Module 6
Logical storage management

About this module

This module focuses on enabling you to do the following:

- Create and manage FlexVol volumes
- Provision application-aware resources
- Move a volume within a storage VM (storage virtual machine, also known as SVM)
- Create a NetApp ONTAP FlexGroup volume

Lesson 1
Flexible volumes

ONTAP storage architecture

Logical layer

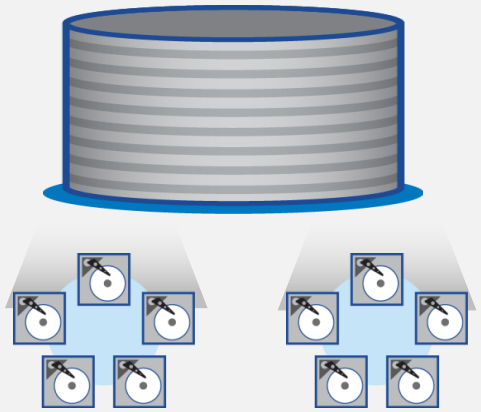
Covered in detail in Module 6

Files and LUNs

FlexVol volumes

Physical layer

Covered in detail in Module 5



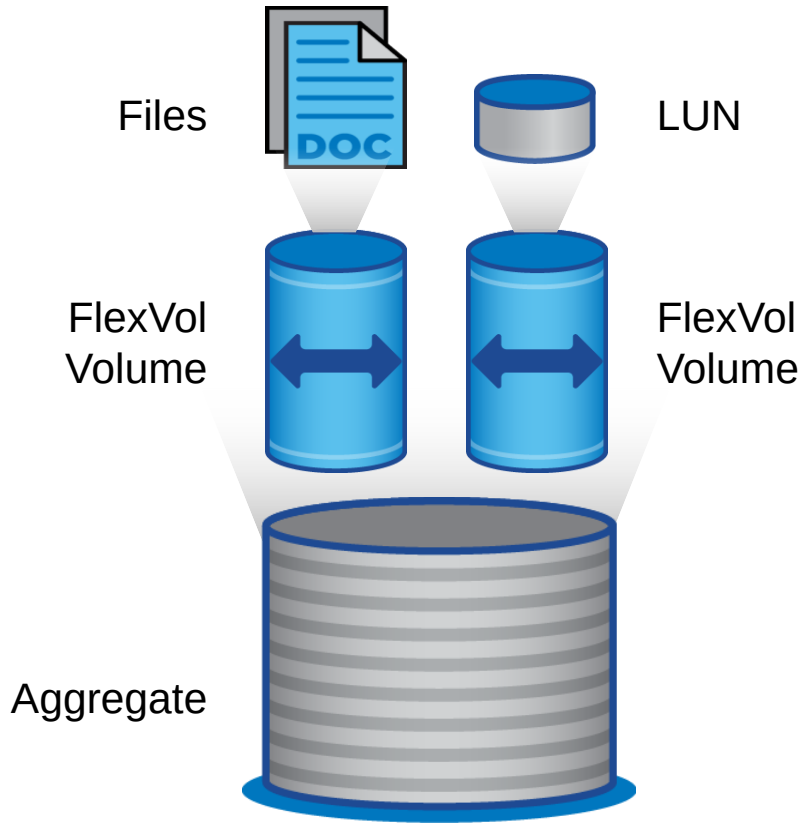
Aggregate

RAID groups of drives

FlexVol volumes

A FlexVol volume is a container for data.

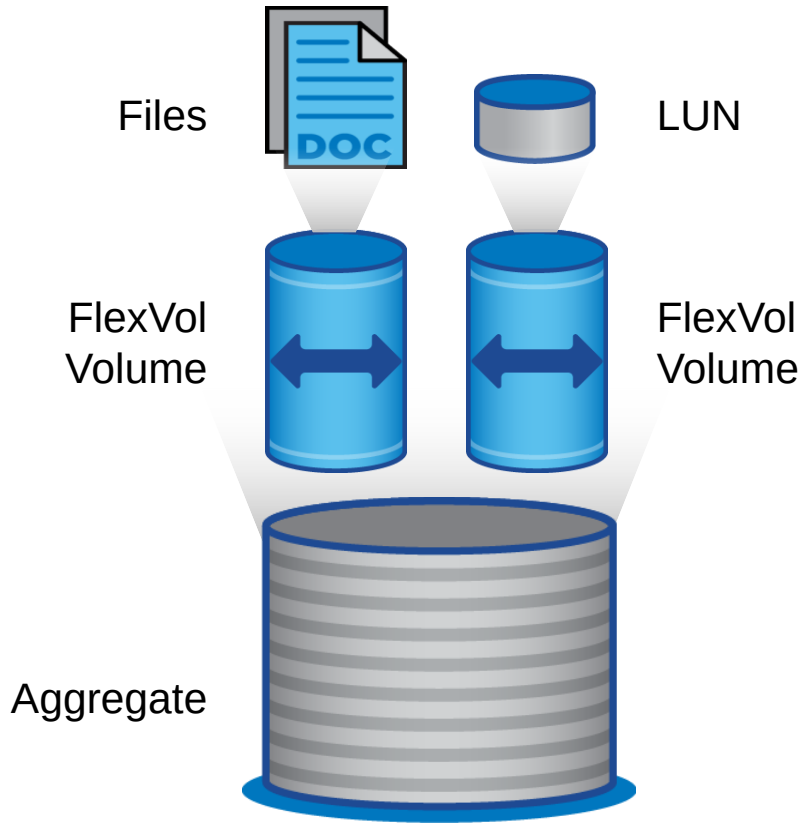
- Can contain NAS, SAN, or both types of data
  Mixing is not recommended.
- Is contained within an aggregate
  An aggregate can hold multiple FlexVol volumes.
- Can increase or decrease in size, as needed



FlexVol volumes

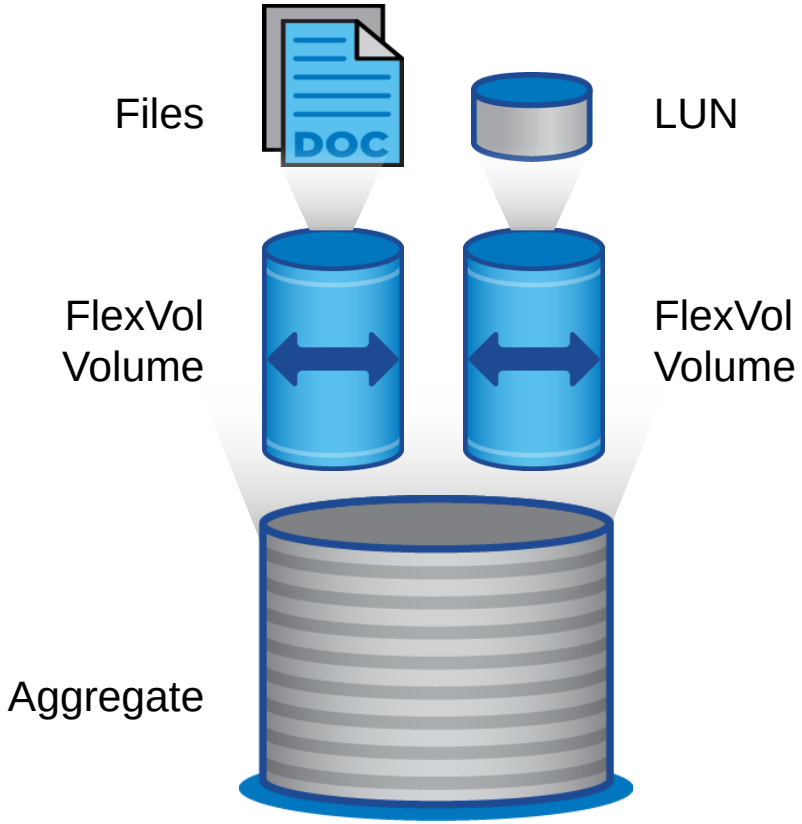
Types

- System (or node root):
  - Typically named vol0
  - Contains only configuration and logs
  - Cannot contain user data
  - Owned by the node SVM
- SVM root volume:
  - Top level of the namespace
  - Should not contain user data
- Data:
  - **NAS:** Contains file systems for user data
  - **SAN:** Contains LUNs



