



# Storage

## Cloud Manager 3.6

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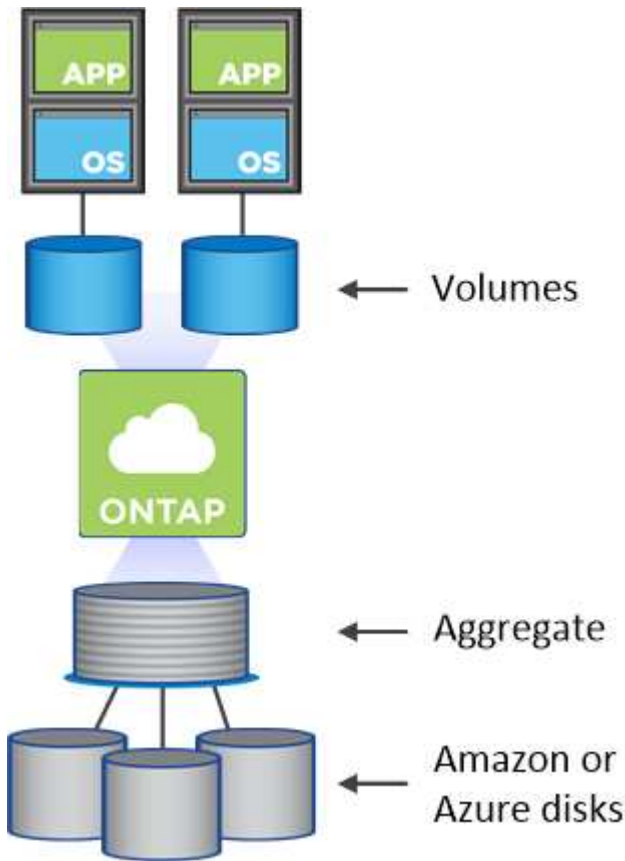
# Storage

## How Cloud Volumes ONTAP uses cloud storage

Understanding how Cloud Volumes ONTAP uses cloud storage can help you understand your storage costs.

### Overview

Cloud Volumes ONTAP uses AWS and Azure volumes as back-end storage. It sees these volumes as disks and groups them into one or more aggregates. Aggregates provide storage to one or more volumes.



Several types of cloud disks are supported. You choose the disk type when creating volumes and the default disk size when you deploy Cloud Volumes ONTAP.



The total amount of storage purchased from AWS or Azure is the *raw capacity*. The *usable capacity* is less because approximately 12 to 14 percent is overhead that is reserved for Cloud Volumes ONTAP use. For example, if Cloud Manager creates a 500 GB aggregate, the usable capacity is 442.94 GB.

### AWS storage

In AWS, an aggregate can contain up to 6 disks that are all the same size. The maximum disk size is 16 TB.

The underlying EBS disk type can be either General Purpose SSD, Provisioned IOPS SSD, Throughput Optimized HDD, or Cold HDD. You can also pair an EBS disk with Amazon S3 for [data tiering](#).

At a high level, the differences between EBS disk types are as follows:

- *General Purpose SSD* disks balance cost and performance for a broad range of workloads. Performance is defined in terms of IOPS.
- *Provisioned IOPS SSD* disks are for critical applications that require the highest performance at a higher cost.
- *Throughput Optimized HDD* disks are for frequently accessed workloads that require fast and consistent throughput at a lower price.
- *Cold HDD* disks are meant for backups, or infrequently accessed data, because the performance is very low. Like Throughput Optimized HDD disks, performance is defined in terms of throughput.



Cold HDD disks are not supported with HA configurations and with data tiering.

For additional details about the use cases for these disks, refer to [AWS Documentation: EBS Volume Types](#).

[Learn how to choose disk types and disk sizes for your systems in AWS.](#)

[Review storage limits for Cloud Volumes ONTAP.](#)

## Azure storage

In Azure, an aggregate can contain up to 12 disks that are all the same size. The disk type and maximum disk size depends on whether you use a single node system or an HA pair:

### Single node systems

Single node systems can use three 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.

Each managed disk type has a maximum disk size of 32 TB.

You can pair a managed disk with Azure Blob storage for [data tiering](#).

