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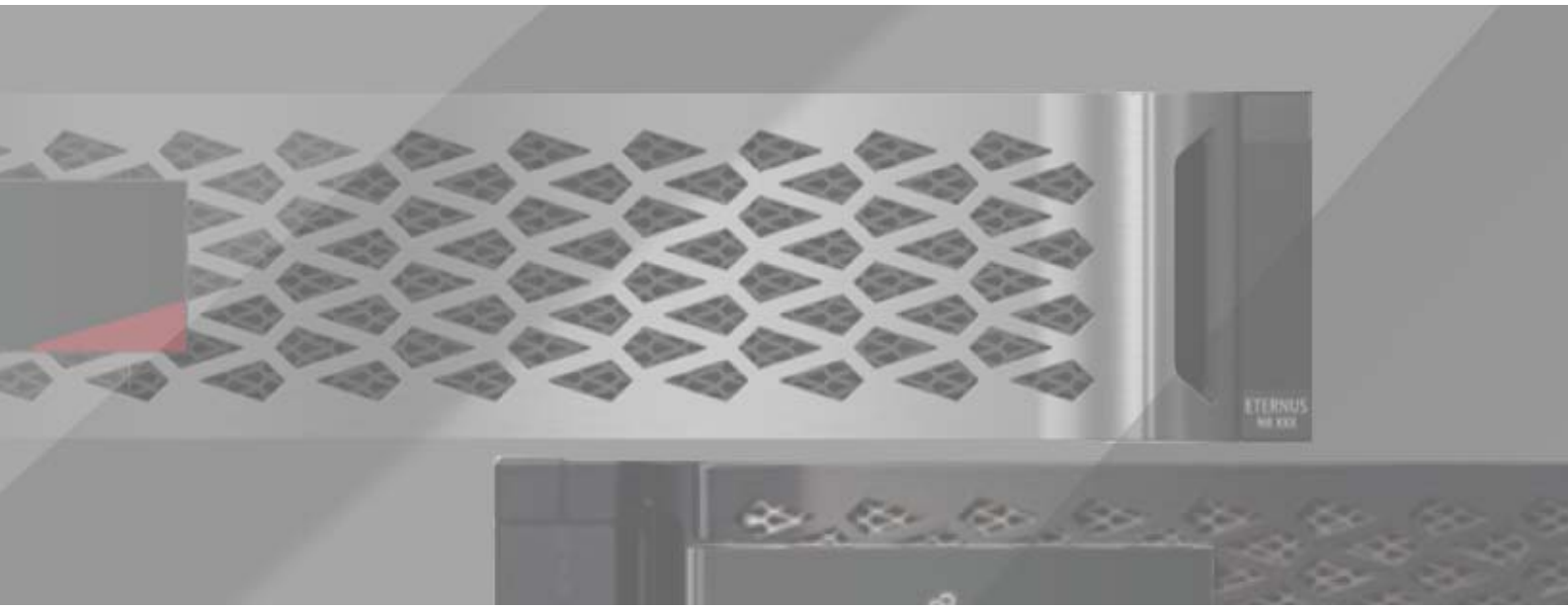
FUJITSU Storage
ETERNUS AX series All-Flash Arrays,
ETERNUS HX series Hybrid Arrays

FabricPool Best Practices ONTAP 9.9.1



FUJITSU

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Preface

This document describes best practices for the ONTAP software component FabricPool. The capabilities, requirements, implementation, and best practices for this software are covered.

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Trademarks

Third-party trademark information related to this product is available at:
https://www.fujitsu.com/global/products/computing/storage/eternus/trademarks.html

Trademark symbols such as ™ and ® are omitted in this document.

About This Manual

Intended Audience

This manual is intended for system administrators who configure and manage operations of the ETERNUS AX/HX, or field engineers who perform maintenance. Refer to this manual as required.

Related Information and Documents

The latest information for the ETERNUS AX/HX is available at:
https://www.fujitsu.com/global/support/products/computing/storage/manuals-list.html

Document Conventions

Notice Symbols

The following notice symbols are used in this manual:

Caution	Indicates information that you need to observe when using the ETERNUS AX/HX. Make sure to read the information.
Note	Indicates information and suggestions that supplement the descriptions included in this manual.

1. Overview

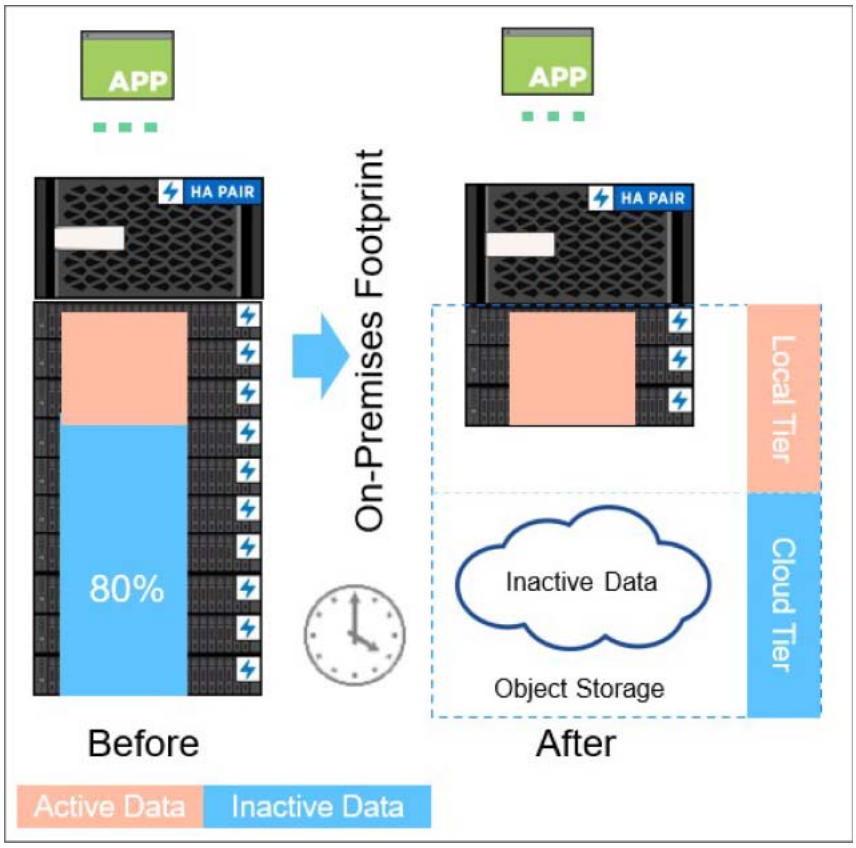
FabricPool is a Data Fabric technology that enables automated tiering of data to low-cost object storage tiers either on or off premises.

Unlike manual tiering solutions, FabricPool reduces total cost of ownership by automating the tiering of data to lower the cost of storage. Cloud Volumes ONTAP delivers the economic benefits of the cloud by supporting data tiring with FUJITSU Hybrid IT Service for Microsoft Azure and FUJITSU Hybrid IT Service for AWS.

FabricPool is transparent to applications and allows enterprises to take advantage of cloud economics without sacrificing performance or having to rearchitect solutions to leverage storage efficiency.

- ETERNUS AX/HX supports FabricPool on SSD and HDD local tiers. Flash Pool aggregates are not supported.
- Cloud Volumes ONTAP supports data tiering with Amazon S3 of FUJITSU Hybrid IT Service for AWS and Microsoft Azure Blob Storage of FUJITSU Hybrid IT Service for Microsoft Azure.

Figure 1 Before and after FabricPool



2. Primary Use Cases

The primary purpose of FabricPool is to reduce storage footprints and associated costs. Active data remains on high-performance local tiers, and inactive data is tiered to low-cost object storage while preserving ONTAP functionality and data efficiencies.

FabricPool has two primary use cases:

- Reclaim capacity on primary storage
- Shrink the secondary storage footprint

Although FabricPool can significantly reduce storage footprints in primary and secondary data centers, it is not a backup solution. Access control lists (ACLs), directory structures, and WAFL metadata always stay on the local tier. If a catastrophic disaster destroys the local tier, a new environment cannot be created using the data on the cloud tier because it contains no WAFL metadata.

For complete data protection, consider using existing ONTAP technologies such as SnapMirror and SnapVault.

Reclaim Capacity on Primary Storage (Auto, Snapshot-Only, or All)

Auto

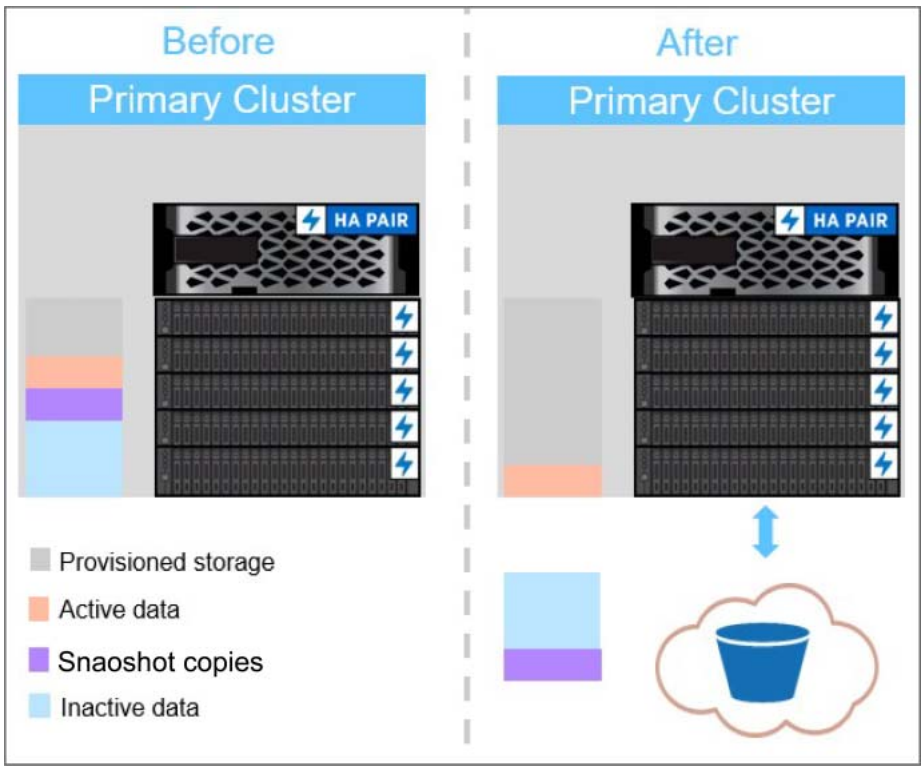
The majority of inactive (cold) data in storage environments is associated with unstructured data, accounting for more than 50% of total storage capacity in many storage environments.

Infrequently accessed data associated with productivity software, completed projects, and old datasets is an inefficient use of high-performance storage capacity, and tiering this data to a low-cost object store is an easy way to reclaim existing local capacity and reduce the amount of required local capacity moving forward.

The Auto volume tiering policy shown in Figure 2 moves all cold blocks in the volume, not just blocks associated with Snapshot copies, to the cloud tier.

If read by random reads, cold data blocks on the cloud tier become hot and are moved to the local tier. If read by sequential reads such as those associated with index and antivirus scans, cold data blocks on the cloud tier stay cold and are not written to the local tier.

