# Red Hat Gluster Storage 3.1
# Administration Guide

Configuring and Managing Red Hat Gluster Storage

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## Configuring and Managing Red Hat Gluster Storage

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## Abstract

Red Hat Gluster Storage Administration Guide describes the configuration and management of Red Hat Gluster Storage for On-Premise and Public Cloud.

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# Part I. Overview

# Chapter 1. Platform Introduction

## 1.1. About Red Hat Gluster Storage

Red Hat Gluster Storage is a software-only, scale-out storage solution that provides flexible and agile unstructured data storage for the enterprise.

Red Hat Gluster Storage provides new opportunities to unify data storage and infrastructure, increase performance, and improve availability and manageability in order to meet a broader set of an organization's storage challenges and needs.

The product can be installed and managed on-premise, or in a public cloud.

## 1.2. About glusterFS

*glusterFS* aggregates various storage servers over network interconnects into one large parallel network file system. Based on a stackable user space design, it delivers exceptional performance for diverse workloads and is a key building block of Red Hat Gluster Storage.

The POSIX compatible glusterFS servers, which use XFS file system format to store data on disks, can be accessed using industry-standard access protocols including Network File System (NFS) and Server Message Block (SMB) (also known as CIFS).

## 1.3. About On-premise Installation

Red Hat Gluster Storage for On-Premise allows physical storage to be utilized as a virtualized, scalable, and centrally managed pool of storage.

Red Hat Gluster Storage can be installed on commodity servers resulting in a powerful, massively scalable, and highly available NAS environment.

See Part II, "Red Hat Gluster Storage Administration On-Premise" for detailed information about this deployment type.

## 1.4. About Public Cloud Installation

Red Hat Gluster Storage for Public Cloud packages glusterFS as an Amazon Machine Image (AMI) for deploying scalable NAS in the Amazon Web Services (AWS) public cloud. This powerful storage server provides all the features of On-Premise deployment, within a highly available, scalable, virtualized, and centrally managed pool of NAS storage hosted off-premise.

Additionally, Red Hat Gluster Storage can be deployed in the public cloud using Red Hat Gluster Storage for Public Cloud, for example, within the Amazon Web Services (AWS) cloud. It delivers all the features and functionality possible in a private cloud or datacenter to the public cloud by providing massively scalable and high available NAS in the cloud.

See Part III, "Red Hat Gluster Storage Administration on Public Cloud" for detailed information about this deployment type.

# Chapter 2. Red Hat Gluster Storage Architecture and Concepts

This chapter provides an overview of Red Hat Gluster Storage architecture and Storage concepts.

## 2.1. Red Hat Gluster Storage Architecture

At the core of the Red Hat Gluster Storage design is a completely new method of architecting storage. The result is a system that has immense scalability, is highly resilient, and offers extraordinary performance.

In a scale-out system, one of the biggest challenges is keeping track of the logical and physical locations of data and metadata. Most distributed systems solve this problem by creating a metadata server to track the location of data and metadata. As traditional systems add more files, more servers, or more disks, the central metadata server becomes a performance bottleneck, as well as a central point of failure.

Unlike other traditional storage solutions, Red Hat Gluster Storage does not need a metadata server, and locates files algorithmically using an elastic hashing algorithm. This no-metadata server architecture ensures better performance, linear scalability, and reliability.

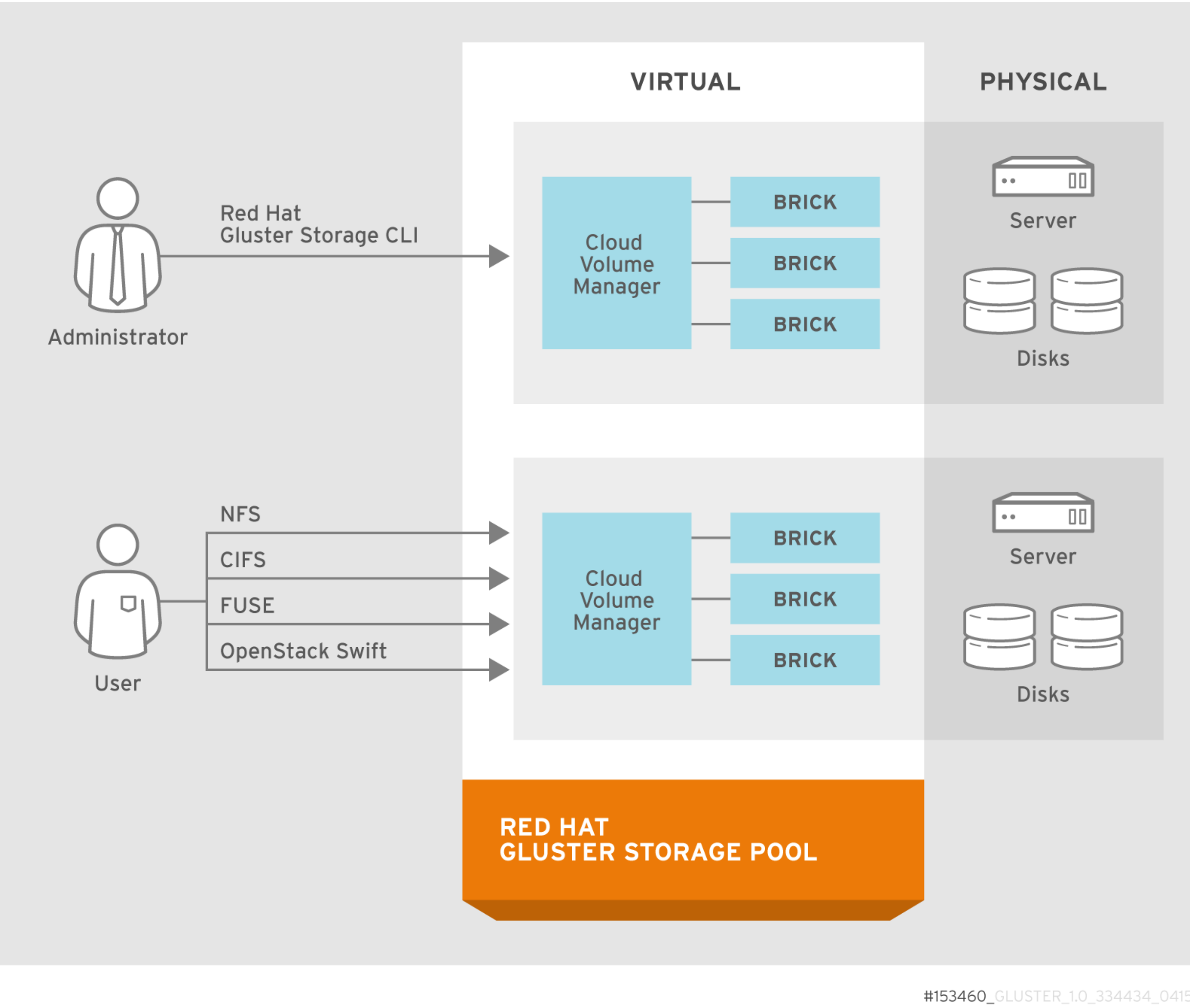



**Figure 2.1. Red Hat Gluster Storage Architecture**

## 2.2. Red Hat Gluster Storage for On-premise Architecture

Red Hat Gluster Storage for On-premise enables enterprises to treat physical storage as a virtualized, scalable, and centrally managed storage pool by using commodity storage hardware.

It supports multi-tenancy by partitioning users or groups into logical volumes on shared storage. It enables users to eliminate, decrease, or manage their dependence on high-cost, monolithic and difficult-to-deploy storage arrays.

You can add capacity in a matter of minutes across a wide variety of workloads without affecting performance. Storage can also be centrally managed across a variety of workloads, thus increasing storage efficiency.

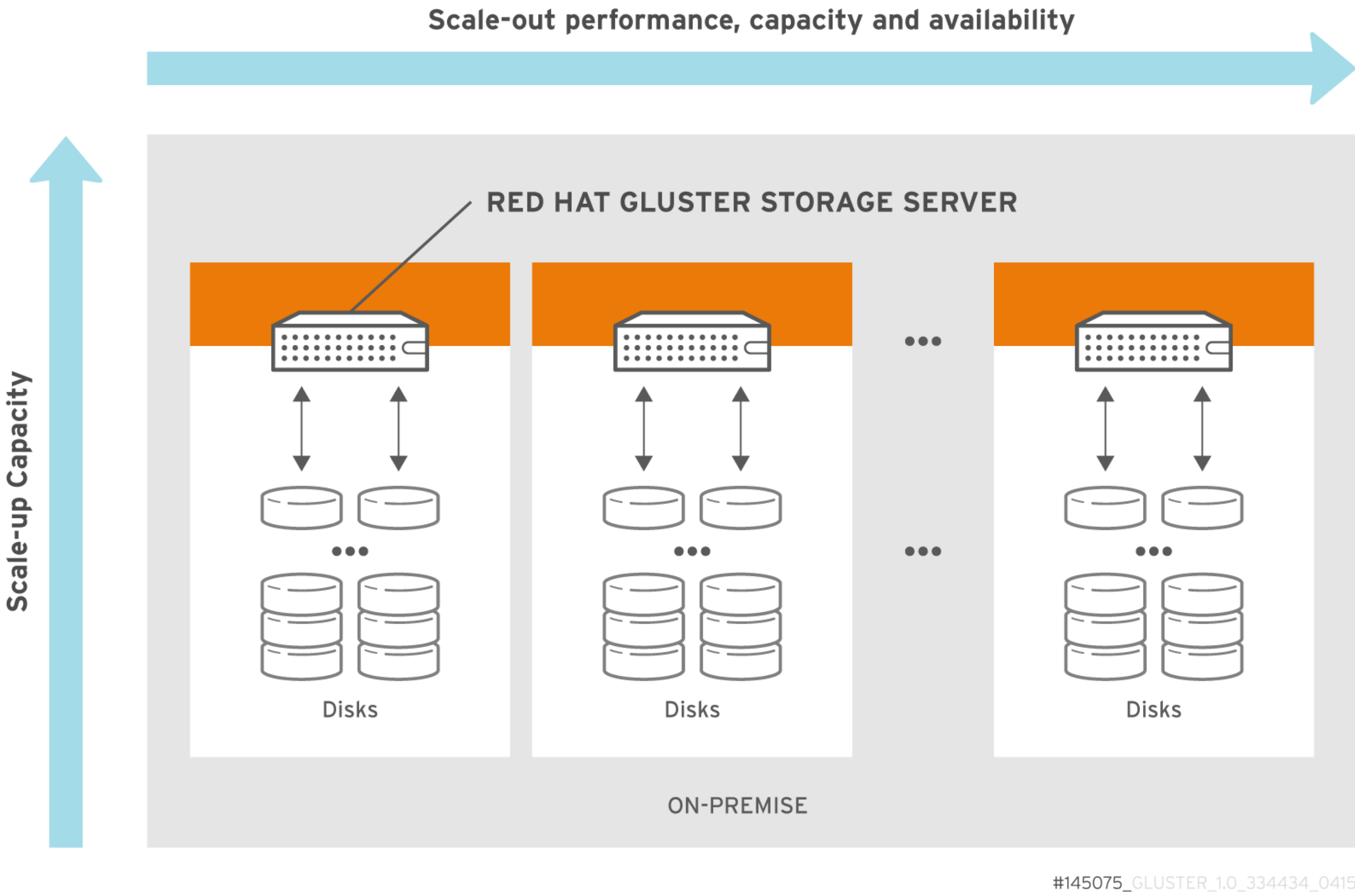



**Figure 2.2. Red Hat Gluster Storage for On-premise Architecture**

Red Hat Gluster Storage for On-premise is based on glusterFS, an open source distributed file system with a modular, stackable design, and a unique no-metadata server architecture. This no-metadata server architecture ensures better performance, linear scalability, and reliability.

## 2.3. Red Hat Gluster Storage for Public Cloud Architecture

Red Hat Gluster Storage for Public Cloud packages glusterFS as an Amazon Machine Image (AMI) for deploying scalable network attached storage (NAS) in the AWS public cloud. This powerful storage server provides a highly available, scalable, virtualized, and centrally managed pool of storage for Amazon users. Red Hat Gluster Storage for Public Cloud provides highly available storage within AWS. Synchronous n-way replication across AWS Availability Zones provides high availability within an AWS Region. Asynchronous geo-replication provides continuous data replication to ensure high availability across AWS regions. The glusterFS global namespace capability aggregates disk and memory resources into a unified storage volume that is abstracted from the physical hardware.

Red Hat Gluster Storage for Public Cloud is the only high availability (HA) storage solution available for AWS. It simplifies the task of managing unstructured file data whether you have few terabytes of storage or multiple petabytes. This unique HA solution is enabled by the synchronous file replication capability built into glusterFS.

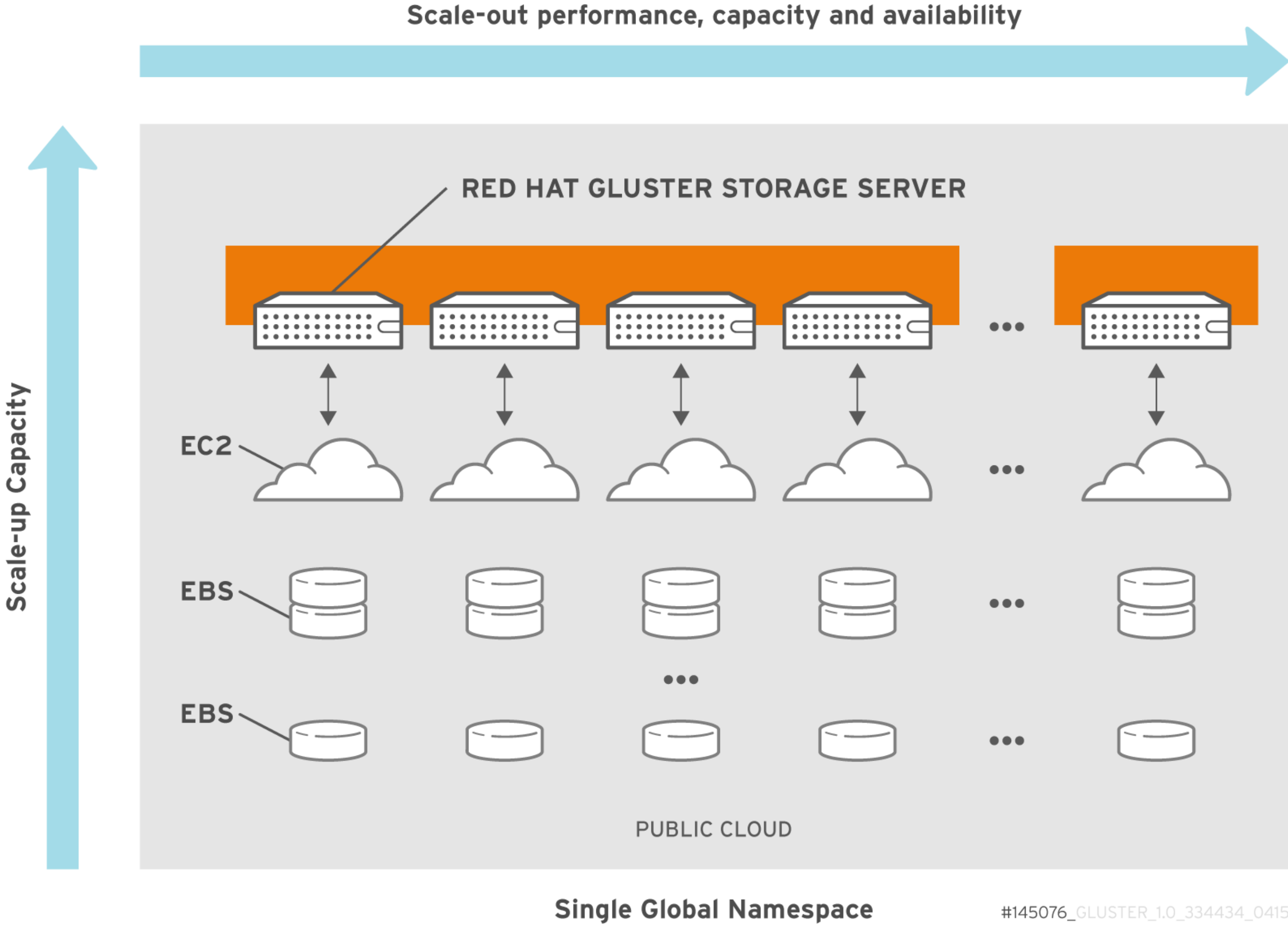



**Figure 2.3. Red Hat Gluster Storage for Public Cloud Architecture**

## 2.4. Storage Concepts

Following are the common terms relating to file systems and storage used throughout the *Red Hat Gluster Storage Administration Guide*.

**Brick**

The glusterFS basic unit of storage, represented by an export directory on a server in the trusted storage pool. A brick is expressed by combining a server with an export directory in the following format:

**SERVER:EXPORT**

For example:

***myhostname*:*/exports/myexportdir/***

**Volume**

A volume is a logical collection of bricks. Most of the Red Hat Gluster Storage management operations happen on the volume.

**Translator**

A translator connects to one or more subvolumes, does something with them, and offers a subvolume connection.

**Subvolume**

A brick after being processed by at least one translator.

**Volfile**

Volume (vol) files are configuration files that determine the behavior of your Red Hat Gluster Storage trusted storage pool. At a high level, GlusterFS has three entities, that is, Server, Client and Management daemon. Each of these entities have their own volume files. Volume files for servers and clients are generated by the management daemon upon creation of a volume.

Server and Client Vol files are located in **`/var/lib/glusterd/vols/VOLNAME`** directory. The management daemon vol file is named as **`glusterd.vol`** and is located in **`/etc/glusterfs/`** directory.

> **Warning**
>
> You must not modify any vol file in **`/var/lib/glusterd`** manually as Red Hat does not support vol files that are not generated by the management daemon.

**glusterd**

glusterd is the glusterFS Management Service that must run on all servers in the trusted storage pool.

**Cluster**

A trusted pool of linked computers working together, resembling a single computing resource. In Red Hat Gluster Storage, a cluster is also referred to as a trusted storage pool.

**Client**

The machine that mounts a volume (this may also be a server).

**File System**

A method of storing and organizing computer files. A file system organizes files into a database for the storage, manipulation, and retrieval by the computer's operating system.

Source: Wikipedia

**Distributed File System**

A file system that allows multiple clients to concurrently access data which is spread across servers/bricks in a trusted storage pool. Data sharing among multiple locations is fundamental to all distributed file systems.

**Virtual File System (VFS)**

VFS is a kernel software layer that handles all system calls related to the standard Linux file system. It provides a common interface to several kinds of file systems.

**POSIX**

Portable Operating System Interface (for Unix) (POSIX) is the name of a family of related standards specified by the IEEE to define the application programming interface (API), as well as shell and utilities interfaces, for software that is compatible with variants of the UNIX operating system. Red Hat Gluster Storage exports a fully POSIX compatible file system.

**Metadata**

Metadata is data providing information about other pieces of data.

**FUSE**

Filesystem in User space (FUSE) is a loadable kernel module for Unix-like operating systems that lets non-privileged users create their own file systems without editing kernel code. This is achieved by running file system code in user space while the FUSE module provides only a "bridge" to the kernel interfaces.

Source: Wikipedia

**Geo-Replication**

Geo-replication provides a continuous, asynchronous, and incremental replication service from one site to another over Local Area Networks (LAN), Wide Area Networks (WAN), and the Internet.

**N-way Replication**

Local synchronous data replication that is typically deployed across campus or Amazon Web Services Availability Zones.

**Petabyte**

A petabyte is a unit of information equal to one quadrillion bytes, or 1000 terabytes. The unit symbol for the petabyte is PB. The prefix peta- (P) indicates a power of 1000:

1 PB = 1,000,000,000,000,000 B = 1000^5 B = 10^15 B.

The term "pebibyte" (PiB), using a binary prefix, is used for the corresponding power of 1024.

Source: Wikipedia

**RAID**

Redundant Array of Independent Disks (RAID) is a technology that provides increased storage reliability through redundancy. It combines multiple low-cost, less-reliable disk drives components into a logical unit where all drives in the array are interdependent.

**RRDNS**

Round Robin Domain Name Service (RRDNS) is a method to distribute load across application servers. RRDNS is implemented by creating multiple records with the same name and different IP addresses in the zone file of a DNS server.

**Server**

The machine (virtual or bare metal) that hosts the file system in which data is stored.

**Block Storage**

Block special files, or block devices, correspond to devices through which the system moves data in the form of blocks. These device nodes often represent addressable devices such as hard disks, CD-ROM drives, or memory regions. Red Hat Gluster Storage supports the XFS file system with extended attributes.

**Scale-Up Storage**

Increases the capacity of the storage device in a single dimension. For example, adding additional disk capacity in a trusted storage pool.

**Scale-Out Storage**

Increases the capability of a storage device in single dimension. For example, adding more systems of the same size, or adding servers to a trusted storage pool that increases CPU, disk capacity, and throughput for the trusted storage pool.

**Trusted Storage Pool**

A storage pool is a trusted network of storage servers. When you start the first server, the storage pool consists of only that server.

**Namespace**

An abstract container or environment that is created to hold a logical grouping of unique identifiers or symbols. Each Red Hat Gluster Storage trusted storage pool exposes a single namespace as a POSIX mount point which contains every file in the trusted storage pool.

**User Space**

Applications running in user space do not directly interact with hardware, instead using the kernel to moderate access. User space applications are generally more portable than applications in kernel space. glusterFS is a user space application.

## Distributed Hash Table Terminology

**Hashed subvolume**

A Distributed Hash Table Translator subvolume to which the file or directory name is hashed to.

**Cached subvolume**

A Distributed Hash Table Translator subvolume where the file content is actually present. For directories, the concept of cached-subvolume is not relevant. It is loosely used to mean subvolumes which are not hashed-subvolume.

**Linkto-file**

For a newly created file, the hashed and cached subvolumes are the same. When directory entry operations like rename (which can change the name and hence hashed subvolume of the file) are performed on the file, instead of moving the entire data in the file to a new hashed subvolume, a file is created with the same name on the newly hashed subvolume. The purpose of this file is only to act as a pointer to the node where the data is present. In the extended attributes of this file, the name of the cached subvolume is stored. This file on the newly hashed-subvolume is called a linkto-file. The linkto file is relevant only for non-directory entities.

**Directory Layout**

The directory layout specifies the hash-ranges of the subdirectories of a directory to which subvolumes they correspond to.

Properties of directory layouts:

- The layouts are created at the time of directory creation and are persisted as extended attributes of the directory.

- A subvolume is not included in the layout if it remained offline at the time of directory creation and no directory entries ( such as files and directories) of that directory are created on that subvolume. The subvolume is not part of the layout until the fix-layout is complete as part of running the rebalance command. If a subvolume is down during access (after directory creation), access to any files that hash to that subvolume fails.

**Fix Layout**

A command that is executed during the rebalance process.

The rebalance process itself comprises of two stages:

1. Fixes the layouts of directories to accommodate any subvolumes that are added or removed. It also heals the directories, checks whether the layout is non-contiguous, and persists the layout in extended attributes, if needed. It also ensures that the directories have the same attributes across all the subvolumes.

2. Migrates the data from the cached-subvolume to the hashed-subvolume.

# Chapter 3. Key Features

This chapter lists the key features of Red Hat Gluster Storage.

## 3.1. Elasticity

Storage volumes are abstracted from the underlying hardware and can grow, shrink, or be migrated across physical systems as necessary. Storage system servers can be added or removed as needed with data rebalanced across the trusted storage pool. Data is always online and there is no application downtime. File system configuration changes are accepted at runtime and propagated throughout the trusted storage pool, allowing changes to be made dynamically for performance tuning, or as workloads fluctuate.

## 3.2. No Metadata with the Elastic Hashing Algorithm

Unlike other storage systems with a distributed file system, Red Hat Gluster Storage does not create, store, or use a separate metadata index. Instead, Red Hat Gluster Storage places and locates files algorithmically. All storage node servers in the trusted storage pool can locate any piece of data without looking it up in an index or querying another server. Red Hat Gluster Storage uses an elastic hashing algorithm to locate data in the storage pool, removing a common source of I/O bottlenecks and single point of failure. Data access is fully parallelized and performance scales linearly.

## 3.3. Scalability

Red Hat Gluster Storage is designed to scale for both performance and capacity. Aggregating the disk, CPU, and I/O resources of large numbers of commodity hardware can create one large and high-performing storage pool with Red Hat Gluster Storage. More capacity can be added by adding more disks, while performance can be improved by deploying disks between more server nodes.

## 3.4. High Availability and Flexibility

Synchronous n-way file replication ensures high data availability and local recovery. Asynchronous geo-replication ensures resilience across data centers and regions. Both synchronous n-way and geo-replication asynchronous data replication are supported in the private cloud, data center, public cloud, and hybrid cloud environments. Within the AWS cloud, Red Hat Gluster Storage supports n-way synchronous replication across Availability Zones and asynchronous geo-replication across AWS Regions. In fact, Red Hat Gluster Storage is the only way to ensure high availability for NAS storage within the AWS infrastructure.

## 3.5. Flexibility

Red Hat Gluster Storage runs in the user space, eliminating the need for complex kernel patches or dependencies. You can also reconfigure storage performance characteristics to meet changing storage needs.

## 3.6. No Application Rewrites

Red Hat Gluster Storage servers are POSIX compatible and use XFS file system format to store data on disks, which can be accessed using industry-standard access protocols including NFS and SMB. Thus, there is no need to rewrite applications when moving data to the cloud as is the case with traditional cloud-based object storage solutions.

## 3.7. Simple Management

Red Hat Gluster Storage allows you to build a scale-out storage system that is highly secure within minutes. It provides a very simple, single command for storage management. It also includes performance monitoring and analysis tools like **`Top`** and **`Profile`**. **`Top`** provides visibility into workload patterns, while **`Profile`** provides performance statistics over a user-defined time period for metrics including latency and amount of data read or written.

## 3.8. Modular, Stackable Design

Users can configure and tune Red Hat Gluster Storage servers to deliver high performance for a wide range of workloads. This stackable design allows users to combine modules as needed depending on storage requirements and workload profiles.

# Part II. Red Hat Gluster Storage Administration On-Premise

# Chapter 4. Getting Started with Red Hat Gluster Storage Server

This chapter provides information on the ports that must be open for Red Hat Gluster Storage Server and the **`glusterd`** service.

The Red Hat Gluster Storage glusterFS daemon **`glusterd`** enables dynamic configuration changes to Red Hat Gluster Storage volumes, without needing to restart servers or remount storage volumes on clients.

## 4.1. Port Information

Red Hat Gluster Storage Server uses the listed ports. You must ensure that the firewall settings do not prevent access to these ports.

Firewall configuration tools differ between Red Hat Entperise Linux 6 and Red Hat Enterprise Linux 7.

For Red Hat Enterprise Linux 6, use the **`iptables`** command to open a port:

```
# iptables -A INPUT -m state --state NEW -m tcp -p tcp --dport 5667 -j
ACCEPT
# service iptables save
```

For Red Hat Enterprise Linux 7, if default ports are in use, it is usually simpler to add a service rather than open a port:

```
# firewall-cmd --zone=zone_name --add-service=glusterfs
# firewall-cmd --zone=zone_name --add-service=glusterfs --permanent
```

However, if the default ports are already in use, you can open a specific port with the following command:

```
# firewall-cmd --zone=public --add-port=5667/tcp
# firewall-cmd --zone=public --add-port=5667/tcp --permanent
```

**Table 4.1. TCP Port Numbers**

| Port Number | Usage |
|---|---|
| 22 | For sshd used by geo-replication. |
| 111 | For rpc port mapper. |
| 139 | For netbios service. |
| 445 | For CIFS protocol. |
| 965 | For NFS's Lock Manager (NLM). |
| 2049 | For glusterFS's NFS exports (nfsd process). |
| 24007 | For glusterd (for management). |
| 24009 - 24108 | For client communication with Red Hat Gluster Storage 2.0. |
| 38465 | For NFS mount protocol. |
| 38466 | For NFS mount protocol. |
| 38468 | For NFS's Lock Manager (NLM). |
| 38469 | For NFS's ACL support. |
| 39543 | For oVirt (Red Hat Gluster Storage Console). |

| Port Number | Usage |
|---|---|
| 49152 - 49251 | For client communication with Red Hat Gluster Storage 2.1 and for brick processes depending on the availability of the ports. The total number of ports required to be open depends on the total number of bricks exported on the machine. |
| 54321 | For VDSM (Red Hat Gluster Storage Console). |
| 55863 | For oVirt (Red Hat Gluster Storage Console). |

**Table 4.2. TCP Port Numbers used for Object Storage (Swift)**

| Port Number | Usage |
|---|---|
| 443 | For HTTPS request. |
| 6010 | For Object Server. |
| 6011 | For Container Server. |
| 6012 | For Account Server. |
| 8080 | For Proxy Server. |

**Table 4.3. TCP Port Numbers for Nagios Monitoring**

| Port Number | Usage |
|---|---|
| 80 | For HTTP protocol (required only if Nagios server is running on a Red Hat Gluster Storage node). |
| 443 | For HTTPS protocol (required only for Nagios server). |
| 5667 | For NSCA service (required only if Nagios server is running on a Red Hat Gluster Storage node). |
| 5666 | For NRPE service (required in all Red Hat Gluster Storage nodes). |

**Table 4.4. UDP Port Numbers**

| Port Number | Usage |
|---|---|
| 111 | For RPC Bind. |
| 963 | For NFS's Lock Manager (NLM). |

## 4.2. Starting and Stopping the glusterd service

Using the **`glusterd`** command line, logical storage volumes can be decoupled from physical hardware. Decoupling allows storage volumes to be grown, resized, and shrunk, without application or server downtime.

Regardless of changes made to the underlying hardware, the trusted storage pool is always available while changes to the underlying hardware are made. As storage is added to the trusted storage pool, volumes are rebalanced across the pool to accommodate the added storage capacity.

The **`glusterd`** service is started automatically on all servers in the trusted storage pool. The service can also be manually started and stopped as required.

- Run the following command to start glusterd manually.

  ```
  # service glusterd start
  ```

- Run the following command to stop glusterd manually.

```
# service glusterd stop
```

When a Red Hat Gluster Storage server node hosting 256 snapshots of one or more volumes is upgraded to Red Hat Gluster Storage 3.1, the cluster management commands may become unresponsive. This is because, glusterd becomes unresponsive when it tries to start all the brick processes concurrently for all the bricks and corresponding snapshots hosted on the node. This issue can be observed even without snapshots, if there are an equal number of brick processes hosted on a single node.

If the issue was observed in a setup with large number of snapshots taken on one or more volumes, deactivate the snapshots before performing an upgrade. The snapshots can be activated after the upgrade is complete.

# Chapter 5. Trusted Storage Pools

A storage pool is a network of storage servers.

When the first server starts, the storage pool consists of that server alone. Adding additional storage servers to the storage pool is achieved using the probe command from a running, trusted storage server.

**Important**

Before adding servers to the trusted storage pool, you must ensure that the ports specified in Section 4.1, “Port Information” are open.

On Red Hat Enterprise Linux 7, enable the glusterFS firewall service in the active zones for runtime and permanent mode using the following commands:

To get a list of active zones, run the following command:

```
# firewall-cmd --get-active-zones
```

To allow the firewall service in the active zones, run the following commands:

```
# firewall-cmd --zone=zone_name --add-service=glusterfs
# firewall-cmd --zone=zone_name --add-service=glusterfs --permanent
```

For more information about using firewalls, see section *Using Firewalls* in the *Red Hat Enterprise Linux 7 Security Guide*: https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/7/html/Security_Guide/sec-Using_Firewalls.html.

**Note**

When any two gluster commands are executed concurrently on the same volume, the following error is displayed:

*Another transaction is in progress.*

This behavior in the Red Hat Gluster Storage prevents two or more commands from simultaneously modifying a volume configuration, potentially resulting in an inconsistent state. Such an implementation is common in environments with monitoring frameworks such as the Red Hat Gluster Storage Console, Red Hat Enterprise Virtualization Manager, and Nagios. For example, in a four node Red Hat Gluster Storage Trusted Storage Pool, this message is observed when **gluster volume status *VOLNAME*** command is executed from two of the nodes simultaneously.

## 5.1. Adding Servers to the Trusted Storage Pool

The **gluster peer probe *[server]*** command is used to add servers to the trusted server pool.

> **Note**
>
> Probing a node from lower version to a higher version of Red Hat Gluster Storage node is not supported.

### Adding Three Servers to a Trusted Storage Pool

Create a trusted storage pool consisting of three storage servers, which comprise a volume.

### Prerequisites

- The **`glusterd`** service must be running on all storage servers requiring addition to the trusted storage pool. See Section 4.2, “Starting and Stopping the glusterd service” for service start and stop commands.
- **`Server1`**, the trusted storage server, is started.
- The host names of the target servers must be resolvable by DNS.

1. Run **`gluster peer probe [server]`** from Server 1 to add additional servers to the trusted storage pool.

   > **Note**
   >
   > - Self-probing **`Server1`** will result in an error because it is part of the trusted storage pool by default.
   > - All the servers in the Trusted Storage Pool must have RDMA devices if either **`RDMA`** or **`RDMA,TCP`** volumes are created in the storage pool. The peer probe must be performed using IP/hostname assigned to the RDMA device.

   ```
   # gluster peer probe server2
   Probe successful

   # gluster peer probe server3
   Probe successful

   # gluster peer probe server4
   Probe successful
   ```

2. Verify the peer status from all servers using the following command:

   ```
   # gluster peer status
   Number of Peers: 3

   Hostname: server2
   Uuid: 5e987bda-16dd-43c2-835b-08b7d55e94e5
   State: Peer in Cluster (Connected)

   Hostname: server3
   Uuid: 1e0ca3aa-9ef7-4f66-8f15-cbc348f29ff7
   State: Peer in Cluster (Connected)

   Hostname: server4
   ```

```
Uuid: 3e0caba-9df7-4f66-8e5d-cbc348f29ff7
State: Peer in Cluster (Connected)
```

**Important**

If the existing trusted storage pool has a geo-replication session, then after adding the new server to the trusted storage pool, perform the steps listed at Section 14.5, "Starting Geo-replication on a Newly Added Brick or Node".

## 5.2. Removing Servers from the Trusted Storage Pool

Run **`gluster peer detach`** ***`server`*** to remove a server from the storage pool.

### Removing One Server from the Trusted Storage Pool

Remove one server from the Trusted Storage Pool, and check the peer status of the storage pool.

### Prerequisites

- The **`glusterd`** service must be running on the server targeted for removal from the storage pool. See Section 4.2, "Starting and Stopping the glusterd service" for service start and stop commands.
- The host names of the target servers must be resolvable by DNS.

1. Run **`gluster peer detach`** ***`[server]`*** to remove the server from the trusted storage pool.

   ```
   # gluster peer detach server4
   Detach successful
   ```

2. Verify the peer status from all servers using the following command:

   ```
   # gluster peer status
   Number of Peers: 2

   Hostname: server2
   Uuid: 5e987bda-16dd-43c2-835b-08b7d55e94e5
   State: Peer in Cluster (Connected)

   Hostname: server3
   Uuid: 1e0ca3aa-9ef7-4f66-8f15-cbc348f29ff7
   ```

# Chapter 6. Red Hat Gluster Storage Volumes

A Red Hat Gluster Storage volume is a logical collection of bricks, where each brick is an export directory on a server in the trusted storage pool. Most of the Red Hat Gluster Storage Server management operations are performed on the volume. For a detailed information about configuring Red Hat Gluster Storage for enhancing performance see, Chapter 13, *Configuring Red Hat Gluster Storage for Enhancing Performance*

**Warning**

Red Hat does not support writing data directly into the bricks. Read and write data only through the Native Client, or through NFS or SMB mounts.

**Note**

Red Hat Gluster Storage supports IP over Infiniband (IPoIB). Install Infiniband packages on all Red Hat Gluster Storage servers and clients to support this feature. Run the **`yum groupinstall "Infiniband Support"`** to install Infiniband packages.

**Volume Types**

**Distributed**

Distributes files across bricks in the volume.

Use this volume type where scaling and redundancy requirements are not important, or provided by other hardware or software layers.

See Section 6.5, “Creating Distributed Volumes” for additional information about this volume type.

**Replicated**

Replicates files across bricks in the volume.

Use this volume type in environments where high-availability and high-reliability are critical.

See Section 6.6, “Creating Replicated Volumes” for additional information about this volume type.

**Distributed Replicated**

Distributes files across replicated bricks in the volume.

Use this volume type in environments where high-reliability and scalability are critical. This volume type offers improved read performance in most environments.

See Section 6.7, “Creating Distributed Replicated Volumes” for additional information about this volume type.

**Dispersed**

Disperses the file's data across the bricks in the volume.

Use this volume type where you need a configurable level of reliability with a minimum space waste.

See Section 6.8, “Creating Dispersed Volumes” for additional information about this volume type.

**Distributed Dispersed**

Distributes file's data across the dispersed subvolume.

Use this volume type where you need a configurable level of reliability with a minimum space waste.

See Section 6.9, “Creating Distributed Dispersed Volumes” for additional information about this volume type.

## 6.1. Setting up Gluster Storage Volumes using gdeploy

The gdeploy tool automates the process of creating, formatting, and mounting bricks. With gdeploy, the manual steps listed between *Section 6.3 Formatting and Mounting Bricks* and *Section 6.8 Creating Distributed Dispersed Volumes* are automated.

When setting-up a new trusted storage pool, gdeploy could be the preferred choice of trusted storage pool set up, as manually executing numerous commands can be error prone.

The advantages of using gdeploy to automate brick creation are as follows:

- Setting-up the backend on several machines can be done from one's laptop/desktop. This saves time and scales up well when the number of nodes in the trusted storage pool increase.
- Flexibility in choosing the drives to configure. (sd, vd, ...).
- Flexibility in naming the logical volumes (LV) and volume groups (VG).

### 6.1.1. Getting Started

#### Prerequisites

1. Generate the passphrase-less SSH keys for the nodes which are going to be part of the trusted storage pool by running the following command:

```
# ssh-keygen -f id_rsa -t rsa -N ''
```

2. Set up password-less SSH access between the gdeploy controller and servers by running the following command:

```
# ssh-copy-id -i root@server
```

> **Note**
>
> If you are using a Red Hat Gluster Storage node as the deployment node and not an external node, then the password-less SSH must be set up for the Red Hat Gluster Storage node from where the installation is performed using the following command:
>
> ```
> # ssh-copy-id -i root@localhost
> ```

3. Install **ansible** by running the following command:

```
# yum install ansible
```

> **Important**
>
> Ensure you install Ansible 1.9* for gdeploy.

4. You must also ensure the following:

   - Devices should be raw and unused
   - For multiple devices, use multiple volume groups, thinpool and thinvol in the **gdeploy** configuration file

gdeploy can be installed in two ways:

- Using a node in a trusted storage pool
- Using a machine outside the trusted storage pool

#### Using a node in a cluster

The **gdeploy** package is bundled as part of the initial installation of Red Hat Gluster Storage.

#### Using a machine outside the trusted storage pool

You must ensure that the Red Hat Gluster Storage is subscribed to the required channels. For more information see, *Subscribing to the Red Hat Gluster Storage Server Channels*in the *Red Hat Gluster Storage 3.1 Installation Guide*.

Execute the following command to install gdeploy:

```
# yum install gdeploy
```

For more information on installing **gdeploy** see, *Installing Ansible to Support Gdeploy* section in the *Red Hat Gluster Storage 3.1 Installation Guide*.

### 6.1.2. Setting up a Trusted Storage Pool

Creating a trusted storage pool is a tedious task and becomes more tedious as the nodes in the trusted storage pool grow. With gdeploy, just a configuration file can be used to set up a trusted storage pool. When gdeploy is installed, a sample configuration file will be created at:

```
/usr/share/doc/ansible/gdeploy/examples/gluster.conf.sample
```

> **Note**
>
> The trusted storage pool can be created either by performing each tasks, such as, setting up a backend, creating a volume, and mounting volumes independently or summed up as a single configuration.

For example, for a basic trusted storage pool of a 2 x 2 replicated volume the configuration details in the configuration file will be as follows:

```
[hosts]
10.0.0.1
10.0.0.2
10.0.0.3
10.0.0.4

[devices]
/dev/vdb

[volume]
action=create
volname=glustervol
transport=tcp,rdma
replica=yes
replica_count=2
force=yes

[clients]
action=mount
hosts=10.0.0.1
fstype=glusterfs
client_mount_points=/mnt/gluster
```

With this configuration a 2 x 2 replica trusted storage pool with the given IP addresses and backend device as **`/dev/vdb`** with the volume name as **`glustervol`** can be created.

For more information on possible values, see Section 6.1.7, “Configuration File”

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

**Note**

You can create a new configuration file by referencing the template file available at **`/usr/share/doc/ansible/gdeploy/examples/gluster.conf.sample`** . To invoke the new configuration file, run **`gdeploy -c`** ***`/path_to_file/config.txt`*** command.

To **`only`** setup the backend see, Section 6.1.3, “Setting up the Backend ”

To **`only`** create a volume see, Section 6.1.4, “Creating a Volume”

To **`only`** mount clients see, Section 6.1.5, “Mounting Clients”

### 6.1.3. Setting up the Backend

In order to setup a Gluster Storage volume, the LVM thin-p must be set up on the storage disks. If the number of machines in the trusted storage pool is huge, these tasks takes a long time, as the number of commands involved are huge and error prone if not cautious. With gdeploy, just a configuration file can be used to set up a backend. The backend is setup at the time of setting up a fresh trusted storage pool, which requires bricks to be setup before creating a volume. When gdeploy is installed, a sample configuration file will be created at:

```
/usr/share/doc/ansible/gdeploy/examples/gluster.conf.sample
```

Example configuration file:

```
[hosts]
10.0.0.1
10.0.0.2

[devices]
/dev/vdb

[disktype]
RAID10

[diskcount]
10

[stripesize]
128
```

For more information on possible values, see Section 6.1.7, “Configuration File”

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

### 6.1.4. Creating a Volume

Setting up volume involves writing long commands by choosing the hostname/IP and brick order carefully and this could be error prone. gdeploy helps in simplifying this task. When gdeploy is installed, a sample configuration file will be created at:

```
/usr/share/doc/ansible/gdeploy/examples/gluster.conf.sample
```

For example, for a basic trusted storage pool of a 2 x 2 replicate volume the configuration details in the configuration file will be as follows:

```
[hosts]
10.0.0.1
10.0.0.2
10.0.0.3
10.0.0.4

[volume]
action=create
volname=glustervol
transport=tcp,rdma
replica=yes
replica_count=2
force=yes
```

For more information on possible values, see Section 6.1.7, “Configuration File”

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

### 6.1.5. Mounting Clients

When mounting clients, instead of logging into every client which has to be mounted, gdeploy can be used to mount clients remotely. When gdeploy is installed, a sample configuration file will be created at:

```
/usr/share/doc/ansible/gdeploy/examples/gluster.conf.sample
```

Following is an example of the modifications to the configuration file in order to mount clients:

```
[clients]
action=mount
hosts=10.70.46.159
fstype=glusterfs
client_mount_points=/mnt/gluster
volname=10.0.0.1:glustervol
```

> **Note**
>
> If the **fstype** is NFS, then mention it as nfs-version. By default it is 3.

For more information on possible values, see Section 6.1.7, “Configuration File”

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

### 6.1.6. Configuring a Volume

The volumes can be configured using the configuration file. The volumes can be configured remotely using the configuration file without having to log into the trusted storage pool. For more information regarding the sections and options in the configuration file, see Section 6.1.7, “Configuration File”

#### 6.1.6.1. Adding and Removing a Brick

The configuration file can be modified to add or remove a brick:

##### Adding a Brick

Modify the [volume] section in the configuration file to add a brick. For example:

```
[volume]
action=add-brick
volname=10.0.0.1:glustervol
bricks=10.0.0.1:/mnt/new_brick
```

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

### Removing a Brick

Modify the [volume] section in the configuration file to remove a brick. For example:

```
[volume]
action=remove-brick
volname=10.0.0.1:glustervol
bricks=10.0.0.2:/mnt/brick
state=commit
```

Other options for **`state`** are stop, start, and force.

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

For more information on possible values, see Section 6.1.7, “Configuration File”

## 6.1.6.2. Rebalancing a Volume

Modify the [volume] section in the configuration file to rebalance a volume. For example:

```
[volume]
action=rebalance
volname=10.70.46.13:glustervol
state=start
```

Other options for **`state`** are stop, and fix-layout.

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

For more information on possible values, see Section 6.1.7, “Configuration File”

## 6.1.6.3. Starting, Stopping, or Deleting a Volume

The configuration file can be modified to start, stop, or delete a volume:

### Starting a Volume

Modify the [volume] section in the configuration file to start a volume. For example:

```
[volume]
action=start
volname=10.0.0.1:glustervol
```

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

### Stopping a Volume

Modify the [volume] section in the configuration file to start a volume. For example:

```
[volume]
action=stop
volname=10.0.0.1:glustervol
```

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

### Deleting a Volume

Modify the [volume] section in the configuration file to start a volume. For example:

```
[volume]
action=delete
volname=10.70.46.13:glustervol
```

After modifying the configuration file, invoke the configuration using the command:

```
# gdeploy -c conf.txt
```

For more information on possible values, see Section 6.1.7, “Configuration File”

## 6.1.7. Configuration File

The configuration file includes the various options that can be used to change the settings for gdeploy. The following options are currently supported:

- [hosts]
- [devices]
- [disktype]
- [diskcount]
- [stripesize]
- [vgs]
- [pools]
- [lvs]
- [mountpoints]
- {host-specific-data-for-above}
- [clients]
- [volume]

The options are briefly explained in the following list:

- **hosts**

  This is a mandatory section which contains the IP address or hostname of the machines in the trusted storage pool. Each hostname or IP address should be listed in a separate line.

  For example:

  ```
  [hosts]
  10.0.0.1
  10.0.0.2
  ```

- **devices**

  This is a generic section and is applicable to all the hosts listed in the [hosts] section. However, if sections of hosts such as the [hostname] or [IP-address] is present, then the data in the generic sections like [devices] is ignored. Host specific data take precedence. This is an optional section.

  For example:

  ```
  [devices]
  /dev/sda
  /dev/sdb
  ```

  > **Note**
  >
  > When configuring the backend setup, the devices should be either listed in this section or in the host specific section.

- **disktype**

  This section specifies the disk configuration that is used while setting up the backend. gdeploy supports RAID 10, RAID 6, and JBOD configurations. This is an optional section and if the field is left empty, JBOD is taken as the default configuration.

  For example:

  ```
  [disktype]
  raid6
  ```

- **diskcount**

  This section specifies the number of data disks in the setup. This is a mandatory field if the [disktype] specified is either RAID 10 or RAID 6. If the [disktype] is JBOD the [diskcount] value is ignored. This is a host specific data.

  For example:

  ```
  [diskcount]
  10
  ```

- **stripesize**

  This section specifies the stripe_unit size in KB.

Case 1: This field is not necessary if the [disktype] is JBOD, and any given value will be ignored.

Case 2: This is a mandatory field if [disktype] is specified as RAID 6.

For [disktype] RAID 10, the default value is taken as 256KB. If you specify any other value the following warning is displayed:

```
"Warning: We recommend a stripe unit size of 256KB for RAID 10"
```

**Note**

Do not add any suffixes like K, KB, M, etc. This is host specific data and can be added in the hosts section.

For example:

```
[stripesize]
128
```

- **vgs**

  This section specifies the volume group names for the devices listed in [devices]. The number of volume groups in the [vgs] section should match the one in [devices]. If the volume group names are missing, the volume groups will be named as GLUSTER_vg{1, 2, 3, ...} as default.

  For example:

```
[vgs]
CUSTOM_vg1
CUSTOM_vg2
```

- **pools**

  This section specifies the pool names for the volume groups specified in the [vgs] section. The number of pools listed in the [pools] section should match the number of volume groups in the [vgs] section. If the pool names are missing, the pools will be named as GLUSTER_pool{1, 2, 3, ...}.

  For example:

```
[pools]
CUSTOM_pool1
CUSTOM_pool2
```

- **lvs**

  This section provides the logical volume names for the volume groups specified in [vgs]. The number of logical volumes listed in the [lvs] section should match the number of volume groups listed in [vgs]. If the logical volume names are missing, it is named as GLUSTER_lv{1, 2, 3, ...}.

  For example:

```
[lvs]
CUSTOM_lv1
CUSTOM_lv2
```

- **mountpoints**

  This section specifies the brick mount points for the logical volumes. The number of mount points should match the number of logical volumes specified in [lvs] If the mount points are missing, the mount points will be names as /gluster/brick{1, 2, 3…}.

  For example:

```
[mountpoints]
/rhs/mnt1
/rhs/mnt2
```

- **brick_dirs**

  This is the directory which will be used as a brick while creating the volume. A mount point cannot be used as a brick directory, hence brick_dir should be a directory inside the mount point.

  This field can be left empty, in which case a directory will be created inside the mount point with a default name. If the backend is not setup, then this field will be ignored. In case mount points have to be used as brick directory, then use the force option in the volume section.

> **Important**
>
> If you only want to create a volume and not setup the back-end, then provide the absolute path of brick directories for each host specified in the [hosts] section under this section along with the volume section.

  For example:

```
[brick_dirs]
/mnt/rhgs/brick1
/mnt/rhgs/brick2
```

- **host-specific-data**

  For the hosts (IP/hostname) listed under [hosts] section, each host can have its own specific data. The following are the variables that are supported for hosts.

```
* devices - List of devices to use
* vgs - Custom volume group names
* pools - Custom pool names
* lvs - Custom logical volume names
* mountpoints - Mount points for the logical names
* brick_dirs - This is the directory which will be used as a brick while
creating the volume
```

  For example:

```
[10.0.01]
devices=/dev/vdb,/dev/vda
vgs=CUSTOM_vg1,CUSTOM_vg2
pools=CUSTOM_pool1,CUSTOM_pool1
lvs=CUSTOM_lv1,CUSTOM_lv2
mountpoints=/rhs/mount1,/rhs/mount2
brick_dirs=brick1,brick2
```

- **peer**

  This section specifies the configurations for the Trusted Storage Pool management (TSP). This section helps in making all the hosts specified in the [hosts] section to either probe each other to create the trusted storage pool or detach all of them from the trusted storage pool. The only option in this section is the option names 'manage' which can have it's values to be either probe or detach.

  For example:

```
[peer]
manage=probe
```

- **clients**

  This section specifies the client hosts and client_mount_points to mount the gluster storage volume created. The 'action' option is to be specified for the framework to determine the action that has to be performed. The options are 'mount' and 'unmount'. The Client hosts field is mandatory. If the mount points are not specified, default will be taken as /mnt/gluster for all the hosts.

  The option fstype specifies how the gluster volume is to be mounted. Default is glusterfs (FUSE mount). The volume can also be mounted as NFS. Each client can have different types of volume mount, which has to be specified with a comma separated. The following fields are included:

```
* action
* hosts
* fstype
* client_mount_points
```

  For example:

```
[clients]
action=mount
hosts=10.0.0.10
fstype=nfs
nfs-version=3
client_mount_points=/mnt/rhs
```

- **volume**

  The section specifies the configuration options for the volume. The following fields are included in this section:

```
* action
* volname
* transport
* replica
```

```
* replica_count
* disperse
* disperse_count
* redundancy_count
* force
```

- **action**

  This option specifies what action must be performed in the volume. The choices can be [create, delete, add-brick, remove-brick].

  *create*: This choice is used to create a volume.

  *delete*: If the delete choice is used, all the options other than 'volname' will be ignored.

  *add-brick* or *remove-brick*: If the add-brick or remove-brick is chosen, extra option bricks with a comma separated list of brick names(in the format <hostname>:<brick path> should be provided. In case of remove-brick, state option should also be provided specifying the state of the volume after brick removal.

- **volname**

  This option specifies the volume name. Default name is glustervol

  > **Note**
  >
  > - In case of a volume operation, the 'hosts' section can be omitted, provided volname is in the format <hostname>:<volname>, where hostname is the hostname / IP of one of the nodes in the cluster
  > - Only single volume creation/deletion/configuration is supported.

- **transport**

  This option specifies the transport type. Default is tcp. Options are tcp or rdma or tcp,rdma.

- **replica**

  This option will specify if the volume should be of type replica. options are yes and no. Default is no. If 'replica' is provided as yes, the 'replica_count' should be provided.

- **disperse**

  This option specifies if the volume should be of type disperse. Options are yes and no. Default is no.

- **disperse_count**

  This field is optional even if 'disperse' is yes. If not specified, the number of bricks specified in the command line is taken as the disperse_count value.

- **redundancy_count**

  If this value is not specified, and if 'disperse' is yes, it's default value is computed so that it generates an optimal configuration.

- **force**

This is an optional field and can be used during volume creation to forcefully create the volume.

For example:

```
[volname]
action=create
volname=glustervol
transport=tcp,rdma
replica=yes
replica_count=3
force=yes
```

## 6.2. Managing Volumes using Heketi

**Important**

Heketi is a technology preview feature. Technology preview features are not fully supported under Red Hat subscription level agreements (SLAs), may not be functionally complete, and are not intended for production use. However, these features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process. As Red Hat considers making future iterations of technology preview features generally available, we will provide commercially reasonable support to resolve any reported issues that customers experience when using these features.

Heketi provides a RESTful management interface which can be used to manage the lifecycle of Red Hat Gluster Storage volumes. With Heketi, cloud services like OpenStack Manila, Kubernetes, and OpenShift can dynamically provision Red Hat Gluster Storage volumes with any of the supported durability types. Heketi will automatically determine the location for bricks across the cluster, making sure to place bricks and its replicas across different failure domains. Heketi also supports any number of Red Hat Gluster Storage clusters, allowing cloud services to provide network file storage without being limited to a single Red Hat Gluster Storage cluster.

With Heketi, the administrator no longer manages or configures bricks, disks, or trusted storage pools. Heketi service will manage all hardware for the administrator, enabling it to allocate storage on demand. Any disks registered with Heketi must be provided in raw format, which will then be managed by it using LVM on the disks provided.

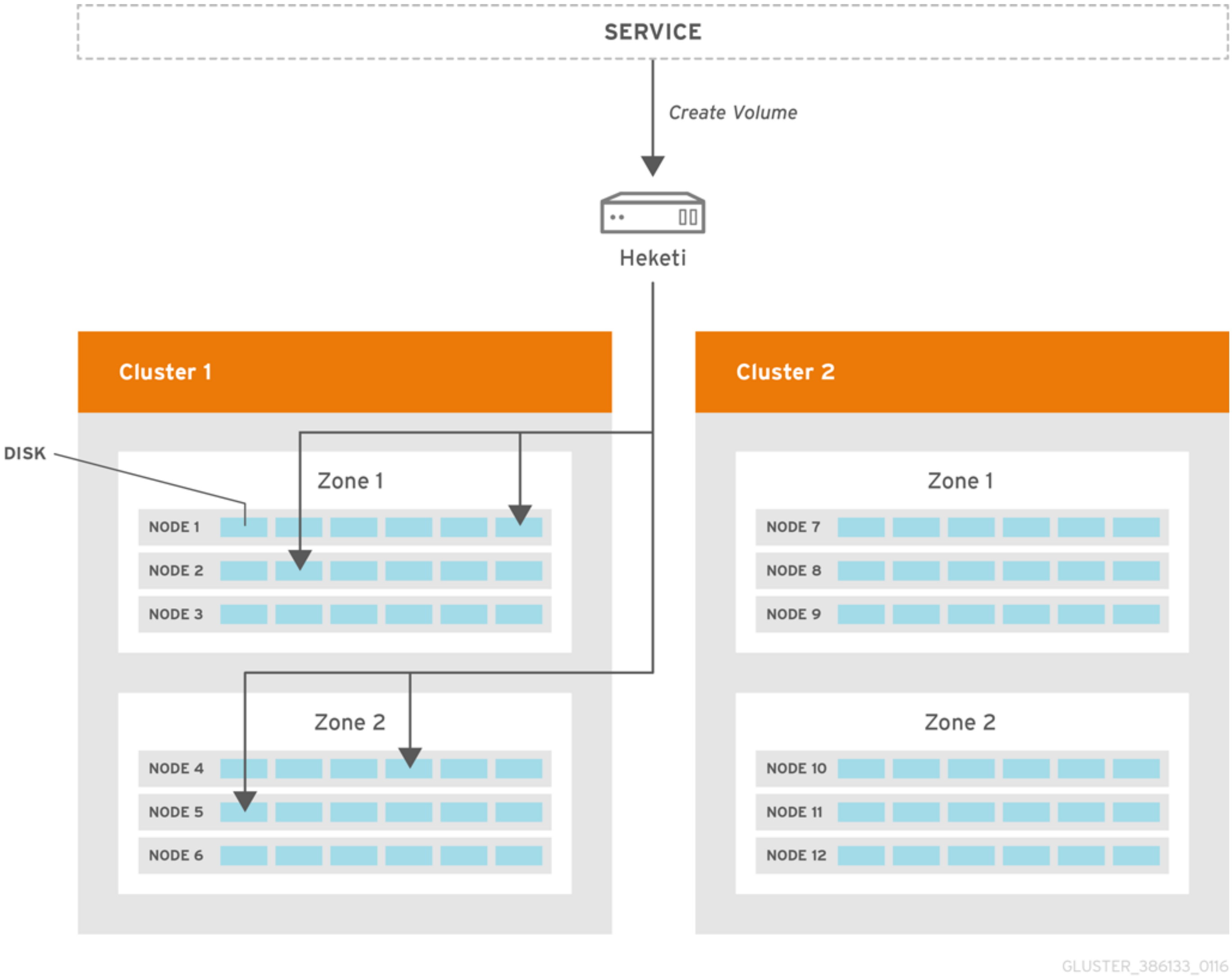



**Figure 6.1. Heketi Architecture**

Heketi can be configured and executed using the CLI or the API. The sections ahead describe configuring Heketi using the CLI. For more information regarding the Heketi API, see Heketi API.

## 6.2.1. Prerequisites

Heketi requires SSH access to the nodes that it will manage. Hence, ensure that the following requirements are met:

- **SSH Access**
  - SSH user and public key must be setup on the node.
  - SSH user must have password-less sudo.
  - Must be able to run sudo commands from SSH. This requires disabling **`requiretty`** in the **`/etc/sudoers`** file
- Start the glusterd service after Red Hat Gluster Storage is installed.
- Disks registered with Heketi must be in the raw format.

## 6.2.2. Installing Heketi

After installing Red Hat Gluster Storage 3.1.2, execute the following command to install Heketi:

```
# yum install heketi
```

For more information about subscribing to the required channels and installing Red Hat Gluster Storage, see the *Red Hat Gluster Storage Installation Guide*.

### 6.2.3. Starting the Heketi Server

Before starting the server, ensure that the following prerequisites are met:

- Generate the passphrase-less SSH keys for the nodes which are going to be part of the trusted storage pool by running the following command:

  ```
  # ssh-keygen -f id_rsa -t rsa -N ''
  ```

- Set up password-less SSH access between Heketi and the Red Hat Gluster Storage servers by running the following command:

  ```
  # ssh-copy-id -i root@server
  ```

- Setup the heketi.json configuration file. The file is located in /etc/heketi/heketi.json. The configuration file has the information required to run the Heketi server. The config file must be in JSON format with the following settings:

  - port: string, Heketi REST service port number
  - use_auth: bool, Enable JWT Authentication
  - jwt: map, JWT Authentication settings
    - admin: map, Settings for the Heketi administrator
      - key: string,
      - user: map, Settings for the Heketi volume requests access user
      - key: string, t
  - glusterfs: map, Red Hat Gluster Storage settings
    - executor: string, Determines the type of command executor to use. Possible values are:
      - mock: Does not send any commands out to servers. Can be used for development and tests
      - ssh: Sends commands to real systems over ssh
    - db: string, Location of Heketi database
    - sshexec: map, SSH configuration
      - keyfile: string, File with private ssh key
      - user: string, SSH user

  Following is an example of the JSON file:

  ```
  {
  ```

```
  "_port_comment": "Heketi Server Port Number",
  "port": "8080",

  "_use_auth": "Enable JWT authorization. Please enable for deployment",
  "use_auth": false,

  "_jwt": "Private keys for access",
  "jwt": {
    "_admin": "Admin has access to all APIs",
    "admin": {
      "key": "My Secret"
    },
    "_user": "User only has access to /volumes endpoint",
    "user": {
      "key": "My Secret"
    }
  },

.....
```

> **Note**
>
> The location for the private SSH key that is created must be set in the **`keyfile`** setting of the configuration file, and the key should be readable by the heketi user.

#### Advanced Options

The following configuration options should only be set on advanced configurations.

- brick_max_size_gb: int, Maximum brick size (Gb)
- brick_min_size_gb: int, Minimum brick size (Gb)
- max_bricks_per_volume: int, Maximum number of bricks per volume

### 6.2.3.1. Starting the Server

#### For Red Hat Enterprise Linux 7

1. Enable heketi by executing the following command:

```
# systemctl enable heketi
```

2. Start the Heketi server, by executing the following command:

```
# systemctl start heketi
```

3. To check the status of the Heketi server, execute the following command:

```
# systemctl status heketi
```

4. To check the logs, execute the following command:

```
# journalctl -u heketi
```

### For Red Hat Enterprise Linux 6

1. To start Heketi, execute the following command:

```
# chkconfig --add heketi
# service heketi start
```

2. Check the logs by executing the following command:

```
# less /var/log/heketi
```

**Note**

The database will be installed in /var/lib/heketi.

#### 6.2.3.2. Verifying the Configuration

To verify if the server is running, execute the following step:

If Heketi is not setup with authentication, then use curl to verify the configuration:

```
# curl http://<server:port>/hello
```

You can also verify the configuration using the heketi-cli when authentication is enabled:

```
# heketi-cli -server http://<server:port> -user <user> -secret <secret>
cluster list
```

### 6.2.4. Setting up the Topology

Setting up the topology allows Heketi to determine which nodes, disks, and clusters to use.

#### 6.2.4.1. Prerequisites

You have to determine the node failure domains and clusters of nodes. Failure domains is a value given to a set of nodes which share the same switch, power supply, or anything else that would cause them to fail at the same time. Heketi uses this information to make sure that replicas are created across failure domains, thus providing cloud services volumes which are resilient to both data unavailability and data loss.

You have to determine which nodes would constitute a cluster. Heketi supports multiple Red Hat Gluster Storage clusters, which gives cloud services the option of specifying a set of clusters where a volume must be created. This provides cloud services and administrators the option of creating SSD, SAS, SATA, or any other type of cluster which provide a specific quality of service to users.

#### 6.2.4.2. Topology Setup

The command line client loads the information about creating a cluster, adding nodes to that cluster, and then adding disks to each one of those nodes.This information is added into the topology file. To load a topology file with heketi-cli, execute the following command:

```
# export HEKETI_CLI_SERVER=http://<heketi_server:port>
# heketi-cli load -json=<topology_file>
```

Where **`topology_file`** is a file in JSON format describing the clusters, nodes, and disks to add to Heketi. The format of the file is as follows:

clusters: array of clusters, Array of clusters

- Each element on the array is a map which describes the cluster as follows
  - nodes: array of nodes, Array of nodes in a cluster

    Each element on the array is a map which describes the node as follows
    - node: map, Same map as Node Add except there is no need to supply the cluster id.
    - devices: array of strings, Name of each disk to be added

**For example**:

1. Topology file:

```
{
    "clusters": [
                {
                   "nodes": [
                                 {
                         "node": {
                                   "hostnames": {
                                              "manage": [
                                              "10.0.0.1"
                                     ],
                                     "storage": [
                                              "10.0.0.1"
                                     ]
                                  },
                                           "zone": 1
                                },
                              "devices": [
                             "/dev/sdb",
                             "/dev/sdc",
                             "/dev/sdd",
                             "/dev/sde",
                             "/dev/sdf",
                             "/dev/sdg",
                             "/dev/sdh",
                             "/dev/sdi"
                 ]
                    },
                {
                     "node": {
                         "hostnames": {
                             "manage": [
                                 "10.0.0.2"
                             ],
                             "storage": [
                                 "10.0.0.2"
```

```
                          ]
                      },
                      "zone": 2
                  },
                  "devices": [
                      "/dev/sdb",
                      "/dev/sdc",
                      "/dev/sdd",
                      "/dev/sde",
                      "/dev/sdf",
                      "/dev/sdg",
                      "/dev/sdh",
                      "/dev/sdi"
                  ]
              },

......
......
```

2. Load the Heketi JSON file:

```
# heketi-cli load -json=topology_libvirt.json
Creating cluster ... ID: a0d9021ad085b30124afbcf8df95ec06
        Creating node 192.168.10.100 ... ID:
b455e763001d7903419c8ddd2f58aea0
                Adding device /dev/vdb ... OK
                Adding device /dev/vdc ... OK
…….
        Creating node 192.168.10.101 ... ID:
4635bc1fe7b1394f9d14827c7372ef54
                Adding device /dev/vdb ... OK
                Adding device /dev/vdc ... OK
………….
```

3. Execute the following command to check the details of a particular node:

```
# heketi-cli node info b455e763001d7903419c8ddd2f58aea0
Node Id: b455e763001d7903419c8ddd2f58aea0
Cluster Id: a0d9021ad085b30124afbcf8df95ec06
Zone: 1
Management Hostname: 192.168.10.100
Storage Hostname: 192.168.10.100
Devices:
Id:0ddba53c70537938f3f06a65a4a7e88b   Name:/dev/vdi            Size
(GiB):499     Used (GiB):0       Free (GiB):499
Id:4fae3aabbaf79d779795824ca6dc433a   Name:/dev/vdg            Size
(GiB):499     Used (GiB):0       Free (GiB):499
…………….
```

4. Execute the following command to check the details of the cluster:

```
# heketi-cli cluster info a0d9021ad085b30124afbcf8df95ec06
Cluster id: a0d9021ad085b30124afbcf8df95ec06
Nodes:
4635bc1fe7b1394f9d14827c7372ef54
```

```
802a3bfab2d0295772ea4bd39a97cd5e
b455e763001d7903419c8ddd2f58aea0
ff9eeb735da341f8772d9415166b3f9d
Volumes:
```

5. To check the details of the device, execute the following command:

```
# heketi-cli device info 0ddba53c70537938f3f06a65a4a7e88b
Device Id: 0ddba53c70537938f3f06a65a4a7e88b
Name: /dev/vdi
Size (GiB): 499
Used (GiB): 0
Free (GiB): 499
Bricks:
```

### 6.2.5. Creating a Volume

After Heketi is set up, you can use the CLI to create a volume.

1. Execute the following command to check the various option for creating a volume:

```
# heketi-cli volume create [options]
```

2. **For example**: After setting up the topology file with two nodes on one failure domain, and two nodes in another failure domain, create a 100Gb volume using the following command:

```
# heketi-cli volume create -size=100
Name: vol_0729fe8ce9cee6eac9ccf01f84dc88cc
Size: 100
Id: 0729fe8ce9cee6eac9ccf01f84dc88cc
Cluster Id: a0d9021ad085b30124afbcf8df95ec06
Mount: 192.168.10.101:vol_0729fe8ce9cee6eac9ccf01f84dc88cc
Mount Options: backupvolfile-servers=192.168.10.100,192.168.10.102
Durability Type: replicate
Replica: 3
Snapshot: Disabled

Bricks:
Id: 8998961142c1b51ab82d14a4a7f4402d
Path:
/var/lib/heketi/mounts/vg_0ddba53c70537938f3f06a65a4a7e88b/brick_89989
61142c1b51ab82d14a4a7f4402d/brick
Size (GiB): 50
Node: b455e763001d7903419c8ddd2f58aea0
Device: 0ddba53c70537938f3f06a65a4a7e88b
 …………….
```

3. If you want to increase the storage capacity of a particular volume by 1TB, then execute the following command:

```
# heketi-cli volume expand -volume=0729fe8ce9cee6eac9ccf01f84dc88cc -
expand-size=1024
Name: vol_0729fe8ce9cee6eac9ccf01f84dc88cc
Size: 1224
```

```
Id: 0729fe8ce9cee6eac9ccf01f84dc88cc
Cluster Id: a0d9021ad085b30124afbcf8df95ec06
Mount: 192.168.10.101:vol_0729fe8ce9cee6eac9ccf01f84dc88cc
Mount Options: backupvolfile-servers=192.168.10.100,192.168.10.102
Durability Type: replicate
Replica: 3
Snapshot: Disabled

Bricks:
Id: 0b53e8c0d8e2b1a3fa5701e3c876d532
Path:
/var/lib/heketi/mounts/vg_0ddba53c70537938f3f06a65a4a7e88b/brick_0b53e
8c0d8e2b1a3fa5701e3c876d532/brick
Size (GiB): 256
Node: b455e763001d7903419c8ddd2f58aea0
Device: 0ddba53c70537938f3f06a65a4a7e88b

.........
.........
```

4. To check the details of the device, execute the following command:

```
# heketi-cli device info 0ddba53c70537938f3f06a65a4a7e88b
Device Id: 0ddba53c70537938f3f06a65a4a7e88b
Name: /dev/vdi
Size (GiB): 499
Used (GiB): 201
Free (GiB): 298
Bricks:
Id:0f1766cc142f1828d13c01e6eed12c74   Size (GiB):50      Path:
/var/lib/heketi/mounts/vg_0ddba53c70537938f3f06a65a4a7e88b/brick_0f176
6cc142f1828d13c01e6eed12c74/brick
Id:5d944c47779864b428faa3edcaac6902   Size (GiB):50      Path:
/var/lib/heketi/mounts/vg_0ddba53c70537938f3f06a65a4a7e88b/brick_5d944
c47779864b428faa3edcaac6902/brick
Id:8998961142c1b51ab82d14a4a7f4402d   Size (GiB):50      Path:
/var/lib/heketi/mounts/vg_0ddba53c70537938f3f06a65a4a7e88b/brick_89989
61142c1b51ab82d14a4a7f4402d/brick
Id:a11e7246bb21b34a157e0e1fd598b3f9   Size (GiB):50      Path:
/var/lib/heketi/mounts/vg_0ddba53c70537938f3f06a65a4a7e88b/brick_a11e7
246bb21b34a157e0e1fd598b3f9/brick
```

### 6.2.6. Deleting a Volume

To delete a volume, execute the following command:

```
# heketi-cli volume delete <volname>
```

For example:

```
$ heketi-cli volume delete 0729fe8ce9cee6eac9ccf01f84dc88cc
Volume 0729fe8ce9cee6eac9ccf01f84dc88cc deleted
```

## 6.3. About Encrypted Disk

## 6.3. About Encrypted Disk

Red Hat Gluster Storage provides the ability to create bricks on encrypted devices to restrict data access. Encrypted bricks can be used to create Red Hat Gluster Storage volumes.

For information on creating encrypted disk, refer to the *Disk Encryption* Appendix of the *Red Hat Enterprise Linux 6 Installation Guide*.

## 6.4. Formatting and Mounting Bricks

To create a Red Hat Gluster Storage volume, specify the bricks that comprise the volume. After creating the volume, the volume must be started before it can be mounted.

### 6.4.1. Creating Bricks Manually

**Important**

- Red Hat supports formatting a Logical Volume using the XFS file system on the bricks.

**Creating a Thinly Provisioned Logical Volume**

To create a thinly provisioned logical volume, proceed with the following steps:

1. Create a physical volume(PV) by using the **`pvcreate`** command.

   For example:

   ```
   pvcreate --dataalignment 1280K /dev/sdb
   ```

   Here, **`/dev/sdb`** is a storage device.

   Use the correct **`dataalignment`** option based on your device. For more information, see Section 13.2, “Brick Configuration”

   **Note**

   The device name and the alignment value will vary based on the device you are using.

2. Create a Volume Group (VG) from the PV using the **`vgcreate`** command:

   For example:

   ```
   vgcreate --physicalextentsize 1280K rhs_vg /dev/sdb
   ```

3. Create a thin-pool using the following commands:

   ```
   lvcreate --thinpool VOLGROUP/thin_pool -L pool_sz --chuncksize
   chunk_sz --poolmetadatasize metadev_sz --zero n
   ```

For example:

```
lvcreate --thinpool rhs_vg/rhs_pool -L 2T --chunksize 1280K  --
poolmetadatasize 16G --zero n
```

To enhance the performance of Red Hat Gluster Storage, ensure you read *Chapter 13, Configuring Red Hat Gluster Storage for Enhancing Performance* chapter.

4. Create a thinly provisioned volume from the previously created pool using the **lvcreate** command:

   For example:

   ```
   lvcreate -V 1G -T rhs_vg/rhs_pool -n rhs_lv
   ```

   It is recommended that only one LV should be created in a thin pool.

**Formatting and Mounting Bricks**

Format bricks using the supported XFS configuration, mount the bricks, and verify the bricks are mounted correctly. To enhance the performance of Red Hat Gluster Storage, ensure you read *Chapter 13, Configuring Red Hat Gluster Storage for Enhancing Performance* before formatting the bricks.

**Important**

Snapshots are not supported on bricks formatted with external log devices. Do not use **-l logdev=device** option with **mkfs.xfs** command for formatting the Red Hat Gluster Storage bricks.

1. Run **# mkfs.xfs -f -i size=512 -n size=8192 -d su=128K,sw=10 *DEVICE*** to format the bricks to the supported XFS file system format. Here, *DEVICE* is the created thin LV. The inode size is set to 512 bytes to accommodate for the extended attributes used by Red Hat Gluster Storage.

2. Run **# mkdir */mountpoint*** to create a directory to link the brick to.

3. Add an entry in **/etc/fstab**:

   ```
   /dev/rhs_vg/rhs_lv/mountpoint  xfs rw,inode64,noatime,nouuid  1 2
   ```

4. Run **# mount */mountpoint*** to mount the brick.

5. Run the **df -h** command to verify the brick is successfully mounted:

   ```
   # df -h /dev/rhs_vg/rhs_lv   16G  1.2G   15G   7% /exp1
   ```

6. If SElinux is enabled, then the SELinux labels that has to be set manually for the bricks created using the following commands:

   ```
   # semanage fcontext -a -t glusterd_brick_t /rhgs/brick1
   # restorecon -Rv /rhgs/brick1
   ```

**Using Subdirectory as the Brick for Volume**

You can create an XFS file system, mount them and point them as bricks while creating a Red Hat Gluster Storage volume. If the mount point is unavailable, the data is directly written to the root file system in the unmounted directory.

For example, the **/exp** directory is the mounted file system and is used as the brick for volume creation. However, for some reason, if the mount point is unavailable, any write continues to happen in the **/exp** directory, but now this is under root file system.

To overcome this issue, you can perform the below procedure.

During Red Hat Gluster Storage setup, create an XFS file system and mount it. After mounting, create a subdirectory and use this subdirectory as the brick for volume creation. Here, the XFS file system is mounted as **/bricks**. After the file system is available, create a directory called **/bricks/bricksrv1** and use it for volume creation. Ensure that no more than one brick is created from a single mount. This approach has the following advantages:

- When the **/bricks** file system is unavailable, there is no longer**/bricks/bricksrv1** directory available in the system. Hence, there will be no data loss by writing to a different location.
- This does not require any additional file system for nesting.

Perform the following to use subdirectories as bricks for creating a volume:

1. Create the **bricksrv1** subdirectory in the mounted file system.

   ```
   # mkdir /bricks/bricksrv1
   ```

   Repeat the above steps on all nodes.

2. Create the Red Hat Gluster Storage volume using the subdirectories as bricks.

   ```
   # gluster volume create distdata01 ad-rhs-srv1:/bricks/bricksrv1 ad-rhs-srv2:/bricks/bricksrv2
   ```

3. Start the Red Hat Gluster Storage volume.

   ```
   # gluster volume start distdata01
   ```

4. Verify the status of the volume.

   ```
   # gluster  volume status distdata01
   ```

**Reusing a Brick from a Deleted Volume**

Bricks can be reused from deleted volumes, however some steps are required to make the brick reusable.

**Brick with a File System Suitable for Reformatting (Optimal Method)**

Run **# mkfs.xfs -f -i size=512 *device*** to reformat the brick to supported requirements, and make it available for immediate reuse in a new volume.

> **Note**
>
> All data will be erased when the brick is reformatted.

**File System on a Parent of a Brick Directory**

If the file system cannot be reformatted, remove the whole brick directory and create it again.

**Cleaning An Unusable Brick**

If the file system associated with the brick cannot be reformatted, and the brick directory cannot be removed, perform the following steps:

1. Delete all previously existing data in the brick, including the **`.glusterfs`** subdirectory.
2. Run **`# setfattr -x trusted.glusterfs.volume-id`** ***`brick`*** and **`# setfattr -x trusted.gfid`** ***`brick`*** to remove the attributes from the root of the brick.
3. Run **`# getfattr -d -m .`** ***`brick`*** to examine the attributes set on the volume. Take note of the attributes.
4. Run **`# setfattr -x`** ***`attribute brick`*** to remove the attributes relating to the glusterFS file system.

   The **`trusted.glusterfs.dht`** attribute for a distributed volume is one such example of attributes that need to be removed.

## 6.5. Creating Distributed Volumes

This type of volume spreads files across the bricks in the volume.

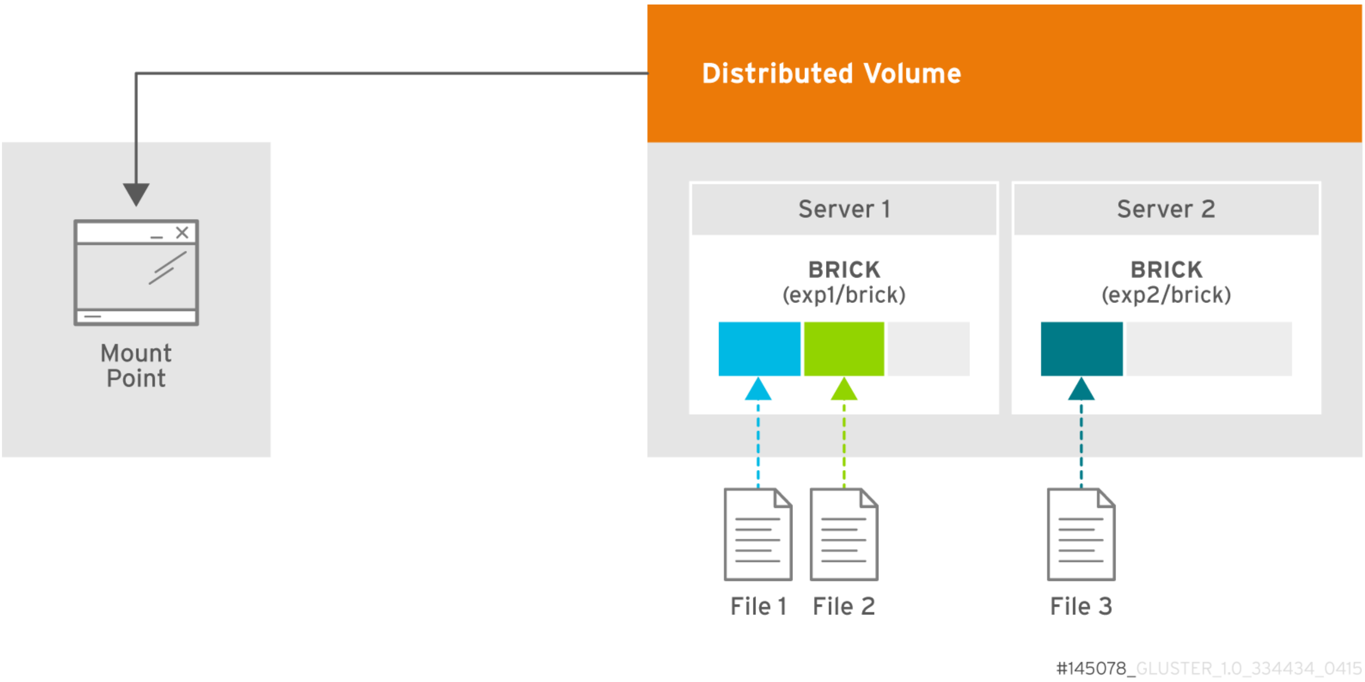



**Figure 6.2. Illustration of a Distributed Volume**

**Warning**

Distributed volumes can suffer significant data loss during a disk or server failure because directory contents are spread randomly across the bricks in the volume.

Use distributed volumes where scalable storage and redundancy is either not important, or is provided by other hardware or software layers.

### Create a Distributed Volume

Use **`gluster volume create`** command to create different types of volumes, and **`gluster volume info`** command to verify successful volume creation.

### Pre-requisites

- A trusted storage pool has been created, as described in Section 5.1, “Adding Servers to the Trusted Storage Pool”.
- Understand how to start and stop volumes, as described in Section 6.10, “Starting Volumes”.

1. Run the **`gluster volume create`** command to create the distributed volume.

   The syntax is **`gluster volume create`** ***`NEW-VOLNAME`*** **`[transport tcp | rdma | tcp,rdma]`** ***`NEW-BRICK...`***

   The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See Section 10.1, “Configuring Volume Options” for a full list of parameters.

   **Example 6.1. Distributed Volume with Two Storage Servers**

   ```
   # gluster volume create test-volume server1:/exp1/brick
   server2:/exp2/brick
   Creation of test-volume has been successful
   Please start the volume to access data.
   ```

   **Example 6.2. Distributed Volume over InfiniBand with Four Servers**

   ```
   # gluster volume create test-volume transport rdma
   server1:/exp1/brick server2:/exp2/brick server3:/exp3/brick
   server4:/exp4/brick
   Creation of test-volume has been successful
   Please start the volume to access data.
   ```

2. Run **`# gluster volume start`** ***`VOLNAME`*** to start the volume.

   ```
   # gluster volume start test-volume
   Starting test-volume has been successful
   ```

3. Run **`gluster volume info`** command to optionally display the volume information.

The following output is the result of Example 6.1, “Distributed Volume with Two Storage Servers”.

```
# gluster volume info
Volume Name: test-volume
Type: Distribute
Status: Created
Number of Bricks: 2
Transport-type: tcp
Bricks:
Brick1: server1:/exp1/brick
Brick2: server2:/exp2/brick
```

## 6.6. Creating Replicated Volumes

**Important**

Creating replicated volume with replica count greater than 3 is under technology preview. Technology Preview features are not fully supported under Red Hat service-level agreements (SLAs), may not be functionally complete, and are not intended for production use.

Tech Preview features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process.

As Red Hat considers making future iterations of Technology Preview features generally available, we will provide commercially reasonable efforts to resolve any reported issues that customers experience when using these features.

Replicated volume creates copies of files across multiple bricks in the volume. Use replicated volumes in environments where high-availability and high-reliability are critical.

Use **`gluster volume create`** to create different types of volumes, and **`gluster volume info`** to verify successful volume creation.

#### Prerequisites

- A trusted storage pool has been created, as described in Section 5.1, “Adding Servers to the Trusted Storage Pool”.
- Understand how to start and stop volumes, as described in Section 6.10, “Starting Volumes”.

### 6.6.1. Creating Two-way Replicated Volumes

Two-way replicated volume creates two copies of files across the bricks in the volume. The number of bricks must be multiple of two for a replicated volume. To protect against server and disk failures, it is recommended that the bricks of the volume are from different servers.

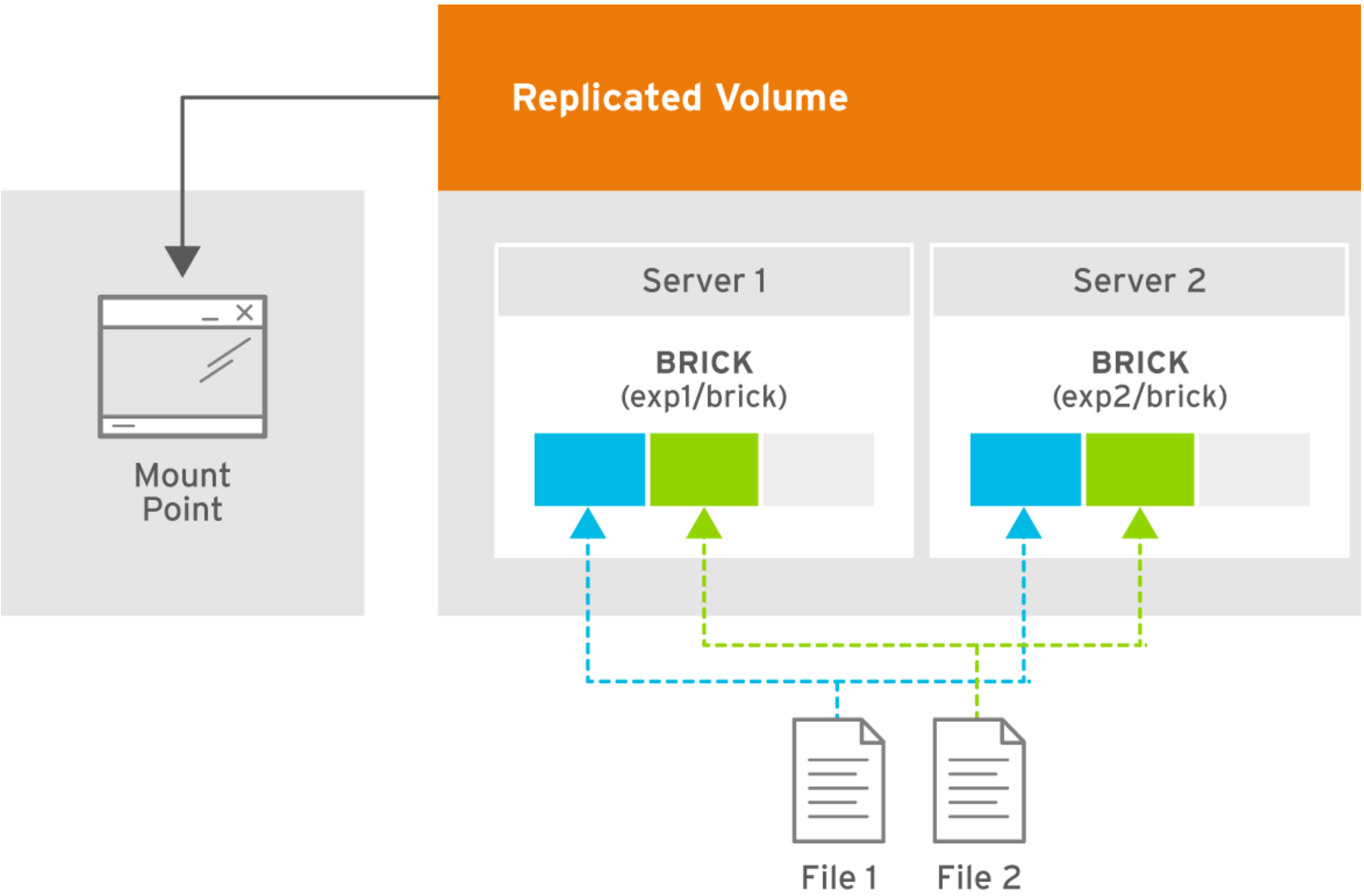



**Figure 6.3. Illustration of a Two-way Replicated Volume**

### Creating two-way replicated volumes

1. Run the **`gluster volume create`** command to create the replicated volume.

   The syntax is **`# gluster volume create`** ***`NEW-VOLNAME`*** **`[replica`** ***`COUNT`*** **`] [transport tcp | rdma | tcp,rdma]`** ***`NEW-BRICK...`***

   The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See [Section 10.1, “Configuring Volume Options”](#) for a full list of parameters.

   > **Example 6.3. Replicated Volume with Two Storage Servers**
   >
   > The order in which bricks are specified determines how they are replicated with each other. For example, every **2** bricks, where **2** is the replica count, forms a replica set. This is illustrated in *Figure 6.2. Illustration of a Two-way Replicated Volume*.
   >
   > ```
   > # gluster volume create test-volume replica 2 transport tcp
   > server1:/exp1/brick server2:/exp2/brick
   > Creation of test-volume has been successful
   > Please start the volume to access data.
   > ```

2. Run **`# gluster volume start`** ***`VOLNAME`*** to start the volume.

```
# gluster volume start test-volume
Starting test-volume has been successful
```

3. Run **`gluster volume info`** command to optionally display the volume information.

> **Important**
>
> You must set client-side quorum on replicated volumes to prevent split-brain scenarios. For more information on setting client-side quorum, see Section 10.11.1.2, "Configuring Client-Side Quorum"

## 6.6.2. Creating Three-way Replicated Volumes

Three-way replicated volume creates three copies of files across multiple bricks in the volume. The number of bricks must be equal to the replica count for a replicated volume. To protect against server and disk failures, it is recommended that the bricks of the volume are from different servers.

Synchronous three-way replication is now fully supported in Red Hat Gluster Storage. Three-way replication volumes are supported only on JBOD configuration.

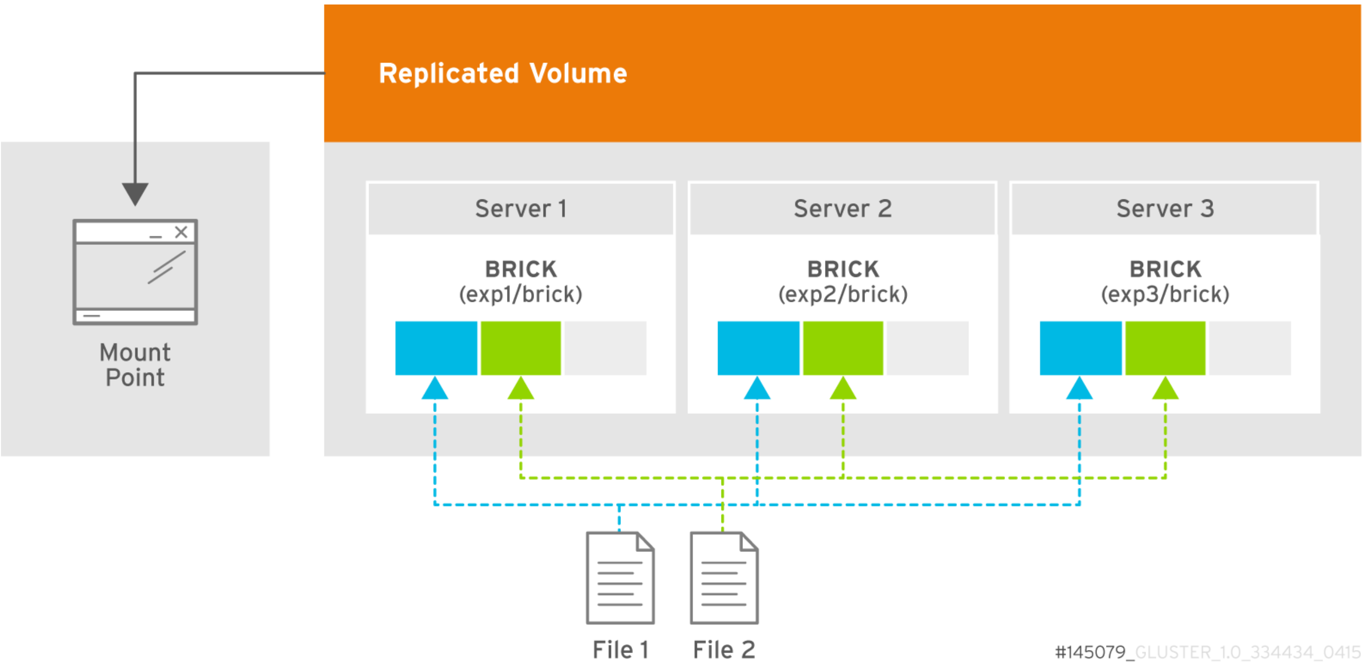



**Figure 6.4. Illustration of a Three-way Replicated Volume**

**Creating three-way replicated volumes**

1. Run the **`gluster volume create`** command to create the replicated volume.

   The syntax is **`# gluster volume create`** ***`NEW-VOLNAME`*** **`[replica`** ***`COUNT`*** **`] [transport tcp | rdma | tcp,rdma]`** ***`NEW-BRICK...`***

   The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See Section 10.1, "Configuring Volume Options" for a full list of parameters.

   > **Example 6.4. Replicated Volume with Three Storage Servers**
   >
   > The order in which bricks are specified determines how bricks are replicated with each other. For example, every **n** bricks, where **n** is the replica count forms a replica set. This is illustrated in *Figure 6.3. Illustration of a Three-way Replicated Volume*.

```
# gluster volume create test-volume replica 3 transport tcp
server1:/exp1/brick server2:/exp2/brick server3:/exp3/brick
Creation of test-volume has been successful
Please start the volume to access data.
```

2. Run `# gluster volume start VOLNAME` to start the volume.

```
# gluster volume start test-volume
Starting test-volume has been successful
```

3. Run `gluster volume info` command to optionally display the volume information.

> **Important**
>
> By default, the client-side quorum is enabled on three-way replicated volumes to minimize split-brain scenarios. For more information on client-side quorum, see Section 10.11.1.2, “Configuring Client-Side Quorum”

## 6.7. Creating Distributed Replicated Volumes

> **Important**
>
> Creating distributed-replicated volume with replica count greater than 3 is under technology preview. Technology Preview features are not fully supported under Red Hat subscription level agreements (SLAs), may not be functionally complete, and are not intended for production use. However, these features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process. As Red Hat considers making future iterations of Technology Preview features generally available, we will provide commercially reasonable efforts to resolve any reported issues that customers experience when using these features.

Use distributed replicated volumes in environments where the requirement to scale storage, and high-reliability is critical. Distributed replicated volumes also offer improved read performance in most environments.

> **Note**
>
> The number of bricks must be a multiple of the replica count for a distributed replicated volume. Also, the order in which bricks are specified has a great effect on data protection. Each replica_count consecutive bricks in the list you give will form a replica set, with all replica sets combined into a distribute set. To ensure that replica-set members are not placed on the same node, list the first brick on every server, then the second brick on every server in the same order, and so on.

### Prerequisites

- A trusted storage pool has been created, as described in Section 5.1, “Adding Servers to the Trusted Storage Pool”.

- Understand how to start and stop volumes, as described in Section 6.10, “Starting Volumes”.

