Module 9
Storage efficiency

About this module

This module focuses on enabling you to do the following:

- Implement storage-efficiency features
- Use FlexClone software volumes

Lesson 1
Thin provisioning

Thick and thin provisioning of volumes

Thick provisioning of volumes (space-guarantee = volume)

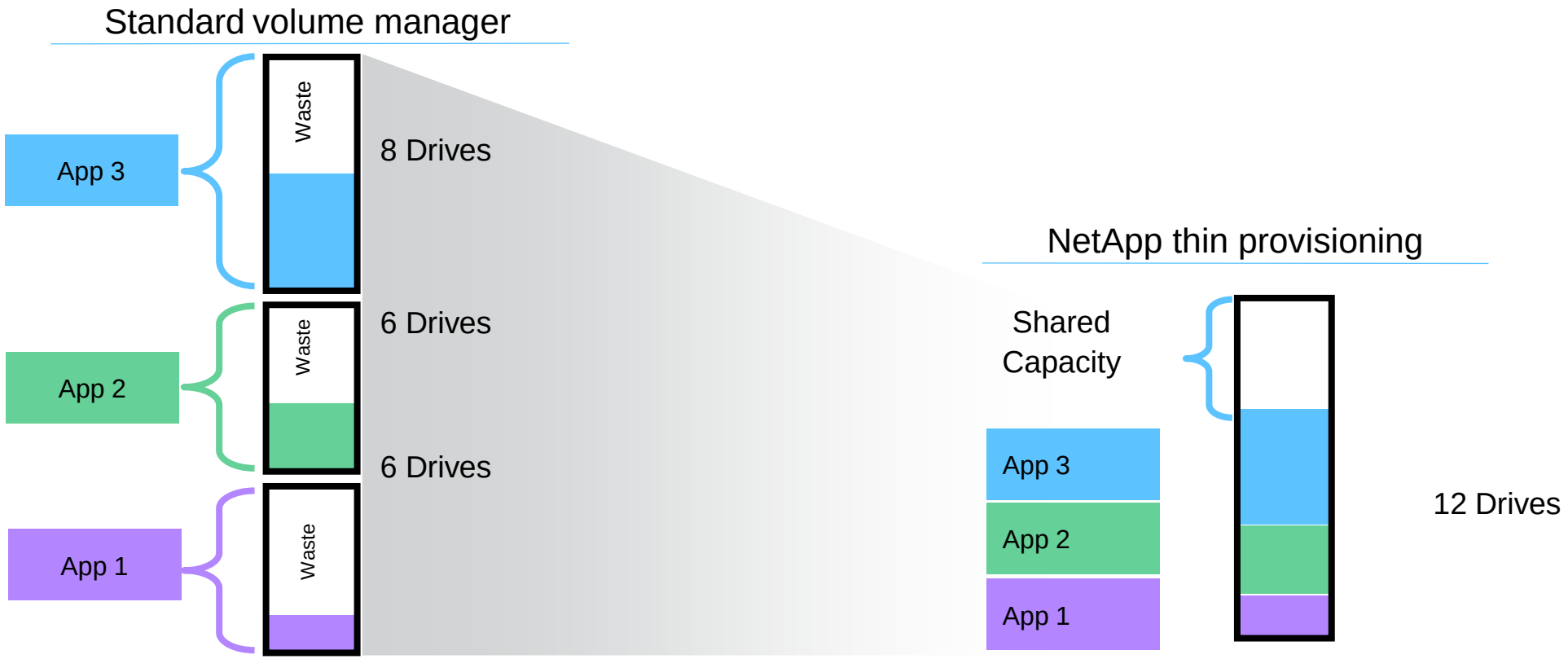
- Requires reserved space within the aggregate for volume creation
- Helps to prevent overcommitment of an aggregate
- Simplifies storage management

Thin provisioning of volumes (space-guarantee = none)

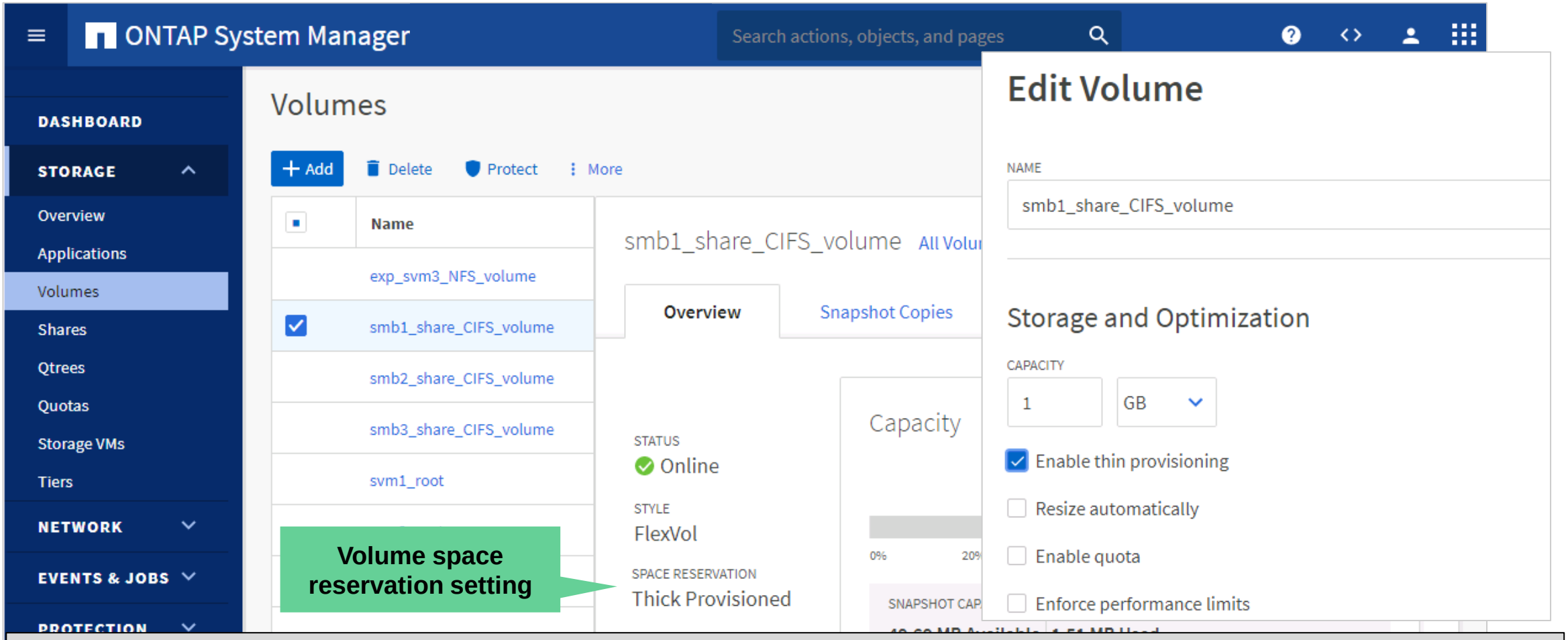
- Does not require reserved space within the aggregate for volume creation
- Enables more aggressive allocation
- Does not prevent overcommitment of an aggregate
- Requires more complex storage management

Thin provisioning

- Typical: Only 40% of provisioned storage is used.
- NetApp: More than 70% is used.
  - Buy 50% less storage.
  - Save 50% power, cooling, and space.