Figure 2 Reclaiming space with the Auto volume tiering policy



Snapshot-Only

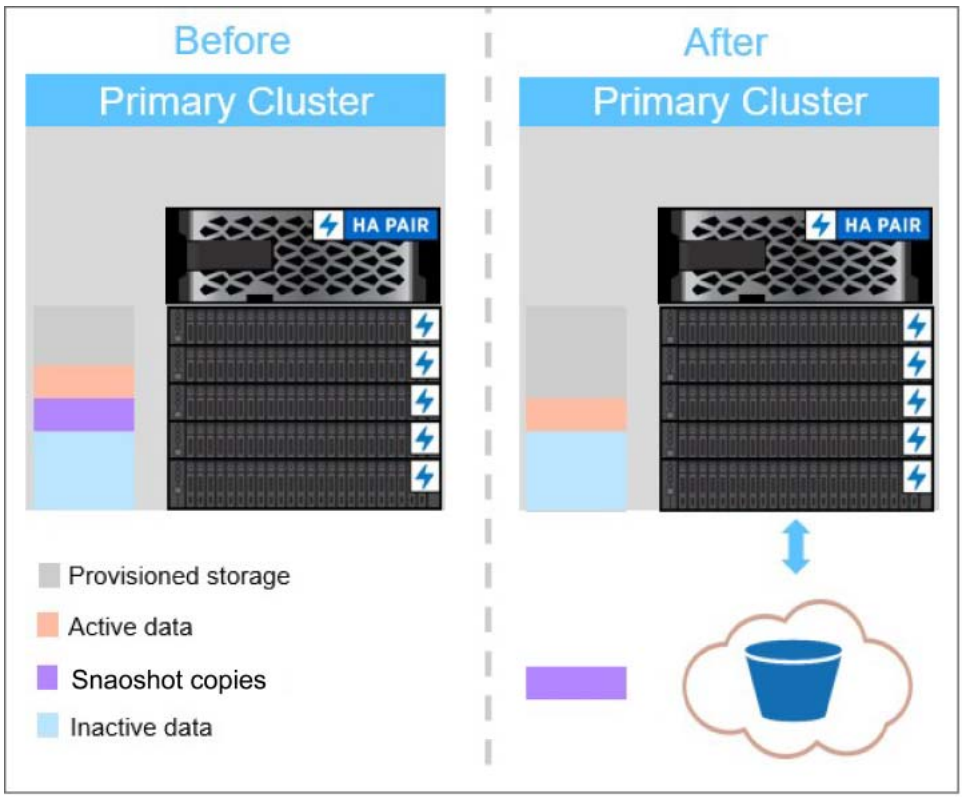
Snapshot copies can frequently consume more than 10% of a typical storage environment. Although essential for data protection and disaster recovery, these point-in-time copies are rarely used and are an inefficient use of high-performance storage.

Snapshot-Only, a volume tiering policy for FabricPool, is an easy way to reclaim storage space on high-performance storage. When configured to use this policy, cold Snapshot blocks in the volume that are not shared with the active file system are moved to the cloud tier. If read, cold data blocks on the cloud tier become hot and are moved to the local tier.

Caution

The FabricPool Snapshot-Only volume tiering policy, as shown in Figure 3, reduces the amount of storage used by Snapshot copies on the local tier. It does not increase the maximum number of Snapshot copies allowed by ONTAP, which remains 1,023.

Figure 3 Reclaiming space with the Snapshot-Only volume tiering policy



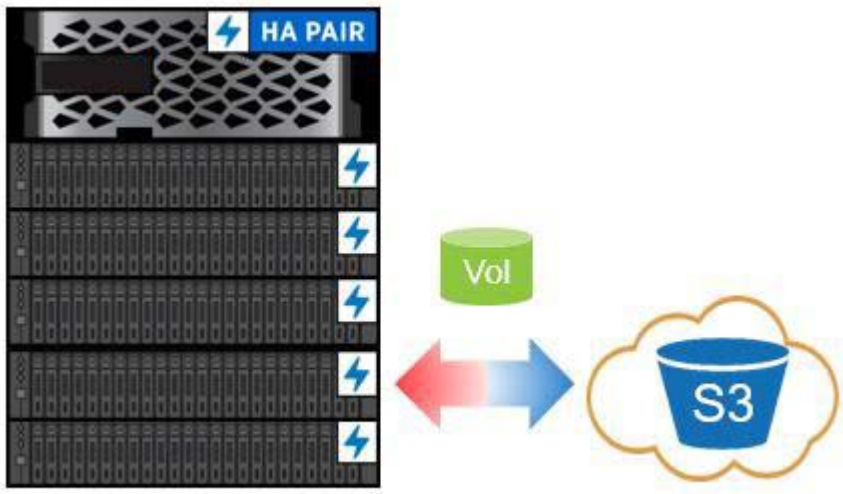
All

In addition to cold primary data in active volumes (Auto) and snapshots (Snapshot-Only), one of the most common uses of FabricPool is to move entire volumes of data to low-cost clouds. Completed projects, legacy reports, or historical records–any dataset that must be retained but is unlikely to be frequently read–are ideal candidates to be tiered to low-cost object storage.

Moving entire volumes is accomplished by setting the All volume tiering policy on a volume. The All volume tiering policy, as shown in Figure 4, is primarily used with secondary data and data protection volumes, but it can also be used to tier all data in read/write volumes, provided the volume is not subject to frequent transactional operations.

Data in volumes using the All tiering policy, (excluding data illegible for tiering) is immediately marked as cold and tiered to the cloud as soon as possible. There is no waiting for a minimum number of days to pass before the data is made cold and tiered. If read, cold data blocks on the cloud tier stay cold and are not written back to the local tier.

Figure 4 Reclaiming space with the All volume tiering policy



Shrink the Secondary Storage Footprint (All)

Secondary data includes data protection volumes that are SnapMirror (disaster recovery) or SnapVault (backup) destination targets. This data is frequently stored on secondary clusters that share a 1:1 or greater ratio with the primary data that they are protecting (one baseline copy and multiple Snapshot copies). For large datasets, this approach can be prohibitively expensive, forcing users to make expensive decisions about the data they need to protect.

Like Snapshot copies, data protection volumes are infrequently used and are an inefficient use of high-performance storage. FabricPool's All volume tiering policy changes this paradigm.

Instead of 1:1 primary-to-backup ratios, the FabricPool All policy allows users to significantly reduce the number of disk shelves on their secondary clusters, tiering most of the backup data to low-cost object stores. ACLs, directory structures, and WAFL metadata remains on the secondary cluster's local tier.

If read, cold data blocks in volumes using the All policy are not written back to the local tier. This reduces the need for high-capacity secondary storage local tiers.

Figure 5 Using the All volume tiering policy with secondary storage

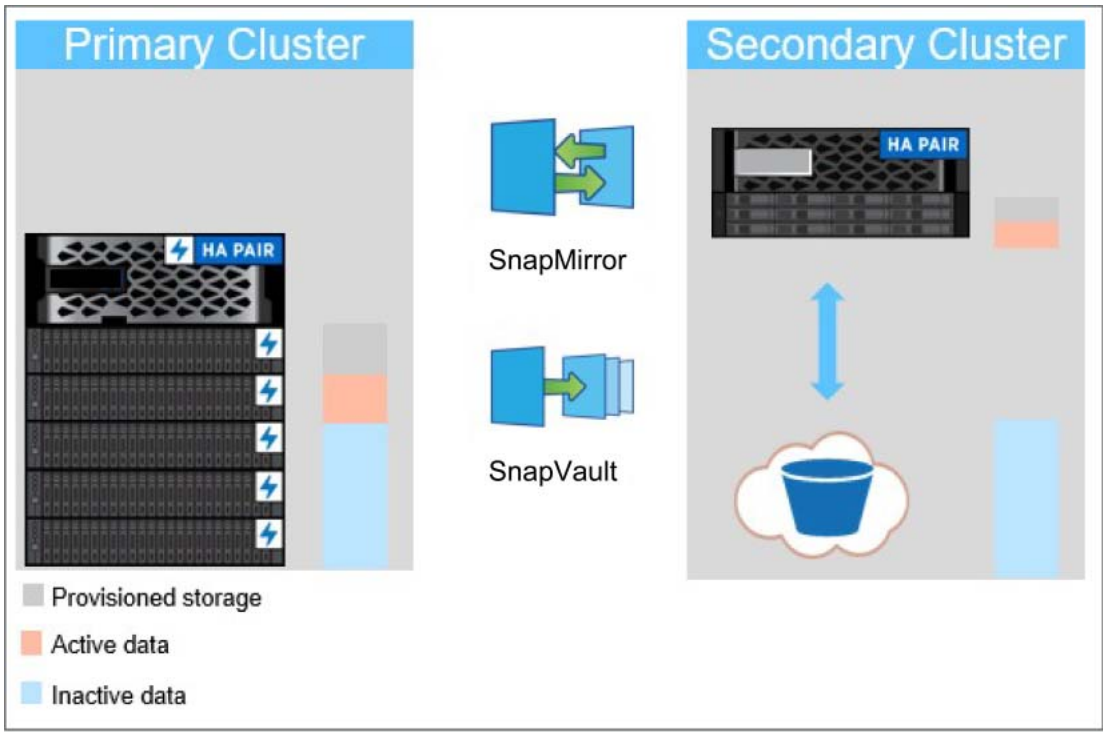


Figure 5 illustrates the secondary as a traditional cluster running ONTAP. The secondary can also be in the cloud using Cloud ONTAP Volumes. Data can be tiered using FabricPool anywhere ONTAP can be deployed.

3. Requirements

FabricPool requires ONTAP 9.2. Additional FabricPool requirements depend on the version of ONTAP being used and the cloud tier being attached.

Prior to ONTAP 9.8, FabricPool was only supported on SSD local tiers.

Platforms

FabricPool is supported by all the ETERNUS AX/HX series platforms:

- Cloud tiers
  - Object Storage of FUJITSU Hybrid IT Service FJcloud-O
  - Microsoft Azure Blob Storage of FUJITSU Hybrid IT Service for Microsoft Azure
  - Amazon S3 of FUJITSU Hybrid IT Service for AWS
  - StorageGRID 10.3+
- Data tiering with Cloud Volumes ONTAP
  - Microsoft Azure Blob Storage of FUJITSU Hybrid IT Service for Microsoft Azure
  - Amazon S3 of FUJITSU Hybrid IT Service for AWS

Intercluster LIFs

Cluster high-availability (HA) pairs that use FabricPool require two intercluster LIFs to communicate with the cloud tier. Fujitsu recommends creating an intercluster LIF on additional HA pairs to seamlessly attach cloud tiers to local tiers on those nodes as well.

If you are using more than one IC LIF on a node with different routing, Fujitsu recommends placing them in different IPspaces. During configuration, FabricPool can select from multiple IPspaces, but it is unable to select specific IC LIFs within an IPspace.

Caution

Disabling or deleting an intercluster LIF interrupts communication to the cloud tier.

