



Get started

Cloud Volumes ONTAP

NetApp
August 10, 2022

This PDF was generated from <https://docs.netapp.com/us-en/cloud-manager-cloud-volumes-ontap/azure/concept-overview-cvo.html> on August 10, 2022. Always check docs.netapp.com for the latest.

Table of Contents

- Get started 1
 - Learn about Cloud Volumes ONTAP 1
 - Get started in Microsoft Azure 2

Get started

Learn about Cloud Volumes ONTAP

Cloud Volumes ONTAP enables you to optimize your cloud storage costs and performance while enhancing data protection, security, and compliance.

Cloud Volumes ONTAP is a software-only storage appliance that runs ONTAP data management software in the cloud. It provides enterprise-grade storage with the following key features:

- Storage efficiencies

Leverage built-in data deduplication, data compression, thin provisioning, and cloning to minimize storage costs.

- High availability

Ensure enterprise reliability and continuous operations in case of failures in your cloud environment.

- Data protection

Cloud Volumes ONTAP leverages SnapMirror, NetApp's industry-leading replication technology, to replicate on-premises data to the cloud so it's easy to have secondary copies available for multiple use cases.

Cloud Volumes ONTAP also integrates with Cloud Backup to deliver backup and restore capabilities for protection, and long-term archive of your cloud data.

[Learn more about Cloud Backup](#)

- Data tiering

Switch between high and low-performance storage pools on-demand without taking applications offline.

- Application consistency

Ensure consistency of NetApp Snapshot copies using NetApp SnapCenter.

[Learn more about SnapCenter](#)

- Data security

Cloud Volumes ONTAP supports data encryption and provides protection against viruses and ransomware.

- Privacy compliance controls

Integration with Cloud Data Sense helps you understand data context and identify sensitive data.

[Learn more about Cloud Data Sense](#)



Licenses for ONTAP features are included with Cloud Volumes ONTAP.

[View supported Cloud Volumes ONTAP configurations](#)

Get started in Microsoft Azure

Quick start for Cloud Volumes ONTAP in Azure

Get started with Cloud Volumes ONTAP for Azure in a few steps.

1

Create a Connector

If you don't have a [Connector](#) yet, an Account Admin needs to create one. [Learn how to create a Connector in Azure.](#)

When you create your first Cloud Volumes ONTAP working environment, Cloud Manager prompts you to deploy a Connector if you don't have one yet.

2

Plan your configuration

Cloud Manager offers preconfigured packages that match your workload requirements, or you can create your own configuration. If you choose your own configuration, you should understand the options available to you. [Learn more.](#)

3

Set up your networking

- a. Ensure that your VNet and subnets will support connectivity between the Connector and Cloud Volumes ONTAP.
- b. Enable outbound internet access from the target VNet so the Connector and Cloud Volumes ONTAP can contact several endpoints.

This step is important because the Connector can't manage Cloud Volumes ONTAP without outbound internet access. If you need to limit outbound connectivity, refer to the list of endpoints for [the Connector and Cloud Volumes ONTAP](#).

[Learn more about networking requirements.](#)

4

Launch Cloud Volumes ONTAP using Cloud Manager

Click **Add Working Environment**, select the type of system that you would like to deploy, and complete the steps in the wizard. [Read step-by-step instructions.](#)

Related links

- [Creating a Connector from Cloud Manager](#)
- [Creating a Connector from the Azure Marketplace](#)
- [Installing the Connector software on a Linux host](#)
- [What Cloud Manager does with permissions](#)

Plan your Cloud Volumes ONTAP configuration in Azure

When you deploy Cloud Volumes ONTAP in Azure, you can choose a preconfigured system that matches your workload requirements, or you can create your own configuration. If you choose your own configuration, you should understand the options available to you.

Choose a Cloud Volumes ONTAP license

Several licensing options are available for Cloud Volumes ONTAP. Each option enables you to choose a consumption model that meets your needs.

- [Learn about licensing options for Cloud Volumes ONTAP](#)
- [Learn how to set up licensing](#)

Choose a supported region

Cloud Volumes ONTAP is supported in most Microsoft Azure regions. [View the full list of supported regions.](#)

Choose a supported VM type

Cloud Volumes ONTAP supports several VM types, depending on the license type that you choose.

[Supported configurations for Cloud Volumes ONTAP in Azure](#)

Understand storage limits

The raw capacity limit for a Cloud Volumes ONTAP system is tied to the license. Additional limits impact the size of aggregates and volumes. You should be aware of these limits as you plan your configuration.

[Storage limits for Cloud Volumes ONTAP in Azure](#)

Size your system in Azure

Sizing your Cloud Volumes ONTAP system can help you meet requirements for performance and capacity. You should be aware of a few key points when choosing a VM type, disk type, and disk size:

Virtual machine type

Look at the supported virtual machine types in the [Cloud Volumes ONTAP Release Notes](#) and then review details about each supported VM type. Be aware that each VM type supports a specific number of data disks.

- [Azure documentation: General purpose virtual machine sizes](#)
- [Azure documentation: Memory optimized virtual machine sizes](#)

Azure disk type

When you create volumes for Cloud Volumes ONTAP, you need to choose the underlying cloud storage that Cloud Volumes ONTAP uses as a disk.

HA systems use Premium page blobs. Meanwhile, single node systems can use two types of Azure Managed Disks:

- *Premium SSD Managed Disks* provide high performance for I/O-intensive workloads at a higher cost.
- *Standard SSD Managed Disks* provide consistent performance for workloads that require low IOPS.
- *Standard HDD Managed Disks* are a good choice if you don't need high IOPS and want to reduce your costs.

For additional details about the use cases for these disks, see [Microsoft Azure Documentation: What disk types are available in Azure?](#).

Azure disk size

When you launch Cloud Volumes ONTAP instances, you must choose the default disk size for aggregates. Cloud Manager uses this disk size for the initial aggregate, and for any additional aggregates that it creates when you use the simple provisioning option. You can create aggregates that use a disk size different from the default by [using the advanced allocation option](#).



All disks in an aggregate must be the same size.

When choosing a disk size, you should take several factors into consideration. The disk size impacts how much you pay for storage, the size of volumes that you can create in an aggregate, the total capacity available to Cloud Volumes ONTAP, and storage performance.

