

NETAPP UNIVERSITY

Integrating Hybrid Clouds with NetApp Data Fabric

Student Guide
Content Version 3



NETAPP UNIVERSITY

Integrating Hybrid Clouds with NetApp Data Fabric

Student Guide

Course ID: STRSW-ILT-INTHCDF
Catalog Number: STRSW-ILT-INTHCDF-SG

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Welcome!

Integrating Hybrid Clouds with Data Fabric

- Be sure that you have your Student Guide and Exercise Guide
- Test your headset and microphone (virtual sessions only)
- Provide yourself with two screens (virtual sessions only)
- Make yourself comfortable—class begins soon



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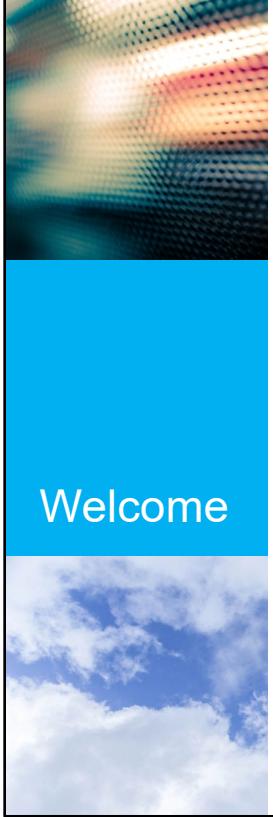
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Welcome

Classroom Logistics

Getting Started

- Schedule (start, stop, breaks, breakout sessions)
- Activities and participation
- Materials
- Equipment check
- Support

Classroom Sessions

- Sign-in sheet
- Refreshments
- Phones
- Alarm signal
- Evacuation procedure
- Electrical safety

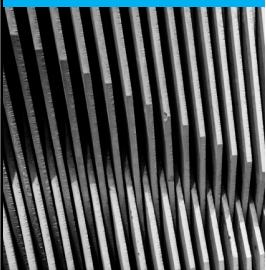
Virtual Sessions

- Collaboration tools
- Ground rules
- Phones and headsets

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Introductions



Virtual Sessions



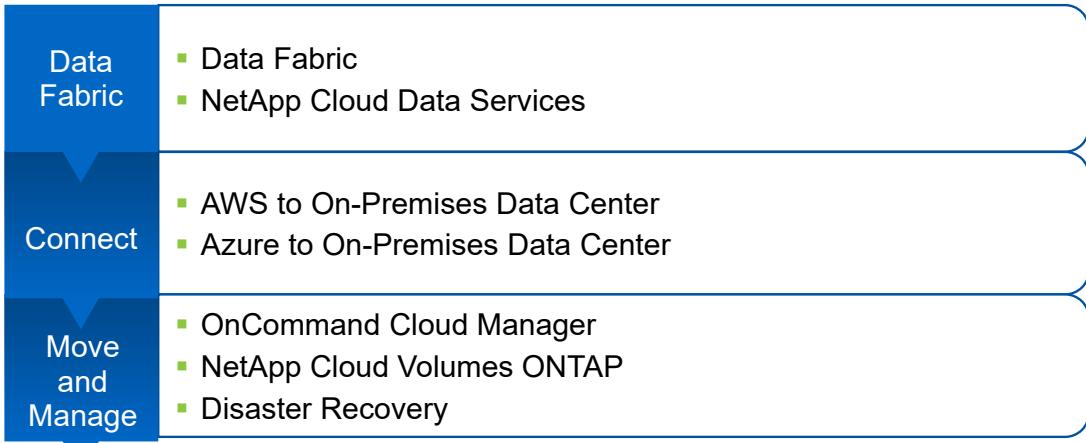
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Classroom Sessions



Introductions

- Name
- Your Role
- Amazon Web Services (AWS) and Azure Experience
- NetApp ONTAP Software Experience
- Hybrid Cloud Experience



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About This Course



Solutions

- Data Tiering for Cloud Volumes ONTAP
- Cloud Volumes ONTAP in High Availability

Solutions

- NetApp Cloud Sync Service
- NetApp Cloud Volumes Service

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Day 1

Morning

- **Module 0: Introduction**
 - Exercise 0: Provision your lab and checking the lab equipment.
- **Module 1: Data Fabric Overview**
 - Exercise 1: Control Cloud Resources with Windows PowerShell
 - Exercise 2: Assess Azure and Amazon Web Services Environments

Afternoon

- **Module 2: Amazon Web Services Virtual Private Cloud and Connectivity to Other Networks**
 - Exercise 1: Configure Amazon Web Services Virtual Private Cloud Resources
 - Exercise 2: Operationalize On-Premises to Cloud Connectivity

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Day 2

Morning

- Module 3: NetApp Cloud Volumes ONTAP
 - Exercise 1: Using OnCommand Cloud Manager to Deploy Cloud Volumes ONTAP
- Module 4: Implementing Disaster Recovery by Using NetApp Cloud Volumes ONTAP
 - Exercise 1: Configure and Manage Disaster Recovery in the Data Fabric

Afternoon

- Module 5: Azure Virtual Network and Connectivity
 - Exercise 1: Configuring Azure Virtual Network to On-Premises VPN Connectivity
- Module 6: NetApp Cloud Volumes ONTAP Data Tiering
 - Exercise 1: Tier Backup Data to Amazon Simple Storage Service

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Day 3

Morning

- Module 7: NetApp Cloud Volumes ONTAP High Availability
 - Exercise 1: Implement Cloud Volumes ONTAP High Availability
- Module 8: Cloud Sync Service
 - Exercise 1: Synchronize Data From On-Premises to Amazon Simple Storage Service

Afternoon

- Module 9: NetApp Cloud Volumes Service
 - Exercise 1: Connect to pre-provisioned LOD Lab and follow the online lab guide for the Cloud Volumes Service

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Pre-Requisite Knowledge

For a successful learning experience

You should have completed the pre-work or have prior knowledge of the following:

Cloud Computing:

- Cloud Characteristics
- Service Delivery Methods
- Cloud Deployment Models

Networking Fundamentals:

- CIDR
- NAT

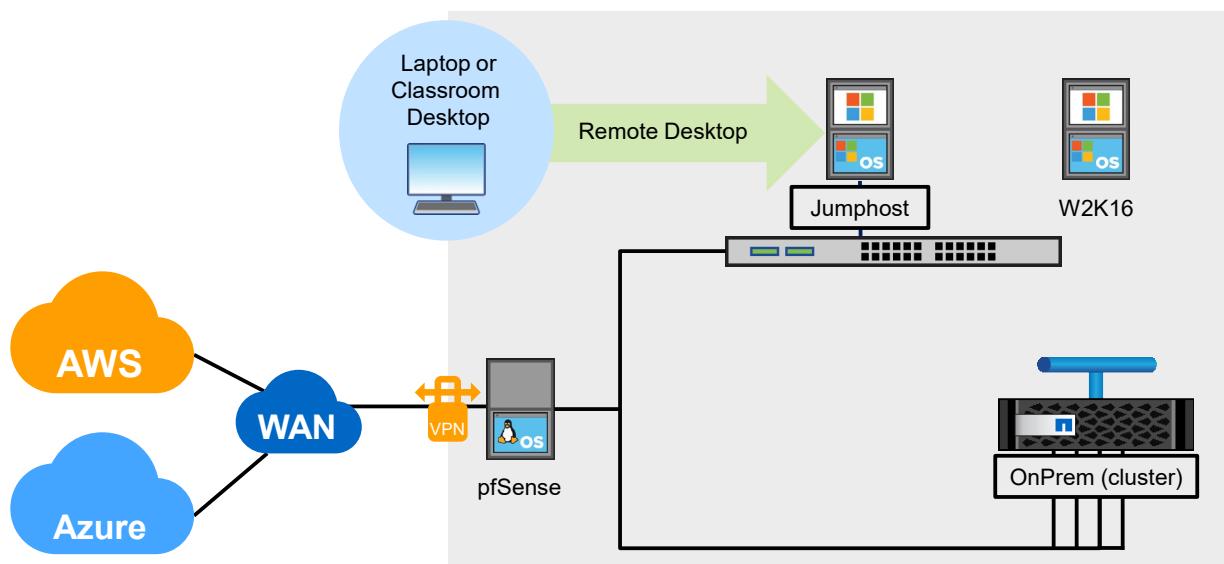
AWS Concepts

- IAM, VPC, Subnets, Network Routing and Security Basics, EC2 launching and logging in

Azure Concepts:

- Subscriptions, VNET, VMs, Azure Storage

Class Equipment: Basic Architecture



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Launch your exercise equipment kit from your laptop or from the classroom desktop. To connect to your exercise equipment, use Remote Desktop Connection or the NetApp University portal.

The Windows 2012 Server is your Windows domain controller for the LEARN windows domain. The Windows Server hosts the domain DNS server.

Your exercise equipment consists of several servers:

1. A single node NetApp ONTAP cluster
2. An AltaVault appliance
3. A CentOS Linux server
4. A pfSense virtual machine used as a virtual router for the VPN connection to the cloud providers



Hands-On Activity

Module 0: Welcome

Exercise 0 Checking the Lab Equipment

This exercise requires approximately **30 minutes**.

ACTION: Share Your Experiences

Roundtable questions for the equipment-based exercises



- Do you have questions about your equipment kit?
- Do you have an issue to report?

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If you encounter an issue, notify your instructor immediately so that the issue can be resolved promptly.

Your Learning Journey

Bookmark these pages

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- [NetApp University Overview](#)
 - Find the training that you need
 - Explore certification
 - Follow your learning map
- [NetApp University Community](#)
Join the discussion
- [NetApp University Support](#)
Contact the support team

NetApp

- [New to NetApp Support Webcast](#)
Ensure a successful support experience
- [NetApp Support](#)
Access downloads, tools, documentation
- [Customer Success Community](#)
Engage with experts
- [NetApp Knowledgebase](#)
Access a wealth of knowledge

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The *NetApp University Overview* page is your front door to learning. Find training that fits your learning map and your learning style, learn how to become certified, link to blogs and discussions, and subscribe to the NetApp newsletter *Tech OnTap*. <http://www.netapp.com/us/services-support/university/index.aspx>

The *NetApp University Community* page is a public forum for NetApp employees, partners, and customers. NetApp University welcomes your questions and comments.

https://communities.netapp.com/community/netapp_university

The *NetApp University Support* page is a self-help tool that enables you to search for answers to your questions and to contact the NetApp University support team. <http://netappusupport.custhelp.com>

Are you new to NetApp? If so, register for the *New to NetApp Support Webcast* to acquaint yourself with the facts and tips that help to ensure that you have a successful support experience.

http://www.netapp.com/us/forms/supportwebcastseries.aspx?REF_SOURCE=new2ntapwl-netappu

The *NetApp Support* page is your introduction to all products and solutions support: <http://mysupport.netapp.com>. Use the *Getting Started* link (<http://mysupport.netapp.com/info/web/ECMP1150550.html>) to establish your support account and hear from the NetApp CEO. Search for products, downloads, tools, and documentation, or link to the *NetApp Support Community* (<http://community.netapp.com/t5/Products-and-Solutions/ct-p/products-and-solutions>).

Join the *Customer Success Community* to ask support-related questions, share tips, and engage with other users and experts. <https://forums.netapp.com/>

Search the *NetApp Knowledgebase* to apply the accumulated knowledge of NetApp users and product experts.
<https://kb.netapp.com/support/index?page=home>



Module 1

Data Fabric Overview

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1



About This Module

This module focuses on enabling you to do the following:

- Explain the value of the Data Fabric solutions
- Describe NetApp solutions for the hybrid cloud
- Describe NetApp Cloud Data Services and how they enable customers to accelerate their cloud workloads
- Describe the tools and APIs for management of data in a hybrid cloud
- Get started with Amazon Web Services (AWS) and Microsoft Azure environments: specifically, run basic Windows PowerShell commands for AWS, Azure, and NetApp

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Data Fabric

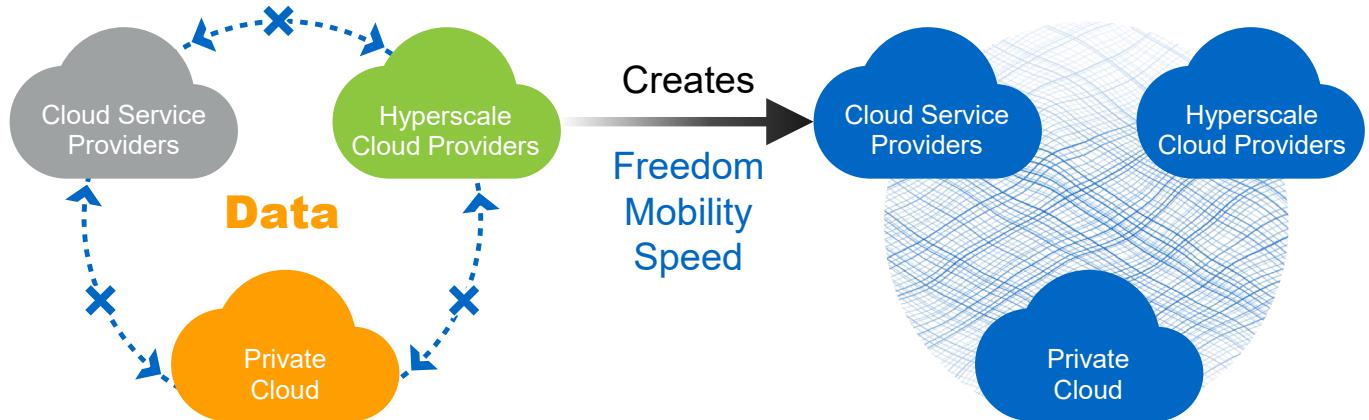
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The Data Fabric Powered by NetApp

Data Fabric enables customers with a shared set of secure data services so that they can manage, access, and protect data where it is needed most. Customers can respond and innovate faster and gain the freedom to make the best decisions for their businesses.

How Does the Data Fabric Powered by NetApp Work?



Realize the full potential of the hybrid cloud.

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Customers' data is often in several locations and disjointed and requires separate management, maintenance, and backup solutions. The Data Fabric powered by NetApp enables customers to access and manage their data no matter where it exists.

Data Fabric Defined

NetApp is a cloud data services and infrastructure company

Dynamic Data Portability



Connects different data management environments across disparate clouds into a cohesive, integrated whole

Control and Choice



Helps organizations maintain control and choice in how they manage, secure, protect, and access their data across the hybrid cloud

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Data Fabric is the NetApp vision for the future of data management. Data Fabric is also the NetApp technology architecture for the hybrid cloud. A Data Fabric seamlessly connects different data management environments across disparate clouds into a cohesive, integrated whole. Organizations maintain control and choice in how they manage, secure, protect, and access their data across the hybrid cloud, no matter where it is. IT has the flexibility to choose the right set of resources and the freedom to change them whenever needed.



Solutions for the Hybrid Cloud

If the fabric has more threads, it becomes stronger, and therefore IT has more solutions with which to solve business problems

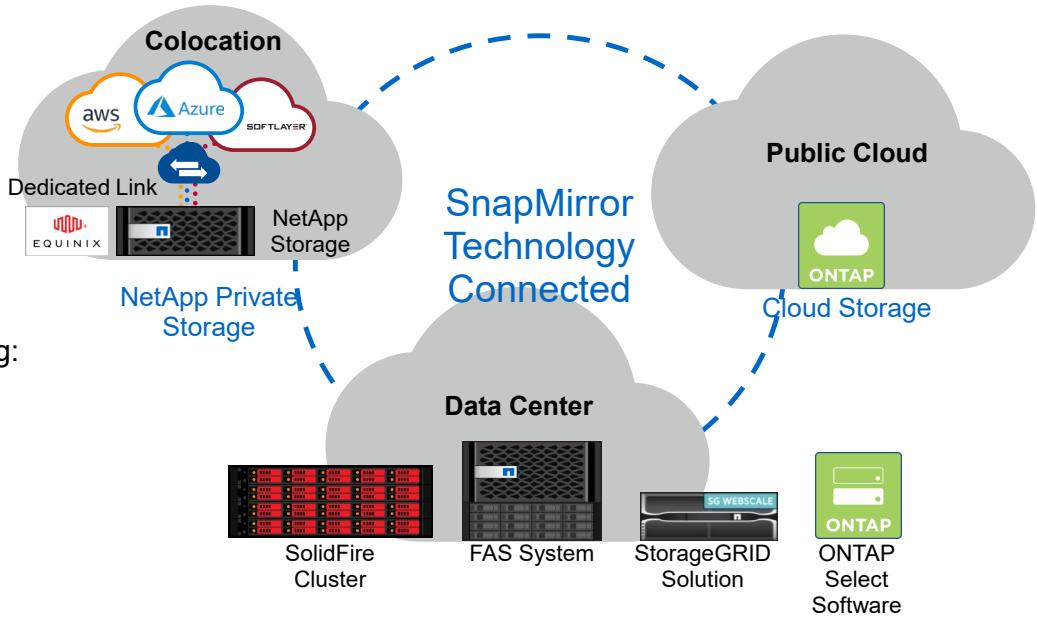
NetApp Solutions for the Hybrid Cloud

NetApp enables customers to easily store, manage, and move data in a hybrid Cloud environment by providing the following:

- Storage
- In-built technologies in ONTAP software
- Software as a service (SaaS) offerings from NetApp Cloud Central
- A suite of management and analytics tools and APIs

Data Fabric Deployment Models

Hybrid cloud is the new normal for enterprises.



Assume the following:

- Encryption
- Compression
- Deduplication
- Security
- Multiple endpoints

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Here is an example of how NetApp systems are used to create the endpoints of a Data Fabric within a hybrid cloud architecture.

In its simplest form, a hybrid cloud deployment can consist of a FAS array in the corporate data center and NetApp Cloud Volumes ONTAP software in AWS or Azure. SnapMirror software replicates data from one location to the other. A hybrid cloud can also connect colocation-managed or dedicated services with cloud resources. For data center private cloud or service provider cloud, the FAS system could be a FlexPod converged infrastructure or a standalone FAS system.

Multiple Cloud Choice with NetApp Private Storage (NPS)

1

Data Sovereignty

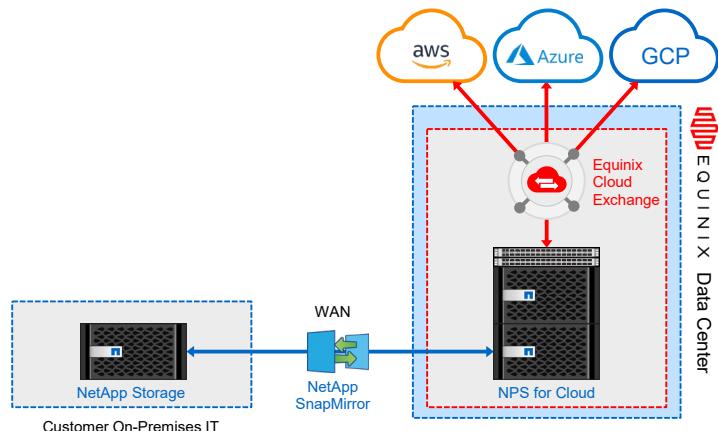
2

Multicloud Choice

3

Performance

- Install dedicated NetApp storage in an Equinix cabinet and connect to Equinix Cloud Exchange for **data sovereignty**
- Replicate the customer's data to "next to" cloud compute resources
- Access **multiple cloud providers** from the controlled data source
- Experience **low latency** (2 ms and less) through cloud proximity and 10-Gigabit Ethernet (10-GbE) connectivity for demanding applications and use cases
- Switch between cloud providers without moving data over a WAN



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Enable choice with multicloud connectivity:

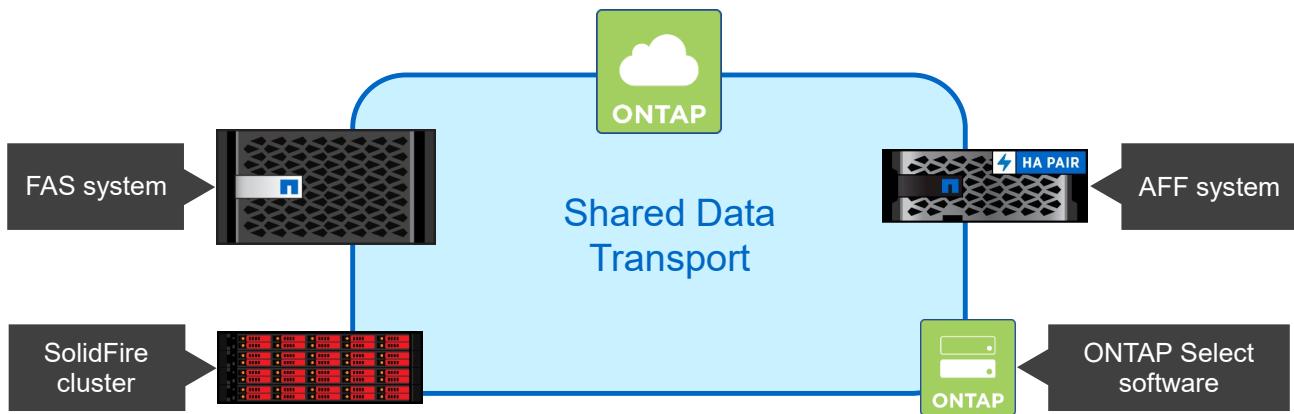
- Connect to AWS, Azure, or Google Cloud Platform through a dedicated network connection
- Connect to and switch cloud providers at any time
- Avoid vendor lock-in and costly data migrations

NetApp Private Storage for Cloud (NPS for Cloud) has the following minimum requirements:

- NetApp storage (FAS, AFF, and SolidFire clusters)
- Cisco (or other) router, firewall, and VPN concentrator
- Colocation cabinet at Equinix (or other colocation facility)
- Equinix Cloud Exchange or cross-connect to communication service provider (CSP)
- Contract with cloud service providers
- Professional services, installation, and integration

Connect Systems

Shared data transport: SnapMirror software and SnapVault software



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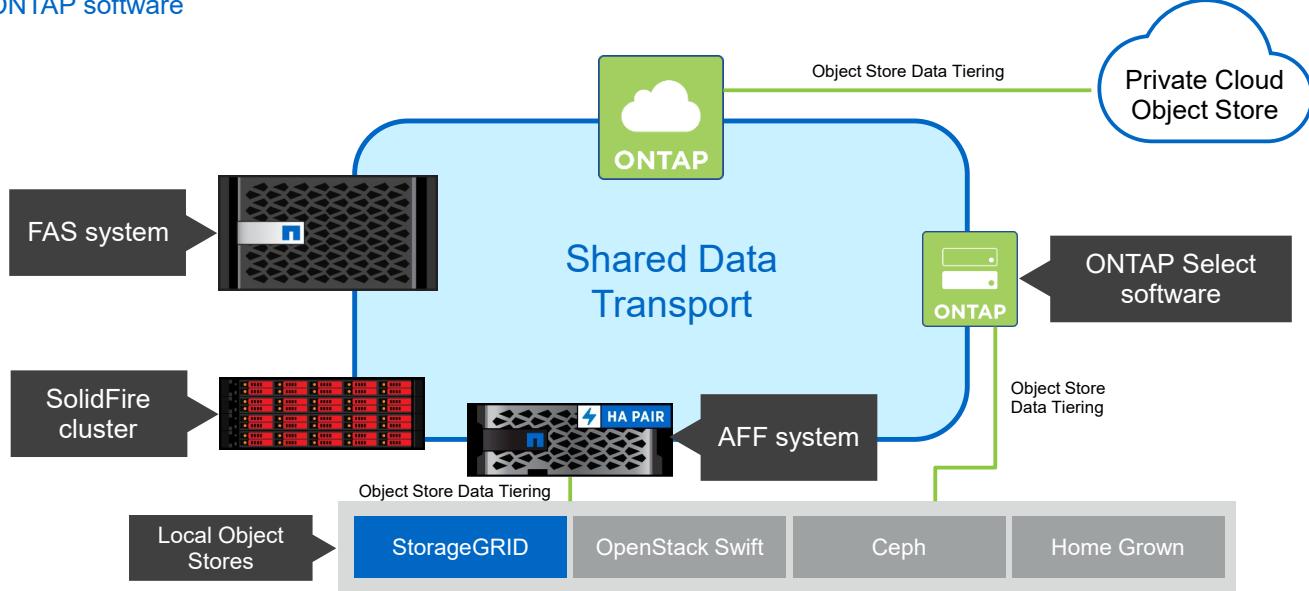
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The key to successfully moving data in your Data Fabric is to have a shared data protocol transport. This transport mechanism enables applications to access data where it is needed most: in a cloud, across storage tiers, or across clusters. Applications are not aware of any data movement.

With a shared data transport, systems can interoperate and move data efficiently between them by using SnapMirror replication or SnapVault backup capabilities. Not only does this transport enable interoperability, it also preserves deduplication and compression storage efficiencies. Data does not rehydrate when moving from one endpoint to another. This transport is the fastest way to move data in bulk in the fabric. It is especially important when the fabric spans WANs for hybrid cloud architectures.

Automatic Object Store Data Tiering

ONTAP software



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This automatic object store data tiering is implemented in ONTAP 9.2 software with the FabricPool feature. This object data tiering is not used as a backup or for disaster recovery. It is storing cool data (for example, Snapshot copies) on a more appropriate tier. ONTAP software understands the access patterns of your data and automatically moves it to the tier that best suits the observed patterns.



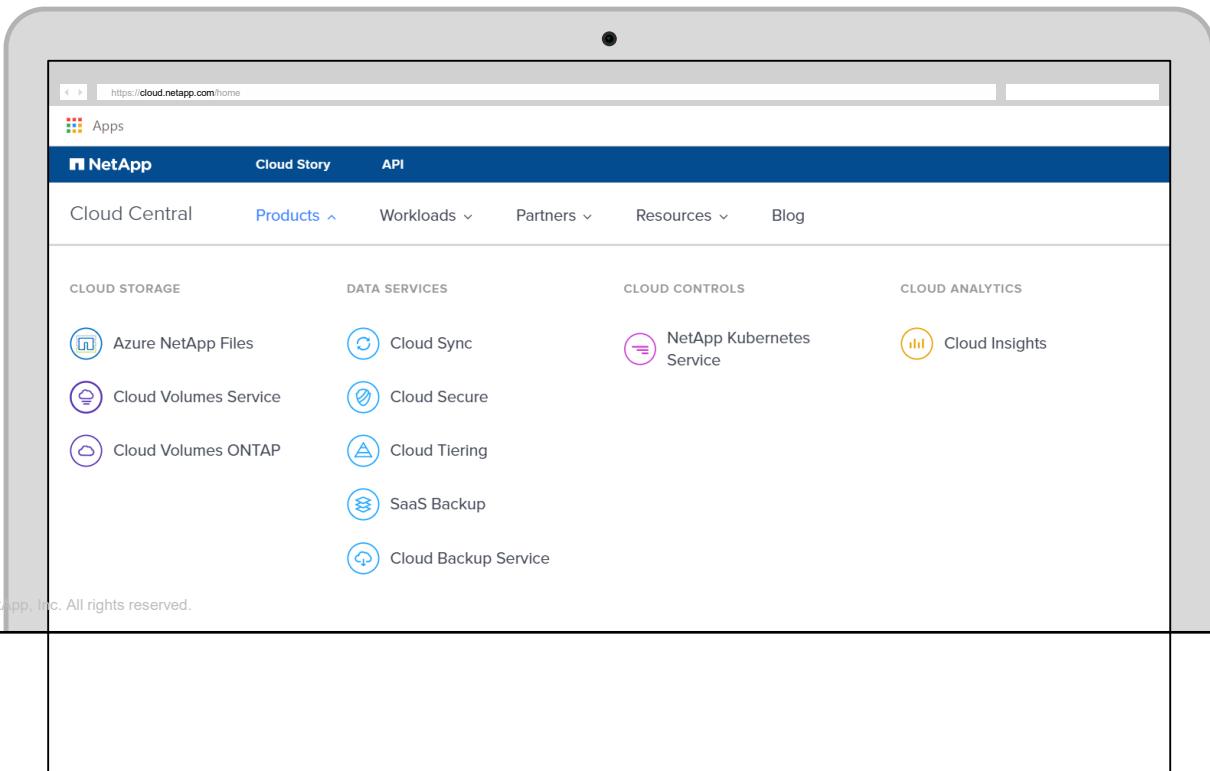
NetApp Cloud Data Services

Empowering the cloud champions

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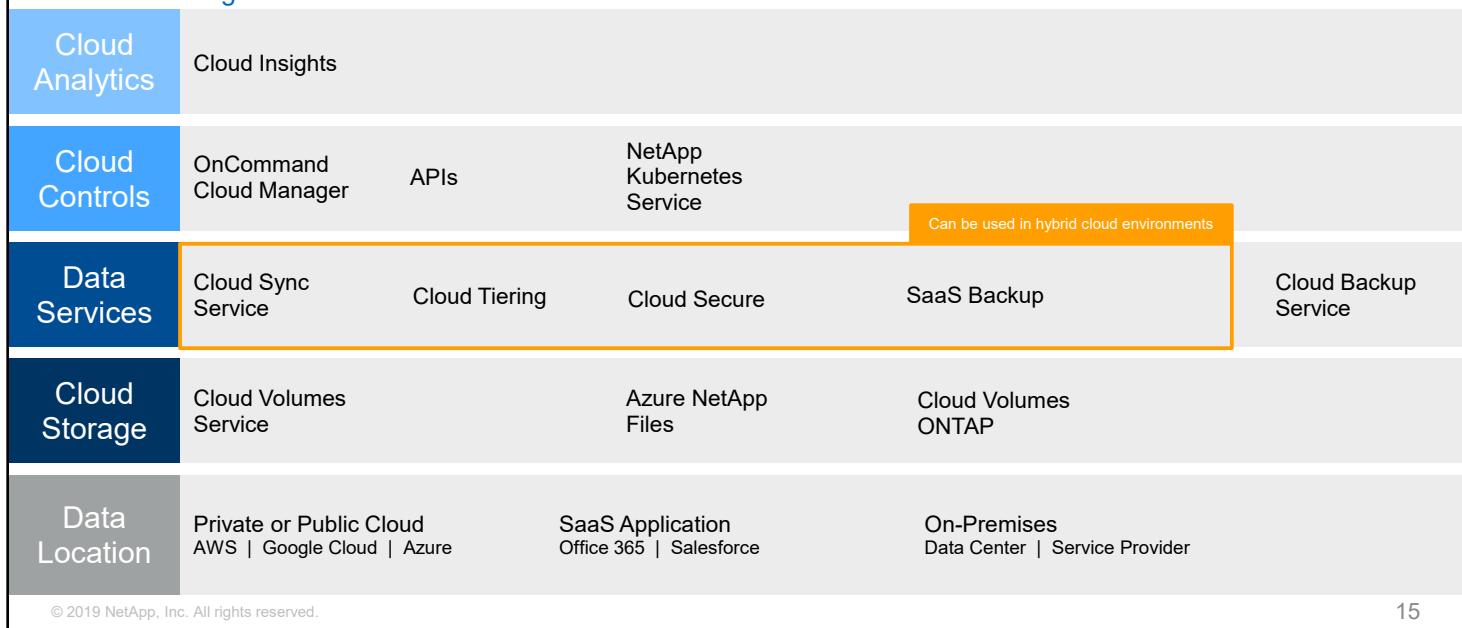
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Cloud Central



NetApp Cloud Data Services

Service offerings



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NetApp cloud data services provide a full stack of services to deploy, run, monitor, maintain, and manage cloud services in the biggest public clouds. These services enable customers to avoid that work.

This illustration is used throughout the course to help you to visualize the cloud data services in respect to where they are typically used.

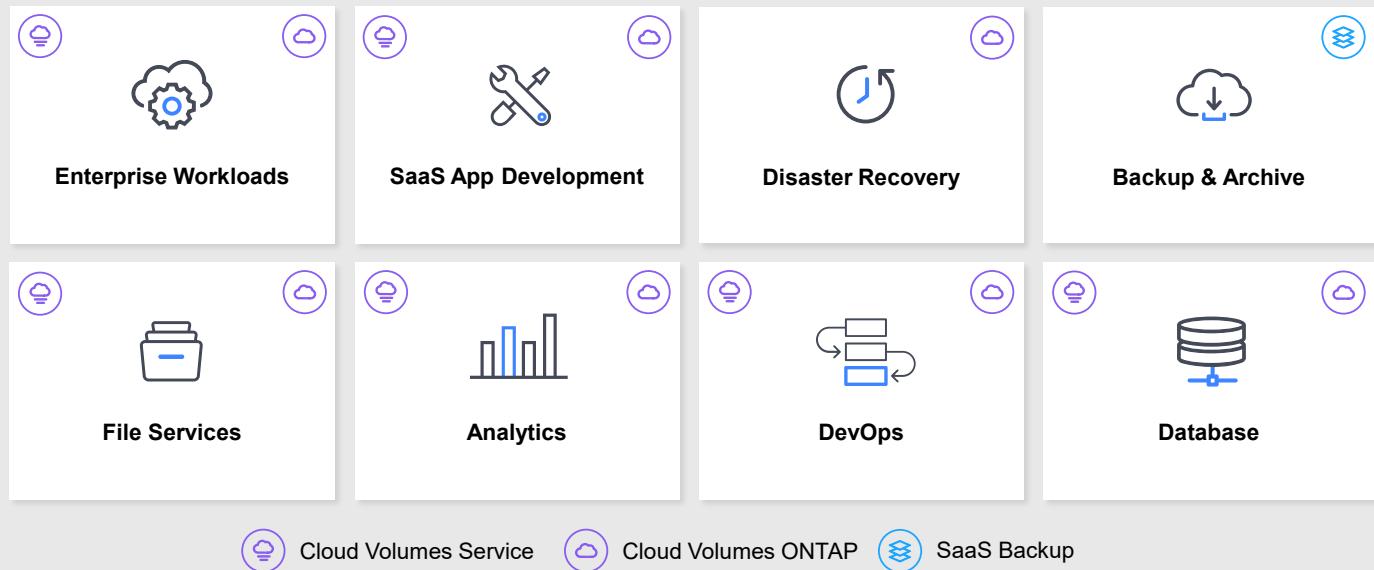
Your NetApp cloud data services journey starts with the location of your data. For example, your data could be in any of the following:

- A private or public cloud like Amazon Web Services (AWS), Google Cloud, or Microsoft Azure
- A SaaS application like Microsoft Office 365 or Salesforce
- An on-premises data center or service provider

NetApp cloud services have many offerings, which are grouped into four categories:

- Cloud Storage, which includes Cloud Volumes Service, Azure NetApp Files, and Cloud Volumes ONTAP
- Data Services, which includes Cloud Sync service and SaaS Backup
- Cloud Controls, which includes Cloud Manager, APIs, and NetApp Kubernetes Service
- Cloud Analytics, which includes Cloud Insights

Cloud Workloads



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There are many workloads that can be run in the cloud. Following are the most frequently seen:

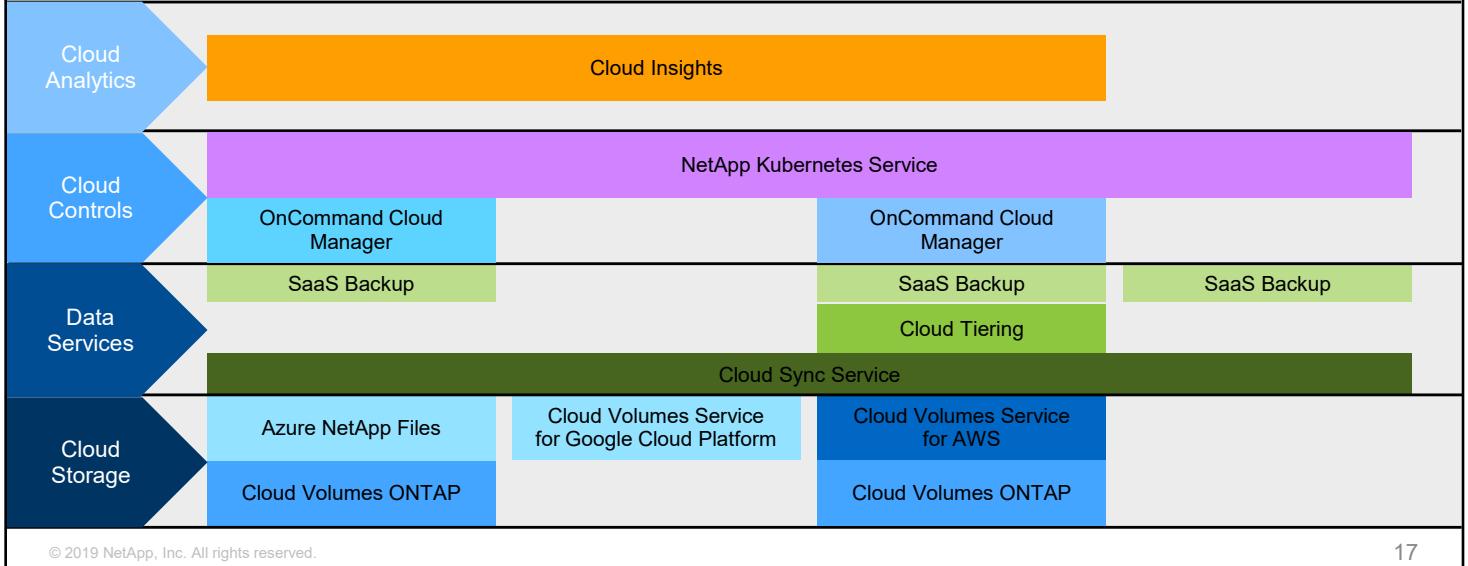
- Enterprise applications, which typically require uninterrupted, secure, and efficient operation
- SaaS app development, which requires the ability to scale up at a reduced cost while staying fast and agile
- Disaster recovery, which requires a cost-effective cloud secondary copy that supports seamless and quick failover and fallback
- Backup and archive, which requires simple and easy management of data to guard from threats or accidental deletion
- File services, which require simple file access, sharing, protection, and management in any geography or scale
- Analytics, which requires using data management, collaboration, and mobility services to analyze massive amounts of data
- DevOps, which requires durable, high-performance, on-demand, and instant volume creation
- Database, which requires an extra level of performance and protection guarantees

As you can see, each workload has specific requirements. Knowing the requirements for your workload helps you to determine the service offering that best fits your needs. Cloud Central provides guidance in choosing the best service for each of the workloads from the workloads menu.

