# Logical storage management with the CLI

ONTAP 9

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## Logical storage management overview with the CLI

Using the ONTAP CLI, you can create and manage FlexVol volumes, use FlexClone technology to create efficient copies of volumes, files, and LUNs, create qtrees and quotas, and manage efficiency features like deduplication and compression.

You should use these procedures under the following circumstances:

- You want to understand the range of ONTAP FlexVol volume capabilities and storage efficiency features.
- You want to use the command-line interface (CLI), not System Manager or an automated scripting tool.

## Create and manage volumes

### Create a volume

You can create a volume and specify its junction point and other properties by using the `volume create` command.

#### About this task

A volume must include a *junction path* for its data to be made available to clients. You can specify the junction path when you create a new volume. If you create a volume without specifying a junction path, you must *mount* the volume in the SVM namespace using the `volume mount` command.

#### Before you begin

- The SVM for the new volume and the aggregate that will supply the storage to the volume must already exist.
- If the SVM has a list of associated aggregates, the aggregate must be included in the list.
- Beginning with ONTAP 9.13.1, you can create volumes with capacity analytics and Activity Tracking enabled. To enable capacity or Activity Tracking, issue the `volume create` command with `-analytics-state` or `-activity-tracking-state` set to `on`.

  To learn more about capacity analytics and Activity Tracking, see Enable File System Analytics. Learn more about `volume create` in the ONTAP command reference.

#### Steps

1. Create a volume:

   `volume create -vserver` *`svm_name`* `-volume` *`volume_name`* `-aggregate` *`aggregate_name`* `-size {integer[KB|MB|GB|TB|PB]} -security-style {ntfs|unix|mixed} -user` *`user_name_or_number`* `-group` *`group_name_or_number`* `-junction-path` *`junction_path`* `[-policy` *`export_policy_name`*`]`

   The `-security style`, `-user`, `-group`, `-junction-path`, and `-policy` options are for NAS namespaces only.

   The choices for `-junction-path` are the following:

- Directly under root, for example, `/new_vol`

  You can create a new volume and specify that it be mounted directly to the SVM root volume.

- Under an existing directory, for example, `/existing_dir/new_vol`

  You can create a new volume and specify that it be mounted to an existing volume (in an existing hierarchy), expressed as a directory.

If you want to create a volume in a new directory (in a new hierarchy under a new volume), for example, `/new_dir/new_vol`, then you must first create a new parent volume that is junctioned to the SVM root volume. You would then create the new child volume in the junction path of the new parent volume (new directory).

2. Verify that the volume was created with the desired junction point:

   `volume show -vserver` *`svm_name`* `-volume` *`volume_name`* `-junction`

   Learn more about `volume show` in the ONTAP command reference.

**Examples**

The following command creates a new volume named users1 on the SVM `vs1.example.com` and the aggregate `aggr1`. The new volume is made available at `/users`. The volume is 750 GB in size, and its volume guarantee is of type volume (by default).

```
cluster1::> volume create -vserver vs1.example.com -volume users1
-aggregate aggr1 -size 750g -junction-path /users
[Job 1642] Job succeeded: Successful

cluster1::> volume show -vserver vs1.example.com -volume users1 -junction
                           Junction                 Junction
Vserver           Volume   Active   Junction Path   Path Source
----------------- -------  -------- --------------- -----------
vs1.example.com   users1   true     /users          RW_volume
```

The following command creates a new volume named “home4” on the SVM"`vs1.example.com`" and the aggregate “aggr1”. The directory `/eng/` already exists in the namespace for the vs1 SVM, and the new volume is made available at `/eng/home`, which becomes the home directory for the `/eng/` namespace. The volume is 750 GB in size, and its volume guarantee is of type `volume` (by default).

```
cluster1::> volume create -vserver vs1.example.com -volume home4
-aggregate aggr1 -size 750g -junction-path /eng/home
[Job 1642] Job succeeded: Successful

cluster1::> volume show -vserver vs1.example.com -volume home4 -junction
                           Junction                 Junction
Vserver          Volume    Active   Junction Path   Path Source
---------------- ------- -------- --------------- -----------
vs1.example.com  home4     true     /eng/home       RW_volume
```

## Enable large volume and large file support in ONTAP

Beginning with ONTAP 9.12.1 P2, you can create a new volume or modify an existing volume to enable support for a maximum volume size of 300TB, maximum FlexGroup volume size of 60PB, and a maximum file (LUN) size of 128TB.

### Before you begin

- ONTAP 9.12.1 P2 or later is installed on the cluster.
- If you are enabling large volume support on the source cluster in a SnapMirror relationship, you must have ONTAP 9.12.1 P2 or later installed on the cluster hosting the source volume as well as the cluster hosting the destination volume.
- You are a cluster or SVM administrator.
- Learn more about the commands described in this procedure in the ONTAP command reference.

### Create a new volume

#### Step

1. Create a volume with large volume and file support enabled:

```
volume create -vserver <svm_name> -volume <volume_name> -aggregate
<aggregate_name> -is-large-size-enabled true
```

#### Example

The following example creates a new volume with large volume and file size support enabled.

```
volume create -vserver vs1 -volume big_vol1 -aggregate aggr1 -is-large
-size-enabled true
```

### Modify an existing volume

#### Step

1. Modify a volume to enable large volume and file support:

```
volume modify -vserver <svm_name> -volume <volume_name> -is-large-size
-enabled true
```

**Example**

The following example modifies an existing volume to support large volume and file size.

```
volume modify -vserver vs2 -volume data_vol -is-large-size-enabled true
```

2. Activate the new configuration settings by remounting the volume:

```
volume unmount -vserver <svm_name> -volume <volume_name>
```

```
volume mount -vserver <svm_name> -volume <volume_name>
```

**Related information**

- Create an ONTAP NFS volume
- ONTAP command reference

## SAN volumes

### Overview of SAN volume provisioning

ONTAP provides several basic options for SAN volume provisioning. Each option uses a different method for managing the volume space and space requirements for the ONTAP block sharing technologies. You should understand how each provisioning option works so you can choose the best option for your environment.

Placing SAN LUNs and NAS shares on the same FlexVol volume is not recommended. You should instead provision separate FlexVol volumes for your SAN LUNs and your NAS shares. This simplifies management and the replication deployments. It also parallels the way FlexVol volumes are supported in Active IQ Unified Manager (formerly OnCommand Unified Manager).

#### Thin provisioning for volumes

When a thinly provisioned volume is created, ONTAP does not reserve any extra space when the volume is created. As data is written to the volume, the volume requests the storage it needs from the aggregate to accommodate the write operation. Using thin-provisioned volumes enables you to overcommit your aggregate, which introduces the possibility of the volume not being able to secure the space it needs when the aggregate runs out of free space.

You create a thin-provisioned FlexVol volume by setting its `-space-guarantee` option to `none`.

#### Thick provisioning for volumes

When a thick-provisioned volume is created, ONTAP sets aside enough storage from the aggregate to ensure that any block in the volume can be written to at any time. When you configure a volume to use thick provisioning, you can employ any of the ONTAP storage efficiency capabilities, such as compression and deduplication, to offset the larger upfront storage requirements.

You create a thick-provisioned FlexVol volume by setting its `-space-slo` (service level objective) option to `thick`.

#### Semi-thick provisioning for volumes

When a volume using semi-thick provisioning is created, ONTAP sets aside storage space from the aggregate to account for the volume size. If the volume is running out of free space because blocks are in use by block-sharing technologies, ONTAP makes an effort to delete protection data objects (snapshots and FlexClone files and LUNs) to free up the space they are holding. As long as ONTAP can delete the protection data objects fast enough to keep pace with the space required for overwrites, the write operations continue to succeed. This is called a “best effort” write guarantee.

> You cannot employ storage efficiency technologies such as deduplication, compression, and compaction on a volume that is using semi-thick provisioning.

You create a semi-thick-provisioned FlexVol volume by setting its `-space-slo` (service level objective) option to `semi-thick`.

#### Use with space-reserved files and LUNs

A space-reserved file or LUN is one for which storage is allocated when it is created. Historically, NetApp has used the term “thin-provisioned LUN” to mean a LUN for which space reservation is disabled (a non-space-reserved LUN).

> Non-space-reserved files are not generally referred to as “thin-provisioned files.”

The following table summarizes the major differences in how the three volume provisioning options can be used with space-reserved files and LUNs:

| Volume provisioning | LUN/file space reservation | Overwrites | Protection data[2] | Storage efficiency[3] |
|---|---|---|---|---|
| Thick | Supported | Guaranteed[1] | Guaranteed | Supported |
| Thin | No effect | None | Guaranteed | Supported |
| Semi-thick | Supported | Best effort[1] | Best effort | Not supported |

### Notes

1. The ability to guarantee overwrites or provide a best-effort overwrite assurance requires that space reservation is enabled on the LUN or file.
2. Protection data includes snapshots, and FlexClone files and LUNs marked for automatic deletion (backup clones).

3. Storage efficiency includes deduplication, compression, any FlexClone files and LUNs not marked for automatic deletion (active clones), and FlexClone subfiles (used for Copy Offload).

#### Support for SCSI thin-provisioned LUNs

ONTAP supports T10 SCSI thin-provisioned LUNs as well as NetApp thin-provisioned LUNs. T10 SCSI thin provisioning enables host applications to support SCSI features including LUN space reclamation and LUN space monitoring capabilities for blocks environments. T10 SCSI thin provisioning must be supported by your SCSI host software.

You use the ONTAP `space-allocation` setting to enable/disable support for the T10 thin provisioning on a LUN. You use the ONTAP `space-allocation enable` setting to enable T10 SCSI thin provisioning on a LUN.

The `[-space-allocation {enabled|disabled}]` command in the ONTAP command reference has more information to enable/disable support for the T10 thin provisioning and to enable T10 SCSI thin provisioning on a LUN.

### Configure volume provisioning options

You can configure a volume for thin provisioning, thick provisioning, or semi-thick provisioning, depending on your space requirements.

#### About this task

Setting the `-space-slo` option to `thick` ensures the following:

- The entire volume is preallocated in the aggregate. You cannot use the `volume create` or `volume modify` command to configure the volume's `-space-guarantee` option.
- 100% of the space required for overwrites is reserved. You cannot use the `volume modify` command to configure the volume's `-fractional-reserve` option

Setting the `-space-slo` option to `semi-thick` ensures the following:

- The entire volume is preallocated in the aggregate. You cannot use the `volume create` or `volume modify` command to configure the volume's `-space-guarantee` option.
- No space is reserved for overwrites. You can use the `volume modify` command to configure the volume's `-fractional-reserve` option.
- Automatic deletion of snapshots is enabled.

#### Step

1. Configure volume provisioning options:

   `volume create -vserver` *`vserver_name`* `-volume` *`volume_name`* `-aggregate` *`aggregate_name`* `-space-slo none|thick|semi-thick -space-guarantee none|volume`

   The `-space-guarantee` option defaults to `none` for AFF systems and for non-AFF DP volumes. Otherwise, it defaults to `volume`. For existing FlexVol volumes, use the `volume modify` command to configure provisioning options.

   The following command configures vol1 on SVM vs1 for thin provisioning:

```
cluster1::> volume create -vserver vs1 -volume vol1 -space-guarantee
none
```

The following command configures vol1 on SVM vs1 for thick provisioning:

```
cluster1::> volume create -vserver vs1 -volume vol1 -space-slo thick
```

The following command configures vol1 on SVM vs1 for semi-thick provisioning:

```
cluster1::> volume create -vserver vs1 -volume vol1 -space-slo semi-
thick
```

**Related information**

- volume create
- volume modify

### Determine space usage in a volume or aggregate in ONTAP

In some cases, enabling a feature in ONTAP might consume more space than you expected. ONTAP helps you determine how space is being consumed by providing three perspectives from which to view space: the volume, a volume's footprint within the aggregate, and the aggregate.

#### View space allocation

A volume can run out of space due to space consumption or insufficient space within the volume, aggregate, or a combination of both. By seeing a feature-oriented breakdown of space usage from different perspectives, you can assess which features you might want to adjust or turn off, or whether you should take other action (such as increasing the size of the aggregate or volume).

You can view space usage details from any of these perspectives:

- The volume's space usage

  This perspective provides details about space usage within the volume, including usage by snapshots.

  Use the `volume show-space` command to see a volume's space usage.

  Learn more about `volume show-space` in the ONTAP command reference.

  Beginning with ONTAP 9.14.1, on volumes with temperature-sensitive storage efficiency (TSSE) enabled, the amount of space used on the volume reported by the `volume show-space -physical used` command includes the space savings realized as a result of TSSE.

- The volume's footprint within the aggregate

  This perspective provides details about the amount of space each volume is using in the containing

aggregate, including the volume's metadata.

Use the `volume show-footprint` command to see a volume's footprint with the aggregate.

Learn more about `volume show-footprint` in the ONTAP command reference.

- The aggregate's space usage

  This perspective includes totals of the volume footprints of all volumes contained in the aggregate, space reserved for aggregate snapshots, and other aggregate metadata.

  WAFL reserves 10% of the total disk space for aggregate level metadata and performance. The space used for maintaining the volumes in the aggregate comes out of the WAFL reserve and cannot be changed.

  Beginning with ONTAP 9.12.1, the WAFL reserve for aggregates greater than 30TB is reduced from 10% to 5% for AFF platforms and for the FAS500f platforms. Beginning with ONTAP 9.14.1, this same reduction applies to aggregates on all FAS platforms, resulting in 5% more usable space in the aggregates.

  Use the `storage aggregate show-space` command to see the aggregate's space usage.

  Learn more about `storage aggregate show-space` in the ONTAP command reference.

Certain features, such as tape backup and deduplication, use space for metadata both from the volume and directly from the aggregate. These features show different space usage between the volume and volume footprint perspectives.

#### Volume metadata and data metric reporting

Historically, several of the volume space metrics have reported the total data consumed as a combination of two metrics: metadata and user data. Beginning with ONTAP 9.15.1, the metadata and user data metrics are reported separately. Two new metadata counters have been introduced to support this:

- total-metadata

  This counter provides the total metadata size inside the volume. It does not include the aggregate resident volume metadata. Reporting it separately helps to determine the logical data allocated by the user.

- total-metadata-footprint

  This counter is the sum of volume resident metadata and aggregate resident volume metadata. It provides the total metadata footprint of the volume inside the aggregate. Reporting it separately helps to determine the physical data allocated by the user.

In addition, several existing counters have been updated to remove the metadata component and present only the user data:

- User data
- Volume data footprint

These changes provide a more accurate view of the data consumed by the user. This has several benefits, including the ability to make more precise chargeback decisions.

**Related Information**

- NetApp Knowledge Base: Space Usage
- Free up 5% of your storage capacity by upgrading to ONTAP 9.12.1

### Enable automatic snapshot and LUN deletion to manage space

You can define and enable a policy for automatically deleting snapshots and FlexClone LUNs. Automatically deleting snapshots and FlexClone LUNs can help you manage space utilization.

#### About this task

You can automatically delete snapshots from read-write volumes and FlexClone LUNs from read-write parent volumes. You cannot set up automatic deletion of snapshots from read-only volumes, for example, SnapMirror destination volumes.

#### Step

1. Define and enable a policy for automatically deleting snapshots by using the `volume snapshot autodelete modify` command.

   Learn more about `volume snapshot autodelete modify` and defining a policy that meets your needs in the ONTAP command reference.

   The following command enables the automatic deletion of snapshots and sets the trigger to `snap_reserve` for the vol3 volume, which is part of the vs0.example.com storage virtual machine (SVM):

   ```
   cluster1::> volume snapshot autodelete modify -vserver vs0.example.com
   -volume vol3 -enabled true -trigger snap_reserve
   ```

   The following command enables the automatic deletion of snapshots and of FlexClone LUNs marked for autodeletion for the vol3 volume, which is part of the vs0.example.com storage virtual machine (SVM):

   ```
   cluster1::> volume snapshot autodelete modify -vserver vs0.example.com
   -volume vol3 -enabled true -trigger volume -commitment try -delete-order
   oldest_first -destroy-list lun_clone,file_clone
   ```

   Aggregate-level snapshots work differently than volume-level snapshots and are managed automatically by ONTAP. The option to delete aggregate snapshots is always enabled and helps in managing space utilization.

   If the trigger parameter is set to `snap_reserve` for an aggregate, the snapshots are maintained until the space reserved crosses the threshold capacity. Therefore, even if the trigger parameter is not set to `snap_reserve`, the space used by the snapshot in the command will be listed as `0` because these snapshots are automatically deleted. Also, the space used by snapshots in an aggregate is considered as free and is included in the available space parameter of the command.

### Configure volumes to automatically provide more space when they are full

When FlexVol volumes get full, ONTAP can use various methods to attempt to automatically provide more free space for the volume. You choose which methods ONTAP can use, and in which order, depending on the requirements imposed by your application and storage architecture.

#### About this task

ONTAP can automatically provide more free space for a full volume by using one or both of the following methods:

- Increase the size of the volume (known as *autogrow*).

  This method is useful if the volume's containing aggregate has enough space to support a larger volume. You can configure ONTAP to set a maximum size for the volume. The increase is automatically triggered based on the amount of data being written to the volume in relation to the current amount of used space and any thresholds set.

  Autogrow is not triggered to support snapshot creation. If you attempt to create a snapshot and there is insufficient space, the snapshot creation fails, even with autogrow enabled.

- Delete Snapshots, FlexClone files, or FlexClone LUNs.

  For example, you can configure ONTAP to automatically delete snapshots that are not linked to snapshots in cloned volumes or LUNs, or you can define which snapshots you want ONTAP to delete first—your oldest or newest snapshots. You can also determine when ONTAP should begin deleting snapshots—for example, when the volume is nearly full or when the volume's snapshot reserve is nearly full.

If you enable both of these methods, you can specify which method ONTAP tries first when a volume is nearly full. If the first method does not provide sufficient additional space to the volume, ONTAP tries the other method next.

By default, ONTAP tries to increase the size of the volume first. In most cases, the default configuration is preferable, because when a snapshot is deleted, it cannot be restored. However, if you need to avoid growing the size of a volume whenever possible, you can configure ONTAP to delete snapshots before increasing the size of the volume.

#### Steps

1. If you want ONTAP to attempt to increase the size of the volume when it gets full, enable the autogrow capability for the volume by using the `volume autosize` command with `grow` mode. Learn more about `volume autosize` in the ONTAP command reference.

   Remember that when the volume grows, it consumes more free space from its associated aggregate. If you are depending on the volume's ability to grow whenever it needs to, you must monitor the free space in the associated aggregate and add more when needed.

2. If you want ONTAP to delete snapshots, FlexClone files, or FlexClone LUNs when the volume gets full, enable autodelete for those object types.
3. If you enabled both the volume autogrow capability and one or more autodelete capabilities, select the first method that ONTAP should use to provide free space to a volume by using the `volume modify` command with the `-space-mgmt-try-first` option. Learn more about `volume modify` in the ONTAP command reference.

To specify increasing the size of the volume first (the default), use `volume_grow`. To specify deleting snapshots first, use `snap_delete`.

#### Configure volumes to automatically grow and shrink their size

You can configure FlexVol volumes to automatically grow and shrink according to how much space they currently require. Automatic growing helps prevent a volume from running out of space, if the aggregate can supply more space. Automatic shrinking prevents a volume from being larger than needed, freeing space in the aggregate for use by other volumes.

##### About this task

Autoshrink can only be used in combination with autogrow to meet changing space demands and is not available alone. When autoshrink is enabled, ONTAP automatically manages the shrinking behavior of a volume to prevent an endless loop of autogrow and autoshrink actions.

As a volume grows, the maximum number of files it can contain might be automatically increased. When a volume is shrunk, the maximum number of files it can contain is left unchanged, and a volume cannot be automatically shrunk below the size that corresponds to its current maximum number of files. For this reason, it might not be possible to automatically shrink a volume all the way to its original size.

By default, the maximum size a volume can grow to is 120% of the size at which autogrow is enabled. If you need to ensure that the volume can grow to be larger than that, you must set the maximum size for the volume accordingly.

##### Before you begin

The FlexVol volume must be online.

##### Step

1. Configure the volume to grow and shrink its size automatically:

   `volume autosize -vserver` *`SVM_name`* `-volume` *`volume_name`* `-mode grow_shrink`

   The following command enables automatic size changes for a volume called test2. The volume is configured to begin shrinking when it is 60% full. The default values are used for when it will begin to grow and its maximum size.

   ```
   cluster1::> volume autosize -vserver vs2 test2 -shrink-threshold-percent
   60
   vol autosize: Flexible volume "vs2:test2" autosize settings UPDATED.

   Volume modify successful on volume: test2
   ```

#### Requirements for enabling both autoshrink and automatic snapshot deletion

The autoshrink functionality can be used with automatic snapshot deletion as long as certain configuration requirements are met.

If you want to enable both the autoshrink functionality and automatic snapshot deletion, your configuration

must meet the following requirements:

- ONTAP must be configured to attempt to increase volume size before trying to delete snapshots (the `-space-mgmt-try-first` option must be set to `volume_grow`).
- The trigger for automatic snapshot deletion must be volume fullness(the `trigger` parameter must be set to `volume`).

#### Autoshrink functionality and snapshot deletion

Because the autoshrink functionality shrinks the size of a FlexVol volume, it can also affect when volume snapshots are automatically deleted.

The autoshrink functionality interacts with automatic volume snapshot deletion in the following ways:

- If both the `grow_shrink` autosize mode and automatic snapshot deletion are enabled, when a volume size shrinks it can trigger an automatic snapshot deletion.

  This is because the snapshot reserve is based on a percentage of the volume size (5 percent by default), and that percentage is now based on a smaller volume size. This can cause snapshots to spill out of the reserve and be deleted automatically.

- If the `grow_shrink` autosize mode is enabled and you manually delete a snapshot, it might trigger an automatic volume shrinkage.

#### Address FlexVol volume fullness and overallocation alerts

ONTAP issues EMS messages when FlexVol volumes are running out of space so that you can take corrective action by providing more space for the full volume. Knowing the types of alerts and how to address them helps you ensure your data availability.

When a volume is described as *full*, it means that the percentage of the space in the volume available for use by the active file system (user data) has fallen below a (configurable) threshold. When a volume becomes *overallocated*, the space used by ONTAP for metadata and to support basic data access has been exhausted. Sometimes space normally reserved for other purposes can be used to keep the volume functioning, but space reservation or data availability can be at risk.

Overallocation can be either logical or physical. *Logical overallocation* means that space reserved to honor future space commitments, such as space reservation, has been used for another purpose. *Physical overallocation* means that the volume is running out of physical blocks to use. Volumes in this state are at risk for refusing writes, going offline, or potentially causing a controller disruption.

A volume can be more than 100% full due to space used or reserved by metadata. However, a volume that is more than 100% full might or might not be overallocated. If qtree-level and volume-level shares exist on the same FlexVol or SCVMM pool, the qtrees appear as directories on the FlexVol share. Therefore, you need to be careful not to delete them accidentally.

The following table describes the volume fullness and overallocation alerts, the actions you can take to address the issue, and the risks of not taking action:

| Alert type | EMS level | Configurable? | Definition | Ways to address | Risk if no action taken |
|---|---|---|---|---|---|
| Nearly full | Debug | Y | The file system has exceeded the threshold set for this alert (the default is 95%). The percentage is the `Used` total minus the size of the snapshot reserve. | • Increasing volume size<br>• Reducing user data | No risk to write operations or data availability yet. |
| Full | Debug | Y | The file system has exceeded the threshold set for this alert (the default is 98%). The percentage is the `Used` total minus the size of the snapshot reserve. | • Increasing volume size<br>• Reducing user data | No risk to write operations or data availability yet, but the volume is approaching the stage where write operations could be at risk. |
| Logically overallocated | SVC Error | N | In addition to the file system being full, the space in the volume used for metadata has been exhausted. | • Increasing volume size<br>• Deleting snapshots<br>• Reducing user data<br>• Disabling space reservation for files or LUNs | Write operations to unreserved files could fail. |
| Physically overallocated | Node Error | N | The volume is running out of physical blocks it can write to. | • Increasing volume size<br>• Deleting snapshots<br>• Reducing user data | Write operations are at risk, as well as data availability; the volume could go offline. |

Every time a threshold is crossed for a volume, whether the fullness percentage is rising or falling, an EMS message is generated. When the fullness level of the volume falls below a threshold, a `volume ok` EMS message is generated.

### Address aggregate fullness and overallocation alerts

ONTAP issues EMS messages when aggregates are running out of space so that you can take corrective action by providing more space for the full aggregate. Knowing the types of alerts and how you can address them helps you ensure your data availability.

When an aggregate is described as *full*, it means that the percentage of the space in the aggregate available for use by volumes has fallen below a predefined threshold. When an aggregate becomes *overallocated*, the space used by ONTAP for metadata and to support basic data access has been exhausted. Sometimes space normally reserved for other purposes can be used to keep the aggregate functioning, but volume guarantees for volumes associated with the aggregate or data availability can be at risk.

Overallocation can be either logical or physical. *Logical overallocation* means that space reserved to honor future space commitments, such as volume guarantees, has been used for another purpose. *Physical overallocation* means that the aggregate is running out of physical blocks to use. Aggregates in this state are at risk for refusing writes, going offline, or potentially causing a controller disruption.

The following table describes the aggregate fullness and overallocation alerts, the actions you can take to address the issue, and the risks of not taking action.

| Alert type | EMS Level | Configurable? | Definition | Ways to address | Risk if no action taken |
|---|---|---|---|---|---|
| Nearly full | Debug | N | The amount of space allocated for volumes, including their guarantees, has exceeded the threshold set for this alert (95%). The percentage is the `Used` total minus the size of the snapshot reserve. | • Adding storage to the aggregate<br>• Shrinking or deleting volumes<br>• Moving volumes to another aggregate with more space<br>• Removing volume guarantees (setting them to `none`) | No risk to write operations or data availability yet. |
| Full | Debug | N | The file system has exceeded the threshold set for this alert (98%). The percentage is the `Used` total minus the size of the snapshot reserve. | • Adding storage to the aggregate<br>• Shrinking or deleting volumes<br>• Moving volumes to another aggregate with more space<br>• Removing volume guarantees (setting them to `none`) | Volume guarantees for volumes in the aggregate might be at risk, as well as write operations to those volumes. |

| Alert type | EMS Level | Configurable? | Definition | Ways to address | Risk if no action taken |
|---|---|---|---|---|---|
| Logically overallocated | SVC Error | N | In addition to the space reserved for volumes being full, the space in the aggregate used for metadata has been exhausted. | • Adding storage to the aggregate<br>• Shrinking or deleting volumes<br>• Moving volumes to another aggregate with more space<br>• Removing volume guarantees (setting them to `none`) | Volume guarantees for volumes in the aggregate are at risk, as well as write operations to those volumes. |
| Physically overallocated | Node Error | N | The aggregate is running out of physical blocks it can write to. | • Adding storage to the aggregate<br>• Shrinking or deleting volumes<br>• Moving volumes to another aggregate with more space | Write operations to volumes in the aggregate are at risk, as well as data availability; the aggregate could go offline. In extreme cases, the node could experience a disruption. |

Every time a threshold is crossed for an aggregate, whether the fullness percentage is rising or falling, an EMS message is generated. When the fullness level of the aggregate falls below a threshold, an `aggregate ok` EMS message is generated.

#### Considerations when setting fractional reserve

Fractional reserve, also called *LUN overwrite reserve*, enables you to turn off overwrite reserve for space-reserved LUNs and files in a FlexVol volume. This can help you maximize your storage utilization.

If your environment is negatively affected by write operations failing due to lack of space, you must understand the requirements that this configuration can impose.

The fractional reserve setting is expressed as a percentage; the only valid values are `0` and `100` percent. The fractional reserve setting is an attribute of the volume. Setting fractional reserve to `0` increases your storage utilization. However, an application accessing data residing in the volume could experience a data outage if the volume is out of free space, even with the volume guarantee set to `volume`. With proper volume configuration and use, however, you can minimize the chance of writes failing. ONTAP provides a "best effort" write guarantee for volumes with fractional reserve set to `0` when *all* of the following requirements are met:

- Deduplication is not in use
- Compression is not in use
- FlexClone sub-files are not in use

- All FlexClone files and FlexClone LUNs are enabled for automatic deletion

  This is not the default setting. You must explicitly enable automatic deletion, either at creation time or by modifying the FlexClone file or FlexClone LUN after it is created.

- ODX and FlexClone copy offload are not in use
- Volume guarantee is set to `volume`
- File or LUN space reservation is `enabled`
- Volume snapshot reserve is set to `0`
- Volume snapshot automatic deletion is `enabled` with a commitment level of `destroy`, a destroy list of `lun_clone,vol_clone,cifs_share,file_clone,sfsr`, and a trigger of `volume`

  This setting also ensures that FlexClone files and FlexClone LUNs are deleted when necessary.

- If all the above requirements are met but your rate of change is high, in rare cases, the snapshot automatic deletion could fall behind, resulting in the volume running out of space.
- If all the above requirements are met and snapshots are not in use, volume writes are guaranteed to not run out of space.

In addition, you can optionally use the volume autogrow capability to decrease the likelihood of volume snapshots needing to be deleted automatically. If you enable the autogrow capability, you must monitor the free space in the associated aggregate. If the aggregate becomes full enough that the volume is prevented from growing, more snapshots will probably be deleted as the free space in the volume is depleted.

If you cannot meet all of the above configuration requirements and you need to ensure that the volume does not run out of space, you must set the volume's fractional reserve setting to `100`. This requires more free space up front, but guarantees that data modification operations will succeed even when the technologies listed above are in use.

The default value and allowed values for the fractional reserve setting depend on the guarantee of the volume:

| Volume guarantee | Default fractional reserve | Allowed values |
|---|---|---|
| Volume | 100 | 0, 100 |
| None | 0 | 0, 100 |

## Determine file and inode usage for a volume

FlexVol volumes have a maximum number of files that they can contain. You can use a CLI command to determine whether you need to increase the number of (public) inodes for your FlexVol volumes to prevent them from hitting their file limit.

### About this task

Public inodes can be either free (they are not associated with a file) or used (they point to a file). The number of free inodes for a volume is the total number of inodes for the volume minus the number of used inodes (the number of files).

If qtree-level and volume-level shares exist on the same FlexVol or SCVMM pool, the qtrees appear as directories on the FlexVol share. Therefore, you need to be careful not to delete them accidentally.

**Steps**

1. To display inode usage for a volume, enter the following command:

```
volume show -vserver <SVM_name> -volume <volume_name> -fields files-used
```

**Example**

```
cluster1::*> volume show -vserver vs1 -volume vol1 -fields files-used
Vserver Name: vs1
Files Used (for user-visible data): 98
```

## Control and monitor FlexVol volume I/O performance with Storage QoS

You can control input/output (I/O) performance to FlexVol volumes by assigning volumes to Storage QoS policy groups. You might control I/O performance to ensure that workloads achieve specific performance objectives or to throttle a workload that negatively impacts other workloads.

**About this task**

Policy groups enforce a maximum throughput limit (for example, 100 MB/s). You can create a policy group without specifying a maximum throughput, which enables you to monitor performance before you control the workload. You can also specify an optional minimum throughput limit.

