be created.

☒ No preference

☐ Select an IP address range



In the Networking section, for Virtual Private Cloud (VPC), choose the appropriate VPC and preferred subnets along with the route table. In this case, vmcfsx2.vpc is selected from the dropdown.

6. In the Security & Encryption section, for the Encryption Key, choose the AWS Key Management Service (AWS KMS) encryption key that protects the file system's data at rest. For the File System Administrative Password, enter a secure password for the fsxadmin user.

Security & encryption

Encryption key [Info](#)
AWS Key Management Service (KMS) encryption key that protects your file system data at rest.

aws/fsx (default) ▼

Description	Account	KMS key ID
Default master key that protects my FSx resources when no other key is defined	139763910815	72745367-7bb0-499c-acc0-4f2c0a80e7c5

File system administrative password
Password for this file system's "fsxadmin" user, which you can use to access the ONTAP CLI or REST API.

☐ Don't specify a password

☒ Specify a password

Password

••••••••

Confirm password

••••••••

7. In virtual machine and specify the password to use with vsadmin for administering ONTAP using REST APIs or the CLI. If no password is specified, a fsxadmin user can be used for administering the SVM. In the Active Directory section, make sure to join Active Directory to the SVM for provisioning SMB shares. In the Default Storage Virtual Machine Configuration section, provide a name for the storage in this validation, SMB shares are provisioned using a self-managed Active Directory domain.

Default storage virtual machine configuration

Storage virtual machine name

vmcfsxval2svm

SVM administrative password

Password for this SVM's "vsadmin" user, which you can use to access the ONTAP CLI or REST API.

☐ Don't specify a password

☒ Specify a password

Password

••••••••

Confirm password

••••••••

Active Directory

Joining an Active Directory enables access from Windows and MacOS clients over the SMB protocol.

☒ Do not join an Active Directory

☐ Join an Active Directory

8. In the Default Volume Configuration section, specify the volume name and size. This is an NFS volume. For Storage Efficiency, choose Enabled to turn on the ONTAP storage efficiency features (compression, deduplication, and compaction) or Disabled to turn them off.

Default volume configuration

Volume name

vol1

Maximum of 203 alphanumeric characters, plus _ .

Junction path

/vol1

The location within your file system where your volume will be mounted.

Volume size

1024

Minimum 20 MiB; Maximum 104857600 MiB

Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

☐ Enabled (recommended)

☒ Disabled

Capacity pool tiering policy

You can optionally enable automatic tiering of your data to lower-cost capacity pool storage.

Auto

9. Review the file system configuration shown on the Create File System page.
10. Click Create File System.

aws Services Search for services, features, marketplace products, and docs [Alt+S] nimo @ cloudheroes Oregon Support

Amazon FSx

File systems (3)

File system name	File system ID	File system type	Status	Deployment type	Storage type	Size
fsxntapcifs	fs-014c28399be9c1f9f	ONTAP	Available	Multi-AZ	SSD	1,024 GiB
vmcfsxval2	fs-040eacc5d0ac31017	ONTAP	Available	Multi-AZ	SSD	1,024 GiB
fsxntapsql	fs-0ab4b447ebd6082aa	ONTAP	Available	Multi-AZ	SSD	2,048 GiB

Network & security Administration **Storage virtual machines** Volumes Backups Tags

Storage virtual machines (SVMs) (2)

Find storage virtual machines

SVM name	SVM ID	Status	Creation time	Active Directory
fsxmbtesting01	svm-075dcfbe2cfa2ece9	Created	2021-10-19 15:17:08 UTC +01:00	FSXTESTING.LOCAL
vmcfsxval2svm	svm-095db076341561212	Created	2021-10-15 15:16:54 UTC +01:00	-

FSx > Storage virtual machines > svm-075dcfbe2cfa2ece9

fsxmbtesting01 (svm-075dcfbe2cfa2ece9) Delete Update

Summary

SVM ID svm-075dcfbe2cfa2ece9	Creation time 2021-10-19T15:17:08+01:00	Active Directory FSXTESTING.LOCAL
SVM name fsxmbtesting01	Lifecycle state Created	Net BIOS name FSXSMBTESTING01
UUID 4a50e659-30e7-11ec-ac4f-f3ad92a6a735	Subtype DEFAULT	Fully qualified domain name FSXTESTING.LOCAL
File system ID fs-040eacc5d0ac31017		Service account username administrator
		Organizational unit distinguished name CN=Computers

For more detailed information, see [Getting started with Amazon FSx for NetApp ONTAP](#).

After the file system is created as above, create the volume with the required size and protocol.

1. Open the [Amazon FSx console](#).
2. In the left navigation pane, choose File systems, and then choose the ONTAP file system that you want to create a volume for.
3. Select the Volumes tab.

4. Select the Create Volume tab.
5. The Create Volume dialog box appears.

For demo purposes, an NFS volume is created in this section that can be easily mounted on VMs running on VMware cloud on AWS. nfsdemo01 is created as depicted below:

Create volume [X]

File system
fs-040eacc5d0ac31017 | vmcfsxval2 ▼

Storage virtual machine
svm-095db076341561212 | vmcfsxval2svm ▼

Volume name
nfsdemo01
Maximum of 205 alphanumeric characters, plus _ and -

Junction path
/nfsdemo01
The location within your file system where your volume will be mounted.

Volume size
1024 [MiB]
Minimum 20 MiB; Maximum 104857600 MiB

Storage efficiency
Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.
☐ Enabled (recommended)
☒ Disabled

Capacity pool tiering policy
You can optionally enable automatic tiering of your data to lower-cost capacity pool storage.
Auto ▼

Cancel Confirm

Mount FSx ONTAP volume on Linux client

To mount the FSx ONTAP volume created in the previous step, from the Linux VMs within VMC on AWS SDDC, complete the following steps:

1. Connect to the designated Linux instance.
2. Open a terminal on the instance using Secure Shell (SSH) and log in with the appropriate credentials.
3. Make a directory for the volume's mount point with the following command:

```
$ sudo mkdir /fsx/nfsdemovol01
```

4. Mount the Amazon FSx for NetApp ONTAP NFS volume to the directory that is created in the previous step.

```
sudo mount -t nfs nfsvers=4.1,198.19.254.239:/nfsdemovol01  
/fsx/nfsdemovol01
```

```
root@ubuntu01:/fsx/nfsdemovol01# mount -t nfs 198.19.254.239:/nfsdemovol01 /fsx/nfsdemovol01
```

5. Once executed, run the df command to validate the mount.



```
root@ubuntu01:/fsx/nfsdemovol01# df
Filesystem            1K-blocks    Used Available Use% Mounted on
tmpfs                  814396      1176    813220   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv 15412168 3666428 10943132 25% /
tmpfs                  4071960         0   4071960   0% /dev/shm
tmpfs                   5120         0     5120   0% /run/lock
tmpfs                   4096         0     4096   0% /sys/fs/cgroup
/dev/sda2              999320 254396    675312 28% /boot
tmpfs                  814392         4    814388   1% /run/user/1000
172.16.0.2:/nfsdemovol01 9961472 4241792 5719680 43% /fsx/votest/ing01/nfsdemovol01
198.19.254.239:/nfsdemovol01 996160    512    995648   1% /fsx/nfsdemovol01
root@ubuntu01:/fsx/nfsdemovol01# cd /fsx/nfsdemovol01/
root@ubuntu01:/fsx/nfsdemovol01# ls
nfsdemo11.txt
root@ubuntu01:/fsx/nfsdemovol01#
```

► https://docs.netapp.com/us-en/netapp-solutions/media/vmc_linux_vm_nfs.mp4 (video)



Attach FSx ONTAP volumes to Microsoft Windows clients

To manage and map file shares on an Amazon FSx file system, the Shared Folders GUI must be used.

1. Open the Start menu and run fsmgmt.msc using Run As Administrator. Doing this opens the Shared Folders GUI tool.
2. Click Action > All tasks and choose Connect to Another Computer.
3. For Another Computer, enter the DNS name for the storage virtual machine (SVM). For example, FSXSMBTESTING01.FSXTESTING.LOCAL is used in this example.



To find the SVM's DNS name on the Amazon FSx console, choose Storage Virtual Machines, choose SVM, and then scroll down to Endpoints to find the SMB DNS name. Click OK. The Amazon FSx file system appears in the list for the Shared Folders.

Endpoints

Management DNS name

svm-075dcfbe2cfa2ece9.fs-040eacc5d0ac31017.fsx.us-west-2.amazonaws.com

NFS DNS name

svm-075dcfbe2cfa2ece9.fs-040eacc5d0ac31017.fsx.us-west-2.amazonaws.com

SMB DNS name

FSXSMBTESTING01.FSXTESTING.LOCAL

iSCSI DNS name

iscsi.svm-075dcfbe2cfa2ece9.fs-040eacc5d0ac31017.fsx.us-west-2.amazonaws.com

Management IP address

198.19.254.9

NFS IP address

198.19.254.9

SMB IP address

198.19.254.9

iSCSI IP addresses

10.222.2.224, 10.222.1.94



4. In the Shared Folders tool, choose Shares in the left pane to see the active shares for the Amazon FSx file system.



5. Now choose a new share and complete the Create a Shared Folder wizard.





To learn more about creating and managing SMB shares on an Amazon FSx file system, see [Creating SMB Shares](#).

6. After connectivity is in place, the SMB share can be attached and used for application data. To accomplish this, Copy the share path and use the Map Network Drive option to mount the volume on the VM running on VMware Cloud on the AWS SDDC.



Connect a FSx for NetApp ONTAP LUN to a host using iSCSI

► https://docs.netapp.com/us-en/netapp-solutions/media/vmc_windows_vm_iscsi.mp4 (video)

iSCSI traffic for FSx traverses the VMware Transit Connect/AWS Transit Gateway via the routes provided in the previous section. To configure a LUN in Amazon FSx for NetApp ONTAP, follow the documentation found [here](#).

On Linux clients, make sure that the iSCSI daemon is running. After the LUNs are provisioned, refer to the detailed guidance on iSCSI configuration with Ubuntu (as an example) [here](#).

In this paper, connecting the iSCSI LUN to a Windows host is depicted:



Provision a LUN in FSx for NetApp ONTAP:

1. Access the NetApp ONTAP CLI using the management port of the FSx for the ONTAP file system.
2. Create the LUNs with the required size as indicated by the sizing output.

```
FsxId040eacc5d0ac31017::> lun create -vserver vmcfssxval2svm  
-volume nimfssxscsivol -lun nimofssxlun01 -size 5gb -ostype  
windows -space-reserve enabled
```

In this example, we created a LUN of size 5g (5368709120).

3. Create the necessary igroups to control which hosts have access to specific LUNs.

```
FsxId040eacc5d0ac31017::> igroup create -vserver vmcfssxval2svm  
-igroup winIG -protocol iscsi -ostype windows -initiator  
iqn.1991-05.com.microsoft:vmcdc01.fsxtesting.local
```

```
FsxId040eacc5d0ac31017::> igroup show
```

Vserver	Igroup	Protocol	OS	Type	Initiators
---------	--------	----------	----	------	------------

-----	-----	-----	-----		
-----	-----	-----	-----		

vmcfssxval2svm

	ubuntu01	iscsi	linux		iqn.2021-10.com.ubuntu:01:initiator01
--	----------	-------	-------	--	---------------------------------------

vmcfssxval2svm

	winIG	iscsi	windows		iqn.1991-05.com.microsoft:vmcdc01.fsxtesting.local
--	-------	-------	---------	--	----------------------------------------------------

Two entries were displayed.

4. Map the LUNs to igroups using the following command:

```
FsxId040eacc5d0ac31017::> lun map -vserver vmcfsxval2svm -path
/vol/nimfsxscsivol/nimofsxlnun01 -igroup winIG

FsxId040eacc5d0ac31017::> lun show
```

Vserver	Path	State	Mapped	Type	Size

vmcfsxval2svm					
	/vol/blocktest01/lun01	online	mapped	linux	5GB
vmcfsxval2svm					
	/vol/nimfsxscsivol/nimofsxlnun01	online	mapped	windows	5GB

Two entries were displayed.

5. Connect the newly provisioned LUN to a Windows VM:

To connect the new LUN for a Windows host residing on VMware cloud on AWS SDDC, complete the following steps:

- RDP to the Windows VM hosted on the VMware Cloud on AWS SDDC.
- Navigate to Server Manager > Dashboard > Tools > iSCSI Initiator to open the iSCSI Initiator Properties dialog box.
- From the Discovery tab, click Discover Portal or Add Portal and then enter the IP address of the iSCSI target port.
- From the Targets tab, select the target discovered and then click Log On or Connect.
- Select Enable Multipath, and then select “Automatically Restore This Connection When the Computer Starts” or “Add This Connection to the List of Favorite Targets”. Click Advanced.



The Windows host must have an iSCSI connection to each node in the cluster. The native DSM selects the best paths to use.



LUNs on the storage virtual machine (SVM) appear as disks to the Windows host. Any new disks that are added are not automatically discovered by the host. Trigger a manual rescan to discover the disks by completing the following steps:

1. Open the Windows Computer Management utility: Start > Administrative Tools > Computer Management.
2. Expand the Storage node in the navigation tree.
3. Click Disk Management.
4. Click Action > Rescan Disks.



