



Technical FAQ

NetApp FlexGroup ONTAP 9.1

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Abstract

This technical FAQ covers common questions about NetApp[®] FlexGroup volumes. For any questions not covered in this document, e-mail flexgroups-info@netapp.com and they will be added as necessary.

Information Classification

NetApp Confidential

Version History

Version	Date	Document Version History
Version 1.0	August 2016	Initial commit; ONTAP 9.0
Version 2.0	October 2016	ONTAP 9.1

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1 Overview

NetApp FlexGroup is a new NAS feature generally available in NetApp ONTAP® 9.1 and later software. This feature is intended to improve the overall NAS experience in ONTAP with a solution that blends near-infinite capacity and seamless scalability with predictable high performance for concurrent workloads.

NetApp FlexGroup enables storage administrators to utilize their entire cluster for NAS workloads without worrying about file or volume layout. Storage administrators can simply create a FlexGroup volume and start writing data.

1.1 Targeted Workloads

A FlexGroup volume can be used for a wide range of workloads in NAS environments. Technically, there is no workload type that a FlexGroup volume cannot cover, but there are specific workloads that see better results with it than others.

These include:

- Electronic design automation (EDA)
- Software build environments
- Oil/gas/seismic data
- Unstructured NAS data (such as home directories)
- Media (file streaming and/or media assets)
- Archives for HIPAA compliance

Essentially, any workload that is metadata intensive and requires large buckets of storage (>100TB) in a single namespace or a high file count (>2 billion files) is an ideal workload for FlexGroup. Workloads that generate very large files or files that grow very large after being written are not ideal workloads.

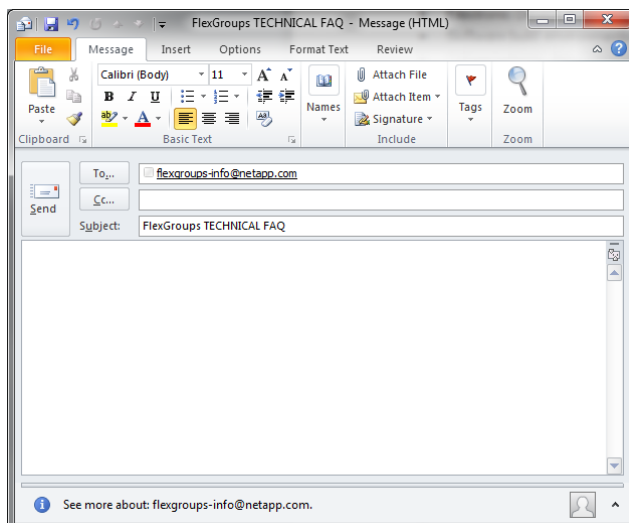
1.2 Questions Not Covered Here

Do you have a question that you think we should include in this FAQ?

Ask us at flexgroups-info@netapp.com.

Include **<PRODUCT/TECHNOLOGY>** TECHNICAL FAQ in the subject line.

Example:



2 Key Terminology

This section covers terminology specific to ONTAP and FlexGroup that might be unfamiliar to people who have not worked with NetApp storage technology. For a complete rundown of these terms, see [TR-3982: NetApp Clustered Data ONTAP 8.3 .x and 8.2.x](#) and [TR-4129: Namespaces in Clustered Data ONTAP](#).

Storage Virtual Machine (SVM)

A storage virtual machine (SVM) is what users connect to when they access data. Each SVM acts as an independent tenant in the cluster for data access and owns its own volumes, LIFs, LUNs, authentication services, and so on.

Flexible Volume (FlexVol Volume)

Flexible volumes (NetApp FlexVol[®] volumes) are logical containers residing on top of physical storage to be used for data storage operations.

Export Policy

An export policy is a container for export policy rules. Export policy rules control NAS access to FlexVol volumes (primarily NFS) by way of client-oriented access lists. These rules control whether a client can mount a FlexVol volume and the share-level access that the client has after the volume is mounted.

Junction Path

A junction path is a NAS-specific directory location mounted into the namespace of an SVM. Junction paths represent the file handle for the volume and allow clients to navigate to the appropriate storage containers in the SVM.

Infinite Volume

An Infinite Volume is a type of volume that is composed of a number of member constituent FlexVol volumes and a single namespace metadata FlexVol volume. The Infinite Volume provides near-infinite scale (up to 20PB) for archival. For more information about Infinite Volumes, see [TR-4037: An Introduction to Infinite Volume](#).

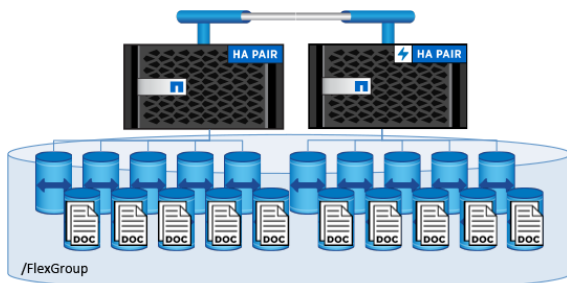
Logical Interface (LIF)

A logical interface (LIF) is a virtualized interface that resides on a physical network port. LIFs provide IP addresses and/or WWPNs to clients for data connectivity. A data LIF is conceptually akin to an IP alias.