You can also assign SVMs, LUNs, and files to policy groups.

Note the following requirements about assigning a volume to a policy group:

- The volume must be contained by the SVM to which the policy group belongs.

  You specify the SVM when you create the policy group.

- Beginning with ONTAP 9.18.1, you can assign QoS policies to volumes contained in SVMs that have QoS policies. When you use nested QoS policies, the most restrictive policy is applied.
- Beginning with ONTAP 9.14.0, you can assign policies to qtrees contained in volumes that have QoS policies.

For more information about how to use Storage QoS, see the System Administration Reference.

**Steps**

1. Use the `qos policy-group create` command to create a policy group.
2. Use the `volume create` command or the `volume modify` command with the `-qos-policy-group` parameter to assign a volume to a policy group.
3. Use the `qos statistics` commands to view performance data.
4. If necessary, use the `qos policy-group modify` command to adjust the policy group's maximum

throughput limit.

**Related information**

- qos policy-group
- xref:./volumes/ qos policy-group create
- volume create
- volume modify
- qos statistics

## Delete a FlexVol volume

You can delete a FlexVol volume that is no longer required.

**Before you begin**

No applications must be accessing the data in the volume you want to delete.

If you accidentally delete a volume, see the NetApp Knowledge Base: How to use the Volume Recovery Queue.

**Steps**

1. If the volume has been mounted, unmount it:

   ```
   volume unmount -vserver vserver_name -volume volume_name
   ```

2. If the volume is part of a SnapMirror relationship, delete the relationship by using the `snapmirror delete` command.
3. If the volume is online, take the volume offline:

   ```
   volume offline -vserver vserver_name volume_name
   ```

4. Delete the volume:

   ```
   volume delete -vserver vserver_name volume_name
   ```

**Result**

The volume is deleted, along with any associated quota policies and qtrees.

**Related information**

- snapmirror delete
- volume unmount
- volume offline
- volume delete

## Protection against accidental volume deletion

Default volume delete behavior aids the recovery of accidentally deleted FlexVol volumes.

A `volume delete` request against a volume that has type `RW` or `DP` (as seen in `volume show` command output) causes that volume to be moved to a partially deleted state. By default, it is retained in a recovery queue for at least 12 hours before being fully deleted.

> Deleting the SVM that contains the deleted volume clears the Volume Recovery Queue (VRQ). Only delete an SVM when you are certain that there is no need to recover volumes owned by the SVM. Volumes in the volume recovery queue cannot exist when the owning SVM is deleted.

**Related information**

- How to use the Volume Recovery Queue
- volume delete
- volume show

## Commands for managing FlexVol volumes in ONTAP

The ONTAP CLI provides specific commands for managing FlexVol volumes. Depending on what you need to do, you can use the following commands to manage FlexVol volumes:

| If you want to… | Use this command… |
|---|---|
| Bring a volume online | `volume online` |
| Change the size of a volume | `volume size` |
| Determine the associated aggregate of a volume | `volume show` |
| Determine the associated aggregate for all volumes on a storage virtual machine (SVM) | `volume show -vserver -fields aggregate` |
| Determine the format of a volume | `volume show -fields block-type` |
| Mount a volume onto another volume using a junction | `volume mount` |
| Put a volume into the restricted state | `volume restrict` |
| Rename a volume | `volume rename` |
| Take a volume offline | `volume offline` |

Learn more about `volume` in the ONTAP command reference.

## Commands for displaying space usage information

You use the `storage aggregate` and `volume` commands to see how space is being

used in your aggregates and volumes and their snapshots.

Beginning with ONTAP 9.18.1, the `storage aggregate show-space` command changes how Logical Referenced Capacity and Logical Unreferenced Capacity is reported. Logical Referenced Capacity reports referenced blocks in all objects and unreferenced blocks in fragmented objects. Logical Unreferenced Capacity reports only unreferenced blocks in objects that have crossed the fullness threshold and are eligible for object deletion and defragmentation.

For example, when you use the default aggregate fullness threshold of 40% for ONTAP S3 and StorageGRID, 60% of the blocks in an object must be unreferenced before the blocks are reported as unreferenced capacity.

In releases earlier than ONTAP 9.18.1, Logical Referenced Capacity reports referenced blocks in all objects (both full and fragmented objects). Logical Unreferenced Capacity reports unreferenced blocks in all objects.

| To display information about… | Use this command… |
|---|---|
| Aggregates, including details about used and available space percentages, snapshot reserve size, and other space usage information | `storage aggregate show`<br><br>`storage aggregate show-space -fields snap-size-total,used-including-snapshot-reserve` |
| How disks and RAID groups are used in an aggregate, and RAID status | `storage aggregate show-status` |
| The amount of disk space that would be reclaimed if you deleted a specific snapshot | `volume snapshot compute-reclaimable` (advanced) |
| The amount of space used by a volume | `volume show -fields size,used,available,percent-used`<br><br>`volume show-space` |
| The amount of space used by a volume in the containing aggregate | `volume show-footprint` |

**Related information**

- storage aggregate show
- storage aggregate show-space
- storage aggregate show-status
- volume snapshot compute-reclaimable
- volume show

# Move and copy volumes

## Move a FlexVol volume overview

You can move or copy volumes for capacity utilization, improved performance, and to

satisfy service-level agreements. Knowing how moving a FlexVol volume works helps you to determine whether the volume move satisfies service-level agreements and to understand where a volume move is in the volume move process.

FlexVol volumes are moved from one aggregate or node to another within the same storage virtual machine (SVM). A volume move does not disrupt client access during the move.

> During the cutover phase of a volume move operation, you cannot create FlexClone files or FlexClone LUNs of a FlexVol volume.

Moving a volume occurs in multiple phases:

- A new volume is made on the destination aggregate.
- The data from the original volume is copied to the new volume.

  During this time, the original volume is intact and available for clients to access.

- At the end of the move process, client access is temporarily blocked.

  During this time the system performs a final replication from the source volume to the destination volume, swaps the identities of the source and destination volumes, and changes the destination volume to the source volume.

- After completing the move, the system routes client traffic to the new source volume and resumes client access.

The move is not disruptive to client access because the time in which client access is blocked ends before clients notice a disruption and time out. Client access is blocked for 30 seconds by default. If the volume move operation cannot finish in the time that access is denied, the system aborts this final phase of the volume move operation and allows client access. The system attempts the final phase three times by default. After the third attempt, the system waits an hour before attempting the final phase sequence again. The system runs the final phase of the volume move operation until the volume move is complete.

## Considerations and recommendations when moving volumes

There are several considerations and recommendations to be aware of when moving a volume. These are based on the volume you are moving as well as the system configuration such as MetroCluster. You should understand all the relevant issues before moving a volume.

#### General considerations and recommendations

- If you’re upgrading the release family for a cluster, don’t move a volume until after you upgrade all of the nodes in the cluster.

  This recommendation prevents you from inadvertently attempting to move a volume from a newer release family to an older release family.

- The source volume must be consistent.
- If you have assigned one or more aggregates to the associated storage virtual machine (SVM), the destination aggregate must be one of the assigned aggregates.

- You should only move a volume to a later ONTAP version.
- You cannot move a volume to or from a taken-over CFO aggregate.
- If a volume that contains LUNs isn't NVFAIL enabled before you move it, the volume will be NVFAIL enabled after you move it.
- You can move a volume from a Flash Pool aggregate to another Flash Pool aggregate.
  - The caching policies of that volume are also moved.
  - The move might affect volume performance.
- You can move volumes between a Flash Pool aggregate and a non-Flash Pool aggregate.
  - If you move a volume from a Flash Pool aggregate to a non-Flash Pool aggregate, ONTAP displays a message warning you that the move might affect volume performance and asks whether you want to continue.
  - If you move a volume from a non-Flash Pool aggregate to a Flash Pool aggregate, ONTAP assigns the `auto` caching policy.
- Volumes have the data-at-rest protections of the aggregate they reside on. If you move a volume from an aggregate that consists of NSE drives to one that does not, the volume no longer has NSE data-at-rest protection.
- If you're moving FabricPool optimized volumes from ONTAP 9.13.1 or earlier to ONTAP 9.15.1 or later, see the NetApp Knowledge Base: CONTAP-307878 - Unexpected reboot during FabricPool optimized volume move if the source ONTAP is less than 9.14.1 and destination is greater than 9.14.1.
- Beginning with ONTAP 9.15.1, moving volumes from an A400 system to an A70, A90, or A1K system may cause increased read latency issues. For details and recommended actions, see the NetApp Knowledge Base: CONTAP-556247 - Slow Compression / Decompression on volumes after being moved from A400 to A70, A90 and A1K.

**FlexClone volume considerations and recommendations**

- FlexClone volumes cannot be offline when they are being moved.
- You can move FlexClone volumes from one aggregate to another aggregate on the same node or another node in the same SVM without initiating the `vol clone split start` command.

  By initiating a volume move operation on a FlexClone volume, the clone volume is split during the move process to a different aggregate. After the volume move on the clone volume is complete, the volume that moved no longer appears as a clone, but appears instead as an independent volume without any clone relationship with the previous parent volume.

- FlexClone volume snapshots aren't lost after moving a clone.
- You can move FlexClone parent volumes from one aggregate to another aggregate.

  When you move a FlexClone parent volume, a temporary volume is left behind that acts as a parent volume for all FlexClone volumes. No operations are allowed on the temporary volume except to take it offline or to delete it. After all FlexClone volumes are either split or destroyed, the temporary volume is cleaned up automatically.

- After you move a FlexClone child volume, the volume is no longer a FlexClone volume.
- FlexClone move operations are mutually exclusive from FlexClone copy or split operations.
- If a clone-splitting operation is in progress, moving a volume might fail.

  You should not move a volume until clone-splitting operations are completed.

#### MetroCluster considerations and recommendations

- During a volume move in a MetroCluster configuration, when a temporary volume is created on the destination aggregate on the source cluster a record of the temporary volume corresponding to the volume in the mirrored, but unassimilated, aggregate is also created on the surviving cluster.
- If a MetroCluster switchover occurs before the cutover, the destination volume has a record and is a temporary volume (a volume of type TMP).

  Move job restarts on the surviving (disaster recovery) cluster, reports a failure, and cleans up all move-related items including the temporary volume. In any event where cleanup cannot be done correctly, an EMS is generated alerting the system administrator to do the necessary cleanup.

- If a MetroCluster switchover occurs after the cutover phase has started but before the move job has completed (that is, the move reached a stage where it can update the cluster to point to the destination aggregate), the move job restarts on the surviving (disaster recovery) cluster and runs to completion.

  All move-related items are cleaned up including the temporary volume (original source). In any event where cleanup cannot be done correctly, an EMS is generated alerting the system administrator to do the necessary cleanup.

- Neither forced nor unforced MetroCluster switchbacks are allowed if there are any volume move operations in progress for volumes belonging to the switched over site.

  Switchbacks aren’t blocked when volume move operations are in progress for volumes local to the surviving site.

- Unforced MetroCluster switchovers are blocked, but forced MetroCluster switchovers aren’t blocked if there are any volume move operations in progress.

## Requirements for moving volumes in a SAN environment

You need to prepare before moving a volume in a SAN environment.

Before moving a volume containing LUNs or namespaces, you must meet the following requirements:

- For volumes containing one or more LUNs, you should have a minimum of two paths per LUN (LIFs) connecting to each node in the cluster.

  This eliminates single points of failure and enables the system to survive component failures.

- For volumes containing namespaces, the cluster must be running ONTAP 9.6 or later.

  Volume move is not supported for NVMe configurations running ONTAP 9.5.

## Move an ONTAP volume

You can move a FlexVol volume to a different aggregate, node, or both within the same storage virtual machine (SVM) to balance storage capacity after determining that there is a storage capacity imbalance.

#### About this task

By default, if the cutover operation fails to complete within 30 seconds, it will retry. You can adjust the default behavior by using the `-cutover-window` and `-cutover-action` parameters, both of which require

advanced privilege level access.

You must be a cluster administrator to perform this task.

**Before you begin**

- If you are moving a volume that uses 8K adaptive compression to one of the following platforms, you should increase the size of the volume's active file system before moving the volume. Data is compressed differently on these platforms so that space is saved at the aggregate level instead of the volume level. Because of this difference, the size of the volume's active file system should be increase by the amount of 8k compression savings to prevent the volume from running out of space during the volume move.
  - AFF and FAS platforms that support dedicated offload processor storage efficiency

    Learn more about AFF and FAS platforms that support dedicated offload processor storage efficiency.

  - AFF C-Series platforms

    See the Hardware Universe for a full list of C-series platforms.
- If you are moving a data protection mirror and you have not initialized the mirror relationship, use the `snapmirror initialize` command to initialize the mirror relationship. Learn more about `snapmirror initialize` in the ONTAP command reference.

  Data protection mirror relationships must be initialized before you can move one of the volumes.

**Steps**

1. Determine an aggregate to which you can move the volume:

   ```
   volume move target-aggr show
   ```

   The aggregate that you select must have enough space for the volume; that is, the available size is bigger than the volume that you are moving.

   The following example shows that the vs2 volume can be moved to any of the listed aggregates:

   ```
   cluster1::> volume move target-aggr show -vserver vs2 -volume user_max
   Aggregate Name   Available Size   Storage Type
   --------------   --------------   ------------
   aggr2            467.9GB          hdd
   node12a_aggr3    10.34GB          hdd
   node12a_aggr2    10.36GB          hdd
   node12a_aggr1    10.36GB          hdd
   node12a_aggr4    10.36GB          hdd
   5 entries were displayed.
   ```

   Learn more about `volume move target-aggr show` in the ONTAP command reference.

2. Perform a validation check to verify that the volume can be moved to the intended aggregate:

```
volume move start -perform-validation-only
```

Learn more about `volume move start` in the ONTAP command reference.

3. Move the volume:

```
volume move start
```

The following command moves the user_max volume on the vs2 SVM to the node12a_aggr3 aggregate. The move runs as a background process.

```
cluster1::> volume move start -vserver vs2 -volume user_max
-destination-aggregate node12a_aggr3
```

4. Determine the status of the volume move operation:

```
volume move show
```

The following example shows the state of a volume move that completed the replication phase and is in the cutover phase:

```
cluster1::> volume move show
Vserver   Volume     State    Move Phase  Percent-Complete Time-To-
Complete
--------- ---------- -------- ----------  ----------------
----------------
vs2       user_max   healthy  cutover     -                -
```

The volume move is complete when it no longer appears in the `volume move show` command output.

Learn more about `volume move show` in the ONTAP command reference.

5. Optionally, view compression savings:

```
volume show-footprint -vserver <SVM> -volume <volume_name>
```

Additional aggregate-level savings might be realized through a post-process conversion scan that runs automatically and shortly after the volume move is completed.

**Related information**

- Considerations and recommendations when moving volumes

## Increase an ONTAP volume's active file system before migrating from 8k adaptive compression

Platforms that support 8k adaptive compression save space at the volume level. AFF C-Series platforms and platforms that support 32k compression save space at the aggregate level. When migrating a volume from 8k adaptive compression to an AFF C-Series platform or to a platform with 32k compression, you need to increase the size of the volume's active file system by the 8k compression savings. This prevents the volume from running out of free space during the volume move.

The following systems support 32k compression:

Unresolved directive in volumes/increase-volume-active-file-system-size.adoc - include::_include/dedicated-offload-processor-supported-platforms.adoc[]

Learn more about AFF and FAS platforms that support 32k compression.

See the Hardware Universe for a full list of AFF C-series platforms.

### About this task

Perform these steps if you are migrating your data using a volume move operation. If you are migrating your data using a SnapMirror operation, you do not need to manually increase the size of the active file system. SnapMirror destination volumes use volume autosize by default and therefore are not expected to run out of space due to compression savings being realized at the aggregate layer instead of the volume layer.

### Before you begin

If logical space reporting and enforcement is not enabled on your volume, you can optionally enable it by setting the `-is-space-reporting-logical` and `-is-space-enforcement-logical` parameters to **true**. Enabling these settings before the volume move can help you assess if your volume is large enough to accommodate the compression savings loss at the volume layer when you convert from 8k compression. You should enable these settings on the volume. If you enable these settings at the SVM level, they are applied to newly created volumes only.

### Steps

1. Verify the volume's current size and snapshot reserve:

```
volume show-space
```

2. Check the volume's compression space savings:

```
volume show -vserver -volume -fields compression-space-saved
```

3. Increase the volume's active filesystem size by the amount shown for `compression-space-saved` plus the snapshot reserve.

```
volume size -vserver <vserver_name> -volume <volume_name> -new-size
+<size>
```

**Example**

IF a volume is 100GB and has a 20% snapshot reserve; then the the active filesystem is 80GB and the snapshot reserve is 20GB. To increase the active filesystem by 20GB, you must add 25GB to the overall volume size; that is, 20GB for the active filesystem and 5GB (20%) for the snapshot reserve.

```
volume size -vserver svm1 -volume volx -size +20GB
```

4. Verify that the size of the volume is increase:

```
volume show -vserver <vserver_name> -volume <volume_name> -fields size
```

**Result**

Your volume's active file system size is increased and you are ready to move the volume.

**What's next?**

Perform a volume move to migrate your data.

## Commands for moving volumes in ONTAP

The ONTAP CLI provides specific commands for managing volume movement. Depending on what you need to do, use the following commands to manage quota rules and quota policies:

| If you want to… | Use this command… |
|---|---|
| Abort an active volume move operation. | `volume move abort` |
| Show status of a volume moving from one aggregate to another aggregate. | `volume move show` |
| Start moving a volume from one aggregate to another aggregate. | `volume move start` |
| Manage target aggregates for volume move. | `volume move target-aggr` |
| Trigger cutover of a move job. | `volume move trigger-cutover` |
| Change the amount of time client access is blocked if the default is not adequate. | `volume move start` or `volume move modify` with the `-cutover-window` parameter. The `volume move modify` command is an advanced command and the `-cutover-window` is an advanced parameter. |

| If you want to… | Use this command… |
| --- | --- |
| Determine what the system does if the volume move operation cannot be completed during the time client access is blocked. | `volume move start` or `volume move modify` with the `-cutover-action` parameter. The `volume move modify` command is an advanced command and the `-cutover-action` is an advanced parameter. |

**Related information**

- volume move

### Methods for copying a volume

The method you use for copying a volume depends on whether you are copying it to the same aggregate or a different aggregate, and whether you want to retain snapshots from the original volume. Copying a volume creates a standalone copy of a volume that you can use for testing and other purposes.

The following table lists characteristics of the copy and the methods used to create that copy.

| If you want to copy a volume… | Then the method you use is… |
| --- | --- |
| Within the same aggregate and you do not want to copy snapshots from the original volume. | Creating a FlexClone volume of the original volume. |
| To another aggregate and you do not want to copy snapshots from the original volume. | Creating a FlexClone volume of the original volume, and then moving the volume to another aggregate by using the `volume move` command. |
| To another aggregate and preserve all of the snapshots from the original volume. | Replicating the original volume using SnapMirror, and then breaking the SnapMirror relationship to make a read-write volume copy. |

# Use FlexClone volumes to create efficient copies of your FlexVol volumes

### FlexClone volume use overview

FlexClone volumes are writable, point-in-time copies of a parent FlexVol volume. FlexClone volumes are space-efficient because they share the same data blocks with their parent FlexVol volumes for common data. The snapshot used to create a FlexClone volume is also shared with the parent volume.

You can clone an existing FlexClone volume to create another FlexClone volume. You can also create a clone of a FlexVol volume containing LUNs and LUN clones.

You can also split a FlexClone volume from its parent volume. Beginning with ONTAP 9.4, for non-guaranteed volumes on AFF systems, the split operation for FlexClone volumes shares the physical blocks and does not

copy the data. Therefore, splitting of FlexClone volumes on AFF systems is faster than the FlexClone splitting operation in other FAS systems in ONTAP 9.4 and later releases.

You can create two types of FlexClone volumes: read-write FlexClone volumes and data protection FlexClone volumes. While you can create a read-write FlexClone volume of a regular FlexVol volume, you must use only a SnapVault secondary volume to create a data protection FlexClone volume.

## Create a FlexClone volume

You can create a data protection FlexClone volume from a SnapMirror destination volume or from a parent FlexVol volume that is a SnapVault secondary volume. Beginning with ONTAP 9.7, you can create a FlexClone volume from a FlexGroup volume. After you create a FlexClone volume, you cannot delete the parent volume while the FlexClone volume exists.

**Before you begin**

- The FlexClone license must be installed on the cluster. This license is included with ONTAP One.
- The volume that you want to clone must be online.

> Cloning a volume as a FlexClone volume on a different SVM is not supported on MetroCluster configurations.

**Create a FlexClone volume of a FlexVol or FlexGroup**

**Step**

1. Create a FlexClone volume:

   ```
   volume clone create
   ```

   > While creating a read-write FlexClone volume from the read-write parent volume, you do not need to specify the base snapshot. ONTAP creates a snapshot if you do not name any specific snapshot that is to be used as the base snapshot for the clone. You must specify the base snapshot for creating a FlexClone volume when the parent volume is a data protection volume.

**Example**

- The following command creates a read-write FlexClone volume vol1_clone from the parent volume vol1:

  ```
  volume clone create -vserver vs0 -flexclone vol1_clone -type RW -parent-volume
  vol1
  ```

- The following command creates a data protection FlexClone volume vol_dp_clone from the parent volume dp_vol by using the base snapshot snap1:

  ```
  volume clone create -vserver vs1 -flexclone vol_dp_clone -type DP -parent
  -volume dp_vol -parent-snapshot snap1
  ```

### Create a FlexClone of any SnapLock type

Beginning with ONTAP 9.13.1, you can specify one of three SnapLock types, `compliance`, `enterprise`, `non-snaplock`, when creating a FlexClone of a RW volume. By default, a FlexClone volume is created with the same SnapLock type as the parent volume. However, you can override the default by using the `snaplock-type` option during FlexClone volume creation.

Using the `non-snaplock` parameter with the `snaplock-type` option, you can create a non-SnapLock type FlexClone volume from a SnapLock parent volume to provide a faster method of bringing data back online when necessary.

Learn more about SnapLock.

#### Before you begin

You should be aware of the following FlexClone volume limitations when they have a different SnapLock type than the parent volume.

- Only RW-type clones are supported. DP-type clones with a SnapLock type different from the parent volume are not supported.
- Volumes with LUNs cannot be cloned using the snaplock-type option set to a value other than 'non-snaplock' because SnapLock volumes do not support LUNs.
- A volume on a MetroCluster mirrored aggregate cannot be cloned with a Compliance SnapLock type because SnapLock Compliance volumes are not supported on MetroCluster mirrored aggregates.
- SnapLock Compliance volumes with Legal-Hold cannot be cloned with a different SnapLock type. Legal-Hold is only supported on SnapLock Compliance volumes.
- SVM DR does not support SnapLock volumes. Attempting to create a SnapLock clone from a volume in an SVM that is part of an SVM DR relationship will fail.
- FabricPool best practices recommend that clones retain the same tiering policy as the parent. However, a SnapLock Compliance clone of a FabricPool-enabled volume cannot have the same tiering policy as the parent. The tiering policy must be set to `none`. Attempting to create a SnapLock Compliance clone from a parent with a tiering policy other than `none` will fail.

#### Steps

1. Create a FlexClone volume with a SnapLock type: `volume clone create -vserver` *`svm_name`* `-flexclone` *`flexclone_name`* `-type RW [ -snaplock-type {non-snaplock|compliance|enterprise} ]`

   Example:

   ```
   > volume clone create -vserver vs0 -flexclone vol1_clone -type RW
   -snaplock-type enterprise -parent-volume vol1
   ```

## Split a FlexClone volume from its parent volume

You can split a FlexClone volume from its parent to make the clone a normal FlexVol volume.

The clone splitting operation takes place in the background. Data is accessible on the clone and the parent

during the split. Beginning with ONTAP 9.4, space efficiency is preserved. The split process only updates metadata and requires minimal IO. No data blocks are copied.

**About this task**

- New snapshots of the FlexClone volume cannot be created during the split operation.
- A FlexClone volume cannot be split from the parent volume if it belongs to a data protection relationship or is part of a load-sharing mirror.
- If you take the FlexClone volume offline while splitting is in progress, the split operation is suspended; when you bring the FlexClone volume back online, the splitting operation resumes.
- After the split, both the parent FlexVol volume and the clone require the full space allocation determined by their volume guarantees.
- After a FlexClone volume is split from its parent the two cannot be rejoined.
- Beginning with ONTAP 9.4, for non-guaranteed volumes on AFF systems, the split operation for FlexClone volumes shares the physical blocks and does not copy the data. Therefore, splitting of FlexClone volumes on AFF systems is faster than the FlexClone splitting operation in other FAS systems in ONTAP 9.4 and later. The improved FlexClone splitting operation on AFF systems has the following benefits:
  - Storage efficiency is preserved after splitting the clone from the parent.
  - Existing snapshots are not deleted.
  - The operation is faster.
  - The FlexClone volume can be split from any point in the clone hierarchy.

**Before you begin**

- You must be a cluster administrator.
- The FlexClone volume must be online when the split operation begins.
- The parent volume must be online for the split to succeed.

**Steps**

1. Determine the amount of free space required to complete the split operation:

   `volume clone show -estimate -vserver` *`vserver_name`* `-flexclone` *`clone_volume_name`* `-parent-volume` *`parent_vol_name`*

   The following example provides information about the free space required to split FlexClone volume “clone1” from its parent volume “vol1”:

   ```
   cluster1::> volume clone show -estimate -vserver vs1 -flexclone clone1
   -parent-volume volume1
                               Split
   Vserver   FlexClone       Estimate
   --------- ------------- ----------
   vs1       clone1           40.73MB
   ```

2. Verify that the aggregate containing the FlexClone volume and its parent has sufficient space:
   a. Determine the amount of free space in the aggregate that contains the FlexClone volume and its parent:

```
storage aggregate show
```

b. If the containing aggregate does not have enough free space available, add storage to the aggregate:

```
storage aggregate add-disks
```

3. Start the split operation:

```
volume clone split start -vserver vserver_name -flexclone clone_volume_name
```

The following example shows how you can initiate the process to split FlexClone volume “clone1” from its parent volume “vol1”:

```
cluster1::> volume clone split start -vserver vs1 -flexclone clone1

Warning: Are you sure you want to split clone volume clone1 in Vserver
vs1 ?
{y|n}: y
[Job 1617] Job is queued: Split clone1.
```

4. Monitor the status of the FlexClone split operation:

```
volume clone split show -vserver vserver_name -flexclone clone_volume_name
```

The following example shows the status of the FlexClone split operation on an AFF system:

```
cluster1::> volume clone split show -vserver vs1 -flexclone clone1
                                              Inodes
Blocks
                                    ---------------------
---------------------
Vserver   FlexClone    Processed Total    Scanned  Updated      % Inode
% Block

Complete  Complete
vs1       clone1        0         0       411247   153600         0
37
```

5. Verify that the split volume is no longer a FlexClone volume:

```
volume show -volume volume_name -fields clone-volume
```

The value of the `clone-volume` option is “false” for a volume that is not a FlexClone volume.

The following example shows how you can verify whether volume “clone1” that is split from its parent is not a FlexClone volume.

```
cluster1::> volume show -volume clone1 -fields clone-volume
vserver volume **clone-volume**
------- ------ **------------**
vs1     clone1 **false**
```

**Related information**

- storage aggregate add-disks

## Determine the space used by a FlexClone volume

You can determine the space used by a FlexClone volume based on its nominal size and the amount of space it shares with the parent FlexVol volume. When a FlexClone volume is created, it shares all of its data with its parent volume. Although the nominal size of the FlexVol volume is the same as its parent's size, it uses very little free space from the aggregate.

**About this task**

The free space used by a newly-created FlexClone volume is approximately 0.5 percent of its nominal size. This space is used to store the FlexClone volume's metadata.

New data written to either the parent or the FlexClone volume is not shared between the volumes. The increase in the amount of new data that gets written to the FlexClone volume leads to an increase in the space the FlexClone volume requires from its containing aggregate.

**Step**

1. Determine the actual physical space used by the FlexClone volume using the `volume show` command.

   The following example shows the total physical space used by the FlexClone volume:

```
cluster1::> volume show -vserver vs01 -volume clone_vol1 -fields
size,used,available,
percent-used,physical-used,physical-used-percent
vserver    volume     size  available  used   percent-used   physical-
used     physical-used-percent
-------   ----------  ----  ---------  -----  ------------
-------------   --------------------
vs01     clone_vol1   20MB   18.45MB   564KB       7%             196KB
1%
```

   Learn more about `volume show` in the ONTAP command reference.

## Considerations for creating a FlexClone volume from a SnapMirror source or destination volume

You can create a FlexClone volume from the source or destination volume in an existing

volume SnapMirror relationship. However, doing so could prevent future SnapMirror replication operations from completing successfully.

Replication might not work because when you create the FlexClone volume, you might lock a snapshot that is used by SnapMirror. If this happens, SnapMirror stops replicating to the destination volume until the FlexClone volume is destroyed or is split from its parent. You have two options for addressing this issue:

- If you require the FlexClone volume on a temporary basis and can accommodate a temporary stoppage of the SnapMirror replication, you can create the FlexClone volume and either delete it or split it from its parent when possible.

  The SnapMirror replication continues normally when the FlexClone volume is deleted or is split from its parent.

- If a temporary stoppage of the SnapMirror replication is not acceptable, you can create a snapshot in the SnapMirror source volume, and then use that snapshot to create the FlexClone volume. (If you are creating the FlexClone volume from the destination volume, you must wait until that snapshot replicates to the SnapMirror destination volume.)

  This method of creating a snapshot in the SnapMirror source volume allows you to create the clone without locking a snapshot that is in use by SnapMirror.

# Use FlexClone files and FlexClone LUNs to create efficient copies of files and LUNs

## FlexClone file and FlexClone LUN use overview

FlexClone files and FlexClone LUNs are writable, space-efficient clones of parent files and parent LUNs, and help in efficient utilization of the physical aggregate space. FlexClone files and FlexClone LUNs are supported only for FlexVol volumes.

FlexClone files and FlexClone LUNs use 0.4 percent of their size to store the metadata. Clones share the data blocks of their parent files and parent LUNs and occupy negligible storage space until clients write new data either to the parent file or LUN, or to the clone.

Clients can perform all file and LUN operations on both the parent and the clone entities.

You can use multiple methods to delete FlexClone files and FlexClone LUNs.

## Create a FlexClone file or FlexClone LUN in ONTAP

You can create space-efficient and time-efficient clones of files and LUNs present in FlexVol volumes or FlexClone volumes by using the `volume file clone create` command.

**Before you begin**

- The FlexClone license must be installed on the cluster. This license is included with ONTAP One.
- If multiple block ranges are used for sub-LUN cloning or sub-file cloning, the block numbers must not overlap.
- If you are creating a sub-LUN or sub-file on volumes with adaptive compression enabled, the block ranges

must not be misaligned.

This means that the source start block number and destination start block number must either be even aligned or odd aligned.

**About this task**

Depending on the privileges assigned by the cluster administrator, an SVM administrator can create FlexClone files and FlexClone LUNs.

You can specify the autodelete setting for FlexClone files and FlexClone LUNs when you create and modify clones. By default, the autodelete setting is disabled.

