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Deciding whether to use the Logical Storage Management Guide

This guide describes how to work with ONTAP FlexVol volumes. It shows you how to create and manage FlexVol volumes, how to use FlexClone technology to create efficient copies of volumes, files, and LUNs, how to create qtrees and quotas, and how to manage efficiency features like deduplication and compression.

You should use this guide 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 OnCommand System Manager or an automated scripting tool.

If you do not want to use FlexVol volumes and want to use FlexGroup volumes or Infinite Volumes instead, you should choose among the following documentation:

- FlexGroup volumes management
- Infinite volumes management

If you want to use OnCommand System Manager to manage volumes, you should choose the following documentation:

- Cluster management using System Manager

If you require additional configuration or conceptual information, you should choose among the following documentation:

- Conceptual background for volumes
  ONTAP concepts
- Best practices for moving volumes
  Volume move express management
- Disk and aggregate management
  Disk and aggregate management
- Command reference
  ONTAP 9 commands
- Automation of management tasks
  NetApp Documentation: OnCommand Workflow Automation (current releases)
- Technical Reports (TRs), which include additional information about ONTAP technology and interaction with external services
  - NetApp Technical Report 3742: Using FlexClone to Clone Files and LUNs
Creating and managing volumes

You can create and delete FlexVol volumes, change their basic attributes, and display information about how their space is being used.

Creating a volume

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

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.

Steps

1. Create a volume:

   ```bash
   volume create -vserver vserver_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:

   ```bash
   volume show -vserver vserver_name -volume volume_name -junction
   ```
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 users -aggregate aggr1 -size 750g -junction-path /users
[Job 1642] Job succeeded: Successful
```

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

Provisioning volumes

ONTAP provides three basic volume provisioning options: thick provisioning, thin provisioning, and semi-thick provisioning. Each option uses different ways to manage the volume space and the space requirements for ONTAP block sharing technologies. Understanding how the options work enables you to choose the best option for your environment.

**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 (Snapshot copies 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.

**Note:** 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).

**Note:** 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:

<table>
<thead>
<tr>
<th>Volume provisioning</th>
<th>LUN/file space reservation</th>
<th>Overwrites</th>
<th>Protection data</th>
<th>Storage efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thick</td>
<td>Supported</td>
<td>Guaranteed&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Guaranteed</td>
<td>Supported</td>
</tr>
<tr>
<td>Thin</td>
<td>No effect</td>
<td>None</td>
<td>Guaranteed</td>
<td>Supported</td>
</tr>
<tr>
<td>Semi-thick</td>
<td>Supported</td>
<td>Best effort&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Best effort</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

**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 Snapshot copies, 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 Manual has more information to enable/disable support for the T10 thin provisioning and to enable T10 SCSI thin provisioning on a LUN.

*(ONTAP 9 commands)*
Configuring volume provisioning options

You can configure a volume for thin provisioning, thick provisioning, or semi-thick provisioning.

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 Snapshot copies 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. Otherwise, it defaults to **volume**. For existing FlexVol volumes, use the volume modify command to configure provisioning options.

Example

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

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

Example

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

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

Example

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

```
cluster1::> volume create -vserver vs1 -volume vol1 -space-slo semi-thick
```
How to determine space usage in a volume or aggregate

Enabling a feature in ONTAP might consume space that you are not aware of or 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.

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 take other action (such as increase 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 Snapshot copies.
  You see a volume's space usage by using the `volume show-space` command.

- **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.
  You see a volume's footprint with the aggregate by using the `volume show-footprint` command.

- **The aggregate's space usage**
  This perspective includes totals of the volume footprints of all of the volumes contained in the aggregate, space reserved for aggregate Snapshot copies, and other aggregate metadata.
  You can see the aggregate's space usage by using the `storage aggregate show-space` command.

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.

Deleting Snapshot copies automatically

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

**About this task**

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

**Step**

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

   See the `volume snapshot autodelete modify` man page for information about the parameters that you can use with this command to define a policy that meets your needs.

**Example**

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

The following command enables the automatic deletion of Snapshot copies 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 snap_reserve
```

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

If the trigger parameter is set to `snap_reserve` for an aggregate, the Snapshot copies 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 copy in the command will be listed as 0 because these Snapshot copies are automatically deleted. Also, the space used by Snapshot copies in an aggregate is considered as free and is included in the available space parameter of the command.

Related tasks

* Configuring a FlexVol volume to automatically delete FlexClone files and FlexClone LUNs on page 36

Configuring 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 copy creation. If you attempt to create a Snapshot copy and there is insufficient space, the Snapshot copy creation fails, even with autogrow enabled.

- Delete Snapshot copies, FlexClone files, or FlexClone LUNs.
  For example, you can configure ONTAP to automatically delete Snapshot copies that are not linked to Snapshot copies in cloned volumes or LUNs, or you can define which Snapshot copies you want ONTAP to delete first—your oldest or newest Snapshot copies. You can also determine when ONTAP should begin deleting Snapshot copies—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 copy 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 Snapshot copies 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.

   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 Snapshot copies, 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.

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

Related tasks

- Deleting Snapshot copies automatically on page 12
- Configuring a FlexVol volume to automatically delete FlexClone files and FlexClone LUNs on page 36

Configuring 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.

Before you begin

The FlexVol volume must be online.

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.
Step

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

   ```bash
   volume autosize -vserver vserver_name vol_name -mode grow_shrink
   ```

Example

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 copy deletion

The autoshrink functionality can be used with automatic Snapshot copy deletion if certain configuration requirements are met.

If you want to enable both the autoshrink functionality and automatic Snapshot copy deletion, your configuration must meet the following requirements:

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

How the autoshrink functionality interacts with Snapshot copy deletion

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

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

- If both the `grow_shrink` autosize mode and automatic Snapshot copy deletion are enabled, when a volume size shrinks it can trigger an automatic Snapshot copy 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 Snapshot copies to spill out of the reserve and be deleted automatically.
- If the `grow_shrink` autosize mode is enabled and you manually delete a Snapshot copy, it might trigger an automatic volume shrinkage.

How to 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:

<table>
<thead>
<tr>
<th>Alert type</th>
<th>EMS level</th>
<th>Configurable?</th>
<th>Definition</th>
<th>Ways to address</th>
<th>Risk if no action taken</th>
</tr>
</thead>
</table>
| Nearly full         | Debug     | Y             | The file system has exceeded the threshold set for this alert (the default is 95%). The percentage is the \( \text{Used total} - \text{size of the Snapshot reserve} \). | • Increasing volume size  
• 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 \( \text{Used total} - \text{size of the Snapshot reserve} \). | • Increasing volume size  
• 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  
• Deleting Snapshot copies  
• Reducing user data  
• Disabling space reservation for files or LUNs | Write operations to unreserved files could fail. |
<table>
<thead>
<tr>
<th>Alert type</th>
<th>EMS level</th>
<th>Configurable?</th>
<th>Definition</th>
<th>Ways to address</th>
<th>Risk if no action taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physically overallocated</td>
<td>Node Error</td>
<td>N</td>
<td>The volume is running out of physical blocks it can write to.</td>
<td>• Increasing volume size</td>
<td>Write operations are at risk, as well as data availability; the volume could go offline.</td>
</tr>
</tbody>
</table>

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.

**How to 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.
<table>
<thead>
<tr>
<th>Alert type</th>
<th>EMS Level</th>
<th>Configurable?</th>
<th>Definition</th>
<th>Ways to address</th>
<th>Risk if no action taken</th>
</tr>
</thead>
</table>
| 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  
• Shrinking or deleting volumes  
• Moving volumes to another aggregate with more space  
• 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  
• Shrinking or deleting volumes  
• Moving volumes to another aggregate with more space  
• 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.                                                                                                                                                                |
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 for 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, but if your environment is negatively affected by write operations failing due to lack of space, you must understand the requirements that this configuration imposes.

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.

<table>
<thead>
<tr>
<th>Alert type</th>
<th>EM S Leve l</th>
<th>Configurable?</th>
<th>Definition</th>
<th>Ways to address</th>
<th>Risk if no action taken</th>
</tr>
</thead>
</table>
| 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  
  • Shrinking or deleting volumes  
  • Moving volumes to another aggregate with more space  
  • 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  
  • Shrinking or deleting volumes  
  • 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. |
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 copy 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.

Note that if your rate of change is high, in rare cases the Snapshot copy automatic deletion could fall behind, resulting in the volume running out of space, even with all of the above required configuration settings in use.

In addition, you can optionally use the volume autogrow capability to decrease the likelihood of volume Snapshot copies 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 Snapshot copies 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:

<table>
<thead>
<tr>
<th>Volume guarantee</th>
<th>Default fractional reserve</th>
<th>Allowed values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>100</td>
<td>0, 100</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>0, 100</td>
</tr>
</tbody>
</table>
Displaying file or inode usage

FlexVol volumes have a maximum number of files that they can contain. Knowing how many files are contained by your volumes helps you determine whether you need to increase the number of (public) inodes for your volumes to prevent them from hitting their maximum 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.

Step

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

   `df -i volume_name`

   You can omit the volume name; in this case, ONTAP displays the inode usage for all volumes in the cluster. You can also specify a storage virtual machine (SVM) to see only volumes on that SVM.

   **Example**

   ```
   cm320c-rst::> df -i -vserver vs1
   Filesystem               iused      ifree  %iused  Mounted on
   /vol/cifs_test/            105       2928      3%  /home
   /vol/root/                  98        468     17%  ---
   /vol/vola/                 103      12047      0%  /nfsv4
   3 entries were displayed.
   ```

Controlling and monitoring I/O performance to FlexVol volumes by using 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 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.
- If you assign a volume to a policy group, then you cannot assign the volume’s containing SVM or any child LUNs or files to a policy group.
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.

**Deleting a FlexVol volume**

You can delete a FlexVol volume that is no longer required or if it contains corrupted data.

**Before you begin**

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

*Note:* If you accidentally delete a volume, contact technical support for assistance.

**Steps**
1. If the volume has been mounted, unmount it by entering the following command:

   ```bash
   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 by entering the following command:

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

4. Delete the volume by entering the following command:

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

**Result**

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

**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.

For more information about this functionality, consult with your NetApp representative.
## Commands for managing FlexVol volumes

There are specific commands for managing FlexVol volumes using the ONTAP CLI.