When a new LUN is first accessed by the Windows host, it has no partition or file system. Initialize the LUN and, optionally, format the LUN with a file system by completing the following steps:

1. Start Windows Disk Management.
2. Right-click the LUN, and then select the required disk or partition type.
3. Follow the instructions in the wizard. In this example, drive F: is mounted.



Cloud Volumes ONTAP (CVO)

Cloud volumes ONTAP, or CVO, is the industry-leading cloud data management solution built on NetApp's ONTAP storage software, available natively on Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform (GCP).

It is a software-defined version of ONTAP that consumes cloud-native storage, allowing you to have the same storage software in the cloud and on-premises, reducing the need to retrain your IT staff in all-new methods to manage your data.

CVO gives customers the ability to seamlessly move data from the edge, to the data center, to the cloud and back, bringing your hybrid cloud together — all managed with a single-pane management console, NetApp Cloud Manager.

By design, CVO delivers extreme performance and advanced data management capabilities to satisfy even your most demanding applications in the cloud

Cloud Volumes ONTAP (CVO) as guest connected storage



Deploy new Cloud Volumes ONTAP instance in AWS (do it yourself)

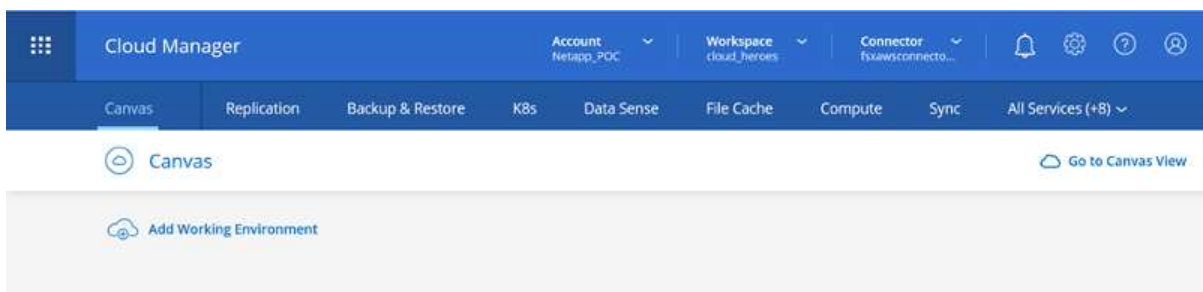
Cloud Volumes ONTAP shares and LUNs can be mounted from VMs that are created in the VMware Cloud on AWS SDDC environment. The volumes can also be mounted on native AWS VM Linux Windows clients, and LUNS can be accessed on Linux or Windows clients as block devices when mounted over iSCSI because Cloud Volumes ONTAP supports iSCSI, SMB, and NFS protocols. Cloud Volumes ONTAP volumes can be set up in a few simple steps.

To replicate volumes from an on-premises environment to the cloud for disaster recovery or migration purposes, establish network connectivity to AWS, either using a site-to-site VPN or DirectConnect. Replicating data from on-premises to Cloud Volumes ONTAP is outside the scope of this document. To replicate data between on-premises and Cloud Volumes ONTAP systems, see [Setting up data replication between systems](#).

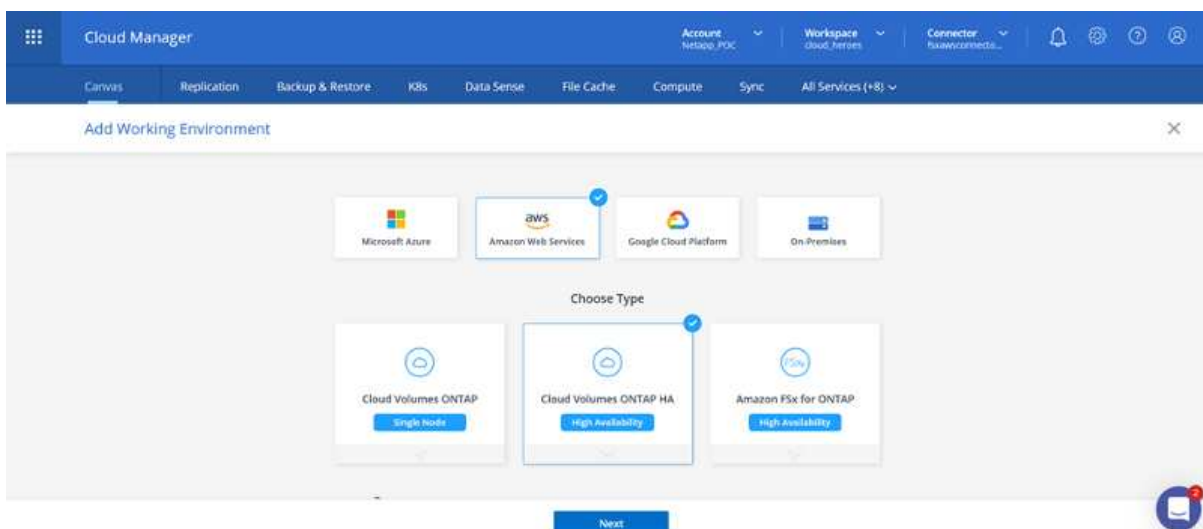


Use the [Cloud Volumes ONTAP sizer](#) to accurately size the Cloud Volumes ONTAP instances. Also, monitor on-premises performance to use as inputs in the Cloud Volumes ONTAP sizer.

1. Log into NetApp Cloud Central; the Fabric View screen is displayed. Locate the Cloud Volumes ONTAP tab and select Go to Cloud Manager. After you are logged in, the Canvas screen is displayed.



2. On the Cloud Manager home page, click Add a Working Environment and then select AWS as the cloud and the type of the system configuration.



3. Provide the details of the environment to be created including the environment name and admin credentials. Click Continue.

Create a New Working Environment Details and Credentials

↑ Previous Step

Instance Profile	139763910815	netapp.com-cloud-volumes-...	Edit Credentials
Credential Name	Account ID	Marketplace Subscription	

Details

Working Environment Name (Cluster Name)

[Add Tags](#) Optional Field | Up to four tags

Credentials

User Name

Password

Confirm Password

[Continue](#)

- Select the add-on services for Cloud Volumes ONTAP deployment, including Cloud Data Sense, Cloud Backup, and Cloud Insights. Click Continue.

Create a New Working Environment Services

Data Sense & Compliance

☒

Backup to Cloud

☒

Monitoring

☒

[Continue](#)

- On the HA Deployment Models page, choose the Multiple Availability Zones configuration.

Create a New Working Environment HA Deployment Models

↑ Previous Step

Multiple Availability Zones

- Provides maximum protection against AZ failures.
- Enables selection of 3 availability zones.
- An HA node serves data if its partner goes offline.

Extended Info

Single Availability Zone

- Protects against failures within a single AZ.
- Single availability zone. HA nodes are in a placement group, spread across distinct underlying hardware.
- An HA node serves data if its partner goes offline.

Extended Info

- On the Region & VPC page, enter the network information and then click Continue.

↑ Previous Step

AWS Region:

VPC:

Security group:

Node 1:

Availability Zone:

Subnet:

Node 2:

Availability Zone:

Subnet:

Mediator:

Availability Zone:

Subnet:

Continue

7. On the Connectivity and SSH Authentication page, choose connection methods for the HA pair and the mediator.

↑ Previous Step

Nodes

SSH Authentication Method:

Mediator

Security Group:

Key Pair Name:

Internet Connection Method:

Continue

8. Specify the floating IP addresses and then click Continue.

↑ Previous Step

Floating IP addresses are required for cluster and SVM access and for NFS and CIFS data access. These floating IPs can migrate between HA nodes if failures occur. To access the data from outside the VPC, [you can set up an AWS transit gateway.](#)

You must specify IP addresses that are outside of the CIDR blocks for all VPCs in the selected AWS region.

Floating IP address for cluster management:

Floating IP address 1 for NFS and CIFS data:

Floating IP address 2 for NFS and CIFS data:

Floating IP address for SVM management (Optional):

Continue

9. Select the appropriate route tables to include routes to the floating IP addresses and then click Continue.

[Create a New Working Environment](#)[Route Tables](#)

[↑ Previous Step](#)

Select the route tables that should include routes to the floating IP addresses. This enables client access to the Cloud Volumes ONTAP HA pair. If you leave a route table unselected, clients that are associated with the route table cannot access the HA pair.

Additional information ⓘ

Name	Main	ID	Associate with Subnet	Tags
<input checked="" type="checkbox"/>	Yes	rtb-00b2d30c3f68fdbdd	0 Subnets	1 Tags

1 Route Tables | The main route table is the default for the VPC

[Continue](#)

10. On the Data Encryption page, choose AWS-managed encryption.

[Create a New Working Environment](#)[Data Encryption](#)

[↑ Previous Step](#)

 **AWS Managed Encryption**

AWS is responsible for data encryption and decryption operations. Key management is handled by AWS key management services.

Default Master Key: **aws/ebs** [Change Key](#)

[Continue](#)

11. Select the license option: Pay-As-You-Go or BYOL for using an existing license. In this example, the Pay-As-You-Go option is used.

Create a New Working EnvironmentCloud Volumes ONTAP Charging Methods & NSS Account

Cloud Volumes ONTAP Charging Methods

[Learn more about our charging methods](#)

☒ Pay-As-You-Go by the hour

☐ Bring your own license

NetApp Support Site Account *(Optional)*

[Learn more about NetApp Support Site \(NSS\) accounts](#)

To register this Cloud Volumes ONTAP to support, you should add NetApp Support Site Account.

Don't have a NetApp Support Site account? Select go to finish deploying this system. After it's created, use the [Support Registration option](#) to create an NSS account.

Continue

12. Select between several preconfigured packages available based on the type of workload to be deployed on the VMs running on the VMware cloud on AWS SDDC.

Create a New Working Environment

Preconfigured Packages

[Select a preconfigured Cloud Volumes ONTAP system that best matches your needs, or create your own configuration. Preconfigured settings can be modified at a later time.](#)

Change Configuration



POC and small workloads
Up to 500GB of storage



Database and application data
production workloads



Cost effective DR
Up to 500GB of storage



Highest performance production
workloads

Continue

13. On the Review & Approve page, review and confirm the selections. To create the Cloud Volumes ONTAP instance, click Go.

Create a New Working Environment

Review & Approve

[Previous Step](#)

[Show API request](#)

us-west-2 | HA

This Cloud Volumes ONTAP instance will be registered with NetApp support under the NSS Account **mchad**.

☒ I understand that Cloud Manager will allocate the appropriate AWS resources to comply with my above requirements. [More information >](#)

Overview | Networking | Storage

Storage System:	Cloud Volumes ONTAP HA	HA Deployment Model:	Multiple Availability Zones
License Type:	Cloud Volumes ONTAP Explore	Encryption:	AWS Managed
Capacity Limit:	2TB	Customer Master Key:	aws/ebs

Go

14. After Cloud Volumes ONTAP is provisioned, it is listed in the working environments on the Canvas page.

Canvas

Go to Tabular View

Add Working Environment

fsxcvotesting01

Cloud Volumes ONTAP

46 GiB

Capacity

aws

vmcnsval2

F5a for ONTAP

9

Volumes

26.49 GiB

Capacity

aws

Amazon S3

4

Buckets

2

Regions

aws

fsxcvotesting01

On

ⓘ

ⓘ

✕

DETAILS

Cloud Volumes ONTAP | AWS | HA

SERVICES

⚙

Replication

●

Off

Enable

ⓘ

⚙

Backup & Restore

⌂

Loading...

Loading...

ⓘ



Additional configurations for SMB volumes

1. After the working environment is ready, make sure the CIFS server is configured with the appropriate DNS and Active Directory configuration parameters. This step is required before you can create the SMB volume.

The screenshot shows the 'Create a CIFS server' configuration page for the instance 'fsxcvotesting01'. The page has tabs for 'Volumes', 'HA Status', 'Cost', and 'Replications'. The 'Create a CIFS server' tab is active, and there is a '+ Advanced' link. The configuration fields are as follows:

- DNS Primary IP Address:** 192.168.1.3
- DNS Secondary IP Address (Optional):** Example: 127.0.0.1
- Active Directory Domain to join:** fctesting.local
- Credentials authorized to join the domain:**
 - Username:** (empty)
 - Password:** (empty)

At the bottom, there are 'Save' and 'Cancel' buttons.

2. Select the CVO instance to create the volume and click the Create Volume option. Choose the appropriate size and cloud manager chooses the containing aggregate or use advanced allocation mechanism to place on a specific aggregate. For this demo, SMB is selected as the protocol.

The screenshot shows the 'Volume Details, Protection & Protocol' configuration page for creating a new volume in the instance 'fsxcvotesting01'. The page is divided into two main sections: 'Details & Protection' and 'Protocol'.

Details & Protection:

- Volume Name:** smbdemovol01
- Size (GB):** 100
- Snapshot Policy:** default
- Default Policy:** (checked)

Protocol:

- NFS:** (unselected)
- CIFS:** (selected)
- iSCSI:** (unselected)
- Share name:** smbdemovol01_share
- Permissions:** Full Control
- Users / Groups:** Everyone;
- Valid users and groups separated by a semicolon

At the bottom, there is a 'Continue' button.

3. After the volume is provisioned, it is available under the Volumes pane. Because a CIFS share is provisioned, you should give your users or groups permission to the files and folders and verify that those users can access the share and create a file.



Connect the LUN to a host

To connect the Cloud Volumes ONTAP LUN to a host, complete the following steps:

1. On the Cloud Manager Canvas page, double-click the Cloud Volumes ONTAP working environment to create and manage volumes.
2. Click Add Volume > New Volume, select iSCSI, and click Create Initiator Group. Click Continue.