Volumes

FabricPool cannot attach a cloud tier to a local tier that contains volumes using a space guarantee other than None.

```
volume modify -space-guarantee none
```

Setting the `space-guarantee none` parameter assures thin provisioning of the volume. The amount of space consumed by volumes with this guaranteed type grows as data is added instead of being determined by the initial volume size. This approach is essential for FabricPool because the volume must support cloud tier data that becomes hot and is brought back to the local tier.

FlexGroup Volumes

All local tiers used by a FlexGroup volume must be FabricPool local tiers.

When provisioning FlexGroup volumes on FabricPool local tiers, automatic processes in ONTAP System Manager require that the FlexGroup volume uses FabricPool local tiers on every cluster node. This is a recommended best practice but is not a requirement when manually provisioning FlexGroup volumes.

Quality of Service Minimums

FabricPool and quality of service minimums (QoS Min) goals are mutually exclusive; QoS Min guarantees performance minimums, whereas FabricPool sends blocks to an object store and decreasing performance. QoS Min must be turned off on volumes in FabricPool local tiers. Alternatively, tiering must be turned off (`-tiering-policy none`) on volumes that require QoS Min.

FabricPool License

FabricPool requires a capacity-based license when attaching third-party object storage providers as cloud tiers for the ETERNUS AX/HX series. A FabricPool license is not required when using StorageGRID or ONTAP S3 as the cloud tier or when using Microsoft Azure Blob Storage of FUJITSU Hybrid IT Service for Microsoft Azure or Amazon S3 of FUJITSU Hybrid IT Service for AWS as the cloud tier for Cloud Volumes for ONTAP.

FabricPool licenses are available in term-based (1-year or 3-year) formats.

Tiering to the cloud tier stops when the amount of data (used capacity) stored on the cloud tier reaches the licensed capacity. Additional data, including SnapMirror copies to volumes using the All tiering policy, cannot be tiered until the license capacity is increased. Although tiering stops, data remains accessible from the cloud tier. Additional cold data remains on the local tier until the licensed capacity is increased.

A FabricPool license can only be deleted from a cluster containing no FabricPool local tiers.

Caution

FabricPool licenses are cluster wide. Have your UUID available when purchasing a license (`cluster identity show`). For additional licensing information, contact Fujitsu Support.

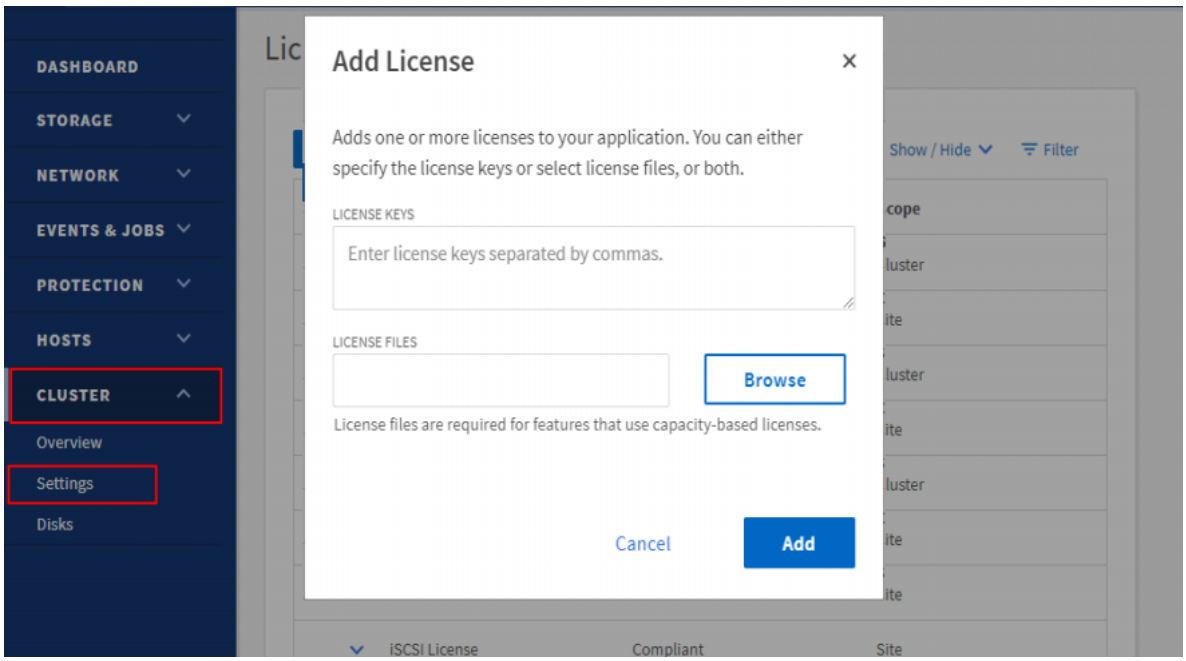
Installation

After you acquire a license file (LF), you can install it by using ONTAP System Manager. To do so, complete the following steps:

Procedure ▶▶▶

1. Click CLUSTER.
2. Click Settings.
3. Click Licenses.
4. Click Add.
5. Click Choose Files to browse and select a file.
6. Click Add.

Figure 6 FabricPool license



License Capacity

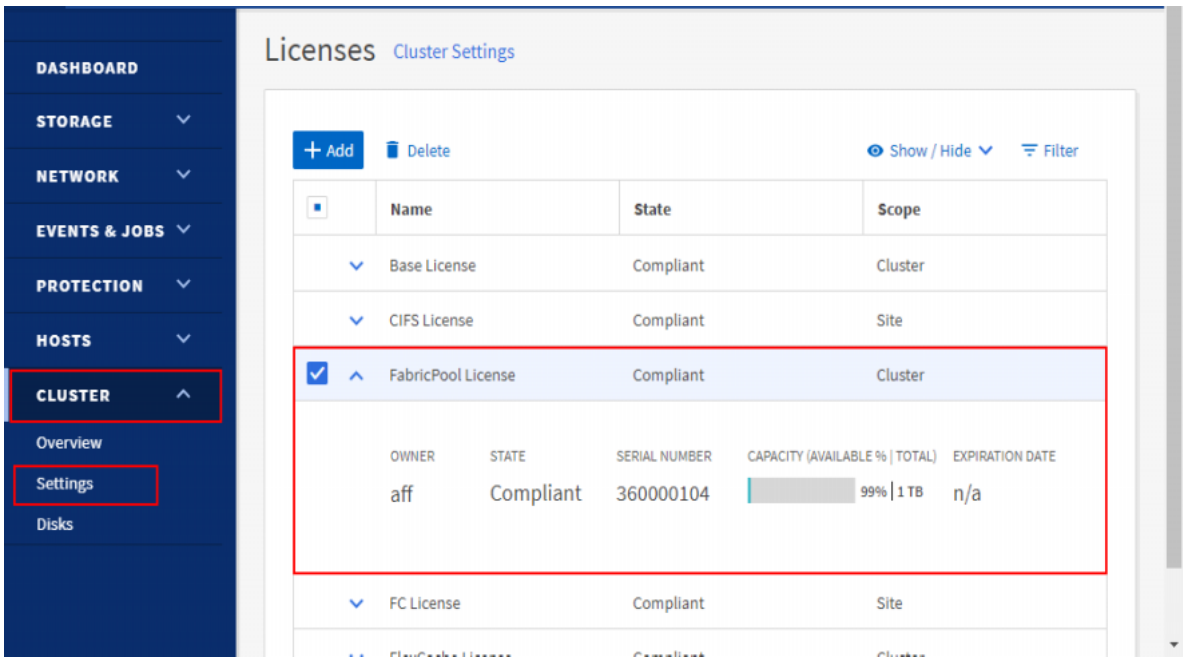
Licensed capacity can be viewed using ONTAP System Manager. To view the licensed capacity, complete the following steps in ONTAP System Manager:

Procedure

1. Click CLUSTER.
2. Click Settings.
3. Click Licenses.
4. Click the FabricPool License.
5. Click the down arrow to view license details.

Maximum capacity and current capacity are listed on the FabricPool License row.

Figure 7 License capacity



Certificate Authority Certification

When FabricPool uses StorageGRID or other private clouds like some FUJITSU Hybrid IT Service FJcloud-O environments as a cloud tier, it must use a Transport Layer Security (TLS) connection. Using FabricPool without TLS configuration is supported but not recommended.

Caution

Using signed certificates from a third-party certificate authority is the recommended best practice.

FQDN

FabricPool requires that CA certificates use the same fully qualified domain name (FQDN) as the cloud tier server with which they are associated.

Prior to StorageGRID 11.3, the default CA certificates use a common name (CN) that isn't based on the server's FQDN. Using the common name causes certificate-based errors that prohibit StorageGRID from being attached to ONTAP local tiers.

Errors might include the following examples:

- Unable to add cloud tier. Cannot verify the certificate provided by the object store server. The certificates might not be installed on the cluster. Do you want to add the certificate now?
- Cannot verify the certificate provided by the object store server.

To avoid these errors and successfully attach StorageGRID 11.2 and earlier as a cloud tier, you must replace the certificates in the grid with certificates that use the correct FQDN.

Although self-signed certificates can be used, using signed certificates from a third-party certificate authority is the recommended best practice.

Installation

To install CA certificates in ONTAP, complete the following steps:

Procedure ▶▶▶

1. Retrieve the CA certificates.
2. Install the certificates into ONTAP.

◀◀◀

Retrieve CA Certificates

Retrieve the Root CA certificate and, if they exist, any intermediate CA certificates in Base-64 encoded format (sometimes also called PEM format) from the Certification Authority who created the certificate.

If you followed the procedure for StorageGRID SSL Certificate Configuration these are the certificates in the `chain.pem` file.

To retrieve the certificate for a StorageGRID endpoint, complete the following steps:

Procedure ▶▶▶

1. Open the StorageGRID Administration console.
2. Select Configuration > Load Balancer Endpoints.
3. Select your endpoint and click Edit Endpoint.
4. Copy the certificate PEM, including:

```
-----BEGIN CERTIFICATE----- and -----END CERTIFICATE-----
```

◀◀◀

To retrieve the certificate when using a third-party load balancer, complete the following steps:

Procedure ▶▶▶

1. Run the following command:

```
openssl s_client -connect <FQDN> -showcerts
```

2. Copy the certificate, including:

```
-----BEGIN CERTIFICATE----- and -----END CERTIFICATE-----
```

◀◀◀

Install Certificates to ONTAP

In ONTAP System Manager, when adding a new Cloud Tier of type StorageGRID, you can paste the CA certificate. If there is an intermediate CA which issued the StorageGRID certificate, then this must be the intermediate CA certificate. If the StorageGRID certificate was issued directly by the Root CA, then you must use the Root CA certificate.

To install the Root certificates (and any intermediate certificates) to ONTAP, run the following command:

```
security certificate install -vserver <name> -type server-ca
```

4. Architecture

FabricPool works by associating a cloud tier (an external object store) with a local tier (storage aggregate) in ONTAP, creating a composite collection of discs: a FabricPool. Volumes inside the FabricPool can then take advantage of the tiering by keeping active (hot) data on high-performance storage (the local tier) and tiering inactivate (cold) data to the external object store (the cloud tier).

Although only a basic level of understanding is necessary to configure and use FabricPool, understanding how FabricPool determines block temperature, creates objects, and writes data is extremely useful when architecting storage solutions.