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bring a volume online</td>
<td><code>volume online</code></td>
</tr>
<tr>
<td>Change the size of a volume</td>
<td><code>volume size</code></td>
</tr>
<tr>
<td>Determine the associated aggregate of a volume</td>
<td><code>volume show</code></td>
</tr>
<tr>
<td>Determine the associated aggregate for all volumes on a storage virtual machine (SVM)</td>
<td><code>volume show -vserver &lt;vserver_name&gt; -fields aggregate</code></td>
</tr>
<tr>
<td>Determine the format of a volume</td>
<td><code>volume show -fields block-type</code></td>
</tr>
<tr>
<td>Mount a volume onto another volume using a junction</td>
<td><code>volume mount</code></td>
</tr>
<tr>
<td>Put a volume into the restricted state</td>
<td><code>volume restrict</code></td>
</tr>
<tr>
<td>Rename a volume</td>
<td><code>volume rename</code></td>
</tr>
<tr>
<td>Take a volume offline</td>
<td><code>volume offline</code></td>
</tr>
</tbody>
</table>

See the man page for each command for more information.

## 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 Snapshot copies.

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

**Related information**

*ONTAP 9 commands*
Moving and copying volumes

You can move or copy volumes for capacity utilization, improved performance, and to satisfy service-level agreements.

How moving a FlexVol volume works

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.

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 35 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

Moving a volume has many considerations and recommendations that are influenced by the volume you are moving or by the system configuration, such as a MetroCluster configuration. You should understand the considerations and recommendations associated with moving volumes.

General considerations and recommendations

• If you are upgrading the release family for a cluster, do not 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 cannot move a volume to or from a taken-over CFO aggregate.

• If a volume that contains LUNs is not 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.

**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 splitting.

• FlexClone volume Snapshot copies are not 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 configuration considerations**

• 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 are not blocked when volume move operations are in progress for volumes local to the surviving site.
- Unforced MetroCluster switchovers are blocked, but forced MetroCluster switchovers are not blocked if there are any volume move operations in progress.

**Requirement for moving volumes in SAN environments**

Before you move a volume that contains 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.

**Moving a 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.

**Before you begin**

The administrator previously determined that clients accessing the data in the volume can tolerate an I/O timeout of, at most, 120 seconds.

**Steps**

1. If you are moving a data protection mirror and you have not initialized the mirror relationship, initialize the mirror relationship by using the `snapmirror initialize` command.
   
   Data protection mirror relationships must be initialized before you can move one of the volumes.

2. Determine an aggregate to which you can move the volume by using the `volume move target-aggr show` command.
   
   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.

**Example**

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          FCAL
node12a_aggr3    10.34GB          FCAL
node12a_aggr2    10.36GB          FCAL
node12a_aggr1    10.36GB          FCAL
node12a_aggr4    10.36GB          FCAL
5 entries were displayed.
```

3. Verify that the volume can be moved to the intended aggregate by using the `volume move start -perform-validation-only` command to run a validation check.
4. Move the volume by using the `volume move start` command.

   **Example**

   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 -cutover-window 35
   ```

5. Determine the status of the volume move operation by using the `volume move show` command.

   **Example**

   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         | -               |
   ```

**Commands for moving volumes**

There are specific ONTAP commands for managing volume movement.

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abort an active volume move operation.</td>
<td><code>volume move abort</code></td>
</tr>
<tr>
<td>Show status of a volume moving from one aggregate to another aggregate.</td>
<td><code>volume move show</code></td>
</tr>
<tr>
<td>Start moving a volume from one aggregate to another aggregate.</td>
<td><code>volume move start</code></td>
</tr>
<tr>
<td>Manage target aggregates for volume move.</td>
<td><code>volume move target-aggr</code></td>
</tr>
<tr>
<td>Trigger cutover of a move job.</td>
<td><code>volume move trigger-cutover</code></td>
</tr>
<tr>
<td>Change the amount of time client access is blocked if the default is not adequate.</td>
<td><code>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 parameter is an advanced parameter.</code></td>
</tr>
<tr>
<td>Determine what the system does if the volume move operation cannot be completed during the time client access is blocked.</td>
<td><code>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 parameter is an advanced parameter.</code></td>
</tr>
</tbody>
</table>

See the man page for each command for more information.
Methods for copying a volume

Copying a volume creates a stand-alone copy of a volume that you can use for testing and other purposes. The method you use to copy a volume depends on the use case.

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 Snapshot copies from the original volume. The following table lists characteristics of the copy and the methods used to create that copy.

<table>
<thead>
<tr>
<th>If you want to copy a volume...</th>
<th>Then the method you use is...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within the same aggregate and you do not want to copy Snapshot copies from the original volume.</td>
<td>Creating a FlexClone volume of the original volume.</td>
</tr>
<tr>
<td>To another aggregate and you do not want to copy Snapshot copies from the original volume.</td>
<td>Creating a FlexClone volume of the original volume, and then moving the volume to another aggregate by using the <code>volume move</code> command.</td>
</tr>
<tr>
<td>To another aggregate and preserve all of the Snapshot copies from the original volume.</td>
<td>Replicating the original volume using SnapMirror, and then breaking the SnapMirror relationship to make a read-write volume copy.</td>
</tr>
</tbody>
</table>
Using FlexClone volumes to create efficient copies of your FlexVol volumes

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 copy 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. As a result, the FlexClone volume becomes an independent FlexVol volume with its own disk space, instead of sharing disk space with its parent.

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.

Creating a FlexClone volume

Before you begin

• The FlexClone license must be installed on the cluster.
• The volume that you want to clone must be online.

About this task

• 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.
• After you create a FlexClone volume, you cannot delete the parent volume while the FlexClone volume exists.

Step

1. Create a FlexClone volume:
   ```sh
close clone create
```
   **Note:** While creating a read-write FlexClone volume from the read-write parent volume, you do not need to specify the base Snapshot copy. ONTAP creates a Snapshot copy if you do not name any specific Snapshot copy that is to be used as the base Snapshot copy for the clone. You must specify the base Snapshot copy 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`:
   ```sh
close 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 copy snap1:

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

### Splitting a FlexClone volume from its parent volume

If you want a read-write FlexClone volume to have its own disk space rather than using that of its parent volume, you can split the FlexClone volume from its parent volume. Because this operation creates a copy of the data that is currently shared between the parent volume and the FlexClone volume, the operation can take some time to complete.

**About this task**

Splitting a FlexClone volume from its parent volume consumes free space from the containing aggregate. If you do not have sufficient privileges to view the space available in your aggregate, you must contact your storage administrator to verify that there is sufficient space in the aggregate for the split operation to finish.

Starting 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. The improved FlexClone splitting operation on AFF systems has the following benefits:

- Storage efficiency is preserved after splitting the clone from the parent.
- Existing Snapshot copies are not deleted.
- The operation is faster.
- The FlexClone volume can be split from any point in the clone hierarchy.

**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
```

**Example**

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

```
cluster1::> volume clone show -estimate -vserver vs1 -flexclone
    clone1 -parent-volume volumel

<table>
<thead>
<tr>
<th>Vserver</th>
<th>FlexClone</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>clone1</td>
<td>40.73MB</td>
</tr>
</tbody>
</table>
```

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
```

Example

The following example shows how you can initiate the process to split the 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
```

4. Monitor the status of the FlexClone split operation:

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

Example

The following example shows the status of the FlexClone split operation on an AFF system running ONTAP 9.4:

```
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.

Example

The following example shows how you can verify whether the 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
```

Determining 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. Therefore, 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.

Example

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%
```

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 copy 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 copy in the SnapMirror source volume, and then use that Snapshot copy to create the FlexClone volume. (If you are creating the FlexClone volume from the destination volume, you must wait until that Snapshot copy replicates to the SnapMirror destination volume.) This method of creating a Snapshot copy in the SnapMirror source volume allows you to create the clone without locking a Snapshot copy that is in use by SnapMirror.
Using FlexClone files and FlexClone LUNs to create efficient copies of files and LUNs

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, not for Infinite Volumes.

FlexClone files and FlexClone LUNs utilize 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.

Creating a FlexClone file or FlexClone LUN

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.
- 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.

Step

1. Create a FlexClone file or FlexClone LUN by using the `volume file clone create` command.
Example

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
```

For more information about using this command, see the man pages.

Related tasks

Viewing node capacity for creating and deleting FlexClone files and FlexClone LUNs on page 34

Related information

ONTAP 9 commands

Viewing node capacity for creating and deleting FlexClone files and FlexClone LUNs

You can view whether a node has capacity to receive new requests to create and delete FlexClone files and FlexClone LUNs 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.

Step

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.

Example

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
----------- ------- --------- ------- -----------
nodel1        15.97TB  0B      100MB     15.97TB
node2          15.97TB  0B      100MB     15.97TB
2 entries were displayed.
```
Viewing the space savings due to FlexClone files and FlexClone LUNs

You can view the percentage of disk space saved by block sharing within a volume containing FlexClone files and LUNs.

Step

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.

   **Note:** 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
```

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

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.

- 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.

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

You can enable a FlexVol volume to automatically delete FlexClone files and FlexClone LUNs with autodelete enabled when the free space in the volume decreases below a particular threshold.

**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.

   - 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.

**Example**

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
```

**Note:** 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.

Example

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
    Deferral Delete: user_created
    Delete Order: oldest_first
    Deferral 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`.

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.

Example

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`.