Constituent/Member

A constituent/member is a FlexVol volume that participates in an Infinite Volume or FlexGroup volume.

Figure 1) FlexGroup graphical depiction.



3 General

This section answers questions about NetApp FlexGroup that are asked on a regular basis. For more detail about the technical aspects of FlexGroup, see [TR-4557: NetApp FlexGroup Technical Overview](#).

What is a FlexGroup volume?

Answer: A FlexGroup volume is a single namespace container that consists of multiple FlexVol member constituents. Data is distributed across these constituents using local and remote hard links. These links are driven by a new NetApp WAFL[®] (Write Anywhere File Layout) feature in ONTAP called the remote access layer (RAL).

What is the WAFL remote access layer (RAL)?

Answer: The WAFL RAL is a new feature in ONTAP that sits on top of the WAFL layer and directs remote traffic in a FlexGroup volume.

When can I use NetApp FlexGroup?

Answer: NetApp FlexGroup is available through PVR only in ONTAP 9.0. NetApp FlexGroup is available to all customers in ONTAP 9.1.

What are the intended workloads for FlexGroup?

Answer: Although there is no limitation on which workloads can leverage FlexGroup, specific workloads are intended for the feature and take the best advantage of FlexGroup benefits. These workloads include:

- EDA
- High file count
- Unstructured NAS/homedirs
- Oil/gas/seismic
- HIPAA-compliant archives
- Software build/test

What happens to an existing FlexGroup volume when upgrading?

Answer: When upgrading from or reverting to ONTAP 9.0, any existing FlexGroup volume needs to be deleted. After upgrading to ONTAP 9.1, subsequent upgrades (that is, 9.2, 9.3, and so on) will require no special action.

How is a FlexGroup volume accessed?

Answer: A FlexGroup volume is designed to be accessed by NAS clients in exactly the same manner that FlexVol volumes are. CIFS/SMB shares or NFS exports are created based on a junction path that is mounted in the designated storage virtual machine's namespace. The clients simply access the storage using the same elements they have always used. There is no SAN support for FlexGroup.

Can I junction a FlexGroup volume to a FlexVol volume or another FlexGroup volume?

Answer: Yes. A FlexGroup volume can be part of a junction path.

Can FlexVol volumes and a FlexGroup volume coexist in the same SVM?

Answer: FlexVol volumes and a FlexGroup volume can coexist in the same SVM. This capability is a departure from Infinite Volumes, which had to have a dedicated SVM.

Does NetApp FlexGroup replace Infinite Volumes?

Answer: No. NetApp FlexGroup and Infinite Volumes will both be available in ONTAP for the foreseeable future.

Can I convert an existing Infinite Volume to a FlexGroup volume?

Answer: Currently, there is no in-place conversion of Infinite Volumes to FlexGroup volumes.

Does a FlexGroup volume replace FlexVol volumes?

Answer: No. There are no plans to replace FlexVol volumes with a FlexGroup volume.

Can I convert an existing FlexVol volume to a FlexGroup volume?

Answer: Currently, there is no in-place conversion of FlexVol volumes to a FlexGroup volume. This functionality is being planned for a future release of ONTAP.

How do Snapshot copies work?

Answer: NetApp Snapshot[®] copies of a FlexGroup volume are performed at the FlexVol member level, but in a coordinated fashion through a consistency group. Every member FlexVol volume in a FlexGroup volume must be able to perform a Snapshot copy for a FlexGroup Snapshot copy to be considered valid. Invalid Snapshot copies are discarded and removed by ONTAP automatically. FlexGroup Snapshot copies function identically to FlexVol Snapshot copies in terms of access through the .snapshot directory, space usage, and volume-level restores.

Can I use a FlexGroup volume in an SVM that has NFSv4 or CIFS enabled?

Answer: Yes. Although FlexGroup volumes can use only NFSv3, they can coexist with NFSv4, CIFS/SMB, and other protocols in the same SVM.

Are files in a FlexGroup volume striped across member volumes?

Answer: No. Files in a FlexGroup volume are allocated to a single, independent member FlexVol volume.

How does a FlexGroup volume balance load?

Answer: A FlexGroup volume balances workload based on algorithms that take into account volume free space and the last *N* seconds of new content/inode allocation. Load balancing occurs only at creation or ingest of the file or folder.

Can a FlexGroup volume rebalance the files or folders across members to distribute them more evenly?

Answer: No. A FlexGroup volume does not have a reallocate feature to rebalance data allocation. All data balancing takes place on ingest of files.

4 Deployment

How do I enable the NetApp FlexGroup feature? It is not available in my ONTAP 9.0 cluster.

Answer: FlexGroup in ONTAP 9.0 is available by PVR only and requires a special license hash to enable the feature. For access, e-mail flexgroups-info@netapp.com. ONTAP 9.1 offers this feature without the need for a license.

Why do I need a license to use NetApp FlexGroup?

Answer: License hashes are required for tracking purposes. ONTAP 9.1 removes the license hash requirement and allows unrestricted access to the feature.

How do I create a FlexGroup volume?