Clouds and Cloud Data Services



Private Cloud



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NetApp cloud data services are available for all major public cloud service providers and for on-premises private clouds. Availability of a particular service in a particular cloud depends on the use case and maturity of the service.

Cloud Storage

- Cloud Volumes ONTAP is supported on Azure and AWS.
- Cloud Volumes Service is available for AWS and Google Cloud Platform.
- Azure NetApp Files is available exclusively for Azure.

Data Services

- Cloud Sync service is available for all these clouds.
- SaaS Backup is available for Azure, AWS, and private clouds.
- Cloud Tiering is available as a SaaS offering to tier data from on-premises to the cloud and is only available for AWS. This product is not the same as data tiering for Cloud Volumes ONTAP, which is available for both AWS and Azure.

Cloud Controls

- OnCommand Cloud Manager, which is primarily used for Cloud Volumes ONTAP, is also supported on Azure and AWS.
- NetApp Kubernetes Service is available for all these clouds.

Cloud Analytics

- Cloud Insights is available for all these public clouds.

As service offerings are added and availability is expanded, this map changes. Cloud Central provides the most current information.

Cloud Storage

Cloud Analytics	Cloud Insights				
Cloud Controls	OnCommand Cloud Manager	APIs	NetApp Kubernetes Service		
Data Services	Cloud Sync Service	Cloud Tiering	Cloud Secure	SaaS Backup	Cloud Backup Service
Cloud Storage	Cloud Volumes Service		Azure NetApp Files		Cloud Volumes ONTAP
Data Location	Private or Public Cloud AWS Google Cloud Azure		SaaS Application Office 365 Salesforce		On-Premises Data Center Service Provider

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Cloud Volumes ONTAP

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Cloud Volumes ONTAP

Enterprise data and storage management running natively in the cloud

Best for:

- Moving applications to the cloud months or years faster
- Automating development and testing for faster time to market
- Ensuring business continuity across IT environments with a data center in the cloud



Data Control. Cost Efficiency. Business Continuity.



Built-in storage efficiency to reduce costs

Deduplication, compression, thin provisioning, and cloning



Preconfigured to match your workload requirements

Deduplication, compression, thin provisioning, and cloning



Ability to synchronize and manage both in-cloud and on-premises data

Single management console



Multiple protocols that public clouds do not offer

NFS, SMB, and iSCSI

Cloud Volumes ONTAP

What is it?

- Cloud Volumes ONTAP is a full-fledged version of ONTAP that is running natively in AWS or Azure.
- It consumes native cloud storage.
- It enables a cloud-first strategy.



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Cloud Volumes ONTAP software is available on the AWS and Azure marketplace:

- Enables high availability for applications
- Supports storage efficiency and replication technologies
- Is available on a pay-per-use or licensed model
- Is simple to launch and operate through a GUI and an API
- Is a virtualized ONTAP that is running in the public cloud as a virtual machine or instance
- Is highly available and uses and manages Elastic block storage (EBS) /Virtual Hard Disk that is provided by AWS and Azure
- Uses storage efficiency and SnapMirror software for data migration
- Is available in all major AWS regions and is quick and easy to deploy



Cloud Volumes Service

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Cloud Volumes Service

A fully managed, API-driven cloud-native file storage service that enables application deployment in the cloud and speeds application development

Best for:

- File-based workloads that benefit from cloud services
- Legacy applications that have not been moved to the cloud because of cloud limits
- Analytics workloads that require cloud storage



Cloud-Native File Services



Deploy any workload that requires file services in the cloud

Even legacy applications, maximum agility



Acquire a subscription

To shift expense from capital expenditures (capex) to operational expenditures (opex)



Secure and protect data

No application performance effect

Cloud Volumes Service

Available in major hyperscalers



NetApp Cloud Volumes
Service for AWS



Google Cloud Platform

NetApp Cloud Volumes
Service for Google
Cloud Platform

File Services

In Microsoft Azure



Azure NetApp Files

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Managing Cloud Storage

Cloud Volumes ONTAP versus Cloud Volumes Service

Provider Managed

- Provides fully managed cloud services powered by NetApp
- Requires little storage management knowledge



Customer Managed

- Provides cloud services that use familiar and reliable data management software
- Requires some basic ONTAP storage management knowledge



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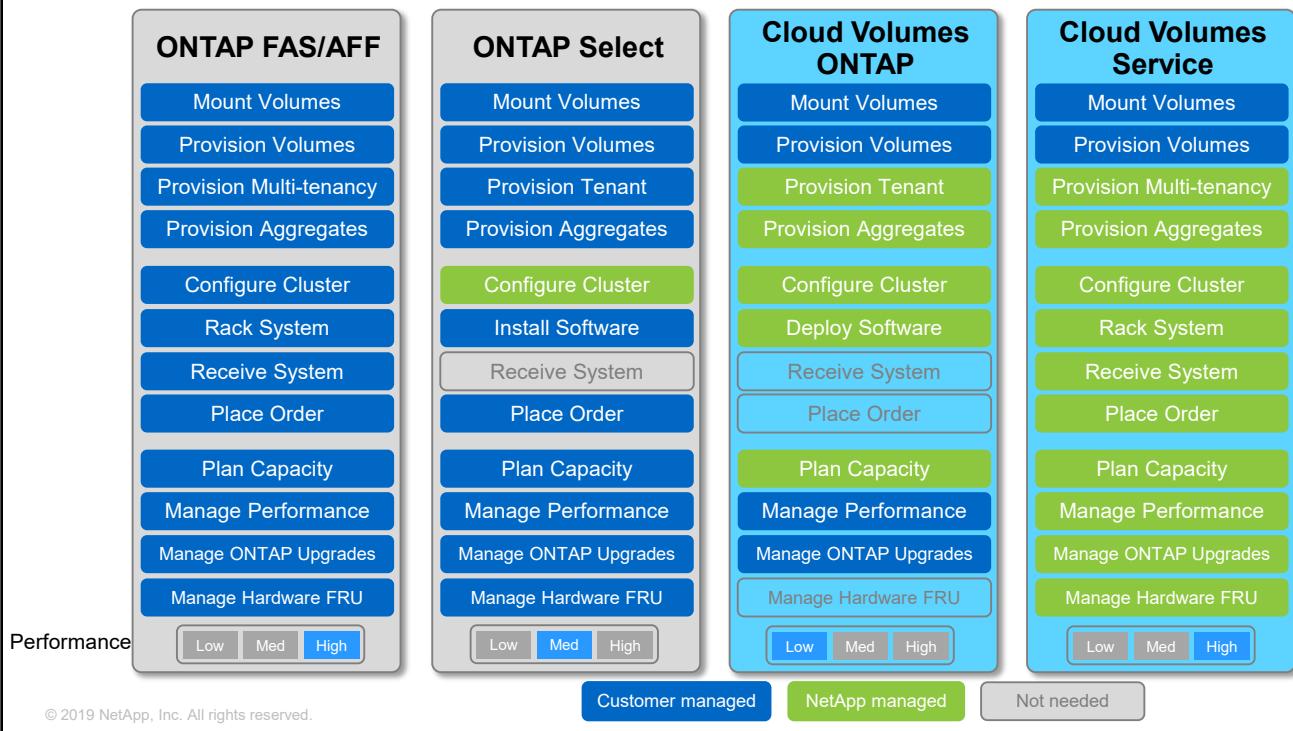
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One consideration that should not be overlooked is the skills that are required to manage the storage.

Some organizations might have storage administrators, or application administrators that perform storage administration. Other organizations might not have those resources available. For example, a developer might simply need a volume to store application data on, without the costs associated with hardware or IT. With a NetApp-managed service like Cloud Volumes Service or Azure NetApp Files, the developer achieves that goal with all the robust features of ONTAP software.

For other organizations with skilled resources, Cloud Volumes ONTAP might be more desirable. Alternatively, the organization might use a mix of both types, depending on the situation.

Moving to simplify and scale management tasks



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Cloud Data Services

Cloud Analytics	Cloud Insights				
Cloud Controls	OnCommand Cloud Manager	APIs	NetApp Kubernetes Service		
Data Services	Cloud Sync Service	Cloud Tiering	Cloud Secure	SaaS Backup	Cloud Backup Service
Cloud Storage	Cloud Volumes Service		Azure NetApp Files		Cloud Volumes ONTAP
Data Location	Private or Public Cloud AWS Google Cloud Azure		SaaS Application Office 365 Salesforce	On-Premises Data Center Service Provider	

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Cloud Sync Service

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Cloud Sync Service

Automate data migration processes, on-premises or to the cloud

Best for:

- Rapid and secure data migration and synchronization across any source and target
- Continuous synchronization of large workloads while maintaining immediate data access
- Onboard cloud environments converting and copying your file-based datasets to the public cloud of your choice



Secure, fast, automated data synchronization



Continuous, automated data synchronization

Extremely fast data movement compared to other synchronizing solutions that only move deltas



Delivery assurance based on built-in data protection

Secure data storage and transport with support for VPN and Virtual Private Cloud



Flexible on-demand consumption

Ability to purchase directly or from the AWS marketplace, licensed or pay-as-you-go model



Ability to bring your data center and the cloud together

Ability to realize the power of the Data Fabric with the ability to get your data where you want, when you want, and in any format

Cloud Sync Service

Synchronize on-premises and cloud storage NAS and object stores



Ways to Use Cloud Sync Service

- Run analytics services in the cloud by using Elastic Map Reduce, Redshift, Insights, and so on
- Create data lakes in Amazon Simple Storage Service (Amazon S3 or S3)
- Synchronize data that was “born in the cloud” to your private cloud
- Create data migration to S3 from Cloud Volumes ONTAP environments
- Create data migration to the cloud volumes



Cloud Tiering

Preview Mode

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What Is Cloud Tiering?

- SaaS offering based on NetApp FabricPool technology
- Intelligent tiering of cold data from on-premises AFF systems to object storage in the cloud

Hot data can be cost efficiently maintained in high-performance storage in the data center.

When the cold data is needed again, the service automatically and seamlessly brings it back to the high-performance tier.

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Cloud Tiering

Reduce storage costs by automatically tiering infrequently used data to object storage in the cloud. Cloud Tiering enables you to provide high-performance storage for a larger set of applications at a lower cost.

Key Features

- Lower Costs

Tier most of your data to low-cost object storage in the cloud

- High Performance

Retain high performance for your frequently used data

- Storage Agility

Pay for only the cloud object storage that you consume

- Resources Optimization

Make high-performance storage available for more workloads

- Smart Management

Experience automatic, seamless transfers between the performance and cloud tiers

- Configurable Policies

Modify cooling periods and tiering policies according to your data requirements



SaaS Backup

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SaaS Backup

Guard your SaaS data from threats or accidental deletion

Best for:

- Extending Office 365 and Salesforce data protection with granular backup and restore
- Meeting regulatory compliance with long-term retention and choice of backup targets
- Protecting and recovering all email, calendar, contacts, tasks, site collections, lists, and files



SaaS Backup for Microsoft Office 365 and
SaaS Backup for Salesforce



Provides a secure, web-based SaaS offering

Microsoft Office 365 or Salesforce accounts with encryption for data at rest and in flight



Protects and manages backups

Microsoft Exchange Online, Microsoft OneDrive for Business, SharePoint Online, Groups, Teams, and Salesforce



Uses cloud or on-premises backup targets

NetApp-managed S3 or Azure Blob accounts or Bring Your Own Storage (BYOS) cloud or on-premises storage

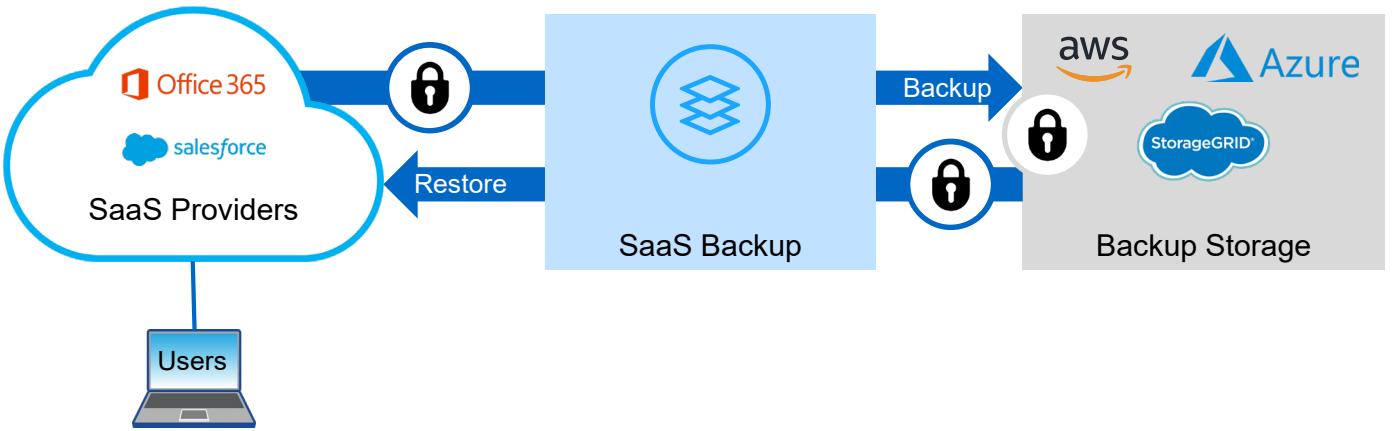


Now supports shared mailboxes for Microsoft Office Exchange Online

Automated discovery and protection

SaaS Backup

Overview

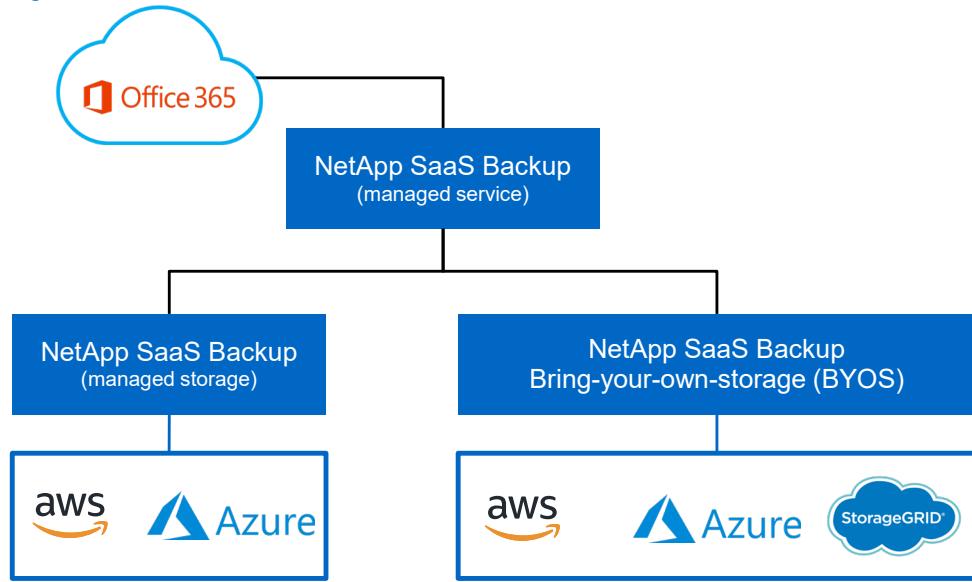


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SaaS Backup for Microsoft Office 365

Choosing backup storage



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Cloud Secure

Preview Mode

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What Is Cloud Secure?

- Identifies malicious data access and compromised users
- Provides centralized visibility and control of all corporate access across hybrid cloud environments
- Ensures that security and compliance goals are met



Cloud Backup Service

Preview Mode

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Cloud Backup Service

Fully managed data protection service for Cloud Volumes Service

A fully managed data protection service for NetApp
Cloud Volumes Service



Scheduled and Manual
Backup of Volumes



Volume Restores



Backup data stored
in AWS object storage

Cloud Backup Service



Integrated with NetApp
Cloud Volumes Service
for AWS (beta)

Future possible feature in the following:

- Azure NetApp Files
- Cloud Volumes Service for Google Cloud Platform



Hands-On Activity

Module 1: Data Fabric Overview

Exercise 1: Control Cloud Resources with Windows PowerShell and the CLI

This exercise requires approximately **30 minutes**.

ACTION: Share Your Experiences

Roundtable questions for the exercise



- Which credentials do you supply to run the AWS CLI and Windows PowerShell commands?
- Can you run all Windows PowerShell commands in the library? How can you limit a user from running certain commands?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.

Cloud Controls

Cloud Analytics	Cloud Insights				
Cloud Controls	OnCommand Cloud Manager	APIs	NetApp Kubernetes Service		
Data Services	Cloud Sync Service		Cloud Tiering	Cloud Secure	SaaS Backup
Cloud Storage	Cloud Volumes Service		Azure NetApp Files	Cloud Volumes ONTAP	
Data Location	Private or Public Cloud AWS Google Cloud Azure		SaaS Application Office 365 Salesforce	On-Premises Data Center Service Provider	

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OnCommand Cloud Manager

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OnCommand Cloud Manager

Simple deployment and management suite for Cloud Volumes ONTAP

- Enjoy an intuitive UI
- Deploy Cloud Volumes ONTAP instances in minutes
- Manage your data replication from the data center to the cloud
- Experience data security choice through NetApp managed encryption
- Use hybrid environments that include Cloud Volumes ONTAP and physical ONTAP systems

The screenshot displays the OnCommand Cloud Manager web interface. At the top left, there's a 'Working Environments' section showing four environments: 'FinanceOnPrem' (6.16 TB), 'FinanceOnCloud' (8.25 TB), 'Sales' (0.48 TB), and 'Marketing' (5.68 TB). Below this is a 'Replication Status' section with summary metrics: 2 Volume Relationships, 2.30 MB Replicated Capacity, 0 Currently Transferring, 2 Healthy, and 0 Failed. A search bar shows '2 relationships'. The main table lists two replication relationships:

Source	Target	Lag Duration	Relationship Health	Status	Mirror State	Last Successful Transfer	Policy	Schedule
Vol54 FinanceOnPrem	Vol54_copy Lab	5 minutes	Healthy	idle	snapmirrored	Feb 3, 2016 02:50:08 pm	Mirror	5min
Vol54 FinanceOnPrem	Vol54_copy Marketing	A few seconds	Healthy	idle	snapmirrored	Feb 3, 2016 02:55:01 pm	Mirror latest Snapshot co...	5min

To the right, a modal window titled 'Drag & Drop to replicate volumes' shows a source volume being moved to a target volume.

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OnCommand Suite of Tools

Simple deployment and management suite for ONTAP software in private data centers

- System Manager
- Unified Manager
- Workflow Automation
- API Services
- Insight



APIs

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API Documentation

[LEARN HOW TO AUTHENTICATE](#)

NetApp Cloud Central

Integrated hub for development information, help, documentation and launching services from NetApp Cloud Central.

[View API Documentation](#)

Cloud Volumes Service for AWS

A cloud native file service that provides NAS volumes over NFS and SMB with all-flash performance.

[View API Documentation](#)

Cloud Volumes ONTAP

A powerful, cost-effective and easy-to-use solution for enterprise cloud storage.

[View API Documentation](#)

Cloud Sync

NetApp's service for rapid and secure data synchronization.

[View API Documentation](#)

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NetApp Cloud Central API

Server

<https://api.services.cloud.netapp.com> ▾

[LEARN HOW TO AUTHENTICATE](#)

Account

Operations related to the account/profile of the logged in user

POST </portal/update-user-info> Update a user's name

Notifications

Operations related to cross service notifications of the logged in user

GET </portal/notifications> List visible notifications (all those which have not been marked as deleted)

NetApp Cloud Central API

Expanding the POST command

The screenshot shows the API documentation for the `/portal/update-user-info` endpoint. The top navigation bar includes a 'Server' dropdown set to `https://api.services.cloud.netapp.com` and a 'LEARN HOW TO AUTHENTICATE' link. The main content area is titled 'Account' with the subtitle 'Operations related to the account/profile of the logged in user'. The `POST` method is selected. The endpoint URL is `/portal/update-user-info` with the description 'Update a user's name'. The 'Parameters' section indicates 'No parameters'. The 'Request body' section is marked as 'required' and contains the following JSON schema:

```
{ "user_name": "string" }
```

The 'Responses' section shows a single response entry for code 204 with the description 'Successful operation - No Content'. A 'Links' section is partially visible on the right. Three blue arrows point from left to right across the interface, highlighting the 'Try it out' button, the request body example, and the responses section.

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NetApp Kubernetes Service

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Concepts

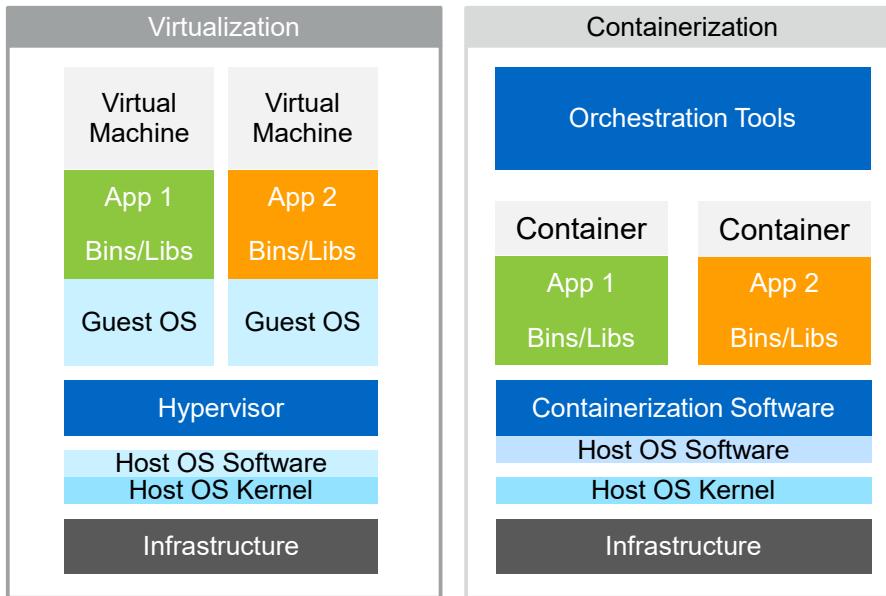


Containerization



Orchestration

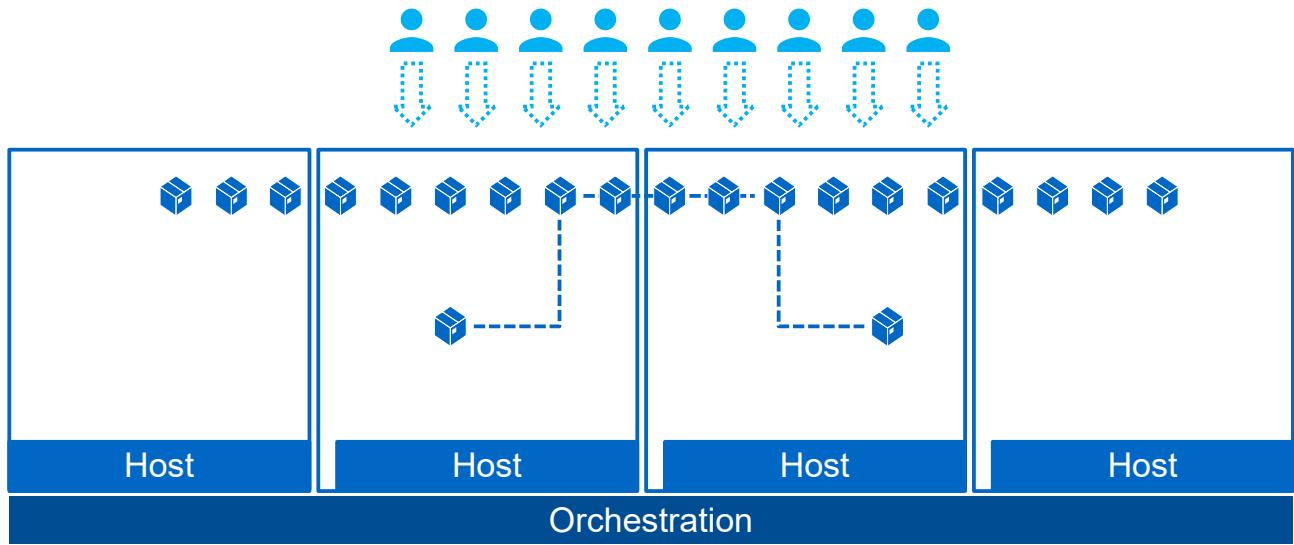
Containerization



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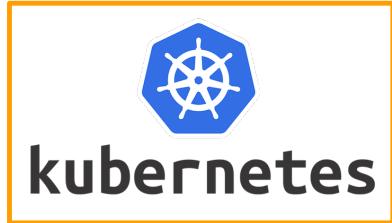
Container Orchestration



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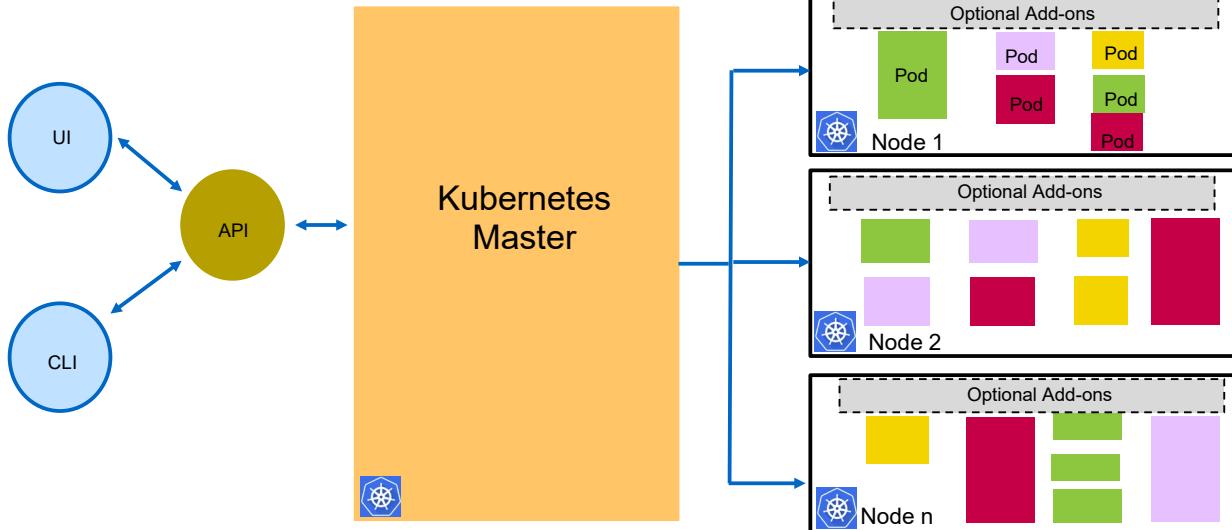
Container Orchestration Technologies



MESOS

- Deploy and Configure
- Fault Isolation and Healing
- Security
- Upgrades
- Scaling Up and Down

Kubernetes Architecture

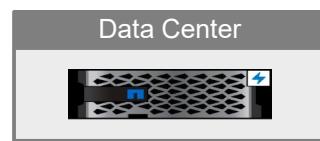


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NetApp Kubernetes Service

- A cloud-native managed service from NetApp
- The industry's first complete multicloud Kubernetes (K8s) control plane
- Simple, uniform user experience from a single pane of glass
- NetApp Trident dynamic storage provisioner for K8s clusters



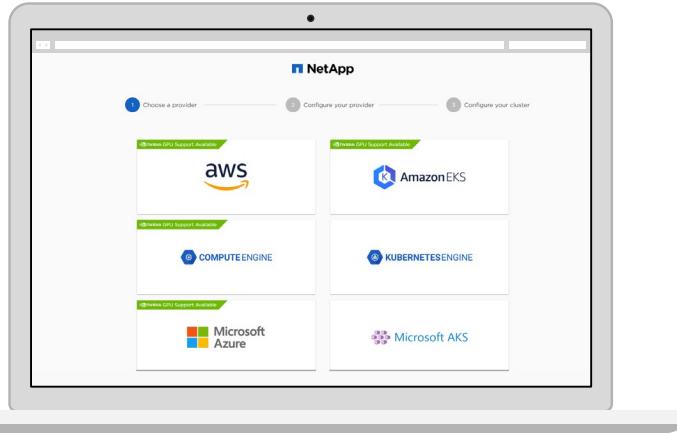
Other optional cloud native solutions like Istio and Helm are pre-installed.

NetApp Kubernetes Service

Capabilities

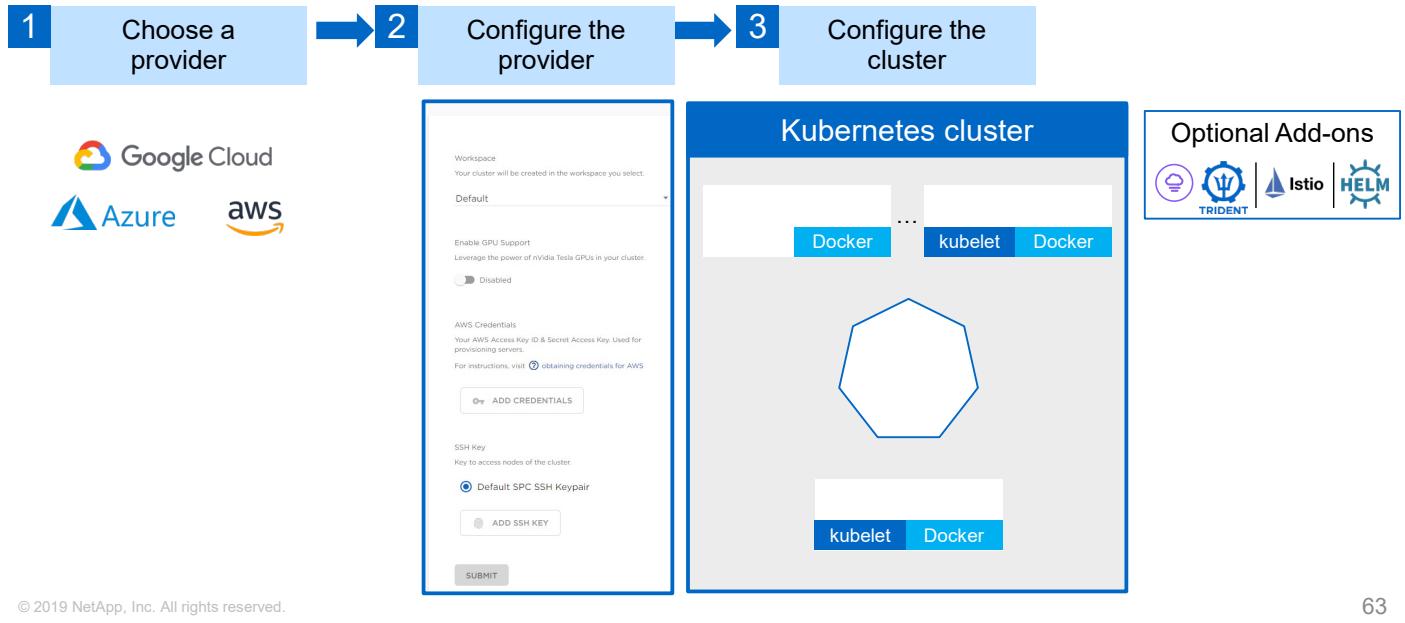
- Pure upstream Kubernetes service.
- You can federate K8s clusters across multiple hyper-scalers and on-premises.
- NetApp Kubernetes Service is the only current K8s service that supports Graphics Processing Unit (GPU) containers.
- ROI is delivered from a single developer to large enterprises.

NetApp Kubernetes Service at Cloud Central



Deploy a production-ready
Kubernetes cluster in three clicks,
when you want it, where you want it

NetApp Kubernetes Service



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Cloud Analytics

Cloud Analytics	Cloud Insights				
Cloud Controls	OnCommand Cloud Manager	APIs	NetApp Kubernetes Service		
Data Services	Cloud Sync Service		Cloud Tiering	Cloud Secure	SaaS Backup
Cloud Storage	Cloud Volumes Service		Azure NetApp Files		Cloud Volumes ONTAP
Data Location	Private or Public Cloud AWS Google Cloud Azure		SaaS Application Office 365 Salesforce	On-Premises Data Center Service Provider	

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Cloud Insights

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Cloud Insights

SaaS-based tool that monitors all your infrastructure assets

Best for:

- Monitoring cloud native applications that dynamically provision infrastructure through APIs
- Rapidly finding problems and reducing mean-time-to-resolution (MTTR)
- Optimizing cloud resources by understanding infrastructure relationships and usage
- Preventing critical infrastructure issues before they affect customers

Innovate faster with insights across your application infrastructure stack



Specifically for cloud application infrastructures

Analyzes dynamic cloud infrastructure at scale and supports micro-services, containers and Kubernetes



SaaS Development to get you up and running quickly

Uses agents to discover your infrastructure in minutes and begin monitoring



Advanced analytics

Provides proactive alerting, fast troubleshooting, and optimization of resources with recommended workload placements



Monitoring of all major vendors and cloud providers



Monitoring Tools



OnCommand
Insight



NetApp Cloud
Insights



NetApp
Active IQ

Location				Data collection built in to NetApp systems, analyzed by Active IQ in the cloud
Construct	Software license	Software as a service (SaaS)		
Monitors	Cloud and on-premises multivendor resources and infrastructure		NetApp systems	
Function	Monitoring and optimization for multivendor and multicloud infrastructure		Predictive optimization and support for NetApp systems	
Reporting	Dashboard and Reports	Dashboard	Dashboard	

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Hands-On Activity

Module 1: Data Fabric Overview

Exercise 2: Assess Azure and Amazon Web Services Environments

This exercise requires approximately **20 minutes**.



ACTION: Share Your Experiences

Roundtable questions for the exercise



- What types of issues can you discover with the Assessment tool?

