Storage

Cloud Manager

NetApp
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Storage

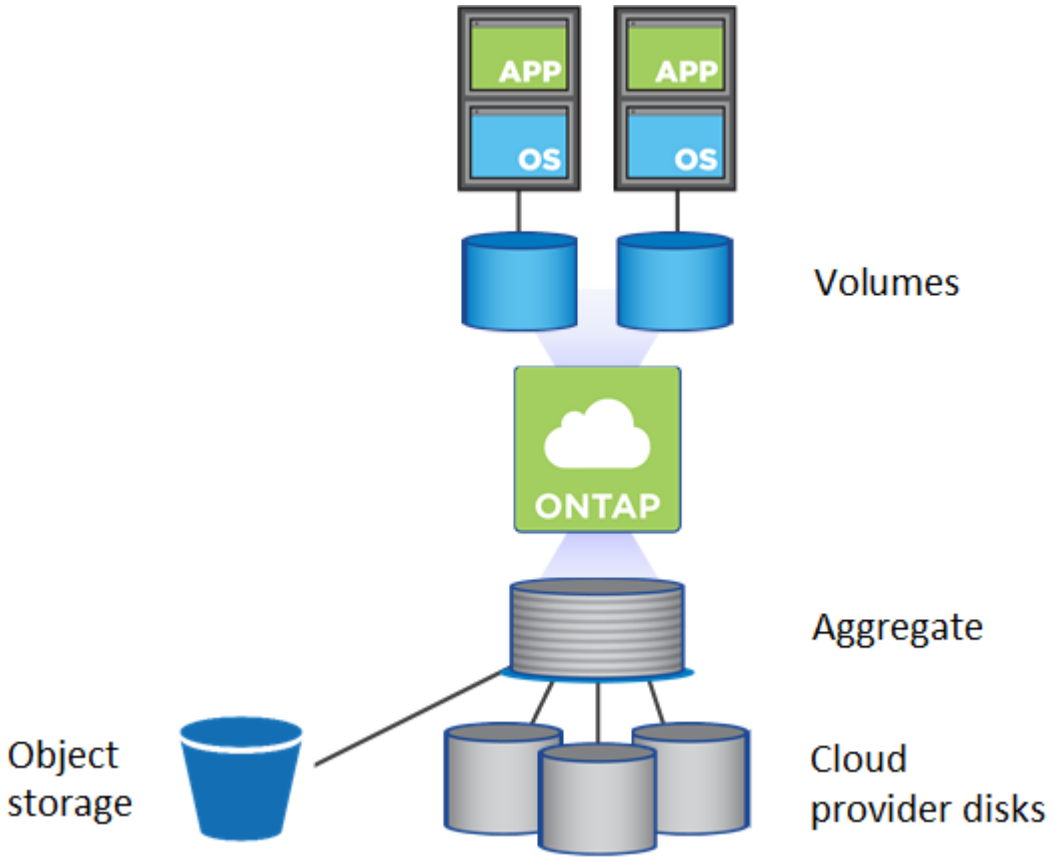
Disks and aggregates

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

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.

Overview

Cloud Volumes ONTAP uses cloud provider storage 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 you create a volume and the default disk size when you deploy Cloud Volumes ONTAP.

The total amount of storage purchased from a cloud provider 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, Cloud Volumes ONTAP uses EBS storage for user data and local NVMe storage as Flash Cache on some EC2 instance types.

EBS 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 pair an EBS disk with Amazon S3 to tier inactive data to low-cost object storage.

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.

Local NVMe storage

Some EC2 instance types include local NVMe storage, which Cloud Volumes ONTAP uses as Flash Cache.

Related links

- 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 in AWS
- Review supported configurations for Cloud Volumes ONTAP in AWS

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 to tier inactive data to low-cost object storage.

HA pairs

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

Related links

- 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 in Azure

GCP storage

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

The disk type can be either *Zonal SSD persistent disks* or *Zonal standard persistent disks*. You can pair persistent disks with a Google Storage bucket to tier inactive data to low-cost object storage.