You can overwrite an existing FlexClone file or FlexClone LUN when you create a clone by using the `volume file clone create` command with the `-overwrite-destination` parameter.

When the node reaches its maximum split load, the node temporarily stops accepting requests to create FlexClone files and FlexClone LUNs and issues an `EBUSY` error message. When the split load for the node falls below the maximum, the node accepts requests to create FlexClone files and FlexClone LUNs again. You should wait until the node has capacity to create the clones before trying the create request again.

The FlexClone LUN inherits the space reservations attribute of the parent LUN. A space-reserved FlexClone LUN requires as much space as the space-reserved parent LUN. If the FlexClone LUN is not space-reserved, the volume must have enough space to accommodate changes to the clone.

**Steps**

1. If you are cloning a LUN, verify that the LUN is not mapped or being written to.
2. Create the FlexClone LUN or file:

   `volume file clone create -vserver` *`vserver_name`* `-volume` *`volume_name`* `-source -path` *`source_path`* `-destination-path` *`destination_path`*

   The following example shows how you can create a FlexClone file file1_clone of the parent file file1_source in the volume vol1:

   ```
   cluster1::> volume file clone create -vserver vs0 -volume vol1 -source
   -path /file1_source -destination-path /file1_clone
   ```

   Learn more about `volume file clone create` in the ONTAP command reference.

### Create FlexClone LUNs from a snapshot in a volume

You can use a snapshot in your volume to create FlexClone copies of your LUNs. FlexClone copies of LUNs are both readable and writeable.

**Before you begin**

A FlexClone license must be installed. This license is included with ONTAP One.

**About this task**

The FlexClone LUN inherits the space reservations attribute of the parent LUN. A space-reserved FlexClone LUN requires as much space as the space-reserved parent LUN. If the FlexClone LUN is not space-reserved,

the volume must have enough space to accommodate changes to the clone.

**Steps**

1. Verify that the LUN is not mapped or being written to.
2. Create a snapshot of the volume that contains the LUNs:

   `volume snapshot create -vserver` *`vserver_name`* `-volume` *`volume_name`* `-snapshot` *`snapshot_name`*

   You must create a snapshot (the backing snapshot) of the LUN you want to clone.

3. Create the FlexClone LUN from the snapshot:

   `volume file clone create -vserver` *`vserver_name`* `-volume` *`volume_name`* `-source -path` *`source_path`* `-snapshot-name` *`snapshot_name`* `-destination-path` *`destination_path`*

   If you need the FlexClone LUN to be available for automatic deletion, you include `-autodelete true`. If you are creating this FlexClone LUN in a volume using semi-thick provisioning, you must enable automatic deletion for all FlexClone LUNs.

4. Verify that the FlexClone LUN is correct:

   `lun show -vserver` *`vserver_name`*

```
Vserver Path                      State    Mapped    Type     Size
------- ----------------------    -------- --------- -------- -------
vs1     /vol/vol1/lun1_clone      online   unmapped windows   47.07MB
vs1     /vol/vol1/lun1_snap_clone online   unmapped windows   47.07MB
```

## View node capacity before creating and deleting FlexClone files and FlexClone LUNs

You should determine whether a node has capacity to receive requests to create and delete FlexClone files and FlexClone LUNs. This can be done by viewing the split load for the node. If the maximum split load is reached, no new requests are accepted until the split load falls below the maximum.

**About this task**

When the node reaches its maximum split load, an `EBUSY` error message is issued in response to create and delete requests. When the split load for the node falls below the maximum, the node accepts requests to create and delete FlexClone files and FlexClone LUNs again.

A node can accept new requests when the `Allowable Split Load` field displays capacity, and the create request fits in the available capacity.

**Steps**

1. View how much capacity a node has to create and delete FlexClone files and FlexClone LUNs by using the `volume file clone split load show` command.

In the following example, the split load is displayed for all of the nodes in cluster1. All nodes in the cluster have capacity to create and delete FlexClone files and FlexClone LUNs as indicated by the Allowable Split Load field:

```
cluster1::> volume file clone split load show
Node       Max         Current    Token          Allowable
           Split Load  Split Load Reserved Load  Split Load
---------- ----------  ---------- -------------  ----------
node1         15.97TB         0B         100MB    15.97TB
node2         15.97TB         0B         100MB    15.97TB
2 entries were displayed.
```

**Related information**

- volume file clone split load show

## View space savings with FlexClone files and FlexClone LUNs

You can view the percentage of disk space saved by block sharing on a volume containing FlexClone files and FlexClone LUNs. You might do this as part of capacity planning.

**Steps**

1. To view the space saving achieved due to FlexClone files and FlexClone LUNs, enter the following command:

   `df -s volname`

   `volname` is the name of the FlexVol volume.

   If you run the `df -s` command on a deduplication-enabled FlexVol volume, you can view the space saved by both deduplication and FlexClone files and LUNs.

**Example**

The following example shows the space saving on a FlexClone volume test1:

```
systemA> df -s test1

Filesystem          used   saved   %saved Vserver
/vol/test1/         4828    5744     54%  vs1
```

Learn more about the commands described in this procedure in the ONTAP command reference.

## Methods to delete FlexClone files and FlexClone LUNs

You can use multiple methods to delete FlexClone files and FlexClone LUNs.

Understanding what methods are available helps you plan how to manage clones.

You can use the following methods to delete FlexClone files and FlexClone LUNs:

- You can configure a FlexVol volume to automatically delete clones with autodelete enabled when the free space in a FlexVol volume decreases below a particular threshold.
- You can configure clients to delete clones by using the NetApp Manageability SDK.
- You can use clients to delete clones by using the NAS and SAN protocols.

  The slower deletion method is enabled by default because this method does not use the NetApp Manageability SDK. However, you can configure the system to use the faster deletion method when you delete FlexClone files by using the `volume file clone deletion` commands.

## How a FlexVol volume can reclaim free space with autodelete setting

### FlexVol volumes and reclaiming free space with autodelete overview

You can enable the autodelete setting of a FlexVol volume to automatically delete FlexClone files and FlexClone LUNs. By enabling autodelete, you can reclaim a target amount of free space in the volume when a volume is nearly full.

You can configure a volume to automatically start deleting FlexClone files and FlexClone LUNs when the free space in the volume decreases below a particular threshold value, and automatically stop deleting clones when a target amount of free space in the volume is reclaimed. Although, you cannot specify the threshold value that starts the automatic deletion of clones, you can specify whether a clone is eligible for deletion, and you can specify the target amount of free space for a volume.

A volume automatically deletes FlexClone files and FlexClone LUNs when the free space in the volume decreases below a particular threshold and when *both* of the following requirements are met:

- The autodelete capability is enabled for the volume that contains the FlexClone files and FlexClone LUNs.

  You can enable the autodelete capability for a FlexVol volume by using the `volume snapshot autodelete modify` command. You must set the `-trigger` parameter to `volume` or `snap_reserve` for a volume to automatically delete FlexClone files and FlexClone LUNs. Learn more about `volume snapshot autodelete modify` in the ONTAP command reference.

- The autodelete capability is enabled for the FlexClone files and FlexClone LUNs.

  You can enable autodelete for a FlexClone file or FlexClone LUN by using the `file clone create` command with the `-autodelete` parameter. As a result, you can preserve certain FlexClone files and FlexClone LUNs by disabling autodelete for the clones and ensuring that other volume settings do not override the clone setting. Learn more about `file clone create` in the ONTAP command reference.

### Configure a FlexVol volume to automatically delete FlexClone files and FlexClone LUNs

You can configure a volume to automatically start deleting FlexClone files and FlexClone LUNs when the free space in the volume decreases below a particular threshold value, and automatically stop deleting clones when a target amount of free space in the volume is reclaimed. Although, you cannot specify the threshold value that starts the automatic

deletion of clones, you can specify whether a clone is eligible for deletion, and you can specify the target amount of free space for a volume.

A volume automatically deletes FlexClone files and FlexClone LUNs when the free space in the volume decreases below a particular threshold and when *both* of the following requirements are met:

- The autodelete capability is enabled for the volume that contains the FlexClone files and FlexClone LUNs.

  You can enable the autodelete capability for a FlexVol volume by using the `volume snapshot autodelete modify` command. You must set the `-trigger` parameter to `volume` or `snap_reserve` for a volume to automatically delete FlexClone files and FlexClone LUNs.

- The autodelete capability is enabled for the FlexClone files and FlexClone LUNs.

  You can enable autodelete for a FlexClone file or FlexClone LUN by using the `file clone create` command with the `-autodelete` parameter. As a result, you can preserve certain FlexClone files and FlexClone LUNs by disabling autodelete for the clones and ensuring that other volume settings do not override the clone setting.

**Before you begin**

- The FlexVol volume must contain FlexClone files and FlexClone LUNs, and be online.
- The FlexVol volume must not be a read-only volume.

**Steps**

1. Enable automatic deletion of FlexClone files and FlexClone LUNs in the FlexVol volume by using the `volume snapshot autodelete modify` command. Learn more about `volume snapshot autodelete modify` in the ONTAP command reference.
   - For the `-trigger` parameter, you can specify `volume` or `snap_reserve`.
   - For the `-destroy-list` parameter, you must always specify `lun_clone,file_clone` regardless of whether you want to delete only one type of clone. The following example shows how you can enable volume vol1 to trigger the automatic deletion of FlexClone files and FlexClone LUNs for space reclamation until 25% of the volume consists of free space:

```
cluster1::> volume snapshot autodelete modify -vserver vs1 -volume
vol1 -enabled true -commitment disrupt -trigger volume -target-free
-space 25 -destroy-list lun_clone,file_clone

Volume modify successful on volume:vol1
```

   While enabling FlexVol volumes for automatic deletion, if you set the value of the `-commitment` parameter to `destroy`, all the FlexClone files and FlexClone LUNs with the `-autodelete` parameter set to `true` might be deleted when the free space in the volume decreases below the specified threshold value. However, FlexClone files and FlexClone LUNs with the `-autodelete` parameter set to `false` will not be deleted.

2. Verify that automatic deletion of FlexClone files and FlexClone LUNs is enabled in the FlexVol volume by using the `volume snapshot autodelete show` command. Learn more about `volume snapshot autodelete show` in the ONTAP command reference.

The following example shows that volume vol1 is enabled for automatic deletion of FlexClone files and FlexClone LUNs:

```
cluster1::> volume snapshot autodelete show -vserver vs1 -volume vol1

         Vserver Name: vs1
          Volume Name: vol1
          Enabled: true
            Commitment: disrupt
         Defer Delete: user_created
         Delete Order: oldest_first
  Defer Delete Prefix: (not specified)
    Target Free Space: 25%
              Trigger: volume
     *Destroy List: lun_clone,file_clone*
Is Constituent Volume: false
```

3. Ensure that autodelete is enabled for the FlexClone files and FlexClone LUNs in the volume that you want to delete by performing the following steps:

   a. Enable automatic deletion of a particular FlexClone file or FlexClone LUN by using the `volume file clone autodelete` command. Learn more about `volume file clone autodelete` in the ONTAP command reference.

      You can force a specific FlexClone file or FlexClone LUN to be automatically deleted by using the `volume file clone autodelete` command with the `-force` parameter.

      The following example shows that automatic deletion of the FlexClone LUN lun1_clone contained in volume vol1 is enabled:

      ```
      cluster1::> volume file clone autodelete -vserver vs1 -clone-path
      /vol/vol1/lun1_clone -enabled true
      ```

      You can enable autodelete when you create FlexClone files and FlexClone LUNs.

   b. Verify that the FlexClone file or FlexClone LUN is enabled for automatic deletion by using the `volume file clone show-autodelete` command. Learn more about `volume file clone show-autodelete` in the ONTAP command reference.

      The following example shows that the FlexClone LUN lun1_clone is enabled for automatic deletion:

      ```
      cluster1::> volume file clone show-autodelete -vserver vs1 -clone
      -path vol/vol1/lun1_clone
      Vserver Name: vs1
      Clone Path: vol/vol1/lun1_clone
      **Autodelete Enabled: true**
      ```

Learn more about the commands described in this procedure in the ONTAP command reference.

### Prevent automatic deletion of a FlexClone file or FlexClone LUN

If you configure a FlexVol volume to automatically delete FlexClone files and FlexClone LUNs, any clone that fits the criteria you specify might be deleted. If you have specific FlexClone files or FlexClone LUNs that you want to preserve, you can exclude them from the automatic FlexClone deletion process.

#### Before you begin

A FlexClone license must be installed. This license is included with ONTAP One.

#### About this task

When you create a FlexClone file or FlexClone LUN, by default the autodelete setting for the clone is disabled. FlexClone files and FlexClone LUNs with autodelete disabled are preserved when you configure a FlexVol volume to automatically delete clones to reclaim space on the volume.

> If you set the `commitment` level on the volume to `try` or `disrupt`, you can individually preserve specific FlexClone files or FlexClone LUNs by disabling autodelete for those clones. However, if you set the `commitment` level on the volume to `destroy` and the destroy lists include `lun_clone,file_clone`, the volume setting overrides the clone setting, and all FlexClone files and FlexClone LUNs can be deleted regardless of the autodelete setting for the clones.

#### Steps

1. Prevent a specific FlexClone file or FlexClone LUN from being automatically deleted by using the `volume file clone autodelete` command.

   The following example shows how you can disable autodelete for FlexClone LUN lun1_clone contained in vol1:

   ```
   cluster1::> volume file clone autodelete -vserver vs1 -volume vol1
   -clone-path lun1_clone -enable false
   ```

   A FlexClone file or FlexClone LUN with autodelete disabled cannot be deleted automatically to reclaim space on the volume.

2. Verify that autodelete is disabled for the FlexClone file or FlexClone LUN by using the `volume file clone show-autodelete` command.

   The following example shows that autodelete is false for the FlexClone LUN lun1_clone:

```
cluster1::> volume file clone show-autodelete -vserver vs1 -clone-path
vol/vol1/lun1_clone
                                                                Vserver
Name: vs1
                                                                Clone Path:
vol/vol1/lun1_clone
                                                                Autodelete
Enabled: false
```

#### Commands for configuring deletion of FlexClone files

When clients delete FlexClone files without using the NetApp Manageability SDK, you can use the `volume file clone deletion` commands to enable faster deletion of FlexClone files from a FlexVol volume. Extensions for and minimum size of FlexClone files are used to enable faster deletion.

You can use the `volume file clone deletion` commands to specify a list of supported extensions and a minimum size requirement for FlexClone files in a volume. The faster deletion method is used only for FlexClone files that meet the requirements. For FlexClone files that do not meet the requirements, the slower deletion method is used.

When clients delete FlexClone files and FlexClone LUNs from a volume by using the NetApp Manageability SDK, the extension and size requirements do not apply because the faster deletion method is always used.

| To… | Use this command… |
|---|---|
| Add an extension to the supported list of extensions for the volume | `volume file clone deletion add-extension` |
| Change the minimum size of FlexClone files that can be deleted from the volume by using the faster deletion method | `volume file clone deletion modify` |
| Remove an extension from the supported list of extensions for the volume | `volume file clone deletion remove-extension` |
| View the supported list of extensions and the minimum size of FlexClone files that clients can delete from the volume by using the faster deletion method | `volume file clone deletion show` |

Learn more about the commands described in this procedure in the ONTAP command reference.

#### Related information

- volume file clone deletion

# Use qtrees to partition your FlexVol volumes

## Qtrees and ONTAP FlexVol volume partitioning

Qtrees enable you to partition FlexVol volumes into smaller segments that can be managed individually. The volume partitioning enabled by qtrees provides a finer level of control when administering storage by project, user, or group. You can use qtrees to better manage quotas, security style, and CIFS oplocks.

ONTAP creates a default qtree for each volume named **qtree0**. If you do not put data in a specific qtree, it's placed in qtree0.

### General limitations

You should be aware of the limitations of qtrees before using them in a production environment. Also review the Operation and limitations when using the extended qtree performance monitoring feature.

- Qtree names can be no more than 64 characters.
- Certain special characters used in the qtree names, such as commas and spaces, can cause problems with other ONTAP capabilities and should be avoided.
- You cannot move directories between different qtrees. Only files can be moved between qtrees.
- If you create qtree-level and volume-level shares on the same FlexVol or SCVMM pool, the qtrees appear as directories on the FlexVol share. You should be careful not to accidentally delete them.

### Commands for managing and configuring qtrees

You can manage and configure qtrees using the ONTAP CLI. Depending on what you want to do, you should use the following commands to administer qtrees.

The command `volume rehost` can cause other concurrent administrative operations targeted at the same volume to fail.

| If you want to… | Use this command… |
|---|---|
| Create a qtree | `volume qtree create` |
| Display a filtered list of qtrees | `volume qtree show` |
| Delete a qtree | `volume qtree delete`<br>This command will fail unless the qtree is empty or the `-force true` flag is used. |
| Modify a qtree's UNIX permissions | `volume qtree modify -unix-permissions` |

| | |
|---|---|
| Modify a qtree's CIFS oplocks setting | `volume qtree oplocks` |
| Modify a qtree's security setting | `volume qtree security` |
| Rename a qtree | `volume qtree rename` |
| Display a qtree's statistics | `volume qtree statistics` |
| Reset a qtree's statistics | `volume qtree statistics -reset` |

### Extended qtree performance monitoring

Beginning with ONTAP 9.16.1, you can use the ONTAP REST API to access the extended qtree monitoring capabilities which includes latency metrics and historical statistics.

The ONTAP REST API includes several endpoints related to qtrees. Prior to ONTAP 9.16.1, customers could access real-time statistics for qtrees, including IO operations per second (IOPs) as well as throughput for read, write, and other operations.

The extended qtree performance monitoring available beginning with ONTAP 9.16.1 gives you the ability to monitor real-time latency statistics as well as IOPs and throughput for NFSv3, NFSv4.0, NFSv4.1, NFSv4.2, pNFS (technically a part of NFSv4.1 and NFSv4.2), and CIFS. It also collects and archives statistics to allow viewing of historical performance data.

This extended monitoring provides storage administrators with greater insight into system performance. You can use this data to identify high-use qtrees, potential bottlenecks, and other areas when working to improve quality of service. Being able to analyze these metrics, including trends over a longer period of time, enables you to make more informed data-driven decisions.

#### Operation and limitations

There are several operational characteristics, including limitations, you should consider before using the extended qtree performance monitoring feature in a production environment.

**Remount required**

After enabling qtree extended monitoring, you need to remount the affected volume to activate the feature.

**Availability of statistics**

After enabling extended performance monitoring, the statistical data is not immediately available. This includes IOPS, throughput, and latency statistics. It can take up to five minutes before this data is displayed for a qtree.

**Qtrees per cluster**

You can enable extended performance monitoring for a maximum of 50,000 qtrees in an ONTAP cluster.

#### Access extended metrics using the ONTAP REST API

Beginning with ONTAP 9.16.1, you can access the extended qtree performance monitoring feature through the ONTAP REST API. The basic capabilities fall into several categories as described below.

**Enable and disable extended performance monitoring**

You can access the property `ext_performance_monitoring.enabled` at the endpoint `/api/storage/qtrees` to enable or disable the extended monitoring feature. The POST and PATCH methods are available depending on whether you are creating a new qtree or configuring an existing qtree.

#### Retrieve global monitoring metrics and settings

Several new global properties have been added to the `/api/storage/qtrees` endpoint. You can retrieve these fields using the GET method.

#### Retrieve metrics for a specific qtree

You can use the GET method at the endpoint `/api/storage/qtrees/{volume.uuid}/{id}/metrics` to retrieve the new statistics and metrics properties for a specific qtree as defined at a specific volume.

#### Upgrading and reverting

If you enable the feature in ONTAP 9.16.1, you can upgrade to a subsequent ONTAP release without restrictions. However, there are two scenarios to consider.

#### Upgrade to 9.16.1 and handling mixed version clusters

The extended performance monitoring feature cannot be used (that is, `ext_performance_monitoring.enabled` cannot be set to `true`) until the effective cluster version (ECV) of the cluster is at 9.16.1.

#### Revert from 9.16.1

If any qtrees have the property `ext_performance_monitoring.enabled` set to `true`, reverting to 9.15.1 from 9.16.1 is not allowed. The revert operation is blocked. The best practice is to set `ext_performance_monitoring.enabled` to `false` for all qtrees prior to reverting to an earlier ONTAP release.

#### Learn more

Learn more about the ONTAP REST API, including what's new with the ONTAP REST API, from the ONTAP automation documentation. You should also review the ONTAP automation documentation for details about the ONTAP REST API qtree endpoints.

## Obtain a qtree junction path

You can mount an individual qtree by obtaining the junction path or namespace path of the qtree. The qtree path displayed by the CLI command `qtree show -instance` is of the format `/vol/<volume_name>/<qtree_name>`. However, this path does not refer to the junction path or namespace path of the qtree.

Learn more about `qtree show` in the ONTAP command reference.

#### About this task

You need to know the junction path of the volume to obtain the junction path or namespace path of the qtree.

#### Steps

1. Use the `vserver volume junction-path` command to obtain the junction path of a volume.

   The following example displays the junction path of the volume named vol1 located on the storage virtual machine (SVM) named vs0:

```
cluster1::> volume show -volume vol1 -vserver vs0 -fields junction-path

------- ------ -------------

vs0 vol1 /vol1
```

From the above output, the volume's junction path is `/vol1`. Since qtrees are always rooted at the volume, the junction path or namespace path of the qtree will be `/vol1/qtree1`.

Learn more about `vserver volume junction-path` in the ONTAP command reference.

## Directory to qtree conversions

### Convert a directory to a qtree

If you have a directory at the root of a FlexVol volume that you want to convert to a qtree, you need to migrate the data contained in the directory to a new qtree with the same name, using your client application.

#### About this task

The steps you take to convert a directory to a qtree depend on what client you use. The following process outlines the general tasks you need to complete.

#### Before you begin

You cannot delete a directory if it is associated with an existing CIFS share.

#### Steps

1. Rename the directory to be made into a qtree.
2. Create a new qtree with the original directory name.
3. Use the client application to move the contents of the directory into the new qtree.
4. Delete the now-empty directory.

### Convert a directory to a qtree using a Windows client

To convert a directory to a qtree using a Windows client, you rename the directory, create a qtree on the storage system, and move the contents of the directory to the qtree.

#### About this task

You must use Windows Explorer for this procedure. You cannot use the Windows command-line interface or the DOS prompt environment.

#### Steps

1. Open Windows Explorer.
2. Click the folder representation of the directory you want to change.

> The directory must reside at the root of its containing volume.

3. From the **File** menu, select **Rename** to give this directory a different name.
4. On the storage system, use the `volume qtree create` command to create a new qtree with the original name of the directory. Learn more about `volume qtree create` in the ONTAP command reference.
5. In Windows Explorer, open the renamed directory folder and select the files inside it.
6. Drag these files into the folder representation of the new qtree.

   The more subfolders contained in the folder that you are moving, the longer the move operation takes.

7. From the **File** menu, select **Delete** to delete the renamed, now-empty directory folder.

#### Convert a directory to a qtree using a UNIX client

To convert a directory to a qtree in UNIX, you rename the directory, create a qtree on the storage system, and move the directory's contents to the qtree.

#### Steps

1. Open a UNIX client window.
2. Use the `mv` command to rename the directory.

   ```
   client: mv /n/user1/vol1/dir1 /n/user1/vol1/olddir
   ```

3. From the storage system, use the `volume qtree create` command to create a qtree with the original name.

   ```
   system1: volume qtree create /n/user1/vol1/dir1
   ```

   Learn more about `volume qtree create` in the ONTAP command reference.

4. From the client, use the `mv` command to move the contents of the old directory into the qtree.

   The more subdirectories contained in a directory that you are moving, the longer the move operation will take.

   ```
   client: mv /n/user1/vol1/olddir/* /n/user1/vol1/dir1
   ```

5. Use the `rmdir` command to delete the old, now-empty directory.

   ```
   client: rmdir /n/user1/vol1/olddir
   ```

#### After you finish

Depending on how your UNIX client implements the `mv` command, file ownership and permissions might not be

preserved. If this occurs, update file owners and permissions to their previous values.

Learn more about the commands described in this procedure in the ONTAP command reference.

# Logical space reporting and enforcement for volumes

## Logical space reporting and enforcement for volumes overview

Beginning with ONTAP 9.4, you can allow the logical space used in a volume and the amount of remaining storage space to be displayed to users. Beginning with ONTAP 9.5, you can limit the amount of logical space consumed by users.

Logical space reporting and enforcement are disabled by default.

The following volume types support logical space reporting and enforcement.

| Volume type | Is space reporting supported? | Is space enforcement supported? |
|---|---|---|
| FlexVol volumes | Yes, beginning with ONTAP 9.4 | Yes, beginning with ONTAP 9.5 |
| SnapMirror destination volumes | Yes, beginning with ONTAP 9.8 | Yes, beginning with ONTAP 9.13.1 |
| FlexGroup volumes | Yes, beginning with ONTAP 9.9.1 | Yes, beginning with ONTAP 9.9.1 |
| FlexCache volumes | Origin setting is used at the cache | Not applicable |

## Logical space enforcement

Logical space enforcement ensures that users are notified when a volume is full or nearly full. When you enable logical space enforcement in ONTAP 9.5 and later, ONTAP counts the logical-used blocks in a volume to determine the amount of space that is still available in that volume. If there is no space available in a volume, the system returns an ENOSPC (out-of-space) error message.

Logical space enforcement returns three types of alerts to inform you about the available space in a volume:

- `Monitor.vol.full.inc.sav`: This alert is triggered when 98% of the logical space in the volume has been used.
- `Monitor.vol.nearFull.inc.sav`: This alert is triggered when 95% of the logical space in the volume has been used.
- `Vol.log.overalloc.inc.sav`: This alert is triggered when the logical space used in the volume is greater than the total size of the volume.

  This alert tells you that adding to the size of the volume might not create available space since that space will already be consumed by overallocated logical blocks.

Total (logical space) should be equal to provisioned space excluding snapshot reserve of the volume with logical space enforcement.

For more information, see Configuring volumes to automatically provide more space when they are full.

## Logical space reporting

When you enable logical space reporting on a volume, your system can display the amount of logical used and available space in addition to the total space in a volume. In addition, users on Linux and Windows client systems can see logical used and available space instead of physical used and physical available space.

Definitions:

- Physical space refers to the physical blocks of storage available or used in the volume.
- Logical space refers to the usable space in a volume.
- Logical space used is physical space used plus savings from storage efficiency features (such as deduplication and compression) that have been configured.

Beginning with ONTAP 9.5, you can enable logical space enforcement together with space reporting.

When enabled, logical space reporting displays the following parameters with the `volume show` command:

| Parameter | Meaning |
|---|---|
| `-logical-used` | Displays information only about the volume or volumes that have the specified logical used size. This value includes all the space saved by the storage efficiency features along with the physically used space. This does not include snapshot reserve but does consider snapshot spill. |
| `-logical-used-by-afs` | Displays information only about the volume or volumes that have the specified logical size used by the active file system. This value differs from the `-logical-used` value by the amount of snapshot spill that exceeds the snapshot reserve. |
| `-logical-available` | When only logical space reporting is enabled, only physical-available space is displayed. When both space reporting and enforcement are enabled, it displays the amount of free space currently available considering space saved by the storage efficiency features as being used. This does not include the snapshot reserve. |
| `-logical-used-percent` | Displays the percentage of the current `-logical-used` value with the provisioned size excluding snapshot reserve of the volume.<br><br>This value can be greater than 100%, because the `-logical-used-by-afs` value includes efficiency savings in the volume. The `-logical-used-by-afs` value of a volume does not include snapshot spill as used space. The `-physical-used` value of a volume includes Snapshot spill as used space. |

| Parameter | Meaning |
| --- | --- |
| `-used` | Displays the amount of space occupied by user data and file system metadata. It differs from `physical-used` space by the sum of the space that is reserved for future writes and the space that is saved by aggregate storage efficiency. It includes snapshot spill (the amount of space by which snapshots exceed snapshot reserve). It does not include the snapshot reserve. |

Enabling logical space reporting in the CLI also allows the Logical Used Space (%) and Logical Space values to display in System Manager

Client systems see logical space displayed as “used” space on the following system displays:

- **df** output on Linux systems
- Space details under Properties using Windows Explorer on Windows systems.

If logical space reporting is enabled without logical space enforcement, the total displayed on client systems can be higher than the provisioned space.

## Enable logical space reporting and enforcement

Beginning with ONTAP 9.4, you can enable logical space reporting. Beginning with 9.5, you can enable logical space enforcement, or both reporting and enforcement together.

**About this task**

In addition to enabling logical space reporting and enforcement at the individual volume level, you can enable them at the SVM level for every volume that supports the functionality. If you enable logical space features for the entire SVM, you can also disable them for individual volumes.

Beginning with ONTAP 9.8, if you enable logical space reporting on a SnapMirror source volume, it is automatically enabled on the destination volume after the transfer.

Beginning with ONTAP 9.13.1, if the enforcement option is enabled on a SnapMirror source volume, the destination will report logical space consumption and will honor its enforcement, enabling better capacity planning.

If you are running an ONTAP release earlier than ONTAP 9.13.1, you should understand that although the enforcement setting is transferred to the SnapMirror destination volume, the destination volume does not support enforcement. As a result, the destination will report logical space consumption but not honor its enforcement.

Learn more about ONTAP release support for logical space reporting.

**Steps**

Enable one or more of the following:

- Enable logical space reporting for a volume:

```
volume modify -vserver svm_name -volume volume_name -size volume_size -is
-space-reporting-logical true
```

- Enable logical space enforcement for a volume:

```
volume modify -vserver svm_name -volume volume_name -size volume_size -is
-space-enforcement-logical true
```

- Enable logical space reporting and enforcement together for a volume:

```
volume modify -vserver svm_name -volume volume_name -size volume_size -is
-space-reporting-logical true -is-space-enforcement-logical true
```

- Enable logical space reporting or enforcement for a new SVM:

```
vserver create -vserver _svm_name_ -rootvolume root-_volume_name_ -rootvolume
-security-style unix -data-services {desired-data-services} [-is-space-
reporting-logical true] [-is-space-enforcement-logical true]
```

- Enable logical space reporting or enforcement for an existing SVM:

```
vserver modify -vserver _svm_name_ {desired-data-services} [-is-space-
reporting-logical true] [-is-space-enforcement-logical true]
```

## Manage SVM capacity limits

Beginning with ONTAP 9.13.1, you can set a maximum capacity for a storage VM (SVM). You can also configure alerts when the SVM approaches a threshold capacity level.

### About this task

Capacity on an SVM is calculated as the sum of FlexVols, FlexGroup volumes, FlexClones, FlexCache volumes. Volumes impact capacity calculation even if they are restricted, offline, or in the recovery queue after deletion. If you have volumes configured with auto-grow, the maximum autosize value of the volume will be calculated toward the SVM size; without auto-grow, the actual size of the volume will be calculated.