Enable thin provisioning




```
::> volume modify -vserver svm4 -volume svm4_vol_002 -space-guarantee none
```


Lesson 2
Deduplication and compression

Volume efficiency

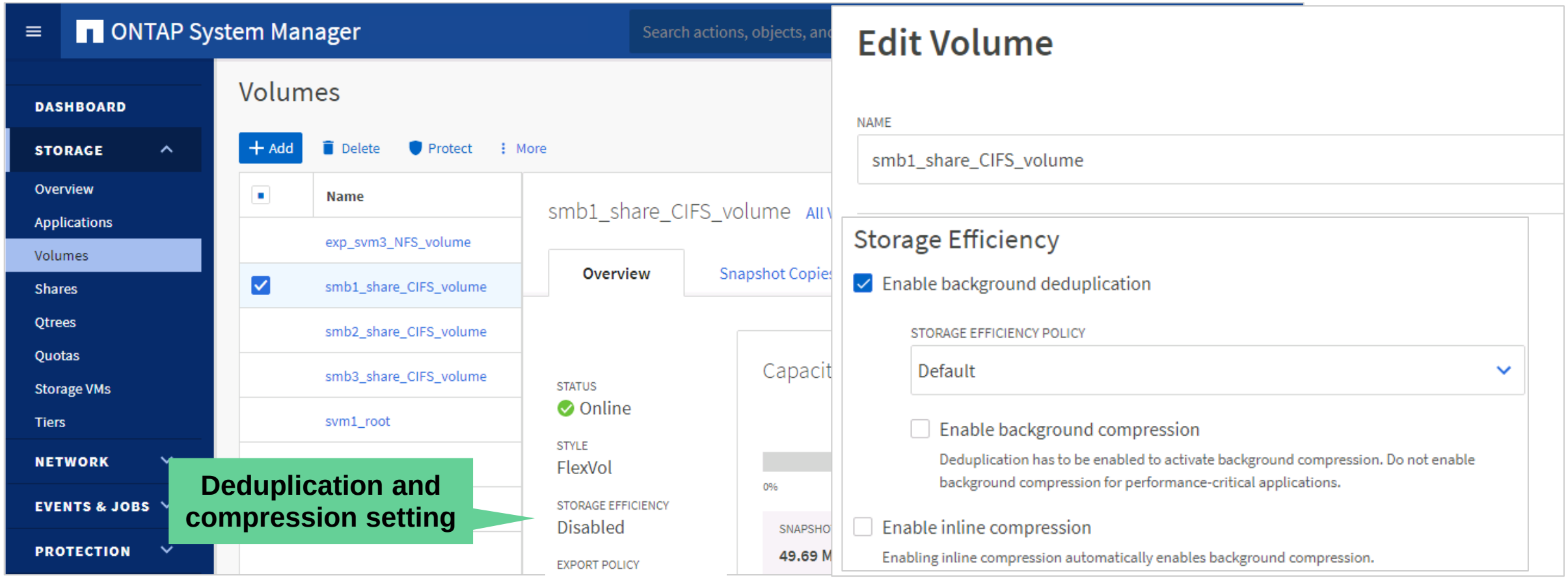
Deduplication

- Elimination of duplicate data blocks
- Inline or postprocess options
- Inline deduplication for AFF systems and Flash Pool systems reduces the number of writes to SSDs

Data compression

- Compression of data within a file
- Inline or postprocess options
- Two compression methods:
  - **Secondary:** 32KB compression groups
  - **Adaptive:** 8KB compression groups, which improve read performance

Enable deduplication




```
::> volume efficiency on -vserver svm4 -volume svm4_vol_002
```


Characteristics of data compression

Inline compression

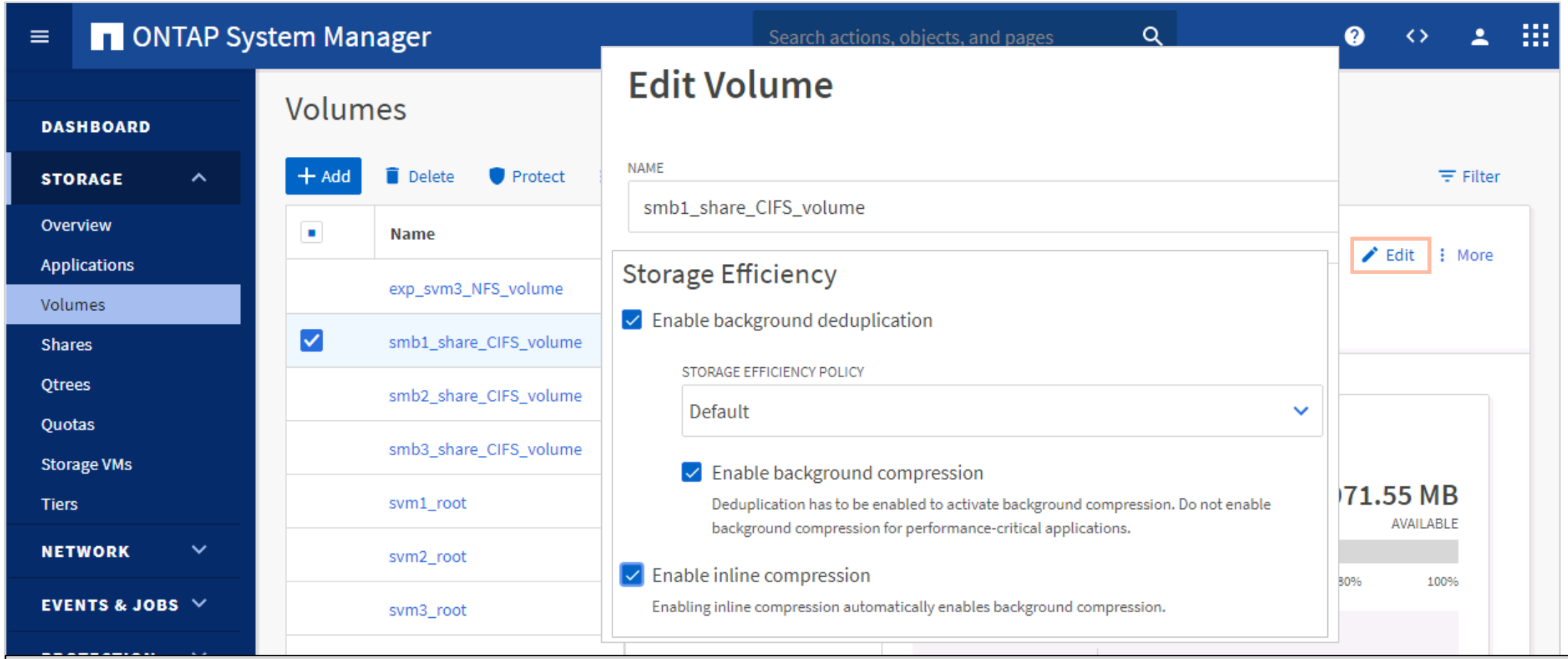
- Data is compressed in memory before being written to the drives.
- Storage consumption and write operations are reduced.
- Throughput increases because of fewer I/O operations.