Related links

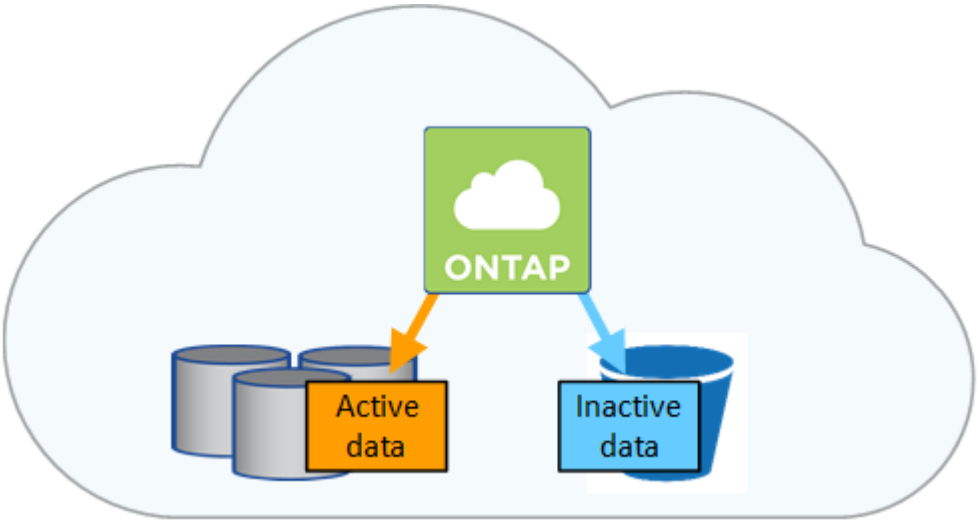
- Google Cloud Platform documentation: Storage Options
- Review storage limits for Cloud Volumes ONTAP in GCP

RAID type

The RAID type for each Cloud Volumes ONTAP aggregate is RAID0 (striping). No other RAID types are supported. Cloud Volumes ONTAP relies on the cloud provider for disk availability and durability.

Data tiering overview

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



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

You don’t need to install a feature license to enable data tiering (FabricPool).

Data tiering 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

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

Capacity tier

A Cloud Volumes ONTAP system tiers inactive data to a single S3 bucket using the *Standard* storage class. Standard is ideal for frequently accessed data stored across multiple Availability Zones.

Cloud Manager creates a single S3 bucket for each working environment and names it fabric-pool-*cluster unique identifier*. A different S3 bucket is not created for each volume.

Storage classes

The default storage class for tiered data in AWS is *Standard*. If you don’t plan to access the inactive data, you can reduce your storage costs by changing the storage class to one of the following: *Intelligent Tiering*, *One-Zone Infrequent Access*, or *Standard-Infrequent Access*. When you change the storage class, inactive data starts in the Standard storage class and transitions to the storage class that you selected, if the data is not accessed after 30 days.

The access costs are higher if you do access the data, so take that into consideration before you change the storage class. Learn more about Amazon S3 storage classes.

You can select a storage class when you create the working environment and you can change it any time after. For details about changing the storage class, see Tiering inactive data to low-cost object storage.

The storage class for data tiering is system wide—it’s not per volume.

Data tiering in 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

The performance tier can be either SSDs or HDDs.

Capacity tier

A Cloud Volumes ONTAP system tiers inactive data to a single Blob container using the Azure *hot* storage tier. The hot tier is ideal for frequently accessed data.

Cloud Manager creates a new storage account with a single container for each Cloud Volumes ONTAP working environment. The name of the storage account is random. A different container is not created for each volume.

Storage access tiers

The default storage access tier for tiered data in Azure is the *hot* tier. If you don't plan to access the inactive data, you can reduce your storage costs by changing to the *cool* storage tier. When you change the storage tier, inactive data starts in the hot storage tier and transitions to the cool storage tier, if the data is not accessed after 30 days.