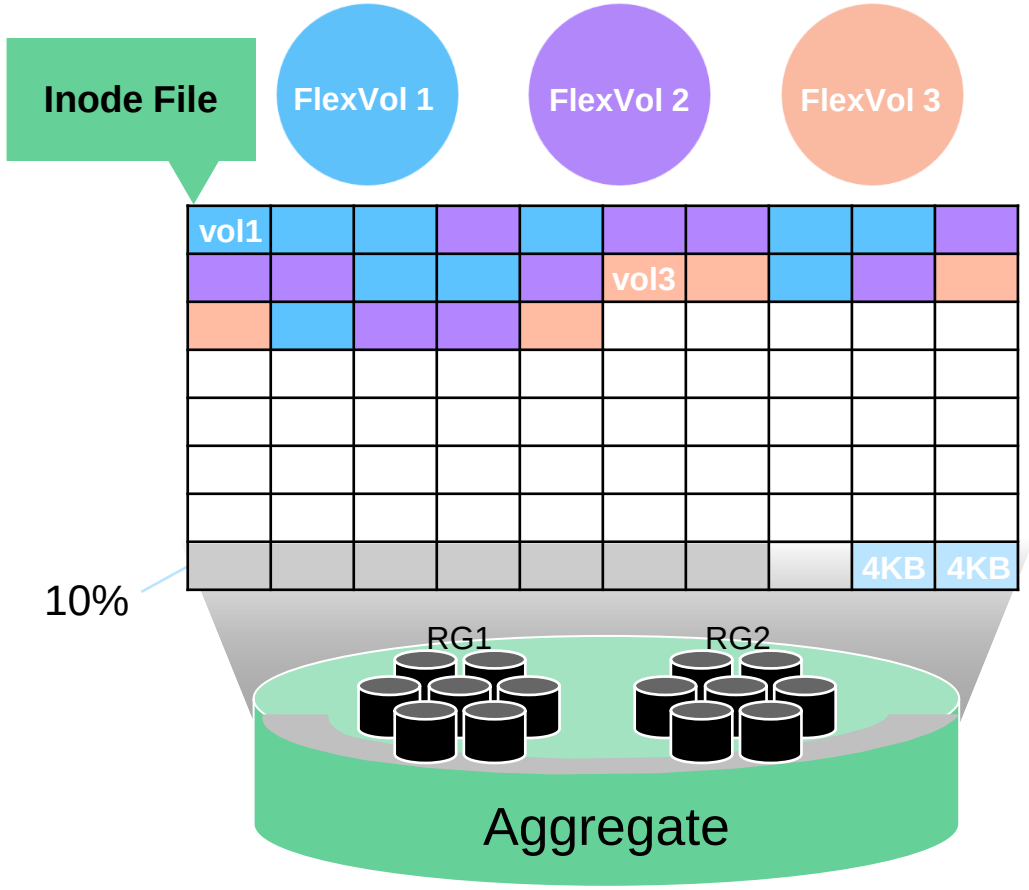
Files and LUNs

- A file refers to any data (including text files, spreadsheets, and databases) that is exported to or shared with NAS clients.
- A LUN represents a logical drive that a SCSI protocol (FC or iSCSI) addresses:
  - It is block level.
  - Data is accessible by only a properly mapped SCSI host.



Volumes in aggregates

- Aggregate:
  - 4KB blocks
  - NetApp WAFL file system reserving 10%
- Volume:
  - Provisioning types:
    - **Thick:** Volume guarantee = volume
    - **Thin:** Volume guarantee = none
  - Dynamic mapping to physical space



Volume properties

Actions that can be taken on volumes

Create

Edit

Resize

Delete

Clone

Move

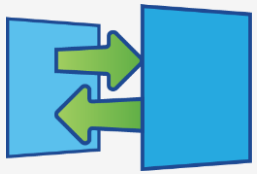
Rehost

Volume options

Storage efficiency

Storage quality of service (QoS)

Tools to protect volumes



Snapshot copies

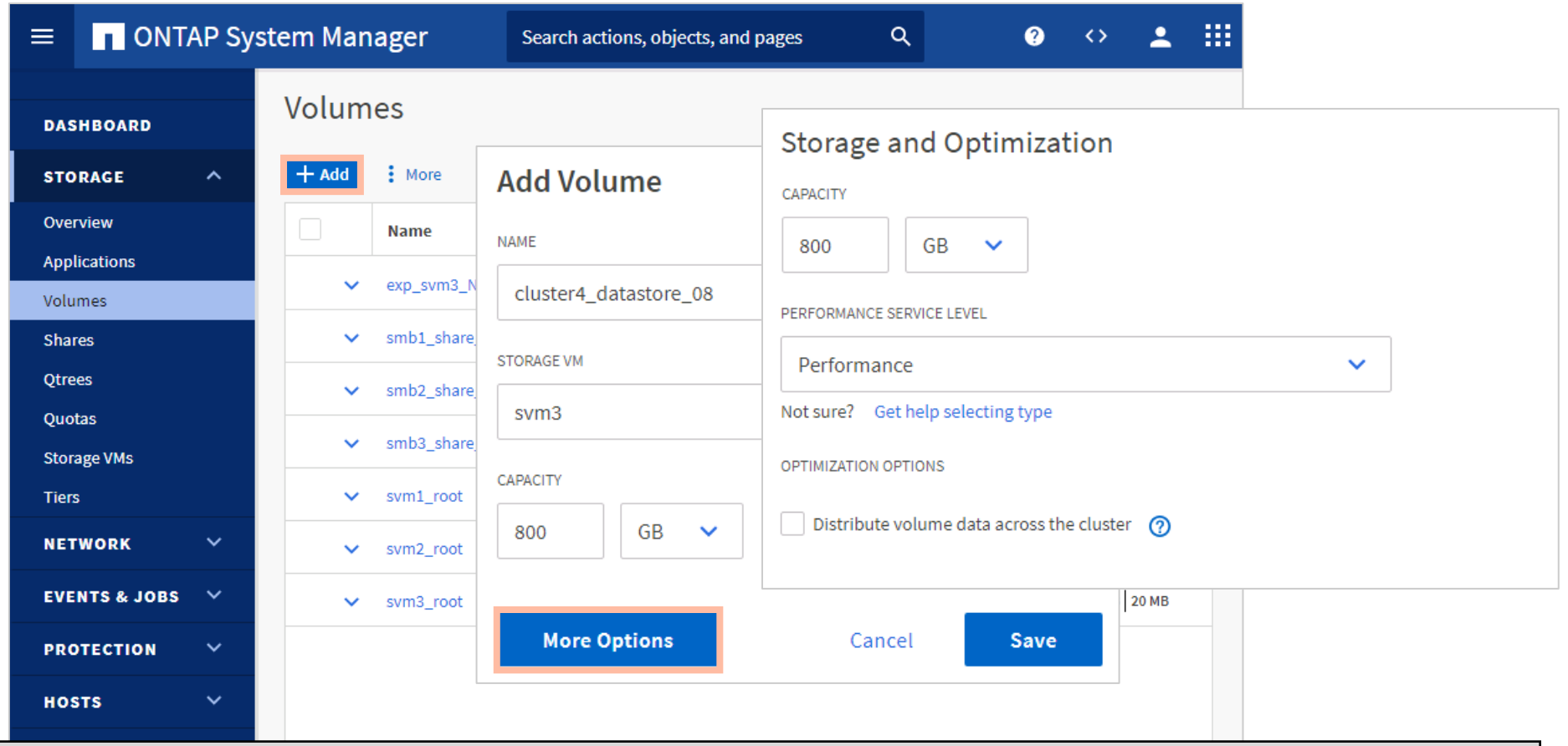
Mirror copies

Vault copies

Create a flexible volume in an SVM

Information to provide:

- Volume name
- SVM name
- Capacity
- Service level




```
::> volume create -vserver svm4 -name svm4_vol_002
    -aggr cluster2_01_FC_1 -size 200gb
```