Answer: NetApp OnCommand® System Manager allows creation of a FlexGroup volume through the new FlexGroup tab. If you use the CLI, use the command `flexgroup deploy` (requires two aggregates) or `use volume create -aggr-list [aggr1,aggr2,...]` if you are creating in the command line.

Can I grow a FlexGroup volume easily?

Answer: Yes. FlexGroup volume size can be increased in one of two ways: (1) growing existing members (`volume size`) or (2) adding additional members (`volume expand`).

What considerations should I make when adding members?

Answer: When adding new members to a FlexGroup volume, always add multiple members. Adding a single member to a FlexGroup volume could cause uneven allocation of the workload until the member FlexVol volume reaches a watermark equal to that of the other members. The `volume expand` command automates the process adequately.

Can I shrink a FlexGroup volume?

Answer: Currently, there is no way to shrink a FlexGroup volume.

What is required to use the `flexgroup deploy` command?

Answer: The `flexgroup deploy` command is intended to be an “easy button” method to create an ideally laid out FlexGroup volume. The command supports only a few flags (size, volume type, volume name, space guarantee, and vservers) and runs only if the following conditions are true:

- There are fewer than four nodes in the cluster.
- Each node has one aggregate for All Flash FAS or at least two data aggregates for other configurations.
- An SVM was created.
- The aggregates have sufficient space to create space-guaranteed volumes.
- For any variations on the preceding, use `volume create` with `-aggr-list` instead.

How do I control the aggregates used by a FlexGroup volume?

Answer: To specify aggregates for a FlexGroup volume, use `volume create -aggr-list [aggr1,aggr2,...]`.

Do I need to deploy the FlexGroup volume across the entire cluster?

Answer: No. A FlexGroup volume can span all nodes or only a subset of nodes if desired. For example, if a four-node cluster has two nodes that are All Flash FAS and two nodes with spinning disk, the FlexGroup volume can be configured to span the nodes based on the workload type. For higher performance, use the flash nodes. For basic capacity, use the cheaper spinning drives.

What considerations are needed for large files?

Answer: Member FlexVol constituents can be 100TB in size. If a workload is writing very large files (tens to hundreds of GB in size), member FlexVol volumes must be sized to reflect the larger file sizes.

5 Support

Which features are supported by NetApp FlexGroup in ONTAP 9.1?

Table 1) What is supported for NetApp FlexGroup in ONTAP 9.1?

Supported ONTAP Features in ONTAP 9.1 (NetApp FlexGroup)
• NFSv3 and SMB 2.0/2.1 (see SMB support limitations, below) • Snapshot copies • NetApp SnapMirror® technology • Thin provisioning • System Manager/OnCommand Performance Manager • NetApp RAID-TEC™ technology • Per-aggregate consistency points • Storage efficiencies (compression, compaction, deduplication) • All Flash FAS • Quota reporting • Constituent/member volume move • Sharing aggregates and storage virtual machines with FlexVol volumes

Is a FlexGroup volume supported for production workloads in ONTAP 9.0?

Answer: FlexGroup volumes are intended for scratch space workloads only in ONTAP 9.0. Production workloads are not allowed. Use ONTAP 9.1 instead.

What is the maximum number of FlexGroup volumes I can have in a cluster?

Answer: The maximum number of FlexGroup volumes is tied directly to the maximum number of FlexVol volumes in a cluster or number of member constituents in each FlexGroup volume. See the [maximums documentation available on the Field Portal](#) for more information about FlexVol maximums.

How many FlexVol members can a FlexGroup volume contain?

Answer: A single FlexGroup volume can currently have 200 member FlexVol volumes.

What is the maximum capacity of a FlexVol volume?

Answer: The current maximum capacity of a FlexVol volume is 100TB (on high-end systems).

What is the maximum capacity of a FlexGroup volume?

Answer: The current maximum capacity of a FlexGroup volume is 20PB. That is 100TB x 200 member FlexVol volumes.

What is the maximum number of inodes allowed in a FlexVol volume?

Answer: The current maximum number of inodes allowed in a FlexVol volume is 2 billion.

What is the maximum number of inodes allowed in a FlexGroup volume?

Answer: The current maximum number of inodes allowed in a FlexGroup volume is 400 billion. That is 2 billion x 200 member FlexVol volumes.

Is there support for Snapshot copies with a FlexGroup volume?

Answer: Yes. FlexGroup supports Snapshot copies.

Is SnapMirror supported?

Answer: SnapMirror is supported in ONTAP 9.1.

What are the limits for SnapMirror with NetApp FlexGroup?

Answer: For SnapMirror, we recommend a limit of 32 members in a FlexGroup volume per SnapMirror relationship. There is an additional clusterwide limit of 100 member FlexVol volumes across all FlexGroup volumes when SnapMirror is present. This limit is based on the number of successful concurrent transfers tested.

We also recommend the following:

- SnapMirror update schedules are no more frequent than 30 minutes per update.
- Snapshot schedules are no more frequent than 30 minutes.
- Stagger the SnapMirror update and Snapshot schedules across FlexGroup volumes.

Is SnapVault supported with NetApp FlexGroup?

Answer: NetApp SnapVault[®] software is currently not supported.

Is NDMP supported?