The following table captures how `autosize-mode` parameters impact the capacity calculation.

| | |
|---|---|
| `autosize-mode off` | Size parameter will be used for computation |
| `autosize-mode grow` | The `max-autosize` parameter will be used for computation |
| `autosize-mode grow-shrink` | The `max-autosize` parameter will be used for computation |

### Before you begin

- You must be a cluster administrator to set an SVM limit.
- Beginning with ONTAP 9.16.1, storage limits can be configured for SVMs that contain data protection volumes, including the following data protection types:
  - FlexVol volumes in asynchronous DR without cascade
  - FlexVol volumes in synchronous DR (both sync and strict-sync policies)
  - Restore
- Storage limits for SVMs is *not* supported for the following configurations:

    - SnapMirror vault relationships
    - SnapMirror active sync
    - FlexGroup volumes
    - Consistency groups
    - SVM DR
    - Cascades
    - MetroCluster
- Beginning with ONTAP 9.16.1, when you create a load-sharing mirror relationship, the destination SVM cannot have a storage limit enabled.
- When you migrate an SVM, the source SVM cannot have a storage limit enabled. To complete the migrate operation, disable the storage limit on the source then complete the migration.
- SVM capacity is distinct from quotas. Quotas cannot exceed the max size.
- You cannot set a storage limit when other operations are in progress on the SVM. Use the `job show vserver <svm_name>` command to see existing jobs. Try running the command again when any jobs have been completed. Learn more about `job show` in the ONTAP command reference.

**Capacity impact**

When you reach the capacity limit, the following operations will fail:

- Creating a LUN, namespace, or volume
- Cloning a LUN, namespace, or volume
- Modifying a LUN, namespace, or volume
- Increasing the size of a LUN, namespace, or volume
- Expanding a LUN, namespace, or volume
- Rehosting a LUN, namespace, or volume

**Set a capacity limit on a new SVM**

**System Manager**

**Steps**

1. Select **Storage** > **Storage VMs**.
2. Select  to create the SVM.
3. Name the SVM and select an **Access protocol**.
4. Under **Storage VM settings**, select **Enable maximum capacity limit**.

   Provide a maximum capacity size for the SVM.

5. Select **Save**.

**CLI**

**Steps**

1. Create the SVM. To set a storage limit, provide a `storage-limit` value. To set a threshold alert for the storage limit, provide a percentage value for `-storage-limit-threshold-alert`.

   ```
   vserver create -vserver <vserver_name> -aggregate <aggregate_name>
   -rootvolume <root_volume_name> -rootvolume-security-style
   {unix|ntfs|mixed} -storage-limit <value> [GiB|TIB] -storage-limit
   -threshold-alert <percentage> [-ipspace <IPspace_name>] [-language
   <language>] [-snapshot-policy <snapshot_policy_name>] [-quota-policy
   <quota_policy_name>] [-comment <comment>]
   ```

   If you do not provide threshold value, by default an alert will be triggered when the SVM is at 90% capacity. To disable the threshold alert, provide a value of zero.

2. Confirm the SVM was created successfully:

   ```
   vserver show -vserver <vserver_name>
   ```

3. If you wish to disable the storage limit, set the `-storage-limit` parameter for the SVM to zero:

   ```
   vserver modify -vserver <vserver_name> -storage-limit 0
   ```

### Set or modify a capacity limit on an existing SVM

You can set a capacity limit and threshold alert on an existing SVM or disable a capacity limit.

Once you set the capacity limit, you cannot modify the limit to a value less than the currently allocated capacity.

**System Manager**

**Steps**

1. Select **Storage** > **Storage VMs**.
2. Select the SVM you want to modify. Next to the name of the SVM, select ⋮ then **Edit**.
3. To enable a capacity limit, select the box next to **Enable capacity limit**. Enter a value for the **Maximum capacity** and a percentage value for **Alert threshold**.

   If you wish to disable the capacity limit, uncheck the box next **Enable capacity limit**.

4. Select **Save**.

**CLI**

**Steps**

1. On the cluster hosting the SVM, issue the `vserver modify` command. Provide a numerical value for `-storage-limit` and a percent value for `-storage-limit-threshold-alert`.

   ```
   vserver modify -vserver <vserver_name> -storage-limit <value>
   [GiB|TIB] -storage-limit-threshold-alert <percentage>
   ```

   If you do not provide a threshold value, you will have a default alert at 90% capacity. To disable the threshold alert, provide a value of zero.

2. If you wish to disable the storage limit, set the `-storage-limit` for the SVM to zero:

   ```
   vserver modify -vserver <vserver_name> -storage-limit 0
   ```

### Reaching capacity limits

When you reach the maximum capacity or the alert threshold, you can consult the `vserver.storage.threshold` EMS messages or use the **Insights** page in System Manager to learn about possible actions. Possible resolutions include:

- Editing the SVM maximum capacity limits
- Purging the volumes recovery queue to free up space
- Delete snapshot to provide space for the volume

**Related information**

- Capacity measurements in System Manager
- Monitor cluster, tier, and SVM capacity in System Manager
- vserver create
- vserver show
- vserver modify

# Use quotas to restrict or track resource usage

## Overview of the quota process

### Understand quotas, quota rules, and quota policies

Quotas are defined in quota rules specific to FlexVol volumes. These quota rules are collected together in a quota policy for a storage virtual machine (SVM) and activated on each volume on the SVM.

A quota rule is always specific to a volume. Quota rules have no effect until quotas are activated on the volume defined in the quota rule.

A quota policy is a collection of quota rules for all the volumes of an SVM. Quota policies are not shared among SVMs. An SVM can have up to five quota policies, which enable you to have backup copies of quota policies. One quota policy is assigned to an SVM at any given time. When you initialize or resize quotas on a volume, you are activating the quota rules in the quota policy that is currently assigned to the SVM.

A quota is the actual restriction that ONTAP enforces or the actual tracking that ONTAP performs. A quota rule always results in at least one quota, and might result in many additional derived quotas. The complete list of enforced quotas is visible only in quota reports.

Activation is the process of triggering ONTAP to create enforced quotas from the current set of quota rules in the assigned quota policy. Activation occurs on a volume-by-volume basis. The first activation of quotas on a volume is called initialization. Subsequent activations are called either reinitialization or resizing, depending on the scope of the changes.

### Benefits of using quotas

You can use quotas to manage and monitor resource usage with FlexVol volumes.

There are several benefits to defining quotas. You can use the default, explicit, derived, and tracking quotas to manage disk usage in the most efficient manner.

#### Limit resource consumption

You can limit the amount of disk space or the number of files used by a user or group or contained in a qtree.

#### Track resource usage

The amount of disk space or number of files used by a user, group, or qtree can be tracked without imposing a limit.

#### Notify users

Notifications can be generated when resource usage reaches specific levels. This warns users when their disk or file usage is too high.

### Quota process

Quotas provide a way to restrict or track the disk space and number of files used by a user, group, or qtree. Quotas are applied to a specific FlexVol volume or qtree.

Quotas can be soft or hard. Soft quotas cause ONTAP to send a notification when specified limits are exceeded, and hard quotas prevent a write operation from succeeding when specified limits are exceeded.

When ONTAP receives a request from a user or user group to write to a FlexVol volume, it checks to see whether quotas are activated on that volume for the user or user group and determines the following:

- Whether the hard limit will be reached

  If yes, the write operation fails when the hard limit is reached and the hard quota notification is sent.

- Whether the soft limit will be breached

  If yes, the write operation succeeds when the soft limit is breached and the soft quota notification is sent.

- Whether a write operation will not exceed the soft limit

  If yes, the write operation succeeds and no notification is sent.

#### Differences among hard, soft, and threshold quotas

Hard quotas prevent operations while soft quotas trigger notifications.

Hard quotas impose a hard limit on system resources; any operation that would result in exceeding the limit fails. The following settings create hard quotas:

- Disk Limit parameter
- Files Limit parameter

Soft quotas send a warning message when resource usage reaches a certain level, but do not affect data access operations, so you can take appropriate action before the quota is exceeded. The following settings create soft quotas:

- Threshold for Disk Limit parameter
- Soft Disk Limit parameter
- Soft Files Limit parameter

Threshold and Soft Disk quotas enable administrators to receive more than one notification about a quota. Typically, administrators set the Threshold for Disk Limit to a value that is only slightly smaller than the Disk Limit, so that the threshold provides a "final warning" before writes start to fail.

#### About quota notifications

Quota notifications are messages that are sent to the event management system (EMS) and also configured as SNMP traps.

Notifications are sent in response to the following events:

- A hard quota is reached; in other words, an attempt is made to exceed it
- A soft quota is exceeded
- A soft quota is no longer exceeded

Thresholds are slightly different from other soft quotas. Thresholds trigger notifications only when they are exceeded, not when they are no longer exceeded.

Hard-quota notifications are configurable byusing the volume quota modify command. You can turn them off

completely, and you can change their frequency, for example, to prevent sending of redundant messages.

Soft-quota notifications are not configurable because they are unlikely to generate redundant messages and their sole purpose is notification.

The following table lists the events that quotas send to the EMS system:

| When this occurs… | This event is sent to the EMS… |
|---|---|
| A hard limit is reached in a tree quota | `wafl.quota.qtree.exceeded` |
| A hard limit is reached in a user quota on the volume | `wafl.quota.user.exceeded` (for a UNIX user) `wafl.quota.user.exceeded.win` (for a Windows user) |
| A hard limit is reached in a user quota on a qtree | `wafl.quota.userQtree.exceeded` (for a UNIX user) `wafl.quota.userQtree.exceeded.win` (for a Windows user) |
| A hard limit is reached in a group quota on the volume | `wafl.quota.group.exceeded` |
| A hard limit is reached in a group quota on a qtree | `wafl.quota.groupQtree.exceeded` |
| A soft limit, including a threshold, is exceeded | `quota.softlimit.exceeded` |
| A soft limit is no longer exceeded | `quota.softlimit.normal` |

The following table lists the SNMP traps that quotas generate:

| When this occurs… | This SNMP trap is sent… |
|---|---|
| A hard limit is reached | quotaExceeded |
| A soft limit, including a threshold, is exceeded | quotaExceeded and softQuotaExceeded |
| A soft limit is no longer exceeded | quotaNormal and softQuotaNormal |

Notifications contain qtree ID numbers rather than qtree names. You can correlate qtree names to ID numbers by using the `volume qtree show -id` command.

#### Quota targets and types

## Every quota has a specific type. The quota target is derived from the type and specifies the user, group, or qtree to which the quota limits are applied.

The following table lists the quota targets, what types of quotas each quota target is associated with, and how each quota target is represented.

| Quota target | Quota type | How target is represented | Notes |
|---|---|---|---|
| user | user quota | UNIX user name UNIX UID<br><br>A file or directory whose UID matches the user<br><br>Windows user name in pre-Windows 2000 format<br><br>Windows SID<br><br>A file or directory with an ACL owned by the user's SID | User quotas can be applied for a specific volume or qtree. |
| group | group quota | UNIX group name UNIX GID<br><br>A file or directory whose GID matches the group | Group quotas can be applied for a specific volume or qtree.<br><br>ONTAP does not apply group quotas based on Windows IDs. |
| qtree | tree quota | qtree name | Tree quotas are applied to a particular volume and do not affect qtrees in other volumes. |
| "" | user quotagroup quota<br><br>tree quota | Double quotation marks ("") | A quota target of "" denotes a *default quota*. For default quotas, the quota type is determined by the value of the type field. |

## Special kinds of quotas

### How default quotas work

You can use default quotas to apply a quota to all instances of a given quota type. For example, a default user quota affects all users on the system for the specified FlexVol volume or qtree. In addition, default quotas enable you to modify your quotas easily.

You can use default quotas to automatically apply a limit to a large set of quota targets without having to create separate quotas for each target. For example, if you want to limit most users to 10 GB of disk space, you can specify a default user quota of 10 GB of disk space instead of creating a quota for each user. If you have specific users for whom you want to apply a different limit, you can create explicit quotas for those users. (Explicit quotas—quotas with a specific target or list of targets—override default quotas.)

In addition, default quotas enable you to use resizing rather than reinitialization when you want quota changes to take effect. For example, if you add an explicit user quota to a volume that already has a default user quota, you can activate the new quota by resizing.

Default quotas can be applied to all three types of quota target (users, groups, and qtrees).

Default quotas do not necessarily have specified limits; a default quota can be a tracking quota.

A quota is indicated by a target that is either an empty string ("") or an asterisk (*), depending on the context:

- When you create a quota using the `volume quota policy rule create` command, setting the `-target` parameter to an empty string ("") creates a default quota.

  Learn more about `volume quota policy rule create` in the ONTAP command reference.

- In the `volume quota policy rule create` command, the `-qtree` parameter specifies the name of the qtree to which the quota rule applies. This parameter is not applicable for tree type rules. For user or group type rules at the volume level, this parameter should contain "".
- In the output of the `volume quota policy rule show` command, a default quota appears with an empty string ("") as the target.

  Learn more about `volume quota policy rule show` in the ONTAP command reference.

- In the output of the `volume quota report` command, a default quota appears with an asterisk (*) as the ID and Quota Specifier.

  Learn more about `volume quota report` in the ONTAP command reference.

#### Default user quota example

The following quota rule uses a default user quota to apply a 50-MB limit on each user for vol1:

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol1
-policy-name default -type user -target "" -qtree "" -disk-limit 50m

cluster1::> volume quota policy rule show -vserver vs0 -volume vol1

Vserver: vs0               Policy: default           Volume: vol1
                                                Soft             Soft
                         User         Disk     Disk   Files    Files
Type   Target    Qtree   Mapping     Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
user   ""        ""      off          50MB        -       -        -
-
```

If any user on the system enters a command that would cause that user's data to take up more than 50 MB in vol1 (for example, writing to a file from an editor), the command fails.

#### How you use explicit quotas

You can use explicit quotas to specify a quota for a specific quota target, or to override a default quota for a specific target.

An explicit quota specifies a limit for a particular user, group, or qtree. An explicit quota replaces any default quota that is in place for the same target.

When you add an explicit user quota for a user that has a derived user quota, you must use the same user mapping setting as the default user quota. Otherwise, when you resize quotas, the explicit user quota is rejected because it is considered a new quota.

Explicit quotas only affect default quotas at the same level (volume or qtree). For example, an explicit user quota for a qtree does not affect the default user quota for the volume that contains that qtree. However, the explicit user quota for the qtree overrides (replaces the limits defined by) the default user quota for that qtree.

**Examples of explicit quotas**

The following quota rules define a default user quota that limits all users in vol1 to 50MB of space. However, one user, jsmith, is allowed 80MB of space, because of the explicit quota (shown in bold):

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol1
-policy-name default -type user -target "" -qtree "" -disk-limit 50m

cluster1::> volume quota policy rule create -vserver vs0 -volume vol1
-policy-name default -type user -target "jsmith" -qtree "" -disk-limit 80m

cluster1::> volume quota policy rule show -vserver vs0 -volume vol1

Vserver: vs0               Policy: default           Volume: vol1
                                                Soft             Soft
                         User         Disk     Disk   Files    Files
Type   Target    Qtree   Mapping     Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
user   ""        ""      off          50MB        -       -        -
-
user   jsmith    ""      off          80MB        -       -        -
-
```

The following quota rule restricts the specified user, represented by four IDs, to 550MB of disk space and 10,000 files in the vol1 volume:

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol1
-policy-name default -type user -target "
jsmith,corp\jsmith,engineering\john smith,S-1-5-32-544" -qtree "" -disk
-limit 550m -file-limit 10000

cluster1::> volume quota policy rule show -vserver vs0 -volume vol1

Vserver: vs0               Policy: default           Volume: vol1
                                                  Soft             Soft
                         User         Disk     Disk   Files    Files
Type   Target    Qtree   Mapping     Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
user   "jsmith,corp\jsmith,engineering\john smith,S-1-5-32-544"
                 ""      off         550MB        -   10000        -
-
```

The following quota rule restricts the eng1 group to 150MB of disk space and an unlimited number of files in the proj1 qtree:

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol2
-policy-name default -type group -target "eng1" -qtree "proj1" -disk-limit
150m

cluster1::> volume quota policy rule show -vserver vs0 -volume vol2

Vserver: vs0               Policy: default           Volume: vol2
                                                  Soft             Soft
                         User         Disk     Disk   Files    Files
Type   Target    Qtree   Mapping     Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
group  eng1      proj1   off         150MB        -       -        -
-
```

The following quota rule restricts the proj1 qtree in the vol2 volume to 750MB of disk space and 75,000 files:

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol2
-policy-name default -type tree -target "proj1" -disk-limit 750m -file
-limit 75000

cluster1::> volume quota policy rule show -vserver vs0 -volume vol2

Vserver: vs0               Policy: default           Volume: vol2
                                                Soft             Soft
                         User          Disk     Disk   Files    Files
Type   Target    Qtree   Mapping      Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
tree   proj1     ""      -           750MB        -   75000        -
-
```

#### How derived quotas work

A quota enforced as a result of a default quota, rather than an explicit quota (a quota with a specific target), is referred to as a *derived quota*.

The number and location of the derived quotas depends on the quota type:

- A default tree quota on a volume creates derived default tree quotas for every qtree on the volume.
- A default user or group quota creates a derived user or group quota for every user or group that owns a file at the same level (volume or qtree).
- A default user or group quota on a volume creates a derived default user or group quota on every qtree that also has a tree quota.

The settings—including limits and user mapping—of derived quotas are the same as the settings of the corresponding default quotas. For example, a default tree quota with a 20-GB disk limit on a volume creates derived tree quotas with 20-GB disk limits on the qtrees in the volume. If a default quota is a tracking quota (with no limits), the derived quotas are also tracking quotas.

To see derived quotas, you can generate a quota report. In the report, a derived user or group quota is indicated by a Quota Specifier that is either blank or an asterisk (*). A derived tree quota, however, has a Quota Specifier. To identify a derived tree quota, you must look for a default tree quota on the volume with the same limits.

Explicit quotas interact with derived quotas in the following ways:

- Derived quotas are not created if an explicit quota already exists for the same target.
- If a derived quota exists when you create an explicit quota for a target, you can activate the explicit quota by resizing rather than having to perform a full quota initialization.

#### Use tracking quotas

A tracking quota generates a report of disk and file usage and does not limit resource

usage. When tracking quotas are used, modifying the quota values is less disruptive because you can resize quotas rather than turning them off and back on.

To create a tracking quota, you omit the Disk Limit and Files Limit parameters. This tells ONTAP to monitor disk and files usage for that target at that level (volume or qtree), without imposing any limits. Tracking quotas are indicated in the output of `show` commands and the quota report with a dash ("-") for all limits. ONTAP automatically creates tracking quotas when you use the System Manager UI to create explicit quotas (quotas with specific targets). When using the CLI, the storage administrator creates tracking quotas on top of explicit quotas.

You can also specify a *default tracking quota*, which applies to all instances of the target. Default tracking quotas enable you to track usage for all instances of a quota type (for example, all qtrees or all users). In addition, they enable you use resizing rather than reinitialization when you want quota changes to take effect.

**Examples**

The output for a tracking rule shows tracking quotas in place for a qtree, user, and group, as shown in the following example for a volume-level tracking rule:

```
Vserver: vs0              Policy: default             Volume: fv1

                                      Soft           Soft
                        User    Disk  Disk   Files   Files
Type  Target   Qtree    Mapping Limit Limit  Limit   Limit  Threshold
----- -------- -------  ------- ------ ------ ------ ------ ---------
tree  ""       ""       -       -      -      -      -      -
user  ""       ""       off     -      -      -      -      -
group ""       ""       -       -      -      -      -      -
```

**How quotas are applied**

## Understanding how quotas are applied enables you to configure quotas properly and set the expected limits.

Whenever an attempt is made to create a file or write data to a file in a FlexVol volume that has quotas enabled, the quota limits are checked before the operation proceeds. If the operation exceeds either the disk limit or the files limit, the operation is prevented.

Quota limits are checked in the following order:

1. The tree quota for that qtree (This check is not relevant if the file is being created or written to qtree0.)
2. The user quota for the user that owns the file on the volume
3. The group quota for the group that owns the file on the volume
4. The user quota for the user that owns the file on the qtree (This check is not relevant if the file is being created or written to qtree0.)
5. The group quota for the group that owns the file on the qtree (This check is not relevant if the file is being created or written to qtree0.)

The quota with the smallest limit might not be the one that is exceeded first. For example, if a user quota for volume vol1 is 100 GB, and the user quota for qtree q2 contained in volume vol1 is 20 GB, the volume limit

could be reached first if that user has already written more than 80 GB of data in volume vol1 (but outside of qtree q2).

**Related information**

- How quotas are applied to the root user
- How quotas are applied to users with multiple IDs

### Considerations for assigning quota policies

A quota policy is a grouping of the quota rules for all the FlexVol volumes of an SVM. You must be aware of certain considerations when assigning the quota policies.

- An SVM has one assigned quota policy at any given time. When an SVM is created, a blank quota policy is created and assigned to the SVM. This default quota policy has the name "default" unless a different name is specified when the SVM is created.
- An SVM can have up to five quota policies. If an SVM has five quota policies, you cannot create a new quota policy for the SVM until you delete an existing quota policy.
- When you need to create a quota rule or change quota rules for a quota policy, you can choose either of the following approaches:
  - If you are working in a quota policy that is assigned to an SVM, you need not assign the quota policy to the SVM.
  - If you are working in an unassigned quota policy and then assigning the quota policy to the SVM, you must have a backup of the quota policy that you can revert to if required.

    For example, you can make a copy of the assigned quota policy, change the copy, assign the copy to the SVM, and rename the original quota policy.
- You can rename a quota policy even when it is assigned to the SVM.

### How quotas work with users and groups

#### Overview of how quotas work with users and groups

You can specify a user or group as the target of a quota. There are several implementation differences to consider when defining a quota.

A few of the differences you need to be aware of include the following:

- User or group
- UNIX or Windows
- Special users and groups
- Are multiple IDs included

There are also different ways to specify IDs for users based on your environment.

#### Specify UNIX users for quotas

You can specify a UNIX user for a quota in one of several different formats.

The three formats available when specifying a UNIX user for a quota include the following:

- The user name (such as jsmith).

> You cannot use a UNIX user name to specify a quota if that name includes a backslash (\) or an @ sign. This is because ONTAP treats names containing these characters as Windows names.

- The user ID or UID (such as 20).
- The path of a file or directory owned by that user, so that the file's UID matches the user.

> If you specify a file or directory name, you must select a file or directory that will last as long as the user account remains on the system.
>
> Specifying a file or directory name for the UID does not cause ONTAP to apply a quota to that file or directory.

#### Specify Windows users for quotas

## You can specify a Windows user for a quota in one of several different formats.

The three formats available when specifying a Windows user for a quota include the following:

- The Windows name in pre-Windows 2000 format.
- The security ID (SID) as displayed by Windows in text form, such as `S-1-5-32-544`.
- The name of a file or directory that has an ACL owned by that user's SID.

> If you specify a file or directory name, you must select a file or directory that will last as long as the user account remains on the system.
>
> For ONTAP to obtain the SID from the ACL, the ACL must be valid.
>
> If the file or directory exists in a UNIX-style qtree, or if the storage system uses UNIX mode for user authentication, ONTAP applies the user quota to the user whose **UID**, not SID, matches that of the file or directory.
>
> Specifying a file or directory name to identify a user for a quota does not cause ONTAP to apply a quota to that file or directory.

#### How default user and group quotas create derived quotas

## When you create default user or group quotas, corresponding derived user or group quotas are automatically created for every user or group that owns files at the same level.

Derived user and group quotas are created in the following ways:

- A default user quota on a FlexVol volume creates derived user quotas for every user that owns a file anywhere on the volume.
- A default user quota on a qtree creates derived user quotas for every user that owns a file in the qtree.
- A default group quota on a FlexVol volume creates derived group quotas for every group that owns a file anywhere on the volume.

- A default group quota on a qtree creates derived group quotas for every group that owns a file in the qtree.

If a user or group does not own files at the level of a default user or group quota, derived quotas are not created for the user or group. For example, if a default user quota is created for qtree proj1 and the user jsmith owns files on a different qtree, no derived user quota is created for jsmith.

The derived quotas have the same settings as the default quotas, including limits and user mapping. For example, if a default user quota has a 50-MB disk limit and has user mapping turned on, any resulting derived quotas also have a 50-MB disk limit and user mapping turned on.

However, no limits exist in derived quotas for three special users and groups. If the following users and groups own files at the level of a default user or group quota, a derived quota is created with the same user-mapping setting as the default user or group quota, but it is only a tracking quota (with no limits):

- UNIX root user (UID 0)
- UNIX root group (GID 0)
- Windows BUILTIN\Administrators group

  Since quotas for Windows groups are tracked as user quotas, a derived quota for this group is a user quota that is derived from a default user quota, not a default group quota.

#### Example of derived user quotas

If you have volume where three users—root, jsmith, and bob—own files, and you create a default user quota on the volume, ONTAP automatically creates three derived user quotas. Therefore, after you reinitialize quotas on the volume, four new quotas appear in the quota report:

```
cluster1::> volume quota report
  Vserver: vs1
                                     ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1               user    *          0B   50MB       0       -   *
vol1               user    root       5B      -       1       -
vol1               user    jsmith    30B   50MB      10       -   *
vol1               user    bob       40B   50MB      15       -   *
4 entries were displayed.
```

The first new line is the default user quota that you created, which is identifiable by the asterisk (*) as the ID. The other new lines are the derived user quotas. The derived quotas for jsmith and bob have the same 50-MB disk limit as the default quota. The derived quota for the root user is a tracking quota without limits.

#### How quotas are applied to the root user

The root user (UID=0) on UNIX clients is subject to tree quotas, but not to user or group quotas. This allows the root user to take actions on behalf of other users that would otherwise be prevented by a quota.

When the root user carries out a file or directory ownership change or other operation (such as the UNIX `chown` command) on behalf of a user with less privileges, ONTAP checks the quotas based on the new owner but does not report errors or stop the operation, even if the hard quota restrictions of the new owner are exceeded. This can be useful when an administrative action, such as recovering lost data, results in temporarily exceeding quotas.

After the ownership transfer is carried out, however, a client system will report a disk space error if the user attempts to allocate more disk space while the quota is still exceeded.

**Related information**

- How quotas are applied
- How quotas are applied to users with multiple IDs

#### How quotas work with special Windows groups

There are several special Windows groups that process quotas differently than other Windows groups. You should understand how quotas are applied for these special groups.

ONTAP does not support group quotas based on Windows group IDs. If you specify a Windows group ID as the quota target, the quota is considered to be a user quota.

**Everyone**

When the quota target is the Everyone group, a file with an ACL showing the owner is Everyone is counted under the SID for Everyone.

**BUILTIN\Administrators**

When the quota target is the BUILTIN\Administrators group, the entry is considered to be a user quota and is used for tracking only. You cannot impose restrictions on BUILTIN\Administrators. If a member of BUILTIN\Administrators creates a file, the file is owned by BUILTIN\Administrators and is counted under the SID for BUILTIN\Administrators (not the user's personal SID).

#### How quotas are applied to users with multiple IDs

A user can be represented by multiple IDs. You can define a single user quota for such a user by specifying a list of IDs as the quota target. A file owned by any of these IDs is subject to the restriction of the user quota.

Suppose a user has the UNIX UID `20` and the Windows IDs `corp\john_smith` and `engineering\jsmith`. For this user, you can specify a quota where the quota target is a list of the UID and Windows IDs. When this user writes to the storage system, the specified quota applies, regardless of whether the write originates from UID `20`, `corp\john_smith`, or `engineering\jsmith`.

Note that separate quota rules are considered separate targets, even if the IDs belong to the same user. For example, for the same user you can specify one quota that limits UID `20` to 1GB of disk space and another quota that limits corp\john_smith to 2GB of disk space, even though both IDs represent the same user. ONTAP applies quotas to UID `20` and `corp\john_smith` separately. In this case, no limits are applied to `engineering\jsmith`, even though limits are applied to the other IDs used by the same user.

**Related information**

- How quotas are applied
- How quotas are applied to the root user

#### How ONTAP determines user IDs in a mixed environment

If you have users accessing your ONTAP storage from both Windows and UNIX clients, both Windows and UNIX security are used to determine file ownership. Several factors determine whether ONTAP uses a UNIX or Windows ID when applying user quotas.

If the security style of the qtree or FlexVol volume that contains the file is only NTFS or only UNIX, then the security style determines the type of ID used when applying user quotas. For qtrees with the mixed security style, the type of ID used is determined by whether the file has an ACL.

The following table summarizes what type of ID is used.

| Security Style | ACL | No ACL |
|---|---|---|
| UNIX | UNIX ID | UNIX ID |
| Mixed | Windows ID | UNIX ID |
| NTFS | Windows ID | Windows ID |

#### How quotas work with multiple users

When you place multiple users in the same quota target, the limits defined by the quota are not applied to each individual user. Rather, the quota limits are shared among all users in the quota target.

Unlike with commands for managing objects, such as volumes and qtrees, you cannot rename a quota target, including a multi-user quota. This means that after a multi-user quota is defined, you cannot modify the users in the quota target, and you cannot add users to a target or remove users from a target. If you want to add or remove a user from a multi-user quota, then the quota containing that user must be deleted and a new quota rule with the set of users in the target defined.

If you combine separate user quotas into one multi-user quota, you can activate the change by resizing quotas. However, if you want to remove users from a quota target with multiple users, or add users to a target that already has multiple users, you must reinitialize quotas before the change takes effect.

#### Example of more than one user in a quota rule

In the following example, there are two users listed in the quota entry. The two users can use up to 80MB of space combined. If one uses 75MB, then the other one can use only 5MB.

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol1
-policy-name default -type user -target "jsmith,chen" -qtree "" -disk
-limit 80m

cluster1::> volume quota policy rule show -vserver vs0 -volume vol1

Vserver: vs0               Policy: default           Volume: vol1
                                                    Soft             Soft
                              User         Disk     Disk   Files    Files
Type   Target         Qtree   Mapping     Limit    Limit   Limit    Limit
Threshold
-----  --------       ------- -------  --------  -------  ------  -------
---------
user   "jsmith,chen"  ""      off          80MB        -       -        -
-
```

#### UNIX and Windows name linking for quotas

In a mixed environment, users can log in as either Windows users or UNIX users. You can configure quotas to recognize that a user's UNIX id and Windows ID represent the same user.

Quotas for Windows user name are mapped to a UNIX user name, or vice versa, when both of the following conditions are met:

- The `user-mapping` parameter is set to "on" in the quota rule for the user.
- The user names have been mapped with the `vserver name-mapping` commands.

When a UNIX and Windows name are mapped together, they are treated as the same person for determining quota usage.

### How tree quotas work

#### Overview of how tree quotas work

You can create a quota with a qtree as its target to limit how large the target qtree can become. These quotas are also called *tree quotas*.

> You can also create user and group quotas for a specific qtree. In addition, quotas for a FlexVol volume are sometimes inherited by the qtrees contained by that volume.

When you apply a quota to a qtree, the result is similar to a disk partition, except that you can change the qtree's maximum size at any time by changing the quota. When applying a tree quota, ONTAP limits the disk space and number of files in the qtree, regardless of their owners. No users, including root and members of the BUILTIN\Administrators group, can write to the qtree if the write operation causes the tree quota to be exceeded.

The size of the quota does not guarantee any specific amount of available space. The size of the quota can be

larger than the amount of free space available to the qtree. You can use the `volume quota report` command to determine the true amount of available space in the qtree.

Learn more about `volume quota report` in the ONTAP command reference.