The access costs are higher if you do access the data, so take that into consideration before you change the storage tier. Learn more about Azure Blob storage access tiers.

You can select a storage tier when you create the working environment and you can change it any time after. For details about changing the storage tier, see Tiering inactive data to low-cost object storage.

The storage access tier for data tiering is system wide—it's not per volume.

Data tiering in GCP

When you enable data tiering in GCP, Cloud Volumes ONTAP uses persistent disks as a performance tier for hot data and a Google Cloud Storage bucket as a capacity tier for inactive data.

Performance tier

The performance tier can be either SSDs or HDDs (standard disks).

Capacity tier

A Cloud Volumes ONTAP system tiers inactive data to a single Google Cloud Storage bucket using the *Regional* storage class.

Cloud Manager creates a single bucket for each working environment and names it fabric-pool-*cluster unique identifier*. A different bucket is not created for each volume.

Storage classes

The default storage class for tiered data is the *Standard Storage* class. If the data is infrequently accessed, you can reduce your storage costs by changing to *Nearline Storage* or *Coldline Storage*. When you change the storage class, inactive data starts in the Standard Storage class and transitions to the storage class that you selected, if the data is not accessed after 30 days.

The access costs are higher if you do access the data, so take that into consideration before you change the storage class. Learn more about storage classes for Google Cloud Storage.

You can select a storage tier when you create the working environment and you can change it any time after. For details about changing the storage class, see Tiering inactive data to low-cost object storage.

The storage class for data tiering is system wide—it's not per volume.

Data tiering and 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. The cooling period starts when data is written to the aggregate.

You can change the minimum cooling period and default aggregate threshold of 50% (more on that below). Learn how to change the cooling period and learn how to change the threshold.

Cloud Manager enables you to choose from the following volume tiering policies when you create or modify a volume:

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.

All

All data (not including metadata) is immediately marked as cold and tiered to object storage as soon as possible. There is no need to wait 48 hours for new blocks in a volume to become cold. Note that blocks located in the volume prior to the All policy being set require 48 hours to become cold.

If read, cold data blocks on the cloud tier stay cold and are not written back to the performance tier. This policy is available starting with ONTAP 9.6.

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.

None

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

When you replicate a volume, you can choose whether to tier the data to object storage. If you do, Cloud Manager applies the **Backup** policy to the data protection volume. Starting with Cloud Volumes ONTAP 9.6, the **All** tiering policy replaces the backup policy.

Turning off Cloud Volumes ONTAP impacts the cooling period

Data blocks are cooled by cooling scans. During this process, blocks that haven’t been used have their block temperature moved (cooled) to the next lower value. The default cooling time depends on the volume tiering policy:

- Auto: 31 days
- Snapshot Only: 2 days

Cloud Volumes ONTAP must be running for the cooling scan to work. If Cloud Volumes ONTAP is turned off, cooling will stop, as well. As a result, you can experience longer cooling times.

When Cloud Volumes ONTAP is turned off, the temperature of each block is preserved until you restart the system. For example, if the temperature of a block is 5 when you turn the system off, the temp is still 5 when you turn the system back on.

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 Account 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 Account 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

The Capacity Management Mode is set to automatic by default. In this mode, 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 can't be returned to AWS, Azure, or GCP in this scenario.

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

Management of LUNs with automatic capacity management

Cloud Manager's automatic capacity management doesn't apply to LUNs. When Cloud Manager creates a LUN, it disables the autogrow feature.

Management of inodes with automatic capacity management

Cloud Manager monitors inode usage on a volume. When 85% of the inodes are used, Cloud Manager

increases the size of the volume to increase the number of available inodes. The number of files a volume can contain is determined by how many inodes it has.

Manual capacity management

If the Account 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.

Write speed

Cloud Manager enables you to choose normal or high write speed 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.

High write speed is supported with all types of single node systems. It's also supported with HA pairs in AWS and Azure when using a specific instance or VM type (refer to the sections below for the list of supported instances and VM types). High write speed is not supported with HA pairs in GCP.

