



Technical FAQ

NetApp FlexGroup ONTAP 9.2

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Abstract

This technical FAQ covers common questions about FlexGroups. For any questions not covered in this document, e-mail flexgroups-info@netapp.com, and they will be added as necessary. For a technical overview, see [TR-4557](#). For best practices, see [TR-4571](#). For roadmap information, please contact your NDA presenter or e-mail flexgroups-info@netapp.com.

Information Classification

NetApp Confidential

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Version History

Version	Date	Document Version History
Version 1.0	August 2016	Initial commit; ONTAP 9.0
Version 2.0	October 2016	ONTAP 9.1RC1
Version 2.1	December 2016	ONTAP 9.1RC2
Version 2.1.1	February 2017	ONTAP 9.1 GA
Version 2.2	May 2017	ONTAP 9.2RC1

1 Overview

NetApp FlexGroup volume is a new NAS feature generally available in NetApp® ONTAP® 9.1 and later that 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 volume enables storage administrators to utilize their entire cluster for NAS workloads without needing to worry about file or volume layout. They 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 than others.

These include:

- Electronic design automation (EDA)
- Software build environments
- Oil/gas/seismic data
- Unstructured NAS data (such as home directories; see note below)
- 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 volumes. Workloads that generate very large files or files that grow very large after being written are not ideal workloads. Additionally, workloads that require specific features not currently available in FlexGroup volumes are not ideal.

Note: Home directories often require support for quota enforcement, antivirus, file auditing and fpolicy. FlexGroup volumes currently do not support these features, so this consideration should be factored in to whether home directories are a proper fit for FlexGroup volumes.

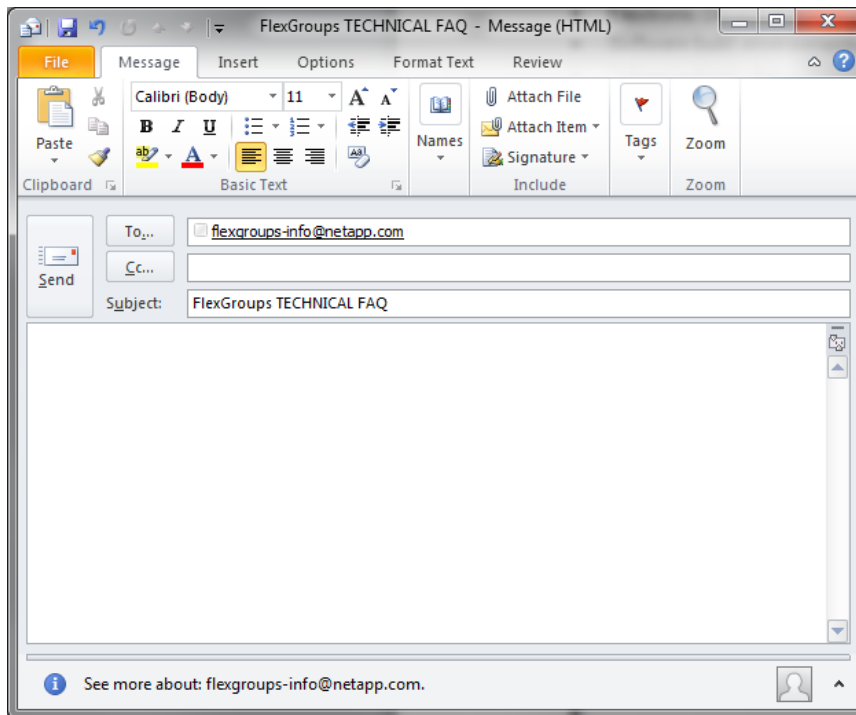
1.2 Questions Not Covered Here

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:



If your question is in regard to future support of a feature or FlexGroup volume roadmap, see your NDA presenter or email flexgroups-info@netapp.com.

2 Key Terminology

This section covers terminology specific to ONTAP and FlexGroup volumes that may 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 (FlexVol®) 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 if a client can mount a FlexVol volume and what share-level access the client has after it 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 is intended to provide near-infinite scale (up to 20PB) for archival. For more information about Infinite Volumes, see [TR-4037: An Introduction to Infinite Volume](#).

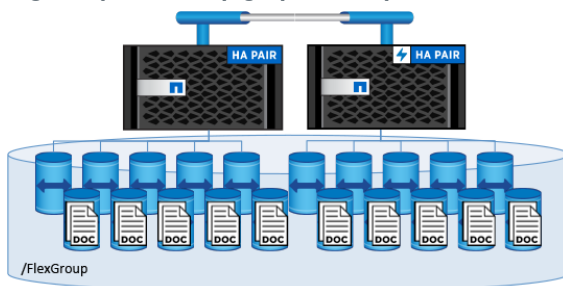
Logical Interface (LIF)

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.