The performance of Azure Premium Storage is tied to the disk size. Larger disks provide higher IOPS and throughput. For example, choosing 1 TiB disks can provide better performance than 500 GiB disks, at a higher cost.

There are no performance differences between disk sizes for Standard Storage. You should choose disk size based on the capacity that you need.

Refer to Azure for IOPS and throughput by disk size:

- [Microsoft Azure: Managed Disks pricing](#)
- [Microsoft Azure: Page Blobs pricing](#)

View default system disks

In addition to the storage for user data, Cloud Manager also purchases cloud storage for Cloud Volumes ONTAP system data (boot data, root data, core data, and NVRAM). For planning purposes, it might help for you to review these details before you deploy Cloud Volumes ONTAP.

[View the default disks for Cloud Volumes ONTAP system data in Azure.](#)



The Connector also requires a system disk. [View details about the Connector's default configuration.](#)

Collect networking information

When you deploy Cloud Volumes ONTAP in Azure, you need to specify details about your virtual network. You can use a worksheet to collect the information from your administrator.

Azure information	Your value
Region	

Azure information	Your value
Virtual network (VNet)	
Subnet	
Network security group (if using your own)	

Choose a write speed

Cloud Manager enables you to choose a write speed setting for Cloud Volumes ONTAP. Before you choose a write speed, you should understand the differences between the normal and high settings and risks and recommendations when using high write speed. [Learn more about write speed.](#)

Choose a volume usage profile

ONTAP includes several storage efficiency features that can reduce the total amount of storage that you need. When you create a volume in Cloud Manager, you can choose a profile that enables these features or a profile that disables them. You should learn more about these features to help you decide which profile to use.

NetApp storage efficiency features provide the following benefits:

Thin provisioning

Presents more logical storage to hosts or users than you actually have in your physical storage pool. Instead of preallocating storage space, storage space is allocated dynamically to each volume as data is written.

Deduplication

Improves efficiency by locating identical blocks of data and replacing them with references to a single shared block. This technique reduces storage capacity requirements by eliminating redundant blocks of data that reside in the same volume.

Compression

Reduces the physical capacity required to store data by compressing data within a volume on primary, secondary, and archive storage.

Networking requirements for Cloud Volumes ONTAP in Azure

Set up your Azure networking so Cloud Volumes ONTAP systems can operate properly. This includes networking for the Connector and Cloud Volumes ONTAP.

Requirements for Cloud Volumes ONTAP

The following networking requirements must be met in Azure.

Outbound internet access

Cloud Volumes ONTAP nodes require outbound internet access for NetApp AutoSupport, which proactively monitors the health of your system and sends messages to NetApp technical support.

Routing and firewall policies must allow HTTP/HTTPS traffic to the following endpoints so Cloud Volumes ONTAP can send AutoSupport messages:

- <https://support.netapp.com/aods/asupmessage>
- <https://support.netapp.com/asupprod/post/1.0/postAsup>

If an outbound internet connection isn't available to send AutoSupport messages, Cloud Manager automatically configures your Cloud Volumes ONTAP systems to use the Connector as a proxy server. The only requirement is to ensure that the Connector's security group allows *inbound* connections over port 3128. You'll need to open this port after you deploy the Connector.

If you defined strict outbound rules for Cloud Volumes ONTAP, then you'll also need to ensure that the Cloud Volumes ONTAP security group allows *outbound* connections over port 3128.

After you've verified that outbound internet access is available, you can test AutoSupport to ensure that it can send messages. For instructions, refer to [ONTAP docs: Set up AutoSupport](#).

IP addresses

Cloud Manager allocates the following number of IP addresses to Cloud Volumes ONTAP in Azure:

- Single node: 5 IP addresses
- HA pair: 16 IP addresses

Note that Cloud Manager creates an SVM management LIF on HA pairs, but not on single node systems in Azure.



A LIF is an IP address associated with a physical port. An SVM management LIF is required for management tools like SnapCenter.

Secure connections to Azure services

By default, Cloud Manager enables an Azure Private Link for connections between Cloud Volumes ONTAP and Azure storage accounts.

In most cases, there's nothing that you need to do—Cloud Manager manages the Azure Private Link for you. But if you use Azure Private DNS, then you'll need to edit a configuration file. You should also be aware of a requirement for the Connector location in Azure.

You can also disable the Private Link connection, if required by your business needs. If you disable the link, Cloud Manager configures Cloud Volumes ONTAP to use a service endpoint instead.

[Learn more about using Azure Private Links or service endpoints with Cloud Volumes ONTAP.](#)

Connections to other ONTAP systems

To replicate data between a Cloud Volumes ONTAP system in Azure and ONTAP systems in other networks, you must have a VPN connection between the Azure VNet and the other network—for example, your corporate network.

For instructions, refer to [Microsoft Azure Documentation: Create a Site-to-Site connection in the Azure portal](#).

Port for the HA interconnect

A Cloud Volumes ONTAP HA pair includes an HA interconnect, which allows each node to continually check whether its partner is functioning and to mirror log data for the other's nonvolatile memory. The HA interconnect uses TCP port 10006 for communication.

By default, communication between the HA interconnect LIFs is open and there are no security group rules for this port. But if you create a firewall between the HA interconnect LIFs, then you need to ensure that TCP traffic is open for port 10006 so that the HA pair can operate properly.

Only one HA pair in an Azure resource group

You must use a *dedicated* resource group for each Cloud Volumes ONTAP HA pair that you deploy in Azure. Only one HA pair is supported in a resource group.

Cloud Manager experiences connection issues if you try to deploy a second Cloud Volumes ONTAP HA pair in an Azure resource group.

Security groups

You don't need to create security groups because Cloud Manager does that for you. If you need to use your own, refer to the security group rules listed below.

Security group rules

Cloud Manager creates Azure security groups that include the inbound and outbound rules that Cloud Volumes ONTAP needs to operate successfully. You might want to refer to the ports for testing purposes or if you prefer your to use own security groups.

The security group for Cloud Volumes ONTAP requires both inbound and outbound rules.

Inbound rules for single node systems

When you create a working environment and choose a predefined security group, you can choose to allow traffic within one of the following:

- **Selected VNet only:** the source for inbound traffic is the subnet range of the VNet for the Cloud Volumes ONTAP system and the subnet range of the VNet where the Connector resides. This is the recommended option.
- **All VNets:** the source for inbound traffic is the 0.0.0.0/0 IP range.