Answer: No. NDMP is not supported. Tape backups can be made with CIFS or NFS shares at a file level, however.

Is SAN supported with NetApp FlexGroup?

Answer: No. SAN is not supported.

Is volume move supported with NetApp FlexGroup?

Answer: Volume moves are supported with FlexGroup at the member constituent level. The recommended maximum for volume operations (vol move, vol offline/vol online) is 10 per hour.

Which NAS protocols are supported for use with a FlexGroup volume?

Answer: ONTAP 9.1 supports NFSv3 and SMB 2.0 and 2.1. SMB support will be available only in ONTAP 9.1 RC2 and later. For SMB support inquiries, e-mail flexgroups-info@netapp.com.

Are there any feature limitations with the NAS protocols?

Answer: There are no feature limitations for NFSv3, but support for the features in Table 2 in SMB 2.0 and 2.1 won't be available.

Table 2) SMB features not supported with NetApp FlexGroup in ONTAP 9.1.

Features not supported for use with NetApp FlexGroup with SMB 2.0 and 2.1 in ONTAP 9.1
• Server-side copy offload • Change/notify • CA shares • SMB Remote VSS • Storage Level Access Guard • File auditing • NetApp FPolicy[®] software component

Are storage efficiencies such as data compaction, deduplication, and compression supported?

Answer: Full support for the following storage efficiency features are available in ONTAP 9.1:

- Deduplication (inline and postprocess)
- Compression
- Compaction
- Thin provisioning

How is storage efficiency achieved?

Answer: Many storage efficiency operations (for example, inline deduplication, inline adaptive compression, and inline data compaction) take place at ingest. Post-process storage efficiency operations are performed at the FlexVol member level, not across the FlexGroup volume.

Is RAID Triple Erasure Coding (RAID-TEC) supported with NetApp FlexGroup?

Answer: Yes. RAID-TEC resides at the storage layer and does not interfere with FlexGroup functionality.

Are per-aggregate CPs supported with NetApp FlexGroup?

Answer: Yes. Per-aggregate CPs do not interfere with FlexGroup functionality.

Are large SSDs (15TB+) supported with NetApp FlexGroup?

Answer: Yes. Large SSDs do not interfere with FlexGroup functionality. In fact, they are a competitive advantage with large-capacity file systems because of their blend of density, performance, and longevity.

Is All Flash FAS (AFF) supported with NetApp FlexGroup?

Answer: Yes. All Flash FAS is supported with NetApp FlexGroup.

Which FAS platforms are supported with NetApp FlexGroup?

Answer: All FAS platforms are supported for use with NetApp FlexGroup. However, lower-end platforms such as the FAS2XXX are not recommended.

Which drive types are supported with NetApp FlexGroup?

Answer: All drive types are supported with NetApp FlexGroup. However, NetApp recommends using a homogenous drive type with each FlexGroup volume to ensure consistent performance and throughput across all member volumes.

Are mixed FAS platforms in the same cluster supported with NetApp FlexGroup?

Answer: Yes. You can use different platform types in the same cluster with NetApp FlexGroup. However, NetApp does not recommend leveraging mixed platforms in the same cluster for a FlexGroup volume. Homogenous platforms help make sure that predictable performance is seen in a FlexGroup volume.

Are mixed aggregate types supported with NetApp FlexGroup?

Answer: Yes. You can leverage aggregates with a mixture of spinning disk and flash, but NetApp does not recommend this practice. Using the same disk types in a FlexGroup volume helps to make sure that predictable performance is seen.

Can a FlexGroup volume span only part of a cluster? For example, if two of four nodes are AFF, can I use only AFF with the FlexGroup volume?

Answer: Yes. You can span a FlexGroup volume across specific nodes in a cluster by specifying the aggregates being used with the FlexGroup volume. If SSD-only configurations are desired, specify only SSD aggregates. If SATA-only is desired, specify only SATA. If you want only AFF nodes, specify only the aggregates owned by the AFF nodes.

What happens if a member runs out of space before other members run out of space?

Answer: If a member FlexVol volume runs out of space before the other members, the client receives ENOSPC from the server and the entire FlexGroup volume is considered full.

What are the remediation steps if a member volume runs out of space?

Answer: If the member volume has room to grow (that is, is >100TB), then grow the member volumes. If the member volumes are already 100TB, then add additional members with the `volume expand` command. If the physical storage is out of space (in thinly provisioned environments), add more disks.