Figure 1) FlexGroup graphical depiction.



3 General

The intent of this section is to answer questions about NetApp FlexGroup volumes that get asked on a regular basis. For more detail around the technical aspects of the FlexGroup, see [TR-4557: NetApp FlexGroup Technical Overview](#). For best practices, see [TR-4571: NetApp FlexGroup Best Practices and Implementation Guide](#).

What is a NetApp FlexGroup volume?

Answer: A FlexGroup volume is a single namespace container that consists of multiple FlexVol volume member constituents. Data is distributed across these constituents using local and remote hard links. These links are driven by a new WAFL® 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 is used to direct remote traffic in a FlexGroup volume.

When can I use NetApp FlexGroup volumes?

Answer: NetApp FlexGroup is available through PVR only in ONTAP 9.0. NetApp FlexGroup is available to all customers in ONTAP 9.1 and does not require a license.

What are the intended workloads for a FlexGroup volumes?

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

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

What workloads are not ideal for FlexGroup volumes?

Answer: Any workload that requires support for features that are unavailable in NetApp FlexGroup volume is not ideal for the feature. For example, if an application needs SMB v1.0, then NetApp FlexGroup volumes should not be recommended. Or, if a virtualization workload requires vSphere integration, FlexClone and/or VAAI support, then FlexGroup volumes would not be ideal for a VMware datastore. For more information on supported/unsupported features, see the section of this document called [Support](#).

Are homedirs a valid workload for FlexGroup volumes?

Answer: Homedirs will work fine with FlexGroup volumes, but the feature is currently missing functionality usually required by homedirs, such as:

- Quota enforcement
- Anti-virus
- Fpolicy support
- Qtrees

Review the latest version of [TR-4571](#) for what functionality is supported with FlexGroup volumes.

What happens to an existing FlexGroup volume when upgrading ONTAP?

Answer: When upgrading from/reverting to ONTAP 9.0, any existing FlexGroup volume will need to be deleted. If it's necessary to preserve the existing data, then the data would need to be copied to one or more FlexVol volumes. After upgrading to ONTAP 9.1, subsequent upgrades (i.e., 9.2, 9.3, etc.) will require no special action and are fully non-disruptive.

How is a FlexGroup volume accessed?

Answer: A FlexGroup volume is designed to be accessed by NAS (file) 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 (block) support for NetApp FlexGroup volumes.

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

Answer: Yes, a FlexGroup volume can be mounted as part of a junction path in the same namespace. See [TR-4571](#) for details.

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

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

Does NetApp FlexGroup volume replace Infinite Volumes?

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

How do I migrate from an Infinite Volume or a FlexVol volume to a FlexGroup volume?

Answer: Currently, the only way to migrate to a FlexGroup volume is to copy the data. Tools like [XCP](#) (for NFSv3) or third party tools such as [Peer](#) or [StorageX from Data Dynamics](#) (for SMB) are ways to do this efficiently.

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

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

Does a FlexGroup volume replace FlexVol volumes?

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

Can I convert an existing FlexVol volume (or multiple FlexVol volumes) to a FlexGroup volume?

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

How do Snapshot copies work?

Answer: Snapshot® copies of a FlexGroup volume are performed at the FlexVol volume 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 volume Snapshot copy to be considered valid. Invalid Snapshot copies are discarded and removed by ONTAP automatically.

FlexGroup volume Snapshot copies function identically to FlexVol Snapshot copies in terms of access through the .snapshot directory, space usage, and volume-level restores.

Does Single File SnapRestore (SFSR) work with NetApp FlexGroup volumes?

Answer: No. Single files must be restored via the snapshot directory (.snapshot in NFS, ~snapshot in CIFS/SMB) or Previous Versions tab in Windows.

Can I use SnapRestore to restore a single member FlexVol volume in a FlexGroup volume?

Answer: No. SnapRestore is an “all or nothing” approach in FlexGroup volumes. If you run SnapRestore on a FlexGroup volume, the **entire** FlexGroup will be restored. This methodology is similar to aggregate-level snapshots and FlexVol volumes.

I tried to use the “snap restore” command on my FlexGroup volume and it failed. Why?

Answer: The “snap restore” command is only available to storage administrators to use at **diag privilege** level. Running the command at other privilege levels will cause the command to fail.

The product documentation says I need to contact support to do a SnapRestore. Why?