3. After the volume is provisioned, select the volume, and then click Target IQN. To copy the iSCSI Qualified Name (IQN), click Copy. Set up an iSCSI connection from the host to the LUN.

To accomplish the same for the host residing on the VMware Cloud on AWS SDDC, complete the following steps:

- a. RDP to the VM hosted on VMware cloud on AWS.
- b. Open the iSCSI Initiator Properties dialog box: Server Manager > Dashboard > Tools > iSCSI Initiator.
- c. From the Discovery tab, click Discover Portal or Add Portal and then enter the IP address of the

iSCSI target port.

- d. From the Targets tab, select the target discovered and then click Log On or Connect.
- e. Select Enable Multipath, and then select Automatically Restore This Connection When the Computer Starts or Add This Connection to the List of Favorite Targets. Click Advanced.



The Windows host must have an iSCSI connection to each node in the cluster. The native DSM selects the best paths to use.



LUNs from the SVM appear as disks to the Windows host. Any new disks that are added are not automatically discovered by the host. Trigger a manual rescan to discover the disks by completing the following steps:

1. Open the Windows Computer Management utility: Start > Administrative Tools > Computer Management.
2. Expand the Storage node in the navigation tree.
3. Click Disk Management.
4. Click Action > Rescan Disks.



When a new LUN is first accessed by the Windows host, it has no partition or file system. Initialize the LUN; and optionally, format the LUN with a file system by completing the following steps:

1. Start Windows Disk Management.
2. Right-click the LUN, and then select the required disk or partition type.
3. Follow the instructions in the wizard. In this example, drive F: is mounted.



On the Linux clients, ensure the iSCSI daemon is running. After the LUNs are provisioned, refer to the detailed guidance on iSCSI configuration for your Linux distribution. For example, Ubuntu iSCSI configuration can be found [here](#). To verify, run `lsblk` cmd from the shell.

Mount Cloud Volumes ONTAP NFS volume on Linux client

To mount the Cloud Volumes ONTAP (DIY) file system from VMs within VMC on AWS SDDC, complete the following steps:

1. Connect to the designated Linux instance.
2. Open a terminal on the instance using secure shell (SSH) and log in with the appropriate credentials.
3. Make a directory for the volume's mount point with the following command.

```
$ sudo mkdir /fsxcvotesting01/nfsdemov0101
```

4. Mount the Amazon FSx for NetApp ONTAP NFS volume to the directory that is created in the previous step.

```
sudo mount -t nfs nfsvers=4.1,172.16.0.2:/nfsdemov0101  
/fsxcvotesting01/nfsdemov0101
```



```
root@ubuntu01:/fsx# mount -t nfs 172.16.0.2:/nfsdemov0101 /fsxcvotesting01/nfsdemov0101_
vSphere - ubuntu01 - Summary X ubuntu01
https://vcenter.sddc-52-37-127-104.vmwarevmc.com/ui/webconsole.html?vmId=vm-1003&vmName=ubuntu01&serv...
Getting Started EC2 Management Con... New Tab
ubuntu01 Enforce US Keyboard Layout View Fullscreen
root@ubuntu01:/fsx/nfsdemov0101# df
Filesystem            1k-blocks    Used Available Use% Mounted on
tmpfs                  814096      1176    813920   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv 15412168 3666428 10943132  26% /
tmpfs                  4071960      0    4071960   0% /dev/shm
tmpfs                   5120         0     5120   0% /run/lock
tmpfs                   4096         0     4096   0% /sys/fs/cgroup
/dev/sda2              999320 254996  675512  28% /boot
tmpfs                  814392      4    814388   1% /run/user/1000
172.16.0.2:/nfsdemov0101 9361472 4241792 5719680  45% /fsxcvotesting01/nfsdemov0101 ←
root@ubuntu01:/fsx/nfsdemov0101# cd /fsx/nfsdemov0101/
root@ubuntu01:/fsx/nfsdemov0101# ls
n1now111.txt
root@ubuntu01:/fsx/nfsdemov0101#
```

NetApp Guest Connected Storage Options for Azure

Azure supports guest connected NetApp storage with the native Azure NetApp Files (ANF) service or with Cloud Volumes ONTAP (CVO).

Azure NetApp Files (ANF)

Azure netApp Files brings enterprise-grade data management and storage to Azure so you can manage your workloads and applications with ease. Migrate your workloads to the cloud and run them without sacrificing performance.

Azure netApp Files removes obstacles, so you can move all of your file-based applications to the cloud. For the first time, you do not

have to re-architect your applications, and you get persistent storage for your applications without complexity.

Because the service is delivered through the Microsoft Azure Portal, users experience a fully managed service as part of their Microsoft enterprise Agreement. World-class support, managed by Microsoft, gives you complete peace of mind. This single solution enables you to quickly and easily add multiprotocol workloads. you can build and deploy both Windows and Linux file-based applications, even for legacy environments.

Azure NetApp Files (ANF) as guest connected storage

Configure Azure NetApp Files with Azure VMware Solution (AVS)

Azure NetApp Files shares can be mounted from VMs that are created in the Azure VMware Solution SDDC environment. The volumes can also be mounted on the Linux client and mapped on the Windows client because Azure NetApp Files supports SMB and NFS protocols. Azure NetApp Files volumes can be set up in five simple steps.

Azure NetApp Files and Azure VMware Solution must be in the same Azure region.

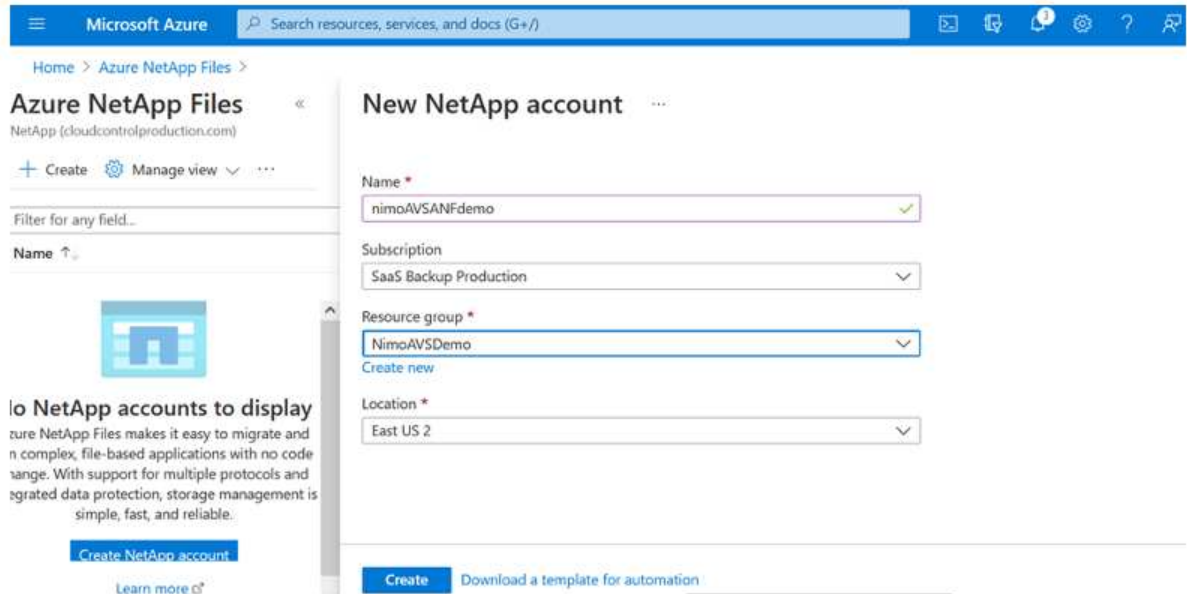


Create and mount Azure NetApp Files volumes

To create and mount Azure NetApp Files volumes, complete the following steps:

1. Log in to the Azure Portal and access Azure NetApp Files. Verify access to the Azure NetApp Files service and register the Azure NetApp Files Resource Provider by using the `az provider register --namespace Microsoft.NetApp --wait` command. After registration is complete, create a NetApp account.

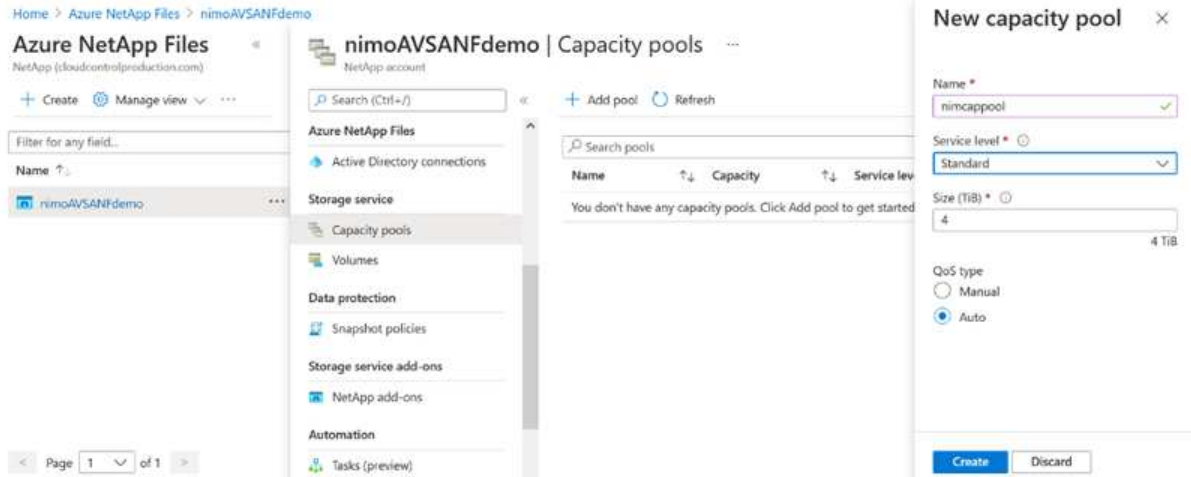
For detailed steps, see [Azure NetApp Files shares](#). This page will guide you through the step-by-step process.



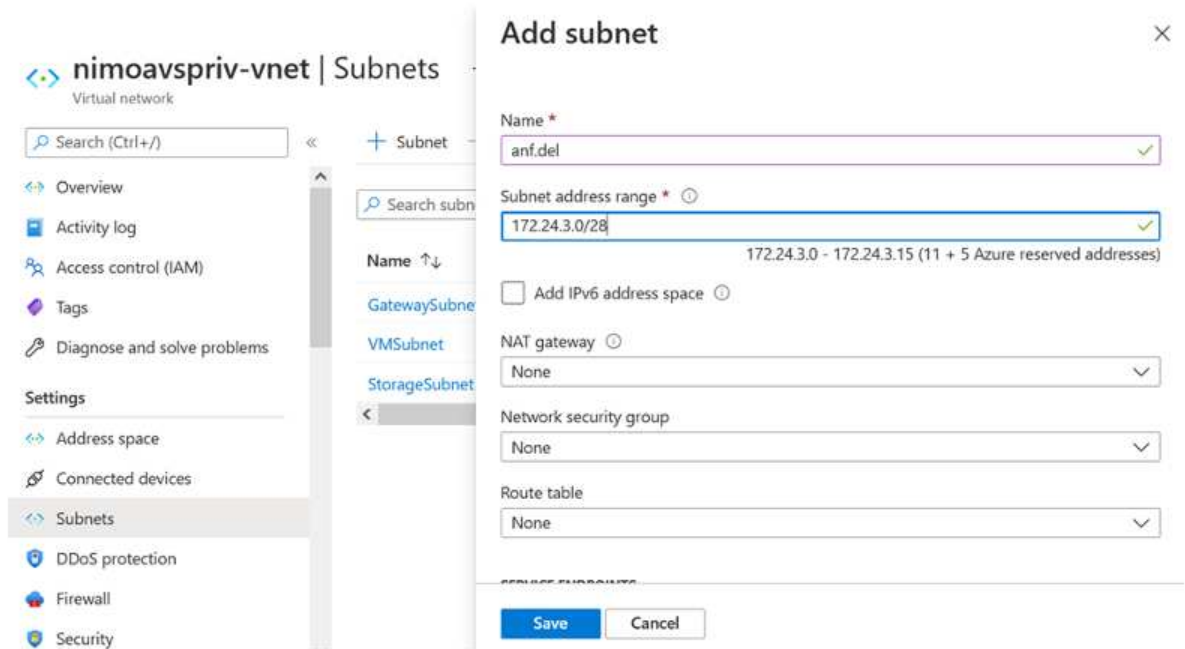
The screenshot shows the Azure NetApp Files 'New NetApp account' page. The left sidebar contains the 'Azure NetApp Files' header, a 'Create' button, a 'Manage view' dropdown, and a filter bar. The main content area is titled 'New NetApp account' and contains a form with the following fields: 'Name' (text input with value 'nimoAVSANFdemo'), 'Subscription' (dropdown menu with value 'SaaS Backup Production'), 'Resource group' (dropdown menu with value 'NimoAVSDemo'), and 'Location' (dropdown menu with value 'East US 2'). Below the form are 'Create' and 'Download a template for automation' buttons. A 'Create new' link is also visible under the Resource group dropdown.