Priority and name	Port and protocol	Source and destination	Description
1000 inbound_ssh	22 TCP	Any to Any	SSH access to the IP address of the cluster management LIF or a node management LIF
1001 inbound_http	80 TCP	Any to Any	HTTP access to the System Manager web console using the IP address of the cluster management LIF
1002 inbound_111_tcp	111 TCP	Any to Any	Remote procedure call for NFS
1003 inbound_111_udp	111 UDP	Any to Any	Remote procedure call for NFS
1004 inbound_139	139 TCP	Any to Any	NetBIOS service session for CIFS
1005 inbound_161-162_tcp	161-162 TCP	Any to Any	Simple network management protocol

Priority and name	Port and protocol	Source and destination	Description
1006 inbound_161-162_udp	161-162 UDP	Any to Any	Simple network management protocol
1007 inbound_443	443 TCP	Any to Any	HTTPS access to the System Manager web console using the IP address of the cluster management LIF
1008 inbound_445	445 TCP	Any to Any	Microsoft SMB/CIFS over TCP with NetBIOS framing
1009 inbound_635_tcp	635 TCP	Any to Any	NFS mount
1010 inbound_635_udp	635 UDP	Any to Any	NFS mount
1011 inbound_749	749 TCP	Any to Any	Kerberos
1012 inbound_2049_tcp	2049 TCP	Any to Any	NFS server daemon
1013 inbound_2049_udp	2049 UDP	Any to Any	NFS server daemon
1014 inbound_3260	3260 TCP	Any to Any	iSCSI access through the iSCSI data LIF
1015 inbound_4045-4046_tcp	4045-4046 TCP	Any to Any	NFS lock daemon and network status monitor
1016 inbound_4045-4046_udp	4045-4046 UDP	Any to Any	NFS lock daemon and network status monitor
1017 inbound_10000	10000 TCP	Any to Any	Backup using NDMP
1018 inbound_11104-11105	11104-11105 TCP	Any to Any	SnapMirror data transfer
3000 inbound_deny_all_tcp	Any port TCP	Any to Any	Block all other TCP inbound traffic
3001 inbound_deny_all_udp	Any port UDP	Any to Any	Block all other UDP inbound traffic
65000 AllowVnetInBound	Any port Any protocol	VirtualNetwork to VirtualNetwork	Inbound traffic from within the VNet

Priority and name	Port and protocol	Source and destination	Description
65001 AllowAzureLoadBalancerInBound	Any port Any protocol	AzureLoadBalancer to Any	Data traffic from the Azure Standard Load Balancer
65500 DenyAllInBound	Any port Any protocol	Any to Any	Block all other inbound traffic

Inbound rules for HA systems

When you create a working environment and choose a predefined security group, you can choose to allow traffic within one of the following:

- **Selected VNet only:** the source for inbound traffic is the subnet range of the VNet for the Cloud Volumes ONTAP system and the subnet range of the VNet where the Connector resides. This is the recommended option.
- **All VNets:** the source for inbound traffic is the 0.0.0.0/0 IP range.



HA systems have less inbound rules than single node systems because inbound data traffic goes through the Azure Standard Load Balancer. Because of this, traffic from the Load Balancer should be open, as shown in the "AllowAzureLoadBalancerInBound" rule.

Priority and name	Port and protocol	Source and destination	Description
100 inbound_443	443 Any protocol	Any to Any	HTTPS access to the System Manager web console using the IP address of the cluster management LIF
101 inbound_111_tcp	111 Any protocol	Any to Any	Remote procedure call for NFS
102 inbound_2049_tcp	2049 Any protocol	Any to Any	NFS server daemon
111 inbound_ssh	22 Any protocol	Any to Any	SSH access to the IP address of the cluster management LIF or a node management LIF
121 inbound_53	53 Any protocol	Any to Any	DNS and CIFS
65000 AllowVnetInBound	Any port Any protocol	VirtualNetwork to VirtualNetwork	Inbound traffic from within the VNet
65001 AllowAzureLoadBalancerInBound	Any port Any protocol	AzureLoadBalancer to Any	Data traffic from the Azure Standard Load Balancer

Priority and name	Port and protocol	Source and destination	Description
65500 DenyAllInBound	Any port Any protocol	Any to Any	Block all other inbound traffic

Outbound rules

The predefined security group for Cloud Volumes ONTAP opens all outbound traffic. If that is acceptable, follow the basic outbound rules. If you need more rigid rules, use the advanced outbound rules.

Basic outbound rules

The predefined security group for Cloud Volumes ONTAP includes the following outbound rules.

Port	Protocol	Purpose
All	All TCP	All outbound traffic
All	All UDP	All outbound traffic

Advanced outbound rules

If you need rigid rules for outbound traffic, you can use the following information to open only those ports that are required for outbound communication by Cloud Volumes ONTAP.



The source is the interface (IP address) on the Cloud Volumes ONTAP system.

Service	Port	Protocol	Source	Destination	Purpose
Active Directory	88	TCP	Node management LIF	Active Directory forest	Kerberos V authentication
	137	UDP	Node management LIF	Active Directory forest	NetBIOS name service
	138	UDP	Node management LIF	Active Directory forest	NetBIOS datagram service
	139	TCP	Node management LIF	Active Directory forest	NetBIOS service session
	389	TCP & UDP	Node management LIF	Active Directory forest	LDAP
	445	TCP	Node management LIF	Active Directory forest	Microsoft SMB/CIFS over TCP with NetBIOS framing
	464	TCP	Node management LIF	Active Directory forest	Kerberos V change & set password (SET_CHANGE)
	464	UDP	Node management LIF	Active Directory forest	Kerberos key administration
	749	TCP	Node management LIF	Active Directory forest	Kerberos V change & set Password (RPCSEC_GSS)
	88	TCP	Data LIF (NFS, CIFS, iSCSI)	Active Directory forest	Kerberos V authentication
	137	UDP	Data LIF (NFS, CIFS)	Active Directory forest	NetBIOS name service
	138	UDP	Data LIF (NFS, CIFS)	Active Directory forest	NetBIOS datagram service
	139	TCP	Data LIF (NFS, CIFS)	Active Directory forest	NetBIOS service session
	389	TCP & UDP	Data LIF (NFS, CIFS)	Active Directory forest	LDAP
	445	TCP	Data LIF (NFS, CIFS)	Active Directory forest	Microsoft SMB/CIFS over TCP with NetBIOS framing
	464	TCP	Data LIF (NFS, CIFS)	Active Directory forest	Kerberos V change & set password (SET_CHANGE)
	464	UDP	Data LIF (NFS, CIFS)	Active Directory forest	Kerberos key administration
	749	TCP	Data LIF (NFS, CIFS)	Active Directory forest	Kerberos V change & set password (RPCSEC_GSS)