### 6.7.1. Creating Two-way Distributed Replicated Volumes

Two-way distributed replicated volumes distribute and create two copies of files across the bricks in a volume. The number of bricks must be multiple of the replica count for a replicated volume. To protect against server and disk failures, the bricks of the volume should be from different servers.

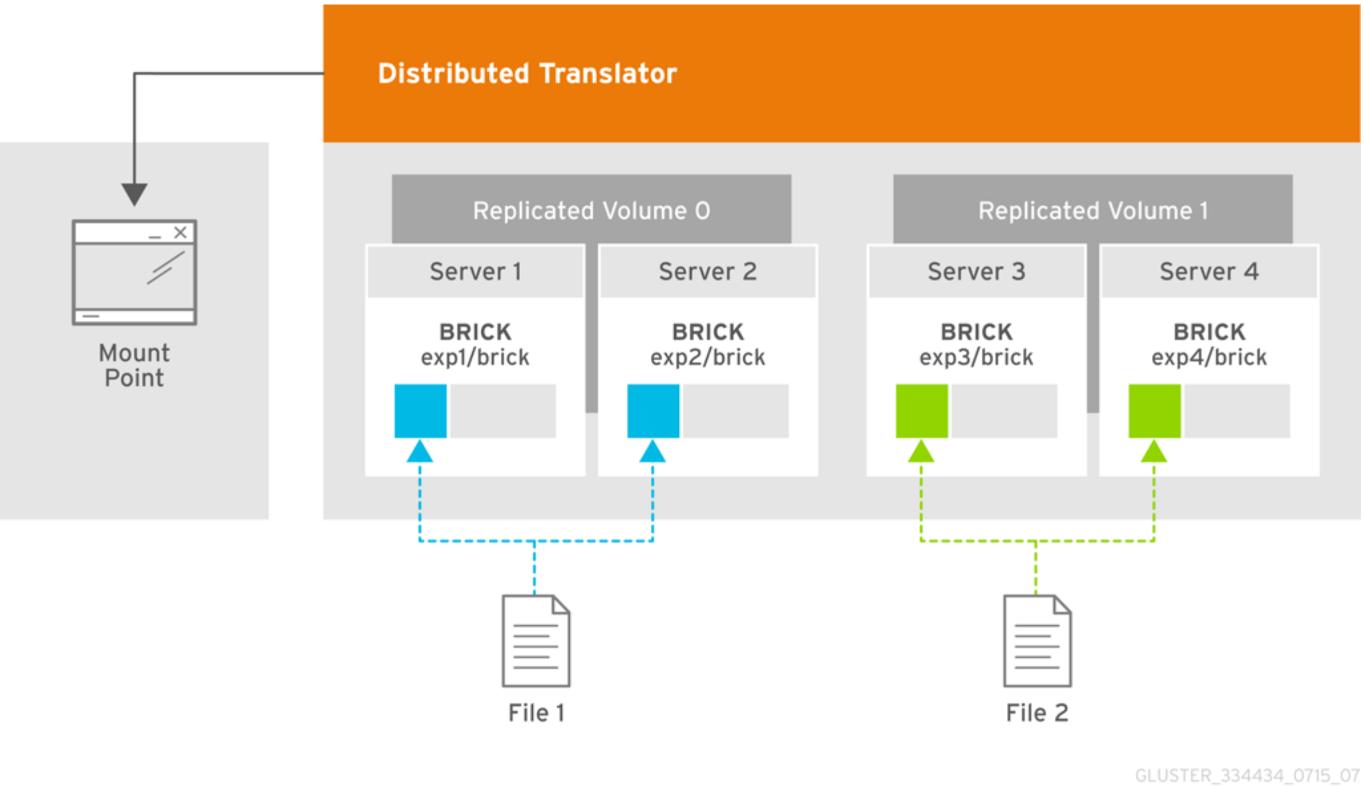



**Figure 6.5. Illustration of a Two-way Distributed Replicated Volume**

**Creating two-way distributed replicated volumes**

1. Run the **`gluster volume create`** command to create the distributed replicated volume.

   The syntax is **`# gluster volume create`** ***`NEW-VOLNAME`*** **`[replica`** ***`COUNT`*** **`] [transport tcp | rdma | tcp,rdma]`** ***`NEW-BRICK...`***

   The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See Section 10.1, “Configuring Volume Options” for a full list of parameters.

   **Example 6.5. Four Node Distributed Replicated Volume with a Two-way Replication**

   The order in which bricks are specified determines how they are replicated with each other. For example, the first two bricks specified replicate each other where *2* is the replica *count*.

   ```
   # gluster volume create test-volume replica 2 transport tcp
   server1:/exp1/brick server2:/exp2/brick server3:/exp3/brick
   server4:/exp4/brick
   Creation of test-volume has been successful
   Please start the volume to access data.
   ```

**Example 6.6. Six Node Distributed Replicated Volume with a Two-way Replication**

```
# gluster volume create test-volume replica 2 transport tcp
server1:/exp1/brick server2:/exp2/brick server3:/exp3/brick
server4:/exp4/brick server5:/exp5/brick server6:/exp6/brick
Creation of test-volume has been successful
Please start the volume to access data.
```

2. Run `# gluster volume start VOLNAME` to start the volume.

```
# gluster volume start test-volume
Starting test-volume has been successful
```

3. Run `gluster volume info` command to optionally display the volume information.

**Important**

You must ensure to set server-side quorum and client-side quorum on the distributed-replicated volumes to prevent split-brain scenarios. For more information on setting quorums, see Section 10.11.1, “Preventing Split-brain”

## 6.7.2. Creating Three-way Distributed Replicated Volumes

Three-way distributed replicated volume distributes and creates three copies of files across multiple bricks in the volume. The number of bricks must be equal to the replica count for a replicated volume. To protect against server and disk failures, it is recommended that the bricks of the volume are from different servers.

Synchronous three-way replication is now fully supported in Red Hat Gluster Storage. Three-way replication volumes are supported only on JBOD configuration.

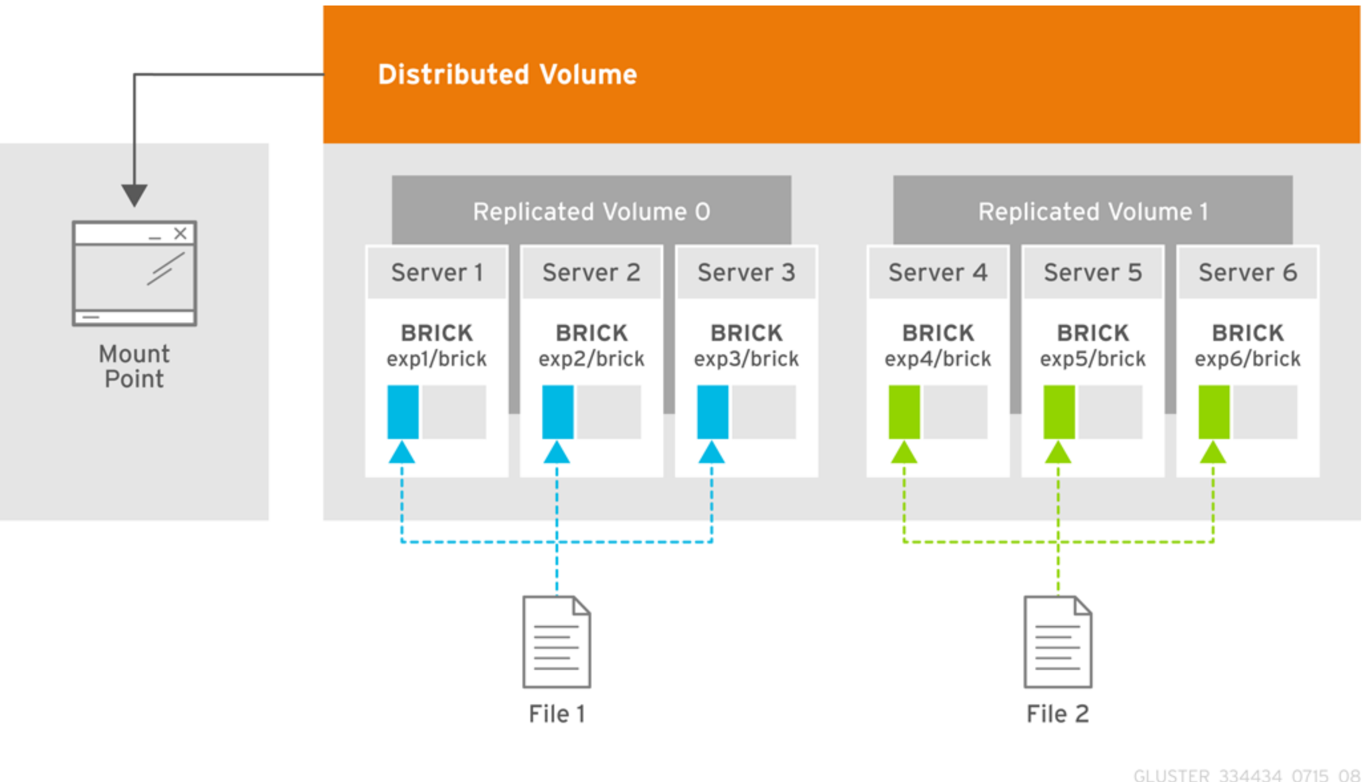


**Figure 6.6. Illustration of a Three-way Distributed Replicated Volume**

### Creating three-way distributed replicated volumes

1. Run the **`gluster volume create`** command to create the distributed replicated volume.

   The syntax is **`# gluster volume create NEW-VOLNAME [replica COUNT] [transport tcp | rdma | tcp,rdma] NEW-BRICK...`**

   The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See Section 10.1, “Configuring Volume Options” for a full list of parameters.

   **Example 6.7. Six Node Distributed Replicated Volume with a Three-way Replication**

   The order in which bricks are specified determines how bricks are replicated with each other. For example, first *3* bricks, where *3* is the replica *count* forms a replicate set.

   ```
   # gluster volume create test-volume replica 3 transport tcp
   server1:/exp1/brick server2:/exp2/brick server3:/exp3/brick
   server4:/exp4/brick server5:/exp5/brick server6:/exp6/brick
   Creation of test-volume has been successful
   Please start the volume to access data.
   ```

2. Run **`# gluster volume start VOLNAME`** to start the volume.

   ```
   # gluster volume start test-volume
   Starting test-volume has been successful
   ```

3. Run **`gluster volume info`** command to optionally display the volume information.

**Important**

By default, the client-side quorum is enabled on three-way distributed replicated volumes. You must also set server-side quorum on the distributed-replicated volumes to prevent split-brain scenarios. For more information on setting quorums, see Section 10.11.1, “Preventing Split-brain” .

## 6.8. Creating Dispersed Volumes

Dispersed volumes are based on erasure coding. Erasure coding (EC) is a method of data protection in which data is broken into fragments, expanded and encoded with redundant data pieces and stored across a set of different locations. This allows the recovery of the data stored on one or more bricks in case of failure. The number of bricks that can fail without losing data is configured by setting the redundancy count.

Dispersed volume requires less storage space when compared to a replicated volume. It is equivalent to a replicated pool of size two, but requires 1.5 TB instead of 2 TB to store 1 TB of data when the redundancy level is set to 2. In a dispersed volume, each brick stores some portions of data and parity or redundancy. The dispersed volume sustains the loss of data based on the redundancy level.

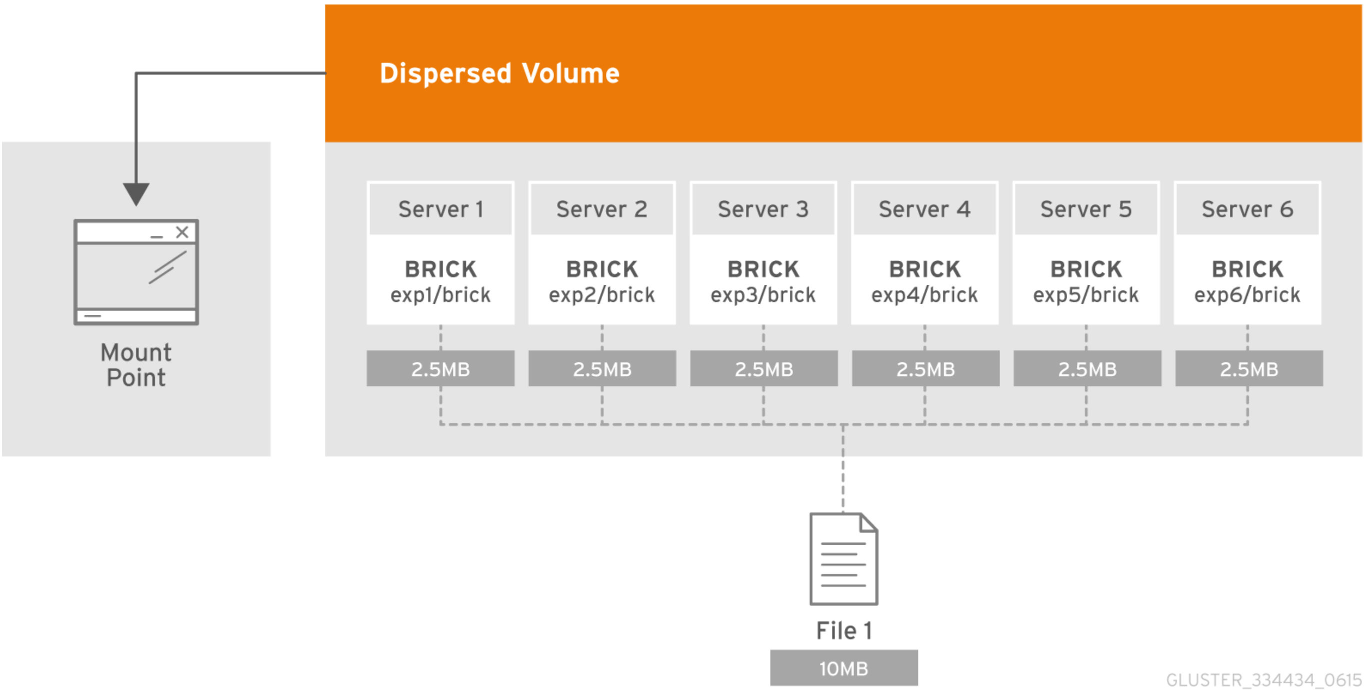



**Figure 6.7. Illustration of a Dispersed Volume**

The data protection offered by erasure coding can be represented in simple form by the following equation: **`n = k + m`**. Here **`n`** is the total number of bricks, we would require any **`k`** bricks out of **`n`** bricks for recovery. In other words, we can tolerate failure up to any **`m`** bricks. With this release, the following configurations are supported:

- 6 bricks with redundancy level 2 (4 +2)
- 11 bricks with redundancy level 3 (8 +3)
- 12 bricks with redundancy level 4 (8 + 4)

Use **`gluster volume create`** to create different types of volumes, and **`gluster volume info`** to verify successful volume creation.

**Prerequisites**

- Create a trusted storage pool as described in Section 5.1, “Adding Servers to the Trusted Storage Pool”.
- Understand how to start and stop volumes, as described in Section 6.10, “Starting Volumes”.

**Important**

Red Hat recommends you to review the Dispersed Volume configuration recommendations explained in Section 6.8, “Creating Dispersed Volumes” before creating the Dispersed volume.

**To Create a dispersed volume**

1. Run the **`gluster volume create`** command to create the dispersed volume.

   The syntax is **`# gluster volume create`** ***`NEW-VOLNAME`*** **`[disperse-data`** ***`COUNT`*****`]`** **`[redundancy`** ***`COUNT`*****`] [transport tcp | rdma | tcp,rdma]`** ***`NEW-BRICK...`***

The number of bricks required to create a disperse volume is the sum of **`disperse-data count`** and **`redundancy count`**.

The **`disperse-data count`** option specifies the number of bricks that is part of the dispersed volume, excluding the count of the redundant bricks. For example, if the total number of bricks is 6 and **`redundancy-count`** is specified as 2, then the disperse-data count is 4 (6 - 2 = 4). If the **`disperse-data count`** option is not specified, and only the **`redundancy count`** option is specified, then the **`disperse-data count`** is computed automatically by deducting the redundancy count from the specified total number of bricks.

Redundancy determines how many bricks can be lost without interrupting the operation of the volume. If **`redundancy count`** is not specified, based on the configuration it is computed automatically to the optimal value and a warning message is displayed.

The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See Section 6.3, “About Encrypted Disk” for a full list of parameters.

**Example 6.8. Dispersed Volume with Six Storage Servers**

```
# gluster volume create test-volume disperse-data 4 redundancy 2
transport tcp server1:/exp1/brick server2:/exp2/brick
server3:/exp3/brick server4:/exp4/brick server5:/exp5/brick
server6:/exp6/brick
Creation of test-volume has been successful
Please start the volume to access data.
```

2. Run **`# gluster volume start VOLNAME`** to start the volume.

```
# gluster volume start test-volume
Starting test-volume has been successful
```

3. Run **`gluster volume info`** command to optionally display the volume information.

## 6.9. Creating Distributed Dispersed Volumes

Distributed dispersed volumes support the same configurations of erasure coding as dispersed volumes. The number of bricks in a distributed dispersed volume must be a multiple of (K+M). With this release, the following configurations are supported:

- Multiple disperse sets containing 6 bricks with redundancy level 2
- Multiple disperse sets containing 11 bricks with redundancy level 3
- Multiple disperse sets containing 12 bricks with redundancy level 4

Use **`gluster volume create`** to create different types of volumes, and **`gluster volume info`** to verify successful volume creation.

**Prerequisites**

- A trusted storage pool has been created, as described in Section 5.1, “Adding Servers to the Trusted Storage Pool”.
- Understand how to start and stop volumes, as described in Section 6.10, “Starting Volumes”.

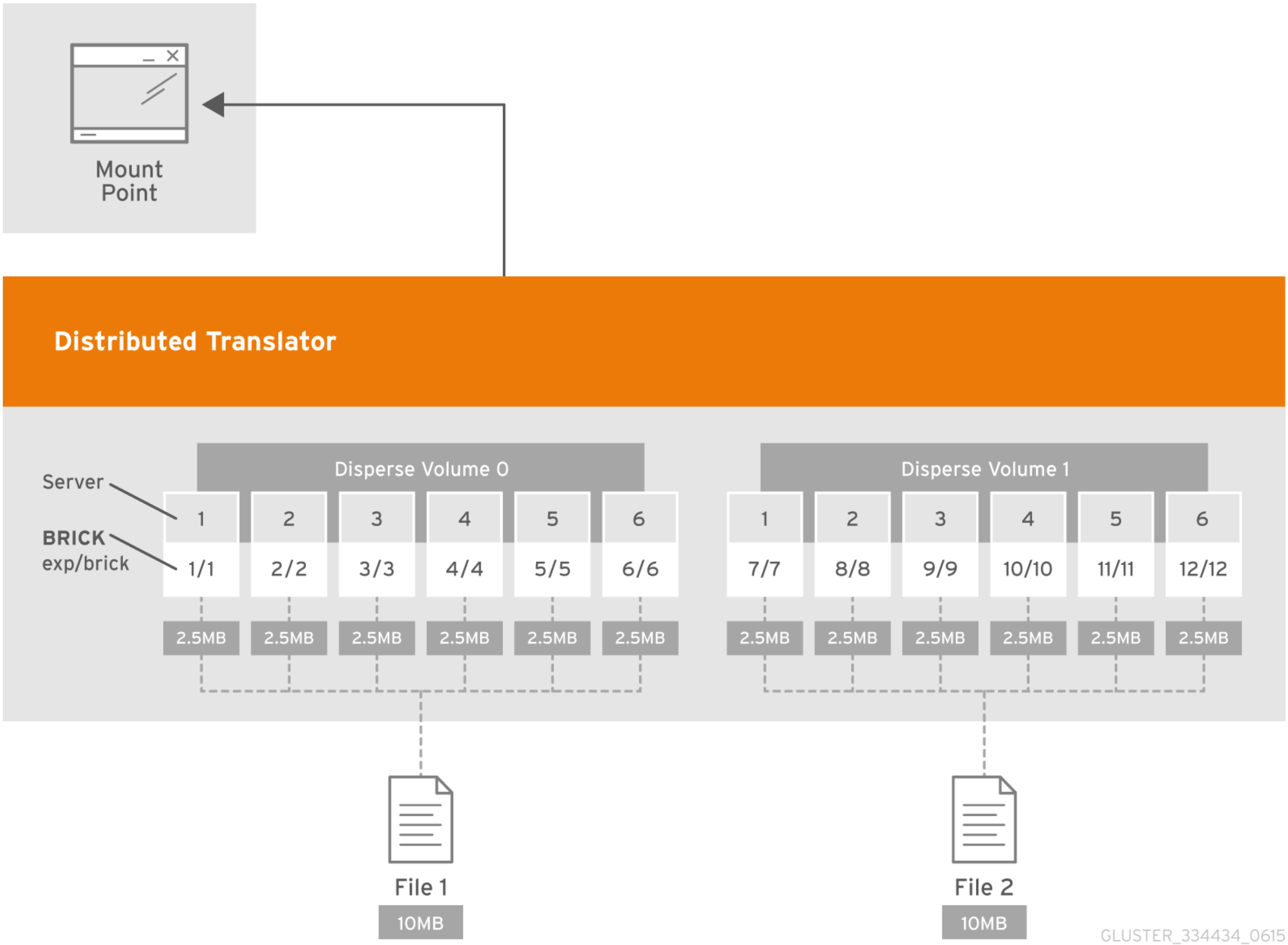



**Figure 6.8. Illustration of a Distributed Dispersed Volume**

#### Creating distributed dispersed volumes

> **Important**
>
> Red Hat recommends you to review the Distributed Dispersed Volume configuration recommendations explained in *Chapter 28, Recommended Configurations - Dispersed Volume* before creating the Distributed Dispersed volume.

1. Run the **`gluster volume create`** command to create the dispersed volume.

   The syntax is **`# gluster volume create`** ***`NEW-VOLNAME`*** **`disperse-data`** ***`COUNT`*** **`[redundancy`** ***`COUNT`*** **`] [transport tcp | rdma | tcp,rdma]`** ***`NEW-BRICK...`***

   The default value for transport is **`tcp`**. Other options can be passed such as **`auth.allow`** or **`auth.reject`**. See Section 10.1, “Configuring Volume Options” for a full list of parameters.

   **Example 6.9. Distributed Dispersed Volume with Six Storage Servers**

   ```
   # gluster volume create test-volume disperse-data 4 redundancy 2
   transport tcp server1:/exp1/brick1 server2:/exp2/brick2
   server3:/exp3/brick3 server4:/exp4/brick4 server5:/exp5/brick5
   ```

```
server6:/exp6/brick6 server1:/exp7/brick7 server2:/exp8/brick8
server3:/exp9/brick9 server4:/exp10/brick10 server5:/exp11/brick11
server6:/exp12/brick12
Creation of test-volume has been successful
Please start the volume to access data.
```

The above example is illustrated in the figure **`Illustration of a Distributed Dispersed Volume`**. In the illustration and example, you are creating 12 bricks from 6 servers.

2. Run **`# gluster volume start`** ***`VOLNAME`*** to start the volume.

```
# gluster volume start test-volume
Starting test-volume has been successful
```

3. Run **`gluster volume info`** command to optionally display the volume information.

## 6.10. Starting Volumes

Volumes must be started before they can be mounted.

To start a volume, run **`# gluster volume start`** ***`VOLNAME`***

For example, to start test-volume:

```
# gluster volume start test-volume
Starting test-volume has been successful
```

# Chapter 7. Accessing Data - Setting Up Clients

Red Hat Gluster Storage volumes can be accessed using a number of technologies:

- Native Client (see Section 7.1, “Native Client”)
- Network File System (NFS) v3 (see Section 7.2, “NFS”)
- Server Message Block (SMB) (see Section 7.3, “SMB”)

### Cross Protocol Data Access

Although a Red Hat Gluster Storage trusted pool can be configured to support multiple protocols simultaneously, a single volume cannot be freely accessed by different protocols due to differences in locking semantics. The table below defines which protocols can safely access the same volume concurrently.

**Table 7.1. Cross Protocol Data Access Matrix**

| | SMB | NFS | Native Client | Object |
|---|---|---|---|---|
| **SMB** | Yes | No | No | No |
| **NFS** | No | Yes | Yes | Yes |
| **Native Client** | No | Yes | Yes | Yes |
| **Object** | No | Yes | Yes | Yes |

### Access Protocols Supportability

The following table provides the support matrix for the supported access protocols with TCP/RDMA.

**Table 7.2. Access Protocol Supportability Matrix**

| Access Protocols | TCP | RDMA |
|---|---|---|
| FUSE | Yes | Yes |
| SMB | Yes | No |
| NFS | Yes | Yes |

**Important**

Red Hat Gluster Storage requires certain ports to be open. You must ensure that the firewall settings allow access to the ports listed at Section 4.1, “Port Information”.

## 7.1. Native Client

Native Client is a FUSE-based client running in user space. Native Client is the recommended method for accessing Red Hat Gluster Storage volumes when high concurrency and high write performance is required.

This section introduces Native Client and explains how to install the software on client machines. This section also describes how to mount Red Hat Gluster Storage volumes on clients (both manually and automatically) and how to verify that the Red Hat Gluster Storage volume has mounted successfully.

**Table 7.3. Red Hat Gluster Storage Support Matrix**

| Red Hat Enterprise Linux version | Red Hat Gluster Storage version | Native client version |
|---|---|---|
| 6.5 | 3.0 | 3.0, 2.1* |
| 6.6 | 3.0.2, 3.0.3, 3.0.4 | 3.0, 2.1* |
| 6.7 | 3.1, 3.1.1, 3.1.2 | 3.1, 3.0, 2.1* |
| 7.1 | 3.1, 3.1.1 | 3.1, 3.0, 2.1* |
| 7.2 | 3.1.2 | 3.1, 3.0, 2.1* |

**Note**

If an existing Red Hat Gluster Storage 2.1 cluster is upgraded to Red Hat Gluster Storage 3.x, older 2.1 based clients can mount the new 3.x volumes, however, clients must be upgraded to Red Hat Gluster Storage 3.x to run rebalance operation. For more information, see Section 7.1.3, “Mounting Red Hat Gluster Storage Volumes”

### 7.1.1. Installing Native Client

After installing the client operating system, register the target system to Red Hat Network and subscribe to the Red Hat Enterprise Linux Server channel.

**Important**

All clients must be of the same version. Red Hat strongly recommends upgrading the servers before upgrading the clients.

#### Use the Command Line to Register and Subscribe a System to Red Hat Network

Register the system using the command line, and subscribe to the correct channels.

#### Prerequisites

- Know the user name and password of the Red Hat Network (RHN) account with Red Hat Gluster Storage entitlements.

1. Run the **`rhn_register`** command to register the system.

   ```
   # rhn_register
   ```

2. In the **`Operating System Release Version`** screen, select **`All available updates`** and follow the prompts to register the system to the standard base channel of the respective Red Hat Enterprise Linux Server version.

3. Run the **`rhn-channel --add --channel`** command to subscribe the system to the correct Red Hat Gluster Storage Native Client channel:

   - For Red Hat Enterprise Linux 7.x clients using Red Hat Satellite Server:

     ```
     # rhn-channel --add --channel=rhel-x86_64-server-7-rh-gluster-3-
     client
     ```

> **Note**
>
> The following command can also be used, but Red Hat Gluster Storage may deprecate support for this channel in future releases.
>
> ```
> # rhn-channel --add --channel=rhel-x86_64-server-rh-common-7
> ```

- For Red Hat Enterprise Linux 6.x clients:

```
# rhn-channel --add --channel=rhel-x86_64-server-rhsclient-6
```

- For Red Hat Enterprise Linux 5.x clients:

```
# rhn-channel --add --channel=rhel-x86_64-server-rhsclient-5
```

4. Verify that the system is subscribed to the required channels.

```
# yum repolist
```

**Use the Command Line to Register and Subscribe a System to Red Hat Subscription Management**

Register the system using the command line, and subscribe to the correct repositories.

**Prerequisites**

- Know the user name and password of the Red Hat Subscription Manager account with Red Hat Gluster Storage entitlements.

1. Run the **`subscription-manager register`** command and enter your Red Hat Subscription Manager user name and password to register the system with Red Hat Subscription Manager.

```
# subscription-manager register --auto-attach
```

2. Depending on your client, run one of the following commands to subscribe to the correct repositories.

- For Red Hat Enterprise Linux 7.x clients:

```
# subscription-manager repos --enable=rhel-7-server-rpms --
enable=rh-gluster-3-client-for-rhel-7-server-rpms
```

> **Note**
>
> The following command can also be used, but Red Hat Gluster Storage may deprecate support for this repository in future releases.
>
> ```
> # subscription-manager repos --enable=rhel-7-server-rh-common-
> rpms
> ```

- For Red Hat Enterprise Linux 6.1 and later clients:

```
# subscription-manager repos --enable=rhel-6-server-rpms --
enable=rhel-6-server-rhs-client-1-rpms
```

- For Red Hat Enterprise Linux 5.7 and later clients:

```
# subscription-manager repos --enable=rhel-5-server-rpms --
enable=rhel-5-server-rhs-client-1-rpms
```

For more information, see Section 3.2 Registering from the Command Line in *Using and Configuring Red Hat Subscription Management*.

3. Verify that the system is subscribed to the required repositories.

```
# yum repolist
```

**Use the Web Interface to Register and Subscribe a System**

Register the system using the web interface, and subscribe to the correct channels.

**Prerequisites**

- Know the user name and password of the Red Hat Network (RHN) account with Red Hat Gluster Storage entitlements.

1. Log on to Red Hat Network (http://rhn.redhat.com).

2. Move the mouse cursor over the **`Subscriptions`** link at the top of the screen, and then click the **`Registered Systems`** link.

3. Click the name of the system to which the **`Red Hat Gluster Storage Native Client`** channel must be appended.

4. Click **`Alter Channel Subscriptions`** in the **`Subscribed Channels`** section of the screen.

5. Expand the node for Additional Services Channels for **`Red Hat Enterprise Linux 7 for x86_64`** or **`Red Hat Enterprise Linux 6 for x86_64`** or for **`Red Hat Enterprise Linux 5 for x86_64`** depending on the client platform.

6. Click the **`Change Subscriptions`** button to finalize the changes.

   When the page refreshes, select the **`Details`** tab to verify the system is subscribed to the appropriate channels.

**Install Native Client Packages**

Install Native Client packages from Red Hat Network

**Prerequisites**

- Use the Command Line to Register and Subscribe a System to Red Hat Network or
- Use the Command Line to Register and Subscribe a System to Red Hat Subscription Management or
- Use the Web Interface to Register and Subscribe a System

1. Run the **yum install** command to install the native client RPM packages.

   ```
   # yum install glusterfs glusterfs-fuse
   ```

2. For Red Hat Enterprise 5.x client systems, run the **modprobe** command to load FUSE modules before mounting Red Hat Gluster Storage volumes.

   ```
   # modprobe fuse
   ```

   For more information on loading modules at boot time, see https://access.redhat.com/knowledge/solutions/47028 .

### 7.1.2. Upgrading Native Client

Before updating the Native Client, subscribe the clients to the channels mentioned in Section 7.1.1, “Installing Native Client”

1. **Unmount gluster volumes**

   Unmount any gluster volumes prior to upgrading the native client.

   ```
   # umount /mnt/glusterfs
   ```

2. **Upgrade the client**

   Run the **yum update** command to upgrade the native client:

   ```
   # yum update glusterfs glusterfs-fuse
   ```

3. **Remount gluster volumes**

   Remount volumes as discussed in Section 7.1.3, “Mounting Red Hat Gluster Storage Volumes”.

### 7.1.3. Mounting Red Hat Gluster Storage Volumes

After installing Native Client, the Red Hat Gluster Storage volumes must be mounted to access data. Two methods are available:

- Section 7.1.3.2, “Mounting Volumes Manually”
- Section 7.1.3.3, “Mounting Volumes Automatically”

After mounting a volume, test the mounted volume using the procedure described in Section 7.1.3.4, “Testing Mounted Volumes”.

**Note**

- For Red Hat Gluster Storage 3.1 and Red Hat Gluster Storage 3.1.z, the recommended native client version should either be 3.1.z, or 3.0.z.
- Server names selected during volume creation should be resolvable in the client machine. Use appropriate **/etc/hosts** entries, or a DNS server to resolve server names to IP addresses.

### 7.1.3.1. Mount Commands and Options

The following options are available when using the **mount -t glusterfs** command. All options must be separated with commas.

```
# mount -t glusterfs -o backup-volfile-
servers=volfile_server2:volfile_server3:.... ..:volfile_serverN,transport-
type tcp,log-level=WARNING,log-file=/var/log/gluster.log server1:/test-
volume /mnt/glusterfs
```

**backup-volfile-servers=<volfile_server2>:<volfile_server3>:...:<volfile_serverN>**

List of the backup volfile servers to mount the client. If this option is specified while mounting the fuse client, when the first volfile server fails, the servers specified in **backup-volfile-servers** option are used as volfile servers to mount the client until the mount is successful.

**Note**

This option was earlier specified as **backupvolfile-server** which is no longer valid.

**log-level**

Logs only specified level or higher severity messages in the log-file.

**log-file**

Logs the messages in the specified file.

**transport-type**

Specifies the transport type that FUSE client must use to communicate with bricks. If the volume was created with only one transport type, then that becomes the default when no value is specified. In case of **tcp,rdma** volume, tcp is the default.

**ro**

Mounts the file system as read only.

**acl**

Enables POSIX Access Control List on mount.

**background-qlen=*n***

Enables FUSE to handle *n* number of requests to be queued before subsequent requests are denied. Default value of *n* is 64.

**enable-ino32**

this option enables file system to present 32-bit inodes instead of 64- bit inodes.

#### 7.1.3.2. Mounting Volumes Manually

**Manually Mount a Red Hat Gluster Storage Volume**

Create a mount point and run the **`mount -t glusterfs`** ***`HOSTNAME|IPADDRESS`*****`:`*****`/VOLNAME /MOUNTDIR`*** command to manually mount a Red Hat Gluster Storage volume.

> **Note**
>
> The server specified in the mount command is used to fetch the glusterFS configuration volfile, which describes the volume name. The client then communicates directly with the servers mentioned in the volfile (which may not actually include the server used for mount).

1. If a mount point has not yet been created for the volume, run the **`mkdir`** command to create a mount point.

```
# mkdir /mnt/glusterfs
```

2. Run the **`mount -t glusterfs`** command, using the key in the task summary as a guide.

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

#### 7.1.3.3. Mounting Volumes Automatically

Volumes can be mounted automatically each time the systems starts.

The server specified in the mount command is used to fetch the glusterFS configuration volfile, which describes the volume name. The client then communicates directly with the servers mentioned in the volfile (which may not actually include the server used for mount).

**Mounting a Volume Automatically**

Mount a Red Hat Gluster Storage Volume automatically at server start.

1. Open the **`/etc/fstab`** file in a text editor.

2. Append the following configuration to the **`fstab`** file.

```
HOSTNAME|IPADDRESS:/VOLNAME /MOUNTDIR glusterfs defaults,_netdev 0 0
```

Using the example server names, the entry contains the following replaced values.

```
server1:/test-volume /mnt/glusterfs glusterfs defaults,_netdev 0 0
```

If you want to specify the transport type then check the following example:

```
server1:/test-volume /mnt/glusterfs glusterfs
defaults,_netdev,transport=tcp 0 0
```

### 7.1.3.4. Testing Mounted Volumes

**Testing Mounted Red Hat Gluster Storage Volumes**

Using the command-line, verify the Red Hat Gluster Storage volumes have been successfully mounted. All three commands can be run in the order listed, or used independently to verify a volume has been successfully mounted.

**Prerequisites**

- Section 7.1.3.3, “Mounting Volumes Automatically”, or
- Section 7.1.3.2, “Mounting Volumes Manually”

1. Run the **mount** command to check whether the volume was successfully mounted.

```
# mount
server1:/test-volume on /mnt/glusterfs type
fuse.glusterfs(rw,allow_other,default_permissions,max_read=131072
```

   If transport option is used while mounting a volume, mount status will have the transport type appended to the volume name. For example, for transport=tcp:

```
# mount
server1:/test-volume.tcp on /mnt/glusterfs type
fuse.glusterfs(rw,allow_other,default_permissions,max_read=131072
```

2. Run the **df** command to display the aggregated storage space from all the bricks in a volume.

```
# df -h /mnt/glusterfs
Filesystem           Size  Used  Avail  Use%  Mounted on
server1:/test-volume  28T  22T   5.4T   82%   /mnt/glusterfs
```

3. Move to the mount directory using the **cd** command, and list the contents.

```
# cd /mnt/glusterfs
# ls
```

## 7.2. NFS

Linux, and other operating systems that support the NFSv3 standard can use NFS to access the Red Hat Gluster Storage volumes.

Differences in implementation of the NFSv3 standard in operating systems may result in some operational issues. If issues are encountered when using NFSv3, contact Red Hat support to receive more information on Red Hat Gluster Storage client operating system compatibility, and information about known issues affecting NFSv3.

NFS ACL v3 is supported, which allows **getfacl** and **setfacl** operations on NFS clients. The following options are provided to configure the Access Control Lists (ACL) in the glusterFS NFS server with the **nfs.acl** option. For example:

- To set nfs.acl **ON**, run the following command:

  ```
  # gluster volume set VOLNAME nfs.acl on
  ```

- To set nfs.acl **OFF**, run the following command:

  ```
  # gluster volume set VOLNAME nfs.acl off
  ```

**Note**

ACL is **ON** by default.

Red Hat Gluster Storage includes Network Lock Manager (NLM) v4. NLM protocol allows NFSv3 clients to lock files across the network. NLM is required to make applications running on top of NFSv3 mount points to use the standard fcntl() (POSIX) and flock() (BSD) lock system calls to synchronize access across clients.

This section describes how to use NFS to mount Red Hat Gluster Storage volumes (both manually and automatically) and how to verify that the volume has been mounted successfully.

**Important**

On Red Hat Enterprise Linux 7, enable the firewall service in the active zones for runtime and permanent mode using the following commands:

To get a list of active zones, run the following command:

```
# firewall-cmd --get-active-zones
```

To allow the firewall service in the active zones, run the following commands:

```
# firewall-cmd --zone=zone_name --add-service=nfs --add-service=rpc-
bind
# firewall-cmd --zone=zone_name --add-service=nfs --add-service=rpc-
bind --permanent
```

### 7.2.1. Using NFS to Mount Red Hat Gluster Storage Volumes

You can use either of the following methods to mount Red Hat Gluster Storage volumes:

> **Note**
>
> Currently GlusterFS NFS server only supports version 3 of NFS protocol. As a preferred option, always configure version 3 as the default version in the **nfsmount.conf** file at **/etc/nfsmount.conf** by adding the following text in the file:
>
> ```
> Defaultvers=3
> ```
>
> In case the file is not modified, then ensure to add **vers=3** manually in all the mount commands.
>
> ```
> # mount nfsserver:export -o vers=3 /MOUNTPOINT
> ```

RDMA support in GlusterFS that is mentioned in the previous sections is with respect to communication between bricks and Fuse mount/GFAPI/NFS server. NFS kernel client will still communicate with GlusterFS NFS server over tcp.

In case of volumes which were created with only one type of transport, communication between GlusterFS NFS server and bricks will be over that transport type. In case of **tcp,rdma** volume it could be changed using the volume set option **nfs.transport-type**.

- Section 7.2.1.1, "Manually Mounting Volumes Using NFS"
- Section 7.2.1.2, "Automatically Mounting Volumes Using NFS"

After mounting a volume, you can test the mounted volume using the procedure described in Section 7.2.1.4, "Testing Volumes Mounted Using NFS".

### 7.2.1.1. Manually Mounting Volumes Using NFS

Create a mount point and run the **mount** command to manually mount a Red Hat Gluster Storage volume using NFS.

1. If a mount point has not yet been created for the volume, run the **mkdir** command to create a mount point.

   ```
   # mkdir /mnt/glusterfs
   ```

2. Run the correct **mount** command for the system.

   **For Linux**

   ```
   # mount -t nfs -o vers=3 server1:/test-volume /mnt/glusterfs
   ```

   **For Solaris**

   ```
   # mount -o vers=3 nfs://server1:38467/test-volume
   /mnt/glusterfs
   ```

**Manually Mount a Red Hat Gluster Storage Volume using NFS over TCP**

Create a mount point and run the **mount** command to manually mount a Red Hat Gluster Storage volume using NFS over TCP.

> **Note**
>
> glusterFS NFS server does not support UDP. If a NFS client such as Solaris client, connects by default using UDP, the following message appears:
>
> **`requested NFS version or transport protocol is not supported`**
>
> The option **`nfs.mount-udp`** is supported for mounting a volume, by default it is disabled. The following are the limitations:
>
> - If **`nfs.mount-udp`** is enabled, the MOUNT protocol needed for NFSv3 can handle requests from NFS-clients that require MOUNT over UDP. This is useful for at least some versions of Solaris, IBM AIX and HP-UX.
> - Currently, MOUNT over UDP does not have support for mounting subdirectories on a volume. Mounting **`server:/volume/subdir`** exports is only functional when MOUNT over TCP is used.
> - MOUNT over UDP does not currently have support for different authentication options that MOUNT over TCP honors. Enabling **`nfs.mount-udp`** may give more permissions to NFS clients than intended via various authentication options like **`nfs.rpc-auth-allow`**, **`nfs.rpc-auth-reject`** and **`nfs.export-dir`**.

1. If a mount point has not yet been created for the volume, run the **`mkdir`** command to create a mount point.

   ```
   # mkdir /mnt/glusterfs
   ```

2. Run the correct **`mount`** command for the system, specifying the TCP protocol option for the system.

   **For Linux**

   ```
   # mount -t nfs -o vers=3,mountproto=tcp server1:/test-volume
   /mnt/glusterfs
   ```

   **For Solaris**

   ```
   # mount -o proto=tcp, nfs://server1:38467/test-volume
   /mnt/glusterfs
   ```

#### 7.2.1.2. Automatically Mounting Volumes Using NFS

Red Hat Gluster Storage volumes can be mounted automatically using NFS, each time the system starts.

> **Note**
>
> In addition to the tasks described below, Red Hat Gluster Storage supports Linux, UNIX, and similar operating system's standard method of auto-mounting NFS mounts.
>
> Update the **`/etc/auto.master`** and **`/etc/auto.misc`** files, and restart the **`autofs`** service. Whenever a user or process attempts to access the directory it will be mounted in the background on-demand.

### Mounting a Volume Automatically using NFS

Mount a Red Hat Gluster Storage Volume automatically using NFS at server start.

1. Open the **/etc/fstab** file in a text editor.
2. Append the following configuration to the **fstab** file.

```
HOSTNAME|IPADDRESS:/VOLNAME /MOUNTDIR glusterfs mountdir nfs
defaults,_netdev, 0 0
```

Using the example server names, the entry contains the following replaced values.

```
server1:/test-volume /mnt/glusterfs nfs defaults,_netdev, 0 0
```

### Mounting a Volume Automatically using NFS over TCP

Mount a Red Hat Gluster Storage Volume automatically using NFS over TCP at server start.

1. Open the **/etc/fstab** file in a text editor.
2. Append the following configuration to the **fstab** file.

```
HOSTNAME|IPADDRESS:/VOLNAME /MOUNTDIR glusterfs nfs
defaults,_netdev,mountproto=tcp 0 0
```

Using the example server names, the entry contains the following replaced values.

```
server1:/test-volume /mnt/glusterfs nfs
defaults,_netdev,mountproto=tcp 0 0
```

## 7.2.1.3. Authentication Support for Subdirectory Mount

This update extends **nfs.export-dir** option to provide client authentication during sub-directory mount. The **nfs.export-dir** and **nfs.export-dirs** options provide granular control to restrict or allow specific clients to mount a sub-directory. These clients can be authenticated with either an IP, host name or a Classless Inter-Domain Routing (CIDR) range.

- *nfs.export-dirs*: By default, all NFS sub-volumes are exported as individual exports. This option allows you to manage this behavior. When this option is turned off, none of the sub-volumes are exported and hence the sub-directories cannot be mounted. This option is on by default.

  To set this option to off, run the following command:

  **# gluster volume set *VOLNAME* nfs.export-dirs off**

  To set this option to on, run the following command:

  **# gluster volume set *VOLNAME* nfs.export-dirs on**

- *nfs.export-dir*: This option allows you to export specified subdirectories on the volume. You can export a particular subdirectory, for example:

  **# gluster volume set *VOLNAME* nfs.export-dir /d1,/d2/d3/d4,/d6**

  where d1, d2, d3, d4, d6 are the sub-directories.

You can also control the access to mount these subdirectories based on the IP address, host name or a CIDR. For example:

**# gluster volume set *VOLNAME* nfs.export-dir "/d1(<*ip address*>),/d2/d3/d4(<*host name*>|<*ip address*>),/d6(<*CIDR*>)"**

The directory /d1, /d2 and /d6 are directories inside the volume. Volume name must not be added to the path. For example if the volume vol1 has directories d1 and d2, then to export these directories use the following command: **gluster volume set vol1 nfs.export-dir "/d1(192.0.2.2),d2(192.0.2.34)"**

#### 7.2.1.4. Testing Volumes Mounted Using NFS

You can confirm that Red Hat Gluster Storage directories are mounting successfully.

**To test mounted volumes**

**Testing Mounted Red Hat Gluster Storage Volumes**

Using the command-line, verify the Red Hat Gluster Storage volumes have been successfully mounted. All three commands can be run in the order listed, or used independently to verify a volume has been successfully mounted.

**Prerequisites**

- Section 7.2.1.2, “Automatically Mounting Volumes Using NFS”, or
- Section 7.2.1.1, “Manually Mounting Volumes Using NFS”

1. Run the **mount** command to check whether the volume was successfully mounted.

```
# mount
server1:/test-volume on /mnt/glusterfs type nfs (rw,addr=server1)
```

2. Run the **df** command to display the aggregated storage space from all the bricks in a volume.

```
# df -h /mnt/glusterfs
Filesystem             Size Used Avail Use% Mounted on
server1:/test-volume   28T  22T  5.4T  82%  /mnt/glusterfs
```

3. Move to the mount directory using the **cd** command, and list the contents.

```
# cd /mnt/glusterfs
# ls
```

### 7.2.2. Troubleshooting NFS

**Q: The mount command on the NFS client fails with `RPC Error: Program not registered`. This error is encountered due to one of the following reasons:**

- **The NFS server is not running. You can check the status using the following command:**

```
# gluster volume status
```

- **The volume is not started. You can check the status using the following command:**

```
# gluster volume info
```

- **rpcbind is restarted. To check if rpcbind is running, execute the following command:**

  **`# ps ax| grep rpcbind`**

**A:**

- If the NFS server is not running, then restart the NFS server using the following command:

```
# gluster volume start VOLNAME
```

- If the volume is not started, then start the volume using the following command:

```
# gluster volume start VOLNAME
```

- If both rpcbind and NFS server is running then restart the NFS server using the following commands:

  **`# gluster volume stop VOLNAME`**

  **`# gluster volume start VOLNAME`**

---

**Q: The `rpcbind` service is not running on the NFS client. This could be due to the following reasons:**

- **The portmap is not running.**
- **Another instance of kernel NFS server or glusterNFS server is running.**

**A:** Start the **`rpcbind`** service by running the following command:

```
# service rpcbind start
```

---

**Q: The NFS server glusterfsd starts but the initialization fails with *nfsrpc- service: portmap registration of program failed* error message in the log.**

**A:** NFS start-up succeeds but the initialization of the NFS service can still fail preventing clients from accessing the mount points. Such a situation can be confirmed from the following error messages in the log file:

```
[2010-05-26 23:33:47] E [rpcsvc.c:2598:rpcsvc_program_register_portmap]
rpc-service: Could notregister with portmap
[2010-05-26 23:33:47] E [rpcsvc.c:2682:rpcsvc_program_register] rpc-
service: portmap registration of program failed
[2010-05-26 23:33:47] E [rpcsvc.c:2695:rpcsvc_program_register] rpc-
service: Program registration failed: MOUNT3, Num: 100005, Ver: 3, Port:
38465
[2010-05-26 23:33:47] E [nfs.c:125:nfs_init_versions] nfs: Program init
failed
[2010-05-26 23:33:47] C [nfs.c:531:notify] nfs: Failed to initialize
protocols
[2010-05-26 23:33:49] E
[rpcsvc.c:2614:rpcsvc_program_unregister_portmap] rpc-service: Could not
unregister with portmap
[2010-05-26 23:33:49] E [rpcsvc.c:2731:rpcsvc_program_unregister] rpc-
```

```
service: portmap unregistration of program failed
[2010-05-26 23:33:49] E [rpcsvc.c:2744:rpcsvc_program_unregister] rpc-
service: Program unregistration failed: MOUNT3, Num: 100005, Ver: 3,
Port: 38465
```

1. Start the rpcbind service on the NFS server by running the following command:

   ```
   # service rpcbind start
   ```

   After starting rpcbind service, glusterFS NFS server needs to be restarted.

2. Stop another NFS server running on the same machine.

   Such an error is also seen when there is another NFS server running on the same machine but it is not the glusterFS NFS server. On Linux systems, this could be the kernel NFS server. Resolution involves stopping the other NFS server or not running the glusterFS NFS server on the machine. Before stopping the kernel NFS server, ensure that no critical service depends on access to that NFS server's exports.

   On Linux, kernel NFS servers can be stopped by using either of the following commands depending on the distribution in use:

   ```
   # service nfs-kernel-server stop
   # service nfs stop
   ```

3. Restart glusterFS NFS server.

**Q: The NFS server start-up fails with the message *Port is already in use* in the log file.**

**A:** This error can arise in case there is already a glusterFS NFS server running on the same machine. This situation can be confirmed from the log file, if the following error lines exist:

```
[2010-05-26 23:40:49] E [rpc-socket.c:126:rpcsvc_socket_listen] rpc-
socket: binding socket failed:Address already in use
[2010-05-26 23:40:49] E [rpc-socket.c:129:rpcsvc_socket_listen] rpc-
socket: Port is already in use
[2010-05-26 23:40:49] E [rpcsvc.c:2636:rpcsvc_stage_program_register]
rpc-service: could not create listening connection
[2010-05-26 23:40:49] E [rpcsvc.c:2675:rpcsvc_program_register] rpc-
service: stage registration of program failed
[2010-05-26 23:40:49] E [rpcsvc.c:2695:rpcsvc_program_register] rpc-
service: Program registration failed: MOUNT3, Num: 100005, Ver: 3, Port:
38465
[2010-05-26 23:40:49] E [nfs.c:125:nfs_init_versions] nfs: Program init
failed
[2010-05-26 23:40:49] C [nfs.c:531:notify] nfs: Failed to initialize
protocols
```

In this release, the glusterFS NFS server does not support running multiple NFS servers on the same machine. To resolve the issue, one of the glusterFS NFS servers must be shutdown.

**Q: The `mount` command fails with NFS server failed error:**

**A:**

```
mount: mount to NFS server '10.1.10.11' failed: timed out (retrying).
```

Review and apply the suggested solutions to correct the issue.

- Disable name lookup requests from NFS server to a DNS server.

  The NFS server attempts to authenticate NFS clients by performing a reverse DNS lookup to match host names in the volume file with the client IP addresses. There can be a situation where the NFS server either is not able to connect to the DNS server or the DNS server is taking too long to respond to DNS request. These delays can result in delayed replies from the NFS server to the NFS client resulting in the timeout error.

  NFS server provides a work-around that disables DNS requests, instead relying only on the client IP addresses for authentication. The following option can be added for successful mounting in such situations:

  ```
  option nfs.addr.namelookup off
  ```

  **Note**

  Remember that disabling the NFS server forces authentication of clients to use only IP addresses. If the authentication rules in the volume file use host names, those authentication rules will fail and client mounting will fail.

- NFS version used by the NFS client is other than version 3 by default.

  glusterFS NFS server supports version 3 of NFS protocol by default. In recent Linux kernels, the default NFS version has been changed from 3 to 4. It is possible that the client machine is unable to connect to the glusterFS NFS server because it is using version 4 messages which are not understood by glusterFS NFS server. The timeout can be resolved by forcing the NFS client to use version 3. The **vers** option to mount command is used for this purpose:

  **# mount *nfsserver:export* -o vers=3 */MOUNTPOINT***

---

**Q: The showmount command fails with *clnt_create: RPC: Unable to receive* error. This error is encountered due to the following reasons:**

- **The firewall might have blocked the port.**
- **rpcbind might not be running.**

**A:** Check the firewall settings, and open ports 111 for portmap requests/replies and glusterFS NFS server requests/replies. glusterFS NFS server operates over the following port numbers: 38465, 38466, and 38467.

---

**Q: The application fails with *Invalid argument* or *Value too large for defined data type***

**A:** These two errors generally happen for 32-bit NFS clients, or applications that do not support 64-bit inode numbers or large files.

Use the following option from the command-line interface to make glusterFS NFS return 32-bit inode numbers instead:

```
NFS.enable-ino32 <on | off>
```

This option is `off` by default, which permits NFS to return 64-bit inode numbers by default.

Applications that will benefit from this option include those that are:

- built and run on 32-bit machines, which do not support large files by default,
- built to 32-bit standards on 64-bit systems.

Applications which can be rebuilt from source are recommended to be rebuilt using the following flag with gcc:

```
-D_FILE_OFFSET_BITS=64
```

**Q: After the machine that is running NFS server is restarted the client fails to reclaim the locks held earlier.**

**A:** The Network Status Monitor (NSM) service daemon (rpc.statd) is started before gluster NFS server. Hence, NSM sends a notification to the client to reclaim the locks. When the clients send the reclaim request, the NFS server does not respond as it is not started yet. Hence the client request fails.

**Solution**: To resolve the issue, prevent the NSM daemon from starting when the server starts.

Run **`chkconfig --list nfslock`** to check if NSM is configured during OS boot.

If any of the entries are **`on,`** run **`chkconfig nfslock off`** to disable NSM clients during boot, which resolves the issue.

**Q: The `rpc actor failed to complete successfully` error is displayed in the nfs.log, even after the volume is mounted successfully.**

**A:** gluster NFS supports only NFS version 3. When nfs-utils mounts a client when the version is not mentioned, it tries to negotiate using version 4 before falling back to version 3. This is the cause of the messages in both the server log and the **`nfs.log`** file.

```
[2013-06-25 00:03:38.160547] W [rpcsvc.c:180:rpcsvc_program_actor] 0-
rpc-service: RPC program version not available (req 100003 4)
[2013-06-25 00:03:38.160669] E
[rpcsvc.c:448:rpcsvc_check_and_reply_error] 0-rpcsvc: rpc actor failed
to complete successfully
```

To resolve the issue, declare NFS version 3 and the **`noacl`** option in the mount command as follows:

```
mount -t nfs -o vers=3,noacl server1:/test-volume /mnt/glusterfs
```

**Q: The mount command fails with `No such file or directory`.**

**A:** This problem is encountered as the volume is not present.

### 7.2.3. NFS-Ganesha

NFS-Ganesha is a user space file server for the NFS protocol with support for NFSv3, v4, v4.1, pNFS.

Red Hat Gluster Storage is supported with the community's V2.2-stable release of NFS-Ganesha. The current release of Red Hat Gluster Storage introduces High Availability (HA) of NFS servers in active-active mode. pNFS is introduced as a tech preview feature. However, it does not support NFSv4 delegations and NFSv4.1.

**Note**

To install NFS-Ganesha refer, *Deploying NFS-Ganesha on Red Hat Gluster Storage* in the *Red Hat Gluster Storage 3.1 Installation Guide*.

**Important**

You must to ensure to enable the NFS firewall service along with the NFS-Ganesha firewall services. For more information NFS firewall services, see .Section 7.2, “NFS”

- On Red Hat Enterprise Linux 7, enable the NFS-Ganesha firewall service for `mountd` and `HA` in the active zones for runtime and permanent mode using the following commands:
  - Get a list of active zones using the following command:

    ```
    # firewall-cmd --get-active-zones
    ```

  - Allow the firewall service in the active zones, run the following commands:

    ```
    # firewall-cmd --zone=zone_name --add-service=mountd --add-
    service=high-availability

    # firewall-cmd --zone=zone_name --add-service=mountd --add-
    service=high-availability --permanent

    # firewall-cmd --zone=public --add-port=4501/tcp --add-
    port=4501/udp \
    --add-port=32803/tcp --add-port=32803/udp --add-port=662/tcp --
    add-port=662/udp

    # firewall-cmd --zone=public --add-port=4501/tcp --add-
    port=4501/udp \
    --add-port=32803/tcp --add-port=32803/udp --add-port=662/tcp --
    add-port=662/udp --permanent
    ```

    - On the NFS-client machine, execute the following commands:

      ```
      # firewall-cmd --zone=public --add-port=662/tcp --add-
      port=662/udp \
      --add-port=32803/tcp --add-port=32769/udp --add-port=892/tcp
      --add-port=892/udp

      # firewall-cmd --zone=public --add-port=662/tcp --add-
      port=662/udp \
      --add-port=32803/tcp --add-port=32769/udp --add-port=892/tcp
      --add-port=892/udp --permanent
      ```

  - Ensure to configure the ports mentioned above. For more information see *Defining Service Ports*. in Section *7.2.3.3.1 Pre-requisites to run nfs-ganesha*,

The following table contains the feature matrix of the NFS support on Red Hat Gluster Storage 3.1:

**Table 7.4. NFS Support Matrix**

| Features | glusterFS NFS (NFSv3) | NFS-Ganesha (NFSv3) | NFS-Ganesha (NFSv4) |
|---|---|---|---|
| Root-squash | Yes | Yes | Yes |
| Sub-directory exports | Yes | Yes | Yes |

| Features | glusterFS NFS (NFSv3) | NFS-Ganesha (NFSv3) | NFS-Ganesha (NFSv4) |
|---|---|---|---|
| Locking | Yes | Yes | Yes |
| Client based export permissions | Yes | Yes | Yes |
| Netgroups | Tech Preview | Tech Preview | Tech Preview |
| Mount protocols | UDP, TCP | UDP, TCP | Only TCP |
| NFS transport protocols | TCP | UDP, TCP | TCP |
| AUTH_UNIX | Yes | Yes | Yes |
| AUTH_NONE | Yes | Yes | Yes |
| AUTH_KRB | No | Yes | Yes |
| ACLs | Yes | No | Yes |
| Delegations | N/A | N/A | No |
| High availability | Yes (but no lock-recovery) | Yes | Yes |
| High availability (fail-back) | Yes (but no lock-recovery) | Yes | Yes |
| Multi-head | Yes | Yes | Yes |
| Gluster RDMA volumes | Yes | Available but not supported | Available but not supported |
| DRC | Available but not supported | No | No |
| Dynamic exports | No | Yes | Yes |
| pseudofs | N/A | N/A | Yes |
| NFSv4.1 | N/A | N/A | Not Supported |
| NFSv4.1/pNFS | N/A | N/A | Tech Preview |

## Note

- Red Hat does not recommend running NFS-Ganesha in mixed-mode and/or hybrid environments. This includes multi-protocol environments where NFS and CIFS shares are used simultaneously, or running NFS-Ganesha together with gluster-nfs, kernel-nfs or gluster-fuse clients
- Only one of NFS-Ganesha, gluster-NFS or kernel-NFS servers can be enabled on a given machine/host as all NFS implementations use the port 2049 and only one can be active at a given time. Hence you must disable kernel-NFS before NFS-Ganesha is started.

### 7.2.3.1. Supported Features of NFS-Ganesha

#### Highly Available Active-Active NFS-Ganesha

In a highly available active-active environment, if a NFS-Ganesha server that is connected to a NFS client running a particular application goes down, the application/NFS client is seamlessly connected to another NFS-Ganesha server without any administrative intervention.

For more information about Highly Available Active-Active NFS-Ganesha, see section *Highly Available Active-Active NFS-Ganesha*.

#### pNFS (Tech-Preview)

The Parallel Network File System (pNFS) is part of the NFS v4.1 protocol that allows compute clients to access storage devices directly and in parallel.

For more information about pNFS, see section *pNFS*.

#### Dynamic Export of Volumes

Previous versions of NFS-Ganesha required a restart of the server whenever the administrator had to add or remove exports. NFS-Ganesha now supports addition and removal of exports dynamically. Dynamic exports is managed by the DBus interface. DBus is a system local IPC mechanism for system management and peer-to-peer application communication.

> **Note**
>
> Modifying an export in place is currently not supported.

#### Exporting Multiple Entries

With this version of NFS-Ganesha, multiple Red Hat Gluster Storage volumes or sub-directories can now be exported simultaneously.

#### Pseudo File System

This version of NFS-Ganesha now creates and maintains a NFSv4 pseudo-file system, which provides clients with seamless access to all exported objects on the server.

#### Access Control List

NFS-Ganesha NFSv4 protocol includes integrated support for Access Control List (ACL)s, which are similar to those used by Windows. These ACLs can be used to identify a trustee and specify the access rights allowed, or denied for that trustee.This feature is disabled by default.

> **Note**
>
> AUDIT and ALARM ACE types are not currently supported.

### 7.2.3.2. Highly Available Active-Active NFS-Ganesha

In a highly available active-active environment, if a NFS-Ganesha server that is connected to a NFS client running a particular application goes down, the application/NFS client is seamlessly connected to another NFS-Ganesha server without any administrative intervention.

The cluster is maintained using Pacemaker and Corosync. Pacemaker acts a resource manager and Corosync provides the communication layer of the cluster. For more information about Pacemaker/Corosync see Clustering.

Data coherency across the multi-head NFS-Ganesha servers in the cluster is achieved using the Gluster's Upcall infrastructure. Gluster's Upcall infrastructure is a generic and extensible framework that sends notifications to the respective glusterfs clients (in this case NFS-Ganesha server) when changes are detected in the back-end file system.

The Highly Available cluster is configured in the following three stages:

1. **Creating the ganesha-ha.conf file**

   The ganesha-ha.conf.example is created in the following location /etc/ganesha when Red Hat Gluster Storage is installed. Rename the file to ganesha-ha.conf and make the changes based on your environment.

   Following is an example:

```
Sample ganesha-ha.conf file:

# Name of the HA cluster created.
# must be unique within the subnet
HA_NAME="ganesha-ha-360"
#
# The gluster server from which to mount the shared data volume.
HA_VOL_SERVER="server1"
#
# You may use short names or long names; you may not use IP addresses.
# Once you select one, stay with it as it will be mildly unpleasant to
clean up if you switch later on. Ensure that all names - short and/or
long - are in DNS or /etc/hosts on all machines in the cluster.
#
# The subset of nodes of the Gluster Trusted Pool that form the
ganesha HA cluster. Hostname is specified.
HA_CLUSTER_NODES="server1,server2,..."
#HA_CLUSTER_NODES="server1.lab.redhat.com,server2.lab.redhat.com,..."
#
# Virtual IPs for each of the nodes specified above.
VIP_server1="VIP_SERVER1"
VIP_server2="VIP_SERVER2"
#VIP_server1.lab.redhat.com="10.0.2.1"
#VIP_server2.lab.redhat.com="10.0.2.2"
```

2. **Configuring NFS-Ganesha using gluster CLI**

   The HA cluster can be set up or torn down using gluster CLI. In addition, it can export and unexport specific volumes. For more information, see section *Configuring NFS-Ganesha using gluster CLI*.

3. **Modifying the HA cluster using the ganesha-ha.sh script**

   After creating the cluster, any further modification can be done using the ganesha-ha.sh script. For more information, see *Modifying the HA cluster using the ganesha-ha.sh script.*

## 7.2.3.3. Configuring NFS-Ganesha using Gluster CLI

### 7.2.3.3.1. Prerequisites to run NFS-Ganesha

Ensure that the following prerequisites are taken into consideration before you run NFS-Ganesha in your environment:

- A Red Hat Gluster Storage volume must be available for export and NFS-Ganesha rpms are installed.
- Disable the gluster-nfs, kernel-nfs, and smbd services.
- Edit the ganesha-ha.conf file based on your environment.

- Create multiple virtual IPs (VIPs) on the network for each of the servers configured in the ganesha-ha.conf file and assign them to any unused NIC.
- IPv6 must be enabled on the host interface which is used by the NFS-Ganesha daemon. To enable IPv6 support, perform the following steps:
  - Comment or remove the line options ipv6 disable=1 in the /etc/modprobe.d/ipv6.conf file.
  - Reboot the system.
- Ensure that all the nodes in the cluster are DNS resolvable. For example, you can populate the /etc/hosts with the details of all the nodes in the cluster.
- Make sure the SELinux is in **`Enforcing`** mode.
- On Red Hat Enterprise Linux 7, execute the following commands to disable and stop NetworkManager service and to enable the network service.

```
# systemctl disable NetworkManager
# systemctl stop NetworkManager
# systemctl enable network
```

- Start network service on all machines using the following command:

  For Red Hat Enterprise Linux 6:

```
# service network start
```

  For Red Hat Enterprise Linux 7:

```
# systemctl start network
```

- Create and mount a gluster shared volume by executing the following command:

```
# gluster volume set all cluster.enable-shared-storage enable
volume set: success
```

  For more information, see Section 10.8, “Setting up Shared Storage Volume”

- For Red Hat Enterprise Linux 6, install pacemaker using the following command

```
# yum install pacemaker
```

> **Note**
>
> - For Red Hat Enterprise Linux 6, the **`corosync`** package is a dependency package of the **`pacemaker`** package and will be installed by default.
> - For Red Hat Enterprise Linux 7, **`pacemaker`** and **`corosync`** packages are installed by default when the **`glusterfs-ganesha`** package is installed.

- Enable the pacemaker service using the following command:

  For Red Hat Enterprise Linux 6:

```
# chkconfig --add pacemaker
# chkconfig pacemaker on
```

For Red Hat Enterprise Linux 7:

```
# systemctl enable pacemaker.service
```

- Start the pcsd service using the following command.

  For Red Hat Enterprise Linux 6:

```
# service pcsd start
```

For Red Hat Enterprise Linux 7:

```
# systemctl start pcsd
```

**Note**

- To start pcsd by default after the system is rebooted, execute the following command:

  For Red Hat Enterprise Linux 6:

```
# chkconfig --add pcsd
# chkconfig pcsd on
```

For Red Hat Enterprise Linux 7:

```
# systemctl enable pcsd
```

- Set a password for the user ‘hacluster’ on all the nodes using the following command. Use the same password for all the nodes:

```
# echo <password> | passwd --stdin hacluster
```

- Perform cluster authentication between the nodes, where, username is ‘hacluster’, and password is the one you used in the previous step. Ensure to execute the following command on every node:

```
# pcs cluster auth <hostname1> <hostname2> ...
```

**Note**

The hostname of all the nodes in the Ganesha-HA cluster must be included in the command when executing it on every node.

For example, in a four node cluster; nfs1, nfs2, nfs3, and nfs4, execute the following command on every node:

```
# pcs cluster auth nfs1 nfs2 nfs3 nfs4
Username: hacluster
Password:
nfs1: Authorized
nfs2: Authorized
nfs3: Authorized
nfs4: Authorized
```

- Passwordless ssh for the root user has to be enabled on all the HA nodes. Follow these steps,

  - On one of the nodes (node1) in the cluster, run:

    ```
    # ssh-keygen -f /var/lib/glusterd/nfs/secret.pem -t rsa -N ''
    ```

  - Deploy the generated public key from node1 to all the nodes (including node1) by executing the following command for every node:

    ```
    # ssh-copy-id -i /var/lib/glusterd/nfs/secret.pem.pub root@<node-
    ip/hostname>
    ```

  - Copy the ssh keypair from node1 to all the nodes in the Ganesha-HA cluster by executing the following command for every node:

    ```
    # scp -i /var/lib/glusterd/nfs/secret.pem
    /var/lib/glusterd/nfs/secret.* root@<node-
    ip/hostname>:/var/lib/glusterd/nfs/
    ```

- As part of cluster setup, port 4501 is used to bind to the Rquota service. If this port is already in use, assign a different port to this service by modifying following line in '/etc/ganesha/ganesha.conf' file on all the nodes.

  ```
  # Use a non-privileged port for RQuota
  Rquota_Port = 4501;
  ```

- **Defining Service Ports**

  To define the service ports, execute the following steps on every node in the nfs-ganesha cluster:

  - Edit '/etc/ganesha/ganesha.conf' as mentioned below:

    ```
    # sed -i '/NFS_Core_Param/a \ \ \ \ \ \ \ \ MNT_Port = 20048;'
    /etc/ganesha/ganesha.conf
    # sed -i '/NFS_Core_Param/a \ \ \ \ \ \ \ \ NLM_Port = 32803;'
    /etc/ganesha/ganesha.conf
    ```

  - Edit /etc/sysconfig/nfs file as mentioned below:

    ```
    # sed -i '/STATD_PORT/s/^#//' /etc/sysconfig/nfs
    ```

  - Restart the statd service:

    For Red Hat Enterprise Linux 6:

    ```
    # service nfslock restart
    ```

For Red Hat Enterprise Linux 7:

```
# systemctl restart nfs-config
# systemctl restart rpc-statd
```

Execute the following steps on the client machine:

- Edit '/etc/sysconfig/nfs' using following commands:

```
# sed -i '/STATD_PORT/s/^#//' /etc/sysconfig/nfs
# sed -i '/LOCKD_TCPPORT/s/^#//' /etc/sysconfig/nfs
# sed -i '/LOCKD_UDPPORT/s/^#//' /etc/sysconfig/nfs
# sed -i '/MOUNTD_PORT/s/^#//' /etc/sysconfig/nfs
```

- Restart the services:

  For Red Hat Enterprise Linux 6:

```
# service nfslock restart
# service nfs restart
```

  For Red Hat Enterprise Linux 7:

```
# systemctl restart nfs-config
# systemctl restart rpc-statd
# systemctl restart nfs-mountd
# systemctl restart nfslock
```

#### 7.2.3.3.2. Configuring the HA Cluster

To setup the HA cluster, enable NFS-Ganesha by executing the following command:

```
# gluster nfs-ganesha enable
```

For example,

```
# gluster nfs-ganesha enable
Enabling NFS-Ganesha requires Gluster-NFS to be disabled across the trusted
pool. Do you still want to continue?
 (y/n) y
This will take a few minutes to complete. Please wait ..
nfs-ganesha : success
```

## Note

After enabling NFS-Ganesha, if **`rpcinfo -p`** shows the statd port different from 662, then, restart the statd service:

For Red Hat Enterprise Linux 6:

```
# service nfslock restart
```

For Red Hat Enterprise Linux 7:

```
# systemctl restart rpc-statd
```

To tear down the HA cluster, execute the following command:

```
# gluster nfs-ganesha disable
```

For example,

```
# gluster nfs-ganesha disable
This will take a few minutes to complete. Please wait ..
nfs-ganesha : success
```

To verify the status of the HA cluster, execute the following script:

```
# /usr/libexec/ganesha/ganesha-ha.sh --status
```

For example:

```
# /usr/libexec/ganesha/ganesha-ha.sh --status

Cluster name: G1437076740.12
Last updated: Tue Jul 21 03:00:23 2015
Last change: Fri Jul 17 06:38:29 2015
Stack: corosync
Current DC: server4 (3) - partition with quorum
Version: 1.1.12-a14efad
4 Nodes configured
16 Resources configured


Online: [ server1 server2 server3 server4 ]

Full list of resources:

 Clone Set: nfs-mon-clone [nfs-mon]
     Started: [ server1 server2 server3 server4 ]
 Clone Set: nfs-grace-clone [nfs-grace]
     Started: [ server1 server2 server3 server4 ]
 server1-cluster_ip-1      (ocf::heartbeat:IPaddr):        Started server1
```

```
  server1-trigger_ip-1      (ocf::heartbeat:Dummy): Started server1
  server2-cluster_ip-1      (ocf::heartbeat:IPaddr):        Started server2

    ...output abbreviated...
```

**Note**

It is recommended to manually restart the **ganesha.nfsd** service after the node is rebooted, to fail back the VIPs.

#### 7.2.3.3.3. Exporting and Unexporting Volumes through NFS-Ganesha

**Exporting Volumes through NFS-Ganesha**

To export a Red Hat Gluster Storage volume, execute the following command:

```
# gluster volume set <volname> ganesha.enable on
```

For example:

```
# gluster vol set testvol ganesha.enable on
volume set: success
```

**Unexporting Volumes through NFS-Ganesha**

To unexport a Red Hat Gluster Storage volume, execute the following command:

```
# gluster volume set <volname> ganesha.enable off
```

This command unexports the Red Hat Gluster Storage volume without affecting other exports.

For example:

```
# gluster vol set testvol ganesha.enable off
volume set: success
```

**Verifying the Status**

To verify the status of the volume set options, follow the guidelines mentioned below:

- Check if NFS-Ganesha is started by executing the following commands:

  On Red Hat Enterprise Linux-6,

  ```
  # service nfs-ganesha status
  ```

  For example:

  ```
  # service nfs-ganesha status
  ganesha.nfsd (pid  4136) is running...
  ```

On Red Hat Enterprise Linux-7

```
# systemctl status nfs-ganesha
```

For example:

```
# systemctl  status nfs-ganesha
   nfs-ganesha.service - NFS-Ganesha file server
   Loaded: loaded (/usr/lib/systemd/system/nfs-ganesha.service; disabled)
   Active: active (running) since Tue 2015-07-21 05:08:22 IST; 19h ago
   Docs: http://github.com/nfs-ganesha/nfs-ganesha/wiki
   Main PID: 15440 (ganesha.nfsd)
   CGroup: /system.slice/nfs-ganesha.service
               └─15440 /usr/bin/ganesha.nfsd -L /var/log/ganesha.log -f
/etc/ganesha/ganesha.conf -N NIV_EVENT
   Jul 21 05:08:22 server1 systemd[1]: Started NFS-Ganesha file server.]
```

- Check if the volume is exported.

```
# showmount -e localhost
```

For example:

```
# showmount -e localhost
Export list for localhost:
/volname (everyone)
```

- The logs of ganesha.nfsd daemon are written to /var/log/ganesha.log. Check the log file on noticing any unexpected behavior.

#### 7.2.3.4. Modifying the HA cluster using the ganesha-ha.sh script

To modify the existing HA cluster and to change the default values of the exports use the ganesha-ha.sh script located at /usr/libexec/ganesha/.

- **Adding a node to the cluster**

  Before adding a node to the cluster, ensure all the prerequisites mentioned in section *Pre-requisites to run NFS-Ganesha* is met. To add a node to the cluster, execute the following command on any of the nodes in the existing NFS-Ganesha cluster:

```
# /usr/libexec/ganesha/ganesha-ha.sh --add <HA_CONF_DIR> <HOSTNAME> <NODE-VIP>
```

  where,

  HA_CONF_DIR: The directory path containing the ganesha-ha.conf file. By default it is **`/etc/ganesha.`**

  HOSTNAME: Hostname of the new node to be added

  NODE-VIP: Virtual IP of the new node to be added.

  For example:

```
# /usr/libexec/ganesha/ganesha-ha.sh --add /etc/ganesha server16
10.00.00.01
```

- **Deleting a node in the cluster**

  To delete a node from the cluster, execute the following command on any of the nodes in the existing NFS-Ganesha cluster:

  ```
  # /usr/libexec/ganesha/ganesha-ha.sh --delete <HA_CONF_DIR> <HOSTNAME>
  ```

  where,

  HA_CONF_DIR: The directory path containing the ganesha-ha.conf file. By default it is located at **`/etc/ganesha`**.

  HOSTNAME: Hostname of the new node to be added

  For example:

  ```
  # /usr/libexec/ganesha/ganesha-ha.sh --delete /etc/ganesha  server16
  ```

- **Modifying the default export configuration**

  To modify the default export configurations perform the following steps on any of the nodes in the existing ganesha cluster:

  - Edit/add the required fields in the corresponding export file located at /etc/ganesha/exports/.

  - Execute the following command:

    ```
    # /usr/libexec/ganesha/ganesha-ha.sh --refresh-config <HA_CONF_DIR>
    <volname>
    ```

    where,

    HA_CONF_DIR: The directory path containing the ganesha-ha.conf file. By default it is located at **`/etc/ganesha`**.

    volname: The name of the volume whose export configuration has to be changed.

    For example:

    ```
    # /usr/libexec/ganesha/ganesha-ha.sh --refresh-config  /etc/ganesha
    testvol
    ```

    **Note**

    The export ID must not be changed.

#### 7.2.3.5. Accessing NFS-Ganesha Exports

NFS-Ganesha exports can be accessed by mounting them in either NFSv3 or NFSv4 mode.

> **Note**
>
> Ensure that NFS clients and NFS-Ganesha servers in the cluster are DNS resolvable with unique host-names to use file locking through Network Lock Manager (NLM) protocol.

### Mounting exports in NFSv3 mode

To mount an export in NFSv3 mode, execute the following command:

```
# mount -t nfs -o vers=3 virtual_ip:/volname /mountpoint
```

For example:

```
mount -t nfs -o vers=3 10.70.0.0:/testvol /mnt
```

### Mounting exports in NFSv4 mode

To mount an export in NFSv4 mode, execute the following command:

```
# mount -t nfs -o vers=4 virtual_ip:/volname /mountpoint
```

For example:

```
mount -t nfs -o vers=4 10.70.0.0:/testvol /mnt
```

## 7.2.3.6. NFS-Ganesha Service Downtime

In a highly available active-active environment, if a NFS-Ganesha server that is connected to a NFS client running a particular application goes down, the application/NFS client is seamlessly connected to another NFS-Ganesha server without any administrative intervention. However, there is a delay or fail-over time in connecting to another NFS-Ganesha server. This delay can be experienced during fail-back too, that is, when the connection is reset to the original node/server.

The following list describes how the time taken for the NFS server to detect a server reboot or resume is calculated.

- By default the maximum time taken to detect if the nfs-ganesha service is down is approximately (a) 10 - 15 seconds.

  > **Note**
  >
  > This interval can be edited using the following command on all the nodes:
  >
  > ```
  > # pcs resource op remove nfs-mon monitor
  > # pcs resource op add nfs-mon monitor interval=
  > <interval_period_value> timeout=<timeout_value>
  > ```

- The time taken to put entire cluster to grace and then move the virtual IP (VIP) is (b) 7 seconds.

- So the maximum total time taken to failover the VIP is (c=a+b) approximately 17 - 22 seconds. In other words, the time taken for NFS clients to detect server reboot or resume I/O is 17 - 22 seconds.

#### 7.2.3.6.1. Modifying the Fail-over Time

Since NFS servers will be in the grace period post failover, as defined by NFS RFC, clients will try to reclaim their lost OPEN/LOCK state. For more information refer to Server Failure and Recovery Servers will block the conflicting FOPs during that period. The list of such FOPs is as below:

**Table 7.5.**

| Protocols | FOPs |
| --- | --- |
| NFSV3 | SETATTR |
| NLM | LOCK<br>UNLOCK<br>SHARE<br>UNSHARE<br>CANCEL<br>LOCKT |
| NFSV4 | LOCK<br>LOCKT<br>OPEN<br>REMOVE<br>RENAME<br>SETATTR |

**Note**

LOCK, SHARE, and UNSHARE will be blocked only if it is requested with reclaim set to FALSE.

OPEN will be blocked if requested with claim type other than CLAIM_PREVIOUS or CLAIM_DELEGATE_PREV.

The default value for the grace period is 90 seconds. This value can be changed by adding the following lines in the **/etc/ganesha/ganesha.conf** file.

```
NFSv4 {
Grace_Period=<grace_period_value_in_sec>;
}
```

After editing the **/etc/ganesha/ganesha.conf** file, restart the NFS-Ganesha service using the following command on all the nodes :

#### On Red Hat Enterprise Linux 6

```
# service nfs-ganesha restart
```

#### On Red Hat Enterprise Linux 7

```
# systemctl restart nfs-ganesha
```

### 7.2.3.7. Configuring Kerberized NFS-Ganesha

Execute the following steps on all the machines:

1. Install the krb5-workstation and the ntpdate packages on all the machines:

   ```
   # yum install krb5-workstation
   # yum install ntpdate
   ```

   **Note**

   - The krb5-libs package will be updated as a dependent package.

2. Configure the ntpdate based on the valid time server according to the environment:

   ```
   # echo <valid_time_server> >> /etc/ntp/step-tickers

   # systemctl enable ntpdate

   # systemctl start ntpdate
   ```

3. Ensure that all systems can resolve each other by FQDN in DNS.

4. Configure the **/etc/krb5.conf** file and add relevant changes accordingly. For example:

   ```
           [logging]
            default = FILE:/var/log/krb5libs.log
            kdc = FILE:/var/log/krb5kdc.log
             admin_server = FILE:/var/log/kadmind.log

           [libdefaults]
            dns_lookup_realm = false
            ticket_lifetime = 24h
            renew_lifetime = 7d
             forwardable = true
             rdns = false
            default_realm = EXAMPLE.COM
            default_ccache_name = KEYRING:persistent:%{uid}

           [realms]
            EXAMPLE.COM = {
             kdc = kerberos.example.com
               admin_server = kerberos.example.com
           }

           [domain_realm]
             .example.com = EXAMPLE.COM
              example.com = EXAMPLE.COM
   ```

5. On the NFS-server and client, update the /etc/idmapd.conf file by making the required change. For example:

```
Domain = example.com
```

#### 7.2.3.7.1. Setting up the NFS-Ganesha Server:

Execute the following steps to set up the NFS-Ganesha server:

**Note**

Before setting up the NFS-Ganesha server, make sure to set up the KDC based on the requirements.

1. Install the following packages:

```
# yum install nfs-utils
# yum install rpcbind
```

2. Install the relevant gluster and NFS-Ganesha rpms. For more information see, *Red Hat Gluster Storage 3.1.2 Installation Guide*.

3. Create a Kerberos principle and add it to krb5.keytab on the NFS-Ganesha server

```
$ kadmin
$ kadmin: addprinc -randkey nfs/<host_name>@EXAMPLE.COM
$ kadmin: ktadd nfs/<host_name>@EXAMPLE.COM
```

For example:

```
# kadmin
Authenticating as principal root/admin@EXAMPLE.COM with password.
Password for root/admin@EXAMPLE.COM:

kadmin:  addprinc -randkey nfs/<host_name>@EXAMPLE.COM
WARNING: no policy specified for nfs/<host_name>@EXAMPLE.COM;
defaulting to no policy
Principal "nfs/<host_name>@EXAMPLE.COM" created.


kadmin:  ktadd nfs/<host_name>@EXAMPLE.COM
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno2, encryption
type aes256-cts-hmac-sha1-96 added to keytab FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
encryption type aes128-cts-hmac-sha1-96 added to keytab
FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
encryption type des3-cbc-sha1 added to keytab FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
encryption type arcfour-hmac added to keytab FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
encryption type camellia256-cts-cmac added to keytab
FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
```

```
encryption type camellia128-cts-cmac added to keytab
FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
encryption type des-hmac-sha1 added to keytab FILE:/etc/krb5.keytab.
Entry for principal nfs/<host_name>@EXAMPLE.COM with kvno 2,
encryption type des-cbc-md5 added to keytab FILE:/etc/krb5.keytab.
```

4. Update **`/etc/ganesha/ganesha.conf`** file as mentioned below:

```
NFS_KRB5
{
        PrincipalName = nfs ;
        KeytabPath = /etc/krb5.keytab ;
        Active_krb5 = true ;

        DomainName = example.com;
}
```

5. Based on the different kerberos security flavours (krb5, krb5i and krb5p) supported by nfs-ganesha, configure the 'SecType' parameter in the volume export file (/etc/ganesha/exports/export.vol.conf) with appropriate security flavour

6. Create an unprivileged user and ensure that the users that are created are resolvable to the UIDs through the central user database. For example:

```
useradd guest
```

> **Note**
>
> The username of this user has to be the same as the one on the NFS-client.

#### 7.2.3.7.2. Setting up the NFS Client

Execute the following steps to set up the NFS client:

> **Note**
>
> For a detailed information on setting up NFS-clients for security on Red Hat Enterprise Linux, see *Section 8.8.2* NFS Security, in the *Red Hat Enterprise Linux 7 Storage Administration Guide*.

1. Install the following packages:

```
# yum install nfs-utils
# yum install rpcbind
```

2. Create a kerberos principle and add it to krb5.keytab on the client side. For example:

```
# kadmin
# kadmin: addprinc -randkey host/<host_name>@EXAMPLE.COM
# kadmin: ktadd host/<host_name>@EXAMPLE.COM
```

```
# kadmin
Authenticating as principal root/admin@EXAMPLE.COM with password.
Password for root/admin@EXAMPLE.COM:

kadmin:  addprinc -randkey host/<host_name>@EXAMPLE.COM
WARNING: no policy specified for host/<host_name>@EXAMPLE.COM;
defaulting to no policy
Principal "host/<host_name>@EXAMPLE.COM" created.

kadmin:  ktadd host/<host_name>@EXAMPLE.COM
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type aes256-cts-hmac-sha1-96 added to keytab
FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type aes128-cts-hmac-sha1-96 added to keytab
FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type des3-cbc-sha1 added to keytab FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type arcfour-hmac added to keytab FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type camellia256-cts-cmac added to keytab
FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type camellia128-cts-cmac added to keytab
FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type des-hmac-sha1 added to keytab FILE:/etc/krb5.keytab.
Entry for principal host/<host_name>@EXAMPLE.COM with kvno 2,
encryption type des-cbc-md5 added to keytab FILE:/etc/krb5.keytab.
```

3. Check the status of nfs-client.target service and start it, if not already started:

```
# systemctl status nfs-client.target
# systemctl start nfs-client.target
# systemctl enable nfs-client.target
```

4. Create an unprivileged user and ensure that the users that are created are resolvable to the UIDs through the central user database. For example:

```
# useradd guest
```

**Note**

The username of this user has to be the same as the one on the NFS-server.

5. Mount the volume specifying kerberos security type:

```
# mount -t nfs -o sec=krb5 <host_name>:/testvolume /mnt
```

As root, all access should be granted.

For example:

Creation of a directory on the mount point and all other operations as root should be successful.

```
# mkdir <directory name>
```

6. Login as a guest user:

```
# su - guest
```

Without a kerberos ticket, all access to /mnt should be denied. For example:

```
# su guest
# ls
ls: cannot open directory .: Permission denied
```

7. Get the kerberos ticket for the guest and access /mnt:

```
# kinit
Password for guest@EXAMPLE.COM:

# ls
<directory created>
```

> **Important**
>
> With this ticket, some access must be allowed to /mnt. If there are directories on the NFS-server where "guest" does not have access to, it should work correctly.

### 7.2.3.8. pNFS

> **Important**
>
> pNFS is a technology preview feature. Technology preview features are not fully supported under Red Hat subscription level agreements (SLAs), may not be functionally complete, and are not intended for production use. However, these features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process. As Red Hat considers making future iterations of technology preview features generally available, we will provide commercially reasonable support to resolve any reported issues that customers experience when using these features.

The Parallel Network File System (pNFS) is part of the NFS v4.1 protocol that allows compute clients to access storage devices directly and in parallel. The pNFS cluster consists of Meta-Data-Server (MDS) and Data-Server (DS). The client sends all the read/write requests directly to DS and all the other operations are handled by the MDS.

Current architecture supports only single MDS and mulitple data servers. The server with which client mounts will act as MDS and all severs including MDS can act as DS

#### 7.2.3.8.1. Prerequisites

- Disable kernel-NFS, glusterFS-NFS servers on the system using the following commands:

```
# service nfs stop
# gluster volume set <volname> nfs.disable ON
```

- Disable nfs-ganesha and tear down HA cluster via gluster CLI (only if nfs-ganesha HA cluster is already created) by executing the following command:

```
# gluster features.ganesha disable
```

- Turn on feature.cache-invalidation for the volume, by executing the following command:

```
# gluster volume set <volname> features.cache-invalidation on
```

#### 7.2.3.8.2. Configuring NFS-Ganesha for pNFS

Ensure you make the following configurations to NFS-Ganesha:

- Configure the MDS by adding following block to the ganesha.conf file located at **`/etc/ganesha`**:

```
GLUSTER
{
 PNFS_MDS = true;
}
```

- For optimal working of pNFS, NFS-Ganesha servers should run on every node in the trusted pool using the following command:

  On RHEL 6

```
# service nfs-ganesha start
```

  On RHEL 7

```
# systemctl start nfs-ganesha
```

- Verify if the volume is exported via NFS-Ganesha on all the nodes by executing the following command:

```
# showmount -e localhost
```

##### 7.2.3.8.2.1. Mounting Volume using pNFS

Mount the volume using NFS-Ganesha MDS server in the trusted pool using the following command.

```
# mount -t nfs4 -o minorversion=1 <IP-or-hostname-of-MDS-server>:/<volname>
/mount-point
```

### 7.2.3.9. Manually Configuring NFS-Ganesha Exports

It is recommended to use gluster CLI options to export or unexport volumes through NFS-Ganesha. However, this section provides some information on changing configurable parameters in NFS-Ganesha. Such parameter changes require NFS-Ganesha to be started manually.

To modify the default export configurations perform the following steps on any of the nodes in the existing ganesha cluster:

1. Edit/add the required fields in the corresponding export file located at /etc/ganesha/exports/.

2. Execute the following command

```
# /usr/libexec/ganesha/ganesha-ha.sh --refresh-config <HA_CONF_DIR>
<volname>
```

where:

- HA_CONF_DIR: The directory path containing the ganesha-ha.conf file. By default it is located at **`/etc/ganesha`**.

- volname: The name of the volume whose export configuration has to be changed.

**Sample export configuration file:**

The following are the default set of parameters required to export any entry. The values given here are the default values used by the CLI options to start or stop NFS-Ganesha.

```
# cat export.conf

EXPORT{
    Export_Id = 1 ;   # Export ID unique to each export
    Path = "volume_path";  # Path of the volume to be exported. Eg:
"/test_volume"

    FSAL {
        name = GLUSTER;
        hostname = "10.xx.xx.xx";  # IP of one of the nodes in the trusted
pool
        volume = "volume_name";     # Volume name. Eg: "test_volume"
    }

    Access_type = RW;     # Access permissions
    Squash = No_root_squash; # To enable/disable root squashing
    Disable_ACL = TRUE;     # To enable/disable ACL
    Pseudo = "pseudo_path";     # NFSv4 pseudo path for this export. Eg:
"/test_volume_pseudo"
    Protocols = "3”, “4" ;     # NFS protocols supported
    Transports = "UDP”, “TCP" ; # Transport protocols supported
    SecType = "sys";     # Security flavors supported
}
```

The following section describes various configurations possible via NFS-Ganesha. Minor changes have to be made to the **`export.conf`** file to see the expected behavior.

- Exporting Subdirectories

- Providing Permissions for Specific Clients

- Enabling and Disabling NFSv4 ACLs

- Providing Pseudo Path for NFSv4 Mount

- Providing pNFS support

### Exporting Subdirectories

To export subdirectories within a volume, edit the following parameters in the **export.conf** file.

```
Path = "path_to_subdirectory";  # Path of the volume to be exported. Eg:
"/test_volume/test_subdir"

 FSAL {
  name = GLUSTER;
  hostname = "10.xx.xx.xx";  # IP of one of the nodes in the trusted pool
  volume = "volume_name";  # Volume name. Eg: "test_volume"
  volpath = "path_to_subdirectory_with_respect_to_volume"; #Subdirectory
path from the root of the volume. Eg: "/test_subdir"
 }
```

### Providing Permissions for Specific Clients

The parameter values and permission values given in the **EXPORT** block applies to any client that mounts the exported volume. To provide specific permissions to specific clients , introduce a **client** block inside the **EXPORT** block.

For example, to assign specific permissions for client 10.00.00.01, add the following block in the **EXPORT** block.

```
client {
        clients = 10.00.00.01;  # IP of the client.
        allow_root_access = true;
        access_type = "RO"; # Read-only permissions
        Protocols = "3"; # Allow only NFSv3 protocol.
        anonymous_uid = 1440;
        anonymous_gid = 72;
  }
```

All the other clients inherit the permissions that are declared outside the **client** block.

### Enabling and Disabling NFSv4 ACLs

To enable NFSv4 ACLs , edit the following parameter:

```
Disable_ACL = FALSE;
```

### Providing Pseudo Path for NFSv4 Mount

To set NFSv4 pseudo path , edit the below parameter:

```
Pseudo = "pseudo_path"; # NFSv4 pseudo path for this export. Eg:
"/test_volume_pseudo"
```

This path has to be used while mounting the export entry in NFSv4 mode.

## 7.2.3.10. Troubleshooting

### Mandatory checks

Ensure you execute the following commands for all the issues/failures that is encountered:

- Make sure all the prerequisites are met.
- Execute the following commands to check the status of the services:

```
# service nfs-ganesha status
# service pcsd status
# service pacemaker status
# pcs status
```

- Review the followings logs to understand the cause of failure.

```
/var/log/ganesha.log
/var/log/ganesha-gfapi.log
/var/log/messages
/var/log/pcsd.log
```

- **Situation**

  NFS-Ganesha fails to start.

  **Solution**

  Ensure you execute all the mandatory checks to understand the root cause before proceeding with the following steps. Follow the listed steps to fix the issue:

  - Ensure the kernel and gluster nfs services are inactive.
  - Ensure that the port 4501 is free to connect to the RQUOTA service.

  For more information see, section *Manually Configuring NFS-Ganesha Exports.*

- **Situation**

  NFS-Ganesha Cluster setup fails.

  **Solution**

  Ensure you execute all the mandatory checks to understand the root cause before proceeding with the following steps.

  - Ensure the kernel and gluster nfs services are inactive.
  - Ensure that **`pcs cluster auth`** command is executed on all the nodes with same password for the user **`hacluster`**
  - Ensure that shared volume storage is mounted on all the nodes.
  - Ensure that the name of the HA Cluster does not exceed 15 characters.
  - Ensure UDP multicast packets are pingable using **`OMPING`**.
  - Ensure that Virtual IPs are not assigned to any NIC.
  - For further trouble shooting guidelines related to clustering, refer to https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/7/

- **Situation**

  NFS-Ganesha has started and fails to export a volume.