2. After the NetApp account is created, set up the capacity pools with the required service level and size.

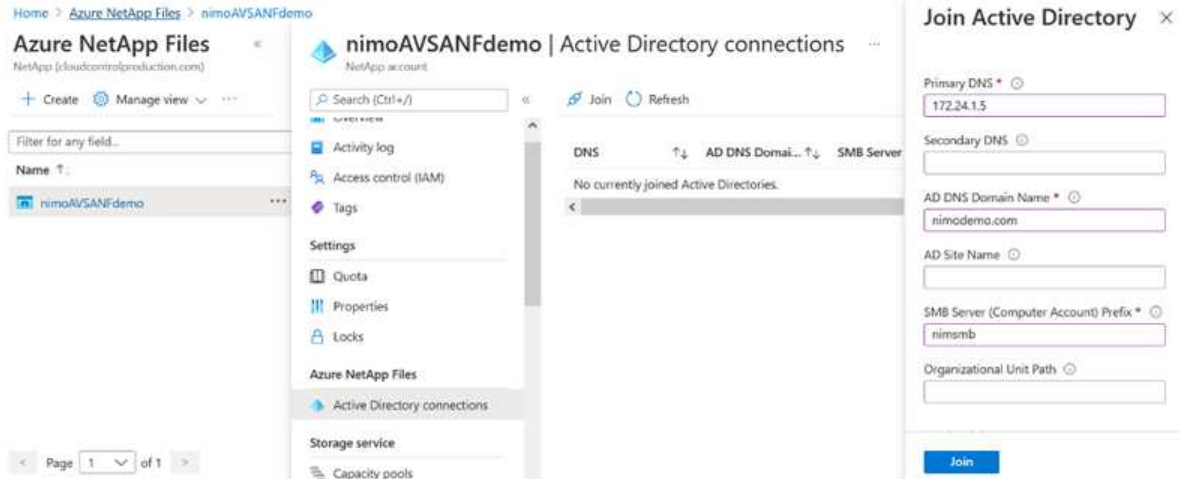
For more information, see [Set up a capacity pool](#).



3. Configure the delegated subnet for Azure NetApp Files and specify this subnet while creating the volumes. For detailed steps to create delegated subnet, see [Delegate a subnet to Azure NetApp Files](#).

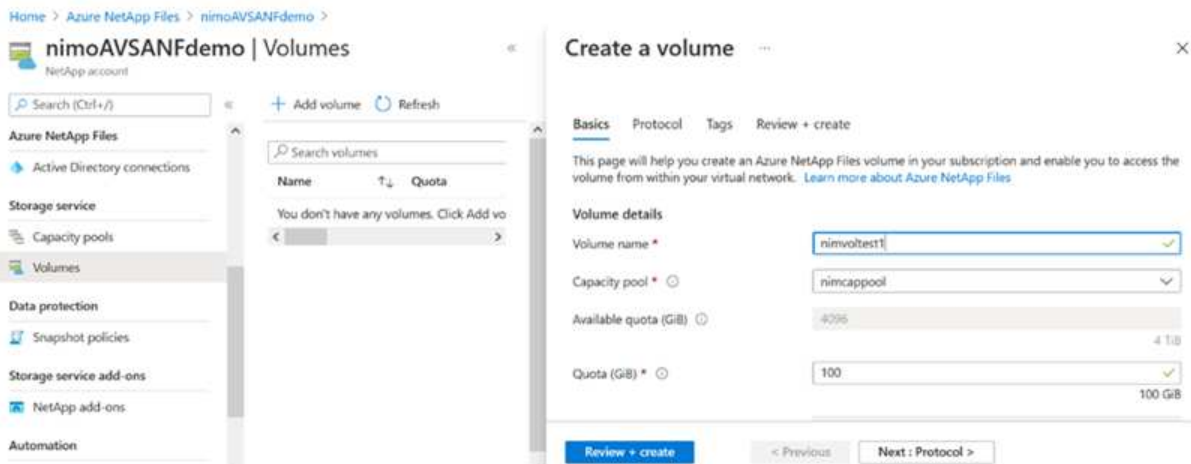


4. Add an SMB volume by using the Volumes blade under the Capacity Pools blade. Make sure the Active Directory connector is configured prior to creating the SMB volume.



5. Click Review + Create to create the SMB volume.

If the application is SQL Server, then enable the SMB continuous availability.





To learn more about Azure NetApp Files volume performance by size or quota, see [Performance considerations for Azure NetApp Files](#).

- After the connectivity is in place, the volume can be mounted and used for application data.

To accomplish this, from the Azure portal, click the Volumes blade, and then select the volume to mount and access the mount instructions. Copy the path and use the Map Network Drive option to mount the volume on the VM running on Azure VMware Solution SDDC.





7. To mount NFS volumes on Linux VMs running on Azure VMware Solution SDDC, use this same process. Use volume reshaping or dynamic service level capability to meet the workload demands.

```
nimoadmin@nimoadmin-virtual-machine:~$ sudo mount -t nfs -o rw,hard,tcp 172.24.3.4:/nimodemonfsv1 /home/nimoadmin/nimodemo11
nimoadmin@nimoadmin-virtual-machine:~$ df
Filesystem                1K-blocks    Used Available Use% Mounted on
udev                      8168112         0   8168112   0% /dev
tmpfs                     1639548     1488   1638060   1% /run
/dev/sda5                 50824704  7902752  40310496  17% /
tmpfs                     8197728         0   8197728   0% /dev/shm
tmpfs                     5120          0     5120     0% /run/lock
tmpfs                     8197728         0   8197728   0% /sys/fs/cgroup
/dev/loop0                56832       56832         0 100% /snap/core18/2128
/dev/loop2                66688       66688         0 100% /snap/gtk-common-the
mes/1515
/dev/loop1                224256     224256         0 100% /snap/gnome-3-34-180
4/72
/dev/loop3                52224       52224         0 100% /snap/snap-store/547
/dev/loop4                33152       33152         0 100% /snap/snapd/12704
/dev/sda1                 523248         4   523244   1% /boot/efi
tmpfs                     1639544         52  1639492   1% /run/user/1000
/dev/sr0                  54738       54738         0 100% /media/nimoadmin/VMw
are Tools
172.24.3.4:/nimodemonfsv1 104857600         0 104857600   0% /home/nimoadmin/nino
demo11
nimoadmin@nimoadmin-virtual-machine:~$
```

For more information, see [Dynamically change the service level of a volume](#).

Cloud Volumes ONTAP (CVO)

Cloud volumes ONTAP, or CVO, is the industry-leading cloud data management solution built on NetApp's ONTAP storage software, available natively on Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform (GCP).

It is a software-defined version of ONTAP that consumes cloud-native storage, allowing you to have the same storage software in the cloud and on-premises, reducing the need to retrain your IT staff in all-new methods to manage your data.

CVO gives customers the ability to seamlessly move data from the edge, to the data center, to the cloud and back, bringing your hybrid cloud together — all managed with a single-pane management console, NetApp Cloud Manager.

By design, CVO delivers extreme performance and advanced data management capabilities to satisfy even your most demanding applications in the cloud

Cloud Volumes ONTAP (CVO) as guest connected storage



Deploy new Cloud Volumes ONTAP in Azure

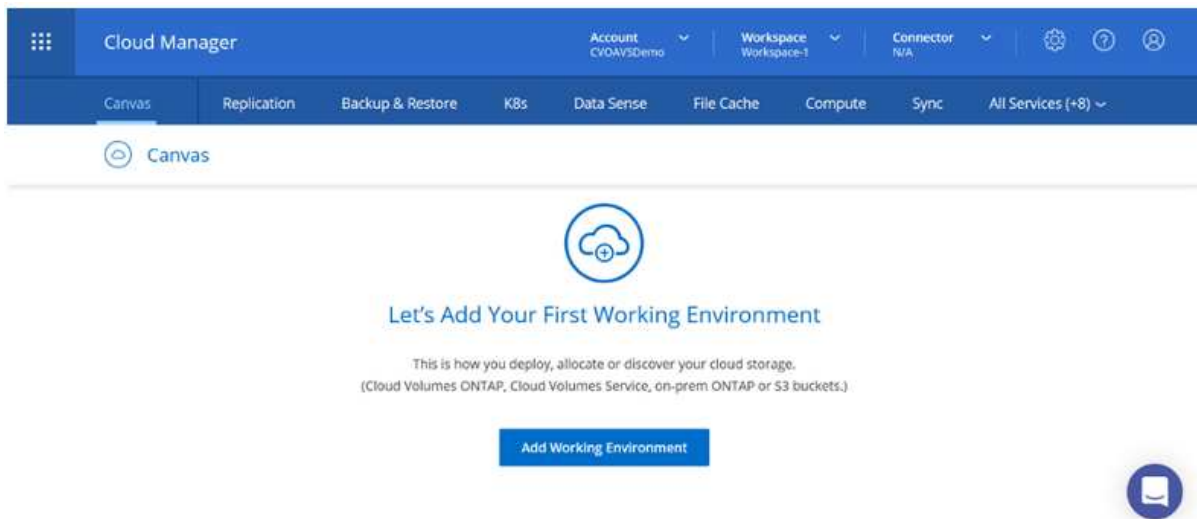
Cloud Volumes ONTAP shares and LUNs can be mounted from VMs that are created in the Azure VMware Solution SDDC environment. The volumes can also be mounted on the Linux client and on Windows client because Cloud Volumes ONTAP supports iSCSI, SMB, and NFS protocols. Cloud Volumes ONTAP volumes can be set up in a few simple steps.

To replicate volumes from an on-premises environment to the cloud for disaster recovery or migration purposes, establish network connectivity to Azure, either using a site-to-site VPN or ExpressRoute. Replicating data from on-premises to Cloud Volumes ONTAP is outside the scope of this document. To replicate data between on-premises and Cloud Volumes ONTAP systems, see [Setting up data replication between systems](#).



Use [Cloud Volumes ONTAP sizer](#) to accurately size the Cloud Volumes ONTAP instances. Also monitor on-premises performance to use as inputs in the Cloud Volumes ONTAP sizer.

1. Log in to NetApp Cloud Central—the Fabric View screen is displayed. Locate the Cloud Volumes ONTAP tab and select Go to Cloud Manager. After you are logged in, the Canvas screen is displayed.



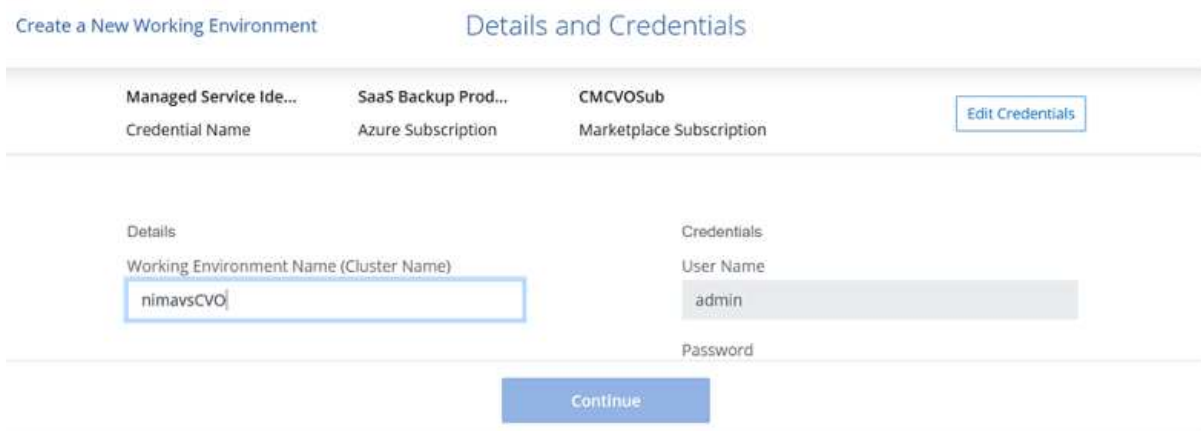
2. On the Cloud Manager home page, click Add a Working Environment and then select Microsoft Azure as the cloud and the type of the system configuration.



- When creating the first Cloud Volumes ONTAP working environment, Cloud Manager prompts you to deploy a Connector.



- After the connector is created, update the Details and Credentials fields.



- Provide the details of the environment to be created including the environment name and admin

credentials. Add resource group tags for the Azure environment as an optional parameter. After you are done, click Continue.







Create a New Working Environment Details and Credentials

Details	Credentials
Working Environment Name (Cluster Name) <input type="text" value="nimavsCVO"/>	User Name <input type="text" value="admin"/>
+ Add Resource Group Tags Optional Field	Password <input type="password" value="....."/>
	Confirm Password <input type="password" value="....."/>

Continue

6. Select the add-on services for Cloud Volumes ONTAP deployment, including Cloud Data Sense, Cloud Backup, and Cloud Insights. Select the services and then click Continue.

Create a New Working Environment Services

 Data Sense & Compliance	<input checked="" type="checkbox"/> 
 Backup to Cloud	<input checked="" type="checkbox"/> 
 Monitoring	<input checked="" type="checkbox"/> 

Continue

7. Configure the Azure location and connectivity. Select the Azure Region, resource group, VNet, and subnet to be used.

Create a New Working Environment Location & Connectivity


Azure Region <input type="text" value="East US 2"/>	Resource Group <input checked="" type="radio"/> Create a new group <input type="radio"/> Use an existing group
Availability Zone (Optional) <input type="text" value="Select an Availability Zone"/>	Resource Group Name <input type="text" value="nimavsCVO-rg"/>
VNet <input type="text" value="nimoavspv-vnet NimoAVSDemo"/>	Security Group <input checked="" type="radio"/> Generated security group <input type="radio"/> Use existing security group
Subnet <input type="text" value="172.24.2.0/24"/>	<input checked="" type="checkbox"/> I have verified network connectivity between the Cloud Manager server and the selected VNet.