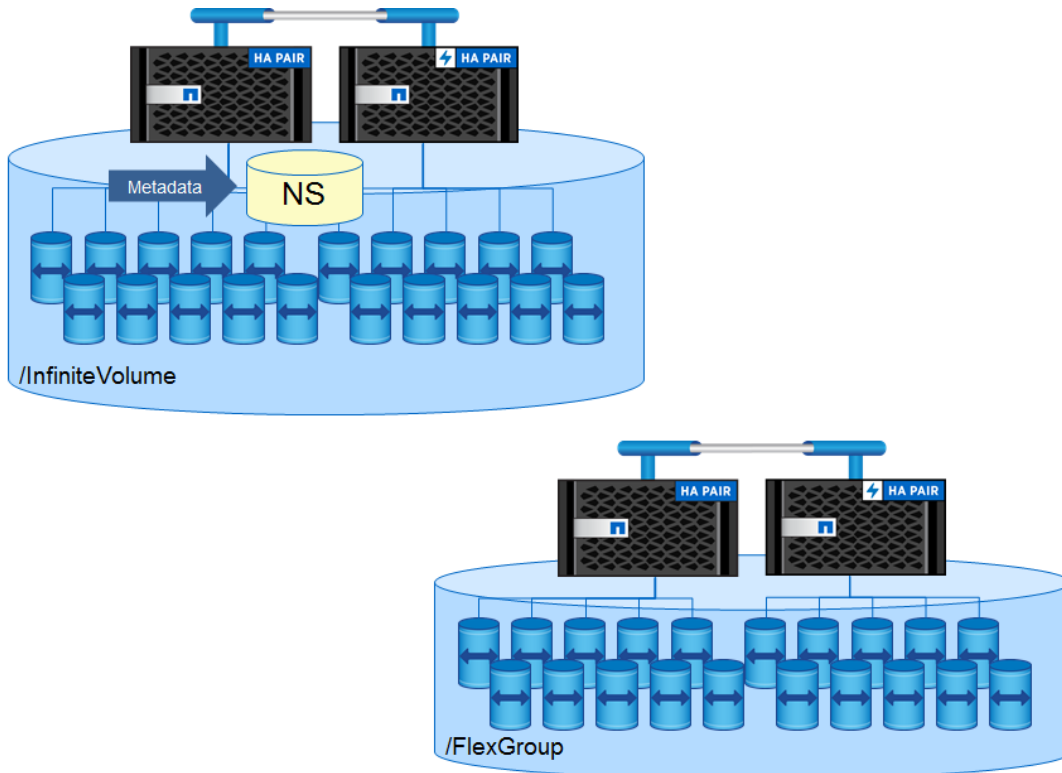
6 Infinite Volumes Compared to FlexGroup Volumes

Table 3) Comparison of features: Infinite Volumes compared to FlexGroup volumes.

	Infinite Volumes	FlexGroup Volumes
Maximum capacity	20PB	20PB
Maximum number of files/inodes	2 billion	400 billion
Metadata handling	Single metadata namespace volume	Handled by all member volumes
Capacity play?	Yes	Yes
Performance play?	No	Yes
FlexVol volumes in same SVM?	No	Yes
NFSv3	Yes	Yes
NFSv4	No	Future
pNFS/NFSv4.1	Yes	Future
SMB 1.0	Yes	No (deprecated by Microsoft)
SMB 2.0/2.1	No	Yes*
SMB 3.0	No	No

Note: * See the SMB support section above for details on what is not yet supported for SMB.

Figure 2) Infinite Volume architecture compared to NetApp FlexGroup architecture.



7 Failure Scenarios

How does NetApp FlexGroup handle storage failovers?

Answer: Storage failovers are handled in the same way that they are handled with FlexVol volumes. The partner node owns the aggregates containing the FlexVol members. No outage is involved until giveback, when protocol-specific considerations come into play. See [TR-4100 for details about nondisruptive operations in SMB](#) and [TR-4067 for details about NFS](#).

How does NetApp FlexGroup handle upgrades to ONTAP?

Answer: NetApp FlexGroup allows nondisruptive upgrades in the same manner as FlexVol. For information on nondisruptive upgrades, see the [Nondisruptive Upgrade Technical FAQ](#).

How does NetApp FlexGroup handle hardware failures (such as aggregates or shelves)?

Answer: In the extremely rare event of a shelf or aggregate outage, the member FlexVol volumes of a FlexGroup volume that exist on the affected hardware are unavailable. This situation causes Snapshot copies and SnapMirror updates to fail. Additionally, because a FlexGroup volume leverages hard links to redirect locations of files and folders in the file system, any hard links that existed on those member FlexVol volumes are also unavailable. That situation potentially affects access to files that exist on FlexVol members that were unaffected by the outage.

What happens if FlexGroup discovers a metadata inconsistency?

Answer: With the addition of NetApp FlexGroup comes a new recovery structure called Automated Incremental Repair (AIR). If an inconsistency is found on file access by a client, AIR repairs it on the fly without any noticeable disruption to the client. The FlexGroup volume remains online and serves data during these operations.

How does WAFL iron work in FlexGroup?

Answer: In very rare cases, a FlexGroup volume might need to run WAFL iron. Because a FlexGroup volume is a series of FlexVol volumes, WAFL iron works identically to FlexVol. In a FlexGroup volume, only the FlexVol members that need to be ironed are repaired; the rest of the members are not affected. However, if any FlexGroup metadata structures need repair, a separate FlexGroup iron needs to be run. FlexGroup iron is performed with the FlexGroup volume online while WAFL iron might need to take the member FlexVol offline. This action should be taken only with the guidance of NetApp Support.

8 Performance

Why does NetApp FlexGroup perform better than FlexVol volumes for metadata workloads?

Answer: The FlexGroup design works around the issue of serial processing of metadata operations in WAFL, known as [waffinity](#). By parallelizing NAS operations and volume affinity across multiple FlexVol members, FlexGroup volumes can deliver up to two times to six times the performance seen from a normal FlexVol volume.