Postprocess compression

- Uncompressed data is compressed during idle time.
- Only previously uncompressed blocks are compressed.
- Compression occurs before deduplication.
- ONTAP software can detect incompressible data before wasting effort.

For more information, see the *ONTAP 9 Logical Storage Management Guide*.

Configuring data compression




```
::> volume efficiency modify -vserver svm4 –volume svm4_vol002
  -compression true -inline-compression true
```


Lesson 3
Flash efficiency

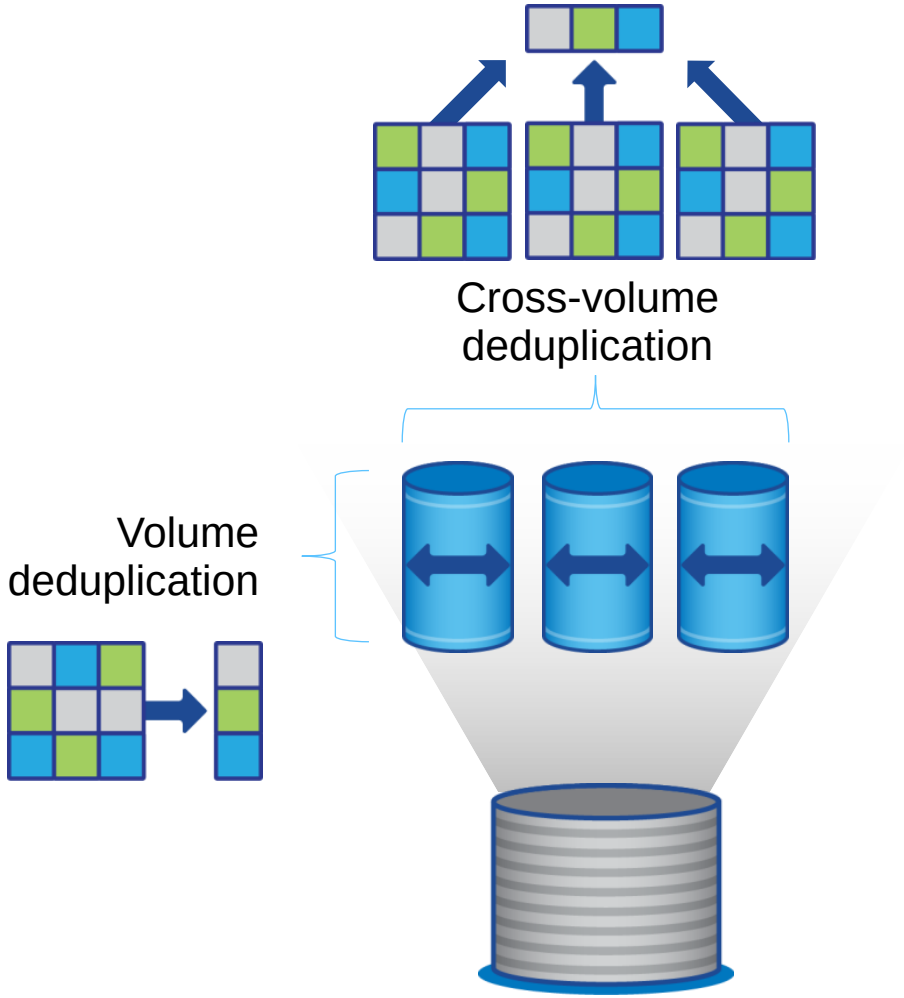
Aggregate inline deduplication

Overview

Aggregate inline deduplication enables block sharing across multiple volumes within an aggregate:

- Is available on only AFF and All SAN Array (ASA) systems
- Uses the volume efficiency parameter:

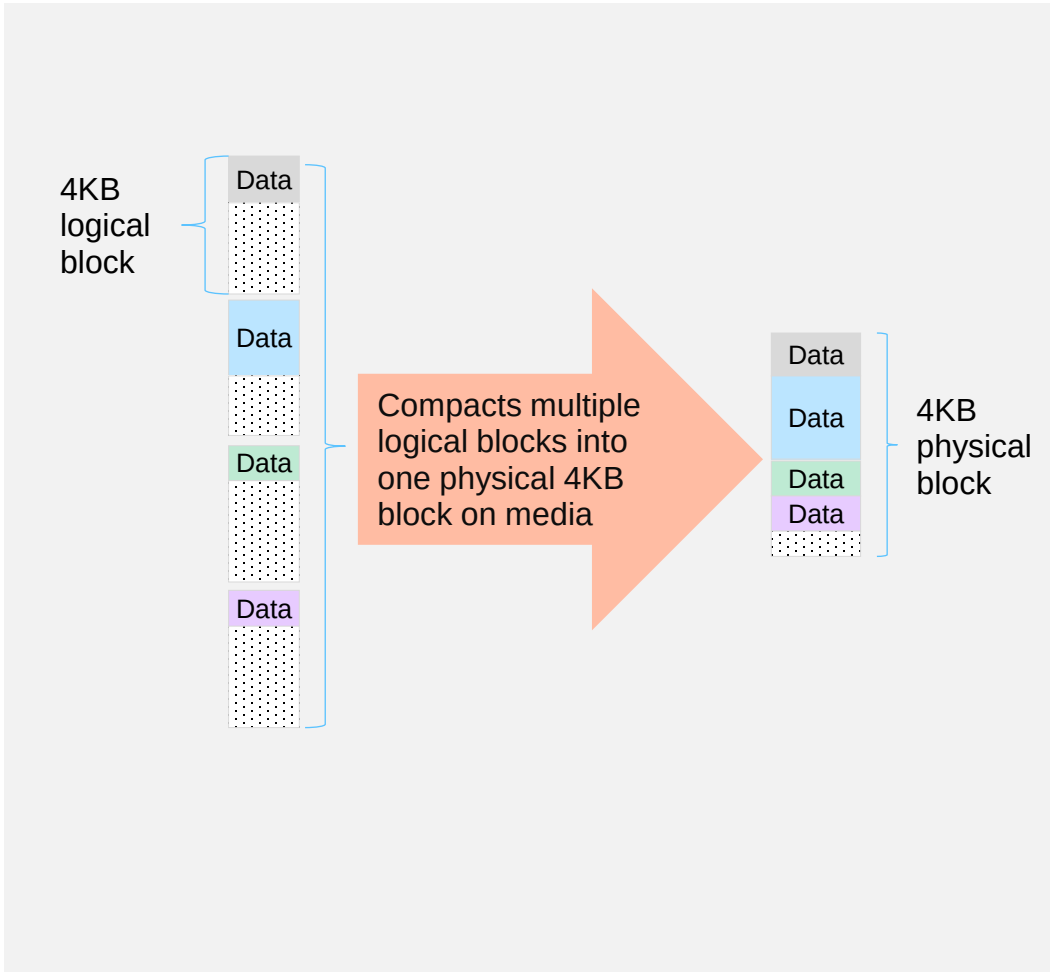
  `-cross-volume-inline-dedupe`



? More info in Addendum

Inline data compaction

- Writes multiple logical data blocks in the same volume to one 4KB block on storage:
  - Compaction occurs during the consistency point (CP) operation just before the write to media.
  - Compaction occurs after inline adaptive compression and inline deduplication.
- Provides additional space savings with highly compressible data
- Is enabled by default for new AFF systems but is disabled on FAS systems:
  - Optional policy for Flash Pool aggregates
  - Optional policy for hard disk-only aggregates



AFF inline storage efficiency

ONTAP workflow

Inline zero-block deduplication

The process detects all zero blocks and eliminates those blocks first.