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Focus of this Course

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Clouds and Cloud Data Services



Private Cloud

Cloud Analytics

Cloud Insights

Cloud Controls

NetApp Kubernetes Service

OnCommand Cloud Manager

OnCommand Cloud Manager

Data Services

SaaS Backup

SaaS Backup

SaaS Backup

Cloud Sync Service

Cloud Storage

Azure NetApp Files

Cloud Volumes Service
for Google Cloud Platform

Cloud Volumes Service
for AWS

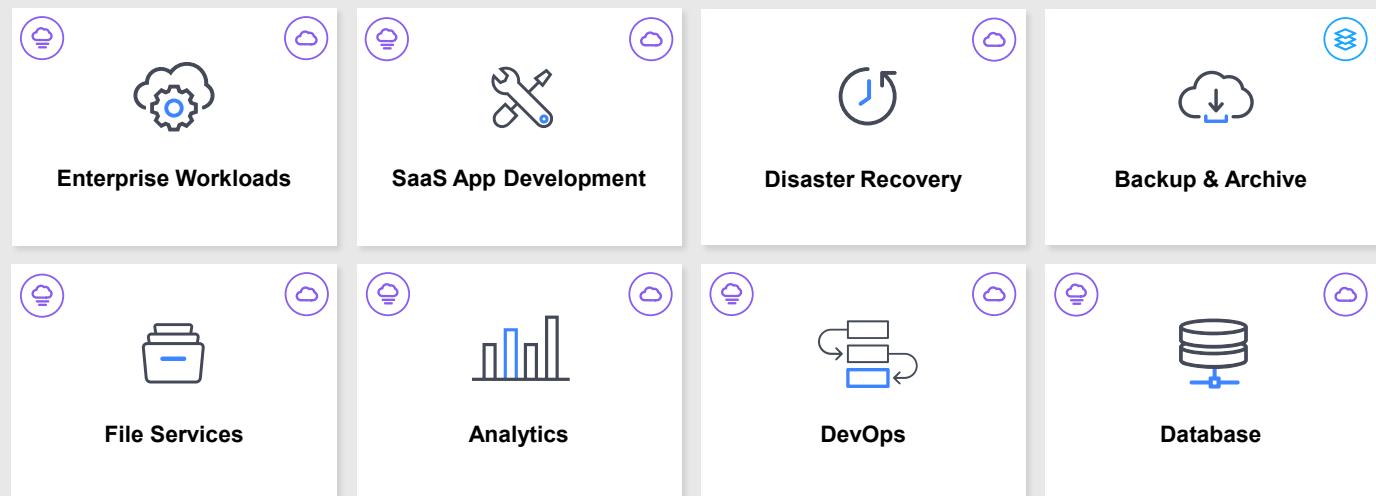
Cloud Volumes ONTAP

Cloud Volumes ONTAP

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Focus of Exercises



Cloud Volumes Service



Cloud Volumes ONTAP



SaaS Backup

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Module Review

- The Data Fabric powered by NetApp provides customers with a shared set of secure data services so that they can manage, access, and protect data where it is needed most.
- NetApp, as a data management company, provides many cloud data services for Data Fabric solutions to empower the cloud champions.
- The OnCommand suite of management products enables management of data in a hybrid cloud environment.
- You can use Windows PowerShell and role-based access control (RBAC) to automate and appropriately administer your hybrid cloud environment.



Module 2

Amazon Web Services Virtual Private Cloud and Connectivity to Other Networks

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1



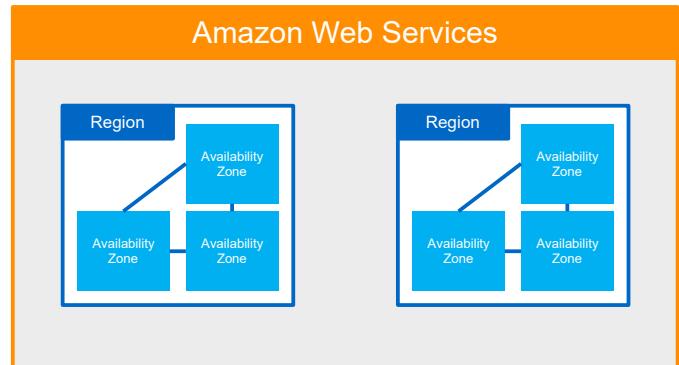
About This Module

This module focuses on enabling you to do the following:

- Configure an Amazon Web Services (AWS) Virtual Private Cloud (VPC) and network resources such as subnets, security groups, and route tables
- Describe AWS connection options, including Direct Connect and VPN
- Configure an AWS VPN connection to an on-premises data center

Regions and Availability Zones

- Amazon Elastic Compute Cloud (Amazon EC2) is hosted in multiple locations worldwide.
- Each region is a separate geographic area.
- Each region has multiple, isolated locations known as Availability Zones.
- Each region is independent.
- Each Availability Zone is isolated, but Availability Zones in a region are connected through low-latency links.



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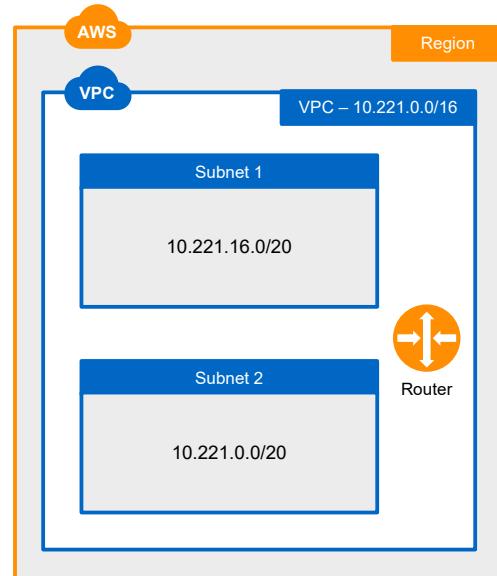
Regions

Each Amazon EC2 region is isolated from the other Amazon EC2 regions. This isolation achieves the greatest possible fault tolerance and stability. When you view your resources, you see only the resources that are tied to the region that you specified. Regions are isolated from each other, and resources do not replicate across regions automatically.

If you distribute your instances across multiple Availability Zones and one instance fails, you can design your application so that an instance in another Availability Zone can manage requests.

VPC

- VPC is a virtual network dedicated to your AWS account.
- Your VPC is logically isolated from other virtual networks in AWS.
- It is defined by a range of IP addresses.
- You launch AWS instances into your VPC.
- It contains subnets and other networking resources (route tables, gateways, and security settings).



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A VPC is a virtual network dedicated to your AWS account. It is logically isolated from other virtual networks in the AWS cloud. You can launch your AWS resources, such as Amazon EC2 instances, into your VPC. You can configure your VPC. You can select its IP address range, create subnets, and configure route tables, network gateways, and security settings.

When you create a VPC, you must specify a range of IPv4 addresses for the VPC in the form of a Classless Inter-Domain Routing (CIDR) block, for example, 10.0.0.0/16. This block is the primary CIDR block for your VPC.

Subnet and Route Tables

- A subnet is a range of IP addresses in your VPC.
- You launch AWS resources (for example, Amazon EC2 instances) into the subnet of your choice.
- You use a public subnet or private subnet:
 - Public for resources that need internet connections (through the internet gateway)
 - Private for resources that do not need or should not be accessed directly from the internet
- Each subnet must be associated with a route table for outbound traffic.
- In a route table, each route specifies a destination Classless Inter-Domain Routing (CIDR) and a target.

Route Table	
Destination	Target
10.221.0.0/16	Local
0.0.0.0/0	IGW

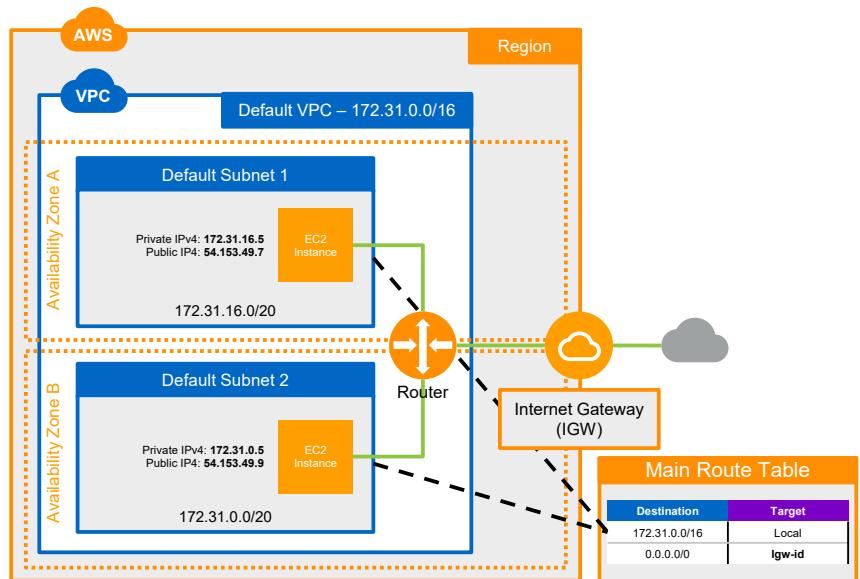
Example route table

IGW: internet gateway

Internet Gateway

Public subnet

- The default VPC includes an internet gateway. Each default subnet is a public subnet.
- Each instance that you launch into a default subnet has a private IPv4 address and a public IPv4 address.
- These instances communicate with the internet through the internet gateway.
- Each region has multiple, isolated Availability Zones.



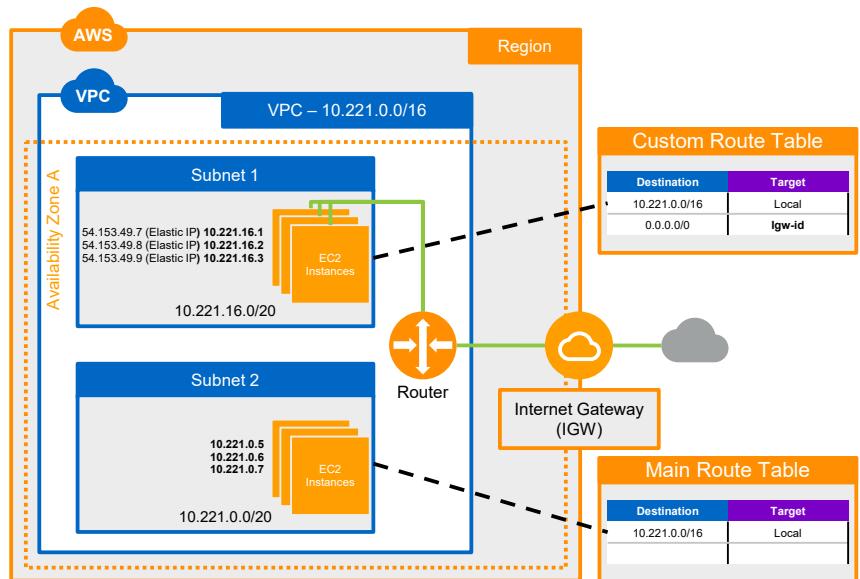
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Nondefault Subnet

Private subnet

- By default, each instance that you launch into a nondefault subnet has a private IPv4 address but no public address.
(See Subnet 2 in the diagram.)
- Instances can communicate with each other, but they cannot access the internet.
(See the main route table in the diagram.)



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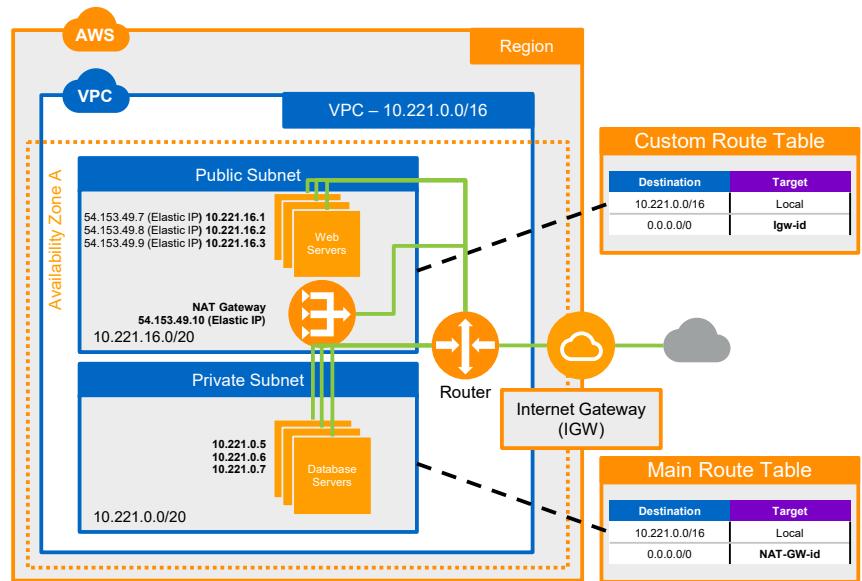
7

If you create any subnets other than the one that is in the default VPC, it is private unless you specifically add an internet gateway to it.

Network Address Translation

Private subnet

- To get internet access in the private subnet, you can set up a network address translation (NAT) device in the public subnet.
- You can add a route to the NAT gateway in the private subnet route table.



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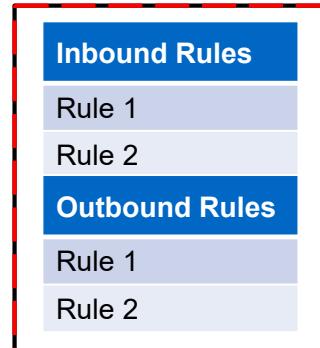
The NAT device sits in the public subnet, and the private subnet route table has an outbound route destination to the NAT device.

Virtual Private Gateway

- By default, instances that are launched in a VPC cannot communicate with outside networks.
- A virtual private gateway (VGW) is the VPN concentrator on the Amazon side of a connection to an external network.
- You can enable access from external networks by attaching a VGW to the VPC.
 - You must update route tables.
 - You might need to update security groups.

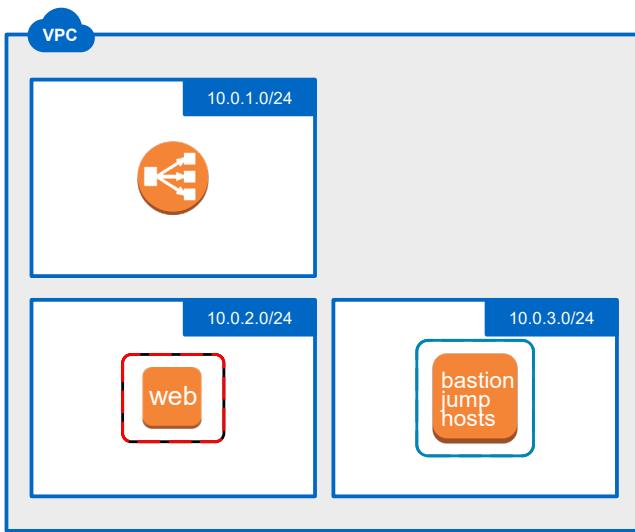
Security Groups

- Security groups form a virtual firewall that controls traffic for instances (Amazon EC2). (These groups are applied at the instance level.)
- You add rules to enable traffic.
- They support inbound and outbound rules.
- By default, outbound rules enable all traffic.
- Rules are permissive and state what you enable. There are no deny rules.



Security Groups

Example



Security Group: web

Rules:

Accept port 80 from load balancers.

Allow Secure Shell (SSH) from only bastion jump hosts.

Type <small>i</small>	Protocol <small>i</small>	Port Range <small>i</small>	Source <small>i</small>
HTTP	TCP	80	10.0.1.0/24
SSH	TCP	22	<input type="checkbox"/> sg-9ceaa8fb (Bastion jump host SG)

Security Group: bastion jump hosts

Network Access Control Lists

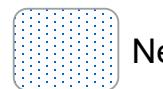
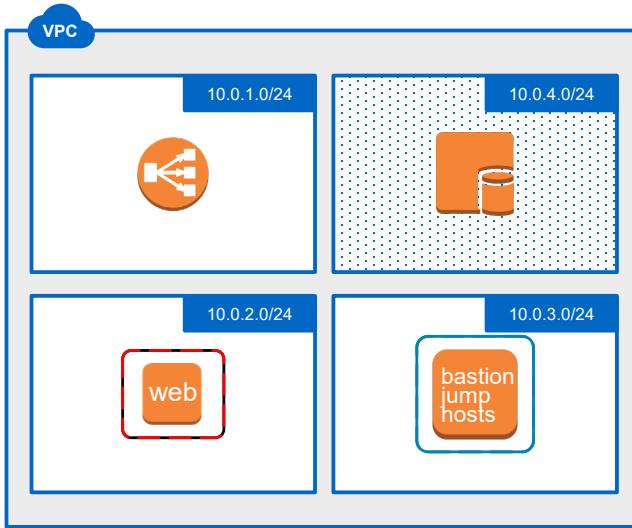
- Network access control lists (ACLs) are an optional layer of security that acts as a firewall at the subnet level.
- A VPC comes with a default network ACL that enables all traffic.
- You can create custom network ACLs. By default, they automatically deny all traffic.
- A network ACL has separate inbound and outbound rules.

Rule #	Type	Protocol	Port Range	Source	Allow / Deny
100	ALL Traffic	ALL	ALL	0.0.0.0/0	ALLOW
*	ALL Traffic	ALL	ALL	0.0.0.0/0	DENY

The illustration shows default inbound rules that enable all traffic.

Network ACL

Example



Network ACL

Deny all traffic between the web server subnet and the database subnet.

Rule #	Type	Protocol	Port Range	Source	Allow / Deny
10	All Traffic	All	All	10.0.2.0/24	DENY
100	All Traffic	All	All	0.0.0.0/0	ALLOW
*	All Traffic	All	All	0.0.0.0/0	DENY

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In this example, there is a database subnet that should never be directly accessed from web servers that are in the 10.0.2.0/24 subnet. You can add a DENY rule to prevent any communication with that subnet (as is shown in this example).

Comparison of Security Groups and Network ACLs

Security Group	Network ACL
Operates at the instance level	Operates at the subnet level
Supports only allow rules	Supports allow and deny rules
Is stateful: Return traffic is automatically allowed.	Is stateless: Return traffic must be explicitly allowed by rules.
Evaluates all rules before deciding to allow	Processes rules in number order
Applies to an instance only if the security group is specified during instance launch or is explicitly associated later	Automatically applies to all instances in the subnet

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AWS Storage

- Amazon Elastic Block Storage (Amazon EBS) provides block level storage for use with Amazon EC2.
 - Has a range of performance and media types (for example, gp2: General Purpose SSD, st1: Throughput Optimized HDD)
 - Is attached to Amazon EC2 instances and exposed as storage volumes
 - Persists independently from the Amazon EC2 instance
 - Is good for file systems, databases, and throughput intensive apps
- Amazon Simple Storage Services (Amazon S3 or S3) is characterized by the following:
 - A repository for internet data
 - Inexpensive
 - Object based
 - Used for Amazon EC2 instance snapshots



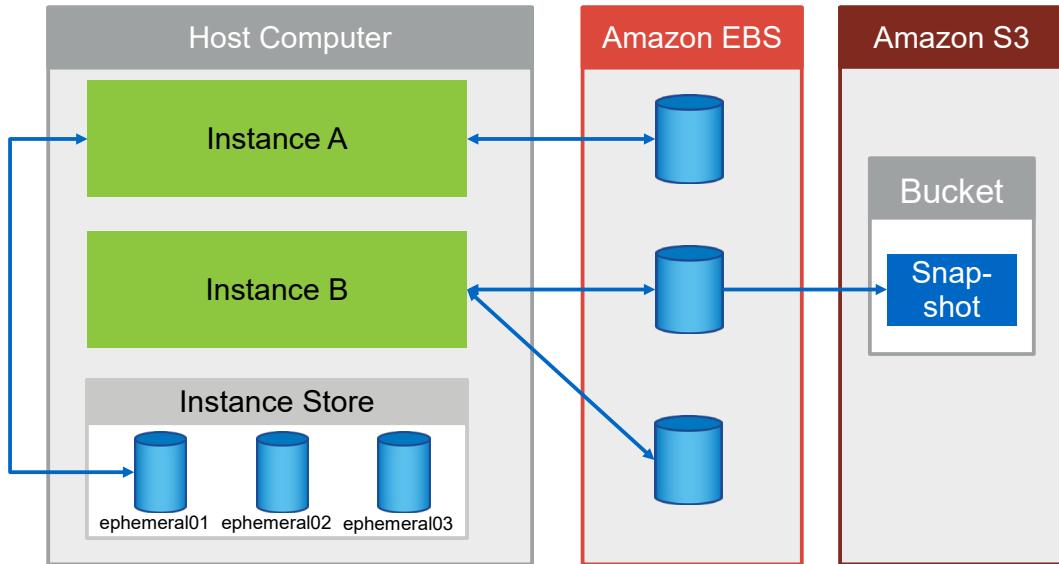
Amazon S3

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For further details about more AWS storage types, see
<http://docs.aws.amazon.com/AWSEC2/latest/UserGuide/Storage.html>

AWS Storage and Amazon EC2 Relationships



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When you shut down an Amazon EC2 instance, the ephemeral storage is lost, but if you have EBS storage, it is persistent.

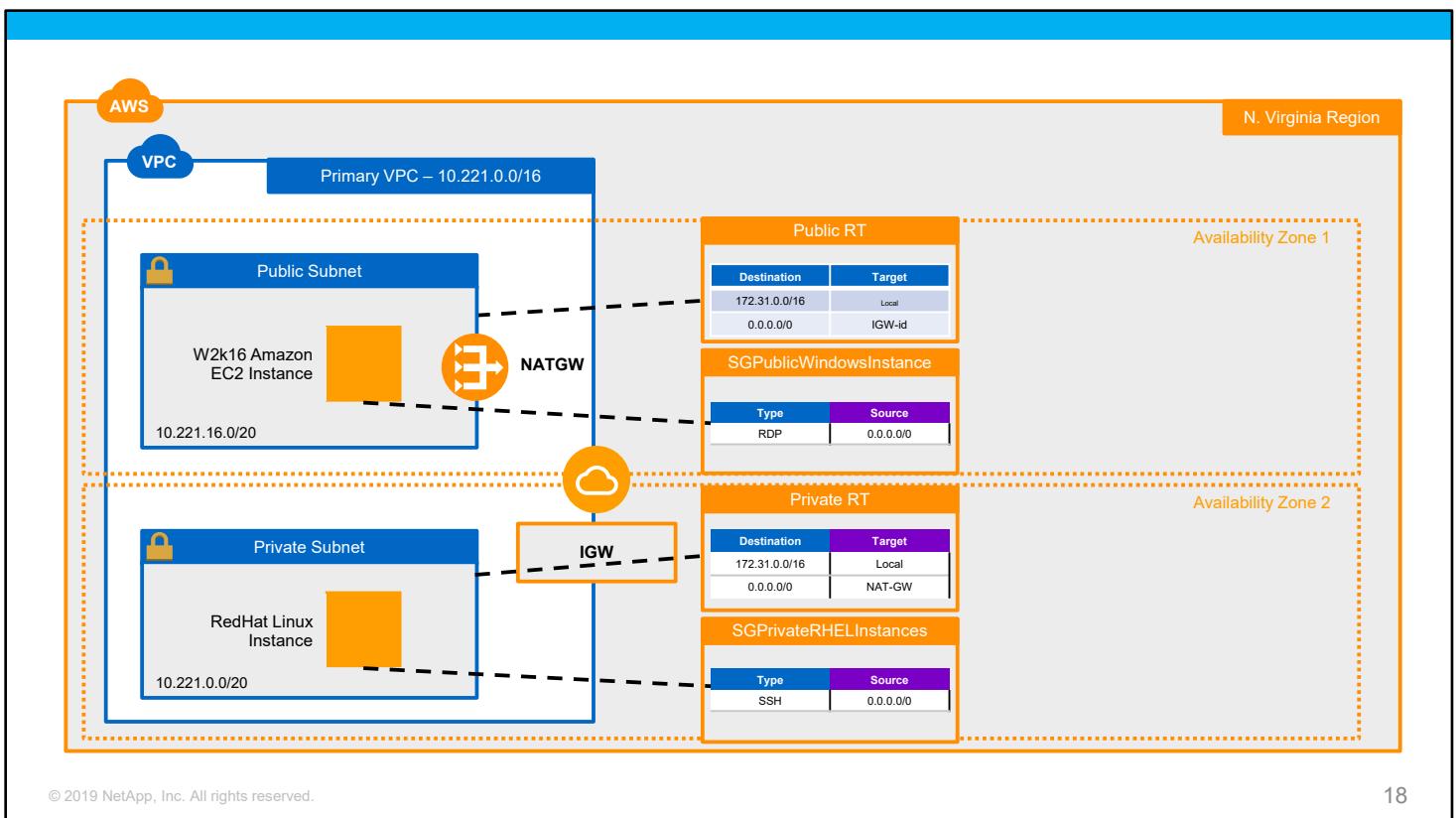


Hands-On Activity

Module 2: Amazon Web Services Virtual Private Cloud and Connectivity to Other Networks

Exercise 1: Configure Amazon Web Services Virtual Private Cloud Resources

This exercise requires approximately **45 minutes**.



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ACTION: Share Your Experiences

Roundtable questions for the exercise



- With which AWS network elements are route tables associated?
- What did you need to configure to enable the Amazon EC2 instances in the private subnet to access resources in the internet?
- With which AWS element are security groups associated?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.

AWS: User Access Key Versus Instance Private Key Files

User Access Key	
 Purpose:	
<ul data-bbox="210 487 360 646" style="list-style-type: none"><li data-bbox="210 487 360 523">▪ Check who sent an API request<li data-bbox="210 538 360 606">▪ Determine whether this user is enabled to perform an action	
This Scope is at the user level for AWS commands	
 Credentials.csv	<p data-bbox="501 684 729 696">Access key ID:</p> <p data-bbox="501 701 729 713">AKIAIT5U7QRUT4CFIFA</p> <p data-bbox="501 764 729 777">Secret access key</p> <p data-bbox="501 781 729 794">LG1IVh5TfbHCYSKZ2D1cqUI</p>

Instance Private Key

Purpose:

- Decrypt login information

This Scope is at the instance level for



Key_File.pem

```

1 -----BEGIN RSA PRIVATE KEY-----
2 MIGfMA0GCSqGSIb3DQEJARYQ/BKjC9MWSsXyLFWpkaMuIV5gC5CKQfsgACT4QRJUGpmSpisYmfuUqlgPi
3 Wbwh1+Kc7ryzr39/ROLmLwvVUOPc1an1t76t/3QDKxuVveMEjFWTQFrlyNPvB1mNj73838eBe
4 usFmufmyRv2z1lOchbFlfaqsgpVbNt10hCSTV0v2536d5JgBNHs6WwqrWtck-imQj9Lflon1PTXX
5 qhTix1/ivL+4uiepl1f3OpCVXxMvq6wFH4n1d13Bd72Egk+05BG0zSQRGw+3zHewPwv/gQWBA
6 BpqrsQ5c2Zc1Zc27MWhTEs-ciosLMwv34Cz1McnaRo-0t9WmIDAQABMI3AGdw15cBcq
7 gBqprQ5c2Zc1Zc27MWhTEs-ciosLMwv34Cz1McnaRo-0t9WmIDAQABMI3AGdw15cBcq
8 mKU4Y23x9YBQVxp8/K18bdFj3rt2zJ13d842Gp2Fjhs7uscpzbYkalcwv8j3u3/kPfrhQO
9 lAxUUTb/X0uevFkFVRFkShs5hV3pCSFxbMyztvpuPej6RhNu0v1z5kx4jgpTrLh+4P7z1
10 YGKz2yHH-lvrkTrST0nMojeHy5BzNenKz/Huh3acHeXsMyzdRF4JpV13//Hgj2gOxCPsA
11 hCpQMFWSERQSAde5bs/yeq1l8wEcqYEAlyFZgnDh/bQo1l6e1HSvFHaGjssSgfkLjuoepd10R

```

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AWS CloudFormation

- Create and provision AWS infrastructure deployments
 - Predictable
 - Repeatable
- Use a template file
 - Create and delete a collection of resources
 - Use as a single unit (a stack)
- Build applications in the cloud that have these characteristics:
 - Highly reliable
 - Highly scalable
 - Cost-effective

There is no need to worry about creating and configuring underlying infrastructure.

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AWS CloudFormation is a service that helps you to model and set up your AWS resources so that you can spend less time managing those resources and more time focusing on your applications that run in AWS. You create a template that describes all the AWS resources that you want (like Amazon EC2 instances or Amazon Relational Database Service [Amazon RDS] database instances). AWS CloudFormation takes care of provisioning and configuring those resources for you. You do not need to individually create and configure AWS resources and figure out what depends on what. AWS CloudFormation manages everything.

AWS CloudFormation Concepts

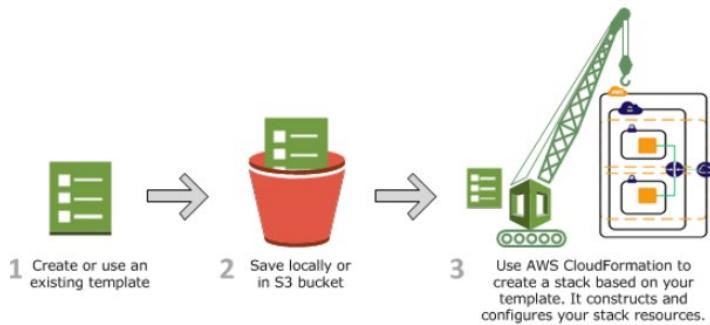
When you use AWS Cloud Formation, you work with the following:

- **Templates**

- You create templates to describe AWS resources and their properties.

- **Stacks**

- Whenever you create a stack, AWS CloudFormation provisions the resources that are in the template.



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Templates:

An AWS CloudFormation template is a JSON or YAML formatted text file. You can save these files with any extension, such as .json, .yaml, .template, or .txt. AWS CloudFormation uses these templates as blueprints for building your AWS resources. For example, in a template, you can describe an Amazon EC2 instance, such as the instance type, the AMI ID, block device mappings, and its Amazon EC2 key pair name.

Stacks:

When you use AWS CloudFormation, you manage related resources as a single unit called a stack. You create, update, and delete a collection of resources by creating, updating, and deleting stacks. All the resources in a stack are defined by the stack's AWS CloudFormation template. Suppose that you created a template that includes an Auto Scaling group, Elastic Load Balancing load balancer, and an Amazon RDS database instance. To create those resources, you create a stack by submitting the template that you created, and AWS CloudFormation provisions all those resources for you. You can work with stacks by using the AWS CloudFormation console, API, or AWS CLI.

Template Anatomy

```
{  
  "AWSTemplateFormatVersion" : "version date",  
  "Description" : "JSON string",  
  "Metadata" : { template metadata },  
  "Parameters" : { set of parameters },  
  "Mappings" : { set of mappings },  
  "Conditions" : { set of conditions },  
  "Transform" : { set of transforms }  
  "Resources" : { set of resources },  
  "Outputs" : { set of outputs }  
}
```

```
"Resources" : {  
  "Logical ID" : {  
    "Type" : "Resource type",  
    "Properties" : {  
      Set of properties  
    }  
  }  
}
```

Resources section is
the only required
section.

AWS CloudFormation Template

A template that creates a VPC: JSON syntax

```
{  
  "Description" : "A template to create a VPC",  
  "Resources": {  
    "PrimaryVPC": {  
      "Type": "AWS::EC2::VPC",  
      "Properties": {  
        "CidrBlock": "10.221.0.0/16",  
        "Tags": [{"Key": "Name", "Value": "PrimaryVPC"}]  
      }  
    }  
  }  
}
```

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You can design an AWS CloudFormation template (a JSON-formatted or YAML-formatted document) in AWS CloudFormation Designer or write one in a text editor. You can also choose to use a provided template. The template describes the resources that you want and their settings. For example, suppose that you want to create an Amazon EC2 instance. Your template can declare an Amazon EC2 instance and describe its properties, as shown in the example on the slide.

Create an AWS CloudFormation stack by specifying the location of your template file, such as a path on your local computer or an Amazon S3 URL. If the template contains parameters, you can specify input values when you create the stack. Parameters enable you to pass in values to your template so that you can customize your resources each time that you create a stack.

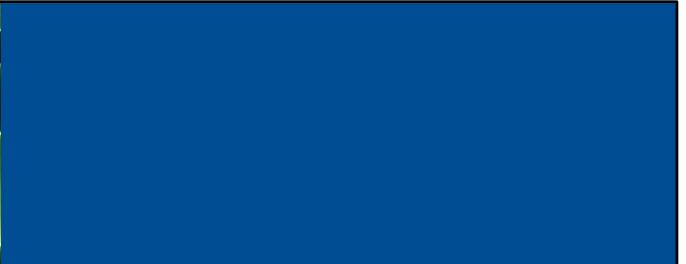
AWS CloudFormation Template

A template that creates an Amazon EC2 instance: JSON syntax

```
"WindowsPublicInstance": {  
    "Type": "AWS::EC2::Instance",  
    "Properties": {  
        "ImageId": "ami-0da19d4527d55af09",  
        "InstanceType": "t2.micro",  
        "NetworkInterfaces": [  
            {  
                "SubnetId": {"Ref": "PublicSubnet"},  
                "GroupSet": [{"Ref": "SGPublicWindowsInstance"}],  
                "AssociatePublicIpAddress": "true"  
            }  
        ]  
    }  
}
```

Referencing other
resources with their
logical ID

[AWS Resources and Property Types Reference](#)



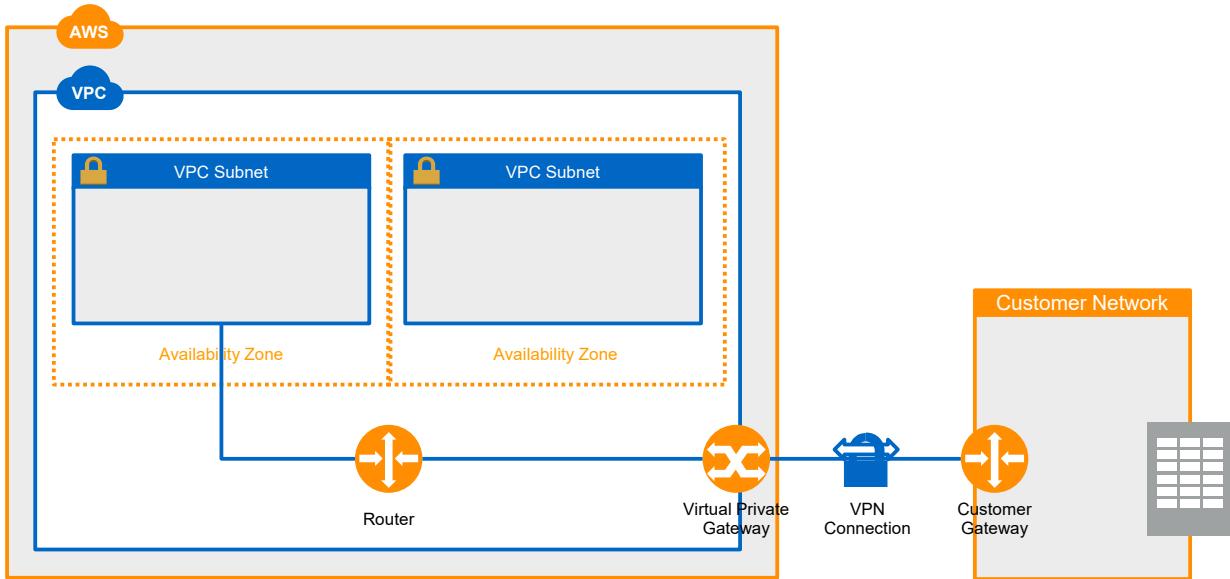
VPC Connectivity to Other Networks

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Connectivity to Private Networks

AWS VPN



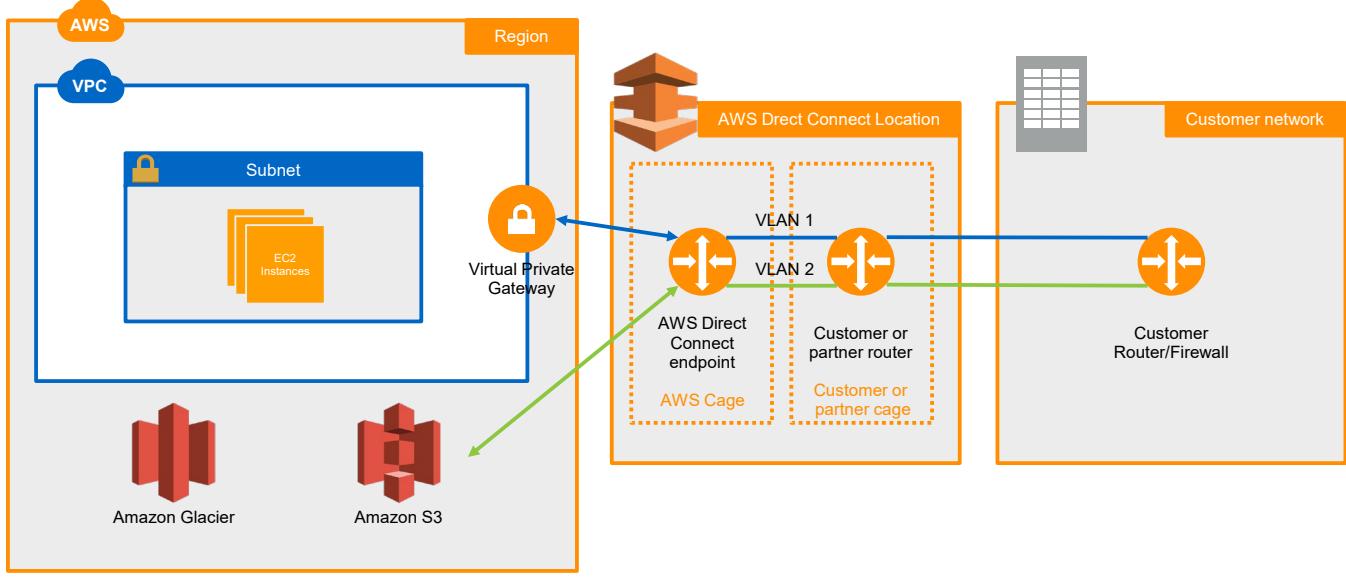
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This diagram illustrates a single VPN connection. The VPC has an attached virtual private gateway, and your network includes a customer gateway, which you must configure to enable the VPN connection. You set up the routing so that any traffic from the VPC that is bound for the customer network is routed to the virtual private gateway.