  **Solution**

  Ensure you execute all the mandatory checks to understand the root cause before proceeding with the following steps. Follow the listed steps to fix the issue:

  - Ensure that volume is in **`Started`** state using the following command:

    ```
    # gluster volume status <volname>
    ```

  - Execute the following commands to check the status of the services:

    ```
    # service nfs-ganesha status
    # showmount -e localhost
    ```

  - Review the followings logs to understand the cause of failure.

    ```
    /var/log/ganesha.log
    /var/log/ganesha-gfapi.log
    /var/log/messages
    ```

  - Ensure that dbus service is running using the following command

    ```
    # service messagebus status
    ```

- **Situation**

  Adding a new node to the HA cluster fails.

  **Solution**

  Ensure you execute all the mandatory checks to understand the root cause before proceeding with the following steps. Follow the listed steps to fix the issue:

  - Ensure to run the following command from one of the nodes that is already part of the cluster:

    ```
    # ganesha-ha.sh --add <HA_CONF_DIR>  <NODE-HOSTNAME>  <NODE-VIP>
    ```

  - Ensure that gluster_shared_storage volume is mounted on the node that needs to be added.

  - Make sure that all the nodes of the cluster is DNS resolvable from the node that needs to be added.

  - Execute the following command for each of the hosts in the HA cluster on the node that needs to be added:

    ```
    # pcs cluster auth <hostname>
    ```

- **Situation**

  Permission issues.

### Solution

By default, the **`root squash`** option is disabled when you start NFS-Ganesha using the CLI. In case, you encounter any permission issues, check the unix permissions of the exported entry.

## 7.3. SMB

The Server Message Block (SMB) protocol can be used to access Red Hat Gluster Storage volumes by exporting directories in GlusterFS volumes as SMB shares on the server.

This section describes how to enable SMB shares, how to mount SMB shares on Microsoft Windows-based clients (both manually and automatically) and how to verify if the share has been mounted successfully.

**Note**

SMB access using the Mac OS X Finder is not supported.

The Mac OS X command line can be used to access Red Hat Gluster Storage volumes using SMB.

In Red Hat Gluster Storage, Samba is used to share volumes through SMB protocol.

**Warning**

- The Samba version 3 is being deprecated from Red Hat Gluster Storage 3.0 Update 4 release. Further updates will not be provided for samba-3.x. You must upgrade the system to Samba-4.x, which is provided in a separate channel or repository, for all updates including the security updates. For more information regarding the installation and upgrade steps refer the *Red Hat Gluster Storage 3.1 Installation Guide*.
- CTDB version 2.5 is not supported from Red Hat Gluster Storage 3.1 Update 2. To use CTDB in Red Hat Gluster Storage 3.1.2 and later, you must upgrade the system to CTDB 4.x, which is provided in the Samba channel of Red Hat Gluster Storage. For more information regarding the installation and upgrade steps refer the *Red Hat Gluster Storage 3.1 Installation Guide*.

**Important**

On Red Hat Enterprise Linux 7, enable the Samba firewall service in the active zones for runtime and permanent mode using the following commands:

To get a list of active zones, run the following command:

```
# firewall-cmd --get-active-zones
```

To allow the firewall services in the active zones, run the following commands

```
# firewall-cmd --zone=zone_name --add-service=samba
# firewall-cmd --zone=zone_name --add-service=samba  --permanent
```

### 7.3.1. Setting up CTDB for Samba

In a replicated volume environment, the CTDB software (Cluster Trivial Database) has to be configured to provide high availability and lock synchronization for Samba shares. CTDB provides high availability by adding virtual IP addresses (VIPs) and a heartbeat service.

When a node in the trusted storage pool fails, CTDB enables a different node to take over the virtual IP addresses that the failed node was hosting. This ensures the IP addresses for the services provided are always available.

**Important**

On Red Hat Enterprise Linux 7, enable the CTDB firewall service in the active zones for runtime and permanent mode using the below commands:

To get a list of active zones, run the following command:

```
# firewall-cmd --get-active-zones
```

To add ports to the active zones, run the following commands:

```
# firewall-cmd --zone=zone_name --add-port=4379/tcp
# firewall-cmd --zone=zone_name --add-port=4379/tcp  --permanent
```

**Note**

Amazon Elastic Compute Cloud (EC2) does not support VIPs and is hence not compatible with this solution.

#### Prerequisites

Follow these steps before configuring CTDB on a Red Hat Gluster Storage Server:

- If you already have an older version of CTDB (version <= ctdb1.x), then remove CTDB by executing the following command:

  ```
  # yum remove ctdb
  ```

  After removing the older version, proceed with installing the latest CTDB.

> **Note**
>
> Ensure that the system is subscribed to the samba channel to get the latest CTDB packages.

- Install CTDB on all the nodes that are used as Samba servers to the latest version using the following command:

  ```
  # yum install ctdb
  ```

- In a CTDB based high availability environment of Samba , the locks will not be migrated on failover.
- You must ensure to open TCP port 4379 between the Red Hat Gluster Storage servers: This is the internode communication port of CTDB.

### Configuring CTDB on Red Hat Gluster Storage Server

To configure CTDB on Red Hat Gluster Storage server, execute the following steps

1. Create a replicate volume. This volume will host only a zero byte lock file, hence choose minimal sized bricks. To create a replicate volume run the following command:

   ```
   # gluster volume create volname replica n ipaddress:/brick
   path.......N times
   ```

   where,

   N: The number of nodes that are used as Samba servers. Each node must host one brick.

   For example:

   ```
   # gluster volume create ctdb replica 4
   10.16.157.75:/rhs/brick1/ctdb/b1 10.16.157.78:/rhs/brick1/ctdb/b2
   10.16.157.81:/rhs/brick1/ctdb/b3 10.16.157.84:/rhs/brick1/ctdb/b4
   ```

2. In the following files, replace "all" in the statement META="all" to the newly created volume name

   ```
   /var/lib/glusterd/hooks/1/start/post/S29CTDBsetup.sh
   /var/lib/glusterd/hooks/1/stop/pre/S29CTDB-teardown.sh
   ```

   For example:

   ```
   META="all"
     to
   META="ctdb"
   ```

3. In the /etc/samba/smb.conf file add the following line in the global section on all the nodes:

```
clustering=yes
```

4. Start the volume.

   The S29CTDBsetup.sh script runs on all Red Hat Gluster Storage servers, adds an entry in **/etc/fstab/** for the mount, and mounts the volume at **/gluster/lock** on all the nodes with Samba server. It also enables automatic start of CTDB service on reboot.

   > **Note**
   >
   > When you stop the special CTDB volume, the S29CTDB-teardown.sh script runs on all Red Hat Gluster Storage servers and removes an entry in **/etc/fstab/** for the mount and unmounts the volume at **/gluster/lock**.

5. Verify if the file **/etc/sysconfig/ctdb** exists on all the nodes that is used as Samba server. This file contains Red Hat Gluster Storage recommended CTDB configurations.

6. Create **/etc/ctdb/nodes** file on all the nodes that is used as Samba servers and add the IPs of these nodes to the file.

   ```
   10.16.157.0
   10.16.157.3
   10.16.157.6
   10.16.157.9
   ```

   The IPs listed here are the private IPs of Samba servers.

7. On all the nodes that are used as Samba server which require IP failover, create /etc/ctdb/public_addresses file and add the virtual IPs that CTDB should create to this file. Add these IP address in the following format:

   ```
   <Virtual IP>/<routing prefix><node interface>
   ```

   For example:

   ```
   192.168.1.20/24 eth0
   192.168.1.21/24 eth0
   ```

8. Start the CTDB service on all the nodes by executing the following command:

   ```
   # service ctdb start
   ```

### 7.3.2. Sharing Volumes over SMB

The following configuration items have to be implemented before using SMB with Red Hat Gluster Storage.

1. Run **gluster volume set *VOLNAME* stat-prefetch off** to disable stat-prefetch for the volume.

2. Run **gluster volume set *VOLNAME* server.allow-insecure on** to permit insecure ports.

> **Note**
>
> This allows Samba to communicate with brick processes even with untrusted ports.

3. Edit the **/etc/glusterfs/glusterd.vol** in each Red Hat Gluster Storage node, and add the following setting:

```
option rpc-auth-allow-insecure on
```

> **Note**
>
> This allows Samba to communicate with glusterd even with untrusted ports.

4. Restart **glusterd** service on each Red Hat Gluster Storage node.

5. Run the following command to verify proper lock and I/O coherency.

```
# gluster volume set VOLNAME storage.batch-fsync-delay-usec 0
```

6. To verify if the volume can be accessed from the SMB/CIFS share, run the following command:

```
# smbclient -L <hostname> -U%
```

For example:

```
# smbclient -L rhs-vm1 -U%
Domain=[MYGROUP] OS=[Unix] Server=[Samba 4.1.17]

     Sharename       Type      Comment
     ---------       ----      -------
     IPC$            IPC       IPC Service (Samba Server Version
4.1.17)
     gluster-vol1    Disk      For samba share of volume vol1
Domain=[MYGROUP] OS=[Unix] Server=[Samba 4.1.17]

     Server               Comment
     ---------            -------

     Workgroup            Master
     ---------            -------
```

7. To verify if the SMB/CIFS share can be accessed by the user, run the following command:

```
#  smbclient //<hostname>/gluster-<volname> -U <username>%<password>
```

For example:

```
# smbclient //10.0.0.1/gluster-vol1 -U root%redhat
Domain=[MYGROUP] OS=[Unix] Server=[Samba 4.1.17]
smb: \> mkdir test
```

```
smb: \> cd test\
smb: \test\> pwd
Current directory is \\10.0.0.1\gluster-vol1\test\
smb: \test\>
```

When a volume is started using the **`gluster volume start`** ***`VOLNAME`*** command, the volume is automatically exported through Samba on all Red Hat Gluster Storage servers running Samba.

To be able to mount from any server in the trusted storage pool, repeat these steps on each Red Hat Gluster Storage node. For more advanced configurations, refer to the Samba documentation.

1. Open the **`/etc/samba/smb.conf`** file in a text editor and add the following lines for a simple configuration:

   ```
   [gluster-VOLNAME]
   comment = For samba share of volume VOLNAME
   vfs objects = glusterfs
   glusterfs:volume = VOLNAME
   glusterfs:logfile = /var/log/samba/VOLNAME.log
   glusterfs:loglevel = 7
   path = /
   read only = no
   guest ok = yes
   ```

   The configuration options are described in the following table:

   **Table 7.6. Configuration Options**

| Configuration Options | Required? | Default Value | Description |
|---|---|---|---|
| Path | Yes | n/a | It represents the path that is relative to the root of the gluster volume that is being shared. Hence **/** represents the root of the gluster volume. Exporting a subdirectory of a volume is supported and /subdir in path exports only that subdirectory of the volume. |
| **`glusterfs:volume`** | Yes | n/a | The volume name that is shared. |

| Configuration Options | Required? | Default Value | Description |
|---|---|---|---|
| **`glusterfs:logfile`** | No | NULL | Path to the log file that will be used by the gluster modules that are loaded by the vfs plugin. Standard Samba variable substitutions as mentioned in **`smb.conf`** are supported. |
| **`glusterfs:loglevel`** | No | 7 | This option is equivalent to the **`client-log-level`** option of gluster. 7 is the default value and corresponds to the INFO level. |
| **`glusterfs:volfile_server`** | No | localhost | The gluster server to be contacted to fetch the volfile for the volume. |

2. Run **`service smb [re]start`** to start or restart the **`smb`** service.

3. Run **`smbpasswd`** to set the SMB password.

```
# smbpasswd -a username
```

Specify the SMB password. This password is used during the SMB mount.

### 7.3.3. Mounting Volumes using SMB

Samba follows the permissions on the shared directory, and uses the logged in username to perform access control.

To allow a non root user to read/write into the mounted volume, ensure you execute the following steps:

1. Add the user on all the Samba servers based on your configuration:

   **`# adduser username`**

2. Add the user to the list of Samba users on all Samba servers and assign password by executing the following command:

   **`# smbpasswd -a username`**

3. Perform a FUSE mount of the gluster volume on any one of the Samba servers:

   **`# mount -t glusterfs -o acl ip-address:/volname /mountpoint`**

   For example:

```
# mount -t glusterfs -o acl rhs-a:/repvol /mnt
```

4. Provide required permissions to the user by executing appropriate **setfacl** command. For example:

   **# setfacl -m user:*username*:rwx *mountpoint***

   For example:

   ```
   # setfacl -m user:cifsuser:rwx /mnt
   ```

### 7.3.3.1. Manually Mounting Volumes Using SMB on Red Hat Enterprise Linux and Windows

- Mounting a Volume Manually using SMB on Red Hat Enterprise Linux
- Mounting a Volume Manually using SMB through Microsoft Windows Explorer
- Mounting a Volume Manually using SMB on Microsoft Windows Command-line.

#### Mounting a Volume Manually using SMB on Red Hat Enterprise Linux

To mount a Red Hat Gluster Storage volume manually using Server Message Block (SMB) on Red Hat Enterprise Linux by executing the following steps:

1. Install the **cifs-utils** package on the client.

   ```
   # yum install cifs-utils
   ```

2. Run **mount -t cifs** to mount the exported SMB share, using the syntax example as guidance.

   ```
   # mount -t cifs -o user=<username>,pass=<password>
   //<hostname>/gluster-<volname> /<mountpoint>
   ```

   For example:

   ```
   # mount -t cifs -o user=cifsuser,pass=redhat //rhs-a/gluster-repvol
   /cifs
   ```

3. Run **# smbstatus -S** on the server to display the status of the volume:

   ```
   Service        pid     machine             Connected at
   -------------------------------------------------------------------
   -
   gluster-VOLNAME 11967   __ffff_192.168.1.60  Mon Aug  6 02:23:25 2012
   ```

#### Mounting a Volume Manually using SMB through Microsoft Windows Explorer

To mount a Red Hat Gluster Storage volume manually using Server Message Block (SMB) on Microsoft Windows using Windows Explorer, follow these steps:

1. In Windows Explorer, click **Tools** → **Map Network Drive…**. to open the **Map Network Drive** screen.
2. Choose the drive letter using the **Drive** drop-down list.
3. In the **Folder** text box, specify the path of the server and the shared resource in the following format: *SERVER_NAME**VOLNAME*.

4. Click **`Finish`** to complete the process, and display the network drive in Windows Explorer.

5. Navigate to the network drive to verify it has mounted correctly.

**Mounting a Volume Manually using SMB on Microsoft Windows Command-line.**

To mount a Red Hat Gluster Storage volume manually using Server Message Block (SMB) on Microsoft Windows using Windows Explorer, follow these steps:

1. Click **Start** → **Run**, and then type **`cmd`**.

2. Enter **`net use z: \\SERVER_NAME\VOLNAME`**, where *z:* is the drive letter to assign to the shared volume.

   For example, **`net use y: \\server1\test-volume`**

3. Navigate to the network drive to verify it has mounted correctly.

### 7.3.3.2. Automatically Mounting Volumes Using SMB on Red Hat Enterprise Linux and Windows

You can configure your system to automatically mount Red Hat Gluster Storage volumes using SMB on Microsoft Windows-based clients each time the system starts.

- Mounting a Volume Automatically using SMB on Red Hat Enterprise Linux
- Mounting a Volume Automatically on Server Start using SMB through Microsoft Windows Explorer

**Mounting a Volume Automatically using SMB on Red Hat Enterprise Linux**

To mount a Red Hat Gluster Storage Volume automatically using SMB at server start execute the following steps:

1. Open the **`/etc/fstab`** file in a text editor.

2. Append the following configuration to the **`fstab`** file.

   You must specify the filename and its path that contains the user name and/or password in the **`credentials`** option in **`/etc/fstab`** file. See the **`mount.cifs`** man page for more information.

   ```
   \\HOSTNAME|IPADDRESS\SHARE_NAME MOUNTDIR
   ```

   Using the example server names, the entry contains the following replaced values.

   ```
   \\server1\test-volume /mnt/glusterfs cifs
   credentials=/etc/samba/passwd,_netdev 0 0
   ```

3. Run **`# smbstatus -S`** on the client to display the status of the volume:

   ```
   Service        pid     machine             Connected at
   -------------------------------------------------------------------
   -
   gluster-VOLNAME 11967   __ffff_192.168.1.60  Mon Aug  6 02:23:25 2012
   ```

**Mounting a Volume Automatically on Server Start using SMB through Microsoft Windows Explorer**

To mount a Red Hat Gluster Storage volume manually using Server Message Block (SMB) on Microsoft Windows using Windows Explorer, follow these steps:

1. In Windows Explorer, click **Tools** → **Map Network Drive…**. to open the **`Map Network Drive`** screen.
2. Choose the drive letter using the **Drive** drop-down list.
3. In the **`Folder`** text box, specify the path of the server and the shared resource in the following format: *SERVER_NAME**VOLNAME*.
4. Click the **`Reconnect at logon`** check box.
5. Click **`Finish`** to complete the process, and display the network drive in Windows Explorer.
6. If the **`Windows Security`** screen pops up, enter the username and password and click **`OK`**.
7. Navigate to the network drive to verify it has mounted correctly.

## 7.3.4. Starting and Verifying your Configuration

Perform the following to start and verify your configuration:

### Verify the Configuration

Verify the virtual IP (VIP) addresses of a shut down server are carried over to another server in the replicated volume.

1. Verify that CTDB is running using the following commands:

```
# ctdb status
# ctdb ip
# ctdb ping -n all
```

2. Mount a Red Hat Gluster Storage volume using any one of the VIPs.
3. Run **`# ctdb ip`** to locate the physical server serving the VIP.
4. Shut down the CTDB VIP server to verify successful configuration.

   When the Red Hat Gluster Storage server serving the VIP is shut down there will be a pause for a few seconds, then I/O will resume.

## 7.3.5. Disabling SMB Shares

### To stop automatic sharing on all nodes for all volumes execute the following steps:

1. On all Red Hat Gluster Storage Servers, with elevated privileges, navigate to /var/lib/glusterd/hooks/1/start/post
2. Rename the S30samba-start.sh to K30samba-start.sh.

   For more information about these scripts, see Section 16.2, “Prepackaged Scripts”.

### To stop automatic sharing on all nodes for one particular volume:

1. Run the following command to disable automatic SMB sharing per-volume:

```
# gluster volume set <VOLNAME> user.smb disable
```

## 7.4. POSIX Access Control Lists

POSIX Access Control Lists (ACLs) allow different permissions for different users or groups to be assigned to files or directories, independent of the original owner or the owning group.

For example, the user **John** creates a file. He does not allow anyone in the group to access the file, except fo another user, Antony (even if there are other users who belong to the group **john**).

This means, in addition to the file owner, the file group, and others, additional users and groups can be granted or denied access by using POSIX ACLs.

### 7.4.1. Setting POSIX ACLs

Two types of POSIX ACLs are available: access ACLs, and default ACLs.

Use access ACLs to grant permission to a specific file or directory.

Use default ACLs to set permissions at the directory level for all files in the directory. If a file inside that directory does not have an ACL, it inherits the permissions of the default ACLs of the directory.

ACLs can be configured for each file:

- Per user
- Per group
- Through the effective rights mask
- For users not in the user group for the file

#### 7.4.1.1. Setting Access ACLs

Access ACLs grant permission for both files and directories.

The **# setfacl –m *entry_typefile_name*** command sets and modifies access ACLs

**setfacl*entry_type* Options**

The ACL *entry_type* translates to the POSIX ACL representations of owner, group, and other.

Permissions must be a combination of the characters **r** (read), **w** (write), and **x** (execute). Specify the ACL *entry_type* as described below, separating multiple entry types with commas.

**u:*user_name*:*permissons***

Sets the access ACLs for a user. Specify the user name, or the UID.

**g:*group_name*:*permissions***

Sets the access ACLs for a group. Specify the group name, or the GID.

**m:*permission***

Sets the effective rights mask. The mask is the combination of all access permissions of the owning group, and all user and group entries.

**o:*permissions***

Sets the access ACLs for users other than the ones in the group for the file.

If a file or directory already has a POSIX ACL, and the **`setfacl`** command is used, the additional permissions are added to the existing POSIX ACLs or the existing rule is modified.

For example, to give read and write permissions to user antony:

```
# setfacl -m u:antony:rw /mnt/gluster/data/testfile
```

### 7.4.1.2. Setting Default ACLs

New files and directories inherit ACL information from their parent directory, if that parent has an ACL that contains default entries. Default ACL entries can only be set on directories.

The `#` **`setfacl -d --set`** ***`entry_type directory`*** command sets default ACLs for files and directories.

#### `setfacl`*entry_type* Options

The ACL *entry_type* translates to the POSIX ACL representations of owner, group, and other.

Permissions must be a combination of the characters **`r`** (read), **`w`** (write), and **`x`** (execute). Specify the ACL *entry_type* as described below, separating multiple entry types with commas.

**u:*user_name*:*permissons***

Sets the access ACLs for a user. Specify the user name, or the UID.

**g:*group_name*:*permissions***

Sets the access ACLs for a group. Specify the group name, or the GID.

**m:*permission***

Sets the effective rights mask. The mask is the combination of all access permissions of the owning group, and all user and group entries.

**o:*permissions***

Sets the access ACLs for users other than the ones in the group for the file.

For example, run `#` **`setfacl -d --set o::r /mnt/gluster/data`** to set the default ACLs for the **`/data`** directory to read-only for users not in the user group,

> **Note**
>
> An access ACL set for an individual file can override the default ACL permissions.

#### Effects of a Default ACL

The following are the ways in which the permissions of a directory's default ACLs are passed to the files and subdirectories in it:

- A subdirectory inherits the default ACLs of the parent directory both as its default ACLs and as an access ACLs.
- A file inherits the default ACLs as its access ACLs.

### 7.4.2. Retrieving POSIX ACLs

Run the **# getfacl** command to view the existing POSIX ACLs for a file or directory.

**# getfacl *path/filename***

View the existing access ACLs of the **sample.jpg** file using the following command.

```
# getfacl /mnt/gluster/data/test/sample.jpg
# owner: antony
# group: antony
user::rw-
group::rw-
other::r--
```

**# getfacl *directory name***

View the default ACLs of the **/doc** directory using the following command.

```
# getfacl /mnt/gluster/data/doc
# owner: antony
# group: antony
user::rw-
user:john:r--
group::r--
mask::r--
other::r--
default:user::rwx
default:user:antony:rwx
default:group::r-x
default:mask::rwx
default:other::r-x
```

### 7.4.3. Removing POSIX ACLs

Run **# setfacl -x *ACL entry_type file*** to remove all permissions for a user, groups, or others.

#### **setfacl*entry_type* Options**

The ACL *entry_type* translates to the POSIX ACL representations of owner, group, and other.

Permissions must be a combination of the characters **r** (read), **w** (write), and **x** (execute). Specify the ACL *entry_type* as described below, separating multiple entry types with commas.

**u:*user_name***

Sets the access ACLs for a user. Specify the user name, or the UID.

**g:*group_name***

Sets the access ACLs for a group. Specify the group name, or the GID.

**m:*permission***

Sets the effective rights mask. The mask is the combination of all access permissions of the owning group, and all user and group entries.

**o:*permissions***

Sets the access ACLs for users other than the ones in the group for the file.

For example, to remove all permissions from the user **antony**:

```
# setfacl -x u:antony /mnt/gluster/data/test-file
```

## 7.4.4. Samba and ACLs

POSIX ACLs are enabled by default when using Samba to access a Red Hat Gluster Storage volume. Samba is compiled with the **--with-acl-support** option, so no special flags are required when accessing or mounting a Samba share.

# Chapter 8. Integrating Red Hat Gluster Storage with Windows Active Directory

In this chapter, the tasks necessary for integrating Red Hat Gluster Storage nodes into an existing Windows Active Directory domain are described. The following diagram describes the architecture of integrating Red Hat Gluster Storage with Windows Active Directory.

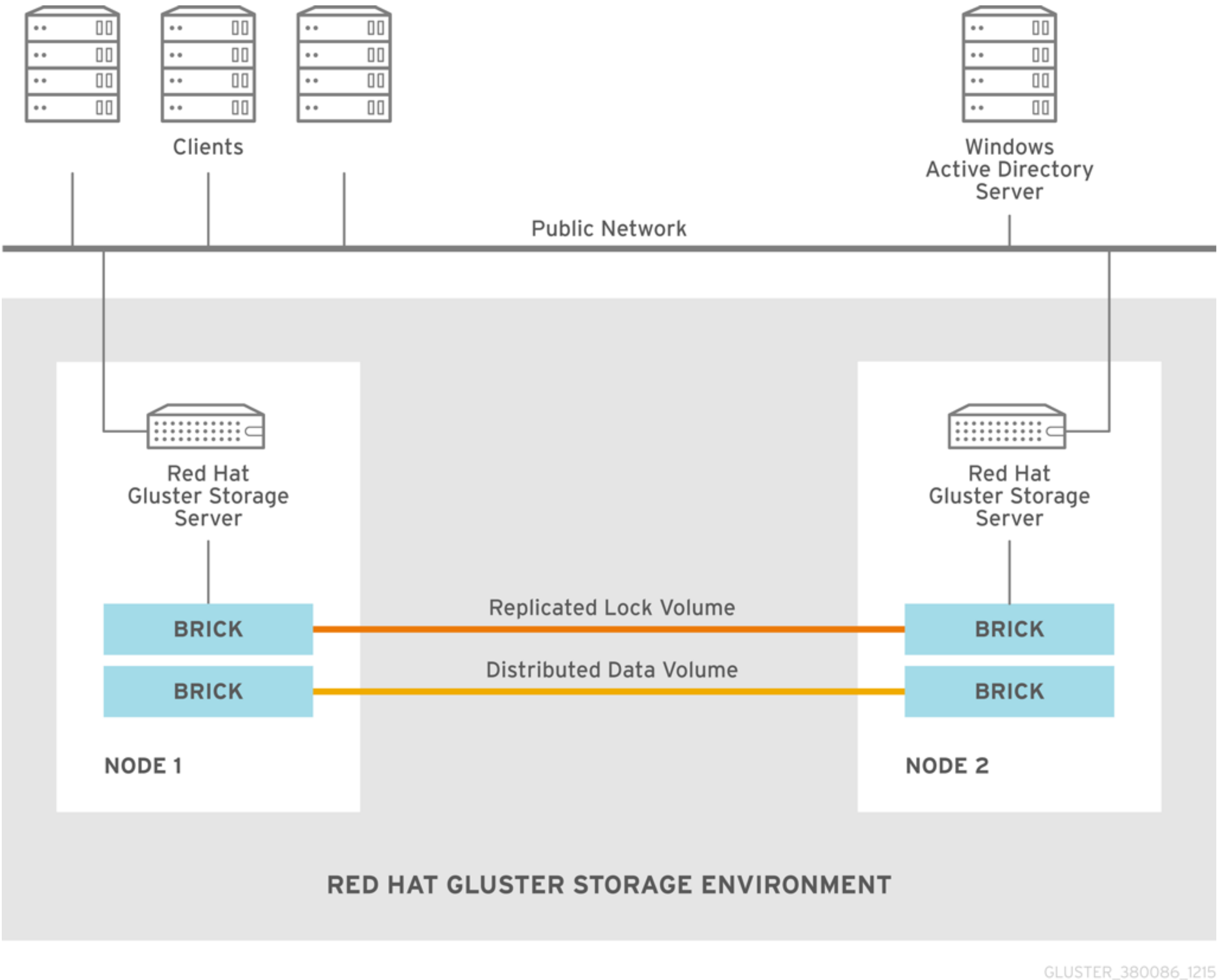



**Figure 8.1. Active Directory Integration**

This section assumes that you have an active directory domain installed. Before we go ahead with the configuration details, following is a list of data along with examples that will be used in the sections ahead.

**Table 8.1.**

| Information | Example Value |
|---|---|
| DNS domain name / realm | addom.example.com |
| NetBIOS domain name | ADDOM |
| Name of administrative account | administrator |
| RHGS nodes | rhs-srv1.addom.example.com, 192.168.56.10 rhs-srv2.addom.example.com, 192.168.56.11 rhs-srv3.addom.example.com, 192.168.56.12 |
| Netbios name of the cluster | RHS-SMB |

## 8.1. Prerequisites

Before integration, the following steps have to be completed on an existing Red Hat Gluster Storage environment:

- **Name Resolution**

  The Red Hat Gluster Storage nodes must be able to resolve names from the AD domain via DNS. To verify the same you can use the following command:

  ```
  host dc1.addom.example.com
  ```

  where, **`addom.example.com`** is the AD domain and dc1 is the name of a domain controller.

  For example, the **`/etc/resolv.conf`** file in a static network configuration could look like this:

  ```
  domain addom.example.com
  search addom.example.com
  nameserver 10.11.12.1 # dc1.addom.example.com
  nameserver 10.11.12.2 # dc2.addom.example.com
  ```

  This example assumes that both the domain controllers are also the DNS servers of the domain.

- **Kerberos Packages**

  If you want to use the kerberos client utilities, like kinit and klist, then manually install the krb5-workstation using the following command:

  ```
  # yum -y install krb5-workstation
  ```

- **Synchronize Time Service**

  It is essential that the time service on each Red Hat Gluster Storage node and the Windows Active Directory server are synchronized, else the Kerberos authentication may fail due to clock skew. In environments where time services are not reliable, the best practice is to configure the Red Hat Gluster Storage nodes to synchronize time from the Windows Server.

  On each Red Hat Storage node, edit the file /etc/ntp.conf so the time is synchronized from a known, reliable time service:

  ```
  # Enable writing of statistics records.
  #statistics clockstats cryptostats loopstats peerstats
  server ntp1.addom.example.com
  server 10.11.12.3
  ```

  Activate the change on each Red Hat Gluster Storage node by stopping the ntp daemon, updating the time, then starting the ntp daemon. Verify the change on both servers using the following commands:

  ```
  # service ntpd stop

  # service ntpd start
  ```

- **Samba Packages**

Ensure to install the following Samba packages along with its dependencies:

- CTDB
- samba
- samba-client
- samba-winbind
- samba-winbind-modules

## 8.2. Integration

Integrating Red Hat Gluster Storage Servers into an Active Directory domain involves the following series of steps:

1. Configure Authentication
2. Join Active Directory Domain
3. Verify/Test Active Directory and Services

### 8.2.1. Configure Authentication

In order to join a cluster to the Active Directory domain, a couple of files have to be edited manually on all nodes.

**Note**

- Ensure that CTDB is configured before the active directory join. For more information see, *Section 7.3.1 Setting up CTDB for Samba* in the *Red Hat Gluster Storage Administration Guide*.
- It is recommended to take backups of the configuration and of Samba's databases (local and ctdb) before making any changes.

#### 8.2.1.1. Basic Samba Configuration

The Samba configuration file **/etc/samba/smb.conf** has to contain the relevant parameters for AD. Along with that, a few other settings are required in order to activate mapping of user and group IDs.

The following example depicts the minimal Samba configuration for AD integration:

```
[global]
netbios name = RHS-SMB
workgroup = ADDOM
realm = addom.example.com
security = ads
clustering = yes
idmap config * : range = 1000000-1999999
idmap config * : backend = tdb

# -----------------RHS Options -------------------------
#
```

```
# The following line includes RHS-specific configuration options. Be careful
with this line.

       include = /etc/samba/rhs-samba.conf

#=================Share Definitions =====================
```

**Warning**

Make sure to edit the smb.conf file such that the above is the complete global section in order to prevent gluster mechanisms from changing the above settings when starting or stopping the ctdb lock volume.

The **`netbios name`** consists of only one name which has to be the same name on all cluster nodes. Windows clients will only access the cluster via that name (either in this short form or as an FQDN). The individual node hostname (rhs-srv1, rhs-srv2, …) must not be used for the **`netbios name`** parameter.

**Note**

- The idmap range is an example. This range should be chosen big enough to cover all objects that can possibly be mapped.
- If you want to be able to use the individual host names to also access specific nodes, you can add them to the **`netbios aliases`** parameter of **`smb.conf`**.
- In an AD environment, it is usually not required to run **nmbd**. However, if you have to run **nmbd**, then make sure to set the **`cluster addresses smb.conf`** option to the list of public IP addresses of the cluster.

#### 8.2.1.2. Additional Configuration (Optional)

It is also possible to further adapt Samba configuration to meet special needs or to specific properties of the AD environment. For example, the ID mapping scheme can be changed. Samba offers many methods for doing id-mapping. One popular way to set up ID mapping in an active directory environment is to use the **`idmap_ad`** module which reads the unix IDs from the AD's special unix attributes. This has to be configured by the AD domain's administrator before it can be used by Samba and winbind.

In order for Samba to use **`idmap_ad`**, the AD domain admin has to prepare the AD domain for using the so called unix extensions and assign unix IDs to all users and groups that should be able to access the Samba server.

Other possible idmap backends are **`rid`** and **`autorid`** and the default **`tdb`**. The **`smb.conf`** manpage and the manpages for the various idmap modules contain all the details.

For example, following is an extended Samba configuration file to use the **`idmap_ad`** back-end for the ADDOM domain.

```
[global]
netbios name = RHS-SMB
workgroup = ADDOM
realm = addom.example.com
```

```
security = ads
clustering = yes
idmap config * : backend = tdb
idmap config * : range = 1000000-1999999
idmap config ADDOM : backend = ad
idmap config ADDOM : range = 3000000-3999999
idmap config addom : schema mode = rfc2307
winbind nss info = rfc2307

# -------------------RHS Options -------------------------------
#
# The following line includes RHS-specific configuration options. Be careful
with this line.

       include = /etc/samba/rhs-samba.conf

#===================Share Definitions =========================
```

**Note**

- The range for the idmap_ad configuration is prescribed by the AD configuration. This has to be obtained by AD administrator.
- Ranges for different idmap configurations must not overlap.
- The schema mode and the winbind nss info setting should have the same value. If the domain is at level 2003R2 or newer, then rfc2307 is the correct value. For older domains, additional values sfu and sfu20 are available. See the manual pages of idmap_ad and smb.conf for further details.

The following table lists some of the other Samba options:

**Table 8.2. Samba Options**

| Parameter | Description |
|---|---|
| winbind enum users = no | Disable enumeration of users at the nsswitch level. |
| winbind enum groups = no | Disable enumeration of groups at the nsswitch level. |
| winbind separator = + | Change default separator from '\' to '+' |
| winbind nested groups = yes | Enable nesting of groups in Active Directory |

### 8.2.1.3. Verifying the Samba Configuration

Test the new configuration file using the testparm command. For example:

```
# testparm -s
Load smb config files from /etc/samba/smb.conf
rlimit_max: increasing rlimit_max (1024) to minimum Windows limit (16384)
Loaded services file OK.

Server role: ROLE_DOMAIN_MEMBER

# Global parameters
[global]
    workgroup = ADDOM
```

```
     realm = addom.example.com
     netbios name = RHS-SMB
     security = ADS
     clustering = Yes
     winbind nss info = rfc2307
     idmap config addom : schema mode = rfc2307
     idmap config addom : range = 3000000-3999999
     idmap config addom : backend = ad
     idmap config * : range = 1000000-1999999
     idmap config * : backend = tdb
```

#### 8.2.1.4. nsswitch Configuration

Once the Samba configuration has been made, Samba has to be enabled to use the mapped users and groups from AD. This is achieved via the local Name Service Switch (NSS) that has to be made aware of the winbind. To use the winbind NSS module, edit the **`/etc/nsswitch.conf`** file. Make sure the file contains the winbind entries for the **`passwd`** and **`group`** databases. For example:

```
...
passwd: files winbind
group: files winbind
...
```

This will enable the use of winbind and should make users and groups **`visible`** on the individual cluster node once Samba is joined to AD and winbind is started.

### 8.2.2. Join Active Directory Domain

Prior to joining AD, CTDB must be started so that the machine account information can be stored in a database file that is available on all cluster nodes via CTDB. In addition to that, all other Samba services should be stopped. If passwordless ssh access for root has been configured between the nodes, you can use the onnode tool to run these commands on all nodes from a single node,

```
# onnode all service ctdb start
# onnode all service winbind stop
# onnode all service smb stop
```

## Note

- If your configuration has CTDB managing Winbind and Samba, they can be temporarily disabled with the following commands (to be executed prior to the above stop commands) so as to prevent CTDB going into an unhealthy state when they are shut down:

```
# onnode all ctdb disablescript 49.winbind
# onnode all ctdb disablescript 50.samba
```

- For some versions of RHGS, a bug in the selinux policy prevents 'ctdb disablescript SCRIPT' from succeeding. If this is the case, 'chmod -x /etc/ctdb/events.d/SCRIPT' can be executed as a workaround from a root shell.
- Shutting down winbind and smb is primarily to prevent access to SMB services during this AD integration. These services may be left running but access to them should be prevented through some other means.

The join is initiated via the **net** utility from a single node:

## Warning

The following step must be executed only on one cluster node and should not be repeated on other cluster nodes. CTDB makes sure that the whole cluster is joined by this step.

```
# net ads join -U Administrator
Enter Administrator's password:
Using short domain name -- ADDOM
Joined 'RHS-SMB' to dns domain addom.example.com'
Not doing automatic DNS update in a clustered setup.
```

Once the join is successful, the cluster ip addresses and the cluster netbios name should be made public in the network. For registering multiple public cluster IP addresses in the AD DNS server, the **net** utility can be used again:

```
# net ads dns register rhs-smb <PUBLIC IP 1> <PUBLIC IP 2> ...
```

This command will make sure the DNS name **rhs-smb** will resolve to the given public IP addresses. The DNS registrations use the cluster machine account for authentication in AD, which means this operation only can be done after the join has succeeded.

Registering the NetBIOS name of the cluster is done by the nmbd service. In order to make sure that the nmbd instances on the hosts don’t overwrite each other’s registrations, the ‘cluster addresses’ smb.conf option should be set to the list of public addresses of the whole cluster.

### 8.2.3. Verify/Test Active Directory and Services

When the join is successful, the Samba and the Winbind daemons can be started.

Start nmdb using the following command:

```
# onnode all service nmb start
```

Start the winbind and smb services:

```
# onnode all service winbind start
# onnode all service smb start
```

## Note

- If you previously disabled CTDB's ability to manage Winbind and Samba they can be re-enabled with the following commands:

  ```
  # onnode all ctdb enablescript 50.samba
  # onnode all ctdb enablescript 49.winbind
  ```

- For some versions of RHGS, a bug in the selinux polict prevents 'ctdb enablescript SCRIPT' from succeeding. If this is the case, 'chmod +x /etc/ctdb/events.d/SCRIPT' can be executed as a workaround from a root shell.
- Ensure that the winbind starts after a reboot. This is achieved by adding 'CTDB_MANAGES_WINBIND=yes' to the /etc/sysconfig/ctdb file on all nodes.

Execute the following verification steps:

1. **Verify the join by executing the following steps**

   Verify the join to check if the created machine account can be used to authenticate to the AD LDAP server using the following command:

   ```
   # net ads testjoin
   Join is OK
   ```

2. Execute the following command to display the machine account's LDAP object

   ```
   # net ads status -P
   objectClass: top
   objectClass: person
   objectClass: organizationalPerson
   objectClass: user
   objectClass: computer
   cn: rhs-smb
   distinguishedName: CN=rhs-smb,CN=Computers,DC=addom,DC=example,DC=com
   instanceType: 4
   whenCreated: 20150922013713.0Z
   whenChanged: 20151126111120.0Z
   displayName: RHS-SMB$
   uSNCreated: 221763
   uSNChanged: 324438
   name: rhs-smb
   objectGUID: a178177e-4aa4-4abc-9079-d1577e137723
   userAccountControl: 69632
   ```

```
badPwdCount: 0
codePage: 0
countryCode: 0
badPasswordTime: 130880426605312806
lastLogoff: 0
lastLogon: 130930100623392945
localPolicyFlags: 0
pwdLastSet: 130930098809021309
primaryGroupID: 515
objectSid: S-1-5-21-2562125317-1564930587-1029132327-1196
accountExpires: 9223372036854775807
logonCount: 1821
sAMAccountName: rhs-smb$
sAMAccountType: 805306369
dNSHostName: rhs-smb.addom.example.com
servicePrincipalName: HOST/rhs-smb.addom.example.com
servicePrincipalName: HOST/RHS-SMB
objectCategory:
CN=Computer,CN=Schema,CN=Configuration,DC=addom,DC=example,DC=com
isCriticalSystemObject: FALSE
dSCorePropagationData: 16010101000000.0Z
lastLogonTimestamp: 130929563322279307
msDS-SupportedEncryptionTypes: 31
```

3. Execute the following command to display general information about the AD server:

```
# net ads info
LDAP server: 10.11.12.1
LDAP server name: dc1.addom.example.com
Realm: ADDOM.EXAMPLE.COM
Bind Path: dc=ADDOM,dc=EXAMPLE,dc=COM
LDAP port: 389
Server time: Thu, 26 Nov 2015 11:15:04 UTC
KDC server: 10.11.12.1
Server time offset: -26
```

4. **Verify if winbind is operating correctly by executing the following steps**

   Execute the following command to verify if winbindd can use the machine account for authentication to AD

```
# wbinfo -t
checking the trust secret for domain ADDOM via RPC calls succeeded
```

5. Execute the following command to resolve the given name to a Windows SID

```
# wbinfo --name-to-sid 'ADDOM\Administrator'
S-1-5-21-2562125317-1564930587-1029132327-500 SID_USER (1)
```

6. Execute the following command to verify authentication:

```
# wbinfo -a 'ADDOM\user'
Enter ADDOM\user's password:
plaintext password authentication succeeded
Enter ADDOM\user's password:
```

```
challenge/response password authentication succeeded
```

or,

```
# wbinfo -a 'ADDOM\user%password'
plaintext password authentication succeeded
challenge/response password authentication succeeded
```

7. Execute the following command to verify if the id-mapping is working properly:

```
# wbinfo --sid-to-uid <SID-OF-ADMIN>
1000000
```

8. Execute the following command to verify if the winbind Name Service Switch module works correctly:

```
# getent passwd 'ADDOM\Administrator'
ADDOM\administrator:*:1000000:1000004::/home/ADDOM/administrator:/bin/
false
```

9. Execute the following command to verify if samba can use winbind and the NSS module correctly:

```
# smbclient -L rhs-smb -U 'ADDOM\Administrator'
Domain=[ADDOM] OS=[Windows 6.1] Server=[Samba 4.2.4]

        Sharename       Type      Comment
        ---------       ----      -------
        IPC$            IPC       IPC Service (Samba 4.2.4)
Domain=[ADDOM] OS=[Windows 6.1] Server=[Samba 4.2.4]

        Server               Comment
        ---------            -------
        RHS-SMB         Samba 4.2.4

        Workgroup            Master
        ---------            -------
        ADDOM             RHS-SMB
```

# Chapter 9. Configuring Network Encryption in Red Hat Gluster Storage

Encryption is the process of converting data into a cryptic format, or code when it is transmitted on a network. Encryption prevents unauthorized use of the data.

Red Hat Gluster Storage supports network encryption using TLS/SSL. Red Hat Gluster Storage uses TLS/SSL for authentication and authorization, in place of the home grown authentication framework used for normal connections. Red Hat Gluster Storage supports the following encryption types:

- I/O encryption - encryption of the I/O connections between the Red Hat Gluster Storage clients and servers
- Management encryption - encryption of the management (**glusterd**) connections within a trusted storage pool.

The following files will be used in configuring the network encryption:

- **/etc/ssl/glusterfs.pem** - Certificate file containing the system's uniquely signed TLS certificate. This file is unique for each system and must not be shared with others.
- **/etc/ssl/glusterfs.key** - This file contains the system's unique private key. This file must not be shared with others.
- **/etc/ssl/glusterfs.ca** - This file contains the certificates of the Certificate Authorities (CA) who have signed the certificates. This file is not unique and should be the same on all servers in the trusted storage pool. All the clients also should have the same file, but not necessarily the same one as the servers. Red Hat Gluster Storage does not use the global CA certificates that come with the system. The CA file on the servers should contain the certificates of the signing CA for all the servers and all the clients

  The CA file on the clients must contain the certificates of the signing CA for all the servers. In case self-signed certificates are being used, the CA file for the servers is a concatenation of the certificate files **/etc/ssl/glusterfs.pem** of every server and every client. The client CA file is a concatenation of the certificate files of every server.
- **/var/lib/glusterd/secure-access** - This file enables encryption on the management (**glusterd**) connections between **glusterd** of all servers and the connection between clients. **glusterd** of all servers uses this file to fetch volfiles and notify the clients with the volfile changes. This file is empty and mandatory only if you configure management encryption. It must be present on all the servers and all the clients. This is required on the clients to indicate the mount command to use an encrypted connection to retrieve the volfiles.

## 9.1. Prerequisites

Before setting up the network encryption, you must first generate a private key and a signed certificate for each system and place it in the respective folders. You must generate a private key and a signed certificate for both clients and servers.

Perform the following to generate a private key and a signed certificate for both clients and servers:

1. Generate a private key for each system.

   ```
   # openssl genrsa -out /etc/ssl/glusterfs.key 2048
   ```

2. Use the generated private key to create a signed certificate by running the following command:

```
# openssl req -new -x509 -key /etc/ssl/glusterfs.key -subj
"/CN=COMMONNAME" -out /etc/ssl/glusterfs.pem
```

If your organization has a common CA, the certificate can be signed by it. To do this a certificate signing request (CSR) must be generated by running the following command:

```
# openssl req -new -sha256 -key /etc/ssl/glusterfs.key -subj '/CN=
<COMMONNAME>' -out glusterfs.csr
```

The generated **glusterfs.csr** file should be given to the CA, and CA will provide a **.pem** file containing the signed certificate. Place that signed **glusterfs.pem** file in the **/etc/ssl/** directory.

3. a. For self signed CA certificates on servers, collect the **.pem** certificates of clients and servers, that is, **/etc/ssl/glusterfs.pem** files from every system. Concatenate the collected files into a single file. Place this file in **/etc/ssl/glusterfs.ca** on all the servers in the trusted storage pool. If you are using common CA, collect the certificate file from the CA and place it in **/etc/ssl/glusterfs.ca** on all servers.

   b. For self-signed CA certificates on clients, collect the **.pem** certificates of servers, that is, **/etc/ssl/glusterfs.pem** files from every server. Concatenate the collected files into a single file. Place this file in **/etc/ssl/glusterfs.ca** on all the clients. If you are using common CA, collect the certificate file from the CA and place it in **/etc/ssl/glusterfs.ca** on all servers.

## 9.2. Configuring Network Encryption for a New Trusted Storage Pool

You can configure network encryption for a new Red Hat Gluster Storage Trusted Storage Pool for both I/O encryption and management encryption. This section assumes that you have installed Red Hat Gluster Storage on the servers and the clients, but has never been run.

### 9.2.1. Enabling Management Encryption

Though Red Hat Gluster Storage can be configured only for I/O encryption without using management encryption, it is recommended to have management encryption. If you want to enable SSL only on the I/O path, skip this section and proceed with Section 9.2.2, “Enabling I/O encryption for a Volume”.

#### On Servers

Perform the following on all the servers

1. Create the **/var/lib/glusterd/secure-access** file.

```
# touch /var/lib/glusterd/secure-access
```

2. Start **glusterd** on all servers.

```
# service glusterd start
```

3. Setup the trusted storage pool by running appropriate peer probe commands. For more information on setting up the trusted storage pool, see Chapter 5, *Trusted Storage Pools*

#### On Clients

Perform the following on all the client machines

1. Create the **/var/lib/glusterd/secure-access** file.

```
# touch /var/lib/glusterd/secure-access
```

2. Mount the volume on all the clients. For example, to manually mount a volume and access data using Native client, use the following command:

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

### 9.2.2. Enabling I/O encryption for a Volume

Enable the I/O encryption between the servers and clients:

1. Create the volume, but do not start it.

2. Set the list of common names of all the servers to access the volume. Be sure to include the common names of clients which will be allowed to access the volume..

```
# gluster volume set VOLNAME auth.ssl-allow
'server1,server2,server3,client1,client2,client3'
```

3. Enable the **client.ssl** and **server.ssl** options on the volume.

```
# gluster volume set VOLNAME client.ssl on
# gluster volume set VOLNAME server.ssl on
```

4. Start the volume.

```
# gluster volume start VOLNAME
```

5. Mount the volume on all the clients which has been authorized. For example, to manually mount a volume and access data using Native client, use the following command:

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

## 9.3. Configuring Network Encryption for an existing Trusted Storage Pool

You can configure network encryption for an existing Red Hat Gluster Storage Trusted Storage Pool for both I/O encryption and management encryption.

### 9.3.1. Enabling I/O encryption for a Volume

Enable the I/O encryption between the servers and clients:

1. Unmount the volume on all the clients.

```
# umount mount-point
```

2. Stop the volume.

```
# gluster volume stop VOLNAME
```

3. Set the list of common names for clients allowed to access the volume. Be sure to include the common names of all the servers.

```
# gluster volume set VOLNAME auth.ssl-allow
'server1,server2,server3,client1,client2,client3'
```

4. Enable **client.ssl** and **server.ssl** on the volume.

```
# gluster volume set VOLNAME client.ssl on
# gluster volume set VOLNAME server.ssl on
```

5. Start the volume.

```
# gluster volume start VOLNAME
```

6. Mount the volume from the new clients. For example, to manually mount a volume and access data using Native client, use the following command:

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

### 9.3.2. Enabling Management Encryption

Though, Red Hat Gluster Storage can be configured only for I/O encryption without using management encryption, management encryption is recommended. On an existing installation, with running servers and clients, schedule a downtime of volumes, applications, clients, and other end-users to enable management encryption.

You cannot currently change between unencrypted and encrypted connections dynamically. Bricks and other local services on the servers and clients do not receive notifications from **glusterd** if they are running when the switch to management encryption is made.

1. Unmount the volume on all the clients.

```
# umount mount-point
```

2. Stop all the volumes.

```
# gluster volume stop VOLNAME
```

3. Stop **glusterd** on all servers.

```
# service glusterd stop
```

4. Stop all gluster-related processes on all servers.

```
# pkill glusterfs
```

5. Create the **/var/lib/glusterd/secure-access** file on all servers and clients.

```
# touch /var/lib/glusterd/secure-access
```

6. Start **glusterd** on all the servers.

```
# service glusterd start
```

7. Start all the volumes

```
# gluster volume start VOLNAME
```

8. Mount the volume on all the clients. For example, to manually mount a volume and access data using Native client, use the following command:

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

## 9.4. Expanding Volumes

In a network encrypted Red Hat Gluster Storage trusted storage pool, you must ensure that you meet the prerequisites listed at Section 9.1, “Prerequisites”.

### 9.4.1. Certificate Signed with a Common Certificate Authority

Adding a server to a storage pool is simple if the servers all use a common Certificate Authority.

1. Copy **/etc/ssl/glusterfs.ca** file from one of the existing servers and save it on the **/etc/ssl/** directory on the new server.

2. If you are using management encryption, create **/var/lib/glusterd/secure-access** file.

```
# touch /var/lib/glusterd/secure-access
```

3. Start **glusterd** on the new peer

```
# service glusterd start
```

4. Add the common name of the new server to the **auth.ssl-allow** list for all volumes which have encryption enabled.

```
# gluster volume set VOLNAME auth.ssl-allow servernew
```

> **Note**
>
> The **gluster volume set** command does not append to existing values of the options. To append the new name to the list, get the existing list using **gluster volume info** command, append the new name to the list and set the option again using **gluster volume set** command.

5. Run **gluster peer probe [server]** to add additional servers to the trusted storage pool. For more information on adding servers to the trusted storage pool, see Chapter 5, *Trusted Storage Pools*.

### 9.4.2. Self-signed Certificates

Using self-signed certificates would require a downtime of servers to add a new server into the trusted storage pool, as the CA list cannot be dynamically reloaded. To add a new server:

1. Generate the private key and self-signed certificate on the new server using the steps listed at Section 9.1, "Prerequisites".

2. Copy the following files:

   a. On an existing server, copy the **/etc/ssl/glusterfs.ca** file, append the content of new server's certificate to it, and distribute it to all servers, including the new server.

   b. On an existing client, copy the **/etc/ssl/glusterfs.ca file**, append the content of the new server's certificate to it, and distribute it to all clients.

3. Stop all gluster-related processes on all servers.

```
# pkill glusterfs
```

4. Create the **/var/lib/glusterd/secure-access** file on the server if management encryption is enable in the trusted storage pool.

5. Start **glusterd** on the new peer

```
# service glusterd start
```

6. Add the common name of the new server to the **auth.ssl-allow** list for all volumes which have encryption enabled.

7. Restart all the glusterfs processes on existing servers and clients by performing the following .

   a. Unmount the volume on all the clients.

   ```
   # umount mount-point
   ```

   b. Stop all volumes.

   ```
   # gluster volume stop VOLNAME
   ```

   c. Restart glusterd on all the servers.

   ```
   # service glusterd start
   ```

   d. Start the volumes

   ```
   # gluster volume start VOLNAME
   ```

   e. Mount the volume on all the clients. For example, to manually mount a volume and access data using Native client, use the following command:

   ```
   # mount -t glusterfs server1:/test-volume /mnt/glusterfs
   ```

8. Peer probe the new server to add it to the trusted storage pool. For more information on peer probe, see Chapter 5, *Trusted Storage Pools*

## 9.5. Authorizing a New Client

If your Red Hat Gluster Storage trusted storage pool is configured for network encryption, and you add a new client, you must ensure to authorize a new client to access the trusted storage pool.

### 9.5.1. Certificate Signed with a Common Certificate Authority

Authorizing access to a volume for a new client is simple if the client has a certificate signed by a Certificate Authority already present in the **/etc/ssl/glusterfs.ca** file.

1. Generate the **glusterfs.key** private key and **glusterfs.csr** certificate signing request. Send the **glusterfs.csr** to get it verified by CA and get the**glusterfs.pem** from the CA. Generate the private key and signed certificate for the new server and place the files in the appropriate locations using the steps listed at Section 9.1, “Prerequisites” .

2. Copy **/etc/ssl/glusterfs.ca** file from another client and place it in the **/etc/ssl/** directory on the new client..

3. Create **/var/lib/glusterd/secure-access** file if management encryption is enabled in the trusted storage pool.

```
# touch /var/lib/glusterd/secure-access
```

4. Set the list of common names of all the servers to access the volume. Be sure to include the common names of clients which will be allowed to access the volume.

```
# gluster volume set VOLNAME auth.ssl-allow
'server1,server2,server3,client1,client2,client3'
```

> **Note**
>
> The **gluster volume set** command does not append to existing values of the options. To append the new name to the list, get the existing list using **gluster volume info** command, append the new name to the list and set the option again using **gluster volume set** command.

5. Mount the volume from the new client. For example, to manually mount a volume and access data using Native client, use the following command:

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

### 9.5.2. Self-signed Certificates

> **Note**
>
> This procedure involves downtime as the volume has to be rendered offline.

To authorize a new client to access the Red Hat Gluster Storage trusted storage pool using self-signed certificate, perform the following.

1. Generate the **glusterfs.key** private key and **glusterfs.pem** certificate for the client, and place them at the appropriate locations on the client using the steps listed at Section 9.1, “Prerequisites” .

2. Copy **/etc/ssl/glusterfs.ca** file from one of the clients, and add it to the new client.

3. Create the **/var/lib/glusterd/secure-access** file on all the client, if the management encryption is enabled.

```
# touch /var/lib/glusterd/secure-access
```

4. Copy **/etc/ssl/glusterfs.ca** file from one of the existing servers, append the content of new client's certificate to it, and distribute the new CA file on all servers.

5. Set the list of common names for clients allowed to access the volume. Be sure to include the common names of all the servers.

```
# gluster volume set VOLNAME auth.ssl-allow
'server1,server2,server3,client1,client2,client3'
```

> **Note**
>
> The **gluster volume set** command does not append to existing values of the options. To append the new name to the list, get the existing list using **gluster volume info** command, append the new name to the list and set the option again using **gluster volume set** command.

6. Restart the volume

```
# gluster volume stop VOLNAME # gluster volume start VOLNAME
```

7. If the management encryption is enabled, restart glusterd on all the servers.

8. Mount the volume from the new client. For example, to manually mount a volume and access data using Native client, use the following command:

```
# mount -t glusterfs server1:/test-volume /mnt/glusterfs
```

# Chapter 10. Managing Red Hat Gluster Storage Volumes

This chapter describes how to perform common volume management operations on the Red Hat Gluster Storage volumes.

## 10.1. Configuring Volume Options

> **Note**
>
> Volume options can be configured while the trusted storage pool is online.

The current settings for a volume can be viewed using the following command:

```
# gluster volume info VOLNAME
```

Volume options can be configured using the following command:

```
# gluster volume set VOLNAME OPTION PARAMETER
```

For example, to specify the performance cache size for **test-volume**:

```
# gluster volume set test-volume performance.cache-size 256MB
Set volume successful
```

The following table lists available volume options along with their description and default value.

> **Note**
>
> The default values are subject to change, and may not be the same for all versions of Red Hat Gluster Storage.

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| auth.allow | IP addresses or hostnames of the clients which are allowed to access the volume. | Valid hostnames or IP addresses, which includes wild card patterns including *. For example, **192.168.1.***. A list of comma separated addresses is acceptable, but a single hostname must not exceed 256 characters. | * (allow all) |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| auth.reject | IP addresses or hostnames of the clients which are denied access to the volume. | Valid hostnames or IP addresses, which includes wild card patterns including *. For example, **`192.168.1.*`**. A list of comma separated addresses is acceptable, but a single hostname must not exceed 256 characters. | none (reject none) |

## Note

Using **`auth.allow`** and **`auth.reject`** options, you can control access of only glusterFS FUSE-based clients. Use **`nfs.rpc-auth-*`** options for NFS access control.

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| changelog | Enables the changelog translator to record all the file operations. | on \| off | off |
| client.event-threads | Specifies the number of network connections to be handled simultaneously by the client processes accessing a Red Hat Gluster Storage node. | 1 - 32 | 2 |
| server.event-threads | Specifies the number of network connections to be handled simultaneously by the server processes hosting a Red Hat Gluster Storage node. | 1 - 32 | 2 |
| cluster.consistent-metadata | If set to On, the readdirp function in Automatic File Replication feature will always fetch metadata from their respective read children as long as it holds the good copy (the copy that does not need healing) of the file/directory. However, this could cause a reduction in performance where readdirps are involved. | on \| off | off |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| **Note**<br>After **`cluster.consistent-metadata`** option is set to On, you must ensure to unmount and mount the volume at the clients for this option to take effect. | | | |
| cluster.min-free-disk | Specifies the percentage of disk space that must be kept free. This may be useful for non-uniform bricks. | Percentage of required minimum free disk space. | 10% |
| cluster.op-version | Allows you to set the operating version of the cluster. The op-version number cannot be downgraded and is set for all the volumes. Also the op-version does not appear when you execute the gluster volume info command. | 3000z \| 30703 \| 30706 | Default value is 3000z after an upgrade from Red Hat Gluster Storage 3.0 or 30703 after upgrade from RHGS 3.1.1. Value is set to 30706 for a new cluster deployment. |
| cluster.self-heal-daemon | Specifies whether proactive self-healing on replicated volumes is activated. | on \| off | on |
| cluster.server-quorum-type | If set to **`server`**, this option enables the specified volume to participate in the server-side quorum. For more information on configuring the server-side quorum, see Section 10.11.1.1, “Configuring Server-Side Quorum” | none \| server | none |
| cluster.server-quorum-ratio | Sets the quorum percentage for the trusted storage pool. | 0 - 100 | >50% |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| cluster.quorum-type | If set to **`fixed`**, this option allows writes to a file only if the number of active bricks in that replica set (to which the file belongs) is greater than or equal to the count specified in the **`cluster.quorum-count`** option. If set to **`auto`**, this option allows writes to the file only if the percentage of active replicate bricks is more than 50% of the total number of bricks that constitute that replica. If there are only two bricks in the replica group, the first brick must be up and running to allow modifications. | fixed \| auto | none |
| cluster.quorum-count | The minimum number of bricks that must be active in a replica-set to allow writes. This option is used in conjunction with **`cluster.quorum-type`** =**`fixed`** option to specify the number of bricks to be active to participate in quorum. The **`cluster.quorum-type`** = **`auto`** option will **`override`** this value. | 1 - **`replica-count`** | 0 |
| cluster.lookup-optimize | If this option, is set **`ON`**, enables the optimization of -ve lookups, by not doing a lookup on non-hashed sub-volumes for files, in case the hashed sub-volume does not return any result. This option disregards the lookup-unhashed setting, when enabled. | | off |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| cluster.read-freq-threshold | Specifies the number of reads, in a promotion/demotion cycle, that would mark a file **HOT** for promotion. Any file that has read hits less than this value will be considered as **COLD** and will be demoted. | 0-20 | 0 |
| cluster.write-freq-threshold | Specifies the number of writes, in a promotion/demotion cycle, that would mark a file **HOT** for promotion. Any file that has write hits less than this value will be considered as **COLD** and will be demoted. | 0-20 | 0 |
| cluster.tier-promote-frequency | Specifies how frequently the tier daemon must check for files to promote. | 1- 172800 seconds | 120 seconds |
| cluster.tier-demote-frequency | Specifies how frequently the tier daemon must check for files to demote. | 1 - 172800 seconds | 3600 seconds |
| cluster.tier-mode | If set to cache mode, promotes or demotes files based on whether the cache is full or not, as specified with watermarks. If set to test mode, periodically demotes or promotes files automatically based on access. | test \| cache | cache |
| cluster.tier-max-mb | Specifies the maximum number of MB that may be migrated in any direction from each node in a given cycle. | 1 -100000 (100 GB) | 4000 MB |
| cluster.tier-max-files | Specifies the maximum number of files that may be migrated in any direction from each node in a given cycle. | 1-100000 files | 10000 |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| cluster.watermark-hi | Upper percentage watermark for promotion. If hot tier fills above this percentage, no promotion will happen and demotion will happen with high probability. | 1- 99 % | 90% |
| cluster.watermark-low | Lower percentage watermark. If hot tier is less full than this, promotion will happen and demotion will not happen. If greater than this, promotion/demotion will happen at a probability relative to how full the hot tier is. | 1- 99 % | 75% |
| config.transport | Specifies the type of transport(s) volume would support communicating over. | tcp OR rdma OR tcp,rdma | tcp |
| diagnostics.brick-log-level | Changes the log-level of the bricks. | INFO \| DEBUG \| WARNING \| ERROR \| CRITICAL \| NONE \| TRACE | info |
| diagnostics.client-log-level | Changes the log-level of the clients. | INFO \| DEBUG \| WARNING \| ERROR \| CRITICAL \| NONE \| TRACE | info |
| diagnostics.brick-sys-log-level | Depending on the value defined for this option, log messages at and above the defined level are generated in the syslog and the brick log files. | INFO \| WARNING \| ERROR \| CRITICAL | CRITICAL |
| diagnostics.client-sys-log-level | Depending on the value defined for this option, log messages at and above the defined level are generated in the syslog and the client log files. | INFO \| WARNING \| ERROR \| CRITICAL | CRITICAL |
| diagnostics.client-log-format | Allows you to configure the log format to log either with a message id or without one on the client. | no-msg-id \| with-msg-id | with-msg-id |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| diagnostics.brick-log-format | Allows you to configure the log format to log either with a message id or without one on the brick. | no-msg-id \| with-msg-id | with-msg-id |
| diagnostics.brick-log-flush-timeout | The length of time for which the log messages are buffered, before being flushed to the logging infrastructure (gluster or syslog files) on the bricks. | 30 - 300 seconds (30 and 300 included) | 120 seconds |
| diagnostics.brick-log-buf-size | The maximum number of unique log messages that can be suppressed until the timeout or buffer overflow, whichever occurs first on the bricks. | 0 and 20 (0 and 20 included) | 5 |
| diagnostics.client-log-flush-timeout | The length of time for which the log messages are buffered, before being flushed to the logging infrastructure (gluster or syslog files) on the clients. | 30 - 300 seconds (30 and 300 included) | 120 seconds |
| diagnostics.client-log-buf-size | The maximum number of unique log messages that can be suppressed until the timeout or buffer overflow, whichever occurs first on the clients. | 0 and 20 (0 and 20 included) | 5 |
| features.ctr-enabled | Enables Change Time Recorder (CTR) translator for a tiered volume. This option is used in conjunction with **`features.record-counters`** option to enable recording write and read heat counters. | on \| off | on |
| features.ctr_link_consistency | Enables a crash consistent way of recording hardlink updates by Change Time Recorder translator. When recording in a crash consistent way the data operations will experience more latency. | on \| off | off |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| features.quota-deem-statfs | When this option is set to on, it takes the quota limits into consideration while estimating the filesystem size. The limit will be treated as the total size instead of the actual size of filesystem. | on \| off | on |
| features.record-counters | If set to **`enabled`**, **`cluster.write-freq-threshold`** and **`cluster.read-freq-threshold`** options defines the number of writes and reads to a given file that are needed before triggering migration. | on \| off | on |
| features.read-only | Specifies whether to mount the entire volume as read-only for all the clients accessing it. | on \| off | off |
| geo-replication.indexing | Enables the marker translator to track the changes in the volume. | on \| off | off |
| performance.quick-read | To enable/disable quick-read translator in the volume. | on \| off | on |
| network.ping-timeout | The time the client waits for a response from the server. If a timeout occurs, all resources held by the server on behalf of the client are cleaned up. When the connection is reestablished, all resources need to be reacquired before the client can resume operations on the server. Additionally, locks are acquired and the lock tables are updated. A reconnect is a very expensive operation and must be avoided. | 42 seconds | 42 seconds |
| nfs.acl | Disabling nfs.acl will remove support for the NFSACL sideband protocol. This is enabled by default. | enable \| disable | enable |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| nfs.enable-ino32 | For nfs clients or applciatons that do not support 64-bit inode numbers, use this option to make NFS return 32-bit inode numbers instead. Disabled by default, so NFS returns 64-bit inode numbers. | enable \| disable | disable |
| nfs.export-dir | By default, all NFS volumes are exported as individual exports. This option allows you to export specified subdirectories on the volume. | The path must be an absolute path. Along with the path allowed, list of IP address or hostname can be associated with each subdirectory. | None |
| nfs.export-dirs | By default, all NFS sub-volumes are exported as individual exports. This option allows any directory on a volume to be exported separately. | on \| off | on |

**Note**

The value set for **`nfs.export-dirs`** and **`nfs.export-volumes`** options are global and applies to all the volumes in the Red Hat Gluster Storage trusted storage pool.

| | | | |
|---|---|---|---|
| nfs.export-volumes | Enables or disables exporting entire volumes. If disabled and used in conjunction with **`nfs.export-dir`**, you can set subdirectories as the only exports. | on \| off | on |
| nfs.mount-rmtab | Path to the cache file that contains a list of NFS-clients and the volumes they have mounted. Change the location of this file to a mounted (with glusterfs-fuse, on all storage servers) volume to gain a trusted pool wide view of all NFS-clients that use the volumes. The contents of this file provide the information that can get obtained with the **`showmount`** command. | Path to a directory | /var/lib/glusterd/nfs/rmtab |

| Option | Value Description | Allowed Values | Default Value |
| --- | --- | --- | --- |
| nfs.mount-udp | Enable UDP transport for the *MOUNT* sideband protocol. By default, UDP is not enabled, and MOUNT can only be used over TCP. Some NFS-clients (certain Solaris, HP-UX and others) do not support MOUNT over TCP and enabling **`nfs.mount-udp`** makes it possible to use NFS exports provided by Red Hat Gluster Storage. | disable \| enable | disable |
| nfs.nlm | By default, the Network Lock Manager (NLMv4) is enabled. Use this option to disable NLM. Red Hat does not recommend disabling this option. | on | on\|off |
| nfs.rpc-auth-allow *IP_ADRESSES* | A comma separated list of IP addresses allowed to connect to the server. By default, all clients are allowed. | Comma separated list of IP addresses | accept all |
| nfs.rpc-auth-reject *IP_ADRESSES* | A comma separated list of addresses not allowed to connect to the server. By default, all connections are allowed. | Comma separated list of IP addresses | reject none |
| nfs.ports-insecure | Allows client connections from unprivileged ports. By default only privileged ports are allowed. This is a global setting for allowing insecure ports for all exports using a single option. | on \| off | off |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| nfs.addr-namelookup | Specifies whether to lookup names for incoming client connections. In some configurations, the name server can take too long to reply to DNS queries, resulting in timeouts of mount requests. This option can be used to disable name lookups during address authentication. Note that disabling name lookups will prevent you from using hostnames in **`nfs.rpc-auth-*`** options. | on \| off | on |
| nfs.port | Associates glusterFS NFS with a non-default port. | 1025-65535 | 38465- 38467 |
| nfs.disable | Specifies whether to disable NFS exports of individual volumes. | on \| off | off |
| nfs.server-aux-gids | When enabled, the NFS-server will resolve the groups of the user accessing the volume. NFSv3 is restricted by the RPC protocol (AUTH_UNIX/AUTH_SYS header) to 16 groups. By resolving the groups on the NFS-server, this limits can get by-passed. | on\|off | off |
| nfs.transport-type | Specifies the transport used by GlusterFS NFS server to communicate with bricks. | tcp OR rdma | tcp |
| open-behind | It improves the application's ability to read data from a file by sending success notifications to the application whenever it receives a open call. | on \| off | on |
| performance.io-thread-count | The number of threads in the IO threads translator. | 0 - 65 | 16 |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| performance.cache-max-file-size | Sets the maximum file size cached by the io-cache translator. Can be specified using the normal size descriptors of KB, MB, GB, TB, or PB (for example, 6GB). | Size in bytes, or specified using size descriptors. | 2 ^ 64-1 bytes |
| performance.cache-min-file-size | Sets the minimum file size cached by the io-cache translator. Can be specified using the normal size descriptors of KB, MB, GB, TB, or PB (for example, 6GB). | Size in bytes, or specified using size descriptors. | 0 |
| performance.cache-refresh-timeout | The number of seconds cached data for a file will be retained. After this timeout, data re-validation will be performed. | 0 - 61 seconds | 1 second |
| performance.cache-size | Size of the read cache. | Size in bytes, or specified using size descriptors. | 32 MB |
| performance.md-cache-timeout | The time period in seconds which controls when metadata cache has to be refreshed. If the age of cache is greater than this time-period, it is refreshed. Every time cache is refreshed, its age is reset to 0. | 0-60 seconds | 1 second |
| performance.use-anonymous-fd | This option requires **`open-behind`** to be on. For read operations, use anonymous FD when the original FD is open-behind and not yet opened in the backend. | Yes \| No | Yes |
| performance.lazy-open | This option requires **`open-behind`** to be on. Perform an open in the backend only when a necessary FOP arrives (for example, write on the FD, unlink of the file). When this option is disabled, perform backend open immediately after an unwinding open. | Yes/No | Yes |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| rebal-throttle | Rebalance process is made multithreaded to handle multiple files migration for enhancing the performance. During multiple file migration, there can be a severe impact on storage system performance. The throttling mechanism is provided to manage it. | lazy, normal, aggressive | normal |
| server.allow-insecure | Allows client connections from unprivileged ports. By default, only privileged ports are allowed. This is a global setting for allowing insecure ports to be enabled for all exports using a single option. | on \| off | off |

**Important**

Turning **`server.allow-insecure`** to **on** allows ports to accept/reject messages from insecure ports. Enable this option only if your deployment requires it, for example if there are too many bricks in each volume, or if there are too many services which have already utilized all the privileged ports in the system. You can control access of only glusterFS FUSE-based clients. Use **`nfs.rpc-auth-*`** options for NFS access control.

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| server.root-squash | Prevents root users from having root privileges, and instead assigns them the privileges of **nfsnobody**. This squashes the power of the root users, preventing unauthorized modification of files on the Red Hat Gluster Storage Servers. | on \| off | off |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| server.anonuid | Value of the UID used for the anonymous user when root-squash is enabled. When root-squash is enabled, all the requests received from the root UID (that is 0) are changed to have the UID of the anonymous user. | 0 - 4294967295 | 65534 (this UID is also known as **`nfsnobody`**) |
| server.anongid | Value of the GID used for the anonymous user when root-squash is enabled. When root-squash is enabled, all the requests received from the root GID (that is 0) are changed to have the GID of the anonymous user. | 0 - 4294967295 | 65534 (this UID is also known as **`nfsnobody`**) |
| server.gid-timeout | The time period in seconds which controls when cached groups has to expire. This is the cache that contains the groups (GIDs) where a specified user (UID) belongs to. This option is used only when **`server.manage-gids`** is enabled. | 0-4294967295 seconds | 2 seconds |
| server.manage-gids | Resolve groups on the server-side. By enabling this option, the groups (GIDs) a user (UID) belongs to gets resolved on the server, instead of using the groups that were send in the RPC Call by the client. This option makes it possible to apply permission checks for users that belong to bigger group lists than the protocol supports (approximately 93). | on\|off | off |
| server.statedump-path | Specifies the directory in which the **`statedump`** files must be stored. | /var/run/gluster (for a default installation) | Path to a directory |

| Option | Value Description | Allowed Values | Default Value |
|---|---|---|---|
| storage.health-check-interval | Sets the time interval in seconds for a filesystem health check. You can set it to 0 to disable. The POSIX translator on the bricks performs a periodic health check. If this check fails, the filesystem exported by the brick is not usable anymore and the brick process (glusterfsd) logs a warning and exits. | 0-4294967295 seconds | 30 seconds |
| storage.owner-uid | Sets the UID for the bricks of the volume. This option may be required when some of the applications need the brick to have a specific UID to function correctly. Example: For QEMU integration the UID/GID must be qemu:qemu, that is, 107:107 (107 is the UID and GID of qemu). | Any integer greater than or equal to -1. | The UID of the bricks are not changed. This is denoted by **`-1`**. |
| storage.owner-gid | Sets the GID for the bricks of the volume. This option may be required when some of the applications need the brick to have a specific GID to function correctly. Example: For QEMU integration the UID/GID must be qemu:qemu, that is, 107:107 (107 is the UID and GID of qemu). | Any integer greater than or equal to -1. | The GID of the bricks are not changed. This is denoted by **`-1`**. |

## 10.2. Configuring Transport Types for a Volume

A volume can support one or more transport types for communication between clients and brick processes. There are three types of supported transport, which are, tcp, rdma, and tcp,rdma.

To change the supported transport types of a volume, follow the procedure:

1. Unmount the volume on all the clients using the following command:

   ```
   # umount mount-point
   ```

2. Stop the volumes using the following command:

```
# gluster volume stop volname
```

3. Change the transport type. For example, to enable both tcp and rdma execute the followimg command:

```
# gluster volume set volname config.transport tcp,rdma OR tcp OR rdma
```

4. Mount the volume on all the clients. For example, to mount using rdma transport, use the following command:

```
# mount -t glusterfs -o transport=rdma server1:/test-volume
/mnt/glusterfs
```

## 10.3. Expanding Volumes

Volumes can be expanded while the trusted storage pool is online and available. For example, you can add a brick to a distributed volume, which increases distribution and adds capacity to the Red Hat Gluster Storage volume. Similarly, you can add a group of bricks to a replicated or distributed replicated volume, which increases the capacity of the Red Hat Gluster Storage volume.

> **Note**
>
> When expanding replicated or distributed replicated volumes, the number of bricks being added must be a multiple of the replica count. For example, to expand a distributed replicated volume with a replica count of 2, you need to add bricks in multiples of 2 (such as 4, 6, 8, etc.).

**Expanding a Volume**

1. From any server in the trusted storage pool, use the following command to probe the server on which you want to add a new brick :

```
# gluster peer probe HOSTNAME
```

For example:

```
# gluster peer probe server5
Probe successful

# gluster peer probe server6
Probe successful
```

2. Add the bricks using the following command:

```
# gluster volume add-brick VOLNAME NEW_BRICK
```

For example:

```
# gluster volume add-brick test-volume server5:/exp5 server6:/exp6
Add Brick successful
```

3. Check the volume information using the following command:

```
# gluster volume info
```

The command output displays information similar to the following:

```
Volume Name: test-volume
Type: Distribute-Replicate
Status: Started
Number of Bricks: 6
Bricks:
Brick1: server1:/exp1
Brick2: server2:/exp2
Brick3: server3:/exp3
Brick4: server4:/exp4
Brick5: server5:/exp5
Brick6: server6:/exp6
```

4. Rebalance the volume to ensure that files will be distributed to the new brick. Use the rebalance command as described in Section 10.7, “Rebalancing Volumes”.

The **add-brick** command should be followed by a **rebalance** operation to ensure better utilization of the added bricks.

### 10.3.1. Expanding a Tiered Volume

You can add a group of bricks to a cold tier volume and to the hot tier volume to increase the capacity of the Red Hat Gluster Storage volume.

#### 10.3.1.1. Expanding a Cold Tier Volume

Expanding a cold tier volume is same as a non-tiered volume. If you are reusing the brick, ensure to perform the steps listed in “Reusing a Brick from a Deleted Volume” section.

1. Detach the tier by performing the steps listed in Section 12.7, “Detaching a Tier from a Volume”

2. From any server in the trusted storage pool, use the following command to probe the server on which you want to add a new brick :

```
# gluster peer probe HOSTNAME
```

For example:

```
# gluster peer probe server5
Probe successful

# gluster peer probe server6
Probe successful
```

3. Add the bricks using the following command:

```
# gluster volume add-brick VOLNAME NEW_BRICK
```

For example:

```
# gluster volume add-brick test-volume server5:/exp5 server6:/exp6
```

4. Rebalance the volume to ensure that files will be distributed to the new brick. Use the rebalance command as described in Section 10.7, “Rebalancing Volumes”.

   The **`add-brick`** command should be followed by a **`rebalance`** operation to ensure better utilization of the added bricks.

5. Reattach the tier to the volume with both old and new (expanded) bricks:

   **`# gluster volume tier`** ***`VOLNAME`*** **`attach [replica COUNT] NEW-BRICK...`**

   > **Important**
   >
   > When you reattach a tier, an internal process called fix-layout commences internally to prepare the hot tier for use. This process takes time and there will a delay in starting the tiering activities.

   If you are reusing the brick, be sure to clearly wipe the existing data before attaching it to the tiered volume.

#### 10.3.1.2. Expanding a Hot Tier Volume

You can expand a hot tier volume by attaching and adding bricks for the hot tier.

1. Detach the tier by performing the steps listed in Section 12.7, “Detaching a Tier from a Volume”

2. Reattach the tier to the volume with both old and new (expanded) bricks:

   **`# gluster volume tier`** ***`VOLNAME`*** **`attach [replica COUNT] NEW-BRICK...`**

   For example,

```
# gluster volume tier test-volume attach replica 2 server1:/exp5/tier5
server1:/exp6/tier6
server2:/exp7/tier7 server2:/exp8/tier8
```

   > **Important**
   >
   > When you reattach a tier, an internal process called fix-layout commences internally to prepare the hot tier for use. This process takes time and there will a delay in starting the tiering activities.

   If you are reusing the brick, be sure to clearly wipe the existing data before attaching it to the tiered volume.

## 10.4. Shrinking Volumes

You can shrink volumes while the trusted storage pool is online and available. For example, you may need to remove a brick that has become inaccessible in a distributed volume because of a hardware or network failure.

> **Note**
>
> When shrinking distributed replicated volumes, the number of bricks being removed must be a multiple of the replica count. For example, to shrink a distributed replicated volume with a replica count of 2, you need to remove bricks in multiples of 2 (such as 4, 6, 8, etc.). In addition, the bricks you are removing must be from the same sub-volume (the same replica set). In a non-replicated volume, all bricks must be available in order to migrate data and perform the remove brick operation. In a replicated volume, at least one of the bricks in the replica must be available.

**Shrinking a Volume**

1. Remove a brick using the following command:

   ```
   # gluster volume remove-brick VOLNAME BRICK start
   ```

   For example:

   ```
   # gluster volume remove-brick test-volume server2:/exp2 start
   Remove Brick start successful
   ```

   > **Note**
   >
   > If the **remove-brick** command is run with **force** or without any option, the data on the brick that you are removing will no longer be accessible at the glusterFS mount point. When using the **start** option, the data is migrated to other bricks, and on a successful commit the removed brick's information is deleted from the volume configuration. Data can still be accessed directly on the brick.

2. You can view the status of the remove brick operation using the following command:

   ```
   # gluster volume remove-brick VOLNAME BRICK status
   ```

   For example:

   ```
   # gluster volume remove-brick test-volume server2:/exp2 status
         Node    Rebalanced-files          size       scanned
   failures          status
    ---------         -----------   -----------   -----------   ------
   -----   ------------
    localhost                   16      16777216            52
   0    in progress
   192.168.1.1                  13      16723211            47
   0    in progress
   ```

3. When the data migration shown in the previous **status** command is complete, run the following command to commit the brick removal:

   ```
   # gluster volume remove-brick VOLNAME BRICK commit
   ```

   For example,

```
# gluster volume remove-brick test-volume server2:/exp2 commit
```

4. After the brick removal, you can check the volume information using the following command:

```
# gluster volume info
```

The command displays information similar to the following:

```
# gluster volume info
Volume Name: test-volume
Type: Distribute
Status: Started
Number of Bricks: 3
Bricks:
Brick1: server1:/exp1
Brick3: server3:/exp3
Brick4: server4:/exp4
```

### 10.4.1. Shrinking a Geo-replicated Volume

1. Remove a brick using the following command:

```
# gluster volume remove-brick VOLNAME BRICK start
```

For example:

```
# gluster volume remove-brick MASTER_VOL MASTER_HOST:/exp2 start
Remove Brick start successful
```

**Note**

If the **remove-brick** command is run with **force** or without any option, the data on the brick that you are removing will no longer be accessible at the glusterFS mount point. When using the **start** option, the data is migrated to other bricks, and on a successful commit the removed brick's information is deleted from the volume configuration. Data can still be accessed directly on the brick.

2. Use geo-replication **config checkpoint** to ensure that all the data in that brick is synced to the slave.

   a. Set a checkpoint to help verify the status of the data synchronization.

```
# gluster volume geo-replication MASTER_VOL
SLAVE_HOST::SLAVE_VOL config checkpoint now
```

   b. Verify the checkpoint completion for the geo-replication session using the following command:

```
# gluster volume geo-replication MASTER_VOL
SLAVE_HOST::SLAVE_VOL status detail
```

3. You can view the status of the remove brick operation using the following command:

```
# gluster volume remove-brick VOLNAME BRICK status
```

For example:

```
# gluster volume remove-brick  MASTER_VOL MASTER_HOST:/exp2 status
```

4. Stop the geo-replication session between the master and the slave:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL stop
```

5. When the data migration shown in the previous **status** command is complete, run the following command to commit the brick removal:

```
# gluster volume remove-brick VOLNAME BRICK commit
```

For example,

```
# gluster volume remove-brick  MASTER_VOL MASTER_HOST:/exp2 commit
```

6. After the brick removal, you can check the volume information using the following command:

```
# gluster volume info
```

7. Start the geo-replication session between the hosts:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
start
```

## 10.4.2. Shrinking a Tiered Volume

You can shrink a tiered volume while the trusted storage pool is online and available. For example, you may need to remove a brick that has become inaccessible because of a hardware or network failure.

### 10.4.2.1. Shrinking a Cold Tier Volume

1. Detach the tier by performing the steps listed in Section 12.7, “Detaching a Tier from a Volume”

2. Remove a brick using the following command:

```
# gluster volume remove-brick VOLNAME BRICK start
```

For example:

```
# gluster volume remove-brick test-volume server2:/exp2 start
Remove Brick start successful
```

> **Note**
>
> If the **remove-brick** command is run with **force** or without any option, the data on the brick that you are removing will no longer be accessible at the glusterFS mount point. When using the **start** option, the data is migrated to other bricks, and on a successful commit the removed brick's information is deleted from the volume configuration. Data can still be accessed directly on the brick.

3. You can view the status of the remove brick operation using the following command:

```
# gluster volume remove-brick VOLNAME BRICK status
```

For example:

```
# gluster volume remove-brick test-volume server2:/exp2 status
      Node    Rebalanced-files          size       scanned
failures         status
 ---------         -----------   -----------   -----------   ------
-----   ------------
 localhost                   16      16777216           52
0    in progress
192.168.1.1                  13      16723211           47
0    in progress
```

4. When the data migration shown in the previous **status** command is complete, run the following command to commit the brick removal:

```
# gluster volume remove-brick VOLNAME BRICK commit
```

For example,

```
# gluster volume remove-brick test-volume server2:/exp2 commit
```

5. Rerun the attach-tier command only with the required set of bricks:

```
# gluster volume tier VOLNAME attach [replica COUNT] BRICK...
```

For example,

```
# gluster volume tier test-volume attach replica 2 server1:/exp1/tier1
server1:/exp2/tier2 server2:/exp3/tier3 server2:/exp5/tier5
```

> **Important**
>
> When you attach a tier, an internal process called fix-layout commences internally to prepare the hot tier for use. This process takes time and there will a delay in starting the tiering activities.

#### 10.4.2.2. Shrinking a Hot Tier Volume

You must first decide on which bricks should be part of the hot tiered volume and which bricks should be removed from the hot tier volume.

1. Detach the tier by performing the steps listed in Section 12.7, “Detaching a Tier from a Volume”

2. Rerun the attach-tier command only with the required set of bricks:

   **`# gluster volume tier VOLNAME attach [replica COUNT] brick...`**

> **Important**
>
> When you reattach a tier, an internal process called fix-layout commences internally to prepare the hot tier for use. This process takes time and there will a delay in starting the tiering activities.

### 10.4.3. Stopping a `remove-brick` Operation

> **Important**
>
> Stopping a **`remove-brick`** operation is a technology preview feature. Technology Preview features are not fully supported under Red Hat subscription level agreements (SLAs), may not be functionally complete, and are not intended for production use. However, these features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process. As Red Hat considers making future iterations of Technology Preview features generally available, we will provide commercially reasonable efforts to resolve any reported issues that customers experience when using these features.

A **`remove-brick`** operation that is in progress can be stopped by using the **`stop`** command.

> **Note**
>
> Files that were already migrated during **`remove-brick`** operation will not be migrated back to the same brick when the operation is stopped.

To stop remove brick operation, use the following command:

```
# gluster volume remove-brick VOLNAME BRICK stop
```

For example:

```
gluster volume remove-brick di rhs1:/brick1/di21 rhs1:/brick1/di21 stop

Node    Rebalanced-files    size     scanned  failures   skipped    status
run-time in secs
----      -------          ----       ----     ------     -----      -----
------
localhost     23           376Bytes    34         0          0       stopped
2.00
rhs1          0            0Bytes      88         0          0       stopped
```

```
2.00
rhs2           0            0Bytes       0         0         0      not
started  0.00
'remove-brick' process may be in the middle of a file migration.
The process will be fully stopped once the migration of the file is
complete.
Please check remove-brick process for completion before doing any further
brick related tasks on the volume.
```

## 10.5. Migrating Volumes

Data can be redistributed across bricks while the trusted storage pool is online and available.Before replacing bricks on the new servers, ensure that the new servers are successfully added to the trusted storage pool.

> **Note**
>
> Before performing a **`replace-brick`** operation, review the known issues related to **`replace-brick`** operation in the Red Hat Gluster Storage 3.1 Release Notes.

### 10.5.1. Replacing a Subvolume on a Distribute or Distribute-replicate Volume

This procedure applies only when at least one brick from the subvolume to be replaced is online. In case of a Distribute volume, the brick that must be replaced must be online. In case of a Distribute-replicate, at least one brick from the subvolume from the replica set that must be replaced must be online.

To replace the entire subvolume with new bricks on a *Distribute-replicate* volume, follow these steps:

1. Add the new bricks to the volume.

   ```
   # gluster volume add-brick VOLNAME [replica <COUNT>] NEW-BRICK
   ```

   **Example 10.1. Adding a Brick to a Distribute Volume**

   ```
   # gluster volume add-brick test-volume server5:/exp5
   Add Brick successful
   ```

2. Verify the volume information using the command:

   ```
   # gluster volume info
    Volume Name: test-volume
       Type: Distribute
       Status: Started
       Number of Bricks: 5
       Bricks:
       Brick1: server1:/exp1
       Brick2: server2:/exp2
       Brick3: server3:/exp3
       Brick4: server4:/exp4
       Brick5: server5:/exp5
   ```

> **Note**
>
> In case of a Distribute-replicate volume, you must specify the replica count in the **`add-brick`** command and provide the same number of bricks as the replica count to the **`add-brick`** command.

3. Remove the bricks to be replaced from the subvolume.

   a. Start the **`remove-brick`** operation using the command:

   ```
   # gluster volume remove-brick VOLNAME [replica <COUNT>] <BRICK>
   start
   ```

   **Example 10.2. Start a remove-brick operation on a distribute volume**

   ```
   # gluster volume remove-brick test-volume server2:/exp2 start
   Remove Brick start successful
   ```

   b. View the status of the **`remove-brick`** operation using the command:

   ```
   # gluster volume remove-brick VOLNAME [replica <COUNT>] BRICK
   status
   ```

   **Example 10.3. View the Status of remove-brick Operation**

   ```
   # gluster volume remove-brick test-volume server2:/exp2 status
   Node     Rebalanced-files size        scanned failures status
   -----------------------------------------------------------
   -------
   server2  16               16777216    52      0        in
   progress
   ```

   Keep monitoring the **`remove-brick`** operation status by executing the above command. When the value of the status field is set to **`complete`** in the output of **`remove-brick`** status command, proceed further.

   c. Commit the **`remove-brick`** operation using the command:

   ```
   # gluster volume remove-brick VOLNAME [replica <COUNT>] <BRICK>
   commit
   ```

   **Example 10.4. Commit the remove-brick Operation on a Distribute Volume**

   ```
   # gluster volume remove-brick test-volume server2:/exp2 commit
   ```

   d. Verify the volume information using the command:

```
# gluster volume info
Volume Name: test-volume
Type: Distribute
Status: Started
Number of Bricks: 4
Bricks:
Brick1: server1:/exp1
Brick3: server3:/exp3
Brick4: server4:/exp4
Brick5: server5:/exp5
```

e. Verify the content on the brick after committing the **remove-brick** operation on the volume. If there are any files leftover, copy it through FUSE or NFS mount.

   a. Verify if there are any pending files on the bricks of the subvolume.

      Along with files, all the application-specific extended attributes must be copied. glusterFS also uses extended attributes to store its internal data. The extended attributes used by glusterFS are of the form **trusted.glusterfs.***, **trusted.afr.***, and **trusted.gfid**. Any extended attributes other than ones listed above must also be copied.

      To copy the application-specific extended attributes and to achieve a an effect similar to the one that is described above, use the following shell script:

      Syntax:

```
# copy.sh <glusterfs-mount-point> <brick>
```

**Example 10.5. Code Snippet Usage**

If the mount point is **/mnt/glusterfs** and brick path is **/export/brick1**, then the script must be run as:

```
# copy.sh /mnt/glusterfs /export/brick
```

```
#!/bin/bash

MOUNT=$1
BRICK=$2

for file in `find $BRICK ! -type d`; do
    rpath=`echo $file | sed -e "s#$BRICK\(.*\)#\1#g"`
    rdir=`dirname $rpath`

    cp -fv $file $MOUNT/$rdir;

    for xattr in `getfattr -e hex -m. -d $file 2>/dev/null
| sed -e '/^#/d' | grep -v -E "trusted.glusterfs.*" | grep
-v -E "trusted.afr.*" | grep -v "trusted.gfid"`;
    do
        key=`echo $xattr | cut -d"=" -f 1`
```

```
            value=`echo $xattr | cut -d"=" -f 2`

            setfattr $MOUNT/$rpath -n $key -v $value
        done
    done
```

b. To identify a list of files that are in a split-brain state, execute the command:

```
# gluster volume heal test-volume info split-brain
```

c. If there are any files listed in the output of the above command, compare the files across the bricks in a replica set, delete the bad files from the brick and retain the correct copy of the file. Manual intervention by the System Administrator would be required to choose the correct copy of file.

### 10.5.2. Replacing an Old Brick with a New Brick on a Replicate or Distribute-replicate Volume

A single brick can be replaced during a hardware failure situation, such as a disk failure or a server failure. The brick that must be replaced could either be online or offline. This procedure is applicable for volumes with replication. In case of a *Replicate* or *Distribute-replicate* volume types, after replacing the brick, self-heal is triggered to heal the data on the new brick.

Procedure to replace an old brick with a new brick on a *Replicate* or *Distribute-replicate* volume:

1. Ensure that the new brick (**`sys5:/home/gfs/r2_5`**) that replaces the old brick (**`sys0:/home/gfs/r2_0`**) is empty. Ensure that all the bricks are online. The brick that must be replaced can be in an offline state.

2. Execute the **`replace-brick`** command with the **`force`** option:

```
# gluster volume replace-brick r2 sys0:/home/gfs/r2_0
sys5:/home/gfs/r2_5 commit force
volume replace-brick: success: replace-brick commit successful
```

3. Check if the new brick is online.

```
# gluster volume status
Status of volume: r2
Gluster process                        Port    Online    Pid
---------------------------------------------------------
Brick sys5:/home/gfs/r2_5              49156     Y    5731

Brick sys1:/home/gfs/r2_1              49153     Y    5354

Brick sys2:/home/gfs/r2_2              49154     Y    5365

Brick sys3:/home/gfs/r2_3              49155     Y    5376
```

4. Ensure that after the self-heal completes, the extended attributes are set to zero on the other bricks in the replica.

```
# getfattr -d -m. -e hex /home/gfs/r2_1
getfattr: Removing leading '/' from absolute path names
# file: home/gfs/r2_1
```

```
security.selinux=0x756e636f6e66696e65645f753a6f626a6563745f723a66696c6
55f743a733000
trusted.afr.r2-client-0=0x000000000000000000000000
trusted.afr.r2-client-1=0x000000000000000000000000
trusted.gfid=0x00000000000000000000000000000001
trusted.glusterfs.dht=0x0000000100000000000000007ffffffe
trusted.glusterfs.volume-id=0xde822e25ebd049ea83bfaa3c4be2b440
```

Note that in this example, the extended attributes **`trusted.afr.r2-client-0`** and **`trusted.afr.r2-client-1`** are set to zero.