Service	Port	Protocol	Source	Destination	Purpose
AutoSupport	HTTPS	443	Node management LIF	support.netapp.com	AutoSupport (HTTPS is the default)
	HTTP	80	Node management LIF	support.netapp.com	AutoSupport (only if the transport protocol is changed from HTTPS to HTTP)
	TCP	3128	Node management LIF	Connector	Sending AutoSupport messages through a proxy server on the Connector, if an outbound internet connection isn't available
DHCP	68	UDP	Node management LIF	DHCP	DHCP client for first-time setup
DHCPS	67	UDP	Node management LIF	DHCP	DHCP server
DNS	53	UDP	Node management LIF and data LIF (NFS, CIFS)	DNS	DNS
NDMP	18600–18699	TCP	Node management LIF	Destination servers	NDMP copy
SMTP	25	TCP	Node management LIF	Mail server	SMTP alerts, can be used for AutoSupport
SNMP	161	TCP	Node management LIF	Monitor server	Monitoring by SNMP traps
	161	UDP	Node management LIF	Monitor server	Monitoring by SNMP traps
	162	TCP	Node management LIF	Monitor server	Monitoring by SNMP traps
	162	UDP	Node management LIF	Monitor server	Monitoring by SNMP traps
SnapMirror	11104	TCP	Intercluster LIF	ONTAP intercluster LIFs	Management of intercluster communication sessions for SnapMirror
	11105	TCP	Intercluster LIF	ONTAP intercluster LIFs	SnapMirror data transfer
Syslog	514	UDP	Node management LIF	Syslog server	Syslog forward messages

Requirements for the Connector

Set up your networking so that the Connector can manage resources and processes within your public cloud environment. The most important step is ensuring outbound internet access to various endpoints.



If your network uses a proxy server for all communication to the internet, you can specify the proxy server from the Settings page. Refer to [Configuring the Connector to use a proxy server](#).

Connections to target networks

A Connector requires a network connection to the VPCs and VNets in which you want to deploy Cloud Volumes ONTAP.

For example, if you install a Connector in your corporate network, then you must set up a VPN connection to the VPC or VNet in which you launch Cloud Volumes ONTAP.

Outbound internet access

The Connector requires outbound internet access to manage resources and processes within your public cloud environment.

Endpoints	Purpose
https://support.netapp.com	To obtain licensing information and to send AutoSupport messages to NetApp support.
https://*.cloudmanager.cloud.netapp.com	To provide SaaS features and services within Cloud Manager.
https://cloudmanagerinfraprod.azurecr.io https://*.blob.core.windows.net	To upgrade the Connector and its Docker components.

Security group rules

The security group for the Connector requires both inbound and outbound rules.

Inbound rules

Port	Protocol	Purpose
22	SSH	Provides SSH access to the Connector host
80	HTTP	Provides HTTP access from client web browsers to the local user interface
443	HTTPS	Provides HTTPS access from client web browsers to the local user interface
TCP	3128	Provides Cloud Volumes ONTAP with internet access to send AutoSupport messages to NetApp Support. You must manually open this port after deploying the Connector.

Outbound rules

The predefined security group for the Connector opens all outbound traffic. If that is acceptable, follow the basic outbound rules. If you need more rigid rules, use the advanced outbound rules.

Basic outbound rules

The predefined security group for the Connector includes the following outbound rules.

Port	Protocol	Purpose
All	All TCP	All outbound traffic
All	All UDP	All outbound traffic

Advanced outbound rules

If you need rigid rules for outbound traffic, you can use the following information to open only those ports that are required for outbound communication by the Connector.



The source IP address is the Connector host.

Service	Port	Protocol	Destination	Purpose
API calls and AutoSupport	443	HTTPS	Outbound internet and ONTAP cluster management LIF	API calls to Azure and ONTAP, to Cloud Data Sense, to the Ransomware service, and sending AutoSupport messages to NetApp
DNS	53	UDP	DNS	Used for DNS resolve by Cloud Manager

Set up Cloud Volumes ONTAP to use a customer-managed key in Azure

Data is automatically encrypted on Cloud Volumes ONTAP in Azure using [Azure Storage Service Encryption](#) with a Microsoft-managed key. But you can use your own encryption key instead by following the steps on this page.

Data encryption overview

Cloud Volumes ONTAP data is automatically encrypted in Azure using [Azure Storage Service Encryption](#). The default implementation uses a Microsoft-managed key. No setup is required.

If you want to use a customer-managed key with Cloud Volumes ONTAP, then you need to complete the following steps:

1. From Azure, create a key vault and then generate a key in that vault
2. From Cloud Manager, use the API to create a Cloud Volumes ONTAP working environment that uses the key

Key rotation

If you create a new version of your key, Cloud Volumes ONTAP automatically uses the latest key version.

How data is encrypted

After you create a Cloud Volumes ONTAP working environment that is configured to use a customer-managed key, Cloud Volumes ONTAP data is encrypted as follows.

HA pairs

- All Azure storage accounts for Cloud Volumes ONTAP are encrypted using a customer-managed key.

- Any new storage accounts (for example, when you add disks or aggregates) also use the same key.

Single node

- All Azure storage accounts for Cloud Volumes ONTAP are encrypted using a customer-managed key.
- For root, boot, and data disks, Cloud Manager uses a [disk encryption set](#), which enables management of encryption keys with managed disks.
- Any new data disks also use the same disk encryption set.
- NVRAM and the core disk are encrypted using a Microsoft-managed key, instead of the customer-managed key.

Create a key vault and generate a key

The key vault must reside in the same Azure subscription and region in which you plan to create the Cloud Volumes ONTAP system.