Connectivity to Other Peering Locations

AWS Direct Connect with Virtual Private Gateway



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■ Private virtual interface

■ Public Virtual interface

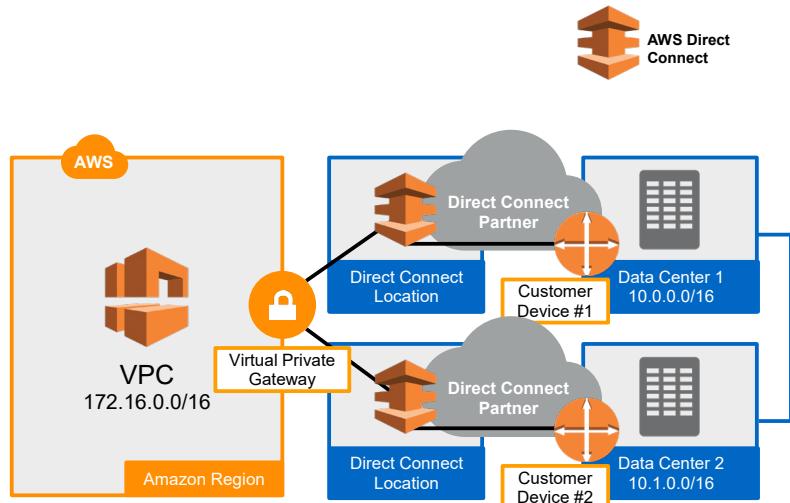
28

This diagram shows the options used for NetApp Private Storage (NPS). One of the frequently used AWS Direct Connect locations is Equinix.

NetApp Private Storage

Uses AWS Direct Connect

- AWS Direct Connect provides LAN-like bandwidth and latency between an AWS region and certain AWS peering locations.
- NetApp Private Storage (NPS) uses AWS Direct Connect.
- Workloads that read heavily from NPS but write minimally are less expensive than workloads that write large amounts of data to NPS from inside AWS.



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NetApp Private Storage (NPS) uses AWS Direct Connect.

Workloads that read heavily from NPS but write minimally are less expensive than workloads that write large amounts of data to NPS from inside AWS.

AWS Direct Connect is a private connection into a customer's VPC context inside AWS.

1Gbps and 10Gbps are standard speeds, but fractional speeds are also available.

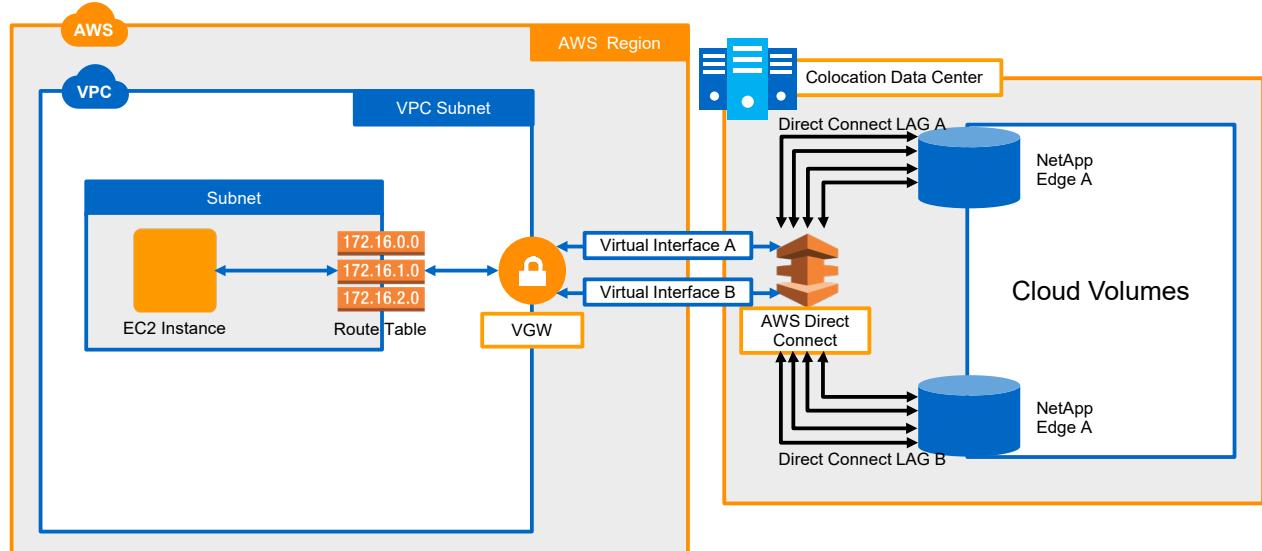
Customers are charged a per-hour fee for the circuit itself.

AWS does not currently charge ingress fees.

AWS data egress fees are lower than fees for VPN or the public internet.

NetApp Cloud Volumes Service

Connectivity by using AWS Direct Connect

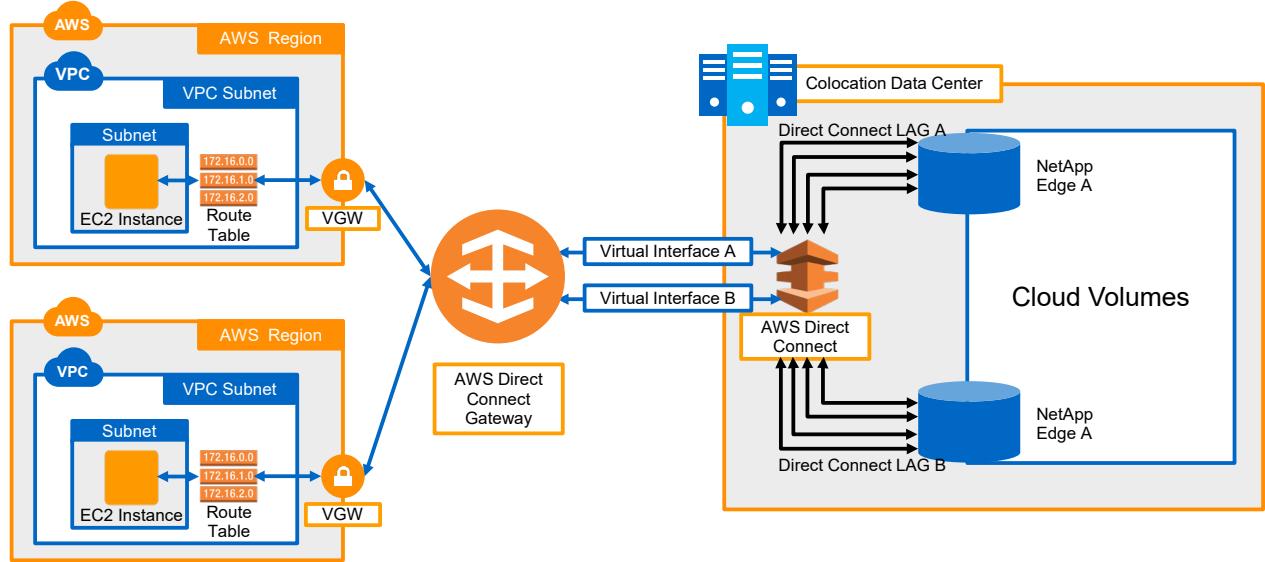


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AWS Direct Connect Gateway

AWS Direct Connect with Direct Connect gateway



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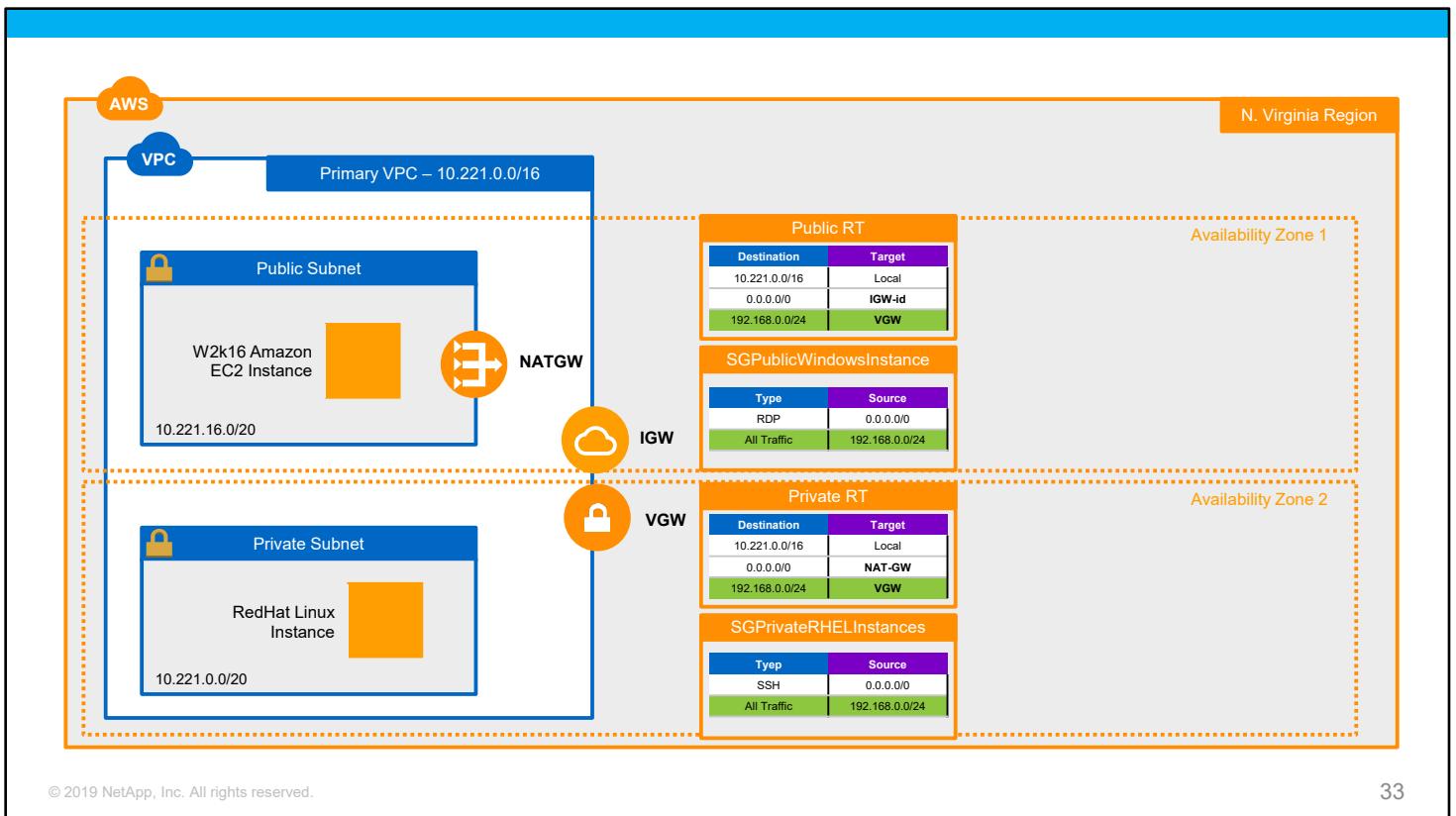


Hands-On Activity

Module 2: Amazon Web Services Virtual Private Cloud and Connectivity to Other Networks

Exercise 2: Operationalize On-Premises to Cloud Connectivity

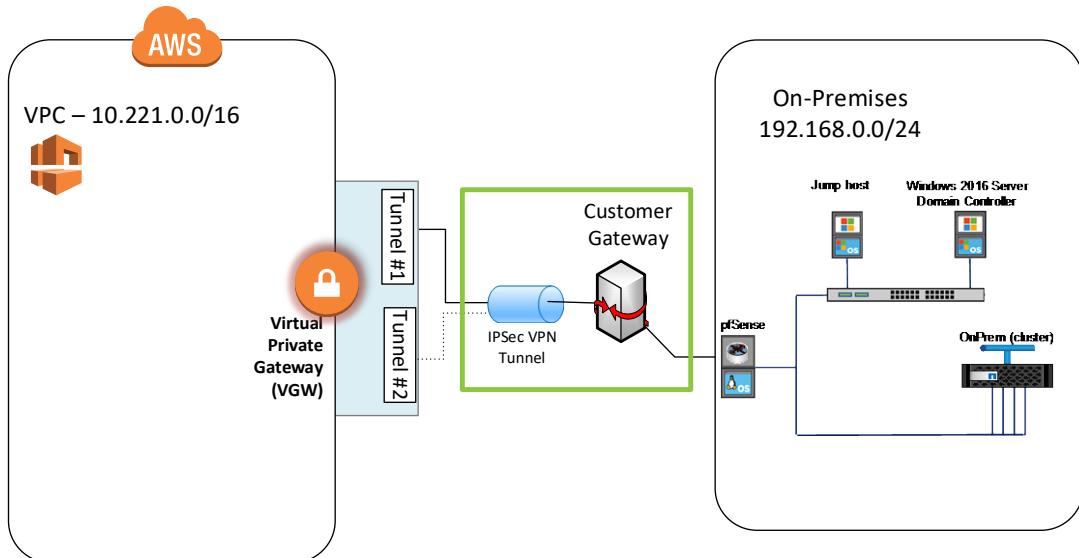
This exercise requires approximately **1 hour**.



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VPN Connections



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ACTION: Share Your Experiences

Roundtable questions for the exercise



- If you set up a second Internet Protocol security (IPsec) tunnel for your VPN connection, what kind of redundancy does that provide or not provide?
- What was the purpose of setting up the Dynamic Host Configuration Protocol (DHCP) option set?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.



Module Review

- In this module, you configured an AWS Virtual Private Cloud. You set up subnets, route tables, and security groups to create public and private subnets with proper connectivity to an on-premises data center.
- You also configured the AWS environment to be able to have virtual machine instances join the on-premises Active Directory domain.
- The environment is now ready to establish on-premises to cloud data management and mobility by using OnCommand Cloud Manager.

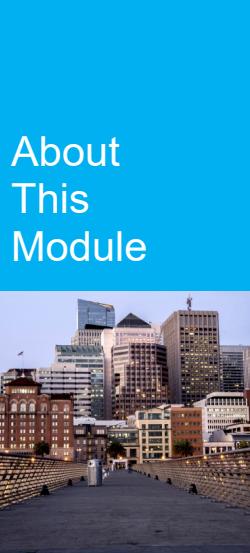


Module 3

NetApp Cloud Volumes ONTAP

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1



About This Module

This module focuses on enabling you to do the following:

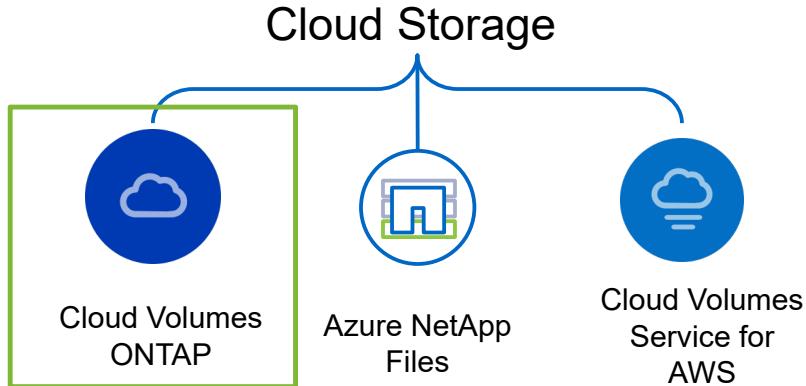
- Deploy and configure OnCommand Cloud Manager from NetApp Cloud Central
- Use Cloud Manager to deploy NetApp Cloud Volumes ONTAP software

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2

Enterprise Class Cloud Storage

Review



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3



Cloud Volumes ONTAP

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Cloud Volumes ONTAP

Advanced storage capabilities in the hyperscale cloud

Software-only storage system that runs on customers' raw cloud storage

- Point-and-click deployment of instances by using Cloud Manager
- Instantaneous Snapshot copies
- Zero-footprint clones with FlexClone volumes
- Storage efficiency with data deduplication, thin provisioning, and compression
- NFS, CIFS, and iSCSI
- Replication capabilities (SnapMirror software and SnapVault software)



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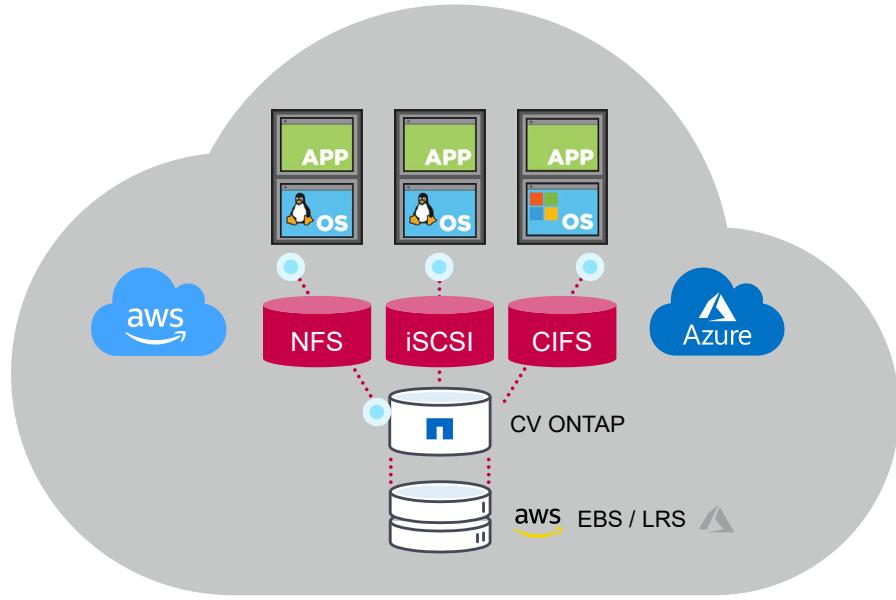
Cloud Volumes ONTAP Software

Use Cases and References



- Data protection: data recovery and backup in the cloud
- Production workloads
- Lightning fast DevOps and application development and test
- Enterprise-grade file shares

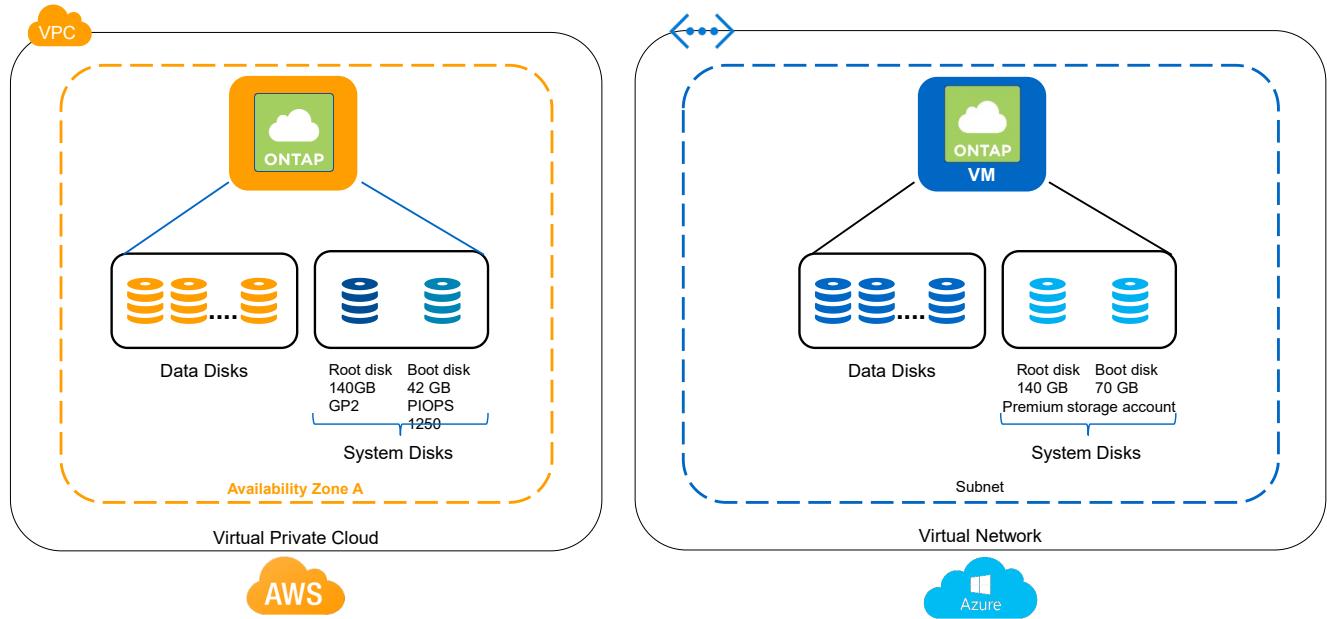
Cloud Volumes ONTAP Architecture



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Cloud Volumes ONTAP Architecture – Disk Allocations

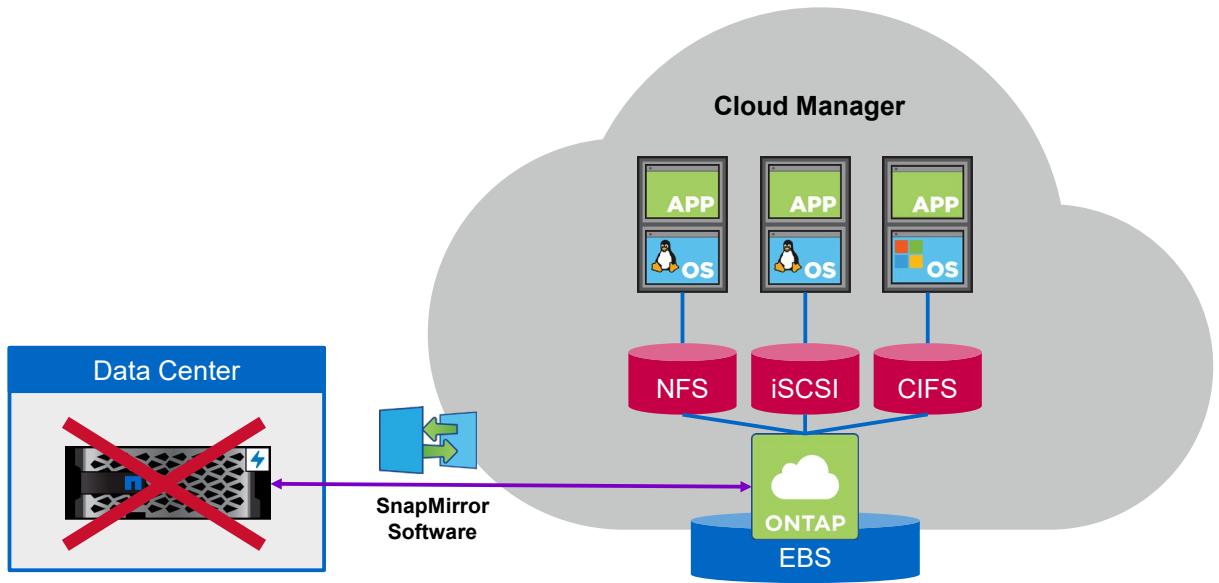


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Usage Example: Disaster Recovery

Using SnapMirror software to protect on-premises data in the cloud for disaster recovery

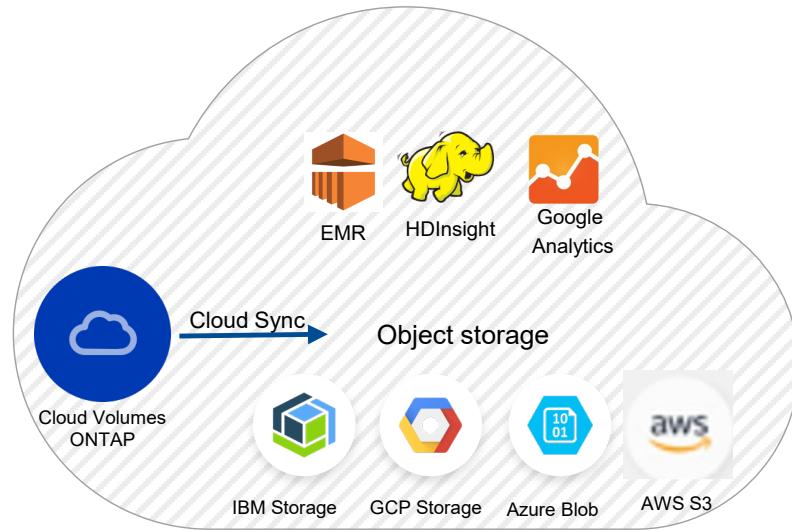


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Usage Example: Data Analytics

Using Cloud Sync service to migrate data to an object store for data analytics



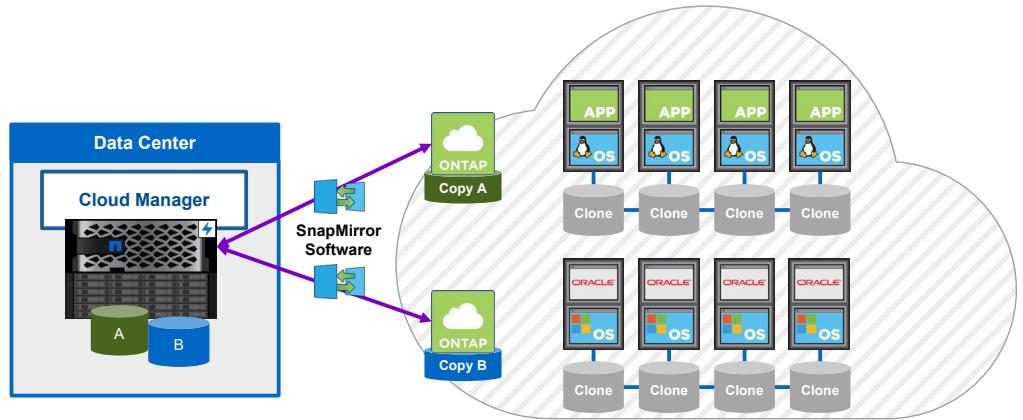
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Usage Example: Development and Test

Build, test, and deploy on Cloud Volumes ONTAP software

- Rapidly build out your test and development environment
- Keep your persistent, production environment in your data center
- Clone your environment in the cloud
- Grow to NetApp Private Storage (NPS) or transition to the data center for production



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Use the public cloud for its “instant” provisioning capabilities.

Turn resources on and off as needed.

Take advantage of cost-effective industry-leading data management features such as FlexClone software and thin Snapshot copies.

Eliminate downtime that is spent waiting on resources.

Usage Example: File Shares in the Cloud

- Replace or extend your on-premises NAS shares with cloud and grow as you go
- Take advantage of the leading NAS capabilities of NetApp:
 - Storage efficiencies
 - Encryption
 - Snapshot copies
- Protect against ransomware in the cloud

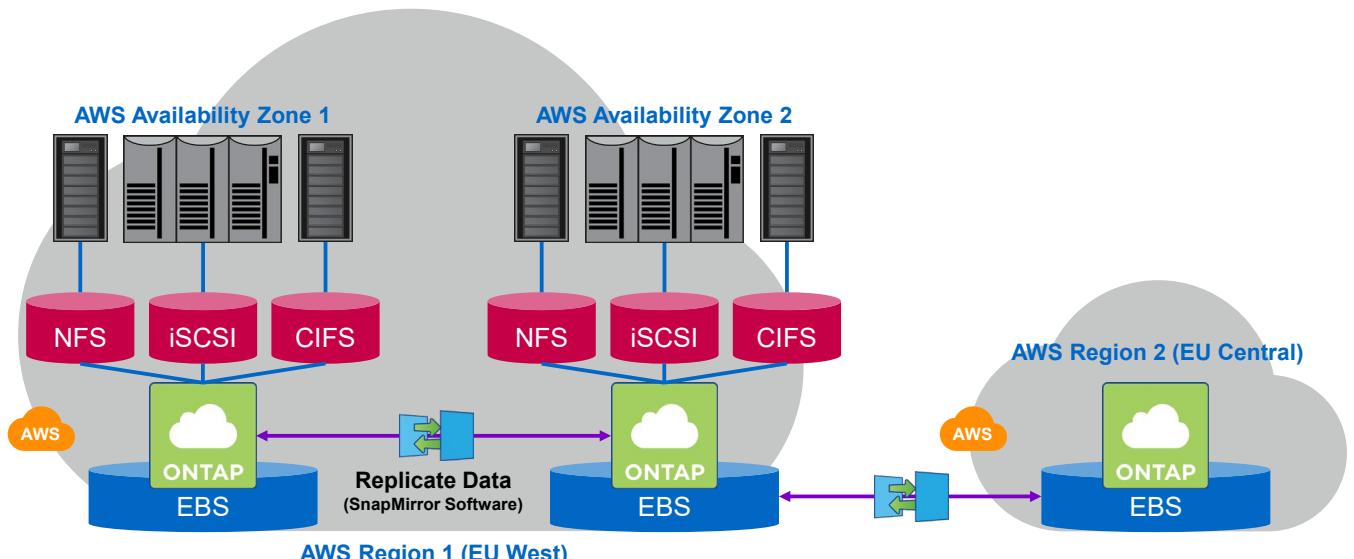


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Usage Example: Multiregion Application Coverage

Multiple Availability Zone (AZ) operation in EU West, data recovery in EU Central



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EBS: Amazon Elastic Block Store

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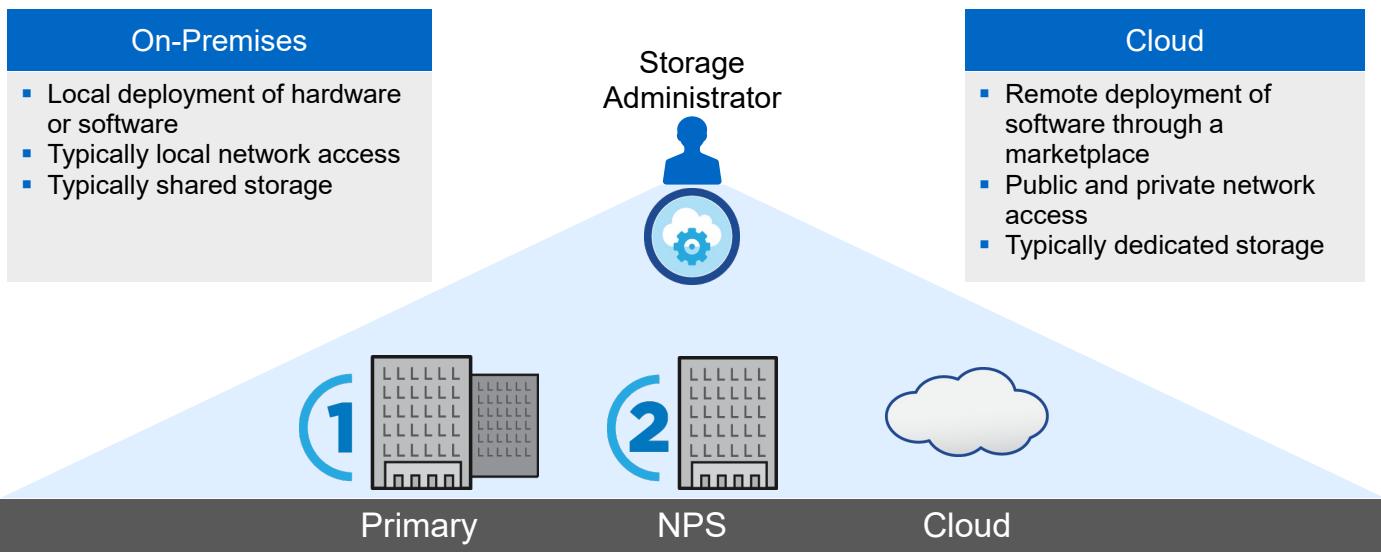


Deploying Cloud Volumes ONTAP by Using Cloud Manager

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Provisioning for the Hybrid Cloud



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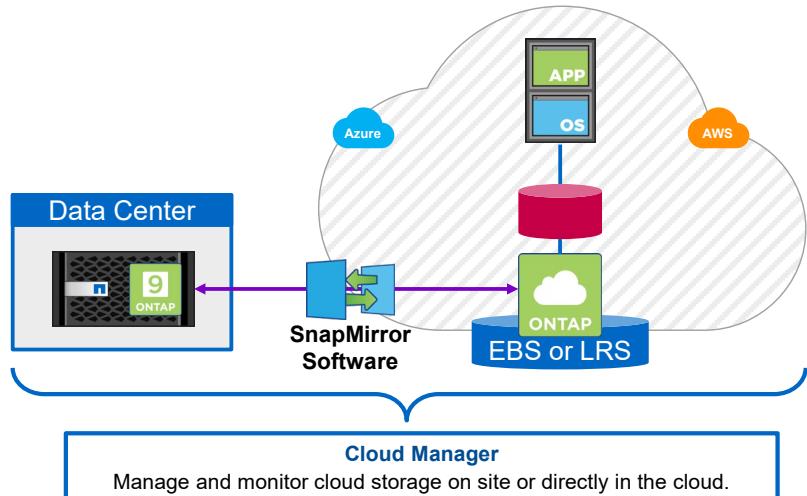
15

The data management requirement for on-premises storage system resources differs from the requirements of resources in the cloud. Cloud Manager was developed to create an easy and intuitive customer experience for both deploying Cloud Volumes ONTAP software and helping to provision NetApp Private Storage (NPS) resources.

Cloud Manager

Features

- Streamline the deployment, management, and tracking of cloud storage
- Achieve enterprise-class management for hybrid cloud storage from on-premises to multiple cloud providers
- Ease the movement of data across the Data Fabric with click-and-drag simplicity



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LRS: Azure Locally Redundant Storage

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Cloud Manager is the deployment environment for Cloud Volumes ONTAP software. It offers a point-and-click installation and automatically selects and assigns resources to each instance. When you deploy Cloud Volumes ONTAP software, Cloud Manager uses your cloud credentials to select the compute and storage necessary to run the instance of your choice. With visibility into the actual resources that are consumed by each instance, Cloud Manager monitors and tracks cloud resource use. You can later use this information in assessing your environment.

Cloud Manager provides management for your ONTAP hybrid enterprise storage environment, including the Cloud Volumes ONTAP storage service and AFF and FAS systems. Cloud Manager brings together Data Fabric elements with a single management interface that is independent of the data location. This solution eases the day-to-day requirements of Cloud Volumes ONTAP storage in both Amazon Web Services (AWS) and Microsoft Azure, including configuring, provisioning, and monitoring each active virtual and hardware storage node.

ONTAP hybrid cloud environments store applications and data both on-premises and in the cloud. Cloud Manager eases the movement of data across the Data Fabric with click-and-drag simplicity to automate data movement between on-premises and the cloud. You simply identify the source volume, destination volume, and a replication policy and schedule. Cloud Manager configures the relationships, applies the replication policy, and then starts the initial transfer between the volumes.