#### How user and group quotas work with qtrees

Tree quotas limit the overall size of the qtree. To prevent individual users or groups from consuming the entire qtree, you specify a user or group quota for that qtree.

**Example user quota in a qtree**

Suppose you have the following quota rules:

```
cluster1::> volume quota policy rule show -vserver vs0 -volume vol1

Vserver: vs0               Policy: default           Volume: vol1
                                                Soft             Soft
                          User          Disk     Disk    Files    Files
Type    Target    Qtree   Mapping      Limit    Limit    Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
user    ""        ""      off           50MB        -       -        -
45MB
user    jsmith    ""      off           80MB        -       -        -
75MB
```

You notice that a certain user, kjones, is taking up too much space in a critical qtree, proj1, which resides in vol1. You can restrict this user's space by adding the following quota rule:

```
cluster1::> volume quota policy rule create -vserver vs0 -volume vol1
-policy-name default -type user -target "kjones" -qtree "proj1" -disk
-limit 20m -threshold 15m

cluster1::> volume quota policy rule show -vserver vs0 -volume vol1

Vserver: vs0               Policy: default           Volume: vol1
                                                Soft             Soft
                         User          Disk     Disk   Files    Files
Type   Target    Qtree   Mapping      Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
user   ""        ""      off           50MB        -       -        -
45MB
user   jsmith    ""      off           80MB        -       -        -
75MB
user   kjones    proj1   off           20MB        -       -        -
15MB
```

#### How default tree quotas on a FlexVol volume create derived tree quotas

When you create a default tree quota on a FlexVol volume, corresponding derived tree quotas are automatically created for every qtree in that volume.

These derived tree quotas have the same limits as the default tree quota. If no additional quotas exist, the limits have the following effects:

- Users can use as much space in a qtree as they are allotted for the entire volume (provided they did not exceed the limit for the volume by using space in the root or another qtree).
- Each of the qtrees can grow to consume the entire volume.

The existence of a default tree quota on a volume continues to affect all new qtrees that are added to the volume. Each time a new qtree is created, a derived tree quota is also created.

Like all derived quotas, derived tree quotas display the following behaviors:

- Are created only if the target does not already have an explicit quota.
- Appear in quota reports but do not appear when you show quota rules with the `volume quota policy rule show` command. Learn more about `volume quota policy rule show` in the ONTAP command reference.

#### Example of derived tree quotas

You have a volume with three qtrees (proj1, proj2, and proj3) and the only tree quota is an explicit quota on the proj1 qtree limiting its disk size to 10 GB. If you create a default tree quota on the volume and reinitialize quotas on the volume, the quota report now contains four tree quotas:

```
                                    ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1     proj1     tree    1           0B   10GB       1       -   proj1
vol1               tree    *           0B   20GB       0       -   *
vol1     proj2     tree    2           0B   20GB       1       -   proj2
vol1     proj3     tree    3           0B   20GB       1       -   proj3
...
```

The first line shows the original explicit quota on the proj1 qtree. This quota remains unchanged.

The second line shows the new default tree quota on the volume. The asterisk (*) Quota Specifier indicates it is a default quota. This quota is a result of the quota rule that you created.

The last two lines show new derived tree quotas for the proj2 and proj3 qtrees. ONTAP automatically created these quotas as a result of the default tree quota on the volume. These derived tree quotas have the same 20-GB disk limit as the default tree quota on the volume. ONTAP did not create a derived tree quota for the proj1 qtree because the proj1 qtree already had an explicit quota.

#### How default user quotas on a FlexVol volume affect quotas for the qtrees in that volume

If a default user quota is defined for a FlexVol volume, a default user quota is automatically created for every qtree contained by that volume for which an explicit or derived tree quota exists.

If a default user quota on the qtree already exists, it remains unaffected when the default user quota on the volume is created.

The automatically created default user quotas on the qtrees have the same limits as the default user quota you create for the volume.

An explicit user quota for a qtree overrides (replaces the limits applied by) the automatically created default user quota, the same way as it overrides a default user quota on that qtree that was created by an administrator.

### How qtree changes affect quotas

When you delete, rename, or change the security style of a qtree, the quotas applied by ONTAP might change, depending on the current quotas being applied.

#### Qtree deletions and tree quotas

When you delete a qtree, all quotas applicable to that qtree, whether they are explicit or derived, are no longer applied by ONTAP.

Whether the quota rules persist depends on where you delete the qtree:

- If you delete a qtree using ONTAP, the quota rules for that qtree are automatically deleted, including tree

quota rules and any user and group quota rules configured for that qtree.

- If you delete a qtree using your CIFS or NFS client, you must delete any quota rules for that qtree to avoid getting errors when you reinitialize quotas. If you create a new qtree with the same name as the one you deleted, the existing quota rules are not applied to the new qtree until you reinitialize quotas.

#### How renaming a qtree affects quotas

When you rename a qtree using ONTAP, the quota rules for that qtree are automatically updated. If you rename a qtree using your CIFS or NFS client, you must update any quota rules for that qtree.

If you rename a qtree using your CIFS or NFS client and do not update quota rules for that qtree with the new name before you reinitialize quotas, quotas will not be applied to the qtree. Explicit quotas for the qtree, including tree quotas and user or group quotas for the qtree, might be converted into derived quotas.

#### Qtree security styles and user quotas

You can apply Access Control Lists (ACLs) on qtrees by using NTFS or mixed security styles, but not by using the UNIX security style. Changing the security style of a qtree might affect how quotas are calculated. You should always reinitialize quotas after you change the security style of a qtree.

If you change the security style of a qtree from NTFS or mixed to UNIX, any ACLs on files in that qtree are ignored and the file usage is charged against the UNIX user IDs.

If you change the security style of a qtree from UNIX to either mixed or NTFS, the previously hidden ACLs become visible. In addition, any ACLs that were ignored become effective again, and the NFS user information is ignored. If no ACL existed before, the NFS information continues to be used in the quota calculation.

To make sure that quota usages for both UNIX and Windows users are properly calculated after you change the security style of a qtree, you must reinitialize quotas for the volume containing that qtree.

#### Example

The following example shows how a change in the security style of a qtree results in a different user being charged for the usage of a file in the particular qtree.

Suppose NTFS security is in effect on qtree A, and an ACL gives Windows user `corp\joe` ownership of a 5MB file. User `corp\joe` is charged with 5MB of disk space usage for qtree A.

Now you change the security style of qtree A from NTFS to UNIX. After quotas are reinitialized, Windows user `corp\joe` is no longer charged for this file; instead, the UNIX user corresponding to the UID of the file is charged for the file. The UID could be a UNIX user mapped to `corp\joe` or the root user.

### How quotas are activated

#### Overview of how quotas are activated

New quotas and changes to existing quotas must be activated to take effective. The activation is performed at the volume level. Knowing how quota activation works can help you manage your quotas with less disruption.

Quotas are activated either by *initializing* (turning them on) or by *resizing*. Turning off quotas and turning them

on again is called reinitializing.

The length of the activation process and its impact on quota enforcement depends on the type of activation:

- The initialization process involves two parts: a `quota on` job and a quota scan of the volume's entire file system. The scan begins after the `quota on` job completes successfully. The quota scan can take some time; the more files that the volume has, the longer it takes. Until the scan is finished, quota activation is not complete and quotas are not enforced.
- The resize process involves only a `quota resize` job. Resizing takes less time than a quota initialization because it does not involve a quota scan. During a resize process, quotas continue to be enforced.

By default, the `quota on` and `quota resize` jobs run in the background, which permits you to use other commands at the same time.

Errors and warnings from the activation process are sent to the event management system. If you use the `-foreground` parameter with the `volume quota on` or `volume quota resize` commands, the command does not return until the job is complete; this is useful if you are reinitializing from a script. To display errors and warnings later, you can use the `volume quota show` command with the `-instance` parameter.

Quota activation persists across halts and reboots. The process of quota activation does not affect the availability of the storage system data.

**Related information**

- volume quota on
- volume quota resize
- volume quota show

#### Understand when to use resizing

Quota resizing is a useful ONTAP feature. And because resizing is faster than quota initialization, you should use resizing whenever possible. However there are a few restrictions you need to be aware of.

Resizing only works for certain types of quota changes. You can resize quotas when making the following types of changes to the quota rules:

- Changing an existing quota.

  For example, changing the limits of an existing quota.

- Adding a quota for a quota target for which a default quota or a default tracking quota exists.
- Deleting a quota for which a default quota or default tracking quota entry is specified.
- Combining separate user quotas into one multi-user quota.

> After you have made extensive quotas changes, you should perform a full reinitialization to ensure that all of the changes take effect.

If you attempt to resize and not all of your quota changes can be incorporated by using a resize operation, ONTAP issues a warning. You can determine from the quota report whether your storage system is tracking disk usage for a particular user, group, or qtree. If you see a quota in the quota report, it means that the storage system is tracking the disk space and the number of files owned by the quota target.

**Example quotas changes that can be made effective by resizing**

Some quota rule changes can be made effective by resizing. Consider the following quotas:

```
#Quota Target type             disk  files thold sdisk sfile
#------------ ----             ----  ----- ----- ----- -----
*             user@/vol/vol2    50M   15K
*             group@/vol/vol2  750M   85K
*             tree@/vol/vol2     -     -
jdoe          user@/vol/vol2/  100M   75K
kbuck         user@/vol/vol2/  100M   75K
```

Suppose you make the following changes:

- Increase the number of files for the default user target.
- Add a new user quota for a new user, boris, that needs more disk limit than the default user quota.
- Delete the kbuck user's explicit quota entry; the new user now needs only the default quota limits.

These changes result in the following quotas:

```
#Quota Target type             disk  files thold sdisk sfile
#------------ ----             ----  ----- ----- ----- -----
*             user@/vol/vol2    50M   25K
*             group@/vol/vol2  750M   85K
*             tree@/vol/vol2     -     -
jdoe          user@/vol/vol2/  100M   75K
boris         user@/vol/vol2/  100M   75K
```

Resizing activates all of these changes; a full quota reinitialization is not necessary.

#### When a full quota reinitialization is required

## Although resizing quotas is faster, you must do a full quota reinitialization if you make certain small or extensive changes to your quotas.

A full quota reinitialization is necessary in the following circumstances:

- You create a quota for a target that has not previously had a quota (neither an explicit quota nor one derived from a default quota).
- You change the security style of a qtree from UNIX to either mixed or NTFS.
- You change the security style of a qtree from mixed or NTFS to UNIX.

- You remove users from a quota target with multiple users, or add users to a target that already has multiple users.
- You make extensive changes to your quotas.

**Example of quotas changes that require initialization**

Suppose you have a volume that contains three qtrees and the only quotas in the volume are three explicit tree quotas. You decide to make the following changes:

- Add a new qtree and create a new tree quota for it.
- Add a default user quota for the volume.

Both of these changes require a full quota initialization. Resizing does not make the quotas effective.

## How you can view quota information

### Overview of viewing quota information

You can use quota reports to view details such as the configuration of quota rules and policies, enforced and configured quotas, and errors that have occurred during quota resizing and reinitialization.

Viewing quota information is useful in situations such as the following:

- Configuring quotas, for example to configure quotas and verify the configurations
- Responding to notifications that disk space or file limits will soon be reached or that they have been reached
- Responding to requests for more space

### See what quotas are in effect using the quota report

Because of the various ways that quotas interact, more quotas are in effect than just the ones you have explicitly created. To see what quotas are in effect, you can view the quota report.

The following examples show quota reports for different types of quotas applied on a FlexVol volume vol1, and a qtree q1 contained in that volume:

**Example with no user quotas specified for the qtree**

In this example, there is one qtree, q1, which is contained by the volume vol1. The administrator has created three quotas:

- A default tree quota limit on vol1 of 400MB
- A default user quota limit on vol1 of 100MB
- An explicit user quota limit on vol1 of 200MB for the user jsmith

The quota rules for these quotas look similar to the following example:

```
cluster1::*> volume quota policy rule show -vserver vs1 -volume vol1

Vserver: vs1               Policy: default           Volume: vol1
                                                Soft             Soft
                          User         Disk     Disk   Files    Files
Type   Target    Qtree   Mapping     Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
tree   ""        ""      -           400MB        -       -        -
-
user   ""        ""      off         100MB        -       -        -
-
user   jsmith    ""      off         200MB        -       -        -
-
```

The quota report for these quotas looks similar to the following example:

```
cluster1::> volume quota report
Vserver: vs1
                                    ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1     -          tree   *           0B  400MB       0       -   *
vol1     -          user   *           0B  100MB       0       -   *
vol1     -          user   jsmith    150B  200MB       7       -   jsmith
vol1     q1         tree   1           0B  400MB       6       -   q1
vol1     q1         user   *           0B  100MB       0       -
vol1     q1         user   jsmith      0B  100MB       5       -
vol1     -          user   root        0B    0MB       1       -
vol1     q1         user   root        0B    0MB       8       -
```

The first three lines of the quota report display the three quotas specified by the administrator. Since two of these quotas are default quotas, ONTAP automatically creates derived quotas.

The fourth line displays the tree quota that is derived from the default tree quota for every qtree in vol1 (in this example, only q1).

The fifth line displays the default user quota that is created for the qtree as a result of the existence of the default user quota on the volume and the qtree quota.

The sixth line displays the derived user quota that is created for jsmith on the qtree because there is a default user quota for the qtree (line 5) and the user jsmith owns files on that qtree. Note that the limit applied to the user jsmith in the qtree q1 is not determined by the explicit user quota limit (200MB). This is because the

explicit user quota limit is on the volume, so it does not affect limits for the qtree. Instead, the derived user quota limit for the qtree is determined by the default user quota for the qtree (100MB).

The last two lines display more user quotas that are derived from the default user quotas on the volume and on the qtree. A derived user quota was created for the root user on both the volume and the qtree because the root user owned files on both the volume and the qtree. Since the root user gets special treatment in terms of quotas, its derived quotas are tracking quotas only.

**Example with user quotas specified for the qtree**

This example is similar to the previous one, except that the administrator has added two quotas on the qtree.

There is still one volume, vol1, and one qtree, q1. The administrator has created the following quotas:

- A default tree quota limit on vol1 of 400MB
- A default user quota limit on vol1 of 100MB
- An explicit user quota limit on vol1 for the user jsmith of 200MB
- A default user quota limit on qtree q1 of 50MB
- An explicit user quota limit on qtree q1 for the user jsmith of 75MB

The quota rules for these quotas look like this:

```
cluster1::> volume quota policy rule show -vserver vs1 -volume vol1

Vserver: vs1               Policy: default           Volume: vol1
                                                Soft             Soft
                         User          Disk     Disk   Files    Files
Type   Target    Qtree   Mapping      Limit    Limit   Limit    Limit
Threshold
-----  --------  ------- -------  --------  -------  ------  -------
---------
tree   ""        ""      -           400MB        -       -        -
-
user   ""        ""      off         100MB        -       -        -
-
user   ""        q1      off          50MB        -       -        -
-
user   jsmith    ""      off         200MB        -       -        -
-
user   jsmith    q1      off          75MB        -       -        -
-
```

The quota report for these quotas looks like this:

```
cluster1::> volume quota report
Vserver: vs1
                                     ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1     -          tree   *           0B  400MB       0       -   *
vol1     -          user   *           0B  100MB       0       -   *
vol1     -          user   jsmith   2000B  200MB       7       -   jsmith
vol1     q1         user   *           0B   50MB       0       -   *
vol1     q1         user   jsmith      0B   75MB       5       -   jsmith
vol1     q1         tree   1           0B  400MB       6       -   q1
vol1     -          user   root        0B    0MB       2       -
vol1     q1         user   root        0B    0MB       1       -
```

The first five lines of the quota report display the five quotas created by the administrator. Since some of these quotas are default quotas, ONTAP automatically creates derived quotas.

The sixth line displays the tree quota that is derived from the default tree quota for every qtree in vol1 (in this example, only q1).

The last two lines display the user quotas that are derived from the default user quotas on the volume and on the qtree. A derived user quota was created for the root user on both the volume and the qtree because the root user owned files on both the volume and the qtree. Since the root user gets special treatment in terms of quotas, its derived quotas are tracking quotas only.

No other default quotas or derived quotas were created for the following reasons:

- A derived user quota was not created for the jsmith user even though the user owns files on both the volume and the qtree because the user already has explicit quotas at both levels.
- No derived user quotas were created for other users because no other users own files on either the volume or the qtree.
- The default user quota on the volume did not create a default user quota on the qtree because the qtree already had a default user quota.

#### Why enforced quotas differ from configured quotas

Enforced quotas differ from configured quotas because derived quotas are enforced without being configured but configured quotas are enforced only after they are successfully initialized. Understanding these differences can help you compare the enforced quotas that are shown in quota reports to the quotas that you configured.

Enforced quotas, which appear in quota reports, might differ from the configured quota rules for the following reasons:

- Derived quotas are enforced without being configured as quota rules. ONTAP creates derived quotas automatically in response to default quotas.

- Quotas might not have been reinitialized on a volume after quota rules were configured.
- Errors might have occurred when quotas were initialized on a volume.

#### Use the quota report to determine which quotas limit writes to a specific file

You can use the volume quota report command with a specific file path to determine which quota limits affect write operations to a file. This can help you understand which quota is preventing a write operation.

**Steps**

1. Use the volume quota report command with the -path parameter.

**Example of showing quotas affecting a specific file**

The following example shows the command and output to determine what quotas are in effect for writes to the file file1, which resides in the qtree q1 in the FlexVol volume vol2:

```
cluster1:> volume quota report -vserver vs0 -volume vol2 -path
/vol/vol2/q1/file1
Virtual Server: vs0
                                    ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol2     q1        tree    jsmith     1MB  100MB       2   10000   q1
vol2     q1        group   eng        1MB  700MB       2   70000
vol2               group   eng        1MB  700MB       6   70000   *
vol2               user    corp\jsmith
                                      1MB   50MB       1       -   *
vol2     q1        user    corp\jsmith
                                      1MB   50MB       1       -
5 entries were displayed.
```

#### Commands for displaying information about quotas in ONTAP

You can use commands to display a quota report containing enforced quotas and resource usage, display information about quota state and errors, or about quota policies and quota rules.

You can run the following commands only on FlexVol volumes.

| If you want to… | Use this command… |
|---|---|
| View information about enforced quotas | `volume quota report` |

| If you want to… | Use this command… |
| --- | --- |
| View resource usage (disk space and number of files) of quota targets | `volume quota report` |
| Determine which quota limits are affected when a write to a file is allowed | `volume quota report` with the `-path` parameter |
| Display the quota state, such as `on`, `off`, and `initializing` | `volume quota show` |
| View information about quota message logging | `volume quota show` with the `-logmsg` parameter |
| View errors that occur during quota initialization and resizing | `volume quota show` with the `-instance` parameter |
| View information about quota policies | `volume quota policy show` |
| View information about quota rules | `volume quota policy rule show` |
| View the name of the quota policy that is assigned to a storage virtual machine (SVM, formerly known as Vserver) | `vserver show` with the `-instance` parameter |

Learn more about `volume quota` in the ONTAP command reference.

#### When to use the volume quota policy rule show and volume quota report commands

Although both commands show information about quotas, the `volume quota policy rule show` quickly displays configured quota rules while the `volume quota report` command, which consumes more time and resources, displays enforced quotas and resource usage.

The `volume quota policy rule show` command is useful for the following purposes:

- Check the configuration of quota rules before activating them

  This command displays all configured quota rules regardless of whether the quotas have been initialized or resized.

- Quickly view quota rules without affecting system resources

  Because it does not display disk and file usage, this command is not as resource intensive as a quota report.

- Display the quota rules in a quota policy that is not assigned to the SVM.

Learn more about `volume quota policy rule show` in the ONTAP command reference.

The `volume quota report` command is useful for the following purposes:

- View enforced quotas, including derived quotas
- View the disk space and number of files used by every quota in effect, including targets affected by derived quotas

  (For default quotas, the usage appears as "0" because the usage is tracked against the resulting derived quota.)

- Determine which quota limits affect when a write to a file will be allowed

  Add the `-path` parameter to the `volume quota report` command.

> The quota report is resource-intensive operation. If you run it on many FlexVol volumes in the cluster, it might take a long time to complete. A more efficient way would be to view the quota report for a particular volume in an SVM.

Learn more about `volume quota report` in the ONTAP command reference.

### Difference in space usage displayed by a quota report and a UNIX client

#### Overview of the difference in space usage displayed by a quota report and a UNIX client

The value of used disk space displayed in a quota report for a FlexVol volume or qtree can be different from the value displayed by a UNIX client for the same volume or qtree. The difference in these values is because of the different methods followed by the quota report and the UNIX commands for calculating the data blocks in the volume or qtree.

For example, if a volume contains a file that has empty data blocks (to which data is not written), the quota report for the volume does not count the empty data blocks while reporting the space usage. However, when the volume is mounted on a UNIX client and the file is shown as the output of the `ls` command, the empty data blocks are also included in the space usage. Therefore, the `ls` command displays a higher file size when compared to the space usage displayed by the quota report.

Similarly, the space usage values shown in a quota report can also differ from the values shown as a result of UNIX commands such as `df` and `du`.

### How a quota report accounts for disk space and file usage

The number of files used and the amount of disk space specified in a quota report for a FlexVol volume or a qtree depend on the count of the used data blocks corresponding to every inode in the volume or the qtree.

The block count includes both direct and indirect blocks used for regular and stream files. The blocks used for directories, Access Control Lists (ACLs), stream directories, and metafiles do not get accounted for in the quota report. In case of UNIX sparse files, empty data blocks are not included in the quota report.

The quota subsystem is designed to consider and include only user controllable aspects of the filesystem. Directories, ACLs, and snapshot space are all examples of space excluded from quota calculations. Quotas are used to enforce limits, not guarantees, and they only operate on the active filesystem. Quota accounting does not count certain filesystem constructs, nor does it account for storage efficiency (such as compression or deduplication).

Learn more about the commands described in this procedure in the ONTAP command reference.

#### Disparity between ls command and quota report for space usage

When you use the `ls` command to view the contents of a FlexVol volume mounted on a UNIX client, the file sizes displayed in the output could differ from the space usage displayed in the quota report for the volume depending on the type of data blocks for the file.

The output of the `ls` command displays only the size of a file and does not include indirect blocks used by the file. Any empty blocks of the file also get included in the output of the command.

Therefore, if a file does not have empty blocks, the size displayed by the `ls` command might be less than the disk usage specified by a quota report because of the inclusion of indirect blocks in the quota report. Conversely, if the file has empty blocks, then the size displayed by the `ls` command might be more than the disk usage specified by the quota report.

The output of the `ls` command displays only the size of a file and does not include indirect blocks used by the file. Any empty blocks of the file also get included in the output of the command.

**Example of the difference between space usage accounted by the ls command and a quota report**

The following quota report shows a limit of 10 MB for a qtree q1:

```
                                    ----Disk----  ----Files-----   Quota
  Volume   Tree       Type    ID        Used  Limit    Used   Limit
Specifier
  -------  --------  ------  -------  -----  -----  ------  ------
---------
  vol1     q1          tree    user1   10MB  10MB        1       -   q1

...
```

A file present in the same qtree can have a size exceeding the quota limit when viewed from a UNIX client by using the `ls` command, as shown in the following example:

```
[user1@lin-sys1 q1]$ ls -lh
-rwxr-xr-x  1 user1 nfsuser  **27M** Apr 09  2013 file1
```

Learn more about `ls` in the ONTAP command reference.

#### How the df command accounts for file size

The way in which in the `df` command reports the space usage depends on two conditions: whether the quotas are enabled or disabled for the volume that contains the qtree, and if quota usage within the qtree is tracked.

When quotas are enabled for the volume that contains the qtree and quota usage within the qtree is tracked,

the space usage reported by the `df` command equals the value specified by the quota report. In this situation, quota usage excludes blocks used by directories, ACLs, stream directories, and metafiles.

When quotas are not enabled on the volume, or when the qtree does not have a quota rule configured, the reported space usage includes blocks used by directories, ACLs, stream directories, and metafiles for the entire volume, including other qtrees within the volume. In this situation, the space usage reported by the `df` command is greater than the expected value reported when quotas are tracked.

When you run the `df` command from the mount point of a qtree for which quota usage is tracked, the command output shows the same space usage as the value specified by the quota report. In most cases, when the tree quota rule has a hard disk-limit, the total size reported by the `df` command equals the disk limit and the space available equals the difference between the quota disk limit and quota usage.

However, in some cases, the space available reported by the `df` command might equal the space available in the volume as a whole. This can occur when there is no hard disk limit configured for the qtree. Beginning with ONTAP 9.9.1, it can also occur when the space available in the volume as a whole is less than the remaining tree quota space. When either of these conditions occur, the total size reported by the `df` command is a synthesized number equal to the quota used within the qtree plus the space available in the FlexVol volume.

This total size is neither the qtree disk limit nor the volume configured size. It can also vary based on your write activity within other qtrees or on your background storage efficiency activity.

**Example of space usage accounted by the `df` command and a quota report**

The following quota report shows a disk limit of 1 GB for qtree alice, 2 GB for qtree bob, and no limit for qtree project1:

```
C1_vsim1::> quota report -vserver vs0
Vserver: vs0
                                    ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol2     alice     tree    1
                                  502.0MB    1GB       2       -   alice
vol2     bob       tree    2
                                   1003MB    2GB       2       -   bob
vol2     project1  tree    3
                                  200.8MB      -       2       -
project1
vol2               tree    *          0B      -       0       -   *
4 entries were displayed.
```

In the following example, the output of the `df` command on qtrees alice and bob reports the same used space as the quota report, and the same total size (in terms of 1M blocks) as the disk limit. This is because the quota rules for qtrees alice and bob have a defined disk limit and the volume available space (1211 MB) is greater than the tree quota space remaining for qtree alice (523 MB) and qtree bob (1045 MB).

```
linux-client1 [~]$ df -m /mnt/vol2/alice
Filesystem          1M-blocks  Used Available Use% Mounted on
172.21.76.153:/vol2      1024   502       523  50% /mnt/vol2

linux-client1 [~]$ df -m /mnt/vol2/bob
Filesystem          1M-blocks  Used Available Use% Mounted on
172.21.76.153:/vol2      2048  1004      1045  50% /mnt/vol2
```

In the following example, the output of the `df` command on qtree project1 reports the same used space as the quota report, but the total size is synthesized by adding the available space in the volume as a whole (1211 MB) to the quota usage of qtree project1 (201 MB) to give a total of 1412 MB. This is because the quota rule for qtree project1 has no disk limit.

```
linux-client1 [~]$ df -m /mnt/vol2/project1
Filesystem          1M-blocks  Used Available Use% Mounted on
172.21.76.153:/vol2      1412   201      1211  15% /mnt/vol2
```

The following example shows how the output of the `df` command on the volume as a whole reports the same available space as project1.

```
linux-client1 [~]$ df -m /mnt/vol2
Filesystem          1M-blocks  Used Available Use% Mounted on
172.21.76.153:/vol2      2919  1709      1211  59% /mnt/vol2
```

Learn more about the commands described in this procedure in the ONTAP command reference.

#### Disparity between du command and quota report for space usage

## When you run the `du` command to check the disk space usage for a qtree or FlexVol volume mounted on a UNIX client, the usage value might be higher than the value displayed by a quota report for the qtree or volume.

The output of the `du` command contains the combined space usage of all the files through the directory tree beginning at the level of the directory where the command is issued. Because the usage value displayed by the `du` command also includes the data blocks for directories, it is higher than the value displayed by a quota report.

#### Example of the difference between space usage accounted by the du command and a quota report

The following quota report shows a limit of 10MB for a qtree q1:

```
                                        ----Disk----  ----Files-----   Quota
  Volume   Tree      Type    ID         Used  Limit    Used   Limit
Specifier
  -------  --------  ------  -------  -----  -----  ------  ------
---------
  vol1     q1        tree    user1    10MB   10MB   1       -        q1

...
```

In the following example, the disk space usage as the output of the `du` command shows a higher value that exceeds the quota limit:

```
[user1@lin-sys1 q1]$ du -sh
**11M**     q1
```

Learn more about the commands described in this procedure in the ONTAP command reference.

#### Examples of quota configuration

## These examples help you understand how to configure quotas and read quota reports.

#### About these examples

For the following examples, assume that you have a storage system that includes an SVM, `vs1`, with one volume, `vol1`.

1. To start setting up quotas, you create a new quota policy for the SVM:

   ```
   cluster1::>volume quota policy create -vserver vs1 -policy-name
   quota_policy_vs1_1
   ```

2. Because the quota policy is new, you assign it to the SVM:

   ```
   cluster1::>vserver modify -vserver vs1 -quota-policy quota_policy_vs1_1
   ```

#### Example 1: Default user quota

1. You decide to impose a hard limit of 50MB for each user in `vol1`:

   ```
   cluster1::>volume quota policy rule create -vserver vs1 -policy-name
   quota_policy_vs1_1 -volume vol1 -type user -target "" -disk-limit 50MB
   -qtree ""
   ```

2. To activate the new rule, you initialize quotas on the volume:

```
cluster1::>volume quota on -vserver vs1 -volume vol1 -foreground
```

3. You view the quota report:

```
cluster1::>volume quota report
```

The resulting quota report is similar to the following report:

```
Vserver: vs1
                                     ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1               user    *           0B   50MB       0       -   *
vol1               user    jsmith     49MB   50MB      37       -   *
vol1               user    root        0B      -       1       -
```

The first line shows the default user quota that you created, including the disk limit. Like all default quotas, this default user quota does not display information about disk or file usage. In addition to the quota that was created, two other quotas appear. There is one quota for each user that currently owns files on `vol1`. These additional quotas are user quotas that were derived automatically from the default user quota. The derived user quota for the user `jsmith` has the same 50MB disk limit as the default user quota. The derived user quota for the root user is a tracking quota (without limits).

If any user on the system (other than the root user) tries to perform an action that would use more than 50MB in `vol1` (for example, writing to a file from an editor), the action fails.

**Example 2: Explicit user quota overriding a default user quota**

1. If you need to provide more space in volume `vol1` to the user `jsmith`, then you enter the following command:

```
cluster1::>volume quota policy rule create -vserver vs1 -policy-name
quota_policy_vs1_1 -volume vol1 -type user -target jsmith -disk-limit
80MB -qtree ""
```

   This is an explicit user quota, because the user is explicitly listed as the target of the quota rule.

   This is a change to an existing quota limit, because it changes the disk limit of the derived user quota for the user `jsmith` on the volume. Therefore, you do not need to reinitialize quotas on the volume to activate the change.

2. To resize quotas:

```
cluster1::>volume quota resize -vserver vs1 -volume vol1 -foreground
```

Quotas remain in effect while you resize, and the resizing process is short.

The resulting quota report is similar to the following report:

```
cluster1::> volume quota report
Vserver: vs1
                                     ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1               user    *           0B   50MB       0       -   *
vol1               user    jsmith     50MB   80MB      37       -   jsmith
vol1               user    root        0B      -       1       -
3 entries were displayed.
```

The second line now shows a disk limit of `80MB` and a quota specifier of `jsmith`.

Therefore, `jsmith` can use up to 80MB of space on `vol1` even though all other users are still limited to 50MB.