Steps

1. [Create a key vault in your Azure subscription.](#)

Note the following requirements for the key vault:

- The key vault must reside in the same region as the Cloud Volumes ONTAP system.
- The following options should be enabled:
 - **Soft-delete** (this option is enabled by default, but must *not* be disabled)
 - **Purge protection**
 - **Azure Disk Encryption for volume encryption** (for single node Cloud Volumes ONTAP systems only)

2. [Generate a key in the key vault.](#)

Note the following requirements for the key:

- The key type must be **RSA**.
- The recommended RSA key size is **2048**, but other sizes are supported.

Create a working environment that uses the encryption key

After you create the key vault and generate an encryption key, you can create a new Cloud Volumes ONTAP system that is configured to use the key. These steps are supported by using the Cloud Manager API.

Required permissions

If you want to use a customer-managed key with a single node Cloud Volumes ONTAP system, ensure that the Cloud Manager Connector has the following permissions:

```
"Microsoft.Compute/diskEncryptionSets/read"
"Microsoft.Compute/diskEncryptionSets/write",
"Microsoft.Compute/diskEncryptionSets/delete"
"Microsoft.KeyVault/vaults/deploy/action",
"Microsoft.KeyVault/vaults/read",
"Microsoft.KeyVault/vaults/accessPolicies/write"
```

[View the latest list of permissions](#)



The first three permissions aren't required for HA pairs.

Steps

1. Obtain the list of key vaults in your Azure subscription by using the following Cloud Manager API call.

For an HA pair: GET /azure/ha/metadata/vaults

For single node: GET /azure/vsa/metadata/vaults

Make note of the **name** and **resourceGroup**. You'll need to specify those values in the next step.

[Learn more about this API call.](#)

2. Obtain the list of keys within the vault by using the following Cloud Manager API call.

For an HA pair: GET /azure/ha/metadata/keys-vault

For single node: GET /azure/vsa/metadata/keys-vault

Make note of the **keyName**. You'll need to specify that value (along with the vault name) in the next step.

[Learn more about this API call.](#)

3. Create a Cloud Volumes ONTAP system by using the following Cloud Manager API call.

- a. For an HA pair:

POST /azure/ha/working-environments

The request body must include the following fields:

```
"azureEncryptionParameters": {
  "key": "keyName",
  "vaultName": "vaultName"
}
```

[Learn more about this API call.](#)

- b. For a single node system:

POST /azure/vsa/working-environments

The request body must include the following fields:

```
"azureEncryptionParameters": {  
  "key": "keyName",  
  "vaultName": "vaultName"  
}
```

[Learn more about this API call.](#)

Result

You have a new Cloud Volumes ONTAP system that is configured to use your customer-managed key for data encryption.

Set up licensing for Cloud Volumes ONTAP in Azure

After you decide which licensing option you want to use with Cloud Volumes ONTAP, a few steps are required before you can choose that licensing option when creating a new working environment.

Freemium

Select the Freemium offering to use Cloud Volumes ONTAP free of charge with up to 500 GiB of provisioned capacity. [Learn more about the Freemium offering.](#)

Steps

1. On the Canvas page, click **Add Working Environment** and follow the steps in Cloud Manager.
 - a. On the **Details and Credentials** page, click **Edit Credentials > Add Subscription** and then follow the prompts to subscribe to the pay-as-you-go offering in the Azure Marketplace.

You won't be charged through the marketplace subscription unless you exceed 500 GiB of provisioned capacity, at which time the system is automatically converted to the [Essentials package](#).

Edit Credentials & Add Subscription

Associate Subscription to Credentials ⓘ

Credentials

Managed Service Identity

Azure Subscription

OCCM Dev (Default)

Marketplace Subscription

ⓘ A marketplace subscription isn't associated with the selected Azure subscription.

+ Add Subscription

Apply Cancel

- b. After you return to Cloud Manager, select **Freemium** when you reach the charging methods page.

Select Charging Method

<input type="radio"/>	Professional	By capacity	▼
<input type="radio"/>	Essential	By capacity	▼
<input checked="" type="radio"/>	Freemium (Up to 500 GiB)	By capacity	▼
<input type="radio"/>	Per Node	By node	▼

[View step-by-step instructions to launch Cloud Volumes ONTAP in Azure.](#)

Capacity-based license

Capacity-based licensing enables you to pay for Cloud Volumes ONTAP per TiB of capacity. Capacity-based licensing is available in the form of a *package*: the Essentials package or the Professional package.

The Essentials and Professional packages are available with the following consumption models:

- A license (BYOL) purchased from NetApp
- An hourly, pay-as-you-go (PAYGO) subscription from the Azure Marketplace
- An annual contract

[Learn more about capacity-based licensing.](#)

The following sections describe how to get started with each of these consumption models.

BYOL

Pay upfront by purchasing a license (BYOL) from NetApp to deploy Cloud Volumes ONTAP systems in any cloud provider.

Steps

1. [Contact NetApp Sales to obtain a license](#)
2. [Add your NetApp Support Site account to Cloud Manager](#)

Cloud Manager automatically queries NetApp's licensing service to obtain details about the licenses associated with your NetApp Support Site account. If there are no errors, Cloud Manager automatically adds the licenses to the Digital Wallet.

Your license must be available from the Digital Wallet before you can use it with Cloud Volumes ONTAP. If needed, you can [manually add the license to the Digital Wallet](#).

3. On the Canvas page, click **Add Working Environment** and follow the steps in Cloud Manager.
 - a. On the **Details and Credentials** page, click **Edit Credentials > Add Subscription** and then follow the prompts to subscribe to the pay-as-you-go offering in the Azure Marketplace.

The license that you purchased from NetApp is always charged first, but you'll be charged from the hourly rate in the marketplace if you exceed your licensed capacity or if the term of your license expires.

Edit Credentials & Add Subscription

Associate Subscription to Credentials ⓘ

Credentials

Managed Service Identity

Azure Subscription

OCCM Dev (Default)

Marketplace Subscription

ⓘ A marketplace subscription isn't associated with the selected Azure subscription.

+ Add Subscription

Apply Cancel

- b. After you return to Cloud Manager, select a capacity-based package when you reach the charging methods page.