Block Temperature

When a block is written to the local tier, it is assigned a temperature value indicating that it is hot. Over time, a background cooling scan cools blocks, making hot blocks warm and eventually turning blocks cold if they have not been read. Assuming no activity, a block becomes cold based on the time set by the `tiering-minimum-cooling-days` setting.

Caution

The All volume tiering policy is an exception to this rule. Blocks in volumes using the All tiering policy are immediately identified as cold and marked for tiering.

Object Creation

FabricPool works at the WAFL block level, cooling blocks, concatenating them into objects, and writing those objects to a cloud tier. Each FabricPool object is 4MB and composed of 1,024 4KB blocks. The object size is fixed at 4MB based on performance recommendations from leading cloud providers and cannot be changed. If cold blocks are read and made hot, only the requested blocks in the 4MB object are fetched. Neither the entire object nor the entire file is written back. Only the necessary blocks are written.

Caution

If ONTAP detects an opportunity for sequential readaheads, it requests blocks from the cloud tier before they are read in order to improve performance.

Data Movement

After a block has been identified as cold, it is marked for tiering. During this time, a background tiering scan looks for cold blocks. When enough 4KB blocks from the same volume have been collected, they are concatenated into a 4MB object and moved to the cloud tier based on the volume tiering policy.

Tiering Fullness Threshold

By default, tiering to the cloud tier only happens if the local tier is >50% full. There is little reason to tier cold data to a cloud tier if the local tier is being underutilized.

In ONTAP 9.5, the 50% tiering fullness threshold is adjustable. Setting the threshold to a lower number reduces the amount of data required to be stored on the local tier before tiering takes place. This may be useful for large local tiers that contain little hot/active data.

Setting the threshold to a higher number increases the amount of data required to be stored on the local tier before tiering takes place. This may be useful for solutions designed to tier only when local tiers are near maximum capacity.

Caution

The All volume tiering policy ignores the tiering fullness threshold. Blocks in volumes using the All tiering policy are tiered irrespective of the tiering fullness threshold.

To change the tiering fullness threshold, run the following command:

```
storage aggregate object-store modify –aggregate <name> –tiering-fullness-threshold
<#> (0%-99%)
```

Caution

Advanced privilege level is required.

Write-Back Prevention

If the local tier is at >90% capacity, cold data is read directly from the cloud tier without being written back to the local tier. By preventing cold data write-backs on heavily utilized local tiers, FabricPool preserves the local tier for active data.

Prior to ONTAP 9.7, write-back prevention took place when the local tier was at 70% capacity.

SnapMirror Behavior

Movement of data from the cloud tier to the local tier can take place any time a block is read.

Table 1 SnapMirror behavior

Source Volume Tiering Policy	Destination Volume Tiering Policy	Write Location
Auto	Auto	Local > Local Cloud > Cloud
Auto	Snapshot-Only	Local
Auto	All	Cloud
Auto	None	Local
Snapshot-Only	Auto	Local > Local Cloud > Cloud
Snapshot-Only	Snapshot-Only	Local > Local Cloud > Cloud
Snapshot-Only	All	Cloud
Snapshot-Only	None	Local
All	Auto	Local
All	Snapshot-Only	Local
All*1	All*1	Cloud*1
All	None	Local
None	Auto	Local
None	Snapshot-Only	Local
None	All	Cloud
None	None	Local

*1: Cascading SnapMirror relationships are not supported when using the All volume tiering policy. Only the final destination volume should use the All volume tiering policy.

Volume Move

Volume move (`vol move`) is the way that ONTAP moves a volume nondisruptively from one local tier (source) to another (destination). Volume moves can be performed for a variety of reasons, although the most common reasons are hardware lifecycle management, cluster expansion, and load balancing.

It is important to understand how volume move works with FabricPool because the changes that take place at both the local tier, the attached cloud tier, and the volume (volume tiering policies) can have a major impact on functionality.

Destination Local Tier

If a volume move's destination local tier does not have an attached cloud tier, data on the source volume that is stored on the cloud tier is written to the local tier on the destination local tier.

For the ETERNUS AX/HX, if a volume move's destination local tier uses the same bucket as the source local tier, data on the source volume that is stored in the bucket does not move back to the local tier. This optimized volume move results in significant network efficiencies.

Caution

Some configurations are incompatible with optimized volume moves:

- Changing tiering policy during volume move
- Source and destination aggregates use different encryption keys
- FlexClone volumes
- FlexClone parent volumes
- MetroCluster (supports optimized volume moves in ONTAP 9.8+)

If a volume move's destination local tier has an attached cloud tier, data on the source volume that is stored on the cloud tier is first written to the local tier on the destination local tier. It is then written to the cloud tier on the destination local tier if this approach is appropriate for the volume's tiering policy. Moving data to the local tier first improves the performance of the volume move and reduces cutover time.

If a volume tiering policy is not specified when performing a volume move, the destination volume uses the tiering policy of the source volume. If a different tiering policy is specified when performing the volume move, the destination volume is created with the specified tiering policy.

Caution

When in an SVM-DR relationship, source and destination volumes must use the same tiering policy.

Minimum Cooling Days

Moving a volume to another local tier resets the inactivity period of blocks on the local tier. For example, a volume using the Auto volume tiering policy with data on the local tier that has been inactive for 20 days has data inactivity reset to 0 days after a volume move.

Auto

If `-tiering-policy auto` is specified during the volume move, data movement is variable, but all data moves to the destination local tier first.

If the source volume uses the Auto, None, or Snapshot-Only policy, blocks are moved to the same tier that they existed on prior to the move. If the source volume uses the All policy, all data is moved to the local tier.

```
vol move start -vserver <name> -volume <name> -destination-aggregate <name> -tiering-policy auto
```

Snapshot-Only

If `-tiering-policy snapshot-only` is specified during the volume move, data movement is variable, but data moves to the destination local first.

If both source and destination volumes use the Snapshot-Only policy, and the Snapshot block is being read from the source cloud tier, then FabricPool knows the Snapshot blocks are cold and moves the cold blocks to the destination cloud tier.

```
vol move start -vserver <name> -volume <name> -destination-aggregate <name> -tiering-policy snapshot-only
```

All

If `-tiering-policy all` is specified during the volume move, data is immediately identified as cold and written to the destination cloud tier. There is no need to wait 48 hours for blocks in the volume to become cold. Metadata is always stored on the local tier.

```
vol move start -vserver <name> -volume <name> -destination-aggregate <name> -tiering-policy all
```

None

If `-tiering-policy none` is specified during the volume move, data is written to the destination local tier.

```
vol move start -vserver <name> -volume <name> -destination-aggregate <name> -tiering-policy none
```

ONTAP System Manager

To perform a volume, move with ONTAP System Manager, complete the following steps:

Procedure ▶▶▶

1. Click STORAGE.
2. Click Volumes.
3. Select the volume you want to move.

4 Click More.

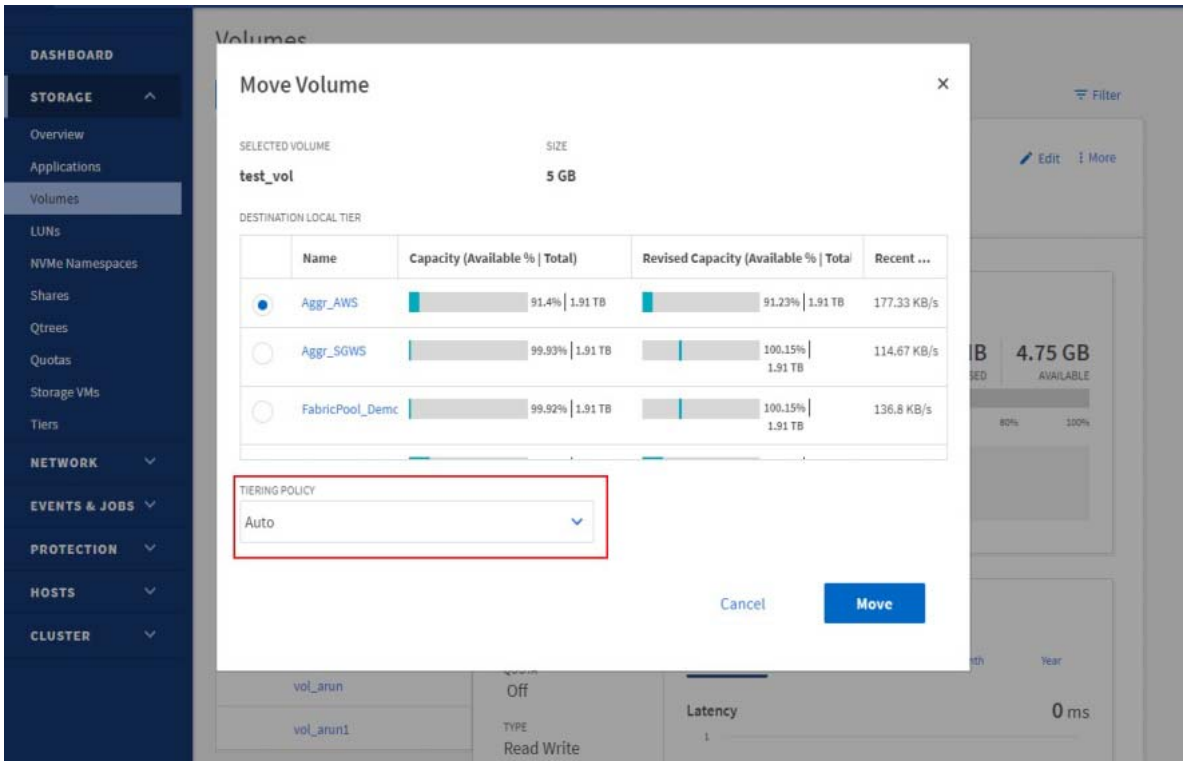
5 Click Move.

6 Select a destination local tier.

7 Select a tiering policy.

8 Click Move.

Figure 8 Changing the volume tiering policy during a volume move



FlexClone Volumes

FlexClone volumes are copies of a parent FlexVol volume. Newly created FlexClone volumes inherit the volume tiering policy and the tiering-minimum-cooling days setting of the parent FlexVol volume. After a FlexVol volume has been created, the volume tiering policy can be changed.

The tiering policy and tiering-minimum-cooling-days of the clone volume only controls the tiering behavior of blocks unique to the clone. Fujitsu recommends using tiering settings on the parent FlexVol that are either equal to or less aggressive than any of the clones. As a best practice, this keeps more data owned by the parent volume on the local tier, increasing the performance of the clone volumes.

FlexClone volumes that copy data protection destination volumes using the All tiering policy do not inherit the volume tiering policy of their parent. Instead, they are created using the Snapshot-Only policy.

If a FlexClone volume is split (`volume clone split`) from its parent volume, the copy operation writes the FlexClone volume's blocks to the local tier.

FlexGroup Volumes

A FlexGroup volume is a single namespace that is made up of multiple constituent member volumes but is managed as a single volume. Individual files in a FlexGroup volume are allocated to individual member volumes and are not striped across volumes or nodes.