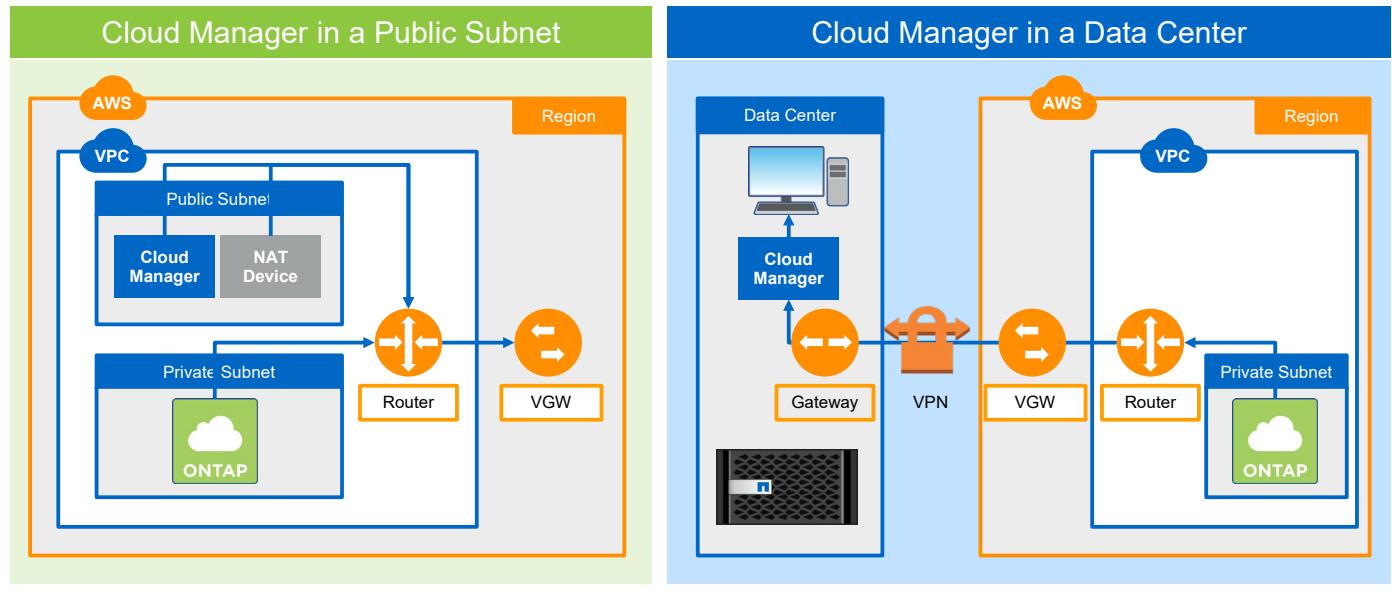
Cloud Manager

[More Features](#)

- Provides cloud resource cost monitoring
- Provides central point of control for all cloud data
- Manages data replication to and from the data center and the cloud
- Eases license and entitlement management

Cloud Manager

Deployment options



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Cloud Manager can be run from various locations, depending on the environment.

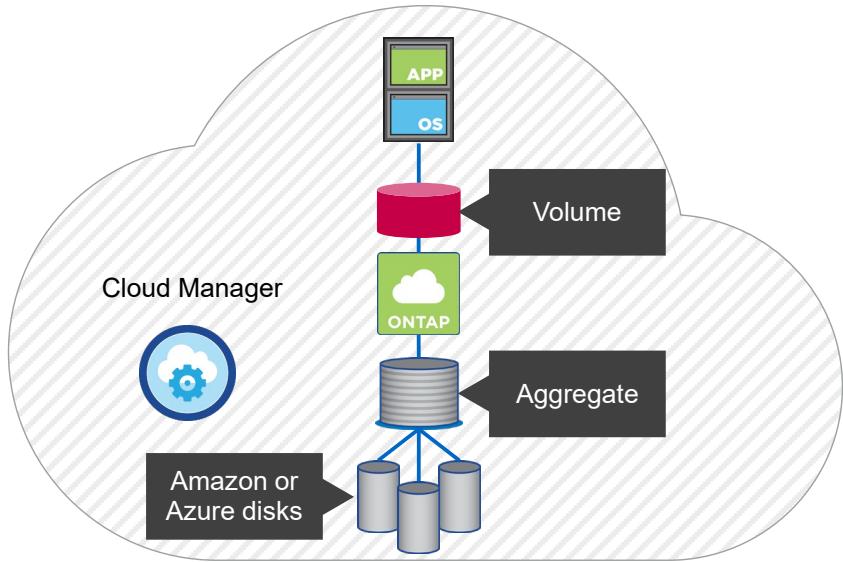
The left graphic shows Cloud Manager that is running in a public subnet and single-node Cloud Volumes ONTAP instances that are running in a private subnet. To deploy this method in an AWS environment, launch an instance from AWS Marketplace. Likewise, in an Azure environment, deploy a new virtual machine (VM) from the Azure Marketplace.

The right graphic shows Cloud Manager that is running in a data center and single-node Cloud Volumes ONTAP instances that are running in a private subnet. To deploy this method for either an AWS or Azure environment, download and install the software on an existing host or VM.

Cloud Manager

Deployment steps

1. Deploy Cloud Manager from Cloud Central.
2. Launch Cloud Manager.
3. Configure Cloud Manager.
4. Deploy Cloud Volumes ONTAP software by using Cloud Manager.



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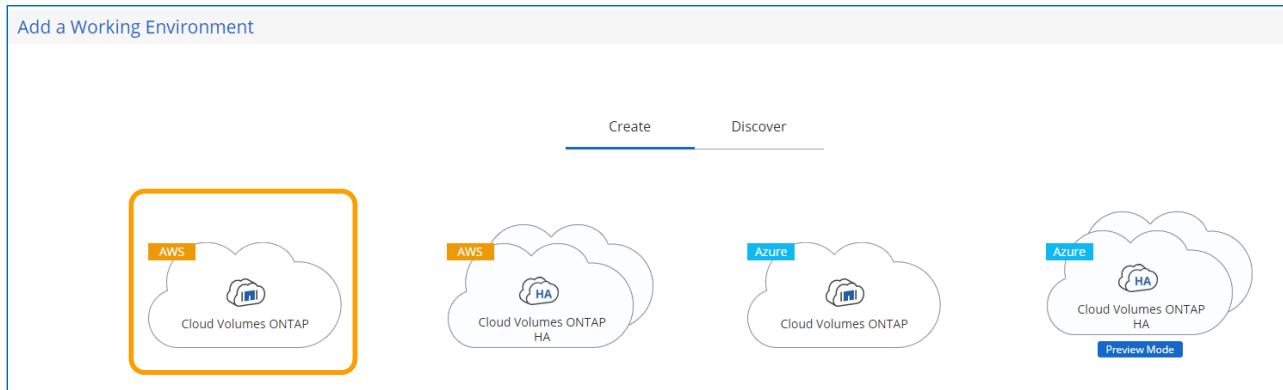
Cloud Manager software can run in the cloud or in your data center. The software just needs a connection to the networks in which you want to deploy Cloud Volumes ONTAP systems.

The easiest method is to deploy Cloud Manager in the cloud. You deploy Cloud Manager and Cloud Volumes ONTAP software from the AWS Marketplace or Azure Marketplace. In the class exercises, deployment is done with the AWS Marketplace.

After deploying, you launch Cloud Manager from the AWS or Azure console. The first time that you run Cloud Manager, a setup wizard guides you through the configuration. After Cloud Manager has been configured, you can deploy an instance of Cloud Volumes ONTAP software.

Cloud Manager

Deploy a Cloud Volumes ONTAP by using Cloud Manager from Cloud Central



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After the Cloud Manager setup is complete, you can create an Cloud Volumes ONTAP system or discover an existing ONTAP system. Selecting Create starts the wizard-driven process to create a new working environment. As with the storage virtual machine (SVM) setup wizard in OnCommand System Manager, you can optionally create a volume during the setup process.

Cloud Volumes ONTAP Software

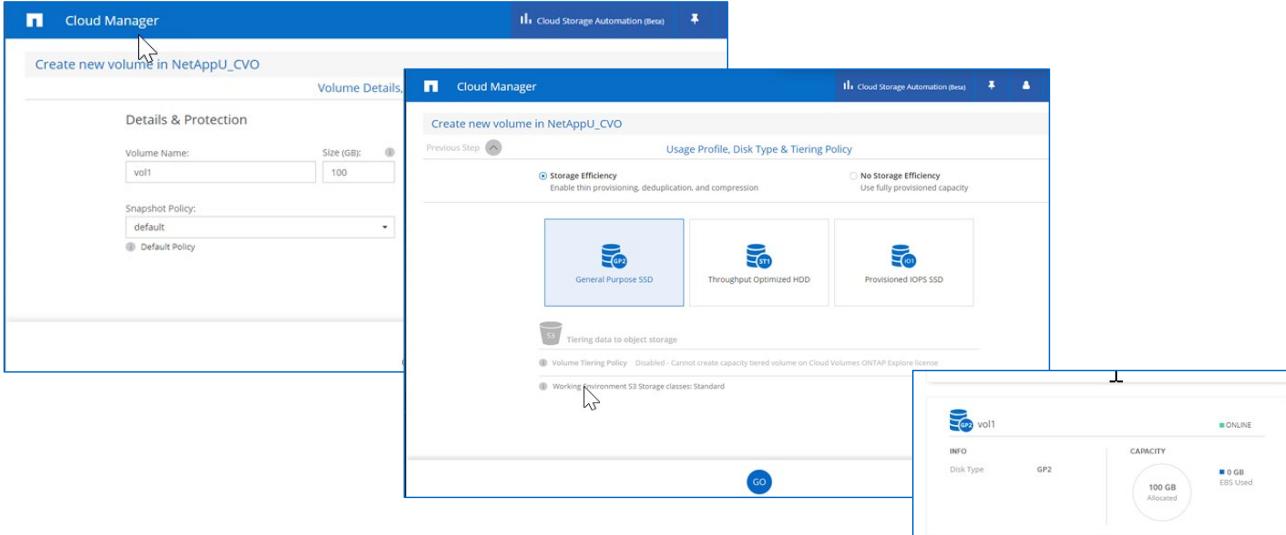
Architecture details

- The software is available as a single system or a high-availability (HA) pair.
- Each Cloud Volumes ONTAP software supports a single storage virtual machine (SVM).
 - Cloud Manager creates this SVM when it launches an instance.
 - You can create another SVM from CLI or OnCommand System Manager, but the use of multiple SVMs is not supported.
- Several network interfaces are created by default.
 - A cluster management LIF
 - An intercluster LIF
 - A node management LIF
 - An iSCSI data LIF
 - A CIFS and NFS Data LIF

Note: LIF failover is disabled by default due to Amazon Elastic Compute Cloud (Amazon EC2) requirements.

Cloud Manager

Provisioning volumes



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You can provision volumes from either Volume View or Storage System View. After entering the details, click **Create**.

Cloud Manager

Managing volumes

The screenshot shows the Cloud Manager interface for managing volumes. On the left, there's a navigation bar with 'Cloud Manager' selected. Below it, under 'NetAppU_CVO', the 'Volumes' tab is highlighted. A modal window is open for a volume named 'nfs_vol1'. Inside the modal, the 'Mount Command' option is highlighted with a yellow box and an arrow pointing from the main 'Volumes' section towards it. The modal also contains options like 'Info', 'Edit', 'Delete', 'Clone', 'Restore from Snapshot copy', and 'Create a Snapshot copy'. To the right of the modal, a panel titled 'NetAppU_CVO' shows tabs for 'Volumes', 'Instances', 'Cost', and 'Replications'. Below this, a section titled 'Mount Volume nfs_vol1' provides a command: 'mount 10.20.1.129:/nfs_vol1 <dest_dir>' with a 'Copy' button.

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You manage volumes from the Volumes pane in Cloud Manager. For information about how to access the volume, click the Mount command. You can create volumes by clicking Add New Volume.

General Networking Requirements for Cloud Manager

- Connection to target networks
- Outbound internet access to deploy and manage Cloud Volumes ONTAP
- Ports and security groups

Cloud Volumes ONTAP

General Networking Requirements

- Outbound internet access for Cloud Volumes ONTAP nodes
- Security groups
- Connection from Cloud Volumes ONTAP to Amazon Simple Storage Service (Amazon S3 or S3) or Azure Blob Storage for data tiering
- Connections to ONTAP systems in other networks
- DNS and Active Directory for CIFS
- For multi-AZ high-availability (HA) deployment in AWS:
 - 3 dedicated AZs
 - 3 floating IPs
 - NAS data access (1 on each node)
 - Cluster management
 - Storage virtual machine (SVM) management (optional)

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Cloud Volumes ONTAP nodes require outbound internet access to send messages to NetApp AutoSupport, which proactively monitors the health of your storage.

Routing and firewall policies must allow AWS HTTP and HTTPS traffic to mysupport.netapp.com.

If you have a NAT instance, you must define an inbound security group rule that allows HTTPS traffic from the private subnet to the internet.

The high-availability (HA) mediator instance must have an outbound connection to the Amazon Elastic Compute Cloud (Amazon EC2) service so that it can assist with storage failover. To provide the connection, you can add a public IP address, specify a proxy server, or use a manual option.

The manual option can be a NAT gateway or an interface Virtual Private Cloud (VPC) endpoint from the target subnet to the Amazon EC2 service.

You do not need to create security groups because Cloud Manager does that for you.

If you want to use EBS as a performance tier and Amazon S3 as a cloud tier, you must ensure that Cloud Volumes ONTAP has a connection to S3. The best way to provide that connection is by creating a VPC Endpoint to the S3 service.

When you create the VPC Endpoint, be sure to select the region, VPC, and route table that corresponds to the Cloud Volumes ONTAP instance. You must also modify the security group to add an outbound HTTPS rule that enables traffic to the S3 endpoint. Otherwise, Cloud Volumes ONTAP cannot connect to the S3 service.

More information:

https://docs.netapp.com/us-en/occm/reference_networking_aws.html

https://docs.netapp.com/us-en/occm/reference_networking_azure.html

Cloud Manager API

- Enables automation and management of Cloud Volumes ONTAP
- Can perform operations on the following:
 - Administrative resources
 - Auditing resources
 - Authentication resources
 - Working environment resources
- Provides interactive API documentation through Swagger interface
- You need to use authentication APIs before you use TryIt from Swagger.
- API URLs are relative to **ip_address:port/occm/api**
- API Documentation: <https://docs.netapp.com/us-en/occm/api.html>

Cloud Manager API

Example

Launching a single Cloud Volumes ONTAP instance in Azure

```
curl http://localhost/occm/api/azure/vsa/working-environments -X POST --header "Content-Type:application/json" --header "Authorization:$token" --data "{\"name\": \"vsAAzure\", \"tenantId\": \"$tenantId\", \"region\": \"westus\", \"vsAMetadata\": { \"ontapVersion\": \"ONTAP-9.4X8.T1.azure\", \"licenseType\": \"azure-cot-standard-paygo\", \"instanceType\": \"Standard_DS4_v2\"}, \"writingSpeedState\": \"NORMAL\", \"subnetId\": \"$azureSubnetId\", \"svmPassword\": \"$svmPassword\", \"vnetId\": \"$azureVnetId\", \"cloudProviderAccount\": \"$azureAccountId\", \"subscriptionId\": \"$azureSubscriptionId\", \"cidr\": \"$azureCidr\", \"dataEncryptionType\": \"NONE\", \"ontapEncryptionParameters\": null, \"securityGroupId\": null, \"skipSnapshots\": false, \"diskSize\": { \"size\": 1, \"unit\": \"TB\"}, \"storageType\": \"Premium_LRS\", \"azureTags\": []}}\" | jq .
```

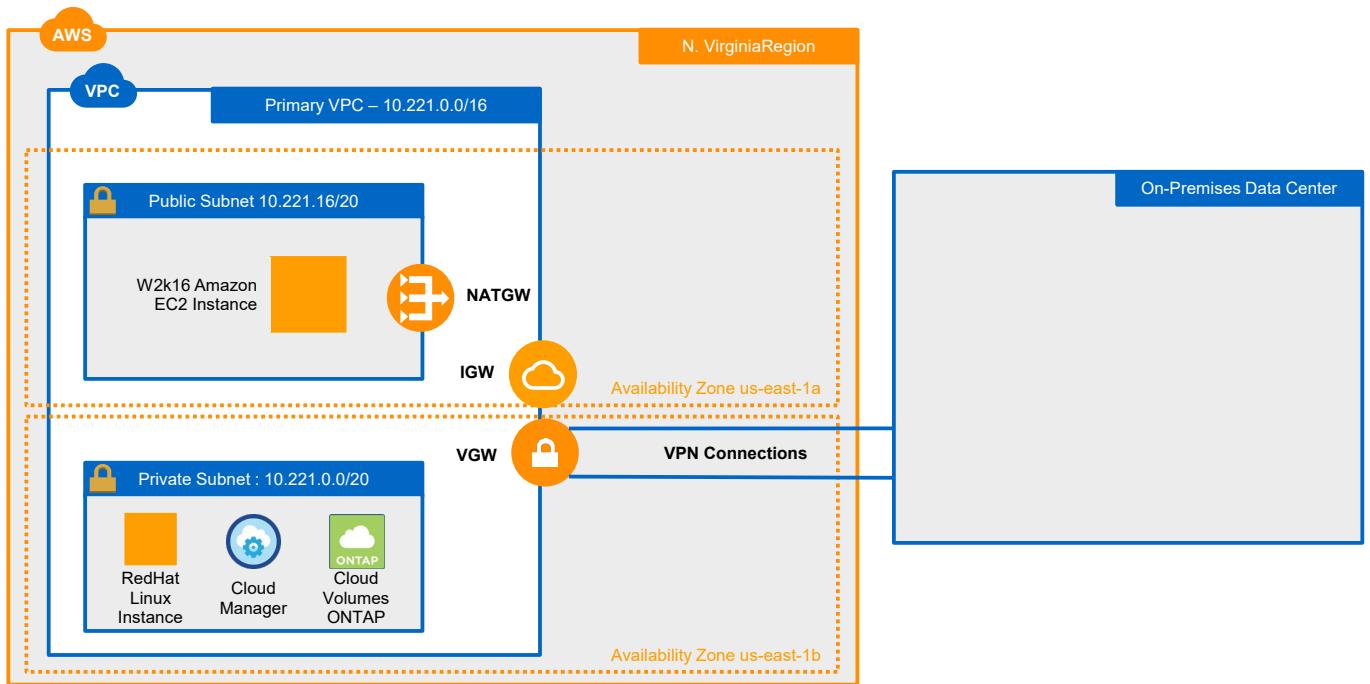


Hands-On Activity

Module 3: NetApp Cloud Volumes ONTAP

Exercise 1: Using OnCommand Cloud Manager to Deploy Cloud Volumes ONTAP

This exercise requires approximately **90 minutes**.



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ACTION: Share Your Experiences

Roundtable questions for the exercise



- How does Cloud Manager have correct permissions to provision AWS resources for Cloud Volumes ONTAP software?
- How many SVMs can a Cloud Volumes ONTAP instance support?
- Can you add more disks to a Cloud Volumes ONTAP aggregate by using Cloud Manager?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.



What Next?

Now that you have Cloud Manager and Cloud Volumes ONTAP software installed, what can you do with them?



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Module Review



- You use Cloud Manager to deploy Cloud Volumes ONTAP in AWS or Azure.
- Cloud Volumes ONTAP is a software version of ONTAP for the cloud with all its rich features.
- Cloud Volumes ONTAP can be used to manage data that can be accessed by using NFS, CIFS, or iSCSI protocols.
- Cloud Manager is a management tool for managing Cloud Volumes ONTAP in the cloud and on-premises.
- You can perform some high-level management functions from Cloud Manager, but for more fine-grained control, you use OnCommand System Manager.



Module 4

Implementing Disaster Recovery by Using NetApp Cloud Volumes ONTAP

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1



About This Module

This module focuses on enabling you to do the following:

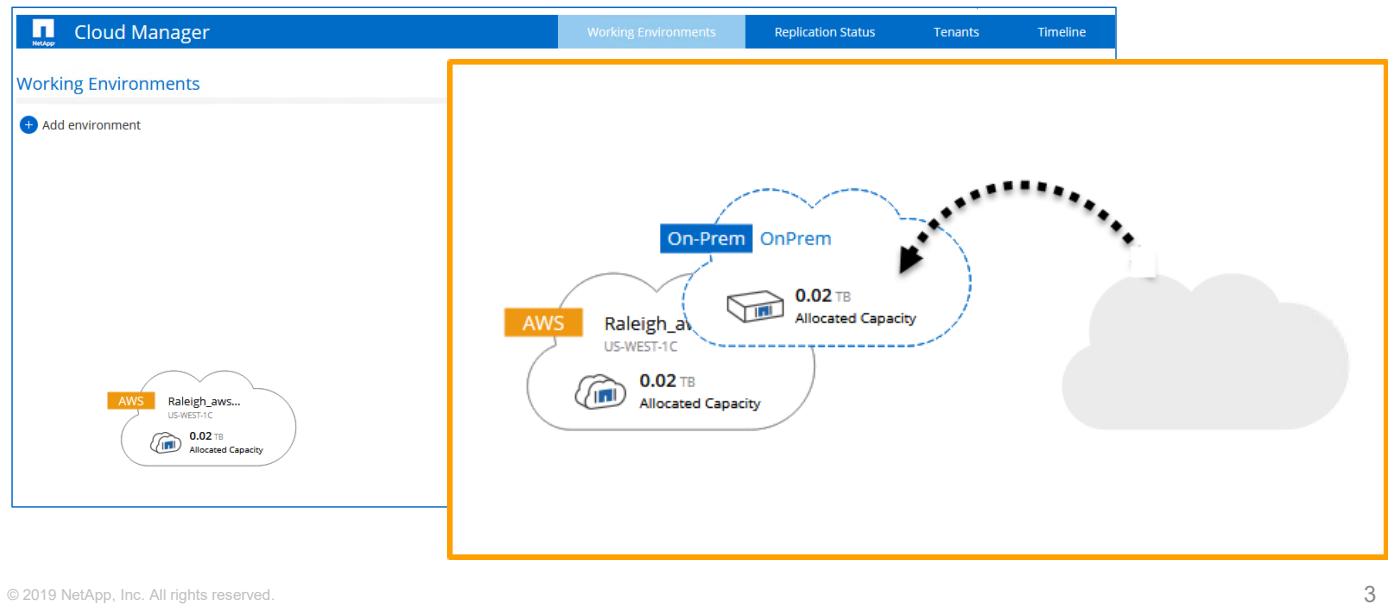
- Use OnCommand Cloud Manager to establish a SnapMirror relationship between ONTAP software on-premises and Cloud Volumes ONTAP software in a hybrid cloud environment
- Use the SnapMirror destination in the cloud as the disaster recovery site
- Bring data back on-premises on recovery

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2

Creating a Data Protection Relationship

The Cloud Manager drag-and-drop feature



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In this example, you discover two systems that are used to create a data-protection relationship. On the right is the primary data stored in an ONTAP cluster that is located in an on-premises data center. On the left is a Cloud Volumes ONTAP instance, which is the backup target.

To create this relationship, simply drag the ONTAP cluster icon to the Cloud Volumes ONTAP icon. This action initiates the Replication Setup wizard.

Creating a Data Protection Relationship

Additional steps

The Cloud Manager UI guides you through the following steps:

1. Select a source volume.
2. Define a destination volume and maximum transfer rate.
3. Set a replication policy (mirror or backup).
4. Select a replication schedule.

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You are asked to select a source volume.

You also need to specify a destination volume. Cloud Manager automatically creates this volume on the destination system, which, in this example, is the Cloud Volumes ONTAP instance. You can set the maximum transfer rate. By default, the rate is unlimited.

You then choose the type of replication to perform on the volume. There are two default replication policies: mirror and backup.

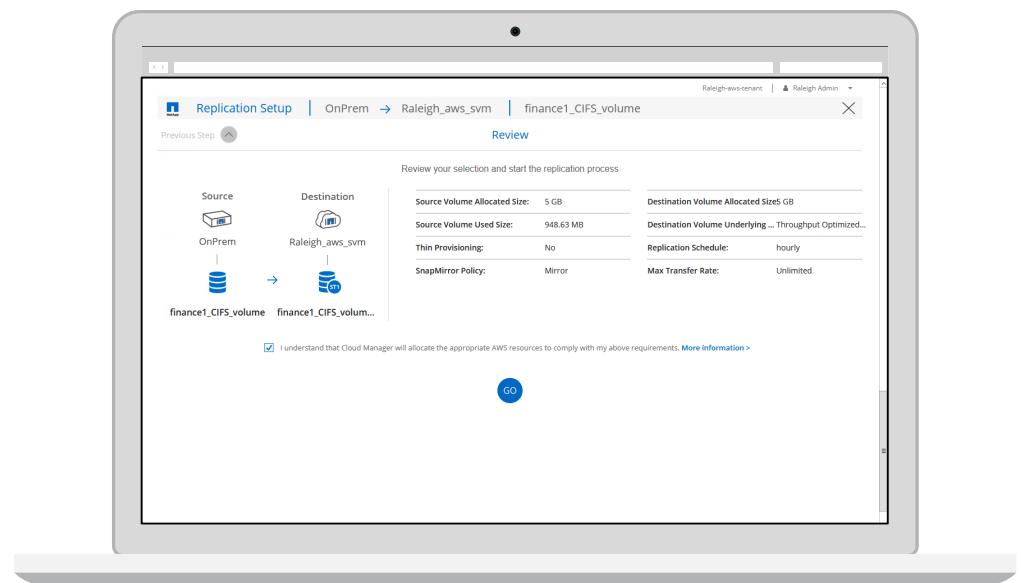
- The mirror policy is typically used for disaster recovery.
- The backup policy is typically used for long-term retention of backup copies.

You select a replication schedule, or you can select a one-time copy.

Creating a Data Protection Relationship

Review

Review again, and then click **Go**.



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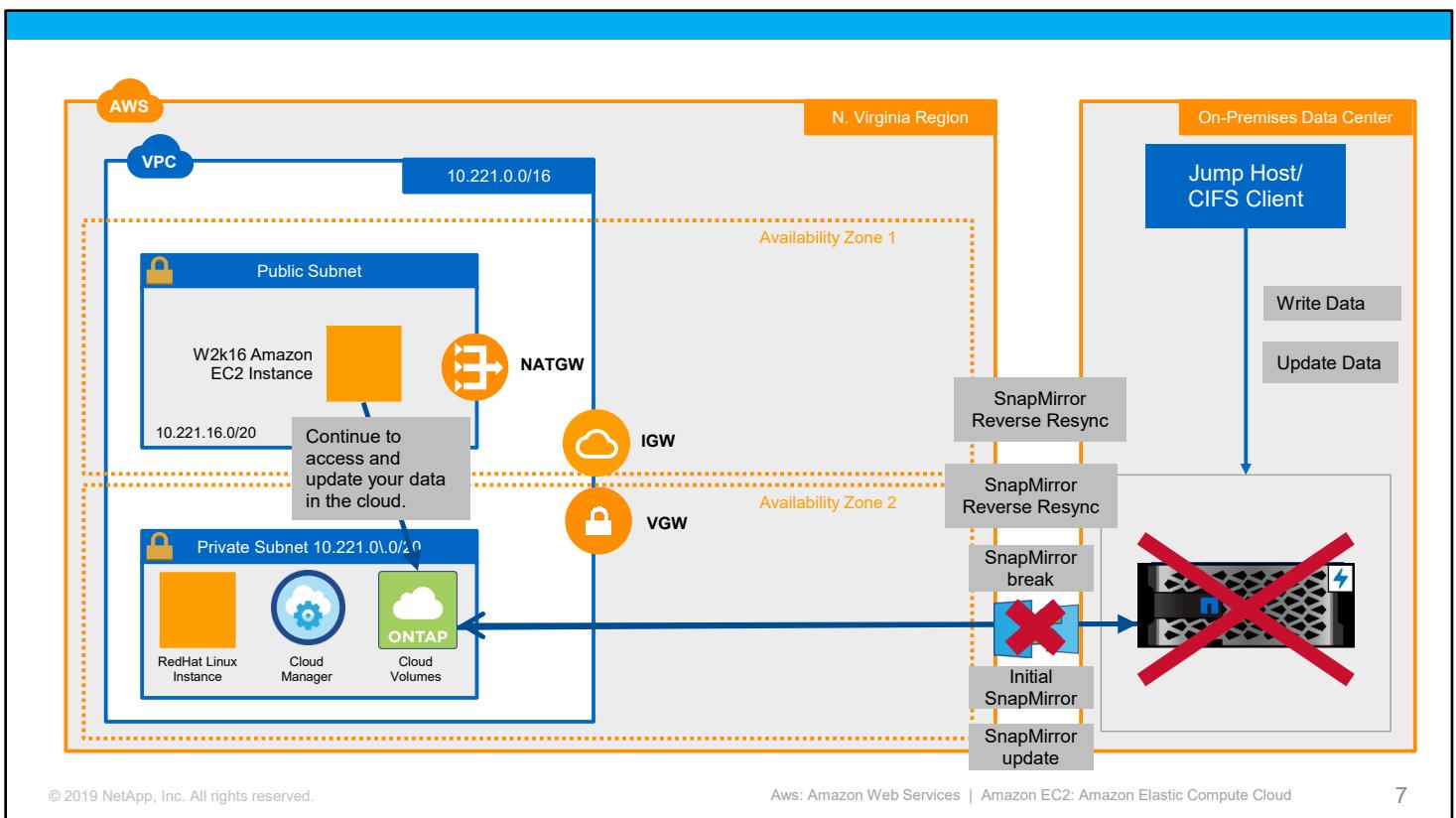


Hands-On Activity

Module 4: Implementing Disaster Recovery by Using NetApp Cloud Volumes ONTAP

Exercise 1: Configure and Manage Disaster Recovery in the Data Fabric

This exercise requires approximately **45 minutes**.



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Aws: Amazon Web Services | Amazon EC2: Amazon Elastic Compute Cloud

7



ACTION: Share Your Experiences

Roundtable questions for the exercise



- What was your experience with using Cloud Manager for creating, updating, and managing a SnapMirror relationship? (Compare and contrast with the CLI or OnCommand System Manager.)
- When you mapped the share in the destination volume during the disaster recovery scenario, which domain did you join?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.



Module Review

This module focused on enabling you to do the following:

- Use Cloud Manager to establish a SnapMirror relationship between ONTAP software on-premises and Cloud Volumes ONTAP software in a hybrid cloud environment
- Use the SnapMirror destination in the cloud as the disaster recovery site
- Bring data back on-premises on recovery



Module 5

Azure Virtual Network and Connectivity

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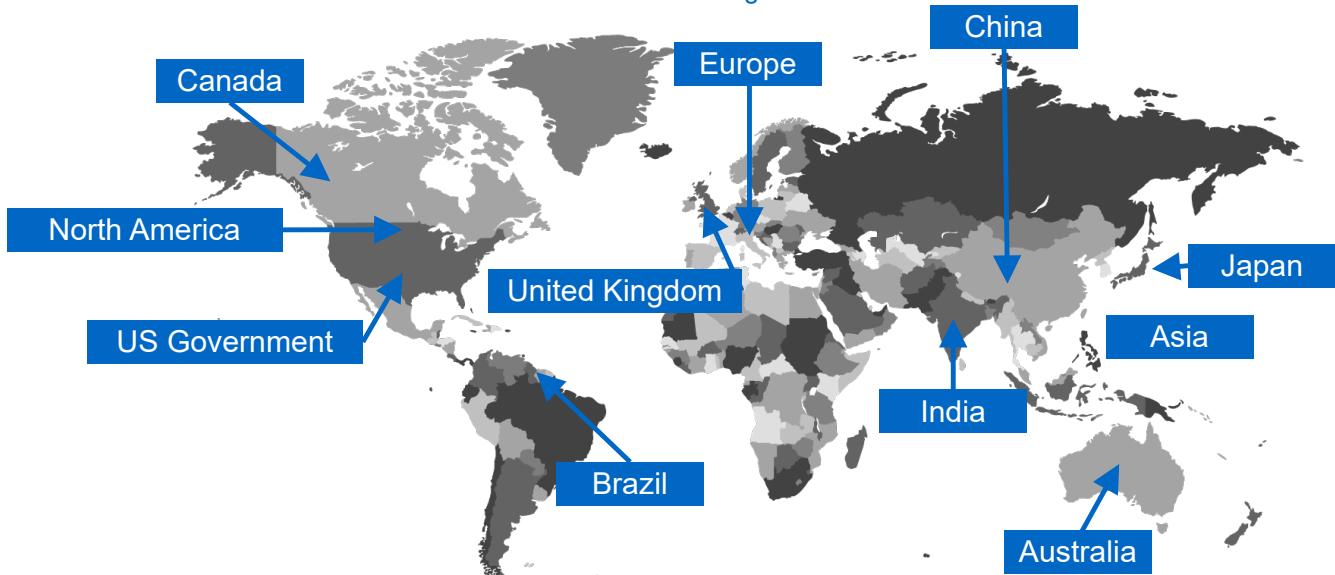
About This Module

This module focuses on enabling you to do the following:

- Configure Azure Virtual Network (VNet) resources by using Windows PowerShell
- Describe Azure VPN connection options, including ExpressRoute and site-to-site VPN
- Configure an Azure VPN connection to an on-premises data center

Azure: Geographies

A defined area of the world that contains at least one Azure region



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The Azure hierarchical model consists of Azure Geographies > Regions > Virtual Networks > Subnets > Applications (to include the virtual machine [VM]).

Azure: Regions

- An Azure region is made up of multiple servers in data centers in a given geography, located ~300 miles (483 km) apart.
- The 34 regions contain region pairs.



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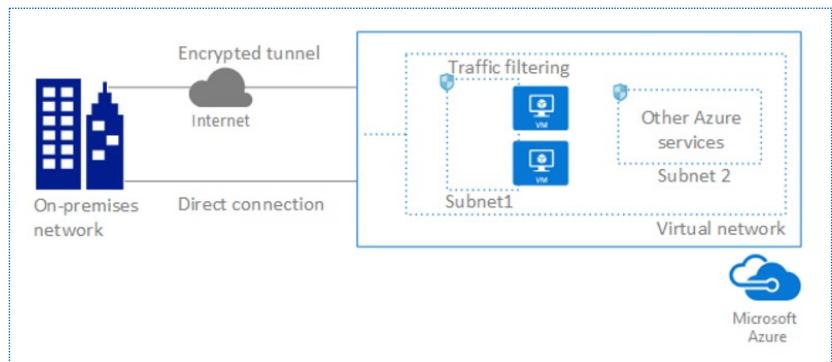
References:

Business continuity and disaster recovery (BCDR): Azure Paired Regions: <https://docs.microsoft.com/en-us/azure/best-practices-availability-paired-regions>

Azure: VNet

Definition

- A VNet is an isolated and secure environment to run virtual machines and applications (defined by Classless Inter-Domain Routing [CIDR], it contains subnets and Network Security Groups).
- You can connect VNets to your on-premises network.
 - Internet Protocol security (IPsec) VPN
 - ExpressRoute
- Network traffic can be filtered inbound and outbound by source IP address and port, destination IP and port, and protocol.



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A VNet is a representation of your own network in the cloud. A VNet is a logical isolation of the Azure cloud that is dedicated to your subscription. You can also connect VNets to your on-premises network.

Azure: VNet

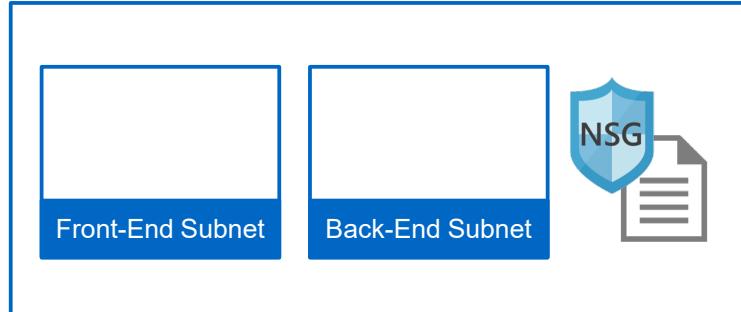
Components

▪ Subnets

- Subnets segment the network into manageable sections.
- All services are available across subnets.

▪ Network Security Groups (NSGs)

- NSGs provide rules to allow or deny traffic.
- NSGs are associated with subnets or network interface cards (NICs).



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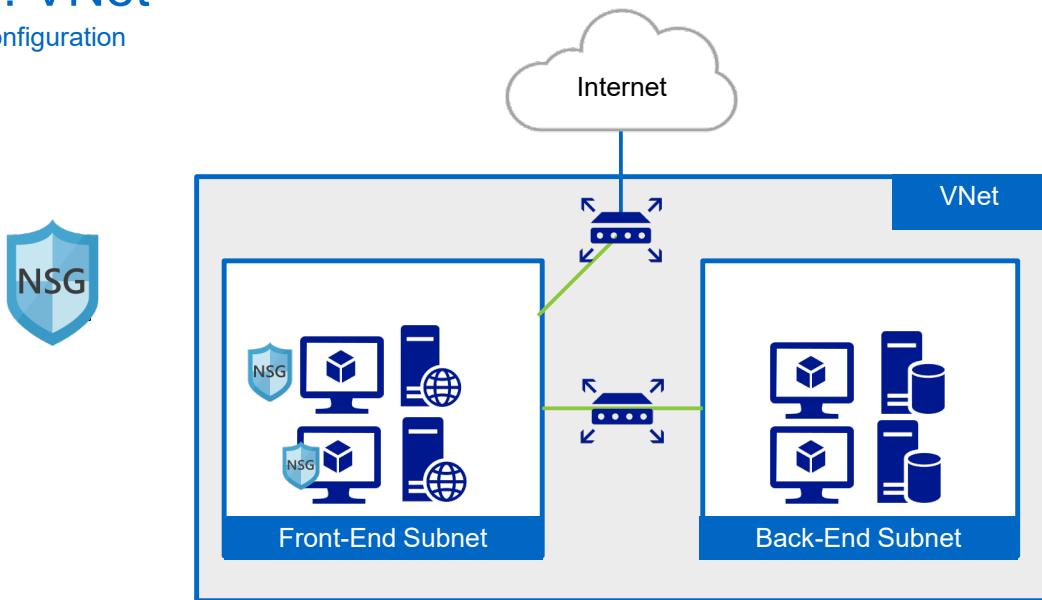
Subnets enable partitioning the VNet into segments for easier management. In this example, the VNet includes a public and private subnet. Public facing services like web servers can be grouped into the public subnet. Their back-end databases can be secured in the private subnet.