Inline adaptive compression

The data is scanned and compressed.

Inline deduplication

The compressed blocks are scanned to identify duplicates:

- Duplicates within a volume
- Duplicates across volumes within an aggregate (if no duplicates are found within a volume)

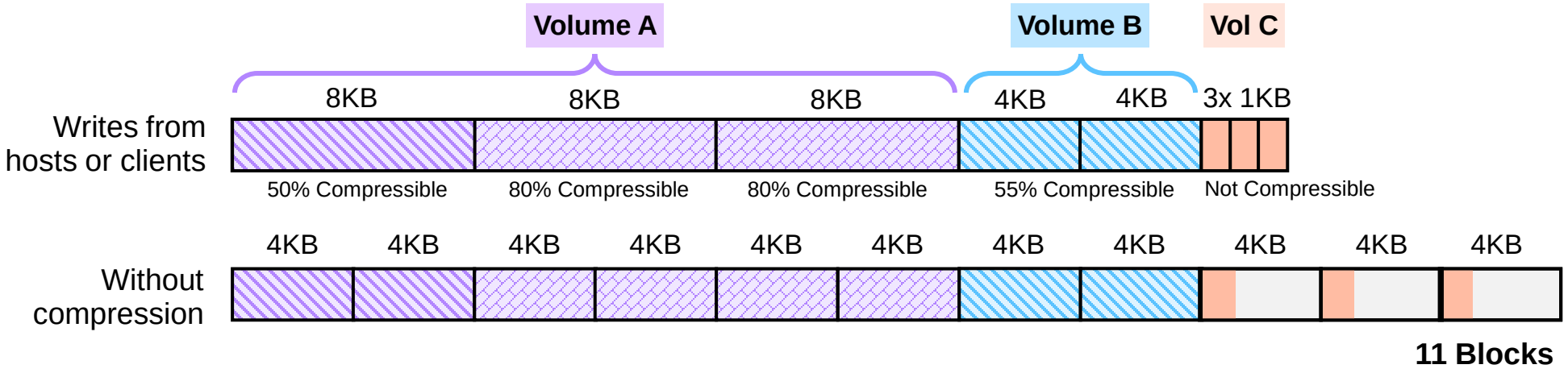
Inline data compaction

Inline deduplication blocks are not compacted.

Other blocks (either compressed or uncompressed) are compacted, where possible.