Answer: Since the “snap restore” command works only at **diag privilege**, the official product documentation cannot give steps out for SnapRestore. NetApp Support is generally referenced whenever a diag command is needed.

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

Answer: Yes. Although FlexGroup volumes can only use NFSv3 and SMB (as of 9.1RC2), they can coexist with 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 one of many single, independent member FlexVol volumes. This is one reason why FlexVol member volume sizes, file counts and file sizes should be considered in the initial implementation of a FlexGroup volume. For more information on best practices, see [TR-4571](#).

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. The load balancing only occurs at creation/ingest of the file/folder. Files that have already been written will handle I/O like a normal FlexVol volume would. More detail can be found in [TR-4557](#).

Can a FlexGroup volume rebalance the files/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. If a re-balance is needed, it would need to occur by re-ingesting the files. This can be done by copying files into a new FlexGroup volume with tools like [XCP](#) (for NFSv3) or third party tools such as [Peer](#) or [StorageX from Data Dynamics](#) (for SMB).

4 Deployment

How do I enable the NetApp FlexGroup volume feature? I don't see it available in my ONTAP 9.0 cluster.

Answer: FlexGroup in ONTAP 9.0 is available by PVR only and require a special license hash to enable the feature. The access program to FlexGroup volumes in ONTAP 9.0 is now closed. ONTAP 9.1 offers this feature without the need for a license. If you wish to use FlexGroup volumes, use ONTAP 9.1 or later.

Why did I need a license to use NetApp FlexGroup volume in ONTAP 9.0?

Answer: License hashes are required for tracking purposes only in ONTAP 9.0. ONTAP 9.1 removes the license hash requirement and allows unrestricted access to the feature.

How do I create a FlexGroup volume?

Answer: OnCommand® System Manager allows creation of a FlexGroup volume via the new FlexGroup tab. If using CLI, use the command `flexgroup deploy` (requires two aggregates per node for spinning disk, one aggregate per node for All-Flash FAS) or `volume create -aggr-list [aggr1,aggr2,...]` if creating in the command line.

Can I grow a FlexGroup volume easily?

Answer: Yes. FlexGroup volume size can be increased one of two ways: (1) grow existing members (`volume size`) or (2) add additional members (`volume expand`). When deciding on the method of growing the volume, please review [TR-4557](#) and [TR-4571](#) to help inform your decision.

What considerations should I make when adding FlexVol volume members to a FlexGroup volume?

Answer: When adding new FlexVol volume members to a FlexGroup volume, always add multiple members. Adding a single volume member to a FlexGroup volume could cause an uneven allocation of workload until the member FlexVol volume reaches a watermark equal to the other members. The `volume expand` command is able to automate the process adequately. Ideally, add member volumes in the same increments as existing member volumes to help keep distribution and performance predictable as the new member volumes catch up to the others in capacity.

Can I shrink a FlexGroup volume?

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

Can I remove FlexGroup member volumes?

Answer: Removing FlexGroup member volumes is not supported. If a member volume was allowed to be removed, the remote hardlinks pointing to other places in the filesystem may also be removed, causing data access outages.

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:

- Less than 4 nodes in the cluster.
- Each node has one aggregate for All-Flash FAS or at least two data aggregates for other configurations.

- SVM created.
- The aggregates have sufficient space to create space guaranteed volumes.
- For any variations on the preceding, use `volume create` with `-aggr-list` instead or the OnCommand System Manager GUI.

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

Answer: To specify aggregates for a FlexGroup, use `volume create -aggr-list [aggr1,aggr2,...]` or the OnCommand System Manager GUI.

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

Answer: No. A FlexGroup volume can span all nodes in a cluster or only a subset of nodes if desired. For example, if a 4 node cluster has 2 nodes that are All-Flash FAS and 2 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. Examples of FlexGroup volume deployment options can be found in [TR-4571](#).

What considerations are needed for large files?

Answer: Member FlexVol volume constituents can be up to 100TB in size. If a workload is writing very large files, member FlexVol volumes must be sized to reflect the larger file sizes.

What is considered to be a “large file” in a FlexGroup volume?

Answer: Files are considered to be large as a percentage of a volume’s overall space as opposed to any set or given size. Large file concepts are covered in detail in [TR-4571](#).

5 Support

What features are supported by NetApp FlexGroup volumes in ONTAP 9.2?

Answer: The following table covers supported features for NetApp FlexGroup volumes in ONTAP 9.2.

Table 1) What is supported for NetApp FlexGroup in ONTAP 9.2?