Select Charging Method

<input checked="" type="radio"/>	Professional	By capacity	⌵
<input type="radio"/>	Essential	By capacity	⌵
<input type="radio"/>	Freemium (Up to 500 GiB)	By capacity	⌵
<input type="radio"/>	Per Node	By node	⌵

[View step-by-step instructions to launch Cloud Volumes ONTAP in Azure.](#)

PAYGO subscription

Pay hourly by subscribing to the offer from your cloud provider's marketplace.

When you create a Cloud Volumes ONTAP working environment, Cloud Manager prompts you to subscribe to the agreement that's available in the Azure Marketplace. That subscription is then associated with the working

environment for charging. You can use that same subscription for additional working environments.

Steps

1. On the Canvas page, click **Add Working Environment** and follow the steps in Cloud Manager.
 - a. On the **Details and Credentials** page, click **Edit Credentials > Add Subscription** and then follow the prompts to subscribe to the pay-as-you-go offering in the Azure Marketplace.

The screenshot shows a dialog box titled "Edit Credentials & Add Subscription". It has a section "Associate Subscription to Credentials" with a help icon. Below this are two dropdown menus: "Credentials" set to "Managed Service Identity" and "Azure Subscription" set to "OCCM Dev (Default)". A message box states: "Marketplace Subscription: A marketplace subscription isn't associated with the selected Azure subscription." Below the message is a "+ Add Subscription" link. At the bottom are "Apply" and "Cancel" buttons.

- b. After you return to Cloud Manager, select a capacity-based package when you reach the charging methods page.

The screenshot shows a dialog box titled "Select Charging Method". It contains four radio button options: "Professional" (selected), "Essential", "Freemium (Up to 500 GiB)", and "Per Node". To the right of each option is a button labeled "By capacity" (for the first three) or "By node" (for the last one), followed by a dropdown arrow.

[View step-by-step instructions to launch Cloud Volumes ONTAP in Azure.](#)



You can manage the Azure Marketplace subscriptions associated with your Azure accounts from the Settings > Credentials page. [Learn how to manage your Azure accounts and subscriptions](#)

Annual contract

Pay for Cloud Volumes ONTAP annually by purchasing an annual contract.

Steps

1. Contact your NetApp sales representative to purchase an annual contract.

The contract is available as a *private* offer in the Azure Marketplace.

After NetApp shares the private offer with you, you can select the annual plan when you subscribe from the Azure Marketplace during working environment creation.

2. On the Canvas page, click **Add Working Environment** and follow the steps in Cloud Manager.
 - a. On the **Details and Credentials** page, click **Edit Credentials > Add Subscription > Continue**.
 - b. In the Azure portal, select the annual plan that was shared with your Azure account and then click **Subscribe**.
 - c. After you return to Cloud Manager, select a capacity-based package when you reach the charging methods page.

Select Charging Method	
<input checked="" type="radio"/> Professional	By capacity
<input type="radio"/> Essential	By capacity
<input type="radio"/> Freemium (Up to 500 GiB)	By capacity
<input type="radio"/> Per Node	By node

[View step-by-step instructions to launch Cloud Volumes ONTAP in Azure.](#)

Keystone Flex Subscription

A Keystone Flex Subscription is a pay-as-you-grow subscription-based service. [Learn more about Keystone Flex Subscriptions.](#)

Steps

1. If you don't have a subscription yet, [contact NetApp](#)
2. [Contact NetApp](#) to authorize your Cloud Manager user account with one or more Keystone Flex

Subscriptions.

3. After NetApp authorizes your account, [link your subscriptions for use with Cloud Volumes ONTAP](#).
4. On the Canvas page, click **Add Working Environment** and follow the steps in Cloud Manager.
 - a. Select the Keystone Flex Subscription charging method when prompted to choose a charging method.

The screenshot shows a 'Select Charging Method' dialog box. The 'Keystone' option is selected, indicated by a blue checkmark. Below this, the text 'Storage management' and 'Charged against your NetApp credit' is displayed. A 'Keystone Subscription' dropdown menu is shown with 'A-AMRITA1' selected. To the right of the 'Keystone' option is a blue button labeled 'By capacity' and an upward-pointing chevron. Below the 'Keystone' option are four other options, each with a radio button: 'Professional', 'Essential', 'Freemium (Up to 500 GiB)', and 'Per Node'. To the right of each of these options is a blue button labeled 'By capacity' (for the first three) or a purple button labeled 'By node' (for 'Per Node'), and a downward-pointing chevron.

[View step-by-step instructions to launch Cloud Volumes ONTAP in Azure.](#)

Enable high availability mode in Azure

Microsoft Azure's high availability mode should be enabled to reduce unplanned failover times and to enable NFSv4 support for Cloud Volumes ONTAP.

Starting with the Cloud Volumes ONTAP 9.10.1 release, we reduced the unplanned failover time for Cloud Volumes ONTAP HA pairs running in Microsoft Azure and added support for NFSv4. To make these enhancements available to Cloud Volumes ONTAP, you need to enable the high availability feature on your Azure subscription.

Cloud Manager will prompt you with these details in an Action Required message when the feature needs to be enabled on an Azure subscription.

Note the following:

- There are no problems with the high availability of your Cloud Volumes ONTAP HA pair. This Azure feature works in concert with ONTAP to reduce the client observed application outage time for NFS protocols that result from unplanned failover events.

- Enabling this feature is non-disruptive to Cloud Volumes ONTAP HA pairs.
- Enabling this feature on your Azure subscription won't cause issues to other VMs.

An Azure user who has "Owner" privileges can enable the feature from the Azure CLI.

Steps

1. [Access the Azure Cloud Shell from the Azure Portal](#)
2. Register the high availability mode feature:

```
az account set -s AZURE_SUBSCRIPTION_NAME_OR_ID
az feature register --name EnableHighAvailabilityMode --namespace
Microsoft.Network
az provider register -n Microsoft.Network
```

3. Optionally verify that the feature is now registered:

```
az feature show --name EnableHighAvailabilityMode --namespace
Microsoft.Network
```

The Azure CLI should return a result similar to the following:

```
{
  "id": "/subscriptions/xxxxxxxx-xxxx-xxxx-xxxx-
xxxxxxxxxxxx/providers/Microsoft.Features/providers/Microsoft.Network/fe
atures/EnableHighAvailabilityMode",
  "name": "Microsoft.Network/EnableHighAvailabilityMode",
  "properties": {
    "state": "Registered"
  },
  "type": "Microsoft.Features/providers/features"
}
```

Launching Cloud Volumes ONTAP in Azure

You can launch a single node system or an HA pair in Azure by creating a Cloud Volumes ONTAP working environment in Cloud Manager.