### 10.5.3. Replacing an Old Brick with a New Brick on a Distribute Volume

**Important**

In case of a *Distribute* volume type, replacing a brick using this procedure will result in data loss.

1. Replace a brick with a commit **`force`** option:

```
# gluster volume replace-brick VOLNAME <BRICK> <NEW-BRICK> commit
force
```

**Example 10.6. Replace a brick on a Distribute Volume**

```
# gluster volume replace-brick r2 sys0:/home/gfs/r2_0
sys5:/home/gfs/r2_5 commit force
volume replace-brick: success: replace-brick commit successful
```

2. Verify if the new brick is online.

```
# gluster volume status
Status of volume: r2
Gluster process                         Port    Online    Pid
---------------------------------------------------------
Brick sys5:/home/gfs/r2_5                 49156    Y    5731

Brick sys1:/home/gfs/r2_1                 49153    Y    5354

Brick sys2:/home/gfs/r2_2                 49154    Y    5365

Brick sys3:/home/gfs/r2_3                 49155    Y    5376
```

**Note**

All the **`replace-brick`** command options except the commit **`force`** option are deprecated.

## 10.6. Replacing Hosts

### 10.6.1. Replacing a Host Machine with a Different Hostname

You can replace a failed host machine with another host that has a different hostname.

> **Important**
>
> Ensure that the new peer has the exact disk capacity as that of the one it is replacing. For example, if the peer in the cluster has two 100GB drives, then the new peer must have the same disk capacity and number of drives.

In the following example the original machine which has had an irrecoverable failure is **`sys0.example.com`** and the replacement machine is **`sys5.example.com`**. The brick with an unrecoverable failure is **`sys0.example.com:/rhs/brick1/b1`** and the replacement brick is **`sys5.example.com:/rhs/brick1/b1`**.

1. Probe the new peer from one of the existing peers to bring it into the cluster.

   ```
   # gluster peer probe sys5.example.com
   ```

2. Ensure that the new brick **`(sys5.example.com:/rhs/brick1/b1)`** that is replacing the old brick **`(sys0.example.com:/rhs/brick1/b1)`** is empty.

3. Retrieve the brick paths in **`sys0.example.com`** using the following command:

   ```
   # gluster volume info <VOLNAME>
   ```

   ```
   Volume Name: vol
   Type: Replicate
   Volume ID: 0xde822e25ebd049ea83bfaa3c4be2b440
   Status: Started
   Snap Volume: no
   Number of Bricks: 1 x 2 = 2
   Transport-type: tcp
   Bricks:
   Brick1: sys0.example.com:/rhs/brick1/b1
   Brick2: sys1.example.com:/rhs/brick1/b1
   Options Reconfigured:
   performance.readdir-ahead: on
   snap-max-hard-limit: 256
   snap-max-soft-limit: 90
   auto-delete: disable
   ```

   Brick path in **`sys0.example.com`** is **`/rhs/brick1/b1`**. This has to be replaced with the brick in the newly added host, **`sys5.example.com`**.

4. Create the required brick path in sys5.example.com.For example, if /rhs/brick is the XFS mount point in sys5.example.com, then create a brick directory in that path.

   ```
   # mkdir /rhs/brick1/b1
   ```

5. Execute the **`replace-brick`** command with the force option:

```
# gluster volume replace-brick vol sys0.example.com:/rhs/brick1/b1
sys5.example.com:/rhs/brick1/b1 commit force
volume replace-brick: success: replace-brick commit successful
```

6. Verify that the new brick is online.

```
# gluster volume status
Status of volume: vol
Gluster process                                         Port    Online Pid
Brick sys5.example.com:/rhs/brick1/b1                   49156     Y     5731
Brick sys1.example.com:/rhs/brick1/b1                   49153     Y     5354
```

7. Initiate self-heal on the volume. The status of the heal process can be seen by executing the command:

```
# gluster volume heal VOLNAME
```

8. The status of the heal process can be seen by executing the command:

```
# gluster volume heal VOLNAME info
```

9. Detach the original machine from the trusted pool.

```
# gluster peer detach sys0.example.com
```

10. Ensure that after the self-heal completes, the extended attributes are set to zero on the other bricks in the replica.

```
# getfattr -d -m. -e hex /rhs/brick1/b1
getfattr: Removing leading '/' from absolute path names
#file: rhs/brick1/b1
security.selinux=0x756e636f6e66696e65645f753a6f626a6563745f723a66696c6
55f743a733000
trusted.afr.vol-client-0=0x000000000000000000000000
trusted.afr.vol-client-1=0x000000000000000000000000
trusted.gfid=0x00000000000000000000000000000001
trusted.glusterfs.dht=0x0000000100000000000000007ffffffe
trusted.glusterfs.volume-id=0xde822e25ebd049ea83bfaa3c4be2b440
```

In this example, the extended attributes **`trusted.afr.vol-client-0`** and **`trusted.afr.vol-client-1`** have zero values. This means that the data on the two bricks is identical. If these attributes are not zero after self-heal is completed, the data has not been synchronised correctly.

## 10.6.2. Replacing a Host Machine with the Same Hostname

You can replace a failed host with another node having the same FQDN (Fully Qualified Domain Name). A host in a Red Hat Gluster Storage Trusted Storage Pool has its own identity called the UUID generated by the glusterFS Management Daemon.The UUID for the host is available in **`/var/lib/glusterd/glusterd/info`** file.

**Warning**

Do not perform this procedure on Geo-replicated volumes.

In the following example, the host with the FQDN as sys0.example.com was irrecoverable and must to be replaced with a host, having the same FQDN. The following steps have to be performed on the new host.

1. Stop the **glusterd** service on the sys0.example.com.

```
# service glusterd stop
```

2. Retrieve the UUID of the failed host (sys0.example.com) from another of the Red Hat Gluster Storage Trusted Storage Pool by executing the following command:

```
# gluster peer status
Number of Peers: 2

Hostname: sys1.example.com
Uuid: 1d9677dc-6159-405e-9319-ad85ec030880
State: Peer in Cluster (Connected)

Hostname: sys0.example.com
Uuid: b5ab2ec3-5411-45fa-a30f-43bd04caf96b
State: Peer Rejected (Connected)
```

Note that the UUID of the failed host is **b5ab2ec3-5411-45fa-a30f-43bd04caf96b**

3. Edit the **glusterd.info** file in the new host and include the UUID of the host you retrieved in the previous step.

```
# cat /var/lib/glusterd/glusterd.info
UUID=b5ab2ec3-5411-45fa-a30f-43bd04caf96b
operating-version=30703
```

4. Select any host (say for example, sys1.example.com) in the Red Hat Gluster Storage Trusted Storage Pool and retrieve its UUID from the **glusterd.info** file.

```
# grep -i uuid /var/lib/glusterd/glusterd.info
UUID=8cc6377d-0153-4540-b965-a4015494461c
```

5. Gather the peer information files from the host (sys1.example.com) in the previous step. Execute the following command in that host (sys1.example.com) of the cluster.

```
# cp -a /var/lib/glusterd/peers /tmp/
```

6. Remove the peer file corresponding to the failed host (sys0.example.com) from the **/tmp/peers** directory.

```
# rm /tmp/peers/b5ab2ec3-5411-45fa-a30f-43bd04caf96b
```

Note that the UUID corresponds to the UUID of the failed host (sys0.example.com) retrieved in Step 2.

7. Archive all the files and copy those to the failed host(sys0.example.com).

```
# cd /tmp; tar -cvf peers.tar peers
```

8. Copy the above created file to the new peer.

```
# scp /tmp/peers.tar root@sys0.example.com:/tmp
```

9. Copy the extracted content to the **/var/lib/glusterd/peers** directory. Execute the following command in the newly added host with the same name (sys0.example.com) and IP Address.

```
# tar -xvf /tmp/peers.tar
# cp peers/* /var/lib/glusterd/peers/
```

10. Select any other host in the cluster other than the node (sys1.example.com) selected in step 4. Copy the peer file corresponding to the UUID of the host retrieved in Step 4 to the new host (sys0.example.com) by executing the following command:

```
# scp /var/lib/glusterd/peers/<UUID-retrieved-from-step4>
root@Example1:/var/lib/glusterd/peers/
```

11. Retrieve the brick directory information, by executing the following command in any host in the cluster.

```
# gluster volume info
Volume Name: vol
Type: Replicate
Volume ID: 0x8f16258c88a0498fbd53368706af7496
Status: Started
Snap Volume: no
Number of Bricks: 1 x 2 = 2
Transport-type: tcp
Bricks:
Brick1: sys0.example.com:/rhs/brick1/b1
Brick2: sys1.example.com:/rhs/brick1/b1
Options Reconfigured:
performance.readdir-ahead: on
snap-max-hard-limit: 256
snap-max-soft-limit: 90
auto-delete: disable
```

In the above example, the brick path in sys0.example.com is, **/rhs/brick1/b1**. If the brick path does not exist in sys0.example.com, perform steps a, b, and c.

a. Create a brick path in the host, sys0.example.com.

```
mkdir /rhs/brick1/b1
```

b. Retrieve the volume ID from the existing brick of another host by executing the following command on any host that contains the bricks for the volume.

```
# getfattr -d -m. -ehex <brick-path>
```

Copy the volume-id.

```
# getfattr -d -m. -ehex /rhs/brick1/b1
getfattr: Removing leading '/' from absolute path names
# file: rhs/brick1/b1
trusted.afr.vol-client-0=0x000000000000000000000000
trusted.afr.vol-client-1=0x000000000000000000000000
trusted.gfid=0x00000000000000000000000000000001
trusted.glusterfs.dht=0x0000000100000000000000007ffffffe
trusted.glusterfs.volume-id=0x8f16258c88a0498fbd53368706af7496
```

In the above example, the volume id is 0x8f16258c88a0498fbd53368706af7496

c. Set this volume ID on the brick created in the newly added host and execute the following command on the newly added host (sys0.example.com).

```
# setfattr -n trusted.glusterfs.volume-id -v <volume-id> <brick-path>
```

For Example:

```
# setfattr -n trusted.glusterfs.volume-id -v
0x8f16258c88a0498fbd53368706af7496 /rhs/brick2/drv2
```

Data recovery is possible only if the volume type is replicate or distribute-replicate. If the volume type is plain distribute, you can skip steps 12 and 13.

12. Create a FUSE mount point to mount the glusterFS volume.

```
# mount -t glusterfs <server-name>:/VOLNAME <mount>
```

13. Perform the following operations to change the Automatic File Replication extended attributes so that the heal process happens from the other brick (sys1.example.com:/rhs/brick1/b1) in the replica pair to the new brick (sys0.example.com:/rhs/brick1/b1). Note that /mnt/r2 is the FUSE mount path.

a. Create a new directory on the mount point and ensure that a directory with such a name is not already present.

```
# mkdir /mnt/r2/<name-of-nonexistent-dir>
```

b. Delete the directory and set the extended attributes.

```
# rmdir /mnt/r2/<name-of-nonexistent-dir>
# setfattr -n trusted.non-existent-key -v abc /mnt/r2
# setfattr -x trusted.non-existent-key /mnt/r2
```

c. Ensure that the extended attributes on the other bricks in the replica (in this example, **trusted.afr.vol-client-0**) is not set to zero.

```
# getfattr -d -m. -e hex /rhs/brick1/b1 # file: rhs/brick1/b1
security.selinux=0x756e636f6e66696e65645f753a6f626a6563745f723a6
6696c655f743a733000
trusted.afr.vol-client-0=0x000000000000000300000002
```

```
trusted.afr.vol-client-1=0x000000000000000000000000
trusted.gfid=0x00000000000000000000000000000001
trusted.glusterfs.dht=0x0000000100000000000000007ffffffe
trusted.glusterfs.volume-id=0x8f16258c88a0498fbd53368706af7496
```

14. Start the **glusterd** service.

```
# service glusterd start
```

15. Perform the self-heal operation on the restored volume.

```
# gluster volume heal VOLNAME
```

16. You can view the gluster volume self-heal status by executing the following command:

```
# gluster volume heal VOLNAME info
```

### Replacing a host with the same Hostname in a two-node Red Hat Gluster Storage Trusted Storage Pool

If there are only 2 hosts in the Red Hat Gluster Storage Trusted Storage Pool where the host sys0.example.com must be replaced, perform the following steps:

1. Stop the **glusterd** service on sys0.example.com.

```
# service glusterd stop
```

2. Retrieve the UUID of the failed host (sys0.example.com) from another peer in the Red Hat Gluster Storage Trusted Storage Pool by executing the following command:

```
# gluster peer status
Number of Peers: 1

Hostname: sys0.example.com
Uuid: b5ab2ec3-5411-45fa-a30f-43bd04caf96b
State: Peer Rejected (Connected)
```

Note that the UUID of the failed host is **b5ab2ec3-5411-45fa-a30f-43bd04caf96b**

3. Edit the **glusterd.info** file in the new host (sys0.example.com) and include the UUID of the host you retrieved in the previous step.

```
# cat /var/lib/glusterd/glusterd.info
UUID=b5ab2ec3-5411-45fa-a30f-43bd04caf96b
operating-version=30703
```

4. Create the peer file in the newly created host (sys0.example.com) in /var/lib/glusterd/peers/<uuid-of-other-peer> with the name of the UUID of the other host (sys1.example.com).

UUID of the host can be obtained with the following:

```
# gluster system:: uuid get
```

**Example 10.7. Example to obtain the UUID of a host**

```
For example,
# gluster system:: uuid get
UUID: 1d9677dc-6159-405e-9319-ad85ec030880
```

In this case the UUID of other peer is **`1d9677dc-6159-405e-9319-ad85ec030880`**

5. Create a file **`/var/lib/glusterd/peers/1d9677dc-6159-405e-9319-ad85ec030880`** in sys0.example.com, with the following command:

```
# touch /var/lib/glusterd/peers/1d9677dc-6159-405e-9319-ad85ec030880
```

The file you create must contain the following information:

```
UUID=<uuid-of-other-node>
state=3
hostname=<hostname>
```

6. Continue to perform steps 11 to 16 as documented in the previous procedure.

## 10.7. Rebalancing Volumes

If a volume has been expanded or shrunk using the **`add-brick`** or **`remove-brick`** commands, the data on the volume needs to be rebalanced among the servers.

**Note**

In a non-replicated volume, all bricks should be online to perform the **`rebalance`** operation using the start option. In a replicated volume, at least one of the bricks in the replica should be online.

To rebalance a volume, use the following command on any of the servers:

```
# gluster volume rebalance VOLNAME start
```

For example:

```
# gluster volume rebalance test-volume start
Starting rebalancing on volume test-volume has been successful
```

A **`rebalance`** operation, without **`force`** option, will attempt to balance the space utilized across nodes, thereby skipping files to rebalance in case this would cause the target node of migration to have lesser available space than the source of migration. This leads to link files that are still left behind in the system and hence may cause performance issues in access when a large number of such link files are present.

Enhancements made to the file rename and rebalance operations in Red Hat Gluster Storage 2.1 update 5 requires that all the clients connected to a cluster operate with the same or later versions. If the clients operate on older versions, and a rebalance operation is performed, the following warning message is displayed and the rebalance operation will not be executed.

```
volume rebalance: VOLNAME: failed: Volume VOLNAME has one or more connected
clients of a version lower than Red Hat Gluster Storage-2.1 update 5.
Starting rebalance in this state could lead to data loss.
Please disconnect those clients before attempting this command again.
```

Red Hat strongly recommends you to disconnect all the older clients before executing the rebalance command to avoid a potential data loss scenario.

> **Warning**
>
> The **`Rebalance`** command can be executed with the force option even when the older clients are connected to the cluster. However, this could lead to a data loss situation.

A **`rebalance`** operation with **`force`**, balances the data based on the layout, and hence optimizes or does away with the link files, but may lead to an imbalanced storage space used across bricks. This option is to be used only when there are a large number of link files in the system.

To rebalance a volume forcefully, use the following command on any of the servers:

```
# gluster volume rebalance VOLNAME start force
```

For example:

```
# gluster volume rebalance test-volume start force
Starting rebalancing on volume test-volume has been successful
```

### 10.7.1. Rebalance Throttling

Rebalance process is made multithreaded to handle multiple files migration for enhancing the performance. During multiple file migration, there can be a severe impact on storage system performance and a throttling mechanism is provided to manage it.

By default, the rebalance throttling is started in the **`normal`** mode. Configure the throttling modes to adjust the rate at which the files must be migrated

```
# gluster volume set VOLNAME rebal-throttle lazy|normal|aggressive
```

For example:

```
# gluster volume set test-volume rebal-throttle lazy
```

### 10.7.2. Displaying Status of a Rebalance Operation

To display the status of a volume rebalance operation, use the following command:

```
# gluster volume rebalance VOLNAME status
```

For example:

```
# gluster volume rebalance test-volume status
```

```
     Node    Rebalanced-files          size        scanned       failures
status
---------        -----------   -----------   -----------   -----------
------------
localhost                 112         14567            150              0
in progress
10.16.156.72              140          2134            201              2
in progress
```

The time taken to complete the rebalance operation depends on the number of files on the volume and their size. Continue to check the rebalancing status, and verify that the number of rebalanced or scanned files keeps increasing.

For example, running the status command again might display a result similar to the following:

```
# gluster volume rebalance test-volume status
     Node    Rebalanced-files          size        scanned       failures
status
---------        -----------   -----------   -----------   -----------
------------
localhost                 112         14567            150              0
in progress
10.16.156.72              140          2134            201              2
in progress
```

The rebalance status will be shown as **`completed`** the following when the rebalance is complete:

```
# gluster volume rebalance test-volume status
     Node    Rebalanced-files          size        scanned       failures
status
---------        -----------   -----------   -----------   -----------
------------
localhost                 112         15674            170              0
completed
10.16.156.72              140          3423            321              2
completed
```

### 10.7.3. Stopping a Rebalance Operation

To stop a rebalance operation, use the following command:

```
# gluster volume rebalance VOLNAME stop
```

For example:

```
# gluster volume rebalance test-volume stop
     Node    Rebalanced-files          size        scanned       failures
status
---------        -----------   -----------   -----------   -----------
------------
localhost                 102         12134            130              0
```

```
stopped
10.16.156.72              110          2123          121          2
stopped
Stopped rebalance process on volume test-volume
```

## 10.8. Setting up Shared Storage Volume

Features like Snapshot Scheduler, NFS Ganesha and geo-replication require a shared storage to be available across all nodes of the cluster. A gluster volume named **gluster_shared_storage** is made available for this purpose, and is facilitated by the following volume set option.

```
cluster.enable-shared-storage
```

This option accepts the following two values:

- **enable**

  When the volume set option is enabled, a gluster volume named **gluster_shared_storage** is created in the cluster, and is mounted at **/var/run/gluster/shared_storage** on all the nodes in the cluster.

  > **Note**
  >
  > - This option cannot be enabled if there is only one node present in the cluster, or if only one node is online in the cluster.
  > - The volume created is either a replica 2, or a replica 3 volume. This depends on the number of nodes which are online in the cluster at the time of enabling this option and each of these nodes will have one brick participating in the volume. The brick path participating in the volume is **/var/lib/glusterd/ss_brick.**
  > - The mount entry is also added to **/etc/fstab** as part of **enable**.
  > - Before enabling this feature make sure that there is no volume named **gluster_shared_storage** in the cluster. This volume name is reserved for internal use only

  After successfully setting up the shared storage volume, when a new node is added to the cluster, the shared storage is not mounted automatically on this node. Neither is the **/etc/fstab** entry added for the shared storage on this node. To make use of shared storage on this node, execute the following commands:

  ```
  # mount -t glusterfs <local node's ip>:gluster_shared_storage
  /var/run/gluster/shared_storage
  # cp /etc/fstab /var/run/gluster/fstab.tmp
  # echo "<local node's ip>:/gluster_shared_storage
  /var/run/gluster/shared_storage/ glusterfs defaults 0 0" >> /etc/fstab
  ```

- **disable**

  When the volume set option is disabled, the **gluster_shared_storage** volume is unmounted on all the nodes in the cluster, and then the volume is deleted. The mount entry from **/etc/fstab** as part of **disable** is also removed.

For example:

```
# gluster volume set all cluster.enable-shared-storage enable
volume set: success
```

## 10.9. Stopping Volumes

To stop a volume, use the following command:

```
# gluster volume stop VOLNAME
```

For example, to stop test-volume:

```
# gluster volume stop test-volume
Stopping volume will make its data inaccessible. Do you want to continue?
(y/n) y
Stopping volume test-volume has been successful
```

## 10.10. Deleting Volumes

To delete a volume, use the following command:

```
# gluster volume delete VOLNAME
```

For example, to delete test-volume:

```
# gluster volume delete test-volume
Deleting volume will erase all information about the volume. Do you want to
continue? (y/n) y
Deleting volume test-volume has been successful
```

## 10.11. Managing Split-brain

Split-brain is a state when a data or availability inconsistencies originating from the maintenance of two separate data sets with overlap in scope, either because of servers in a network design, or a failure condition based on servers not communicating and synchronizing their data to each other.

In Red Hat Gluster Storage, split-brain is a term applicable to Red Hat Gluster Storage volumes in a replicate configuration. A file is said to be in split-brain when the copies of the same file in different bricks that constitute the replica-pair have mismatching data and/or meta-data contents such that they are conflicting each other and automatic healing is not possible. In this scenario, you can decide which is the correct file (source) and which is the one that require healing (sink) by inspecting at the mismatching files from the backend bricks.

The AFR translator in glusterFS makes use of extended attributes to keep track of the operations on a file. These attributes determine which brick is the source and which brick is the sink for a file that require healing. If the files are clean, the extended attributes are all zeroes indicating that no heal is necessary. When a heal is required, they are marked in such a way that there is a distinguishable source and sink and the heal can happen automatically. But, when a split brain occurs, these extended attributes are marked in such a way that both bricks mark themselves as sources, making automatic healing impossible.

When a split-brain occurs, applications cannot perform certain operations like *read* and *write* on the file. Accessing the files results in the application receiving an Input/Output Error.

The three types of split-brains that occur in Red Hat Gluster Storage are:

- Data split-brain: Contents of the file under split-brain are different in different replica pairs and automatic healing is not possible.
- Metadata split-brain : The metadata of the files (example, user defined extended attribute) are different and automatic healing is not possible.
- Entry split-brain: This happens when a file have different gfids on each of the replica pair.

The only way to resolve split-brains is by manually inspecting the file contents from the backend and deciding which is the true copy (source ) and modifying the appropriate extended attributes such that healing can happen automatically.

### 10.11.1. Preventing Split-brain

To prevent split-brain in the trusted storage pool, you must configure server-side and client-side quorum.

#### 10.11.1.1. Configuring Server-Side Quorum

The quorum configuration in a trusted storage pool determines the number of server failures that the trusted storage pool can sustain. If an additional failure occurs, the trusted storage pool will become unavailable. If too many server failures occur, or if there is a problem with communication between the trusted storage pool nodes, it is essential that the trusted storage pool be taken offline to prevent data loss.

After configuring the quorum ratio at the trusted storage pool level, you must enable the quorum on a particular volume by setting **`cluster.server-quorum-type`** volume option as **`server`**. For more information on this volume option, see Section 10.1, “Configuring Volume Options”.

Configuration of the quorum is necessary to prevent network partitions in the trusted storage pool. Network Partition is a scenario where, a small set of nodes might be able to communicate together across a functioning part of a network, but not be able to communicate with a different set of nodes in another part of the network. This can cause undesirable situations, such as split-brain in a distributed system. To prevent a split-brain situation, all the nodes in at least one of the partitions must stop running to avoid inconsistencies.

This quorum is on the server-side, that is, the **`glusterd`** service. Whenever the **`glusterd`** service on a machine observes that the quorum is not met, it brings down the bricks to prevent data split-brain. When the network connections are brought back up and the quorum is restored, the bricks in the volume are brought back up. When the quorum is not met for a volume, any commands that update the volume configuration or peer addition or detach are not allowed. It is to be noted that both, the **`glusterd`** service not running and the network connection between two machines being down are treated equally.

You can configure the quorum percentage ratio for a trusted storage pool. If the percentage ratio of the quorum is not met due to network outages, the bricks of the volume participating in the quorum in those nodes are taken offline. By default, the quorum is met if the percentage of active nodes is more than 50% of the total storage nodes. However, if the quorum ratio is manually configured, then the quorum is met only if the percentage of active storage nodes of the total storage nodes is greater than *or equal to* the set value.

To configure the quorum ratio, use the following command:

```
# gluster volume set all cluster.server-quorum-ratio PERCENTAGE
```

For example, to set the quorum to 51% of the trusted storage pool:

```
# gluster volume set all cluster.server-quorum-ratio 51%
```

In this example, the quorum ratio setting of 51% means that more than half of the nodes in the trusted storage pool must be online and have network connectivity between them at any given time. If a network disconnect happens to the storage pool, then the bricks running on those nodes are stopped to prevent further writes.

You must ensure to enable the quorum on a particular volume to participate in the server-side quorum by running the following command:

```
# gluster volume set VOLNAME cluster.server-quorum-type server
```

**Important**

For a two-node trusted storage pool, it is important to set the quorum ratio to be *greater than* 50% so that two nodes separated from each other do not both believe they have a quorum.

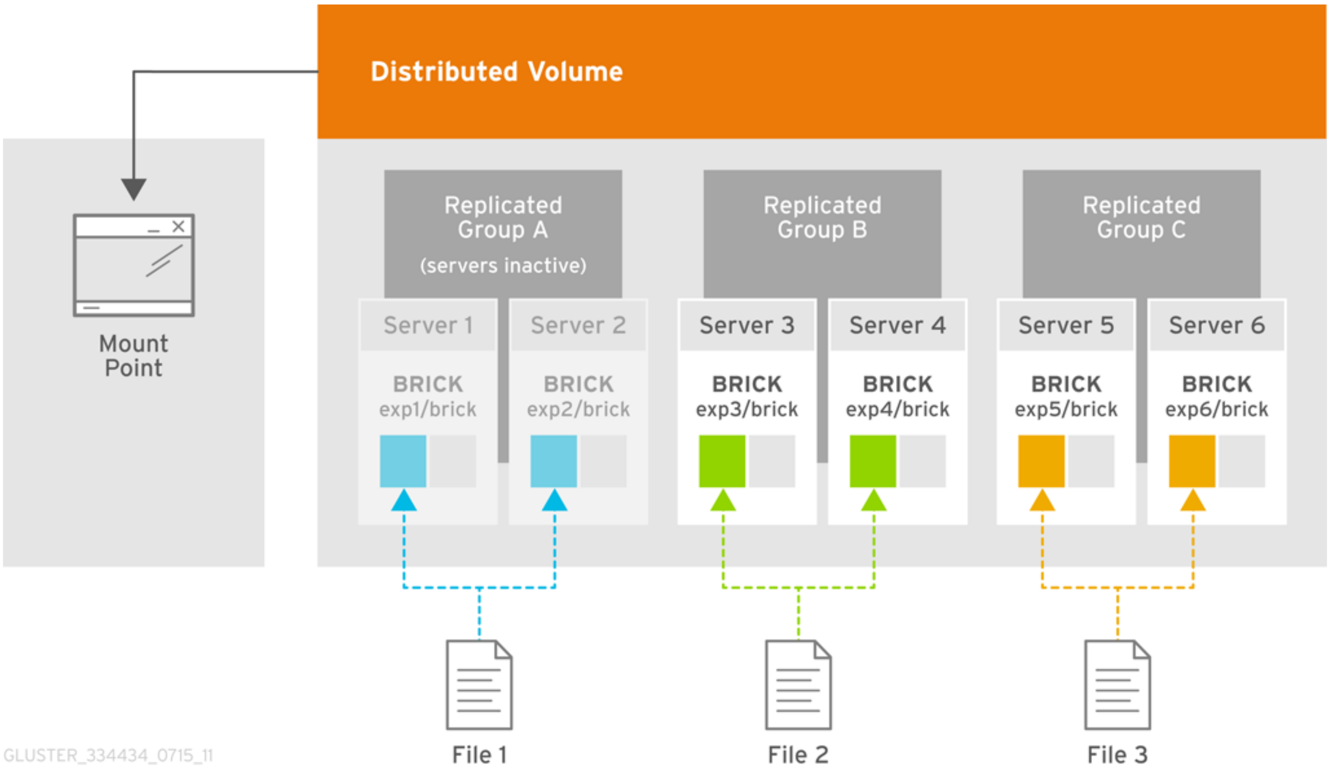
For a replicated volume with two nodes and one brick on each machine, if the server-side quorum is enabled and one of the nodes goes offline, the other node will also be taken offline because of the quorum configuration. As a result, the high availability provided by the replication is ineffective. To prevent this situation, a dummy node can be added to the trusted storage pool which does not contain any bricks. This ensures that even if one of the nodes which contains data goes offline, the other node will remain online. Note that if the dummy node and one of the data nodes goes offline, the brick on other node will be also be taken offline, and will result in data unavailability.

#### 10.11.1.2. Configuring Client-Side Quorum

Replication in Red Hat Gluster Storage Server allows modifications as long as at least one of the bricks in a replica group is online. In a network-partition scenario, different clients connect to different bricks in the replicated environment. In this situation different clients may modify the same file on different bricks. When a client is witnessing brick disconnections, a file could be modified on different bricks at different times while the other brick is off-line in the replica. For example, in a 1 X 2 replicate volume, while modifying the same file, it can so happen that client C1 can connect only to brick B1 and client C2 can connect only to brick B2. These situations lead to split-brain and the file becomes unusable and manual intervention is required to fix this issue.

Client-side quorum is implemented to minimize split-brains. Client-side quorum configuration determines the number of bricks that must be up for it to allow data modification. If client-side quorum is not met, files in that replica group become read-only. This client-side quorum configuration applies for all the replica groups in the volume, if client-side quorum is not met for `m` of `n` replica groups only `m` replica groups becomes read-only and the rest of the replica groups continue to allow data modifications.

**Example 10.8. Client-Side Quorum**




In the above scenario, when the client-side quorum is not met for replica group **A**, only replica group **A** becomes read-only. Replica groups **B** and **C** continue to allow data modifications.

## Important

1. If **`cluster.quorum-type`** is **`fixed`**, writes will continue till number of bricks up and running in replica pair is equal to the count specified in **`cluster.quorum-count`** option. This is irrespective of first or second or third brick. All the bricks are equivalent here.
2. If **`cluster.quorum-type`** is **`auto`**, then at least ceil (n/2) number of bricks need to be up to allow writes, where **`n`** is the replica count. For example,

   ```
   for replica 2, ceil(2/2)= 1 brick
   for replica 3, ceil(3/2)= 2 bricks
   for replica 4, ceil(4/2)= 2 bricks
   for replica 5, ceil(5/2)= 3 bricks
   for replica 6, ceil(6/2)= 3 bricks
   and so on
   ```

   In addition, for **`auto`**, if the number of bricks that are up is exactly ceil (n/2),**and** **`n`** is an even number, then the first brick of the replica must also be up to allow writes. For replica 6, if more than 3 bricks are up, then it can be any of the bricks. But if exactly 3 bricks are up, then the first brick has to be up and running.
3. In a three-way replication setup, it is recommended to set **`cluster.quorum-type`** to **`auto`** to avoid split brains. If the quorum is not met, the replica pair becomes read-only.

Configure the client-side quorum using **`cluster.quorum-type`** and **`cluster.quorum-count`** options. For more information on these options, see Section 10.1, “Configuring Volume Options”.

## Important

When you integrate Red Hat Gluster Storage with Red Hat Enterprise Virtualization or Red Hat OpenStack, the client-side quorum is enabled when you run **`gluster volume set`** ***`VOLNAME`*** **`group virt`** command. If on a two replica set up, if the first brick in the replica pair is offline, virtual machines will be paused because quorum is not met and writes are disallowed.

Consistency is achieved at the cost of fault tolerance. If fault-tolerance is preferred over consistency, disable client-side quorum with the following command:

```
# gluster volume reset VOLNAME quorum-type
```

### Example - Setting up server-side and client-side quorum to avoid split-brain scenario

This example provides information on how to set server-side and client-side quorum on a Distribute Replicate volume to avoid split-brain scenario. The configuration of this example has 2 X 2 ( 4 bricks) Distribute Replicate setup.

```
# gluster volume info testvol
Volume Name: testvol
Type: Distributed-Replicate
Volume ID: 0df52d58-bded-4e5d-ac37-4c82f7c89cfh
Status: Created
Number of Bricks: 2 x 2 = 4
Transport-type: tcp
Bricks:
Brick1: server1:/bricks/brick1
Brick2: server2:/bricks/brick2
Brick3: server3:/bricks/brick3
Brick4: server4:/bricks/brick4
```

**Setting Server-side Quorum**

Enable the quorum on a particular volume to participate in the server-side quorum by running the following command:

```
# gluster volume set VOLNAME cluster.server-quorum-type server
```

Set the quorum to 51% of the trusted storage pool:

```
# gluster volume set all cluster.server-quorum-ratio 51%
```

In this example, the quorum ratio setting of 51% means that more than half of the nodes in the trusted storage pool must be online and have network connectivity between them at any given time. If a network disconnect happens to the storage pool, then the bricks running on those nodes are stopped to prevent further writes.

**Setting Client-side Quorum**

Set the **`quorum-type`**option to **`auto`** to allow writes to the file only if the percentage of active replicate bricks is more than 50% of the total number of bricks that constitute that replica.

```
# gluster volume set VOLNAME quorum-type auto
```

In this example, as there are only two bricks in the replica pair, the first brick must be up and running to allow writes.

> **Important**
>
> Atleast n/2 bricks need to be up for the quorum to be met. If the number of bricks (**n**) in a replica set is an even number, it is mandatory that the **n/2** count must consist of the primary brick and it must be up and running. If **n** is an odd number, the **n/2** count can have any brick up and running, that is, the primary brick need not be up and running to allow writes.

## 10.11.2. Recovering from File Split-brain

You can recover from the data and meta-data split-brain using one of the following methods:

- See Section 10.11.2.1, " Recovering File Split-brain from the Mount Point" for information on how to recover from data and meta-data split-brain from the mount point.
- See Section 10.11.2.2, "Recovering File Split-brain from the gluster CLI" for information on how to recover from data and meta-data split-brain using CLI

For information on resolving **gfid/entry** split-brain, see Chapter 30, *Manually Recovering File Split-brain* .

### 10.11.2.1. Recovering File Split-brain from the Mount Point

**Steps to recover from a split-brain from the mount point**

1. You can use a set of **getfattr** and **setfattr** commands to detect the data and meta-data split-brain status of a file and resolve split-brain from the mount point.

   > **Important**
   >
   > This process for split-brain resolution from mount will not work on NFS mounts as it does not provide extended attributes support.

   In this example, the **test-volume** volume has bricks **b0**, **b1**, **b2** and **b3**.

   ```
   # gluster volume info test-volume
   Volume Name: test-volume
   Type: Distributed-Replicate
   Status: Started
   Number of Bricks: 2 x 2 = 4
   Transport-type: tcp
   Bricks:
   Brick1: test-host:/test/b0
   Brick2: test-host:/test/b1
   Brick3: test-host:/test/b2
   Brick4: test-host:/test/b3
   ```

   Directory structure of the bricks is as follows:

```
# tree -R /test/b?
/test/b0
├── dir
│   └── a
└── file100

/test/b1
├── dir
│   └── a
└── file100

/test/b2
├── dir
├── file1
├── file2
└── file99

/test/b3
├── dir
├── file1
├── file2
└── file99
```

In the following output, some of the files in the volume are in split-brain.

```
# gluster volume heal test-volume info split-brain
Brick test-host:/test/b0/
/file100
/dir
Number of entries in split-brain: 2

Brick test-host:/test/b1/
/file100
/dir
Number of entries in split-brain: 2

Brick test-host:/test/b2/
/file99
<gfid:5399a8d1-aee9-4653-bb7f-606df02b3696>
Number of entries in split-brain: 2

Brick test-host:/test/b3/
<gfid:05c4b283-af58-48ed-999e-4d706c7b97d5>
<gfid:5399a8d1-aee9-4653-bb7f-606df02b3696>
Number of entries in split-brain: 2
```

To know data or meta-data split-brain status of a file:

```
# getfattr -n replica.split-brain-status <path-to-file>
```

The above command executed from mount provides information if a file is in data or meta-data split-brain. This command is not applicable to gfid/entry split-brain.

For example,

- **`file100`** is in meta-data split-brain. Executing the above mentioned command for **`file100`** gives :

  ```
  # getfattr -n replica.split-brain-status file100
  # file: file100
  replica.split-brain-status="data-split-brain:no    metadata-split-brain:yes    Choices:test-client-0,test-client-1"
  ```

- **`file1`** is in data split-brain.

  ```
  # getfattr -n replica.split-brain-status file1
  # file: file1
  replica.split-brain-status="data-split-brain:yes    metadata-split-brain:no    Choices:test-client-2,test-client-3"
  ```

- **`file99`** is in both data and meta-data split-brain.

  ```
  # getfattr -n replica.split-brain-status file99
  # file: file99
  replica.split-brain-status="data-split-brain:yes    metadata-split-brain:yes    Choices:test-client-2,test-client-3"
  ```

- **`dir`** is in **`gfid/entry`** split-brain but as mentioned earlier, the above command is does not display if the file is in **`gfid/entry`** split-brain. Hence, the command displays **`The file is not under data or metadata split-brain`**. For information on resolving gfid/entry split-brain, see Chapter 30, *Manually Recovering File Split-brain* .

  ```
  # getfattr -n replica.split-brain-status dir
  # file: dir
  replica.split-brain-status="The file is not under data or metadata split-brain"
  ```

- **`file2`** is not in any kind of split-brain.

  ```
  # getfattr -n replica.split-brain-status file2
  # file: file2
  replica.split-brain-status="The file is not under data or metadata split-brain"
  ```

2. **Analyze the files in data and meta-data split-brain and resolve the issue**

   When you perform operations like **`cat`**, **`getfattr`**, and more from the mount on files in split-brain, it throws an input/output error. For further analyzing such files, you can use **`setfattr`** command.

   ```
   # setfattr -n replica.split-brain-choice -v "choiceX" <path-to-file>
   ```

   Using this command, a particular brick can be chosen to access the file in split-brain.

   For example,

   **`file1`** is in data-split-brain and when you try to read from the file, it throws input/output error.

```
# cat file1
cat: file1: Input/output error
```

Split-brain choices provided for file1 were **test-client-2** and **test-client-3**.

Setting **test-client-2** as split-brain choice for file1 serves reads from **b2** for the file.

```
# setfattr -n replica.split-brain-choice -v test-client-2 file1
```

Now, you can perform operations on the file. For example, read operations on the file:

```
# cat file1
xyz
```

Similarly, to inspect the file from other choice, **replica.split-brain-choice** is to be set to **test-client-3**.

Trying to inspect the file from a wrong choice errors out. You can undo the split-brain-choice that has been set, the above mentioned **setfattr** command can be used with **none** as the value for extended attribute.

For example,

```
# setfattr -n replica.split-brain-choice -v none file1
```

Now performing **cat** operation on the file will again result in input/output error, as before.

```
# cat file
cat: file1: Input/output error
```

After you decide which brick to use as a source for resolving the split-brain, it must be set for the healing to be done.

```
# setfattr -n replica.split-brain-heal-finalize -v <heal-choice>
<path-to-file>
```

Example

```
# setfattr -n replica.split-brain-heal-finalize -v test-client-2 file1
```

The above process can be used to resolve data and/or meta-data split-brain on all the files.

**Setting the split-brain-choice on the file**

After setting the split-brain-choice on the file, the file can be analyzed only for five minutes. If the duration of analyzing the file needs to be increased, use the following command and set the required time in **timeout-in-minute** argument.

```
# setfattr -n replica.split-brain-choice-timeout -v <timeout-in-
minutes> <mount_point/file>
```

This is a global timeout and is applicable to all files as long as the mount exists. The timeout need not be set each time a file needs to be inspected but for a new mount it will have to be set again for the first time. This option becomes invalid if the operations like add-brick or remove-brick are performed.

**Note**

If **`fopen-keep-cache`** FUSE mount option is disabled, then inode must be invalidated each time before selecting a new **`replica.split-brain-choice`** to inspect a file using the following command:

```
# setfattr -n inode-invalidate -v 0 <path-to-file>
```

### 10.11.2.2. Recovering File Split-brain from the gluster CLI

You can resolve the split-brin from the gluster CLI by the following ways:

- Use bigger-file as source
- Use one replica as source for a particular file
- Use one replica as source for all files

**Note**

The **`entry/gfid`** split-brain resolution is not supported using CLI. For information on resolving **`gfid/entry`** split-brain, see Chapter 30, *Manually Recovering File Split-brain* .

#### Selecting the bigger-file as source

This method is useful for per file healing and where you can decided that the file with bigger size is to be considered as source.

1. Run the following command to obtain the list of files that are in split-brain:

```
# gluster volume heal VOLNAME info split-brain
```

```
Brick <hostname:brickpath-b1>
<gfid:aaca219f-0e25-4576-8689-3bfd93ca70c2>
<gfid:39f301ae-4038-48c2-a889-7dac143e82dd>
<gfid:c3c94de2-232d-4083-b534-5da17fc476ac>
Number of entries in split-brain: 3

Brick <hostname:brickpath-b2>
/dir/file1
/dir
/file4
Number of entries in split-brain: 3
```

From the command output, identify the files that are in split-brain.

You can find the differences in the file size and md5 checksums by performing a stat and md5 checksums on the file from the bricks. The following is the stat and md5 checksum output of a file:

```
On brick b1:
# stat b1/dir/file1
  File: ‘b1/dir/file1’
  Size: 17              Blocks: 16         IO Block: 4096   regular
file
Device: fd03h/64771d    Inode: 919362      Links: 2
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/
root)
Access: 2015-03-06 13:55:40.149897333 +0530
Modify: 2015-03-06 13:55:37.206880347 +0530
Change: 2015-03-06 13:55:37.206880347 +0530
 Birth: -

# md5sum b1/dir/file1
040751929ceabf77c3c0b3b662f341a8  b1/dir/file1

On brick b2:
# stat b2/dir/file1
  File: ‘b2/dir/file1’
  Size: 13              Blocks: 16         IO Block: 4096   regular
file
Device: fd03h/64771d    Inode: 919365      Links: 2
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/
root)
Access: 2015-03-06 13:54:22.974451898 +0530
Modify: 2015-03-06 13:52:22.910758923 +0530
Change: 2015-03-06 13:52:22.910758923 +0530
 Birth: -

# md5sum b2/dir/file1
cb11635a45d45668a403145059c2a0d5  b2/dir/file1
```

You can notice the differences in the file size and md5 checksums.

2. Execute the following command along with the full file name as seen from the root of the volume (or) the gfid-string representation of the file, which is displayed in the heal info command's output.

```
# gluster volume heal <VOLNAME> split-brain bigger-file <FILE>
```

For example,

```
# gluster volume heal test-volume split-brain bigger-file /dir/file1
Healed /dir/file1.
```

After the healing is complete, the md5sum and file size on both bricks must be same. The following is a sample output of the stat and md5 checksums command after completion of healing the file.

```
On brick b1:
# stat b1/dir/file1
  File: ‘b1/dir/file1’
  Size: 17              Blocks: 16         IO Block: 4096   regular file
Device: fd03h/64771d    Inode: 919362      Links: 2
```

```
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/    root)
Access: 2015-03-06 14:17:27.752429505 +0530
Modify: 2015-03-06 13:55:37.206880347 +0530
Change: 2015-03-06 14:17:12.880343950 +0530
 Birth: -

# md5sum b1/dir/file1
040751929ceabf77c3c0b3b662f341a8  b1/dir/file1

On brick b2:
# stat b2/dir/file1
  File: ‘b2/dir/file1’
  Size: 17              Blocks: 16         IO Block: 4096   regular file
Device: fd03h/64771d    Inode: 919365      Links: 2
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/    root)
Access: 2015-03-06 14:17:23.249403600 +0530
Modify: 2015-03-06 13:55:37.206880000 +0530
Change: 2015-03-06 14:17:12.881343955 +0530
 Birth: -

# md5sum b2/dir/file1
040751929ceabf77c3c0b3b662f341a8  b2/dir/file1
```

### Selecting one replica as source for a particular file

This method is useful if you know which file is to be considered as source.

1. Run the following command to obtain the list of files that are in split-brain:

   ```
   # gluster volume heal VOLNAME info split-brain
   ```

   ```
   Brick <hostname:brickpath-b1>
   <gfid:aaca219f-0e25-4576-8689-3bfd93ca70c2>
   <gfid:39f301ae-4038-48c2-a889-7dac143e82dd>
   <gfid:c3c94de2-232d-4083-b534-5da17fc476ac>
   Number of entries in split-brain: 3

   Brick <hostname:brickpath-b2>
   /dir/file1
   /dir
   /file4
   Number of entries in split-brain: 3
   ```

   From the command output, identify the files that are in split-brain.

   You can find the differences in the file size and md5 checksums by performing a stat and md5 checksums on the file from the bricks. The following is the stat and md5 checksum output of a file:

   ```
   On brick b1:

    stat b1/file4
     File: ‘b1/file4’
     Size: 4              Blocks: 16         IO Block: 4096   regular
   file
   Device: fd03h/64771d    Inode: 919356      Links: 2
   ```

```
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/
root)
Access: 2015-03-06 13:53:19.417085062 +0530
Modify: 2015-03-06 13:53:19.426085114 +0530
Change: 2015-03-06 13:53:19.426085114 +0530
 Birth: -

# md5sum b1/file4
b6273b589df2dfdbd8fe35b1011e3183  b1/file4

On brick b2:

# stat b2/file4
  File: ‘b2/file4’
  Size: 4               Blocks: 16         IO Block: 4096   regular
file
Device: fd03h/64771d    Inode: 919358      Links: 2
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/
root)
Access: 2015-03-06 13:52:35.761833096 +0530
Modify: 2015-03-06 13:52:35.769833142 +0530
Change: 2015-03-06 13:52:35.769833142 +0530
 Birth: -

# md5sum b2/file4
0bee89b07a248e27c83fc3d5951213c1  b2/file4
```

You can notice the differences in the file size and md5 checksums.

2. Execute the following command

```
# gluster volume heal <VOLNAME> split-brain source-brick
<HOSTNAME:BRICKNAME> <FILE>
```

In this command, *FILE* present in *<HOSTNAME:BRICKNAME>* is taken as source for healing.

For example,

```
# gluster volume heal test-volume split-brain source-brick test-
host:b1/file4 file4 test-host:/test/b2/file4
Healed /b1/file4
```

After the healing is complete, the md5 checksum and file size on both bricks must be same. The following is a sample output of the stat and md5 checksums command after completion of healing the file.

```
On brick b1:
# stat b1/file4
  File: ‘b1/file4’
  Size: 4               Blocks: 16         IO Block: 4096   regular
file
Device: fd03h/64771d    Inode: 919356      Links: 2
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/
root)
Access: 2015-03-06 14:23:38.944609863 +0530
Modify: 2015-03-06 13:53:19.426085114 +0530
```

```
Change: 2015-03-06 14:27:15.058927962 +0530
 Birth: -

# md5sum b1/file4
b6273b589df2dfdbd8fe35b1011e3183  b1/file4

On brick b2:
# stat b2/file4
 File: ‘b2/file4’
  Size: 4               Blocks: 16         IO Block: 4096   regular
file
Device: fd03h/64771d    Inode: 919358      Links: 2
Access: (0644/-rw-r--r--)  Uid: (    0/    root)   Gid: (    0/
root)
Access: 2015-03-06 14:23:38.944609000 +0530
Modify: 2015-03-06 13:53:19.426085000 +0530
Change: 2015-03-06 14:27:15.059927968 +0530
 Birth: -

# md5sum b2/file4
b6273b589df2dfdbd8fe35b1011e3183  b2/file4
```

#### Selecting one replica as source for all files

This method is useful if you know want to use a particular brick as a source for the split-brain files in that replica pair.

1. Run the following command to obtain the list of files that are in split-brain:

   ```
   # gluster volume heal VOLNAME info split-brain
   ```

   From the command output, identify the files that are in split-brain.

2. Execute the following command

   ```
   # gluster volume heal <VOLNAME> split-brain source-brick
   <HOSTNAME:BRICKNAME>
   ```

   In this command, for all the files that are in split-brain in this replica, *<HOSTNAME:BRICKNAME>* is taken as source for healing.

   For example,

   ```
   # gluster volume heal test-volume split-brain source-brick test-
   host:b1
   ```

### 10.11.3. Triggering Self-Healing on Replicated Volumes

For replicated volumes, when a brick goes offline and comes back online, self-healing is required to re-sync all the replicas. There is a self-heal daemon which runs in the background, and automatically initiates self-healing every 10 minutes on any files which require healing.

There are various commands that can be used to check the healing status of volumes and files, or to manually initiate healing:

- To view the list of files that need healing:

```
# gluster volume heal VOLNAME info
```

For example, to view the list of files on test-volume that need healing:

```
# gluster volume heal test-volume info
Brick server1:/gfs/test-volume_0
Number of entries: 0

Brick server2:/gfs/test-volume_1
/95.txt
/32.txt
/66.txt
/35.txt
/18.txt
/26.txt - Possibly undergoing heal
/47.txt
/55.txt
/85.txt - Possibly undergoing heal
...
Number of entries: 101
```

- To trigger self-healing only on the files which require healing:

```
# gluster volume heal VOLNAME
```

For example, to trigger self-healing on files which require healing on test-volume:

```
# gluster volume heal test-volume
Heal operation on volume test-volume has been successful
```

- To trigger self-healing on all the files on a volume:

```
# gluster volume heal VOLNAME full
```

For example, to trigger self-heal on all the files on test-volume:

```
# gluster volume heal test-volume full
Heal operation on volume test-volume has been successful
```

- To view the list of files on a volume that are in a split-brain state:

```
# gluster volume heal VOLNAME info split-brain
```

For example, to view the list of files on test-volume that are in a split-brain state:

```
# gluster volume heal test-volume info split-brain
Brick server1:/gfs/test-volume_2
Number of entries: 12
at                   path on brick
----------------------------------
2012-06-13 04:02:05  /dir/file.83
```

```
2012-06-13 04:02:05  /dir/file.28
2012-06-13 04:02:05  /dir/file.69
Brick server2:/gfs/test-volume_2
Number of entries: 12
at                   path on brick
----------------------------------
2012-06-13 04:02:05  /dir/file.83
2012-06-13 04:02:05  /dir/file.28
2012-06-13 04:02:05  /dir/file.69
...
```

## 10.12. Non Uniform File Allocation (NUFA)

**Important**

Non Uniform File Allocation (NUFA) is a technology preview feature. Technology preview features are not fully supported under Red Hat subscription level agreements (SLAs), may not be functionally complete, and are not intended for production use. However, these features provide early access to upcoming product innovations, enabling customers to test functionality and provide feedback during the development process. As Red Hat considers making future iterations of technology preview features generally available, we will provide commercially reasonable support to resolve any reported issues that customers experience when using these features. Red Hat Gluster Storage currently does not support NFSv4 delegations, Multi-head NFS and High Availability. These will be added in the upcoming releases of Red Hat Gluster Storage nfs-ganesha. It is not a feature recommended for production deployment in its current form. However, Red Hat Gluster Storage volumes can be exported via nfs-ganesha for consumption by both NFSv3 and NFSv4 clients.

When a client on a server creates files, the files are allocated to a brick in the volume based on the file name. This allocation may not be ideal, as there is higher latency and unnecessary network traffic for read/write operations to a non-local brick or export directory. NUFA ensures that the files are created in the local export directory of the server, and as a result, reduces latency and conserves bandwidth for that server accessing that file. This can also be useful for applications running on mount points on the storage server.

If the local brick runs out of space or reaches the minimum disk free limit, instead of allocating files to the local brick, NUFA distributes files to other bricks in the same volume if there is space available on those bricks.

NUFA should be enabled before creating any data in the volume. To enable NUFA, execute **`gluster volume set `*`VOLNAME`*`cluster.nufa enable`*`on`***.

**Important**

NUFA is supported under the following conditions:

- Volumes with only with one brick per server.
- For use with a FUSE client. NUFA is not supported with NFS or SMB.
- A client that is mounting a NUFA-enabled volume must be present within the trusted storage pool.

# Chapter 11. Managing Containerized Red Hat Gluster Storage

With the Red Hat Gluster Storage 3.1 update 2 release, a Red Hat Gluster Storage service can be set up as a container on a Red Hat Enterprise Linux atomic host 7.2. Containers use the shared kernel concept and are much more efficient than hypervisors in system resource terms. Containers rest on top of a single Linux instance and allows applications to use the same Linux kernel as the system that they are running on. This improves the overall efficiency and reduces the space consumption considerably.

Containerized Red Hat Gluster Storage 3.1.2 is supported only on Red Hat Enterprise Linux Atomic Host 7.2. For more information about installing containerized Red Hat Gluster Storage, see the Red Hat Gluster Storage 3.1 Installation Guide.

**Note**

For Red Hat Gluster Storage 3.1.2, Erasure Coding, NFS-Ganesha, BitRot, and Data Tiering are not supported with containerized Red Hat Gluster Storage.

## 11.1. Prerequisites

Before creating a container, execute the following steps.

1. Create the directories in the atomic host for persistent mount by executing the following command:

```
# mkdir -p /etc/glusterfs /var/lib/glusterd /var/log/glusterfs
```

2. Ensure the bricks that are required are mounted on the atomic hosts. For more information see, Brick Configuration.

3. If Snapshot is required, then ensure that the **dm-snapshot** kernel module is loaded in Atomic Host system. If it is not loaded, then load it by executing the following command:

```
# modprobe dm_snapshot
```

## 11.2. Starting a Container

Execute the following steps to start the container.

1. Create a data container for RHGS container by executing the following command:

```
# docker run --name glusterdata  -v /etc/glusterfs:/etc/glusterfs:z -v
/var/lib/glusterd:/var/lib/glusterd:z -v
/var/log/glusterfs:/var/log/glusterfs:z -v
/sys/fs/cgroup:/sys/fs/cgroup:ro <image name> /usr/sbin/setup.sh
```

For example:

```
# docker run --name glusterdata  -v /etc/glusterfs:/etc/glusterfs:z -v
/var/lib/glusterd:/var/lib/glusterd:z -v
/var/log/glusterfs:/var/log/glusterfs:z -v
/sys/fs/cgroup:/sys/fs/cgroup:ro rhgs3/rhgs-server-rhel7
```

```
/usr/sbin/setup.sh

Script Ran Successfully
```

> **Note**
>
> - The data container will be stopped once the script is run.
> - SELinux labels are automatically reset to **`svirt_sandbox_file_t`** so that the container can interact with the Atomic Host directory.
> - In the above command, the following ensures that the gluster configuration are persistent.
>
> ```
> -v /etc/glusterfs:/etc/glusterfs:z -v
> /var/lib/glusterd:/var/lib/glusterd -v
> /var/log/glusterfs:/var/log/glusterfs
> ```

2. Execute the following command to run the container:

```
# docker run -d --privileged=true --net=host --name <container-name> -
-volumes-from glusterdata -v /mnt/brick1:/mnt/container_brick1:z
<image name>
```

where,

- --net=host option ensures that the container has full access to the network stack of the host.
- --volumes-from option is used to bind mount all the volumes from the data container.
- **`/mnt/brick1`** is the mountpoint of the brick in the atomic host and **`:/mnt/container_brick1`** is the mountpoint of the brick in the container.
- -d option starts the container in the detached mode.

For example:

```
# docker run -d --privileged=true --net=host --name glusternode1 --
volumes-from glusterdata -v /mnt/brick1:/mnt/container_brick1:z
rhgs3/rhgs-server-rhel7

5ac864b5abc74a925aecc4fe9613c73e83b8c54a846c36107aa8e2960eeb97b4
```

Where, 5ac864b5abc74a925aecc4fe9613c73e83b8c54a846c36107aa8e2960eeb97b4 is the container ID.

3. If you want to use snapshot then execute the following command:

```
# docker run -d --privileged=true --net=host --name <container-name> -
v /dev:/dev --volumes-from glusterdata -v
/mnt/brick1:/mnt/container_brick1:z <image name>
```

where, /mnt/brick1 is the mountpoint of the brick in the atomic host and :/mnt/container_brick1 is the mountpoint of the brick in the container.

For example:

```
# docker run -d --privileged=true --net=host --name glusternode1 -v
/dev:/dev --volumes-from glusterdata -v
/mnt/brick1:/mnt/container_brick1:z rhgs3/rhgs-server-rhel7

5da2bc217c0852d2b1bfe4fb31e0181753410071584b4e38bd77d7502cd3e92b
```

4. To verify if the container is created, execute the following command:

```
# docker ps -a
```

For example:

```
# docker ps -a

CONTAINER ID        IMAGE               COMMAND
CREATED             STATUS                      PORTS
NAMES
5da2bc217c08        891ea0584e94        "/usr/sbin/init"       10
seconds ago      Up 9 seconds
glusternode1
1042bf93cf87        891ea0584e94        "/usr/sbin/setup.sh"   35
seconds ago      Exited (0) 33 seconds ago
glusterdata
```

## 11.3. Creating a Trusted Storage Pool

Perform the following steps to create a Trusted Storage Pool:

1. Access the container using the following command:

```
# docker exec -it <container-name> /bin/bash
```

For example:

```
# docker exec -it glusternode1 /bin/bash
```

2. To verify if glusterd is running, execute the following command:

```
# systemctl status glusterd
```

3. To verify if the bricks are mounted successfully, execute the following command:

```
# mount |grep <brick_name>
```

4. Peer probe the container to form the Trusted Storage Pool:

```
# gluster peer probe <atomic host IP>
```

5. Execute the following command to verify the peer probe status:

```
# gluster peer status
```

## 11.4. Creating a Volume

Perform the following steps to create a volume.

1. To create a volume execute the following command:

```
# gluster volume create <vol-name> IP:/brickpath
```

2. Start the volume by executing the following command:

```
# gluster volume start <volname>
```

## 11.5. Mounting a Volume

Execute the following command to mount the volume created earlier:

```
# mount -t glusterfs <atomic host IP>:/<vol-name> /mount/point
```

# Chapter 12. Managing Tiering

Tiering refers to automatic classification and movement of data based on the user I/O access. The tiering feature continuously monitors the workload, identifies hotspots by measuring and analysing the statistics of the activity, and places the frequently accessed data on to the highest performance hot tier (such as solid state drives (SSDs)), and inactive data to the lower performing cold tier (such as Spinning disks) all without I/O interruption. With tiering, data promotion and auto-rebalancing address performance while cold demotion works to address capacity.

Tiering monitors and identifies the activity level of the data and auto rebalances the active and inactive data to the most appropriate storage tier. Moving data between tiers of hot and cold storage is a computationally expensive task. To address this, Red Hat Gluster Storage supports automated promotion and demotion of data within a volume in the background so as to minimize impact on foreground I/O. Data becomes hot or cold based on the rate at which it is accessed. If access to a file increases, it moves, or retains its place in the hot tier. If the file is not accessed for a while, it moves, or retains it place in the cold tier. Hence, the data movement can happen in either direction which is based totally on the access frequency.

Different sub-volume types act as hot and cold tiers and data is automatically assigned or reassigned a “temperature” based on the frequency of access. Red Hat Gluster Storage allows attaching fast performing disks as hot tier, uses the existing volume as cold tier, and these hot tier and cold tier forms a single tiered volume. For example, the existing volume may be distributed dispersed on HDDs and the hot tier could be distributed-replicated on SSDs.

### Hot Tier

The hot tier is the tiering volume created using better performing subvolumes, an example of which could be SSDs. Frequently accessed data is placed in the highest performance and most expensive hot tier. Hot tier volume could be a distributed volume or distributed-replicated volume.

> **Warning**
>
> Distributed volumes can suffer significant data loss during a disk or server failure because directory contents are spread randomly across the bricks in the volume. Red Hat recommends creating distributed-replicated tier volume.

### Cold Tier

The cold tier is the existing Red Hat Gluster Storage volume created using slower storage such as Spinning disks. Inactive or infrequently accessed data is placed in the lowest-cost cold tier.

### Data Migration

Tiering automatically migrates files between hot tier and cold tier to improve the storage performance and resource use.

## 12.1. Tiering Architecture

Tiering provides better I/O performance as a subset of the data is stored in the hot tier. Tiering involves creating a pool of relatively fast/expensive storage devices (example, solid state drives) configured to act as a hot tier, and an existing volume which are relatively slower/cheaper devices configured to act as a cold tier. The tiering translator handles where to place the files and when to migrate files from the cold tier to the hot tier and vice versa. .

The following diagrams illustrates how tiering works when attached to a distributed-dispersed volume. Here, the existing distributed-dispersed volume would become a cold-tier and the new fast/expensive storage device would act as a hot tier. Frequently accessed files will be migrated from cold tier to the hot tier for better performance.

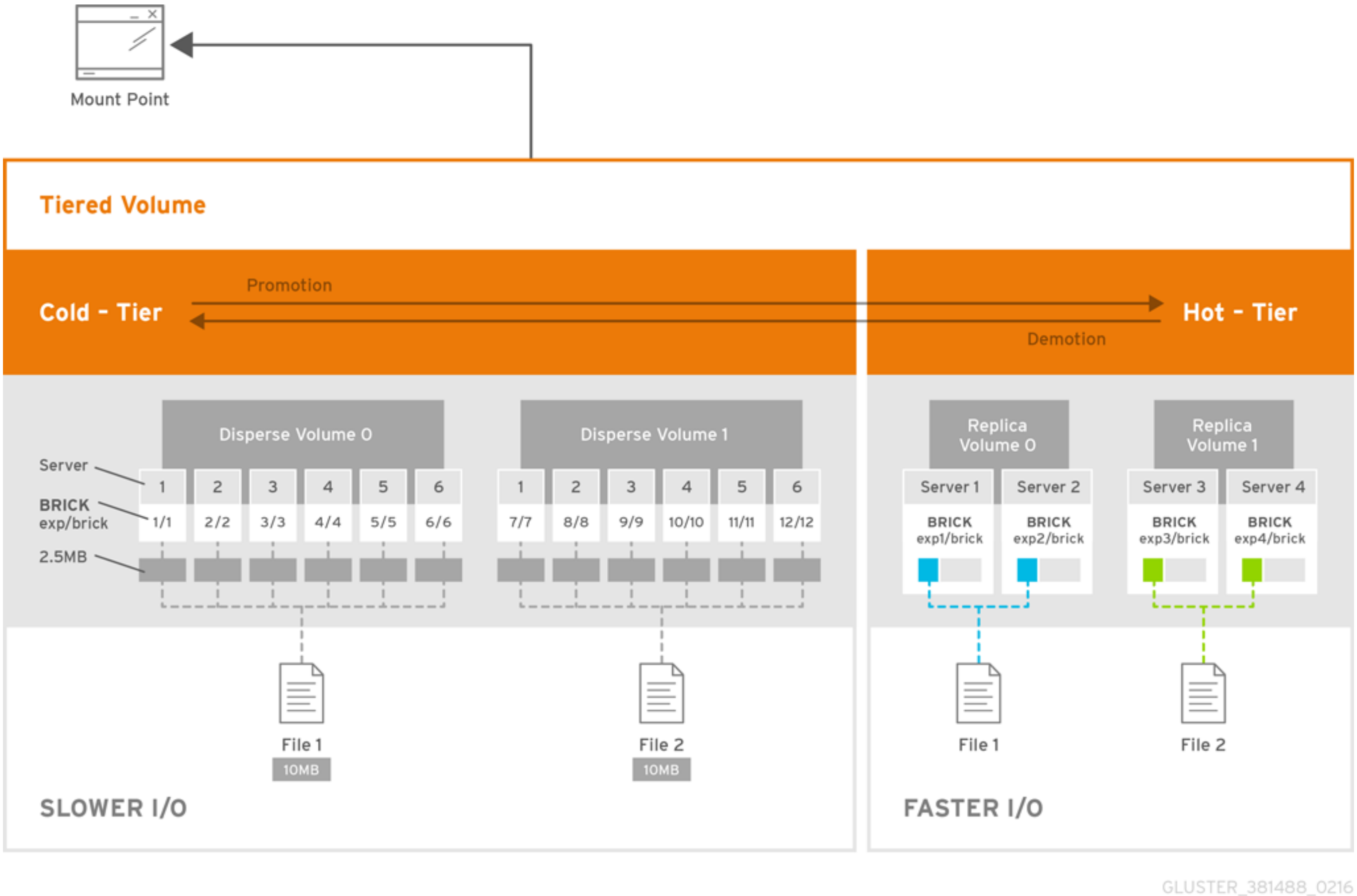



**Figure 12.1. Tiering Architecture**

## 12.2. Key Benefits of Tiering

The following are the key benefits of data tiering:

- Automatic classification and movement of files based on the access patterns
- Faster response time and reduced latency
- Better I/O performance
- Improved data-storage efficiency
- Reduced deployment and operating costs

## 12.3. Tiering Limitations

The following limitations apply to the use Tiering feature:

- Tiering works only with **`cache friendly`** workloads. Attaching a tier volume to a cache unfriendly workload will lead to slow performance. In a **`cache friendly`** workload, most of the reads and writes are accessing a subset of the total amount of data. And, this subset fits on the hot tier. This subset should change only infrequently.

- Tiering feature is supported only on Red Hat Enterprise Linux 7 based Red Hat Gluster Storage. Tiering feature is not supported on Red Hat Enterprise Linux 6 based Red Hat Gluster Storage.
- In this release, only Fuse and NFSv3 access is supported. Server Message Block (SMB) and NFSv4 access to tiered volume is not supported.
- Snapshot clones are not supported with the tiered volumes.
- When you run **`tier detach commit force`**, ongoing I/O operation may fail with *Transport endpoint is not connected* error.
- Files with hardlinks and softlinks are not migrated.
- Files on which POSIX locks has been taken are not migrated until all locks are released.
- Add brick, remove brick, and rebalance operations are not supported on the tiered volume. For information on expanding a tiered volume, see Section 10.3.1, “Expanding a Tiered Volume” and for information on shrinking a tiered volume, see Section 10.4.2, “Shrinking a Tiered Volume ”

## 12.4. Attaching a Tier to a Volume

By default, tiering is not enabled on gluster volumes. An existing volume can be modified via a CLI command to have a *hot-tier*. You must enable a volume by performing an attach tier operation. The **`attach`** command will declare an existing volume as *cold-tier* and creates a new *hot-tier* volume which is appended to it. Together, the combination is a single *cache tiered* volume.

It is highly recommended to provision your storage liberally and generously before attaching a tier. You create a normal volume and then *attach* bricks to it, which are the *hot tier*:

1. Attach the tier to the volume by executing the following command:

   **`# gluster volume tier`** ***`VOLNAME`*** **`attach [replica COUNT] NEW-BRICK...`**

   For example,

   ```
   # gluster volume tier test-volume attach replica 2 server1:/exp1/tier1
   server1:/exp2/tier2
   server2:/exp3/tier3 server2:/exp4/tier4
   ```

2. Run **`gluster volume info`** command to optionally display the volume information.

   The command output displays information similar to the following:

   ```
   # gluster volume info test-volume
   Volume Name: test-volume
   Type: Tier
   Status: Started
   Number of Bricks: 8
   Transport-type: tcp
   Hot Tier :
   Hot Tier Type : Distributed-Replicate
   Number of Bricks: 2 x 2 = 4
   Brick1: server1:/exp1/tier1
   Brick2: server1:/exp2/tier2
   Brick3: server2:/exp3/tier3
   Brick4: server2:/exp4/tier4
   Cold Tier:
   ```

```
Cold Tier Type : Distributed-Replicate
Number of Bricks: 2 x 2 = 4
Brick5: server1:/exp1/brick1
Brick6: server1:/exp2/brick2
Brick7: server2:/exp3/brick3
Brick8: server2:/exp4/brick4
Options Reconfigured:
cluster.watermark-low: 70
cluster.watermark-hi: 90
cluster.tier-demote-frequency: 45
cluster.tier-mode: cache
features.ctr-enabled: on
performance.readdir-ahead: on
```

The tier start command is triggered automatically after the tier has been attached. In some cases, if the tier process has not started you must start it manually using the **`gluster volume tier`** ***`VOLNAME`*** **`start force`** command.

### 12.4.1. Attaching a Tier to a Geo-replicated Volume

You can attach a tier volume to the master volume of the geo-replication session for better performance.

**Important**

A crash has been observed in the Slave mounts when **`performance.quick-read`** option is enabled and geo-replicated from a tiered master volume. If the master volume is a tiered volume, you must disable the **`performance.quick-read`** option in the Slave Volume using the following command:

```
# gluster volume set Slavevol performance.quick-read off
```

1. Stop geo-replication between the master and slave, using the following command:

   **`# gluster volume geo-replication`** ***`MASTER_VOL SLAVE_HOST::SLAVE_VOL`*** **`stop`**

   For example:

   ```
   # gluster volume geo-replication Volume1 example.com::slave-vol stop
   ```

2. Attach the tier to the volume using the following command:

   **`# gluster volume tier`** ***`VOLNAME`*** **`attach [replica`** ***`COUNT`*** **`]`** ***`NEW-BRICK...`***

   For example, to create a distributed-replicated tier volume with replica count two:

   ```
   # gluster volume tier test-volume attach replica 2 server1:/exp1/tier1
   server1:/exp2/tier2
   server2:/exp3/tier3 server2:/exp4/tier4
   ```

3. Restart the geo-replication sessions, using the following command:

   **`# gluster volume geo-replication`** ***`MASTER_VOL SLAVE_HOST::SLAVE_VOL`*** **`start`**

For example

```
# gluster volume geo-replication Volume1 example.com::slave-vol start
```

4. Verify whether geo-replication session has started with tier's bricks, using the following command:

   **# gluster volume geo-replication *MASTER_VOL SLAVE_HOST::SLAVE_VOL* status**

   For example,

```
# gluster volume geo-replication Volume1 example.com::slave-vol status
```

## 12.5. Configuring a Tiering Volume

Tiering volume has several configuration options. You may set tier volume configuration options with the following usage:

**# gluster volume set VOLNAME *key value***

### 12.5.1. Configuring Watermarks

When the tier volume is configured to use the **cache** mode, the configured watermark values and the percentage of the hot tier that is full determine whether a file will be promoted or demoted. The **cluster.watermark-low** and **cluster.watermark-hi** volume options set the lower and upper watermark values respectively for a tier volume.

The promotion and demotion of files is determined by how full the hot tier is. Data accumulates on the hot tier until it reaches the low watermark, even if it is not accessed for a period of time. This prevents files from being demoted unnecessarily when there is plenty on free space on the hot tier. When the hot tier is fuller than the lower watermark but less than the high watermark, data is randomly promoted and demoted where the likelihood of promotion decreases as the tier becomes fuller; the opposite holds for demotion. If the hot tier is fuller than the high watermark, promotions stop and demotions happen more frequently in order to free up space.

The following diagram illustrates how cache mode works and the example values you can set.

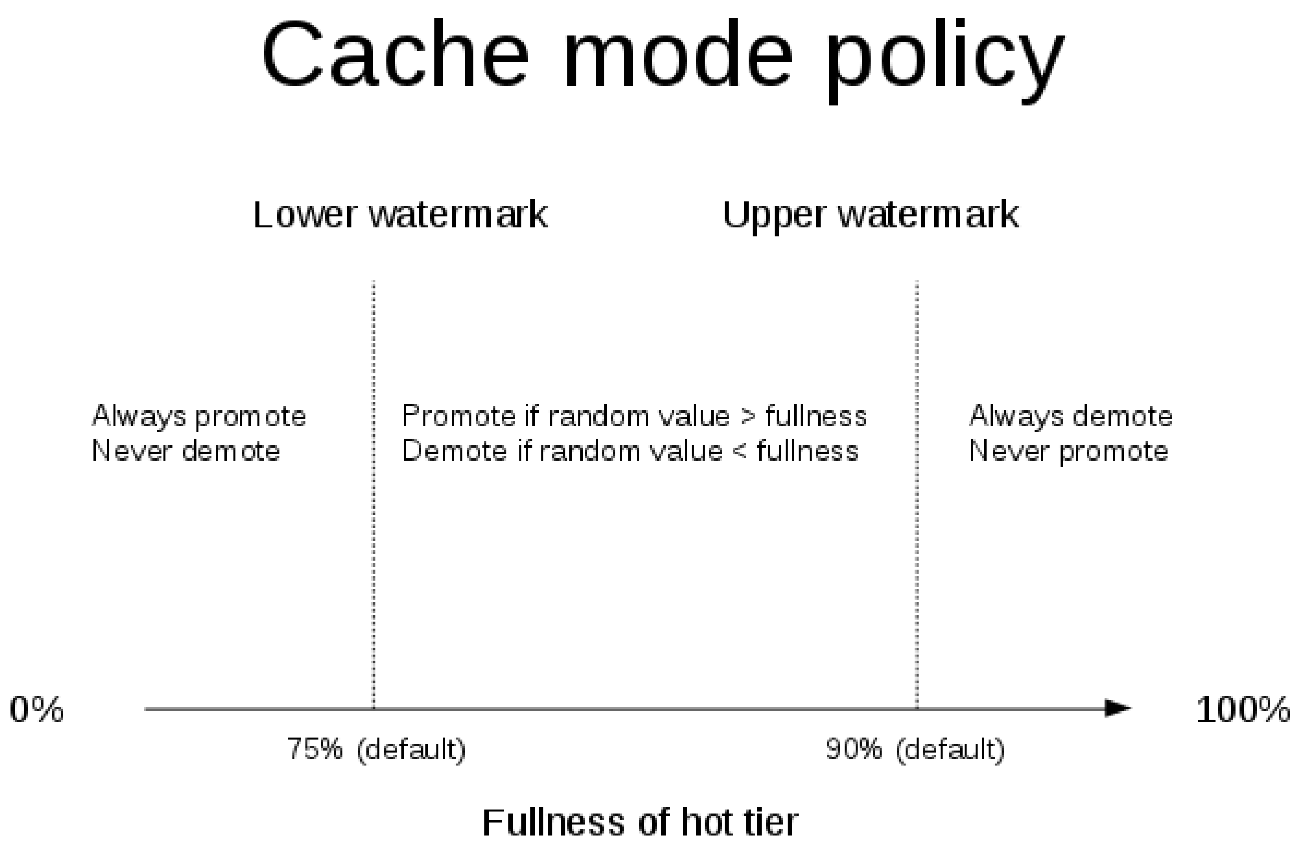



**Figure 12.2. Tiering Watermarks**

To set the percentage for promotion and demotion of files, run the following commands:

```
# gluster volume set VOLNAME cluster.watermark-hi value
```

```
# gluster volume set VOLNAME cluster.watermark-low value
```

## 12.5.2. Configuring Promote and Demote Frequency

You can configure how frequently the files are to be checked for promotion and demotion of files. The check is based on whether the file was accessed or not in the last *n* seconds. If the promote/demote frequency is not set, then the default value for promote frequency is 120 seconds and demote frequency is 3600 seconds.

To set the frequency for the promotion and demotion of files, run the following command:

```
# gluster volume set VOLNAME cluster.tier-demote-frequency value_in_seconds
```

```
# gluster volume set VOLNAME cluster.tier-promote-frequency value_in_seconds
```

## 12.5.3. Configuring Read and Write Frequency

You can configure the number of reads and writes in a promotion/demotion cycle, that would mark a file **HOT** for promotion. Any file that has read or write hits less than this value will be considered as **COLD** and will be demoted. If the read/write access count is not set, then the default count is set to 0.

Set the read and write frequency threshold by executing the following command:

```
# gluster volume set VOLNAME cluster.write-freq-threshold value
```

> **Note**
>
> The value of 0 indicates that the threshold value is not considered. Any value in the range of 1-1000 denotes the number of times the contents of file must be modified to consider for promotion or demotion...

```
# gluster volume set VOLNAME cluster.read-freq-threshold value
```

> **Note**
>
> The value of 0 indicates that the threshold value is not considered. Any value in the range of 1-1000 denotes the number of times the contents of file contents have been accessed to consider for promotion or demotion.

### 12.5.4. Configuring Target Data Size

The maximum amount of data that may be migrated in any direction in one promotion/demotion cycle from each node can be configured using the following command:

```
# gluster volume set VOLNAME cluster.tier-max-mb value_in_mb
```

If the **`cluster.tier-max-mb`** count is not set, then the default data size is set to 4000 MB.

### 12.5.5. Configuring the File Count per Cycle

The maximum number of files that may be migrated in any direction in one promotion/demotion cycle from each node can be configured using the following command:

```
# gluster volume set VOLNAME cluster.tier-max-files count
```

If the **`cluster.tier-max-files`** count is not set, then the default count is set to 10000.

## 12.6. Displaying Tiering Status Information

The status command displays the tiering volume information.

```
# gluster volume tier VOLNAME status
```

For example,

```
# gluster volume tier test-volume status
Node                 Promoted files       Demoted files        Status
---------            ---------            ---------            ---------
localhost            1                    5                    in progress
server1              0                    2                    in
progress
Tiering Migration Functionality: test-volume: success
```

## 12.7. Detaching a Tier from a Volume

To detach a tier, perform the following steps:

1. Start the detach tier by executing the following command:

   **# gluster volume tier *VOLNAME* detach start**

   For example,

   ```
   # gluster volume tier test-volume detach start
   ```

2. Monitor the status of detach tier until the status displays the status as complete.

   **# gluster volume tier *VOLNAME* detach status**

   For example,

   ```
   # gluster volume tier test-volume detach status
   Node Rebalanced-files          size       scanned      failures
   skipped               status       run time in secs
   --------      -----------   -----------   -----------   -----------
   -----------        ------------     --------------
   localhost            0        0Bytes            0             0
   0          completed               0.00
   server1              0        0Bytes            0             0
   0          completed               1.00
   server1              0        0Bytes            0             0
   0          completed               0.00
   server2              0        0Bytes            0             0
   0          completed
   server2              0        0Bytes            0             0
   0          completed
   ```

   **Note**

   It is possible that some files are not migrated to the cold tier on a detach operation for various reasons like POSIX locks being held on them. Check for files on the hot tier bricks and you can either manually move the files, or turn off applications (which would presumably unlock the files) and stop/start detach tier, to retry.

3. When the tier is detached successfully as shown in the previous status command, run the following command to commit the tier detach:

   **# gluster volume tier *VOLNAME* detach commit**

   For example,

   ```
   # gluster volume tier test-volume detach commit
   Removing tier can result in data loss. Do you want to Continue? (y/n)
   y
   volume detach-tier commit: success
   Check the detached bricks to ensure all files are migrated.
   If files with data are found on the brick path, copy them via a
   gluster mount point before re-purposing the removed brick.
   ```

After the detach tier commit is completed, you can verify that the volume is no longer a tier volume by running **gluster volume info** command.

### 12.7.1. Detaching a Tier of a Geo-replicated Volume

1. Start the detach tier by executing the following command:

   **# gluster volume tier *VOLNAME* detach start**

   For example,

   ```
   # gluster volume tier test-volume detach start
   ```

2. Monitor the status of detach tier until the status displays the status as complete.

   **# gluster volume tier *VOLNAME* detach status**

   For example,

   ```
   # gluster volume tier test-volume detach status
   Node Rebalanced-files          size        scanned      failures
   skipped               status        run time in secs
   --------      -----------   -----------   -----------   -----------
   -----------         ------------     --------------
   localhost             0        0Bytes             0              0
   0             completed                 0.00
   server1               0        0Bytes             0              0
   0             completed                 1.00
   server1               0        0Bytes             0              0
   0             completed                 0.00
   server2               0        0Bytes             0              0
   0             completed
   server2               0        0Bytes             0              0
   0             completed
   ```

   > **Note**
   >
   > There could be some number of files that were not moved. Such files may have been locked by the user, and that prevented them from moving to the cold tier on the detach operation. You must check for such files. If you find any such files, you can either manually move the files, or turn off applications (which would presumably unlock the files) and stop/start detach tier, to retry.

3. Set a checkpoint on a geo-replication session to ensure that all the data in that cold-tier is synced to the slave. For more information on geo-replication checkpoints, see Section 14.4.4.1, “Geo-replication Checkpoints”.

   **# gluster volume geo-replication *MASTER_VOL* *SLAVE_HOST*::*SLAVE_VOL* config checkpoint now**

   For example,

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
checkpoint now
```

4. Use the following command to verify the checkpoint completion for the geo-replication session

   **# gluster volume geo-replication *MASTER_VOL SLAVE_HOST::SLAVE_VOL* status detail**

5. Stop geo-replication between the master and slave, using the following command:

   **# gluster volume geo-replication *MASTER_VOL SLAVE_HOST::SLAVE_VOL* stop**

   For example:

   ```
   # gluster volume geo-replication Volume1 example.com::slave-vol stop
   ```

6. Commit the detach tier operation using the following command:

   **# gluster volume tier *VOLNAME* detach commit**

   For example,

   ```
   # gluster volume tier test-volume detach commit
   Removing tier can result in data loss. Do you want to Continue? (y/n)
   y
   volume detach-tier commit: success
   Check the detached bricks to ensure all files are migrated.
   If files with data are found on the brick path, copy them via a
   gluster mount point before re-purposing the removed brick.
   ```

   After the detach tier commit is completed, you can verify that the volume is no longer a tier volume by running **gluster volume info** command.

7. Restart the geo-replication sessions, using the following command:

   **# gluster volume geo-replication *MASTER_VOL SLAVE_HOST::SLAVE_VOL* start**

   For example,

   ```
   # gluster volume geo-replication Volume1 example.com::slave-vol start
   ```

# Chapter 13. Configuring Red Hat Gluster Storage for Enhancing Performance

This chapter provides information on configuring Red Hat Gluster Storage and explains clear and simple activities that can improve system performance. A script that encodes the best-practice recommendations in this section is located at **`/usr/lib/glusterfs/.unsupported/rhs-system-init.sh`**. You can refer the same for more information.

## 13.1. Disk Configuration

Red Hat Gluster Storage includes support for JBOD (Just a Bunch of Disks). In the JBOD configuration, a single physical disk serves as storage for a Red Hat Gluster Storage brick. JBOD is supported with three-way replication. Red Hat Gluster Storage in JBOD configuration is recommended for highly multi-threaded workloads with sequential reads to large files. For such workloads, JBOD results in more efficient use of disk bandwidth by reducing disk head movement from concurrent accesses. For other workloads, two-way replication with hardware RAID is recommended.

### 13.1.1. Hardware RAID

The RAID levels that are most commonly recommended are RAID 6 and RAID 10. RAID 6 provides better space efficiency, good read performance and good performance for sequential writes to large files.

When configured across 12 disks, RAID 6 can provide ~40% more storage space in comparison to RAID 10, which has a 50% reduction in capacity. However, RAID 6 performance for small file writes and random writes tends to be lower than RAID 10. If the workload is strictly small files, then RAID 10 is the optimal configuration.

An important parameter in hardware RAID configuration is the stripe unit size. With thin provisioned disks, the choice of RAID stripe unit size is closely related to the choice of thin-provisioning chunk size.

For RAID 10, a stripe unit size of 256 KiB is recommended.

For RAID 6, the stripe unit size must be chosen such that the full stripe size (stripe unit * number of data disks) is between 1 MiB and 2 MiB, preferably in the lower end of the range. Hardware RAID controllers usually allow stripe unit sizes that are a power of 2. For RAID 6 with 12 disks (10 data disks), the recommended stripe unit size is 128KiB.

### 13.1.2. JBOD

Support for JBOD has the following limitations:

- Each server in the JBOD configuration can have a maximum of 24 disks.
- Three-way replication must be used when using JBOD.

In the JBOD configuration, physical disks are not aggregated into RAID devices, but are visible as separate disks to the operating system. This simplifies system configuration by not requiring a hardware RAID controller.

If disks on the system are connected through a hardware RAID controller, refer to the RAID controller documentation on how to create a JBOD configuration; typically, JBOD is realized by exposing **`raw`** drives to the operating system using a **`pass-through`** mode.

## 13.2. Brick Configuration

Format bricks using the following configurations to enhance performance:

**Procedure 13.1. Brick Configuration**

1. **LVM layer**

   - **Creating the Physical Volume**

     The **pvcreate** command is used to create the physical volume. The Logical Volume Manager can use a portion of the physical volume for storing its metadata while the rest is used as the data portion.Align the I/O at the Logical Volume Manager (LVM) layer using **--dataalignment** option while creating the physical volume.

     The command is used in the following format:

     ```
     pvcreate --dataalignment alignment_value disk
     ```

     For JBOD, use an alignment value of **256K**.

     In case of hardware RAID, the *alignment_value* should be obtained by multiplying the RAID stripe unit size with the number of data disks. If 12 disks are used in a RAID 6 configuration, the number of data disks is 10; on the other hand, if 12 disks are used in a RAID 10 configuration, the number of data disks is 6.

     For example, the following command is appropriate for 12 disks in a RAID 6 configuration with a stripe unit size of 128 KiB:

     ```
     # pvcreate --dataalignment 1280k disk
     ```

     The following command is appropriate for 12 disks in a RAID 10 configuration with a stripe unit size of 256 KiB:

     ```
     # pvcreate --dataalignment 1536k disk
     ```

     To view the previously configured physical volume settings for **--dataalignment**, run the following command:

     ```
     # pvs -o +pe_start disk
       PV         VG   Fmt  Attr PSize PFree 1st PE
       /dev/sdb        lvm2 a--  9.09t 9.09t   1.25m
     ```

   - **Creating the Volume Group**

     The volume group is created using the **vgcreate** command.

     For hardware RAID, in order to ensure that logical volumes created in the volume group are aligned with the underlying RAID geometry, it is important to use the **-- physicalextentsize** option. Execute the **vgcreate** command in the following format:

     ```
     # vgcreate --physicalextentsize extent_size VOLGROUP
     physical_volume
     ```

     The *extent_size* should be obtained by multiplying the RAID stripe unit size with the number of data disks. If 12 disks are used in a RAID 6 configuration, the number of data disks is 10; on the other hand, if 12 disks are used in a RAID 10 configuration, the number of data disks is 6.

For example, run the following command for RAID-6 storage with a stripe unit size of 128 KB, and 12 disks (10 data disks):

```
# vgcreate --physicalextentsize 1280k VOLGROUP physical_volume
```

In the case of JBOD, use the **`vgcreate`** command in the following format:

```
# vgcreate VOLGROUP physical_volume
```

- **Creating the Thin Pool**

A thin pool provides a common pool of storage for thin logical volumes (LVs) and their snapshot volumes, if any.

Execute the following command to create a thin-pool:

```
# lvcreate --thinpool VOLGROUP/thin_pool --size <pool_size> --
chunksize <chunk_size> --poolmetadatasize <meta_size> --zero n
```

**Recommended parameter values for thin pool creation**

**poolmetadatasize**

Internally, a thin pool contains a separate metadata device that is used to track the (dynamically) allocated regions of the thin LVs and snapshots. The **`poolmetadatasize`** option in the above command refers to the size of the pool meta data device.

The maximum possible size for a metadata LV is 16 GiB. Red Hat Gluster Storage recommends creating the metadata device of the maximum supported size. You can allocate less than the maximum if space is a concern, but in this case you should allocate a minimum of 0.5% of the pool size.

**chunksize**

An important parameter to be specified while creating a thin pool is the chunk size,which is the unit of allocation. For good performance, the chunk size for the thin pool and the parameters of the underlying hardware RAID storage should be chosen so that they work well together.

For RAID-6 storage, the striping parameters should be chosen so that the full stripe size (stripe_unit size * number of data disks) is between 1 MiB and 2 MiB, preferably in the low end of the range. The thin pool chunk size should be chosen to match the RAID 6 full stripe size. Matching the chunk size to the full stripe size aligns thin pool allocations with RAID 6 stripes, which can lead to better performance. Limiting the chunk size to below 2 MiB helps reduce performance problems due to excessive copy-on-write when snapshots are used.

For example, for RAID 6 with 12 disks (10 data disks), stripe unit size should be chosen as 128 KiB. This leads to a full stripe size of 1280 KiB (1.25 MiB). The thin pool should then be created with the chunk size of 1280 KiB.

For RAID 10 storage, the preferred stripe unit size is 256 KiB. This can also serve as the thin pool chunk size. Note that RAID 10 is recommended when the workload has a large proportion of small file writes or random writes. In this case, a small thin pool chunk size is more appropriate, as it reduces copy-on-write overhead with snapshots.

For JBOD, use a thin pool chunk size of 256 KiB.

**block zeroing**

By default, the newly provisioned chunks in a thin pool are zeroed to prevent data leaking between different block devices. In the case of Red Hat Gluster Storage, where data is accessed via a file system, this option can be turned off for better performance with the **`--zero n`** option. Note that **`n`** does not need to be replaced.

The following example shows how to create the thin pool:

```
lvcreate --thinpool VOLGROUP/thin_pool --size 800g --
chunksize 1280k --poolmetadatasize 16G --zero n
```

- **Creating a Thin Logical Volume**

  After the thin pool has been created as mentioned above, a thinly provisioned logical volume can be created in the thin pool to serve as storage for a brick of a Red Hat Gluster Storage volume.

  LVM allows multiple thinly-provisioned LVs to share a thin pool; this allows a common pool of physical storage to be used for multiple Red Hat Gluster Storage bricks and simplifies provisioning. However, such sharing of the thin pool metadata and data devices can impact performance in a number of ways.

  > **Note**
  >
  > To avoid performance problems resulting from the sharing of the same thin pool, Red Hat Gluster Storage recommends that the LV for each Red Hat Gluster Storage brick have a dedicated thin pool of its own. As Red Hat Gluster Storage volume snapshots are created, snapshot LVs will get created and share the thin pool with the brick LV

  ```
  lvcreate --thin --name LV_name --virtualsize LV_size
  VOLGROUP/thin_pool
  ```

2. **XFS Inode Size**

   As Red Hat Gluster Storage makes extensive use of extended attributes, an XFS inode size of 512 bytes works better with Red Hat Gluster Storage than the default XFS inode size of 256 bytes. So, inode size for XFS must be set to 512 bytes while formatting the Red Hat Gluster Storage bricks. To set the inode size, you have to use -i size option with the **`mkfs.xfs`** command as shown in the following *Logical Block Size for the Directory* section.

3. **XFS RAID Alignment**

   When creating an XFS file system, you can explicitly specify the striping parameters of the underlying storage in the following format:

   ```
   mkfs.xfs other_options -d
   su=stripe_unit_size,sw=stripe_width_in_number_of_disks device
   ```

   For RAID 6, ensure that I/O is aligned at the file system layer by providing the striping parameters. For RAID 6 storage with 12 disks, if the recommendations above have been followed, the values must be as following:

```
# mkfs.xfs other_options -d su=128k,sw=10 device
```

For RAID 10 and JBOD, the **-d su=<>,sw=<>** option can be omitted. By default, XFS will use the thin-p chunk size and other parameters to make layout decisions.

4. **Logical Block Size for the Directory**

   An XFS file system allows to select a logical block size for the file system directory that is greater than the logical block size of the file system. Increasing the logical block size for the directories from the default 4 K, decreases the directory I/O, which in turn improves the performance of directory operations. To set the block size, you need to use **-n size** option with the **mkfs.xfs** command as shown in the following example output.

   Following is the example output of RAID 6 configuration along with inode and block size options:

```
# mkfs.xfs -f -i size=512 -n size=8192 -d su=128k,sw=10 logical volume
meta-data=/dev/mapper/gluster-brick1 isize=512    agcount=32,
agsize=37748736 blks
         =    sectsz=512   attr=2, projid32bit=0
data     =     bsize=4096   blocks=1207959552, imaxpct=5
         =    sunit=32     swidth=320 blks
naming   = version 2   bsize=8192   ascii-ci=0
log      =internal log   bsize=4096   blocks=521728, version=2
         =    sectsz=512   sunit=32 blks, lazy-count=1
realtime =none    extsz=4096   blocks=0, rtextents=0
```

5. **Allocation Strategy**

   inode32 and inode64 are two most common allocation strategies for XFS. With inode32 allocation strategy, XFS places all the inodes in the first 1 TiB of disk. With larger disk, all the inodes would be stuck in first 1 TiB. inode32 allocation strategy is used by default.

   With inode64 mount option inodes would be replaced near to the data which would be minimize the disk seeks.

   To set the allocation strategy to inode64 when file system is being mounted, you need to use **-o inode64** option with the **mkfs.xfs** command as shown in the following *Access Time* section.

6. **Access Time**

   If the application does not require to update the access time on files, than file system must always be mounted with **noatime** mount option. For example:

```
# mount -t xfs -o inode64,noatime <logical volume> <mount point>
```

   This optimization improves performance of small-file reads by avoiding updates to the XFS inodes when files are read.

```
/etc/fstab entry for option E + F
 <logical volume> <mount point>xfs     inode64,noatime   0 0
```

7. **Performance tuning option in Red Hat Gluster Storage**

A tuned profile is designed to improve performance for a specific use case by tuning system parameters appropriately. Red Hat Gluster Storage includes tuned profiles tailored for its workloads. These profiles are available in both Red Hat Enterprise Linux 6 and Red Hat Enterprise Linux 7.

**Table 13.1. Recommended Profiles for Different Workloads**

| Workload | Profile Name |
| --- | --- |
| Large-file, sequential I/O workloads | **`rhgs-sequential-io`** |
| Small-file workloads | **`rhgs-random-io`** |
| Random I/O workloads | **`rhgs-random-io`** |

Earlier versions of Red Hat Gluster Storage on Red Hat Enterprise Linux 6 recommended tuned profiles **`rhs-high-throughput`** and **`rhs-virtualization`**. These profiles are still available on Red Hat Enterprise Linux 6. However, switching to the new profiles is recommended.

To apply tunings contained in the tuned profile, run the following command after creating a Red Hat Gluster Storage volume.