Normal write speed

When you choose normal write speed, data is written directly to disk. When data is written directly to disk, reduces the likelihood of data loss in the event of an unplanned system outage, or a cascading failure involving an unplanned system outage (HA pairs only).

Normal write speed is the default option.

High write speed

When you choose high write speed, data is buffered in memory before it is written to disk, which provides faster write performance. Due to this caching, there is the potential for data loss if an unplanned system outage occurs.

The amount of data that can be lost in the event of an unplanned system outage is the span of the last two consistency points. A consistency point is the act of writing buffered data to disk. A consistency point occurs when the write log is full or after 10 seconds (whichever comes first). However, the performance of the storage provided by your cloud provider can affect consistency point processing time.

When to use high write speed

High write speed is a good choice if fast write performance is required for your workload and you can withstand the risk of data loss in the event of an unplanned system outage, or a cascading failure involving an unplanned system outage (HA pairs only).

Recommendations when using high write speed

If you enable high write speed, you should ensure write protection at the application layer, or that the applications can tolerate data loss, if it occurs.

Configurations that support high write speed

Not all Cloud Volumes ONTAP configurations support high write speed. Those configurations use normal write speed by default.

AWS

If you use a single node system, Cloud Volumes ONTAP supports high write speed with all instance types.

If you use an HA pair, Cloud Volumes ONTAP supports high write speed with the following instance types, starting with the 9.8 release:

- c5.9xlarge
- c5.18xlarge
- c5d.4xlarge
- c5d.9xlarge
- c5d.18xlarge
- c5n.9xlarge
- c5n.18xlarge
- m5.2xlarge
- m5.4xlarge
- m5.16xlarge
- m5d.8xlarge
- m5d.12xlarge
- m5n.2xlarge
- r5.2xlarge
- r5.8xlarge
- r5.12xlarge
- r5d.2xlarge

Azure

If you use a single node system, Cloud Volumes ONTAP supports high write speed with all VM types.

If you use an HA pair, Cloud Volumes ONTAP supports high write speed with the following VM types, starting with the 9.8 release:

- DS5_v2
- DS14_v2
- DS15_v2
- E48s_v3

Google Cloud

If you use a single node system, Cloud Volumes ONTAP supports high write speed with all machine types.

Cloud Volumes ONTAP doesn't support high write speed with HA pairs in Google Cloud.

How to select a write speed

You can choose a write speed when you create a new working environment and you can change the write speed for an existing system.

What to expect if data loss occurs

If you choose high write speed and data loss occurs, the system should be able to boot up and continue to serve data without user intervention. Two EMS messages will be reported when a node runs into data loss. One is wafl.root.content.changed with the ERROR severity level event, the other is nv.check.failed with the DEBUG severity level event. Both messages must be present as an indication of data loss.

How to stop data access if data loss occurs

If you are concerned about data loss, want the applications to stop running upon data loss, and the data access to be resumed after the data loss issue is properly addressed, you can use the NVFAIL option from the CLI to achieve that goal.

To enable the NVFAIL option

```
vol modify -volume <vol-name> -nvfail on
```

To check NVFAIL settings

```
vol show -volume <vol-name> -fields nvfail
```

To disable the NVFAIL option

```
vol modify -volume <vol-name> -nvfail off
```

When data loss occurs, an NFS or iSCSI volume with NVFAIL enabled should stop serving data (there's no impact to CIFS which is a stateless protocol). For more details, refer to How NVFAIL impacts access to NFS volumes or LUNs.

To check the NVFAIL state

```
vol show -fields in-nvfailed-state
```

After the data loss issue is properly addressed, you can clear the NVFAIL state and the volume will be available for data access.

To clear the NVFAIL state

```
vol modify -volume <vol-name> -in-nvfailed-state false
```

Flash Cache

Some Cloud Volumes ONTAP configurations in AWS and Azure include local NVMe storage, which Cloud Volumes ONTAP uses as *Flash Cache* for better performance.

What's Flash Cache?