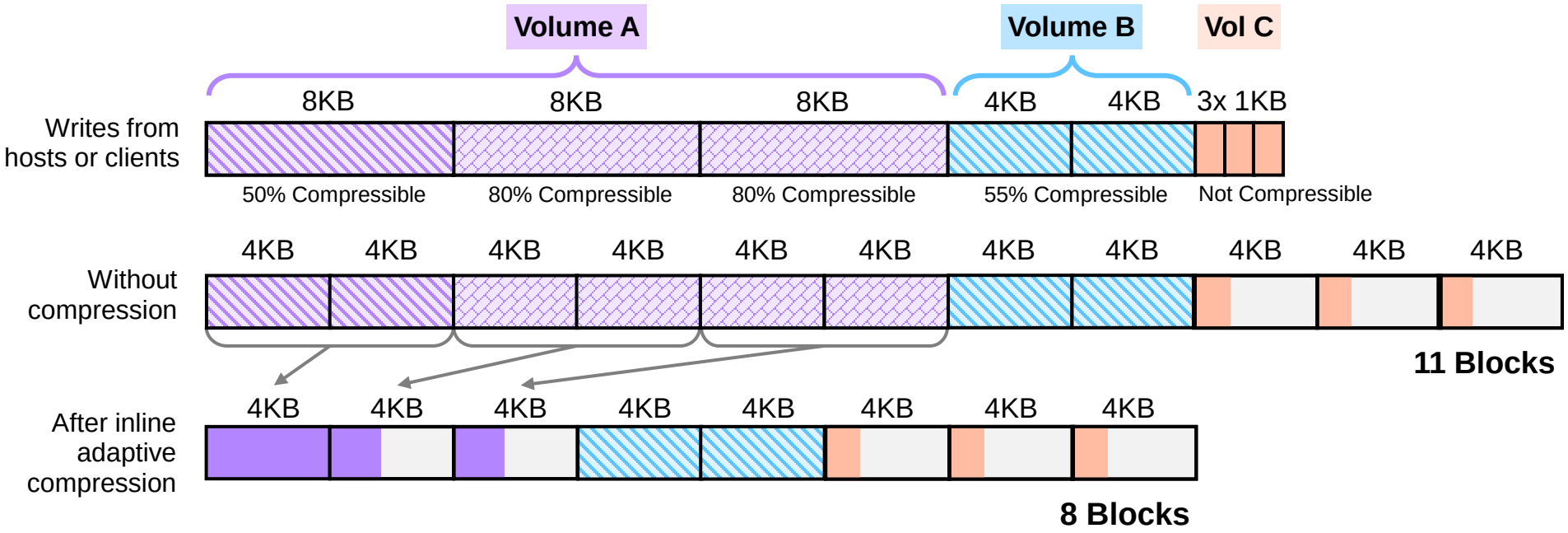
Storage consumption

No inline storage efficiency



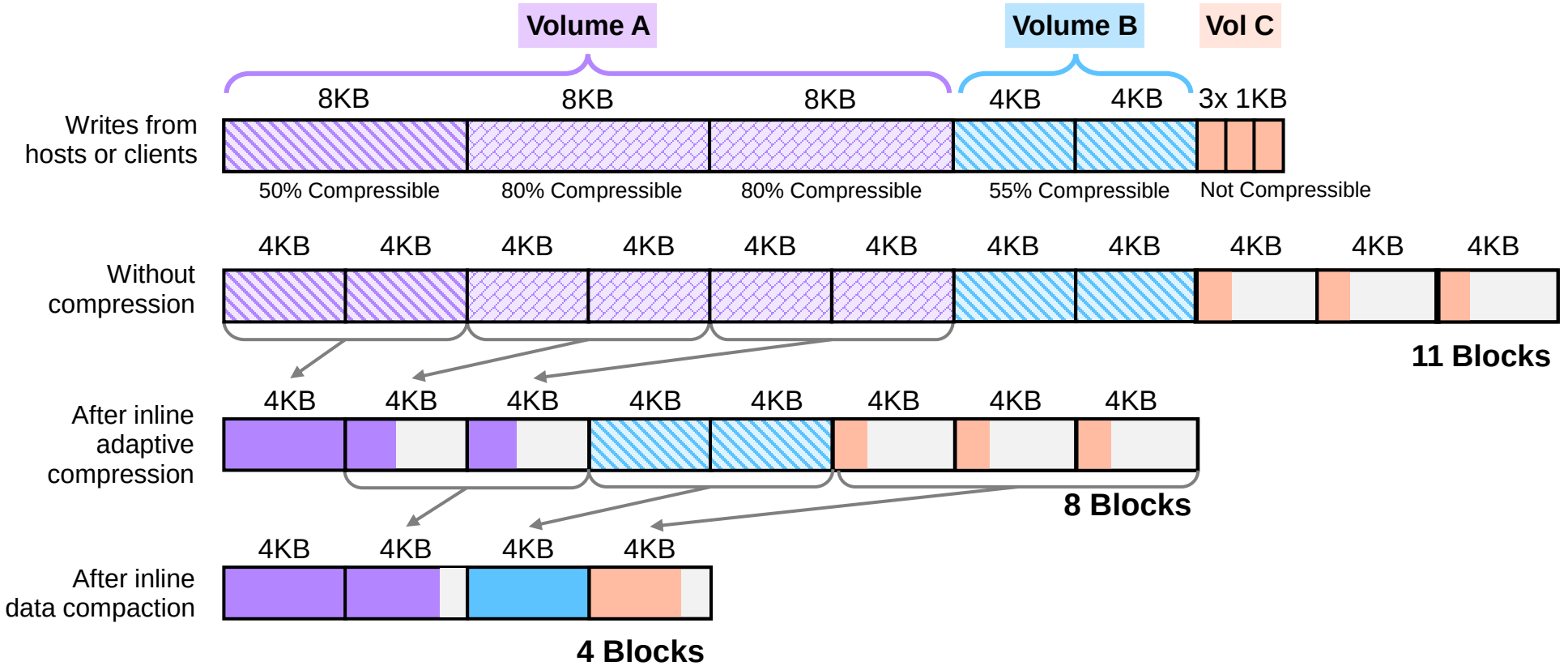
Storage consumption

Inline adaptive compression



Storage consumption

Inline adaptive compression and inline data compaction



Default storage efficiency settings

Storage efficiency feature	AFF	FAS
Inline compression	**Enabled**	Disabled
Background compression	Not supported	Disabled
Inline volume deduplication	**Enabled**	Flash Pool only
Background volume deduplication	**Enabled***	Disabled
Inline aggregate deduplication	**Enabled**	Not supported
Background aggregate deduplication	**Enabled***	Not supported
Inline compaction	**Enabled**	Disabled

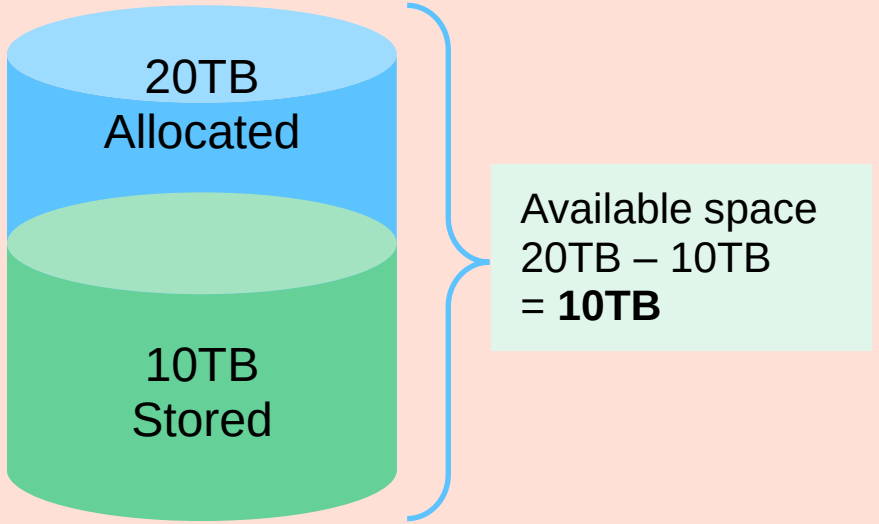
* - Background deduplication operations are disabled when the `-inline-only` storage efficiency policy is applied to a volume.

Lesson 4
Logical space reporting

The storage service provider conflict

Charge for data stored

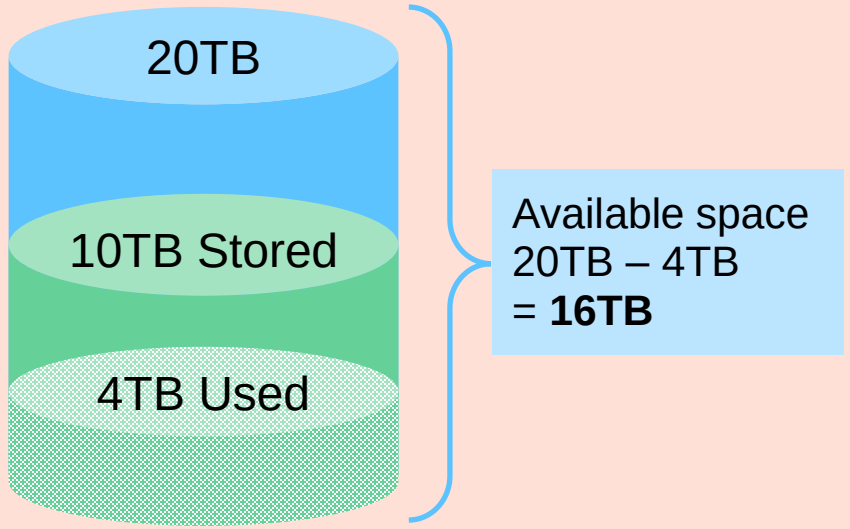
- Storage service providers want to charge customers for data space that they reserve.
- Customers want to pay for only the data that they store.



The storage service provider conflict

Storage efficiencies provide more space

- Storage efficiencies give customers more storage space than they pay for.
- Before ONTAP 9.4 software, ONTAP software provided reporting only for consumed physical storage. Storage service providers could charge only for the space consumed, not for the data that was stored.