### HA pairs

HA pairs use Premium page blobs, which have a maximum disk size of 8 TB.

For additional details about the use cases for these disks, see [Microsoft Azure Documentation: Introduction to Microsoft Azure Storage](#).

[Learn how to choose disk types and disk sizes for your systems in Azure.](#)

[Review storage limits for Cloud Volumes ONTAP.](#)

## Data tiering overview

You can reduce your storage costs by enabling automated tiering of inactive data to low-cost object storage. Active data remains in high-performance SSDs or HDDs (the

performance tier), while inactive data is tiered to low-cost object storage (the capacity tier). This enables you to reclaim space on your primary storage and shrink secondary storage.

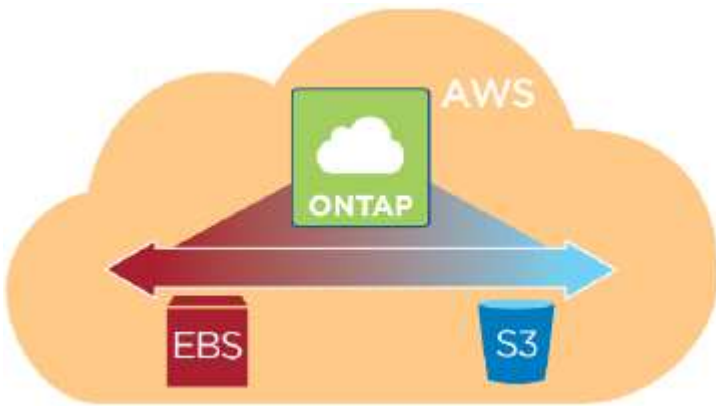
Cloud Volumes ONTAP supports data tiering in AWS and in Microsoft Azure. Data tiering is powered by FabricPool technology.



You do not need to install a feature license to enable data tiering.

## How data tiering works in AWS

When you enable data tiering in AWS, Cloud Volumes ONTAP uses EBS as a performance tier for hot data and AWS S3 as a capacity tier for inactive data:



### Performance tier in AWS

The performance tier can be General Purpose SSDs, Provisioned IOPS SSDs, or Throughput Optimized HDDs.

### Capacity tier in AWS

By default, Cloud Volumes ONTAP tiers inactive data to the S3 *Standard* storage class. Standard is ideal for frequently accessed data stored across multiple Availability Zones.

If you do not plan to access the inactive data, you can reduce your storage costs by changing a system's tiering level to one of the following, after you deploy Cloud Volumes ONTAP:

#### Intelligent Tiering

Optimizes storage costs by moving data between two tiers as data access patterns change. One tier is for frequent access and the other is for infrequent access.

#### One Zone-Infrequent Access

For infrequently accessed data stored in a single Availability Zone.

#### Standard-Infrequent Access

For infrequently accessed data stored across multiple Availability Zones.

The access costs are higher if you do access the data, so you must take that into consideration before you change the tiering level. For more details about S3 storage classes, refer to [AWS documentation](#).

When you change the tiering level, inactive 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. For details about changing the tiering level, see [Tiering inactive data to low-cost object storage](#).

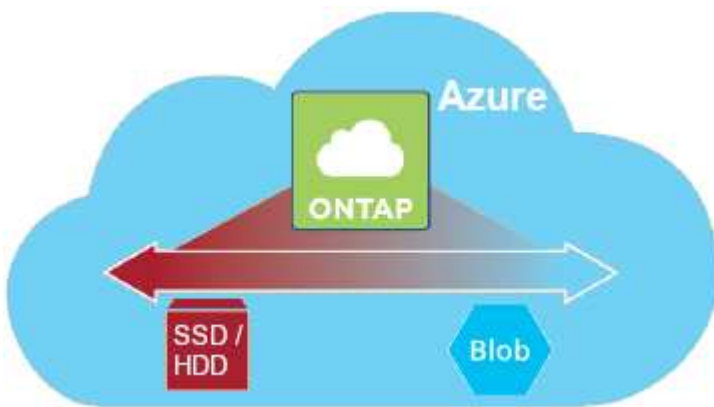
The tiering level is system wide—it is not per volume.