Balanced placement

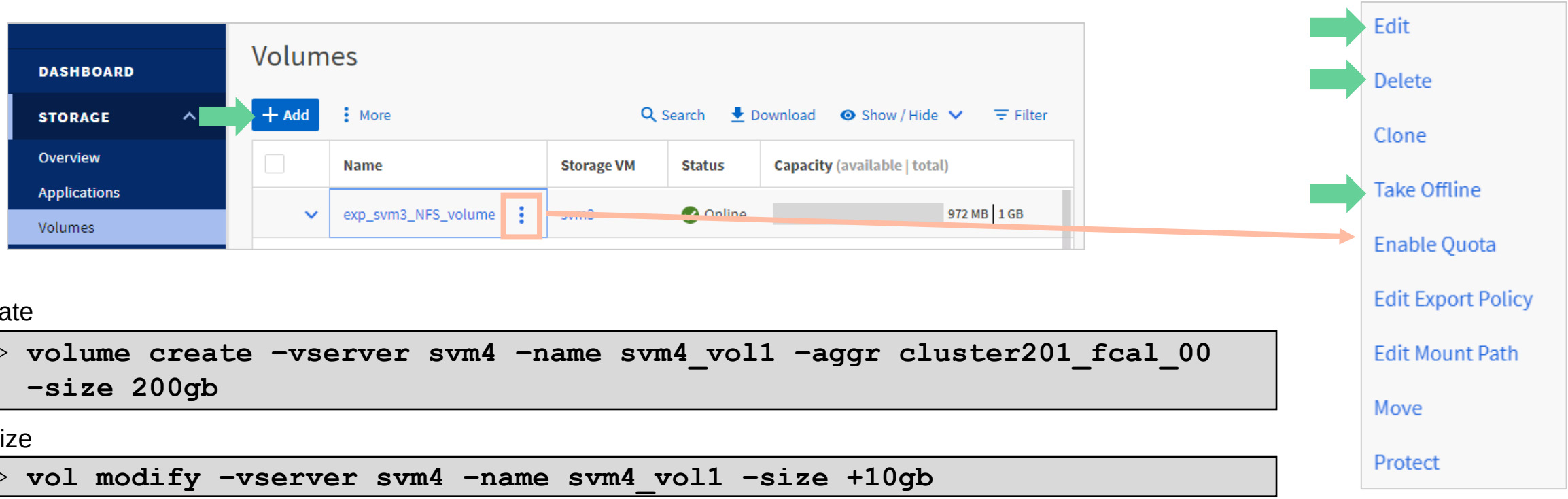
Storage service levels

	Application-Aligned Storage Service Levels		
Service Level	**Value**	**Performance**	**Extreme**
Workload Type	Email, web, file shares, backup	Database and virtualized applications	Latency-sensitive applications
Expected IOPS (IOPS per TB allocated)	128	2048	6144
Maximum Service-Level Objective (SLO) (QoS limit in IOPS per TB stored)	512	4096	12288
Minimum SLA (IOPS per TB allocated)	75	500	1500
Latency (ms)	17	2	1

Balanced use of cluster resources

- Simplified provisioning
- Recommended placement based on size of application components, desired storage service levels, and available system resources
- Predefined storage service levels to match the media with requested performance characteristics (QoS)

Management of FlexVol volumes



Create

```
::> volume create -vserver svm4 -name svm4_vol1 -aggr cluster201_fcal_00
    -size 200gb
```

Resize

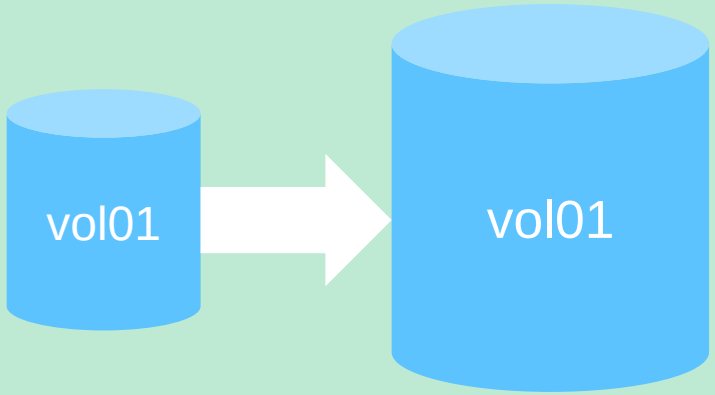
```
::> vol modify -vserver svm4 -name svm4_vol1 -size +10gb
```

Destroy

```
::> vol offline -vserver svm4 -name svm4_vol1
::> vol delete -vserver svm4 -name svm4_vol1
```

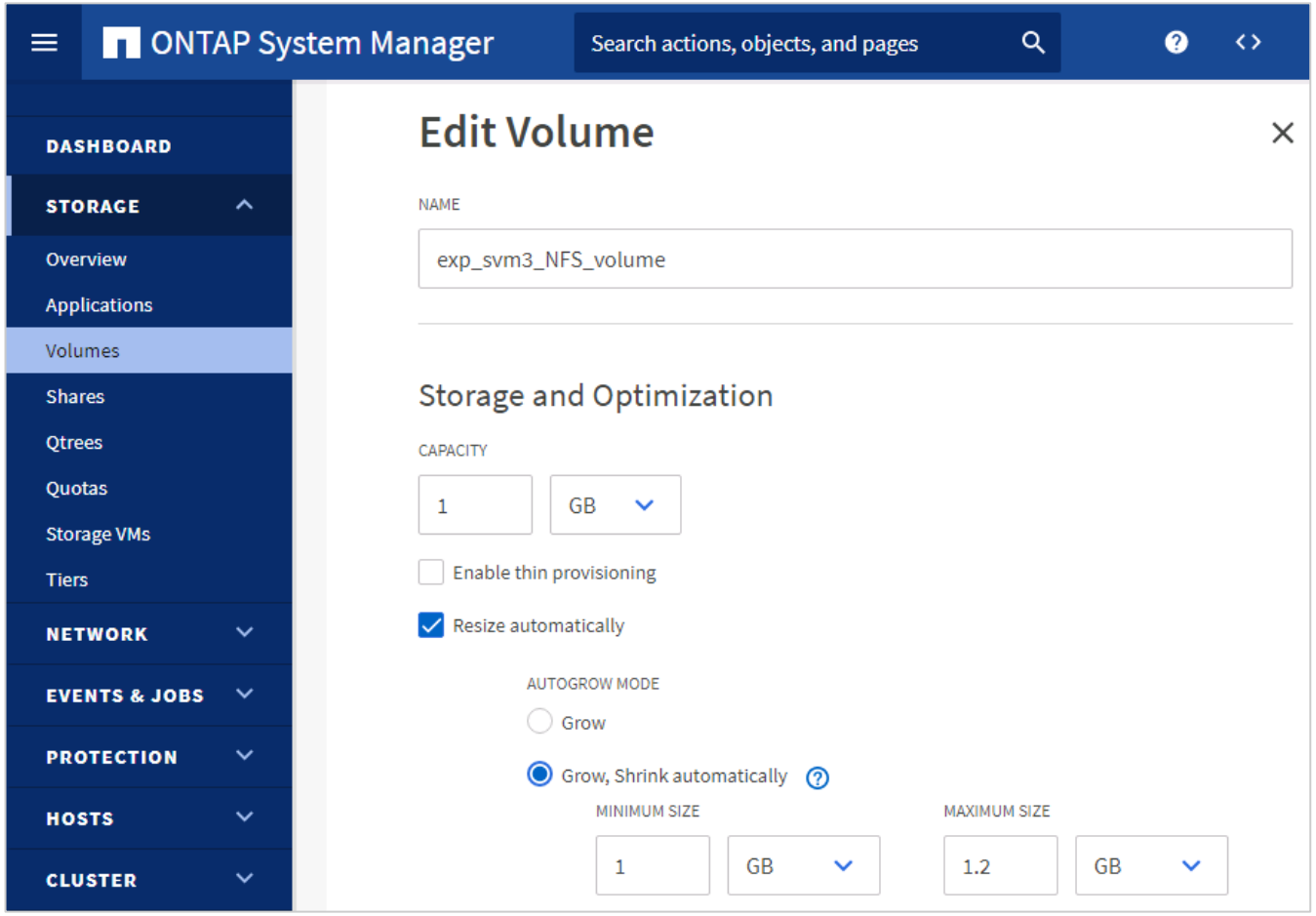

Automatic resizing of volumes

- Automatic resizing of volumes enables a FlexVol volume to automatically grow or shrink the maximum space capacity of the volume.
- You can specify a mode:
  - **Off:** The volume does not grow or shrink.
  - **Grow:** The volume automatically grows when space in the volume reaches a threshold.
  - **Grow_shrink:** The volume automatically grows or shrinks in response to the amount of used space.
- Also, you can specify the following:
  - Maximum to grow (default is 120% of volume size)
  - Minimum to shrink (default is volume size)
  - Grow and shrink thresholds



Enable automatic resizing

1. In the Volumes page, select the volume and select **Edit** from the menu.
2. Select the **Resize automatically** checkbox.
3. Select an Autogrow Mode option.
4. Specify the Maximum Size value.




```
::> volume autosize -vserver svm4 -volume svm4_vol_002
    -mode grow -maximum-size 200GB
```


Try this task

Use cluster1 on your exercise kit:

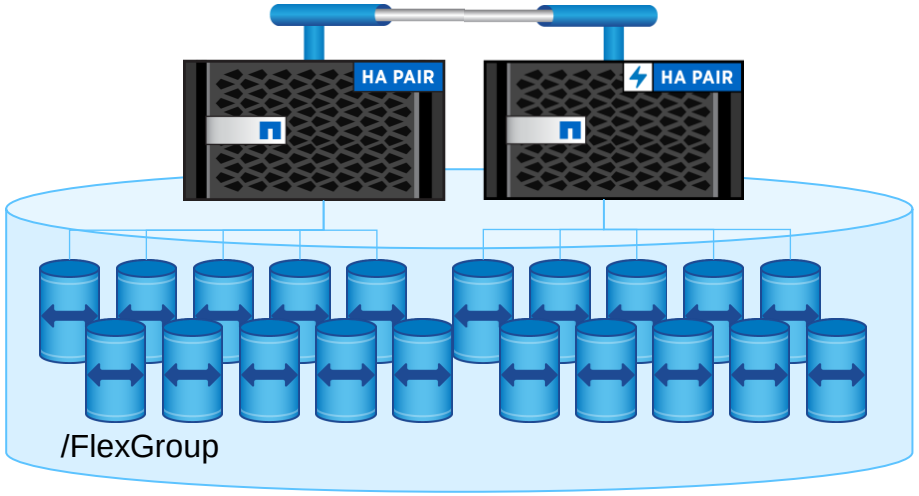
1. Enter the **`vol show`** command.
2. Enter the **`vol show -instance`** command.
3. Enter the **`vol show -fields comment`** command.
4. Answer the following questions:
   - What was different about the output?
   - Can you think of other reasons to use `-fields`?
   - How can you get a list of all the fields that are available for a command?

What is a FlexGroup volume?

- A scale-out file system that is created from a group of FlexVol volumes
- A system that you and NAS clients can interact with as you interact with a FlexVol volume

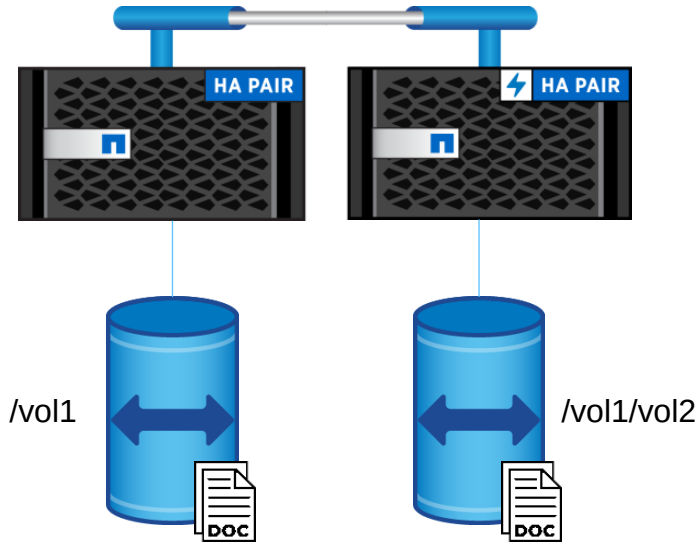
FlexGroup volumes solve three problems with modern NAS in scale-out storage:

- **Performance:** FlexGroup volumes provide consistently low latency.
- **Capacity:** FlexGroup volumes provide almost unlimited capacity.
- **Management:** A FlexGroup volume looks like a FlexVol volume.



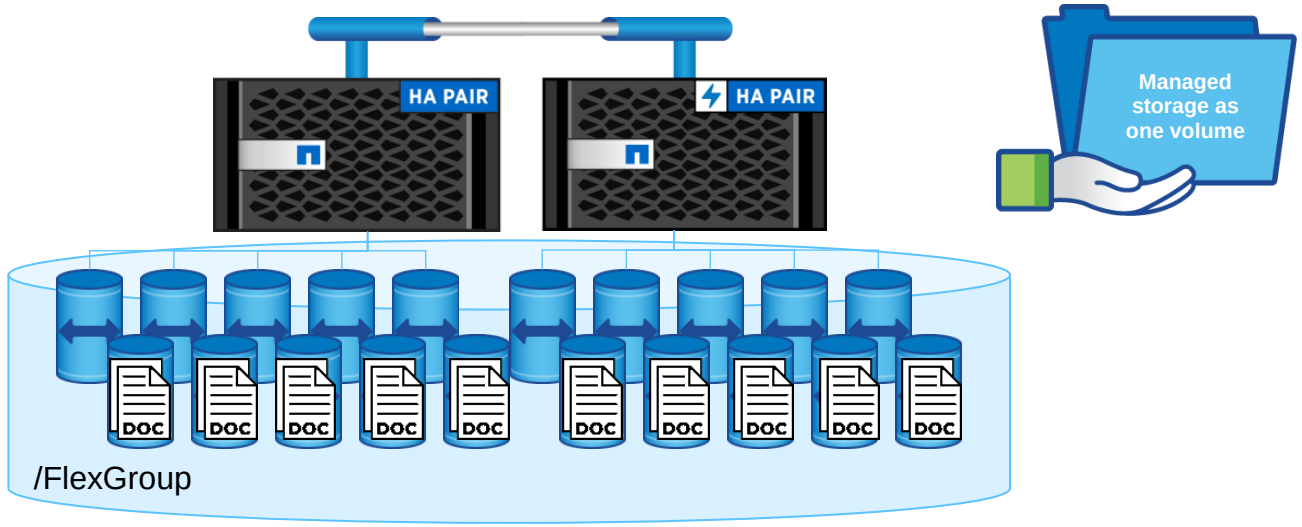
FlexVol volumes versus FlexGroup volumes

How they differ at a high level



FlexVol volumes

- Are owned by one node
- Span one aggregate
- Isolate reads and writes to one node and aggregate
- Are limited to storing 100TB (system-dependent)
- Are within one namespace, but with limits



FlexGroup volumes

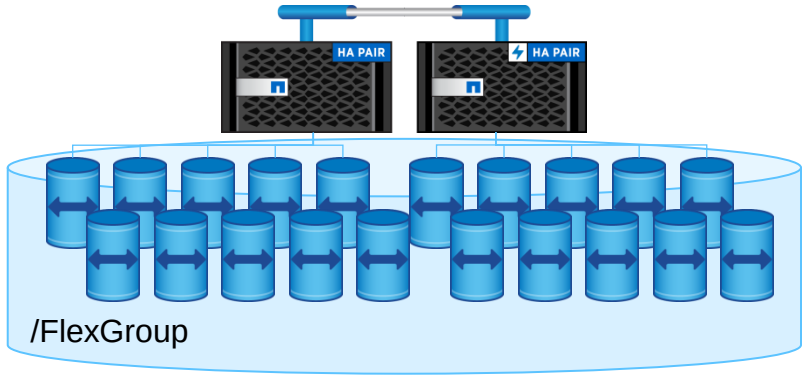
- Are shared pools of FlexVol volumes
- Have component volumes that span multiple aggregates
- Balance reads and writes across all nodes and aggregates
- Can store up to 20PB (200 FlexVol volumes)
- Are within one namespace, almost without limits

HA = high-availability

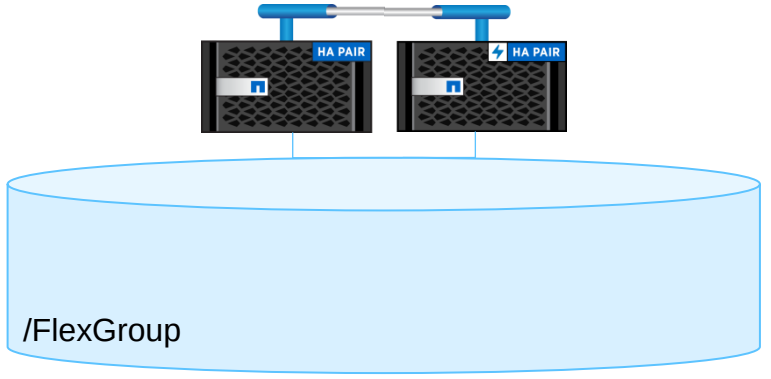
Management of FlexGroup volumes

You manage FlexGroup volumes as you manage FlexVol volumes.

- You create the FlexGroup volume, and ONTAP software manages the rest:
  - When you create the FlexGroup volume, you specify the size, aggregates, SVM, and file system path.
  - ONTAP software creates equally sized constituent volumes.
- If you need more space, you can add a constituent volume anywhere in the cluster.