The network security group (NSG) is the main tool that is used to enforce and control network traffic rules by source and destination IP address, port, and protocol. Customers control access by allowing or denying communication between the workloads within a virtual network from systems in other connected networks.

<https://blogs.msdn.microsoft.com/igorpag/2016/05/14/azure-network-security-groups-nsg-best-practices-and-lessons-learned/>

Azure: VNet

Example configuration



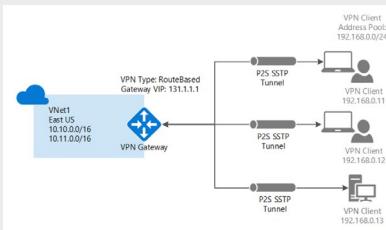
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In this example, the VNet is segmented into two subnets. A public internet facing subnet, Front-End Subnet, contains web server virtual machines. A private subnet, Back-End Subnet, contains database server virtual machines. All traffic is allowed from the VNet to the internet and within the VNet by default. No traffic is allowed from the internet directly to the subnets. NSGs contain a list of security rules that allow or deny network traffic to resources that are connected to VNets. NSGs and VNet default routes or user-defined routes (UDRs) allow internet traffic to the web servers in only the Front-End Subnet. NSGs can be applied to subnets or individual network interfaces.

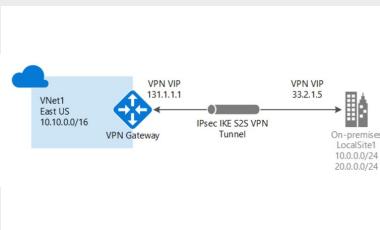
Azure Connections to On-Premises Networks

Point-to-site VPN



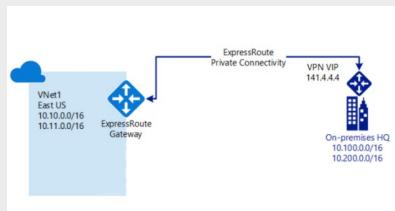
- Established between a single PC and VNet
- Good for experimentation or developers

Site-to-site VPN



- Used for cross-premises and hybrid configurations
- Used for the classroom lab environment

Azure ExpressRoute

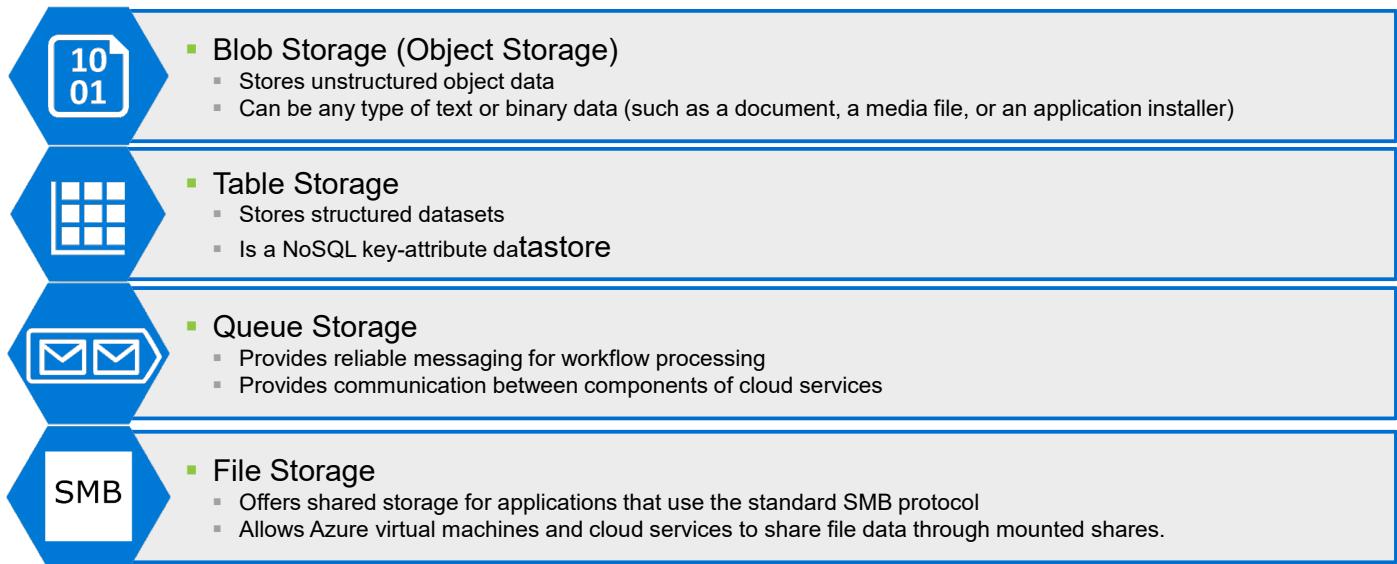


- Provides a direct, dedicated connection
- ★ Is used for the NetApp Private Storage (NPS) solution
- Has faster speeds, lower latencies, and higher security

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Azure Storage

Storage types



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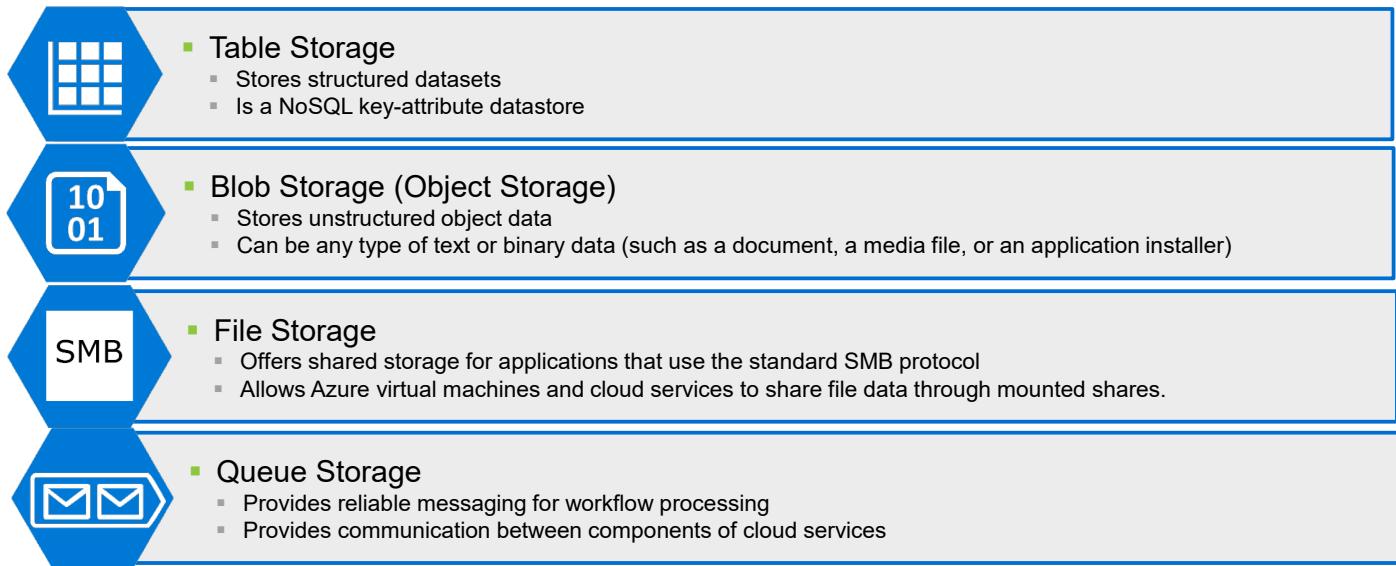
General-Purpose Storage Accounts

A general-purpose storage account gives you access to Azure storage services (such as tables, queues, files, blobs, and Azure Virtual Machine Disks) under a single account. This type of storage account has two performance tiers:

- A standard storage performance tier which enables you to store tables, queues, files, blobs, and Azure Virtual Machine Disks
- A premium storage performance tier which currently supports only Azure Virtual Machine Disks

Azure Storage

Storage types

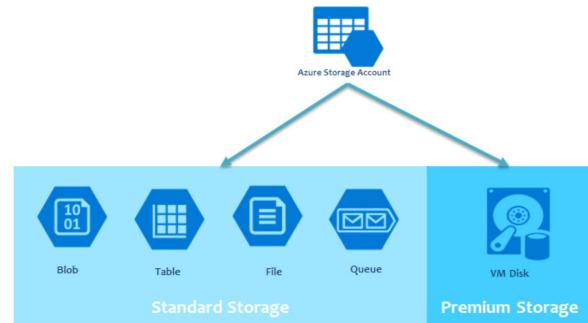


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Azure Storage Accounts

- An **Azure storage account** contains all of your **Azure Storage** data objects:
 - blobs
 - files
 - queues
 - tables
 - disks
- Data in your **Azure storage account** is
 - durable and highly available
 - Secure
 - massively scalable
 - accessible from anywhere in the world over HTTP or HTTPS

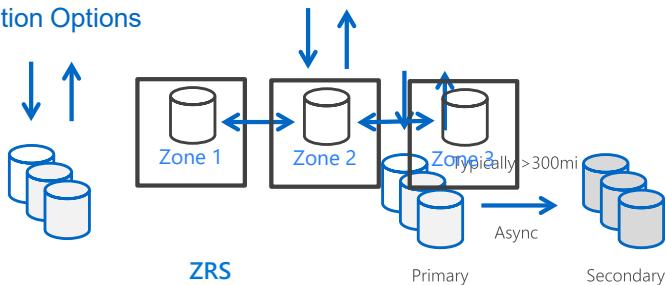


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Storage Durability and Availability

Replication Options

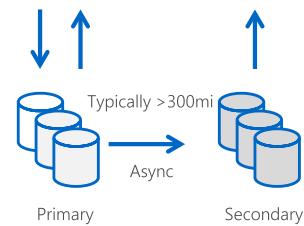


LRS

3 replicas, 1 region
Protect against disk, node, rack failures
Write is ack'd when all replicas are committed

GRS

3 replicas across 3 Zones
Protect against disk, node, rack and **zone** failures
Synchronous writes Protects against major regional disasters
Asynchronous to secondary
Generally Available now in 6 regions



RA-GRS

GRS + Read access to secondary
Separate secondary endpoint
RPO delay to secondary can be queried

AWS Versus Azure

Feature comparison

AWS	Feature	Azure
EBS	Block Storage	Page Blobs
Amazon S3	Object Storage	Block Blobs and Files
RDS	Relational Database (DB)	Relational DBs
Glacier	Archiving	Blobs (cool storage tier)
DynamoDB, EMR, Kinesis, Redshift	NoSQL and Big Data	Windows Azure Table, HDInsight
VPC	Virtual Network	VNet
Route 53	DNS	Azure DNS
Amazon CloudFront	Content Delivery Network (CDN)	Azure CDN

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AWS: Amazon Web Services | EBS: Amazon Elastic Block Store | Amazon S3: Amazon Simple Storage Service
RDS: Amazon Relational Database Service | VPC: Virtual Private Cloud

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AWS Versus Azure

Further feature comparison

AWS	<u>Feature</u>	Azure
Amazon Elastic Compute Cloud (Amazon EC2), Amazon Elastic Beanstalk	Compute Services	Virtual Machines, Cloud Services, Azure Websites and Applications, Azure Visual Studio Online
Auto Scaling	Scaling	Azure Autoscale
Elastic Load Balancing	Load Balancing	Load Balancer Application Gateway

See the latest comparison of the top four cloud providers:

<http://cloudcomparison.righscale.com/>



Hands-On Activity

Module 5: Azure Virtual Network and Connectivity

Exercise 1: Configuring Azure Virtual Network to On-Premises VPN Connectivity

This exercise requires approximately **1 hour**.



ACTION: Share Your Experiences

Roundtable questions for the exercise



- What was the purpose of the gateway subnet that you created in the VNet?
- Are there any limitations on the shared key that was created?
- What type of storage is used for the virtual machine that you launched?

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More Azure Training

Cloud Volumes ONTAP

Self-paced vClassroom course:

“[Cloud Volumes ONTAP Deployment and Management for Azure](#)”

Deeplink:

<http://learningcenter.netapp.com/LC?ObjectType=WBT&ObjectID=00369436>



Module Review

This module focused on enabling you to do the following:

- Create a VNet, subnet gateway, and VPN connection by using PowerShell scripts and verified connectivity between the on-premises data center and the VNet
- Compare Azure resources and features to similar AWS entities



Module 6

NetApp Cloud Volumes ONTAP Data Tiering

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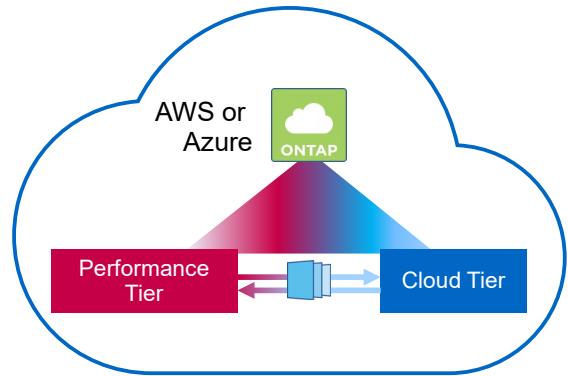
About This Module

This module focuses on enabling you to do the following:

- Explain data tiering
- Describe the tiering policies
- Configure data tiering in Cloud Volumes ONTAP in Amazon Web Services (AWS)

Data Tiering

- Cloud Volumes ONTAP supports data tiering in AWS and in Microsoft Azure.
- Data tiering is powered by FabricPool technology.
- The system's capacity limit is spread across the performance tier and the cloud tier.
- You do not need to install a feature license to enable data tiering.
- You do not need to create the cloud tier (either an Amazon Simple Storage Service [Amazon S3 or S3] bucket or an Azure Blob container). OnCommand Cloud Manager does that for you.



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You can enable data tiering when you use specific configurations and features:

- Data tiering is supported with Cloud Volumes ONTAP Standard, Premium, and BYOL, starting with version 9.2 in AWS and version 9.4 in Microsoft Azure.
- Data tiering is not supported in Azure with the DS3_v2 virtual machine type.
- In AWS, the performance tier can be general-purpose solid-state drives (SSDs), provisioned IOPS SSDs, or throughput optimized HDDs.
- In Azure, the performance tier can be either premium SSD-managed disks or standard HDD-managed disks.
- Data tiering is supported with AWS-managed encryption and Azure-managed encryption.
- Thin provisioning must be enabled on volumes.

Data Tiering

Cloud Manager

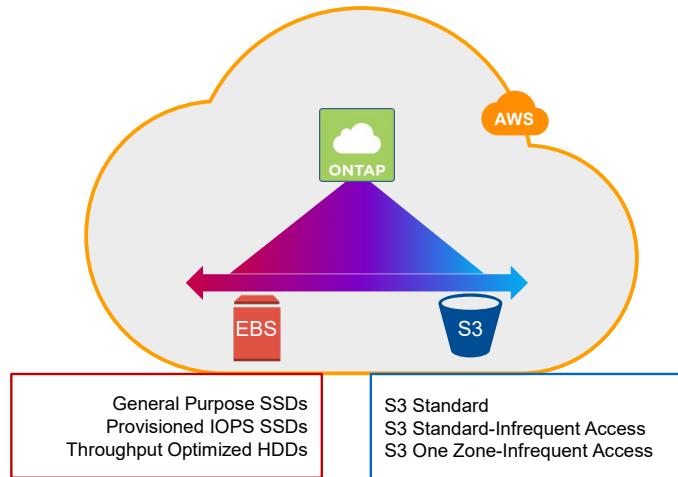
- Cloud Manager is used to configure data tiering in AWS and Azure.
- This tiering is not the same as the cloud tiering available as a service from NetApp Cloud Central.

Currently, Cloud Tiering Service enables tiering of infrequently accessed data from the on-premises, high-performance AFF storage to the cloud tier.

The screenshot shows a configuration dialog for a volume. At the top, there are two radio button options: "Storage Efficiency" (selected) and "No Storage Efficiency". Below this, under "General Purpose SSD", it says "Cloud Manager will create the volume using the disk type that you previously selected. You can use different disk types with future volumes." A green box highlights the "Tiering data to object storage" section, which includes a "Volume Tiering Policy" dropdown set to "None" and three radio button options: "Auto", "Snapshot Only", and "None" (selected).

Data Tiering in AWS

- Cloud Volumes ONTAP uses Amazon Elastic Block Store (Amazon EBS or EBS) as a performance tier for hot data.
- It uses S3 as a cloud tier for cold data.
- A Cloud Volumes ONTAP working environment uses an S3 bucket for all tiered data from the system.



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Standard: Ideal for frequently accessed data that is stored across multiple Availability Zones

Standard-Infrequent Access: For infrequently accessed data that is stored across multiple Availability Zones

One Zone-Infrequent Access: For infrequently accessed data that is stored in a single Availability Zone

Access costs are higher if you do access the data, so you must take that into consideration before you change the tiering level.

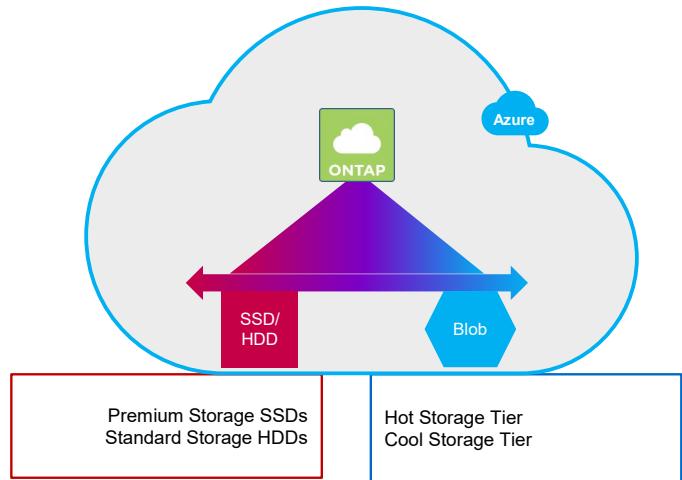
When you change the tiering level, cold data starts in the standard storage class and moves to the storage class that you selected if the data is not accessed after 30 days.

The tiering level is system wide. It is not per volume.

A Cloud Volumes ONTAP working environment uses an S3 bucket for all tiered data from the system. A different S3 bucket is not used for each volume. This condition includes a high-availability (HA) working environment. Cloud Manager creates an S3 bucket and names it *fabric-pool-cluster unique identifier*.

Data Tiering in Azure

- Cloud Volumes ONTAP uses Azure-managed disks as a performance tier for hot data.
- Cloud Volumes ONTAP uses Azure Blob Storage as a cloud tier for cold data.



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By default, Cloud Volumes ONTAP tiers cold data to the Azure *hot* storage tier, which is ideal for frequently accessed data.

If you do not plan to access the cold data, you can reduce your storage costs. You can change a system's tiering level to the Azure *cool* storage tier after you deploy Cloud Volumes ONTAP. The cool tier is ideal for infrequently accessed data that resides in the tier for at least 30 days.

Access costs are higher if you do access the data, so you must take that into consideration before you change the tiering level.

When you change the tiering level, cold data starts in the hot storage tier and moves to the cool storage tier if the data is not accessed after 30 days.

The tiering level is system wide. It is not per volume.

A Cloud Volumes ONTAP working environment uses an Azure Blob container for all tiered data from the system. A different container is not used for each volume. Cloud Manager creates a storage account with a container for each Cloud Volumes ONTAP system. The name of the storage account is random.

Tiering Policies

▪ Snapshot only

- Aggregate is at 50% capacity. (Starting in ONTAP 9.5 the minimum capacity threshold is adjustable)
- Tier cold Snapshot copies.
- Cooling period is 2 days.

▪ Auto

- Aggregate is at 50% capacity.
- Tier cold data blocks (includes Snapshot copies and user data from the active file system).
- Cooling period is 31 days.
- Random reads: Cold data moves back to performance tier.
- Sequential reads: (for example, antivirus scan): Cold data remains in cloud tier.

▪ Backup

- Destination volume (SnapMirror volume or SnapVault volume) starts in cloud tier.
- Activate destination volume: Data moves gradually to performance tier as it is read.

▪ None

- Data is prevented from moving to cloud tier

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To enable data tiering, you must select a volume tiering policy when you create, modify, or replicate a volume. You can select a different policy for each volume.

Some tiering policies have an associated minimum cooling period, which sets the time that user data in a volume must remain inactive for the data to be considered "cold" and moved to the cloud tier.

Cloud Volumes ONTAP supports the following tiering policies:

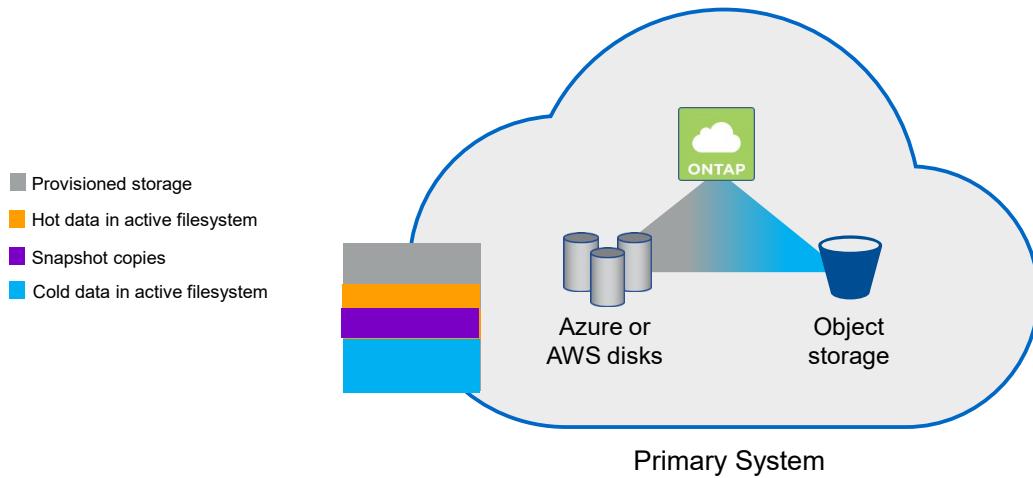
Snapshot Only:

After an aggregate has reached 50% capacity, Cloud Volumes ONTAP tiers cold user data of Snapshot copies that are not associated with the active file system to the cloud tier. The cooling period is approximately two days.

If read, cold data blocks on the cloud tier become hot and are moved to the performance tier.

Data Tiering with Primary Data

Tiering Policy: Snapshot Only, Snapshot data is tiered



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Tiering Policies

▪ Snapshot only

- Aggregate is at 50% capacity.
- Tier cold Snapshot copies.
- Cooling period is 2 days.

▪ Auto

- Aggregate is at 50% capacity.
- Tier cold data blocks (includes Snapshot copies and user data from the active file system).
- Cooling period is 31 days.
- Random reads: Cold data moves back to performance tier.
- Sequential reads: (for example, antivirus scan): Cold data remains in cloud tier.

▪ Backup

- Destination volume (SnapMirror volume or SnapVault volume) starts in cloud tier.
- Activate destination volume: Data moves gradually to performance tier as it is read.

▪ None

- Data is prevented from moving to cloud tier

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To enable data tiering, you must select a volume tiering policy when you create, modify, or replicate a volume. You can select a different policy for each volume.

Some tiering policies have an associated minimum cooling period, which sets the time that user data in a volume must remain inactive for the data to be considered "cold" and moved to the cloud tier.

Cloud Volumes ONTAP supports the following tiering policies:

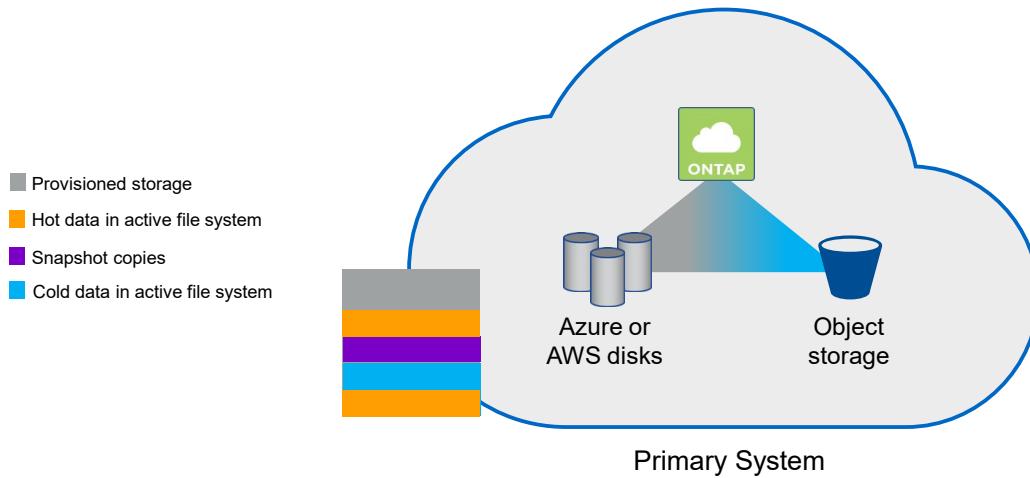
Snapshot Only:

After an aggregate has reached 50% capacity, Cloud Volumes ONTAP tiers cold user data of Snapshot copies that are not associated with the active file system to the cloud tier. The cooling period is approximately two days.

If read, cold data blocks on the cloud tier become hot and are moved to the performance tier.

Data Tiering with Primary Data

Tiering Policy: Auto, Inactive data and Snapshot data are tiered.



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Tiering Policies

- Snapshot only
 - Aggregate is at 50% capacity.
 - Tier cold Snapshot copies.
 - Cooling period is 2 days.
- Auto
 - Aggregate is at 50% capacity.
 - Tier cold data blocks (includes Snapshot copies and user data from the active file system).
 - Cooling period is 31 days.
 - Random reads: Cold data moves back to performance tier.
 - Sequential reads: (for example, antivirus scan): Cold data remains in cloud tier.
- Backup
 - Destination volume (SnapMirror volume or SnapVault volume) starts in cloud tier.
 - Activate destination volume: Data moves gradually to performance tier as it is read.
- None
 - Data is prevented from moving to cloud tier

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To enable data tiering, you must select a volume tiering policy when you create, modify, or replicate a volume. You can select a different policy for each volume.

Some tiering policies have an associated minimum cooling period, which sets the time that user data in a volume must remain inactive for the data to be considered "cold" and moved to the cloud tier.

Cloud Volumes ONTAP supports the following tiering policies:

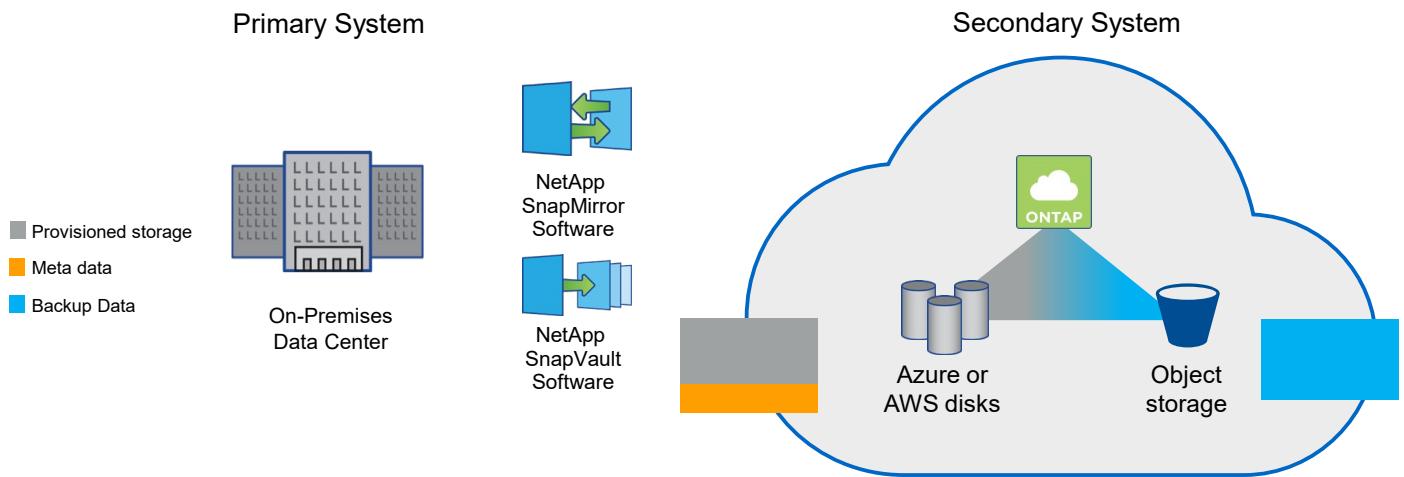
Snapshot Only:

After an aggregate has reached 50% capacity, Cloud Volumes ONTAP tiers cold user data of Snapshot copies that are not associated with the active file system to the cloud tier. The cooling period is approximately two days.

If read, cold data blocks on the cloud tier become hot and are moved to the performance tier.

Data Tiering with Primary Data

Tiering Policy: Backup, Meta data remains in backup destination, backup data is tiered



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Hands-On Activity

Module 6: NetApp Cloud Volumes ONTAP Data Tiering

Exercise 1: Tier Backup Data to Amazon Simple Storage Service

This exercise requires approximately **30 minutes**.

See your Exercise Guide.

ACTION: Share Your Experiences

Roundtable questions for the exercise



- If you lose the destination volume, can the S3 data be used as a backup?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.



Module Review

This module focused on enabling you to do the following:

- Cloud Volumes ONTAP supports data tiering in both AWS and Azure.
- There are four different data tiering policies that you can attach to a volume to enable tiering:
 - Snapshot only
 - Auto
 - Backup
 - None

You can use Cloud Manager to configure tiering policy at the following times:

- When you create a volume
- When you set up a SnapMirror relationship

You can use OnCommand System Manager to change the policy afterwards.



Module 7

NetApp Cloud Volumes ONTAP High Availability

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About This Module

This module focuses on enabling you to do the following:

- Explain high availability of Cloud Volumes ONTAP
- Describe the high-availability (HA) architecture of Cloud Volumes ONTAP in Amazon Web Services (AWS) and Azure
- Deploy Cloud Volumes ONTAP high availability in AWS by using OnCommand Cloud Manager

Why High Availability?

- Business continuity
- Regulation compliance
- Protection against failures
 - Cloud provider data center outage, hardware failures, or maintenance operations
- Zero downtime and no data loss
- Automatic failover and fallback processes



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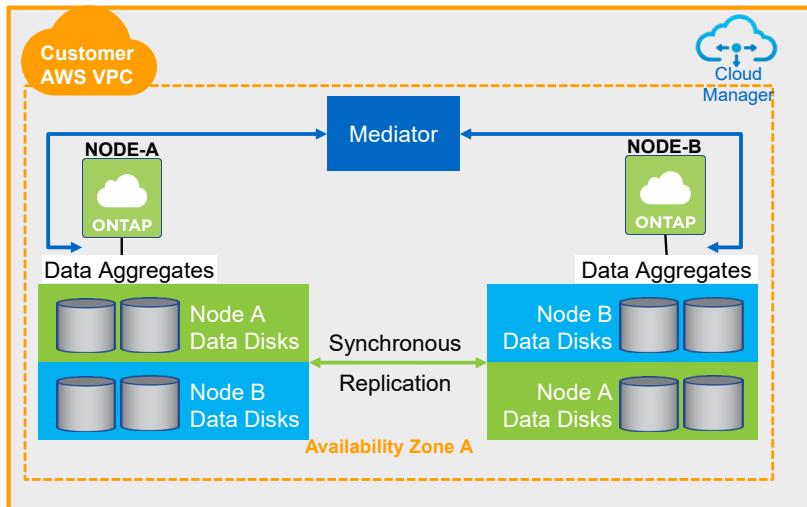
Recovery Point Objective and Recovery Time Objective

An HA configuration maintains high availability of your data as follows:

- The recovery point objective (RPO) is 0 seconds.
 - Data is transactionally consistent with no data loss.
- The recovery time objective (RTO) is 60 seconds.
 - In an outage, data should be available in 60 seconds or less.
- This condition is true for Cloud Volumes ONTAP high availability on the following:
 - AWS
 - Azure

Cloud Volumes ONTAP HA Architecture for Single AZ

Single availability Zone



Cloud Manager deploys the HA nodes and the mediator node in the same AZ.

VPC: Virtual Private Cloud

5

In AWS, Cloud Volumes ONTAP HA configurations include the following components:

- Two Cloud Volumes ONTAP nodes whose data is synchronously mirrored between each other.
- A mediator instance that provides a communication channel between the nodes to help in storage takeover and giveback processes.

The mediator instance runs the Linux OS on a t2.micro instance and uses one Amazon Elastic Block Store (Amazon EBS) magnetic disk that is approximately 8 GB.

Storage takeover and giveback:

If a node goes down, the other node can serve data for its partner to provide continued data service.

Clients can access the same data from the partner node because the data was synchronously mirrored to the partner.

After the node reboots, the partner must resynchronize data before it can return the storage. The time that it takes to resynchronize data depends on how much data was changed while the node was down.

A Cloud Volumes ONTAP HA configuration across multiple Availability Zones can enable high availability if a Cloud Volumes ONTAP node fails or an Availability Zone becomes unavailable.

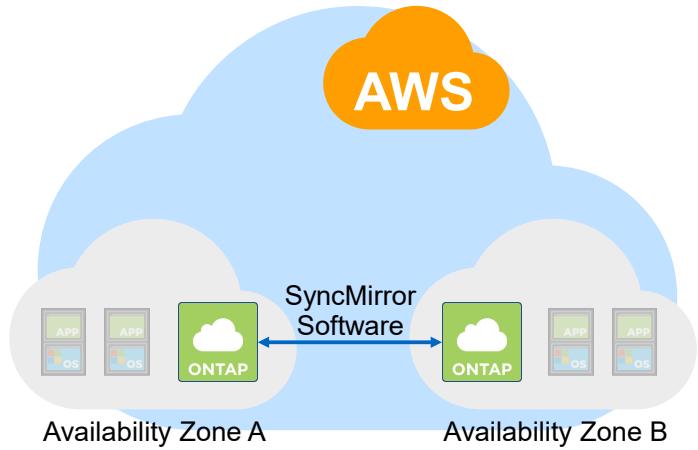
When a Cloud Volumes ONTAP HA configuration is spread across multiple Availability Zones, floating IP addresses are required for NAS data access from within the VPC. The floating IP addresses can migrate between nodes when failures occur. These floating IP addresses are not natively accessible to clients that are outside of the VPC. You should review requirements for floating IP addresses and route tables before you deploy an HA configuration across multiple Availability Zones.

For iSCSI, Cloud Volumes ONTAP uses multipath I/O and asymmetric logical unit access (or ALUA) to manage path failover between the active-optimized and indirect data paths.

High Availability with Synchronous Replication in multiple Availability Zones

Cloud Volumes ONTAP software high availability enables the following:

- Multi-Availability Zone (AZ) high availability and failover
- Multi-AZ synchronous data replication with zero RPO
- Enterprise applications in the cloud



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A Cloud Volumes ONTAP HA configuration provides nondisruptive operations and fault tolerance.

RPO and RTO

An HA configuration maintains high availability of your data as follows:

- The recovery point objective (RPO) is 0 seconds.