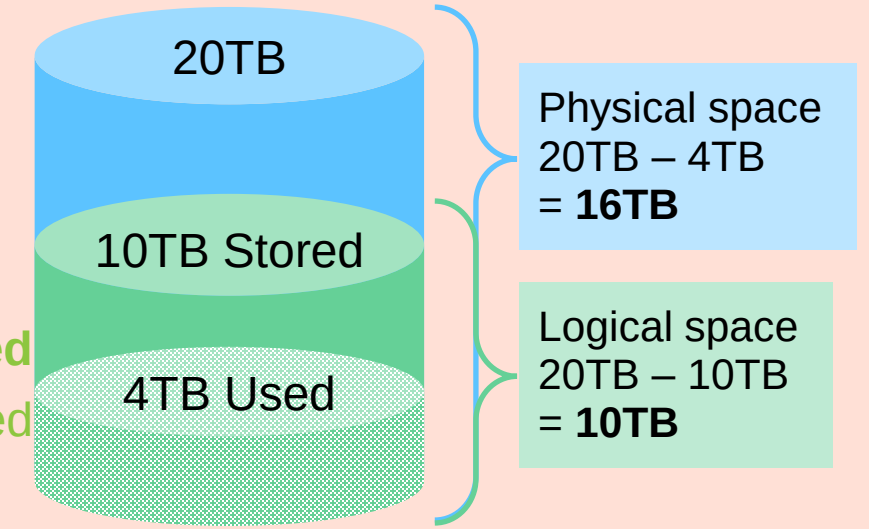


Logical space reporting

Volume option
`-is-space-reporting-logical [true | false]`
shows customers the consumed logical space, rather than the consumed physical space.

With logical space accounting: 10TB used

Without logical space accounting: 4TB used



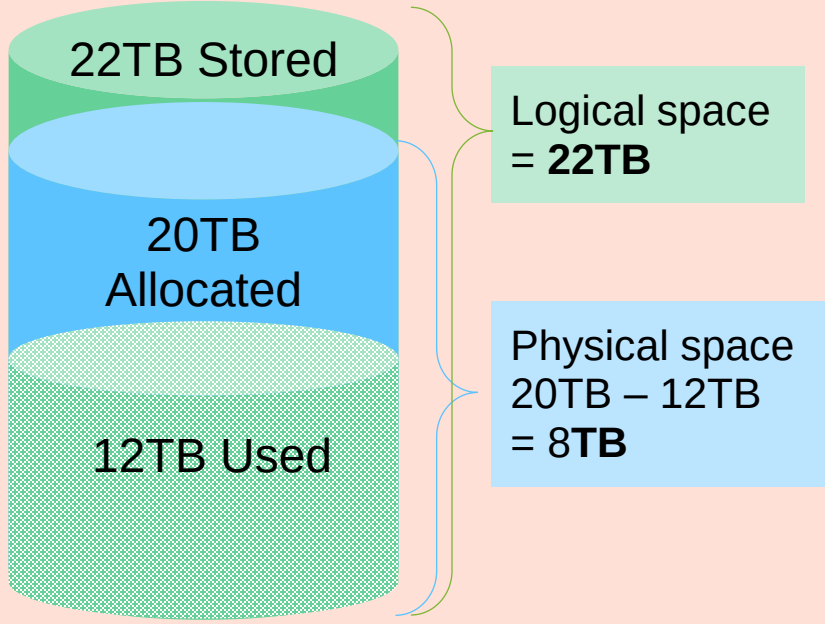

```
volume modify -vserver SVM-name -volume volume-name
-is-space-reporting-logical true
```


Logical space enforcement

- Storage efficiencies enable customers to store more data than space was allocated for.
- Volume option `-is-space-enforcement-logical [true | false]` ensures that customers cannot store more than the logical space that is allocated, regardless of the physical space that is consumed.

  Error messages are generated when stored data reaches 95%, 98%, and 100% of logical space limits.

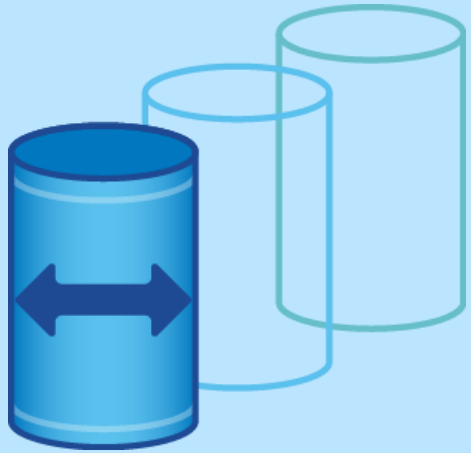
```
volume modify -vserver SVM-name -volume volume-name
-is-space-enforcement-logical true
```



Lesson 5
Volume and file clones

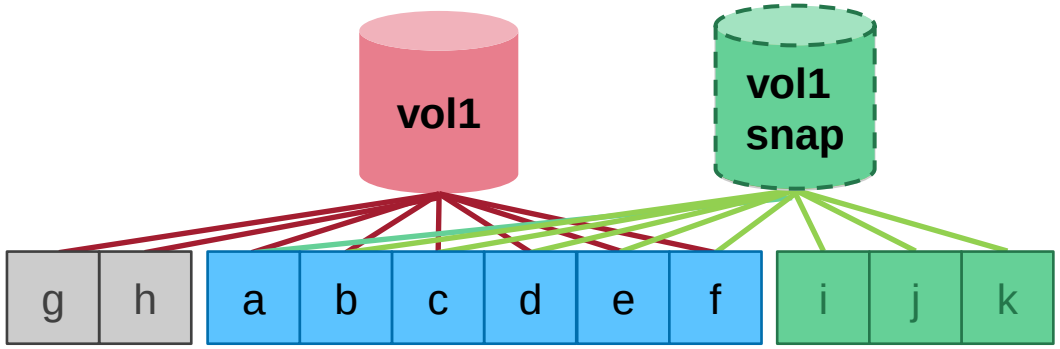
FlexClone technology

- FlexClone software uses block pointers to enable you to create multiple, instant dataset clones (files, LUNs, or entire volumes) with no storage overhead.
- FlexClone technology provides dramatic improvement for application testing and development environments:
  - Create an instantaneous replica of a file or LUN (such as an entire database).
  - Provision thousands of virtual machines (VMs) in seconds by cloning *golden images*.
- Clones can be split from the source, but then make copies of all shared blocks.