```
tuned-adm profile profile-name
```

For example:

```
tuned-adm profile rhgs-sequential-io
```

8. **Writeback caching**

   For small-file and random write performance, we strongly recommend writeback cache, that is, non-volatile random-access memory (NVRAM) in your storage controller. For example, normal Dell and HP storage controllers have it. Ensure that NVRAM is enabled, that is, the battery is working. Refer your hardware documentation for details on enabling NVRAM.

   Do not enable writeback caching in the disk drives, this is a policy where the disk drive considers the write is complete before the write actually made it to the magnetic media (platter). As a result, the disk write cache might lose its data during a power failure or even loss of metadata leading to file system corruption.

9. **Allocation groups**

   Each XFS file system is partitioned into regions called allocation groups. Allocation groups are similar to the block groups in ext3, but allocation groups are much larger than block groups and are used for scalability and parallelism rather than disk locality. The default allocation for an allocation group is 1 TiB.

   Allocation group count must be large enough to sustain the concurrent allocation workload. In most of the cases allocation group count chosen by **`mkfs.xfs`** command would give the optimal performance. Do not change the allocation group count chosen by **`mkfs.xfs`**, while formatting the file system.

10. **Percentage of space allocation to inodes**

    If the workload is very small files (average file size is less than 10 KB ), then it is recommended to set **`maxpct`** value to **`10`**, while formatting the file system.

## 13.3. Network

Data traffic Network becomes a bottleneck as and when number of storage nodes increase. By adding a 10GbE or faster network for data traffic, you can achieve faster per node performance. Jumbo frames must be enabled at all levels, that is, client , Red Hat Gluster Storage node, and ethernet switch levels. MTU of size N+208 must be supported by ethernet switch where N=9000. We recommend you to have a separate network for management and data traffic when protocols like NFS /CIFS are used instead of native client. Preferred bonding mode for Red Hat Gluster Storage client is mode 6 (balance-alb), this allows client to transmit writes in parallel on separate NICs much of the time.

## 13.4. Memory

Red Hat Gluster Storage does not consume significant compute resources from the storage nodes themselves. However, read intensive workloads can benefit greatly from additional RAM.

### 13.4.1. Virtual Memory Parameters

The data written by the applications is aggregated in the operating system page cache before being flushed to the disk. The aggregation and writeback of dirty data is governed by the Virtual Memory parameters. The following parameters may have a significant performance impact:

- vm.dirty_ratio
- vm.dirty_background_ratio

The appropriate values of these parameters vary with the type of workload:

- Large-file sequential I/O workloads benefit from higher values for these parameters.
- For small-file and random I/O workloads it is recommended to keep these parameter values low.

The Red Hat Gluster Storage tuned profiles set the values for these parameters appropriately. Hence, it is important to select and activate the appropriate Red Hat Gluster Storage profile based on the workload.

## 13.5. Small File Performance Enhancements

The ratio of the time taken to perform operations on the metadata of a file to performing operations on its data determines the difference between large files and small files. **`Metadata-intensive workload`** is the term used to identify such workloads. A few performance enhancements can be made to optimize the network and storage performance and minimize the effect of slow throughput and response time for small files in a Red Hat Gluster Storage trusted storage pool.

> **Note**
>
> For a small-file workload, activate the **`rhgs-random-io`** tuned profile.

#### Configuring Threads for Event Processing

You can set the **`client.event-thread`** and **`server.event-thread`** values for the client and server components. Setting the value to 3, for example, would enable handling three network connections simultaneously.

**Setting the event threads value for a client**

You can tune the Red Hat Gluster Storage Server performance by tuning the event thread values.

```
# gluster volume set VOLNAME client.event-threads <value>
```

**Example 13.1. Tuning the event threads for a client accessing a volume**

```
# gluster volume set test-vol client.event-threads 3
```

### Setting the event thread value for a server

You can tune the Red Hat Gluster Storage Server performance using event thread values.

```
# gluster volume set VOLNAME server.event-threads <value>
```

**Example 13.2. Tuning the event threads for a server accessing a volume**

```
# gluster volume set test-vol server.event-threads 3
```

### Verifying the event thread values

You can verify the event thread values that are set for the client and server components by executing the following command:

```
# gluster volume info VOLNAME
```

See topic, *Configuring Volume Options* for information on the minimum, maximum, and default values for setting these volume options.

## Best practices to tune event threads

It is possible to see performance gains with the Red Hat Gluster Storage stack by tuning the number of threads processing events from network connections.The following are the recommended best practices to tune the event thread values.

1. As each thread processes a connection at a time, having more threads than connections to either the brick processes (**glusterfsd**) or the client processes (**glusterfs** or **gfapi**) is not recommended. Due to this reason, monitor the connection counts (using the **netstat** command) on the clients and on the bricks to arrive at an appropriate number for the event thread count.

2. Configuring a higher event threads value than the available processing units could again cause context switches on these threads. As a result reducing the number deduced from the previous step to a number that is less that the available processing units is recommended.

3. If a Red Hat Gluster Storage volume has a high number of brick processes running on a single node, then reducing the event threads number deduced in the previous step would help the competing processes to gain enough concurrency and avoid context switches across the threads.

4. If a specific thread consumes more number of CPU cycles than needed, increasing the event thread count would enhance the performance of the Red Hat Gluster Storage Server.

5. In addition to the deducing the appropriate event-thread count, increasing the **server.outstanding-rpc-limit** on the storage nodes can also help to queue the requests for the brick processes and not let the requests idle on the network queue.

6. Another parameter that could improve the performance when tuning the event-threads value is to set the **performance.io-thread-count** (and its related thread-counts) to higher values, as these threads perform the actual IO operations on the underlying file system.

### 13.5.1. Enabling Lookup Optimization

Distribute xlator (DHT) has a performance penalty when it deals with negative lookups. Negative lookups are lookup operations for entries that does not exist in the volume. A lookup for a file/directory that does not exist is a negative lookup.

Negative lookups are expensive and typically slows down file creation, as DHT attempts to find the file in all sub-volumes. This especially impacts small file performance, where a large number of files are being added/created in quick succession to the volume.

The negative lookup fan-out behavior can be optimized by not performing the same in a balanced volume.

The **cluster.lookup-optimize** configuration option enables DHT lookup optimization. To enable this option run the following command:

```
# gluster volume set VOLNAME cluster.lookup-optimize <on/off>\
```

**Note**

The configuration takes effect for newly created directories immediately post setting the above option. For existing directories, a rebalance is required to ensure the volume is in balance before DHT applies the optimization on older directories.

## 13.6. Replication

If a system is configured for two ways, active-active replication, write throughput will generally be half of what it would be in a non-replicated configuration. However, read throughput is generally improved by replication, as reads can be delivered from either storage node.

# Chapter 14. Managing Geo-replication

This section introduces geo-replication, illustrates the various deployment scenarios, and explains how to configure geo-replication and mirroring.

## 14.1. About Geo-replication

Geo-replication provides a distributed, continuous, asynchronous, and incremental replication service from one site to another over Local Area Networks (LANs), Wide Area Networks (WANs), and the Internet.

Geo-replication uses a master–slave model, where replication and mirroring occurs between the following partners:

- Master – a Red Hat Gluster Storage volume.
- Slave – a Red Hat Gluster Storage volume. A slave volume can be either a local volume, such as **`localhost::volname`**, or a volume on a remote host, such as **`remote-host::volname`**.

## 14.2. Replicated Volumes vs Geo-replication

The following table lists the differences between replicated volumes and geo-replication:

| Replicated Volumes | Geo-replication |
| --- | --- |
| Mirrors data across bricks within one trusted storage pool. | Mirrors data across geographically distributed trusted storage pools. |
| Provides high-availability. | Provides back-ups of data for disaster recovery. |
| Synchronous replication: each and every file operation is applied to all the bricks. | Asynchronous replication: checks for changes in files periodically, and syncs them on detecting differences. |

## 14.3. Preparing to Deploy Geo-replication

This section provides an overview of geo-replication deployment scenarios, lists prerequisites, and describes how to setup the environment for geo-replication session.

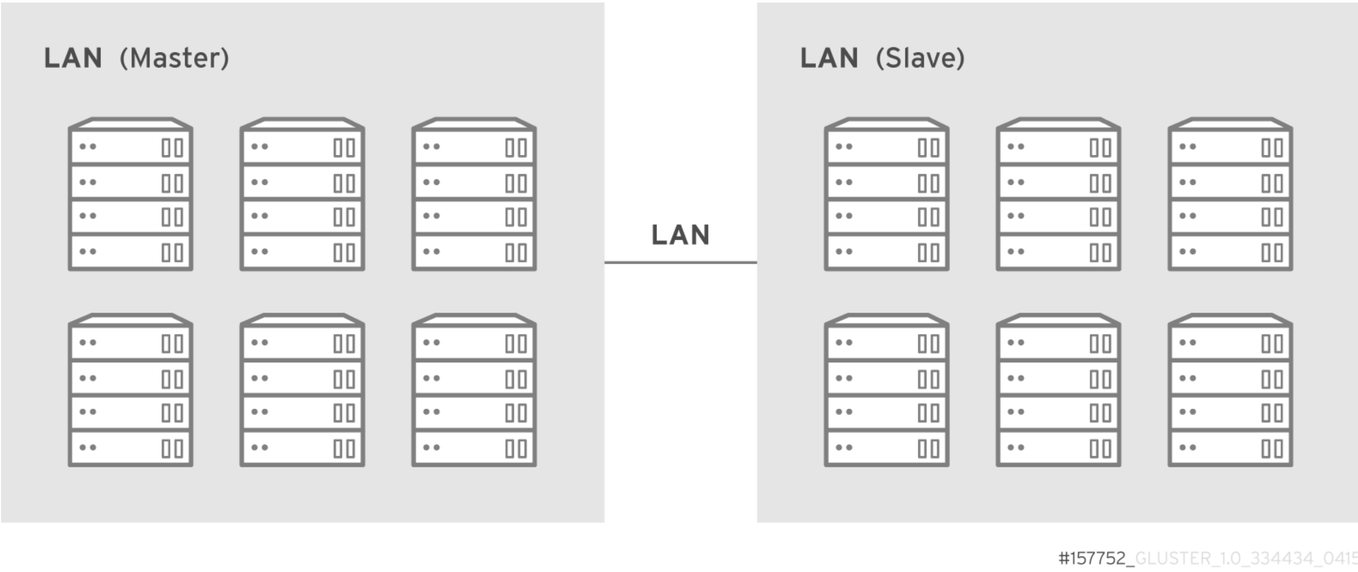

- Section 14.3.1, “Exploring Geo-replication Deployment Scenarios”
- Section 14.3.2, “Geo-replication Deployment Overview”
- Section 14.3.3, “Prerequisites”
- Section 14.3.4.2, “Setting Up your Environment for a Secure Geo-replication Slave”
- Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”
- Section 14.3.5, “Configuring a Meta-Volume”


### 14.3.1. Exploring Geo-replication Deployment Scenarios

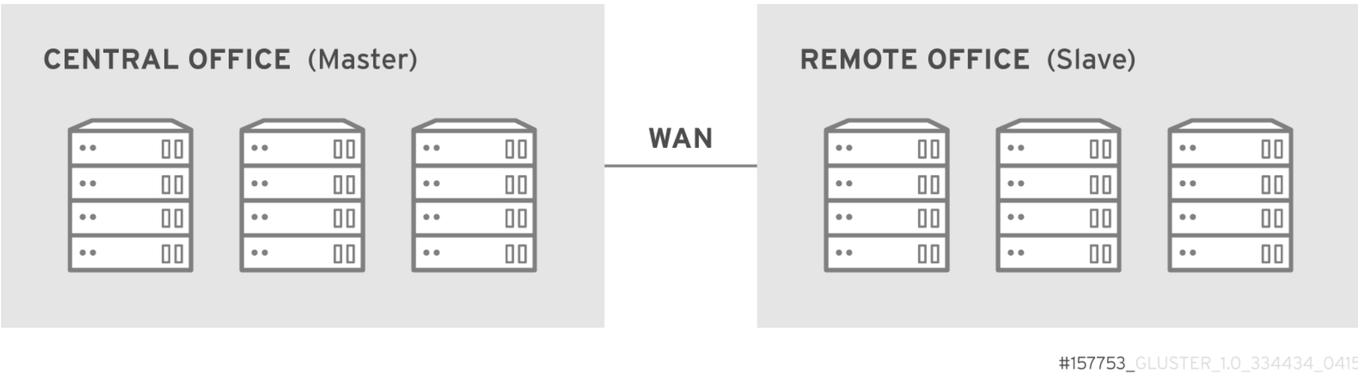
Geo-replication provides an incremental replication service over Local Area Networks (LANs), Wide Area Network (WANs), and the Internet. This section illustrates the most common deployment scenarios for geo-replication, including the following:

- Geo-replication over LAN
- Geo-replication over WAN
- Geo-replication over the Internet
- Multi-site cascading geo-replication

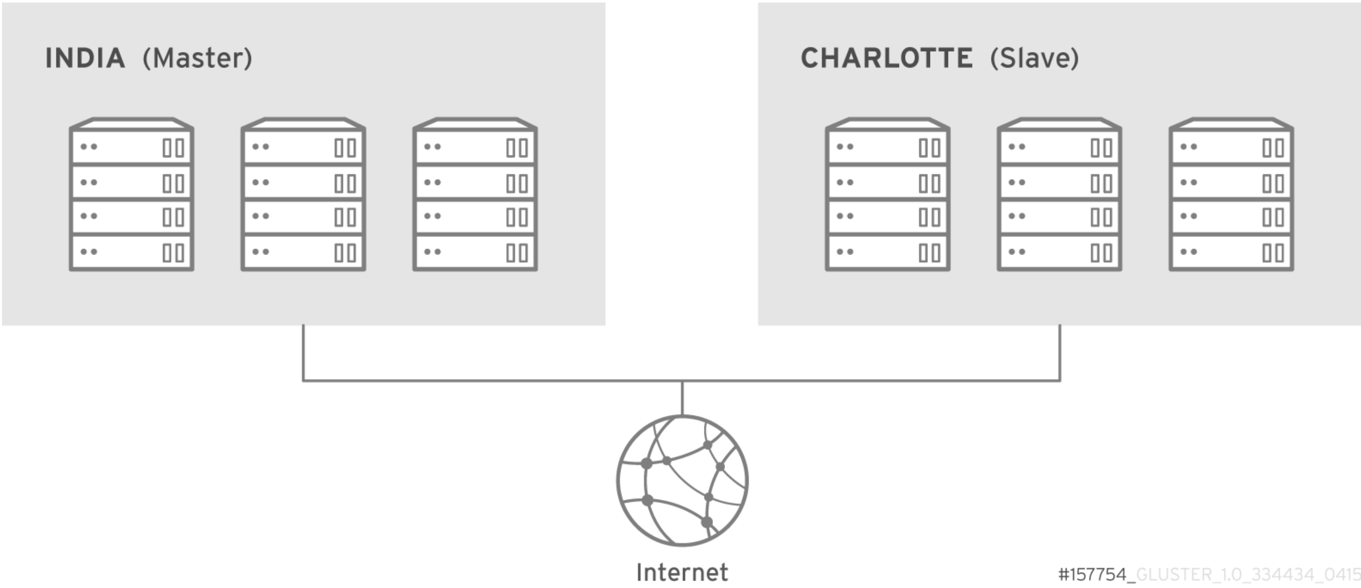
**Geo-replication over LAN**



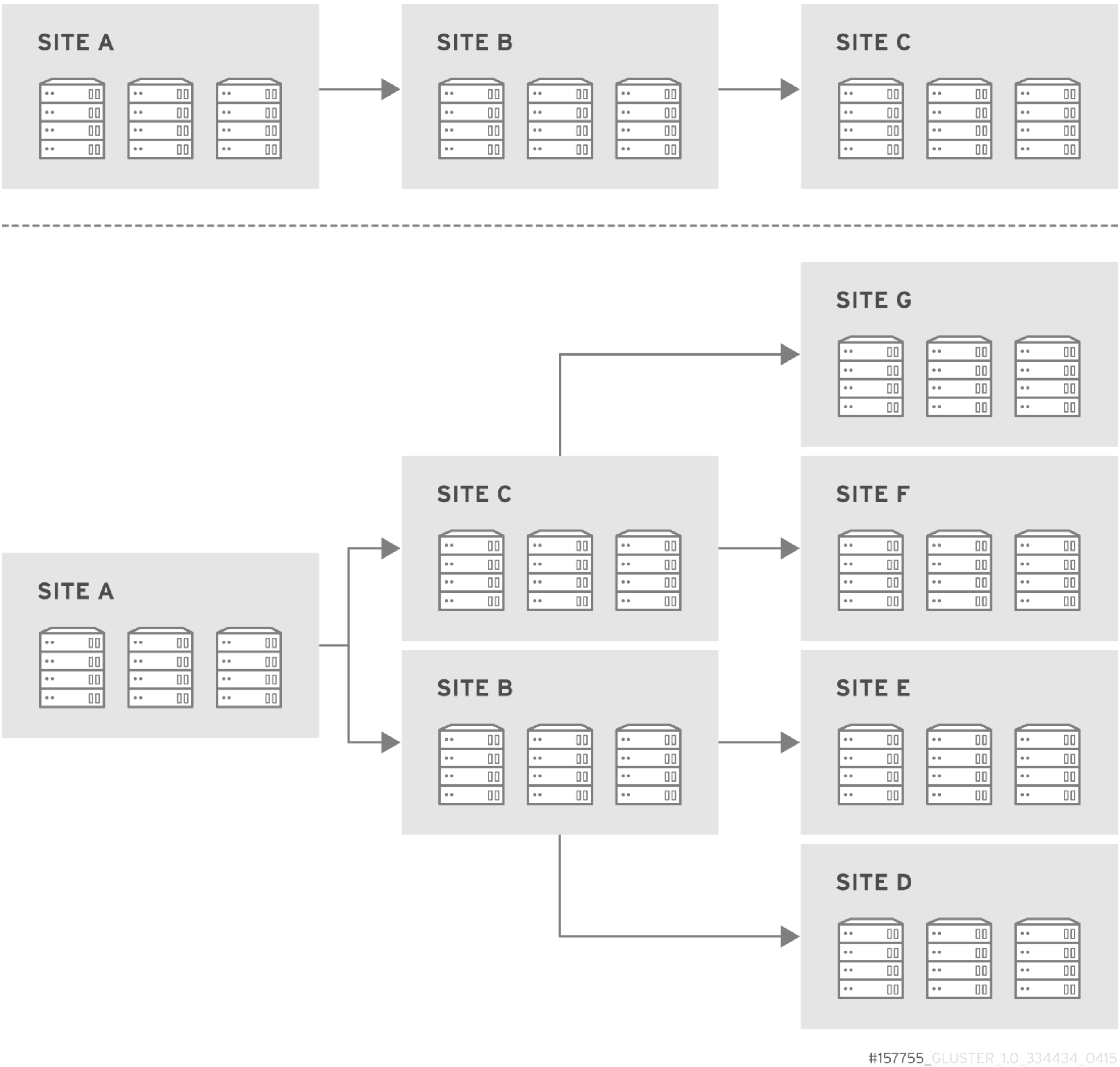

**Geo-replication over WAN**




**Geo-replication over Internet**




**Multi-site cascading Geo-replication**



### 14.3.2. Geo-replication Deployment Overview

Deploying geo-replication involves the following steps:

1. Verify that your environment matches the minimum system requirements. See Section 14.3.3, “Prerequisites”.
2. Determine the appropriate deployment scenario. See Section 14.3.1, “Exploring Geo-replication Deployment Scenarios”.
3. Start geo-replication on the master and slave systems. See Section 14.4, “Starting Geo-replication”.

### 14.3.3. Prerequisites

The following are prerequisites for deploying geo-replication:

- The master and slave volumes must be of same version of Red Hat Gluster Storage instances.
- Slave node must not be a peer of the any of the nodes of the Master trusted storage pool.
- Passwordless SSH access is required between one node of the master volume (the node from which the **geo-replication create** command will be executed), and one node of the slave volume (the node whose IP/hostname will be mentioned in the slave name when running the **geo-replication create** command).

  Create the public and private keys using **ssh-keygen** (without passphrase) on the master node:

  ```
  # ssh-keygen
  ```

  Copy the public key to the slave node using the following command:

  ```
  # ssh-copy-id -i identity_file root@slave_node_IPaddress/Hostname
  ```

  If you are setting up a non-root geo-replicaton session, then copy the public key to the respective **user** location.

  > **Note**
  >
  > - Passwordless SSH access is required from the master node to slave node, whereas passwordless SSH access is not required from the slave node to master node.
  > - **ssh-copy-id** command does not work if **ssh authorized_keys** file is configured in the custom location. You must copy the contents of **.ssh/id_rsa.pub** file from the Master and paste it to authorized_keys file in the custom location on the Slave node.

  A passwordless SSH connection is also required for **gsyncd** between every node in the master to every node in the slave. The **gluster system:: execute gsec_create** command creates **secret-pem** files on all the nodes in the master, and is used to implement the passwordless SSH connection. The **push-pem** option in the **geo-replication create** command pushes these keys to all the nodes in the slave.

  For more information on the **gluster system::execute gsec_create** and **push-pem** commands, see Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”.

## 14.3.4. Setting Up your Environment

You can set up your environment for a geo-replication session in the following ways:

- Section 14.3.4.1, "Setting Up your Environment for Geo-replication Session" - In this method, the slave mount is owned by the root user.
- Section 14.3.4.2, "Setting Up your Environment for a Secure Geo-replication Slave" - This method is more secure as the slave mount is owned by a normal user.

**Time Synchronization**

Before configuring the geo-replication environment, ensure that the time on all the servers are synchronized.

- All the servers' time must be uniform on bricks of a geo-replicated master volume. It is recommended to set up a NTP (Network Time Protocol) service to keep the bricks' time synchronized, and avoid out-of-time sync effects.

  For example: In a replicated volume where brick1 of the master has the time 12:20, and brick2 of the master has the time 12:10 with a 10 minute time lag, all the changes on brick2 between in this period may go unnoticed during synchronization of files with a Slave.

  For more information on configuring NTP, see https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/6/html/Deployment_Guide/ch-Configuring_NTP_Using_ntpd.html.

### 14.3.4.1. Setting Up your Environment for Geo-replication Session

**Creating Geo-replication Sessions**

1. To create a common `pem pub` file, run the following command on the master node where the passwordless SSH connection is configured:

```
# gluster system:: execute gsec_create
```

2. Create the geo-replication session using the following command. The `push-pem` option is needed to perform the necessary `pem-file` setup on the slave nodes.

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
create push-pem [force]
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol create
push-pem
```

**Note**

There must be passwordless SSH access between the node from which this command is run, and the slave host specified in the above command. This command performs the slave verification, which includes checking for a valid slave URL, valid slave volume, and available space on the slave. If the verification fails, you can use the `force` option which will ignore the failed verification and create a geo-replication session.

3. Configure the meta-volume for geo-replication:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
config use_meta_volume true
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
use_meta_volume true
```

For more information on configuring meta-volume, see Section 14.3.5, “Configuring a Meta-Volume”.

4. Start the geo-replication by running the following command on the master node:

   For example,

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
start [force]
```

5. Verify the status of the created session by running the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
status
```

#### 14.3.4.2. Setting Up your Environment for a Secure Geo-replication Slave

Geo-replication supports access to Red Hat Gluster Storage slaves through SSH using an unprivileged account (user account with non-zero UID). This method is more secure and it reduces the master's capabilities over slave to the minimum. This feature relies on **mountbroker**, an internal service of glusterd which manages the mounts for unprivileged slave accounts. You must perform additional steps to configure glusterd with the appropriate **mountbroker's** access control directives. The following example demonstrates this process:

**Perform the following steps on all the Slave nodes to setup an auxiliary glusterFS mount for the unprivileged account**:

1. Create a new group. For example, **geogroup**.

2. Create a unprivileged account. For example, **geoaccount**. Add **geoaccount** as a member of **geogroup** group.

3. As a root, create a new directory with permissions 0711 and with correct SELinux context. Ensure that the location where this directory is created is writeable only by root but **geoaccount** is able to access it.

   For example,

```
# mkdir /var/mountbroker-root
# chmod 0711 /var/mountbroker-root
# semanage fcontext -a -e /home /var/mountbroker-root
# restorecon -Rv /var/mountbroker-root
```

4. Run the following commands in any one of the Slave node:

```
# gluster system:: execute mountbroker opt mountbroker-root
/var/mountbroker-root
```

```
# gluster system:: execute mountbroker user geoaccount slavevol
# gluster system:: execute mountbroker opt geo-replication-log-group
geogroup
# gluster system:: execute mountbroker opt rpc-auth-allow-insecure on
```

See Section 2.4, “Storage Concepts” for information on **glusterd.vol** volume file of a Red Hat Gluster Storage volume.

If the above commands fails, check if the **glusterd.vol** file is available at **/etc/glusterfs/** directory. If not found, create a **glusterd.vol** file containing the default configuration and save it at **/etc/glusterfs/** directory. Now re-run the above commands listed above to get all the required geo-replication options.

The following is the sample **glusterd.vol** file along with default options:

```
volume management
    type mgmt/glusterd
    option working-directory /var/lib/glusterd
    option transport-type socket,rdma
    option transport.socket.keepalive-time 10
    option transport.socket.keepalive-interval 2
    option transport.socket.read-fail-log off
    option rpc-auth-allow-insecure on

    option mountbroker-root /var/mountbroker-root
    option mountbroker-geo-replication.geoaccount slavevol
    option geo-replication-log-group geogroup
end-volume
```

- If you have multiple slave volumes on Slave, repeat Step 2 for each of them and run the following commands to update the vol file:

  ```
  # gluster system:: execute mountbroker user geoaccount2 slavevol2
  # gluster system:: execute mountbroker user geoaccount3 slavevol3
  ```

  You can use **gluster system:: execute mountbroker info** command to view the configured mountbroker options.

- You can add multiple slave volumes within the same account (geoaccount) by providing comma-separated list (without spaces) as the argument of **mountbroker-geo-replication.geogroup**. You can also have multiple options of the form **mountbroker-geo-replication.***. It is recommended to use one service account per Master machine. For example, if there are multiple slave volumes on Slave for the master machines Master1, Master2, and Master3, then create a dedicated service user on Slave for them by repeating Step 2. for each (like geogroup1, geogroup2, and geogroup3), and then run the following commands to add the corresponding options to the volfile:

  ```
  # gluster system:: execute mountbroker user geoaccount1
  slavevol11,slavevol12,slavevol13
  # gluster system:: execute mountbroker user geoaccount2
  slavevol21,slavevol22
  # gluster system:: execute mountbroker user geoaccount3 slavevol31
  ```

5. Restart **glusterd** service on all the Slave nodes.

**After you setup an auxiliary glusterFS mount for the unprivileged account on all the Slave nodes, perform the following steps to setup a non-root geo-replication session.**:

6. Setup a passwordless SSH from one of the master node to the **`user`** on one of the slave node.

   For example, to setup a passwordless SSH to the user *geoaccount*.

```
# ssh-keygen
# ssh-copy-id -i identity_file
geoaccount@slave_node_IPaddress/Hostname
```

7. Create a common pem pub file by running the following command on the master node where the passwordless SSH connection is configured to the **`user`** on the slave node:

```
# gluster system:: execute gsec_create
```

8. Create a geo-replication relationship between master and slave to the **`user`** by running the following command on the master node:

   For example,

```
# gluster volume geo-replication MASTERVOL
geoaccount@SLAVENODE::slavevol create push-pem
```

   If you have multiple slave volumes and/or multiple accounts, create a geo-replication session with that particular user and volume.

   For example,

```
# gluster volume geo-replication MASTERVOL
geoaccount2@SLAVENODE::slavevol2 create push-pem
```

9. In the slavenode, which is used to create relationship, run **`/usr/libexec/glusterfs/set_geo_rep_pem_keys.sh`** as a root with user name, master volume name, and slave volume names as the arguments.

   For example,

```
 # /usr/libexec/glusterfs/set_geo_rep_pem_keys.sh geoaccount MASTERVOL
SLAVEVOL_NAME
```

10. Configure the meta-volume for geo-replication:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
config use_meta_volume true
```

   For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
use_meta_volume true
```

   For more information on configuring meta-volume, see Section 14.3.5, “Configuring a Meta-Volume”.

11. Start the geo-replication with slave user by running the following command on the master node:

For example,

```
# gluster volume geo-replication MASTERVOL
geoaccount@SLAVENODE::slavevol start
```

12. Verify the status of geo-replication session by running the following command on the master node:

```
# gluster volume geo-replication MASTERVOL
geoaccount@SLAVENODE::slavevol status
```

### Deleting a mountbroker geo-replication options after deleting session

When mountbroker geo-replicaton session is deleted, use the following command to remove volumes per mountbroker user. If the volume to be removed is the last one for the mountbroker user, the user is also removed.

- To delete a volumes per mountbroker user:

```
# gluster system:: execute mountbroker volumedel geoaccount2 slavevol2
```

You can delete multiple volumes per mountbroker user by providing comma-separated list (without spaces) as the argument of this command.

```
# gluster system:: execute mountbroker volumedel geoaccount2
slavevol2,slavevol3
```

**Important**

If you have a secured geo-replication setup, you must ensure to prefix the unprivileged user account to the slave volume in the command. For example, to execute a geo-replication status command, run the following:

```
# gluster volume geo-replication MASTERVOL
geoaccount@SLAVENODE::slavevol status
```

In this command, **geoaccount** is the name of the unprivileged user account.

## 14.3.5. Configuring a Meta-Volume

For effective handling of node fail-overs in Master volume, geo-replication requires a shared storage to be available across all nodes of the cluster. Hence, you must ensure that a gluster volume named **gluster_shared_storage** is created in the cluster, and is mounted at **/var/run/gluster/shared_storage** on all the nodes in the cluster. For more information on setting up shared storage volume, see Section 10.8, “Setting up Shared Storage Volume”.

- Configure the meta-volume for geo-replication:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL config
use_meta_volume true
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
use_meta_volume true
```

## 14.4. Starting Geo-replication

This section describes how to and start geo-replication in your storage environment, and verify that it is functioning correctly.

- Section 14.4.1, “Starting a Geo-replication Session”
- Section 14.4.2, “Verifying a Successful Geo-replication Deployment”
- Section 14.4.3, “Displaying Geo-replication Status Information”
- Section 14.4.4, “Configuring a Geo-replication Session”
- Section 14.4.5, “Stopping a Geo-replication Session”
- Section 14.4.6, “Deleting a Geo-replication Session”

### 14.4.1. Starting a Geo-replication Session

> **Important**
>
> You must create the geo-replication session before starting geo-replication. For more information, see Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”.

To start geo-replication, use one of the following commands:

- To start the geo-replication session between the hosts:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL start
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol start
Starting geo-replication session between Volume1 & example.com::slave-vol
has been successful
```

This command will start distributed geo-replication on all the nodes that are part of the master volume. If a node that is part of the master volume is down, the command will still be successful. In a replica pair, the geo-replication session will be active on any of the replica nodes, but remain passive on the others.

After executing the command, it may take a few minutes for the session to initialize and become stable.

**Note**

If you attempt to create a geo-replication session and the slave already has data, the following error message will be displayed:

```
slave-node::slave is not empty. Please delete existing files in
slave-node::slave and retry, or use force to continue without
deleting the existing files. geo-replication command failed
```

- To start the geo-replication session *forcefully* between the hosts:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL start
force
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol start
force
Starting geo-replication session between Volume1 & example.com::slave-vol
has been successful
```

This command will force start geo-replication sessions on the nodes that are part of the master volume. If it is unable to successfully start the geo-replication session on any node which is online and part of the master volume, the command will still start the geo-replication sessions on as many nodes as it can. This command can also be used to re-start geo-replication sessions on the nodes where the session has died, or has not started.

### 14.4.2. Verifying a Successful Geo-replication Deployment

You can use the **`status`** command to verify the status of geo-replication in your environment:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL status
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol status
```

### 14.4.3. Displaying Geo-replication Status Information

The **`status`** command can be used to display information about a specific geo-replication master session, master-slave session, or all geo-replication sessions. The status output provides both node and brick level information.

- To display information on all geo-replication sessions from a particular master volume, use the following command:

```
# gluster volume geo-replication MASTER_VOL status
```

- To display information of a particular master-slave session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL status
```

- To display the details of a master-slave session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL status
detail
```

**Important**

There will be a mismatch between the outputs of the **df** command (including **-h** and **-k**) and inode of the master and slave volumes when the data is in full sync. This is due to the extra inode and size consumption by the **changelog** journaling data, which keeps track of the changes done on the file system on the **master** volume. Instead of running the **df** command to verify the status of synchronization, use **# gluster volume geo-replication *MASTER_VOL* *SLAVE_HOST*::*SLAVE_VOL* status detail** instead.

The geo-replication status command output provides the following information:

- **Master Node**: Master node and Hostname as listed in the **gluster volume info** command output
- **Master Vol**: Master volume name
- **Master Brick**: The path of the brick
- **Status**: The status of the geo-replication worker can be one of the following:
  - **Initializing**: This is the initial phase of the Geo-replication session; it remains in this state for a minute in order to make sure no abnormalities are present.
  - **Created**: The geo-replication session is created, but not started.
  - **Active**: The **gsync** daemon in this node is active and syncing the data.
  - **Passive**: A replica pair of the active node. The data synchronization is handled by the active node. Hence, this node does not sync any data.
  - **Faulty**: The geo-replication session has experienced a problem, and the issue needs to be investigated further. For more information, see Section 14.10, “Troubleshooting Geo-replication” section.
  - **Stopped**: The geo-replication session has stopped, but has not been deleted.
- **Crawl Status** : Crawl status can be on of the following:
  - **Changelog Crawl:** The **changelog** translator has produced the changelog and that is being consumed by **gsyncd** daemon to sync data.
  - **Hybrid Crawl**: The **gsyncd** daemon is crawling the glusterFS file system and generating pseudo changelog to sync data.
  - **History Crawl**: The **gsyncd** daemon consumes the history changelogs produced by the changelog translator to sync data.
- **Last Synced**: The last synced time.

- **Entry**: The number of pending entry (CREATE, MKDIR, RENAME, UNLINK etc) operations per session.
- **Data**: The number of `Data` operations pending per session.
- **Meta**: The number of `Meta` operations pending per session.
- **Failures**: The number of failures. If the failure count is more than zero, view the log files for errors in the Master bricks.
- **Checkpoint Time**: Displays the date and time of the checkpoint, if set. Otherwise, it displays as N/A.
- **Checkpoint Completed**: Displays the status of the checkpoint.
- **Checkpoint Completion Time**: Displays the cCompletion time if Checkpoint is completed. Otherwise, it displays as N/A.

### 14.4.4. Configuring a Geo-replication Session

To configure a geo-replication session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL config
[options]
```

For example, to view the list of all option/value pairs:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
```

To delete a setting for a geo-replication config option, prefix the option with `!` (exclamation mark). For example, to reset `log-level` to the default value:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
'!log-level'
```

#### Configurable Options

The following table provides an overview of the configurable options for a geo-replication setting:

| Option | Description |
|---|---|
| gluster-log-file *LOGFILE* | The path to the geo-replication glusterfs log file. |
| gluster-log-level *LOGFILELEVEL* | The log level for glusterfs processes. |
| log-file *LOGFILE* | The path to the geo-replication log file. |
| log-level *LOGFILELEVEL* | The log level for geo-replication. |
| ssh-command *COMMAND* | The SSH command to connect to the remote machine (the default is `SSH`). |
| rsync-command *COMMAND* | The rsync command to use for synchronizing the files (the default is `rsync`). |
| use-tarssh *[true \| false]* | The use-tarssh command allows tar over Secure Shell protocol. Use this option to handle workloads of files that have not undergone edits. |
| volume_id=*UID* | The command to delete the existing master UID for the intermediate/slave node. |
| timeout *SECONDS* | The timeout period in seconds. |

| Option | Description |
|---|---|
| sync-jobs *N* | The number of simultaneous files/directories that can be synchronized. |
| ignore-deletes | If this option is set to **`1`**, a file deleted on the master will not trigger a delete operation on the slave. As a result, the slave will remain as a superset of the master and can be used to recover the master in the event of a crash and/or accidental delete. |
| checkpoint *[LABEL\|now]* | Sets a checkpoint with the given option *LABEL*. If the option is set as **`now`**, then the current time will be used as the label. |
| sync-acls *[true \| false]* | Syncs acls to the Slave cluster. By default, this option is enabled.<br><br>**Note**<br><br>Geo-replication can sync acls only with **`rsync`** as the sync engine and not with **`tarssh`** as the sync engine. |
| sync-xattrs *[true \| false]* | Syncs extended attributes to the Slave cluster. By default, this option is enabled.<br><br>**Note**<br><br>Geo-replication can sync extended attributes only with **`rsync`** as the sync engine and not with **`tarssh`** as the sync engine. |
| log-rsync-performance *[true \| false]* | If this option is set to **`enable`**, geo-replication starts recording the rsync performance in log files. By default, this option is disabled. |
| rsync-options | Additional options to rsync. For example, you can limit the rsync bandwidth usage "--bwlimit=<value>". |
| use-meta-volume *[true \| false]* | Set this option to **`enable`**, to use meta volume in Geo-replicaiton. By default, this option is disabled.<br><br>**Note**<br><br>More more information on meta-volume, see Section 14.3.5, “Configuring a Meta-Volume”. |
| meta-volume-mnt *PATH* | The path of the meta volume mount point. |

#### 14.4.4.1. Geo-replication Checkpoints

##### 14.4.4.1.1. About Geo-replication Checkpoints

Geo-replication data synchronization is an asynchronous process, so changes made on the master may take time to be replicated to the slaves. Data replication to a slave may also be interrupted by various issues, such network outages.

Red Hat Gluster Storage provides the ability to set geo-replication checkpoints. By setting a checkpoint, synchronization information is available on whether the data that was on the master at that point in time has been replicated to the slaves.

##### 14.4.4.1.2. Configuring and Viewing Geo-replication Checkpoint Information

- To set a checkpoint on a geo-replication session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL config
checkpoint [now|LABEL]
```

  For example, to set checkpoint between **Volume1** and **example.com:/data/remote_dir**:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
checkpoint now
geo-replication config updated successfully
```

  The label for a checkpoint can be set as the current time using **now**, or a particular label can be specified, as shown below:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
checkpoint NEW_ACCOUNTS_CREATED
geo-replication config updated successfully.
```

- To display the status of a checkpoint for a geo-replication session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL status
detail
```

- To delete checkpoints for a geo-replication session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL config
'!checkpoint'
```

  For example, to delete the checkpoint set between **Volume1** and **example.com::slave-vol**:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
'!checkpoint'
geo-replication config updated successfully
```

## 14.4.5. Stopping a Geo-replication Session

To stop a geo-replication session, use one of the following commands:

- To stop a geo-replication session between the hosts:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL stop
```

  For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol stop
Stopping geo-replication session between Volume1 & example.com::slave-vol
has been successful
```

**Note**

The **stop** command will fail if:

- any node that is a part of the volume is offline.
- if it is unable to stop the geo-replication session on any particular node.
- if the geo-replication session between the master and slave is not active.

- To stop a geo-replication session *forcefully* between the hosts:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL stop
force
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol stop force
Stopping geo-replication session between Volume1 & example.com::slave-vol
has been successful
```

Using **force** will stop the geo-replication session between the master and slave even if any node that is a part of the volume is offline. If it is unable to stop the geo-replication session on any particular node, the command will still stop the geo-replication sessions on as many nodes as it can. Using **force** will also stop inactive geo-replication sessions.

### 14.4.6. Deleting a Geo-replication Session

**Important**

You must first stop a geo-replication session before it can be deleted. For more information, see Section 14.4.5, “Stopping a Geo-replication Session”.

To delete a geo-replication session, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL delete
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol delete
geo-replication command executed successfully
```

**Note**

The **delete** command will fail if:

- any node that is a part of the volume is offline.
- if it is unable to delete the geo-replication session on any particular node.
- if the geo-replication session between the master and slave is still active.

**Important**

The SSH keys will not removed from the master and slave nodes when the geo-replication session is deleted. You can manually remove the **pem** files which contain the SSH keys from the **/var/lib/glusterd/geo-replication/** directory.

## 14.5. Starting Geo-replication on a Newly Added Brick or Node

### 14.5.1. Starting Geo-replication for a New Brick or New Node

If a geo-replication session is running, and a new node is added to the trusted storage pool or a brick is added to the volume from a newly added node in the trusted storage pool, then you must perform the following steps to start the geo-replication daemon on the new node:

1. Run the following command on the master node where passwordless SSH connection is configured, in order to create a common **pem pub** file.

   ```
   # gluster system:: execute gsec_create
   ```

2. Create the geo-replication session using the following command. The **push-pem** and **force** options are required to perform the necessary **pem-file** setup on the slave nodes.

   ```
   # gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
   create push-pem force
   ```

   For example:

   ```
   # gluster volume geo-replication Volume1 example.com::slave-vol create
   push-pem force
   ```

   **Note**

   There must be passwordless SSH access between the node from which this command is run, and the slave host specified in the above command. This command performs the slave verification, which includes checking for a valid slave URL, valid slave volume, and available space on the slave.

3. After successfully setting up the shared storage volume, when a new node is added to the cluster, the shared storage is not mounted automatically on this node. Neither is the **/etc/fstab** entry added for the shared storage on this node. To make use of shared storage on this node, execute the following commands:

```
# mount -t glusterfs <local node's ip>:gluster_shared_storage
/var/run/gluster/shared_storage
# cp /etc/fstab /var/run/gluster/fstab.tmp
# echo "<local node's ip>:/gluster_shared_storage
/var/run/gluster/shared_storage/ glusterfs defaults 0 0" >> /etc/fstab
```

   For more information on setting up shared storage volume, see Section 10.8, “Setting up Shared Storage Volume”.

4. Configure the meta-volume for geo-replication:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
config use_meta_volume true
```

   For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config
use_meta_volume true
```

   For more information on configuring meta-volume, see Section 14.3.5, “Configuring a Meta-Volume”.

5. If a node is added at slave, stop the geo-replication session using the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL stop
```

6. Start the geo-replication session between the slave and master forcefully, using the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
start force
```

7. Verify the status of the created session, using the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
status
```

### 14.5.2. Starting Geo-replication for a New Brick on an Existing Node

When adding a brick to the volume on an existing node in the trusted storage pool with a geo-replication session running, the geo-replication daemon on that particular node will automatically be restarted. The new brick will then be recognized by the geo-replication daemon. This is an automated process and no configuration changes are required.

## 14.6. Disaster Recovery

When the master volume goes offline, you can perform the following disaster recovery procedures to minimize the interruption of service:

- Section 14.6.1, “Promoting a Slave to Master”
- Section 14.6.2, “Failover and Failback”


### 14.6.1. Promoting a Slave to Master

If the master volume goes offline, you can promote a slave volume to be the master, and start using that volume for data access.

Run the following commands on the slave machine to promote it to be the master:

```
# gluster volume set VOLNAME geo-replication.indexing on
# gluster volume set VOLNAME changelog on
```

You can now configure applications to use the slave volume for I/O operations.

### 14.6.2. Failover and Failback

Red Hat Gluster Storage provides geo-replication failover and failback capabilities for disaster recovery. If the master goes offline, you can perform a failover procedure so that a slave can replace the master. When this happens, all the I/O operations, including reads and writes, are done on the slave which is now acting as the master. When the original master is back online, you can perform a failback procedure on the original slave so that it synchronizes the differences back to the original master.

**Performing a Failover and Failback**

1. Create a new geo-replication session with the original slave as the new master, and the original master as the new slave. For more information on setting and creating geo-replication session, see Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”.

2. Start the special synchronization mode to speed up the recovery of data from slave.

   ```
   # gluster volume geo-replication ORIGINAL_SLAVE_VOL
   ORIGINAL_MASTER_HOST::ORIGINAL_MASTER_VOL config special-sync-mode
   recover
   ```

3. Set a checkpoint to help verify the status of the data synchronization.

   ```
   # gluster volume geo-replication ORIGINAL_SLAVE_VOL
   ORIGINAL_MASTER_HOST::ORIGINAL_MASTER_VOL config checkpoint now
   ```

4. Start the new geo-replication session using the following command:

   ```
   # gluster volume geo-replication ORIGINAL_SLAVE_VOL
   ORIGINAL_MASTER_HOST::ORIGINAL_MASTER_VOL start
   ```

5. Verify the checkpoint completion for the geo-replication session using the following command:

   ```
   # gluster volume geo-replication ORIGINAL_SLAVE_VOL
   ORIGINAL_MASTER_HOST::ORIGINAL_MASTER_VOL status detail
   ```

6. To resume the original master and original slave back to their previous roles, stop the I/O operations on the original slave, and using steps 3 and 5, ensure that all the data from the original slave is restored back to the original master. After the data from the original slave is restored back to the

original master, stop the current geo-replication session (the failover session) between the original slave and original master, and resume the previous roles.

7. Reset the options that were set for promoting the slave volume as the master volume by running the following commands:

```
# gluster volume reset ORIGINAL_SLAVE_VOL geo-replication.indexing
force
# gluster volume reset ORIGINAL_SLAVE_VOL changelog
```

   For more information on promoting slave volume to be the master volume, see Section 14.6.1, “Promoting a Slave to Master”.

## 14.7. Creating a Snapshot of Geo-replicated Volume

The Red Hat Gluster Storage Snapshot feature enables you to create point-in-time copies of Red Hat Gluster Storage volumes, which you can use to protect data. You can create snapshots of Geo-replicated volumes.

For information on prerequisites, creating, and restoring snapshots of geo-replicated volume, see Chapter 16, *Managing Snapshots*. Creation of a snapshot when geo-replication session is live is not supported and creation of snapshot in this scenario will display the following error:

```
# gluster snapshot create snap1 master
snapshot create: failed: geo-replication session is running for the volume
master. Session needs to be stopped before taking a snapshot.
Snapshot command failed
```

.

You must ensure to pause the geo-replication session before creating snapshot and resume geo-replication session after creating the snapshot. Information on restoring geo-replicated volume is also available in the *Managing Snapshots* chapter.

## 14.8. Example - Setting up Cascading Geo-replication

This section provides step by step instructions to set up a cascading geo-replication session. The configuration of this example has three volumes and the volume names are master-vol, interimmaster-vol, and slave-vol.

1. Verify that your environment matches the minimum system requirements listed in Section 14.3.3, “Prerequisites”.

2. Determine the appropriate deployment scenario. For more information on deployment scenarios, see Section 14.3.1, “Exploring Geo-replication Deployment Scenarios”.

3. Configure the environment and create a geo-replication session between master-vol and interimmaster-vol.

   a. Create a common pem pub file, run the following command on the master node where the passwordless SSH connection is configured:

   ```
   # gluster system:: execute gsec_create
   ```

   b. Create the geo-replication session using the following command. The push-pem option is needed to perform the necessary pem-file setup on the interimmaster nodes.

```
# gluster volume geo-replication master-vol
interimhost.com::interimmaster-vol create
push-pem
```

c. Verify the status of the created session by running the following command:

```
# gluster volume geo-replication master-vol
interimhost::interimmaster-vol status
```

4. Start a Geo-replication session between the hosts:

```
# gluster volume geo-replication master-vol
interimhost.com::interimmaster-vol start
```

This command will start distributed geo-replication on all the nodes that are part of the master volume. If a node that is part of the master volume is down, the command will still be successful. In a replica pair, the geo-replication session will be active on any of the replica nodes, but remain passive on the others. After executing the command, it may take a few minutes for the session to initialize and become stable.

5. Verifying the status of geo-replication session by running the following command:

```
# gluster volume geo-replication master-vol
interimhost.com::interimmaster-vol status
```

6. Create a geo-replication session between interimmaster-vol and slave-vol.

a. Create a common pem pub file by running the following command on the interimmaster master node where the passwordless SSH connection is configured:

```
# gluster system:: execute gsec_create
```

b. On interimmaster node, create the geo-replication session using the following command. The push-pem option is needed to perform the necessary pem-file setup on the slave nodes.

```
# gluster volume geo-replication interimmaster-vol
slave_host.com::slave-vol create push-pem
```

c. Verify the status of the created session by running the following command:

```
# gluster volume geo-replication interrimmaster-vol
slave_host::slave-vol status
```

7. Start a geo-replication session between interrimaster-vol and slave-vol by running the following command:

```
# gluster volume geo-replication interrimmaster-vol
slave_host.com::slave-vol start
```

8. Verify the status of geo-replication session by running the following:

```
# gluster volume geo-replication interrimmaster-vol
slave_host.com::slave-vol status
```

## 14.9. Recommended Practices

### Manually Setting the Time

If you have to change the time on the bricks manually, then the geo-replication session and indexing must be disabled when setting the time on all the bricks. All bricks in a geo-replication environment must be set to the same time, as this avoids the out-of-time sync issue described in Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”. Bricks not operating on the same time setting, or changing the time while the geo-replication is running, will corrupt the geo-replication index. The recommended way to set the time manually is using the following procedure.

**Manually Setting the Time on Bricks in a Geo-replication Environment**

1. Stop geo-replication between the master and slave, using the following command:

   ```
   # gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL stop
   ```

2. Stop geo-replication indexing, using the following command:

   ```
   # gluster volume set MASTER_VOL geo-replication.indexing off
   ```

3. Set a uniform time on all the bricks.

4. Restart the geo-replication sessions, using the following command:

   ```
   # gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
   start
   ```

### Performance Tuning

When the following option is set, it has been observed that there is an increase in geo-replication performance. On the slave volume, run the following command:

```
# gluster volume set SLAVE_VOL batch-fsync-delay-usec 0
```

### Initially Replicating Large Volumes to a Remote Slave Locally using a LAN

For replicating large volumes to a slave in a remote location, it may be useful to do the initial replication to disks locally on a local area network (LAN), and then physically transport the disks to the remote location. This eliminates the need of doing the initial replication of the whole volume over a slower and more expensive wide area network (WAN) connection. The following procedure provides instructions for setting up a local geo-replication session, physically transporting the disks to the remote location, and then setting up geo-replication over a WAN.

**Initially Replicating to a Remote Slave Locally using a LAN**

1. Create a geo-replication session locally within the LAN. For information on creating a geo-replication session, see Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”.

**Important**

You must remember the order in which the bricks/disks are specified when creating the slave volume. This information is required later for configuring the remote geo-replication session over the WAN.

2. Ensure that the initial data on the master is synced to the slave volume. You can verify the status of the synchronization by using the **status** command, as shown in Section 14.4.3, “Displaying Geo-replication Status Information”.

3. Stop and delete the geo-replication session.

   For information on stopping and deleting the the geo-replication session, see Section 14.4.5, “Stopping a Geo-replication Session” and Section 14.4.6, “Deleting a Geo-replication Session”.

**Important**

You must ensure that there are no stale files in **/var/lib/glusterd/geo-replication/**.

4. Stop and delete the slave volume.

   For information on stopping and deleting the volume, see Section 10.9, “Stopping Volumes” and Section 10.10, “Deleting Volumes”.

5. Remove the disks from the slave nodes, and physically transport them to the remote location. Make sure to remember the order in which the disks were specified in the volume.

6. At the remote location, attach the disks and mount them on the slave nodes. Make sure that the file system or logical volume manager is recognized, and that the data is accessible after mounting it.

7. Configure a trusted storage pool for the slave using the **peer probe** command.

   For information on configuring a trusted storage pool, see Chapter 5, *Trusted Storage Pools*.

8. Delete the glusterFS-related attributes on the bricks. This should be done before creating the volume. You can remove the glusterFS-related attributes by running the following command:

```
# for i in `getfattr -d -m . ABSOLUTE_PATH_TO_BRICK 2>/dev/null | grep
trusted | awk -F = '{print $1}'`; do setfattr -x $i
ABSOLUTE_PATH_TO_BRICK; done
```

   Run the following command to ensure that there are no **xattrs** still set on the brick:

```
# getfattr -d -m . ABSOLUTE_PATH_TO_BRICK
```

9. After creating the trusted storage pool, create the Red Hat Gluster Storage volume with the same configuration that it had when it was on the LAN. For information on creating volumes, see Chapter 6, *Red Hat Gluster Storage Volumes*.

> **Important**
>
> Make sure to specify the bricks in same order as they were previously when on the LAN. A mismatch in the specification of the brick order may lead to data loss or corruption.

10. Start and mount the volume, and check if the data is intact and accessible.

    For information on starting and mounting volumes, see Section 6.10, “Starting Volumes” and Chapter 7, *Accessing Data - Setting Up Clients*.

11. Configure the environment and create a geo-replication session from the master to this remote slave.

    For information on configuring the environment and creating a geo-replication session, see Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”.

12. Start the geo-replication session between the master and the remote slave.

    For information on starting the geo-replication session, see Section 14.4, “Starting Geo-replication”.

13. Use the **status** command to verify the status of the session, and check if all the nodes in the session are stable.

    For information on the **status**, see Section 14.4.3, “Displaying Geo-replication Status Information”.

## 14.10. Troubleshooting Geo-replication

This section describes the most common troubleshooting scenarios related to geo-replication.

### 14.10.1. Tuning Geo-replication performance with Change Log

There are options for the change log that can be configured to give better performance in a geo-replication environment.

The **rollover-time** option sets the rate at which the change log is consumed. The default rollover time is 60 seconds, but it can be configured to a faster rate. A recommended rollover-time for geo-replication is 10-15 seconds. To change the **rollover-time** option, use following the command:

```
# gluster volume set VOLNAME rollover-time 15
```

The **fsync-interval** option determines the frequency that updates to the change log are written to disk. The default interval is 0, which means that updates to the change log are written synchronously as they occur, and this may negatively impact performance in a geo-replication environment. Configuring **fsync-interval** to a non-zero value will write updates to disk asynchronously at the specified interval. To change the **fsync-interval** option, use following the command:

```
# gluster volume set VOLNAME fsync-interval 3
```

### 14.10.2. Triggering Explicit Sync on Entries

Geo-replication provides an option to explicitly trigger the sync operation of files and directories. A virtual extended attribute **glusterfs.geo-rep.trigger-sync** is provided to accomplish the same.

```
# setfattr -n glusterfs.geo-rep.trigger-sync -v "1" <file-path>
```

The support of explicit trigger of sync is supported only for directories and regular files.

### 14.10.3. Synchronization Is Not Complete

#### Situation

The geo-replication status is displayed as **Stable**, but the data has not been completely synchronized.

#### Solution

A full synchronization of the data can be performed by erasing the index and restarting geo-replication. After restarting geo-replication, it will begin a synchronization of the data using checksums. This may be a long and resource intensive process on large data sets. If the issue persists, contact Red Hat Support.

For more information about erasing the index, see Section 10.1, “Configuring Volume Options”.

### 14.10.4. Issues with File Synchronization

#### Situation

The geo-replication status is displayed as **Stable**, but only directories and symlinks are synchronized. Error messages similar to the following are in the logs:

```
[2011-05-02 13:42:13.467644] E [master:288:regjob] GMaster: failed to sync
./some_file`
```

#### Solution

Geo-replication requires **rsync** v3.0.0 or higher on the host and the remote machines. Verify if you have installed the required version of **rsync**.

### 14.10.5. Geo-replication Status is Often `Faulty`

#### Situation

The geo-replication status is often displayed as **Faulty**, with a backtrace similar to the following:

```
012-09-28 14:06:18.378859] E [syncdutils:131:log_raise_exception] <top>:
FAIL: Traceback (most recent call last): File
"/usr/local/libexec/glusterfs/python/syncdaemon/syncdutils.py", line 152, in
twraptf(*aa) File "/usr/local/libexec/glusterfs/python/syncdaemon/repce.py",
line 118, in listen rid, exc, res = recv(self.inf) File
"/usr/local/libexec/glusterfs/python/syncdaemon/repce.py", line 42, in recv
return pickle.load(inf) EOFError
```

#### Solution

This usually indicates that RPC communication between the master gsyncd module and slave gsyncd module is broken. Make sure that the following pre-requisites are met:

- Passwordless SSH is set up properly between the host and remote machines.

- FUSE is installed on the machines. The geo-replication module mounts Red Hat Gluster Storage volumes using FUSE to sync data.

### 14.10.6. Intermediate Master is in a Faulty State

#### Situation

In a cascading environment, the intermediate master is in a faulty state, and messages similar to the following are in the log:

```
raise RuntimeError ("aborting on uuid change from %s to %s" % \
RuntimeError: aborting on uuid change from af07e07c-427f-4586-ab9f-
4bf7d299be81 to de6b5040-8f4e-4575-8831-c4f55bd41154
```

#### Solution

In a cascading configuration, an intermediate master is loyal to its original primary master. The above log message indicates that the geo-replication module has detected that the primary master has changed. If this change was deliberate, delete the **`volume-id`** configuration option in the session that was initiated from the intermediate master.

### 14.10.7. Remote gsyncd Not Found

#### Situation

The master is in a faulty state, and messages similar to the following are in the log:

```
[2012-04-04 03:41:40.324496] E [resource:169:errfail] Popen: ssh> bash:
/usr/local/libexec/glusterfs/gsyncd: No such file or directory
```

#### Solution

The steps to configure a SSH connection for geo-replication have been updated. Use the steps as described in Section 14.3.4.1, “Setting Up your Environment for Geo-replication Session”

# Chapter 15. Managing Directory Quotas

Directory quotas allow you to set limits on disk space used by directories or the volume. Storage administrators can control the disk space utilization at the directory or the volume level, or both. This is particularly useful in cloud deployments to facilitate the use of utility billing models.

## 15.1. Enabling Quotas

You must enable directory quotas to set disk limits.

Enable quotas on a volume using the following command:

**`# gluster volume quota VOLNAME enable`**

For example, to enable quota on *test-volume*:

```
# gluster volume quota test-volume enable
volume quota : success
```

> **Important**
>
> - Do not enable quota using the **`volume-set`** command. This option is no longer supported.
> - Do not enable quota while **`quota-remove-xattr.sh`** is still running.

## 15.2. Setting Limits

> **Note**
>
> - Before setting quota limits on any directory, ensure that there is at least one brick available per replica set.
>
>   To see the current status of bricks of a volume, run the following command:
>
>   ```
>   # gluster volume status VOLNAME status
>   ```
>
> - If the Red Hat Gluster Storage volume is mounted at **`/mntglusterfs`** and you want to perform a certain function pertaining to Quota on **`/mntglusterfs/dir`**, then the path to be provided in any corresponding command should be **`/dir`**, where **`/dir`** is the absolute path relative to the Red Hat Gluster Storage volume mount point.

A *Hard Limit* is the maximum disk space you can utilize on a volume or directory.

Set the hard limit for a directory in the volume with the following command, specifying the hard limit size in MB, GB, TB or PB:

**`# gluster volume quota VOLNAME limit-usage path hard_limit`**

For example:

- To set a hard limit of 100GB on **/dir**:

```
# gluster volume quota VOLNAME limit-usage /dir 100GB
```

- To set a hard limit of 1TB for the volume:

```
# gluster volume quota VOLNAME limit-usage / 1TB
```

A *Soft Limit* is an attribute of a directory that is specified as a percentage of the hard limit. When disk usage reaches the soft limit of a given directory, the system begins to log this information in the logs of the brick on which data is written. The brick logs can be fount at:

```
/var/log/glusterfs/bricks/<path-to-brick.log>
```

By default, the soft limit is 80% of the hard limit.

Set the soft limit for a volume with the following command, specifying the soft limit size as a percentage of the hard limit:

**# gluster volume quota *VOLNAME* limit-usage *path* *hard_limit* *soft_limit***

For example:

- To set the soft limit to 76% of the hard limit on **/dir**:

```
# gluster volume quota VOLNAME limit-usage /dir 100GB 76%
```

- To set the soft limit to 68% of the hard limit on the volume:

```
# gluster volume quota VOLNAME limit-usage / 1TB 68%
```

**Note**

When setting the soft limit, ensure you retain the hard limit value previously created.

## 15.3. Setting the Default Soft Limit

The default soft limit is an attribute of the volume that is specified as a percentage. The default soft limit for any volume is 80%.

When you do not specify the soft limit along with the hard limit, the default soft limit is applied to the directory or volume.

Configure the default soft limit value using the following command:

**# gluster volume quota *VOLNAME* default-soft-limit *soft_limit***

For example, to set the default soft limit to 90% on *test-volume* run the following command:

```
# gluster volume quota test-volume default-soft-limit 90%
volume quota : success
```

Ensure that the value is set using the following command:

```
# gluster volume quota test-volume list
```

**Note**

If you change the soft limit at the directory level and then change the volume's default soft limit, the directory-level soft limit previously configured will remain the same.

## 15.4. Displaying Quota Limit Information

You can display quota limit information on all of the directories on which a limit is set.

To display quota limit information on all of the directories on which a limit is set, use the following command:

```
# gluster volume quota VOLNAME list
```

For example, to view the quota limits set on *test-volume*:

```
# gluster volume quota test-volume list
Path        Hard-limit  Soft-limit   Used    Available
------------------------------------------------------
/             50GB         75%       0Bytes    50.0GB
/dir          10GB         75%       0Bytes    10.0GB
/dir/dir2     20GB         90%       0Bytes    20.0GB
```

To display disk limit information on a particular directory on which limit is set, use the following command:

```
# gluster volume quota VOLNAME list /<directory_name>
```

For example, to view limits set on */dir* directory of the volume */test-volume* :

```
# gluster volume quota test-volume list /dir
Path  Hard-limit   Soft-limit   Used   Available
-------------------------------------------------
/dir   10.0GB          75%       0Bytes  10.0GB
```

To display disk limit information on multiple directories on which a limit is set, using the following command:

```
# gluster volume quota VOLNAME list /<directory_name1> /<directory_name2>
```

For example, to view quota limits set on directories */dir* and */dir/dir2* of volume *test-volume* :

```
# gluster volume quota test-volume list /dir /dir/dir2
Path     Hard-limit   Soft-limit   Used     Available
------------------------------------------------------
/dir        10.0GB        75%        0Bytes     10.0GB
/dir/dir2   20.0GB        90%        0Bytes     20.0GB
```

### 15.4.1. Displaying Quota Limit Information Using the `df` Utility

To report the disk usage using the **df** utility, taking quota limits into consideration, run the following command:

```
# gluster volume set VOLNAME quota-deem-statfs on
```

In this case, the total disk space of the directory is taken as the quota hard limit set on the directory of the volume.

The following example displays the disk usage when **quota-deem-statfs** is off:

```
# gluster volume set test-volume features.quota-deem-statfs off
volume set: success
# gluster volume quota test-volume list
Path         Hard-limit    Soft-limit     Used     Available
-----------------------------------------------------------
/               300.0GB        90%        11.5GB     288.5GB
/John/Downloads 77.0GB         75%        11.5GB     65.5GB
```

Disk usage for volume test-volume as seen on client1:

```
# df -hT /home
Filesystem            Type             Size  Used Avail Use% Mounted on
server1:/test-volume fuse.glusterfs  400G   12G  389G   3% /home
```

The following example displays the disk usage when **quota-deem-statfs** is on:

```
# gluster volume set test-volume features.quota-deem-statfs on
volume set: success
# gluster vol quota test-volume list
Path         Hard-limit    Soft-limit     Used     Available
-----------------------------------------------------------
/               300.0GB        90%        11.5GB     288.5GB
/John/Downloads 77.0GB         75%        11.5GB     65.5GB
```

Disk usage for volume test-volume as seen on client1:

```
# df -hT /home
Filesystem            Type             Size  Used Avail Use% Mounted on
server1:/test-volume  fuse.glusterfs  300G   12G  289G   4% /home
```

The **quota-deem-statfs** option when set to on, allows the administrator to make the user view the total disk space available on the directory as the hard limit set on it.

## 15.5. Setting Timeout

There are two types of timeouts that you can configure for a volume quota:

- *Soft timeout* is the frequency at which the quota server-side translator checks the volume usage when the usage is below the soft limit. The soft timeout is in effect when the disk usage is less than the soft limit.

  To set the soft timeout, use the following command:

**# gluster volume quota *VOLNAME* soft-timeout *time***

**Note**

The default soft timeout is 60 seconds.

For example, to set the soft timeout on *test-volume* to 1 minute:

```
# gluster volume quota test-volume soft-timeout 1min
volume quota : success
```

- *Hard timeout* is the frequency at which the quota server-side translator checks the volume usage when the usage is above the soft limit. The hard timeout is in effect when the disk usage is between the soft limit and the hard limit.

  To set the hard timeout, use the following command:

  **# gluster volume quota *VOLNAME* hard-timeout *time***

  **Note**

  The default hard timeout is 5 seconds.

  For example, to set the hard timeout for 30 seconds:

```
# gluster volume quota test-volume hard-timeout 30s
volume quota : success
```

**Note**

As the margin of error for disk usage is proportional to the workload of the applications running on the volume, ensure that you set the hard-timeout and soft-timeout taking the workload into account.

## 15.6. Setting Alert Time

*Alert time* is the frequency at which you want your usage information to be logged after you reach the soft limit.

To set the alert time, use the following command:

**# gluster volume quota *VOLNAME* alert-time *time***

**Note**

The default alert-time is 1 week.

For example, to set the alert time to 1 day:

```
# gluster volume quota test-volume alert-time 1d
volume quota : success
```

## 15.7. Removing Disk Limits

You can remove disk limit usage settings on a given directory, if quota set is not required.

Remove disk limit usage set on a particular directory using the following command:

**# gluster volume quota *VOLNAME* remove */<directory-name>***

For example, to remove the disk limit usage on */data* directory of *test-volume*:

```
# gluster volume quota test-volume remove /data
volume quota : success
```

For example, to remove quota from volume:

```
# gluster vol quota test-volume remove /
volume quota : success
```

**Note**

Removing quota limit from the volume ("/" in the above example) does not impact quota limit usage on directories.

## 15.8. Disabling Quotas

You can disable directory quotas using the following command:

**# gluster volume quota *VOLNAME* disable**

For example, to disable directory quotas on *test-volume*:

```
# gluster volume quota test-volume disable
Disabling quota will delete all the quota configuration. Do you want to
continue? (y/n) y
volume quota : success
```

**Note**

- When you disable quotas, all previously configured limits are removed from the volume.

# Chapter 16. Managing Snapshots

Red Hat Gluster Storage Snapshot feature enables you to create point-in-time copies of Red Hat Gluster Storage volumes, which you can use to protect data. Users can directly access Snapshot copies which are read-only to recover from accidental deletion, corruption, or modification of the data.

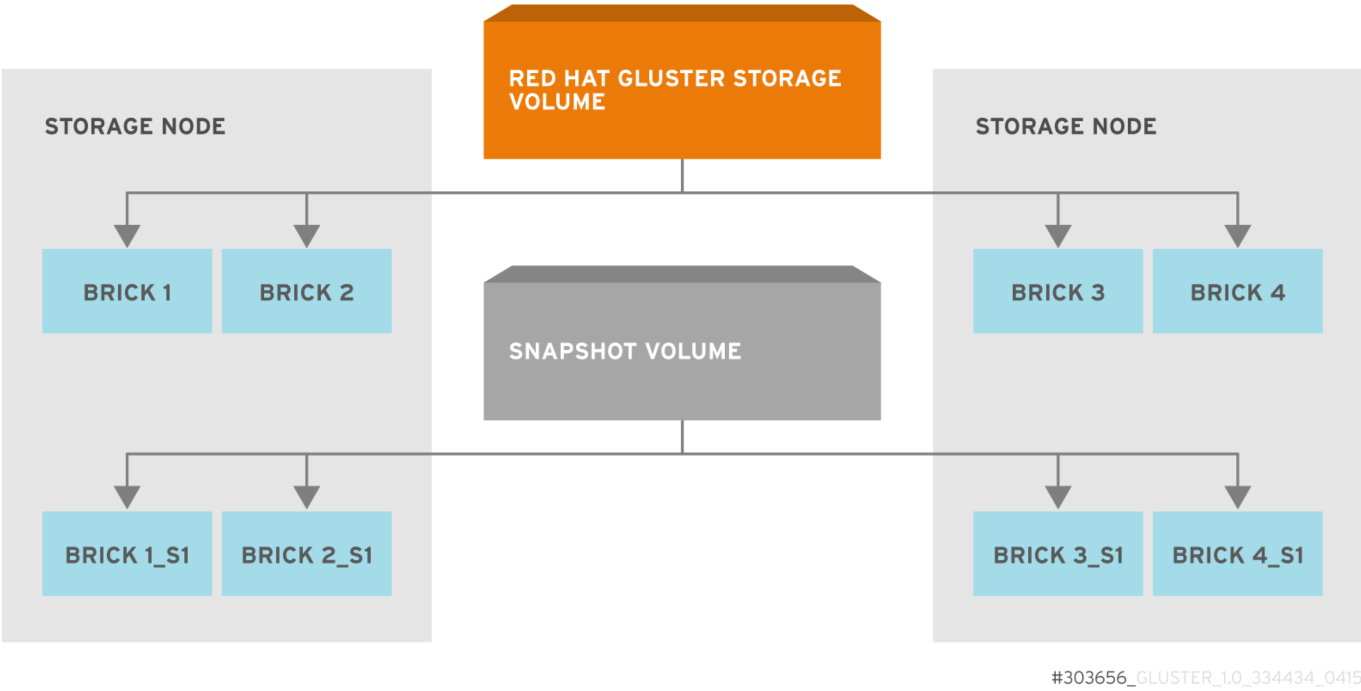



**Figure 16.1. Snapshot Architecture**

In the Snapshot Architecture diagram, Red Hat Gluster Storage volume consists of multiple bricks (Brick1 Brick2 etc) which is spread across one or more nodes and each brick is made up of independent thin Logical Volumes (LV). When a snapshot of a volume is taken, it takes the snapshot of the LV and creates another brick. Brick1_s1 is an identical image of Brick1. Similarly, identical images of each brick is created and these newly created bricks combine together to form a snapshot volume.

Some features of snapshot are:

- **Crash Consistency**

  A crash consistent snapshot is captured at a particular point-in-time. When a crash consistent snapshot is restored, the data is identical as it was at the time of taking a snapshot.

  > **Note**
  >
  > Currently, application level consistency is not supported.

- **Online Snapshot**

  Snapshot is an online snapshot hence the file system and its associated data continue to be available for the clients even while the snapshot is being taken.

- **Quorum Based**

The quorum feature ensures that the volume is in a good condition while the bricks are down. If any brick that is down for a n way replication, where n <= 2 , quorum is not met. In a n-way replication where n >= 3, quorum is met when m bricks are up, where m >= (n/2 +1) where n is odd and m >= n/2 and the first brick is up where n is even. If quorum is not met snapshot creation fails.

> **Note**
>
> The quorum check feature in snapshot is in technology preview. Snapshot delete and restore feature checks node level quorum instead of brick level quorum. Snapshot delete and restore is successful only when m number of nodes of a n node cluster is up, where m >= (n/2+1).

- **Barrier**

  To guarantee crash consistency some of the fops are blocked during a snapshot operation.

  These fops are blocked till the snapshot is complete. All other fops is passed through. There is a default time-out of 2 minutes, within that time if snapshot is not complete then these fops are unbarriered. If the barrier is unbarriered before the snapshot is complete then the snapshot operation fails. This is to ensure that the snapshot is in a consistent state.

> **Note**
>
> Taking a snapshot of a Red Hat Gluster Storage volume that is hosting the Virtual Machine Images is not recommended. Taking a Hypervisor assisted snapshot of a virtual machine would be more suitable in this use case.

## 16.1. Prerequisites

Before using this feature, ensure that the following prerequisites are met:

- Snapshot is based on thinly provisioned LVM. Ensure the volume is based on LVM2. Red Hat Gluster Storage is supported on Red Hat Enterprise Linux 6.7, 7.1 and 7.2. Both these versions of Red Hat Enterprise Linux is based on LVM2 by default. For more information, see https://access.redhat.com/site/documentation/en-US/Red_Hat_Enterprise_Linux/6/html/Logical_Volume_Manager_Administration/thinprovisioned_volumes.html
- Each brick must be independent thinly provisioned logical volume(LV).
- The logical volume which contains the brick must not contain any data other than the brick.
- Only linear LVM is supported with Red Hat Gluster Storage. For more information, see https://access.redhat.com/site/documentation/en-US/Red_Hat_Enterprise_Linux/4/html-single/Cluster_Logical_Volume_Manager/#lv_overview
- Each snapshot creates as many bricks as in the original Red Hat Gluster Storage volume. Bricks, by default, use privileged ports to communicate. The total number of privileged ports in a system is restricted to 1024. Hence, for supporting 256 snapshots per volume, the following options must be set on Gluster volume. These changes will allow bricks and glusterd to communicate using non-privileged ports.
  - Run the following command to permit insecure ports:

```
# gluster volume set VOLNAME server.allow-insecure on
```

- Edit the **/etc/glusterfs/glusterd.vol** in each Red Hat Gluster Storage node, and add the following setting:

```
option rpc-auth-allow-insecure on
```

- Restart glusterd service on each Red Hat Server node using the following command:

```
# service glusterd restart
```

### Recommended Setup

The recommended setup for using Snapshot is described below. In addition, you must ensure to read Chapter 13, *Configuring Red Hat Gluster Storage for Enhancing Performance* for enhancing snapshot performance:

- For each volume brick, create a dedicated thin pool that contains the brick of the volume and its (thin) brick snapshots. With the current thin-p design, avoid placing the bricks of different Red Hat Gluster Storage volumes in the same thin pool, as this reduces the performance of snapshot operations, such as snapshot delete, on other unrelated volumes.
- The recommended thin pool chunk size is 256KB. There might be exceptions to this in cases where we have a detailed information of the customer's workload.
- The recommended pool metadata size is 0.1% of the thin pool size for a chunk size of 256KB or larger. In special cases, where we recommend a chunk size less than 256KB, use a pool metadata size of 0.5% of thin pool size.

### For Example

To create a brick from device /dev/sda1.

1. Create a physical volume(PV) by using the **pvcreate** command.

   ```
   pvcreate /dev/sda1
   ```

   Use the correct **dataalignment** option based on your device. For more information, Section 13.2, “Brick Configuration”

2. Create a Volume Group (VG) from the PV using the following command:

   ```
   vgcreate dummyvg /dev/sda1
   ```

3. Create a thin-pool using the following command:

   ```
   lvcreate -L 1T -T dummyvg/dummypool -c 256k --poolmetadatasize 16G
   ```

   A thin pool of size 1 TB is created, using a chunksize of 256 KB. Maximum pool metadata size of 16 G is used.

4. Create a thinly provisioned volume from the previously created pool using the following command:

   ```
   lvcreate -V 1G -T dummyvg/dummypool -n dummylv
   ```

5. Create a file system (XFS) on this. Use the recommended options to create the XFS file system on the thin LV.

   For example,

   ```
   mkfs.xfs -f -i size=512 -n size=8192 /dev/dummyvg/dummylv
   ```

6. Mount this logical volume and use the mount path as the brick.

   ```
   mount/dev/dummyvg/dummylv /mnt/brick1
   ```

## 16.2. Creating Snapshots

Before creating a snapshot ensure that the following prerequisites are met:

- Red Hat Gluster Storage volume has to be present and the volume has to be in the **`Started`** state.
- All the bricks of the volume have to be on an independent thin logical volume(LV).
- Snapshot names must be unique in the cluster.
- All the bricks of the volume should be up and running, unless it is a n-way replication where n >= 3. In such case quorum must be met. For more information see Chapter 16, *Managing Snapshots*
- No other volume operation, like **`rebalance`**, **`add-brick`**, etc, should be running on the volume.
- Total number of snapshots in the volume should not be equal to *Effective snap-max-hard-limit*. For more information see *Configuring Snapshot Behavior*.
- If you have a geo-replication setup, then pause the geo-replication session if it is running, by executing the following command:

  ```
  # gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL pause
  ```

  For example,

  ```
  # gluster volume geo-replication master-vol example.com::slave-vol pause
  Pausing geo-replication session between master-vol example.com::slave-vol
  has been successful
  ```

  Ensure that you take the snapshot of the master volume and then take snapshot of the slave volume.

- If you have a Hadoop enabled Red Hat Gluster Storage volume, you must ensure to stop all the Hadoop Services in Ambari.

To create a snapshot of the volume, run the following command:

```
# gluster snapshot create <snapname> <volname> [no-timestamp] [description
<description>] [force]
```

where,

- *snapname* - Name of the snapshot that will be created.

- *VOLNAME(S)* - Name of the volume for which the snapshot will be created. We only support creating snapshot of single volume.
- *description* - This is an optional field that can be used to provide a description of the snap that will be saved along with the snap.
- **`force`** - Snapshot creation will fail if any brick is down. In a n-way replicated Red Hat Gluster Storage volume where n >= 3 snapshot is allowed even if some of the bricks are down. In such case quorum is checked. Quorum is checked only when the **`force`** option is provided, else by-default the snapshot create will fail if any brick is down. Refer the *Overview* section for more details on quorum.
- no-timestamp: By default a timestamp is appended to the snapshot name. If you do not want to append timestamp then pass no-timestamp as an argument.

For Example 1:

```
# gluster snapshot create snap1 vol1 no-timestamp
snapshot create: success: Snap snap1 created successfully
```

For Example 2:

```
# gluster snapshot create snap1 vol1
snapshot create: success: Snap snap1_GMT-2015.07.20-10.02.33 created
successfully
```

Snapshot of a Red Hat Gluster Storage volume creates a read-only Red Hat Gluster Storage volume. This volume will have identical configuration as of the original / parent volume. Bricks of this newly created snapshot is mounted as **`/var/run/gluster/snaps/<snap-volume-name>/brick<bricknumber>`**.

For example, a snapshot with snap volume name **`0888649a92ea45db8c00a615dfc5ea35`** and having two bricks will have the following two mount points:

```
/var/run/gluster/snaps/0888649a92ea45db8c00a615dfc5ea35/brick1
/var/run/gluster/snaps/0888649a92ea45db8c00a615dfc5ea35/brick2
```

These mounts can also be viewed using the **`df`** or **`mount`** command.

### Note

If you have a geo-replication setup, after creating the snapshot, resume the geo-replication session by running the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
resume
```

For example,

```
# gluster volume geo-replication master-vol example.com::slave-vol
resume
Resuming geo-replication session between master-vol example.com::slave-
vol has been successful
```

Execute the following command

```
./ganesha-ha.sh --refresh-config <HA_CONFDIR> <volname>
```

## 16.3. Cloning a Snapshot

A clone or a writable snapshot is a new volume, which is created from a particular snapshot.

To clone a snapshot, execute the following command.

```
# gluster snapshot clone <clonename> <snapname>
```

where,

clonename: It is the name of the clone, ie, the new volume that will be created.

snapname: It is the name of the snapshot that is being cloned.

**Note**

- Unlike restoring a snapshot, the original snapshot is still retained, after it has been cloned.
- The snapshot should be in activated state and all the snapshot bricks should be in running state before taking clone. Also the server nodes should be in quorum.
- This is a space efficient clone therefore both the Clone (new volume) and the snapshot LVM share the same LVM backend. The space consumption of the LVM grow as the new volume (clone) diverge from the snapshot.

For example:

```
# gluster snapshot clone clone_vol snap1
snapshot clone: success: Clone clone_vol created successfully
```

To check the status of the newly cloned snapshot execute the following command

```
# gluster vol info <clonename>
```

For example:

```
# gluster vol info clone_vol

Volume Name: clone_vol
Type: Distribute
Volume ID: cdd59995-9811-4348-8e8d-988720db3ab9
Status: Created
Number of Bricks: 1
Transport-type: tcp
Bricks:
Brick1: 10.00.00.01:/var/run/gluster/snaps/clone_vol/brick1/brick3
Options Reconfigured:
performance.readdir-ahead: on
```

In the example it is observed that clone is in **`Created`** state, similar to a newly created volume. This volume should be explicitly started to use this volume.

## 16.4. Listing of Available Snapshots

To list all the snapshots that are taken for a specific volume, run the following command:

```
# gluster snapshot list [VOLNAME]
```

where,

- *VOLNAME* - This is an optional field and if provided lists the snapshot names of all snapshots present in the volume.

For Example:

```
# gluster snapshot list
snap3
# gluster snapshot list test_vol
No snapshots present
```

## 16.5. Getting Information of all the Available Snapshots

The following command provides the basic information of all the snapshots taken. By default the information of all the snapshots in the cluster is displayed:

```
# gluster snapshot info [(<snapname> | volume VOLNAME)]
```

where,

- *snapname* - This is an optional field. If the *snapname* is provided then the information about the specified snap is displayed.
- *VOLNAME* - This is an optional field. If the *VOLNAME* is provided the information about all the snaps in the specified volume is displayed.

For Example:

```
# gluster snapshot info snap3
Snapshot                  : snap3
Snap UUID                 : b2a391ce-f511-478f-83b7-1f6ae80612c8
Created                   : 2014-06-13 09:40:57
Snap Volumes:

     Snap Volume Name          : e4a8f4b70a0b44e6a8bff5da7df48a4d
     Origin Volume name        : test_vol1
     Snaps taken for test_vol1      : 1
     Snaps available for test_vol1  : 255
     Status                    : Started
```

## 16.6. Getting the Status of Available Snapshots

This command displays the running status of the snapshot. By default the status of all the snapshots in the cluster is displayed. To check the status of all the snapshots that are taken for a particular volume, specify a volume name:

```
# gluster snapshot status [(<snapname> | volume VOLNAME)]
```

where,

- *snapname* - This is an optional field. If the *snapname* is provided then the status about the specified snap is displayed.
- *VOLNAME* - This is an optional field. If the *VOLNAME* is provided the status about all the snaps in the specified volume is displayed.

For Example:

```
# gluster snapshot status snap3

Snap Name : snap3
Snap UUID : b2a391ce-f511-478f-83b7-1f6ae80612c8

     Brick Path        :
10.70.42.248:/var/run/gluster/snaps/e4a8f4b70a0b44e6a8bff5da7df48a4d/brick1/
brick1
     Volume Group      :   snap_lvgrp1
     Brick Running     :   Yes
     Brick PID         :   1640
     Data Percentage   :   1.54
     LV Size           :   616.00m


     Brick Path        :
10.70.43.139:/var/run/gluster/snaps/e4a8f4b70a0b44e6a8bff5da7df48a4d/brick2/
brick3
     Volume Group      :   snap_lvgrp1
     Brick Running     :   Yes
     Brick PID         :   3900
     Data Percentage   :   1.80
     LV Size           :   616.00m


     Brick Path        :
10.70.43.34:/var/run/gluster/snaps/e4a8f4b70a0b44e6a8bff5da7df48a4d/brick3/b
rick4
     Volume Group      :   snap_lvgrp1
     Brick Running     :   Yes
     Brick PID         :   3507
     Data Percentage   :   1.80
     LV Size           :   616.00m
```

## 16.7. Configuring Snapshot Behavior

The configurable parameters for snapshot are:

- *snap-max-hard-limit*: If the snapshot count in a volume reaches this limit then no further snapshot creation is allowed. The range is from 1 to 256. Once this limit is reached you have to remove the snapshots to create further snapshots. This limit can be set for the system or per volume. If both system limit and volume limit is configured then the effective max limit would be the lowest of the two value.
- *snap-max-soft-limit*: This is a percentage value. The default value is 90%. This configuration works along with auto-delete feature. If auto-delete is enabled then it will delete the oldest snapshot when snapshot count in a volume crosses this limit. When auto-delete is disabled it will not delete any snapshot, but it will display a warning message to the user.
- *auto-delete*: This will enable or disable auto-delete feature. By default auto-delete is disabled. When enabled it will delete the oldest snapshot when snapshot count in a volume crosses the snap-max-soft-limit. When disabled it will not delete any snapshot, but it will display a warning message to the user

- **Displaying the Configuration Values**

  To display the existing configuration values for a volume or the entire cluster, run the following command:

  ```
  # gluster snapshot config [VOLNAME]
  ```

  where:

  - *VOLNAME*: This is an optional field. The name of the volume for which the configuration values are to be displayed.

  If the volume name is not provided then the configuration values of all the volume is displayed. System configuration details are displayed irrespective of whether the volume name is specified or not.

  For Example:

  ```
  # gluster snapshot config

  Snapshot System Configuration:
  snap-max-hard-limit : 256
  snap-max-soft-limit : 90%
  auto-delete : disable

  Snapshot Volume Configuration:

  Volume : test_vol
  snap-max-hard-limit : 256
  Effective snap-max-hard-limit : 256
  Effective snap-max-soft-limit : 230 (90%)

  Volume : test_vol1
  snap-max-hard-limit : 256
  Effective snap-max-hard-limit : 256
  Effective snap-max-soft-limit : 230 (90%)
  ```

- **Changing the Configuration Values**

  To change the existing configuration values, run the following command:

  ```
  # gluster snapshot config [VOLNAME] ([snap-max-hard-limit <count>] [snap-max-soft-limit <percent>]) | ([auto-delete <enable|disable>])
  ```

where:

- *VOLNAME*: This is an optional field. The name of the volume for which the configuration values are to be changed. If the volume name is not provided, then running the command will set or change the system limit.
- *snap-max-hard-limit*: Maximum hard limit for the system or the specified volume.
- *snap-max-soft-limit*: Soft limit mark for the system.
- *auto-delete*: This will enable or disable auto-delete feature. By default auto-delete is disabled.

For Example:

```
# gluster snapshot config test_vol snap-max-hard-limit 100
Changing snapshot-max-hard-limit will lead to deletion of snapshots if
they exceed the new limit.
Do you want to continue? (y/n) y
snapshot config: snap-max-hard-limit for test_vol set successfully
```

## 16.8. Activating and Deactivating a Snapshot

Only activated snapshots are accessible. Check the *Accessing Snapshot* section for more details. Since each snapshot is a Red Hat Gluster Storage volume it consumes some resources hence if the snapshots are not needed it would be good to deactivate them and activate them when required. To activate a snapshot run the following command:

```
# gluster snapshot activate <snapname> [force]
```

where:

- *snapname*: Name of the snap to be activated.
- **`force`**: If some of the bricks of the snapshot volume are down then use the **`force`** command to start them.

For Example:

```
# gluster snapshot activate snap1
```

To deactivate a snapshot, run the following command:

```
# gluster snapshot deactivate <snapname>
```

where:

- *snapname*: Name of the snap to be deactivated.

For example:

```
# gluster snapshot deactivate snap1
```

## 16.9. Deleting Snapshot

Before deleting a snapshot ensure that the following prerequisites are met:

- Snapshot with the specified name should be present.
- Red Hat Gluster Storage nodes should be in quorum.
- No volume operation (e.g. add-brick, rebalance, etc) should be running on the original / parent volume of the snapshot.

To delete a snapshot run the following command:

```
# gluster snapshot delete <snapname>
```

where,

- *snapname* - The name of the snapshot to be deleted.

For Example:

```
# gluster snapshot delete snap2
Deleting snap will erase all the information about the snap. Do you still
want to continue? (y/n) y
snapshot delete: snap2: snap removed successfully
```

**Note**

Red Hat Gluster Storage volume cannot be deleted if any snapshot is associated with the volume. You must delete all the snapshots before issuing a volume delete.

### 16.9.1. Deleting Multiple Snapshots

Multiple snapshots can be deleted using either of the following two commands.

To delete all the snapshots present in a system, execute the following command:

```
# gluster snapshot delete all
```

To delete all the snapshot present in a specified volume, execute the following command:

```
# gluster snapshot delete volume <volname>
```

## 16.10. Restoring Snapshot

Before restoring a snapshot ensure that the following prerequisites are met

- The specified snapshot has to be present
- The original / parent volume of the snapshot has to be in a stopped state.
- Red Hat Gluster Storage nodes have to be in quorum.
- If you have a Hadoop enabled Red Hat Gluster Storage volume, you must ensure to stop all the Hadoop Services in Ambari.

- No volume operation (e.g. add-brick, rebalance, etc) should be running on the origin or parent volume of the snapshot.

  ```
  # gluster snapshot restore <snapname>
  ```

  where,

  - *snapname* - The name of the snapshot to be restored.

  For Example:

  ```
  # gluster snapshot restore snap1
  Snapshot restore: snap1: Snap restored successfully
  ```

  After snapshot is restored and the volume is started, trigger a self-heal by running the following command:

  ```
  # gluster volume heal VOLNAME full
  ```

  If you have a Hadoop enabled Red Hat Gluster Storage volume, you must start all the Hadoop Services in Ambari.

  **Note**

  - The snapshot will be deleted once it is restored. To restore to the same point again take a snapshot explicitly after restoring the snapshot.
  - After restore the brick path of the original volume will change. If you are using **fstab** to mount the bricks of the origin volume then you have to fix **fstab** entries after restore. For more information see, https://access.redhat.com/site/documentation/en-US/Red_Hat_Enterprise_Linux/6/html/Installation_Guide/apcs04s07.html

- In the cluster, identify the nodes participating in the snapshot with the snapshot status command. For example:

  ```
   # gluster snapshot status snapname

      Snap Name : snapname
      Snap UUID : bded7c02-8119-491b-a7e1-cc8177a5a1cd

       Brick Path        :
  10.70.43.46:/var/run/gluster/snaps/816e8403874f43a78296decd7c127205/brick2
  /brick2
       Volume Group      :   snap_lvgrp
       Brick Running     :   Yes
       Brick PID         :   8303
       Data Percentage   :   0.43
       LV Size           :   2.60g


       Brick Path        :
  10.70.42.33:/var/run/gluster/snaps/816e8403874f43a78296decd7c127205/brick3
  /brick3
       Volume Group      :   snap_lvgrp
       Brick Running     :   Yes
  ```

```
      Brick PID           :   4594
      Data Percentage     :   42.63
      LV Size             :   2.60g


      Brick Path          :
10.70.42.34:/var/run/gluster/snaps/816e8403874f43a78296decd7c127205/brick4
/brick4
      Volume Group        :   snap_lvgrp
      Brick Running       :   Yes
      Brick PID           :   23557
      Data Percentage     :   12.41
      LV Size             :   2.60g
```

- In the nodes identified above, check if the **`geo-replication`** repository is present in **`/var/lib/glusterd/snaps/`*`snapname`***. If the repository is present in any of the nodes, ensure that the same is present in **`/var/lib/glusterd/snaps/`*`snapname`*** throughout the cluster. If the **`geo-replication`** repository is missing in any of the nodes in the cluster, copy it to **`/var/lib/glusterd/snaps/`*`snapname`*** in that node.

- Restore snapshot of the volume using the following command:

```
# gluster snapshot restore snapname
```

### Restoring Snapshot of a Geo-replication Volume

If you have a geo-replication setup, then perform the following steps to restore snapshot:

1. Stop the geo-replication session.

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL stop
```

2. Stop the slave volume and then the master volume.

```
# gluster volume stop VOLNAME
```

3. Restore snapshot of the slave volume and the master volume.

```
# gluster snapshot restore snapname
```

4. Start the slave volume first and then the master volume.

```
# gluster volume start VOLNAME
```

5. Start the geo-replication session.

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
start
```

6. Resume the geo-replication session.

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
resume
```

## 16.11. Accessing Snapshots

Snapshot of a Red Hat Gluster Storage volume can be accessed only via FUSE mount. Use the following command to mount the snapshot.