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 includes an HA working environment. Cloud Manager creates an S3 bucket and names it *fabric-pool-cluster unique identifier*.

## How data tiering works in Microsoft Azure

When you enable data tiering in Azure, Cloud Volumes ONTAP uses Azure managed disks as a performance tier for hot data and Azure Blob storage as a capacity tier for inactive data:



### Performance tier in Azure

The performance tier can be either Premium Storage (SSD) or Standard Storage (HDD).

### Capacity tier in Azure

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

If you do not plan to access the inactive data, you can reduce your storage costs by changing 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 will reside in the tier for at least 30 days.

The access costs are higher if you do access the data, so you must take that into consideration before you change the tiering level. For more details about Azure Blob storage tiers, refer to [Azure documentation](#).

When you change the tiering level, inactive data starts in the hot storage tier and moves to the cool storage tier, if the data is not accessed after 30 days. For details about changing the tiering level, see [Tiering inactive data to low-cost object storage](#).

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 new storage account with a container for each Cloud Volumes ONTAP system. The name of the storage account is random.

## How data tiering affects capacity limits

If you enable data tiering, a system's capacity limit stays the same. The limit is spread across the performance tier and the capacity tier.

## Volume tiering policies

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 capacity 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 capacity tier. The cooling period is approximately 2 days.

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

### Auto

After an aggregate has reached 50% capacity, Cloud Volumes ONTAP tiers cold data blocks in a volume to a capacity tier. The cold data includes not just Snapshot copies but also cold user data from the active file system. The cooling period is approximately 31 days.

This policy is supported starting with Cloud Volumes ONTAP 9.4.

If read by random reads, the cold data blocks in the capacity tier become hot and move to the performance tier. If read by sequential reads, such as those associated with index and antivirus scans, the cold data blocks stay cold and do not move to the performance tier.

### Backup

When you replicate a volume for disaster recovery or long-term retention, data for the destination volume starts in the capacity tier. If you activate the destination volume, the data gradually moves to the performance tier as it is read.

### None

Keeps data of a volume in the performance tier, preventing it from being moved to the capacity tier.

## Setting up data tiering

For instructions and a list of supported configurations, see [Tiering inactive data to low-cost object storage](#).

# Storage management

Cloud Manager provides simplified and advanced management of Cloud Volumes ONTAP storage.



All disks and aggregates must be created and deleted directly from Cloud Manager. You should not perform these actions from another management tool. Doing so can impact system stability, hamper the ability to add disks in the future, and potentially generate redundant cloud provider fees.

## Storage provisioning

Cloud Manager makes storage provisioning for Cloud Volumes ONTAP easy by purchasing disks and managing aggregates for you. You simply need to create volumes. You can use an advanced allocation option to provision aggregates yourself, if desired.

### Simplified provisioning

Aggregates provide cloud storage to volumes. Cloud Manager creates aggregates for you when you launch an instance, and when you provision additional volumes.

When you create a volume, Cloud Manager does one of three things:

- It places the volume on an existing aggregate that has sufficient free space.
- It places the volume on an existing aggregate by purchasing more disks for that aggregate.
- It purchases disks for a new aggregate and places the volume on that aggregate.

Cloud Manager determines where to place a new volume by looking at several factors: an aggregate's maximum size, whether thin provisioning is enabled, and free space thresholds for aggregates.



The Cloud Manager Admin can modify free space thresholds from the **Settings** page.

### Disk size selection for aggregates in AWS

When Cloud Manager creates new aggregates for Cloud Volumes ONTAP in AWS, it gradually increases the disk size in an aggregate, as the number of aggregates in the system increases. Cloud Manager does this to ensure that you can utilize the system's maximum capacity before it reaches the maximum number of data disks allowed by AWS.

For example, Cloud Manager might choose the following disk sizes for aggregates in a Cloud Volumes ONTAP Premium or BYOL system:

Aggregate number	Disk size	Max aggregate capacity
1	500 MB	3 TB
4	1 TB	6 TB
6	2 TB	12 TB

You can choose the disk size yourself by using the advanced allocation option.