Supported ONTAP Features in ONTAP 9.2 (NetApp FlexGroup)
• NFSv3 and SMB 2.x/3.x (see Table 3 for more information) • Snapshots/SnapRestore • SnapMirror • Thin provisioning • System Manager/OnCommand Performance Manager • RAID-TEC • ADPv2 • Per-aggregate consistency points • Storage efficiencies (compression, compaction, deduplication) • All-Flash FAS • Quota reporting (user and group only) • Constituent/member volume move • Sharing aggregates and Storage Virtual Machines with FlexVols • NetApp Volume Encryption • ONTAP Select support

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

Answer: FlexGroups are intended for scratch space workloads only in ONTAP 9.0. Production workloads are not recommended in ONTAP 9.0. Use ONTAP 9.1 or later instead for production workloads.

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. See the [maximums documentation available on the Field Portal](#) for more information about FlexVol maximums, as well as [TR-4571](#) for considerations regarding architectural limits for NetApp FlexGroup volumes.

How many FlexVol member volumes can a FlexGroup volume contain?

Answer: A single FlexGroup volume has no architectural limits on how many FlexVol member volumes it can contain other than the maximum volume counts allowed on a single node. However, best performance results are seen when using 8 member volumes per node in a cluster due to volume affinities and overall remote access layer penalties.

What is the maximum capacity of a FlexVol volume?

Answer: The current maximum capacity of a FlexVol volume is 100TB (on high-end systems). See the [maximums documentation available on the Field Portal](#) for more information about FlexVol maximums.

What is the maximum capacity of a FlexGroup volume?

Answer: A single FlexGroup volume has no architectural limits on how many FlexVol member volumes it can contain other than the maximum volume counts allowed on a single node. Thus, the maximum capacity is dependent on number of nodes in a cluster, type of platform being used, etc. See the section on architectural maximums in [TR-4571](#) for more information.

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. This is pertinent to a FlexGroup volume because it is comprised of FlexVol volumes.

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

Answer: There is no architectural limit to the number of inodes allowed in a FlexGroup volume outside of the FlexVol maximums allowed on a platform. Thus, the maximum inodes allowed in a FlexGroup is (x member FlexVols * 2 billion inodes). See the [maximums documentation available on the Field Portal](#) for more information about FlexVol maximums.

Is there support for Snapshot copies with a FlexGroup volume?

Answer: Yes. FlexGroup volumes support Snapshot copies.

Is SnapMirror supported with FlexGroup volumes?

Answer: SnapMirror is supported with FlexGroup volumes starting in ONTAP 9.1.

What are the caveats for SnapMirror with NetApp FlexGroup volumes?

The following table shows what caveats exist for SnapMirror support with NetApp FlexGroup volumes.

Table 2) SnapMirror support caveats with NetApp FlexGroup volumes

SnapMirror support caveats with NetApp FlexGroup volumes
• 32 FlexVol member volumes per FlexGroup volume (concurrent transfer consideration) • 100 total FlexVol member volumes per cluster (across all SVMs) • SnapMirror and Snapshot update schedules no more frequent than 30 minutes per update • Staggering of Snapmirror and Snapshot schedules across FlexGroup volumes Currently no support for: • Synchronous SnapMirror • Cascading SnapMirror • SnapMirror to tape • SnapMirror between FlexVol or Infinite Volume and FlexGroup volumes • Qtree SnapMirror

Can I SnapMirror to/from an existing FlexVol volume or Infinite Volume to/from a FlexGroup volume?

Answer: No, this is currently not a possible migration or DR path.

Is SnapVault supported with NetApp FlexGroup volumes?

Answer: SnapVault is currently not supported with FlexGroup volumes.

Is SnapLock supported with NetApp Flexgroup volumes?

Answer: No, SnapLock is currently not supported with FlexGroup volumes.

Is NDMP supported with NetApp FlexGroup volumes?

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

Is NetApp Volume Encryption (NVE) supported with NetApp FlexGroup volumes?

Answer: Yes, NVE is supported with NetApp FlexGroup volumes starting with ONTAP 9.2.

Is SAN supported with NetApp FlexGroup volumes?

Answer: No, SAN is not supported. FlexGroup volumes are NAS only.

Is volume move supported with NetApp FlexGroup volumes?

Answer: Volume moves are supported with FlexGroup volumes at the FlexVol member constituent level.

What is the recommended maximum volume operations per hour for a NetApp FlexGroup?

Answer: The recommended maximum volume operations (vol move, vol offline/vol online) is 10 per hour.

What NAS protocols are supported for use with a FlexGroup?

Answer: ONTAP 9.2 supports NFSv3 and SMB 2.x/3.x.