FlexGroup volumes are not constrained by the 100TB and two-billion file limitations of FlexVol volumes. Instead, FlexGroup volumes are only limited by the physical maximums of the underlying hardware and have been tested to 20PB and 400 billion files. Architectural maximums could be higher.

Volume tiering policies are set at the FlexGroup volume level—they cannot be set on the various constituent/member volumes that compose the FlexGroup volume.

When provisioning FlexGroup volumes on FabricPool local tiers, automatic processes require that the FlexGroup volume uses FabricPool local tier on every cluster node. This is a recommended best practice but not a requirement when manually provisioning FlexGroup volumes.

Object Storage

Object storage is a storage architecture that manages data as objects, as opposed to other storage architectures such as file or block storage. Objects are kept inside a single container (such as a bucket) and are not nested as files inside a directory inside other directories.

Although object storage is generally less performative than file or block storage, it is significantly more scalable. ONTAP currently has a maximum volume size of 100TB and a maximum local tier size of 800TB. Object stores have no such limits, and buckets with petabytes of data in them are not uncommon.

ONTAP S3

Starting in ONTAP 9.8, ONTAP supports tiering to buckets creating using ONTAP S3, allowing for ONTAP to ONTAP tiering as well. FabricPool can tier to buckets located on the local cluster (a local bucket using cluster LIFs) or buckets located on a remote cluster (a traditional FabricPool cloud tier).

Fujitsu recommends using StorageGRID, Fujitsu's premier object store solution, when tiering more than 300TB of inactive data.

Object Deletion and Defragmentation

FabricPool does not delete blocks from attached object stores. Instead, FabricPool deletes entire objects after a certain percentage of the blocks in the object are no longer referenced by ONTAP.

For example, there are 1,024 4KB blocks in a 4MB object tiered to Amazon S3 of FUJITSU Hybrid IT Service for AWS. Defragmentation and deletion do not occur until less than 205 4KB blocks (20% of 1,024) are being referenced by ONTAP. When enough (1,024) blocks have zero references, their original 4MB objects are deleted, and a new object is created.

This percentage, the unreclaimed space threshold, can be customized, but is set to different default levels for different object stores. The default settings are as follows:

Object store	ONTAP 9.7	ONTAP 9.8 and later	Cloud Volumes ONTAP
Microsoft Azure Blob Storage of FUJITSU Hybrid IT Service for Microsoft Azure	15%	25%	35%
Amazon S3 of FUJITSU Hybrid IT Service for AWS	20%	20%	30%
Object Storage of FUJITSU Hybrid IT Service FJcloud-O	40%	40%	N/A
StorageGRID	40%	40%	N/A

Unreclaimed Space Threshold

Object defragmentation reduces the amount of physical capacity used by the cloud tier at the expense of additional object store resources (reads and writes).

Reducing the Threshold

To avoid additional expenses, consider reducing the unreclaimed space thresholds when using object store pricing schemes that reduce the cost of storage but increase the cost of reads.

For example, tiering a volume of 10-year-old projects that has been saved for legal reasons might be less expensive when using a pricing scheme such as Standard-IA or cool than it would be when using standard pricing schemes. Although reads are more expensive for such a volume, including reads required by object defragmentation, they are unlikely to occur frequently here.

Increasing the Threshold

Alternatively, consider increasing unreclaimed space thresholds if object fragmentation is resulting in significantly more object store capacity being used then necessary for the data being referenced by ONTAP. For example, using an unreclaimed space threshold of 20%, in a worst-case scenario where all objects are equally fragmented to the maximum allowable extent, it is possible for 80% of total capacity in the cloud tier to be unreferenced by ONTAP.

- 2TB referenced by ONTAP + 8TB unreferenced by ONTAP = 10TB total capacity used by the cloud tier.

In situations such as these, it might be advantageous to increase the unreclaimed space threshold–or increasing volume minimum cooling days–to reduce capacity being used by unreferenced blocks.

To change the default unreclaimed space threshold, run the following command:

```
storage aggregate object-store modify –aggregate <name> -object-store-name <name> –
unreclaimed- space-threshold <%> (0%-99%)
```

(Advanced privilege level required.)

ONTAP Storage Efficiencies

Storage efficiencies such as compression, deduplication, and compaction are preserved when moving data to the cloud tier, reducing required object storage capacity and transport costs.

Aggregate inline deduplication is supported on the local tier, but associated storage efficiencies are not carried over to objects stored on the cloud tier.

When using the All volume tiering policy, storage efficiencies associated with background deduplication processes may be reduced as data is likely to be tiered before the additional storage efficiencies can be applied.

Caution

Third-party deduplication has not been qualified by Fujitsu.

5. Configuration

After the FabricPool basic requirements have been met, attaching a cloud tier to a local tier in ONTAP requires the following four steps:

Procedure ▶▶▶

1. Create a bucket/container on the object store.
2. Add a cloud tier using the bucket to ONTAP.
3. Attach the cloud tier to a local tier.
4. Set volume tiering policies.

◀◀◀

Create a Bucket/Container

Buckets are object store containers that hold data. You must provide the name and location of the bucket in which data is stored before it can be added to a local tier as a cloud tier.

Buckets cannot be created using ONTAP System Manager, Active IQ, or ONTAP.

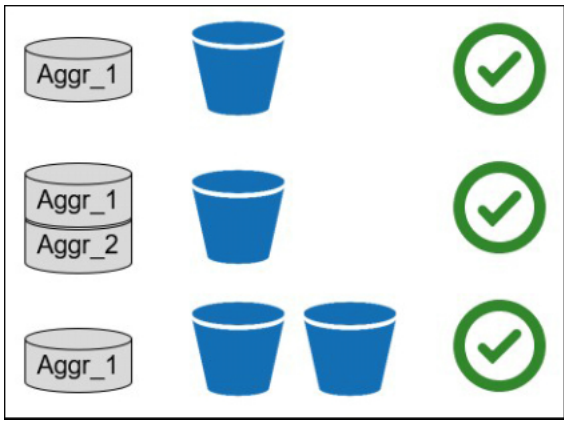
A single cloud tier can be attached to a single local tier, and a single cloud tier can be attached to multiple local tiers. Attaching a single cloud tier to multiple local tiers in a cluster is the general best practice.
Fujitsu does not recommend attaching a single cloud tier to local tiers in multiple clusters.

Caution

Consider how cloud tier-to-local tier relationships might affect performance when planning storage architectures. Many public object store providers set a maximum number of supported IOPS at the bucket/container level. Environments that require maximum performance from public object stores should use multiple buckets to reduce the possibility that object-store IOPS limitations affect performance across multiple local tiers tiering to the same cloud tier.

Attaching a cloud tier to all FabricPool local tiers is the general best practice and provides significant benefits to environments that value manageability over public object store cloud tier performance.

Figure 9 Possible cloud tier-to-local tier relationships in ONTAP 9.7

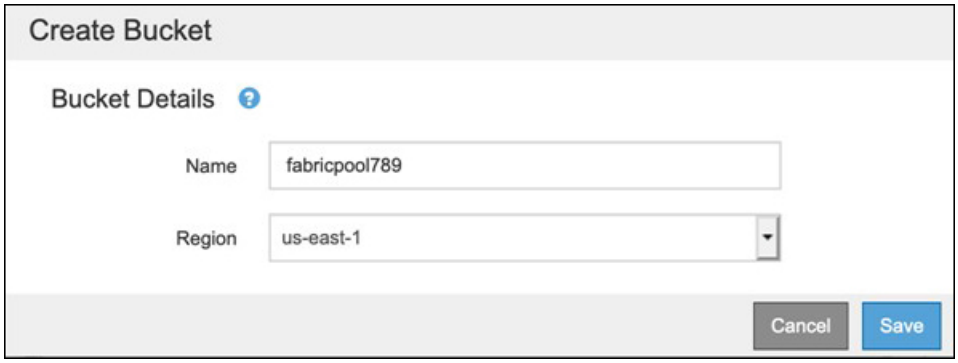


StorageGRID

To create a bucket in StorageGRID, complete the following steps using the StorageGRID Tenant Manager:

Procedure

1. Open the Admin Node in a web browser (for example, https://admin.company.com/?accountId=###).
2. Log in with your tenant account ID, user name, and password.
3. Select S3.
4. Select Buckets.
5. Click Create Bucket.
6. Provide a DNS compliant name.
7. Click Save.



Caution

- Prior to StorageGRID 11.1, creating a bucket required using a third-party S3 client such as an S3 browser.
- ONTAP and StorageGRID system clocks must not be out of sync by more than a few minutes. Significant clock skew prevents the StorageGRID bucket from being attached to the local tier.

ONTAP S3

Instructions for creating buckets in ONTAP S3 can be found in Provisioning Object Storage with System Manager.

Other Object Store Providers

Instructions for creating buckets on FUJITSU Hybrid IT Service for Microsoft Azure and FUJITSU Hybrid IT Service for AWS can be found on their respective sites:

- Amazon S3
- Microsoft Azure Blob Storage

To create buckets on FUJITSU Hybrid IT Service FJcloud-O, contact Fujitsu Support.

Other Object Store Provider Settings

Outside of StorageGRID, FabricPool does not support ILM policies applied to object store buckets.

ILM typically includes various movement and deletion policies based on geography, storage class, retention, and other categories that would be disruptive to FabricPool cloud tier data. FabricPool has no knowledge of ILM policies or configurations set on external object stores, and misconfiguration of ILM policies can result in data loss.

Caution

ONTAP and private cloud system clocks must not be out of sync by more than a few minutes. Significant clock skew prevents the Cleversafe bucket from being attached to the local tier.

Add a Cloud Tier to ONTAP

Before a cloud tier can be attached to a local tier, it must be added to and identified by ONTAP. This task can be completed using either ONTAP System Manager.

You need the following information:

- Server name (FQDN) (for example, s3.amazonaws.com)

  Caution

  Azure may require the account prefix (for example, `accountprefix.blob.core.windows.net`).

- Access key ID
- Secret key
- Container name (bucket name)

ONTAP System Manager

To add a cloud tier using ONTAP System Manager, complete the following steps:

Procedure ▶▶▶

1. Launch ONTAP System Manager.
2. Click STORAGE.
3. Click Tiers.
4. Click Add Cloud Tier.
5. Select an object store provider.
6. Complete the text fields as required for your object store provider.