## Advanced allocation

Rather than let Cloud Manager manage aggregates for you, you can do it yourself. [From the Advanced allocation page](#), you can create new aggregates that include a specific number of disks, add disks to an existing aggregate, and create volumes in specific aggregates.

## Capacity management

The Cloud Manager Admin can choose whether Cloud Manager notifies you of storage capacity decisions or whether Cloud Manager automatically manages capacity requirements for you. It might help for you to understand how these modes work.

### Automatic capacity management

If the Cloud Manager Admin set the Capacity Management Mode to automatic, Cloud Manager automatically purchases new disks for Cloud Volumes ONTAP instances when more capacity is needed, deletes unused collections of disks (aggregates), moves volumes between aggregates when needed, and attempts to unfail disks.

The following examples illustrate how this mode works:

- If an aggregate with 5 or fewer EBS disks reaches the capacity threshold, Cloud Manager automatically purchases new disks for that aggregate so volumes can continue to grow.
- If an aggregate with 12 Azure disks reaches the capacity threshold, Cloud Manager automatically moves a volume from that aggregate to an aggregate with available capacity or to a new aggregate.

If Cloud Manager creates a new aggregate for the volume, it chooses a disk size that accommodates the size of that volume.

Note that free space is now available on the original aggregate. Existing volumes or new volumes can use that space. The space cannot be returned to AWS or Azure in this scenario.

- If an aggregate contains no volumes for more than 12 hours, Cloud Manager deletes it.

### Manual capacity management

If the Cloud Manager Admin set the Capacity Management Mode to manual, Cloud Manager displays Action Required messages when capacity decisions must be made. The same examples described in the automatic mode apply to the manual mode, but it is up to you to accept the actions.

## Storage isolation using tenants

Cloud Manager enables you to provision and manage storage in isolated groups called tenants. You need to decide how to organize Cloud Manager users and their working environments across tenants.

### Working environments

Cloud Manager represents storage systems as *working environments*. A working environment is any of the following:

- A single Cloud Volumes ONTAP system or an HA pair
- An on-premises ONTAP cluster in your network
- An ONTAP cluster in a NetApp Private Storage configuration

The following image shows a Cloud Volumes ONTAP working environment:

## Tenants

A *tenant* isolates working environments in groups. You create one or more working environments within a tenant. The following image shows three tenants defined in Cloud Manager:

### User management of tenants and working environments

The tenants and working environments that Cloud Manager users can manage depend on user role and assignments. The three distinct user roles are as follows:

#### Cloud Manager Admin

Administers the product and can access all tenants and working environments.

#### Tenant Admin

Administers a single tenant. Can create and manage all working environments and users in the tenant.

#### Working Environment Admin

Can create and manage one or more working environments in a tenant.

### Example of how you can create tenants and users

If your organization has departments that operate independently, it is best to have a tenant for each department.