Is Windows NFS supported with NetApp FlexGroup volumes?

Answer: No, NetApp FlexGroup volumes lack unmonitored locking support, which Windows NFS depends on. FlexVol volumes support Windows NFS.

Are there any feature limitations with the NAS protocols?

Answer: There are no feature limitations for NFSv3, but support for the following in SMB 2.x/3.x are currently not available:

Table 3) SMB Features not supported with NetApp FlexGroup in ONTAP 9.2.

Features not supported for use with NetApp FlexGroup with SMB 2.x/3.x in ONTAP 9.2	
• Server-side copy offload (ODX) • Scale-out • Persistent handles • Transparent failover • Cluster Client Failover (v2) • Change/notify • CA shares • SMB Remote VSS • Storage Level Access Guard (SLAG) • File auditing • Fpolicy • AntiVirus	

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 and later:

- Deduplication (inline and post-process)
- Compression (inline and post-process)
- Compaction
- Thin provisioning

Support for aggregate inline deduplication was added in 9.2.

Is Inline Aggregate Deduplication supported with FlexGroup volumes?

Answer: Inline Aggregate Deduplication support for ONTAP was added in ONTAP 9.2 and is supported with NetApp FlexGroup Volumes.

Are FabricPools supported with NetApp FlexGroup volumes?

Answer: FabricPools were added in ONTAP 9.2, but this feature does not currently support NetApp FlexGroup volumes. Support for FlexGroup volumes is targeted for a future release.

How is storage efficiency done?

Answer: Many storage efficiencies are done at ingest (ie, inline deduplication, compression, compaction). Post-process storage efficiencies are done at the FlexVol member level, not across the FlexGroup. As a result, if duplicate blocks are present in a FlexGroup volume, deduplication will only apply to files in the same member FlexVol volume, not across the entire FlexGroup.

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

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

Are per-aggregate CPs supported with NetApp FlexGroup volumes?

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

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

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

Is All Flash FAS supported with NetApp FlexGroup volume?

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

What FAS platforms are supported with NetApp FlexGroup volumes?

Answer: All FAS platforms are supported for use with NetApp FlexGroup volumes.

What drive types are supported with NetApp FlexGroup volumes?

Answer: All drive types are supported with NetApp FlexGroup volumes. However, it is recommended to use 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 volume?

Answer: Yes. You can use different platform types in the same cluster with NetApp FlexGroup volumes. However, it is not recommended to leverage mixed platforms in the same cluster for a FlexGroup volume. For instance, if using AFF and FAS in the same cluster, consider allocating the FlexGroup member volumes to the AFF systems only rather than spreading across the FAS as well. Homogenous platforms help make sure that predictable performance is seen in a FlexGroup volume. For FlexGroup volume deployment examples, see [TR-4571](#).

Are mixed aggregate types supported with NetApp FlexGroup volumes?

Answer: Yes. You can leverage aggregates with a mixture of spinning disk and flash, but it is not a recommended practice. Using the same disk types in a FlexGroup volume helps to influence predictable performance.

Can a FlexGroup volume span only part of a cluster?

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, only specify SSD aggregates. If SATA-only is desired, specify only SATA. If you only want AFF nodes, only specify the aggregates owned by the AFF nodes. For FlexGroup volume deployment examples, see [TR-4571](#).

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

Answer: If a FlexVol member volume runs out of space before the other members, the client receives ENOSPC, from the server and the entire FlexGroup volume is considered full. However, the FlexGroup ingest heuristics are designed to heavily skew when a member volume is getting close to full, thus prioritizing avoidance of this scenario as heavily as possible. For more detail on ingest heuristics, see [TR-4557](#) and [TR-4571](#).

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

Answer: If the member volume has room to grow (ie, 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. For more detail on identification and remediation of capacity issues, see [TR-4571](#).

Is MetroCluster supported with NetApp FlexGroup volumes?

Answer: No, MetroCluster is not currently supported.

Are software defined versions of ONTAP (such as Edge, Select or ONTAP Cloud) supported?

Answer: ONTAP Select is qualified as supported with NetApp FlexGroup volumes as of ONTAP 9.2 Other software defined versions of ONTAP have yet to be qualified as supported with NetApp FlexGroup volumes.

Are qtrees supported with NetApp FlexGroup volumes?

Answer: No, qtrees are currently not supported with NetApp FlexGroup volumes.