Continue

8. Select the license option: Pay-As-You-Go or BYOL for using existing license. In this example, Pay-As-You-Go option is used.

Cloud Volumes ONTAP Charging Methods

[Learn more about our charging methods](#)


☒ Pay-As-You-Go by the hour


☐ Bring your own license

NetApp Support Site Account *(Optional)*

[Learn more about NetApp Support Site \(NSS\) accounts](#)

To register this Cloud Volumes ONTAP to support, you should add NetApp Support Site Account.

Don't have a NetApp Support Site account? Select go to finish deploying this system. After it's created, use the Support Registration option to create an NSS account.

Continue

9. Select between several preconfigured packages available for the various types of workloads.

Create a New Working Environment

Preconfigured Packages

×

Select a preconfigured Cloud Volumes ONTAP system that best matches your needs, or create your own configuration. Preconfigured settings can be modified at a later time.

Change Configuration



POC and small workloads
Up to 500GB of storage



Database and application data production workloads



Cost effective DR
Up to 500GB of storage



Highest performance production workloads

Continue

10. Accept the two agreements regarding activating support and allocation of Azure resources. To create the Cloud Volumes ONTAP instance, click Go.

Create a New Working Environment

Review & Approve

nimavsCVO

Azure | East US 2

☒ I understand that in order to activate support, I must first register Cloud Volumes ONTAP with NetApp. [More information >](#)

☒ I understand that Cloud Manager will allocate the appropriate Azure resources to comply with my above requirements. [More information >](#)

Overview

Networking

Storage

Go

11. After Cloud Volumes ONTAP is provisioned, it is listed in the working environments on the Canvas page.

CanvasReplicationBackup & RestoreK8sData SenseFile CacheComputeSyncAll Services (+8) ▾

Canvas

Go to Tabular View

Add Working Environment

SINGLE

nimavsCVO

Cloud Volumes ONTAP

Freemium

-

+

nimavsCVO

On

i

:

x

DETAILS

Cloud Volumes ONTAP | Azure | Single

SERVICES

Replication

Enter Working Environment



Additional configurations for SMB volumes

1. After the working environment is ready, make sure the CIFS server is configured with the appropriate DNS and Active Directory configuration parameters. This step is required before you can create the SMB volume.

The screenshot shows the 'nimavsCVO' console interface. At the top, there are tabs for 'Volumes' and 'Replications'. Below the tabs, there's a 'Create a CIFS server' button and a '+ Advanced' link. The configuration fields are as follows:

Field	Value
DNS Primary IP Address	172.24.1.5
Active Directory Domain to join	nimodemo.com
DNS Secondary IP Address (Optional)	Example: 127.0.0.1
Credentials authorized to join the domain	nimoadmin

2. Creating the SMB volume is an easy process. Select the CVO instance to create the volume and click the Create Volume option. Choose the appropriate size and cloud manager chooses the containing aggregate or use advanced allocation mechanism to place on a specific aggregate. For this demo, SMB is selected as the protocol.

The screenshot shows the 'Volume Details, Protection & Protocol' configuration page. It has two main sections: 'Details & Protection' and 'Protocol'.

Details & Protection:

Field	Value
Volume Name:	nimavssmbvol1
Size (GB):	50
Snapshot Policy:	default

Protocol:

The 'Protocol' section has three tabs: 'NFS', 'CIFS', and 'iSCSI'. The 'CIFS' tab is selected.


Field	Value
Share name:	nimavssmbvol1_share
Permissions:	Full Control
Users / Groups:	Everyone;

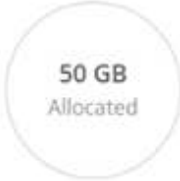
At the bottom of the page, there is a blue 'Continue' button.

3. After the volume is provisioned, it will be available under the Volumes pane. Because a CIFS share is provisioned, give your users or groups permission to the files and folders and verify that those users can access the share and create a file. This step is not required if the volume is replicated from an on-premises environment because the file and folder permissions are all retained as part of SnapMirror replication.

Volumes

1 Volume | 50 GB Allocated | 1.74 MB Total Used (1.74 MB in Disk, 0 KB in Blob)


nimavssmbvol1
ONLINE

INFO		CAPACITY	
Disk Type	PREMIUM_LRS		1.74 MB Disk Used
Tiering Policy	Auto		0 GB Blob Used
Backup	OFF		

- After the volume is created, use the mount command to connect to the share from the VM running on the Azure VMware Solution SDDC hosts.
- Copy the following path and use the Map Network Drive option to mount the volume on the VM running on Azure VMware Solution SDDC.

Mount Volume nimavssmbvol1

Go to your machine and enter this command

\\172.24.2.8\nimavssmbvol1_share





Connect the LUN to a host

To connect the LUN to a host, complete the following steps:

1. On the Canvas page, double-click the Cloud Volumes ONTAP working environment to create and manage volumes.
2. Click Add Volume > New Volume and select iSCSI and click Create Initiator Group. Click Continue.

The screenshot shows two side-by-side configuration panels. The left panel, titled 'Details & Protection', contains a 'Volume Name' field with the value 'nimavsscsi1', a 'Size (GB)' field with the value '500', a 'Snapshot Policy' dropdown menu set to 'default', and a 'Default Policy' link. The right panel, titled 'Protocol', has three tabs: 'NFS', 'CIFS', and 'iSCSI' (which is selected). Below the tabs is a link 'What about LUNs?'. Under the 'Initiator Group' section, there are two radio buttons: 'Map Existing Initiator Groups' (unselected) and 'Create Initiator Group' (selected). Below this is an 'Initiator Group' text field containing the value 'avsvmlG'. At the bottom center of the two panels is a blue 'Continue' button.

3. After the volume is provisioned, select the volume, and then click Target IQN. To copy the iSCSI Qualified Name (IQN), click Copy. Set up an iSCSI connection from the host to the LUN.

To accomplish the same for the host residing on Azure VMware Solution SDDC:

- a. RDP to the VM hosted on Azure VMware Solution SDDC.
- b. Open the iSCSI Initiator Properties dialog box: Server Manager > Dashboard > Tools > iSCSI Initiator.
- c. From the Discovery tab, click Discover Portal or Add Portal and then enter the IP address of the iSCSI target port.
- d. From the Targets tab, select the target discovered and then click Log on or Connect.
- e. Select Enable multipath, and then select Automatically Restore This Connection When the Computer Starts or Add This Connection to the List of Favorite Targets. Click Advanced.

Note: The Windows host must have an iSCSI connection to each node in the cluster. The native DSM selects the best paths to use.



LUNs on storage virtual machine (SVM) appear as disks to the Windows host. Any new disks that are added are not automatically discovered by the host. Trigger a manual rescan to discover the disks by completing the following steps:

1. Open the Windows Computer Management utility: Start > Administrative Tools > Computer Management.
2. Expand the Storage node in the navigation tree.
3. Click Disk Management.
4. Click Action > Rescan Disks.



When a new LUN is first accessed by the Windows host, it has no partition or file system. Initialize the LUN; and optionally, format the LUN with a file system by completing the following steps:

1. Start Windows Disk Management.

2. Right-click the LUN, and then select the required disk or partition type.
3. Follow the instructions in the wizard. In this example, drive E: is mounted



NetApp Storage Options for GCP

GCP supports guest connected NetApp storage with Cloud Volumes ONTAP (CVO) or Cloud Volumes Service (CVS).

Cloud Volumes ONTAP (CVO)

Cloud volumes ONTAP, or CVO, is the industry-leading cloud data management solution built on NetApp's ONTAP storage software, available natively on Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform (GCP).

It is a software-defined version of ONTAP that consumes cloud-native storage, allowing you to have the same storage software in the cloud and on-premises, reducing the need to retrain your IT staff in all-new methods to manage your data.

CVO gives customers the ability to seamlessly move data from the edge, to the data center, to the cloud and

back, bringing your hybrid cloud together — all managed with a single-pane management console, NetApp Cloud Manager.

By design, CVO delivers extreme performance and advanced data management capabilities to satisfy even your most demanding applications in the cloud

Cloud Volumes ONTAP (CVO) as guest connected storage



Deploy Cloud Volumes ONTAP in Google Cloud (Do It Yourself)

Cloud Volumes ONTAP shares and LUNs can be mounted from VMs that are created in the GCVE private cloud environment. The volumes can also be mounted on the Linux client and on Windows client and LUNS can be accessed on Linux or Windows clients as block devices when mounted over iSCSI because Cloud Volumes ONTAP supports iSCSI, SMB, and NFS protocols. Cloud Volumes ONTAP volumes can be set up in a few simple steps.

To replicate volumes from an on-premises environment to the cloud for disaster recovery or migration purposes, establish network connectivity to Google Cloud, either using a site-to-site VPN or Cloud Interconnect. Replicating data from on-premises to Cloud Volumes ONTAP is outside the scope of this document. To replicate data between on-premises and Cloud Volumes ONTAP systems, see [xref:./ehc/gcp/Setting up data replication between systems](#).



Use [Cloud Volumes ONTAP sizer](#) to accurately size the Cloud Volumes ONTAP instances. Also monitor on-premises performance to use as inputs in the Cloud Volumes ONTAP sizer.

1. Log in to NetApp Cloud Central—the Fabric View screen is displayed. Locate the Cloud Volumes ONTAP tab and select Go to Cloud Manager. After you are logged in, the Canvas screen is displayed.



2. On the Cloud Manager Canvas tab, click Add a Working Environment and then select Google Cloud Platform as the cloud and the type of the system configuration. Then, click Next.



3. Provide the details of the environment to be created including the environment name and admin credentials. After you are done, click Continue.

[↑ Previous Step](#)

CV-Performance-Testing
Google Cloud Project


HCLMainBillingAccountSubs...
Marketplace Subscription

Edit Project

Details

Working Environment Name (Cluster Name)
cvogcveva

Service Account ☒

 **Notice:** A Google Cloud service account is required to use two features: backing up data using Backup

Credentials

User Name
admin

Password


Confirm Password


Continue


4. Select or deselect the add-on services for Cloud Volumes ONTAP deployment, including Data Sense & Compliance or Backup to Cloud. Then, click Continue.

HINT: A verification pop-up message will be displayed when deactivating add-on services. Add-on services can be added/removed after CVO deployment, consider to deselect them if not needed from the beginning to avoid costs.

[↑ Previous Step](#)

 Data Sense & Compliance ☒

 Backup to Cloud ☐

 **WARNING:**By turning off Backup to Cloud, future data recovery will not be possible in case of data corruption or loss

Continue

5. Select a location, choose a firewall policy, and select the checkbox to confirm network connectivity to Google Cloud storage.

↑ Previous Step Location Connectivity

GCP Region
europe-west3

GCP Zone
europe-west3-c

VPC
cloud-volumes-vpc

Subnet
10.0.6.0/24

Firewall Policy
☒ Generated firewall policy ☐ Use existing firewall policy

☒ I have verified connectivity between the target VPC and Google Cloud storage.

Continue

6. Select the license option: Pay-As-You-Go or BYOL for using existing license. In this example, Freemium option is used. Then, click on Continue.

↑ Previous Step Cloud Volumes ONTAP Charging Methods NetApp Support Site Account

Learn more about our charging methods

☐ Pay-As-You-Go by the hour

☐ Bring your own license

☒ Freemium (Up to 500GB)

Learn more about NetApp Support Site (NSS) accounts

NetApp Support Site Account
mchad

To add a new NetApp Support Site account, go to the Support - NSS Management tab.

Continue

7. Select between several preconfigured packages available based on the type of workload that will be deployed on the VMs running on VMware cloud on AWS SDDC.

HINT: Hoover your mouse over the tiles for details or customize CVO components and ONTAP version by clicking on Change Configuration.

Create a New Working Environment Preconfigured Packages

Select a preconfigured Cloud Volumes ONTAP system that best matches your needs, or create your own configuration. Preconfigured settings can be modified at a later time.

Change Configuration

POC and small workloads
Up to 500GB of storage

Database and application data production workloads

Cost effective DR
Up to 500GB of storage

Highest performance production workloads

Continue

8. On the Review & Approve page, review and confirm the selections. To create the Cloud Volumes ONTAP instance, click Go.

Create a New Working Environment Review & Approve

↑ Previous Step Show API request

cvogcveval Google Cloud | europe-west3

This Cloud Volumes ONTAP instance will be registered with NetApp support under the NSS Account **mchad**.

☒ I understand that Cloud Manager will allocate the appropriate GCP resources to comply with my above requirements. [More information >](#)

Overview Networking Storage

Storage System:	Cloud Volumes ONTAP	Cloud Volumes ONTAP runs on:	n2-standard-4
License Type:	Cloud Volumes ONTAP Freemium	Encryption:	Google Cloud Managed
Capacity Limit:	500GB	Write Speed:	Normal

Go

9. After Cloud Volumes ONTAP is provisioned, it is listed in the working environments on the Canvas page.

Cloud Manager Account: NetApp_POC Workspace: cloud_futures Connector: williammcc Notifications Settings Help User

Canvas Replication Backup & Restore KBs Data Sense File Cache Compute Sync All Services (+7) ▾

Canvas Go to Tabular View

Add Working Environment

cvogcve01
Cloud Volumes ONTAP
Freemium

DatacenterDude
Azure NetApp Files
31 Volumes 9.71 TiB Capacity

Working Environments

- 1 Cloud Volumes ONTAP
43.05 GiB Provisioned Capacity
- 1 FSx for ONTAP (High-Availability)
0 B Provisioned Capacity
- 1 Azure NetApp Files
9.71 TiB Provisioned Capacity



Additional configurations for SMB volumes

1. After the working environment is ready, make sure the CIFS server is configured with the appropriate DNS and Active Directory configuration parameters. This step is required before you can create the SMB volume.