Why does NetApp FlexGroup perform better than an Infinite Volume yet achieve equal capacity?

Answer: The FlexGroup design enables leveraging up to 200 member constituents for metadata operations at any given time. Infinite Volume, however, uses a single metadata namespace volume for these operations, which proved to be a performance bottleneck in some cases because of waffinity. See the section in this document called “Infinite Volumes Compared to FlexGroup Volumes for a more detailed look.

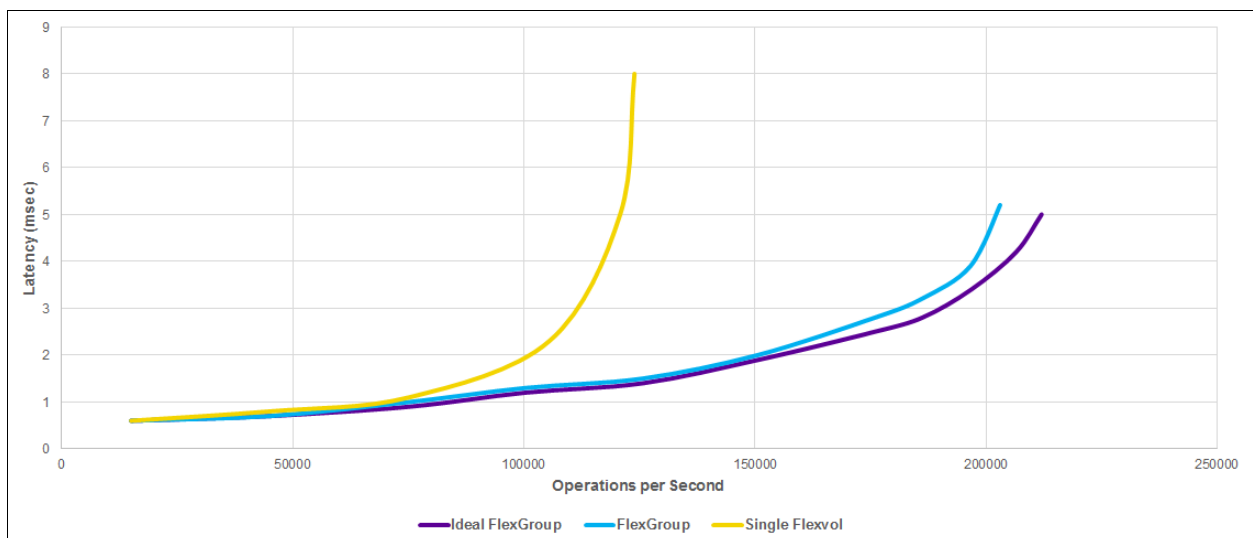
Is any performance penalty associated with a FlexGroup volume?

Answer: A FlexGroup volume has two areas in which performance can be affected. First, remote I/O over a cluster network can add some latency to NAS requests that might or might not be noticeable to NAS clients. There is also the notion of a “FlexGroup tax” that can cause 8% to 10% performance degradation. However, both penalties are more than offset when leveraging two or more member constituents in a FlexGroup volume.

How many IOPS can a FlexGroup volume achieve compared to a FlexVol volume?

Answer: In preliminary testing, a FAS8080 with two aggregates of SAS drives showed that a FlexGroup volume of 32 member constituents could push upward of ~250,000 IOPS of NFSv3 traffic using standard testing suites. Conversely, a single FlexVol volume maxed out at around ~125,000 IOPS with a more drastic latency spike. (See Figure 3.)

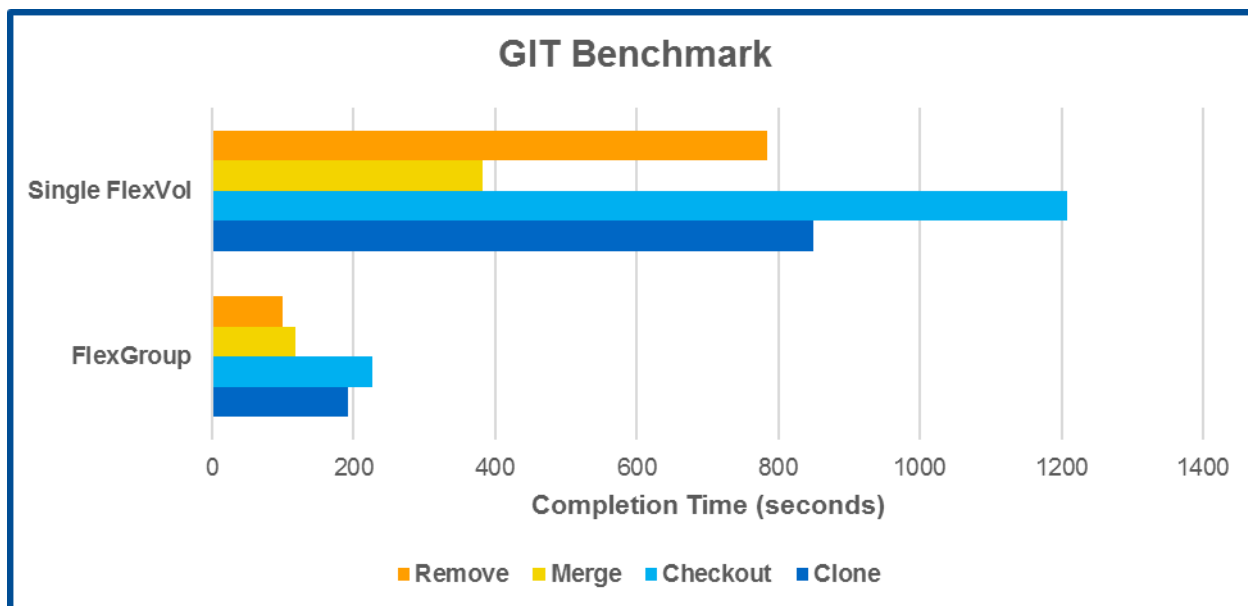
Figure 3) FlexVol performance versus FlexGroup (standardized workload benchmark).