Example

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
```

For more information about using the commands, see the respective man pages.

Related tasks

* Deleting Snapshot copies automatically on page 12
Preventing a specific FlexClone file or FlexClone LUN from being automatically deleted

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.

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.

Attention: 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.

   Example

   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 voll -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.

   Example

   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/voll/lun1_clone

   Name: vs1
   Path: vol/voll/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.

<table>
<thead>
<tr>
<th>To...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add an extension to the supported list of extensions for the volume</td>
<td><code>volume file clone deletion add-extension</code></td>
</tr>
<tr>
<td>Change the minimum size of FlexClone files that can be deleted from the volume by using the faster deletion method</td>
<td><code>volume file clone deletion modify</code></td>
</tr>
<tr>
<td>Remove an extension from the supported list of extensions for the volume</td>
<td><code>volume file clone deletion remove-extension</code></td>
</tr>
<tr>
<td>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</td>
<td><code>volume file clone deletion show</code></td>
</tr>
</tbody>
</table>

For detailed information about these commands, see the appropriate man page.
Using qtrees to partition your FlexVol volumes

Qtrees enable you to partition your FlexVol volumes into smaller segments that you can manage individually. You can use qtrees to manage quotas, security style, and CIFS oplocks.

ONTAP creates a default qtree, called qtree0, for each volume. If you do not put data into a qtree, it resides in qtree0.

Qtree names must have no more than 64 characters.

Directories cannot be moved between 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. Therefore, you need to be careful not to delete them accidentally.

Obtaining 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.

About this task

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

Step

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

Example

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.

Qtree name restrictions

Qtree names can be no more than 64 characters in length. In addition, using some special characters in qtree names, such as commas and spaces, can cause problems with other capabilities, and should be avoided.
Converting 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 must 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:

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.

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

Converting 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 directory's contents 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.

Note: 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.
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.

Note: 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.
Converting 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.

   **Example**
   ```
   client: mv /n/user1/voll/dir1 /n/user1/voll/olddir
   ```

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

   **Example**
   ```
   system1: volume qtree create /n/user1/voll/dir1
   ```

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

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

   **Example**
   ```
   client: mv /n/user1/voll/olddir/* /n/user1/voll/dir1
   ```

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

   **Example**
   ```
   client: rmdir /n/user1/voll/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.

Commands for managing and configuring qtrees

You can manage and configure qtrees by using specific ONTAP commands.

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create a qtree</td>
<td><code>volume qtree create</code></td>
</tr>
<tr>
<td>Display a filtered list of qtrees</td>
<td><code>volume qtree show</code></td>
</tr>
<tr>
<td>If you want to...</td>
<td>Use this command...</td>
</tr>
<tr>
<td>----------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Delete a qtree</td>
<td><code>volume qtree delete</code></td>
</tr>
<tr>
<td><strong>Note:</strong> The qtree command <code>volume qtree delete</code> will fail unless the qtree is empty or the <code>-force true</code> flag is added.</td>
<td></td>
</tr>
<tr>
<td>Modify a qtree's UNIX permissions</td>
<td><code>volume qtree modify -unix-permissions</code></td>
</tr>
<tr>
<td>Modify a qtree's CIFS oplocks setting</td>
<td><code>volume qtree oplocks</code></td>
</tr>
<tr>
<td>Modify a qtree's security setting</td>
<td><code>volume qtree security</code></td>
</tr>
<tr>
<td>Rename a qtree</td>
<td><code>volume qtree rename</code></td>
</tr>
<tr>
<td>Display a qtree's statistics</td>
<td><code>volume qtree statistics</code></td>
</tr>
<tr>
<td>Reset a qtree's statistics</td>
<td><code>volume qtree statistics -reset</code></td>
</tr>
</tbody>
</table>

**Note:** The `volume rehost` command can cause other concurrent administrative operations targeted at that volume to fail.
Using quotas to restrict or track resource usage

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.

Overview of the quota process

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.

Understanding 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 by using 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:

<table>
<thead>
<tr>
<th>When this occurs...</th>
<th>This event is sent to the EMS...</th>
</tr>
</thead>
<tbody>
<tr>
<td>A hard limit is reached in a tree quota</td>
<td>waf1.quota.qtree.exceeded</td>
</tr>
<tr>
<td>A hard limit is reached in a user quota on the volume</td>
<td>waf1.quota.user.exceeded (for a UNIX user)</td>
</tr>
<tr>
<td></td>
<td>waf1.quota.user.exceeded.win (for a Windows user)</td>
</tr>
<tr>
<td>A hard limit is reached in a user quota on a qtree</td>
<td>waf1.quota.userQtree.exceeded (for a UNIX user)</td>
</tr>
<tr>
<td></td>
<td>waf1.quota.userQtree.exceeded.win (for a Windows user)</td>
</tr>
<tr>
<td>A hard limit is reached in a group quota on the volume</td>
<td>waf1.quota.group.exceeded</td>
</tr>
<tr>
<td>A hard limit is reached in a group quota on a qtree</td>
<td>waf1.quota.groupQtree.exceeded</td>
</tr>
<tr>
<td>A soft limit, including a threshold, is exceeded</td>
<td>quota.softlimit.exceeded</td>
</tr>
<tr>
<td>A soft limit is no longer exceeded</td>
<td>quota.softlimit.normal</td>
</tr>
</tbody>
</table>

The following table lists the SNMP traps that quotas generate:

<table>
<thead>
<tr>
<th>When this occurs...</th>
<th>This SNMP trap is sent...</th>
</tr>
</thead>
<tbody>
<tr>
<td>A hard limit is reached</td>
<td>quotaExceeded</td>
</tr>
<tr>
<td>A soft limit, including a threshold, is exceeded</td>
<td>quotaExceeded and softQuotaExceeded</td>
</tr>
<tr>
<td>A soft limit is no longer exceeded</td>
<td>quotaNormal and softQuotaNormal</td>
</tr>
</tbody>
</table>

**Note:** 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.

**Why you use quotas**

You can use quotas to limit resource usage in FlexVol volumes, to provide notification when resource usage reaches specific levels, or to track resource usage.

You specify a quota for the following reasons:
- To limit the amount of disk space or the number of files that can be used by a user or group, or that can be contained by a qtree
- To track the amount of disk space or the number of files used by a user, group, or qtree, without imposing a limit
- To warn users when their disk usage or file usage is high

**What quota rules, quota policies, and quotas are**

Quotas are defined in quota rules specific to FlexVol volumes. These quota rules are collected together in a quota policy of a storage virtual machine (SVM), and then 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.

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.

**Note:** 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.

**Quota targets and types**

Quotas have a type: they can be either user, group, or tree. Quota targets specify the user, group, or qtree for which the quota limits are applied.

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

<table>
<thead>
<tr>
<th>Quota target</th>
<th>Quota type</th>
<th>How target is represented</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>user</td>
<td>user quota</td>
<td>UNIX user name</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNIX UID</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A file or directory whose UID matches the user</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Windows user name in pre-Windows 2000 format</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Windows SID</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A file or directory with an ACL owned by the user's SID</td>
<td>User quotas can be applied for a specific volume or qtree.</td>
</tr>
</tbody>
</table>
### Special kinds of quotas

You use default, explicit, derived and tracking quotas to manage disk usage in the most efficient manner.

### 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.
- In the output of the `volume quota policy rule show` command, a default quota appears with an empty string ("") as the Target.
- In the output of the `volume quota report` command, a default quota appears with an asterisk (*) as the ID and Quota Specifier.
Default user quota example

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

```
# Quota target type           disk  files  thold  sdisk  sfile  
#-----------  ----           ----  -----  -----  -----  -----  
*             user@/vol/vol1  50M  
```

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

```
# Quota target type           disk  files  thold  sdisk  sfile  
#-----------  ----           ----  -----  -----  -----  -----  
*             user@/vol/vol1  50M  
jsmith        user@/vol/vol1  80M  
```

The following quotas entry restricts the specified user, represented by four IDs, to 500MB of disk space and 10,240 files in the vol1 volume:

```
jsmith,corp\jsmith,engineering\"john smith",S-1-5-32-544   user@/vol/vol1         500M      10K  
```

The following quotas entry restricts the eng1 group to 150 MB of disk space and an unlimited number of files in the /vol/vol2/proj1 qtree:

```
eng1        group@/vol/vol2/proj1  150M  
```

The following quotas entry restricts the proj1 qtree in the vol2 volume to 750 MB of disk space and 76,800 files:

```
/vol/vol2/proj1   tree                750M      75K  
```
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 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 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.

How you use tracking quotas

Tracking quotas generate reports of disk and file usage and do not limit resource usage. When tracking quotas are used, modifying 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.

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 following quotas file shows tracking quotas in place for a specific user, group, and qtree:

<table>
<thead>
<tr>
<th>Quota target</th>
<th>type</th>
<th>disk</th>
<th>files</th>
<th>thold</th>
<th>sdisk</th>
<th>sfile</th>
</tr>
</thead>
<tbody>
<tr>
<td>kjones</td>
<td>user@/vol/vol1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>eng1</td>
<td>group@/vol/vol1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>proj1</td>
<td>tree@/vol/vol1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The following quotas file contains the three possible default tracking quotas (users, groups, and qtrees):
How quotas are applied

Understanding how quotas are applied enables you to configure quotas 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).

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

When you specify a user or group as the target of a quota, the limits imposed by that quota are applied to that user or group. However, some special groups and users are handled differently. There are different ways to specify IDs for users, depending on your environment.

How you specify UNIX users for quotas

You can specify a UNIX user for a quota using one of three formats: the user name, the UID, or a file or directory owned by the user.

To specify a UNIX user for a quota, you can use one of the following formats:

- The user name, such as jsmith.
  
  **Note:** 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 UID, such as 20.

- The path of a file or directory owned by that user, so that the file's UID matches the user.
  
  **Note:** 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.

How you specify Windows users for quotas

You can specify a Windows user for a quota using one of three formats: the Windows name in pre-Windows 2000 format, the SID, or a file or directory owned by the SID of the user.

To specify a Windows user for a quota, you can use one of the following formats:

- 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.
  
  **Note:** 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 user quotas 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 root 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.
Note: 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.

How quotas work with special Windows groups
Quotas are applied to the Everyone group and the BUILTIN\Administrators group differently than to other Windows groups.

The following list describes what happens if the quota target is a special Windows group ID:

- If the quota target is the Everyone group, a file whose ACL shows that the owner is Everyone is counted under the SID for Everyone.
- If the quota target is BUILTIN\Administrators, the entry is considered a user quota, 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.