Flash Cache speeds access to data through real-time intelligent caching of recently read user data and NetApp metadata. It's effective for random read-intensive workloads, including databases, email, and file services.

Supported instances in AWS

Select one of the following EC2 instance types with a new or existing Cloud Volumes ONTAP Premium or BYOL system:

- c5d.4xlarge
- c5d.9xlarge
- c5d.18xlarge
- m5d.8xlarge
- m5d.12xlarge
- r5d.2xlarge

Supported VM type in Azure

Select the Standard_L8s_v2 VM type with a single node Cloud Volumes ONTAP BYOL system in Azure.

Limitations

- Compression must be disabled on all volumes to take advantage of the Flash Cache performance improvements.

  Choose no storage efficiency when creating a volume from Cloud Manager, or create a volume and then disable data compression by using the CLI.

- Cache rewarming after a reboot is not supported with Cloud Volumes ONTAP.

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.

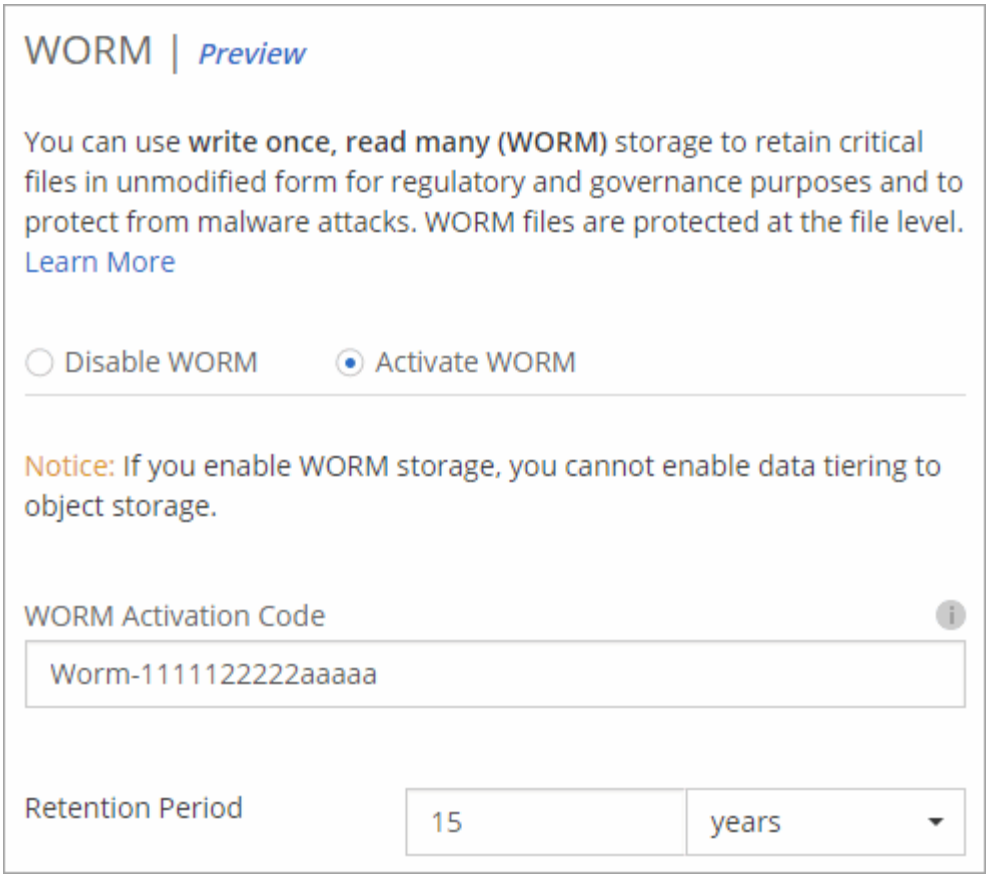
After the retention period has elapsed, you are responsible for deleting any files that you no longer need.

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:



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 can’t be enabled.
- Cloud Backup must be disabled in order to enable WORM storage.