HINT: Click on the Menu Icon (°), select Advanced to display more options and select CIFS setup.

The screenshot shows the 'Create a CIFS server' configuration page for a volume named 'cvogcve01'. The page has tabs for 'Volumes' and 'Replications'. A 'GCP' badge and 'GCP Managed Encryption' status are visible in the top right. The configuration fields include: 'DNS Primary IP Address' (192.168.0.16), 'DNS Secondary IP Address (Optional)' (Example: 127.0.0.1), 'Active Directory Domain to join' (nimgcveval.com), and 'Credentials authorized to join the domain' (administrator). There is a password field with masked characters. A '+ Advanced' link is on the right. At the bottom are 'Save' and 'Cancel' buttons.

2. Creating the SMB volume is an easy process. At Canvas, double-click the Cloud Volumes ONTAP working environment to create and manage volumes and click on the Create Volume option. Choose the appropriate size and cloud manager chooses the containing aggregate or use advanced allocation mechanism to place on a specific aggregate. For this demo, CIFS/SMB is selected as the protocol.

The screenshot shows the 'Volume Details, Protection & Protocol' configuration page. It has two main sections: 'Details & Protection' and 'Protocol'. In 'Details & Protection', the 'Volume Name' is 'cvogcvesmbvol01', 'Size (GB)' is '10', and 'Snapshot Policy' is 'default'. In the 'Protocol' section, 'CIFS' is selected over 'NFS' and 'iSCSI'. The 'Share name' is 'cvogcvesmbvol01_share', 'Permissions' are set to 'Full Control', and 'Users / Groups' is 'Everyone;'. A 'Continue' button is at the bottom.

3. After the volume is provisioned, it will be available under the Volumes pane. Because a CIFS share is provisioned, give your users or groups permission to the files and folders and verify that those users can access the share and create a file. This step is not required if the volume is replicated from an on-premises environment because the file and folder permissions are all retained as part of SnapMirror replication.

HINT: Click on the volume menu (°) to display its options.



cvogcvesmbvol01

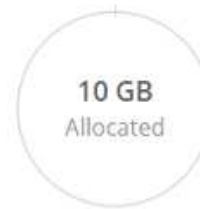
ONLINE



INFO

Disk Type PD-SSD
Tiering Policy None

CAPACITY



1.84 MB
Disk Used

- After the volume is created, use the mount command to display the volume connection instructions, then connect to the share from the VMs on Google Cloud VMware Engine.



cvogcve01

Volumes

Replications



Mount Volume cvogcvesmbvol01

Go to your machine and enter this command

```
\\10.0.6.251\cvogcvesmbvol01_share
```



Copy

- Copy the following path and use the Map Network Drive option to mount the volume on the VM running on the Google Cloud VMware Engine.

Specify the drive letter for the connection and the folder that you want to connect to:

Drive:
Folder:

Example: \\server\share

☒ Reconnect at sign-in

☐ Connect using different credentials

[Connect to a Web site that you can use to store your documents and pictures.](#)

Finish

Cancel

Once mapped, it can be easily accessed, and the NTFS permissions can be set accordingly.

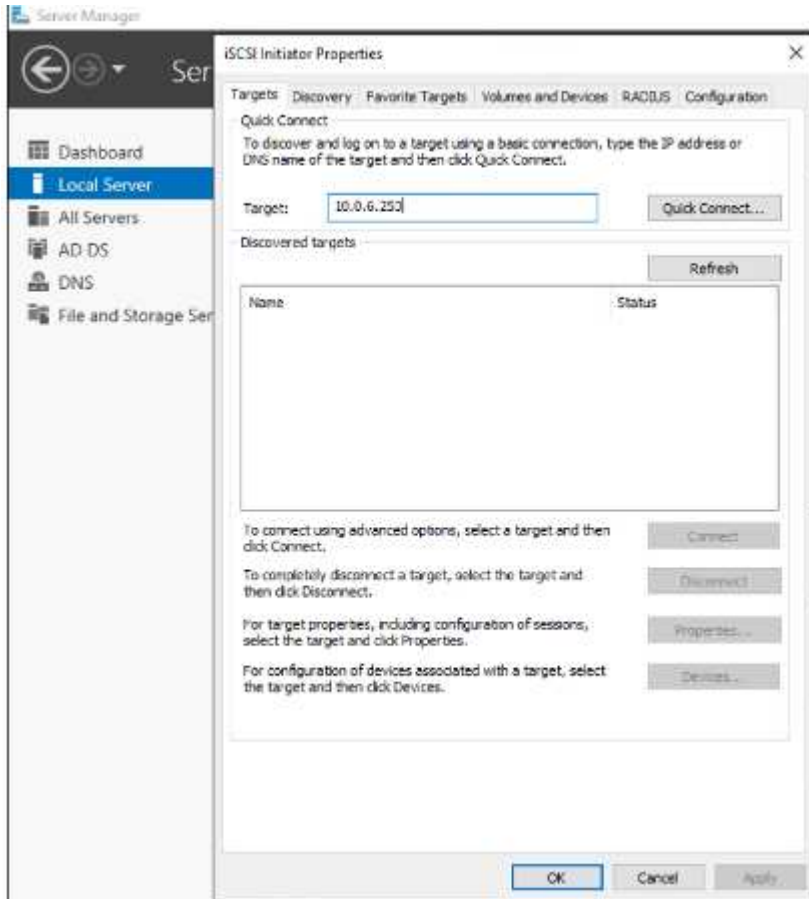




- c. From the Discovery tab, click Discover Portal or Add Portal and then enter the IP address of the iSCSI target port.
- d. From the Targets tab, select the target discovered and then click Log on or Connect.
- e. Select Enable multipath, and then select Automatically Restore This Connection When the Computer Starts or Add This Connection to the List of Favorite Targets. Click Advanced.



The Windows host must have an iSCSI connection to each node in the cluster. The native DSM selects the best paths to use.



LUNs on storage virtual machine (SVM) appear as disks to the Windows host. Any new disks that are added are not automatically discovered by the host. Trigger a manual rescan to discover the disks by completing the following steps:

1. Open the Windows Computer Management utility: Start > Administrative Tools > Computer Management.
2. Expand the Storage node in the navigation tree.
3. Click Disk Management.
4. Click Action > Rescan Disks.



When a new LUN is first accessed by the Windows host, it has no partition or file system. Initialize the LUN; and optionally, format the LUN with a file system by completing the following steps:

5. Start Windows Disk Management.
6. Right-click the LUN, and then select the required disk or partition type.
7. Follow the instructions in the wizard. In this example, drive F: is mounted.



On the Linux clients, ensure the iSCSI daemon is running. Once the LUNs are provisioned, refer to the detailed guidance on iSCSI configuration with Ubuntu as an example here. To verify, run `lsblk` cmd from the shell.

```
niyaz@nimubu01:~$ lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
loop0       7:0      0   55.4M 1 loop /snap/core18/2128
loop1       7:1      0   219M 1 loop /snap/gnome-3-34-1804/72
loop2       7:2      0   65.1M 1 loop /snap/gtk-common-themes/1515
loop3       7:3      0    51M 1 loop /snap/snap-store/547
loop4       7:4      0   32.3M 1 loop /snap/snapd/12704
loop5       7:5      0   32.5M 1 loop /snap/snapd/13640
loop6       7:6      0   55.5M 1 loop /snap/core18/2246
loop7       7:7      0     4K 1 loop /snap/bare/5
loop8       7:8      0   65.2M 1 loop /snap/gtk-common-themes/1519
sda         8:0      0    16G 0 disk
├─sda1      8:1      0   512M 0 part /boot/efi
├─sda2      8:2      0     1K 0 part
└─sda5      8:5      0   15.5G 0 part /
sdb         8:16     0     1G 0 disk
```

```

niyaz@nimubu01:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G   0    1.9G   0% /dev
tmpfs           394M  1.5M  392M   1% /run
/dev/sda5       16G   7.6G  6.9G  53% /
tmpfs           2.0G   0    2.0G   0% /dev/shm
tmpfs           5.0M   0    5.0M   0% /run/lock
tmpfs           2.0G   0    2.0G   0% /sys/fs/cgroup
/dev/loop1      219M  219M   0 100% /snap/gnome-3-34-1804/72
/dev/loop2       66M   66M   0 100% /snap/gtk-common-themes/1515
/dev/loop3       51M   51M   0 100% /snap/snap-store/547
/dev/loop0       56M   56M   0 100% /snap/core18/2128
/dev/loop4       33M   33M   0 100% /snap/snapd/12704
/dev/sda1       511M   4.0K  511M   1% /boot/efi
tmpfs           394M   64K  394M   1% /run/user/1000
/dev/loop5       33M   33M   0 100% /snap/snapd/13640
/dev/loop6       56M   56M   0 100% /snap/core18/2246
/dev/loop7      128K  128K   0 100% /snap/bare/5
/dev/loop8       66M   66M   0 100% /snap/gtk-common-themes/1519
/dev/sdb        976M  2.6M  907M   1% /mnt

```

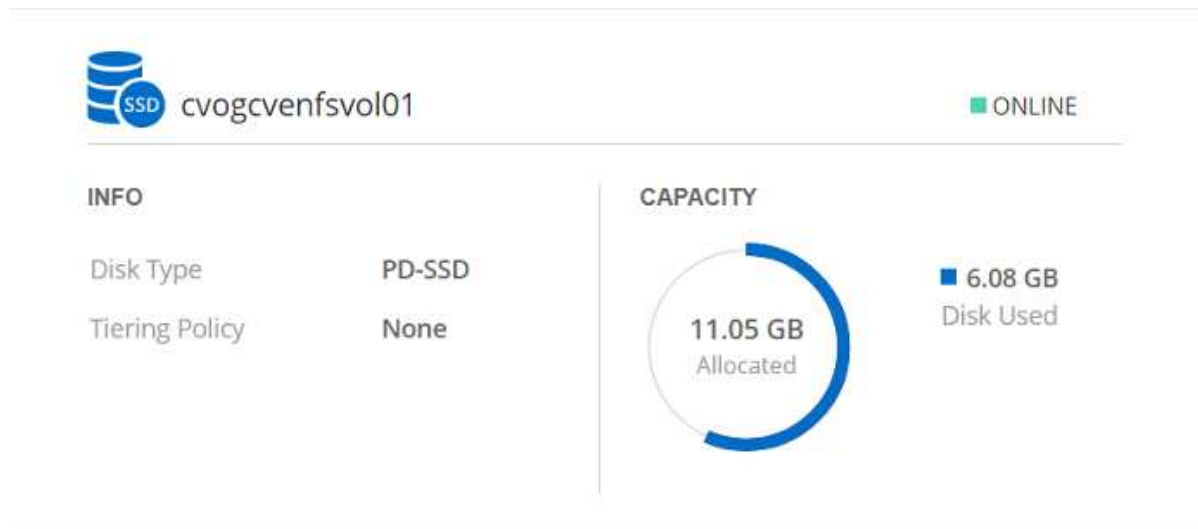



Mount Cloud Volumes ONTAP NFS volume on Linux client

To mount the Cloud Volumes ONTAP (DIY) file system from VMs within Google Cloud VMware Engine, follow the below steps:

Provision the volume following the below steps

1. In the Volumes tab, click Create New Volume.
2. On the Create New Volume page, select a volume type:



3. In the Volumes tab, place your mouse cursor over the volume, select the menu icon (°), and then click Mount Command.



Go to your Linux machine and enter this mount command

```
mount 10.0.6.251:/cvogcvenfsvol01 <dest_dir>
```



4. Click Copy.
5. Connect to the designated Linux instance.
6. Open a terminal on the instance using secure shell (SSH) and log in with the appropriate credentials.
7. Make a directory for the volume's mount point with the following command.