How do FlexGroup volumes stack up in a real-world use case?

Answer: Preliminary testing of FlexGroup volumes with GIT benchmarking (single FAS8080, SAS drives, 2 aggregates, 16 members) showed 2 times to 6 times performance improvements compared to a single FlexVol volume. (See Figure 4.)

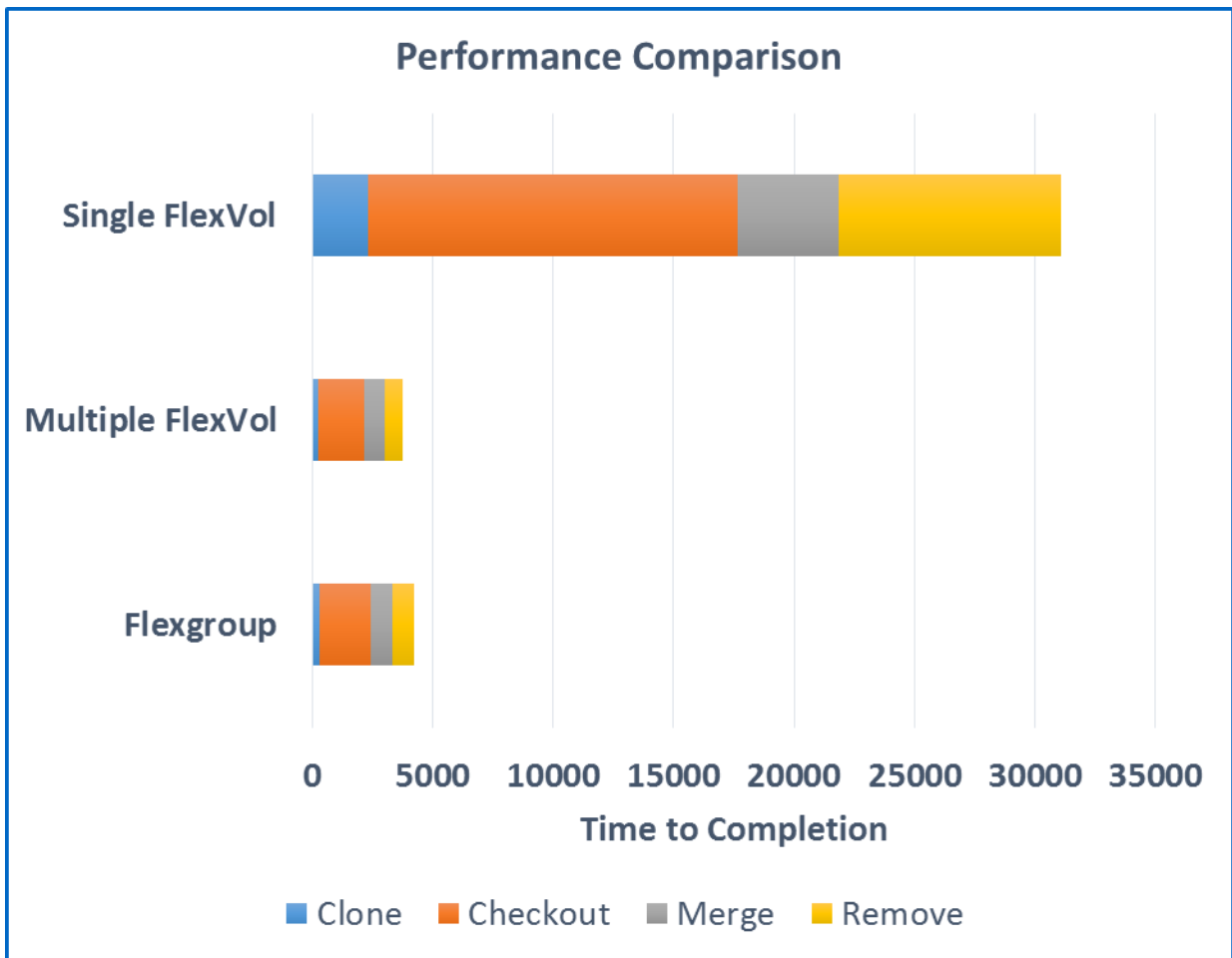
Figure 4) FlexVol versus FlexGroup: GIT benchmark, Linux kernel compile.