Note: 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.

How quotas are applied to users with multiple IDs
A user can be represented by multiple IDs. You can set up 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: Separate quota file entries 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 1 GB of disk space and another quota that limits corp\john_smith to 2 GB 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.

How ONTAP determines user IDs in a mixed environment
If you have users accessing your ONTAP storage from both Windows and UNIX clients, then 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:

<table>
<thead>
<tr>
<th>Security Style</th>
<th>ACL</th>
<th>No ACL</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIX</td>
<td>UNIX ID</td>
<td>UNIX ID</td>
</tr>
<tr>
<td>Mixed</td>
<td>Windows ID</td>
<td>UNIX ID</td>
</tr>
</tbody>
</table>
How quotas with multiple users work

When you put multiple users in the same quota target, the quota limits defined by that quota are not applied to each individual user; in this case, the quota limits are shared among all users listed 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.

**Note:** 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 quotas file entry

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

<table>
<thead>
<tr>
<th>Quota</th>
<th>target type</th>
<th>disk files</th>
<th>thold</th>
<th>sdisk</th>
<th>sfile</th>
</tr>
</thead>
<tbody>
<tr>
<td>jsmith, chen</td>
<td>user@/vol/vol1</td>
<td>80M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How you link UNIX and Windows names 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 quotas work with qtrees

You can create quotas with a qtree as their target; these quotas are 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.

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*.

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

<table>
<thead>
<tr>
<th>Security Style</th>
<th>ACL</th>
<th>No ACL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTFS</td>
<td>Windows ID</td>
<td>Windows ID</td>
</tr>
</tbody>
</table>
root and members of the BUILTIN\Administrators group, can write to the qtree if the write operation causes the tree quota to be exceeded.

**Note:** 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.

### 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 quotas file:

<table>
<thead>
<tr>
<th>#Quota target type</th>
<th>disk files thold sdisk sfile</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>user@/vol/vol1 50M - 45M</td>
</tr>
<tr>
<td>jsmith</td>
<td>user@/vol/vol1 80M - 75M</td>
</tr>
</tbody>
</table>

It comes to your attention that a certain user, kjones, is taking up too much space in a critical qtree, qt1, which resides in vol2. You can restrict this user’s space by adding the following line to the quotas file:

| kjones | user@/vol2/qt1 20M - 15M |

### 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.

#### 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:
<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>----Disk----</th>
<th>----Files----</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol1</td>
<td>proj1</td>
<td>tree</td>
<td>1</td>
<td>0B 10GB</td>
<td>1</td>
<td>proj1</td>
</tr>
<tr>
<td>vol1</td>
<td>proj2</td>
<td>tree</td>
<td>*</td>
<td>0B 20GB</td>
<td>0</td>
<td>*</td>
</tr>
<tr>
<td>vol1</td>
<td>proj3</td>
<td>tree</td>
<td>3</td>
<td>0B 20GB</td>
<td>1</td>
<td>proj3</td>
</tr>
</tbody>
</table>

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.

How deleting a qtree affects 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.

**Note:** 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 and
explicit quotas for the qtree—including tree quotas and user or group quotas for the qtree—might be converted into derived quotas.

**How changing the security style of a qtree affects 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. Therefore, 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.

**Note:** 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 5 MB file. User corp\joe is charged with 5 MB 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**

New quotas and changes to quotas do not take effect until they are activated. Knowing how quota activation works can help you manage your quotas less disruptively.

You can activate quotas at the volume level.

Your quotas file does not need to be free of all errors to activate quotas. Invalid entries are reported and skipped. If the quotas file contains any valid entries, the quotas are activated.

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. Because it does not involve a quota scan, resizing takes less time than a quota initialization. During a resize process, quotas are 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 \texttt{-foreground} parameter with the \texttt{volume quota on} or \texttt{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 \texttt{volume quota show} command with the \texttt{-instance} parameter.

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

\textbf{When you can use resizing}

Because quota resizing is faster than quota initialization, you should use resizing whenever possible. However, resizing only works for certain types of quota changes.

You can resize quotas when making the following types of changes to the quota rules:

\begin{itemize}
\item Changing an existing quota.
  For example, changing the limits of an existing quota.
\item Adding a quota for a quota target for which a default quota or a default tracking quota exists.
\item Deleting a quota for which a default quota or default tracking quota entry is specified.
\item Combining separate user quotas into one multi-user quota.
\end{itemize}

\textbf{Attention}: After you have made extensive quotas changes, you should perform a full reinitialization to ensure that all of the changes take effect.

\textbf{Note}: 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.

\textbf{Example quotas changes that can be made effective by resizing}

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

\begin{verbatim}
#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
\end{verbatim}

Suppose you make the following changes:

\begin{itemize}
\item Increase the number of files for the default user target.
\item Add a new user quota for a new user, boris, that needs more disk limit than the default user quota.
\item Delete the kbuck user’s explicit quota entry; the new user now needs only the default quota limits.
\end{itemize}

These changes result in the following quotas:

\begin{verbatim}
#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
\end{verbatim}
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.
- You change user mapping in the `usermap.cfg` file and you use the `QUOTA_PERFORM_USER_MAPPING` entry in the quotas file.
- 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 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

You can use quota reports to view details such as the configuration of quota rules and policies, enforced and configured quotas, and errors that occur 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

How you can use the quota report to see what quotas are in effect

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

The quotas file for these quotas looks similar to the following excerpt:

<table>
<thead>
<tr>
<th>#Quota target</th>
<th>type</th>
<th>disk files</th>
<th>thold</th>
<th>sdisk</th>
<th>sfile</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>tree@/vol/vol1</td>
<td>400M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>user@/vol/vol1</td>
<td>100M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>jsmith</td>
<td>user@/vol/vol1</td>
<td>200M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

```
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    corp/jsmith 150B 200MB       7       -   corp/jsmith
vol1     q1       tree    1           0B  400MB       6       -   q1
vol1     q1       user    *           0B  100MB       0       -   *
vol1     q1       user    corp/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 (200 MB). 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 (100 MB).

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 400 MB
• A default user quota limit on vol1 of 100 MB
• An explicit user quota limit on vol1 for the user jsmith of 200 MB
• A default user quota limit on qtree q1 of 50 MB
• An explicit user quota limit on qtree q1 for the user jsmith of 75 MB

The quotas file for these quotas looks like this:

```
#Quota target type             disk files thold sdisk sfile
#------------  ----             ---  -----  ----  -----  -----  
*             tree@/vol/vol1   400M
*             user@/vol/vol1   100M
jsmith        user@/vol/vol1/q1 50M
jsmith        user@/vol/vol1/q1 75M
```

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   corp/jsmith 2000B 200MB       7       -   corp/jsmith
vol1     q1         user   *           0B 50MB        0       -   *
vol1     q1         user   corp/jsmith 0B   75MB       5       -   corp/jsmith
vol1     q1         tree   1           0B 400MB       6       -   q1
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.

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` command 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.

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.

**Note:** 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.

Difference in space usage displayed by a quota report and a UNIX client

The value of used disk space that is 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 usage values is because of the difference in 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.

How the ls command accounts 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 be lesser or more than 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:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used Limit</th>
<th>Used Limit</th>
<th>Quota Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol1</td>
<td>q1</td>
<td>tree</td>
<td>user1</td>
<td>10MB</td>
<td>10MB</td>
<td>q1</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
```

How the df command accounts for file size

When you run the `df` command from the mount point of a qtree for which a quota rule is configured, the output of the command shows the same space usage as the value specified by the quota report.

If quotas are enabled for the volume that contains the qtree, the space usage reported by the `df` command excludes blocks used by directories, ACLs, stream directories, and metafiles. Therefore, the reported space usage exactly matches the value specified by the quota report.

However, if the qtree does not have a quota rule configured or if quotas are not enabled for the FlexVol volume, then the reported space usage includes the blocks consumed by directories, Access Control Lists (ACLs), stream directories and metafiles for the entire volume, including other qtrees within the volume. In such a situation, the space usage reported by the `df` command is more than the value specified by the quota report.
Example of space usage accounted by the df command and a quota report

The following quota report shows a limit of 10 MB for a qtree q1:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol1</td>
<td>q1</td>
<td>tree</td>
<td>user1</td>
<td>10MB</td>
<td>10MB</td>
<td>1</td>
<td>-</td>
<td>q1</td>
</tr>
</tbody>
</table>

In the following example, the space usage as the output of the df command shows the same limit of 10 MB (in terms of 1K blocks) because quota rules are configured for the qtree:

```
[user1@lin-sys1 q1]$ df -k
192.0.2.245:/vol/vol1/q1
10240 10240 0 100% /q1
```

How the du command accounts 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 10 MB for a qtree q1:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol1</td>
<td>q1</td>
<td>tree</td>
<td>user1</td>
<td>10MB</td>
<td>10MB</td>
<td>1</td>
<td>-</td>
<td>q1</td>
</tr>
</tbody>
</table>

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
```

Examples of quota configuration

These examples help you understand how to configure quotas and read quota reports.

For the following examples, assume that you have a storage system that includes an SVM, vs1, with one volume, vol1. To start setting up quotas, you create a new quota policy for the SVM with the following command:

```
class cluster1::>/volume quota policy create -vserver vs1 -policy-name quota_policy_vs1_1
```
Since the quota policy is new, you assign it to the SVM by entering the following command:

```
classcluster1::>vserver modify -vserver vs1 -quota-policy quota_policy_vs1_1
```

**Example 1: Default user quota**

You decide to impose a hard limit of 50 MB for each user in vol1 by entering the following command:

```
cluster1::>volume quota policy rule create -vserver vs1 -policy-name quota_policy_vs1_1 -volume vol1 -type user -target "" -disk-limit 50MB -qtree ""
```

To activate the new rule, you initialize quotas on the volume by entering the following command:

```
cluster1::>volume quota on -vserver vs1 -volume vol1 -foreground
```

To view the quota report, you enter the following command:

```
cluster1::>volume quota report
```

The resulting quota report is similar to the following report:

```
Vserver: vs1
<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol1</td>
<td></td>
<td>user</td>
<td>*</td>
<td>0B</td>
<td>50MB</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>vol1</td>
<td></td>
<td>user</td>
<td>jsmith</td>
<td>49MB</td>
<td>50MB</td>
<td>37</td>
<td>-</td>
</tr>
<tr>
<td>vol1</td>
<td></td>
<td>user</td>
<td>root</td>
<td>0B</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
```

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—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 50-MB 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 50 MB in vol1 (for example, writing to a file from an editor), the action fails.

**Example 2: Explicit user quota overriding a default user quota**

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. You can resize quotas by entering the following command:

```
cluster1::> volume quota resize -vserver vs1 -volume voll -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
<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Quota Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td>user</td>
<td>*</td>
<td></td>
<td>0B</td>
<td>50MB</td>
<td>0</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td>voll</td>
<td>user</td>
<td>jsmith</td>
<td></td>
<td>50MB</td>
<td>80MB</td>
<td>37</td>
<td>-</td>
<td>jsmith</td>
</tr>
<tr>
<td>voll</td>
<td>user</td>
<td>root</td>
<td></td>
<td>0B</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
```

The second line now shows a Disk Limit of 80 MB and a Quota Specifier of jsmith. Therefore, jsmith can use up to 80 MB of space on voll, even though all other users are still limited to 50 MB.

**Example 3: Thresholds**

Suppose you want to receive a notification when users reach within 5 MB of their disk limits. To create a threshold of 45 MB for all users, and a threshold of 75 MB for jsmith, you change the existing quota rules by entering the following commands:

```
cluster1::>volume quota policy rule modify -vserver vs1 -policy quota_policy_vs1_1 -volume voll -type user -target "" -qtree "" -threshold 45MB
cluster1::>volume quota policy rule modify -vserver vs1 -policy quota_policy_vs1_1 -volume voll -type user -target jsmith -qtree "" -threshold 75MB
```

Since 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.

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
<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used (Thold)</th>
<th>Limit (Thold)</th>
<th>Used Limit</th>
<th>Limit</th>
<th>Quota Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td>user</td>
<td>*</td>
<td></td>
<td>0B</td>
<td>50MB</td>
<td>0</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td>voll</td>
<td>user</td>
<td>jsmith</td>
<td></td>
<td>50MB (45MB)</td>
<td>80MB</td>
<td>37</td>
<td>-</td>
<td>jsmith</td>
</tr>
<tr>
<td>voll</td>
<td>user</td>
<td>root</td>
<td></td>
<td>0B</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
```

The thresholds appear in parentheses in the Disk Limit column.

**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 voll.

```
```
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. If you want to ensure that neither qtree grows beyond 20 GB, you can create default tree quota on the volume by entering the following command:

```
cluster1:>>volume quota policy rule create -vserver vs1 -policy-name quota_policy_vs1_1 -volume voll -type tree -target "" -disk-limit 20GB
```

Note that the correct type is tree, not qtree.

Because this is a new quota, you cannot activate it by resizing. You reinitialize quotas on the volume by entering the following commands:

```
cluster1:>>volume quota off -vserver vs1 -volume voll
cluster1:>>volume quota on -vserver vs1 -volume voll -foreground
```

**Note:** 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.

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:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>----Disk----</th>
<th>----Files----</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voll</td>
<td>tree</td>
<td>*</td>
<td></td>
<td>0B</td>
<td>20GB</td>
<td>-</td>
</tr>
<tr>
<td>voll</td>
<td>proj1</td>
<td>tree</td>
<td>1</td>
<td>0B</td>
<td>20GB</td>
<td>1</td>
</tr>
<tr>
<td>voll</td>
<td>proj2</td>
<td>tree</td>
<td>2</td>
<td>0B</td>
<td>20GB</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>----Disk----</th>
<th>----Files----</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voll</td>
<td>proj1</td>
<td>user</td>
<td>*</td>
<td>0B</td>
<td>50MB</td>
<td>0</td>
</tr>
<tr>
<td>voll</td>
<td>proj1</td>
<td>user</td>
<td>root</td>
<td>0B</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>voll</td>
<td>proj2</td>
<td>user</td>
<td>*</td>
<td>0B</td>
<td>50MB</td>
<td>0</td>
</tr>
<tr>
<td>voll</td>
<td>proj2</td>
<td>user</td>
<td>root</td>
<td>0B</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**

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 10 MB in the proj1 qtree. Therefore, you create a default user quota for the qtree by entering the following command:

```bash
cluster1::>volume quota policy rule create -vserver vs1 -policy-name quota_policy_vs1_1 -volume voll -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:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td>proj1</td>
<td>user</td>
<td>*</td>
<td>0B</td>
<td>10MB</td>
<td>0</td>
<td>-</td>
<td>*</td>
</tr>
</tbody>
</table>

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. To provide more space to the user jsmith, you add an explicit user quota rule for the qtree with an 80 MB disk limit to override the default user quota rule for the qtree by entering the following command:

```bash
cluster1::>volume quota policy rule create -vserver vs1 -policy-name quota_policy_vs1_1 -volume voll -type user -target jsmith -disk-limit 80MB -qtree proj1
```

Since 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:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td>proj1</td>
<td>user</td>
<td>jsmith</td>
<td>61MB</td>
<td>80MB</td>
<td>57</td>
<td>-</td>
<td>jsmith</td>
</tr>
</tbody>
</table>

The final quota report is similar to the following report:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

cluster1::>volume quota report

Vserver: vs1

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tree</th>
<th>Type</th>
<th>ID</th>
<th>Used</th>
<th>Limit</th>
<th>Used</th>
<th>Limit</th>
<th>Specifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>voll</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Setting up quotas on an SVM

To set up quotas on a new storage virtual machine (SVM, formerly known as Vserver), you must create a quota policy, add quota policy rules to the policy, assign the policy to the SVM, and initialize quotas on each FlexVol volume on the SVM.

Steps

1. Use the `vserver show` command with the `-instance` option 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 also use the `vserver quota policy rename` command to give the default policy a name.

   **Note:** 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.

## Modifying (or Resizing) quota limits

When you make changes to the size of existing quotas, you can 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.
Reinitializing quotas after making extensive changes

When you make extensive changes to existing quotas; for example, by adding or deleting quotas for targets that have no enforced quotas—you must make the changes and re-initialize quotas on all affected volumes.

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:

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Then...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create new quota rules</td>
<td>Use the volume quota policy rule create command</td>
</tr>
<tr>
<td>Modify the settings of existing quota rules</td>
<td>Use the volume quota policy rule modify command</td>
</tr>
<tr>
<td>Delete existing quota rules</td>
<td>Use the volume quota policy rule delete command</td>
</tr>
</tbody>
</table>

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.

   **Note:** 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.

**How you can view 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 occur 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

**How you can use the quota report to see what quotas are in effect**

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

The quotas file for these quotas looks similar to the following excerpt:

<table>
<thead>
<tr>
<th>#Quota target type</th>
<th>disk</th>
<th>files</th>
<th>thold</th>
<th>sdisk</th>
<th>sfile</th>
</tr>
</thead>
<tbody>
<tr>
<td>* tree@/vol/vol1</td>
<td>400M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* user@/vol/vol1</td>
<td>100M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>jsmith user@/vol/vol1</td>
<td>200M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

```
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   corp/jsmith 0B  100MB       0       -   *
vol1     q1         tree   1           0B  400MB       0       -   q1
vol1     q1         user   *           0B  100MB       0       -   *
vol1     q1         user   corp/jsmith 0B  100MB       0       -   *
vol1     -          user   root        0B   0MB        0       -   *
vol1     q1         user   root        0B   0MB        0       -   *
```

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 (200 MB). 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 (100 MB).

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 400 MB
- A default user quota limit on vol1 of 100 MB
- An explicit user quota limit on vol1 for the user jsmith of 200 MB
- A default user quota limit on qtree q1 of 50 MB
- An explicit user quota limit on qtree q1 for the user jsmith of 75 MB

The quotas file for these quotas looks like this:

```
#Quota target type          disk files thold sdisk sfile
#-----------  ----          ---  -----  ----  -----  -----  ----
  *          tree@/vol/vol1  400M
  *          user@/vol/vol1  100M
jsmith     user@/vol/vol1/q1 50M
jsmith     user@/vol/vol1/q1 75M
```

The quota report for these quotas looks like this:

```
cluster1::> volume quota report
Vserver: vs1
---- Disk ----  ---- Files ----  Quota Specification
Volume  Tree  Type  ID  Used Limit  Used Limit  Specifier
-------  ------  ----  --------  -----------  ------------
vol1    -      tree  *  0B   400MB    0       -   *  
vol1    -      user  *  0B   100MB    0       -   *  
vol1    -      user  corp/jsmith 2000B  200MB  7       -   corp/jsmith
vol1    q1     user  *  0B   50MB    0       -   *  
vol1    q1     user  corp/jsmith 0B   75MB    5       -   corp/jsmith
vol1    q1     tree  1  0B   400MB    6       -   q1
vol1    q1     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.