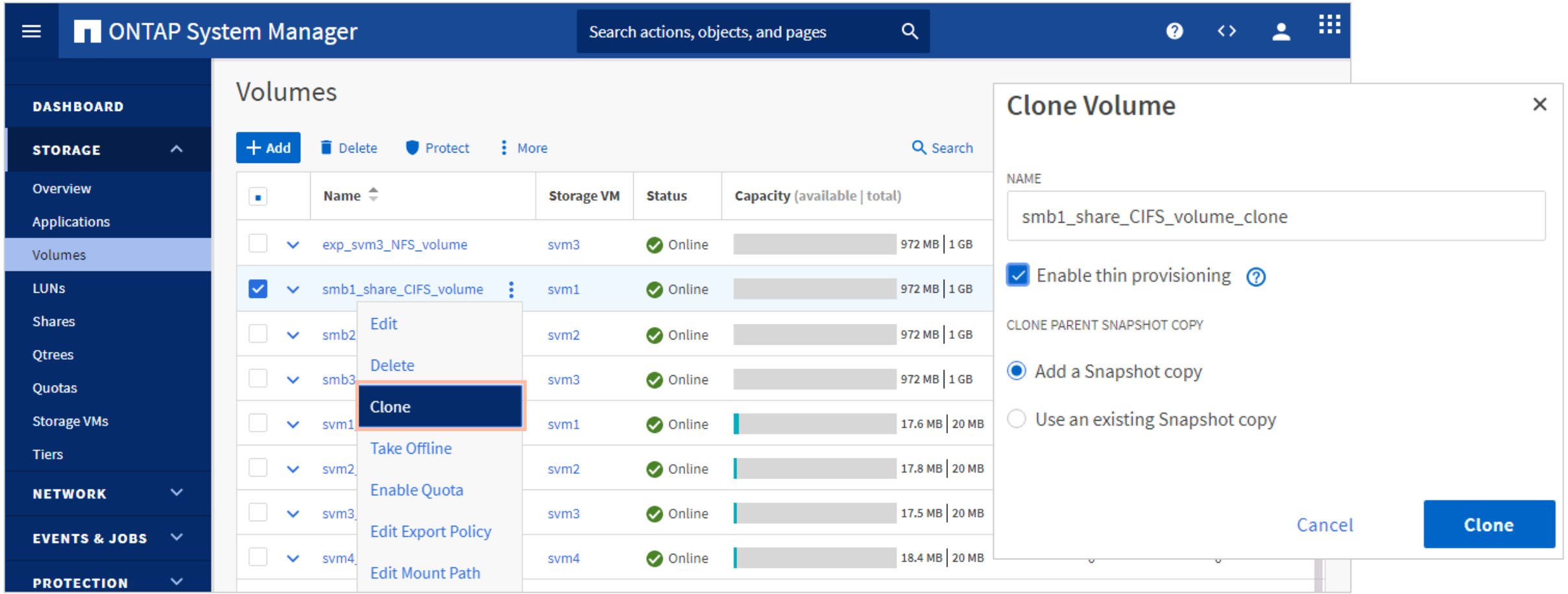


How cloning works

- Make a Snapshot copy of the volume.
- Create a clone by adding another pointer to the blocks in the Snapshot copy (blocks A–H):
  - Modifications to the original volume are separate from modifications to the cloned volume (blocks G and H).
  - Modifications to the clone are separate from the original volume (blocks I – K). These blocks are the only drive space that is consumed by the clone.