**Example 3: Thresholds**

Suppose you want to receive a notification when users reach within 5MB of their disk limits.

1. To create a threshold of 45MB for all users, and a threshold of 75MB for `jsmith`, you change the existing quota rules:

   ```
   cluster1::>volume quota policy rule modify -vserver vs1 -policy
   quota_policy_vs1_1 -volume vol1 -type user -target "" -qtree ""
   -threshold 45MB
   cluster1::>volume quota policy rule modify -vserver vs1 -policy
   quota_policy_vs1_1 -volume vol1 -type user -target jsmith -qtree ""
   -threshold 75MB
   ```

   Because the sizes of the existing rules are changed, you resize quotas on the volume in order to activate the changes. You wait until the resize process is finished.

2. To see the quota report with thresholds, you add the `-thresholds` parameter to the `volume quota report` command:

```
cluster1::>volume quota report -thresholds
Vserver: vs1
                                     ----Disk----  ----Files-----
Volume   Tree      Type    ID        Used  Limit   Used    Limit  Quota
                                          (Thold)
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1               user    *           0B   50MB       0       -  *
                                         (45MB)
vol1               user    jsmith     59MB   80MB      55       -  jsmith
                                         (75MB)
vol1               user    root        0B      -       1       -
                                         ( -)
3 entries were displayed.
```

The thresholds appear in parentheses in the Disk Limit column.

Learn more about `volume quota report` in the ONTAP command reference.

**Example 4: Quotas on qtrees**

Suppose you need to partition some space for two projects. You can create two qtrees, named `proj1` and `proj2`, to accommodate those projects within `vol1`.

Currently, users can use as much space in a qtree as they are allotted for the entire volume (provided they did not exceed the limit for the volume by using space in the root or another qtree). In addition, each of the qtrees can grow to consume the entire volume.

1. If you want to ensure that neither qtree grows beyond 20GB, you can create default tree quota on the volume:

```
cluster1:>>volume quota policy rule create -vserver vs1 -policy-name
quota_policy_vs1_1 -volume vol1 -type tree -target "" -disk-limit 20GB
```

> The correct type is *tree*, not qtree.

2. Because this is a new quota, you cannot activate it by resizing. You reinitialize quotas on the volume:

```
cluster1:>>volume quota off -vserver vs1 -volume vol1
cluster1:>>volume quota on -vserver vs1 -volume vol1 -foreground
```

You must ensure that you wait for about five minutes before reactivating the quotas on each affected volume, as attempting to activate them almost immediately after running the `volume quota off` command might result in errors. Alternatively, you can run the commands to re-initialize the quotas for a volume from the node that contains the particular volume. Learn more about `volume quota off` in the ONTAP command reference.

Quotas are not enforced during the reinitialization process, which takes longer than the resizing process.

When you display a quota report, it has several new lines. Some lines are for tree quotas and some lines are for derived user quotas.

The following new lines are for the tree quotas:

```
                                     ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
...
vol1              tree    *           0B   20GB       0       -   *
vol1     proj1    tree    1           0B   20GB       1       -   proj1
vol1     proj2    tree    2           0B   20GB       1       -   proj2
...
```

The default tree quota that you created appears in the first new line, which has an asterisk (*) in the ID column. In response to the default tree quota on a volume, ONTAP automatically creates derived tree quotas for each qtree in the volume. These are shown in the lines where `proj1` and `proj2` appear in the `Tree` column.

The following new lines are for derived user quotas:

```
                                     ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
...
vol1     proj1     user    *           0B   50MB       0       -
vol1     proj1     user    root        0B      -       1       -
vol1     proj2     user    *           0B   50MB       0       -
vol1     proj2     user    root        0B      -       1       -
...
```

Default user quotas on a volume are automatically inherited for all qtrees contained by that volume, if quotas are enabled for qtrees. When you added the first qtree quota, you enabled quotas on qtrees. Therefore, derived default user quotas were created for each qtree. These are shown in the lines where ID is asterisk (*).

Because the root user is the owner of a file, when default user quotas were created for each of the qtrees,

special tracking quotas were also created for the root user on each of the qtrees. These are shown in the lines where ID is root.

**Example 5: User quota on a qtree**

1. You decide to limit users to less space in the `proj1` qtree than they get in the volume as a whole. You want to keep them from using any more than 10MB in the `proj1` qtree. Therefore, you create a default user quota for the qtree:

   ```
   cluster1::>volume quota policy rule create -vserver vs1 -policy-name
   quota_policy_vs1_1 -volume vol1 -type user -target "" -disk-limit 10MB
   -qtree proj1
   ```

   This is a change to an existing quota, because it changes the default user quota for the proj1 qtree that was derived from the default user quota on the volume. Therefore, you activate the change by resizing quotas. When the resize process is complete, you can view the quota report.

   The following new line appears in the quota report showing the new explicit user quota for the qtree:

   ```
                                      ----Disk----  ----Files-----   Quota
   Volume   Tree      Type    ID        Used  Limit    Used   Limit
   Specifier
   -------  --------  ------  -------  -----  -----  ------  ------
   ---------
   vol1     proj1     user    *           0B   10MB       0       -   *
   ```

   However, the user `jsmith` is being prevented from writing more data to the proj1 qtree because the quota you created to override the default user quota (to provide more space) was on the volume. As you have added a default user quota on the `proj1` qtree, that quota is being applied and limiting all the users' space in that qtree, including `jsmith`.

2. To provide more space to the user `jsmith`, you add an explicit user quota rule for the qtree with an 80MB disk limit to override the default user quota rule for the qtree:

   ```
   cluster1::>volume quota policy rule create -vserver vs1 -policy-name
   quota_policy_vs1_1 -volume vol1 -type user -target jsmith -disk-limit
   80MB -qtree proj1
   ```

   Because this is an explicit quota for which a default quota already existed, you activate the change by resizing quotas. When the resize process is complete, you display a quota report.

The following new line appears in the quota report:

```
                                    ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1     proj1     user    jsmith    61MB   80MB      57       -   jsmith
```

The final quota report is similar to the following report:

```
cluster1::>volume quota report
Vserver: vs1
                                    ----Disk----  ----Files-----   Quota
Volume   Tree      Type    ID        Used  Limit    Used   Limit
Specifier
-------  --------  ------  -------  -----  -----  ------  ------
---------
vol1               tree    *           0B   20GB       0       -   *
vol1               user    *           0B   50MB       0       -   *
vol1               user    jsmith    70MB   80MB      65       -   jsmith
vol1     proj1     tree    1           0B   20GB       1       -   proj1
vol1     proj1     user    *           0B   10MB       0       -   *
vol1     proj1     user    root        0B      -       1       -
vol1     proj2     tree    2           0B   20GB       1       -   proj2
vol1     proj2     user    *           0B   50MB       0       -
vol1     proj2     user    root        0B      -       1       -
vol1               user    root        0B      -       3       -
vol1     proj1     user    jsmith    61MB   80MB      57       -   jsmith
11 entries were displayed.
```

The user `jsmith` is required to meet the following quota limits to write to a file in `proj1`:

1. The tree quota for the `proj1` qtree.
2. The user quota on the `proj1` qtree.
3. The user quota on the volume.

## Set up quotas on an SVM

You can set up quotas on a new SVM to management and monitor resource utilization.

**About this task**

At a high level, there several steps involved when configuring quotas including:

1. Create a quota policy
2. Add the quota rules to the policy

3. Assign the policy to the SVM
4. Initialize the quotas on each FlexVol volume on the SVM

**Steps**

1. Enter the command `vserver show -instance` to display the name of the default quota policy that was automatically created when the SVM was created.

   If a name was not specified when the SVM was created, the name is "default". You can use the `vserver quota policy rename` command to give the default policy a name.

   > You can also create a new policy by using the `volume quota policy create` command.

2. Use the `volume quota policy rule create` command to create *any* of the following quota rules for each volume on the SVM:
   - Default quota rules for all users
   - Explicit quota rules for specific users
   - Default quota rules for all groups
   - Explicit quota rules for specific groups
   - Default quota rules for all qtrees
   - Explicit quota rules for specific qtrees
3. Use the `volume quota policy rule show` command to check that the quota rules are configured correctly.
4. If you are working on a new policy, use the `vserver modify` command to assign the new policy to the SVM.
5. Use the `volume quota on` command to initialize the quotas on each volume on the SVM.

   You can monitor the initialization process in the following ways:

   - When you use the `volume quota on` command, you can add the `-foreground` parameter to run the quota on job in the foreground. (By default, the job runs in the background.)

     When the job runs in the background, you can monitor its progress by using the `job show` command.

   - You can use the `volume quota show` command to monitor the status of the quota initialization.
6. Use the `volume quota show -instance` command to check for initialization errors, such as quota rules that failed to initialize.
7. Use the `volume quota report` command to display a quota report so that you can ensure the enforced quotas match your expectations.

**Related information**

- vserver show
- vserver modify
- job show
- volume quota

## Modify or resize quota limits

You can change or resize the quotas on all affected volumes, which is faster than reinitializing quotas on those volumes.

### About this task

You have a storage virtual machine (SVM, formerly known as Vserver) with enforced quotas and you want either to change the size limits of existing quotas or to add or delete quotas for targets that already have derived quotas.

### Steps

1. Use the `vserver show` command with the `-instance` parameter to determine the name of the policy that is currently assigned to the SVM.
2. Modify quota rules by performing any of the following actions:
   - Use the `volume quota policy rule modify` command to modify the disk or file limits of existing quota rules.
   - Use the `volume quota policy rule create` command to create explicit quota rules for targets (users, groups, or qtrees) that currently have derived quotas.
   - Use the `volume quota policy rule delete` command to delete explicit quota rules for targets (users, groups, or qtrees) that also have default quotas.
3. Use the `volume quota policy rule show` command to check that the quota rules are configured correctly.
4. Use the `volume quota resize` command on each volume where you changed quotas, to activate the changes on each volume.

   You can monitor the resize process in either of the following ways:

   - When you use the `volume quota resize` command, you can add the `-foreground` parameter to run the resize job in the foreground. (By default, the job runs in the background.)

     When the job runs in the background, you can monitor its progress by using the `job show` command.

   - You can use the `volume quota show` command to monitor the resize status.
5. Use the `volume quota show -instance` command to check for resize errors such as, quota rules that failed to get resized.

   In particular, check for “new definition” errors, which occur when you resize quotas after adding an explicit quota for a target that does not already have a derived quota.

6. Use the `volume quota report` command to display a quota report so that you can ensure the enforced quotas match your requirements.

### Related information

- volume quota policy rule
- volume quota
- job show

## Reinitialize quotas after making extensive changes

After you make extensive changes to existing quota definitions, you must re-initialize the quotas on all affected volumes. An example of this type of change is adding or deleting quotas for targets that have no enforced quotas.

### About this task

You have a storage virtual machine (SVM) with enforced quotas and you want to make changes that require a full reinitialization of quotas.

### Steps

1. Use the `vserver show` command with the `-instance` parameter to determine the name of the policy that is currently assigned to the SVM.
2. Modify quota rules by performing any of the following actions:

| If you want to… | Then… |
|---|---|
| Create new quota rules | Use the `volume quota policy rule create` command |
| Modify the settings of existing quota rules | Use the `volume quota policy rule modify` command |
| Delete existing quota rules | Use the `volume quota policy rule delete` command |

3. Use the `volume quota policy rule show` command to check that the quota rules are configured correctly.
4. Re-initialize quotas on each volume where you changed quotas by turning quotas off and then turning quotas on for those volumes.
   a. Use the `volume quota off` command on each affected volume to deactivate quotas on that volume.
   b. Use the `volume quota on` command on each affected volume to activate quotas on that volume.

> ⓘ You must ensure that you wait for about five minutes before reactivating the quotas on each affected volume, as attempting to activate them almost immediately after running the `volume quota off` command might result in errors.
>
> Alternatively, you can run the commands to re-initialize the quotas for a volume from the node that contains the particular volume.

You can monitor the initialization process in either of the following ways:

- When you use the `volume quota on` command, you can add the `-foreground` parameter to run the quota on job in the foreground. (By default, the job runs in the background.)

  When the job runs in the background, you can monitor its progress by using the `job show` command.

- You can use the `volume quota show` command to monitor the status of the quota initialization.

5. Use the `volume quota show -instance` command to check for initialization errors, such as quota rules that failed to initialize.
6. Use the `volume quota report` command to display a quota report so that you can ensure the enforced quotas match your expectations.

**Related information**

- vserver show
- volume quota policy rule
- volume quota
- job show

## Commands to manage quota rules and quota policies

The `volume quota policy rule` commands enable you to configure quota rules, and the `volume quota policy` commands and some `vserver` commands enable you to configure quota policies. Depending on what you need to do, use the following commands to manage quota rules and quota policies:

You can run the following commands only on FlexVol volumes.

**Commands for managing quota rules**

| If you want to… | Use this command… |
|---|---|
| Create a new quota rule | `volume quota policy rule create` |
| Delete an existing quota rule | `volume quota policy rule delete` |
| Modify an existing quota rule | `volume quota policy rule modify` |
| Display information about configured quota rules | `volume quota policy rule show` |

**Commands for managing quota policies**

| If you want to… | Use this command… |
|---|---|
| Duplicate a quota policy and the quota rules it contains | `volume quota policy copy` |
| Create a new, blank quota policy | `volume quota policy create` |
| Delete an existing quota policy that is not currently assigned to a storage virtual machine (SVM) | `volume quota policy delete` |

| If you want to… | Use this command… |
| --- | --- |
| Rename a quota policy | `volume quota policy rename` |
| Display information about quota policies | `volume quota policy show` |
| Assign a quota policy to an SVM | `vserver modify -quota-policy` *`policy_name`* |
| Display the name of the quota policy assigned to an SVM | `vserver show` |

Learn more about the commands described in this procedure in the ONTAP command reference.

**Related information**

- volume quota policy
- vserver modify -quota-policy policy_name
- vserver show

## Commands to activate and modify quotas in ONTAP

`volume quota` commands enable you to change the state of quotas and configure message logging of quotas. Depending on what you need to do, you can use the following commands to activate and modify quotas:

| If you want to… | Use this command… |
| --- | --- |
| Turn quotas on (also called *initializing* them) | `volume quota on` |
| Resize existing quotas | `volume quota resize` |
| Turn quotas off | `volume quota off` |
| Change the message logging of quotas, turn quotas on, turn quotas off, or resize existing quotas | `volume quota modify` |

Learn more about the commands described in this procedure in the ONTAP command reference.

**Related information**

- volume quota on
- volume quota resize
- volume quota off
- volume quota modify

# Use deduplication, data compression, and data compaction to increase storage efficiency

## Deduplication, data compression, data compaction, and storage efficiency

You can run deduplication, data compression, and data compaction together or independently to achieve optimal space savings on a FlexVol volume. Deduplication eliminates duplicate data blocks. Data compression compresses the data blocks to reduce the amount of physical storage that is required. Data compaction stores more data in less space to increase storage efficiency.

All inline storage efficiency features, such as inline deduplication and inline compression, are enabled by default on AFF volumes.

## Enable deduplication on a volume

You can enable deduplication on a FlexVol volume to achieve storage efficiency. You can enable postprocess deduplication on all volumes and inline deduplication on volumes that reside on AFF or Flash Pool aggregates.

If you want to enable inline deduplication on other types of volumes, see the NetApp Knowledge Base: How to enable volume inline deduplication on Non-AFF (All Flash FAS) aggregates.

### Before you begin

For a FlexVol volume, you must have verified that enough free space exists for deduplication metadata in volumes and aggregates. The deduplication metadata requires a minimum amount of free space in the aggregate. This amount is equal to 3% of the total amount of physical data for all deduplicated FlexVol volumes or data constituents within the aggregate. Each FlexVol volume or data constituent should have 4% of the total amount of physical data's worth of free space, for a total of 7%.

Inline deduplication is enabled by default on AFF systems.

### Choices

- Use the `volume efficiency on` command to enable postprocess deduplication. Learn more about `volume efficiency on` in the ONTAP command reference.

  The following command enables postprocess deduplication on volume VolA:

  ```
  volume efficiency on -vserver vs1 -volume VolA
  ```

- Use the `volume efficiency on` command followed by the `volume efficiency modify` command with the `-inline-deduplication` option set to `true` to enable both postprocess deduplication and inline deduplication. Learn more about `volume efficiency modify` in the ONTAP command reference.

  The following commands enable both postprocess deduplication and inline deduplication on volume VolA:

  ```
  volume efficiency on -vserver vs1 -volume VolA
  ```

```
volume efficiency modify -vserver vs1 -volume VolA -inline-dedupe true
```

- Use the `volume efficiency on` command followed by the `volume efficiency modify` command with the `-inline-deduplication` option set to `true` and the `-policy` option set to `inline-only` to enable only inline deduplication.

  The following commands enable only inline deduplication on volume VolA:

  ```
  volume efficiency on -vserver vs1 -volume VolA

  volume efficiency modify -vserver vs1 -volume VolA -policy inline-only -inline
  -dedupe true
  ```

#### After you finish

Verify that the setting has changed by viewing the volume efficiency settings:
`volume efficiency show -instance`

Learn more about `volume efficiency show -instance` in the ONTAP command reference.

## Disable deduplication on a volume

You can disable postprocess deduplication and inline deduplication independently on a volume.

#### Before you begin

Stop any volume efficiency operation that is currently active on the volume: `volume efficiency stop`

Learn more about `volume efficiency stop` in the ONTAP command reference.

#### About this task

If you have enabled data compression on the volume, running the `volume efficiency off` command disables data compression. Learn more about `volume efficiency off` in the ONTAP command reference.

#### Choices

- Use the `volume efficiency off` command to disable both postprocess deduplication and inline deduplication.

  The following command disable both postprocess deduplication and inline deduplication on volume VolA:

  ```
  volume efficiency off -vserver vs1 -volume VolA
  ```

- Use the `volume efficiency modify` command with the `-policy` option set to `inline only` to disable postprocess deduplication, but inline deduplication remains enabled.

  The following command disables postprocess deduplication, but inline deduplication remains enabled on volume VolA:

  ```
  volume efficiency modify -vserver vs1 -volume VolA -policy inline-only
  ```

- Use the `volume efficiency modify` command with the `-inline-deduplication` option set to `false` to disable inline deduplication only.

The following command disables only inline deduplication on volume VolA:

```
volume efficiency modify -vserver vs1 -volume VolA -inline-deduplication false
```

Learn more about `volume efficiency modify` in the ONTAP command reference.

## Automatic volume-level background deduplication on AFF systems

Beginning with ONTAP 9.3, you can configure volume-level background deduplication to run automatically using a predefined `auto` AFF policy. No manual configuration of the schedules is required. The `auto` policy performs continuous deduplication in the background.

The `auto` policy is set for all newly created volumes and for all upgraded volumes that have not been manually configured for background deduplication. You can change the policy to `default` or any other policy to disable the feature.

If a volume moves from a non-AFF system to an AFF system, the `auto` policy is enabled on the destination node by default. If a volume moves from an AFF node to a non-AFF node, the `auto` policy on the destination node is replaced by the `inline-only` policy by default.

On AFF, the system monitors all the volumes having the `auto` policy and deprioritizes the volume that has less savings or has frequent overwrites. The deprioritized volumes no longer participate in automatic background deduplication. Change logging on deprioritized volumes is disabled and metadata on the volume is truncated.

Users can promote the deprioritized volume to re-participate in an automatic background deduplication using the `volume efficiency promote` command available at the advanced privilege level.

Learn more about `volume efficiency promote` in the ONTAP command reference.

## Manage aggregate-level inline deduplication on AFF systems

Aggregate-level deduplication eliminates duplicate blocks across volumes belonging to the same aggregate. You can perform aggregate-level deduplication inline on AFF systems. The feature is enabled by default for all newly created volumes and all upgraded volumes with volume inline deduplication turned on.

### About this task

The deduplication operation eliminates duplicate blocks before data is written to disk. Only volumes with the `space guarantee` set to `none` can participate in aggregate-level inline deduplication. This is the default setting on AFF systems.

> Aggregate-level inline deduplication is sometimes referred to as cross-volume inline deduplication.

### Step

1. Manage aggregate-level inline deduplication on AFF systems:

| If you want to… | Use this command |
| --- | --- |
| Enable aggregate-level inline deduplication | `volume efficiency modify -vserver vserver_name -volume vol_name -cross -volume-inline-dedupe true` |
| Disable aggregate-level inline deduplication | `volume efficiency modify -vserver vserver_name -volume vol_name -cross -volume-inline-dedupe false` |
| Display aggregate-level inline deduplication status | `volume efficiency config -volume vol_name` |

#### Examples

The following command displays the aggregate-level inline deduplication status:

```
wfit-8020-03-04::> volume efficiency config -volume choke0_wfit_8020_03_0
Vserver:                                    vs0
Volume:                                     choke0_wfit_8020_03_0
Schedule:                                   -
Policy:                                     choke_VE_policy
Compression:                                true
Inline Compression:                         true
Inline Dedupe:                              true
Data Compaction:                            true
Cross Volume Inline Deduplication:          false
```

## Manage aggregate-level background deduplication on AFF systems

Aggregate-level deduplication eliminates duplicate blocks across volumes belonging to the same aggregate. Beginning with ONTAP 9.3, you can perform aggregate-level deduplication in the background on AFF systems. The feature is enabled by default for all newly created volumes and all upgraded volumes with volume background deduplication turned on.

#### About this task

The operation is triggered automatically when a large enough percentage of the change log has been populated. No schedule or policy is associated with the operation.

Beginning with ONTAP 9.4, AFF users can also run the aggregate-level deduplication scanner to eliminate duplicates of existing data across volumes in the aggregate. You can use the `storage aggregate efficiency cross-volume-dedupe start` command with the `-scan-old-data=true` option to start the scanner:

```
cluster-1::> storage aggregate efficiency cross-volume-dedupe start
-aggregate aggr1 -scan-old-data true
```

Deduplication scanning can be time consuming. You might want to run the operation in off-peak hours.

Aggregate-level background deduplication is sometimes referred to as cross-volume background deduplication.

Learn more about `storage aggregate efficiency cross-volume-dedupe start` in the ONTAP command reference.

**Steps**

1. Manage aggregate-level background deduplication on AFF systems:

| If you want to… | Use this command |
|---|---|
| Enable aggregate-level background deduplication | `volume efficiency modify -vserver <vserver_name\> -volume <vol_name\> -cross-volume-background-dedupe true` |
| Disable aggregate-level background deduplication | `volume efficiency modify -vserver <vserver_name\> -volume <vol_name\> -cross-volume-background-dedupe false` |
| Display aggregate-level background deduplication status | `aggregate efficiency cross-volume-dedupe show` |

Learn more about the commands described in this procedure in the ONTAP command reference.

**Related information**

- volume efficiency modify
- aggregate efficiency cross-volume-dedupe show

## Learn about ONTAP temperature-sensitive storage efficiency

ONTAP provides temperature-sensitive storage efficiency (TSSE) benefits by assessing how often your volume's data is accessed and mapping that frequency to the degree of compression applied to that data. For cold data that is accessed infrequently, larger data blocks are compressed, and for hot data, which is accessed frequently and is overwritten more often, smaller data blocks are compressed, making the process more efficient.

TSSE is introduced in ONTAP 9.8 and is enabled automatically on newly created thinly provisioned AFF volumes. You can enable temperature-sensitive storage efficiency on existing thinly provisioned AFF volumes and on thinly provisioned non-AFF DP volumes. TSSE is not supported on thickly provisioned volumes.

Temperature-sensitive storage efficiency is not applied on the following platforms:

Unresolved directive in volumes/enable-temperature-sensitive-efficiency-concept.adoc - include::_include/dedicated-offload-processor-supported-platforms.adoc[]

These platforms use CPU or dedicated offload processor storage efficiency. Compression is performed using either the main CPU or a dedicated offload processor is not based on hot or cold data.

> Over time, the amount of space used in your volume might be more pronounced with TSSE compared to 8K adaptive compression. This behavior is expected due to the architectural differences between TSSE and 8K adaptive compression.

**Introduction of "default" and "efficient" modes**

Beginning with ONTAP 9.10.1, *default* and *efficient* volume-level storage efficiency modes are introduced for AFF systems only. The two modes provide a choice between file compression (default), which is the default mode when creating new AFF volumes, or temperature-sensitive storage efficiency (efficient), which uses auto adaptive compression to provide increased compression savings on cold, infrequently accessed, data.

When upgrading to ONTAP 9.10.1 and later, existing volumes are assigned a storage efficiency mode based on the type of compression currently enabled on the volumes. During an upgrade, volumes with compression enabled are assigned the default mode, and volumes with temperature-sensitive storage efficiency enabled are assigned the efficient mode. If compression is not enabled, storage efficiency mode remains blank.

With ONTAP 9.10.1, temperature-sensitive storage efficiency must be explicitly set to enable auto adaptive compression. However, other storage efficiency features like data-compaction, auto dedupe schedule, inline deduplication, cross volume inline deduplication, and cross volume background deduplication are enabled by default on AFF platforms for both default and efficient modes.

Both storage efficiency modes (default and efficient) are supported on FabricPool-enabled aggregates and with all tiering policy types.

**Temperature-sensitive storage efficiency enabled on C-Series platforms**

Temperature-sensitive storage efficiency is enabled by default on AFF C-Series platforms and when migrating thinly provisioned volumes from a non-TSSE platform to a TSSE-enabled C-Series platform using volume move or SnapMirror with the following releases installed on the destination:

- ONTAP 9.12.1P4 and later
- ONTAP 9.13.1 and later

For more information, see Storage efficiency behavior with volume move and SnapMirror operations.

For existing thinly provisioned volumes, temperature-sensitive storage efficiency is not enabled automatically; however, you can modify the storage efficiency mode manually to change to efficient mode.

> Once you change the storage efficiency mode to efficient you cannot change it back.

**Improved storage efficiency with sequential packing of contiguous physical blocks**

Beginning with ONTAP 9.13.1, temperature-sensitive storage efficiency adds sequential packing of contiguous physical blocks to further improve storage efficiency. Volumes that have temperature-sensitive storage efficiency enabled automatically have sequential packing enabled when you upgrade systems to ONTAP 9.13.1. After sequential packing is enabled, you must manually repack existing data.

## Storage efficiency behavior with volume move and SnapMirror operations

The behavior of storage efficiency can be affected by other storage operations that are active or started at the same time. You should be aware of the impact of these operations on storage efficiency.

There are several situations where storage efficiency on a volume can be affected by other operations including volume moves, SnapMirror relationships, FabricPool volumes, and temperature-sensitive storage efficiency (TSSE).

### FabricPool

The `all` tiering policy is commonly used on data protection volumes to immediately mark data as cold and tier it as soon as possible. There is no waiting for a minimum number of days to pass before the data is made cold and tiered.

Because the `all` tiering policy tiers data as soon as possible, storage efficiencies that rely on background processes, like 32K efficient adaptive compression (TSSE), do not have enough time to be applied. Inline storage efficiencies like 8K compression are applied as normal.

The following table describes the behavior of a source volume and destination volume when you perform one of these operations.

| **Source volume efficiency** | **Destination volume default behavior** | | | **Default behavior after manually enabling TSSE (after SnapMirror break)** | | |
|---|---|---|---|---|---|---|
| | **Storage efficiency type** | **New writes** | **Cold data compression** | **Storage efficiency type** | **New writes** | **Cold data compression** |
| No storage efficiency (likely FAS) | File compression | File compression is attempted inline on newly written data | No cold data compression, data remains as it is | TSSE with cold data scan algorithm as ZSTD | 8k inline compression is attempted in TSSE format | **File compressed data**: N/A<br><br>**Uncompressed data**: 32K compression attempted after threshold days met<br><br>**Newly written data**: 32K compression attempted after threshold days met |

| | | | | | | |
|---|---|---|---|---|---|---|
| No storage efficiency (likely FAS) | File compression on C-Series platforms using ONTAP 9.11.1P10 or ONTAP 9.12.1P3 | No TSSE-enabled cold data compression | **File compressed data**: N/A | TSSE with cold data scan algorithm as ZSTD | 8K inline compression | **File compressed data**: N/A<br><br>**Uncompressed data**: 32K compression attempted after threshold days met<br><br>**Newly written data**: 32K compression attempted after threshold days met |
| No storage efficiency (likely FAS) | TSSE on C-Series platforms using ONTAP 9.12.1P4 and later or ONTAP 9.13.1 and later | 8K inline compression is attempted in TSSE format | **File compressed data**: N/A<br><br>**Uncompressed data**: 32K compression attempted after threshold days met<br><br>**Newly written data**: 32K compression attempted after threshold days met | TSSE with cold data scan algorithm as ZSTD | 8K inline compression is attempted in TSSE format | **File compressed data**: N/A<br><br>**Uncompressed data**: 32K compression attempted after threshold days met<br><br>**Newly written data**: 32K compression attempted after threshold days met |
| File compression group | Same as source | File compression is attempted inline on newly written data | No cold data compression, data remains as it is | TSSE with cold data scan algorithm as ZSTD | 8k inline compression is attempted in TSSE format | **File compressed data**: Not compressed<br><br>**Uncompressed data**: 32K compression is attempted after threshold days met<br><br>**Newly written data**: 32K compression is attempted after threshold days met |
| TSSE cold data scan | TSSE using the same compression algorithm as source volume (LZOPro→LZOPro and ZSTD→ZSTD) | 8K inline compression attempted in TSSE format | 32K compression attempted with LzoPro after threshold days based coldness is met on both existing data and newly written data. | TSSE is enabled. NOTE: LZOPro cold data scan algorithm can be changed to ZSTD. | 8K inline compression is attempted in TSSE format | 32K compression is attempted after threshold days coldness is met on both existing data and newly written data. |

## Set storage efficiency mode during volume creation

Beginning with ONTAP 9.10.1, you can set the storage efficiency mode when creating a new AFF volume.

### About this task

You can control the storage efficiency mode on a new AFF volume using the parameter `-storage -efficiency-mode`. You can choose between two options to set the storage efficiency mode: `default` or `efficient`. The storage efficiency mode you choose depends on whether you want greater performance or higher storage efficiency on the volume. The parameter `-storage-efficiency-mode` is not supported on non-AFF volumes or on data protection volumes.

Performance mode is set by default when you create new AFF volumes with storage efficiency.

Learn more about temperature-sensitive storage efficiency and storage efficiency modes.

### Steps

1. Create a new volume and set the efficiency mode:

   ```
   volume create -vserver <vserver name> -volume <volume name> -aggregate
   <aggregate name> -size <volume size> -storage-efficiency-mode
   <efficient|default>
   ```

   Set `-storage-efficiency-mode` to `efficient` for efficiency mode or to `default` for performance mode.

   In the following example, aff_vol1 is created with efficiency mode.

```
volume create -vserver vs1 -volume aff_vol1 -aggregate aff_aggr1 -storage
-efficiency-mode efficient -size 10g
```

## Change the volume inactive data compression threshold in ONTAP

You can change how frequently ONTAP performs a cold data scan by modifying the coldness threshold on volumes using temperature-sensitive storage efficiency.

### Before you begin

You must be a cluster or SVM administrator and use the ONTAP CLI advanced privilege level.

### About this task

The coldness threshold can be from 1 to 60 days. The default threshold is 14 days.