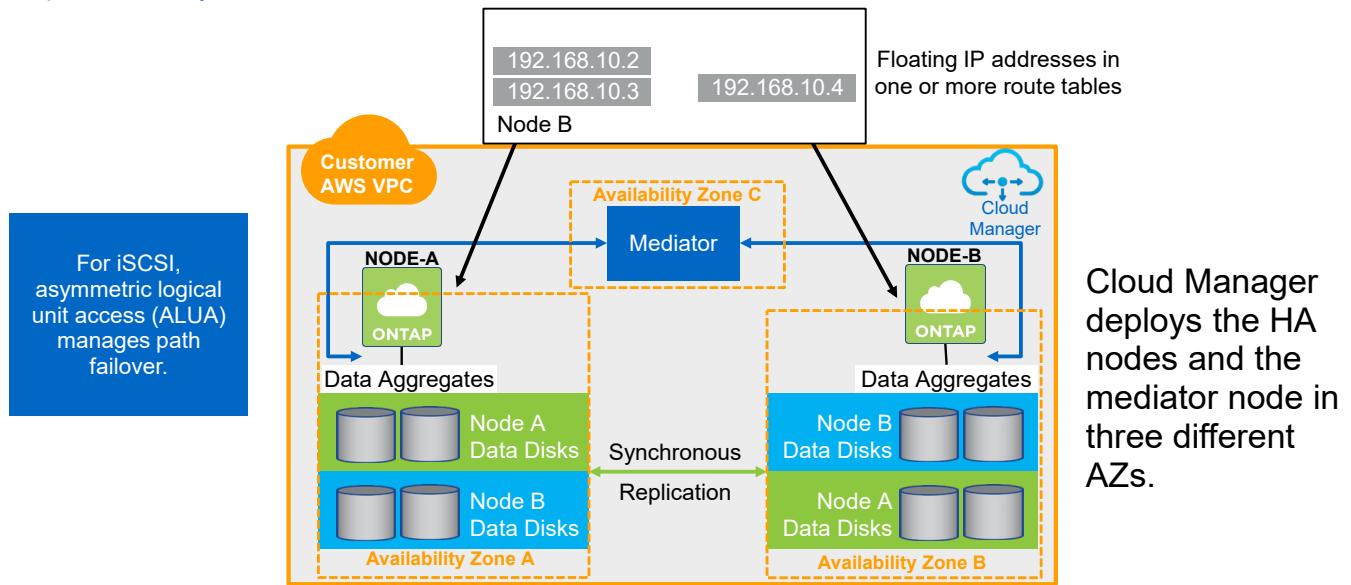
Your data is transactionally consistent with no data loss.

- The recovery time objective (RTO) is 60 seconds.

In an outage, data should be available in 60 seconds or less.

Cloud Volumes ONTAP HA Architecture for Multiple AZ

Multiple Availability Zones



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In AWS, Cloud Volumes ONTAP HA configurations include the following components:

- Two Cloud Volumes ONTAP nodes whose data is synchronously mirrored between each other.
- A mediator instance that provides a communication channel between the nodes to help in storage takeover and giveback processes.

The mediator instance runs the Linux OS on a t2.micro instance and uses one Amazon Elastic Block Store (Amazon EBS) magnetic disk that is approximately 8 GB.

Storage takeover and giveback:

If a node goes down, the other node can serve data for its partner to provide continued data service.

Clients can access the same data from the partner node because the data was synchronously mirrored to the partner.

After the node reboots, the partner must resynchronize data before it can return the storage. The time that it takes to resynchronize data depends on how much data was changed while the node was down.

A Cloud Volumes ONTAP HA configuration across multiple Availability Zones can enable high availability if a Cloud Volumes ONTAP node fails or an Availability Zone becomes unavailable.

When a Cloud Volumes ONTAP HA configuration is spread across multiple Availability Zones, floating IP addresses are required for NAS data access from within the VPC. The floating IP addresses can migrate between nodes when failures occur. These floating IP addresses are not natively accessible to clients that are outside of the VPC. You should review requirements for floating IP addresses and route tables before you deploy an HA configuration across multiple Availability Zones.

For iSCSI, Cloud Volumes ONTAP uses multipath I/O and asymmetric logical unit access (or ALUA) to manage path failover between the active-optimized and indirect data paths.

Cloud Volumes ONTAP High Availability in Multiple Availability Zones in AWS

Floating IP addresses

- High availability of your data is ensured if a failure occurs:
 - An AZ failure
 - An instance that runs a Cloud Volumes ONTAP node failure
- Three floating IP addresses are required for NAS data access from within the VPC.
 - Must be outside of the Classless Inter-Domain Routing (CIDR) blocks of all VPCs in the region
 - Can migrate between nodes when failures occur
- You provide the floating IP addresses to Cloud Manager when deploying Cloud Volumes ONTAP high availability.
- No floating IP addresses are needed for HA nodes in the same AZ.

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Deploying an HA configuration in multiple AZs ensures high availability of your data if a failure occurs with an AZ or an instance that runs a Cloud Volumes ONTAP node. You should understand how NAS IP addresses affect data access and storage failover.

These floating IP addresses are not natively accessible to clients that are outside of the VPC.

When deployed in multiple AZs, Cloud Volumes ONTAP high availability includes a separate set of IP addresses for NAS clients that are outside of the VPC. These IP addresses are static. They cannot migrate between nodes.

Three floating IP addresses are required:

One floating IP address is for cluster management, one is for NFS/CIFS data on node 1, and one is for NFS/CIFS data on node 2.

You must specify three floating IP addresses that are outside of the CIDR blocks for all VPCs in the AWS region in which you deploy the HA configuration. You can think of the floating IP addresses as a logical subnet that is outside of the VPCs in your region.

Route Table

The screenshot shows the AWS Route Table management interface. At the top, there are buttons for 'Create route table' and 'Actions'. Below is a search bar and a table with columns: Name, Route Table ID, Explicitly Associated with, Main, and VPC ID. Two rows are listed: 'private_rt' and 'public_rt'. The 'private_rt' row has 'Yes' under 'Main' and 'vpc-0b68ad2b3cefa9232' under 'VPC ID'. The 'public_rt' row has 'No' under 'Main' and 'vpc-0b68ad2b3cefa9232' under 'VPC ID'. Below the table is a 'Edit routes' button. Underneath is a 'View' dropdown set to 'All routes' and a table with columns: Destination, Target, and Status. Several routes are listed, including 10.223.0.0/16 (local, active), 0.0.0.0/0 (nat-0de3388f79da4424d, active), 172.16.55.128/28 (vgw-037f61f6cef575bbb, active), 192.168.0.1/32 (eni-085cedc25713e4d80, active), 192.168.0.2/32 (eni-085cedc25713e4d80, active), and 192.168.0.3/32 (eni-0306282e953766a9a, active). A callout box points to the '192.168.0.1/32' entry with the text: 'Route entries are automatically added or modified by using floating IPs.'

Name	Route Table ID	Explicitly Associated with	Main	VPC ID
private_rt	rtb-01ec475d26f0674a8	subnet-0f2051277d55429c1	Yes	vpc-0b68ad2b3cefa9232 ...
public_rt	rtb-0c9b2e6ec1c3a5332	subnet-0477dfce96d7c0948	No	vpc-0b68ad2b3cefa9232 ...

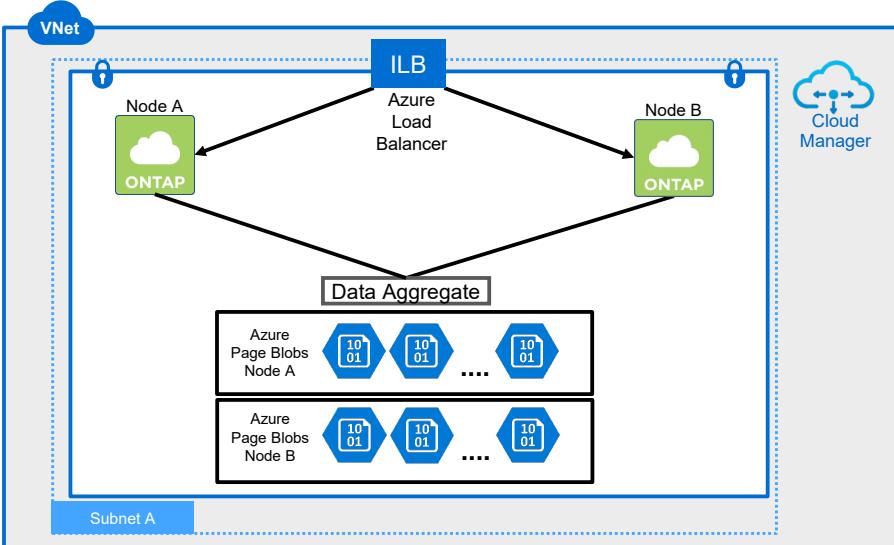
Destination	Target	Status
10.223.0.0/16	local	active
0.0.0.0/0	nat-0de3388f79da4424d	active
172.16.55.128/28	vgw-037f61f6cef575bbb	active
192.168.0.1/32	eni-085cedc25713e4d80	active
192.168.0.2/32	eni-085cedc25713e4d80	active
192.168.0.3/32	eni-0306282e953766a9a	active

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Cloud Volumes ONTAP High Availability in Azure

Architecture



- Same Resource Group
- VMs (Cloud Volumes ONTAP nodes)
 - In one availability set
 - In separate Update Domains and Fault Domains
- Storage
 - Nodes share a data aggregate
 - There is a single copy of data
 - Each node can access the other node's storage
 - Azure guarantees data availability

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ILB: Internal load balancing | VNet: Azure Virtual Network | VM: Virtual machine

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- Azure Standard Load Balancer: The load balancer manages incoming traffic to the Cloud Volumes ONTAP HA pair.
- 2 VMs
- Same resource group (logical grouping)
- Availability Set configuration: Guarantees that VMs are distributed across multiple isolated hardware nodes in a cluster, resulting in separate Update Domains (UDs) and Fault Domains (FDs).
- Storage: Customer data resides on premium storage page blobs. Each node has access to the other node's storage.

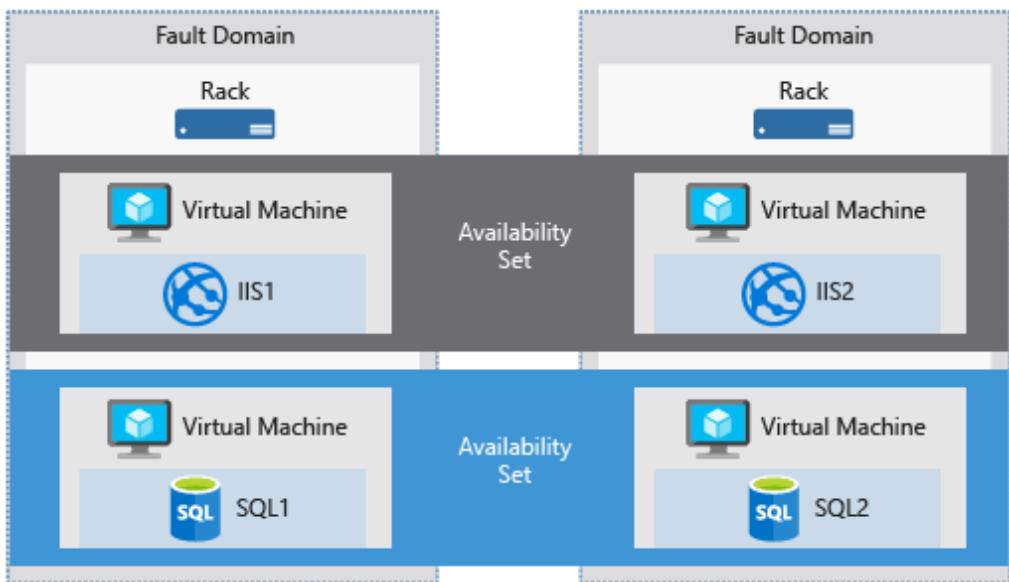
Only one copy of the data (Azure guarantees data availability with three copies.)

Storage Configurations

You can use an HA pair as an active-active configuration, in which both nodes serve data to clients. You can also use the HA pair as an active-passive configuration, in which the passive node responds to data requests only if it has taken over storage for the active node.

Fault Domain in Azure

Availability set



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Hands-On Activity

Module 7: NetApp Cloud Volumes ONTAP High Availability

Exercise 1: Implement Cloud Volumes ONTAP High Availability

This exercise requires approximately **60 minutes**.

See your Exercise Guide.

ACTION: Share Your Experiences

Roundtable questions for the exercise



- How did you specify that you need the HA nodes to be in different AZs?
- How many floating IP addresses did you provide when you deployed the Cloud Volumes ONTAP high availability in AWS?
- What did you need to do to include routes to the floating IP addresses?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.

Module Review



- You can deploy Cloud Volumes ONTAP in HA mode in AWS and Azure.
- In AWS, HA nodes can be in the same AZ or in different AZs.
- Floating IPs are needed for NAS data access when HA nodes are deployed in multiple AZs.
- HA nodes in Azure are deployed in separate Fault Domains but within the same resource group.



Module 8

Cloud Sync Service

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About This Module



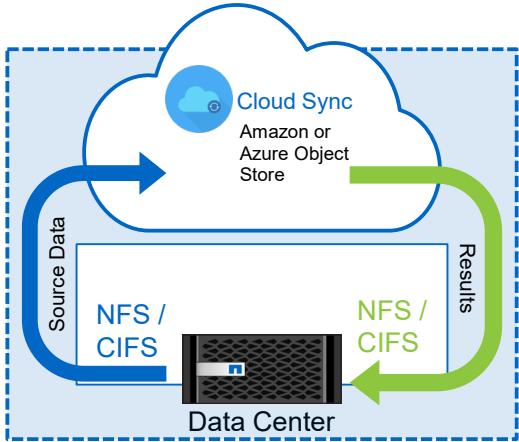
This module focuses on enabling you to do the following:

- Understand Cloud Sync offerings
- Implement data migration by using Cloud Sync service

Cloud Sync Service

- A data management service that enables seamless and secure synchronization of data between private and public clouds and object stores
- Capable of reducing data transfer times from hours to minutes through continuous data synchronization
- Charged by the hour based on the number of synchronization relationships that are created
- Ideal for analytics and big data applications because it puts data in the cloud where scalable compute resources can be tasked to process it

How Does Cloud Sync Service Work?



Continuously synchronize data to the cloud

- Avoid long upload times
- Achieve data synchronization between on-premises storage and Amazon Simple Storage Service (Amazon S3 or S3)
- Choose what data to synchronize and set the schedule

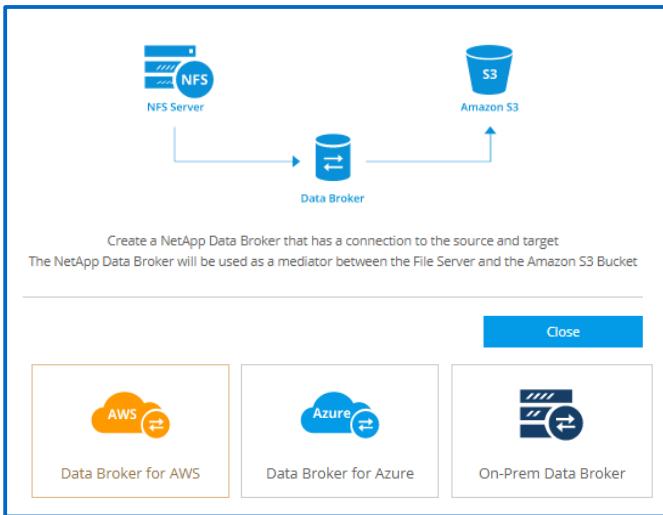
Run cloud-based services on demand

- Trigger services such as EMR, Redshift, and HDInsight with data in object stores
- Scale out compute resources nearly instantaneously

Deliver results automatically

- Optimize data transfer
- Synchronize from cloud object storage to on-premises storage
- Verify automatically

Data Broker: Powering Cloud Sync Service



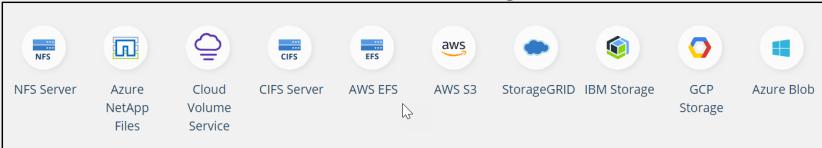
- Data Broker is the agent for data transformation.
- Data Broker serves as the mid point between the source and target.
- Data Broker works with API against S3 and natively with NFS (v3 and v4), CIFS, and Amazon Elastic File System (EFS).
- Deploy Data Broker in Amazon Web Services (AWS) or Azure or on-premises.

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Synchronization Relationships

Source and Target



Source and Target Requirements



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Set up synchronization relationships from the source and the target.

Cloud Sync API

- Enables automation and management of Cloud Sync service
- Can perform operations on resources that are categorized as the following:
 - NetApp Data Brokers
 - Relationships
 - Storages
 - Users
 - Many more
- Provides interactive API documentation through a Swagger interface
- Constructs curl commands

Base URL: /api

Reference Documentation: <https://cloudsync.netapp.com/docs/>

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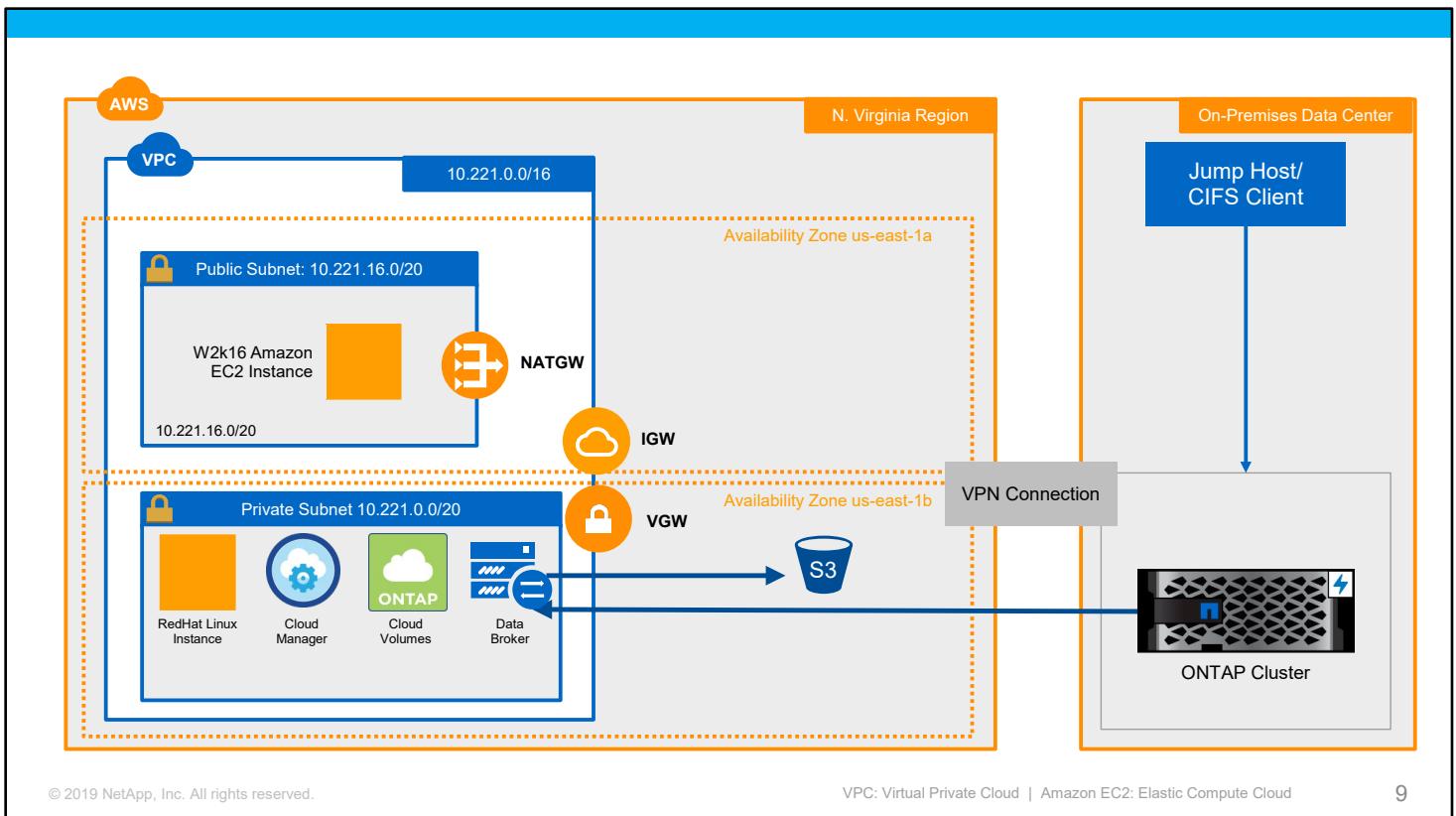
Hands-On Activity

Module 9: Cloud Sync Service

Exercise 1: Synchronize Data From On-Premises to Amazon Simple Storage Service

This exercise requires approximately **30 minutes**.

See your Exercise Guide.



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VPC: Virtual Private Cloud | Amazon EC2: Elastic Compute Cloud

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Use the existing setup:

- On-premises cluster with a CIFS client
- Existing VPC with Cloud Volumes ONTAP in a private subnet and a CIFS client in the public subnet

Create an S3 bucket in AWS.

Perform the cloud synchronization.

ACTION: Share Your Experiences

Roundtable questions for the exercise



- Does Cloud Sync service synchronize new data to the destination every time that the source data changes?

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If you encounter an issue, notify your instructor immediately so that it can be resolved promptly.

Module Review



- This module focused on enabling you to implement data migration by using Cloud Sync service.



Module 9

NetApp Cloud Volumes Service

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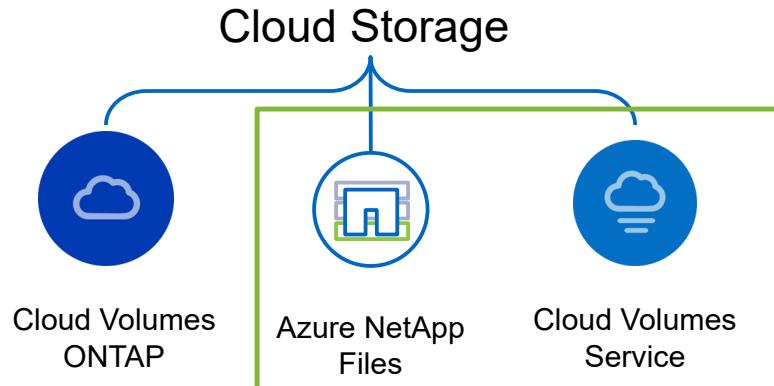
About This Module

This module focuses on enabling you to do the following:

- Explain the networking requirements in Amazon Web Services (AWS) to set up Cloud Volumes Service
- Describe NetApp Cloud Volumes Service for Google Cloud Platform
- Describe the Azure NetApp Files architecture
- Describe accessing NetApp Cloud Volumes
- Describe how Cloud Volumes accelerates cloud strategy

Enterprise Class Cloud Storage

Review



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Cloud Volumes Service

Available in major hyperscalers



NetApp Cloud Volumes
Service for AWS



Google Cloud Platform

NetApp Cloud Volumes
Service for Google
Cloud Platform

File Services

In Microsoft Azure



Azure NetApp Files

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Scenarios and Workloads



Migrate to Cloud

Portable Operating System Interface (POSIX)-compliant enterprise file workloads



Build New Applications

Simple, scalable, fast applications that use high-performance shared storage



Extract Insights

Ability to use cloud services. Big data, containers, machine learning



Open Source Software or Mixed Environment



Home Directories

Enterprise File Applications

Databases

Web Applications

Analytics

DevOps

Electronic Design Automation

Media and Entertainment

Collaborative Tools

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Migrate to Cloud: The customer is migrating workloads to the cloud but has dependency on file storage and has strict on-premises requirements about versions. The customer cannot eliminate features or sacrifice on performance or scale.

Build New Applications: The customer needs new applications. These cloud native applications require shared storage and some of the capabilities that ONTAP software provides, such as Snapshot copies, FlexClone volumes, or granular control over data protection.

Extract Insights: The customer wants to do more with data and use IP of Azure for more services. These services are such as machine learning, cognitive services, AI, and Internet of Things (IoT), that are not practical or feasible in a normal on-premises deployment. Cloud Volumes can be the secure and scalable storage to enable these services.



Cloud Volumes Service for AWS

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What Is Cloud Volumes Service for AWS?

- Provides a fully managed service in AWS with advanced data management capabilities
- Supports workloads in the cloud that require NFS or SMB or both
- Enables customers to match capacity and performance to their application needs and attain persistent storage without adding complexity

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Amazon Elastic File System (Amazon EFS) is the first native NFS service on AWS, but it has some limitations:

- No support for SMB or NFSv3
- Support for only NFSv4
- Limited NFSv4.1 support
- No built-in backup, snapshots, or clones
- Limited number of file systems per account
- Performance challenges
- No Kerberos or access control list (ACL)
- Complex to scale

Cloud Volumes adds the following:

- Support for NFSv3, NFSv4, CIFS, and SMB (~80% of enterprise file data is on NFSv3)
- Native Snapshot copies
- Predictable performance based on SLAs (2-ms latency)
- NetApp reliability, availability, and security
- More than 25 years of experience in developing solutions and contributing code to NFS

Cloud Volumes Service for AWS

Overview

Fully managed Service	<ul style="list-style-type: none">▪ Requested, fulfilled, and billed through AWS▪ APIs in the cloud
Availability and durability	<ul style="list-style-type: none">▪ High durability (8 nines)▪ High availability (4 nines)
Scalability	<ul style="list-style-type: none">▪ 100 TB per file volume▪ 100s of shares per subscription – 1,000s of clients per share▪ Multiple Virtual Private Clouds (VPCs) supported
Performance	<ul style="list-style-type: none">▪ Multiple service levels to match application needs▪ Low latency, consistent performance
Simple, on-demand file share	<ul style="list-style-type: none">▪ NFS v3, v4, and v4.1▪ SMB 3.0 and 3.1.1
Rich data management (add-on services)	<ul style="list-style-type: none">▪ NetApp Snapshot copies, restore, and clones▪ Cross-region and hybrid-cloud backup and replication with NetApp data movers
Security	<ul style="list-style-type: none">▪ Data at rest encryption▪ Secure multitenancy, Active Directory, and (LDAP) integration export policies

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Cloud Volumes Service for AWS

Service levels



GO FROM ZERO TO 100TB deployed in seconds, fully automated

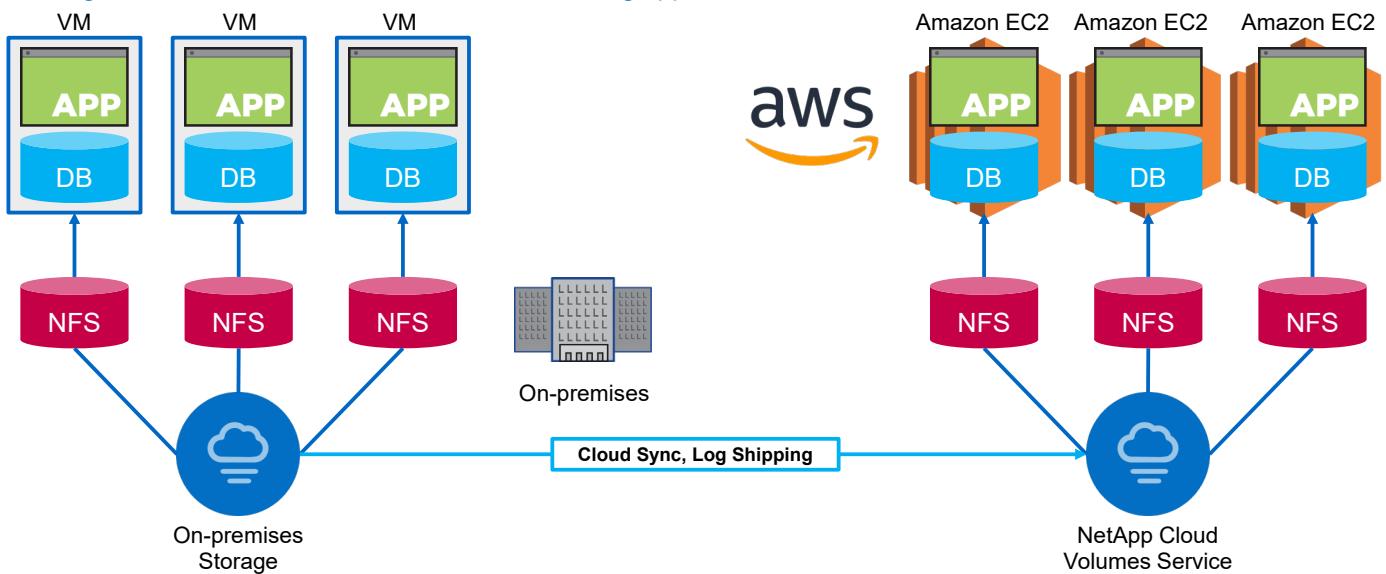
Standard Package	Premium Package	Extreme Package
<p>Standard performance provides the following:</p> <ul style="list-style-type: none">▪ 1000 IOPS per TB▪ 16 MBps per TB	<p>Premium performance provides the following:</p> <ul style="list-style-type: none">▪ 4000 IOPS per TB▪ 64 MBps per TB	<p>Extreme performance provides the following:</p> <ul style="list-style-type: none">▪ 8000 IOPS per TB▪ 128 MBps per TB
NFS or SMB. Snapshot copies, clones, Cloud Sync integration		

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Cloud Volumes Service for AWS: Usage Example

Shifting databases to the cloud to avoid rearchitecting applications

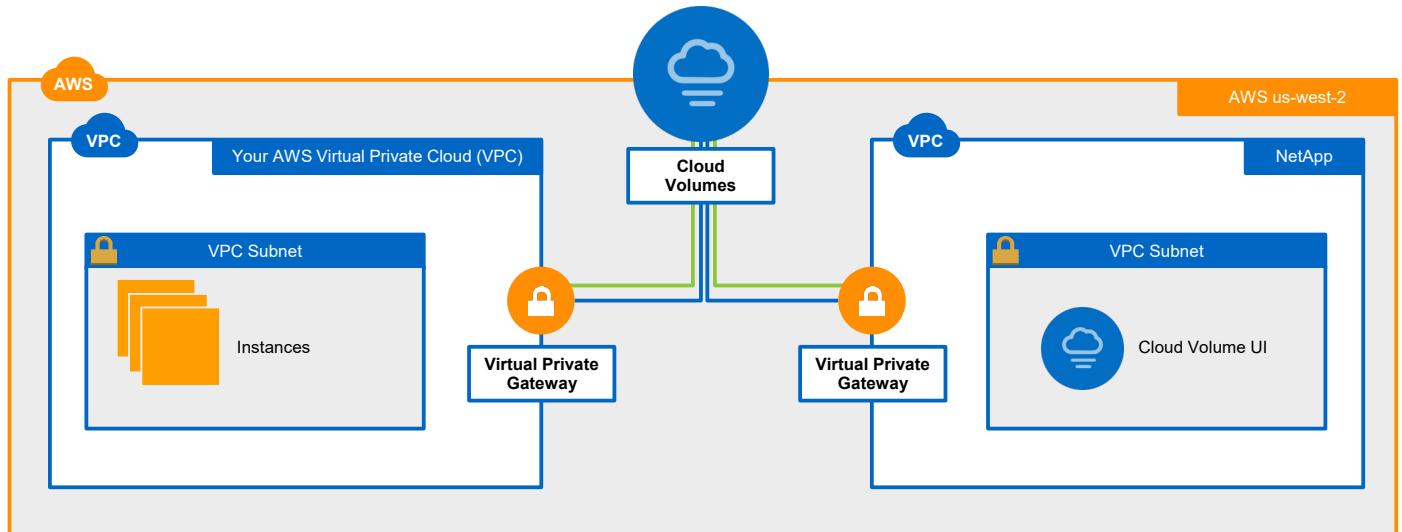


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VM: Virtual machine | Amazon EC2: Amazon Elastic Compute Cloud

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Architecture



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Network Connectivity to Infrastructure That Is Hosting Cloud Volumes

Virtual private gateway and Direct Connect gateway

- **Virtual Private Gateway**

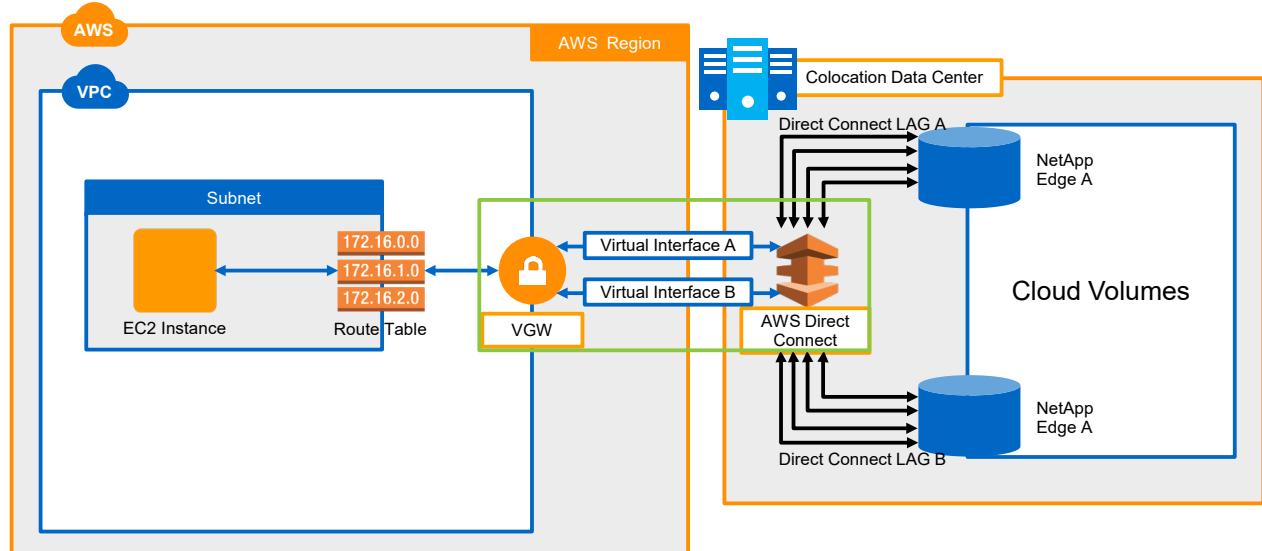
- This gateway enables only one VPC to be connected to the infrastructure that is hosting Cloud Volumes.
- Data access is isolated to a single VPC for security.

- **Direct Connect Gateway**

- This gateway enables up to 10 VPCs to be connected to the Cloud Volumes Service.
- VPCs can be in different regions.

Cloud Volumes Service Connectivity

Using virtual private gateway

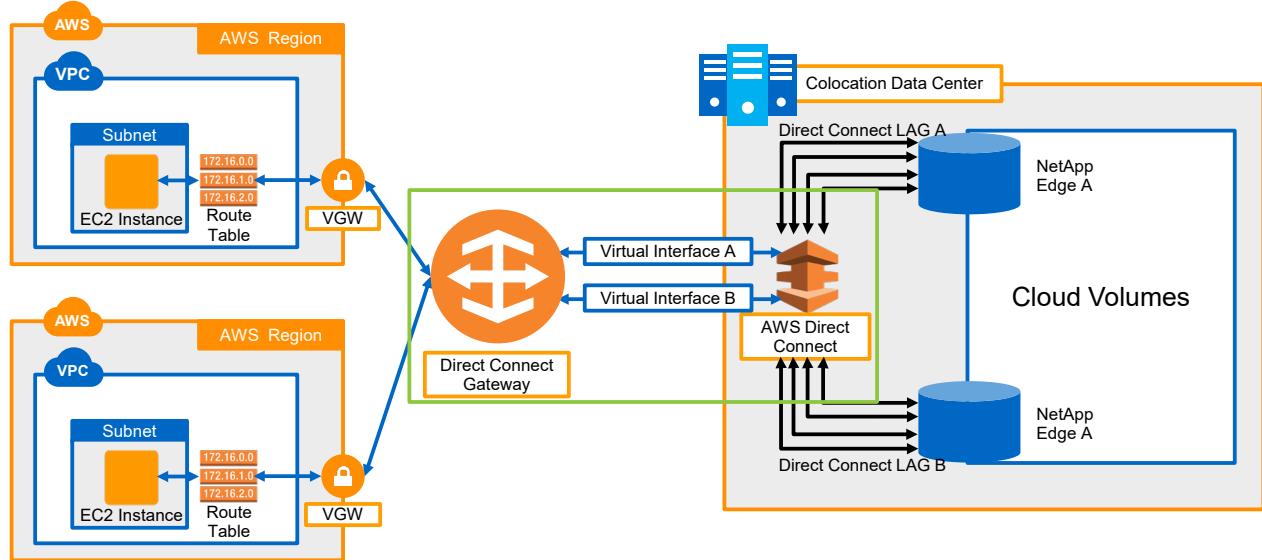


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Cloud Volumes Service Connectivity

Using Direct Connect gateway



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You can use an AWS Direct Connect gateway to connect your AWS Direct Connect connection over a private virtual interface to one or more VPCs in your account. These VPCs can be located in the same region or different regions. You associate a Direct Connect gateway with the virtual private gateway for the VPC. You then create a private virtual interface for your AWS Direct Connect connection to the Direct Connect gateway. You can attach multiple private virtual interfaces to your Direct Connect gateway.