**Using 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.

**Step**

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

Quota

Volume Tree Type ID Used Limit Used Limit
---- ---- ---- ---- ---- ---- ---- ----
vol2 q1 tree jsmith 1MB 100MB 2 10000
```
### Commands for displaying information about quotas

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.

**Note:** You can run the following commands only on FlexVol volumes.

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>View information about enforced quotas</td>
<td>volume quota report</td>
</tr>
<tr>
<td>View resource usage (disk space and number of files) of quota targets</td>
<td>volume quota report</td>
</tr>
<tr>
<td>Determine which quota limits are affected when a write to a file is allowed</td>
<td>volume quota report with the -path parameter</td>
</tr>
<tr>
<td>Display the quota state, such as on, off, and initializing</td>
<td>volume quota show</td>
</tr>
<tr>
<td>View information about quota message logging</td>
<td>volume quota show with the -logmsg parameter</td>
</tr>
<tr>
<td>View errors that occur during quota initialization and resizing</td>
<td>volume quota show with the -instance parameter</td>
</tr>
<tr>
<td>View information about quota policies</td>
<td>volume quota policy show</td>
</tr>
<tr>
<td>View information about quota rules</td>
<td>volume quota policy rule show</td>
</tr>
<tr>
<td>View the name of the quota policy that is assigned to a storage virtual machine (SVM, formerly known as Vserver)</td>
<td>vserver show with the -instance parameter</td>
</tr>
</tbody>
</table>

See the man page for each command for more information.

### 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` command 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.

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.

**Note:** 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.

### Commands to manage quota rules and quota policies

You can use the `volume quota policy rule` commands to configure quota rules, and use the `volume quota policy` commands and some `vserver` commands to configure quota policies.

**Note:** You can run the following commands only on FlexVol volumes.

#### Commands for managing quota rules

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create a new quota rule</td>
<td><code>volume quota policy rule create</code></td>
</tr>
<tr>
<td>Delete an existing quota rule</td>
<td><code>volume quota policy rule delete</code></td>
</tr>
<tr>
<td>Modify an existing quota rule</td>
<td><code>volume quota policy rule modify</code></td>
</tr>
<tr>
<td>Display information about configured quota rules</td>
<td><code>volume quota policy rule show</code></td>
</tr>
</tbody>
</table>

#### Commands for managing quota policies

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplicate a quota policy and the quota rules it contains</td>
<td><code>volume quota policy copy</code></td>
</tr>
<tr>
<td>Create a new, blank quota policy</td>
<td><code>volume quota policy create</code></td>
</tr>
<tr>
<td>Delete an existing quota policy that is not currently assigned to a storage virtual machine (SVM)</td>
<td><code>volume quota policy delete</code></td>
</tr>
<tr>
<td>Rename a quota policy</td>
<td><code>volume quota policy rename</code></td>
</tr>
<tr>
<td>Display information about quota policies</td>
<td><code>volume quota policy show</code></td>
</tr>
<tr>
<td>Assign a quota policy to an SVM</td>
<td><code>vserver modify</code></td>
</tr>
<tr>
<td>Display the name of the quota policy assigned to an SVM</td>
<td><code>vserver show</code></td>
</tr>
</tbody>
</table>

See the man page for each command for more information.
Commands to activate and modify quotas

You can use the `volume quota` commands to change the state of quotas and configure message logging of quotas.

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn quotas on (also called <em>initializing</em> them)</td>
<td><code>volume quota on</code></td>
</tr>
<tr>
<td>Resize existing quotas</td>
<td><code>volume quota resize</code></td>
</tr>
<tr>
<td>Turn quotas off</td>
<td><code>volume quota off</code></td>
</tr>
<tr>
<td>Change the message logging of quotas, turn quotas on, turn quotas off, or resize existing quotas</td>
<td><code>volume quota modify</code></td>
</tr>
</tbody>
</table>

See the man page for each command for more information.
Using deduplication, data compression, and data compaction to increase 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.

Note: Beginning with ONTAP 9.2, all inline storage efficiency features, such as inline deduplication and inline compression, are enabled by default on AFF volumes.

Enabling 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. You must contact technical support if you want to enable inline deduplication on other types of volumes.

Before you begin

For a FlexVol volume, you must have verified that enough free space exists for deduplication metadata in volumes and aggregates.

Note: Beginning with ONTAP 9.2, inline deduplication is enabled by default on AFF systems.

Choices

• Use the `volume efficiency on` command to enable postprocess deduplication.

Example

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.

Example

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-deduplication 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.

Example

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-deduplication true

After you finish
Verify that the setting has changed by viewing the volume efficiency settings:
volume efficiency show -instance

Related concepts
Managing volume efficiency operations using schedules on page 93

Disabling 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 by entering the following command:
volume efficiency stop

About this task
If you have enabled data compression on the volume, running the volume efficiency off command disables data compression.

Choices
• Use the volume efficiency off command to disable both postprocess deduplication and inline deduplication.

Example
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.

Example
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.

Example
The following command disables only inline deduplication on volume VolA:
volume efficiency modify -vserver vs1 -volume VolA -inline-deduplication false
Managing automatic volume-level background deduplication on AFF systems

Beginning with ONTAP 9.3, volume-level background deduplication can be managed 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.

Managing aggregate-level inline deduplication on AFF systems

Aggregate-level deduplication eliminates duplicate blocks across volumes belonging to the same aggregate. Beginning with ONTAP 9.2, 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.

Note: Aggregate-level inline deduplication is sometimes referred to as cross-volume inline deduplication.

Step

1. Manage aggregate-level inline deduplication on AFF systems:

<table>
<thead>
<tr>
<th>If you want to...</th>
<th>Use this command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable aggregate-level inline deduplication</td>
<td><code>volume efficiency modify -vserver &lt;vserver_name&gt; -volume &lt;vol_name&gt; -cross-volume-inline-dedupe true</code></td>
</tr>
<tr>
<td>Disable aggregate-level inline deduplication</td>
<td><code>volume efficiency modify -vserver &lt;vserver_name&gt; -volume &lt;vol_name&gt; -cross-volume-inline-dedupe false</code></td>
</tr>
</tbody>
</table>
### 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
```

---

## Managing 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 run the aggregate-level background 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.

**Note:** Aggregate-level background deduplication is sometimes referred to as cross-volume background deduplication.

### Step

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 | `volume efficiency config -volume <vol_name>`

## Enabling data compression on a volume

You can enable data compression on a FlexVol volume or an Infinite Volume to achieve space savings by using the `volume efficiency modify` command. 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.

### Before you begin

You must have enabled deduplication on the volume.

**Notes:**

- 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.

### 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.
- The compression type is automatically assigned based on the aggregates, platform:

<table>
<thead>
<tr>
<th>Platform/aggregates</th>
<th>Compression type</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFF</td>
<td>Adaptive compression</td>
</tr>
<tr>
<td>Flash Pool aggregates</td>
<td>Adaptive compression</td>
</tr>
<tr>
<td>HDD aggregates</td>
<td>Secondary compression</td>
</tr>
</tbody>
</table>
Choices

- Use the `volume efficiency modify` command to enable data compression with the default compression type.

**Example**

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.

  1. Use the `set -privilege advanced` command to change the privilege level to advanced.
  2. Use the `volume efficiency modify` command to assign a compression type to a volume.

**Example**

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
```

  3. Use the `set -privilege admin` command to change the privilege level to admin.

**Related concepts**

*Managing volume efficiency operations using schedules* on page 93

**Moving 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 data compression on the volume:

```
volume efficiency modify
```
Example
The following command disables data compression on volume vol1:

```
volume efficiency modify -compression false -inline-compression false -volume vol1
```

2. Change to the advanced privilege level:

```
set -privilege advanced
```

3. Decompress the compressed data:

```
volume efficiency undo
```

Example
The following command decompresses the compressed data on volume vol1:

```
volume efficiency undo -vserver vs1 -volume vol1 -compression true
```

Note: You must verify that you have sufficient space in the volume to accommodate the decompressed data.

4. Verify that the status of the operation is idle:

```
volume efficiency show
```

Example
The following command displays the status of an efficiency operation on volume vol1:

```
volume efficiency show -vserver vs1 -volume vol1
```

5. Enable data compression, and then set the type of compression:

```
volume efficiency modify
```

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
```

Note: 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.

6. Change to the admin privilege level:

```
set -privilege admin
```

7. Optional: Enable inline compression:

```
volume efficiency modify
```

Example
The following command enables inline compression on volume vol1:
volume efficiency modify -vserver vs1 -volume vol1 -inline-compression true

Disabling data compression on a volume

You can disable data compression on a FlexVol volume or an Infinite Volume by using the `volume efficiency modify` command.

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
   ```

Managing 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.

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:
   
   ```bash
   volume efficiency modify -vserver vserver_name -volume volume_name -
   data-compaction false
   ```

4. To display data compaction status:
   
   ```bash
   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
```

## Enabling inline data compaction for FAS systems

You can control inline data compaction on FAS systems with Flash Pool (hybrid) aggregates or HDD aggregates at the volume or aggregate level by using the `wafl compaction enable` node shell command. Data compaction is disabled by default for FAS systems.

### About this task

If you enable data compaction at the aggregate level, data compaction is enabled on any new volume that is created with a volume space guarantee of `none` in the aggregate. Enabling data compaction on a volume on an HDD aggregate uses additional CPU resources.

### Steps

1. Change to the advanced privilege level:
   ```bash
   set -privilege advanced
   ```

2. Check the data compaction state of the volumes and aggregates for the desired node:
   ```bash
   node run –node node_name –command wafl compaction status –all
   ```

3. Enable data compaction on the aggregate and volume:
   - For aggregates:
     ```bash
     node run –node node_name –command wafl compaction enable –A
     aggregate_name
     ```
   - For volumes:
     ```bash
     node run –node node_name –command wafl compaction enable volume_name
     ```

   **Note:** 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 (in ONTAP 9.1 and later).

### ONTAP 9 commands

4. View the compaction statistics:
   ```bash
   node run –node node_name –command wafl compaction stats
   ```
Enabling 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.

**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 Snapshot copies.
- Ratio split for the following efficiency technologies: volume deduplication, volume compression, Snapshot copies, 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 the logical and physical used details. The view was enhanced to now display the efficiency technologies separately.

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 <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
```
Creating a volume efficiency policy to run efficiency operations

You can create a volume efficiency policy to run deduplication or data compression followed by deduplication on a FlexVol volume or an Infinite 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*.

**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 the *Administrator Authentication and RBAC Power Guide*.

*Note:* 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 specified percentage and then triggers the deduplication or data compression operation.