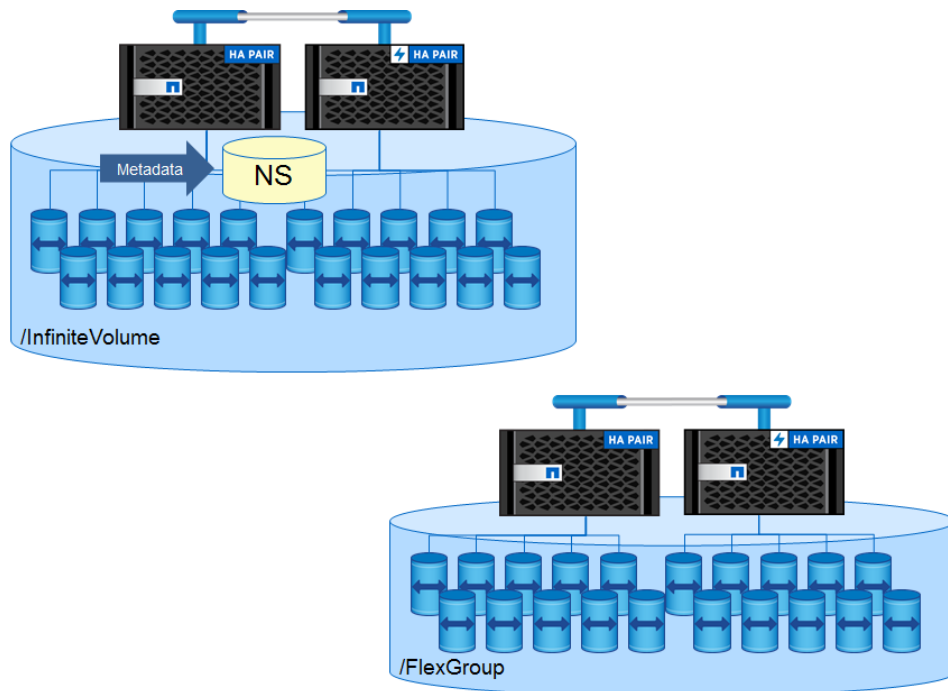
6 Infinite Volumes Compared to NetApp FlexGroup

Table 4) Comparison of features: Infinite Volumes compared to NetApp FlexGroup.

	Infinite Volume	FlexGroups
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.x	No	Yes*

Note: See above for details on what is not supported for SMB yet.

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



7 Failure Scenarios

How do NetApp FlexGroup volumes handle storage failovers?

Answer: Storage failovers are handled identically to the way 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 do NetApp FlexGroup volumes handle upgrades to ONTAP?

Answer: NetApp FlexGroup volume allows for non-disruptive upgrades in the same manner as a FlexVol. For information on non-disruptive upgrades, see the [Non-Disruptive Upgrade Technical FAQ](#).

How do NetApp FlexGroup volumes handle hardware failures (such as aggregates/shelves)?

Answer: In the extremely rare event of a shelf or aggregate outage, the FlexVol member volumes of a FlexGroup volume that exist on the affected hardware are unavailable. This also 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 FlexVol member volumes are also unavailable and potentially affect access to files that exist on FlexVol member volumes that were unaffected by the outage.

What happens if a FlexGroup volume discovers a metadata inconsistency?

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

How does WAFL iron work in FlexGroup volume?

Answer: In very rare cases, a FlexGroup volume may need to run WAFL iron. Because a FlexGroup volume is simply a series of FlexVol volumes, WAFL iron will work identically to FlexVol volumes. In a FlexGroup volume, only the FlexVol member volumes that need to be ironed will be repaired – the rest of the members will not be affected. This process should only be done with the guidance of NetApp support

8 Performance

Why does a single FlexGroup volume perform better than a single FlexVol volume for metadata workloads?

Answer: The FlexGroup volume design is intended to work around the issue of serial processing of metadata operations in WAFL known as [waffinity](#). By parallelizing NAS operations and volume affinity across multiple FlexVol member volumes, FlexGroup volumes can deliver up to 2x to 6x the performance seen from a normal FlexVol volume. Essentially, you are merging the performance capabilities and coordinated hardware usage of multiple FlexVol volumes with the ease of management and use of a single container namespace provided by the FlexGroup volume.

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

Answer: The FlexGroup volume design provides the ability to leverage multiple member constituents for metadata operations at any given time. Infinite Volume, however, used a single metadata namespace volume for these operations, which proved to be a bottleneck for performance in some cases due to serial processing and waffinity. See the section in this document Infinite Volumes Compared to NetApp FlexGroup for a more detailed look.