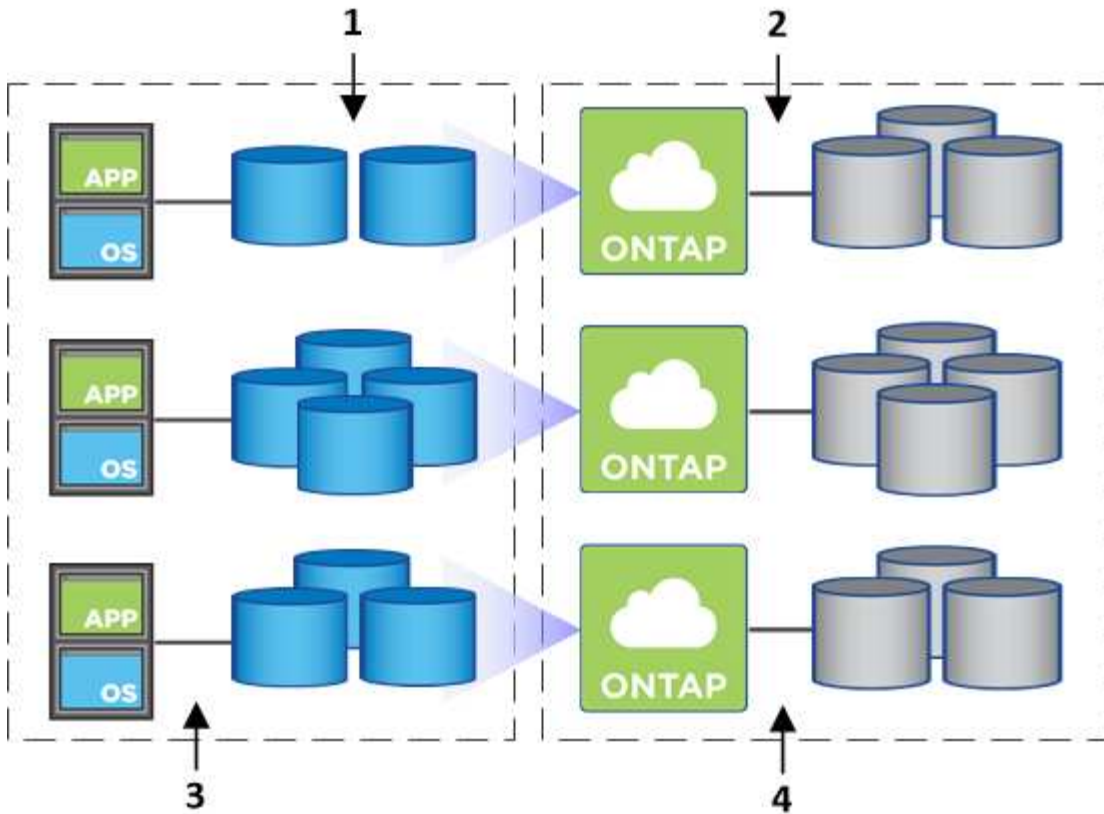
For example, you might create three tenants for three separate departments. You would then create a Tenant Admin for each tenant. Within each tenant would be one or more Working Environment Admins who manage working environments. The following image depicts this scenario:

## Simplified storage management using the Volume View

Cloud Manager provides a separate management view called the *Volume View*, which further simplifies storage management in AWS.

The Volume View enables you to simply specify the NFS volumes that you need in AWS and then Cloud Manager handles the rest: it deploys Cloud Volumes ONTAP systems as needed and it makes capacity allocation decisions as volumes grow. This view gives you the benefits of enterprise-class storage in the cloud with very little storage management.

The following image shows how you interact with Cloud Manager in the Volume View:

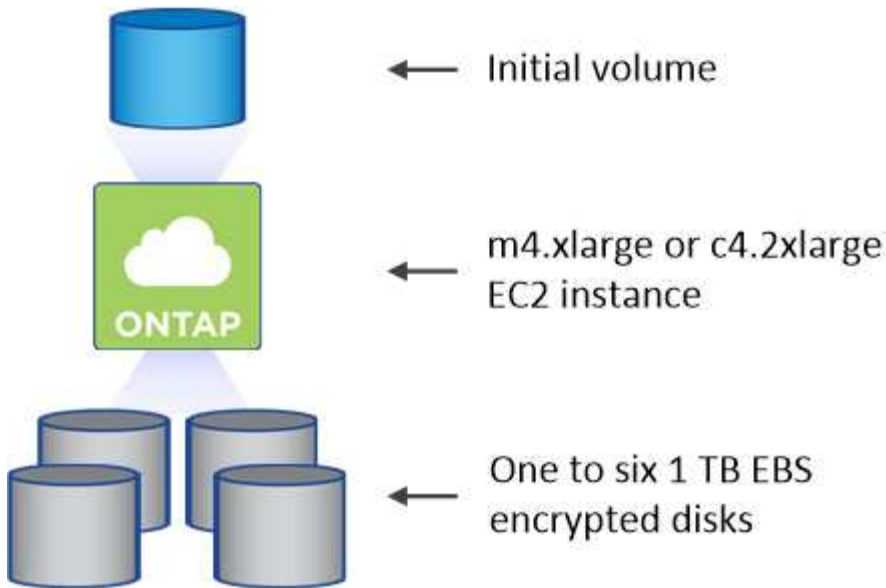


1. You create NFS volumes.
2. Cloud Manager launches Cloud Volumes ONTAP instances in AWS for new volumes or it creates volumes on existing instances. It also purchases physical EBS storage for the volumes.
3. You make the volumes available to your hosts and applications.
4. Cloud Manager makes capacity allocation decisions as your volumes grow.