   Caution

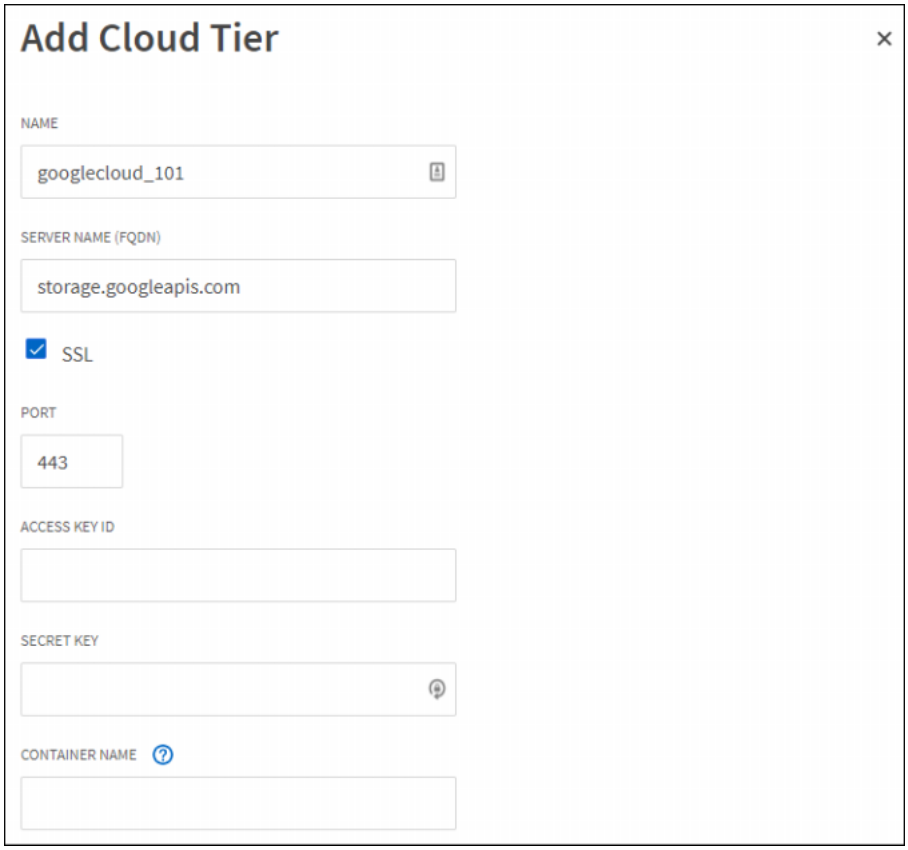
   Enter the object store's bucket/container name in the Container Name field.

7. (Optional; cloud tiers can be attached to local tiers later if desired.) Add the cloud tier to local tiers as a primary cloud.

   Caution

   Attaching a cloud tier to a local tier is a permanent action. A cloud tier cannot be unattached from a local tier after being attached.

8. Click Save.



ONTAP S3 Local Buckets

Starting in ONTAP 9.8, ONTAP supports tiering to buckets creating using ONTAP S3, allowing for ONTAP to ONTAP tiering. Buckets located on the local cluster are known to ONTAP automatically and are available as an option when attaching a cloud tier to a local tier.

Certificate Authority Certificate Validation

CA certificates associated with private cloud object stores, such as StorageGRID and FUJITSU Hybrid IT Service FJcloud-O environments, should be installed on ONTAP before attaching them to local tiers. Using CA certificates creates a trusted relationship between ONTAP and the object store and helps to secure access to management interfaces, gateway nodes, and storage.

Failure to install a CA certificate results in an error unless certificate validation is turned off. Turning off certificate validation is not recommended, but it is possible starting in ONTAP 9.4.

ONTAP System Manager

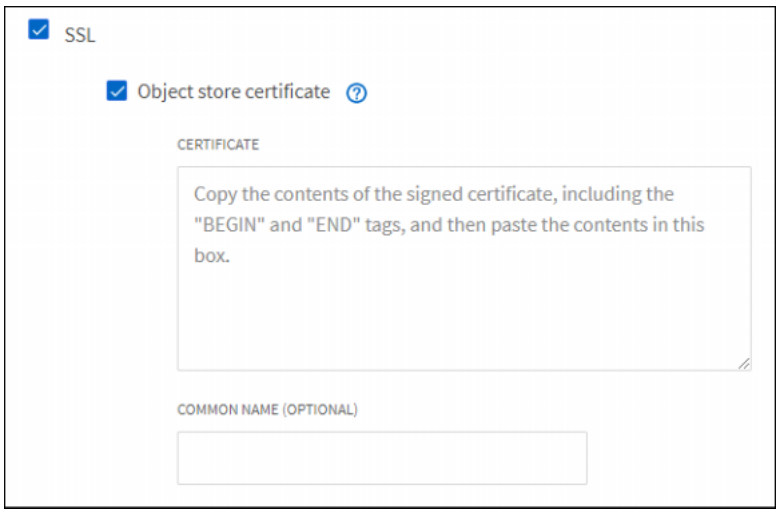
CA certificate validation can be turned off when adding a StorageGRID cloud tier using ONTAP System Manager. To do so, complete the following steps:

Procedure

1. Launch ONTAP System Manager.
2. Click STORAGE.
3. Click Tiers.
4. Click Add Cloud Tier.
5. Select an object store provider.
6. Complete the text fields as required for your object store provider.
7. Click the Object Store Certificate button to turn it off.

> **Caution**
>
> Turning off certificate validation is not recommended.

8. Click Save.



Attach a Cloud Tier to a Local Tier

After an object store has been added to and identified by ONTAP as a cloud tier, it can be attached to a local tier to create a FabricPool. This task can be completed using either ONTAP System Manager.

Caution

Attaching a cloud tier to a local tier is a permanent action. A cloud tier cannot be unattached from a local tier after being attached.

Thin Provisioning

FabricPool cannot attach a cloud tier to a local tier that contains volumes using a space guarantee other than none (for example, `volume`). For additional information, refer to FabricPool's requirements.

FlexGroup Volumes

All local tiers used by a FlexGroup volume must be FabricPool local tiers.

When provisioning FlexGroup volumes on FabricPool local tiers, automatic processes require that the FlexGroup volume uses FabricPool local tiers on every cluster node. This is a recommended best practice but is not a requirement when manually provisioning FlexGroup volumes.

Caution

Consider how cloud tier-to-local tier relationships might affect performance when planning storage architectures. Many public object store providers set a maximum number of supported IOPS at the bucket/container level. Environments that require maximum performance from public object stores should use multiple buckets to reduce the possibility that object-store IOPS limitations affect performance across multiple local tiers tiering to the same cloud tier.

Attaching a cloud tier to all FabricPool local tiers is the general best practice and provides significant benefits to environments that value manageability over public object store cloud tier performance.

ONTAP System Manager

To attach a cloud tier to a local tier using ONTAP System Manager, complete the following steps:

Procedure ▶▶▶

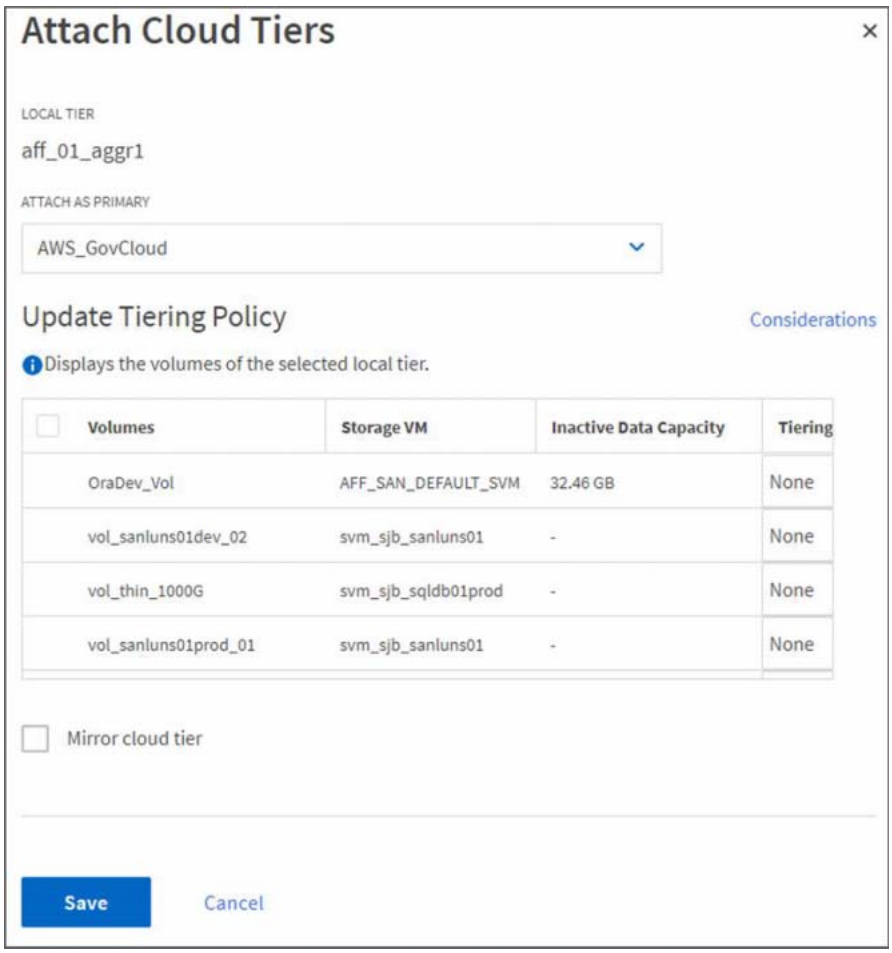
1. Launch ONTAP System Manager.
2. Click STORAGE.
3. Click the name of a local tier.
4. Click More.
5. Click Attach Cloud Tiers.
6. Select the primary cloud tier to attach.

7 Select volumes to set tiering policies.

8 Click Save.

Caution

Attaching a cloud tier to a local tier is a permanent action. A cloud tier cannot be unattached from a local tier after being attached.



ONTAP S3 Local Buckets

To attach a local bucket to a local tier using ONTAP System Manager, complete the following steps:

Procedure

1 Launch ONTAP System Manager.

2 Click STORAGE.

3 Click the name of a local tier.

4 Click More.

5 Click Tier to Local Bucket.

6 Select Existing or New.

If selecting New, a new SVM and bucket is created. If available, System Manager selects low-cost media (FAS HDD) for the bucket.

7 Select bucket capacity.

8 Click Save.

When a new bucket is created, its secret key is displayed. Save/download this key for future use because it is not displayed again.

Caution

- Unlike local tiers attached to cloud tiers where FabricPool uses intercluster LIFs to communicate with the cloud tier, when a local tier is attached to a local bucket, FabricPool uses cluster LIFs for intracluster traffic.
- Performance degradation might occur if cluster LIFs resources become saturated. To avoid this, Fujitsu recommends using 2-node, or greater, clusters when tiering to a local bucket. Tiering to local buckets on single node clusters is not recommended.

Volume Tiering Policies

By default, volumes use the None volume tiering policy. After volume creation, the volume tiering policy can be changed using ONTAP System Manager.

FabricPool provides four volume tiering policies, as described in the following sections.

Caution

When used by FlexGroup volumes, the volume tiering policy is set at the FlexGroup volume level. Volume tiering policies cannot be set on the various constituent/member volumes that compose the FlexGroup volume.