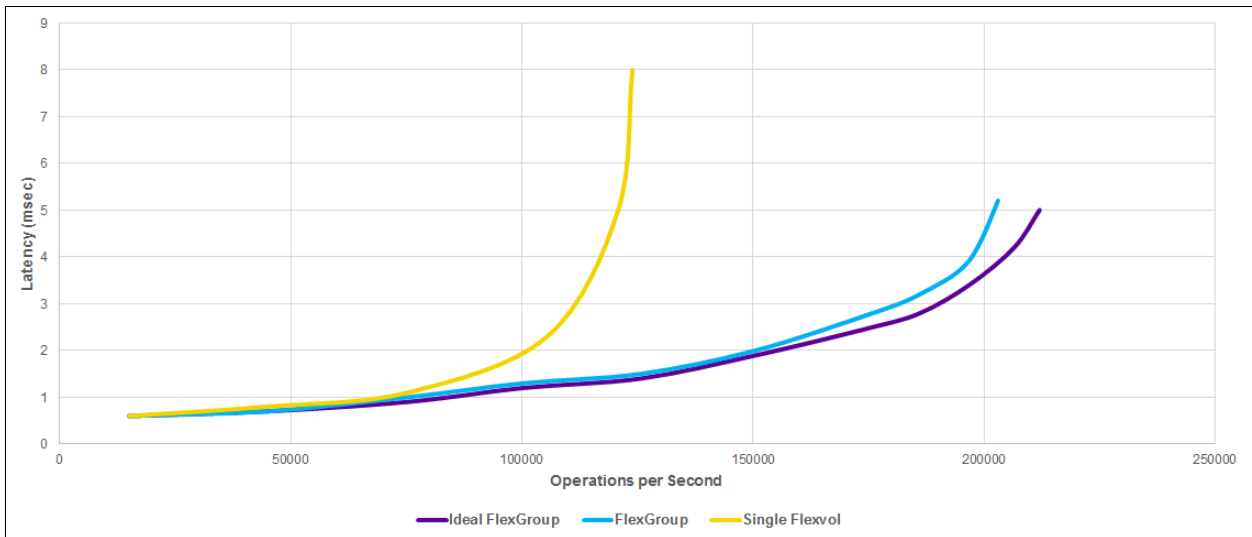
Is any performance penalty associated with a FlexGroup volume?

Answer: A FlexGroup volume has two areas where performance can be impacted by remoteness. First, remote I/O over a cluster network can add some latency to NAS requests that may or may not be noticeable to NAS clients and would be seen in normal FlexVol volumes as well. There is also a concept of a “FlexGroup tax” that can cause 8% to 10% performance degradation, depending on how many remote hardlinks are created in a FlexGroup volume. Remote hardlink creation is heavily dependent on free space in FlexVol member volumes, as well as workload types. Both penalties are more than offset when leveraging two or more member constituents in a FlexGroup volume. However, performance of multiple FlexVol volumes that are not part of a FlexGroup can exceed that of a FlexGroup volume. The downsides of using multiple FlexVol volumes with junction paths would include management overhead (volume creation, export policies and rules, manually balancing volume load across nodes, folder structure), application architecture changes to reflect a controlled folder structure and lack of a single large bucket of storage, as junctioned FlexVol volumes still are subject to a capacity and file/inode count limit.

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 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.)

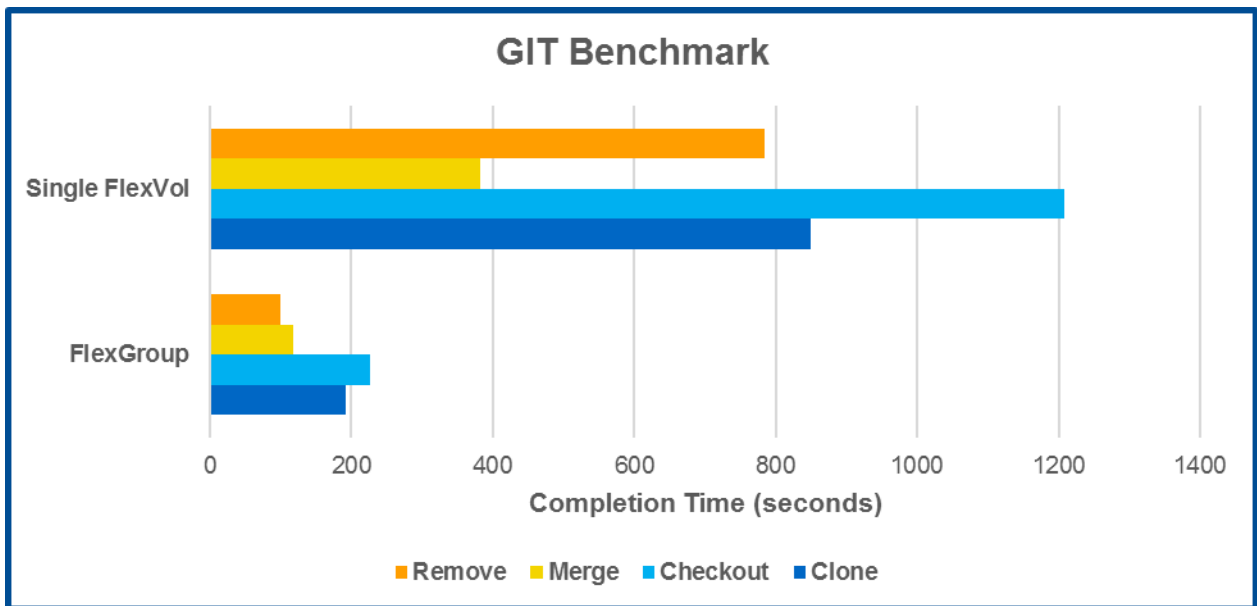
Figure 3) FlexVol performance vs. FlexGroup (standardized workload benchmark).