A Direct Connect gateway is a globally available resource. You can create the Direct Connect gateway in any public region. You can access it from all other public regions.

In the diagram, the Direct Connect gateway enables you to use your AWS Direct Connect connection in the US East (N. Virginia) region to access VPCs in your account in both the US East (N. Virginia) and US West (N. California) regions.

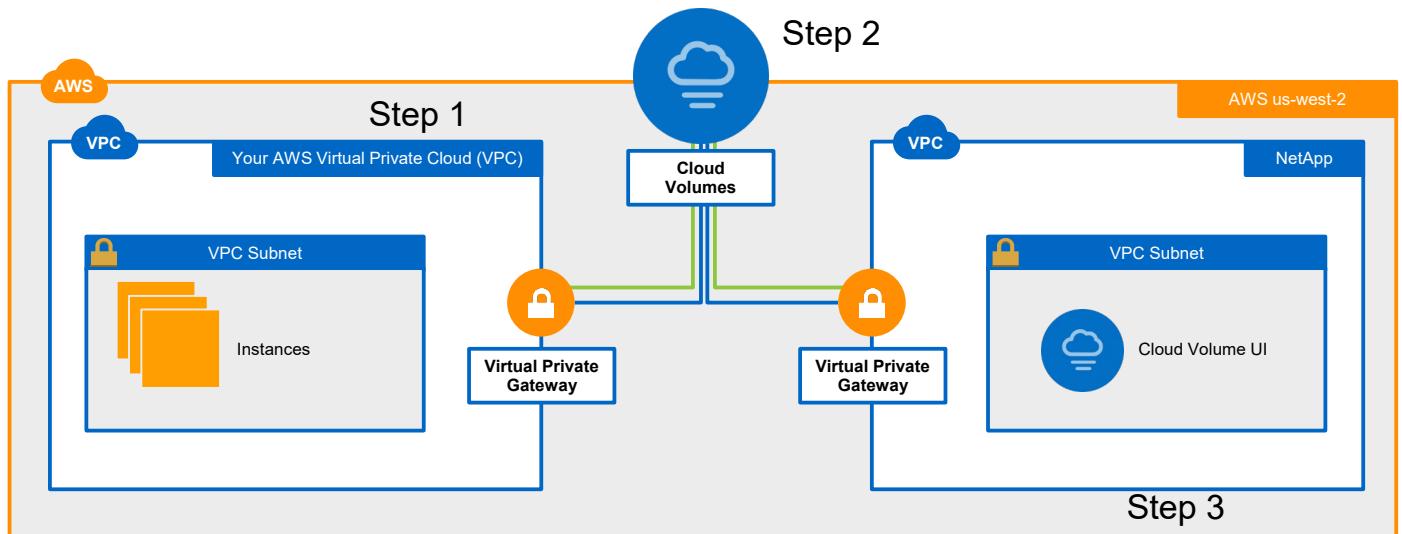


Setting up Cloud Volumes Service for AWS

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Architecture

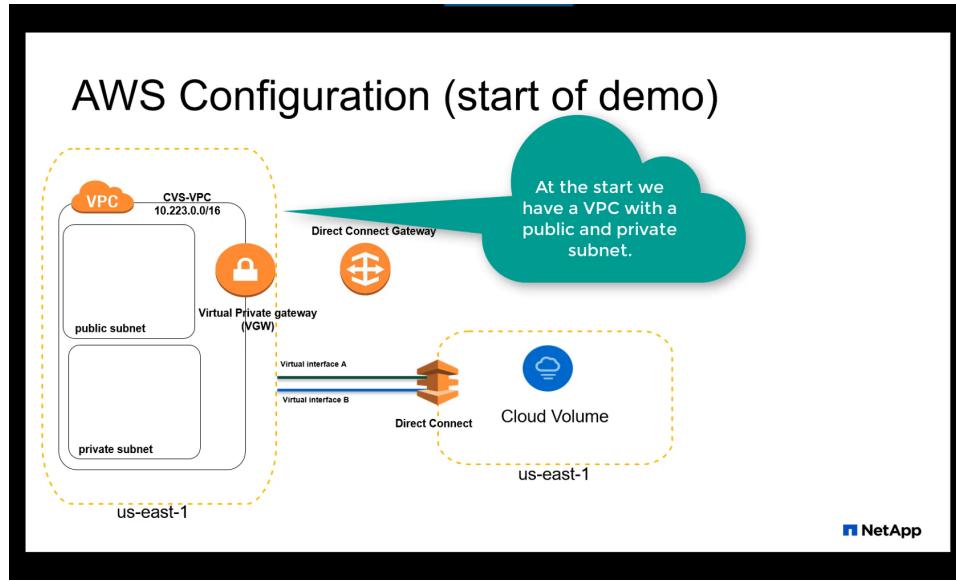


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Demonstration

Customer VPC to NetApp Private Storage Connectivity for Cloud Volumes Service



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Cloud Volumes Service API

- Enables automation and management of Cloud Volumes Service
- Supports operations on resources categorized as the following:
 - File systems
 - Mount targets
 - Snapshot copies
 - Backups
 - And more
- Provides interactive API documentation through a Swagger interface
- Constructs curl commands

API URLs are relative to nfs.netapp.com

https://app.swaggerhub.com/apis/NetApp-Cloud/c-vaa_s/



Hands-On Activity

Module 10: NetApp Cloud Volumes Service

Exercise 1: Create NFS and CIFS volume

This exercise requires approximately **90 minutes**

See your Exercise Guide.

Integrated Cloud Backup Service (Beta)

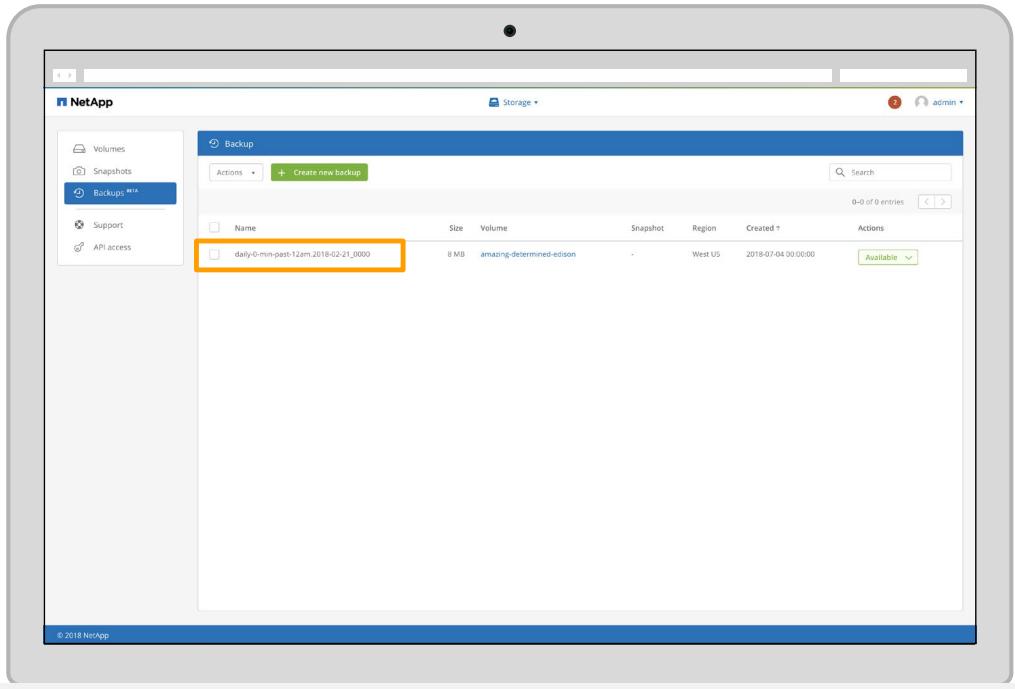
The screenshot shows the NetApp Storage interface. On the left, a sidebar menu includes 'Volumes', 'Snapshots', 'Backups BETA' (selected), 'Support', and 'API access'. The main area displays a 'Create backup' dialog with the following fields: 'Volume Required' set to 'amazing-determined-edison (el)', 'Description' set to 'Creating ad-hoc backup...', and two buttons at the bottom: 'Cancel' and 'Create backup'.

Cloud Volumes

A blue cloud icon with a white outline and a grey cylinder icon representing a volume are connected by a blue arrow pointing towards an orange cloud icon containing the AWS logo and the text 'S3 Object Storage'. Below this diagram is the text 'S3: Amazon Simple Storage Service (Amazon S3)'.

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Volumes

Snapshots

Backups BETA

Support

API access

Volume - amazing-determined-edison (e8473aa6-ac40-0116-adf1-3e0dba8059bc)

Name: amazing-determined-edison [edit](#)

Tags: [edit](#)

Volume path: /amazing-determined-edison

Reserved for snapshots: 0% [edit](#)

Created: 2 days ago

Used storage: 0 B

Quota: 1 TB [edit](#)

Service level: Premium [edit](#)

Available

Mount targets Export policy Snapshots Snapshot policy Backups BETA

Backup policy

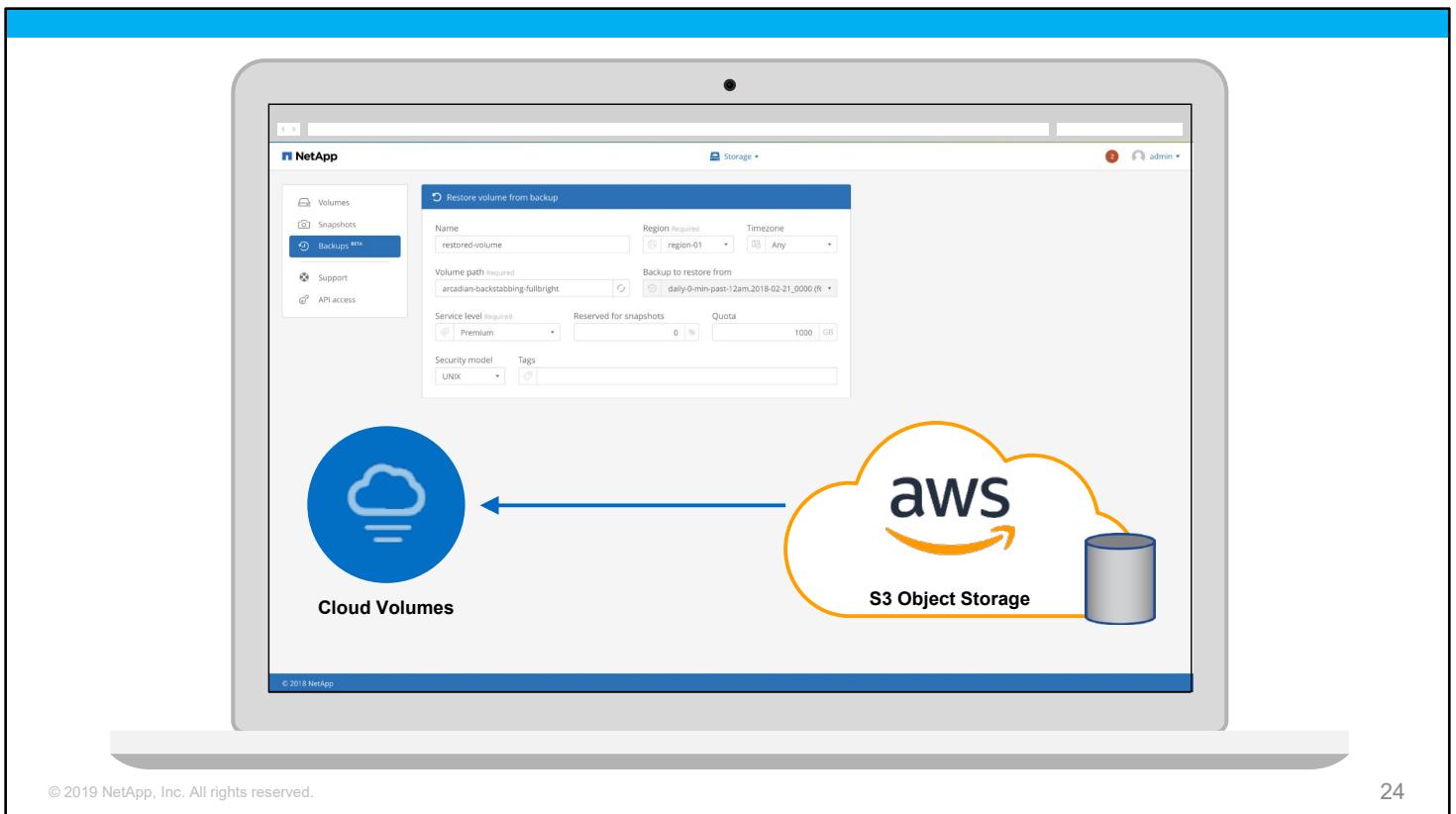
Enabled OFF

Daily Weekly Monthly

Restore points to keep

Explanation: No daily backups scheduled, change "Restore points to keep" to activate daily backup.

Save changes



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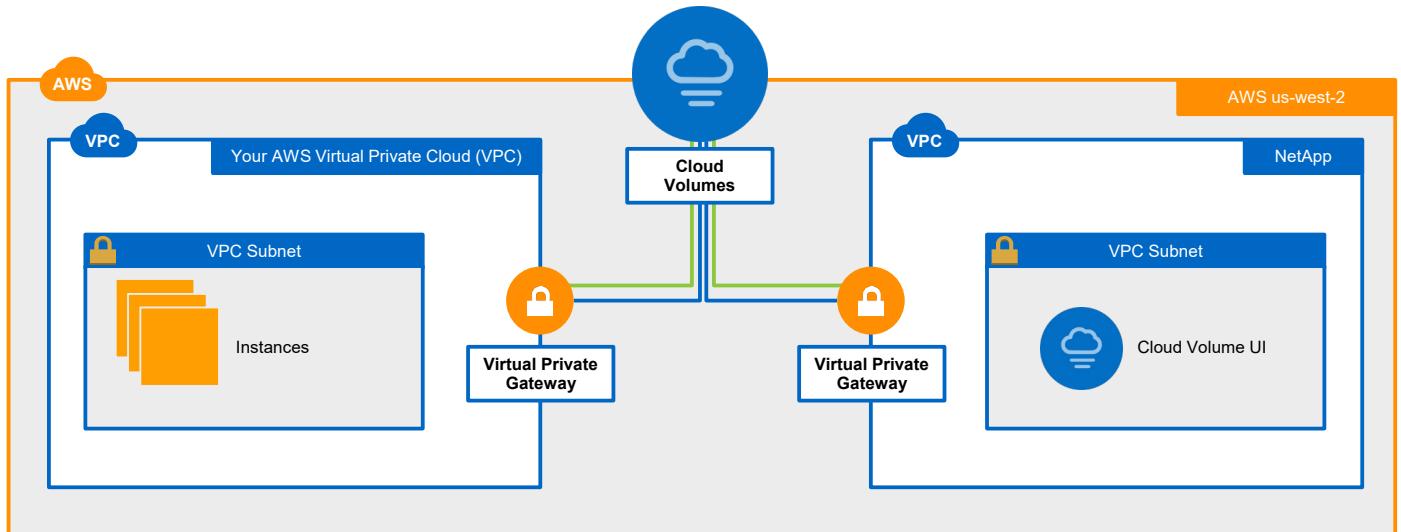
24

Are Backups Secure?



- Yes! End-to-end security
- Data secured at rest with AES-256 bit encryption
- Data secured in flight to object storage by using Transport Layer Security (TLS) and HTTPS
- NetApp controlled cloud access (encryption key, cloud credentials, and cloud management access)
 - Multiple layers of encryption for tenant security and separation
 - No single global encryption key
- Private network connections to Cloud Volumes Service and object storage for operations
No public access

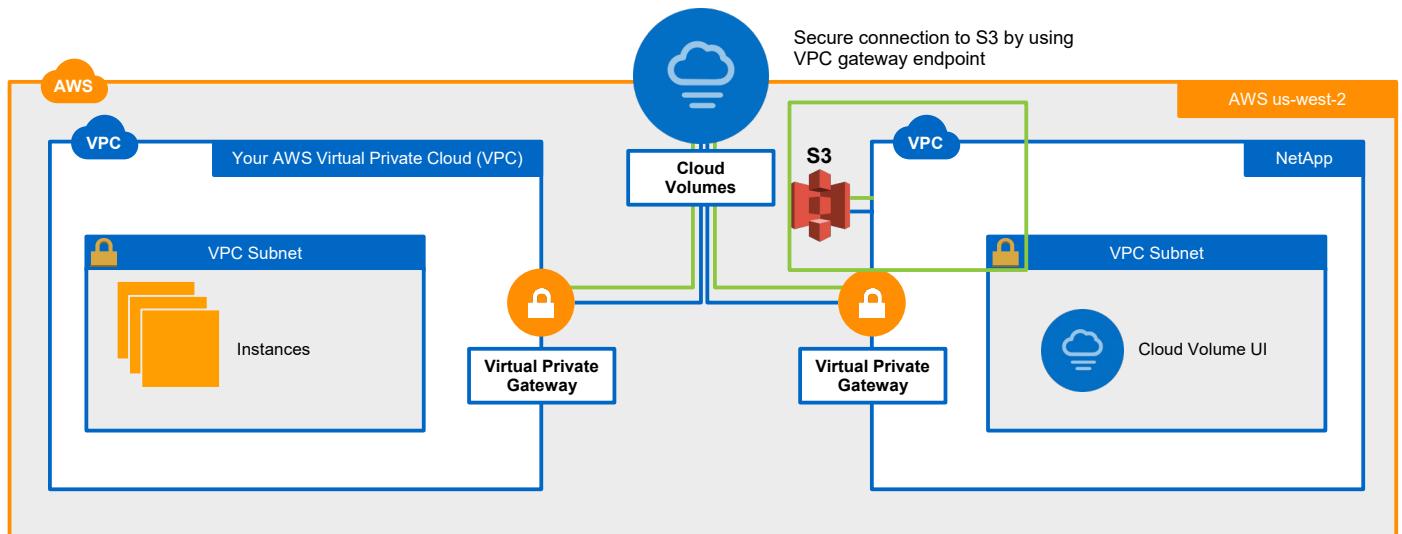
Architecture



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Architecture for S3 Backup



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Cloud Volumes Service for Google Cloud Platform

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Cloud Volumes for Google Cloud Platform



NoOps (managed) service

No infrastructure to be configured or managed. Automated monitoring, patching, upgrades, and so on.



Native user experience

Ability to manage service through Google Cloud Platform console: provision, manage, and monitor Cloud Volumes



Three performance service levels

Select among Extreme (128 MBps per TB), Premium, and Standard



Integrated support

L1 support managed by Google Cloud team, with the same service-level objectives (SLOs) as Google Cloud Platform services



Multiprotocol NFS and SMB

Ability to run applications that require POSIX-compliant enterprise file services



"Pay-as-you-go"

GB per month pricing per SKU, just like other cloud native services



Integrated billing

Single line-item for service, billed by Google Cloud as part of regular Google Cloud Platform invoice



Rich data management

Snapshot copies, rapid copies, and data synchronization

Service Levels



Standard

16 MBps per TB

Use cases

- Webserving
- File backup
- Home directories



Premium

64 MBps per TB

Use cases

- Virtualized applications
- General-purpose databases
- Binary artifact repositories
- Application transfer bus



Extreme

128 MBps per TB

Use cases

- High performance computing
- OLTP

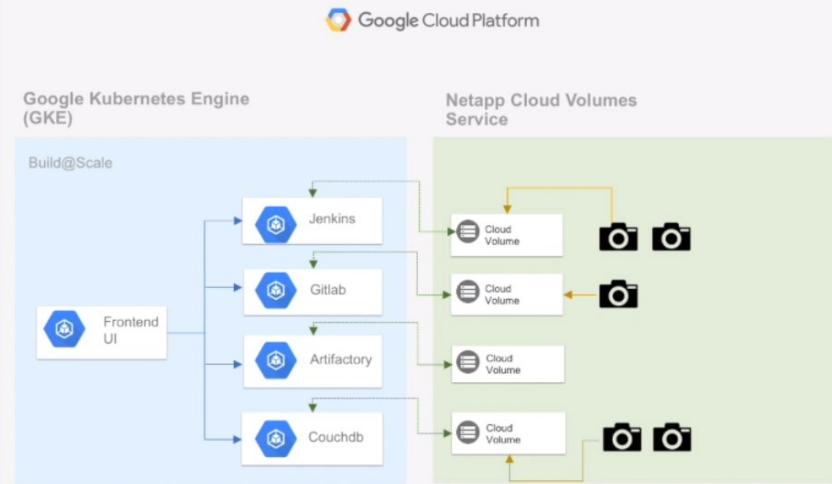
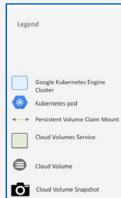
Protocols: NFS | SMB

Data Management Features: Snapshot Copies | Copies | Clones | Synchronization

Cloud Volumes Service for Google Cloud Platform: Usage Example

Persistent storage for containerized applications with Cloud Volumes Service for Google Cloud Platform

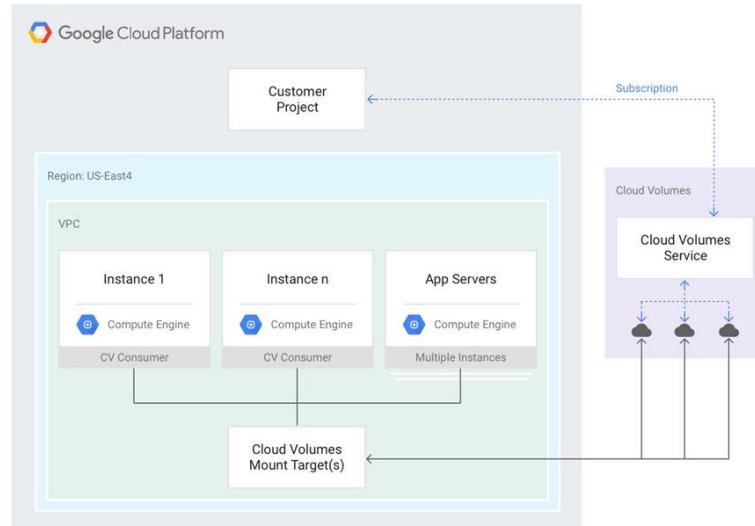
- Data persistence for Kubernetes applications
- Improved resiliency for critical Kubernetes applications



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Architecture

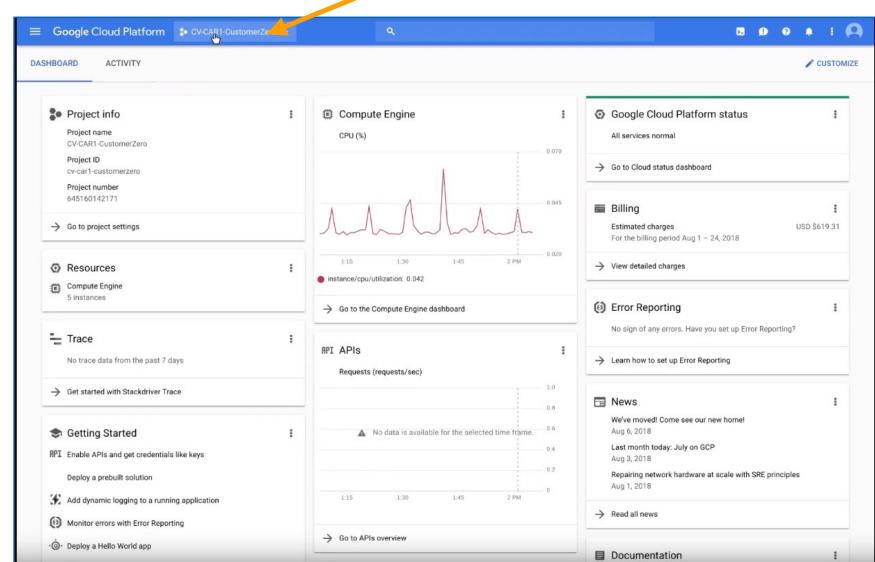


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Cloud Volumes Service for Google Cloud Platform

- Log in to your GCP project.
- Get whitelisted for CVS.
- Use a custom URL to access the Cloud Volumes Service.
- It takes you to the landing page of the Cloud Volumes Service UI.



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Cloud Volumes Service for Google Cloud Platform

Cloud Volumes Service UI for Google Cloud Platform

The screenshot shows two windows side-by-side. On the left is the 'Cloud Volumes' list page, and on the right is the 'Create volume' dialog.

Cloud Volumes List (Left):

- Header: Google Cloud Platform, Project: CV-CART-CustomerZero, Filter: Volumes
- Actions: Volumes, CREATE, DELETE
- Table Headers: Name, Region, Life cycle, Service level, Mount targets, Usage, Allocated capacity
- Table Data:

Name	Region	Life cycle	Service level	Mount targets	Usage	Allocated capacity
joshua...v	us-east4	available	premium	0 GB	1000 GB	
mogj...v	us-east4	available	premium	0 GB	100 GB	
mogi...v	us-east4	available	premium	0 GB	100 GB	
mogi...v	us-east4	available	premium	0 GB	1000 GB	
randomtest	us-east4	error	premium	0 GB	100 GB	
randomtest2	us-east4	available	premium	0 GB	100 GB	

Create Volume Dialog (Right):

- Header: Google Cloud Platform, Project: CV-CART-CustomerZero, Create volume
- Section: NFS
- Form Fields:
 - Name: demovolume1
 - Volume path: infallible-hopeful-yallow
 - Service level:
 - Standard (selected)
 - Premium
 - Extreme
 - Region: us-east4
 - Snapshot: (dropdown)
 - Allocated capacity: 2000 GB
 - Reserved for snapshots: (checkbox)
 - Export policy: (checkbox)
 - Rules: (button)

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Azure NetApp Files

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Azure NetApp Files

Overview

- Fully Managed File Service
 - Native Azure integration (Portal, REST, CLI, Billing, Monitoring, and Security)
 - Sold and supported by Microsoft
- The Power of ONTAP Software
 - The world's No. 1 storage systems, 300,000 customers over 25 years
 - Complete protocol support
 - High availability, data protection, data management (Snapshot copies and clones), and performance
- Hybrid
 - Data migration and replication capabilities
- Secure
 - Data-at-rest encryption, role-based access control (RBAC)



Azure NetApp Files

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Service Levels

	Standard	Premium	Ultra
Performance	HDD Class	Solid-State Drive (SSD) ▪ Up to 4,000 IOPS/TB provisioned (16k) ▪ Up to 64 MBps per TB provisioned	High-Performance Flash
Workload Type	Static Web Content, File Shares, and Database Backups	Databases, Enterprise Applications, Analytics, and Technical Applications	Latency-Sensitive Applications
Availability	Future	Now	Future

Performance SLA is indexed against volume quota.

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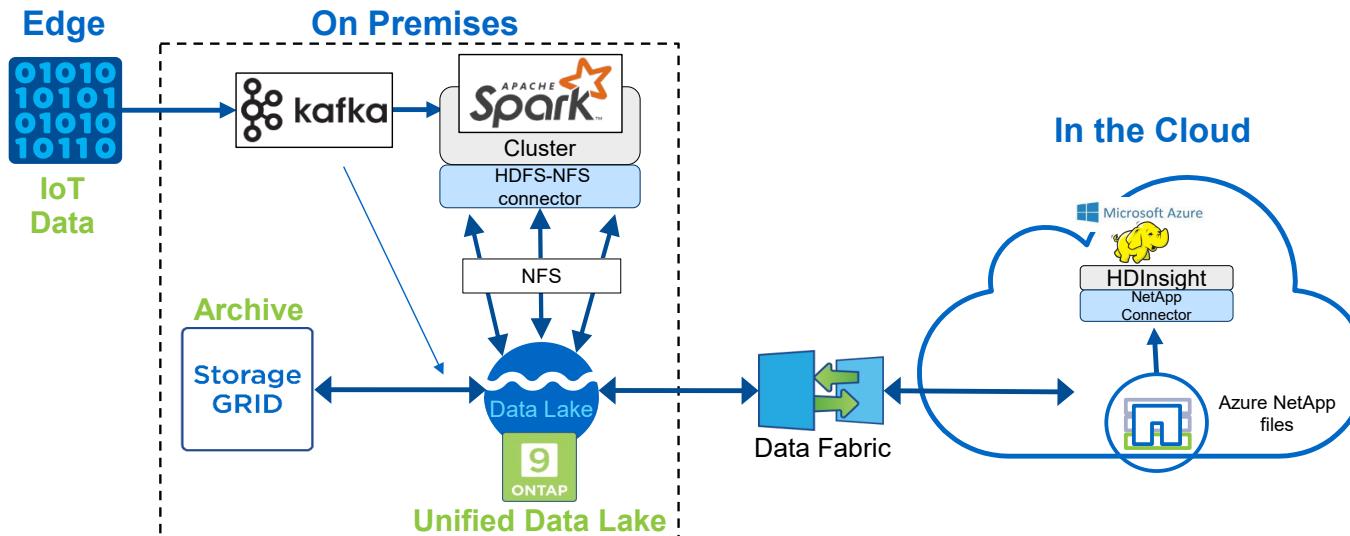
You have a purchased capacity. Another attribute is the service level of that capacity pool.

Premium is mainstream SSD class performance.

With Premium, you have 64 MBps of throughput per purchased TB. This capacity scales in real time with the volume that you create. If you have a 1TB volume, you get 64MBps of throughput. If you have a 2TB volume, you get 128MBps of throughput.

Azure NetApp Files: Usage Example

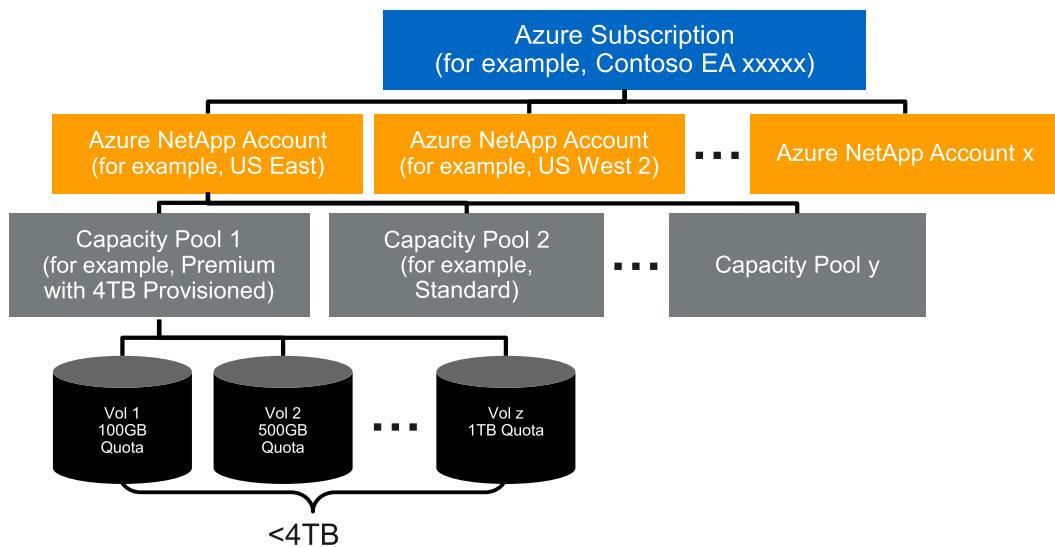
HDInsight using NFS data available in ANF



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Storage Hierarchy



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Two key components are storage capacity and performance level.

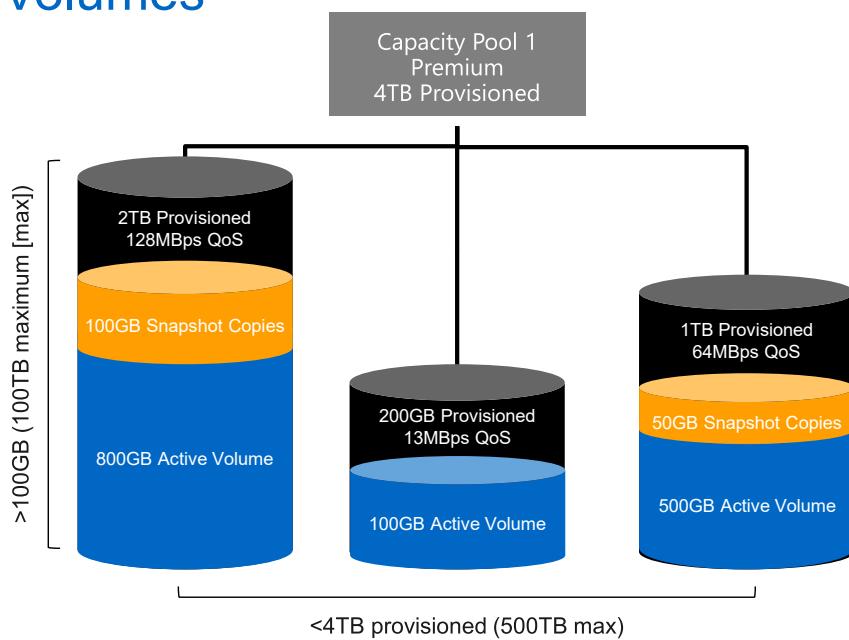
Storage capacity is purchased on a “provisioned” capacity basis. 4TB is the first minimum purchase.

The performance level then dictates how much performance per TB that you receive.

You partition volumes from the capacity pools. Volumes can be as small as 100GB up to the size of the capacity pool.

The pool is the purchased amount. You consume volumes against that amount.

Volumes



▪ Provisioned Capacity Pool

- Provisioned 4TB
- Billed provisioned amount (hourly)

▪ Create Volumes

- Assign Quota (3.2TB assigned)
- Decrements from pool capacity (0.8TB remaining)
- Quality of service (QoS) per volume assigned based on quota

▪ Consume Capacity

- Active file system at logical
- Snapshot copies at incremental
- 1.55TB of actual consumption

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Module Review

This module enabled you to:

- Describe Cloud Volumes Service for AWS, Cloud Volumes Service for Google Cloud Platform, and Azure NetApp Files
- Explain the networking requirements in AWS to set up Cloud Volumes Service
- Describe accessing Cloud Volumes
- Describe how Cloud Volumes accelerates cloud strategy

Course Highlights



- The Data Fabric powered by NetApp provides customers with a shared set of secure data services so that they can manage, access, and protect data where it is needed most
- The Data Fabric can be woven to implement many use cases in a hybrid cloud (for example, disaster recovery, cloudburst, and primary workloads)
- NetApp provides many cloud data services for customers through the NetApp Cloud Central page to accelerate their cloud workloads



Action: Take the Assessment

- Please complete the Integrating Hybrid Clouds with NetApp Data Fabric Assessment.
- Deeplink:
learningcenter.netapp.com/LC?ObjectType=WBT&ObjectID=00359244



ACTION: Provide Feedback



Take a few minutes to complete the survey for this course.

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Your feedback is important to ensure the quality of NetApp courses. Use the instructions from your instructor to find the survey for this class and to use the survey website.

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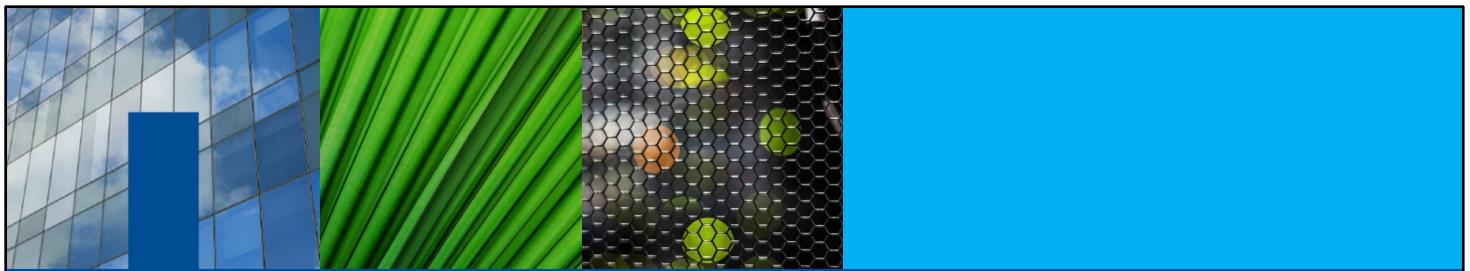
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