- **Auto:**
  - All cold blocks in the volume are moved to the cloud tier. Assuming the local tier is >50% utilized, it takes approximately 31 days for inactive blocks to become cold. The Auto cooling period is adjustable between 2 days and 183 days using the minimum-cooling-days setting. (63-day maximum prior to ONTAP 9.8.)
  - When cold blocks in a volume with a tiering policy set to Auto are read randomly, they are made hot and written to the local tier.
  - When cold blocks in a volume with a tiering policy set to Auto are read sequentially, they stay cold and remain on the cloud tier. They are not written to the local tier.
- **Snapshot-Only:**
  - Cold Snapshot blocks in the volume that are not shared with the active file system are moved to the cloud tier. Assuming the local tier is >50% utilized, it takes approximately two days for inactive Snapshot blocks to become cold. The Snapshot-Only cooling period is adjustable from 2 to 183 days using the minimum-cooling-days setting. (63-day maximum prior to ONTAP 9.8.)
  - When cold blocks in a volume with a tiering policy set to Snapshot-Only are read, they are made hot and written to the local tier.
- **All:**
  - All data blocks (not including metadata) placed in the volume are immediately marked as cold and moved to the cloud tier as soon as possible. There is no need to wait 48 hours for new blocks in a volume using the All tiering policy to become cold.
  - Blocks located in the volume prior to the All policy being set require 48 hours to become cold.
  - When cold blocks in a volume with a tiering policy set to All are read, they remain cold and stay on the cloud tier. They are not written to the local tier.
  - Prior to ONTAP 9.6, the Backup volume tiering policy functioned the same as the All policy with the exception that the Backup policy can only be set on data protection volumes (destination targets).

Caution

Object storage is not transactional like file or block storage. Making changes to files being stored as objects in volumes using the All tiering policy can result in the creation of new objects, fragmentation of existing objects, and the addition of storage inefficiencies.

Because the All tiering policy tiers data as soon as possible, storage efficiencies that rely on background processes, like deduplication, might not have enough time to be applied. Inline storage efficiencies like compression and compaction are still applied.

Consider the impact of SnapMirror transfers before assigning the All tiering policy to source volumes in data protection relationships. Because data is tiered immediately, SnapMirror reads data from the cloud tier rather than the local tier. This results in slower SnapMirror operations–possibly slowing other SnapMirror operations later in queue–even if they are using different tiering policies.

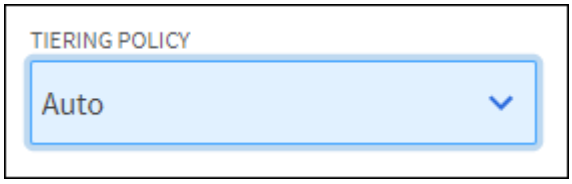
- **None (default):**
  - Volumes set to use None as their tiering policy do not tier cold data to the cloud tier.
  - Setting the tiering policy to None prevents new tiering. Volume data that has previously been moved to the cloud tier remains in the cloud tier until it becomes hot and is automatically moved back to the local tier.
  - When cold blocks in a volume with a tiering policy set to None are read, they are made hot and written to the local tier.

ONTAP System Manager

To change a volume's tiering policy by using ONTAP System Manager, complete the following steps:

Procedure

1. Launch ONTAP System Manager.
2. Click STORAGE.
3. Click Volumes.
4. Select a volume.
5. Click Edit.
6. Select the tiering policy you want to apply to the volume.



7. Click Save.

Caution

Starting in ONTAP 9.8, changing the tiering policy to All, Auto, or Snapshot-Only will trigger the background tiering scan to immediately run.

Cloud Retrieval

When using the Auto volume tiering policy, if cold blocks are read sequentially, they stay cold and remain on the cloud tier. For most client applications this is desirable behavior and prevents deep file scans common to antivirus and analytics applications from writing cold data back to the local tier.

Starting in ONTAP 9.8, volumes can set cloud retrieval policies to override this default behavior.

FabricPool provides four cloud retrieval policies, as described in the following sections.

- **Default (default):**
  - When cold blocks in a volume are read, they use the default behavior of their volume tiering policy.
- **Never:**
  - When cold blocks in a volume with a cloud retrieval policy set to Never are read, they remain cold and stay on the cloud tier. They are not written to the local tier.
  - Setting the cloud retrieval policy to Never is similar to the All tiering policy in that data is not allowed to return to the local tier, but differs from the All tiering policy in that it continues to use the volume's tiering-minimum-cooling-days setting rather than being tiered as soon as possible.
  - For example, a volume using the Auto tiering policy's default setting would not mark data as cold until after 31-days of inactivity. After 31-days, the inactive data would be tiered to object storage and would not come back when read because the volume's cloud retrieval policy had been set to Never.
- **On-Read:**
  - When cold blocks in a volume with a cloud retrieval policy set to On-Read are read, randomly or sequentially, they are made hot and written to the local tier.
  - Applications that use sequential reads triggers write-backs to the local tier by setting the volume cloud retrieval policy to On-Read. This can be beneficial for applications that need local-tier performance for previously cold data that is now being read by active workloads.
- **Promote:**
  - Setting the cloud retrieval policy to Promote brings all data back to the local tier the next time the daily tiering scan runs–provided the tiering policy allows it. For example:
    - Bring all data back to the local tier:

	Tiering policy	Cloud retrieval policy
Before	Auto	Default
After	None (Cold blocks are not tiered)	Promote (Previously tiered blocks return to the local tier)

    - Bring the active file system back to the local tier, but keep snapshot copies on the cloud tier:

	Tiering policy	Cloud retrieval policy
Before	Auto	Default
After	Snapshot-Only (Only cold Snapshot blocks is tiered)	Promote (Previously tiered, non-Snapshot blocks, return to the local tier)

Volume Tiering Minimum Cooling Days

FabricPool is not an ILM policy that permanently archives data after a set period of time. FabricPool is a high-performance tiering solution that makes data immediately accessible and dynamically moves data to and from the cloud tier-based client application activity.

The tiering-minimum-cooling-days setting determines how many days must pass before inactive data in a volume using the Auto or Snapshot-Only policy is considered cold and eligible for tiering.

Caution

- Increasing -tiering-minimum-cooling-days increases the footprint of inactive data on the local tier: data takes longer before it is marked inactive and eligible for tiering to the cloud tier. Additionally, if data is read from the cloud tier, made hot, and written back to the local tier, it takes longer to become inactive again and tiered back to the cloud.
- Although 60-day, 90-day, or 180-day minimum cooling policies may be needed to conform to SLAs that require data to stay on a specific tier of storage (SLAs that are time-based rather than activity based), they are not recommended as a best practice.

Auto

The default tiering-minimum-cooling-days setting for the Auto tiering policy is 31 days.

Because reads keep block temperatures hot, increasing this value might reduce the amount of data that is eligible to be tiered and increase the amount of data kept on the local tier.

If you would like to reduce this value from the default 31-days, be aware that data should no longer be active before being marked as cold. For example, if a multi-day workload is expected to perform a significant number of writes on day seven, the volume's tiering-minimum-cooling-days setting should be set no lower than eight days.

Object storage is not transactional like file or block storage. Making changes to files being stored as objects in volumes with overly aggressive minimum cooling days can result in the creation of new objects, fragmentation of existing objects, and the addition of storage inefficiencies.

Snapshot-Only

The default tiering-minimum-cooling-days setting for the Snapshot-Only tiering policy is two days. A two- day minimum provides additional time for background processes to provide maximum storage efficiency and prevents daily data-protection processes from needing to read data from the cloud tier.

Security

FabricPool maintains AES-256-GCM encryption on the local tier, on the cloud tier, and over the wire when moving data between the tiers.

Local Tier

FabricPool supports Storage Encryption (SE), Volume Encryption (VE), and Aggregate Encryption (AE). Neither SE, VE, nor AE are required to use FabricPool.

Over the Wire

Objects moving between local and cloud tiers are encrypted by using TLS 1.2 using AES-256-GCM. Other encryption modes, such as CCM, are not supported. To some extent, encryption affects connectivity (latency) because object stores must use CPU cycles to decrypt the data. Communicating with object stores without TLS encryption is supported but is not recommended.

Cloud Tier

All objects encrypted by VE/AE remain encrypted when moved to the cloud tier. Client-side encryption keys are owned by ONTAP.

All objects not encrypted using VE/AE are automatically encrypted server-side using AES-256-GCM encryption. No additional encryption is necessary. Server-side encryption keys are owned by the respective object store.

Caution

FabricPool requires the use of the AES-256-GCM authenticated encryption. Other encryption modes, such as CCM, are not supported.

Disabling Cloud Tier Encryption

Using FabricPool without encrypting data at rest is not recommended but may be required by low performance S3 compatible object storage providers who cannot provide server-side encryption and low latency at the same time. Fujitsu highly recommends using client-side VE or VA encryption in these circumstances as encrypting data at rest remains the recommended best practice.

To disable cloud tier encryption, run the following command:

```
storage aggregate object-store config modify -serverside-encyption false
```

(Advanced privilege level is required.)

6. Interoperability

In general, ONTAP functionality is unchanged on FabricPool local tiers. Although ONTAP must create and transfer objects and blocks between local and cloud tiers, data protection, efficiency, and security are nearly identical to standard local tiers in ONTAP. The primary differentiators are performance and cost, with object stores being slower and less expensive.

The exceptions to normal interoperability listed in Table 2 and Table 3 are unique to FabricPool local tiers.

Table 2 Interoperability

Focus	Supported	Not Supported
Cloud tier	StorageGRID 10.3+	ONTAP local tiers
Data protection	• MetroCluster • MetroCluster SDS • SnapMirror (XDP and DP) • SnapMirror Synchronous • SnapVault (XDP and DP) • SVM-DR • StorageGRID replication and erasure coding **Caution** For best results, use replication with StorageGRID 11.2 or lower and erasure coding with StorageGRID 11.3+.	• 7-Mode Data Transition Using SnapMirror • 7-Mode Transition Tool (7MTT) • DP_Optimized license (DPO) • SyncMirror technology • Cascading SnapMirror relationships using the All (or Backup) tiering policy. • SMTape • SnapLock technology • StorageGRID ILM policies other than replication and erasure coding • Object versioning • WORM • StorageGRID Compliance buckets • Secure Purge
Encryption	• Volume Encryption • Storage Encryption • Server-side encryption (AES-256) • TLS 1.2	-
Storage efficiency	• Inline deduplication • Inline compression • Compaction • Aggregate inline deduplication • (local tier only)	-
Storage virtualization	-	FlexArray technology
Quality of service (QoS)	QoS maximums (ceiling)	QoS minimums (floors)
Additional features	-	Auto Balance Aggregate Flash Pools

Table 3 Third-party interoperability

Focus	Supported	Not Supported
Cloud tier	• Object Storage of FUJITSU Hybrid IT Service FJcloud-O • Microsoft Azure Blob Storage of FUJITSU Hybrid IT Service for Microsoft Azure • Amazon S3 of FUJITSU Hybrid IT Service for AWS • S3 in ONTAP 9.8+ • StorageGRID 10.3+	-
Data protection	Amazon's 99.999999999% multi-region durability	ILM policies
Encryption	Server-side encryption (AES-256) TLS 1.2	-

7. Performance

Sizing the Local Tier

When considering sizing, the local tier should be capable of the following tasks:

- Supporting hot data
- Supporting cold data until the tiering scan moves the data to the cloud tier
- Supporting cloud tier data that becomes hot and is written back to the local tier
- Supporting WAFL metadata associated with the attached cloud tier

For most environments, a 1 : 10 :: local tier : cloud tier ratio is extremely conservative while providing significant storage savings.

> **Caution**
>
> Writes from the cloud tier to the local tier are disabled if local tier capacity is greater than 90%. If this occurs, blocks are read directly from the cloud tier.