The following test was done with an All Flash FAS system. The configuration was:

- 4-node AFF8080.
- 8 FlexVol members per node.
- 1 aggregate per node.
- Single FlexVol test was all local.
- Multiple FlexVol tests were clusterwide; 25% local traffic (junctioned volumes).
- The FlexGroup volume had 32 member constituents.

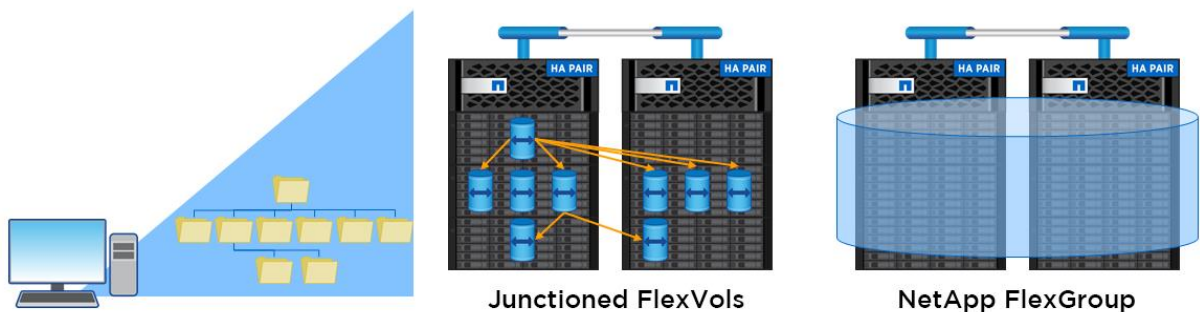
Figure 5) FlexVol versus FlexGroup: GIT benchmark, Linux kernel compile.



Can a FlexVol volume compete with a FlexGroup volume in terms of performance?

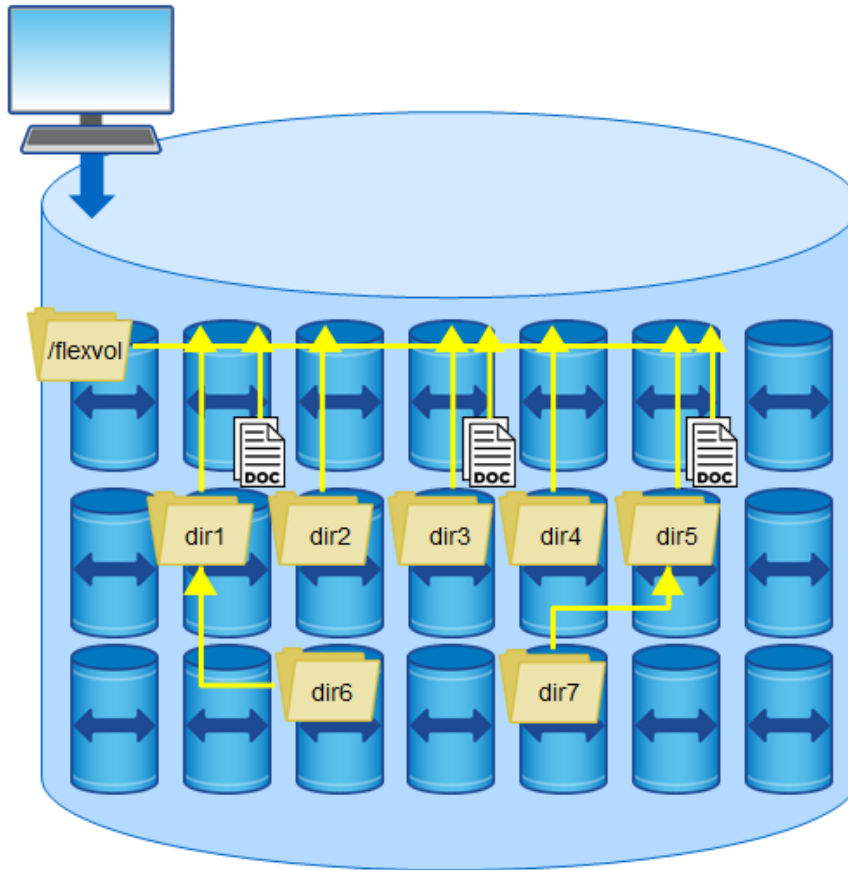
Answer: If a FlexVol volume is configured as part of a junction tree of many FlexVol volumes and distributed across a cluster, it is possible to get better performance for operations by way of the same notion of volume affinity as that of a FlexGroup volume.

Figure 6) Example of junctioned FlexVol volumes in a cluster versus FlexGroup volumes.



However, this configuration adds complexity to the storage administrator's tasks in both setup and continued maintenance as well as limiting clients to how the file system is constructed. Junctions appear as folders to clients, so the workloads would need to be modified to take that into consideration.

Figure 7) File system layout on a NetApp FlexGroup volume.



In addition, junctioned FlexVol volumes do not offer the single bucket of 20PB that a FlexGroup volume offers, nor can it offer the 400 billion files. Each individual FlexVol volume still has the 100TB/2 billion file limit.

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