**Step**

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%
```

**Related information**

*Administrator authentication and RBAC*

Assigning a volume efficiency policy to a volume

You can assign an efficiency policy to a volume to run deduplication or data compression operation by using the `volume efficiency modify` command.

**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` with volume `VolA`:

   ```bash
   volume efficiency modify -vserver vs1 -volume VolA -policy new_policy
   ```

Modifying 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.

Step

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:

   ```bash
   volume efficiency policy modify -vserver vs1 -policy policy1 -schedule hourly
   ```

   The following command modifies a volume efficiency policy named `pol2` to threshold 30%:

   ```bash
   volume efficiency policy modify -vserver vs1 -policy pol1 -type threshold -start-threshold-percent 30%
   ```

Viewing a volume efficiency policy

You can view the volume efficiency policy name, schedule, duration, and description by using the `volume efficiency policy show` command.

**About this task**

When you run the `volume efficiency policy show` command from the cluster scope, the cluster-scoped policies are not displayed. However, you can view the cluster-scoped policies in the storage virtual machine (SVM) context.

Step

1. Use the `volume efficiency policy show` command to view information about a volume efficiency policy.

   The output depends on the parameters you specify. For more information about displaying detailed view and other parameters, see the man page for this command.

   **Examples**

   The following command displays information about the policies created for the SVM vs1:

   ```bash
   volume efficiency policy show -vserver vs1
   ```

   The following command displays the policies for which the duration is set as 10 hours:
Disassociating 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 -
```

Deleting 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 FlexVol volume or an Infinite Volume.

**Note:** 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
```

Managing volume efficiency operations manually

You can manage how the efficiency operations run on a FlexVol volume or Infinite 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.
Running efficiency operations manually

You can run efficiency operations manually on a FlexVol volume or an Infinite Volume by using the `volume efficiency start` command.

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

If deduplication and data compression are enabled on a volume, data compression is run initially followed by deduplication.

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.

When you run deduplication or data compression on an Infinite Volume, a separate operation runs on each data constituent in the volume, with a maximum of eight concurrent operations per node.

Step

1. Use the `volume efficiency start` command to start the efficiency operation on a volume.

   **Example**

   The following command allows you to manually start only deduplication or data compression followed by deduplication on the volume VolA:

   ```bash
   volume efficiency start -vserver vs1 -volume VolA
   ```

Using checkpoints to resume efficiency operation

The 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 last efficiency operation failed or stopped) and checkpoint data exists, the efficiency operation can resume from the latest checkpoint file.

For an Infinite Volume, checkpoints are created on each individual data constituents. You cannot view the checkpoints on an Infinite Volume, but you can resume the operation.

A checkpoint is created:

- in each stage or substage of the operation
- when you run the `sis stop` command
- when the duration expires

Resuming 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 by using the `volume efficiency start` command.
with the checkpoint option. This helps in saving time and resources by not having to restart the efficiency 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.

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.

Step

1. Use the `volume efficiency start` command with the `-use-checkpoint` option to resume an efficiency operation.

Example

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
```

Running efficiency operations manually on existing data

You can run the efficiency operations manually on the data that exists in FlexVol volumes or an Infinite Volume prior to enabling deduplication, data compression, or data compaction. You can run these operations by using the `volume efficiency start -scan-old-data` command.

About this task

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 Snapshot copies. 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. The technical report TR 4476: NetApp Data Compression, Deduplication, and Data Compaction contains more information.

You can run a maximum of eight deduplication, data compression, or data compaction operations concurrently per node. The remaining operations are queued.

Note: Postprocess compression does not run on AFF platforms. An EMS message is generated to inform you that this operation was skipped.
Step

1. Use the `volume efficiency start -scan-old-data` command to run deduplication, data compression, or data compaction manually on the existing data.

Example

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

*TR 4476: NetApp Data Compression, Deduplication, and Data Compaction*

Managing volume efficiency operations using schedules

You can manage how the efficiency operations run on a FlexVol volume or Infinite Volume by using a schedule or by depending on the amount of new data written to the FlexVol volume or Infinite Volume.

Running efficiency operations depending 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 (performed manually or scheduled) exceeds a specified threshold percentage.

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.

Step

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
```
Running efficiency operations using scheduling

You can modify the scheduling of deduplication or data compression operation on a FlexVol volume or Infinite Volume by using the `volume efficiency modify` command. The configuration options of a schedule and volume efficiency policy are mutually exclusive.

**Step**

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
```

Monitoring volume efficiency operations

You can monitor the progress of efficiency operations on a FlexVol volume or an Infinite Volume by viewing the status of the efficiency operations and the space savings achieved on the FlexVol volume or an Infinite Volume.

For more information about efficiency operations and space savings on an Infinite Volume, see the Infinite Volumes Management Guide.

**Related information**

Infinite Volumes Management Guide

Viewing the status of efficiency operations

You can view whether deduplication or data compression is enabled on a FlexVol volume or an Infinite Volume. You can also view the status, state, type of compression, and progress of the efficiency operations on a FlexVol volume or individual data constituents in an Infinite Volume by using the `volume efficiency show` command.

**Step**

1. Use the `volume efficiency show` command to view the status of an efficiency operation on a volume.

```
Example
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
```
Viewing efficiency space savings

You can view the amount of space savings achieved through deduplication and data compression on a volume by using the `volume show` command.

**About this task**

The space savings in Snapshot copies are 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.

**Step**

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%

... 
```

Viewing efficiency statistics of a FlexVol volume

You can view the details of the efficiency operations run on a FlexVol volume by using the `volume efficiency stat` command.

**Step**

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

Stopping volume efficiency operations

You can stop a deduplication or postprocess compression operation by using the `volume efficiency stop` command. This command automatically generates a checkpoint.

Step

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
```

Information about removing space savings from a volume

You can choose to remove the space savings achieved by running efficiency operations on a volume. You must ensure that you contact technical support before removing or undoing the space savings on a volume.

For more information about removing space savings from a volume, see the technical report `TR-4476: NetApp Data Compression and Deduplication Deployment and Implementation Guide`.

Related information

Rehosting a volume from one SVM to another SVM

Volume rehost enables you to reassign NAS or SAN volumes from one storage virtual machine (SVM, formerly known as Vserver) to another SVM without requiring a SnapMirror copy. The volume rehost procedures depend upon the protocol type and the volume type. Volume rehost is a disruptive operation for data access and volume management.

Before you begin

Several conditions must be met before you can rehost a volume from one SVM to another:

- The volume must be online.
- Protocols: SAN or NAS
  - For the NAS protocol, the volume must be unmounted.
- If the volume is in a SnapMirror relationship, then the relationship must be either deleted or broken prior to volume rehost.
  - You can resynchronize the SnapMirror relationship after the volume rehost operation.

Choices

- **Rehosting CIFS volumes** on page 97
  
  You can rehost volumes that serve data over SMB protocol. After rehosting the CIFS volume, to continue accessing data over SMB protocol, you must manually configure policies and the associated rules.

- **Rehosting NFS volumes** on page 99
  
  You can rehost volumes that serve data over NFS protocol. After rehosting the NFS volumes, to continue accessing data over NFS protocol, you must associate the volume with the export policy of the hosting SVM and manually configure policies and associated rules.

- **Rehosting SAN volumes** on page 100
  
  You can rehost volumes that have mapped LUNs. After re-creating the initiator group (igroup) in the destination SVM, volume rehost can automatically remap the volume on the same SVM.

- **Rehosting volumes in a SnapMirror relationship** on page 101
  
  You can rehost volumes in a SnapMirror relationship.

- **Features that do not support volume rehost** on page 103
  
  There are certain features that do not support volume rehost.

Rehosting CIFS volumes

You can rehost volumes that serve data over SMB protocol. After rehosting the CIFS volume, to continue accessing data over SMB protocol, you must manually configure policies and the associated rules.

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.

  Note: 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.

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.

• 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

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:
   ```bash
   volume unmount
   ```

3. Switch to the advanced privilege level:
   ```bash
   set -privilege advanced
   ```

4. Rehost the volume on the destination SVM:
   ```bash
   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/CIFS configuration express*

*SMB/CIFS and NFS multiprotocol express configuration*

---

**Rehosting NFS volumes**

You can rehost volumes that serve data over NFS protocol. After rehosting the NFS volumes, to continue accessing data over NFS protocol, you must associate the volume with the export policy of the hosting SVM and manually configure policies and associated rules.

**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.

**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
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 vol_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.

NFS express configuration

Rehosting SAN volumes

You can rehost volumes that have mapped LUNs. After re-creating the initiator group (igroup) in the destination SVM, volume rehost can automatically remap the volume on the same SVM.

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`.

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:
  - 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

Steps

1. Record LUN mapping information on target volume:
   ```
   lun mapping show-volume volume to be rehosted-vserver source vserver
   ```
   This is a precautionary step to avoid losing information about LUN mapping in case the volume rehost fails.

2. Delete igroups associated with the target volume.

3. Rehost the target volume to the destination SVM:
   ```
   volume rehost -vserver source_svm -volume vol_name -destination-vserver destination_svm
   ```

4. Map LUNs on the target volume to appropriate igroups.
   - Volume rehost preserves LUNs on the target volume; however, 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.

Rehosting volumes in a SnapMirror relationship

You can rehost volumes in a SnapMirror relationship.

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.

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

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
   ```
   You must 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 Snapshot copies.
4. Switch to the advanced privilege level:
   ```
   set -privilege advanced
   ```
5. Rehost the volume on the destination SVM:
   ```
   volume rehost -vserver source_svm -volume vol_name -destination-vserver destination_svm
   ```
6. If the SVM peering relation is not present, create the SVM peer relationship between the source SVM and destination SVM:
   ```bash
   vserver peer create
   ```