What ONTAP software sees



What clients see

FlexCache volumes

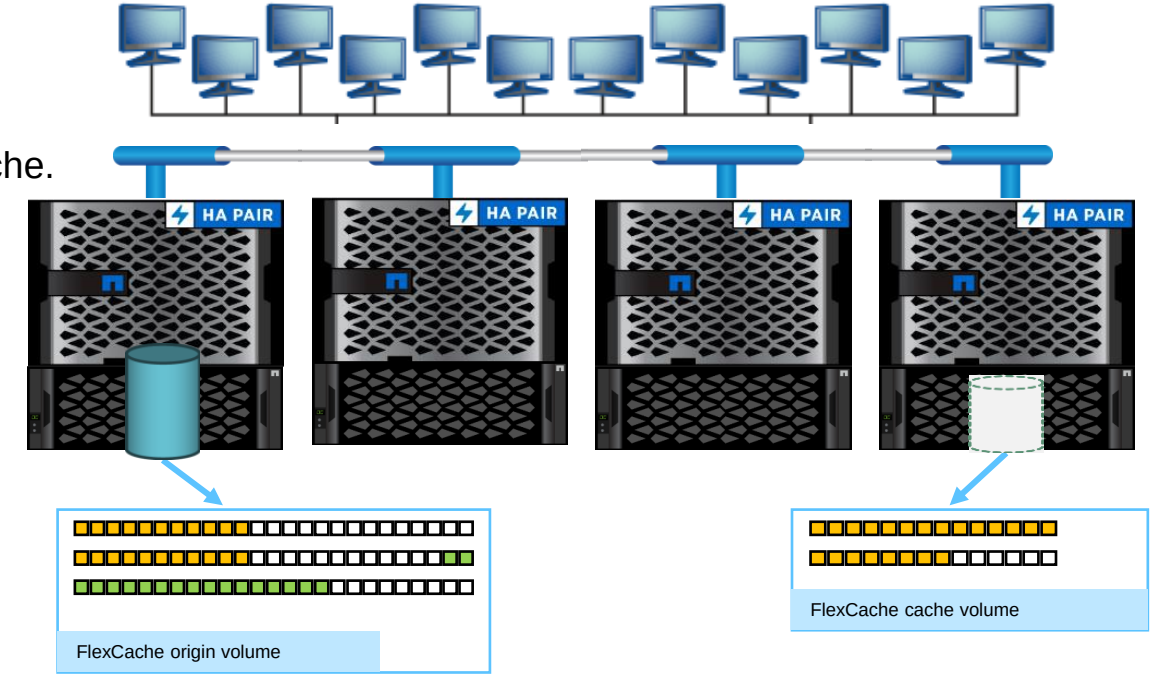
Accelerate hot volumes

A FlexCache volume is a sparsely populated FlexGroup volume that is used to cache data from a particular volume called the origin. Data is only cached when a client connected to the cache reads it.

- Cache read for I/O intensive workloads
- Cache data within the cluster (intracluster) or to remote sites (including the cloud)

FlexCache volume limitations:

- There are no Snapshot copies or FlexClone support on the cache.
- Deduplication, compression, and compaction are supported.
- FlexCache supports only NFS version 3 (NFSv3) and CIFS or SMB at the cache volume.

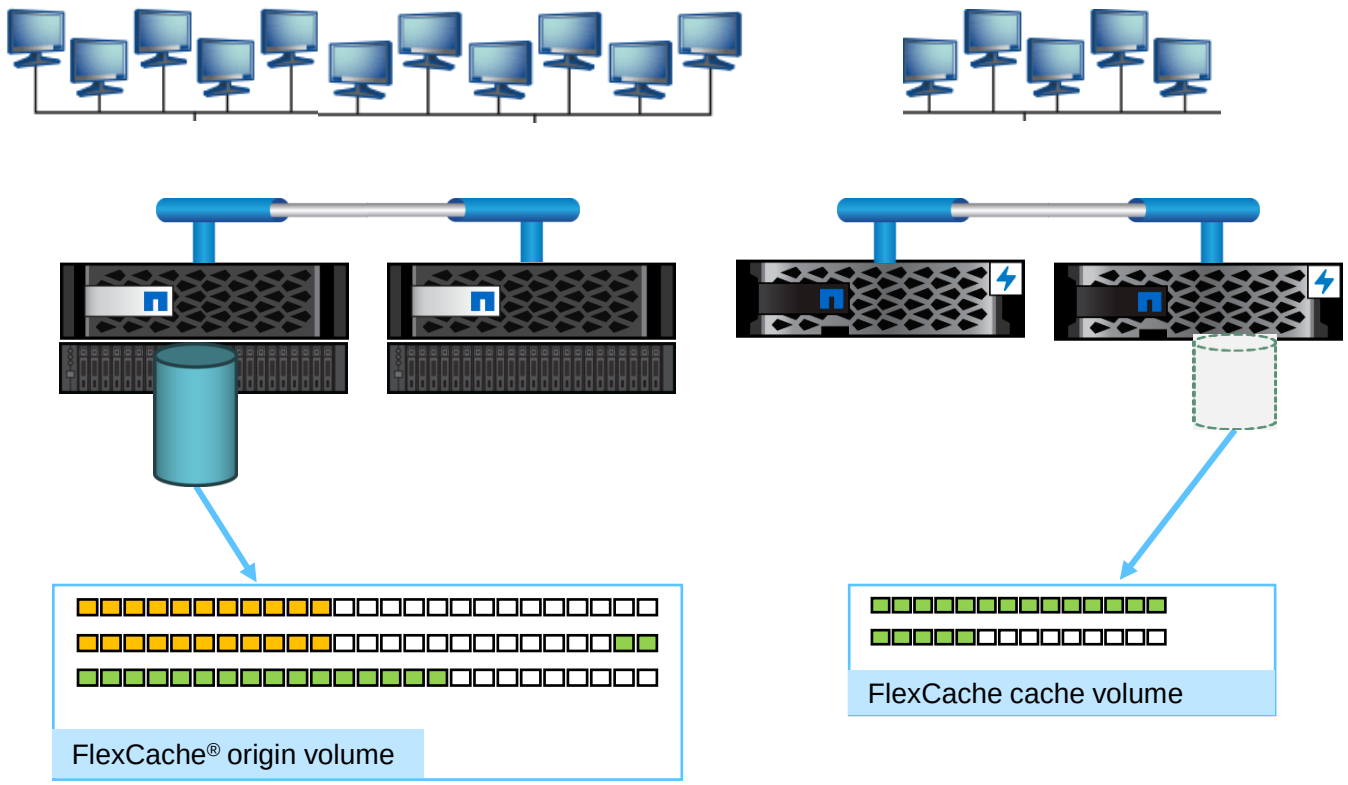


FlexCache volumes

Accelerate data access to remote users

Data distribution across data centers:

- Caches across multiple data centers to reduce WAN latencies
- Brings data closer to compute or users or both
- Populates the cache to reduce initial read latencies
- Works among NetApp AFF, FAS, ONTAP Select, and Cloud Volumes ONTAP systems

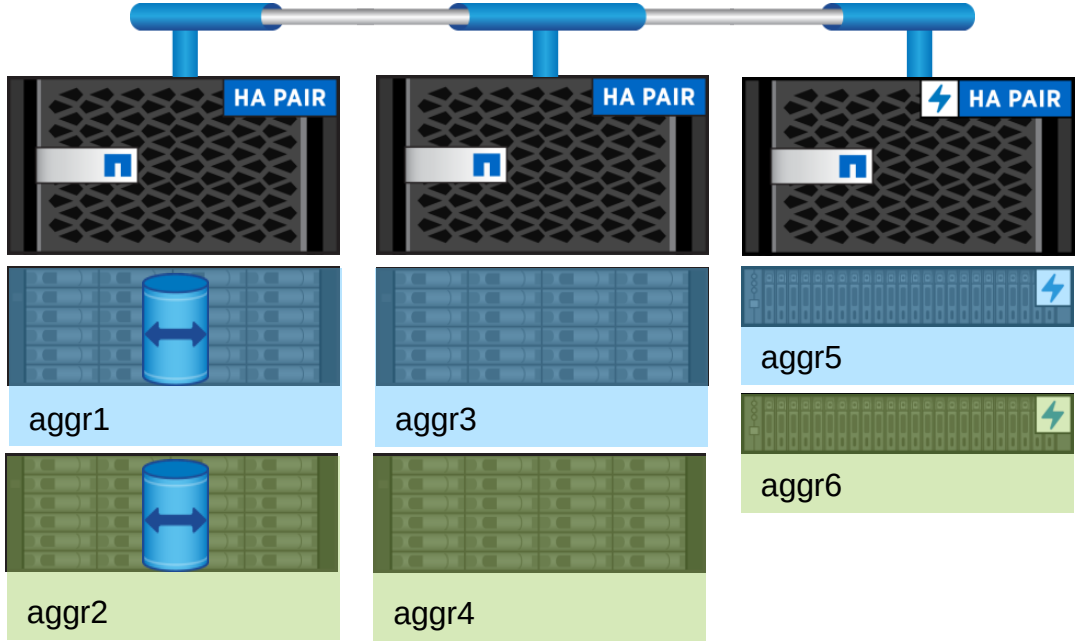


? More info in Addendum

Lesson 2
Moving storage resources

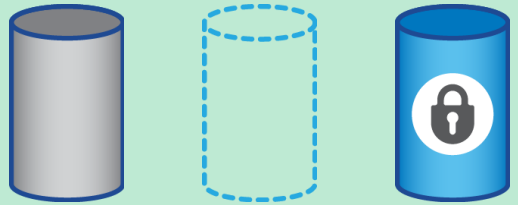
Volume move

- Rules:
  - Move only within the SVM.
  - Move to any aggregate to which the SVM has permission.
  - Move is nondisruptive to the client.
- Use cases:
  - **Capacity:** Move a volume to an aggregate with more space.
  - **Performance:** Move to an aggregate with different performance characteristics.
  - **Servicing:** Move to newly added nodes or from nodes that are being retired.