```
mount -t glusterfs <hostname>:/snaps/<snapname>/parent-VOLNAME /mount_point
```

- *parent-VOLNAME* - Volume name for which we have created the snapshot.

  For example,

  ```
  # mount -t glusterfs myhostname:/snaps/snap1/test_vol /mnt
  ```

Since the Red Hat Gluster Storage snapshot volume is read-only, no write operations are allowed on this mount. After mounting the snapshot the entire snapshot content can then be accessed in a read-only mode.

> **Note**
>
> NFS and CIFS mount of snapshot volume is not supported.

Snapshots can also be accessed via User Serviceable Snapshots. For more information see, Section 16.13, “User Serviceable Snapshots”

> **Warning**
>
> External snapshots, such as snapshots of a virtual machine/instance, where Red Hat Gluster Storage Server is installed as a guest OS or FC/iSCSI SAN snapshots are not supported.

## 16.12. Scheduling of Snapshots

Snapshot scheduler creates snapshots automatically based on the configured scheduled interval of time. The snapshots can be created every hour, a particular day of the month, particular month, or a particular day of the week based on the configured time interval. The following sections describes scheduling of snapshots in detail.

### 16.12.1. Prerequisites

- To initialize snapshot scheduler on all the nodes of the cluster, execute the following command:

  ```
  snap_scheduler.py init
  ```

  This command initializes the snap_scheduler and interfaces it with the crond running on the local node. This is the first step, before executing any scheduling related commands from a node.

> **Note**
>
> This command has to be run on all the nodes participating in the scheduling. Other options can be run independently from any node, where initialization has been successfully completed.

- A shared storage named **`gluster_shared_storage`** is used across nodes to co-ordinate the scheduling operations. This shared storage is mounted at /var/run/gluster/shared_storage on all the nodes. For more information see, Section 10.8, “Setting up Shared Storage Volume”

- All nodes in the cluster have their times synced using NTP or any other mechanism. This is a hard requirement for this feature to work.

### 16.12.2. Snapshot Scheduler Options

> **Note**
>
> There is a latency of one minute, between providing a command by the helper script and for the command to take effect. Hence, currently, we do not support snapshot schedules with per minute granularity.

#### Enabling Snapshot Scheduler

To enable snap scheduler, execute the following command:

```
snap_scheduler.py enable
```

> **Note**
>
> Snapshot scheduler is disabled by default after initialization

For example:

```
# snap_scheduler.py enable
snap_scheduler: Snapshot scheduling is enabled
```

#### Disabling Snapshot Scheduler

To enable snap scheduler, execute the following command:

```
 snap_scheduler.py disable
```

For example:

```
# snap_scheduler.py disable
snap_scheduler: Snapshot scheduling is disabled
```

#### Displaying the Status of Snapshot Scheduler

To display the the current status(Enabled/Disabled) of the snap scheduler, execute the following command:

```
snap_scheduler.py status
```

For example:

```
# snap_scheduler.py status
snap_scheduler: Snapshot scheduling status: Disabled
```

### Adding a Snapshot Schedule

To add a snapshot schedule, execute the following command:

```
snap_scheduler.py add "Job Name" "Schedule" "Volume Name"
```

where,

Job Name: This name uniquely identifies this particular schedule, and can be used to reference this schedule for future events like edit/delete. If a schedule already exists for the specified Job Name, the add command will fail.

Schedule: The schedules are accepted in the format crond understands. For example:

```
Example of job definition:
.---------------- minute (0 - 59)
| .------------- hour (0 - 23)
| | .---------- day of month (1 - 31)
| | | .------- month (1 - 12) OR jan,feb,mar,apr ...
| | | | .---- day of week (0 - 6) (Sunday=0 or 7) OR
sun,mon,tue,wed,thu,fri,sat
| | | | |
* * * * * user-name command to be executed
```

> **Note**
>
> Currently, we support snapshot schedules to a maximum of half-hourly snapshots.

Volume name: The name of the volume on which the scheduled snapshot operation will be performed

For example:

```
# snap_scheduler.py add "Job1" "* * * * *" test_vol
snap_scheduler: Successfully added snapshot schedule
```

> **Note**
>
> The snapshots taken by the scheduler will have the following naming convention: Scheduler-<Job Name>-<volume name>_<Timestamp>.
>
> For example:
>
> ```
> Scheduled-Job1-test_vol_GMT-2015.06.19-09.47.01
> ```

### Editing a Snapshot Schedule

To edit an existing snapshot schedule, execute the following command:

```
snap_scheduler.py edit "Job Name" "Schedule" "Volume Name"
```

where,

Job Name: This name uniquely identifies this particular schedule, and can be used to reference this schedule for future events like edit/delete. If a schedule already exists for the specified Job Name, the add command will fail.

Schedule: The schedules are accepted in the format crond understands. For example:

```
Example of job definition:
.---------------- minute (0 - 59)
| .------------- hour (0 - 23)
| | .---------- day of month (1 - 31)
| | | .------- month (1 - 12) OR jan,feb,mar,apr ...
| | | | .---- day of week (0 - 6) (Sunday=0 or 7) OR
sun,mon,tue,wed,thu,fri,sat
| | | | |
* * * * * user-name command to be executed
```

Volume name: The name of the volume on which the snapshot schedule will be edited.

For Example:

```
# snap_scheduler.py edit "Job1" "*/5 * * * *" gluster_shared_storage
snap_scheduler: Successfully edited snapshot schedule
```

### Listing a Snapshot Schedule

To list the existing snapshot schedule, execute the following command:

```
snap_scheduler.py list
```

For example:

```
# snap_scheduler.py list
JOB_NAME         SCHEDULE         OPERATION        VOLUME NAME
--------------------------------------------------------------------
Job0                            * * * * *               Snapshot Create
```

```
test_vol
```

### Deleting a Snapshot Schedule

To delete an existing snapshot schedule, execute the following command:

```
snap_scheduler.py delete "Job Name"
```

where,

Job Name: This name uniquely identifies the particular schedule that has to be deleted.

For example:

```
# snap_scheduler.py delete Job1
snap_scheduler: Successfully deleted snapshot schedule
```

## 16.13. User Serviceable Snapshots

User Serviceable Snapshot is a quick and easy way to access data stored in snapshotted volumes. This feature is based on the core snapshot feature in Red Hat Gluster Storage. With User Serviceable Snapshot feature, you can access the activated snapshots of the snapshot volume.

Consider a scenario where a user wants to access a file **test.txt** which was in the Home directory a couple of months earlier and was deleted accidentally. You can now easily go to the virtual **.snaps** directory that is inside the home directory and recover the test.txt file using the **cp** command.

**Note**

- User Serviceable Snapshot is not the recommended option for bulk data access from an earlier snapshot volume. For such scenarios it is recommended to mount the Snapshot volume and then access the data. For more information see, Chapter 16, *Managing Snapshots*
- Each activated snapshot volume when initialized by User Serviceable Snapshots, consumes some memory. Most of the memory is consumed by various house keeping structures of gfapi and xlators like DHT, AFR, etc. Therefore, the total memory consumption by snapshot depends on the number of bricks as well. Each brick consumes approximately 10MB of space, for example, in a 4x2 replica setup the total memory consumed by snapshot is around 50MB and for a 6x2 setup it is roughly 90MB.

  Therefore, as the number of active snapshots grow, the total memory footprint of the snapshot daemon (snapd) also grows. Therefore, in a low memory system, the snapshot daemon can get **OOM** killed if there are too many active snapshots

### 16.13.1. Enabling and Disabling User Serviceable Snapshot

To enable user serviceable snapshot, run the following command:

```
# gluster volume set VOLNAME features.uss enable
```

For example:

```
# gluster volume set test_vol features.uss enable
volume set: success
```

To disable user serviceable snapshot run the following command:

```
# gluster volume set VOLNAME features.uss disable
```

For example:

```
# gluster volume set test_vol features.uss disable
volume set: success
```

### 16.13.2. Viewing and Retrieving Snapshots using NFS / FUSE

For every snapshot available for a volume, any user who has access to the volume will have a read-only view of the volume. You can recover the files through these read-only views of the volume from different point in time. Each snapshot of the volume will be available in the **.snaps** directory of every directory of the mounted volume.

**Note**

To access the snapshot you must first mount the volume.

For NFS mount refer Section 7.2.1.1, “Manually Mounting Volumes Using NFS” for more details. Following command is an example.

```
# mount -t nfs -o vers=3 server1:/test-vol /mnt/glusterfs
```

For FUSE mount refer Section 7.1.3.2, “Mounting Volumes Manually” for more details. Following command is an example.

```
# mount -t glusterfs server1:/test-vol /mnt/glusterfs
```

The **.snaps** directory is a virtual directory which will not be listed by either the **ls** command, or the **ls -a** option. The .snaps directory will contain every snapshot taken for that given volume as individual directories. Each of these snapshot entries will in turn contain the data of the particular directory the user is accessing from when the snapshot was taken.

To view or retrieve a file from a snapshot follow these steps:

1. Go to the folder where the file was present when the snapshot was taken. For example, if you had a test.txt file in the root directory of the mount that has to be recovered, then go to that directory.

   ```
   # cd /mnt/glusterfs
   ```

> **Note**
>
> Since every directory has a virtual **.snaps** directory, you can enter the **.snaps** directory from here. Since **.snaps** is a virtual directory, **ls** and **ls -a** command will not list the **.snaps** directory. For example:
>
> ```
> # ls -a
>       ....Bob  John  test1.txt  test2.txt
> ```

2. Go to the **.snaps** folder

```
# cd .snaps
```

3. Run the **ls** command to list all the snaps

For example:

```
 # ls -p
 snapshot_Dec2014/    snapshot_Nov2014/    snapshot_Oct2014/
snapshot_Sept2014/
```

4. Go to the snapshot directory from where the file has to be retrieved.

For example:

```
cd snapshot_Nov2014
```

```
# ls -p
    John/  test1.txt  test2.txt
```

5. Copy the file/directory to the desired location.

```
# cp -p test2.txt  $HOME
```

### 16.13.3. Viewing and Retrieving Snapshots using CIFS for Windows Client

For every snapshot available for a volume, any user who has access to the volume will have a read-only view of the volume. You can recover the files through these read-only views of the volume from different point in time. Each snapshot of the volume will be available in the **.snaps** folder of every folder in the root of the CIFS share. The **.snaps** folder is a hidden folder which will be displayed only when the following option is set to **ON** on the volume using the following command:

```
# gluster volume set volname features.show-snapshot-directory on
```

After the option is set to **ON**, every Windows client can access the **.snaps** folder by following these steps:

1. In the **Folder** options, enable the **Show hidden files, folders, and drives** option.

2. Go to the root of the CIFS share to view the **.snaps** folder.

> **Note**
>
> The **.snaps** folder is accessible only in the root of the CIFS share and not in any sub folders.

3. The list of snapshots are available in the **.snaps** folder. You can now access the required file and retrieve it.

## 16.14. Troubleshooting

- **Situation**

  Snapshot creation fails.

  **Step 1**

  Check if the bricks are thinly provisioned by following these steps:

  - Execute the **mount** command and check the device name mounted on the brick path. For example:

    ```
    # mount
    /dev/mapper/snap_lvgrp-snap_lgvol on /brick/brick-dirs type xfs (rw)
    /dev/mapper/snap_lvgrp1-snap_lgvol1 on /brick/brick-dirs1 type xfs
    (rw)
    ```

  - Run the following command to check if the device has a LV pool name.

    ```
    lvs device-name
    ```

    For example:

    ```
    #  lvs -o pool_lv /dev/mapper/snap_lvgrp-snap_lgvol
       Pool
       snap_thnpool
    ```

    If the **Pool** field is empty, then the brick is not thinly provisioned.

  - Ensure that the brick is thinly provisioned, and retry the snapshot create command.

  **Step 2**

  Check if the bricks are down by following these steps:

  - Execute the following command to check the status of the volume:

    ```
    # gluster volume status VOLNAME
    ```

  - If any bricks are down, then start the bricks by executing the following command:

    ```
    # gluster volume start VOLNAME force
    ```

- To verify if the bricks are up, execute the following command:

```
# gluster volume status VOLNAME
```

- Retry the snapshot create command.

**Step 3**

Check if the node is down by following these steps:

- Execute the following command to check the status of the nodes:

```
# gluster volume status VOLNAME
```

- If a brick is not listed in the status, then execute the following command:

```
# gluster pool list
```

- If the status of the node hosting the missing brick is **`Disconnected`**, then power-up the node.
- Retry the snapshot create command.

**Step 4**

Check if rebalance is in progress by following these steps:

- Execute the following command to check the rebalance status:

```
gluster volume rebalance VOLNAME status
```

- If rebalance is in progress, wait for it to finish.
- Retry the snapshot create command.

- **Situation**

  Snapshot delete fails.

  **Step 1**

  Check if the server quorum is met by following these steps:

  - Execute the following command to check the peer status:

  ```
  # gluster pool list
  ```

  - If nodes are down, and the cluster is not in quorum, then power up the nodes.
  - To verify if the cluster is in quorum, execute the following command:

  ```
  # gluster pool list
  ```

  - Retry the snapshot delete command.

- **Situation**

Snapshot delete command fails on some node(s) during commit phase, leaving the system inconsistent.

### Solution

- Identify the node(s) where the delete command failed. This information is available in the delete command's error output. For example:

  ```
  # gluster snapshot delete snapshot1
  Deleting snap will erase all the information about the snap. Do you
  still want to continue? (y/n) y
  snapshot delete: failed: Commit failed on 10.00.00.02. Please check
  log file for details.
  Snapshot command failed
  ```

- On the node where the delete command failed, bring down glusterd using the following command:

  ```
  # service glusterd stop
  ```

- Delete that particular snaps repository in **`/var/lib/glusterd/snaps/`** from that node. For example:

  ```
  # rm -rf /var/lib/glusterd/snaps/snapshot1
  ```

- Start glusterd on that node using the following command:

  ```
  # service glusterd start.
  ```

- Repeat the 2nd, 3rd, and 4th steps on all the nodes where the commit failed as identified in the 1st step.

- Retry deleting the snapshot. For example:

  ```
  # gluster snapshot delete snapshot1
  ```

- ### Situation

  Snapshot restore fails.

  ### Step 1

  Check if the server quorum is met by following these steps:

  - Execute the following command to check the peer status:

    ```
    # gluster pool list
    ```

  - If nodes are down, and the cluster is not in quorum, then power up the nodes.

  - To verify if the cluster is in quorum, execute the following command:

    ```
    # gluster pool list
    ```

  - Retry the snapshot restore command.

**Step 2**

Check if the volume is in **`Stop`** state by following these steps:

- Execute the following command to check the volume info:

```
# gluster volume info VOLNAME
```

- If the volume is in **`Started`** state, then stop the volume using the following command:

```
gluster volume stop VOLNAME
```

- Retry the snapshot restore command.

- **Situation**

The brick process is hung.

**Solution**

Check if the LVM data / metadata utilization had reached 100% by following these steps:

- Execute the mount command and check the device name mounted on the brick path. For example:

```
# mount
      /dev/mapper/snap_lvgrp-snap_lgvol on /brick/brick-dirs type
xfs (rw)
      /dev/mapper/snap_lvgrp1-snap_lgvol1 on /brick/brick-dirs1
type xfs (rw)
```

- Execute the following command to check if the data/metadatautilization has reached 100%:

```
lvs -v device-name
```

For example:

```
#  lvs -o data_percent,metadata_percent -v /dev/mapper/snap_lvgrp-
snap_lgvol
     Using logical volume(s) on command line
   Data%  Meta%
     0.40
```

**Note**

Ensure that the data and metadata does not reach the maximum limit. Usage of monitoring tools like Nagios, will ensure you do not come across such situations. For more information about Nagios, see Chapter 17, *Monitoring Red Hat Gluster Storage*

- **Situation**

Snapshot commands fail.

### Step 1

Check if there is a mismatch in the operating versions by following these steps:

- Open the following file and check for the operating version:

  ```
  /var/lib/glusterd/glusterd.info
  ```

  If the **`operating-version`** is lesser than 30000, then the snapshot commands are not supported in the version the cluster is operating on.

- Upgrade all nodes in the cluster to Red Hat Gluster Storage 3.1.

- Retry the snapshot command.

- ### Situation

After rolling upgrade, snapshot feature does not work.

### Solution

You must ensure to make the following changes on the cluster to enable snapshot:

- Restart the volume using the following commands.

  ```
  # gluster volume stop VOLNAME
  # gluster volume start VOLNAME
  ```

- Restart glusterd services on all nodes.

  ```
  # service glusterd restart
  ```

# Chapter 17. Monitoring Red Hat Gluster Storage

Monitoring of Red Hat Gluster Storage servers is built on Nagios platform to monitor Red Hat Gluster Storage trusted storage pool, hosts, volumes, and services. You can monitor utilization, status, alerts and notifications for status and utilization changes.

For more information on Nagios software, refer *Nagios Documentation*.

Using Nagios, the physical resources, logical resources, and processes (CPU, Memory, Disk, Network, Swap, cluster, volume, brick, Host, Volumes, Brick, nfs, shd, quotad, ctdb, smb, glusterd, quota, geo-replication, self-heal,and server quorum) can be monitored. You can view the utilization and status through Nagios Server GUI.

Red Hat Gluster Storage trusted storage pool monitoring can be setup in one of the three deployment scenarios listed below:

- Nagios deployed on Red Hat Gluster Storage node.
- Nagios deployed on Red Hat Gluster Storage Console node.
- Nagios deployed on Red Hat Enterprise Linux node.

This chapter describes the procedures for deploying Nagios on Red Hat Gluster Storage node and Red Hat Enterprise Linux node. For information on deploying Nagios on Red Hat Gluster Storage Console node, see *Red Hat Gluster Storage Console Administration Guide*.

The following diagram illustrates deployment of Nagios on Red Hat Gluster Storage node.

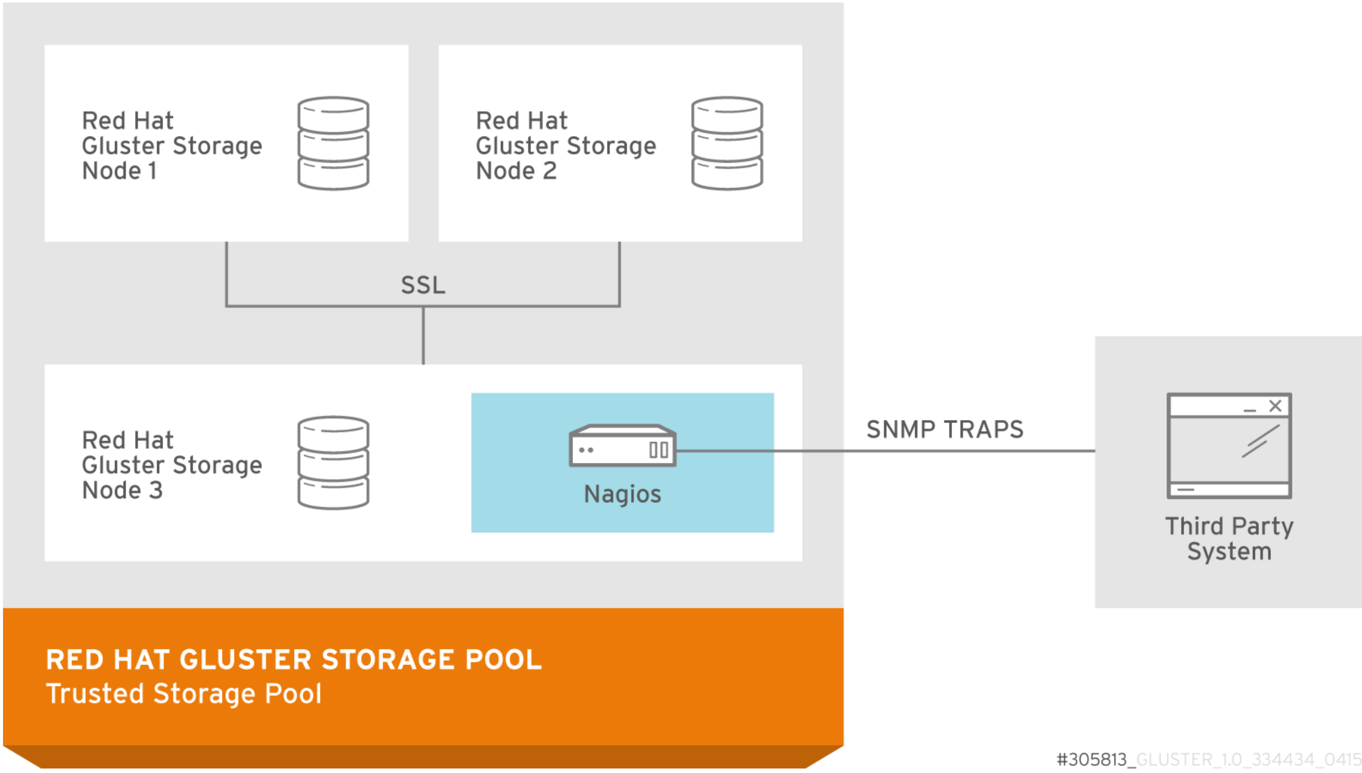



**Figure 17.1. Nagios deployed on Red Hat Gluster Storage node**

The following diagram illustrates deployment of Nagios on Red Hat Enterprise Linux node.

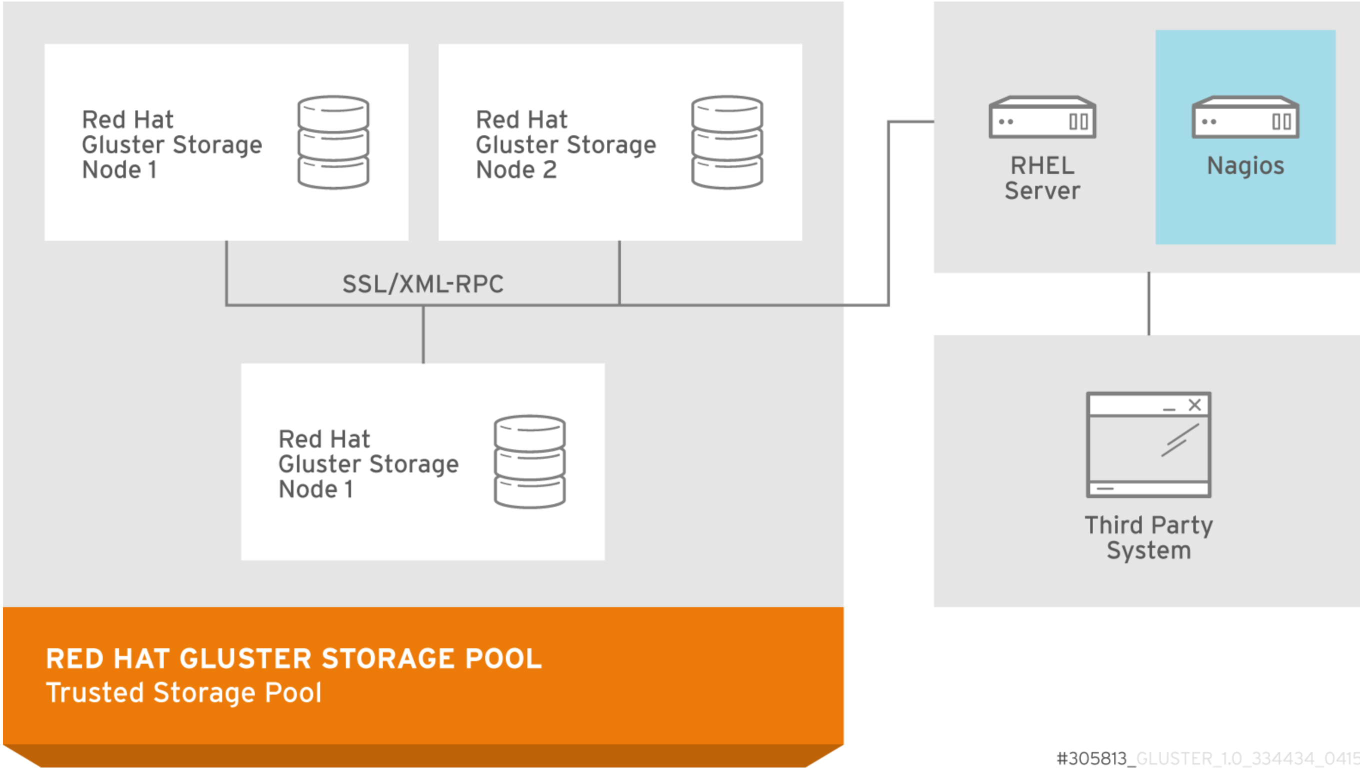



**Figure 17.2. Nagios deployed on Red Hat Enterprise Linux node**

## 17.1. Prerequisites

Ensure that you register using Subscription Manager or Red Hat Network Classic (RHN) and enable the Nagios repositories before installing the Nagios Server.

> **Note**
>
> Register using Red Hat Network (RHN) Classic only if you are a Red Hat Satellite user.

- Registering using Subscription Manager and enabling Nagios repositories
  - To install Nagios on Red Hat Gluster Storage node, subscribe to **`rhs-nagios-3-for-rhel-6-server-rpms`** repository.
  - To install Nagios on Red Hat Enterprise Linux node, subscribe to **`rhel-6-server-rpms`**, **`rhs-nagios-3-for-rhel-6-server-rpms`** repositories.
  - To install Nagios on Red Hat Gluster Storage node based on RHEL7, subscribe to **`rh-gluster-3-nagios-for-rhel-7-server-rpms`** repository.
  - To install Nagios on Red Hat Enterprise Linux node, subscribe to **`rhel-7-server-rpms`**, **`rh-gluster-3-nagios-for-rhel-7-server-rpms`** repositories.
- Registering using Red Hat Network (RHN) Classic and subscribing to Nagios channels
  - To install Nagios on Red Hat Gluster Storage node, subscribe to **`rhel-x86_64-server-6-rhs-nagios-3`** channel.

- To install Nagios on Red Hat Gluster Storage node, subscribe to **`rhel-x86_64-server-7-rh-gluster-3-nagios`** channel.
- To install Nagios on Red Hat Enterprise Linux node, subscribe to **`rhel-x86_64-server-6`**, **`rhel-x86_64-server-6-rhs-nagios-3`** channels.
- To install Nagios on Red Hat Enterprise Linux node, subscribe to **`rhel-x86_64-server-7`**, **`rhel-x86_64-server-7-rh-gluster-3-nagios`** channels.

> **Note**
>
> Once nagios is installed on Red Hat Gluster Storage or RHEL node, verify that the following booleans are ON by running the **`getsebool -a | grep nagios`** command:
>
> - **`nagios_run_sudo --> on`**
> - **`nagios_run_pnp4nagios --> on`**

## 17.2. Installing Nagios

The Nagios monitoring system is used to provide monitoring and alerts for the Red Hat Gluster Storage network and infrastructure. Installing Nagios installs the following components.

***nagios***

Core program, web interface and configuration files for Nagios server.

***python-cpopen***

Python package for creating sub-process in simple and safe manner.

***python-argparse***

Command line parser for python.

***libmcrypt***

Encryptions algorithm library.

***rrdtool***

Round Robin Database Tool to store and display time-series data.

***pynag***

Python modules and utilities for Nagios plugins and configuration.

***check-mk***

General purpose Nagios-plugin for retrieving data.

***mod_python***

An embedded Python interpreter for the Apache HTTP Server.

***nrpe***

Monitoring agent for Nagios.

***nsca***

Nagios service check acceptor.

***nagios-plugins***

Common monitoring plug-ins for nagios.

***gluster-nagios-common***

Common libraries, tools, configurations for Gluster node and Nagios server add-ons.

***nagios-server-addons***

Gluster node management add-ons for Nagios.

### 17.2.1. Installing Nagios Server

Use the following command to install Nagios server:

```
# yum install nagios-server-addons
```

You must install Nagios on the node which would be used as the Nagios server.

### 17.2.2. Configuring Red Hat Gluster Storage Nodes for Nagios

Configure all the Red Hat Gluster Storage nodes, including the node on which the Nagios server is installed.

**Note**

If SELinux is configured, the sebooleans must be enabled on all Red Hat Gluster Storage nodes and the node on which Nagios server is installed.

Enable the following sebooleans on Red Hat Enterprise Linux node if Nagios server is installed.

```
# setsebool -P logging_syslogd_run_nagios_plugins on
# setsebool -P nagios_run_sudo on
```

To configure the nodes, follow the steps given below:

1. In **/etc/nagios/nrpe.cfg** file, add the central Nagios server IP address as shown below:

```
allowed_hosts=127.0.0.1, NagiosServer-HostName-or-IPaddress
```

2. Restart the **NRPE** service using the following command:

```
# service nrpe restart
```

> **Note**
>
> - The host name of the node is used while configuring Nagios server using auto-discovery. To view the host name, run **hostname** command.
> - Ensure that the host names are unique.

3. Start the **glusterpmd** service using the following command:

```
# service glusterpmd start
```

To start **glusterpmd** service automatically when the system reboots, run **chkconfig --add glusterpmd** command.

You can start the **glusterpmd** service using **service glusterpmd start** command and stop the service using **service glusterpmd stop** command.

The **glusterpmd** service is a Red Hat Gluster Storage process monitoring service running in every Red Hat Gluster Storage node to monitor glusterd, self heal, smb, quotad, ctdbd and brick services and to alert the user when the services go down. The **glusterpmd** service sends its managing services detailed status to the Nagios server whenever there is a state change on any of its managing services.

This service uses **/etc/nagios/nagios_server.conf** file to get the Nagios server name and the local host name given in the Nagios server. The **nagios_server.conf** is configured by auto-discovery.

## 17.3. Monitoring Red Hat Gluster Storage Trusted Storage Pool

This section describes how you can monitor Gluster storage trusted pool.

### 17.3.1. Configuring Nagios

Auto-Discovery is a python script which automatically discovers all the nodes and volumes in the cluster. It also creates Nagios configuration to monitor them. By default, it runs once in 24 hours to synchronize the Nagios configuration from Red Hat Gluster Storage Trusted Storage Pool configuration.

For more information on Nagios Configuration files, see Chapter 29, *Nagios Configuration Files*

> **Note**
>
> Before configuring Nagios using **configure-gluster-nagios** command, ensure that all the Red Hat Gluster Storage nodes are configured as mentioned in Section 17.2.2, “Configuring Red Hat Gluster Storage Nodes for Nagios”.

1. Execute the **configure-gluster-nagios** command manually on the Nagios server using the following command:

```
# configure-gluster-nagios -c cluster-name -H HostName-or-IP-address
```

For ***-c***, provide a cluster name (a logical name for the cluster) and for ***-H***, provide the host name or ip address of a node in the Red Hat Gluster Storage trusted storage pool.

2. Perform the steps given below when **configure-gluster-nagios** command runs:

   a. Confirm the configuration when prompted.

   b. Enter the current Nagios server host name or IP address to be configured all the nodes.

   c. Confirm restarting Nagios server when prompted.

```
# configure-gluster-nagios -c demo-cluster -H HostName-or-IP-
address
Cluster configurations changed
Changes :
Hostgroup demo-cluster - ADD
Host demo-cluster - ADD
  Service - Volume Utilization - vol-1 -ADD
  Service - Volume Split-Brain - vol-1 -ADD
  Service - Volume Status - vol-1 -ADD
  Service - Volume Utilization - vol-2 -ADD
  Service - Volume Status - vol-2 -ADD
  Service - Cluster Utilization -ADD
  Service - Cluster - Quorum -ADD
  Service - Cluster Auto Config -ADD
Host Host_Name - ADD
  Service - Brick Utilization - /bricks/vol-1-5 -ADD
  Service - Brick - /bricks/vol-1-5 -ADD
  Service - Brick Utilization - /bricks/vol-1-6 -ADD
  Service - Brick - /bricks/vol-1-6 -ADD
  Service - Brick Utilization - /bricks/vol-2-3 -ADD
  Service - Brick - /bricks/vol-2-3 -ADD
Are you sure, you want to commit the changes? (Yes, No) [Yes]:
Enter Nagios server address [Nagios_Server_Address]:
Cluster configurations synced successfully from host ip-address
Do you want to restart Nagios to start monitoring newly
discovered entities? (Yes, No) [Yes]:
Nagios re-started successfully
```

   All the hosts, volumes and bricks are added and displayed.

3. Login to the Nagios server GUI using the following URL.

```
https://NagiosServer-HostName-or-IPaddress/nagios
```

> **Note**
>
> - The default Nagios user name and password is *nagiosadmin / nagiosadmin*.
> - You can manually update/discover the services by executing the **`configure-gluster-nagios`** command or by running **`Cluster Auto Config`** service through Nagios Server GUI.
> - If the node with which auto-discovery was performed is down or removed from the cluster, run the **`configure-gluster-nagios`** command with a different node address to continue discovering or monitoring the nodes and services.
> - If new nodes or services are added, removed, or if snapshot restore was performed on Red Hat Gluster Storage node, run **`configure-gluster-nagios`** command.

### 17.3.2. Verifying the Configuration

1. Verify the updated configurations using the following command:

   ```
   # nagios -v /etc/nagios/nagios.cfg
   ```

   If error occurs, verify the parameters set in **`/etc/nagios/nagios.cfg`** and update the configuration files.

2. Restart Nagios server using the following command:

   ```
   # service nagios restart
   ```

3. Log into the Nagios server GUI using the following URL with the Nagios Administrator user name and password.

   ```
   https://NagiosServer-HostName-or-IPaddress/nagios
   ```

   > **Note**
   >
   > To change the default password, see *Changing Nagios Password* section in *Red Hat Gluster Storage Administration Guide.*

4. Click **`Services`** in the left pane of the Nagios server GUI and verify the list of hosts and services displayed.

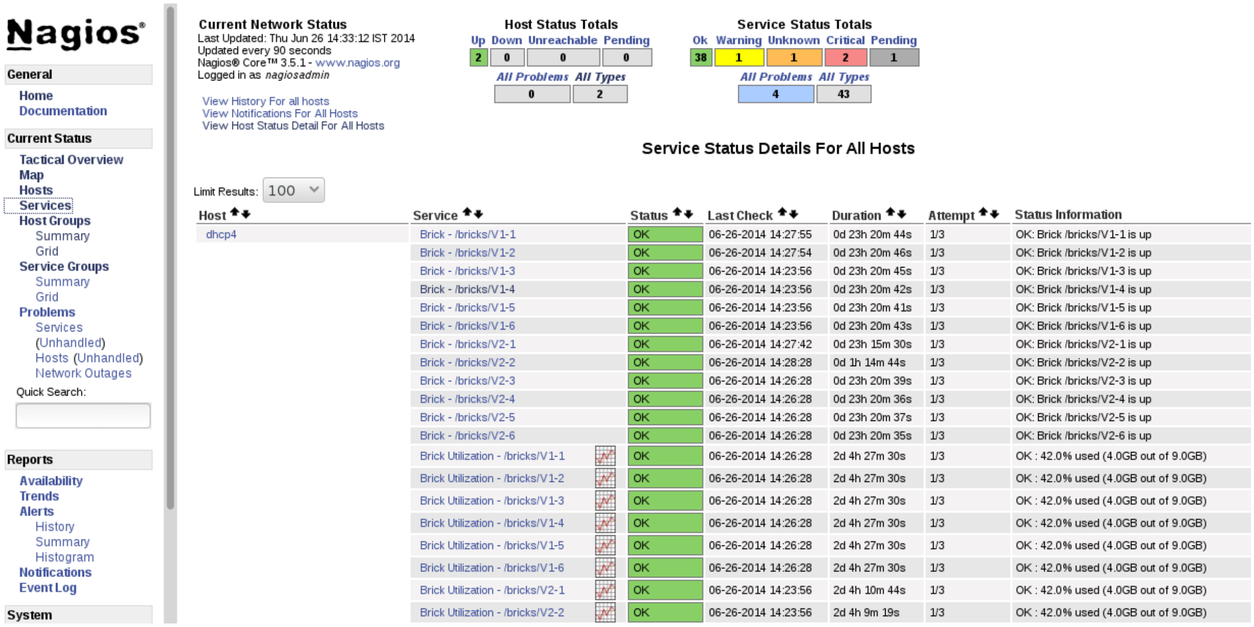



**Figure 17.3. Nagios Services**

## 17.3.3. Using Nagios Server GUI

You can monitor Red Hat Gluster Storage trusted storage pool through Nagios Server GUI.

To view the details, log into the Nagios Server GUI by using the following URL.

```
https://NagiosServer-HostName-or-IPaddress/nagios
```

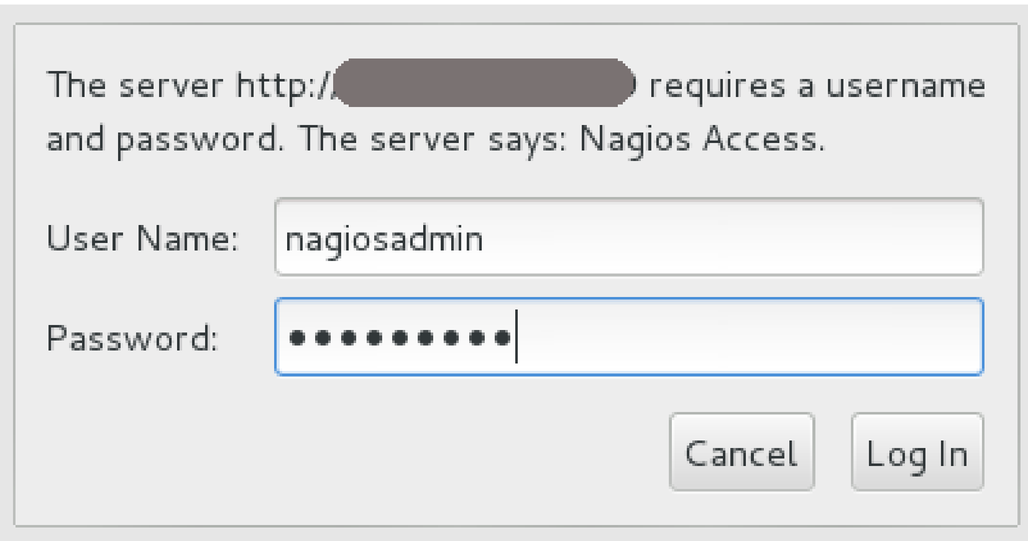



**Figure 17.4. Nagios Login**

### Cluster Overview

To view the overview of the hosts and services being monitored, click **`Tactical Overview`** in the left pane. The overview of Network Outages, Hosts, Services, and Monitoring Features are displayed.


**Figure 17.5. Tactical Overview**

## Host Status

To view the status summary of all the hosts, click **`Summary`** under **`Host Groups`** in the left pane.

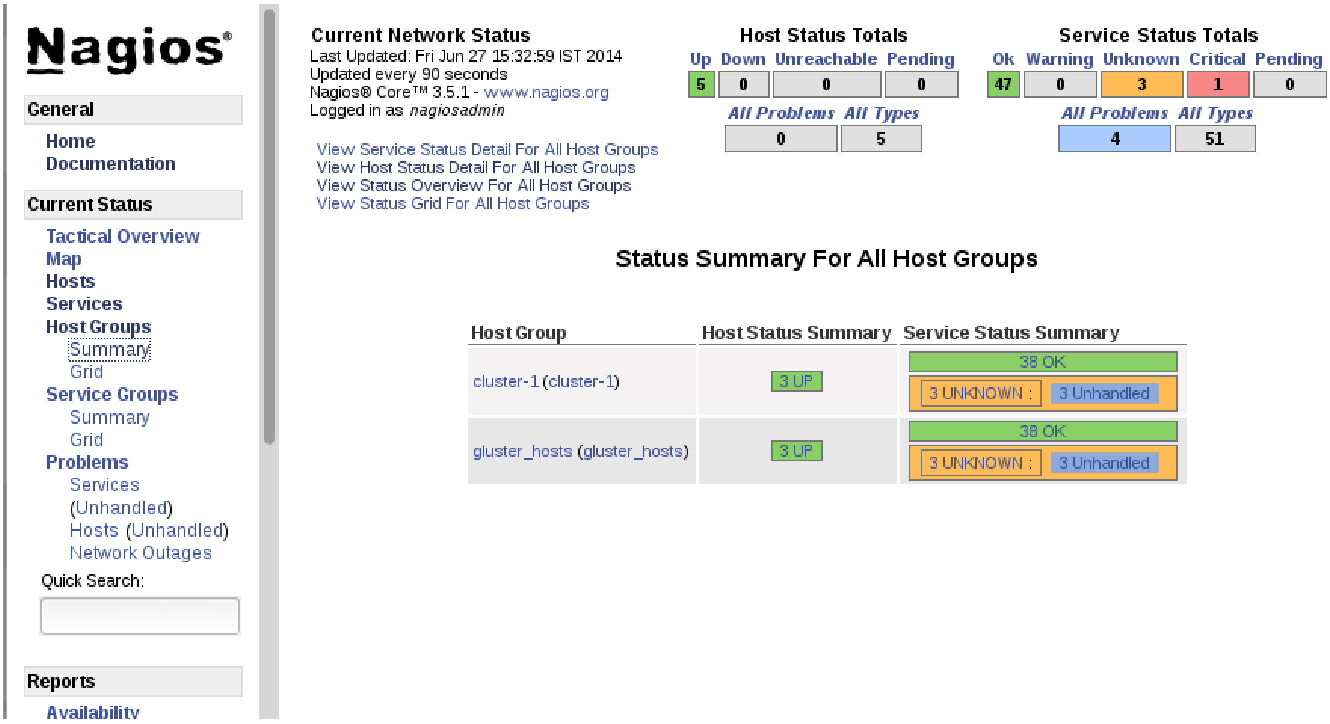



**Figure 17.6. Host Groups Summary**

To view the list of all hosts and their status, click **`Hosts`** in the left pane.

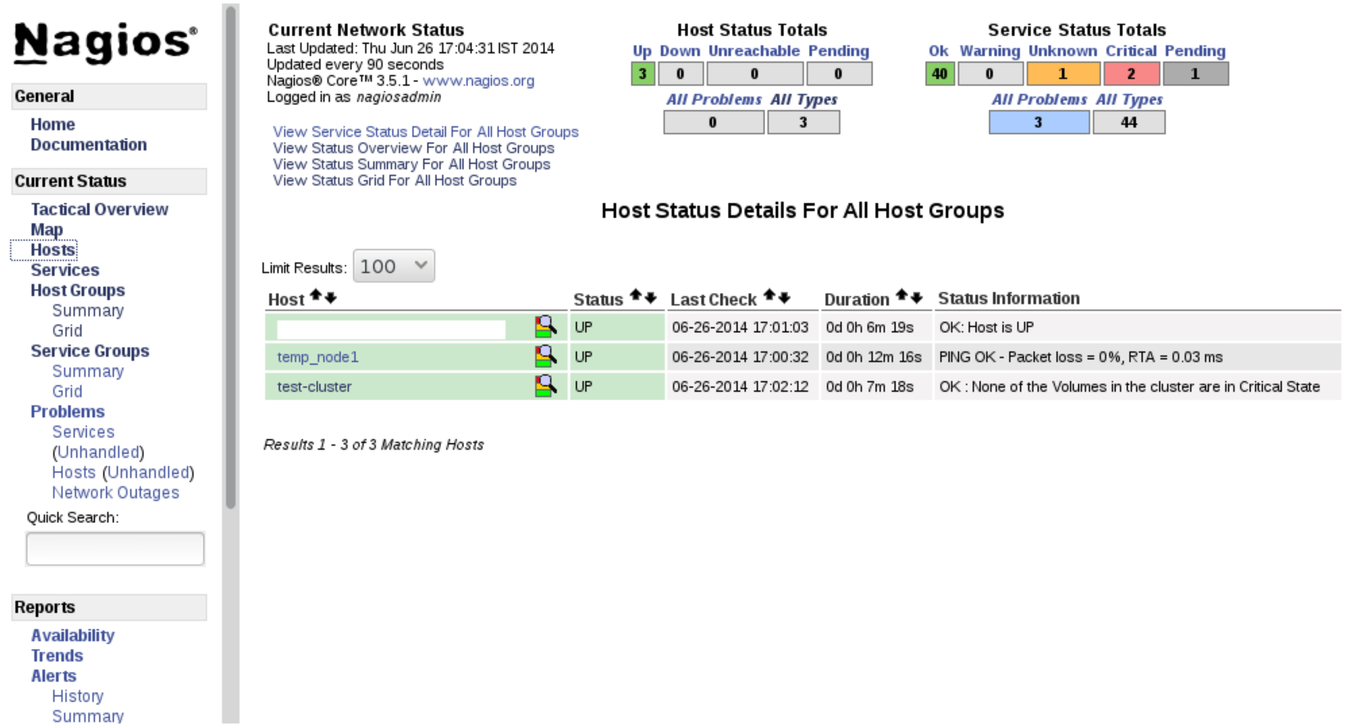



**Figure 17.7. Host Status**

## Note

Cluster also will be shown as Host in Nagios and it will have all the volume services.

## Service Status

To view the list of all hosts and their service status click **`Services`** in the left pane.

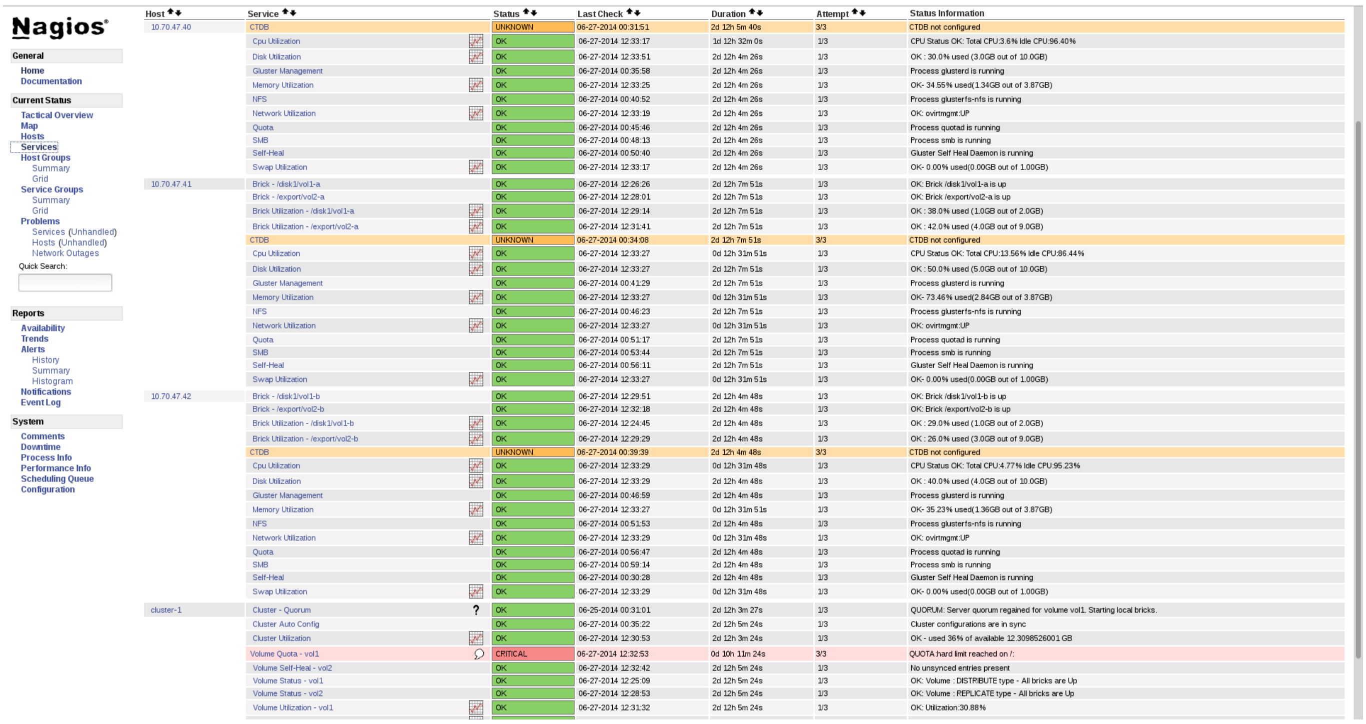


**Figure 17.8. Service Status**

> **Note**
>
> In the left pane of Nagios Server GUI, click **`Availability`** and **`Trends`** under the **`Reports`** field to view the Host and Services Availability and Trends.

### Host Services

1. Click **`Hosts`** in the left pane. The list of hosts are displayed.

2. Click  corresponding to the host name to view the host details.

3. Select the service name to view the Service State Information. You can view the utilization of the following services:

   - Memory
   - Swap
   - CPU
   - Network
   - Brick
   - Disk

     The Brick/Disk Utilization Performance data has four sets of information for every mount point which are brick/disk space detail, inode detail of a brick/disk, thin pool utilization and thin pool metadata utilization if brick/disk is made up of thin LV.

     The Performance data for services is displayed in the following format: *value[UnitOfMeasurement]*;*warningthreshold*;*criticalthreshold*;*min*;*max*.

     For Example,

     Performance Data: /bricks/brick2=31.596%;80;90;0;0.990 /bricks/brick2.inode=0.003%;80;90;0;1048064 /bricks/brick2.thinpool=19.500%;80;90;0;1.500 /bricks/brick2.thinpool-metadata=4.100%;80;90;0;0.004

     As part of disk utilization service, the following mount points will be monitored: **`/ , /boot, /home, /var and /usr`** if available.

4. To view the utilization graph, click  corresponding to the service name. The utilization graph is displayed.

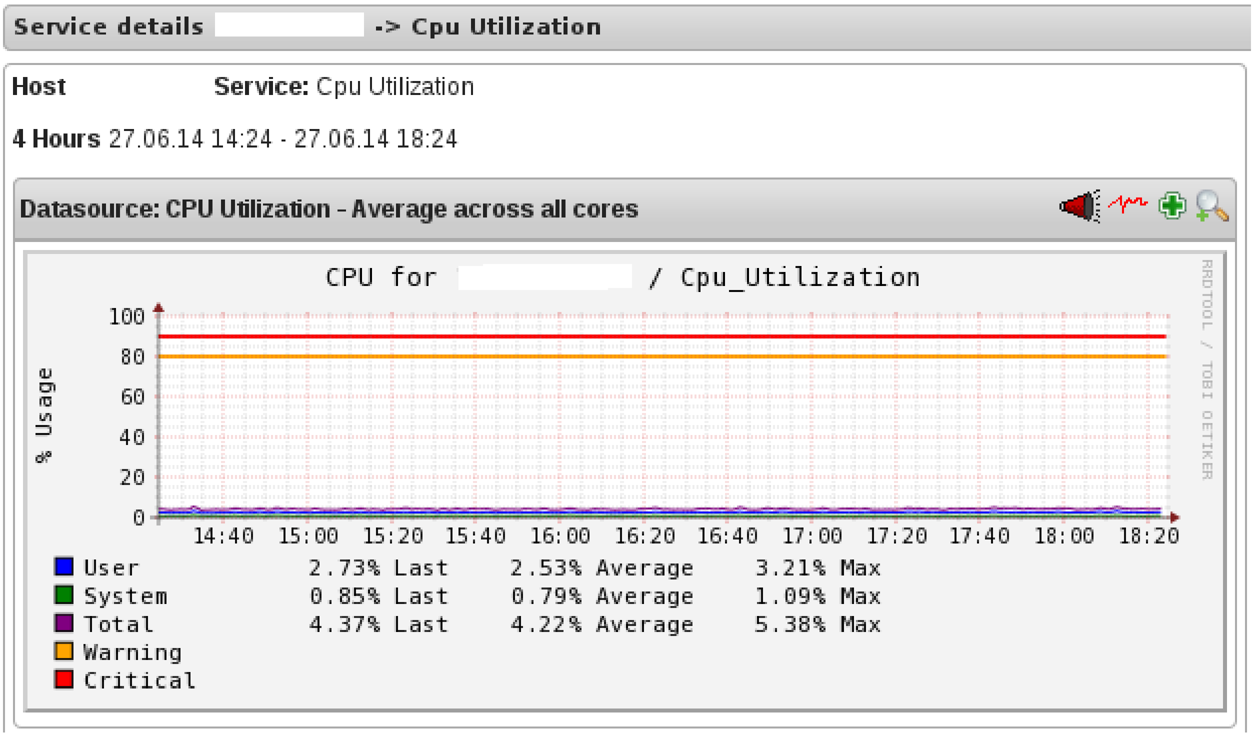


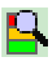

**Figure 17.9. CPU Utilization**

5. To monitor status, click on the service name. You can monitor the status for the following resources:
   - Disk
   - Network
6. To monitor process, click on the process name. You can monitor the following processes:
   - Gluster NFS (Network File System)
   - Self-Heal (Self-Heal)
   - Gluster Management (glusterd)
   - Quota (Quota daemon)
   - CTDB
   - SMB

**Note**

Monitoring Openstack Swift operations is not supported.

## Cluster Services

1. Click **`Hosts`** in the left pane. The list of hosts and clusters are displayed.
2. Click  corresponding to the cluster name to view the cluster details.
3. To view utilization graph, click  corresponding to the service name. You can monitor the

following utilizations:

- Cluster
- Volume

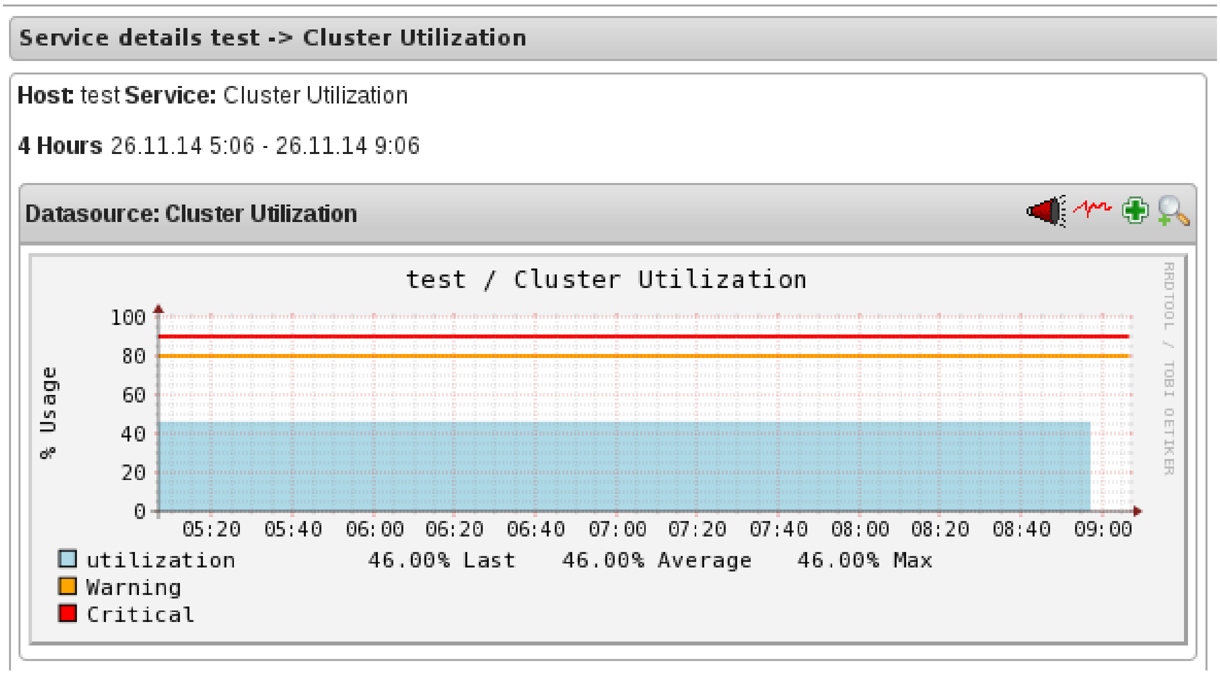



**Figure 17.10. Cluster Utilization**

4. To monitor status, click on the service name. You can monitor the status for the following resources:
   - Host
   - Volume
   - Brick
5. To monitor cluster services, click on the service name. You can monitor the following:
   - Volume Quota
   - Volume Geo-replication
   - Volume Split-Brain
   - Cluster Quorum (A cluster quorum service would be present only when there are volumes in the cluster.)

## Rescheduling Cluster Auto config using Nagios Server GUI

If new nodes or services are added or removed, or if snapshot restore is performed on Red Hat Gluster Storage node, reschedule the **`Cluster Auto config`** service using Nagios Server GUI or execute the **`configure-gluster-nagios`** command. To synchronize the configurations using Nagios Server GUI, perform the steps given below:

1. Login to the Nagios Server GUI using the following URL in your browser with nagiosadmin user name and password.

```
https://NagiosServer-HostName-or-IPaddress/nagios
```

2. Click **`Services`** in left pane of Nagios server GUI and click **`Cluster Auto Config`**.

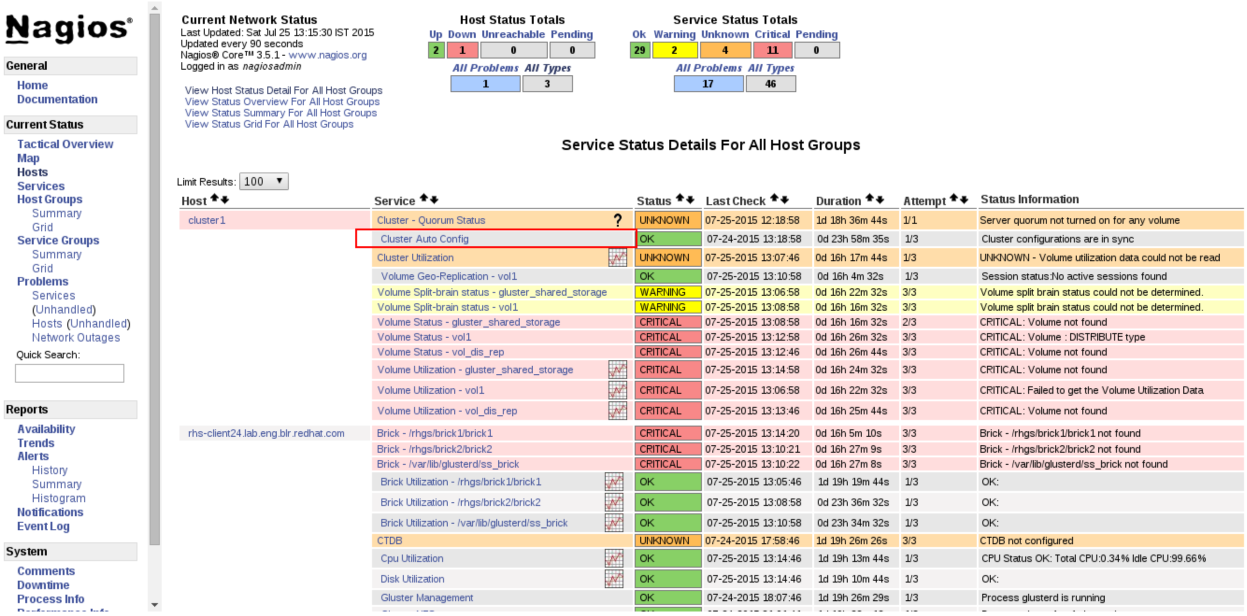



**Figure 17.11. Nagios Services**

3. In **`Service Commands`**, click **`Re-schedule the next check of this service`**. The **`Command Options`** window is displayed.

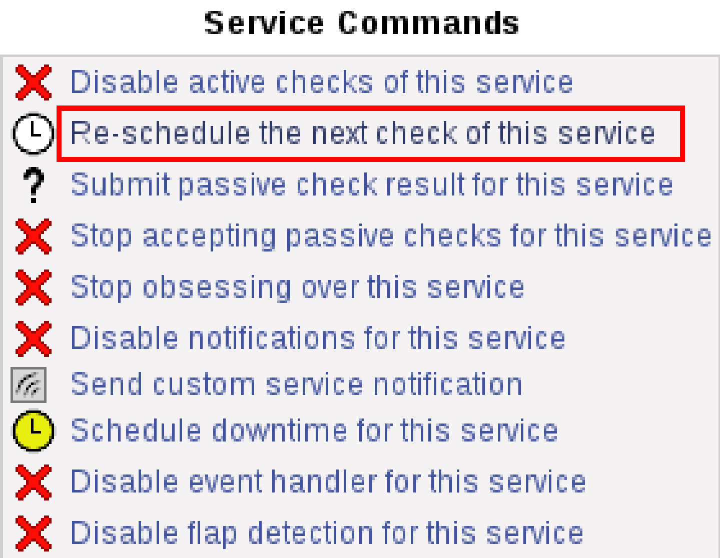



**Figure 17.12. Service Commands**

4. In **`Command Options`** window, click **`Commit`**.

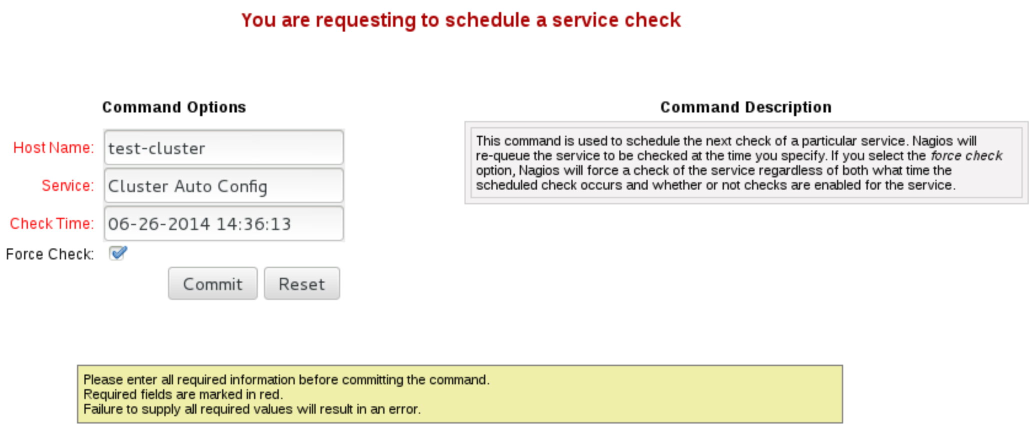



**Figure 17.13. Command Options**

## Enabling and Disabling Notifications using Nagios GUI

You can enable or disable Host and Service notifications through Nagios GUI.

- To enable and disable Host Notifcations:
  - Login to the Nagios Server GUI using the following URL in your browser with **`nagiosadmin`** user name and password.

    ```
    https://NagiosServer-HostName-or-IPaddress/nagios
    ```

  - Click **`Hosts`** in left pane of Nagios server GUI and select the host.
  - Click **`Enable notifications for this host`** or **`Disable notifications for this host`** in Host Commands section.
  - Click **`Commit`** to enable or disable notification for the selected host.
- To enable and disable Service Notification:
  - Login to the Nagios Server GUI.
  - Click **`Services`** in left pane of Nagios server GUI and select the service to enable or disable.
  - Click **`Enable notifications for this service`** or **`Disable notifications for this service`** from the Service Commands section.
  - Click **`Commit`** to enable or disable the selected service notification.
- To enable and disable all Service Notifications for a host:
  - Login to the Nagios Server GUI.
  - Click **`Hosts`** in left pane of Nagios server GUI and select the host to enable or disable all services notifications.
  - Click **`Enable notifications for all services on this host`** or **`Disable notifications for all services on this host`** from the Service Commands section.
  - Click **`Commit`** to enable or disable all service notifications for the selected host.
- To enable or disable all Notifications:

- Login to the Nagios Server GUI.
- Click **Process Info** under **Systems** section from left pane of Nagios server GUI.
- Click **Enable notifications** or **Disable notifications** in Process Commands section.
- Click **Commit**.

### Enabling and Disabling Service Monitoring using Nagios GUI

You can enable a service to monitor or disable a service you have been monitoring using the Nagios GUI.

- To enable Service Monitoring:
  - Login to the Nagios Server GUI using the following URL in your browser with **nagiosadmin** user name and password.

    ```
    https://NagiosServer-HostName-or-IPaddress/nagios
    ```

  - Click **Services** in left pane of Nagios server GUI and select the service to enable monitoring.
  - Click **Enable active checks of this service** from the Service Commands and click **Commit**.
  - Click **Start accepting passive checks for this service** from the Service Commands and click **Commit**.

    Monitoring is enabled for the selected service.
- To disable Service Monitoring:
  - Login to the Nagios Server GUI using the following URL in your browser with **nagiosadmin** user name and password.

    ```
    https://NagiosServer-HostName-or-IPaddress/nagios
    ```

  - Click **Services** in left pane of Nagios server GUI and select the service to disable monitoring.
  - Click **Disable active checks of this service** from the Service Commands and click **Commit**.
  - Click **Stop accepting passive checks for this service** from the Service Commands and click **Commit**.

    Monitoring is disabled for the selected service.

### Monitoring Services Status and Messages

> **Note**
>
> Nagios sends email and SNMP notifications, once a service status changes. Refer *Configuring Nagios Server to Send Mail Notifications* section of *Red Hat Gluster Storage 3 Console Administation Guide* to configure email notification and *Configuring Simple Network Management Protocol (SNMP) Notification* section of *Red Hat Gluster Storage 3 Administation Guide* to configure SNMP notification.

**Table 17.1.**

| Service Name | Status | Messsage | Description |
|---|---|---|---|
| SMB | OK | OK: No gluster volume uses smb | When no volumes are exported through smb. |
| | OK | Process smb is running | When SMB service is running and when volumes are exported using SMB. |
| | CRITICAL | CRITICAL: Process smb is not running | When SMB service is down and one or more volumes are exported through SMB. |
| CTDB | UNKNOWN | CTDB not configured | When CTDB service is not running, and smb or nfs service is running. |
| | CRITICAL | Node status: BANNED/STOPPED | When CTDB service is running but Node status is *BANNED/STOPPED*. |
| | WARNING | Node status: UNHEALTHY/DISABLED /PARTIALLY_ONLINE | When CTDB service is running but Node status is *UNHEALTHY/DISABLED /PARTIALLY_ONLINE*. |
| | OK | Node status: OK | When CTDB service is running and healthy. |
| Gluster Management | OK | Process glusterd is running | When glusterd is running as unique. |
| | WARNING | PROCS WARNING: 3 processes | When there are more then one glusterd is running. |
| | CRITICAL | CRITICAL: Process glusterd is not running | When there is no glusterd process running. |
| | UNKNOWN | NRPE: Unable to read output | When unable to communicate or read output |
| Gluster NFS | OK | OK: No gluster volume uses nfs | When no volumes are configured to be exported through NFS. |
| | OK | Process glusterfs-nfs is running | When glusterfs-nfs process is running. |
| | CRITICAL | CRITICAL: Process glusterfs-nfs is not running | When glusterfs-nfs process is down and there are volumes which requires NFS export. |

| Service Name | Status | Messsage | Description |
|---|---|---|---|
| Auto-Config | OK | Cluster configurations are in sync | When auto-config has not detected any change in Gluster configuration. This shows that Nagios configuration is already in synchronization with the Gluster configuration and auto-config service has not made any change in Nagios configuration. |
| | OK | Cluster configurations synchronized successfully from host *host-address* | When auto-config has detected change in the Gluster configuration and has successfully updated the Nagios configuration to reflect the change Gluster configuration. |
| | CRITICAL | Can't remove all hosts except sync host in 'auto' mode. Run auto discovery manually. | When the host used for auto-config itself is removed from the Gluster peer list. Auto-config will detect this as all host except the synchronized host is removed from the cluster. This will not change the Nagios configuration and the user need to manually run the auto-config. |
| QUOTA | OK | OK: Quota not enabled | When quota is not enabled in any volumes. |
| | OK | Process quotad is running | When glusterfs-quota service is running. |
| | CRITICAL | CRITICAL: Process quotad is not running | When glusterfs-quota service is down and quota is enabled for one or more volumes. |
| CPU Utilization | OK | CPU Status OK: Total CPU:4.6% Idle CPU:95.40% | When CPU usage is less than 80%. |
| | WARNING | CPU Status WARNING: Total CPU:82.40% Idle CPU:17.60% | When CPU usage is more than 80%. |
| | CRITICAL | CPU Status CRITICAL: Total CPU:97.40% Idle CPU:2.6% | When CPU usage is more than 90%. |
| Memory Utilization | OK | OK- 65.49% used(1.28GB out of 1.96GB) | When used memory is below warning threshold. (Default warning threshold is 80%) |

| Service Name | Status | Messsage | Description |
| --- | --- | --- | --- |
| | WARNING | WARNING- 85% used(1.78GB out of 2.10GB) | When used memory is below critical threshold (Default critical threshold is 90%) and greater than or equal to warning threshold (Default warning threshold is 80%). |
| | CRITICAL | CRITICAL- 92% used(1.93GB out of 2.10GB) | When used memory is greater than or equal to critical threshold (Default critical threshold is 90% ) |
| Brick Utilization | OK | OK | When used space of any of the four parameters, space detail, inode detail, thin pool, and thin pool-metadata utilizations, are below threshold of 80%. |
| | WARNING | WARNING:mount point /brick/brk1 Space used (0.857 / 1.000) GB | If any of the four parameters, space detail, inode detail, thin pool utilization, and thinpool-metadata utilization, crosses warning threshold of 80% (Default is 80%). |
| | CRITICAL | CRITICAL : mount point /brick/brk1 (inode used 9980/1000) | If any of the four parameters, space detail, inode detail, thin pool utilization, and thinpool-metadata utilizations, crosses critical threshold 90% (Default is 90%). |
| Disk Utilization | OK | OK | When used space of any of the four parameters, space detail, inode detail, thin pool utilization, and thinpool-metadata utilizations, are below threshold of 80%. |
| | WARNING | WARNING:mount point /boot Space used (0.857 / 1.000) GB | When used space of any of the four parameters, space detail, inode detail, thin pool utilization, and thinpool-metadata utilizations, are above warning threshold of 80%. |

| Service Name | Status | Messsage | Description |
|---|---|---|---|
| | CRITICAL | CRITICAL : mount point /home (inode used 9980/1000) | If any of the four parameters, space detail, inode detail, thin pool utilization, and thinpool-metadata utilizations, crosses critical threshold 90% (Default is 90%). |
| Network Utilization | OK | OK: tun0:UP,wlp3s0:UP,virbr0:UP | When all the interfaces are UP. |
| | WARNING | WARNING: tun0:UP,wlp3s0:UP,virbr0:DOWN | When any of the interfaces is down. |
| | UNKNOWN | UNKNOWN | When network utilization/status is unknown. |
| Swap Utilization | OK | OK- 0.00% used(0.00GB out of 1.00GB) | When used memory is below warning threshold (Default warning threshold is 80%). |
| | WARNING | WARNING- 83% used(1.24GB out of 1.50GB) | When used memory is below critical threshold (Default critical threshold is 90%) and greater than or equal to warning threshold (Default warning threshold is 80%). |
| | CRITICAL | CRITICAL- 83% used(1.42GB out of 1.50GB) | When used memory is greater than or equal to critical threshold (Default critical threshold is 90%). |
| Cluster Quorum | PENDING | | When cluster.quorum-type is not set to *server*; or when there are no problems in the cluster identified. |
| | OK | Quorum regained for volume | When quorum is regained for volume. |
| | CRITICAL | Quorum lost for volume | When quorum is lost for volume. |
| Volume Geo-replication | OK | "Session Status: *slave_vol1*-OK .....*slave_voln*-OK. | When all sessions are active. |
| | OK | Session status :No active sessions found | When Geo-replication sessions are deleted. |
| | CRITICAL | Session Status: *slave_vol1*-FAULTY *slave_vol2*-OK | If one or more nodes are Faulty and there's no replica pair that's active. |

| Service Name | Status | Messsage | Description |
|---|---|---|---|
| | WARNING | Session Status: *slave_vol1*-NOT_STARTED *slave_vol2*-STOPPED *slave_vol3*-PARTIAL_FAULTY | - Partial faulty state occurs with replicated and distributed replicate volume when one node is faulty, but the replica pair is active.<br>- *STOPPED* state occurs when Geo-replication sessions are stopped.<br>- *NOT_STARTED* state occurs when there are multiple Geo-replication sessions and one of them is stopped. |
| | WARNING | Geo replication status could not be determined. | When there's an error in getting Geo replication status. This error occurs when **`volfile`** is locked as another transaction is in progress. |
| | UNKNOWN | Geo replication status could not be determined. | When glusterd is down. |
| Volume Quota | OK | QUOTA: not enabled or configured | When quota is not set |
| | OK | QUOTA:OK | When quota is set and usage is below quota limits. |
| | WARNING | QUOTA:Soft limit exceeded on *path of directory* | When quota exceeds soft limit. |
| | CRITICAL | QUOTA:hard limit reached on *path of directory* | When quota reaches hard limit. |
| | UNKNOWN | QUOTA: Quota status could not be determined as command execution failed | When there's an error in getting Quota status. This occurs when<br>- Volume is stopped or glusterd service is down.<br>- volfile is locked as another transaction in progress. |
| Volume Status | OK | Volume : *volume type* - All bricks are Up | When all volumes are up. |

| Service Name | Status | Messsage | Description |
|---|---|---|---|
| | WARNING | Volume :*volume type* Brick(s) - *list of bricks* is\|are down, but replica pair(s) are up | When bricks in the volume are down but replica pairs are up. |
| | UNKNOWN | Command execution failed *Failure message* | When command execution fails. |
| | CRITICAL | Volume not found. | When volumes are not found. |
| | CRITICAL | Volume: *volume-type* is stopped. | When volumes are stopped. |
| | CRITICAL | Volume : *volume type* - All bricks are down. | When all bricks are down. |
| | CRITICAL | Volume : *volume type* Bricks - *brick list* are down, along with one or more replica pairs | When bricks are down along with one or more replica pairs. |
| Volume Self-Heal<br><br>(available in Red Hat Gluster Storage version 3.1.0 and earlier) | OK | | When volume is not a replicated volume, there is no self-heal to be done. |
| | OK | No unsynced entries present | When there are no unsynched entries in a replicated volume. |
| | WARNING | Unsynched entries present : There are unsynched entries present. | If self-heal process is turned on, these entries may be auto healed. If not, self-heal will need to be run manually. If unsynchronized entries persist over time, this could indicate a split brain scenario. |
| | WARNING | Self heal status could not be determined as the volume was deleted | When self-heal status can not be determined as the volume is deleted. |
| | UNKNOWN | | When there's an error in getting self heal status. This error occurs when:<br><br>• Volume is stopped or glusterd service is down.<br>• volfile is locked as another transaction in progress. |
| Cluster Utilization | OK | OK : 28.0% used (1.68GB out of 6.0GB) | When used % is below the warning threshold (Default warning threshold is 80%). |

| Service Name | Status | Messsage | Description |
|---|---|---|---|
| | WARNING | WARNING: 82.0% used (4.92GB out of 6.0GB) | Used% is above the warning limit. (Default warning threshold is 80%) |
| | CRITICAL | CRITICAL : 92.0% used (5.52GB out of 6.0GB) | Used% is above the warning limit. (Default critical threshold is 90%) |
| | UNKNOWN | Volume utilization data could not be read | When volume services are present, but the volume utilization data is not available as it's either not populated yet or there is error in fetching volume utilization data. |
| Volume Utilization | OK | OK: Utilization: 40 % | When used % is below the warning threshold (Default warning threshold is 80%). |
| | WARNING | WARNING - used *84*% of available *200* GB | When used % is above the warning threshold (Default warning threshold is 80%). |
| | CRITICAL | CRITICAL - used *96*% of available *200* GB | When used % is above the critical threshold (Default critical threshold is 90%). |
| | UNKNOWN | UNKNOWN - Volume utilization data could not be read | When all the bricks in the volume are killed or if glusterd is stopped in all the nodes in a cluster. |

## 17.4. Monitoring Notifications

### 17.4.1. Configuring Nagios Server to Send Mail Notifications

1. In the **`/etc/nagios/gluster/gluster-contacts.cfg`** file, add contacts to send mail in the format shown below:

   Modify **`contact_name`**, **`alias`**, and **`email`**.

```
define contact {
        contact_name                            Contact1
        alias                                   ContactNameAlias
        email                                   email-address
        service_notification_period             24x7
        service_notification_options            w,u,c,r,f,s
        service_notification_commands           notify-service-by-
email
        host_notification_period                24x7
        host_notification_options               d,u,r,f,s
        host_notification_commands              notify-host-by-email
}
```

```
define contact {
        contact_name                            Contact2
        alias                                   ContactNameAlias2
        email                                   email-address
        service_notification_period             24x7
        service_notification_options            w,u,c,r,f,s
        service_notification_commands           notify-service-by-
email
        host_notification_period                24x7
        host_notification_options               d,u,r,f,s
        host_notification_commands              notify-host-by-email
}
```

The **service_notification_options** directive is used to define the service states for which notifications can be sent out to this contact. Valid options are a combination of one or more of the following:

- **w**: Notify on WARNING service states
- **u**: Notify on UNKNOWN service states
- **c**: Notify on CRITICAL service states
- **r**: Notify on service RECOVERY (OK states)
- **f**: Notify when the service starts and stops FLAPPING
- **n (none)**: Do not notify the contact on any type of service notifications

The **host_notification_options** directive is used to define the host states for which notifications can be sent out to this contact. Valid options are a combination of one or more of the following:

- **d**: Notify on DOWN host states
- **u**: Notify on UNREACHABLE host states
- **r**: Notify on host RECOVERY (UP states)
- **f**: Notify when the host starts and stops FLAPPING
- **s**: Send notifications when host or service scheduled downtime starts and ends
- **n (none)**: Do not notify the contact on any type of host notifications.

**Note**

By default, a contact and a contact group are defined for administrators in **contacts.cfg** and all the services and hosts will notify the administrators. Add suitable email id for administrator in **contacts.cfg** file.

2. To add a group to which the mail need to be sent, add the details as given below:

```
define contactgroup{
        contactgroup_name                       Group1
        alias                                   GroupAlias
```

```
        members                             Contact1,Contact2
}
```

3. In the **/etc/nagios/gluster/gluster-templates.cfg** file specify the contact name and contact group name for the services for which the notification need to be sent, as shown below:

   Add **contact_groups** name and **contacts** name.

```
define host{
   name                             gluster-generic-host
   use                              linux-server
   notifications_enabled            1
   notification_period              24x7
   notification_interval            120
   notification_options             d,u,r,f,s
   register                         0
   contact_groups             Group1
   contacts                         Contact1,Contact2
   }

 define service {
   name                             gluster-service
   use                              generic-service
   notifications_enabled           1
   notification_period              24x7
   notification_options             w,u,c,r,f,s
   notification_interval            120
   register                         0
   _gluster_entity                  Service
   contact_groups            Group1
   contacts                      Contact1,Contact2

}
```

   You can configure notification for individual services by editing the corresponding node configuration file. For example, to configure notification for brick service, edit the corresponding node configuration file as shown below:

```
define service {
  use                               brick-service
  _VOL_NAME                         VolumeName
  __GENERATED_BY_AUTOCONFIG         1
  notes                             Volume : VolumeName
  host_name                         RedHatStorageNodeName
  _BRICK_DIR                        brickpath
  service_description               Brick Utilization - brickpath
  contact_groups              Group1
    contacts                    Contact1,Contact2
}
```

4. To receive detailed information on every update when Cluster Auto-Config is run, edit **/etc/nagios/objects/commands.cfg** file add **$NOTIFICATIONCOMMENT$\n** after **$SERVICEOUTPUT$\n** option in **notify-service-by-email** and **notify-host-by-email**command definition as shown below:

```
# 'notify-service-by-email' command definition
define command{
        command_name    notify-service-by-email
        command_line    /usr/bin/printf "%b" "***** Nagios
*****\n\nNotification Type: $NOTIFICATIONTYPE$\n\nService:
$SERVICEDESC$\nHost: $HOSTALIAS$\nAddress: $HOSTADDRESS$\nState:
$SERVICESTATE$\n\nDate/Time: $LONGDATETIME$\n\nAdditional
Info:\n\n$SERVICEOUTPUT$\n $NOTIFICATIONCOMMENT$\n" | /bin/mail -s "**
$NOTIFICATIONTYPE$ Service Alert: $HOSTALIAS$/$SERVICEDESC$ is
$SERVICESTATE$ **" $CONTACTEMAIL$
        }
```

5. Restart the Nagios server using the following command:

```
# service nagios restart
```

The Nagios server sends notifications during status changes to the mail addresses specified in the file.

**Note**

- By default, the system ensures three occurences of the event before sending mail notifications.
- By default, Nagios Mail notification is sent using **`/bin/mail`** command. To change this, modify the definition for **`notify-host-by-email`** command and **`notify-service-by-email`** command in **`/etc/nagios/objects/commands.cfg`** file and configure the mail server accordingly.

### 17.4.2. Configuring Simple Network Management Protocol (SNMP) Notification

1. Log in as *root* user.

2. In the **`/etc/nagios/gluster/snmpmanagers.conf`** file, specify the Host Name or IP address and community name of the SNMP managers to whom the SNMP traps need to be sent as shown below:

```
HostName-or-IP-address public
```

In the **`/etc/nagios/gluster/gluster-contacts.cfg`** file specify the contacts name as *+snmp* as shown below:

```
define contact {
       contact_name                  snmp
       alias                         Snmp Traps
       email                         admin@ovirt.com
       service_notification_period   24x7
       service_notification_options  w,u,c,r,f,s
       service_notification_commands gluster-notify-service-by-snmp
       host_notification_period      24x7
       host_notification_options     d,u,r,f,s
       host_notification_commands    gluster-notify-host-by-snmp
}
```

You can download the required Management Information Base (MIB) files from the URLs given below:

- NAGIOS-NOTIFY-MIB: https://github.com/nagios-plugins/nagios-mib/blob/master/MIB/NAGIOS-NOTIFY-MIB
- NAGIOS-ROOT-MIB: https://github.com/nagios-plugins/nagios-mib/blob/master/MIB/NAGIOS-ROOT-MIB

3. Restart Nagios using the following command:

```
# service nagios restart
```

## 17.5. Nagios Advanced Configuration

### 17.5.1. Creating Nagios User

To create a new Nagios user and set permissions for that user, follow the steps given below:

1. Login as **root** user.

2. Run the command given below with the new user name and type the password when prompted.

```
# htpasswd /etc/nagios/passwd newUserName
```

3. Add permissions for the new user in **/etc/nagios/cgi.cfg** file as shown below:

```
authorized_for_system_information=nagiosadmin,newUserName
authorized_for_configuration_information=nagiosadmin,newUserName
authorized_for_system_commands=nagiosadmin,newUserName
authorized_for_all_services=nagiosadmin,newUserName
authorized_for_all_hosts=nagiosadmin,newUserName
authorized_for_all_service_commands=nagiosadmin,newUserName
authorized_for_all_host_commands=nagiosadmin,newUserName
```

**Note**

To set **read only** permission for users, add **authorized_for_read_only=*username*** in the **/etc/nagios/cgi.cfg** file.

4. Start **nagios** and **httpd** services using the following commands:

```
# service httpd restart
# service nagios restart
```

5. Verify Nagios access by using the following URL in your browser, and using the user name and password.

```
https://NagiosServer-HostName-or-IPaddress/nagios
```

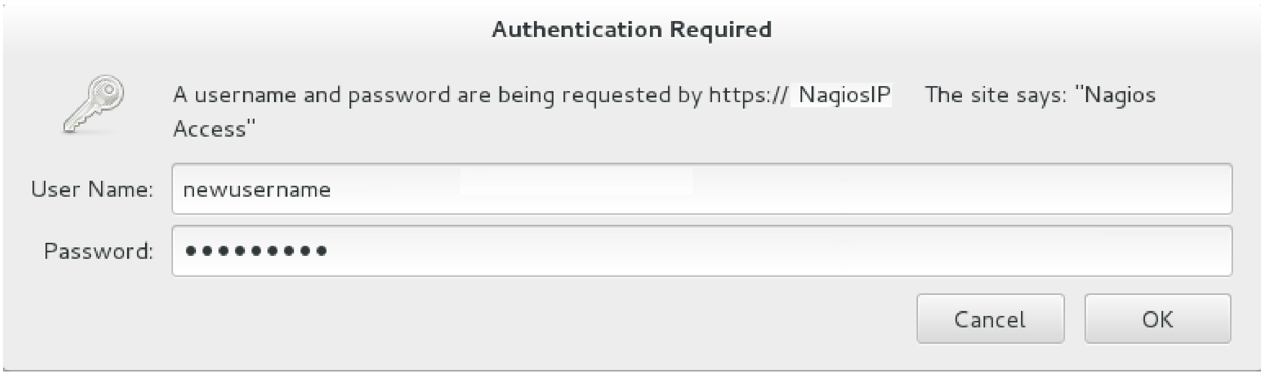



**Figure 17.14. Nagios Login**

## 17.5.2. Changing Nagios Password

The default Nagios user name and password is **`nagiosadmin`**. This value is available in the **`/etc/nagios/cgi.cfg`** file.

1. Login as **`root`** user.

2. To change the default password for the Nagios Administrator user, run the following command with the new password:

```
# htpasswd -c /etc/nagios/passwd nagiosadmin
```

3. Start **`nagios`** and **`httpd`** services using the following commands:

```
#  service httpd restart
#  service nagios restart
```

4. Verify Nagios access by using the following URL in your browser, and using the user name and password that was set in Step 2:

```
https://NagiosServer-HostName-or-IPaddress/nagios
```

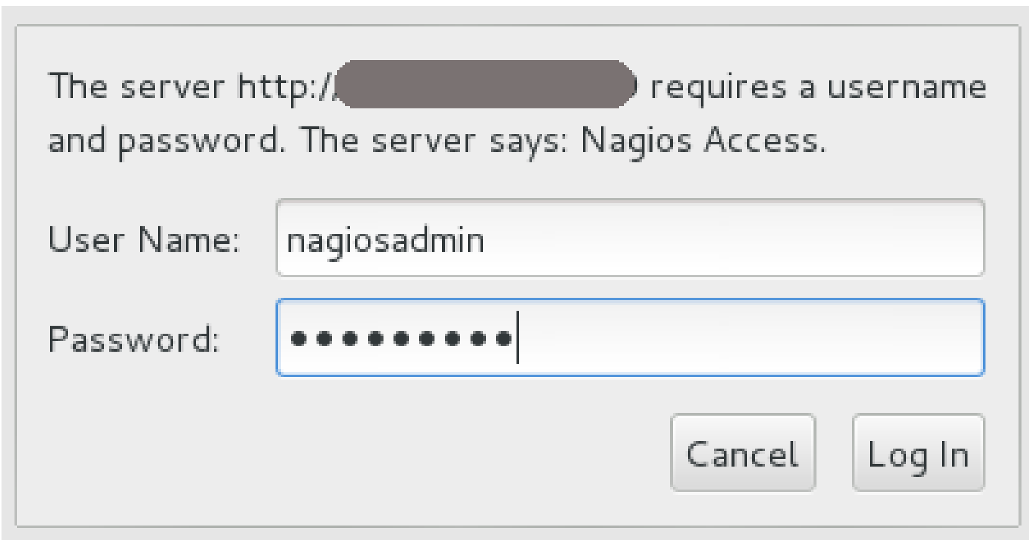



**Figure 17.15. Nagios Login**

### 17.5.3. Configuring SSL

For secure access of Nagios URL, configure SSL:

1. Create a 1024 bit RSA key using the following command:

   ```
   openssl genrsa -out /etc/ssl/private/{cert-file-name.key} 1024
   ```

2. Create an SSL certificate for the server using the following command:

   ```
   openssl req -key nagios-ssl.key -new | openssl x509 -out nagios-
   ssl.crt -days 365 -signkey  nagios-ssl.key -req
   ```

   Enter the server's host name which is used to access the Nagios Server GUI as *Common Name*.

3. Edit the **`/etc/httpd/conf.d/ssl.conf`** file and add path to SSL Certificate and key files correspondingly for **`SSLCertificateFile`** and **`SSLCertificateKeyFile`** fields as shown below:

   ```
    SSLCertificateFile     /etc/pki/tls/certs/nagios-ssl.crt
    SSLCertificateKeyFile  /etc/pki/tls/private/nagios-ssl.key
   ```

4. Edit the **`/etc/httpd/conf/httpd.conf`** file and comment the port 80 listener as shown below:

   ```
   # Listen 80
   ```

5. In **`/etc/httpd/conf/httpd.conf`** file, ensure that the following line is not commented:

   ```
   <Directory "/var/www/html">
   ```

6. Restart the **`httpd`** service on the **`nagios`** server using the following command:

   ```
   # service httpd restart
   ```

### 17.5.4. Integrating LDAP Authentication with Nagios

You can integrate LDAP authentication with Nagios plug-in. To integrate LDAP authentication, follow the steps given below:

1. In apache configuration file **`/etc/httpd/conf/httpd.conf`**, ensure that LDAP is installed and LDAP apache module is enabled.

   The configurations are displayed as given below if the LDAP apache module is enabled.You can enable the LDAP apache module by deleting the # symbol.

   ```
   LoadModule ldap_module modules/mod_ldap.so
   LoadModule authnz_ldap_module modules/mod_authnz_ldap.so
   ```

2. Edit the **`nagios.conf`** file in **`/etc/httpd/conf.d/nagios.conf`** with the corresponding values for the following:

   - AuthBasicProvider

- AuthLDAPURL
- AuthLDAPBindDN
- AuthLDAPBindPassword

3. Edit the CGI authentication file **/etc/nagios/cgi.cfg** as given below with the path where Nagios is installed.

```
nagiosinstallationdir = /usr/local/nagios/ or /etc/nagios/
```

4. Uncomment the lines shown below by deleting # and set permissions for specific users:

**Note**

Replace **nagiosadmin** and *user names* with * to give any LDAP user full functionality of Nagios.

```
authorized_for_system_information=user1,user2,user3

authorized_for_configuration_information=nagiosadmin,user1,user2,user3


authorized_for_system_commands=nagiosadmin,user1,user2,user3

authorized_for_all_services=nagiosadmin,user1,user2,user3

authorized_for_all_hosts=nagiosadmin,user1,user2,user3

authorized_for_all_service_commands=nagiosadmin,user1,user2,user3

authorized_for_all_host_commands=nagiosadmin,user1,user2,user3
```

5. Restart **httpd** service and **nagios** server using the following commands:

```
# service httpd restart
# service nagios restart
```

## 17.6. Configuring Nagios Manually

You can configure the Nagios server and node manually to monitor a Red Hat Gluster Storage trusted storage pool.

**Note**

It is recommended to configure Nagios using Auto-Discovery. For more information on configuring Nagios using Auto-Discovery, see Section 17.3.1, “Configuring Nagios”

For more information on Nagios Configuration files, see Chapter 29, *Nagios Configuration Files*

### Configuring Nagios Server

1. In the **`/etc/nagios/gluster`** directory, create a directory with the cluster name. All configurations for the cluster are added in this directory.

2. In the **`/etc/nagios/gluster/`*`cluster-name`*** directory, create a file with name ***`clustername`*`.cfg`** to specify the **`host`** and **`hostgroup`** configurations. The service configurations for all the cluster and volume level services are added in this file.

   **Note**

   Cluster is configured as host and host group in Nagios.

   In the ***`clustername`*`.cfg`** file, add the following definitions:

   a. Define a host group with cluster name as shown below:

   ```
   define hostgroup{
                hostgroup_name                  cluster-name
                alias                           cluster-name
       }
   ```

   b. Define a host with cluster name as shown below:

   ```
    define host{
                host_name                       cluster-name
                alias                           cluster-name
                use                             gluster-cluster
                address                         cluster-name
       }
   ```

   c. Define *Cluster-Quorum* service to monitor cluster quorum status as shown below:

   ```
   define service {
                service_description             Cluster - Quorum
                use                             gluster-passive-
   service
           host_name                       cluster-name
       }
   ```

   d. Define the *Cluster Utilization* service to monitor cluster utilization as shown below:

   ```
   define service {
                service_description               Cluster
   Utilization
                use gluster-service-with-graph
                check_command     check_cluster_vol_usage!warning-
   threshold!critcal-threshold;
                host_name                         cluster-name
       }
   ```

   e. Add the following service definitions for each volume in the cluster:

- Volume Status service to monitor the status of the volume as shown below:

```
define service {
                 service_description             Volume
Status - volume-name
                 host_name                       cluster-
name
                 use gluster-service-without-graph
                 _VOL_NAME                       volume-
name
                 notes                           Volume
type : Volume-Type
                 check_command     check_vol_status!cluster-
name!volume-name
        }
```

- Volume Utilization service to monitor the volume utilization as shown below:

```
define service {
                 service_description             Volume
Utilization - volume-name
                 host_name                       cluster-
name
                 use gluster-service-with-graph
                 _VOL_NAME                       volume-
name
                 notes                           Volume
type : Volume-Type
                 check_command
check_vol_utilization!cluster-name!volume-name!warning-
threshold!critcal-threshold
        }
```

- Volume Split-brain service to monitor split brain status as shown below:

```
define service {
                         service_description    Volume
Split-brain status - volume-name
                         host_name                 cluster-
name
                         use gluster-service-without-graph
                         _VOL_NAME
volume-name
                        check_command
check_vol_heal_status!cluster1!vol1
}
```

- Volume Quota service to monitor the volume quota status as shown below:

```
define service {
                 service_description            Volume Quota
- volume-name
                 host_name                      cluster-
name
                 use gluster-service-without-graph
```

```
                    _VOL_NAME                          volume-name
                    check_command
check_vol_quota_status!cluster-name!volume-name
                    notes                              Volume type
: Volume-Type
          }
```

- Volume Geo-Replication service to monitor Geo Replication status as shown below:

```
define service {
                    service_description                Volume Geo
Replication - volume-name
                    host_name                          cluster-
name
                    use gluster-service-without-graph
                    _VOL_NAME                          volume-name
                    check_command
check_vol_georep_status!cluster-name!volume-name
          }
```

3. In the **`/etc/nagios/gluster/`*`cluster-name`*** directory, create a file with name ***`host-name`*`.cfg`**. The host configuration for the node and service configuration for all the brick from the node are added in this file.

   In ***`host-name`*`.cfg`** file, add following definitions:

   a. Define Host for the node as shown below:

```
 define host {
         use                               gluster-host
         hostgroups    gluster_hosts,cluster-name
         alias                             host-name
         host_name                         host-name #Name given
by user to identify the node in Nagios
         _HOST_UUID                        host-uuid #Host UUID
returned by gluster peer status
         address                           host-address  # This
can be FQDN or IP address of the host
      }
```

   b. Create the following services for each brick in the node:

   - Add *Brick Utilization* service as shown below:

```
define service {
                   service_description               Brick
Utilization - brick-path
                    host_name                        host-name  #
Host name given in host definition
                    use                              brick-
service
                    _VOL_NAME                        Volume-Name
                    notes                            Volume :
Volume-Name
                    _BRICK_DIR                       brick-path
          }
```

- Add *Brick Status* service as shown below:

```
define service {
                 service_description           Brick -
brick-path
                 host_name                     host-name  #
Host name given in host definition
                 use          gluster-brick-status-service
                 _VOL_NAME                     Volume-Name
                 notes                         Volume :
Volume-Name
                 _BRICK_DIR                    brick-path
        }
```

4. Add host configurations and service configurations for all nodes in the cluster as shown in Step 3.

### Configuring Red Hat Gluster Storage node

1. In **/etc/nagios** directory of each Red Hat Gluster Storage node, edit **nagios_server.conf** file by setting the configurations as shown below:

```
# NAGIOS SERVER
# The nagios server IP address or FQDN to which the NSCA command
# needs to be sent
[NAGIOS-SERVER]
nagios_server=NagiosServerIPAddress


# CLUSTER NAME
# The host name of the logical cluster configured in Nagios under
which
# the gluster volume services reside
[NAGIOS-DEFINTIONS]
cluster_name=cluster_auto


# LOCAL HOST NAME
# Host name given in the nagios server
[HOST-NAME]
hostname_in_nagios=NameOfTheHostInNagios

# LOCAL HOST CONFIGURATION
# Process monitoring sleeping intevel
[HOST-CONF]
proc-mon-sleep-time=TimeInSeconds
```

   The **nagios_server.conf** file is used by **glusterpmd** service to get server name, host name, and the process monitoring interval time.

2. Start the **glusterpmd** service using the following command:

```
# service glusterpmd start
```

### Changing Nagios Monitoring time interval

By default, the active Red Hat Gluster Storage services are monitored every 10 minutes. You can change the time interval for monitoring by editing the **gluster-templates.cfg** file.

1. In **/etc/nagios/gluster/gluster-templates.cfg** file, edit the service with **gluster-service** name.

2. Add **normal_check_interval** and set the time interval to 1 to check all Red Hat Gluster Storage services every 1 minute as shown below:

```
define service {
   name                         gluster-service
   use                          generic-service
   notifications_enabled        1
   notification_period          24x7
   notification_options         w,u,c,r,f,s
   notification_interval        120
   register                     0
   contacts                     +ovirt,snmp
   _GLUSTER_ENTITY              HOST_SERVICE
   normal_check_interval        1
}
```

3. To change this on individual service, add this property to the required service definition as shown below:

```
define service {
   name                    gluster-brick-status-service
   use                     gluster-service
   register                0
   event_handler           brick_status_event_handler
   check_command           check_brick_status
   normal_check_interval   1
}
```

   The **check_interval** is controlled by the global directive **interval_length**. This defaults to 60 seconds. This can be changed in **/etc/nagios/nagios.cfg** as shown below:

```
# INTERVAL LENGTH
# This is the seconds per unit interval as used in the
# host/contact/service configuration files.  Setting this to 60 means
# that each interval is one minute long (60 seconds).  Other settings
# have not been tested much, so your mileage is likely to vary...

interval_length=TimeInSeconds
```

# 17.7. Troubleshooting Nagios

## 17.7.1. Troubleshooting NSCA and NRPE Configuration Issues

The possible errors while configuring Nagios Service Check Acceptor (NSCA) and Nagios Remote Plug-in Executor (NRPE) and the troubleshooting steps are listed in this section.

### Troubleshooting NSCA Configuration Issues

- **Check Firewall and Port Settings on Nagios Server**

  If port 5667 is not opened on the server host's firewall, a timeout error is displayed. Ensure that port *5667* is opened.

  **On Red Hat Gluster Storage based on Red Hat Enterprise Linux 6**

  - Log in as root and run the following command on the Red Hat Gluster Storage node to get the list of current iptables rules:

    ```
    # iptables -L
    ```

  - The output is displayed as shown below:

    ```
    ACCEPT     tcp  --  anywhere             anywhere            tcp
    dpt:5667
    ```

  **On Red Hat Gluster Storage based on Red Hat Enterprise Linux 7:**

  - Run the following command on the Red Hat Gluster Storage node as root to get a listing of the current firewall rules:

    ```
    # firewall-cmd --list-all-zones
    ```

  - If the port is open, **`5667/tcp`** is listed beside **`ports:`** under one or more zones in your output.

- If the port is not open, add a firewall rule for the port:

  **On Red Hat Gluster Storage based on Red Hat Enterprise Linux 6**

  - If the port is not open, add an iptables rule by adding the following line in **`/etc/sysconfig/iptables`** file:

    ```
    -A INPUT -m state --state NEW -m tcp -p tcp --dport 5667 -j ACCEPT
    ```

  - Restart the iptables service using the following command:

    ```
    # service iptables restart
    ```

  - Restart the NSCA service using the following command:

    ```
    # service nsca restart
    ```

  **On Red Hat Gluster Storage based on Red Hat Enterprise Linux 7:**

  - Run the following commands to open the port:

    ```
    # firewall-cmd --zone=public --add-port=5667/tcp
    # firewall-cmd --zone=public --add-port=5667/tcp --permanent
    ```

- **Check the Configuration File on Red Hat Gluster Storage Node**

Messages cannot be sent to the NSCA server, if Nagios server IP or FQDN, cluster name and hostname (as configured in Nagios server) are not configured correctly.

Open the Nagios server configuration file */etc/nagios/nagios_server.conf* and verify if the correct configurations are set as shown below:

```
# NAGIOS SERVER
# The nagios server IP address or FQDN to which the NSCA command
# needs to be sent
[NAGIOS-SERVER]
nagios_server=NagiosServerIPAddress


# CLUSTER NAME
# The host name of the logical cluster configured in Nagios under which
# the gluster volume services reside
[NAGIOS-DEFINTIONS]
cluster_name=cluster_auto


# LOCAL HOST NAME
# Host name given in the nagios server
[HOST-NAME]
hostname_in_nagios=NagiosServerHostName
```

If Host name is updated, restart the NSCA service using the following command:

```
# service nsca restart
```

### Troubleshooting NRPE Configuration Issues

- **CHECK_NRPE: Error - Could Not Complete SSL Handshake**

  This error occurs if the IP address of the Nagios server is not defined in the **`nrpe.cfg`** file of the Red Hat Gluster Storage node. To fix this issue, follow the steps given below:

  - Add the Nagios server IP address in **`/etc/nagios/nrpe.cfg`** file in the **`allowed_hosts`** line as shown below:

    ```
    allowed_hosts=127.0.0.1, NagiosServerIP
    ```

    The **`allowed_hosts`** is the list of IP addresses which can execute NRPE commands.

  - Save the **`nrpe.cfg`** file and restart NRPE service using the following command:

    ```
    # service nrpe restart
    ```

- **CHECK_NRPE: Socket Timeout After n Seconds**

  To resolve this issue perform the steps given below:

  **On Nagios Server:**

  The default timeout value for the NRPE calls is 10 seconds and if the server does not respond within 10 seconds, Nagios Server GUI displays an error that the NRPE call has timed out in 10 seconds. To fix this issue, change the timeout value for NRPE calls by modifying the command definition configuration files.

- Changing the NRPE timeout for services which directly invoke *check_nrpe*.

  For the services which directly invoke *check_nrpe* (check_disk_and_inode, check_cpu_multicore, and check_memory), modify the command definition configuration file **`/etc/nagios/gluster/gluster-commands.cfg`** by adding *-t Time in Seconds* as shown below:

  ```
  define command {
         command_name check_disk_and_inode
         command_line $USER1$/check_nrpe -H $HOSTADDRESS$ -c
  check_disk_and_inode -t TimeInSeconds
  }
  ```

- Changing the NRPE timeout for the services in **`nagios-server-addons`** package which invoke NRPE call through code.

  The services which invoke **`/usr/lib64/nagios/plugins/gluster/check_vol_server.py`** (check_vol_utilization, check_vol_status, check_vol_quota_status, check_vol_heal_status, and check_vol_georep_status) make NRPE call to the Red Hat Gluster Storage nodes for the details through code. To change the timeout for the NRPE calls, modify the command definition configuration file **`/etc/nagios/gluster/gluster-commands.cfg`** by adding *-t No of seconds* as shown below:

  ```
  define command {
        command_name check_vol_utilization
        command_line $USER1$/gluster/check_vol_server.py $ARG1$ $ARG2$
  -w $ARG3$ -c $ARG4$ -o utilization -t TimeInSeconds
  }
  ```

  The auto configuration service **`gluster_auto_discovery`** makes NRPE calls for the configuration details from the Red Hat Gluster Storage nodes. To change the NRPE timeout value for the auto configuration service, modify the command definition configuration file **`/etc/nagios/gluster/gluster-commands.cfg`** by adding *-t TimeInSeconds* as shown below:

  ```
  define command{
          command_name    gluster_auto_discovery
          command_line    sudo $USER1$/gluster/configure-gluster-
  nagios.py -H $ARG1$ -c $HOSTNAME$ -m auto -n $ARG2$ -t TimeInSeconds
  }
  ```

- Restart Nagios service using the following command:

  ```
   #  service nagios restart
  ```

**On Red Hat Gluster Storage node:**

- Add the Nagios server IP address as described in *CHECK_NRPE: Error - Could Not Complete SSL Handshake* section in *Troubleshooting NRPE Configuration Issues* section.

- Edit the **`nrpe.cfg`** file using the following command:

  ```
  # vi /etc/nagios/nrpe.cfg
  ```

- Search for the **`command_timeout`** and **`connection_timeout`** settings and change the value. The **`command_timeout`** value must be greater than or equal to the timeout value set in Nagios server.

  The timeout on checks can be set as *connection_timeout=300* and the *command_timeout=60* seconds.

- Restart the NRPE service using the following command:

```
# service nrpe restart
```

- **Check the NRPE Service Status**

  This error occurs if the NRPE service is not running. To resolve this issue perform the steps given below:

  - Log in as root to the Red Hat Gluster Storage node and run the following command to verify the status of NRPE service:

```
# service nrpe status
```

  - If NRPE is not running, start the service using the following command:

```
# service nrpe start
```

- **Check Firewall and Port Settings**

  This error is associated with firewalls and ports. The timeout error is displayed if the NRPE traffic is not traversing a firewall, or if port *5666* is not open on the Red Hat Gluster Storage node.

  Ensure that port 5666 is open on the Red Hat Gluster Storage node.

  - Run **`check_nrpe`** command from the Nagios server to verify if the port is open and if NRPE is running on the Red Hat Gluster Storage Node .

  - Log into the Nagios server as root and run the following command:

```
# /usr/lib64/nagios/plugins/check_nrpe -H RedHatStorageNodeIP
```

  - The output is displayed as given below:

```
NRPE v2.14
```

  If not, ensure the that port 5666 is opened on the Red Hat Gluster Storage node.

  **On Red Hat Gluster Storage based on Red Hat Enterprise Linux 6:**

  - Run the following command on the Red Hat Gluster Storage node as root to get a listing of the current iptables rules:

```
# iptables -L
```

  - If the port is open, the following appears in your output.