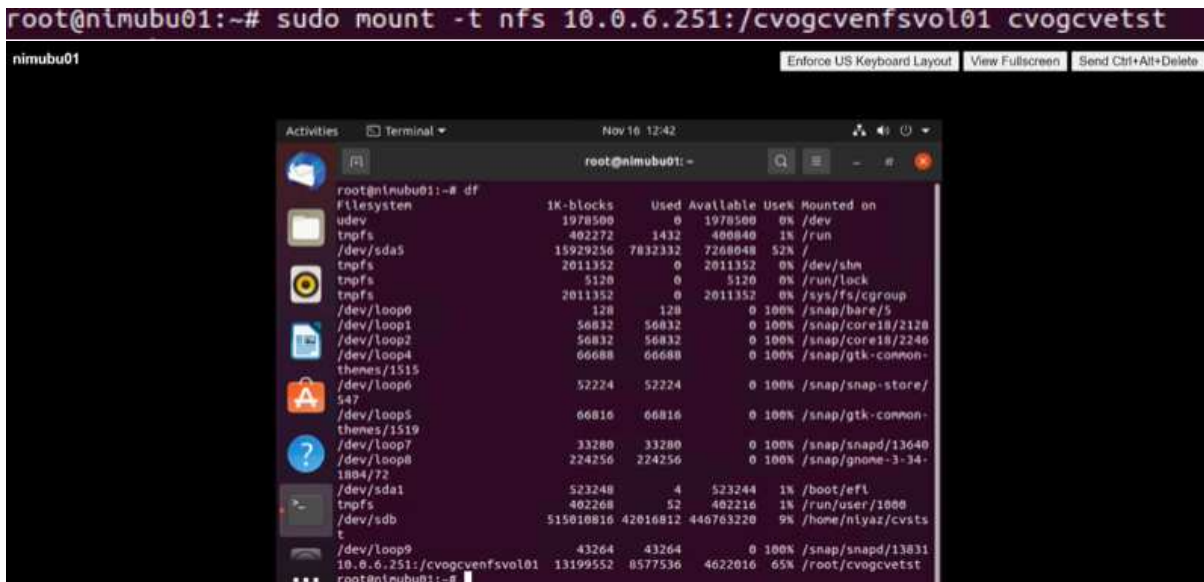
```
$ sudo mkdir /cvogcvetst
```

```
root@nimubu01:~# sudo mkdir cvogcvetst
```

8. Mount the Cloud Volumes ONTAP NFS volume to the directory that is created in the previous step.

```
sudo mount 10.0.6.251:/cvogcvenfsvol01 /cvogcvetst
```

```
root@nimubu01:~# sudo mount -t nfs 10.0.6.251:/cvogcvenfsvol01 cvogcvetst
```



Filesystem	1K-blocks	Used	Available	Use%	Mounted on
udev	1978500	0	1978500	0%	/dev
tmpfs	402272	1432	400840	1%	/run
/dev/sda5	15929256	7832332	7268048	52%	/
tmpfs	2011352	0	2011352	0%	/dev/shm
tmpfs	5120	0	5120	0%	/run/lock
tmpfs	2011352	0	2011352	0%	/sys/fs/cgroup
/dev/loop0	128	128	0	100%	/snap/bare/5
/dev/loop1	50832	50832	0	100%	/snap/core18/2128
/dev/loop2	50832	50832	0	100%	/snap/core18/2246
/dev/loop4	66688	66688	0	100%	/snap/gtk-common-
thenes/1515					
/dev/loop6	52224	52224	0	100%	/snap/snap-store/
547					
/dev/loop5	66816	66816	0	100%	/snap/gtk-common-
thenes/1519					
/dev/loop7	33280	33280	0	100%	/snap/snapd/13640
/dev/loop8	224256	224256	0	100%	/snap/gnome-3-34-
1804/72					
/dev/sda1	523248	4	523244	1%	/boot/efi
tmpfs	402268	52	402216	1%	/run/user/1000
/dev/sdb	515010816	42016812	446763220	9%	/home/nlyaz/cvsts
t					
/dev/loop9	43264	43264	0	100%	/snap/snapd/13831
10.0.6.251:/cvogcvenfsvol01	13199552	8577536	4622016	65%	/root/cvogcvetst

Cloud Volumes Service (CVS)

Cloud Volumes Services (CVS) is a complete portfolio of data services to deliver advanced cloud solutions. Cloud Volumes Services supports multiple file access protocols for major cloud providers (NFS and SMB support).

Other benefits and features include: data protection and restore with Snapshot; special features to replicate, sync and migrate data destinations on-prem or in the cloud; and consistent high performance at the level of a dedicated flash storage system.

Cloud Volumes Service (CVS) as guest connected storage

Configure Cloud Volumes Service with VMware Engine

Cloud Volumes Service shares can be mounted from VMs that are created in the VMware Engine environment. The volumes can also be mounted on the Linux client and mapped on the Windows client because Cloud Volumes Service supports SMB and NFS protocols. Cloud Volumes Service volumes can be set up in simple steps.

Cloud Volume Service and Google Cloud VMware Engine private cloud must be in the same region.

To purchase, enable and configure NetApp Cloud Volumes Service for Google Cloud from the Google Cloud Marketplace, follow this detailed [guide](#).



Create a CVS NFS volume to GCVE private cloud

To create and mount NFS volumes, complete the following steps:

1. Access Cloud Volumes from Partner Solutions within the Google cloud console.



2. In the Cloud Volumes Console, go to the Volumes page and click Create.



3. On the Create File System page, specify the volume name and billing labels as required for chargeback mechanisms.

Cloud Volumes	Create File System
<ul style="list-style-type: none"> Volumes Backups Snapshots Active Directories Volume Replication 	<p>Volume Name</p> <p>Name *</p> <input type="text" value="nimCVNFSvol01"/> <p>A human readable name used for display purposes.</p> <p>Billing Labels</p> <p>Label your volumes for billing reports, queries. Supported with CVS-Performance service type; can be set with CVS service type but not available for billing at this time.</p> <p>+ ADD LABEL</p>

4. Select the appropriate service. For GCVE, choose CVS-Performance and desired service level for improved latency and higher performance based on the application workload requirements.

Cloud Volumes	Create File System
<ul style="list-style-type: none"> Volumes Backups Snapshots Active Directories Volume Replication 	<p>Service Type</p> <p>Cloud Volumes Service is offered as two service types: CVS and CVS-Performance. Select the service type that matches your workload needs. Region availability varies by service type. Learn more</p> <p> <input type="radio"/> CVS Offers volumes created with zonal high availability. </p> <p> <input checked="" type="radio"/> CVS-Performance Offers 3 performance levels and improved latency to address higher performance application requirements. </p> <p>Volume Replication</p> <p> <input type="checkbox"/> Secondary Select to create volume as a destination target for volume replication. Applicable only to CVS-performance volumes. </p>

5. Specify the Google Cloud region for the volume and volume path (The volume path must be unique across all of cloud volumes in the project)

Cloud Volumes	Create File System
<ul style="list-style-type: none"> Volumes Backups Snapshots Active Directories Volume Replication 	<p>Region</p> <p>Region availability varies by service type.</p> <p>Region *</p> <input type="text" value="europe-west3"/> <p>Volume will be provisioned in the region you select.</p> <p>Volume Path *</p> <input type="text" value="nimCVSNFSol01"/> <p>Must be unique to the project.</p>

6. Select the level of performance for the volume.

7. Specify the size of the volume and the protocol type. In this testing, NFSv3 is used.

8. In this step, select the VPC Network from which the volume will be accessible. Ensure VPC peering is in place.

HINT: If VPC peering has not been done, a pop-up button will be displayed to guide you through the peering commands. Open a Cloud Shell session and execute the appropriate commands to peer your VPC with Cloud Volumes Service producer. In case you decide to prepare VPC peering in beforehand, refer to these instructions.

Cloud Volumes

Volumes

Backups

Snapshots

Active Directories

Volume Replication

← Create File System

Network Details

☐ Shared VPC configuration
Provide the host project name when deploying in a shared VPC service project.

VPC Network Name *

cloud-volumes-vpc

Select the VPC Network from which the volume will be accessible. This cannot be changed later.

☐ Use Custom Address Range
Reserved Address range
netapp-addresses

- Manage the Export policy rules by adding the appropriate rules and Select the checkbox for the corresponding NFS version.

Note: Access to NFS volumes won't be possible unless an export policy is added.

Cloud Volumes

Volumes

Backups

Snapshots

Active Directories

Volume Replication

← Create File System

Export Policy

Rules

Item 1

Allowed Clients 1 *

0.0.0.0/0

Access

☒ Read & Write
☐ Read Only

Root Access

☒ On
☐ Off

Protocol Type (Select at least 1 of the below options)

Must select for Protocol type NFSv3. Optional for Protocol Type Both. Do not select for NFSv4.1

☒ Allows Matching Clients for NFSv3

- Click Save to create the volume.

<input type="checkbox"/>		4b8ed9d9-bc6d43d5-5a0f-7da26aed3ed0	nimnfsdemods02	europa-west3	Available for use	CVS-Performance	Primary	Extreme	NFSv3: 10.53.0.4/nimnfsdemods02
--------------------------	--	-------------------------------------	----------------	--------------	-------------------	-----------------	---------	---------	---------------------------------



Mounting NFS exports to VMs running on VMware Engine

Before preparing to mount the NFS volume, ensure the peering status of private connection is listed as Active. Once status is Active, use the mount command.

To mount an NFS volume, do the following:

1. In the Cloud Console, go to Cloud Volumes > Volumes.
2. Go to the Volumes page
3. Click the NFS volume for which you want to mount NFS exports.
4. Scroll to the right, under Show More, click Mount Instructions.

To perform the mounting process from within the guest OS of the VMware VM, follow the below steps:

1. Use SSH client and SSH to the virtual machine.
2. Install the nfs client on the instance.
 - a. On Red Hat Enterprise Linux or SuSE Linux instance:

```
sudo yum install -y nfs-utils
```

- b. On an Ubuntu or Debian instance:

```
sudo apt-get install nfs-common
```

3. Create a new directory on the instance, such as "/nimCVSNFSol01":

```
sudo mkdir /nimCVSNFSol01
```



4. Mount the volume using the appropriate command. Example command from the lab is below:

```
sudo mount -t nfs -o rw,hard,rsz=65536,wsz=65536,vers=3,tcp  
10.53.0.4:/nimCVSNFSol01 /nimCVSNFSol01
```

```
root@vm1:~# sudo mkdir /nimCVSNFSol01  
root@vm1:~# sudo mount -t nfs -o rw,hard,rsz=65536,wsz=65536,vers=3,tcp 10.53.0.4:/nimCVSNFSol01 /nimCVSNFSol01
```

```

root@vm1:~# df
Filesystem                1K-blocks      Used    Available Use% Mounted on
udev                    16409952         0    16409952   0% /dev
tmpfs                   3288328      1580     3286748   1% /run
/dev/sdb5               61145932  19231356    38778832  34% /
tmpfs                  16441628         0    16441628   0% /dev/shm
tmpfs                   5120         0         5120   0% /run/lock
tmpfs                  16441628         0    16441628   0% /sys/fs/cgroup
/dev/loop0              128         128         0 100% /snap/bare/5
/dev/loop1             56832     56832         0 100% /snap/core18/2128
/dev/loop2             66688     66688         0 100% /snap/gtk-common-themes/1515
/dev/loop4             66816     66816         0 100% /snap/gtk-common-themes/1519
/dev/loop3             52224     52224         0 100% /snap/snap-store/547
/dev/loop5             224256    224256         0 100% /snap/gnome-3-34-1804/72
/dev/sdb1              523248         4     523244   1% /boot/efi
tmpfs                  3288324        28     3288296   1% /run/user/1000
10.53.0.4:/gcve-ds-1    107374182400 1136086016 106238096384   2% /base
/dev/mapper/nfsprdvgl-prod01 419155968 55384972 363770996 14% /datastore1
/dev/loop8             33280     33280         0 100% /snap/snapd/13270
/dev/loop6             33280     33280         0 100% /snap/snapd/13640
/dev/loop7             56832     56832         0 100% /snap/core18/2246
10.53.0.4:/nimCVSNFSol01 107374182400 256 107374182144   1% /nimCVSNFSol01
root@vm1:~#

```



Creating and Mounting SMB Share to VMs running on VMware Engine

For SMB volumes, make sure the Active Directory connections is configured prior to creating the SMB volume.

Active Directory connections [+ CREATE](#) [DELETE](#) [C](#)

Create a Windows Active Directory connection to your existing AD server. This is a prerequisite step before creating volumes with the SMB protocol type. [Learn more](#)

Filter Search for Active Directory connections by ID, username, DNS, netBIOS, region, etc.

<input type="checkbox"/>	Username	Domain	DNS Servers	NetBIOS Prefix	OU Path	AD Server Name	KDC IP	Region	Status
<input checked="" type="checkbox"/>	administrator	nimgcveval.com	192.168.0.16	nimgsmb	CN=Computers			europa-west3	In Use

Once the AD connection is in place, create the volume with the desired service level. The steps are like creating NFS volume except selecting the appropriate protocol.

1. In the Cloud Volumes Console, go to the Volumes page and click Create.
2. On the Create File System page, specify the volume name and billing labels as required for chargeback mechanisms.

[←](#) Create File System

Volume Name

Name *

nimCVSMBvol01

A human readable name used for display purposes.

Billing Label

Label your volumes for billing reports, queries.

Supported with CVS-Performance service type; can be set with CVS service type but not available for billing at this time.

[+ ADD LABEL](#)

3. Select the appropriate service. For GCVE, choose CVS-Performance and desired service level for improved latency and higher performance based on the workload requirements.

Create File System

Service Type

Cloud Volumes Service is offered as two service types: CVS and CVS-Performance. Select the service type that matches your workload needs. [Region availability](#)  varies by service type. [Learn more](#) 

☐ CVS

Offers volumes created with zonal high availability.

☒ CVS-Performance

Offers 3 performance levels and improved latency to address higher performance application requirements.

Volume Replication

☐ Secondary

Select to create volume as a destination target for volume replication. Applicable only to CVS-performance volumes.

4. Specify the Google Cloud region for the volume and volume path (The volume path must be unique across all of cloud volumes in the project)

Create File System

Region

Region availability varies by service type.

Region *

europa-west3



Volume will be provisioned in the region you select.

Volume Path *

nimCVSMBvol01



Must be unique to the project.