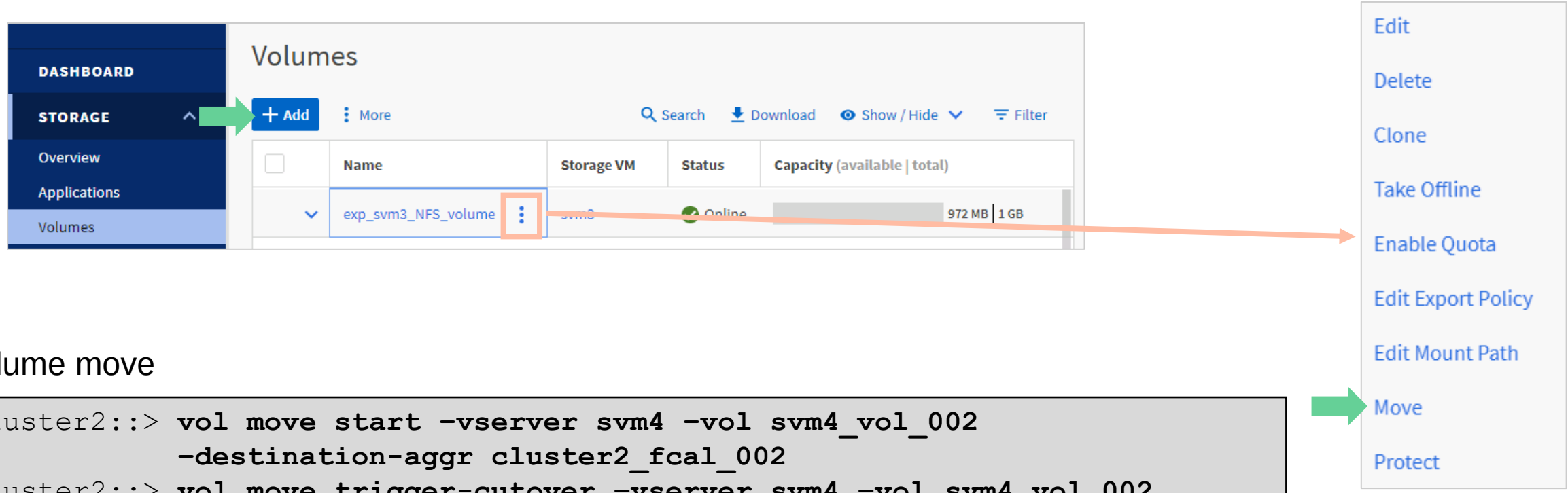


How a volume move works

1. A volume is created on the destination aggregate.
2. A Snapshot copy of the source volume is created.
3. The Snapshot copy is replicated to the destination volume.
4. When replication is complete, client access is temporarily blocked.
5. A final replication is performed to reach consistency.
6. Cutover is initiated.
7. Clients access the destination volume, and the source volume is cleaned up.



The `volume move` command



Volume move

```
cluster2::> vol move start -vserver svm4 -vol svm4_vol_002
            -destination-aggr cluster2_fcal_002
cluster2::> vol move trigger-cutover -vserver svm4 -vol svm4_vol_002
```


Autobalancing aggregates

Default settings

- If you frequently move volumes to free up space, you can use the `autobalance aggregate` command to configure ONTAP software to autobalance automatically for all aggregates.
- The autobalance aggregate feature is turned off by default. See the addendum for more information.

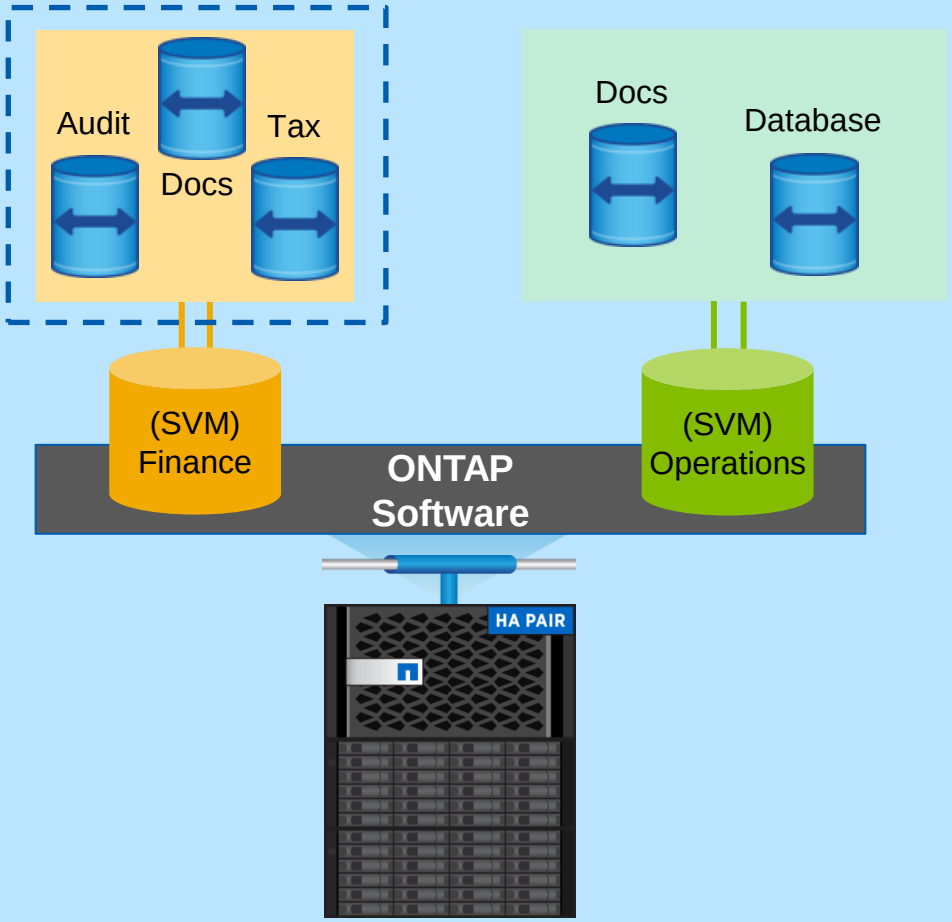
```
::*> autobalance aggregate config show
                Is the Auto Balance Aggregate Feature Enabled: false
     Threshold When Aggregate Is Considered Unbalanced (%): 70
       Threshold When Aggregate Is Considered Balanced (%): 40
```