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 2x to 6x performance improvements compared to a single FlexVol volume. (See Figure 4.)

Figure 4) FlexVol vs. FlexGroup: GIT Benchmark, Linux kernel compile.



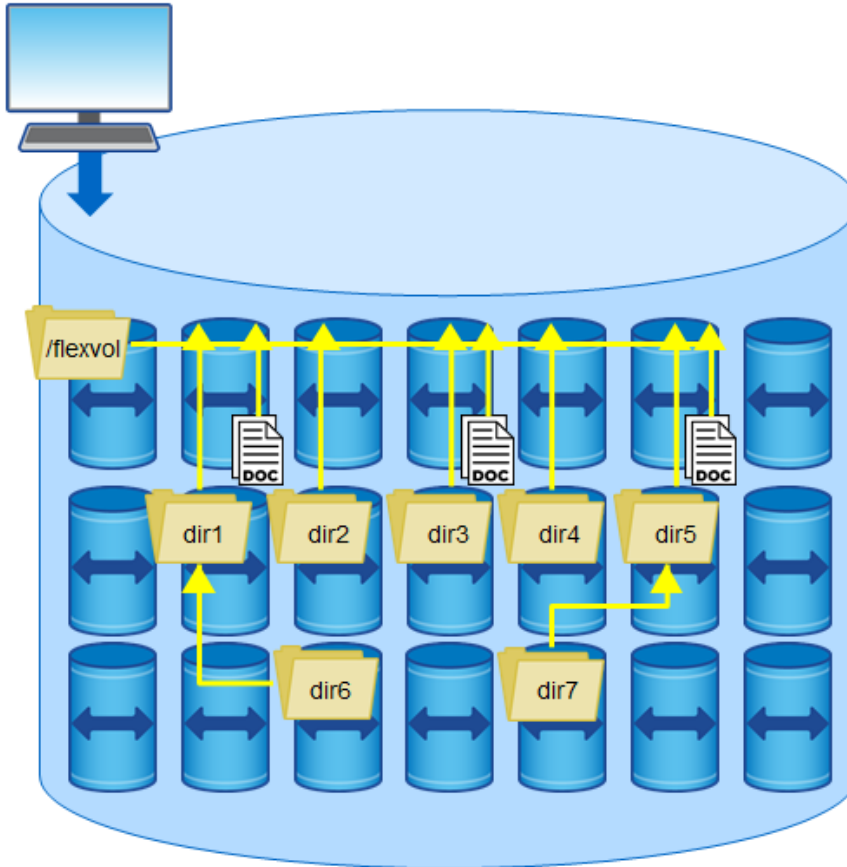
Can a FlexVol volume compete with a FlexGroup volume in terms of performance?

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 a FlexGroup volume.

Figure 3) Example of junctioned FlexVols in a cluster vs. FlexGroup.

However, this configuration adds complexity to the storage administrator's tasks in both set up 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 4) File system layout on a NetApp FlexGroup.



In addition, junctioned FlexVol volumes do not offer the single bucket large capacity and file/inode count that a FlexGroup volume offers. Each individual FlexVol volume still has the 100TB/2 billion file limit in a junctioned FlexVol volume architecture, which would be reflected in individual folders in the file system.

For more examples of performance graphs and charts, see [TR-4571](#) and [TR-4557](#).

Refer to the [Interoperability Matrix Tool \(IMT\)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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