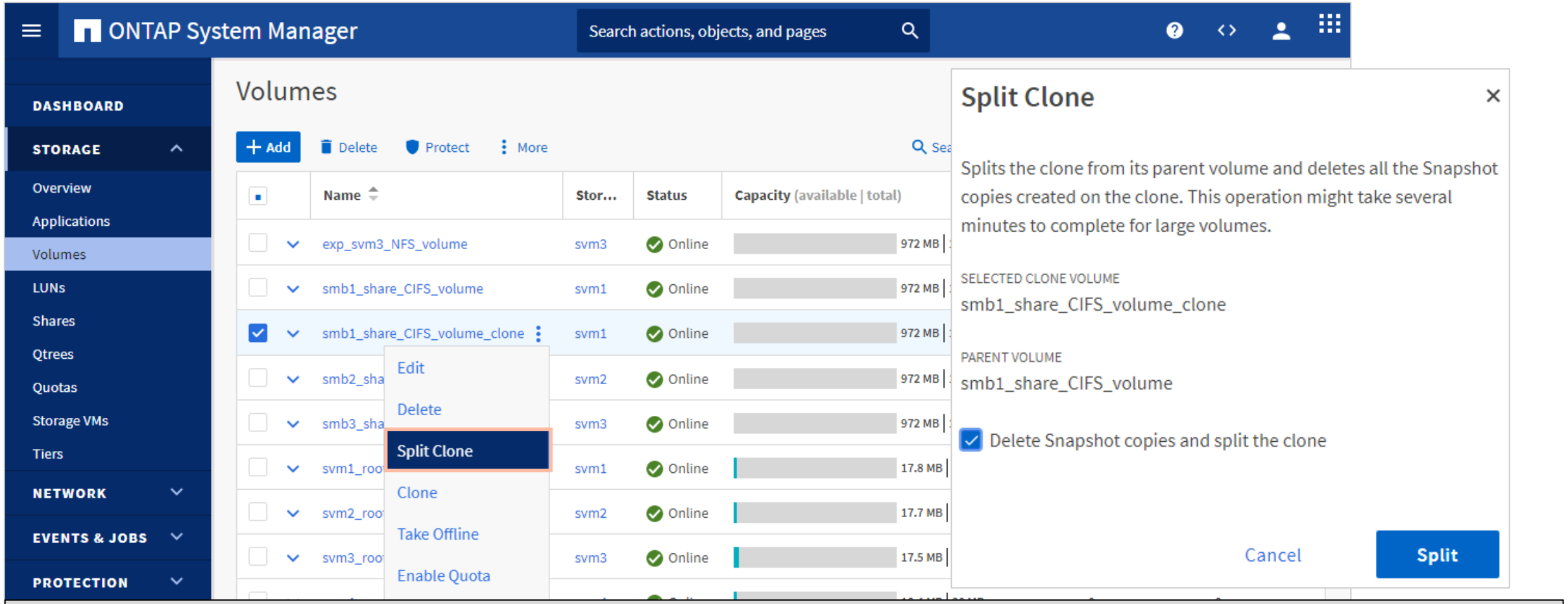


Clone a volume



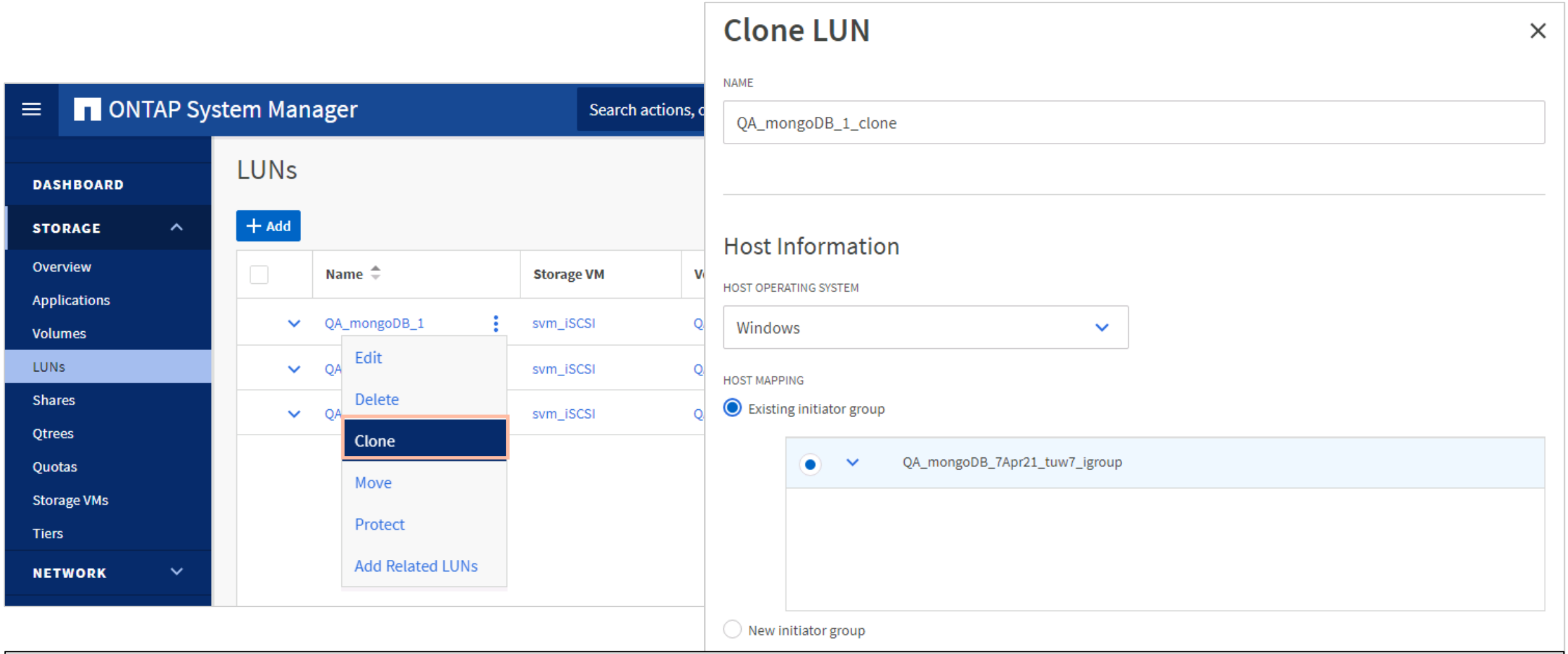

```
::> volume clone create -vserver svm3 -parent-volume exp_svm3_NFS_volume
  -flexclone exp_svm3_NFS_volume_clone
```


Split a cloned volume




```
::> volume clone split start -vserver svm3 -flexclone svm3_vol_002_clone
```


Clone a file or LUN




```
::> volume file clone create -vserver svm5 –volume svm5_vol_002
  –source-path file1 –destination-path file1_clone
```


Knowledge check

Module 9: Storage efficiency

Knowledge check

Which types of data compression are available in ONTAP software?

a. inline and external

b. inline and preprocess

c. inline and postprocess

d. inline and reclaimable

Knowledge check

Which types of data compression are available in ONTAP software?

a. inline and external

b. inline and preprocess

c. inline and postprocess

d. inline and reclaimable

Knowledge check

Data can be written to a FlexClone volume.

a. true

b. false

Knowledge check

Data can be written to a FlexClone volume.

a. true

b. false

Knowledge check

A FlexClone volume, by definition, shares no data blocks with the parent volume.

a. true

b. false

Knowledge check

A FlexClone volume, by definition, shares no data blocks with the parent volume.

a. true

b. false

References

- NetApp Hardware Universe: http://hwu.netapp.com
- ONTAP 9 Documentation Center: http://docs.netapp.com/ontap-9/index.jsp
  - *Cluster Management Using OnCommand System Manager*
  - *Logical Storage Management Guide*
- TR-4476: NetApp Deduplication, Compression, and Compaction
- Storage Efficiency Video: How NetApp FlexClone Works (YouTube) https://www.youtube.com/watch?v=c8VI_L5K8VM

Module summary

This module focused on enabling you to do the following:

- Implement storage-efficiency features
- Use FlexClone software volumes

Complete an exercise

Module 9
Storage efficiencies

Managing storage efficiency

Managing FlexClone volumes

Bonus: Creating a FlexGroup volume

- Access your lab equipment.
- Open your Exercise Guide, Module 9.
- Complete Exercises 1 and 2.
- Share your results.

This exercise requires approximately **30 minutes**.

Share your experiences

Roundtable discussion

- Were you able to observe storage-efficiency benefits in your exercise environment?
- What are some popular uses for FlexClone volumes?

Addendum
Inline deduplication status

Aggregate inline deduplication

Status

Volume status

```
::> volume efficiency show -vserver svm4 –volume svm4_vol003
    -fields cross-volume-inline-dedupe
vserver   volume       cross-volume-inline-dedupe
--------- ------------ --------------------------
svm4      svm4_vol003  true
```

Aggregate status

```
::> aggregate efficiency show -aggregate n1_data_003
                          Aggregate: n1_data_003
                               Node: cluster1-01
 Cross Volume Background Deduplication: false
     Cross Volume Inline Deduplication: true
Has Cross Volume Deduplication Savings: true
 Has Auto Adaptive Compression Savings: false
```


Aggregate inline deduplication

Savings

Aggregate Savings

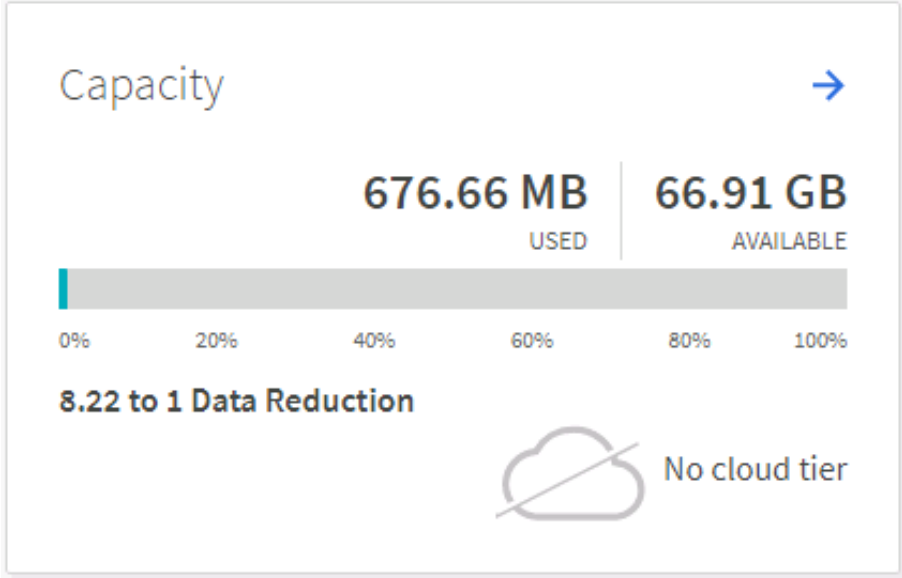
```
::> aggr show-efficiency -details

Aggregate: cluster1_ssd_001
   Node: cluster1-01

     Total Storage Efficiency Ratio: 25.22:1
         Total Data Reduction Ratio:  2.57:1

Aggregate level Storage Efficiency
  (Aggr Dedupe and Data Compaction):  1.33:1
           Volume Dedupe Efficiency:  1.40:1
             Compression Efficiency:  1.29:1

 Snapshot Volume Storage Efficiency: 27.14:1
FlexClone Volume Storage Efficiency:    -
```



The data-reduction ratio includes aggregate inline deduplication savings.