5. Select the level of performance for the volume.

← Create File System

Service Level

Select the performance level required for your workload.

- ☒ Standard
Up to 16 MiB/s per TiB
- ☐ Premium
Up to 64 MiB/s per TiB
- ☐ Extreme
Up to 128 MiB/s per TiB

Snapshot

The snapshot to create the volume from.

6. Specify the size of the volume and the protocol type. In this testing, SMB is used.

← Create File System

Volume Details

Allocated Capacity *

1024

GiB

Allocated size must be between 1 TiB (1024 GiB) and 100 TiB (102400 GiB)

Protocol Type *

SMB

- ☐ Make snapshot directory (.snapshot) visible
Makes .snapshot directory visible to clients. For NFSv4.1 volumes (CVS-Performance only), the directory itself will not be listed but can be accessed to list contents, etc.
- ☐ Enable SMB Encryption
Enable this option only if you require encryption of your SMB data traffic.
- ☐ Enable CA share support for SQL Server, FSLogix
Enable this option only for SQL Server and FSLogix workloads that require continuous availability.
- ☐ Hide SMB Share
Enable this option to make SMB shares non-browsable

7. In this step, select the VPC Network from which the volume will be accessible. Ensure VPC peering is in place.

HINT: If VPC peering has not been done, a pop-up button will be displayed to guide you through the peering commands. Open a Cloud Shell session and execute the appropriate commands to peer your VPC with Cloud Volumes Service producer. In case you decide to prepare VPC

peering in beforehand, refer to these [instructions](#).

Network Details

☐ Shared VPC configuration

Provide the host project name when deploying in a shared VPC service project.

VPC Network Name +

cloud-volumes-vpc

Select the VPC Network from which the volume will be accessible. This cannot be changed later.

☐ Use Custom Address Range

Reserved Address range

netapp-addresses

✓ SHOW SNAPSHOT POLICY

SAVE

CANCEL

8. Click Save to create the volume.

<input type="checkbox"/>	<input checked="" type="checkbox"/>	6a4552ed-7378-7302-be28-21a169374f28	nimCVSMBvol01	europa-west3	Available for use	CVS-Performance	Primary	Standard	SMB : \\nimasmb-3830.nimgcveval.com\nimCVSMBvol01
--------------------------	-------------------------------------	--------------------------------------	---------------	--------------	-------------------	-----------------	---------	----------	---------------------------------------------------

To mount the SMB volume, do the following:

1. In the Cloud Console, go to Cloud Volumes > Volumes.
2. Go to the Volumes page
3. Click the SMB volume for which you want to map an SMB share.
4. Scroll to the right, under Show More, click Mount Instructions.

To perform the mounting process from within the Windows guest OS of the VMware VM, follow the below steps:

1. Click the Start button and then click on Computer.
2. Click Map Network Drive.
3. In the Drive list, click any available drive letter.
4. In the folder box, type:

```
\\nimasmb-3830.nimgcveval.com\nimCVSMBvol01
```

Map Network Drive

What network folder would you like to map?

Specify the drive letter for the connection and the folder that you want to connect to:

Drive:

Folder:

Example: \\server\share

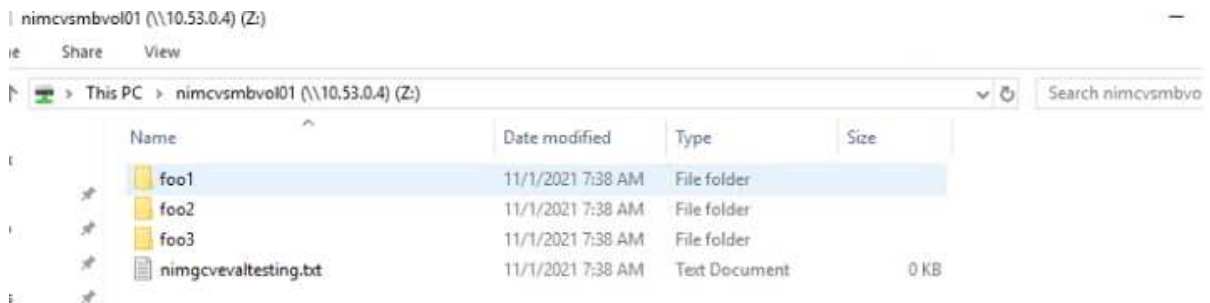
☒ Reconnect at sign-in

☐ Connect using different credentials

[Connect to a Web site that you can use to store your documents and pictures.](#)

To connect every time you log on to your computer, select the Reconnect at sign-in check box.

5. Click Finish.



Region Availability for NFS datastores on AWS / VMC, Azure / AVS, and GCP / GCVE

Learn more about the the Global Region support for NFS datastores on AWS, Azure and Google Cloud Platform (GCP).

AWS Region Availability

Americas

AWS Region	VMC Availability	FSx ONTAP Availability	NFS Datastore Availability
US East (Northern Virginia)	Yes	Yes	Yes
US East (Ohio)	Yes	Yes	Yes
US West (Northern California)	Yes	No	No
US West (Oregon)	Yes	Yes	Yes
GovCloud (US West)	Yes	Yes	Yes
Canada (Central)	Yes	Yes	Yes
South America (Sao Paulo)	Yes	Yes	Yes

Last updated on: June 2, 2022.

EMEA

AWS Region	VMC Availability	FSx ONTAP Availability	NFS Datastore Availability
Europe (Ireland)	Yes	Yes	Yes
Europe (London)	Yes	Yes	Yes
Europe (Frankfurt)	Yes	Yes	Yes
Europe (Paris)	Yes	Yes	Yes
Europe (Milan)	Yes	Yes	Yes
Europe (Stockholm)	Yes	Yes	Yes

Last updated on: June 2, 2022.

Asia Pacific

AWS Region	VMC Availability	FSx ONTAP Availability	NFS Datastore Availability
Asia Pacific (Sydney)	Yes	Yes	Yes
Asia Pacific (Tokyo)	Yes	Yes	Yes
Asia Pacific (Osaka)	Yes	No	No
Asia Pacific (Singapore)	Yes	Yes	Yes
Asia Pacific (Seoul)	Yes	Yes	Yes
Asia Pacific (Mumbai)	Yes	Yes	Yes
Asia Pacific (Jakarta)	No	No	No
Asia Pacific (Hong Kong)	No	Yes	No

Last updated on: June 2, 2022.

Americas

Azure Region	AVS Availability	ANF Availability	NFS Datastore Availability
Central US	Yes	Yes	Yes
East US	Yes	Yes	Yes
East US 2	No	Yes	No
North Central US	Yes	Yes	Yes
South Central US	Yes	Yes	Yes
West Central US	No	No	No
West US	Yes	Yes	Yes
West US2	No	Yes	No
West US3	GA: H1-2023	Yes	Yes
Canada Central	Yes	Yes	Yes
Canada East	Yes	Yes	Yes
Brazil South	Yes	Yes	Yes
Brazil Southeast	No	GA: Q2-2022	No

Last updated on: June 7, 2022.

EMEA

Azure Region	AVS Availability	ANF Availability	NFS Datastore Availability
North Europe	Yes	Yes	Yes
West Europe	No	Yes	No
France Central	Yes	Yes	Yes
France South	No	GA: H2-2022	No
Germany North	No	Yes	No
Germany West Central	Yes	Yes	Yes
Norway East	No	Yes	No
Norway West	No	Yes	No
Sweden Central	GA: Q2-2022	GA: Q2-2022	No
Sweden South	No	No	No
Switzerland North	No	Yes	No
Switzerland West	No	Yes	No
UAE Central	No	Yes	No
UAE North	No	Yes	No
UK South	Yes	Yes	Yes

UK West	Yes	Yes	Yes
---------	-----	-----	-----

Last updated on: June 7, 2022.

Asia Pacific

Azure Region	AVS Availability	ANF Availability	NFS Datastore Availability
Australia East	Yes	Yes	Yes
Australia Southeast	Yes	Yes	Yes
Australia Central	No	Yes	No
Japan East	Yes	Yes	No
Japan West	Yes	Yes	Yes
East Asia	No	Yes	No
Southeast Asia	Yes	Yes	Yes
Central India	No	Yes	No
South India	No	Yes	No
Korea Central	No	Yes	No

Last updated on: June 20, 2022.

Summary and Conclusion: Why NetApp Hybrid Multi-Cloud with VMware

NetApp Cloud Volumes along with VMware solutions for the major hyperscalers provides great potential for organizations looking to leverage hybrid cloud. The rest of this section provides the use cases that show integrating NetApp Cloud Volumes enables true hybrid multi-cloud capabilities.

Use case #1: Optimizing storage

When performing a sizing exercise using RVtools output, it is always evident that the horsepower (vCPU/vMem) scale is parallel with storage. Many times, organizations find themselves in a situation where the storage space requires drives the size of the cluster well beyond what is needed for horsepower.

By integrating NetApp Cloud Volumes, organizations can realize a vSphere-based cloud solution with a simple migration approach, with no re-platforming, no IP changes, and no architectural changes. Additionally, this optimization enables you to scale the storage footprint while keeping the host count to least amount required in vSphere, but no change to the storage hierarchy, security, or files made available. This allows you to optimize the deployment and reduce the overall TCO by 35–45%. This integration also enables you to scale storage from warm storage to production-level performance in seconds.

Use case #2: Cloud migration

Organizations are under pressure to migrate applications from on-premises data centers to the Public Cloud for multiple reasons: an upcoming lease expiration; a finance directive to move from capital expenditure

(capex) spending to operational expenditures (opex) spending; or simply a top-down mandate to move everything to the cloud.

When speed is critical, only a streamlined migration approach is feasible because re-platforming and refactoring applications to adapt to the cloud's particular IaaS platform is slow and expensive, often taking months. By combining NetApp Cloud Volumes with the bandwidth-efficient SnapMirror replication for guest-connected storage (including RDMS in conjunction with application-consistent Snapshot copies and HCX, cloud specific migration (e.g. Azure Migrate), or third-party products for replicating VMs), this transition is even easier than relying on time-consuming I/O filters mechanisms.

Use case #3: Data center expansion

When a data center reaches capacity limits due to seasonal demand spikes or just steady organic growth, moving to the cloud-hosted VMware along with NetApp Cloud Volumes is an easy solution. Leveraging NetApp Cloud Volumes allows storage creation, replication, and expansion very easily by providing high availability across availability zones and dynamic scaling capabilities. Leveraging NetApp Cloud Volumes helps in minimizing host cluster capacity by overcoming the need for stretch clusters.

Use case #4: Disaster recovery to the cloud

In a traditional approach, if a disaster occurs, the VMs replicated to the cloud would require conversion to the cloud's own hypervisor platform before they could be restored – not a task to be handled during a crisis.

By using NetApp Cloud Volumes for guest-connected storage using SnapCenter and SnapMirror replication from on-premises along with public cloud virtualization solutions, a better approach for disaster recovery can be devised allowing VM replicas to be recovered on fully consistent VMware SDDC infrastructure along with cloud specific recovery tools (e.g. Azure Site Recovery) or equivalent third-party tools such as Veeam. This approach also enables you to perform disaster recovery drills and recovery from ransomware quickly. This also enables you to scale to full production for testing or during a disaster by adding hosts on-demand.

Use case #5: Application modernization

After applications are in the public cloud, organizations will want to take advantage of the hundreds of powerful cloud services to modernize and extend them. With the use of NetApp Cloud Volumes, modernization is an easy process because the application data is not locked into vSAN and allows data mobility for a wide range of use cases, including Kubernetes.

Conclusion

Whether you are targeting an all-cloud or hybrid cloud, NetApp Cloud Volumes provides excellent options to deploy and manage the application workloads along with file services and block protocols while reducing the TCO by making the data requirements seamless to the application layer.

Whatever the use case, choose your favorite cloud/hyperscaler together with NetApp Cloud Volumes for rapid realization of cloud benefits, consistent infrastructure, and operations across on-premises and multiple clouds, bidirectional portability of workloads, and enterprise-grade capacity and performance.

It is the same familiar process and procedures that are used to connect the storage. Remember, it is just the position of the data that changed with new names; the tools and processes all remain the same and NetApp Cloud Volumes helps in optimizing the overall deployment.

Copyright Information

Copyright © 2022 NetApp, Inc. All rights reserved. Printed in the U.S. No part of this document covered by copyright may be reproduced in any form or by any means-graphic, electronic, or mechanical, including photocopying, recording, taping, or storage in an electronic retrieval system-without prior written permission of the copyright owner.

Software derived from copyrighted NetApp material is subject to the following license and disclaimer:

THIS SOFTWARE IS PROVIDED BY NETAPP "AS IS" AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED. IN NO EVENT SHALL NETAPP BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

NetApp reserves the right to change any products described herein at any time, and without notice. NetApp assumes no responsibility or liability arising from the use of products described herein, except as expressly agreed to in writing by NetApp. The use or purchase of this product does not convey a license under any patent rights, trademark rights, or any other intellectual property rights of NetApp.

The product described in this manual may be protected by one or more U.S. patents, foreign patents, or pending applications.

RESTRICTED RIGHTS LEGEND: Use, duplication, or disclosure by the government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.277-7103 (October 1988) and FAR 52-227-19 (June 1987).

Trademark Information

NETAPP, the NETAPP logo, and the marks listed at <http://www.netapp.com/TM> are trademarks of NetApp, Inc. Other company and product names may be trademarks of their respective owners.