### Steps

1. Set the privilege level:

   ```
   set -privilege advanced
   ```

2. Modify inactive data compression on a volume:

```
volume efficiency inactive-data-compression modify -vserver <vserver_name>
-volume <volume_name> -threshold-days <integer>
```

Learn more about `volume efficiency inactive-data-compression modify` in the ONTAP command reference.

## Check volume efficiency mode

You can use the `volume-efficiency-show` command on an AFF volume to check whether efficiency is set and to view the current efficiency mode.

**Step**

1. Check the efficiency mode on a volume:

```
volume efficiency show -vserver <vserver name> -volume <volume name> -fields
storage-efficiency-mode
```

Learn more about `volume efficiency show` in the ONTAP command reference.

## Change volume efficiency mode

Beginning with ONTAP 9.10.1, the volume-level storage efficiency modes *default* and *efficient* are supported for AFF systems only. These modes provide a choice between file compression (default), which is the default mode when creating new AFF volumes, or temperature-sensitive storage efficiency (efficient), which enables temperature-sensitive storage efficiency (TSSE).

TSSE is supported only on thinly provisioned volumes. Learn more about TSSE.

**Steps**

You can perform this task using ONTAP System Manager or the ONTAP CLI.

**System Manager**

Beginning with ONTAP 9.10.1, you can use System Manager to enable higher storage efficiency using the temperature-sensitive storage efficiency feature. Performance-based storage efficiency is enabled by default.

1. Click **Storage > Volumes**.
2. Locate the volume on which you want to enable or disable storage efficiency, and click ⋮.
3. Click **Edit > Volumes**, and scroll to **Storage Efficiency**.
4. Select **Enable Higher Storage Efficiency**.

**CLI**

You can use the `volume efficiency modify` command to change the storage efficiency mode for an AFF volume from `default` to `efficient`, or you can set an efficiency mode when volume efficiency is not already set.

1. Change the volume efficiency mode:

```
volume efficiency modify -vserver <vserver name> -volume <volume
name> -storage-efficiency-mode <default|efficient>
```

Learn more about `volume efficiency modify` in the ONTAP command reference.

## View volume footprint savings with or without temperature-sensitive storage efficiency

Depending on your ONTAP release, you can view the physical footprint savings on each volume. You might do this to assess the effectiveness of your administrative processes or as part of capacity planning.

**About this task**

Beginning with ONTAP 9.11.1, you can use the command `volume show-footprint` to view the physical footprint savings on volumes with temperature-sensitive storage efficiency (TSSE) enabled. Beginning with ONTAP 9.13.1, you can use the same command to view the physical footprint savings on volumes not enabled with TSSE.

**Steps**

1. View the volume footprint savings:

```
volume show-footprint
```

**Example output with TSSE enabled**

```
Vserver : vs0
Volume  : vol_tsse_75_per_compress

Feature                                    Used       Used%
--------------------------------          ----------    -----
Volume Data Footprint                       10.15GB      13%
Volume Guarantee                                0B       0%
Flexible Volume Metadata                    64.25MB       0%
Delayed Frees                               235.0MB       0%
File Operation Metadata                         4KB       0%

Total Footprint                             10.45GB      13%

Footprint Data Reduction                     6.85GB       9%
     Auto Adaptive Compression               6.85GB       9%
Effective Total Footprint                    3.59GB       5%
```

**Example output without TSSE enabled**

```
Vserver : vs0
Volume  : vol_file_cg_75_per_compress

Feature                                    Used       Used%
--------------------------------          ----------    -----
Volume Data Footprint                        5.19GB       7%
Volume Guarantee                                0B       0%
Flexible Volume Metadata                    32.12MB       0%
Delayed Frees                               90.17MB       0%
File Operation Metadata                         4KB       0%

Total Footprint                              5.31GB       7%

Footprint Data Reduction                     1.05GB       1%
     Data Compaction                         1.05GB       1%
Effective Total Footprint                    4.26GB       5%
```

**Related information**

- Set storage efficiency mode during volume creation

## Enable data compression on a volume

You can enable data compression on a FlexVol volume to achieve space savings by using the `volume efficiency modify` command. You can also assign a compression

type to your volume, if you do not want the default compression type. Learn more about `volume efficiency modify` in the ONTAP command reference.

**Before you begin**

You must have enabled deduplication on the volume.

- Deduplication only needs to be enabled and does not need to be running on the volume.
- The compression scanner must be used to compress the existing data on the volumes present in AFF platforms.

## Enabling deduplication on a volume

**About this task**

- In HDD aggregates and Flash Pool aggregates, you can enable both inline and postprocess compression or only postprocess compression on a volume.

  If you are enabling both, then you must enable postprocess compression on the volume before enabling inline compression.

- In AFF platforms, only inline compression is supported.

  Before enabling inline compression, you must enable postprocess compression on the volume. However, because postprocess compression is not supported in AFF platforms, no postprocess compression takes place on those volumes and an EMS message is generated informing you that postprocess compression was skipped.

- Temperature sensitive storage efficiency is introduced in ONTAP 9.8. With this feature, storage efficiency is applied according to whether data is hot or cold. For cold data, larger data blocks are compressed, and for hot data, which is overwritten more often, smaller data blocks are compressed, making the process more efficient. Temperature sensitive storage efficiency is enabled automatically on newly created thin-provisioned AFF volumes.
- The compression type is automatically assigned based on the aggregate's platform:

| Platform/aggregates | Compression type |
|---|---|
| AFF | Adaptive compression |
| Flash Pool aggregates | Adaptive compression |
| HDD aggregates | Secondary compression |

**Choices**

- Use the `volume efficiency modify` command to enable data compression with the default compression type.

  The following command enables postprocess compression on volume VolA of SVM vs1:

  ```
  volume efficiency modify -vserver vs1 -volume VolA -compression true
  ```

  The following command enables both postprocess and inline compression on volume VolA of SVM vs1:

```
volume efficiency modify -vserver vs1 -volume VolA -compression true -inline
-compression true
```

- Use the `volume efficiency modify` command at the advanced privilege level to enable data compression with a specific compression type.
  a. Use the `set -privilege advanced` command to change the privilege level to advanced.
  b. Use the `volume efficiency modify` command to assign a compression type to a volume.

     The following command enables postprocess compression and assigns the adaptive compression type to volume VolA of SVM vs1:

     ```
     volume efficiency modify -vserver vs1 -volume VolA -compression true
     -compression-type adaptive
     ```

     The following command enables both postprocess and inline compression and assigns the adaptive compression type to volume VolA of SVM vs1:

     ```
     volume efficiency modify -vserver vs1 -volume VolA -compression true
     -compression-type adaptive -inline-compression true
     ```

  c. Use the `set -privilege admin` command to change the privilege level to admin.

## Move between secondary compression and adaptive compression

You can switch between secondary compression and adaptive compression depending on the amount of data reads. Adaptive compression is preferred when there are a high volume of random reads on the system and higher performance is required. Secondary compression is preferred when data is written sequentially and higher compression savings are required.

### About this task

The default compression type is selected based on your aggregates and platform.

### Steps

1. Disable efficiency on the volume:

   ```
   volume efficiency off
   ```

   For example, the following command disables efficiency on volume vol1:

   ```
   volume efficiency off -vserver vs1 -volume vol1
   ```

2. Change to the advanced privilege level:

   ```
   set -privilege advanced
   ```

3. Decompress the compressed data:

   ```
   volume efficiency undo
   ```

   For example, the following command decompresses the compressed data on volume vol1:

```
volume efficiency undo -vserver vs1 -volume vol1 -compression true
```

> You must verify that you have sufficient space in the volume to accommodate the decompressed data.

4. Change to the admin privilege level:

```
set -privilege admin
```

5. Verify that the status of the operation is idle:

```
volume efficiency show
```

For example, the following command displays the status of an efficiency operation on volume vol1:

```
volume efficiency show -vserver vs1 -volume vol1
```

6. Enable efficiency for the volume:

```
volume efficiency on
```
For example, the following command enables efficiency on volume vol1:

```
volume efficiency on -vserver vs1 -volume vol1
```

7. Enable data compression, and then set the type of compression:

```
volume efficiency modify
```

For example, the following command enables data compression and sets the compression type as secondary compression on volume vol1:

```
volume efficiency modify -vserver vs1 -volume vol1 -compression true
-compression-type secondary
```

> This step only enables secondary compression on the volume; the data on the volume is not compressed.
>
> - To compress existing data on AFF systems, you must run the background compression scanner.
> - To compress existing data on Flash Pool aggregates or HDD aggregates, you must run the background compression.

8. Optional: Enable inline compression:

```
volume efficiency modify
```

For example, the following command enables inline compression on volume vol1:

```
volume efficiency modify -vserver vs1 -volume vol1 -inline-compression true
```

## Disable data compression on a volume

You can disable data compression on a volume by using the `volume efficiency modify` command. Learn more about `volume efficiency modify` in the ONTAP command reference.

### About this task

If you want to disable postprocess compression, you must first disable inline compression on the volume.

### Steps

1. Stop any volume efficiency operation that is currently active on the volume:

   ```
   volume efficiency stop
   ```

2. Disable data compression:

   ```
   volume efficiency modify
   ```

   Existing compressed data will remain compressed on the volume. Only new writes coming into the volume are not compressed.

### Examples

The following command disables inline compression on volume VolA:

```
volume efficiency modify -vserver vs1 -volume VolA -inline-compression false
```

The following command disables both postprocess compression and inline compression on volume VolA:

```
volume efficiency modify -vserver vs1 -volume VolA -compression false -inline
-compression false
```

Learn more about `volume efficiency stop` in the ONTAP command reference.

## Manage inline data compaction for AFF systems

You can control inline data compaction on AFF systems at the volume level using the `volume efficiency modify` command. Data compaction is enabled by default for all volumes on AFF systems.

### Before you begin

Data compaction requires that the volume space guarantee be set to `none`. This is the default for AFF systems.

The default space guarantee on non-AFF data protection volumes is set to none.

### Steps

1. To verify the space guarantee setting for the volume:

   ```
   volume show -vserver vserver_name -volume volume_name -fields space-guarantee
   ```

2. To enable data compaction:

   ```
   volume efficiency modify -vserver vserver_name -volume volume_name -data
   -compaction true
   ```

3. To disable data compaction:

   ```
   volume efficiency modify -vserver vserver_name -volume volume_name -data
   -compaction false
   ```

4. To display data compaction status:

   ```
   volume efficiency show -instance
   ```

**Examples**

```
cluster1::> volume efficiency modify -vserver vs1 -volume vol1 -data-compaction
true cluster1::> volume efficiency modify -vserver vs1 -volume vol1 -data
-compaction false
```

## Enable inline data compaction for FAS systems

YYou can enable inline data compaction on FAS systems with Flash Pool (hybrid) aggregates or HDD aggregates at the volume level by using the `volume efficiency` cluster shell command. Data compaction is disabled by default for volumes created on FAS systems. Learn more about `volume efficiency` in the ONTAP command reference.

**About this task**

To enable inline data compaction on a volume, its `-space-guarantee` option must be set to `none`. Enabling data compaction on a volume on an HDD aggregate uses additional CPU resources.

**Steps**

1. Change to the advanced privilege level:

   ```
   set -privilege advanced
   ```

   Learn more about `set` in the ONTAP command reference.

2. Check the data compaction state of the volumes and aggregates for the desired node:

   ```
   volume efficiency show -volume <volume_name>
   ```

   Learn more about `volume efficiency show` in the ONTAP command reference.

3. Enable data compaction on volume:

```
volume efficiency modify -volume <volume_name> -data-compaction true
```

Learn more about `volume efficiency modify` in the ONTAP command reference.

> If data compaction is set to `false` for either an aggregate or a volume, then compaction fails. Enabling compaction does not compact existing data; only new writes to the system are compacted. The `volume efficiency start` command contains more information about how to compact existing data. Learn more about `volume efficiency start` in the ONTAP command reference.

4. View the compaction statistics:

```
volume efficiency show -volume <volume_name>
```

## Inline storage efficiency enabled by default on AFF systems

Storage efficiency features are enabled by default on all newly created volumes on AFF systems. All inline storage efficiency features are enabled by default on all existing and newly created volumes on all AFF systems.

Storage efficiency features include inline deduplication, inline cross-volume deduplication and inline compression, and are enabled by default on AFF systems as shown in the table.

> Data compaction behavior on AFF volumes is enabled by default.

| Volume conditions | Storage efficiency features enabled by default | | |
|---|---|---|---|
| | Inline deduplication | Inline cross-volume deduplication | Inline compression |
| Cluster upgrade | Yes | Yes | Yes |
| ONTAP 7-Mode transition to clustered ONTAP | Yes | Yes | Yes |
| Volume move | Yes | Yes | Yes |
| Thick-provisioned volumes | Yes | No | Yes |
| Encrypted volumes | Yes | No | Yes |

The following exceptions apply to one or more inline storage efficiency features:

- Only read-write volumes can support default inline storage efficiency enablement.

- Volumes with compression savings are omitted from enabling inline compression.
- Volumes that have postprocess deduplication turned on are omitted from enabling inline compression.
- On volumes where volume efficiency is turned off, the system overrides the existing volume efficiency policy settings and sets it to enable the inline-only policy.

## Storage efficiency visualization

Use the `storage aggregate show-efficiency` command to display information about the storage efficiency of all the aggregates in your system.

The `storage aggregate show-efficiency` command has three different views that can be invoked by passing command options.

Learn more about `storage aggregate show-efficiency` in the ONTAP command reference.

### Default view

The default view displays the overall ratio for each of the aggregates.

```
cluster1::> storage aggregate show-efficiency
```

### Detailed view

Invoke the detailed view with the `-details` command option. This view displays the following:

- Overall efficiency ratio for each of the aggregates.
- Overall ratio without snapshots.
- Ratio split for the following efficiency technologies: volume deduplication, volume compression, snapshots, clones, data compaction, and aggregate inline deduplication.

```
cluster1::> storage aggregate show-efficiency -details
```

### Advanced view

The advanced view is similar to the detailed view and displays both logical and physical used details.

You must run this command at the advanced privilege level. Switch to advanced privilege by using the `set -privilege advanced` command.

The command prompt changes to `cluster::*>`.

```
cluster1::> set -privilege advanced
```

Invoke the advanced view with the `-advanced` command option.

```
cluster1::*> storage aggregate show-efficiency -advanced
```

To view ratios for a single aggregate individually invoke the `-aggregate` *`aggregate_name`* command. This command can be run at the admin level, as well as the advanced privilege level.

```
cluster1::> storage aggregate show-efficiency -aggregate aggr1
```

Learn more about `set -privilege advanced` in the ONTAP command reference.

## Create a volume efficiency policy to run efficiency operations

### Create a volume efficiency policy

You can create a volume efficiency policy to run deduplication or data compression followed by deduplication on a volume for a specific duration, and specify the job schedule using the `volume efficiency policy create` command.

#### Before you begin

You must have created a cron schedule using the `job schedule cron create` command. For more information about managing the cron schedules, see the System administration reference. Learn more about `job schedule cron create` in the ONTAP command reference.

#### About this task

An SVM administrator with default predefined roles cannot manage the deduplication policies. However, the cluster administrator can modify the privileges assigned to an SVM administrator by using any customized roles. For more information about the SVM administrator capabilities, see Administrator authentication and RBAC.

> You can run deduplication or data compression operations at a scheduled time, or by creating a schedule with a specific duration, or by specifying a threshold percentage, which waits for the new data to exceed the threshold and then triggers the deduplication or data compression operation. This threshold value is the percentage of the total number of blocks used in the volume. For example, if you set the threshold value on a volume to 20% when the total number of blocks used on the volume is 50%, data deduplication or data compression triggers automatically when new data written on the volume reaches 10% (20% of 50% blocks used). If required, you can obtain the total number of blocks used from the `df` command output.

#### Steps

1. Use the `volume efficiency policy create` command to create a volume efficiency policy.

#### Examples

The following command creates a volume efficiency policy named pol1 that triggers an efficiency operation daily:

```
volume efficiency policy create -vserver vs1 -policy pol1 -schedule daily
```

The following command creates a volume efficiency policy named pol2 that triggers an efficiency operation when the threshold percentage reaches 20%:

```
volume efficiency policy create -vserver vs1 -policy pol2 -type threshold -start
-threshold-percent 20%
```

Learn more about `volume efficiency policy create` in the ONTAP command reference.

### Assign a volume efficiency policy to a volume

You can assign an efficiency policy to a volume to run deduplication or data compression

operations by using the `volume efficiency modify` command.

**Before you begin**

Ensure that you create the volume efficiency policy before you assign it to a volume.

**About this task**

If an efficiency policy is assigned to a SnapVault secondary volume, only the volume efficiency priority attribute is considered when running volume efficiency operations. The job schedules are ignored and the deduplication operation is run when incremental updates are made to the SnapVault secondary volume.

**Step**

1. Use the `volume efficiency modify` command to assign a policy to a volume.

**Example**

The following command assigns the volume efficiency policy named `new_policy` to volume `VolA`:

```
volume efficiency modify -vserver vs1 -volume VolA -policy new_policy
```

Learn more about `volume efficiency modify` in the ONTAP command reference.

### Modify a volume efficiency policy

You can modify a volume efficiency policy to run deduplication and data compression for a different duration or change the job schedule using the `volume efficiency policy modify` command. Learn more about `volume efficiency policy modify` in the ONTAP command reference.

**Steps**

1. Use the `volume efficiency policy modify` command to modify a volume efficiency policy.

**Examples**

The following command modifies the volume efficiency policy named policy1 to run every hour:

```
volume efficiency policy modify -vserver vs1 -policy policy1 -schedule hourly
```

The following command modifies a volume efficiency policy named pol2 to threshold 30%:

```
volume efficiency policy modify -vserver vs1 -policy pol1 -type threshold -start
-threshold-percent 30%
```

### View a volume efficiency policy in ONTAP

You can view the volume efficiency policy including the name, schedule, duration, and description.

**About this task**

The command `volume efficiency policy show` is used to display a volume efficiency policy. When you run the command in cluster scope, the cluster-scoped policies are not displayed. However, you can view the cluster-scoped policies in the SVM context. Learn more about `volume efficiency policy show` in the ONTAP command reference.

### Steps

1. Use the `volume efficiency policy show` command to view information about a volume efficiency policy.

   The output depends on the parameters you specify.
   Learn more about `volume efficiency policy show` in the ONTAP command reference.

### Examples

The following command displays information about the policies created for the SVM vs1:
`volume efficiency policy show -vserver vs1`

The following command displays the policies for which the duration is set as 10 hours:
`volume efficiency policy show -duration 10`

### Disassociate a volume efficiency policy from a volume

You can disassociate a volume efficiency policy from a volume to stop running any further schedule-based deduplication and data compression operations on the volume. Once you disassociate a volume efficiency policy, you have to trigger it manually.

### Step

1. Use the `volume efficiency modify` command to disassociate a volume efficiency policy from a volume.

### Example

The following command disassociates the volume efficiency policy from volume VolA: `volume efficiency modify -vserver vs1 -volume VolA -policy -`

Learn more about `volume efficiency modify` in the ONTAP command reference.

### Delete a volume efficiency policy

You can delete a volume efficiency policy by using the `volume efficiency policy delete` command.

### Before you begin

You must have ensured that the policy you want to delete is not associated with any volume.

> You cannot delete the *inline-only* and the *default* predefined efficiency policy.

### Step

1. Use the `volume efficiency policy delete` command to delete a volume efficiency policy.

### Example

The following command deletes a volume efficiency policy named policy1: `volume efficiency policy delete -vserver vs1 -policy policy1`

Learn more about `volume efficiency policy delete` in the ONTAP command reference.

# Manage volume efficiency operations manually

## Manage volume efficiency operations manually overview

You can manage how the efficiency operations run on a volume by running efficiency operations manually.

You can also control how the efficiency operations run based on the following conditions:

- Use checkpoints or not
- Run efficiency operations on existing data or only new data
- Stop efficiency operations if required

You can use the `volume efficiency show` command with `schedule` as value for the `-fields` option to view the schedule assigned to the volumes.

Learn more about `volume efficiency show` in the ONTAP command reference.

## Run an efficiency operation manually

You can run efficiency operations on a volume manually. You might do this when scheduling efficiency operations is not appropriate.

### Before you begin

Depending on the efficiency operation you want to run manually, you must have enabled deduplication or both data compression and deduplication on a volume.

### About this task

This operation is performed using the `volume efficiency start` command. When temperature-sensitive storage efficiency is enabled on a volume, deduplication is run initially followed by data compression.

Deduplication is a background process that consumes system resources while it is running. If the data does not change often in a volume, it is best to run deduplication less frequently. Multiple concurrent deduplication operations running on a storage system lead to a higher consumption of system resources.

You can run a maximum of eight concurrent deduplication or data compression operations per node. If any more efficiency operations are scheduled, the operations are queued.

Beginning with ONTAP 9.13.1, if temperature-sensitive storage efficiency is enabled on a volume, you can run volume efficiency on existing data to take advantage of sequential packing to further improve storage efficiency.

#### Run efficiency manually

### Steps

1. Start the efficiency operation on a volume: `volume efficiency start`

### Example

+
The following command allows you to manually start only deduplication or deduplication followed by logical compression and container compression on the volume VolA

+

```
volume efficiency start -vserver vs1 -volume VolA
```

#### Repack existing data

To take advantage of sequential data packing introduced in ONTAP 9.13.1 on volumes with temperature-sensitive storage efficiency enabled, you can repack existing data. You must be in advanced privilege mode to use this command.

#### Steps

1. Set the privilege level: `set -privilege advanced`
2. Repack existing data: `volume efficiency inactive-data-compression start -vserver` *`vserver_name`* `-volume` *`volume_name`* `-scan-mode extended_recompression`

#### Example

```
volume efficiency inactive-data-compression start -vserver vs1 -volume
vol1 -scan-mode extended_recompression
```

#### Related information

- Run efficiency operations manually on existing data

### Checkpoints and efficiency operations

Checkpoints are used internally to log the execution process of an efficiency operation. When an efficiency operation is stopped for any reason (such as system halt, system disruption, reboot, or because the last efficiency operation failed or stopped) and checkpoint data exists, the efficiency operation can resume from the latest checkpoint file.

A checkpoint is created:

- in each stage or substage of the operation
- when you run the `sis stop` command
- when the duration expires

Learn more about the commands described in this procedure in the ONTAP command reference.

### Resume a halted efficiency operation

If an efficiency operation is halted due to a system halt, system disruption, or reboot, you can resume the efficiency operation from the same point it was halted. This helps to save time and resources by not needing to restart the operation from the beginning.

#### About this task

If you enabled only deduplication on the volume, deduplication runs on the data. If you enabled both deduplication and data compression on a volume, then data compression runs first, followed by deduplication.

You can view the details of the checkpoint for a volume by using the `volume efficiency show` command. Learn more about `volume efficiency show` in the ONTAP command reference.

By default, the efficiency operations resume from checkpoints. However, if a checkpoint corresponding to a previous efficiency operation (the phase when the `volume efficiency start`-scan-old-data` command is run) is older than 24 hours, then the efficiency operation does not resume from the previous checkpoint automatically. In this case, the efficiency operation starts from the beginning. However, if you know that significant changes have not occurred in the volume since the last scan, you can force continuation from the previous checkpoint by using the `-use-checkpoint` option.

**Steps**

1. Use the `volume efficiency start` command with the `-use-checkpoint` option to resume an efficiency operation.

   The following command enables you to resume an efficiency operation on new data on volume VolA:

   ```
   volume efficiency start -vserver vs1 -volume VolA -use-checkpoint true
   ```

   The following command enables you to resume an efficiency operation on existing data on volume VolA:

   ```
   volume efficiency start -vserver vs1 -volume VolA -scan-old-data true -use
   -checkpoint true
   ```

   Learn more about `volume efficiency start` in the ONTAP command reference.

### Run an efficiency operation manually on existing data

You can run the efficiency operations manually on the data that exists in non-temperature sensitive storage efficiency volumes prior to enabling deduplication, data compression, or data compaction. You can run these operations with ONTAP versions earlier than ONTAP 9.8.

**About this task**

This operation is performed using the `volume efficiency start` command with the `-scan-old-data` parameter. The `-compression` option does not work with `-scan-old-data` on temperature sensitive storage efficiency volumes. Inactive data compression runs automatically on pre-existing data for temperature sensitive storage efficiency volumes in ONTAP 9.8 and later.

If you enable only deduplication on a volume, then deduplication runs on the data. If you enable deduplication, data compression, and data compaction on a volume, then data compression runs first, followed by deduplication and data compaction.

When you run data compression on existing data, by default the data compression operation skips the data blocks that are shared by deduplication and the data blocks that are locked by snapshots. If you choose to run data compression on shared blocks, then optimization is turned off and the fingerprint information is captured and used for sharing again. You can change the default behavior of data compression when compressing existing data.

You can run a maximum of eight deduplication, data compression, or data compaction operations concurrently per node. The remaining operations are queued.

Post process compression does not run on AFF platforms. An EMS message is generated to inform you that this operation was skipped.

Learn more about `volume efficiency start` in the ONTAP command reference.

**Steps**

1. Use the `volume efficiency start -scan-old-data` command to run deduplication, data compression, or data compaction manually on the existing data.

   The following command enables you to run these operations manually on the existing data in volume VolA:

   ```
   volume efficiency start -vserver vs1 -volume VolA -scan-old-data true [-
   compression | -dedupe | -compaction ] true
   ```

**Related information**

- Run efficiency operations manually

## Manage volume efficiency operations using schedules

### Run an efficiency operation based on the amount of new data written

You can modify the efficiency operation schedule to run deduplication or data compression when the number of new blocks written to the volume after the previous efficiency operation exceeds a specified threshold percentage. This applies whether the previous efficiency operation was performed manually or scheduled.

**About this task**

If the `schedule` option is set to `auto`, the scheduled efficiency operation runs when the amount of new data exceeds the specified percentage. The default threshold value is 20 percent. This threshold value is the percentage of the total number of blocks already processed by the efficiency operation.

**Steps**

1. Use the `volume efficiency modify` command with the `auto@num` option to modify the threshold percentage value.

   `num` is a two-digit number to specify the percentage.

**Example**

The following command modifies the threshold percentage value to 30 percent for the volume VolA:

```
volume efficiency modify -vserver vs1 -volume -VolA -schedule auto@30
```

**Related information**

- Run efficiency operations using scheduling
- volume efficiency modify

### Run an efficiency operation using scheduling

You can modify the scheduling of deduplication or data compression operations on a

volume. The configuration options of a schedule and volume efficiency policy are mutually exclusive.

#### About this task

This operation is performed using the `volume efficiency modify` command. Learn more about `volume efficiency modify` in the ONTAP command reference.

#### Steps

1. Use the `volume efficiency modify` command to modify the scheduling of deduplication or data compression operations on a volume.

#### Examples

The following command modifies the scheduling of efficiency operations for VolA to run at 11 p.m., Monday through Friday:

```
volume efficiency modify -vserver vs1 -volume VolA -schedule mon-fri@23
```

#### Related information

- Run efficiency operations depending on the amount of new data written

## Monitor volume efficiency operations

### View efficiency operations and status

You can view whether deduplication or data compression is enabled on a volume. You can also view the status, state, type of compression, and progress of the efficiency operations on a volume.

There are two tasks available. Both use the command `volume efficiency show`.

#### View efficiency status

#### Steps

1. View the status of an efficiency operation on a volume: `volume efficiency show`

   The following command displays the status of an efficiency operation on volume VolA that is assigned the adaptive compression type:

   ```
   volume efficiency show -instance -vserver vs1 -volume VolA
   ```

   If the efficiency operation is enabled on volume VolA and the operation is idle, then you can see the following in the system output:

```
cluster1::> volume efficiency show -vserver vs1 -volume VolA

  Vserver Name: vs1
   Volume Name: VolA
   Volume Path: /vol/VolA
         State: Enabled
        Status: Idle
      Progress: Idle for 00:03:20
```

#### Determine if volumes contain sequentially packed data

You can display a list of volumes that have sequential packing enabled, for instance, when you need to revert to an ONTAP release earlier than 9.13.1. You must be in advanced privilege mode to use this command.

**Steps**

1. Set the privilege level: `set -privilege advanced`
2. List volumes that have sequential packing enabled:

   `volume efficiency show -extended-auto-adaptive-compression true`

### View efficiency space savings

You can view the amount of space savings achieved through deduplication and data compression on a volume. You might do this to assess the effectiveness of your administrative processes or as part of capacity planning.

**About this task**

You need to use the command `volume show` to display the space savings on a volume. Note that the space savings in snapshots is not included when calculating the space savings achieved on a volume. Using deduplication does not affect volume quotas. Quotas are reported at the logical level and remain unchanged.

**Steps**

1. Use the `volume show` command to view space savings achieved on a volume using deduplication and data compression.

**Example**

The following command enables you to view the space savings achieved by using deduplication and data compression on volume VolA: `volume show -vserver vs1 -volume VolA`

```
cluster1::> volume show -vserver vs1 -volume VolA

                                  Vserver Name: vs1
                                   Volume Name: VolA

...
            Space Saved by Storage Efficiency: 115812B
       Percentage Saved by Storage Efficiency: 97%
                 Space Saved by Deduplication: 13728B
            Percentage Saved by Deduplication: 81%
                Space Shared by Deduplication: 1028B
                   Space Saved by Compression: 102084B
        Percentage Space Saved by Compression: 97%

...
```

Learn more about `volume show` in the ONTAP command reference.

#### View efficiency statistics of a FlexVol volume

You can view the details of the efficiency operations run on a FlexVol volume. You might do this to assess the effectiveness of your administrative processes or as part of capacity planning.

#### Steps

1. Use the `volume efficiency stat` command to view the statistics of efficiency operations on a FlexVol volume.

#### Example

The following command enables you to view the statistics of the efficiency operations on the volume VolA: `volume efficiency stat -vserver vs1 -volume VolA`

```
cluster1::> volume efficiency stat -vserver vs1 -volume VolA

               Vserver Name: vs1
                Volume Name: VolA
                Volume Path: /vol/VolA
Inline Compression Attempts: 0
```

Learn more about `volume efficiency stat` in the ONTAP command reference.

## Stop volume efficiency operations

You can stop a deduplication or postprocess compression operation.

**About this task**

This operation uses the command `volume efficiency stop`. This command automatically generates a checkpoint.

**Steps**

1. Use the `volume efficiency stop` command to stop an active deduplication or postprocess compression operation.

   If you specify the `-all` option, active and queued efficiency operations are aborted.

**Examples**

The following command stops the deduplication or postprocess compression operation that is currently active on volume VolA:

```
volume efficiency stop -vserver vs1 -volume VolA
```

The following command aborts both active and queued deduplication or postprocess compression operations on volume VolA:

```
volume efficiency stop -vserver vs1 -volume VolA -all true
```

Learn more about `volume efficiency stop` in the ONTAP command reference.

### Additional information about removing space savings from a volume

You can choose to remove the space savings achieved by running efficiency operations on a volume. However, you must have enough space to accommodate a reversal.

There are several related resources available to help you plan and implement the removal of the space savings.