? More info in Addendum

Volume rehost within a cluster

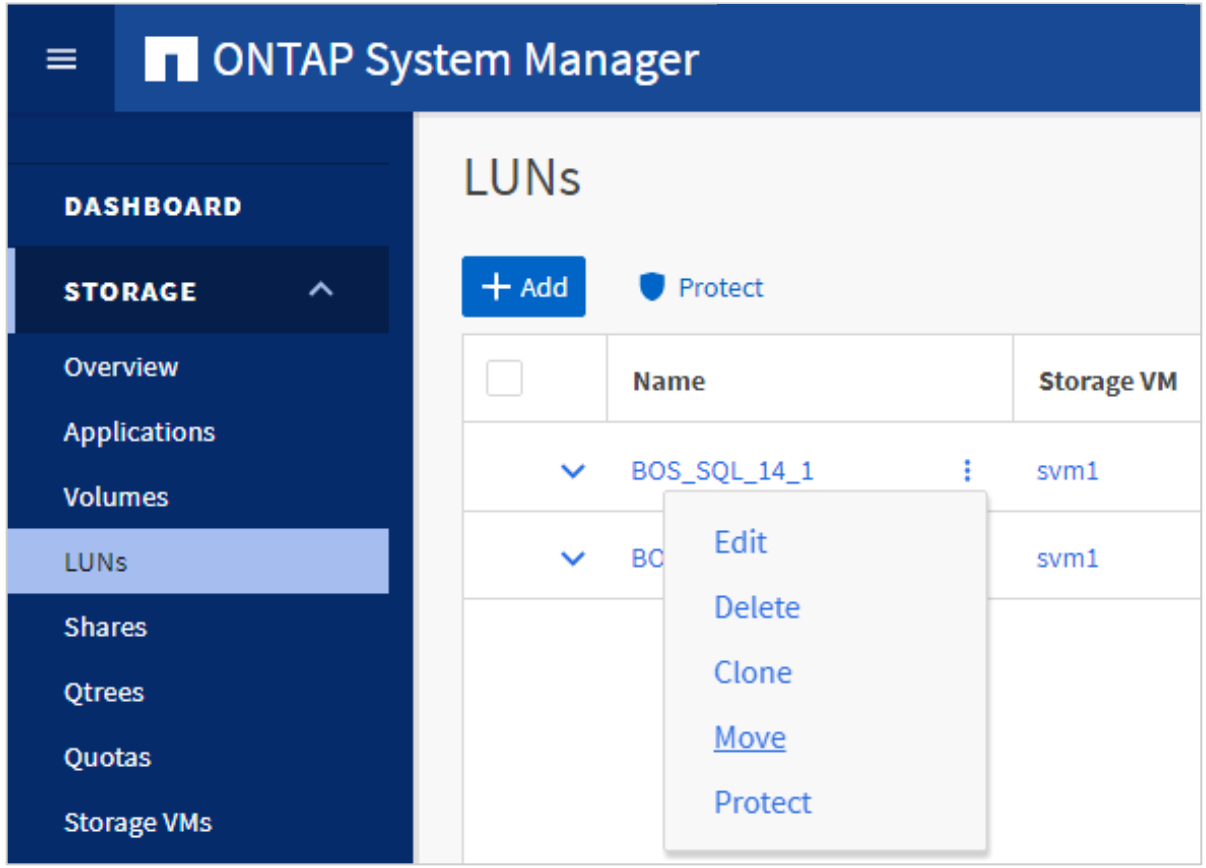
Steps to rehost a volume:

1. Identify the source volume and SVM.
2. Identify the destination SVM within the cluster.
3. Prevent access to the volume that is being rehosted.
4. Use the **`rehost`** command to reassign the volume to the destination SVM.
5. Configure access to the volume in the destination SVM.



LUN move

- The `lun move` set of commands enables you to move a LUN to a volume on another node or even the same node.
- The LUN can move only within the same SVM.
- Snapshot policies are at the volume level so do not follow to new volume. Therefore, storage efficiency features must be reapplied.
- Use the `lun move-in-volume` command to rename a LUN without moving the LUN.



Knowledge check

Module 6:
Logical storage management

Knowledge check

Which item is not a mode of the volume automatic resize feature?

a. off

b. grow

c. shrink

d. grow_shrink

Knowledge check

Which item is not a mode of the volume automatic resize feature?

a. off

b. grow

c. shrink

d. grow_shrink

References
Documentation

- ONTAP 9 Documentation Center:
  - Logical Storage Management Guide
  - Volume Move Express Guide
  - Scalability and Performance Using FlexGroup Volumes Power Guide

- TR-4557: NetApp FlexGroup: A Technical Overview

- TR-4571: NetApp ONTAP FlexGroup Volumes Best Practices

- TR-4743: FlexCache Volumes in NetApp ONTAP

References
Videos

- ONTAP 9 Feature Overview: FlexGroup
  https://www.youtube.com/watch?v=Wp6jEd4VkgI
- Manage FlexGroup using OnCommand System Manager 9.4
  https://www.youtube.com/watch?v=mLpVjolI4GY

Module summary

This module focused on enabling you to do the following:

- Create and manage FlexVol volumes
- Provision application-aware resources
- Move a volume within an SVM
- Create a FlexGroup volume

Complete an exercise

Module 6: Logical storage management

Managing data volumes

- Access your lab equipment.
- Open your Exercise Guide, Module 6.
- Complete Exercise 1.
- Share your results.

This exercise requires approximately **20 minutes**.

Topic for discussion

Did your volume move operation disrupt the workload on the volume that you moved?

Addendum
FlexGroup volumes and FlexCache volumes

FlexGroup predeployment

Recommended practices

- Confirm homogenous hardware and capacity.
  - Disks, nodes, and available capacity should be identical for predictable performance.
  - Relocate volumes in aggregates by using a nondisruptive volume move if necessary.
- Use a reliable network that is 10Gb or greater.

  Flow control is unnecessary across high-bandwidth networks.
- Know the average file size of the workload.
  - Avoid creating small member volumes with large file workloads.
  - Use 8 member volumes per node for low-end platforms.
    Use 16 volumes per node for higher-end platforms.
- Use two aggregates per node to maximize affinities.

  Advanced Disk Partitioning avoids concerns with wasting drive space.
- Verify that your applications can process 64-bit file IDs.

  This capacity is needed for more than 2 billion files.

File size considerations

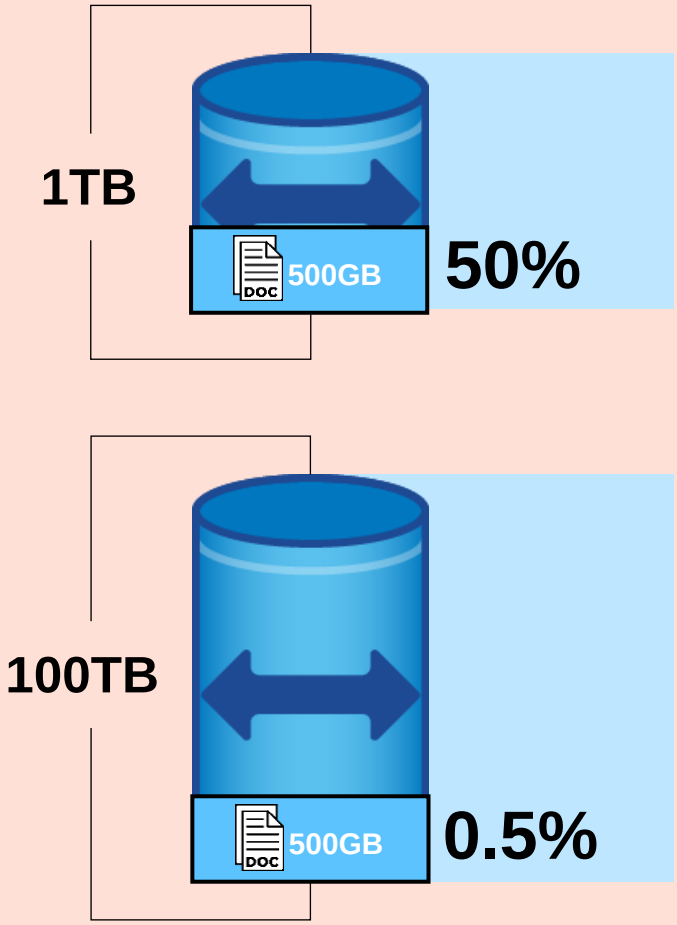
FlexGroup volumes work best with small files.

- What is a “small” file? A “large” file?