What you'll need

You need the following to create a working environment.

- A Connector that's up and running.
 - You should have a [Connector that is associated with your workspace](#).
 - [You should be prepared to leave the Connector running at all times](#).

- An understanding of the configuration that you want to use.

You should have chose a configuration and obtained Azure networking information from your administrator. For details, see [Planning your Cloud Volumes ONTAP configuration](#).

- An understanding of what's required to set up licensing for Cloud Volumes ONTAP.

[Learn how to set up licensing](#).

About this task

When Cloud Manager creates a Cloud Volumes ONTAP system in Azure, it creates several Azure objects, such as a resource group, network interfaces, and storage accounts. You can review a summary of the resources at the end of the wizard.



Potential for Data Loss

The best practice is to use a new, dedicated resource group for each Cloud Volumes ONTAP system.

Deploying Cloud Volumes ONTAP in an existing, shared resource group is not recommended due to the risk of data loss. While Cloud Manager can remove Cloud Volumes ONTAP resources from a shared resource group in case of deployment failure or deletion, an Azure user might accidentally delete Cloud Volumes ONTAP resources from a shared resource group.

Steps

1. On the Canvas page, click **Add Working Environment** and follow the prompts.
2. **Choose a Location:** Select **Microsoft Azure** and **Cloud Volumes ONTAP Single Node** or **Cloud Volumes ONTAP High Availability**.
3. If you're prompted, [create a Connector](#).
4. **Details and Credentials:** Optionally change the Azure credentials and subscription, specify a cluster name, add tags if needed, and then specify credentials.

The following table describes fields for which you might need guidance:

Field	Description
Working Environment Name	Cloud Manager uses the working environment name to name both the Cloud Volumes ONTAP system and the Azure virtual machine. It also uses the name as the prefix for the predefined security group, if you select that option.
Resource Group Tags	<p>Tags are metadata for your Azure resources. When you enter tags in this field, Cloud Manager adds them to the resource group associated with the Cloud Volumes ONTAP system.</p> <p>You can add up to four tags from the user interface when creating a working environment, and then you can add more after its created. Note that the API does not limit you to four tags when creating a working environment.</p> <p>For information about tags, refer to Microsoft Azure Documentation: Using tags to organize your Azure resources.</p>

Field	Description
User name and password	These are the credentials for the Cloud Volumes ONTAP cluster administrator account. You can use these credentials to connect to Cloud Volumes ONTAP through System Manager or its CLI. Keep the default <i>admin</i> user name or change it to a custom user name.
Edit Credentials	You can choose different Azure credentials and a different Azure subscription to use with this Cloud Volumes ONTAP system. You need to associate an Azure Marketplace subscription with the selected Azure subscription in order to deploy a pay-as-you-go Cloud Volumes ONTAP system. Learn how to add credentials.

The following video shows how to associate a Marketplace subscription to an Azure subscription:

► <https://docs.netapp.com/us-en/cloud-manager-cloud-volumes->

5. **Services:** Keep the services enabled or disable the individual services that you don't want to use with Cloud Volumes ONTAP.

- [Learn more about Cloud Data Sense.](#)
- [Learn more about Cloud Backup.](#)
- [Learn more about the Monitoring service.](#)

6. **Location:** Select a region, availability zone, VNet, and subnet, and then select the checkbox to confirm network connectivity between the Connector and the target location.

For single node systems, you can choose the Availability Zone in which you'd like to deploy Cloud Volumes ONTAP. If you don't select an AZ, Cloud Manager will select one for you.

7. **Connectivity:** Choose a new or existing resource group and then choose whether to use the predefined security group or to use your own.

The following table describes fields for which you might need guidance:

Field	Description
Availability Zone	For single node systems, you can choose the Availability Zone in which you'd like to deploy Cloud Volumes ONTAP. If you don't select an AZ, Cloud Manager will select one for you.
Resource Group	<p>Create a new resource group for Cloud Volumes ONTAP or use an existing resource group. The best practice is to use a new, dedicated resource group for Cloud Volumes ONTAP. While it is possible to deploy Cloud Volumes ONTAP in an existing, shared resource group, it's not recommended due to the risk of data loss. See the warning above for more details.</p> <p>You must use a dedicated resource group for each Cloud Volumes ONTAP HA pair that you deploy in Azure. Only one HA pair is supported in a resource group. Cloud Manager experiences connection issues if you try to deploy a second Cloud Volumes ONTAP HA pair in an Azure resource group.</p> <div> If the Azure account that you're using has the required permissions, Cloud Manager removes Cloud Volumes ONTAP resources from a resource group, in case of deployment failure or deletion.</div>
Generated security group	<p>If you let Cloud Manager generate the security group for you, you need to choose how you'll allow traffic:</p> <ul style="list-style-type: none">• If you choose Selected VNet only, the source for inbound traffic is the subnet range of the selected VNet and the subnet range of the VNet where the Connector resides. This is the recommended option.• If you choose All VNets, the source for inbound traffic is the 0.0.0.0/0 IP range.
Use existing	If you choose an existing security group, then it must meet Cloud Volumes ONTAP requirements. View the default security group.

8. **Charging Methods and NSS Account:** Specify which charging option would you like to use with this system, and then specify a NetApp Support Site account.
 - [Learn about licensing options for Cloud Volumes ONTAP.](#)
 - [Learn how to set up licensing.](#)
9. **Preconfigured Packages:** Select one of the packages to quickly deploy a Cloud Volumes ONTAP system, or click **Create my own configuration**.

If you choose one of the packages, you only need to specify a volume and then review and approve the configuration.

10. **Licensing:** Change the Cloud Volumes ONTAP version as needed and select a virtual machine type.



If a newer Release Candidate, General Availability, or patch release is available for the selected version, then Cloud Manager updates the system to that version when creating the working environment. For example, the update occurs if you select Cloud Volumes ONTAP 9.10.1 and 9.10.1 P4 is available. The update does not occur from one release to another—for example, from 9.6 to 9.7.