**Related information**

- How to see space savings from deduplication, compression, and compaction in ONTAP 9
- How to undo the storage efficiency savings in ONTAP

# Rehost a volume from one SVM to another SVM

### Prepare to rehost a volume from one SVM to another SVM

A volume rehost operation enables you to reassign a NAS or SAN volume from one SVM to another SVM without requiring a SnapMirror copy. The exact rehost procedure depends upon the client access protocol used and the volume type. Volume rehost is a disruptive operation for data access and volume management.

Before you can rehost a volume from one SVM to another, the following conditions must be met:

- The volume must be online
- The volume protocol must be SAN or NAS
  - For the NAS protocol volumes, the volume should not be a part of junction-path and must be

unmounted

- If the volume is in a SnapMirror relationship, then the relationship must be deleted, followed by releasing the relationship information only, or broken prior to volume rehost
  - You can resynchronize the SnapMirror relationship after the volume rehost operation
- The vserver subtype should be same for both source and destination SVMs
  - Volumes can only be rehosted between SVMs of the same subtype
- The volume cannot be FlexClone or FlexClone Parent
  - FlexClones must be split before rehosting the parent or clone volume

## Rehost an SMB volume

You can rehost a volume that serves data using the SMB protocol. To allow clients to continue accessing the data after the rehosting operation, you must manually configure policies and the associated rules.

**About this task**

- Rehosting is a disruptive operation.
- If the rehosting operation fails, you might need to reconfigure the volume policies and the associated rules on the source volume.
- If the source SVM and destination SVM Active Directory domains differ, you might lose access to the objects on the volume.
- Beginning with ONTAP 9.8, rehosting a volume with NetApp Volume Encryption (NVE) is supported. If you are using an onboard key manager, the encrypted metadata will be modified during the rehost operation. User data is not changed.

  If you are using ONTAP 9.8 or early, you must unencrypt the volume before performing the rehost operation.

- When the source SVM has local users and groups, the permissions for the files and directories (ACLs) that are set are no longer effective after volume rehost operation.

  The same is true for audit ACLs (SACLs)

- After the rehost operation, the following volume policies, policy rules, and configurations are lost from the source volume, and must be manually reconfigured on the rehosted volume:
  - Volume and qtree export policies
  - Antivirus policies
  - Volume efficiency policy
  - Quality of service (QoS) policies
  - Snapshot policies
  - Quota rules
  - ns-switch and name services configuration export policy and rules
  - User and group IDs

**Before you begin**

- Volume must be online.
- Volume management operations, such as volume move or LUN move, must not be running.
- Data access to the volume that is being rehosted must be stopped.
- The ns-switch and name services configuration of the target SVM must be configured to support data access of the rehosting volume.
- The source SVM and destination SVM must have the same Active Directory and realmDNS domain.
- The user ID and group ID of the volume must be either available in the target SVM or changed on the hosting volume.

> If local users and groups are configured, and if there are files and directories on that volume with permissions set for those users or groups, these permissions are no longer effective.

**Steps**

1. Record information about the CIFS shares to avoid losing information on CIFS shares in case volume rehost operation fails.
2. Unmount the volume from the parent volume:

   ```
   volume unmount
   ```

3. Switch to the advanced privilege level:

   ```
   set -privilege advanced
   ```

4. Rehost the volume on the destination SVM:

   ```
   volume rehost -vserver source_svm -volume vol_name -destination-vserver
   destination_svm
   ```

5. Mount the volume under the appropriate junction path in the destination SVM:

   ```
   volume mount
   ```

6. Create CIFS shares for the rehosted volume:

   ```
   vserver cifs share create
   ```

7. If the DNS domains differ between the source SVM and destination SVM, create new users and groups.
8. Update the CIFS client with the new destination SVM LIFs and junction path to the rehosted volume.

**After you finish**

You must manually reconfigure the policies and the associated rules on the rehosted volume.

SMB configuration

SMB and NFS multiprotocol configuration

## Rehost an NFS volume

You can rehost a volume that serves data using the NFS protocol. To allow clients to

continue accessing the data after the rehosting operation, you must associate the volume with the export policy of the SVM as well as manually configure the policies and associated rules.

**About this task**

- Rehosting is a disruptive operation.
- If the rehosting operation fails, you might need to reconfigure the volume policies and the associated rules on the source volume.
- Beginning with ONTAP 9.8, rehosting a volume with NetApp Volume Encryption (NVE) is supported. If you are using an onboard key manager, the encrypted metadata will be modified during the rehost operation. User data is not changed.

  If you are using ONTAP 9.8 or early, you must unencrypt the volume before performing the rehost operation.

- After the rehost operation, the following volume policies, policy rules, and configurations are lost from the source volume, and must be manually reconfigured on the rehosted volume:
  - Volume and qtree export policies
  - Antivirus policies
  - Volume efficiency policy
  - Quality of service (QoS) policies
  - Snapshot policies
  - Quota rules
  - ns-switch and name services configuration export policy and rules
  - User and group IDs

**Before you begin**

- The volume must be online.
- Volume management operations, such as volume moves or LUN moves, must not be running.
- Data access to the volume that is being rehosted must be stopped.
- The ns-switch and name services configuration of the target SVM must be configured to support data access of the rehosting volume.
- The user ID and group ID of the volume must be either available in the target SVM or changed on the hosting volume.

**Steps**

1. Record information about the NFS export policies to avoid losing information on NFS policies in case volume rehost operation fails.
2. Unmount the volume from the parent volume:

   ```
   volume unmount
   ```

3. Switch to the advanced privilege level:

   ```
   set -privilege advanced
   ```

4. Rehost the volume on the destination SVM:

   `volume rehost -vserver source_svm -volume volume_name -destination-vserver destination_svm`

   The default export policy of the destination SVM is applied to the rehosted volume.

5. Create the export policy:

   `vserver export-policy create`

6. Update the export policy of the rehosted volume to a user-defined export policy:

   `volume modify`

7. Mount the volume under the appropriate junction path in the destination SVM:

   `volume mount`

8. Verify that the NFS service is running on the destination SVM.
9. Resume NFS access to the rehosted volume.
10. Update the NFS client credentials and LIF configurations to reflect the destination SVM LIFs.

    This is because the volume access path (LIFs and junction path) has undergone changes.

**After you finish**

You must manually reconfigure the policies and the associated rules on the rehosted volume. See NFS configuration for more information.

## Rehost a SAN volume

You can rehost a SAN volume that serves data through mapped LUNs. After re-creating the initiator group (igroup) in the destination SVM, volume rehost operation can automatically remap the volume at the same SVM.

**About this task**

- Rehosting is a disruptive operation.
- If the rehosting operation fails, you might need to reconfigure the volume policies and the associated rules on the source volume.
- Beginning with ONTAP 9.8, rehosting a volume with NetApp Volume Encryption (NVE) is supported. If you are using an onboard key manager, the encrypted metadata will be modified during the rehost operation. User data is not changed.

  If you are using ONTAP 9.8 or early, you must unencrypt the volume before performing the rehost operation.

- After the rehost operation, the following volume policies, policy rules, and configurations are lost from the source volume and must be manually reconfigured on the rehosted volume:
  - Antivirus policies

- Volume efficiency policy
- Quality of service (QoS) policies
- Snapshot policies
- ns-switch and name services configuration export policy and rules
- User and group IDs

**Before you begin**

- The volume must be online.
- Volume management operations, such as volume moves or LUN moves, must not be running.
- There must be no active I/O on the volumes or LUNs.
- You must have verified that the destination SVM does not have igroup of the same name but different initiators.

  If the igroup has the same name, then you must have renamed the igroup in either one of the SVMs (source or destination).

- You must have enabled the `force-unmap-luns` option.
  - The default value of the `force-unmap-luns` option is `false`.
  - No warning or confirmation message is displayed when you set the `force-unmap-luns` option to `true`.

**Steps**

1. Record LUN mapping information on target volume:

   `lun mapping show volume` *`volume`* `vserver` *`source_svm`*

   This is a precautionary step to avoid losing information about LUN mapping in case the volume rehost fails.

   Learn more about `lun mapping show volume` in the ONTAP command reference.

2. Delete igroups associated with the target volume.
3. Rehost the target volume to the destination SVM:

   `volume rehost -vserver` *`source_svm`* `-volume` *`volume_name`* `-destination-vserver` *`destination_svm`*

4. Map LUNs on the target volume to appropriate igroups:
   - Volume rehost preserves LUNs on the target volume, however the LUNs remain unmapped.
   - Use the destination SVM port set while mapping LUNs.
   - If the `auto-remap-luns` option is set to `true`, the LUNs are mapped automatically after rehost.

## Rehost a volume in a SnapMirror relationship

You can rehost a volume defined as part of a SnapMirror relationship. There are several issues you need to consider before rehosting the relationship.

**About this task**

- Rehosting is a disruptive operation.
- If the rehosting operation fails, you might need to reconfigure the volume policies and the associated rules on the source volume.
- After the rehost operation, the following volume policies, policy rules, and configurations are lost from the source volume and must be manually reconfigured on the rehosted volume:
  - Volume and qtree export policies
  - Antivirus policies
  - Volume efficiency policy
  - Quality of service (QoS) policies
  - Snapshot policies
  - Quota rules
  - ns-switch and name services configuration export policy and rules
  - User and group IDs

**Before you begin**

- The volume must be online.
- Volume management operations, such as volume moves or LUN moves, must not be running.
- Data access to the volume that is being rehosted must be stopped.
- The ns-switch and name services configuration of the target SVM must be configured to support data access of the rehosting volume.
- The user ID and group ID of the volume must be either available in the target SVM or changed on the hosting volume.

**Steps**

1. Record the SnapMirror relationship type:

   ```
   snapmirror show
   ```

   This is a precautionary step to avoid losing information about the SnapMirror relationship type in case the volume rehost fails.

2. From the destination cluster, delete the SnapMirror relationship:

   ```
   snapmirror delete
   ```

   Do not break the SnapMirror relationship; otherwise, the data protection capability of the destination volume is lost and the relationship cannot be reestablished after the rehosting operation.

3. From the source cluster, remove the SnapMirror relationship information:

   ```
   snapmirror release -relationship-info-only true
   ```

   Setting the `-relationship-info-only` parameter to `true` removes the source relationship information without deleting the snapshots.

4. If the volume is mounted, unmount it:

```
volume unmount -vserver <source_svm> -volume <vol_name>
```

5. Switch to the advanced privilege level:

   ```
   set -privilege advanced
   ```

6. Rehost the volume on the destination SVM:

   ```
   volume rehost -vserver <source_svm> -volume <vol_name> -destination-vserver
   <destination_svm>
   ```

7. If the SVM peering relation is not present, create the SVM peer relationship between the source SVM and destination SVM:

   ```
   vserver peer create
   ```

8. Create the SnapMirror relationship between the source volume and destination volume:

   ```
   snapmirror create
   ```

   You must run the `snapmirror create` command from the SVM that is hosting the DP volume. The rehosted volume can be the source or destination of the SnapMirror relationship.

9. Resynchronize the SnapMirror relationship.

**Related information**

- set
- snapmirror
- volume rehost
- volume unmount
- vserver peer create

## Features not supported with a volume rehost in ONTAP

There are several ONTAP features that do not support volume rehost. You should be aware of these features before attempting a rehost operation.

The following features are not supported with a volume rehost:

- SVM DR
- MetroCluster configurations

  Cloning a volume as a FlexClone volume on a different SVM is also not supported on MetroCluster configurations.

- SnapLock volumes
- NetApp Volume Encryption (NVE) volumes (in versions of ONTAP before 9.8)

  In ONTAP releases prior to 9.8, you must unencrypt the volume before rehosting it. Volume encryption keys depend on SVM keys. If a volume is moved to another SVM and if multitenant key configuration is

enabled on either the source or destination SVM, the volume and the SVM keys will not match.

Beginning with ONTAP 9.8, you can rehost a volume with NVE.

- FlexGroup volumes
- Clone volumes

# Recommended volume and file or LUN configuration combinations

## Overview of recommended volume and file or LUN configuration combinations

There are specific combinations of FlexVol volume and file or LUN configurations you can use, depending on your application and administration requirements. Understanding the benefits and costs of these combinations can help you determine the right configuration for your environment.

The following volume and LUN configuration combinations are recommended:

- Space-reserved files or LUNs with thick volume provisioning
- Non-space-reserved files or LUNs with thin volume provisioning
- Space-reserved files or LUNs with semi-thick volume provisioning

You can use SCSI thin provisioning on your LUNs in conjunction with any of these configuration combinations.

#### Space-reserved files or LUNs with thick volume provisioning

**Benefits:**

- All write operations within space-reserved files are guaranteed; they will not fail due to insufficient space.
- There are no restrictions on storage efficiency and data protection technologies on the volume.

**Costs and limitations:**

- Enough space must be set aside from the aggregate up front to support the thickly provisioned volume.
- Space equal to twice the size of the LUN is allocated from the volume at LUN creation time.

#### Non-space-reserved files or LUNs with thin volume provisioning

**Benefits:**

- There are no restrictions on storage efficiency and data protection technologies on the volume.
- Space is allocated only as it is used.

**Costs and restrictions:**

- Write operations are not guaranteed; they can fail if the volume runs out of free space.
- You must manage the free space in the aggregate effectively to prevent the aggregate from running out of free space.

**Space-reserved files or LUNs with semi-thick volume provisioning**

**Benefits:**

Less space is reserved up front than for thick volume provisioning, and a best-effort write guarantee is still provided.

**Costs and restrictions:**

- Write operations can fail with this option.

  You can mitigate this risk by properly balancing free space in the volume against data volatility.

- You cannot rely on retention of data protection objects such as snapshots and FlexClone files and LUNs.
- You cannot use ONTAP block-sharing storage efficiency capabilities that cannot be automatically deleted, including deduplication, compression, and ODX/Copy Offload.

## Determine the correct volume and LUN configuration for your needs

Answering a few basic questions about your environment can help you determine the best FlexVol volume and LUN configuration for your environment.

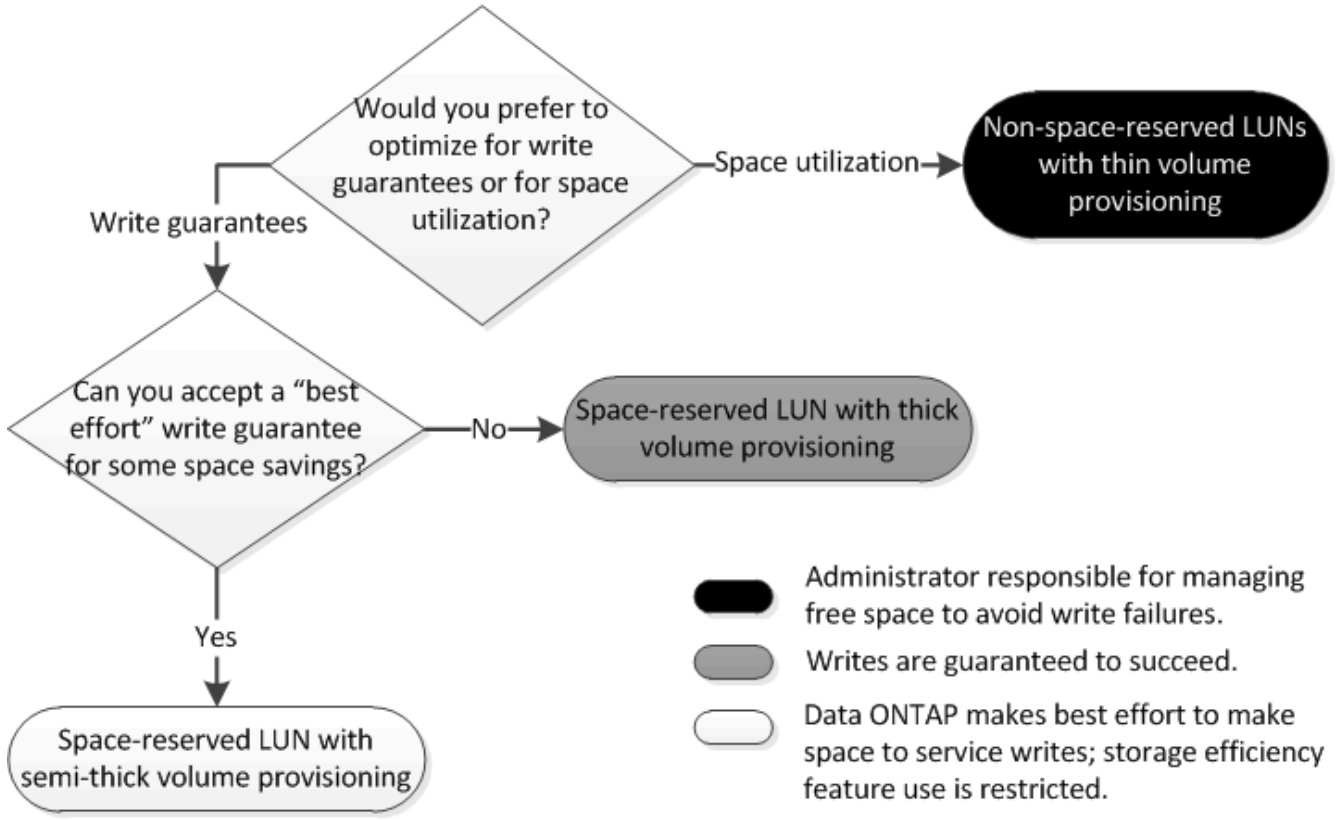
**About this task**

You can optimize your LUN and volume configurations for maximum storage utilization or for the security of write guarantees. Based on your requirements for storage utilization and your ability to monitor and replenish free space quickly, you must determine the FlexVol volume and LUN volumes appropriate for your installation.

You do not need a separate volume for each LUN.

**Step**

1. Use the following decision tree to determine the best volume and LUN configuration combination for your environment:




## Configuration settings for space-reserved files or LUNs with thick-provisioned volumes

There are several configuration combinations of FlexVol volume and file or LUN configurations you can use.
This combination based on thick-provisioned volumes provides the ability to use storage efficiency technologies and does not require you to actively monitor your free space because sufficient space is allocated up front.

The following settings are required to configure a space-reserved file or LUN in a volume using thick provisioning:

| Volume setting | Value |
|---|---|
| Guarantee | Volume |
| Fractional reserve | 100 |
| Snapshot reserve | Any |
| Snapshot autodelete | Optional |
| Autogrow | Optional; if enabled, aggregate free space must be actively monitored. |

| File or LUN setting | Value |
| --- | --- |
| Space reservation | Enabled |

**Related information**

- Recommended volume and file or LUN configuration combinations overview

## Settings for non-space-reserved files or LUNs with thin-provisioned volumes

This FlexVol volume and file or LUN configuration combination requires the smallest amount of storage to be allocated up front, but requires active free space management to prevent errors due to lack of space.

The following settings are required to configure a non-space-reserved files or LUN in a thin-provisioned volume:

| Volume setting | Value |
| --- | --- |
| Guarantee | None |
| Fractional reserve | 0 |
| Snapshot reserve | Any |
| Snapshot autodelete | Optional |
| Autogrow | Optional |

| File or LUN setting | Value |
| --- | --- |
| Space reservation | Disabled |

**Additional considerations**

When the volume or aggregate runs out of space, write operations to the file or LUN can fail.

If you do not want to actively monitor free space for both the volume and the aggregate, you should enable Autogrow for the volume and set the maximum size for the volume to the size of the aggregate. In this configuration, you must monitor aggregate free space actively, but you do not need to monitor the free space in the volume.

## Configuration settings for space-reserved files or LUNs with semi-thick volume provisioning

There are several configuration combinations of FlexVol volume and file or LUN configurations you can use. This combination based on semi-thick volume provisioning requires less storage to be allocated up front than the fully provisioned combination. But it places restrictions on the efficiency technologies you can use for the volume. Overwrites

are fulfilled on a best-effort basis for this configuration combination.

The following settings are required to configure a space-reserved LUN in a volume using semi-thick provisioning:

| Volume setting | Value |
|---|---|
| Guarantee | Volume |
| Fractional reserve | 0 |
| Snapshot reserve | 0 |
| Snapshot autodelete | On, with a commitment level of destroy, a destroy list that includes all objects, the trigger set to volume, and all FlexClone LUNs and FlexClone files enabled for automatic deletion. |
| Autogrow | Optional; if enabled, aggregate free space must be actively monitored. |

| File or LUN setting | Value |
|---|---|
| Space reservation | Enabled |

#### Technology restrictions

You cannot use the following volume storage efficiency technologies for this configuration combination:

- Compression
- Deduplication
- ODX and FlexClone Copy Offload
- FlexClone LUNs and FlexClone files not marked for automatic deletion (active clones)
- FlexClone subfiles
- ODX/Copy Offload

#### Additional considerations

The following facts must be considered when employing this configuration combination:

- When the volume that supports that LUN runs low on space, protection data (FlexClone LUNs and files, snapshots) is destroyed.
- Write operations can time out and fail when the volume runs out of free space.

Compression is enabled by default for AFF platforms. You must explicitly disable compression for any volume for which you want to use semi-thick provisioning on an AFF platform.

#### Related information

- Recommended volume and file or LUN configuration combinations overview

# Cautions and considerations for changing file or directory capacity

## The default and maximum number of files allowed for FlexVol volumes in ONTAP

FlexVol volumes have a default and maximum number of files they can contain. If your data requires a large number of files, you can increase the number of user visible files allowed on a volume up to a maximum value. You should understand the limitations and caveats before proceeding.

The number of user visible files a volume can contain is determined by the available inode capacity for the volume. An inode is a data structure that contains information about files.

ONTAP automatically sets the default and maximum number of available inodes for a newly created volume as follows based on the size of the volume.

| Default number of inodes | Maximum number of inodes |
|---|---|
| 1 per 32 KB of volume size | 1 per 4 KB of volume size |

When the size of a volume is increased, either manually by an administrator or automatically by ONTAP's autosize feature, ONTAP also increases (if necessary) the number of available inodes so that there is at least 1 inode per 32 KB of volume size, until the volume reaches approximately 680 GB in size.

In ONTAP 9.12.1 and earlier, creating a new volume or resizing an existing volume greater than 680 GB in size does not automatically result in additional inode capacity. If you need more files than the default number for any size volume, you can use the `volume modify` command to increase the available number of inodes for the volume up to the maximum.

Beginning with ONTAP 9.13.1, creating a new volume or resizing an existing volume sets the default number of available inodes to 1 inode per 32 KB of volume space even if the volume is larger than 680 GB. This ratio persists until the volume reaches the absolute inode maximum of 2,040,109,451.

You can also decrease the available number of inodes. This does not change the amount of space allocated to inodes, but it does lower the maximum amount of space the public inode file can consume. After space has been allocated for inodes, it is never returned to the volume. Therefore, it is not possible to lower the maximum number of inodes below the number of inodes currently allocated.

**More information**

- Determine file and inode usage for a volume
- NetApp Knowledge Base: FAQ - ONTAP default and maximum number of files (inodes)

## Maximum directory size for FlexVol volumes

You can increase the default maximum directory size for a specific FlexVol volume by using the `-maxdir-size` option of the `volume modify` command, but doing so could impact system performance. See the NetApp Knowledge Base: What is maxdirsize?.

To learn more about the model-dependent maximum directory sizes for FlexVol volumes, visit the NetApp

Hardware Universe.

Learn more about `volume modify` in the ONTAP command reference.

## Restrictions on node root volumes and root aggregates

You should be aware of the restrictions governing a node's root volume and root aggregate.

A node's root volume contains special directories and files for the node. The root volume is contained in the root aggregate.

A node's root volume is a FlexVol volume that is installed at the factory or by setup software. It is reserved for system files, log files, and core files. The directory name is `/mroot`, which is accessible only through the systemshell by technical support. The minimum size for a node's root volume depends on the platform model.

- The following rules govern the node's root volume:
  - Unless technical support instructs you to do so, do not modify the configuration or content of the root volume.
  - Do not store user data in the root volume.

    Storing user data in the root volume increases the storage giveback time between nodes in an HA pair.
  - You can move the root volume to another aggregate.

    Relocating root volumes to new aggregates
- The root aggregate is dedicated to the node's root volume only.

  ONTAP prevents you from creating other volumes in the root aggregate.

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## Relocate a root volume to new aggregates

The root replacement procedure migrates the current root aggregate to another set of disks without disruption. You might need to perform this as part of a disk replacement or preventative maintenance process.

**About this task**

You can change the location of the root volume to a new aggregate in the following scenarios:

- When the root aggregates are not on the disk you prefer
- When you want to rearrange the disks connected to the node
- When you are performing a shelf replacement of the EOS disk shelves

**Steps**

1. Relocate the root aggregate:

```
system node migrate-root -node node_name -disklist disk_list -raid-type
```

`raid_type`

- **-node**

  Specifies the node that owns the root aggregate that you want to migrate.

- **-disklist**

  Specifies the list of disks on which the new root aggregate will be created. All disks must be spares and owned by the same node. The minimum number of disks required is dependent on the RAID type.

- **-raid-type**

  Specifies the RAID type of the root aggregate. The default value is `raid-dp`. This is the only type supported in advanced mode.

2. Monitor the progress of the job:

```
job show -id jobid -instance
```

**Results**

If all of the pre-checks are successful, the command starts a root volume replacement job and exits.

# Features supported by FlexClone files and FlexClone LUNs

## Features supported by FlexClone files and FlexClone LUNs

FlexClone files and FlexClone LUNs work with different ONTAP features, such as deduplication, snapshots, quotas, and volume SnapMirror.

The following features are supported by FlexClone files and FlexClone LUNs:

- Deduplication
- Snapshots
- Access control lists
- Quotas
- FlexClone volumes
- NDMP
- Volume SnapMirror
- The `volume move` command
- Space reservation
- HA configuration

## Deduplication with FlexClone files and FlexClone LUNs

You can efficiently use the physical storage space of the data blocks by creating a FlexClone file or FlexClone LUN of the parent file and parent LUN in a deduplication-

enabled volume.

The block-sharing mechanism used by FlexClone files and LUNs is also used by deduplication. You can maximize the space savings in a FlexVol volume by enabling deduplication on the volume and then cloning the deduplication-enabled volume.

> While executing the `sis undo` command on a deduplication-enabled volume, you cannot create FlexClone files and FlexClone LUNs of the parent files and parent LUNs residing in that volume.

Learn more about the commands described in this procedure in the ONTAP command reference.

## How snapshots work with FlexClone files and FlexClone LUNs

There is a synergy between snapshots and the FlexClone files and FlexClone LUNs. If you work with these technologies, you should be aware of what is possible as well as the relevant restrictions.

#### Creating FlexClone files and LUNs

You can create a FlexClone file or FlexClone LUN from an existing snapshot. The copy is based on the the parent files and parent LUNs contained in a FlexVol volume.

#### Deleting a snapshot

You cannot manually delete a snapshot from which FlexClone files or FlexClone LUNs are currently being created. The snapshot remains locked until the background block-sharing process is completed. If you try to delete a locked snapshot, the system displays a message asking you to retry the operation after some amount of time. In this case, you need to continue retrying the deletion operation. You'll be able to delete the snapshot after the block sharing is done.

## Inheritance of access control lists by FlexClone files and FlexClone LUNs

FlexClone files and FlexClone LUNs inherit the access control lists of their parent files and LUNs.

If the parent files contain Windows NT streams, the FlexClone files also inherit the stream information. However, parent files containing more than six streams cannot be cloned.

## How quotas work with FlexClone files and FlexClone LUNs

You should be familiar with how quotas work with FlexClone files and FlexClone LUNs before using them.

Quota limits are applied on the total logical size of the FlexClone files or FlexClone LUNs. Cloning operations do not fail block sharing even if it causes quotas to be exceeded.

When you create a FlexClone file or FlexClone LUN, quotas do not recognize any space savings. For example, if you create a FlexClone file of a parent file of 10 GB, you are only using 10 GB of physical space, but the quota utilization is recorded as 20 GB (10 GB for the parent and 10 GB for the FlexClone file).

If the creation of a FlexClone file or LUN results in the group or user quota's being exceeded, the clone operation succeeds provided the FlexVol volume has enough space to hold the metadata for the clone.

However, the quota for that user or group is oversubscribed.

## FlexClone volumes and associated FlexClone files and FlexClone LUNs

You can create a FlexClone volume of a FlexVol volume that has both a FlexClone file and FlexClone LUN and its parent file or LUN in it.

FlexClone files or FlexClone LUNs and their parent files or LUNs that are present in the FlexClone volume continue to share blocks the same way they do in the parent FlexVol volume. In fact, all the FlexClone entities and their parents share the same underlying physical data blocks, minimizing physical disk space usage.

If the FlexClone volume is split from its parent volume, then the FlexClone files or FlexClone LUNs and their parent files or LUNs stop sharing the blocks in the clone of the FlexClone volume. Thereafter they exist as independent files or LUNs. This means that the clone of the volume uses more space than before the splitting operation.

## How NDMP works with FlexClone files and FlexClone LUNs

NDMP works at the logical level with FlexClone files and FlexClone LUNs. All FlexClone files or LUNs are backed up as separate files or LUNs.

When you use NDMP services to back up a qtree or a FlexVol volume that contains FlexClone files or FlexClone LUNs, block sharing between parent and clone entities is not preserved, and clone entities are backed up to tape as separate files or LUNs. The space saving is lost. Therefore, the tape onto which you are backing up should have sufficient space to store the expanded amount of data. When you restore, all the FlexClone files and FlexClone LUNs are restored as separate physical files and LUNs. You can enable deduplication on the volume to restore the block-sharing benefits.

When FlexClone files and FlexClone LUNs are being created from an existing snapshot of a FlexVol volume, you cannot back up the volume to tape until the block-sharing process, which happens in the background, is complete. If you use NDMP on the volume when the block-sharing process is in progress, the system displays a message asking you to retry the operation after some time. In such a situation, you must keep retrying the tape backup operation so that it succeeds after the block sharing is complete.

## How volume SnapMirror works with FlexClone files and FlexClone LUNs

Using volume SnapMirror with FlexClone files and FlexClone LUNs helps in maintaining space savings because the cloned entities are replicated only once.

If a FlexVol volume is a volume SnapMirror source and contains FlexClone files or FlexClone LUNs, volume SnapMirror transfers only the shared physical block and a small amount of metadata to the volume SnapMirror destination. The destination stores only one copy of the physical block, and this block is shared between the parent and cloned entities. Therefore, the destination volume is an exact copy of the source volume and all the clone files or LUNs on the destination volume share the same physical block.

## How space reservation works with FlexClone files and FlexClone LUNs

When using FlexClone files and FlexClone LUNs, you should understand how the space reservation attribute works.

By default, the FlexClone files and LUNs inherit the space reservation attribute from the parent file and parent

LUN respectively. However, you can create FlexClone files and FlexClone LUNs with space reservation disabled if the FlexVol volume lacks space. This is possible even if the attribute in the respective parent is enabled.

Note that if the FlexVol volume does not contain enough space to create a FlexClone file or FlexClone LUN with the same space reservation as that of the parent, the cloning operation will fail.

## How an HA configuration works with FlexClone files and FlexClone LUNs

FlexClone file and FlexClone LUN operations are supported in an HA configuration.

In an HA pair, you cannot create FlexClone files or FlexClone LUNs on the partner while the takeover or giveback operation is in progress. All the pending block sharing operations on the partner are resumed after the takeover or giveback operation is complete.