This means that you simply need to interact with volumes (the image on the left), while Cloud Manager interacts with the storage system and its underlying storage (the image on the right).

### Allocation of cloud resources for the initial volume

When you create your first volume, Cloud Manager launches a Cloud Volumes ONTAP instance or a Cloud Volumes ONTAP HA pair in AWS and purchases Amazon EBS storage for the volume:



The size of the initial volume determines the EC2 instance type and the number of EBS disks.



Cloud Manager launches a Cloud Volumes ONTAP Explore or Standard instance, depending on the initial volume size. As the volumes grow, Cloud Manager might prompt you to make an AWS instance change which means it needs to upgrade the instance's license to Standard or Premium. Upgrading increases the EBS raw capacity limit, which allows your volumes to grow.



Cloud Manager does not launch Cloud Volumes ONTAP BYOL instances in the Volume View. You should use Cloud Manager in the Storage System View if you purchased a Cloud Volumes ONTAP license.

### Allocation of cloud resources for additional volumes

When you create additional volumes, Cloud Manager creates the volumes on existing Cloud Volumes ONTAP instances or on new Cloud Volumes ONTAP instances. Cloud Manager can create a volume on an existing instance if the instance's AWS location and disk type match the requested volume, and if there is enough space.

### NetApp storage efficiency features and storage costs

Cloud Manager automatically enables NetApp storage efficiency features on all volumes. These efficiencies can reduce the total amount of storage that you need. You might see a difference between your allocated capacity and the purchased AWS capacity, which can result in storage cost savings.

### Capacity allocation decisions that Cloud Manager automatically handles

- Cloud Manager purchases additional EBS disks as capacity thresholds are exceeded. This happens as your volumes grow.
- Cloud Manager deletes unused sets of EBS disks if the disks contain no volumes for 12 hours.
- Cloud Manager moves volumes between sets of disks to avoid capacity issues.

In some cases, this requires purchasing additional EBS disks. It also frees space on the original set of disks for new and existing volumes.

# WORM storage

You can activate write once, read many (WORM) storage on a Cloud Volumes ONTAP system to retain files in unmodified form for a specified retention period. WORM storage is powered by SnapLock technology in Enterprise mode, which means WORM files are protected at the file level.

Once a file has been committed to WORM storage, it cannot be modified, even after the retention period has expired. A tamper-proof clock determines when the retention period for a WORM file has elapsed.

After the retention period has elapsed, you are responsible for deleting any files that you no longer need.

## Activating WORM storage

You can activate WORM storage on a Cloud Volumes ONTAP system when you create a new working environment. This includes specifying an activation code and setting the default retention period for files. You can obtain an activation code by using the chat icon in the lower right of the Cloud Manager interface.



You cannot activate WORM storage on individual volumes—WORM must be activated at the system level.

The following image shows how to activate WORM storage when creating a working environment:

## WORM | [Preview](#)

You can use **write once, read many (WORM)** storage to retain critical files in unmodified form for regulatory and governance purposes and to protect from malware attacks. WORM files are protected at the file level. [Learn More](#)

Disable WORM     Activate WORM

**Notice:** If you enable WORM storage, you cannot enable data tiering to object storage.

WORM Activation Code 

Worm-1111122222aaaaa

Retention Period

15

years 

## Committing files to WORM

You can use an application to commit files to WORM over NFS or CIFS, or use the ONTAP CLI to autocommit

files to WORM automatically. You can also use a WORM appendable file to retain data that is written incrementally, like log information.

After you activate WORM storage on a Cloud Volumes ONTAP system, you must use the ONTAP CLI for all management of WORM storage. For instructions, refer to [ONTAP documentation](#).



Cloud Volumes ONTAP support for WORM storage is equivalent to SnapLock Enterprise mode.

### Limitations

- If you delete or move a disk directly from AWS or Azure, then a volume can be deleted before its expiry date.
- When WORM storage is activated, data tiering to object storage cannot be enabled.

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