11. **Subscribe from the Azure Marketplace:** Follow the steps if Cloud Manager could not enable programmatic deployments of Cloud Volumes ONTAP.
12. **Underlying Storage Resources:** Choose settings for the initial aggregate: a disk type, a size for each disk, and whether data tiering to Blob storage should be enabled.

Note the following:

- The disk type is for the initial volume. You can choose a different disk type for subsequent volumes.
- The disk size is for all disks in the initial aggregate and for any additional aggregates that Cloud Manager creates when you use the simple provisioning option. You can create aggregates that use a different disk size by using the advanced allocation option.

For help choosing a disk type and size, see [Sizing your system in Azure](#).

- You can choose a specific volume tiering policy when you create or edit a volume.
- If you disable data tiering, you can enable it on subsequent aggregates.

[Learn more about data tiering.](#)

13. **Write Speed & WORM** (single node systems only): Choose **Normal** or **High** write speed, and activate write once, read many (WORM) storage, if desired.

[Learn more about write speed.](#)

WORM can't be enabled if data tiering was enabled.

[Learn more about WORM storage.](#)

14. **Secure Communication to Storage & WORM** (HA only): Choose whether to enable an HTTPS connection to Azure storage accounts, and activate write once, read many (WORM) storage, if desired.

The HTTPS connection is from a Cloud Volumes ONTAP 9.7 HA pair to Azure storage accounts. Note that enabling this option can impact write performance. You can't change the setting after you create the working environment.

[Learn more about WORM storage.](#)

15. **Create Volume:** Enter details for the new volume or click **Skip**.

[Learn about supported client protocols and versions.](#)

Some of the fields in this page are self-explanatory. The following table describes fields for which you might need guidance:

Field	Description
Size	The maximum size that you can enter largely depends on whether you enable thin provisioning, which enables you to create a volume that is bigger than the physical storage currently available to it.
Access control (for NFS only)	An export policy defines the clients in the subnet that can access the volume. By default, Cloud Manager enters a value that provides access to all instances in the subnet.
Permissions and Users / Groups (for CIFS only)	These fields enable you to control the level of access to a share for users and groups (also called access control lists or ACLs). You can specify local or domain Windows users or groups, or UNIX users or groups. If you specify a domain Windows user name, you must include the user's domain using the format domain\username.
Snapshot Policy	A Snapshot copy policy specifies the frequency and number of automatically created NetApp Snapshot copies. A NetApp Snapshot copy is a point-in-time file system image that has no performance impact and requires minimal storage. You can choose the default policy or none. You might choose none for transient data: for example, tempdb for Microsoft SQL Server.
Advanced options (for NFS only)	Select an NFS version for the volume: either NFSv3 or NFSv4.
Initiator group and IQN (for iSCSI only)	<p>iSCSI storage targets are called LUNs (logical units) and are presented to hosts as standard block devices.</p> <p>Initiator groups are tables of iSCSI host node names and control which initiators have access to which LUNs.</p> <p>iSCSI targets connect to the network through standard Ethernet network adapters (NICs), TCP offload engine (TOE) cards with software initiators, converged network adapters (CNAs) or dedicated host bus adapters (HBAs) and are identified by iSCSI qualified names (IQNs).</p> <p>When you create an iSCSI volume, Cloud Manager automatically creates a LUN for you. We've made it simple by creating just one LUN per volume, so there's no management involved. After you create the volume, use the IQN to connect to the LUN from your hosts.</p>

The following image shows the Volume page filled out for the CIFS protocol:

Volume Details, Protection & Protocol

Details & Protection

Volume Name: Size (GB): ⓘ

Snapshot Policy: ▼

ⓘ Default Policy

Protocol

NFS
CIFS
iSCSI

Share name: Permissions: ▼

Users / Groups:

Valid users and groups separated by a semicolon

16. **CIFS Setup:** If you chose the CIFS protocol, set up a CIFS server.

Field	Description
DNS Primary and Secondary IP Address	The IP addresses of the DNS servers that provide name resolution for the CIFS server. The listed DNS servers must contain the service location records (SRV) needed to locate the Active Directory LDAP servers and domain controllers for the domain that the CIFS server will join.
Active Directory Domain to join	The FQDN of the Active Directory (AD) domain that you want the CIFS server to join.
Credentials authorized to join the domain	The name and password of a Windows account with sufficient privileges to add computers to the specified Organizational Unit (OU) within the AD domain.
CIFS server NetBIOS name	A CIFS server name that is unique in the AD domain.
Organizational Unit	The organizational unit within the AD domain to associate with the CIFS server. The default is CN=Computers. To configure Azure AD Domain Services as the AD server for Cloud Volumes ONTAP, you should enter OU=AADDCC Computers or OU=AADDCC Users in this field. Azure Documentation: Create an Organizational Unit (OU) in an Azure AD Domain Services managed domain
DNS Domain	The DNS domain for the Cloud Volumes ONTAP storage virtual machine (SVM). In most cases, the domain is the same as the AD domain.
NTP Server	Select Use Active Directory Domain to configure an NTP server using the Active Directory DNS. If you need to configure an NTP server using a different address, then you should use the API. See the Cloud Manager automation docs for details. Note that you can configure an NTP server only when creating a CIFS server. It's not configurable after you create the CIFS server.

17. **Usage Profile, Disk Type, and Tiering Policy:** Choose whether you want to enable storage efficiency

features and change the volume tiering policy, if needed.

For more information, see [Understanding volume usage profiles](#) and [Data tiering overview](#).

18. **Review & Approve:** Review and confirm your selections.

- a. Review details about the configuration.
- b. Click **More information** to review details about support and the Azure resources that Cloud Manager will purchase.
- c. Select the **I understand...** check boxes.
- d. Click **Go**.

Result

Cloud Manager deploys the Cloud Volumes ONTAP system. You can track the progress in the timeline.

If you experience any issues deploying the Cloud Volumes ONTAP system, review the failure message. You can also select the working environment and click **Re-create environment**.

For additional help, go to [NetApp Cloud Volumes ONTAP Support](#).

After you finish

- If you provisioned a CIFS share, give users or groups permissions to the files and folders and verify that those users can access the share and create a file.
- If you want to apply quotas to volumes, use System Manager or the CLI.

Quotas enable you to restrict or track the disk space and number of files used by a user, group, or qtree.

Copyright Information

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

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

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

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

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

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

Trademark Information

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