7. Create the SnapMirror relationship between the source volume and destination volume:
   ```bash
   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.

8. Resynchronize the SnapMirror relationship.

**Features that do not support volume rehost**

There are certain features that do not support volume rehost.

The following features do not support volume rehost:

- VDR setup
- MetroCluster configurations
- SnapLock volumes
- VGE volumes
  Volume encryption keys depend on SVM keys, so if a volume is moved to another SVM, the volume and the SVM keys do not match.
- FlexGroup volumes
- Clone volumes
Storage limits

There are limits for storage objects that you should consider when planning and managing your storage architecture.

Limits are listed in the following sections:

- **Volume limits**
- **FlexClone file and FlexClone LUN limits**

Storage limits for Cloud Volumes ONTAP are documented in the *Cloud Volumes ONTAP Release Notes*.

### Volume limits

<table>
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<th>Storage object</th>
<th>Limit</th>
<th>Native storage</th>
<th>Storage arrays</th>
<th>Data ONTAP Edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Array LUNs</td>
<td>Minimum size for root volume</td>
<td>N/A</td>
<td>Model-dependent</td>
<td>N/A</td>
</tr>
<tr>
<td>Files</td>
<td>Maximum size</td>
<td>16 TB</td>
<td>16 TB</td>
<td>16 TB</td>
</tr>
<tr>
<td></td>
<td>Maximum per volume</td>
<td>Volume size dependent, up to 2 billion</td>
<td>Volume size dependent, up to 2 billion</td>
<td>Volume size dependent, up to 2 billion</td>
</tr>
<tr>
<td>FlexClone volumes</td>
<td>Hierarchical clone depth</td>
<td>499</td>
<td>499</td>
<td>499</td>
</tr>
<tr>
<td>FlexVol volumes</td>
<td>Maximum per node</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Maximum per node per SVM</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Minimum size</td>
<td>20 MB</td>
<td>20 MB</td>
<td>20 MB</td>
</tr>
<tr>
<td></td>
<td>Maximum size</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
</tr>
<tr>
<td>FlexVol root volumes</td>
<td>Minimum size</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
</tr>
<tr>
<td>LUNs</td>
<td>Maximum per node</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>1,024</td>
</tr>
<tr>
<td></td>
<td>Maximum per cluster</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>1,024</td>
</tr>
<tr>
<td></td>
<td>Maximum per volume</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>512</td>
</tr>
<tr>
<td></td>
<td>Maximum size</td>
<td>16 TB</td>
<td>16 TB</td>
<td>16 TB</td>
</tr>
<tr>
<td>Qtrees</td>
<td>Maximum per FlexVol volume</td>
<td>4,995</td>
<td>4,995</td>
<td>4,995</td>
</tr>
<tr>
<td>Snapshot copies</td>
<td>Maximum per FlexVol volume or Infinite Volume</td>
<td>255</td>
<td>255</td>
<td>255</td>
</tr>
</tbody>
</table>
### Storage limits

<table>
<thead>
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<th>Data ONTAP Edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumes</td>
<td>Maximum per cluster for NAS&lt;sup&gt;6&lt;/sup&gt;</td>
<td>12,000</td>
<td>12,000</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Maximum per cluster with SAN protocols configured&lt;sup&gt;7&lt;/sup&gt;</td>
<td>Model-dependent</td>
<td>Model-dependent</td>
<td>200</td>
</tr>
</tbody>
</table>

#### Notes:

1. **Hardware Universe**
2. 2 billion = $2 \times 10$ to the 9<sup>th</sup> power.
3. The maximum depth of a nested hierarchy of FlexClone volumes that can be created from a single FlexVol volume.
4. This limit applies only in SAN environments.  
   *SAN Configuration Guide*  
5. You can use a SnapMirror cascade deployment to increase this limit.
6. Infinite Volumes do not count against this limit, but their constituent volumes do.
7. Infinite Volumes do not count against this limit, but their constituent volumes do.  
   *SAN Configuration Guide*

#### FlexClone file and FlexClone LUN limits

<table>
<thead>
<tr>
<th>Limit</th>
<th>Native storage</th>
<th>Storage arrays</th>
<th>Data ONTAP Edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum per file or LUN&lt;sup&gt;1&lt;/sup&gt;</td>
<td>32,767</td>
<td>32,767</td>
<td>32,767</td>
</tr>
<tr>
<td>Maximum total shared data per FlexVol volume</td>
<td>640 TB</td>
<td>640 TB</td>
<td>100 TB</td>
</tr>
</tbody>
</table>

#### Note:

1. If you try to create more than 32,767 clones, ONTAP automatically creates a new physical copy of the parent file or LUN.
   This limit might be lower for FlexVol volumes that use deduplication.

#### Related information

*Find the Release Notes for your version of Cloud Volumes ONTAP*
Appendix: 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 volume and LUN configuration combination 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 Snapshot copies 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.

Determining the correct volume and LUN configuration combination for your environment

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.

Note: 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

This FlexVol volume and file or LUN configuration combination 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:

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.

Note: 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

This FlexVol volume and file or LUN configuration combination 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:
### Configuration 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:

<table>
<thead>
<tr>
<th>Volume setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guarantee</td>
<td>Volume</td>
</tr>
<tr>
<td>Fractional reserve</td>
<td>100</td>
</tr>
<tr>
<td>Snapshot reserve</td>
<td>Any</td>
</tr>
<tr>
<td>Snapshot autodelete</td>
<td>Optional</td>
</tr>
<tr>
<td>Autogrow</td>
<td>Optional; if enabled, aggregate free space must be actively monitored.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>File or LUN setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space reservation</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

### 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

This FlexVol volume and file or LUN configuration combination requires less storage to be allocated up front than the fully provisioned combination, but 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:

<table>
<thead>
<tr>
<th>Volume setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guarantee</td>
<td>None</td>
</tr>
<tr>
<td>Fractional reserve</td>
<td>0</td>
</tr>
<tr>
<td>Snapshot reserve</td>
<td>Any</td>
</tr>
<tr>
<td>Snapshot autodelete</td>
<td>Optional</td>
</tr>
<tr>
<td>Autogrow</td>
<td>Optional</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>File or LUN setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space reservation</td>
<td>Disabled</td>
</tr>
</tbody>
</table>
### Volume setting

<table>
<thead>
<tr>
<th>Volume setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guarantee</td>
<td>Volume</td>
</tr>
<tr>
<td>Fractional reserve</td>
<td>0</td>
</tr>
<tr>
<td>Snapshot reserve</td>
<td>0</td>
</tr>
<tr>
<td>Snapshot autodelete</td>
<td>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.</td>
</tr>
<tr>
<td>Autogrow</td>
<td>Optional; if enabled, aggregate free space must be actively monitored.</td>
</tr>
</tbody>
</table>

### File or LUN setting

<table>
<thead>
<tr>
<th>File or LUN setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space reservation</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

### 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, Snapshot copies) 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.
Appendix: Cautions and considerations for changing file or directory capacity

If your data requires a large number of files or very large directories, you can expand ONTAP file or directory capacity. However, you should understand the limitations and caveats for doing so before proceeding.

Considerations for changing the maximum number of files allowed on a FlexVol volume

FlexVol volumes have a maximum number of files that they can contain. You can change the maximum number of files for a volume, but before doing so you should understand how this change affects the volume.

The number of files a volume can contain is determined by how many inodes it has. An inode is a data structure that contains information about files. Volumes have both private and public inodes. Public inodes are used for files that are visible to the user; private inodes are used for files that are used internally by ONTAP. You can change only the maximum number of public inodes for a volume. You cannot affect the number of private inodes.

ONTAP automatically sets the maximum number of public inodes for a newly created volume based on the size of the volume: 1 inode per 32 KB of volume size. When the size of a volume is increased, either directly by an administrator or automatically by ONTAP through the autosize feature, ONTAP also increases (if necessary) the maximum number of public inodes so there is at least 1 inode per 32 KB of volume size, until the volume reaches approximately 680 GB in size. Growing the volume greater than 680 GB in size does not automatically result in more inodes, because ONTAP does not automatically create more than 22,369,621 inodes. If you need more files than the default number for any size volume, you can use the volume modify command to increase the maximum number of inodes for the volume.

You can also decrease the maximum number of public inodes. This does not change the amount of space currently allocated to inodes, but it does lower the maximum amount of space the public inode file can consume. However, after space has been allocated for inodes, it is never returned to the volume. Therefore, lowering the maximum number of inodes below the number of inodes currently allocated does not return the space used by the allocated but unused inodes to the volume.

Cautions for increasing the maximum directory size for FlexVol volumes

The default maximum directory size for FlexVol volumes is model-dependent, and optimized for the size of system memory. Before increasing the maximum directory size, involve technical support.

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. This command has no effect for Infinite Volumes.
Rules governing node root volumes and root aggregates

A node's root volume contains special directories and files for that node. The root aggregate contains the root volume. A few rules govern a node's root volume and 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.
  ◦ Contact technical support if you need to designate a different volume to be the new root volume or move the root volume to another aggregate.

• The root aggregate is dedicated to the node's root volume only. ONTAP prevents you from creating other volumes in the root aggregate.

Related information

NetApp Hardware Universe
Appendix: Features supported with FlexClone files and FlexClone LUNs

FlexClone files and FlexClone LUNs work with different ONTAP features, such as deduplication, Snapshot copies, quotas, and volume SnapMirror.

The following features are supported with FlexClone files and FlexClone LUNs:

• Deduplication
• Snapshot copies
• Access control lists
• Quotas
• FlexClone volumes
• NDMP
• Volume SnapMirror
• The `volume move` command
• Space reservation
• HA configuration

How deduplication works 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.

**Note:** 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.

How Snapshot copies work with FlexClone files and FlexClone LUNs

You can create FlexClone files and FlexClone LUNs from an existing Snapshot copy of the parent files and parent LUNs contained in a FlexVol volume.

However, you cannot manually delete a Snapshot copy from which FlexClone files or FlexClone LUNs are being created until the block-sharing process between the parent and clone entities is complete. The Snapshot copy remains locked until the completion of the block-sharing process, which occurs in the background. Therefore, when you try to delete a locked Snapshot copy, the system displays a message asking you to retry the operation after some time. In such a situation, if you want to manually delete the particular Snapshot copy, you must keep retrying the deletion operation so that the Snapshot copy is deleted after the block sharing is complete.
How access control lists work with 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

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 exceed.

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.

How FlexClone volumes work with 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.

Note: When FlexClone files and FlexClone LUNs are being created from an existing Snapshot copy 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**

Volume SnapMirror used 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 volume move affects FlexClone files and FlexClone LUNs**

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

**How space reservation works with FlexClone files and FlexClone LUNs**

FlexClone files and FlexClone LUNs inherit the space reservation attribute from the parent file and parent LUN by default. However, you can create FlexClone files and FlexClone LUNs with space reservation disabled from a parent file and parent LUN with space reservation enabled if the FlexVol volume lacks space.

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, then the cloning operation fails.

**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.
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