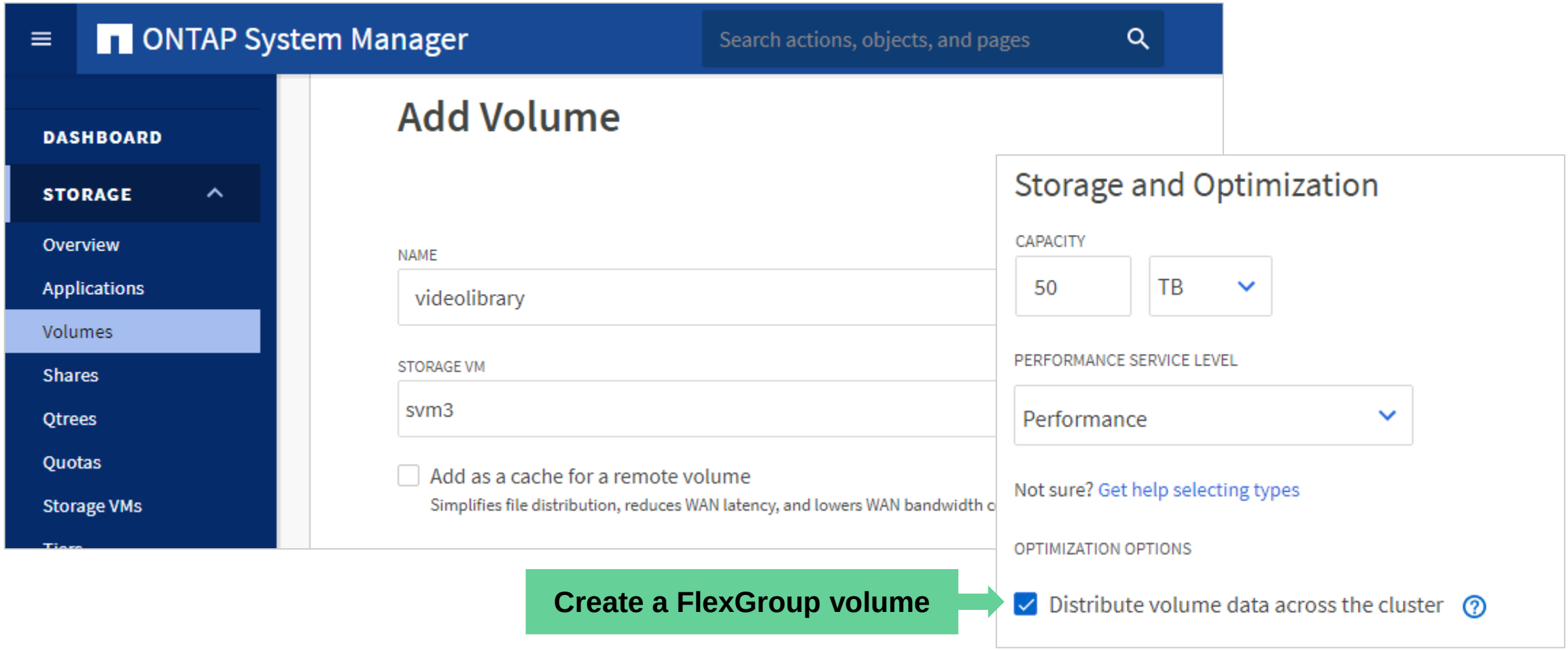
  Answer: “It depends.”

- Files do not stripe across FlexGroup member volumes.
- Large files and files that grow over time can potentially fill member volumes.
- FlexGroup members that fill up prematurely can create “out of space” issues.

  “Large” files aren’t necessarily a great fit, unless you size the FlexGroup properly.



Creating FlexGroup volumes



Commonly used FlexGroup volume options

CLI: `volume create`

Volume option	What the volume option does
`-aggr-list`	The option specifies the names of aggregates that contain constituent volumes. Each entry in the list creates a constituent on the specified aggregate.
`-aggr-list-multiplier`	The option specifies the number of times to iterate over the aggregates that are listed with the `-aggr-list` parameter during the creation of a FlexGroup volume.
`-max-constituent-size`	The option specifies the maximum size of a constituent volume. The default value is determined by identifying the maximum FlexVol size setting on all nodes that the FlexGroup volume uses. The smallest value that is found is selected as the default for the maximum constituent size for the FlexGroup volume.

Managing a FlexGroup volume

Recommended practices

- To increase capacity, grow existing member volumes before adding new members.

  FlexGroup volumes currently do not support shrinking or renaming of volumes.

- Monitor free space and inode counts of member volumes.

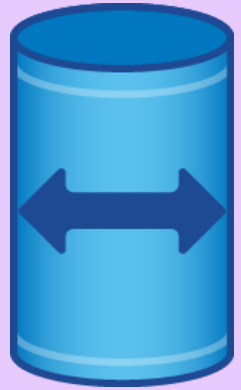
  If you have an 80% threshold, take action.

- Use nondisruptive volume move to relocate member volumes to newly added nodes.

  Then expand the FlexGroup volume to add more members.

- Add new members in multiples. Adding single members can create hotspots.

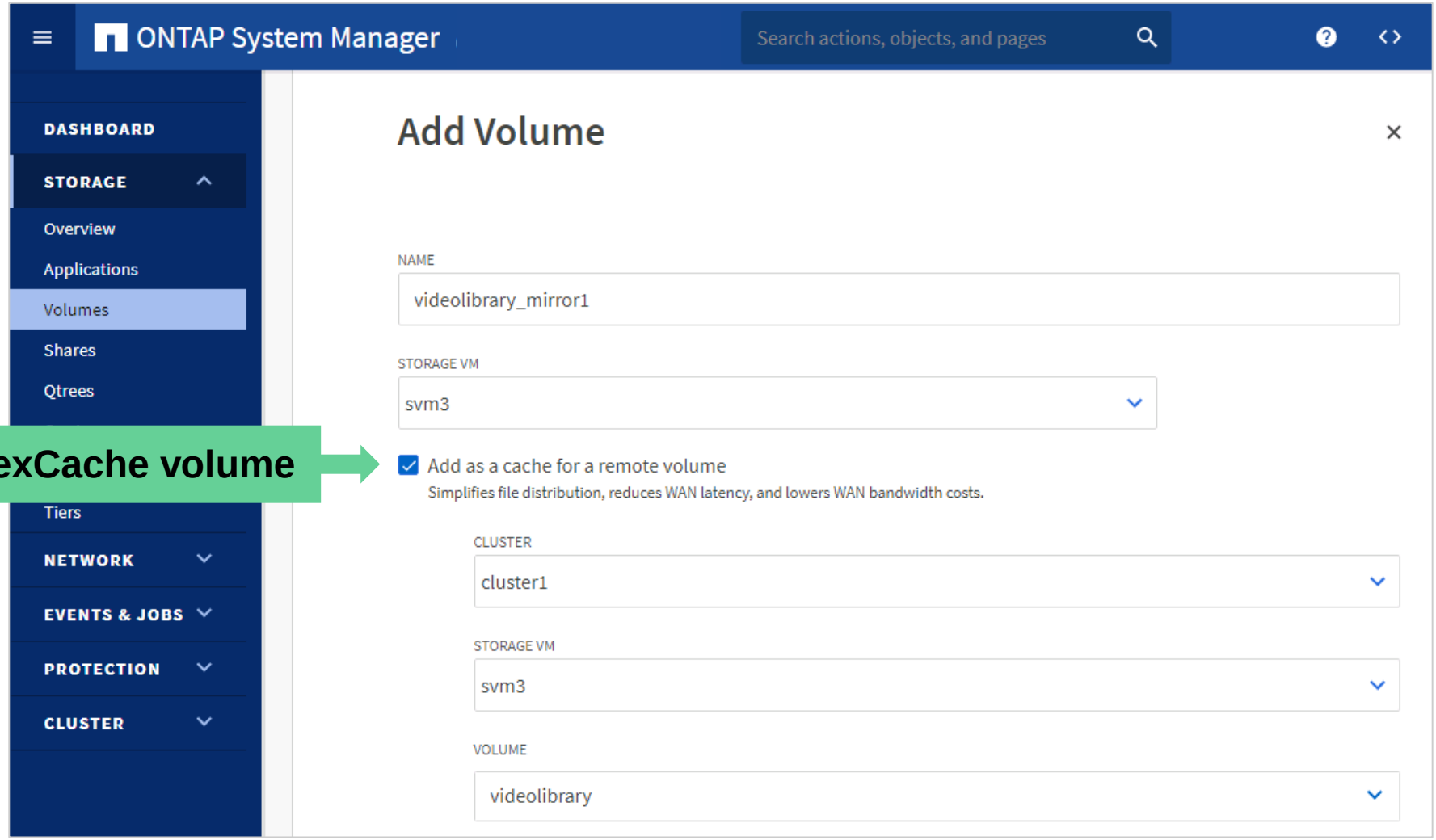
- Consider disabling change or notify on CIFS shares if they are unneeded.



FlexCache software

Topology	Configuration	Systems	Licensing
• Intracluster caching • Within an SVM • Across SVMs • Cross-cluster caching	• Write-around caches • Support for up to 10 caches per origin volume • Protocol: NFSv3 Cache volumes are FlexGroup volumes or FabricPool volumes.	• NetApp FAS • NetApp AFF • NetApp ONTAP Select • NetApp Cloud Volumes ONTAP	• No-cost capacity-based licensing • Based on cache-volume capacity • Aggregated at a cluster level

Creating FlexCache volumes



Create a FlexCache volume

Addendum
Autobalance aggregate

Autobalance aggregate syntax

Enable autobalancing and modify the thresholds with the following commands:

Enable the autobalance feature for the cluster:

```
::> autobalance aggregate config modify -is-enabled true
```

Modify the threshold when an aggregate is considered unbalanced:

```
::> autobalance aggregate config modify
    -aggregate-unbalanced-threshold-percent <integer>
```

Modify the threshold when an aggregate is considered balanced:

```
autobalance aggregate config modify -aggregate-available-threshold-percent
```