Sizing the Cloud Tier

When considering sizing, the object store acting as the cloud tier should be capable of the following tasks:

- Supporting reads of existing cold data
- Supporting writes of new cold data
- Supporting object deletion and defragmentation

Inactive Data Reporting

Inactive data reporting (IDR) is an excellent tool for determining the amount of inactive (cold) data that can be tiered from a local tier.

By default, IDR uses a 31-day cooling period to determine what data is considered inactive. The amount of cold data that is tiered is dependent on the tiering policies set on volumes. Prior to ONTAP 9.8, IDR used a fixed 31-day cooling period.

- ONTAP 9.8+
  - IDR cooling period can be adjusted using the volume -tiering-minimum-cooling-days setting.
- ONTAP 9.6+
  - IDR is enabled by default on all non-FabricPool SSD local tiers.
  - IDR can be enabled on HDD local tiers using the ONTAP CLI.

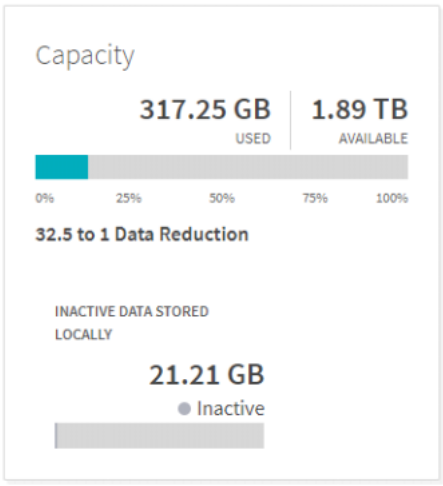
Table 4 IDR behavior

FabricPool aggregate	Tiering policy	Behavior	Window
Yes	None	Reports all cold data	ONTAP 9.8: -tiering-minimum-cooling-days setting ONTAP 9.7 and earlier: 31 days
	Snapshot-Only	Reports all cold data	ONTAP 9.8: -tiering-minimum-cooling-days setting ONTAP 9.7 and earlier: 31 days **Caution** Snapshot blocks would have already been tiered by using the default two-day setting.
	Auto	Does not report IDR	Inactive data has already tiered
	All/Backup	Does not report IDR	Inactive data has already tiered
No	None	Reports all cold data	31 days
	Snapshot-Only	Reports all cold data	31 days
	Auto	Reports all cold data	31 days
	All/Backup	Reports all cold data	31 days

ONTAP System Manager

IDR is displayed on the local tiers overview in ONTAP System Manager.

Figure 10 IDR in ONTAP System Manager



Caution

Although IDR is enabled by default on all SSD local tiers, if a client workload needs 100% of system resources, it automatically turns off, resetting cooling days to zero. If this happens, IDR does not automatically turn back on.

To avoid automated process shutting off IDR in order to free up resources for other workloads, manually enable `-is-inactive-data-reporting-enabled` to `true`.

Connectivity

FabricPool read latency is a function of connectivity to the cloud tier. LIFs using 10 Gbps/25 Gbps ports provide adequate performance. Fujitsu recommends validating the latency and throughput of your specific network environment to determine the impact it has on FabricPool performance.

Object Store Profiler

An object store profiler is available through the CLI that lets you test latency and throughput performance of object stores before you attach them to FabricPool local tiers.

Caution

The cloud tier must be added to ONTAP before it can be used with the object store profiler.

Start the object store profiler.

```
storage aggregate object-store profiler start -object-store-name <name> -node <name>
```

(Advanced privilege level required.)

View the results.

```
storage aggregate object-store profiler show
```

Caution

Cloud tiers do not provide performance similar to that found on the local tier (typically GB per second).

Although cloud tiers can easily provide SATA-like performance, they can also tolerate latencies as high as 10 seconds and low throughputs for tiering solutions that do not need SATA-like performance.

When using FabricPool in low-performance environments, minimum performance requirements for client applications must continue to be met, and recovery time objectives (RTOs) should be adjusted accordingly.

Network Connections

Because performance can be significantly better, using 10Gbps or 25Gbps is the recommended best practice for FabricPool.

StorageGRID

Unlike public clouds that might set a maximum number of supported IOPS at the bucket/container level, StorageGRID performance scales with the number of nodes in a system. For acceptable performance targets, Fujitsu recommends using enough nodes to meet or exceed FabricPool connectivity requirements.

SnapMirror Concurrency

Because concurrent SnapMirror and SnapVault replication operations share the network link to the cloud tier, initialization and RTO are dependent on the available bandwidth and latency to the cloud tier.
Performance degradation might occur if connectivity resources become saturated.

Proactive configuration of multiple LIFs can significantly decrease this type of network saturation.

Caution

If you are using more than one IC LIF on a node with different routing, Fujitsu recommends placing them in different IPspaces. During configuration, FabricPool can select from multiple IPspaces, but it is unable to select specific IC LIFs within an IPspace.

Loss of Connectivity

If for any reason connectivity to the cloud is lost, the FabricPool local tier remains online, but applications receive an error message when attempting to get data from the cloud tier. Cold blocks that exist exclusively on the cloud tier remain unavailable until connectivity is reestablished.

NAS Protocols

NFS and SMB protocols generally retry every five seconds until a connection is reestablished.

Error messages include the following:

- **SMB**
  `STATUS_INTERNAL_ERROR`
  Client applications might or might not retry upon receiving this error (this is client dependent). The client does not have to remount.
- **NFS**
  v3: `EJUKEBOX`
  v4: `EDELAY`
  NFS client applications retry after five seconds. The NFS client hangs until connectivity is reestablished if it gets the same error after a retry.

SAN Protocols

FC and iSCSI protocols generally take longer before experiencing a timeout (60–120 seconds), but they do not retry to establish a connection in the same way NAS protocols do. If a SAN protocol times out, the application must be restarted.

Even a short disruption could be disastrous to production applications using SAN protocols because there is no way to guarantee connectivity to public clouds. To avoid this, Fujitsu recommends using private clouds, like StorageGRID, when tiering data that is accessed by SAN protocols.

- **SAN**
  `UNRECOVERED READ ERROR/RECOMMEND REWRITE THE DATA`
  If the host is connected to the ONTAP LUN and the LUN is configured in a RAID set on the host (for example, Volume Manager), the host RAID subsystem might be able to recover the data from parity, and the data is rewritten to a new location. If the host is unable to recover this data, then the application on the host might need to be restarted so that the read can be retried.

Capacity

Storage Tiers

Fujitsu's recommended 1:10 local tier:cloud tier ratio is conservative. FabricPool continues to tier cold data to a cloud tier until the local tier reaches 98% capacity. For example, an 800TB local tier reachs 98% capacity at 784TB. Given a dataset using 5% metadata, 15.6PB could have been tiered to the cloud before reaching 784TB on the local tier.

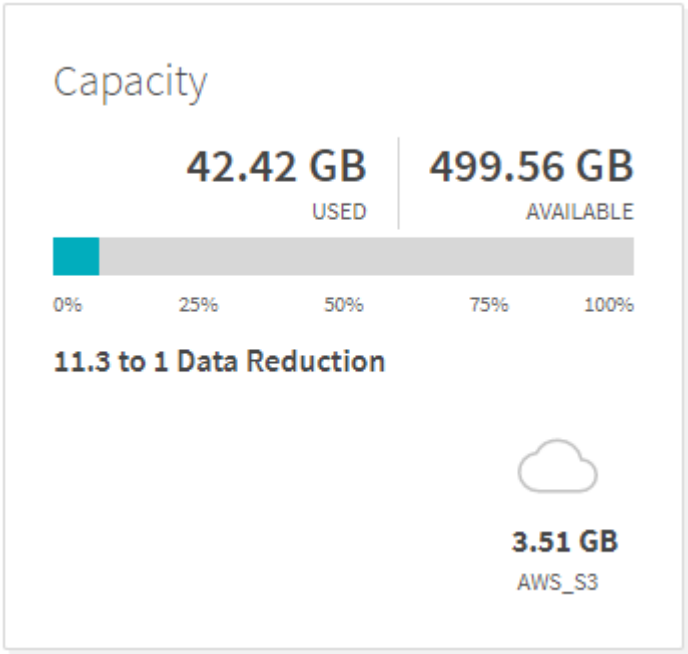
Because of the difference in ingress and egress rates, it is possible run out of space on a small local tier when attempting to move more data than it has capacity to hold. Data is usually coming into the local tier at a faster rate than it can be converted into objects and tiered out.

For example, if a volume move takes place at 2GBps but tiering takes place at 500MBps, 50TB completes the volume move to the local tier in ~7 hours. However, ~28 hours are required for tiering to an object store. The local tier must have enough capacity to store the data before it is tiered. Local space utilization can be determined by using ONTAP System Manager.

ONTAP System Manager

In ONTAP System Manager, FabricPool space utilization is displayed on the local tiers overview. Details include local tier maximum capacity, used capacity, and external tier used capacity.

Figure 11 FabricPool space utilization information



Volumes

FlexVol volumes in a FabricPool local tier cannot exceed the 100TB maximum volume size for FlexVols regardless of what tier the data is located on. For example, a FlexVol with 1TB on the local tier and 99TB on the cloud tier has reached the 100TB maximum FlexVol size, even though only 1TB is stored on the local tier.

Unlike FlexVol volumes, FlexGroup volumes have virtually no capacity or file count constraints outside of the physical limits of hardware or the total volume limits of ONTAP.

If the local tier reaches 98% capacity, FabricPool stops tiering cold data to the cloud tier. If the local tier reaches 90% capacity, cold data is read directly from the cloud tier without being written back to the local tier.

FabricPool volume space utilization can be determined by using ONTAP System Manager .

Available License Capacity

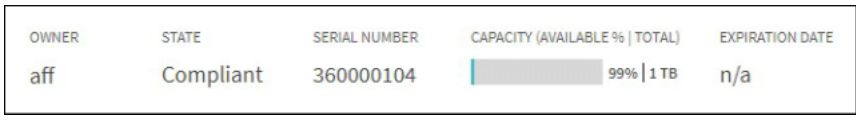
A capacity warning is triggered when the cloud tier reaches 85% of the maximum capacity set by the capacity-based license. Tiering to the cloud tier stops when the amount of data (used capacity) stored on the third-party cloud tier reaches the licensed capacity. Additional data, including SnapMirror copies to volumes using the All tiering policy, cannot be tiered until the license capacity is increased. Although tiering stops, data remains accessible from the cloud tier. Cold data remains on the local tier until the licensed capacity is increased.

To view the capacity status of the FabricPool license using ONTAP System Manager, complete the following steps:

Procedure ▶▶▶

1. Click CLUSTER.
2. Click Settings.
3. Click FabricPool License.
4. Current capacity is listed in the Current Capacity column.

Figure 12 License capacity



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Virtualized Object Storage

Set the tiering policy to None for volumes in virtualized object stores (also referred to as bare metal object storage) that tier inactive data.

Failure to set the tiering policy to None can place the virtualized object store at risk as blocks associated with the virtual machines may be marked as cold and tiered into themselves, causing significant spikes in latency and reductions in throughput when read.

FUJITSU Storage
ETERNUS AX series All-Flash Arrays,
ETERNUS HX series Hybrid Arrays
FabricPool Best Practices
ONTAP 9.9.1

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