```
ACCEPT     tcp  --  anywhere             anywhere            tcp
dpt:5666
```

**On Red Hat Gluster Storage based on Red Hat Enterprise Linux 7:**

- Run the following command on the Red Hat Gluster Storage node as root to get a listing of the current firewall rules:

```
# firewall-cmd --list-all-zones
```

- If the port is open, **`5666/tcp`** is listed beside **`ports:`** under one or more zones in your output.

- If the port is not open, add an iptables rule for the port.

**On Red Hat Gluster Storage based on Red Hat Enterprise Linux 6:**

- To add iptables rule, edit the **`iptables`** file as shown below:

```
# vi /etc/sysconfig/iptables
```

- Add the following line in the file:

```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 5666 -j ACCEPT
```

- Restart the iptables service using the following command:

```
# service iptables restart
```

- Save the file and restart the NRPE service:

```
# service nrpe restart
```

**On Red Hat Gluster Storage based on Red Hat Enterprise Linux 7:**

- Run the following commands to open the port:

```
# firewall-cmd --zone=public --add-port=5666/tcp
# firewall-cmd --zone=public --add-port=5666/tcp --permanent
```

- **Checking Port 5666 From the Nagios Server with Telnet**

Use telnet to verify the Red Hat Gluster Storage node's ports. To verify the ports of the Red Hat Gluster Storage node, perform the steps given below:

- Log in as root on Nagios server.

- Test the connection on port 5666 from the Nagios server to the Red Hat Gluster Storage node using the following command:

```
# telnet RedHatStorageNodeIP 5666
```

- The output displayed is similar to:

```
telnet 10.70.36.49 5666
Trying 10.70.36.49...
Connected to 10.70.36.49.
Escape character is '^]'.
```

### Connection Refused By Host

This error is due to port/firewall issues or incorrectly configured *allowed_hosts* directives. See the sections *CHECK_NRPE: Error - Could Not Complete SSL Handshake* and *CHECK_NRPE: Socket Timeout After n Seconds* for troubleshooting steps.

# Chapter 18. Monitoring Red Hat Gluster Storage Gluster Workload

Monitoring storage volumes is helpful when conducting a capacity planning or performance tuning activity on a Red Hat Gluster Storage volume. You can monitor the Red Hat Gluster Storage volumes with different parameters and use those system outputs to identify and troubleshoot issues.

You can use the **`volume top`** and **`volume profile`** commands to view vital performance information and identify bottlenecks on each brick of a volume.

You can also perform a statedump of the brick processes and NFS server process of a volume, and also view volume status and volume information.

> **Note**
>
> If you restart the server process, the existing **`profile`** and **`top`** information will be reset.

## 18.1. Running the Volume Profile Command

The **`volume profile`** command provides an interface to get the per-brick or NFS server I/O information for each File Operation (FOP) of a volume. This information helps in identifying the bottlenecks in the storage system.

This section describes how to use the **`volume profile`** command.

### 18.1.1. Start Profiling

To view the file operation information of each brick, start the profiling command:

**`# gluster volume profile`** ***`VOLNAME`*** **`start`**

For example, to start profiling on *test-volume*:

```
# gluster volume profile test-volume start
Profiling started on test-volume
```

> **Important**
>
> Running **`profile`** command can affect system performance while the profile information is being collected. Red Hat recommends that profiling should only be used for debugging.

When profiling is started on the volume, the following additional options are displayed when using the **`volume info`** command:

```
diagnostics.count-fop-hits: on

diagnostics.latency-measurement: on
```

### 18.1.2. Displaying the I/O Information

To view the I/O information of the bricks on a volume, use the following command:

**# gluster volume profile *VOLNAME* info**

For example, to view the I/O information of *test-volume*:

```
# gluster volume profile test-volume info
Brick: Test:/export/2
Cumulative Stats:

Block                     1b+           32b+           64b+
Size:
       Read:                0              0              0
       Write:             908             28              8

Block                   128b+           256b+         512b+
Size:
       Read:                0               6             4
       Write:               5              23            16

Block                  1024b+          2048b+        4096b+
Size:
       Read:                 0             52            17
       Write:               15            120           846

Block                   8192b+         16384b+      32768b+
Size:
       Read:                52              8            34
       Write:              234            134           286

Block                                  65536b+     131072b+
Size:
       Read:                               118          622
       Write:                             1341          594


%-latency  Avg-       Min-       Max-       calls     Fop
          latency    Latency    Latency

___________________________________________________________
4.82      1132.28    21.00      800970.00    4575     WRITE
5.70       156.47     9.00      665085.00    39163    READDIRP
11.35      315.02     9.00     1433947.00    38698    LOOKUP
11.88     1729.34    21.00     2569638.00     7382    FXATTROP
47.35   104235.02  2485.00     7789367.00      488    FSYNC

------------------

------------------

Duration     : 335

BytesRead    : 94505058

BytesWritten : 195571980
```

To view the I/O information of the NFS server on a specified volume, use the following command:

**# gluster volume profile *VOLNAME* info nfs**

For example, to view the I/O information of the NFS server on *test-volume*:

```
# gluster volume profile test-volume info nfs
NFS Server : localhost
----------------------
Cumulative Stats:
   Block Size:              32768b+               65536b+
 No. of Reads:                    0                     0
No. of Writes:                 1000                  1000
 %-latency   Avg-latency   Min-Latency   Max-Latency   No. of calls
Fop
 ---------   -----------   -----------   -----------   ------------
----
      0.01     410.33 us     194.00 us     641.00 us              3
STATFS
      0.60     465.44 us     346.00 us     867.00 us            147
FSTAT
      1.63     187.21 us      67.00 us    6081.00 us           1000
SETATTR
      1.94     221.40 us      58.00 us   55399.00 us           1002
ACCESS
      2.55     301.39 us      52.00 us   75922.00 us            968
STAT
      2.85     326.18 us      88.00 us   66184.00 us           1000
TRUNCATE
      4.47     511.89 us      60.00 us  101282.00 us           1000
FLUSH
      5.02    3907.40 us    1723.00 us   19508.00 us            147
READDIRP
     25.42    2876.37 us     101.00 us  843209.00 us           1012
LOOKUP
     55.52    3179.16 us     124.00 us  121158.00 us           2000
WRITE

    Duration: 7074 seconds
   Data Read: 0 bytes
Data Written: 102400000 bytes

Interval 1 Stats:
   Block Size:              32768b+               65536b+
 No. of Reads:                    0                     0
No. of Writes:                 1000                  1000
 %-latency   Avg-latency   Min-Latency   Max-Latency   No. of calls
Fop
 ---------   -----------   -----------   -----------   ------------
----
      0.01     410.33 us     194.00 us     641.00 us              3
STATFS
      0.60     465.44 us     346.00 us     867.00 us            147
FSTAT
      1.63     187.21 us      67.00 us    6081.00 us           1000
SETATTR
```

```
       1.94     221.40 us       58.00 us   55399.00 us           1002
ACCESS
       2.55     301.39 us       52.00 us   75922.00 us            968
STAT
       2.85     326.18 us       88.00 us   66184.00 us           1000
TRUNCATE
       4.47     511.89 us       60.00 us  101282.00 us           1000
FLUSH
       5.02    3907.40 us     1723.00 us   19508.00 us            147
READDIRP
      25.41    2878.07 us      101.00 us  843209.00 us           1011
LOOKUP
      55.53    3179.16 us      124.00 us  121158.00 us           2000
WRITE

    Duration: 330 seconds
   Data Read: 0 bytes
Data Written: 102400000 bytes
```

### 18.1.3. Stop Profiling

To stop profiling on a volume, use the following command:

**# gluster volume profile *VOLNAME* stop**

For example, to stop profiling on *test-volume*:

```
# gluster volume profile test-volume stop
Profiling stopped on test-volume
```

## 18.2. Running the Volume Top Command

The **volume top** command allows you to view the glusterFS bricks' performance metrics, including read, write, file open calls, file read calls, file write calls, directory open calls, and directory real calls. The **volume top** command displays up to 100 results.

This section describes how to use the **volume top** command.

### 18.2.1. Viewing Open File Descriptor Count and Maximum File Descriptor Count

You can view the current open file descriptor count and the list of files that are currently being accessed on the brick with the **volume top** command. The **volume top** command also displays the maximum open file descriptor count of files that are currently open, and the maximum number of files opened at any given point of time since the servers are up and running. If the brick name is not specified, then the open file descriptor metrics of all the bricks belonging to the volume displays.

To view the open file descriptor count and the maximum file descriptor count, use the following command:

**# gluster volume top *VOLNAME* open [nfs | brick *BRICK-NAME*] [list-cnt *cnt*]**

For example, to view the open file descriptor count and the maximum file descriptor count on brick *server:/export* on *test-volume*, and list the top 10 open calls:

```
# gluster volume top test-volume open brick server:/export  list-cnt 10
```

```
Brick: server:/export/dir1
Current open fd's: 34 Max open fd's: 209
             ==========Open file stats========

open                file name
call count

2                   /clients/client0/~dmtmp/PARADOX/
                    COURSES.DB

11                  /clients/client0/~dmtmp/PARADOX/
                    ENROLL.DB

11                  /clients/client0/~dmtmp/PARADOX/
                    STUDENTS.DB

10                  /clients/client0/~dmtmp/PWRPNT/
                    TIPS.PPT

10                  /clients/client0/~dmtmp/PWRPNT/
                    PCBENCHM.PPT

9                   /clients/client7/~dmtmp/PARADOX/
                    STUDENTS.DB

9                   /clients/client1/~dmtmp/PARADOX/
                    STUDENTS.DB

9                   /clients/client2/~dmtmp/PARADOX/
                    STUDENTS.DB

9                   /clients/client0/~dmtmp/PARADOX/
                    STUDENTS.DB

9                   /clients/client8/~dmtmp/PARADOX/
                    STUDENTS.DB
```

### 18.2.2. Viewing Highest File Read Calls

You can view a list of files with the highest file read calls on each brick with the **volume top** command. If the brick name is not specified, a list of 100 files are displayed by default.

To view the highest read() calls, use the following command:

**# gluster volume top *VOLNAME* read [nfs | brick *BRICK-NAME*] [list-cnt *cnt*]**

For example, to view the highest read calls on brick *server:/export* of *test-volume*:

```
# gluster volume top test-volume read brick server:/export list-cnt 10
Brick: server:/export/dir1
          ==========Read file stats========

read              filename
call count

116                /clients/client0/~dmtmp/SEED/LARGE.FIL
```

```
64                /clients/client0/~dmtmp/SEED/MEDIUM.FIL

54                /clients/client2/~dmtmp/SEED/LARGE.FIL

54                /clients/client6/~dmtmp/SEED/LARGE.FIL

54                /clients/client5/~dmtmp/SEED/LARGE.FIL

54                /clients/client0/~dmtmp/SEED/LARGE.FIL

54                /clients/client3/~dmtmp/SEED/LARGE.FIL

54                /clients/client4/~dmtmp/SEED/LARGE.FIL

54                /clients/client9/~dmtmp/SEED/LARGE.FIL

54                /clients/client8/~dmtmp/SEED/LARGE.FIL
```

### 18.2.3. Viewing Highest File Write Calls

You can view a list of files with the highest file write calls on each brick with the **volume top** command. If the brick name is not specified, a list of 100 files displays by default.

To view the highest write() calls, use the following command:

**# gluster volume top *VOLNAME* write [nfs | brick *BRICK-NAME*] [list-cnt *cnt*]**

For example, to view the highest write calls on brick *server:/export* of *test-volume*:

```
# gluster volume top test-volume write brick server:/export/ list-cnt 10
Brick: server:/export/dir1

               ==========Write file stats========
write call count   filename

83                 /clients/client0/~dmtmp/SEED/LARGE.FIL

59                 /clients/client7/~dmtmp/SEED/LARGE.FIL

59                 /clients/client1/~dmtmp/SEED/LARGE.FIL

59                 /clients/client2/~dmtmp/SEED/LARGE.FIL

59                 /clients/client0/~dmtmp/SEED/LARGE.FIL

59                 /clients/client8/~dmtmp/SEED/LARGE.FIL

59                 /clients/client5/~dmtmp/SEED/LARGE.FIL

59                 /clients/client4/~dmtmp/SEED/LARGE.FIL

59                 /clients/client6/~dmtmp/SEED/LARGE.FIL

59                 /clients/client3/~dmtmp/SEED/LARGE.FIL
```

### 18.2.4. Viewing Highest Open Calls on a Directory

You can view a list of files with the highest open calls on the directories of each brick with the **`volume top`** command. If the brick name is not specified, the metrics of all bricks belonging to that volume displays.

To view the highest open() calls on each directory, use the following command:

**`# gluster volume top VOLNAME opendir [brick BRICK-NAME] [list-cnt cnt]`**

For example, to view the highest open calls on brick *server:/export/* of *test-volume*:

```
# gluster volume top test-volume opendir brick server:/export/ list-cnt 10
Brick: server:/export/dir1
         ==========Directory open stats========

Opendir count     directory name

1001              /clients/client0/~dmtmp

454               /clients/client8/~dmtmp

454               /clients/client2/~dmtmp

454               /clients/client6/~dmtmp

454               /clients/client5/~dmtmp

454               /clients/client9/~dmtmp

443               /clients/client0/~dmtmp/PARADOX

408               /clients/client1/~dmtmp

408               /clients/client7/~dmtmp

402               /clients/client4/~dmtmp
```

### 18.2.5. Viewing Highest Read Calls on a Directory

You can view a list of files with the highest directory read calls on each brick with the **`volume top`** command. If the brick name is not specified, the metrics of all bricks belonging to that volume displays.

To view the highest directory read() calls on each brick, use the following command:

**`# gluster volume top VOLNAME readdir [nfs | brick BRICK-NAME] [list-cnt cnt]`**

For example, to view the highest directory read calls on brick *server:/export/* of *test-volume*:

```
# gluster volume top test-volume readdir brick server:/export/ list-cnt 10
Brick: server:/export/dir1
==========Directory readdirp stats========

readdirp count           directory name

1996                    /clients/client0/~dmtmp
```

```
1083                        /clients/client0/~dmtmp/PARADOX

904                         /clients/client8/~dmtmp

904                         /clients/client2/~dmtmp

904                         /clients/client6/~dmtmp

904                         /clients/client5/~dmtmp

904                         /clients/client9/~dmtmp

812                         /clients/client1/~dmtmp

812                         /clients/client7/~dmtmp

800                         /clients/client4/~dmtmp
```

## 18.2.6. Viewing Read Performance

You can view the read throughput of files on each brick with the **volume top** command. If the brick name is not specified, the metrics of all the bricks belonging to that volume is displayed. The output is the read throughput.

This command initiates a read() call for the specified count and block size and measures the corresponding throughput directly on the back-end export, bypassing glusterFS processes.

To view the read performance on each brick, use the command, specifying options as needed:

**# gluster volume top *VOLNAME* read-perf [bs *blk-size* count *count*] [nfs | brick *BRICK-NAME*] [list-cnt *cnt*]**

For example, to view the read performance on brick **server:/export/** of *test-volume*, specifying a 256 block size, and list the top 10 results:

```
# gluster volume top test-volume read-perf bs 256 count 1 brick
server:/export/ list-cnt 10
Brick: server:/export/dir1 256 bytes (256 B) copied, Throughput: 4.1 MB/s
       ==========Read throughput file stats========

read         filename                         Time
through
put(MBp
s)

2912.00   /clients/client0/~dmtmp/PWRPNT/    -2012-05-09
           TRIDOTS.POT                   15:38:36.896486

2570.00   /clients/client0/~dmtmp/PWRPNT/    -2012-05-09
           PCBENCHM.PPT                  15:38:39.815310

2383.00   /clients/client2/~dmtmp/SEED/      -2012-05-09
           MEDIUM.FIL                    15:52:53.631499

2340.00   /clients/client0/~dmtmp/SEED/      -2012-05-09
           MEDIUM.FIL                    15:38:36.926198
```

```
2299.00   /clients/client0/~dmtmp/SEED/      -2012-05-09
           LARGE.FIL                       15:38:36.930445

2259.00  /clients/client0/~dmtmp/PARADOX/    -2012-05-09
          COURSES.X04                      15:38:40.549919

2221.00  /clients/client9/~dmtmp/PARADOX/    -2012-05-09
          STUDENTS.VAL                     15:52:53.298766

2221.00  /clients/client8/~dmtmp/PARADOX/    -2012-05-09
         COURSES.DB                        15:39:11.776780

2184.00  /clients/client3/~dmtmp/SEED/       -2012-05-09
          MEDIUM.FIL                       15:39:10.251764

2184.00  /clients/client5/~dmtmp/WORD/       -2012-05-09
         BASEMACH.DOC                      15:39:09.336572
```

### 18.2.7. Viewing Write Performance

You can view the write throughput of files on each brick or NFS server with the **`volume top`** command. If brick name is not specified, then the metrics of all the bricks belonging to that volume will be displayed. The output will be the write throughput.

This command initiates a write operation for the specified count and block size and measures the corresponding throughput directly on back-end export, bypassing glusterFS processes.

To view the write performance on each brick, use the following command, specifying options as needed:

**`# gluster volume top`** ***`VOLNAME`*** **`write-perf [bs`** ***`blk-size`*** **`count`** ***`count`*** **`] [nfs | brick`** ***`BRICK-NAME`*** **`] [list-cnt`** ***`cnt`*** **`]`**

For example, to view the write performance on brick **`server:/export/`** of *test-volume*, specifying a 256 block size, and list the top 10 results:

```
# gluster volume top test-volume write-perf bs 256 count 1 brick
server:/export/ list-cnt 10
Brick: server:/export/dir1 256 bytes (256 B) copied, Throughput: 2.8 MB/s
       ==========Write throughput file stats========

write                filename                 Time
throughput
(MBps)

1170.00    /clients/client0/~dmtmp/SEED/     -2012-05-09
           SMALL.FIL                       15:39:09.171494

1008.00    /clients/client6/~dmtmp/SEED/     -2012-05-09
           LARGE.FIL                        15:39:09.73189

949.00    /clients/client0/~dmtmp/SEED/      -2012-05-09
          MEDIUM.FIL                       15:38:36.927426

936.00   /clients/client0/~dmtmp/SEED/       -2012-05-09
         LARGE.FIL                          15:38:36.933177
```

```
897.00    /clients/client5/~dmtmp/SEED/       -2012-05-09
          MEDIUM.FIL                         15:39:09.33628

897.00    /clients/client6/~dmtmp/SEED/       -2012-05-09
          MEDIUM.FIL                         15:39:09.27713

885.00    /clients/client0/~dmtmp/SEED/       -2012-05-09
           SMALL.FIL                        15:38:36.924271

528.00    /clients/client5/~dmtmp/SEED/       -2012-05-09
          LARGE.FIL                          15:39:09.81893

516.00    /clients/client6/~dmtmp/ACCESS/    -2012-05-09
          FASTENER.MDB                      15:39:01.797317
```

## 18.3. gstatus Command

### 18.3.1. gstatus Command

A Red Hat Gluster Storage trusted storage pool consists of nodes, volumes, and bricks. A new command called **gstatus** provides an overview of the health of a Red Hat Gluster Storage trusted storage pool for distributed, replicated, distributed-replicated, dispersed, and distributed-dispersed volumes.

The **gstatus** command provides an easy-to-use, high-level view of the health of a trusted storage pool with a single command. By executing the glusterFS commands, it gathers information about the statuses of the Red Hat Gluster Storage nodes, volumes, and bricks. The checks are performed across the trusted storage pool and the status is displayed. This data can be analyzed to add further checks and incorporate deployment best-practices and free-space triggers.

A Red Hat Gluster Storage volume is made from individual file systems (glusterFS bricks) across multiple nodes. Although the complexity is abstracted, the status of the individual bricks affects the data availability of the volume. For example, even without replication, the loss of a single brick in the volume will not cause the volume itself to be unavailable, instead this would manifest as inaccessible files in the file system.

#### 18.3.1.1. Prerequisites

**Package dependencies**

- Python 2.6 or above

To install gstatus, refer to the *Deploying gstatus on Red Hat Gluster Storage* chapter in the *Red Hat Gluster Storage 3.1 Installation Guide*.

### 18.3.2. Executing the gstatus command

The **gstatus** command can be invoked in different ways. The table below shows the optional switches that can be used with gstatus.

```
# gstatus -h
Usage: gstatus [options]
```

**Table 18.1. gstatus Command Options**

| Option | Description |
| --- | --- |
| --version | Displays the program's version number and exits. |
| -h, --help | Displays the help message and exits. |
| -s, --state | Displays the high level health of the Red Hat Gluster Storage trusted storage pool. |
| -v, --volume | Displays volume information of all the volumes, by default. Specify a volume name to display the volume information of a specific volume. |
| -b, --backlog | Probes the self heal state. |
| -a, --all | Displays the detailed status of volume health. (This output is aggregation of -s and -v). |
| -l, --layout | Displays the brick layout when used in combination with -v, or -a . |
| -o OUTPUT_MODE, --output-mode=OUTPUT_MODE | Produces outputs in various formats such as - json, keyvalue, or console(default). |
| -D, --debug | Enables the debug mode. |
| -w, --without-progress | Disables progress updates during data gathering. |
| -u UNITS, --units=UNITS | Displays capacity units in decimal or binary format (GB vs GiB). |
| -t TIMEOUT, --timeout=TIMEOUT | Specify the command timeout value in seconds. |

**Table 18.2. Commonly used gstatus Commands**

| Command | Description |
| --- | --- |
| **`gstatus -s`** | An overview of the trusted storage pool. |
| **`gstatus -a`** | View detailed status of the volume health. |
| **`gstatus -vl`** ***`VOLNAME`*** | View the volume details, including the brick layout. |
| **`gstatus -o`** ***`<keyvalue>`*** | View the summary output for Nagios and Logstash. |

**Interpreting the output with Examples**

Each invocation of **`gstatus`** provides a header section, which provides a high level view of the state of the Red Hat Gluster Storage trusted storage pool. The **`Status`** field within the header offers two states; **`Healthy`** and **`Unhealthy`**. When problems are detected, the status field changes to Unhealthy(n), where n denotes the total number of issues that have been detected.

The following examples illustrate **`gstatus`** command output for both healthy and unhealthy Red Hat Gluster Storage environments.

**Example 18.1. Example 1: Trusted Storage Pool is in a healthy state; all nodes, volumes and bricks are online**

```
# gstatus -a

   Product: RHGS Server v3.1.1      Capacity:  36.00 GiB(raw bricks)
      Status: HEALTHY                         7.00 GiB(raw used)
   Glusterfs: 3.7.1                         18.00 GiB(usable from volumes)
  OverCommit: No                  Snapshots:   0

   Nodes    :  4/ 4  Volumes:  1 Up
   Self Heal:  4/ 4            0 Up(Degraded)
   Bricks   :  4/ 4            0 Up(Partial)
```

```
   Connections  : 5 / 20       0 Down

Volume Information
 splunk       UP - 4/4 bricks up - Distributed-Replicate
                  Capacity: (18% used) 3.00 GiB/18.00 GiB (used/total)
                  Snapshots: 0
                  Self Heal:  4/ 4
                  Tasks Active: None
                  Protocols: glusterfs:on  NFS:on  SMB:off
                  Gluster Connectivty: 5 hosts, 20 tcp connections



Status Messages
- Cluster is HEALTHY, all_bricks checks successful
```

**Example 18.2. Example 2: A node is down within the trusted pool**

```
# gstatus -al

     Product: RHGS Server v3.1.1      Capacity:  27.00 GiB(raw bricks)
      Status: UNHEALTHY(4)                       5.00 GiB(raw used)
   Glusterfs: 3.7.1                         18.00 GiB(usable from volumes)
  OverCommit: No                Snapshots:   0

   Nodes    :  3/ 4  Volumes:  0 Up
   Self Heal:  3/ 4            1 Up(Degraded)
   Bricks   :  3/ 4            0 Up(Partial)
   Connections  :  5/ 20       0 Down

Volume Information
 splunk           UP(DEGRADED) - 3/4 bricks up - Distributed-Replicate
                  Capacity: (18% used) 3.00 GiB/18.00 GiB (used/total)
                  Snapshots: 0
                  Self Heal:  3/ 4
                  Tasks Active: None
                  Protocols: glusterfs:on  NFS:on  SMB:off
                  Gluster Connectivty: 5 hosts, 20 tcp connections

 splunk---------- +
                  |
                Distribute (dht)
                         |
                         +-- Repl Set 0 (afr)
                         |     |
                         |     +--splunk-rhs1:/rhs/brick1/splunk(UP) 2.00
GiB/9.00 GiB
                         |     |
                         |     +--splunk-rhs2:/rhs/brick1/splunk(UP) 2.00
GiB/9.00 GiB
                         |
                         +-- Repl Set 1 (afr)
                               |
                               +--splunk-rhs3:/rhs/brick1/splunk(DOWN)
0.00 KiB/0.00 KiB
```

```
                                |
                                +--splunk-rhs4:/rhs/brick1/splunk(UP)
2.00 GiB/9.00 GiB
 Status Messages
  - Cluster is UNHEALTHY
  - One of the nodes in the cluster is down
  - Brick splunk-rhs3:/rhs/brick1/splunk in volume 'splunk' is
down/unavailable
  - INFO -> Not all bricks are online, so capacity provided is NOT accurate
```

Example 2, displays the output of the command when the **`-l`** option is used. The **`brick layout`** mode shows the brick and node relationships. This provides a simple means of checking the replication relationships for bricks across nodes is as intended.

**Table 18.3. Field Descriptions of the `gstatus` command output**

| Field | Description |
|---|---|
| Volume State | Up – The volume is started and available, and all the bricks are up . |
| | Up (Degraded) - This state is specific to replicated volumes, where at least one brick is down within a replica set. Data is still 100% available due to the alternate replicas, but the resilience of the volume to further failures within the same replica set flags this volume as **`degraded`**. |
| | Up (Partial) - Effectively, this means that all though some bricks in the volume are online, there are others that are down to a point where areas of the file system will be missing. For a distributed volume, this state is seen if any brick is down, whereas for a replicated volume a complete replica set needs to be down before the volume state transitions to **`PARTIAL`**. |
| | Down - Bricks are down, or the volume is yet to be started. |
| Capacity Information | This information is derived from the brick information taken from the **`volume status detail`** command. The accuracy of this number hence depends on the nodes and bricks all being online - elements missing from the configuration are not considered in the calculation. |
| Over-commit Status | The physical file system used by a brick could be re-used by multiple volumes, this field indicates whether a brick is used by multiple volumes. But this exposes the system to capacity conflicts across different volumes when the quota feature is not in use. Reusing a brick for multiple volumes is not recommended. |
| Connections | Displays a count of connections made to the trusted pool and each of the volumes. |

| Field | Description |
| --- | --- |
| Nodes / Self Heal / Bricks X/Y | This indicates that X components of Y total/expected components within the trusted pool are online. In Example 2, note that 3/4 is displayed against all of these fields, indicating 3 nodes are available out of 4 nodes. A node, brick, and the self-heal daemon are also unavailable. |
| Tasks Active | Active background tasks such as rebalance, remove-brick are displayed here against individual volumes. |
| Protocols | Displays which protocols have been enabled for the volume. |
| Snapshots | Displays a count of the number of snapshots taken for the volume. The snapshot count for each volume is **`rolled up`** to the trusted storage pool to provide a high level view of the number of snapshots in the environment. |
| Status Messages | After the information is gathered, any errors detected are reported in the **`Status Messages`** section. These descriptions provide a view of the problem and the potential impact of the condition. |

## 18.4. Listing Volumes

You can list all volumes in the trusted storage pool using the following command:

**`# gluster volume list`**

For example, to list all volumes in the trusted storage pool:

```
# gluster volume list
test-volume
volume1
volume2
volume3
```

## 18.5. Displaying Volume Information

You can display information about a specific volume, or all volumes, as needed, using the following command:

**`# gluster volume info`** ***`VOLNAME`***

For example, to display information about *test-volume*:

```
# gluster volume info test-volume
Volume Name: test-volume
Type: Distribute
Status: Created
Number of Bricks: 4
Bricks:
```

```
Brick1: server1:/exp1
Brick2: server2:/exp2
Brick3: server3:/exp3
Brick4: server4:/exp4
```

## 18.6. Performing Statedump on a Volume

Statedump is a mechanism through which you can get details of all internal variables and state of the glusterFS process at the time of issuing the command. You can perform statedumps of the brick processes and NFS server process of a volume using the statedump command. You can use the following options to determine what information is to be dumped:

- **mem** - Dumps the memory usage and memory pool details of the bricks.
- **iobuf** - Dumps iobuf details of the bricks.
- **priv** - Dumps private information of loaded translators.
- **callpool** - Dumps the pending calls of the volume.
- **fd** - Dumps the open file descriptor tables of the volume.
- **inode** - Dumps the inode tables of the volume.
- **history** - Dumps the event history of the volume

To perform a statedump of a volume or NFS server, use the following command, specifying options as needed:

**`# gluster volume statedump`** ***`VOLNAME`*** **`[nfs] [all|mem|iobuf|callpool|priv|fd|inode|history]`**

For example, to perform a statedump of *test-volume*:

```
# gluster volume statedump test-volume
Volume statedump successful
```

The statedump files are created on the brick servers in the **`/var/run/gluster/`** directory or in the directory set using **`server.statedump-path`** volume option. The naming convention of the dump file is ***`brick-path.brick-pid`*****`.dump`**.

You can change the directory of the statedump file using the following command:

**`# gluster volume set`** ***`VOLNAME`*** **`server.statedump-path`** ***`path`***

For example, to change the location of the statedump file of *test-volume*:

```
# gluster volume set test-volume server.statedump-path
/usr/local/var/log/glusterfs/dumps/
Set volume successful
```

You can view the changed path of the statedump file using the following command:

**`# gluster volume info`** ***`VOLNAME`***

To retrieve the statedump information for client processes:

**kill -USR1 *process_ID***

For example, to retrieve the statedump information for the client process ID *4120*:

```
kill -USR1 4120
```

To obtain the statedump file of the GlusterFS Management Daemon, execute the following command:

**# kill -SIGUSR1 *PID_of_the_glusterd_process***

The glusterd statedump file is found in the, **/var/run/gluster/** directory with the name in the format:

**glusterdump-<PID_of_the_glusterd_process>.dump.<timestamp>**

## 18.7. Displaying Volume Status

You can display the status information about a specific volume, brick, or all volumes, as needed. Status information can be used to understand the current status of the brick, NFS processes, self-heal daemon and overall file system. Status information can also be used to monitor and debug the volume information. You can view status of the volume along with the details:

- **detail** - Displays additional information about the bricks.
- **clients** - Displays the list of clients connected to the volume.
- **mem** - Displays the memory usage and memory pool details of the bricks.
- **inode** - Displays the inode tables of the volume.
- **fd** - Displays the open file descriptor tables of the volume.
- **callpool** - Displays the pending calls of the volume.

Display information about a specific volume using the following command:

**# gluster volume status [all|*VOLNAME* [nfs | shd | *BRICKNAME*]] [detail |clients | mem | inode | fd |callpool]**

For example, to display information about *test-volume*:

```
# gluster volume status test-volume
Status of volume: test-volume
Gluster process                        Port    Online   Pid
------------------------------------------------------------
Brick arch:/export/rep1                24010   Y       18474
Brick arch:/export/rep2                24011   Y       18479
NFS Server on localhost                38467   Y       18486
Self-heal Daemon on localhost          N/A     Y       18491
```

The self-heal daemon status will be displayed only for replicated volumes.

Display information about all volumes using the command:

**# gluster volume status all**

```
# gluster volume status all
Status of volume: test
```

```
Gluster process                       Port    Online   Pid
------------------------------------------------------------
Brick 192.168.56.1:/export/test       24009   Y       29197
NFS Server on localhost               38467   Y       18486

Status of volume: test-volume
Gluster process                       Port    Online   Pid
------------------------------------------------------------
Brick arch:/export/rep1               24010   Y       18474
Brick arch:/export/rep2               24011   Y       18479
NFS Server on localhost               38467   Y       18486
Self-heal Daemon on localhost         N/A     Y       18491
```

Display additional information about the bricks using the command:

**# gluster volume status *VOLNAME* detail**

For example, to display additional information about the bricks of *test-volume*:

```
# gluster volume status test-volume detail
Status of volume: test-vol
------------------------------------------------------------------------
------
Brick                : Brick arch:/exp
Port                 : 24012
Online               : Y
Pid                  : 18649
File System          : ext4
Device               : /dev/sda1
Mount Options        :
rw,relatime,user_xattr,acl,commit=600,barrier=1,data=ordered
Inode Size           : 256
Disk Space Free      : 22.1GB
Total Disk Space     : 46.5GB
Inode Count          : 3055616
Free Inodes          : 2577164
```

Detailed information is not available for NFS and the self-heal daemon.

Display the list of clients accessing the volumes using the command:

**# gluster volume status *VOLNAME* clients**

For example, to display the list of clients connected to *test-volume*:

```
# gluster volume status test-volume clients
Brick : arch:/export/1
Clients connected : 2
Hostname          Bytes Read   BytesWritten
--------          ---------    ------------
127.0.0.1:1013    776          676
127.0.0.1:1012    50440        51200
```

Client information is not available for the self-heal daemon.

Display the memory usage and memory pool details of the bricks on a volume using the command:

```
# gluster volume status VOLNAME mem
```

For example, to display the memory usage and memory pool details for the bricks on *test-volume*:

```
# gluster volume status test-volume mem
Memory status for volume : test-volume
----------------------------------------------
Brick : arch:/export/1
Mallinfo
--------
Arena    : 434176
Ordblks  : 2
Smblks   : 0
Hblks    : 12
Hblkhd   : 40861696
Usmblks  : 0
Fsmblks  : 0
Uordblks : 332416
Fordblks : 101760
Keepcost : 100400

Mempool Stats
-------------
Name                               HotCount ColdCount PaddedSizeof
AllocCount MaxAlloc
----                               -------- --------- ------------ ------
---- --------
test-volume-server:fd_t                0     16384           92         57
5
test-volume-server:dentry_t           59       965           84         59
59
test-volume-server:inode_t            60       964          148         60
60
test-volume-server:rpcsvc_request_t    0       525         6372        351
2
glusterfs:struct saved_frame           0      4096          124          2
2
glusterfs:struct rpc_req               0      4096         2236          2
2
glusterfs:rpcsvc_request_t             1       524         6372          2
1
glusterfs:call_stub_t                  0      1024         1220        288
1
glusterfs:call_stack_t                 0      8192         2084        290
2
glusterfs:call_frame_t                 0     16384          172       1728
6
```

Display the inode tables of the volume using the command:

```
# gluster volume status VOLNAME inode
```

For example, to display the inode tables of *test-volume*:

```
# gluster volume status test-volume inode
inode tables for volume test-volume
```

```
----------------------------------------------
Brick : arch:/export/1
Active inodes:
GFID                                            Lookups            Ref
IA type
----                                            -------            ---
-------
6f3fe173-e07a-4209-abb6-484091d75499                  1              9
2
370d35d7-657e-44dc-bac4-d6dd800ec3d3                  1              1
2

LRU inodes:
GFID                                            Lookups            Ref
IA type
----                                            -------            ---
-------
80f98abe-cdcf-4c1d-b917-ae564cf55763                  1              0
1
3a58973d-d549-4ea6-9977-9aa218f233de                  1              0
1
2ce0197d-87a9-451b-9094-9baa38121155                  1              0
2
```

Display the open file descriptor tables of the volume using the command:

**# gluster volume status *VOLNAME* fd**

For example, to display the open file descriptor tables of *test-volume*:

```
# gluster volume status test-volume fd

FD tables for volume test-volume
----------------------------------------------
Brick : arch:/export/1
Connection 1:
RefCount = 0  MaxFDs = 128  FirstFree = 4
FD Entry            PID                 RefCount            Flags
--------            ---                 --------            -----
0                   26311               1                   2
1                   26310               3                   2
2                   26310               1                   2
3                   26311               3                   2

Connection 2:
RefCount = 0  MaxFDs = 128  FirstFree = 0
No open fds

Connection 3:
RefCount = 0  MaxFDs = 128  FirstFree = 0
No open fds
```

FD information is not available for NFS and the self-heal daemon.

Display the pending calls of the volume using the command:

**# gluster volume status *VOLNAME* callpool**

Note, each call has a call stack containing call frames.

For example, to display the pending calls of *test-volume*:

```
# gluster volume status test-volume callpool

Pending calls for volume test-volume
----------------------------------------------
Brick : arch:/export/1
Pending calls: 2
Call Stack1
 UID    : 0
 GID    : 0
 PID    : 26338
 Unique : 192138
 Frames : 7
 Frame 1
  Ref Count   = 1
  Translator  = test-volume-server
  Completed   = No
 Frame 2
  Ref Count   = 0
  Translator  = test-volume-posix
  Completed   = No
  Parent      = test-volume-access-control
  Wind From   = default_fsync
  Wind To     = FIRST_CHILD(this)->fops->fsync
 Frame 3
  Ref Count   = 1
  Translator  = test-volume-access-control
  Completed   = No
  Parent      = repl-locks
  Wind From   = default_fsync
  Wind To     = FIRST_CHILD(this)->fops->fsync
 Frame 4
  Ref Count   = 1
  Translator  = test-volume-locks
  Completed   = No
  Parent      = test-volume-io-threads
  Wind From   = iot_fsync_wrapper
  Wind To     = FIRST_CHILD (this)->fops->fsync
 Frame 5
  Ref Count   = 1
  Translator  = test-volume-io-threads
  Completed   = No
  Parent      = test-volume-marker
  Wind From   = default_fsync
  Wind To     = FIRST_CHILD(this)->fops->fsync
 Frame 6
  Ref Count   = 1
  Translator  = test-volume-marker
  Completed   = No
  Parent      = /export/1
  Wind From   = io_stats_fsync
```

```
  Wind To     = FIRST_CHILD(this)->fops->fsync
 Frame 7
  Ref Count   = 1
  Translator  = /export/1
  Completed   = No
  Parent      = test-volume-server
  Wind From   = server_fsync_resume
  Wind To     = bound_xl->fops->fsync
```

## 18.8. Troubleshooting issues in the Red Hat Gluster Storage Trusted Storage Pool

### 18.8.1. Troubleshooting a network issue in the Red Hat Gluster Storage Trusted Storage Pool

When enabling the network components to communicate with Jumbo frames in a Red Hat Gluster Storage Trusted Storage Pool, ensure that all the network components such as switches, Red Hat Gluster Storage nodes etc are configured properly. Verify the network configuration by running the **ping** from one Red Hat Gluster Storage node to another.

If the nodes in the Red Hat Gluster Storage Trusted Storage Pool or any other network components are not configured to fully support Jumbo frames, the **ping** command times out and displays the following error:

```
# ping -s 1600 '-Mdo'
local error: Message too long, mtu=1500
```

# Chapter 19. Detecting Data Corruption with BitRot

BitRot detection is a technique used in Red Hat Gluster Storage to identify when silent corruption of data has occurred. BitRot also helps to identify when a brick's data has been manipulated directly, without using FUSE, NFS or any other access protocols. BitRot detection is particularly useful when using JBOD, since JBOD does not provide other methods of determining when data on a disk has become corrupt.

The **`gluster volume bitrot`** command scans all the bricks in a volume for BitRot issues in a process known as scrubbing. The process calculates the checksum for each file or object, and compares that checksum against the actual data of the file. When BitRot is detected in a file, that file is marked as corrupted, and the detected errors are logged in the following files:

- /var/log/glusterfs/bitd.log
- /var/log/glusterfs/scrub.log

## 19.1. Enabling and Disabling the BitRot daemon

The BitRot daemon is disabled by default. In order to use or configure the daemon, you first need to enable it.

**`gluster volume bitrot *VOLNAME* enable`**

Enable the BitRot daemon for the specified volume.

**`gluster volume bitrot *VOLNAME* disable`**

Disable the BitRot daemon for the specified volume.

## 19.2. Modifying BitRot Detection Behavior

Once the daemon is enabled, you can pause and resume the detection process, check its status, and modify how often or how quickly it runs.

**`gluster volume bitrot *VOLNAME* scrub pause`**

Pauses the scrubbing process on the specified volume. Note that this does not stop the BitRot daemon; it stops the process that cycles through the volume checking files.

**`gluster volume bitrot *VOLNAME* scrub resume`**

Resumes the scrubbing process on the specified volume. Note that this does not start the BitRot daemon; it restarts the process that cycles through the volume checking files.

**`gluster volume bitrot *VOLNAME* scrub status`**

This command prints a summary of scrub status on the specified volume, including various configuration details and the location of the bitrot and scrubber error logs for this volume. It also prints details each node scanned for errors, along with identifiers for any corrupted objects located.

**`gluster volume bitrot *VOLNAME* scrub-throttle *rate*`**

Because the BitRot daemon scrubs the entire file system, scrubbing can have a severe performance impact. This command changes the rate at which files and objects are verified. Valid rates are **`lazy`**, **`normal`**, and **`aggressive`**. By default, the scrubber process is started in **`lazy`** mode.

**gluster volume bitrot *VOLNAME* scrub-frequency *frequency***

This command changes how often the scrub operation runs when the BitRot daemon is enabled. Valid options are **daily**, **weekly**, **biweekly**, and **monthly**.By default, the scrubber process is set to run **biweekly**.

## 19.3. Restore a bad file

When bad files are revealed by the scrubber, you can perform the following process to heal the file by recovering a copy from a replicate volume.

### Important

The following procedure is easier if GFID-to-path translation is enabled.

Mount all volumes using the **-oaux-gfid-mount** mount option, and enable GFID-to-path translation on each volume by running the following command.

```
# gluster volume set VOLNAME build-pgfid on
```

Files created before this option was enabled must be looked up with the **find** command.

**Procedure 19.1. Restoring a bad file from a replicate volume**

1. **Note the identifiers of bad files**

   Check the output of the **scrub status** command to determine the identifiers of corrupted files.

   ```
   # gluster volume bitrot VOLNAME scrub status
   Volume name: VOLNAME
   ...
   Node name: NODENAME
   ...
   Error count: 3
   Corrupted objects:
   5f61ade8-49fb-4c37-af84-c95041ff4bf5
   e8561c6b-f881-499b-808b-7fa2bce190f7
   eff2433f-eae9-48ba-bdef-839603c9434c
   ```

2. **Determine the path of each corrupted object**

   For files created after GFID-to-path translation was enabled, use the **getfattr** command to determine the path of the corrupted files.

   ```
   # getfattr -n glusterfs.ancestry.path -e text
   /mnt/VOLNAME/.gfid/GFID
   ...
   glusterfs.ancestry.path="/path/to/corrupted_file"
   ```

   For files created before GFID-to-path translation was enabled, use the **find** command to determine the path of the corrupted file and the index file that match the identifying GFID.

```
# find /rhgs/brick*/.glusterfs -name GFID
/rhgs/brick1/.glusterfs/path/to/GFID
```

```
# find /rhgs -samefile /rhgs/brick1/.glusterfs/path/to/GFID
/rhgs/brick1/.glusterfs/path/to/GFID
/rhgs/brick1/path/to/corrupted_file
```

3. **Delete the corrupted files**

   Delete the corrupted files from the path output by the **getfattr** or **find** command.

4. **Delete the GFID file**

   Delete the GFID file from the **/rhgs/brick*N*/.glusterfs** directory.

5. **Heal the file**

   If you have client self-heal enabled, the file is healed the next time that you access it.

   If you do not have client self-heal enabled, you must manually heal the volume with the following command.

   ```
   # gluster volume heal VOLNAME
   ```

   The next time that the bitrot scrubber runs, this GFID is no longer listed (unless it has become corrupted again).

# Chapter 20. Managing Red Hat Gluster Storage Logs

The log management framework generates log messages for each of the administrative functionalities and the components to increase the user-serviceability aspect of Red Hat Gluster Storage Server. Logs are generated to track the event changes in the system. The feature makes the retrieval, rollover, and archival of log files easier and helps in troubleshooting errors that are user-resolvable with the help of the Red Hat Gluster Storage Error Message Guide. The Red Hat Gluster Storage Component logs are rotated on a weekly basis. Administrators can rotate a log file in a volume, as needed. When a log file is rotated, the contents of the current log file are moved to **log-file-name.epoch-time-stamp**.The components for which the log messages are generated with message-ids are glusterFS Management Service, Distributed Hash Table (DHT), and Automatic File Replication (AFR).

## 20.1. Log Rotation

Log files are rotated on a weekly basis and the log files are zipped in the gzip format on a fortnightly basis. When the content of the log file is rotated, the current log file is moved to log-file- name.epoch-time-stamp. The archival of the log files is defined in the configuration file. As a policy, log file content worth 52 weeks is retained in the Red Hat Gluster Storage Server.

## 20.2. Red Hat Gluster Storage Component Logs and Location

The table lists the component, services, and functionality based logs in the Red Hat Gluster Storage Server. As per the File System Hierarchy Standards (FHS) all the log files are placed in the **/var/log** directory.

**Table 20.1.**

| Component/Service Name | Location of the Log File | Remarks |
|---|---|---|
| glusterd | **/var/log/glusterfs/etc-glusterfs-glusterd.vol.log** | One glusterd log file per server. This log file also contains the snapshot and user logs. |
| gluster commands | **/var/log/glusterfs/cmd_history.log** | Gluster commands executed on a node in a Red Hat Gluster Storage Trusted Storage Pool is logged in this file. |
| bricks | **/var/log/glusterfs/bricks/*<path extraction of brick path>*.log** | One log file per brick on the server |
| rebalance | **/var/log/glusterfs/*VOLNAME*- rebalance.log** | One log file per volume on the server |
| self heal deamon | **/var/log/glusterfs/glustershd.log** | One log file per server |

| Component/Service Name | Location of the Log File | Remarks |
|---|---|---|
| quota | • **`/var/log/glusterfs/quotad.log`** Log of the quota daemons running on each node.<br>• **`/var/log/glusterfs/quota-crawl.log`** Whenever quota is enabled, a file system crawl is performed and the corresponding log is stored in this file<br>• **`/var/log/glusterfs/quota-mount-`*`VOLNAME`*`.log`** An auxiliary FUSE client is mounted in <gluster-run-dir>/*VOLNAME* of the glusterFS and the corresponding client logs found in this file. | One log file per server (and per volume from quota-mount. |
| Gluster NFS | **`/var/log/glusterfs/nfs.log`** | One log file per server |
| SAMBA Gluster | **`/var/log/samba/glusterfs-`*`VOLNAME`*`-<ClientIP>.log`** | If the client mounts this on a glusterFS server node, the actual log file or the mount point may not be found. In such a case, the mount outputs of all the glusterFS type mount operations need to be considered. |
| NFS - Ganesha | **`/var/log/ganesha.log`**, **`/var/log/ganesha-gfapi.log`** | One log file per server |
| FUSE Mount | **`/var/log/glusterfs/<`*`mountpoint path extraction`*`>.log`** | |
| Geo-replication | **`/var/log/glusterfs/geo-replication/<master>`** **`/var/log/glusterfs/geo-replication-slaves`** | |
| **`gluster volume heal`** ***`VOLNAME`*** **`info`** command | **`/var/log/glusterfs/glfsheal-`*`VOLNAME`*`.log`** | One log file per server on which the command is executed. |
| gluster-swift | **`/var/log/messages`** | |
| SwiftKrbAuth | **`/var/log/httpd/error_log`** | |
| Command Line Interface logs | **`/var/log/glusterfs/`*`cli`*`.log`** | This file captures log entries for every command that is executed on the Command Line Interface(CLI). |

## 20.3. Configuring the Log Format

You can configure the Red Hat Gluster Storage Server to generate log messages either with message IDs or without them.

To know more about these options, see topic *Configuring Volume Options* in the *Red Hat Gluster Storage Administration Guide*.

**To configure the log-format for bricks of a volume:**

```
gluster volume set VOLNAME diagnostics.brick-log-format <value>
```

**Example 20.1. Generate log files with `with-msg-id`:**

```
# gluster volume set testvol diagnostics.brick-log-format with-msg-id
```

**Example 20.2. Generate log files with `no-msg-id`:**

```
# gluster volume set testvol diagnostics.brick-log-format no-msg-id
```

**To configure the log-format for clients of a volume:**

```
gluster volume set VOLNAME diagnostics.client-log-format <value>
```

**Example 20.3. Generate log files with `with-msg-id`:**

```
# gluster volume set testvol diagnostics.client-log-format with-msg-id
```

**Example 20.4. Generate log files with `no-msg-id`:**

```
# gluster volume set testvol diagnostics.client-log-format no-msg-id
```

**To configure the log format for `glusterd`:**

```
# glusterd --log-format=<value>
```

**Example 20.5. Generate log files with `with-msg-id`:**

```
# glusterd --log-format=with-msg-id
```

**Example 20.6. Generate log files with `no-msg-id`:**

```
# glusterd --log-format=no-msg-id
```

To a list of error messages, see the *Red Hat Gluster Storage Error Message Guide*.

**See Also:**

- Section 10.1, “Configuring Volume Options”

## 20.4. Configuring the Log Level

Every log message has a log level associated with it. The levels, in descending order, are CRITICAL, ERROR, WARNING, INFO, DEBUG, and TRACE. Red Hat Gluster Storage can be configured to generate log messages only for certain log levels. Only those messages that have log levels above or equal to the configured log level are logged.

For example, if the log level is set to **`INFO`**, only **`CRITICAL`**, **`ERROR`**, **`WARNING`**, and **`INFO`** messages are logged.

The components can be configured to log at one of the following levels:

- CRITICAL
- ERROR
- WARNING
- INFO
- DEBUG
- TRACE

> **Important**
>
> Setting the log level to TRACE or DEBUG generates a very large number of log messages and can lead to disks running out of space very quickly.

**To configure the log level on bricks**

```
# gluster volume set VOLNAME diagnostics.brick-log-level <value>
```

**Example 20.7. Set the log level to warning on a brick**

```
# gluster volume set testvol diagnostics.brick-log-level WARNING
```

**To configure the syslog level on bricks**

```
# gluster volume set VOLNAME diagnostics.brick-sys-log-level <value>
```

**Example 20.8. Set the syslog level to warning on a brick**

```
# gluster volume set testvol diagnostics.brick-sys-log-level WARNING
```

**To configure the log level on clients**

```
# gluster volume set VOLNAME diagnostics.client-log-level <value>
```

**Example 20.9. Set the log level to error on a client**

```
# gluster volume set testvol diagnostics.client-log-level ERROR
```

**To configure the syslog level on clients**

```
# gluster volume set VOLNAME diagnostics.client-sys-log-level <value>
```

**Example 20.10. Set the syslog level to error on a client**

```
# gluster volume set testvol diagnostics.client-sys-log-level ERROR
```

**To configure the log level for `glusterd` persistently**

Edit the **`/etc/sysconfig/glusterd`** file, and set the value of the ***`LOG_LEVEL`*** parameter to the log level that you want glusterd to use.

```
## Set custom log file and log level (below are defaults)
#LOG_FILE='/var/log/glusterfs/glusterd.log'
LOG_LEVEL='VALUE'
```

This change does not take effect until glusterd is started or restarted with the **`service`** or **`systemctl`** command.

**Example 20.11. Set the log level to WARNING on `glusterd`**

In the **`/etc/sysconfig/glusterd`** file, locate the ***`LOG_LEVEL`*** parameter and set its value to **`WARNING`**.

```
## Set custom log file and log level (below are defaults)
#LOG_FILE='/var/log/glusterfs/glusterd.log'
LOG_LEVEL='WARNING'
```

Then start or restart the glusterd service. On Red Hat Enterprise Linux 7, run:

```
# systemctl restart glusterd.service
```

On Red Hat Enterprise Linux 6, run:

```
# service glusterd restart
```

**To run a gluster command once with a specified log level**

```
gluster --log-level=ERROR VOLNAME COMMAND
```

**Example 20.12. Run `volume status` with a log level of ERROR**

```
# gluster --log-level=ERROR volume status
```

**See Also:**

- Section 10.1, “Configuring Volume Options”

## 20.5. Suppressing Repetitive Log Messages

Repetitive log messages in the Red Hat Gluster Storage Server can be configured by setting a **`log-flush-timeout`** period and by defining a **`log-buf-size`** buffer size options with the **`gluster volume set`** command.

### Suppressing Repetitive Log Messages with a Timeout Period

**To set the timeout period on the bricks:**

```
# gluster volume set VOLNAME diagnostics.brick-log-flush-timeout <value>
```

**Example 20.13. Set a timeout period on the bricks**

```
# gluster volume set testvol diagnostics.brick-log-flush-timeout 200
volume set: success
```

**To set the timeout period on the clients:**

```
# gluster volume set VOLNAME diagnostics.client-log-flush-timeout <value>
```

**Example 20.14. Set a timeout period on the clients**

```
# gluster volume set testvol diagnostics.client-log-flush-timeout 180
volume set: success
```

**To set the timeout period on `glusterd`:**

```
# glusterd --log-flush-timeout=<value>
```

**Example 20.15. Set a timeout period on the `glusterd`**

```
# glusterd --log-flush-timeout=60
```

### Suppressing Repetitive Log Messages by defining a Buffer Size

The maximum number of unique log messages that can be suppressed until the timeout or buffer overflow, whichever occurs first on the bricks.

**To set the buffer size on the bricks:**

```
# gluster volume set VOLNAME diagnostics.brick-log-buf-size <value>
```

**Example 20.16. Set a buffer size on the bricks**

```
# gluster volume set testvol diagnostics.brick-log-buf-size 10
volume set: success
```

**To set the buffer size on the clients:**

```
# gluster volume set VOLNAME diagnostics.client-log-buf-size <value>
```

**Example 20.17. Set a buffer size on the clients**

```
# gluster volume set testvol diagnostics.client-log-buf-size 15
volume set: success
```

**To set the log buffer size on `glusterd`:**

```
# glusterd --log-buf-size=<value>
```

**Example 20.18. Set a log buffer size on the `glusterd`**

```
# glusterd --log-buf-size=10
```

**Note**

To disable suppression of repetitive log messages, set the log-buf-size to zero.

**See Also:**

- Section 10.1, “Configuring Volume Options”

## 20.6. Geo-replication Logs

The following log files are used for a geo-replication session:

- **`Master-log-file`** - log file for the process that monitors the master volume.

- **`Slave-log-file`** - log file for process that initiates changes on a slave.
- **`Master-gluster-log-file`** - log file for the maintenance mount point that the geo-replication module uses to monitor the master volume.
- **`Slave-gluster-log-file`** - If the slave is a Red Hat Gluster Storage Volume, this log file is the slave's counterpart of **`Master-gluster-log-file`**.

### 20.6.1. Viewing the Geo-replication Master Log Files

To view the Master-log-file for geo-replication, use the following command:

```
# gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL config
log-file
```

For example:

```
# gluster volume geo-replication Volume1 example.com::slave-vol config log-
file
```

### 20.6.2. Viewing the Geo-replication Slave Log Files

To view the log file for geo-replication on a slave, use the following procedure. **`glusterd`** must be running on slave machine.

1. On the master, run the following command to display the session-owner details:

   ```
   # gluster volume geo-replication MASTER_VOL SLAVE_HOST::SLAVE_VOL
   config session-owner
   ```

   For example:

   ```
   # gluster volume geo-replication Volume1 example.com::slave-vol config
   session-owner 5f6e5200-756f-11e0-a1f0-0800200c9a66
   ```

2. On the slave, run the following command with the session-owner value from the previous step:

   ```
   # gluster volume geo-replication SLAVE_VOL config log-file
   /var/log/gluster/SESSION_OWNER:remote-mirror.log
   ```

   For example:

   ```
   # gluster volume geo-replication slave-vol config log-file
   /var/log/gluster/5f6e5200-756f-11e0-a1f0-0800200c9a66:remote-
   mirror.log
   ```

# Chapter 21. Managing Red Hat Gluster Storage Volume Life-Cycle Extensions

Red Hat Gluster Storage allows automation of operations by user-written scripts. For every operation, you can execute a pre and a post script.

**Pre Scripts**: These scripts are run before the occurrence of the event. You can write a script to automate activities like managing system-wide services. For example, you can write a script to stop exporting the SMB share corresponding to the volume before you stop the volume.

**Post Scripts**: These scripts are run after execution of the event. For example, you can write a script to export the SMB share corresponding to the volume after you start the volume.

You can run scripts for the following events:

- Creating a volume
- Starting a volume
- Adding a brick
- Removing a brick
- Tuning volume options
- Stopping a volume
- Deleting a volume

**Naming Convention**

While creating the file names of your scripts, you must follow the naming convention followed in your underlying file system like XFS.

> **Note**
>
> To enable the script, the name of the script must start with an **S** . Scripts run in lexicographic order of their names.

## 21.1. Location of Scripts

This section provides information on the folders where the scripts must be placed. When you create a trusted storage pool, the following directories are created:

- /var/lib/glusterd/hooks/1/create/
- /var/lib/glusterd/hooks/1/delete/
- /var/lib/glusterd/hooks/1/start/
- /var/lib/glusterd/hooks/1/stop/
- /var/lib/glusterd/hooks/1/set/
- /var/lib/glusterd/hooks/1/add-brick/

- /var/lib/glusterd/hooks/1/remove-brick/

After creating a script, you must ensure to save the script in its respective folder on all the nodes of the trusted storage pool. The location of the script dictates whether the script must be executed before or after an event. Scripts are provided with the command line argument **`--volname=`*`VOLNAME`*** to specify the volume. Command-specific additional arguments are provided for the following volume operations:

- Start volume
  - **`--first=yes`**, if the volume is the first to be started
  - **`--first=no`**, for otherwise
- Stop volume
  - **`--last=yes`**, if the volume is to be stopped last.
  - **`--last=no`**, for otherwise
- Set volume
  - **`-o key=value`**

    For every key, value is specified in volume set command.

## 21.2. Prepackaged Scripts

Red Hat provides scripts to export Samba (SMB) share when you start a volume and to remove the share when you stop the volume. These scripts are available at: **`/var/lib/glusterd/hooks/1/start/post`** and **`/var/lib/glusterd/hooks/1/stop/pre`**. By default, the scripts are enabled.

When you start a volume using the following command:

```
# gluster volume start VOLNAME
```

The **`S30samba-start.sh`** script performs the following:

1. Adds Samba share configuration details of the volume to the **`smb.conf`** file
2. Mounts the volume through FUSE and adds an entry in **`/etc/fstab`** for the same.
3. Restarts Samba to run with updated configuration

When you stop the volume using the following command:

```
# gluster volume stop VOLNAME
```

The **`S30samba-stop.sh`** script performs the following:

1. Removes the Samba share details of the volume from the **`smb.conf`** file
2. Unmounts the FUSE mount point and removes the corresponding entry in **`/etc/fstab`**
3. Restarts Samba to run with updated configuration

# Chapter 22. Red Hat Gluster Storage Utilities

Glusterfind is a utility that provides the list of files that are modified between the previous backup session and the current period. The commands can be executed at regular intervals to retrieve the list. Multiple sessions for the same volume can be present for different use cases. The changes that are recorded are, new file/directories, data/metadata modifications, rename, and deletes.

## 22.1. Glusterfind Configuration Options

The following is the list configuration options available in Glusterfind:

- Glusterfind Create
- Glusterfind Pre
- Glusterfind Post
- Glusterfind List
- Glusterfind Delete

**Note**

All the glusterfind configuration commands such as, glusterfind pre, glusterfind post, glusterfind list, and glusterfind delete for a session have to be executed only on the node on which session is created.

### Glusterfind Create

To create a session for a particular instance in the volume, execute the following command:

```
glusterfind create [-h] [--debug] [--force] <SessionName> <volname> [-
-reset-session-time]
```

where,

--force: is executed when a new node/brick is added to the volume .

--reset-session-time: forces reset of the session time. The next incremental run will start from this time.

--help OR -h: Used to display help for the command.

SessionName: Unique name of a session.

volname: Name of the volume for which the **`create`** command is executed.

For example:

```
# glusterfind create sess_vol1 vol1
Session sess_vol1 created with volume vol1
```

### Glusterfind Pre

To retrieve the list of modified files and directories and store it in the outfile, execute the following command:

```
glusterfind pre [-h] [-N | --only-namespace-changes] [--debug] [--full] [--
output-prefix OUTPUT_PREFIX] [--disable-partial] <SessionName> <volname>
<outfile>
```

where,

OUTPUT_PREFIX: It is the prefix to the path/name that is specified in the outfile.

--only-namespace-changes OR -N: It lists only those files that are detected as New, Rename, Link, Unlink etc. It does not list files/directories which are modified.

--full: It triggers a full crawl of the filesystem

--disable-partial: It is used to disable the partial-find feature that is enabled by default.

--help OR -h: Displays help for the command

outfile: The incremental list of modified files.

SessionName: Unique name of a session.

volname: Name of the volume for which the **pre** command is executed.

For example:

```
# glusterfind pre sess_vol1 vol1 /tmp/outfile.txt
Generated output file /tmp/outfile.txt
```

### Note

The output format is <TYPE> <PATH1> <PATH2>. Possible type values are, NEW, MODIFY, DELETE and RENAME. PATH2 is applicable only if type is RENAME. For example:

```
NEW file1
NEW dir1%2F%2Ffile2
MODIFY dir3%2Fdir4%2Ftest3
RENAME test1 dir1%2F%2Ftest1new
DELETE test2
```

**Glusterfind Post:**

The following command is run to update the session time:

```
glusterfind post [-h] [--debug] <SessionName> <volname>
```

where,

SessionName: Unique name of a session.

volname: Name of the volume for which the **post** command is executed.

For example:

```
# glusterfind post sess_vol1 vol1
Session sess_vol1 with volume vol1 updated
```

### Glusterfind List:

To list all the active sessions and the corresponding volumes present in the cluster, execute the following command:

```
glusterfind list [-h] [--session SESSION] [--volume VOLUME] [--debug]
```

where,

--session SESSION: Displays the information related to that session

--volume VOLUME: Displays all the active sessions corresponding to that volume

--help OR -h: Displays help for the command

For example:

```
# glusterfind list
SESSION VOLUME SESSION TIME
--------------------------------------------------
sess_vol1 vol1 2015-06-22 22:22:53
```

### Glusterfind Delete:

To clear out all the session information associated with that particular session, execute the following command:

Ensure, no further backups are expected to be taken in a particular session.

```
glusterfind delete [-h] [--debug] <SessionName> <volname>
```

where,

SessionName: Unique name of a session.

volname: Name of the volume for which the **delete** command is executed.

For example:

```
# glusterfind delete sess_vol1 vol1
Session sess_vol1 with volume vol1 deleted
```

## 22.1.1. Adding or Replacing a Brick from an Existing Glusterfind Session

When a new brick is added or an existing brick is replaced, execute the **glusterfind create** command with **force** for the existing session to work. For example:

```
# glusterfind create existing-session volname --force
```

# Part III. Red Hat Gluster Storage Administration on Public Cloud

# Chapter 23. Accessing Red Hat Gluster Storage using Amazon Web Services

Red Hat Gluster Storage Server for Public Cloud is a pre-integrated, pre-verified and ready to run Amazon Machine Image (AMI) that provides a fully POSIX compatible highly available scale-out NAS and object storage solution for the Amazon Web Services (AWS) public cloud infrastructure.

**Important**

The following features of Red Hat Gluster Storage Server is not supported on Amazon Web Services:

- Red Hat Gluster Storage Console and Nagios Monitoring

- NFS and CIFS High Availability

**Note**

For information on obtaining access to AMI, see https://access.redhat.com/knowledge/articles/145693.

## 23.1. Launching Red Hat Gluster Storage Instances

This section describes how to launch Red Hat Gluster Storage instances on Amazon Web Services.

The supported configuration for two-way and three-way replication is up to 24 Amazon EBS volumes of equal size.

**Table 23.1. Supported Configuration on Amazon Web Services**

| EBS Volume Type | Minimum Number of Volumes per Instance | Maximum Number of Volumes per Instance | EBS Volume Capacity Range | Brick Range |
|---|---|---|---|---|
| Magnetic | 1 | 24 | 1 GiB - 1 TiB | 1 GiB - 24 TiB |
| General purpose SSD | 1 | 24 | 1 GiB - 16 TiB | 1GiB - 384 TiB |
| PIOPS SSD | 1 | 24 | 4 GiB - 16 TiB | 128 GiB - 384 TiB |

- There is a limit on the total provisioned IOPS per volume and the limit is 40,000. Hence, while adding 24 PIOPS SSD disks, you must ensure that the total IOPS of all disks does not exceed 40,000.

- Creation of Red Hat Gluster Storage volume snapshot is supported on magnetic, general purpose SSD and PIOPS EBS volumes. You can also browse the snapshot content using USS. See Chapter 16, *Managing Snapshots* for information on managing Red Hat Gluster Storage volume snapshots.

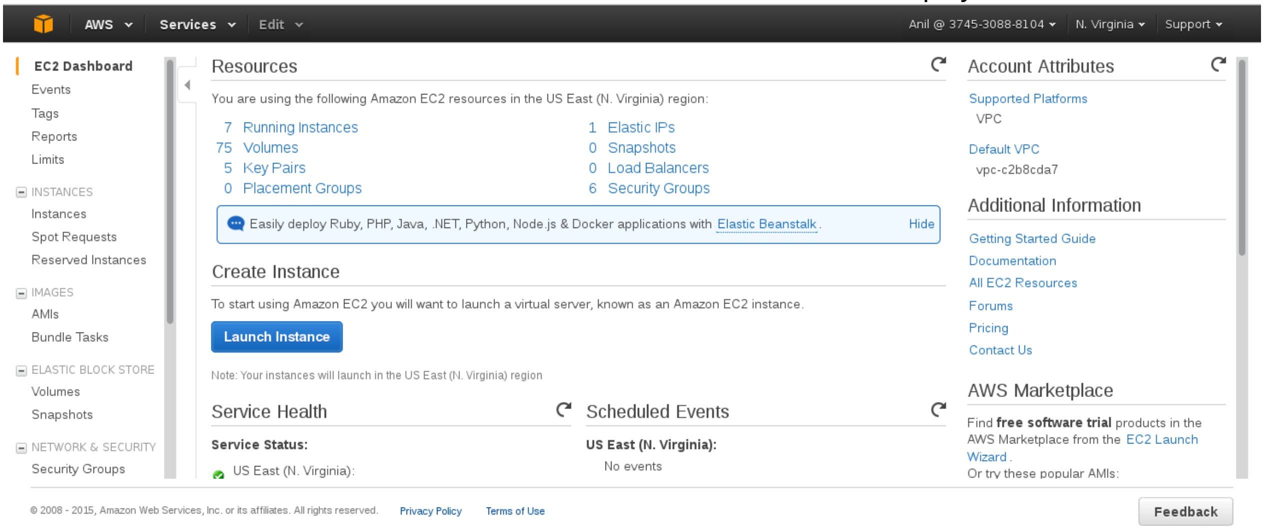
- Tiering feature of Red Hat Gluster Storage is supported in the Amazon Web Service environment. You can attach bricks created out of PIOPS or general purpose SSD volumes as hot tier to an existing or new Red Hat Gluster Storage volume created out of magnetic EBS volumes. See Chapter 12, *Managing Tiering* for information on creation of tiered volumes.

**To launch the Red Hat Gluster Storage Instance**

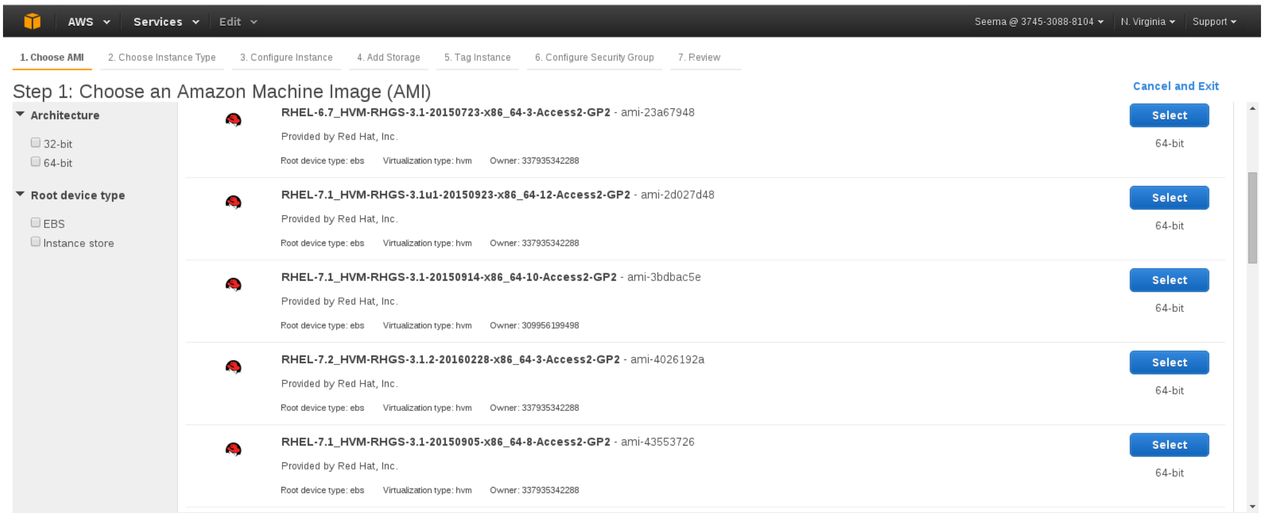
1. Navigate to the Amazon Web Services home page at http://aws.amazon.com. The Amazon Web Services home page appears.

2. Login to Amazon Web Services. The **Amazon Web Services** main screen is displayed.

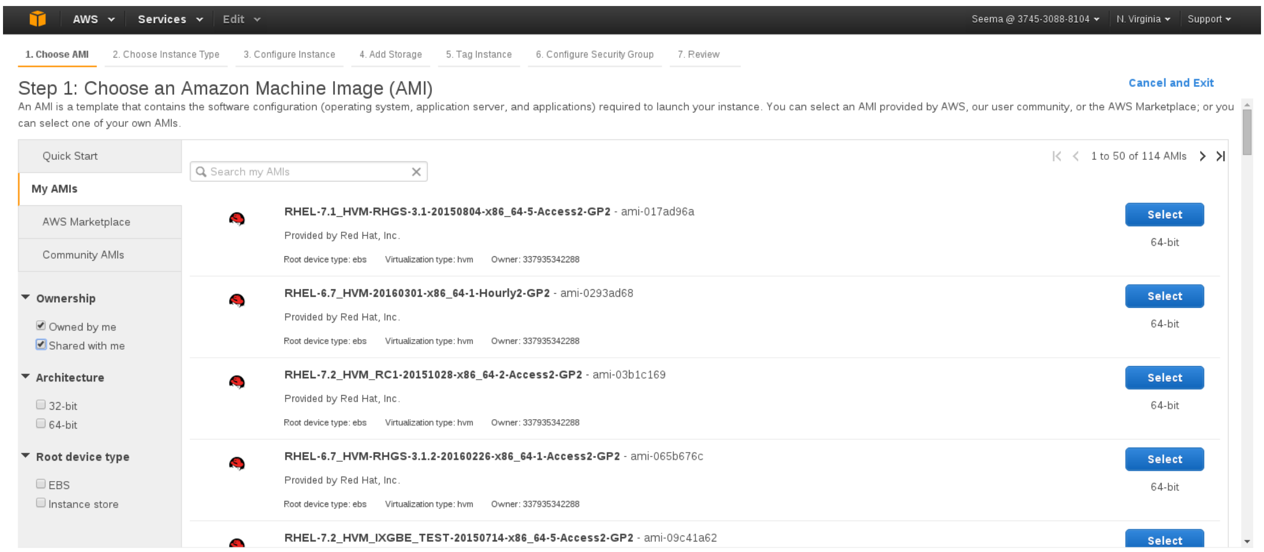
3. Click the **Amazon EC2** tab. The **Amazon EC2 Console Dashboard** is displayed.



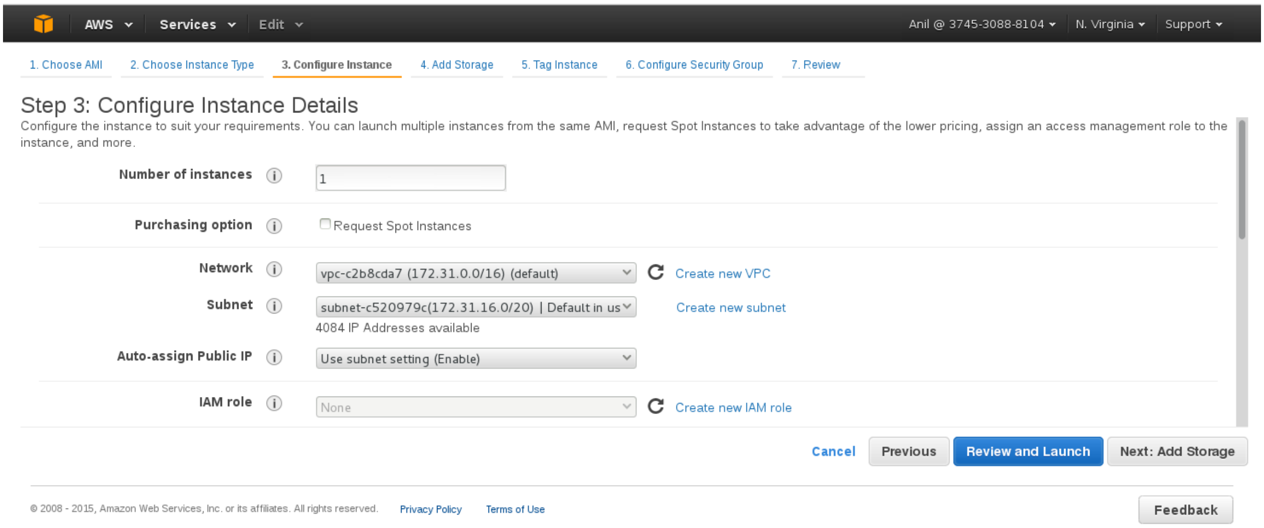

4. Click **Launch Instance**.The **Step 1: Choose an AMI** screen is displayed.



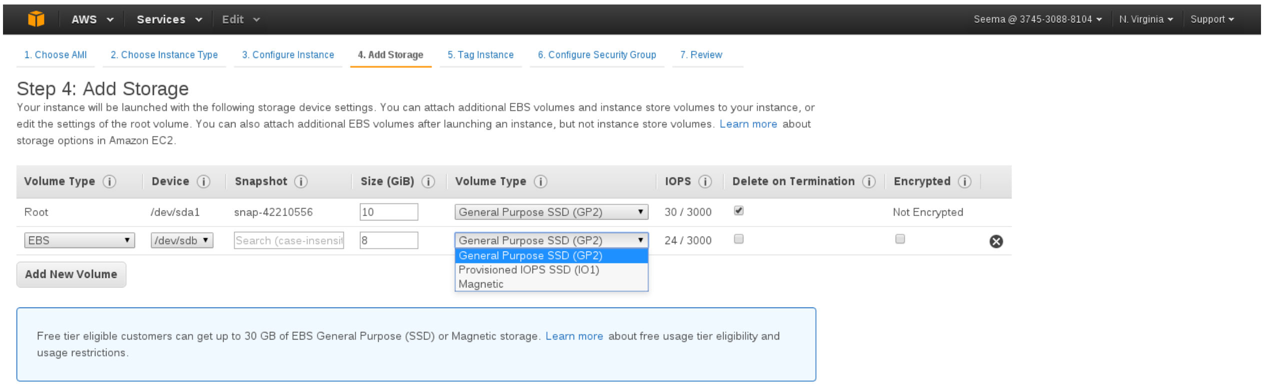

5. Click **My AMIs** and select **shared with me** checkbox. Click **Select** for the corresponding AMI and click **Next: Choose an Instance Type**. The **Step 2: Choose an Instance Type** screen is displayed.



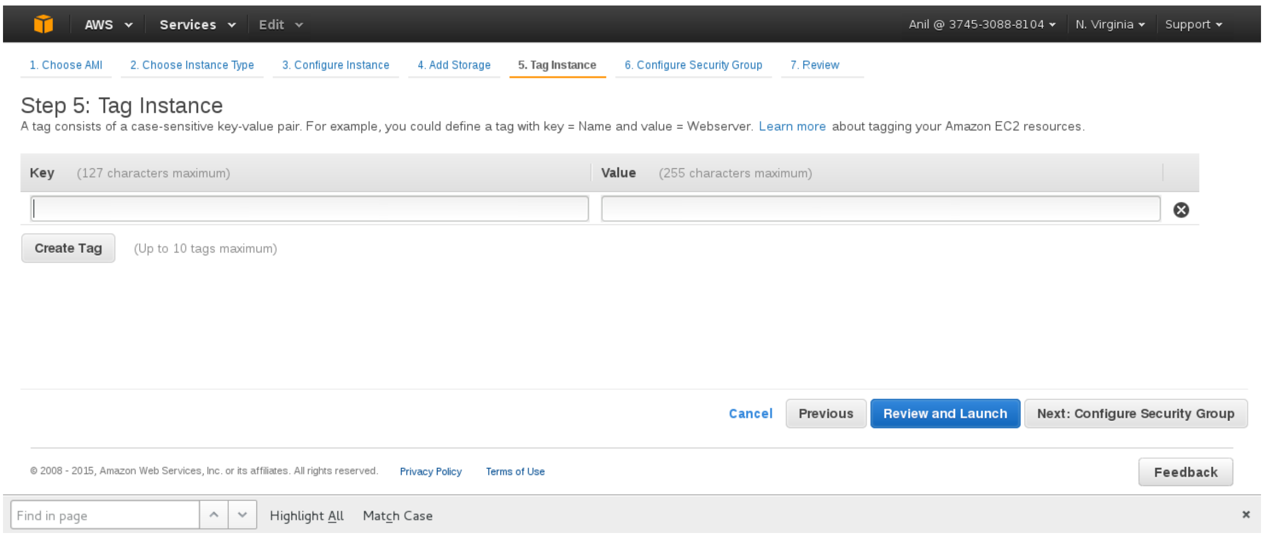
6. Select **Large** as the instance type, and click **Next: Configure Instance Details** . The **Step 3: Configure Instance Details** screen displays.



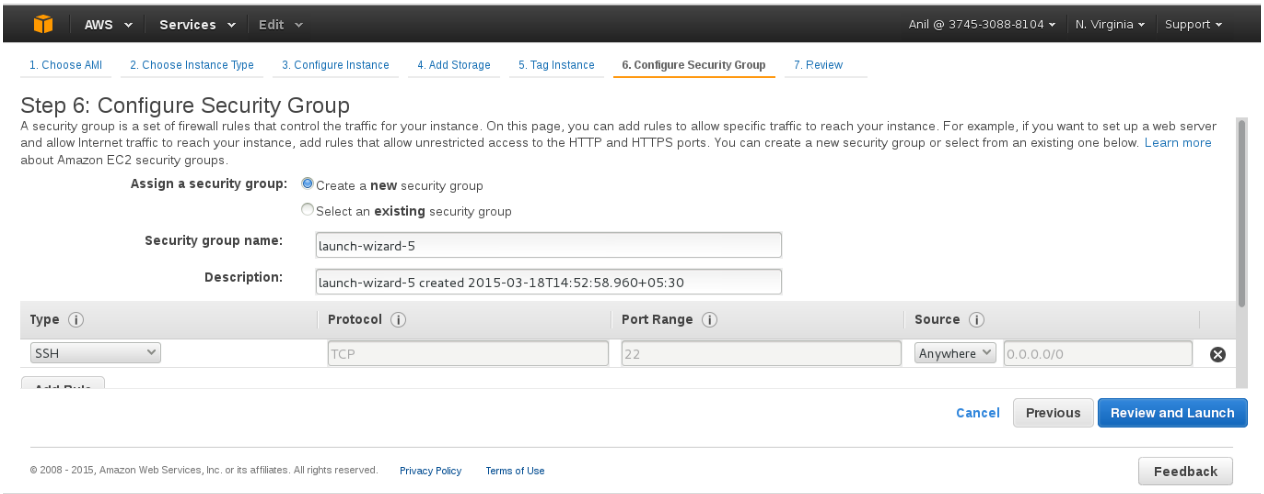

7. Specify the configuration for your instance or continue with the default settings, and click **Next: Add Storage** The **Step 4: Add Storage** screen displays.




8. In the **Add Storage** screen, specify the storage details and click **Next: Tag Instance**. The **Step 5: Tag Instance** screen is displayed.




9. Enter a name for the instance in the **Value** field for **Name**, and click **Next: Configure Security Group**. You can use this name later to verify that the instance is operating correctly. The **Step 6: Configure Security Group** screen is displayed.

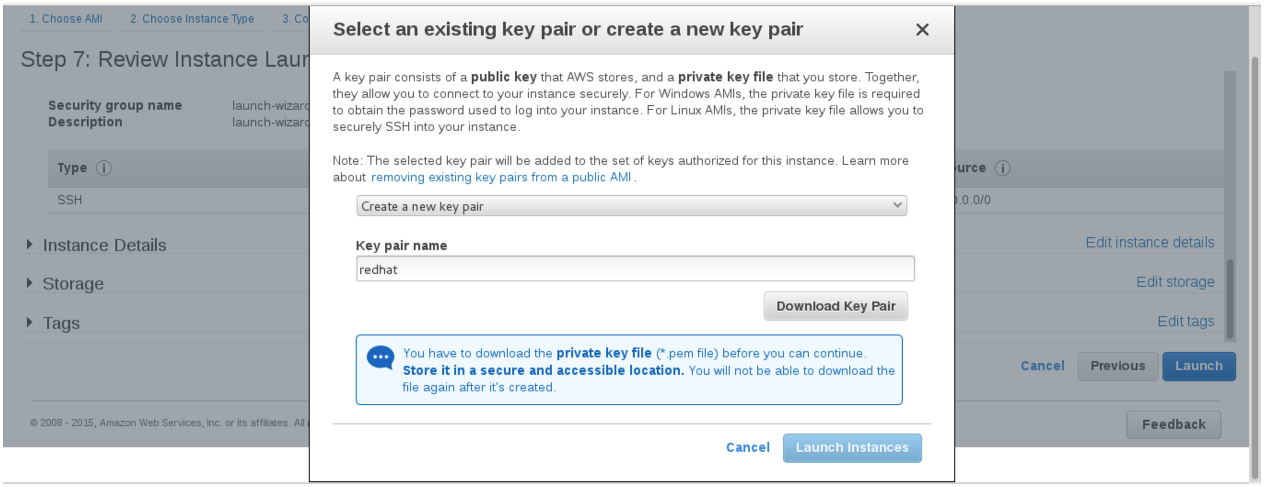



10. Select an existing security group or create a new security group and click **Review and Launch**.

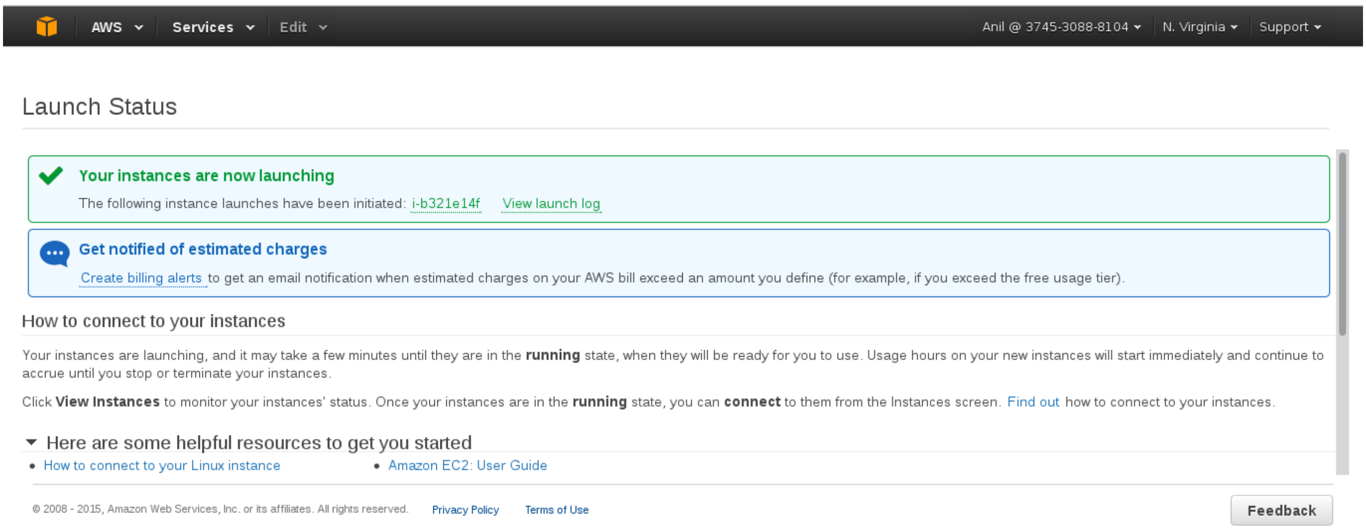
    You must ensure to open the following TCP port numbers in the selected security group:

    - 22
    - 6000, 6001, 6002, 443, and 8080 ports if Red Hat Gluster Storage for OpenStack Swift is enabled

11. Choose an existing key pair or create a new key pair, and click **Launch Instance**.




The **Launch Status** screen is displayed indicating that the instance is launching.



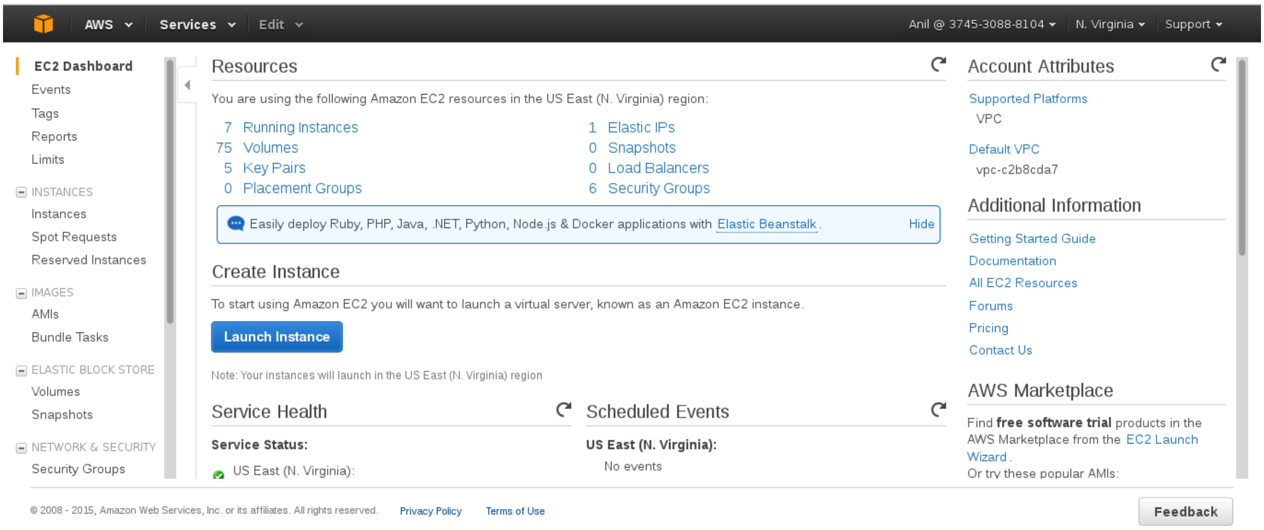

## 23.2. Verifying that Red Hat Gluster Storage Instance is Running

## 23.2. Verifying that Red Hat Gluster Storage Instance is Running

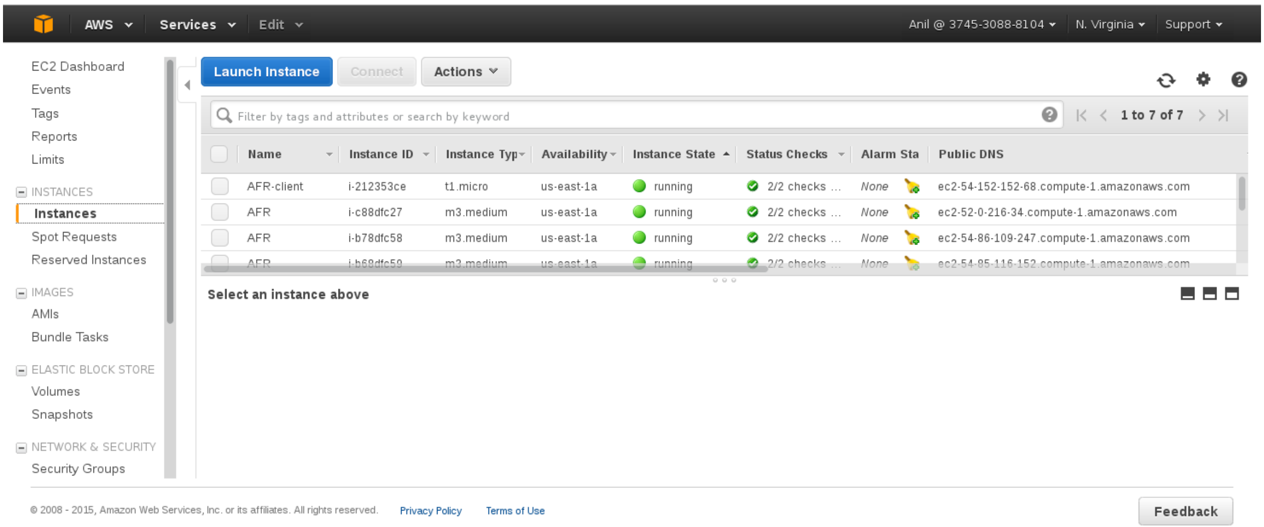
You can verify that Red Hat Gluster Storage instance is running by performing a remote login to the Red Hat Gluster Storage instance and issuing a command.

### To verify that Red Hat Gluster Storage instance is running

1. On the Amazon Web Services home page, click the **Amazon EC2** tab. The **Amazon EC2 Console Dashboard** is displayed.

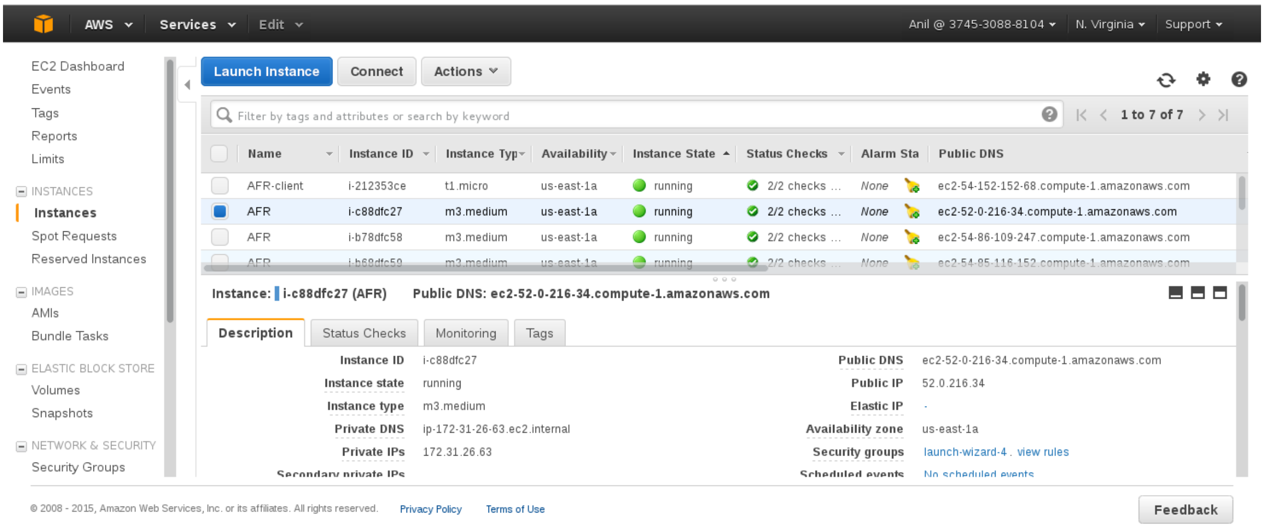



2. Click the **Instances** link from the **Instances** section on the left. The screen displays your current instances.




3. Check the Status column and verify that the instance is running. A yellow circle indicates a status of pending while a green circle indicates that the instance is running.

   Click the instance and verify the details displayed in the **Description** tab.




4. Note the domain name in the **Public DNS** field. You can use this domain to perform a remote login to the instance.

5. Using SSH and the domain from the previous step, login to the Red Hat Amazon Machine Image instance. You must use the key pair that was selected or created when launching the instance.

   Example:

   Enter the following in command line:

```
# ssh -i rhs-aws.pem ec2-user@ec2-23-20-52-123.compute-1.amazonaws.com
# sudo su
```

6. At the command line, enter the following command:

   **`# service glusterd status`**

   Verify that the command indicates that the **`glusterd`** daemon is running on the instance.

## Note

Samba and NFS-Ganesha channels are disabled by default. To use standalone Samba and NFS-Ganesha, perform the following steps to enable the repos and install the relevant packages.

- For enabling the Red Hat Gluster Storage Samba repo, run the following command:

```
yum-config-manager --enable rhui-REGION-rh-gluster-3-samba-for-rhel-6-server-rpms
```

- For enabling the Red Hat Gluster Storage NFS-Ganesha repo, run the following command:

```
yum-config-manager --enable rhui-REGION-rh-gluster-3-nfs-for-rhel-6-server-rpms
```

> **Important**
>
> Before using **`yum update`** to update the Amazon EC2 Red Hat Gluster Storage AMI, follow the steps listed in https://access.redhat.com/solutions/1556793 Knowledgebase article.

## 23.3. Provisioning Storage

Amazon Elastic Block Storage (EBS) is designed specifically for use with Amazon EC2 instances. Amazon EBS provides storage that behaves like a raw, unformatted, external block device.

> **Important**
>
> External snapshots, such as snapshots of a virtual machine/instance, where Red Hat Gluster Storage Server is installed as a guest OS or FC/iSCSI SAN snapshots are not supported.

### 23.3.1. Provisioning Storage for Two-way Replication Volumes

The supported configuration for two-way replication is upto 24 Amazon EBS volumes of equal size, attached as a brick, which enables consistent I/O performance.

Single EBS volumes exhibit inconsistent I/O performance. Hence, other configurations are not supported by Red Hat.

**To Add Amazon Elastic Block Storage Volumes**

1. Login to Amazon Web Services at http://aws.amazon.com and select the **Amazon EC2** tab.

2. In the **Amazon EC2 Dashboard** select the **Elastic Block Store > Volumes** option to add the Amazon Elastic Block Storage Volumes

3. Create a thinly provisioned logical volume using the following steps:

   a. Create a physical volume (PV) by using the **`pvcreate`** command.

      For example:

      ```
      pvcreate --dataalignment 1280K /dev/sdb
      ```

      > **Note**
      >
      > - Here, **`/dev/sdb`** is a storage device. This command has to be executed on all the disks if there are multiple volumes. For example:
      >
      >   ```
      >   # pvcreate --dataalignment 1280K /dev/sdc /dev/sdd
      >   /dev/sde ...
      >   ```
      >
      > - The device name and the alignment value will vary based on the device you are using.

Use the correct **dataalignment** option based on your device. For more information, see Section 13.2, “Brick Configuration”

b. Create a Volume Group (VG) from the PV using the **vgcreate** command:

For example:

```
vgcreate --physicalextentsize 128K rhs_vg /dev/sdb
```

**Note**

Here, **/dev/sdb** is a storage device. This command has to be executed on all the disks if there are multiple volumes. For example:

```
vgcreate --physicalextentsize 128K rhs_vg /dev/sdc /dev/sdd
/dev/sde ...
```

c. Create a thin-pool using the following commands:

a. Create an LV to serve as the metadata device using the following command:

```
lvcreate -L metadev_sz --name metadata_device_name
VOLGROUP
```

For example:

```
lvcreate -L 16776960K --name rhs_pool_meta rhs_vg
```

b. Create an LV to serve as the data device using the following command:

```
lvcreate -L datadev_sz --name thin_pool VOLGROUP
```

For example:

```
lvcreate -L 536870400K --name rhs_pool rhs_vg
```

c. Create a thin pool from the data LV and the metadata LV using the following command:

```
lvconvert --chunksize STRIPE_WIDTH --thinpool
VOLGROUP/thin_pool --poolmetadata
VOLGROUP/metadata_device_name
```

For example:

```
lvconvert --chunksize 1280K --thinpool rhs_vg/rhs_pool --
poolmetadata rhs_vg/rhs_pool_meta
```

> **Note**
>
> By default, the newly provisioned chunks in a thin pool are zeroed to prevent data leaking between different block devices. In the case of Red Hat Gluster Storage, where data is accessed via a file system, this option can be turned off for better performance.
>
> ```
> lvchange --zero n VOLGROUP/thin_pool
> ```
>
> For example:
>
> ```
> lvchange --zero n rhs_vg/rhs_pool
> ```

d. Create a thinly provisioned volume from the previously created pool using the **`lvcreate`** command:

   For example:

   ```
   lvcreate -V 1G -T rhs_vg/rhs_pool -n rhs_lv
   ```

   It is recommended that only one LV should be created in a thin pool.

4. Format the logical volume using the following command:

   ```
   # mkfs.xfs -i size=512 DEVICE
   ```

   For example, to format **`/dev/glustervg/glusterlv`**:

   ```
   # mkfs.xfs -i size=512 /dev/glustervg/glusterlv
   ```

5. Mount the device using the following commands:

   ```
   # mkdir -p /export/glusterlv
   # mount /dev/glustervg/glusterlv /export/glusterlv
   ```

6. Using the following command, add the device to **`/etc/fstab`** so that it mounts automatically when the system reboots:

   ```
   # echo "/dev/glustervg/glusterlv /export/glusterlv xfs defaults 0 2"
   >> /etc/fstab
   ```

After adding the EBS volumes, you can use the mount point as a brick with existing and new volumes. For more information on creating volumes, see Chapter 6, *Red Hat Gluster Storage Volumes*.

### 23.3.2. Provisioning Storage for Three-way Replication Volumes

Red Hat Gluster Storage supports synchronous three-way replication across three availability zones. The supported configuration for three-way replication is upto 24 Amazon EBS volumes of equal size, attached as a brick, which enables consistent I/O performance.

1. Login to Amazon Web Services at http://aws.amazon.com and select the **Amazon EC2** tab.

2. Create three AWS instances in three different availability zones. All the bricks of a replica pair must be from different availability zones. For each replica set, select the instances for the bricks from three different availability zones. A replica pair must not have a brick along with its replica from the same availability zone.

3. Add single EBS volume to each AWS instances

4. Create a thinly provisioned logical volume using the following steps:

   a. Create a physical volume (PV) by using the **`pvcreate`** command.

      For example:

      ```
      pvcreate --dataalignment 1280K /dev/sdb
      ```

      **Note**

      - Here, **`/dev/sdb`** is a storage device. This command has to be executed on all the disks if there are multiple volumes. For example:

        ```
        pvcreate --dataalignment 1280K /dev/sdc /dev/sdd
        /dev/sde ...
        ```

      - The device name and the alignment value will vary based on the device you are using.

      Use the correct **`dataalignment`** option based on your device. For more information, see Section 13.2, “Brick Configuration”

   b. Create a Volume Group (VG) from the PV using the **`vgcreate`** command:

      For example:

      ```
      vgcreate --physicalextentsize 128K rhs_vg /dev/sdb
      ```

      **Note**

      Here, **`/dev/sdb`** is a storage device. This command has to be executed on all the disks if there are multiple volumes. For example:

      ```
      vgcreate --physicalextentsize 128K rhs_vg /dev/sdc /dev/sdd
      /dev/sde ...
      ```

   c. Create a thin-pool using the following commands:

      a. Create an LV to serve as the metadata device using the following command:

```
lvcreate -L metadev_sz --name metadata_device_name
VOLGROUP
```

For example:

```
lvcreate -L 16776960K --name rhs_pool_meta rhs_vg
```

b. Create an LV to serve as the data device using the following command:

```
lvcreate -L datadev_sz --name thin_pool VOLGROUP
```

For example:

```
lvcreate -L 536870400K --name rhs_pool rhs_vg
```

c. Create a thin pool from the data LV and the metadata LV using the following command:

```
lvconvert --chunksize STRIPE_WIDTH --thinpool
VOLGROUP/thin_pool --poolmetadata
VOLGROUP/metadata_device_name
```

For example:

```
lvconvert --chunksize 1280K --thinpool rhs_vg/rhs_pool --
poolmetadata rhs_vg/rhs_pool_meta
```

**Note**

By default, the newly provisioned chunks in a thin pool are zeroed to prevent data leaking between different block devices. In the case of Red Hat Gluster Storage, where data is accessed via a file system, this option can be turned off for better performance.

```
lvchange --zero n VOLGROUP/thin_pool
```

For example:

```
lvchange --zero n rhs_vg/rhs_pool
```

d. Create a thinly provisioned volume from the previously created pool using the **lvcreate** command:

For example:

```
lvcreate -V 1G -T rhs_vg/rhs_pool -n rhs_lv
```

It is recommended that only one LV should be created in a thin pool.

5. Format the logical volume using the following command:

```
# mkfs.xfs -i size=512 DEVICE
```

For example, to format **/dev/glustervg/glusterlv**:

```
# mkfs.xfs -i size=512 /dev/glustervg/glusterlv
```

6. Mount the device using the following commands:

```
# mkdir -p /export/glusterlv
# mount /dev/glustervg/glusterlv /export/glusterlv
```

7. Using the following command, add the device to **/etc/fstab** so that it mounts automatically when the system reboots:

```
# echo "/dev/glustervg/glusterlv /export/glusterlv xfs defaults 0 2"
>> /etc/fstab
```

**Client-side Quorum**

You must ensure to create each replica set of a volume in three difference zones. With this configuration, there will be no impact on the data availability even if two availability zones have hit an outage. However, when you set **client-side quorum** to avoid split-brain scenarios, unavailability of two zones would make the access **read-only**.

For information on creating three-way replicated volumes, see Section 6.7, “Creating Distributed Replicated Volumes”. For more information on configuring client-side quorum, see Section 10.11.1.2, “Configuring Client-Side Quorum”.

## 23.4. Stopping and Restarting Red Hat Gluster Storage Instance

When you stop and restart a Red Hat Gluster Storage instance, Amazon Web Services assigns the instance a new IP address and hostname. This results in the instance losing its association with the virtual hardware, causing disruptions to the trusted storage pool. To prevent errors, add the restarted Red Hat Gluster Storage instance to the trusted storage pool. See Section 5.1, “Adding Servers to the Trusted Storage Pool”.

Rebooting the Red Hat Gluster Storage instance preserves the IP address and hostname and does not lose its association with the virtual hardware. This does not cause any disruptions to the trusted storage pool.

# Chapter 24. Accessing Red Hat Gluster Storage using Microsoft Azure

Red Hat Gluster Storage for Public Cloud enables customers to build a Virtual Machine (VM) image for deployment within Azure. Red Hat Gluster Storage node in Azure is created by attaching Azure data disks to an Azure VM instance. Two or more such nodes make up the trusted storage pool of storage nodes. This trusted storage pool can live along-side the application/clients within an Azure **`cloud service`** or can be located in a separate Azure cloud service connected by a common virtual network (vnet). The Red Hat Gluster Instances exploit Azure's **`availability sets`**, helping to maintain data availability during planned or unplanned outages within the Azure service.

For more information on deploying Red Hat Gluster Storage on Microsoft Azure , see https://access.redhat.com/articles/using-gluster-with-azure.

# Part IV. Data Access with Other Interfaces

# Chapter 25. Managing Object Store

Object Store provides a system for data storage that enables users to access the same data, both as an object and as a file, thus simplifying management and controlling storage costs.

Red Hat Gluster Storage is based on glusterFS, an open source distributed file system. Object Store technology is built upon OpenStack Swift. OpenStack Swift allows users to store and retrieve files and content through a simple Web Service REST (Representational State Transfer) interface as objects. Red Hat Gluster Storage uses glusterFS as a back-end file system for OpenStack Swift. It also leverages on OpenStack Swift's REST interface for storing and retrieving files over the web combined with glusterFS features like scalability and high availability, replication, and elastic volume management for data management at disk level.

Object Store technology enables enterprises to adopt and deploy cloud storage solutions. It allows users to access and modify data as objects from a REST interface along with the ability to access and modify files from NAS interfaces. In addition to decreasing cost and making it faster and easier to access object data, it also delivers massive scalability, high availability and replication of object storage. Infrastructure as a Service (IaaS) providers can utilize Object Store technology to enable their own cloud storage service. Enterprises can use this technology to accelerate the process of preparing file-based applications for the cloud and simplify new application development for cloud computing environments.

OpenStack Swift is an open source software for creating redundant, scalable object storage using clusters of standardized servers to store petabytes of accessible data. It is not a file system or real-time data storage system, but rather a long-term storage system for a more permanent type of static data that can be retrieved, leveraged, and updated.

## 25.1. Architecture Overview

OpenStack Swift and Red Hat Gluster Storage integration consists of:

- OpenStack Object Storage environment.

  For detailed information on Object Storage, see OpenStack Object Storage Administration Guide available at: http://docs.openstack.org/admin-guide-cloud/content/ch_admin-openstack-object-storage.html.

- Red Hat Gluster Storage environment.

  Red Hat Gluster Storage environment consists of bricks that are used to build volumes. For more information on bricks and volumes, see Section 6.4, “Formatting and Mounting Bricks”.

The following diagram illustrates OpenStack Object Storage integration with Red Hat Gluster Storage:

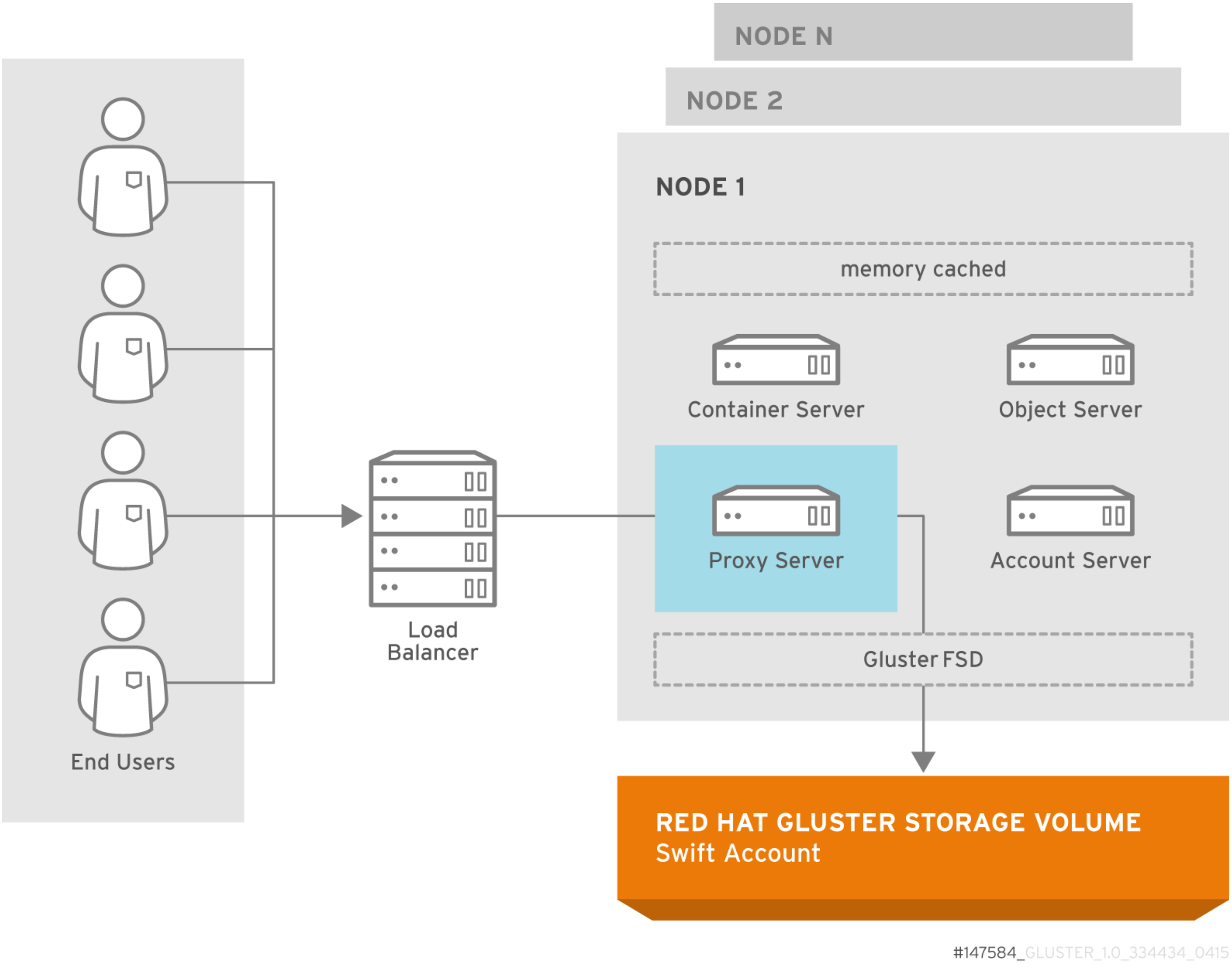



**Figure 25.1. Object Store Architecture**

**Important**

On Red Hat Enterprise Linux 7, enable the Object Store firewall service in the active zones for runtime and permanent mode using the following commands:

To get a list of active zones, run the following command:

```
# firewall-cmd  --get-active-zones
```

To add ports to the active zones, run the following commands:

```
# firewall-cmd  --zone=zone_name  --add-port=6010/tcp  --add-port=6011/tcp --add-port=6012/tcp  --add-port=8080/tcp

# firewall-cmd  --zone=zone_name --add-port=6010/tcp  --add-port=6011/tcp --add-port=6012/tcp  --add-port=8080/tcp   --permanent
```

Add the port number 443 **only** if your swift proxy server is configured with SSL. To add the port number, run the following commands:

```
# firewall-cmd --zone=zone_name --add-port=443/tcp
# firewall-cmd --zone=zone_name --add-port=443/tcp --permanent
```

## 25.2. Components of Object Store

The major components of Object Storage are:

**Proxy Server**

The Proxy Server is responsible for connecting to the rest of the OpenStack Object Storage architecture. For each request, it looks up the location of the account, container, or object in the ring and routes the request accordingly. The public API is also exposed through the proxy server. When objects are streamed to or from an object server, they are streamed directly through the proxy server to or from the user – the proxy server does not spool them.

**The Ring**

The Ring maps swift accounts to the appropriate Red Hat Gluster Storage volume. When other components need to perform any operation on an object, container, or account, they need to interact with the Ring to determine the correct Red Hat Gluster Storage volume.

**Object and Object Server**

An object is the basic storage entity and any optional metadata that represents the data you store. When you upload data, the data is stored as-is (with no compression or encryption).

The Object Server is a very simple storage server that can store, retrieve, and delete objects stored on local devices.

**Container and Container Server**

A container is a storage compartment for your data and provides a way for you to organize your data. Containers can be visualized as directories in a Linux system. However, unlike directories, containers cannot be nested. Data must be stored in a container and hence the objects are created within a container.

The Container Server's primary job is to handle listings of objects. The listing is done by querying the glusterFS mount point with a path. This query returns a list of all files and directories present under that container.

**Accounts and Account Servers**

The OpenStack Swift system is designed to be used by many different storage consumers.

The Account Server is very similar to the Container Server, except that it is responsible for listing containers rather than objects. In Object Store, each Red Hat Gluster Storage volume is an account.

**Authentication and Access Permissions**

Object Store provides an option of using an authentication service to authenticate and authorize user access. Once the authentication service correctly identifies the user, it will provide a token which must be passed to Object Store for all subsequent container and object operations.

Other than using your own authentication services, the following authentication services are supported by Object Store:

- Authenticate Object Store against an external OpenStack Keystone server.

  Each Red Hat Gluster Storage volume is mapped to a single account. Each account can have multiple users with different privileges based on the group and role they are assigned to. After authenticating using *accountname:username* and *password*, user is issued a token which will be used for all subsequent REST requests.

  **Integration with Keystone**

  When you integrate Red Hat Gluster Storage Object Store with Keystone authentication, you must ensure that the Swift account name and Red Hat Gluster Storage volume name are the same. It is common that Red Hat Gluster Storage volumes are created before exposing them through the Red Hat Gluster Storage Object Store.

  When working with Keystone, account names are defined by Keystone as the **`tenant id`**. You must create the Red Hat Gluster Storage volume using the Keystone **`tenant id`** as the name of the volume. This means, you must create the Keystone tenant before creating a Red Hat Gluster Storage Volume.

  > **Important**
  >
  > Red Hat Gluster Storage does not contain any Keystone server components. It only acts as a Keystone client. After you create a volume for Keystone, ensure to export this volume for accessing it using the object storage interface. For more information on exporting volume, see Section 25.6.8, "Exporting the Red Hat Gluster Storage Volumes".

  **Integration with GSwauth**

  GSwauth is a Web Server Gateway Interface (WGSI) middleware that uses a Red Hat Gluster Storage Volume itself as its backing store to maintain its metadata. The benefit in this authentication service is to have the metadata available to all proxy servers and saving the data to a Red Hat Gluster Storage volume.

To protect the metadata, the Red Hat Gluster Storage volume should only be able to be mounted by the systems running the proxy servers. For more information on mounting volumes, see *Chapter 7, Accessing Data - Setting Up Clients*.

### Integration with TempAuth

You can also use the **`TempAuth`** authentication service to test Red Hat Gluster Storage Object Store in the data center.

## 25.3. Advantages of using Object Store

The advantages of using Object Store include:

- Default object size limit of 1 TiB
- Unified view of data across NAS and Object Storage technologies
- High availability
- Scalability
- Replication
- Elastic Volume Management

## 25.4. Limitations

This section lists the limitations of using Red Hat Gluster Storage Object Store:

- Object Name

  Object Store imposes the following constraints on the object name to maintain the compatibility with network file access:

  - Object names must not be prefixed or suffixed by a '/' character. For example, **`a/b/`**
  - Object names must not have contiguous multiple '/' characters. For example, **`a//b`**

- Account Management

  - Object Store does not allow account management even though OpenStack Swift allows the management of accounts. This limitation is because Object Store treats **`accounts`** equivalent to the Red Hat Gluster Storage volumes.
  - Object Store does not support account names (i.e. Red Hat Gluster Storage volume names) having an underscore.
  - In Object Store, every account must map to a Red Hat Gluster Storage volume.

- Subdirectory Listing

  Headers **`X-Content-Type: application/directory`** and **`X-Content-Length: 0`** can be used to create subdirectory objects under a container, but GET request on a subdirectory would not list all the objects under it.

## 25.5. Prerequisites

Ensure that you do the following before using Red Hat Gluster Storage Object Store.

- Ensure that the *openstack-swift-** and *swiftonfile* packages have matching version numbers.

```
# rpm -qa | grep swift
openstack-swift-container-1.13.1-6.el7ost.noarch
openstack-swift-object-1.13.1-6.el7ost.noarch
swiftonfile-1.13.1-6.el7rhgs.noarch
openstack-swift-proxy-1.13.1-6.el7ost.noarch
openstack-swift-doc-1.13.1-6.el7ost.noarch
openstack-swift-1.13.1-6.el7ost.noarch
openstack-swift-account-1.13.1-6.el7ost.noarch
```

- Ensure that SELinux is in permissive mode.

```
# sestatus
SELinux status:                 enabled
SELinuxfs mount:                /sys/fs/selinux
SELinux root directory:         /etc/selinux
Loaded policy name:             targeted
Current mode:                   permissive
Mode from config file:          permissive
Policy MLS status:              enabled
Policy deny_unknown status:     allowed
Max kernel policy version:      28
```

  If the **`Current mode`** and **`Mode from config file`** fields are not set to **`permissive`**, run the following commands to set SELinux into permissive mode persistently, and reboot to ensure that the configuration takes effect.

```
# setenforce 1
# reboot
```

- Ensure that the gluster-swift services are owned by and run as the **`root`** user, not the **`swift`** user as in a typical OpenStack installation.

```
# cd /usr/lib/systemd/system
# sed -i s/User=swift/User=root/ openstack-swift-proxy.service openstack-swift-account.service openstack-swift-container.service openstack-swift-object.service openstack-swift-object-expirer.service
```

- Start the **`memcached`** service:

```
# service memcached start
```

- Ensure that the ports for the Object, Container, Account, and Proxy servers are open. Note that the ports used for these servers are configurable. The ports listed in Table 25.1, “Ports required for Red Hat Gluster Storage Object Store” are the default values.

**Table 25.1. Ports required for Red Hat Gluster Storage Object Store**

| Server | Port |
| --- | --- |
| Object Server | 6010 |

| Server | Port |
|---|---|
| Container Server | 6011 |
| Account Server | 6012 |
| Proxy Server (HTTPS) | 443 |
| Proxy Server (HTTP) | 8080 |

- Create and mount a Red Hat Gluster Storage volume for use as a Swift Account. For information on creating Red Hat Gluster Storage volumes, see Chapter 6, *Red Hat Gluster Storage Volumes* . For information on mounting Red Hat Gluster Storage volumes, see Chapter 7, *Accessing Data - Setting Up Clients* .

## 25.6. Configuring the Object Store

This section provides instructions on how to configure Object Store in your storage environment.

**Warning**

When you install Red Hat Gluster Storage 3.1, the **/etc/swift** directory would contain both ***.conf** extension and ***.conf-gluster** files. You must delete the ***.conf** files and create new configuration files based on ***.conf-gluster** template. Otherwise, inappropriate python packages will be loaded and the component may not work as expected.

If you are upgrading to Red Hat Gluster Storage 3.1, the older configuration files will be retained and new configuration files will be created with **.rpmnew** extension. You must ensure to delete **.conf** files and folders (account-server, container-server, and object-server) for better understanding of the loaded configuration.

### 25.6.1. Configuring a Proxy Server

Create a new configuration file **/etc/swift/proxy-server.conf** by referencing the template file available at **/etc/swift/proxy-server.conf-gluster**.

#### 25.6.1.1. Configuring a Proxy Server for HTTPS

By default, proxy server only handles HTTP requests. To configure the proxy server to process HTTPS requests, perform the following steps:

1. Create self-signed cert for SSL using the following commands:

```
# cd /etc/swift
# openssl req -new -x509 -nodes -out cert.crt -keyout cert.key
```

2. Add the following lines to **/etc/swift/proxy-server.conf** under *[DEFAULT]*

```
bind_port = 443
 cert_file = /etc/swift/cert.crt
 key_file = /etc/swift/cert.key
```

**Important**

When Object Storage is deployed on two or more machines, not all nodes in your trusted storage pool are used. Installing a load balancer enables you to utilize all the nodes in your trusted storage pool by distributing the proxy server requests equally to all storage nodes.

Memcached allows nodes' states to be shared across multiple proxy servers. Edit the **memcache_servers** configuration option in the **proxy-server.conf** and list all memcached servers.

Following is an example listing the memcached servers in the **proxy-server.conf** file.

```
[filter:cache]
use = egg:swift#memcache
memcache_servers =
192.168.1.20:11211,192.168.1.21:11211,192.168.1.22:11211
```

The port number on which the memcached server is listening is 11211. You must ensure to use the same sequence for all configuration files.

### 25.6.2. Configuring the Authentication Service

This section provides information on configuring **Keystone, GSwauth,** and **TempAuth** authentication services.

#### 25.6.2.1. Integrating with the Keystone Authentication Service

- To configure Keystone, add **authtoken** and **keystoneauth** to **/etc/swift/proxy-server.conf** pipeline as shown below:

```
[pipeline:main]
pipeline = catch_errors healthcheck proxy-logging cache authtoken
keystoneauth proxy-logging proxy-server
```

- Add the following sections to **/etc/swift/proxy-server.conf** file by referencing the example below as a guideline. You must substitute the values according to your setup:

```
[filter:authtoken]
paste.filter_factory = keystoneclient.middleware.auth_token:filter_factory
signing_dir = /etc/swift
auth_host = keystone.server.com
auth_port = 35357
auth_protocol = http
auth_uri = http://keystone.server.com:5000
# if its defined
admin_tenant_name = services
admin_user = swift
admin_password = adminpassword
delay_auth_decision = 1

[filter:keystoneauth]
```

```
use = egg:swift#keystoneauth
operator_roles = admin, SwiftOperator
is_admin = true
cache = swift.cache
```

### Verify the Integrated Setup

Verify that the Red Hat Gluster Storage Object Store has been configured successfully by running the following command:

```
$ swift -V 2 -A http://keystone.server.com:5000/v2.0 -U tenant_name:user -K
password stat
```

## 25.6.2.2. Integrating with the GSwauth Authentication Service

### Integrating GSwauth

Perform the following steps to integrate GSwauth:

1. Create and start a Red Hat Gluster Storage volume to store metadata.

   ```
   # gluster volume create NEW-VOLNAME NEW-BRICK
   # gluster volume start NEW-VOLNAME
   ```

   For example:

   ```
   # gluster volume create gsmetadata server1:/exp1
   # gluster volume start gsmetadata
   ```

2. Run **gluster-swift-gen-builders** tool with all the volumes to be accessed using the Swift client including **gsmetadata** volume:

   ```
   # gluster-swift-gen-builders gsmetadata other volumes
   ```

3. Edit the **/etc/swift/proxy-server.conf** pipeline as shown below:

   ```
   [pipeline:main]
   pipeline = catch_errors cache gswauth proxy-server
   ```

4. Add the following section to **/etc/swift/proxy-server.conf** file by referencing the example below as a guideline. You must substitute the values according to your setup.

   ```
   [filter:gswauth]
   use = egg:gluster_swift#gswauth
   set log_name = gswauth
   super_admin_key = gswauthkey
   metadata_volume = gsmetadata
   auth_type = sha1
   auth_type_salt = swauthsalt
   ```

> **Important**
>
> You must ensure to secure the **`proxy-server.conf`** file and the **`super_admin_key`** option to prevent unprivileged access.

5. Restart the proxy server by running the following command:

```
# swift-init proxy restart
```

### Advanced Options:

You can set the following advanced options for GSwauth WSGI filter:

- default-swift-cluster: The default storage-URL for the newly created accounts. When you attempt to authenticate for the first time, the access token and the storage-URL where data for the given account is stored will be returned.
- token_life: The set default token life. The default value is 86400 (24 hours).
- max_token_life: The maximum token life. You can set a token lifetime when requesting a new token with header **`x-auth-token-lifetime`**. If the passed in value is greater than the **`max_token_life`**, then the **`max_token_life`** value will be used.

### GSwauth Common Options of CLI Tools

GSwauth provides CLI tools to facilitate managing accounts and users. All tools have some options in common:

- -A, --admin-url: The URL to the auth. The default URL is **`http://127.0.0.1:8080/auth/`**.
- -U, --admin-user: The user with administrator rights to perform action. The default user role is **`.super_admin`**.
- -K, --admin-key: The key for the user with administrator rights to perform the action. There is no default value.

### Preparing Red Hat Gluster Storage Volumes to Save Metadata

Prepare the Red Hat Gluster Storage volume for **`gswauth`** to save its metadata by running the following command:

```
# gswauth-prep [option]
```

For example:

```
# gswauth-prep -A http://10.20.30.40:8080/auth/ -K gswauthkey
```

### 25.6.2.2.1. Managing Account Services in GSwauth

### Creating Accounts

Create an account for GSwauth. This account is mapped to a Red Hat Gluster Storage volume.

```
# gswauth-add-account [option] <account_name>
```

For example:

```
# gswauth-add-account -K gswauthkey <account_name>
```

### Deleting an Account

You must ensure that all users pertaining to this account must be deleted before deleting the account. To delete an account:

```
# gswauth-delete-account [option] <account_name>
```

For example:

```
# gswauth-delete-account -K gswauthkey test
```

### Setting the Account Service

Sets a service URL for an account. User with **`reseller admin`** role only can set the service URL. This command can be used to change the default storage URL for a given account. All accounts will have the same storage-URL as default value, which is set using **`default-swift-cluster`** option.

```
# gswauth-set-account-service [options] <account> <service> <name> <value>
```

For example:

```
# gswauth-set-account-service -K gswauthkey test storage local
http://newhost:8080/v1/AUTH_test
```

## 25.6.2.2.2. Managing User Services in GSwauth

### User Roles

The following user roles are supported in GSwauth:

- A regular user has no rights. Users must be given both read and write privileges using Swift ACLs.
- The **`admin`** user is a super-user at the account level. This user can create and delete users for that account. These members will have both write and read privileges to all stored objects in that account.
- The **`reseller admin`** user is a super-user at the cluster level. This user can create and delete accounts and users and has read and write privileges to all accounts under that cluster.
- GSwauth maintains its own swift account to store all of its metadata on accounts and users. The **`.super_admin`** role provides access to GSwauth own swift account and has all privileges to act on any other account or user.

### User Access Matrix

The following table provides user access right information.

**Table 25.2. User Access Matrix**

| Role/Group | get list of accounts | get Acccount Details | Create Account | Delete Account | Get User Details | Create admin user | Create reseller_admin user | Create regular user | Delete admin user |
|---|---|---|---|---|---|---|---|---|---|
| .super_admin (username) | X | X | X | X | X | X | X | X | X |
| .reseller_admin (group) | X | X | X | X | X | X | | X | X |
| .admin (group) | | X | | | X | X | | X | X |
| regular user (type) | | | | | | | | | |

### Creating Users

You can create an user for an account that does not exist. The account will be created before creating the user.

You must add **`-r`** flag to create a **`reseller admin`** user and **`-a`** flag to create an **`admin`** user. To change the password or role of the user, you can run the same command with the new option.

```
# gswauth-add-user [option] <account_name> <user> <password>
```

For example

```
# gswauth-add-user -K gswauthkey -a test ana anapwd
```

### Deleting a User

Delete a user by running the following command:

```
gswauth-delete-user [option] <account_name> <user>
```

For example

```
gwauth-delete-user -K gswauthkey test ana
```

### Authenticating a User with the Swift Client

There are two methods to access data using the Swift client. The first and simple method is by providing the user name and password everytime. The swift client will acquire the token from gswauth.

For example:

```
$ swift -A http://127.0.0.1:8080/auth/v1.0 -U test:ana -K anapwd upload
container1 README.md
```

The second method is a two-step process, first you must authenticate with a username and password to obtain a token and the storage URL. Then, you can make the object requests to the storage URL with the given token.

It is important to remember that tokens expires, so the authentication process needs to be repeated very often.

Authenticate a user with the cURL command:

```
curl -v -H 'X-Storage-User: test:ana' -H 'X-Storage-Pass: anapwd' -k
http://localhost:8080/auth/v1.0
...
< X-Auth-Token: AUTH_tk7e68ef4698f14c7f95af07ab7b298610
< X-Storage-Url: http://127.0.0.1:8080/v1/AUTH_test
...
```

Now, you use the given token and storage URL to access the object-storage using the Swift client:

```
$ swift --os-auth-token=AUTH_tk7e68ef4698f14c7f95af07ab7b298610 --os-
storage-url=http://127.0.0.1:8080/v1/AUTH_test upload container1 README.md
README.md
bash-4.2$
bash-4.2$ swift --os-auth-token=AUTH_tk7e68ef4698f14c7f95af07ab7b298610 --
os-storage-url=http://127.0.0.1:8080/v1/AUTH_test list container1
README.md
```

**Important**

**`Reseller admins`** must always use the second method to acquire a token to get access to other accounts other than his own. The first method of using the username and password will give them access only to their own accounts.

#### 25.6.2.2.3. Managing Accounts and Users Information

##### Obtaining Accounts and User Information

You can obtain the accounts and users information including stored password.

```
# gswauth-list [options] [account] [user]
```

For example:

```
# gswauth-list -K gswauthkey test ana
+----------+
|  Groups  |
+----------+
| test:ana |
|   test   |
|  .admin  |
+----------+
```

- If [account] and [user] are omitted, all the accounts will be listed.

- If [account] is included but not [user], a list of users within that account will be listed.
- If [account] and [user] are included, a list of groups that the user belongs to will be listed.
- If the [user] is *.groups*, the active groups for that account will be listed.

The default output format is in tabular format. Adding **`-p`** option provides the output in plain text format, **`-j`** provides the output in JSON format.

### Changing User Password

You can change the password of the user, account administrator, and reseller_admin roles.

- Change the password of a regular user by running the following command:

```
# gswauth-add-user -U account1:user1 -K old_passwd account1 user1
new_passwd
```

- Change the password of an **`account administrator`** by running the following command:

```
# gswauth-add-user -U account1:admin -K old_passwd -a account1 admin
new_passwd
```

- Change the password of the **`reseller_admin`** by running the following command:

```
# gswauth-add-user -U account1:radmin -K old_passwd -r account1 radmin
new_passwd
```

### Cleaning Up Expired Tokens

Users with **`.super_admin`** role can delete the expired tokens.

You also have the option to provide the expected life of tokens, delete all tokens or delete all tokens for a given account.

```
# gswauth-cleanup-tokens [options]
```

For example

```
# gswauth-cleanup-tokens -K gswauthkey --purge test
```

The tokens will be deleted on the disk but it would still persist in memcached.

You can add the following options while cleaning up the tokens:

- -t, --token-life: The expected life of tokens. The token objects modified before the give number of seconds will be checked for expiration (default: 86400).
- --purge: Purges all the tokens for a given account whether the tokens have expired or not.
- --purge-all: Purges all the tokens for all the accounts and users whether the tokens have expired or not.

## 25.6.2.3. Integrating with the TempAuth Authentication Service

**Warning**

TempAuth authentication service must only be used in test deployments and not for production.

TempAuth is automatically installed when you install Red Hat Gluster Storage. TempAuth stores user and password information as **cleartext** in a single **proxy-server.conf** file. In your **/etc/swift/proxy-server.conf** file, enable TempAuth in pipeline and add user information in **TempAuth** section by referencing the below example.

```
[pipeline:main]
pipeline = catch_errors healthcheck proxy-logging cache tempauth proxy-
logging proxy-server

[filter:tempauth]
use = egg:swift#tempauth
user_admin_admin = admin.admin.reseller_admin
user_test_tester = testing .admin
user_test_tester2 = testing2
```

You can add users to the account in the following format:

```
user_accountname_username = password [.admin]
```

Here the **accountname** is the Red Hat Gluster Storage volume used to store objects.

You must restart the Object Store services for the configuration changes to take effect. For information on restarting the services, see Section 25.6.9, “Starting and Stopping Server”.

### 25.6.3. Configuring Object Servers

Create a new configuration file **/etc/swift/object.server.conf** by referencing the template file available at **/etc/swift/object-server.conf-gluster**.

### 25.6.4. Configuring Container Servers

Create a new configuration file **/etc/swift/container-server.conf** by referencing the template file available at **/etc/swift/container-server.conf-gluster**.

### 25.6.5. Configuring Account Servers

Create a new configuration file **/etc/swift/account-server.conf** by referencing the template file available at **/etc/swift/account-server.conf-gluster**.

### 25.6.6. Configuring Swift Object and Container Constraints

Create a new configuration file **/etc/swift/swift.conf** by referencing the template file available at **/etc/swift/swift.conf-gluster**.

### 25.6.7. Configuring Object Expiration

The Object Expiration feature allows you to schedule automatic deletion of objects that are stored in the Red

Hat Gluster Storage volume. You can use the object expiration feature to specify a lifetime for specific objects in the volume; when the lifetime of an object expires, the object store would automatically quit serving that object and would shortly thereafter remove the object from the Red Hat Gluster Storage volume. For example, you might upload logs periodically to the volume, and you might need to retain those logs for only a specific amount of time.

The client uses the X-Delete-At or X-Delete-After headers during an object PUT or POST and the Red Hat Gluster Storage volume would automatically quit serving that object.

**Note**

Expired objects appear in container listings until they are deleted by the **`object-expirer`** daemon. This is an expected behavior.

A DELETE object request on an expired object would delete the object from Red Hat Gluster Storage volume (if it is yet to be deleted by the object expirer daemon). However, the client would get a 404 (Not Found) status in return. This is also an expected behavior.

### 25.6.7.1. Setting Up Object Expiration

Object expirer uses a separate account (a Red Hat Gluster Storage volume) named **`gsexpiring`** for managing object expiration. Hence, you must create a Red Hat Gluster Storage volume and name it as **`gsexpiring`**.

Create a new configuration file **`/etc/swift/object.expirer.conf`** by referencing the template file available at **`/etc/swift/object-expirer.conf-gluster`**.

### 25.6.7.2. Using Object Expiration

When you use the X-Delete-At or X-Delete-After headers during an object PUT or POST, the object is scheduled for deletion. The Red Hat Gluster Storage volume would automatically quit serving that object at the specified time and will shortly thereafter remove the object from the Red Hat Gluster Storage volume.

Use PUT operation while uploading a new object. To assign expiration headers to existing objects, use the POST operation.

#### X-Delete-At header

The X-Delete-At header requires a UNIX epoch timestamp, in integer form. For example, 1418884120 represents Thu, 18 Dec 2014 06:27:31 GMT. By setting the header to a specific epoch time, you indicate when you want the object to expire, not be served, and be deleted completely from the Red Hat Gluster Storage volume. The current time in Epoch notation can be found by running this command:

```
$ date +%s
```

- Set the object expiry time during an object PUT with X-Delete-At header using cURL:

  ```
  curl -v -X PUT -H 'X-Delete-At: 1392013619'
  http://127.0.0.1:8080/v1/AUTH_test/container1/object1 -T ./localfile
  ```

  Set the object expiry time during an object PUT with X-Delete-At header using swift client:

```
swift --os-auth-token=AUTH_tk99a39aecc3dd4f80b2b1e801d00df846 --os-
storage-url=http://127.0.0.1:8080/v1/AUTH_test upload container1
./localfile --header 'X-Delete-At: 1392013619'
```

#### X-Delete-After

The X-Delete-After header takes an integer number of seconds that represents the amount of time from now when you want the object to be deleted.

- Set the object expiry time with an object PUT with X-Delete-After header using cURL:

  ```
  curl -v -X PUT -H 'X-Delete-After: 3600'
  http://127.0.0.1:8080/v1/AUTH_test/container1/object1 -T ./localfile
  ```

  Set the object expiry time with an object PUT with X-Delete-At header using swift client:

  ```
  swift --os-auth-token=AUTH_tk99a39aecc3dd4f80b2b1e801d00df846 --os-
  storage-url=http://127.0.0.1:8080/v1/AUTH_test upload container1
  ./localfile --header 'X-Delete-After: 3600'
  ```

### 25.6.7.3. Running Object Expirer Service

The object-expirer service runs once in every 300 seconds, by default. You can modify the duration by configuring **`interval`** option in **`/etc/swift/object-expirer.conf`** file. For every pass it makes, it queries the gsexpiring account for **tracker objects**. Based on the timestamp and path present in the name of **tracker objects**, object-expirer deletes the actual object and the corresponding tracker object.

To start the object-expirer service:

```
# swift-init object-expirer start
```

To run the object-expirer once:

```
# swift-object-expirer -o -v /etc/swift/object-expirer.conf
```

## 25.6.8. Exporting the Red Hat Gluster Storage Volumes

After creating configuration files, you must now add configuration details for the system to identify the Red Hat Gluster Storage volumes to be accessible as Object Store. These configuration details are added to the ring files. The ring files provide the list of Red Hat Gluster Storage volumes to be accessible using the object storage interface to the **`Swift on File`** component.

Create the ring files for the current configurations by running the following command:

```
# cd /etc/swift
# gluster-swift-gen-builders VOLUME [VOLUME...]
```

For example,

```
# cd /etc/swift
# gluster-swift-gen-builders testvol1 testvol2 testvol3
```

Here *testvol1, testvol2, and testvol3* are the Red Hat Gluster Storage volumes which will be mounted locally under the directory mentioned in the object, container, and account configuration files (default value is **/mnt/gluster-object**). The default value can be changed to a different path by changing the **devices** configurable option across all account, container, and object configuration files. The path must contain Red Hat Gluster Storage volumes mounted under directories having the same names as volume names. For example, if **devices** option is set to **/home**, it is expected that the volume named **testvol1** be mounted at **/home/testvol1**.

Note that all the volumes required to be accessed using the Swift interface must be passed to the **gluster-swift-gen-builders** tool even if it was previously added. The **gluster-swift-gen-builders** tool creates new ring files every time it runs successfully.

To remove a *VOLUME*, run **gluster-swift-gen-builders** only with the volumes which are required to be accessed using the Swift interface.

For example, to remove the **testvol2** volume, run the following command:

```
# gluster-swift-gen-builders testvol1 testvol3
```

You must restart the Object Store services after creating the new ring files.

### 25.6.9. Starting and Stopping Server

You must start or restart the server manually whenever you update or modify the configuration files. These processes must be owned and run by the root user.

- To start the server, run the following command:

  ```
  # swift-init main start
  ```

- To stop the server, run the following command:

  ```
  # swift-init main stop
  ```

- To restart the server, run the following command:

  ```
  # swift-init main restart
  ```

## 25.7. Starting the Services Automatically

To configure the gluster-swift services to start automatically when the system boots, run the following commands:

On Red Hat Enterprise Linux 6:

```
# chkconfig memcached on
# chkconfig openstack-swift-proxy on
# chkconfig openstack-swift-account on
# chkconfig openstack-swift-container on
# chkconfig openstack-swift-object on
# chkconfig openstack-swift-object-expirer on
```

On Red Hat Enterprise Linux 7:

```
# systemctl enable openstack-swift-proxy.service
# systemctl enable openstack-swift-account.service
# systemctl enable openstack-swift-container.service
# systemctl enable openstack-swift-object.service
# systemctl enable openstack-swift-object-expirer.service
# systemctl enable openstack-swift-object-expirer.service
```

Configuring the gluster-swift services to start at boot time by using the **systemctl** command may require additional configuration. Refer to https://access.redhat.com/solutions/2043773 for details if you encounter problems.

> **Important**
>
> You must restart all Object Store services servers whenever you change the configuration and ring files.

## 25.8. Working with the Object Store

For more information on Swift operations, see OpenStack Object Storage API Reference Guide available at http://docs.openstack.org/api/openstack-object-storage/1.0/content/ .

### 25.8.1. Creating Containers and Objects

Creating container and objects in Red Hat Gluster Storage Object Store is very similar to OpenStack swift. For more information on Swift operations, see OpenStack Object Storage API Reference Guide available at http://docs.openstack.org/api/openstack-object-storage/1.0/content/.

### 25.8.2. Creating Subdirectory under Containers

You can create a subdirectory object under a container using the headers **Content-Type: application/directory** and **Content-Length: 0**. However, the current behavior of Object Store returns **200 OK** on a **GET** request on subdirectory but this does not list all the objects under that subdirectory.

### 25.8.3. Working with Swift ACLs

Swift ACLs work with users and accounts. ACLs are set at the container level and support lists for read and write access. For more information on Swift ACLs, see http://docs.openstack.org/user-guide/content/managing-openstack-object-storage-with-swift-cli.html.

# Chapter 26. Administering the Hortonworks Data Platform on Red Hat Gluster Storage

**Warning**

Support for Hortonworks Data Platform (HDP) on Red Hat Gluster Storage integrated using the Hadoop Plug-In is deprecated as of Red Hat Gluster Storage 3.1 Update 2, and is unlikely to be supported in the next major release. Red Hat discourages further use of this plug-in for deployments where Red Hat Gluster Storage is directly used for holding analytics data for running in-place analytics. However, Red Hat Gluster Storage can be used as a general purpose repository for holding analytics data and as a companion store where the bulk of the data is stored and then moved to Hadoop clusters for analysis when necessary.

Red Hat Gluster Storage provides filesystem compatibility for Apache Hadoop and uses the standard file system APIs available in Hadoop to provide a new storage option for Hadoop deployments. Existing Hadoop Ecosystem applications can use Red Hat Gluster Storage seamlessly.

**Important**

The following features of Red Hat Gluster Storage is not supported with Hadoop:

- Dispersed Volumes and Distributed Dispersed Volume
- Red Hat Enterprise Linux 7

### Advantages

The following are the advantages of Hadoop Compatible Storage with Red Hat Gluster Storage:

- Provides file-based access to Red Hat Gluster Storage volumes by Hadoop while simultaneously supporting POSIX features for the volumes such as NFS Mounts, Fuse Mounts, Snapshotting and Geo-Replication.
- Eliminates the need for a centralized metadata server (HDFS Primary and Redundant Namenodes) by replacing HDFS with Red Hat Gluster Storage.
- Provides compatibility with MapReduce and Hadoop Ecosystem applications with no code rewrite required.
- Provides a fault tolerant file system.
- Allows co-location of compute and data and the ability to run Hadoop jobs across multiple namespaces using multiple Red Hat Gluster Storage volumes.

## 26.1. Deployment Scenarios

You must ensure to meet the prerequisites by establishing the basic infrastructure required to enable Hadoop Distributions to run on Red Hat Gluster Storage. For information on prerequisites and installation procedure, see *Deploying the Hortonworks Data Platform on Red Hat Gluster Storage* chapter in *Red Hat Gluster Storage 3.1 Installation Guide*.

The supported volume configuration for Hadoop is Distributed Replicated volume with replica count 2 or 3.

The following table provides the overview of the components of the integrated environment.

**Table 26.1. Component Overview**

| Component Overview | Component Description |
| --- | --- |
| Ambari | Management Console for the Hortonworks Data Platform |
| Red Hat Gluster Storage Console | (Optional) Management Console for Red Hat Gluster Storage |
| YARN Resource Manager | Scheduler for the YARN Cluster |
| YARN Node Manager | Worker for the YARN Cluster on a specific server |
| Job History Server | This logs the history of submitted YARN Jobs |
| glusterd | This is the Red Hat Gluster Storage process on a given server |

### 26.1.1. Red Hat Gluster Storage Trusted Storage Pool with Two Additional Servers

The recommended approach to deploy the Hortonworks Data Platform on Red Hat Gluster Storage is to add two additional servers to your trusted storage pool. One server acts as the Management Server hosting the management components such as Hortonworks Ambari and Red Hat Gluster Storage Console (optional). The other server acts as the YARN Master Server and hosts the YARN Resource Manager and Job History Server components. This design ensures that the YARN Master processes do not compete for resources with the YARN NodeManager processes. Furthermore, it also allows the Management server to be multi-homed on both the Hadoop Network and User Network, which is useful to provide users with limited visibility into the cluster.

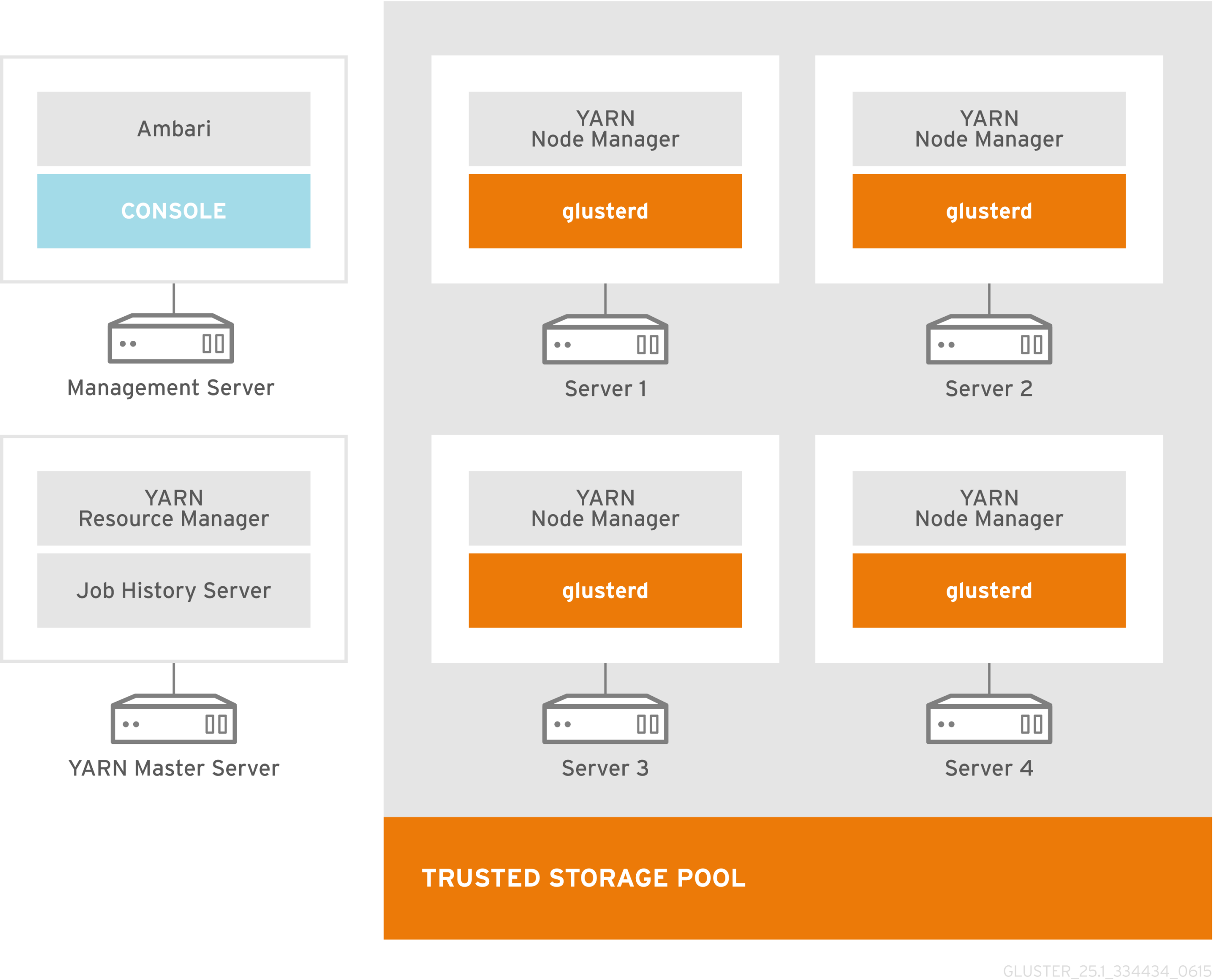



**Figure 26.1. Recommended Deployment Topology for Large Clusters**

## 26.1.2. Red Hat Gluster Storage Trusted Storage Pool with One Additional Server

If two servers are not available, you can install the YARN Master Server and the Management Server on a single server. This is also an option if you have a server with abundant CPU and Memory available. It is recommended that the utilization is carefully monitored on the server to ensure that sufficient resources are available to all the processes. If resources are being over-utilized, it is recommended that you move to the deployment topology for a large cluster as explained in the previous section. Ambari supports the ability to relocate the YARN Resource Manager to another server after it is deployed. It is also possible to move Ambari to another server after it is installed.

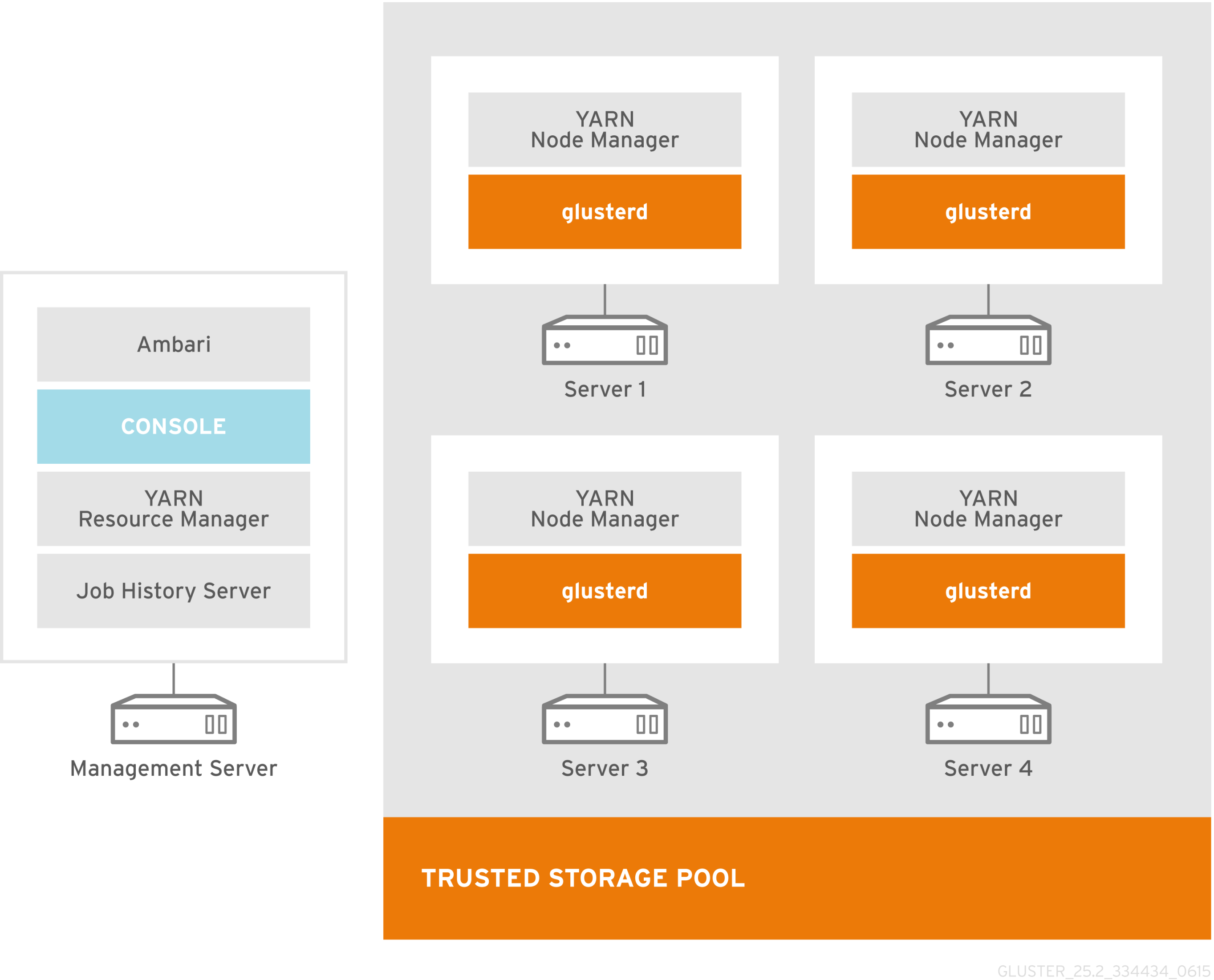



**Figure 26.2. Recommended Deployment Topology for Smaller Clusters**

## 26.1.3. Red Hat Gluster Storage Trusted Storage Pool only

If no additional servers are available, one can condense the processes on the YARN Master Server and the Management Server on a server within the trusted storage pool. This option is recommended only in a evaluation environment with workloads that do not utilize the servers heavily. It is recommended that the utilization is carefully monitored on the server to ensure that sufficient resources are available for all the processes. If the resources start are over-utilized, it is recommended that you move to the deployment topology detailed in Section 26.1.1, “Red Hat Gluster Storage Trusted Storage Pool with Two Additional Servers”. Ambari supports the ability to relocate the YARN Resource Manager to another server after it is deployed. It is also possible to move Ambari to another server after it is installed.

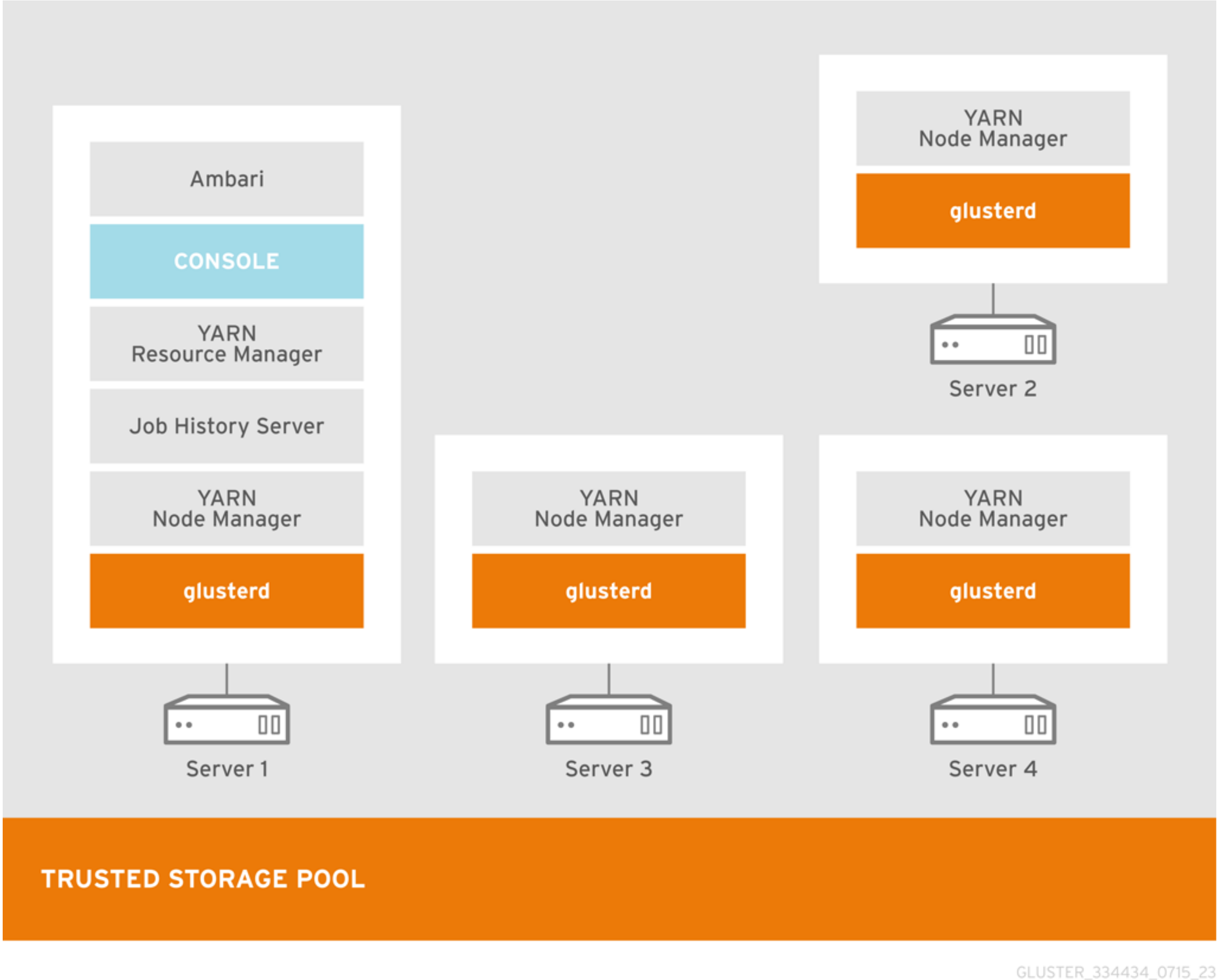



**Figure 26.3. Evaluation deployment topology using the minimum amount of servers**

### 26.1.4. Deploying Hadoop on an existing Red Hat Gluster Storage Trusted Storage Pool

If you have an existing Red Hat Gluster Storage Trusted Storage Pool then you need to procure two additional servers for the YARN Master and Ambari Management Server as depicted in the deployment topology detailed in Section 26.1.1, “Red Hat Gluster Storage Trusted Storage Pool with Two Additional Servers”. If you have no existing volumes within the trusted storage pool you need to follow the instructions in the installation guide to create and enable those volumes for Hadoop. If you have existing volumes you need to follow the instructions to enable them for Hadoop.

The supported volume configuration for Hadoop is Distributed Replicated volume with replica count 2 or 3.

### 26.1.5. Deploying Hadoop on a New Red Hat Gluster Storage Trusted Storage Pool

If you do not have an existing Red Hat Gluster Storage Trusted Storage Pool, you must procure all the servers listed in the deployment topology detailed in Section 26.1.1, “Red Hat Gluster Storage Trusted Storage Pool with Two Additional Servers”. You must then follow the installation instructions listed in the *Red Hat Gluster Storage 3.1 Installation Guide* so that the **`setup_cluster.sh`** script can build the storage pool for you. The rest of the installation instructions will articulate how to create and enable volumes for use with Hadoop.

The supported volume configuration for Hadoop is Distributed Replicated volume with replica count 2 or 3.

## 26.2. Administration of HDP Services with Ambari on Red Hat Gluster Storage

Hadoop is a large scale distributed data storage and processing infrastructure using clusters of commodity hosts networked together. Monitoring and managing such complex distributed systems is a tough task. To help you deal with the complexity, Apache Ambari collects a wide range of information from the cluster's nodes and services and presents them to you in an easy-to-read format. It uses a centralized web interface called the Ambari Web. Ambari Web displays information such as service-specific summaries, graphs, and alerts. It also allows you to perform basic management tasks such as starting and stopping services, adding hosts to your cluster, and updating service configurations.

For more information on Administering Hadoop using Apache Ambari, see *Administering Hadoop 2 with Ambari Web* guide on *Hortonworks Data Platform* website.

## 26.3. Managing Users of the System

By default, Ambari uses an internal database as the user store for authentication and authorization. To add LDAP or Active Directory (AD) or Kerberos external authentication in addition for Ambari Web, you must collect the required information and run a special setup command. Ambari Server must not be running when you execute this command.

For information on setting up LDAP or Active Directory authentication, see section *1. Optional: Set Up LDAP or Active Directory Authentication* of chapter *2. Advanced Security Options for Ambari* in *Ambari Security Guide* on *Hortonworks Data Platform* website.

For information on Setting Up Kerberos authentication, see chapter *1. Configuring Kerberos Authentication* in *Ambari Security Guide* on *Hortonworks Data Platform* website.

For information on adding and removing users from Hadoop group, see section *7.3. Adding and Removing Users* in *Red Hat Gluster Storage 3.1 Installation Guide*.

## 26.4. Running Hadoop Jobs Across Multiple Red Hat Gluster Storage Volumes

If you are already running Hadoop Jobs on a volume and wish to enable Hadoop on existing additional Red Hat Gluster Storage Volumes, then you must follow the steps in the *Enabling Existing Volumes for use with Hadoop* section in *Deploying the Hortonworks Data Platform on Red Hat Gluster Storage* chapter, in the *Red Hat Gluster Storage 3.1 Installation Guide* . If you do not have an additional volume and wish to add one, then you must first complete the procedures mentioned in the *Creating volumes for use with Hadoop* section and then the procedures mentioned in *Enabling Existing Volumes for use with Hadoop* section. This will configure the additional volume for use with Hadoop.

### Specifying volume specific paths when running Hadoop Jobs

When you specify paths in a Hadoop Job, the full URI of the path is required. For example, if you have a volume named **`VolumeOne`** and that must pass in a file called **`myinput.txt`** in a directory named **`input`**, then you would specify it as **`glusterfs://VolumeOne/input/myinput.txt`**, the same formatting goes for the output. The example below shows data read from a path on VolumeOne and written to a path on VolumeTwo.

```
# bin/hadoop jar /opt/HadoopJobs.jar ProcessLogs
glusterfs://VolumeOne/input/myinput.txt glusterfs://VolumeTwo/output/
```

> **Note**
>
> The very first Red Hat Gluster Storage volume that is configured for using with Hadoop is the Default Volume. This is usually the volume name you specified when you went through the Installation Guide. The Default Volume is the only volume that does not require a full URI to be specified and is allowed to use a relative path. Thus, assuming your default volume is called HadoopVol, both **`glusterfs://HadoopVol/input/myinput.txt`** and **`/input/myinput.txt`** are processed the same when providing input to a Hadoop Job or using the Hadoop CLI.

## 26.5. Scaling Up and Scaling Down

The supported volume configuration for Hadoop is Distributed Replicated volume with replica count 2 or 3. Hence, you must add or remove servers from the trusted storage pool in multiples of replica count. Red Hat recommends you to not have more than one brick that belongs to the same volume, on the same server. Adding additional servers to a Red Hat Gluster Storage volume increases both the storage and the compute capacity for that trusted storage pool as the bricks on those servers add to the storage capacity of the volume, and the CPUs increase the amount of Hadoop Tasks that the Hadoop Cluster on the volume can run.

### 26.5.1. Scaling Up

The following is the procedure to add 2 new servers to an existing Hadoop on Red Hat Gluster Storage trusted storage pool.

1. Ensure that the new servers meet all the prerequisites and have the appropriate channels and components installed. For information on prerequisites, see section *Prerequisites* in the chapter *Deploying the Hortonworks Data Platform on Red Hat Gluster Storage* of *Red Hat Gluster Storage 3.1 Installation Guide*. For information on adding servers to the trusted storage pool, see *Chapter 5, Trusted Storage Pools*

2. In the Ambari Console, click **`Stop All`** in the **`Services`** navigation panel. You must wait until all the services are completely stopped.

3. Open the terminal window of the server designated to be the Ambari Management Server and navigate to the **`/usr/share/rhs-hadoop-install/`** directory.

4. Run the following command by replacing the *examples* with the necessary values. This command below assumes the LVM partitions on the server are **`/dev/vg1/lv1`** and you wish them to be mounted as **`/mnt/brick1`**:

   ```
   # ./setup_cluster.sh --yarn-master <the-existing-yarn-master-node>  [-
   -hadoop-mgmt-node <the-existing-mgmt-node>] new-
   node1.hdp:/mnt/brick1:/dev/vg1/lv1 new-node2.hdp
   ```

5. Open the terminal of any Red Hat Gluster Storage server in the trusted storage pool and run the following command. This command assumes that you want to add the servers to a volume called **`HadoopVol`**:

   ```
   # gluster volume add-brick HadoopVol replica 2 new-
   node1:/mnt/brick1/HadoopVol new-node2:/mnt/brick1/HadoopVol
   ```

For more information on expanding volumes, see Section 10.3, “Expanding Volumes”.

6. Open the terminal of any Red Hat Gluster Storage Server in the cluster and rebalance the volume using the following command:

```
# gluster volume rebalance HadoopVol start
```

   Rebalancing the volume will distribute the data on the volume among the servers. To view the status of the rebalancing operation, run **`# gluster volume rebalance HadoopVol status`** command. The rebalance status will be shown as **`completed`** when the rebalance is complete. For more information on rebalancing a volume, see Section 10.7, “Rebalancing Volumes”.

7. Open the terminal of both of the new storage nodes and navigate to the **`/usr/share/rhs-hadoop-install/`** directory and run the command given below:

```
# ./setup_container_executor.sh
```

8. Access the Ambari Management Interface via the browser (http://*ambari-server-hostname*:*8080*) and add the new nodes by selecting the HOSTS tab and selecting *add new host*. Select the services you wish to install on the new host and deploy the service to the hosts.

9. Follow the instructions in *Configuring the Linux Container Executor* section in the *Red Hat Gluster Storage 3.1 Installation Guide*.

### 26.5.2. Scaling Down

If you remove servers from a Red Hat Gluster Storage trusted storage pool it is recommended that you rebalance the data in the trusted storage pool. The following is the process to remove 2 servers from an existing Hadoop on Red Hat Gluster Storage Cluster:

1. In the Ambari Console, click **`Stop All`** in the **Services** navigation panel. You must wait until all the services are completely stopped.

2. Open the terminal of any Red Hat Gluster Storage server in the trusted storage pool and run the following command. This procedure assumes that you want to remove 2 servers, that is **`old-node1`** and **`old-node2`** from a volume called **`HadoopVol`**:

```
# gluster volume remove-brick HadoopVol [replica count] old-
node1:/mnt/brick2/HadoopVol old-node2:/mnt/brick2/HadoopVol start
```

   To view the status of the remove brick operation, run **`# gluster volume remove-brick HadoopVol old-node1:/mnt/brick2/HadoopVol old-node2:/mnt/brick2/HadoopVol status`** command.

3. When the data migration shown in the status command is **`Complete`**, run the following command to commit the brick removal:

```
# gluster volume remove-brick HadoopVol old-
node1:/mnt/brick2/HadoopVol old-node2:/mnt/brick2/HadoopVol commit
```

   After the bricks removal, you can check the volume information using **`# gluster volume info HadoopVol`** command. For detailed information on removing volumes, see Section 10.4, “Shrinking Volumes”

4. Open the terminal of any Red Hat Gluster Storage server in the trusted storage pool and run the following command to detach the removed server:

```
# gluster peer detach old-node1
# gluster peer detach old-node2
```

5. Open the terminal of any Red Hat Gluster Storage Server in the cluster and rebalance the volume using the following command:

```
# gluster volume rebalance HadoopVol start
```

Rebalancing the volume will distribute the data on the volume among the servers. To view the status of the rebalancing operation, run **`# gluster volume rebalance HadoopVol status`** command. The rebalance status will be shown as **`completed`** when the rebalance is complete. For more information on rebalancing a volume, see Section 10.7, “Rebalancing Volumes”.

6. Remove the nodes from Ambari by accessing the Ambari Management Interface via the browser (http://*ambari-server-hostname*:*8080*) and selecting the HOSTS tab. Click on the host(node) that you would like to delete and select **`Host Actions`** on the right hand side. Select **`Delete Host`** from the drop down.

## 26.6. Creating a Snapshot of Hadoop enabled Red Hat Gluster Storage Volumes

The Red Hat Gluster Storage Snapshot feature enables you to create point-in-time copies of Red Hat Gluster Storage volumes, which you can use to protect data and helps in disaster recovery solution. You can directly access Snapshot copies which are read-only to recover from accidental deletion, corruption, or modification of their data.

For information on prerequisites, creating, and restoring snapshots, see Chapter 16, *Managing Snapshots*. However, you must ensure to stop all the Hadoop Services in Ambari before creating snapshot and before restoring a snapshot. You must also start the Hadoop services again after restoring the snapshot.

You can create snapshots of Hadoop enabled Red Hat Gluster Storage volumes and the following scenarios are supported:

### Scenario 1: Existing Red Hat Gluster Storage trusted storage pool

You have an existing Red Hat Gluster Storage volume and you created a snapshot of that volume but you are not yet using the volume with Hadoop. You then add more data to the volume and decide later that you want to rollback the volume's contents. You rollback the contents by restoring the snapshot. The volume can then be enabled later to support Hadoop workloads the same way that a newly created volume does.

### Scenario 2: Hadoop enabled Red Hat Gluster Storage volume

You are running Hadoop workloads on the volume prior to the snapshot being created. You then create a snapshot of the volume and later restore from the snapshot. Hadoop continues to work on the volume once it is restored.

### Scenario 3: Restoring Subset of Files

In this scenario, instead of restoring the full volume, only a subset of the files are restored that may have been lost or corrupted. This means that certain files that existed when the volume was originally snapped have subsequently been deleted. You want to restore just those files back from the Snapshot and add them to the current volume state. This means that the files will be copied from the snapshot into the volume. Once the copy has occurred, Hadoop workloads will run on the volume as normal.

## 26.7. Creating Quotas on Hadoop enabled Red Hat Gluster Storage Volume

You must not configure quota on any of the Hadoop System directories as Hadoop uses those directories for writing temporary and intermediate data. If the quota is exceeded, it will break Hadoop and prevent all users from running Jobs. Rather, you must set quotas on specific user directories so that they can limit the amount of storage capacity is available to a user without affecting the other users of the Hadoop Cluster.

# Part V. Appendices

# Chapter 27. Troubleshooting

This chapter provides some of the Red Hat Gluster Storage troubleshooting methods.

## 27.1. Identifying locked file and clear locks

You can use the **statedump** command to list the locks held on files. The **statedump** output also provides information on each lock with its range, basename, and PID of the application holding the lock, and so on. You can analyze the output to find the locks whose owner/application is no longer running or interested in that lock. After ensuring that no application is using the file, you can clear the lock using the following **clear-locks** command:

**# gluster volume clear-locks *VOLNAME* *path* kind {blocked | granted | all}{inode *range* | entry *basename* | posix *range*}**

For more information on performing **statedump**, see Section 18.6, “Performing Statedump on a Volume”

**To identify locked file and clear locks**

1. Perform **statedump** on the volume to view the files that are locked using the following command:

   **# gluster volume statedump *VOLNAME***

   For example, to display **statedump** of test-volume:

   ```
   # gluster volume statedump test-volume
   Volume statedump successful
   ```

   The **statedump** files are created on the brick servers in the **/tmp** directory or in the directory set using the **server.statedump-path** volume option. The naming convention of the dump file is ***brick-path*.*brick-pid*.dump**.

2. Clear the entry lock using the following command:

   **# gluster volume clear-locks *VOLNAME* *path* kind granted entry *basename***

   The following are the sample contents of the **statedump** file indicating entry lock (entrylk). Ensure that those are stale locks and no resources own them.

   ```
   [xlator.features.locks.vol-locks.inode]
   path=/
   mandatory=0
   entrylk-count=1
   lock-dump.domain.domain=vol-replicate-0
   xlator.feature.locks.lock-dump.domain.entrylk.entrylk[0]
   (ACTIVE)=type=ENTRYLK_WRLCK on basename=file1, pid = 714782904,
   owner=ffffff2a3c7f0000, transport=0x20e0670, , granted at Mon Feb 27
   16:01:01 2012

   conn.2.bound_xl./gfs/brick1.hashsize=14057
   conn.2.bound_xl./gfs/brick1.name=/gfs/brick1/inode
   conn.2.bound_xl./gfs/brick1.lru_limit=16384
   conn.2.bound_xl./gfs/brick1.active_size=2
   conn.2.bound_xl./gfs/brick1.lru_size=0
   conn.2.bound_xl./gfs/brick1.purge_size=0
   ```

For example, to clear the entry lock on **file1** of test-volume:

```
# gluster volume clear-locks test-volume / kind granted entry file1
Volume clear-locks successful
test-volume-locks: entry blocked locks=0 granted locks=1
```

3. Clear the inode lock using the following command:

   **# gluster volume clear-locks *VOLNAME* *path* kind granted inode *range***

   The following are the sample contents of the **statedump** file indicating there is an inode lock (inodelk). Ensure that those are stale locks and no resources own them.

```
[conn.2.bound_xl./gfs/brick1.active.1]
gfid=538a3d4a-01b0-4d03-9dc9-843cd8704d07
nlookup=1
ref=2
ia_type=1
[xlator.features.locks.vol-locks.inode]
path=/file1
mandatory=0
inodelk-count=1
lock-dump.domain.domain=vol-replicate-0
inodelk.inodelk[0](ACTIVE)=type=WRITE, whence=0, start=0, len=0, pid =
714787072, owner=00ffff2a3c7f0000, transport=0x20e0670, , granted at
Mon Feb 27 16:01:01 2012
```

   For example, to clear the inode lock on **file1** of test-volume:

```
# gluster  volume clear-locks test-volume /file1 kind granted inode
0,0-0
Volume clear-locks successful
test-volume-locks: inode blocked locks=0 granted locks=1
```

4. Clear the granted POSIX lock using the following command:

   **# gluster volume clear-locks *VOLNAME* *path* kind granted posix *range***

   The following are the sample contents of the **statedump** file indicating there is a granted POSIX lock. Ensure that those are stale locks and no resources own them.

```
xlator.features.locks.vol1-locks.inode]
path=/file1
mandatory=0
posixlk-count=15
posixlk.posixlk[0](ACTIVE)=type=WRITE, whence=0, start=8, len=1, pid =
23848, owner=d824f04c60c3c73c, transport=0x120b370, , blocked at Mon
Feb 27 16:01:01 2012
, granted at Mon Feb 27 16:01:01 2012

posixlk.posixlk[1](ACTIVE)=type=WRITE, whence=0, start=7, len=1, pid =
1, owner=30404152462d436c-69656e7431, transport=0x11eb4f0, , granted
at Mon Feb 27 16:01:01 2012
```

```
posixlk.posixlk[2](BLOCKED)=type=WRITE, whence=0, start=8, len=1, pid =
1, owner=30404152462d436c-69656e7431, transport=0x11eb4f0, , blocked
at Mon Feb 27 16:01:01 2012

posixlk.posixlk[3](ACTIVE)=type=WRITE, whence=0, start=6, len=1, pid =
12776, owner=a36bb0aea0258969, transport=0x120a4e0, , granted at Mon
Feb 27 16:01:01 2012
...
```

For example, to clear the granted POSIX lock on **file1** of test-volume:

```
# gluster volume clear-locks test-volume /file1 kind granted posix
0,8-1
Volume clear-locks successful
test-volume-locks: posix blocked locks=0 granted locks=1
test-volume-locks: posix blocked locks=0 granted locks=1
test-volume-locks: posix blocked locks=0 granted locks=1
```

5. Clear the blocked POSIX lock using the following command:

   **# gluster volume clear-locks *VOLNAME path* kind blocked posix *range***

   The following are the sample contents of the **statedump** file indicating there is a blocked POSIX lock. Ensure that those are stale locks and no resources own them.

```
[xlator.features.locks.vol1-locks.inode]
path=/file1
mandatory=0
posixlk-count=30
posixlk.posixlk[0](ACTIVE)=type=WRITE, whence=0, start=0, len=1, pid =
23848, owner=d824f04c60c3c73c, transport=0x120b370, , blocked at Mon
Feb 27 16:01:01 2012
, granted at Mon Feb 27 16:01:01

posixlk.posixlk[1](BLOCKED)=type=WRITE, whence=0, start=0, len=1, pid =
1, owner=30404146522d436c-69656e7432, transport=0x1206980, , blocked
at Mon Feb 27 16:01:01 2012

posixlk.posixlk[2](BLOCKED)=type=WRITE, whence=0, start=0, len=1, pid =
1, owner=30404146522d436c-69656e7432, transport=0x1206980, , blocked
at Mon Feb 27 16:01:01 2012

posixlk.posixlk[3](BLOCKED)=type=WRITE, whence=0, start=0, len=1, pid =
1, owner=30404146522d436c-69656e7432, transport=0x1206980, , blocked
at Mon Feb 27 16:01:01 2012

posixlk.posixlk[4](BLOCKED)=type=WRITE, whence=0, start=0, len=1, pid =
1, owner=30404146522d436c-69656e7432, transport=0x1206980, , blocked
at Mon Feb 27 16:01:01 2012

...
```

For example, to clear the blocked POSIX lock on **file1** of test-volume:

```
# gluster volume clear-locks test-volume /file1 kind blocked posix
```

```
0,0-1
Volume clear-locks successful
test-volume-locks: posix blocked locks=28 granted locks=0
test-volume-locks: posix blocked locks=1 granted locks=0
No locks cleared.
```

6. Clear all POSIX locks using the following command:

   **# gluster volume clear-locks *VOLNAME* *path* kind all posix *range***

   The following are the sample contents of the **statedump** file indicating that there are POSIX locks. Ensure that those are stale locks and no resources own them.

```
[xlator.features.locks.vol1-locks.inode]
path=/file1
mandatory=0
posixlk-count=11
posixlk.posixlk[0](ACTIVE)=type=WRITE, whence=0, start=8, len=1, pid =
12776, owner=a36bb0aea0258969, transport=0x120a4e0, , blocked at Mon
Feb 27 16:01:01 2012
, granted at Mon Feb 27 16:01:01 2012

posixlk.posixlk[1](ACTIVE)=type=WRITE, whence=0, start=0, len=1, pid =
12776, owner=a36bb0aea0258969, transport=0x120a4e0, , granted at Mon
Feb 27 16:01:01 2012

posixlk.posixlk[2](ACTIVE)=type=WRITE, whence=0, start=7, len=1, pid =
23848, owner=d824f04c60c3c73c, transport=0x120b370, , granted at Mon
Feb 27 16:01:01 2012

posixlk.posixlk[3](ACTIVE)=type=WRITE, whence=0, start=6, len=1, pid =
1, owner=30404152462d436c-69656e7431, transport=0x11eb4f0, , granted
at Mon Feb 27 16:01:01 2012

posixlk.posixlk[4](BLOCKED)=type=WRITE, whence=0, start=8, len=1, pid =
23848, owner=d824f04c60c3c73c, transport=0x120b370, , blocked at Mon
Feb 27 16:01:01 2012
...
```

   For example, to clear all POSIX locks on **file1** of test-volume:

```
# gluster volume clear-locks test-volume /file1 kind all posix 0,0-1
Volume clear-locks successful
test-volume-locks: posix blocked locks=1 granted locks=0
No locks cleared.
test-volume-locks: posix blocked locks=4 granted locks=1
```

You can perform **statedump** on test-volume again to verify that all the above locks are cleared.

## 27.2. Retrieving File Path from the Gluster Volume

The heal info command lists the GFIDs of the files that needs to be healed. If you want to find the path of the files associated with the GFIDs, use the **getfattr** utility. The **getfattr** utility enables you to locate a file residing on a gluster volume brick. You can retrieve the path of a file even if the filename is unknown.

### 27.2.1. Retrieving Known File Name

To retrieve a file path when the file name is known, execute the following command in the Fuse mount directory:

```
# getfattr -n trusted.glusterfs.pathinfo -e text
<path_to_fuse_mount/filename>
```

Where,

path_to_fuse_mount: The fuse mount where the gluster volume is mounted.

filename: The name of the file for which the path information is to be retrieved.

For example:

```
# getfattr  -n trusted.glusterfs.pathinfo -e text /mnt/fuse_mnt/File1
getfattr: Removing leading '/' from absolute path names
# file: mnt/fuse_mnt/File1
trusted.glusterfs.pathinfo="(<DISTRIBUTE:testvol-dht> (<REPLICATE:testvol-
replicate-0>
<POSIX(/home/ravi/bricks/brick1):tuxpad:/home/ravi/bricks/brick1/File1>
<POSIX(/home/ravi/bricks/brick2):tuxpad:/home/ravi/bricks/brick2/File1>))"
```

The command output displays the brick pathinfo under the <POSIX> tag. In this example output, two paths are displayed as the file is replicated twice and resides on a two-way replicated volume.

### 27.2.2. Retrieving Unknown File Name

You can retrieve the file path of an unknown file using its gfid string. The gfid string is the hyphenated version of the `trusted.gfid` attribute. For example, if the gfid is `80b0b1642ea4478ba4cda9f76c1e6efd`, then the gfid string will be `80b0b164-2ea4-478b-a4cd-a9f76c1e6efd`.

**Note**

To obtain the gfid of a file, run the following command:

```
# getfattr -d -m. -e hex /path/to/file/on/the/brick
```

### 27.2.3. Retrieving File Path using gfid String

To retrieve the file path using the gfid string, follow these steps:

1. Fuse mount the volume with the aux-gfid option enabled.

   ```
   # mount -t glusterfs -o aux-gfid-mount hostname:volume-name
   <path_to_fuse_mnt>
   ```

   Where,

   path_to_fuse_mount: The fuse mount where the gluster volume is mounted.

For example:

```
# mount -t glusterfs -o aux-gfid-mount 127.0.0.2:testvol
/mnt/aux_mount
```

2. After mounting the volume, execute the following command

```
#  getfattr -n trusted.glusterfs.pathinfo -e text<path-to-fuse-
mnt>/.gfid/<GFID string>
```

Where,

path_to_fuse_mount: The fuse mount where the gluster volume is mounted.

GFID string: The GFID string.

For example:

```
# getfattr -n trusted.glusterfs.pathinfo -e text
/mnt/aux_mount/.gfid/80b0b164-2ea4-478b-a4cd-a9f76c1e6efd
getfattr: Removing leading '/' from absolute path names
# file: mnt/aux_mount/.gfid/80b0b164-2ea4-478b-a4cd-a9f76c1e6efd
trusted.glusterfs.pathinfo="(<DISTRIBUTE:testvol-dht>
(<REPLICATE:testvol-replicate-0>
<POSIX(/home/ravi/bricks/brick2):tuxpad:/home/ravi/bricks/brick2/File1
>
<POSIX(/home/ravi/bricks/brick1):tuxpad:/home/ravi/bricks/brick1/File1
>))
```

The command output displays the brick pathinfo under the <POSIX> tag. In this example output, two paths are displayed as the file is replicated twice and resides on a two-way replicated volume.

# Chapter 28. Recommended Configurations - Dispersed Volume

This chapter describes the recommended configurations, examples, and illustrations for Dispersed and Distributed Dispersed volumes.

For a Distributed Dispersed volume, there will be multiple sets of bricks (subvolumes) that stores data with erasure coding. All the files are distributed over these sets of erasure coded subvolumes. In this scenario, even if a redundant number of bricks is lost from every dispersed subvolume, there is no data loss.

For example, assume you have Distributed Dispersed volume of configuration 2 X (4 + 2). Here, you have two sets of dispersed subvolumes where the data is erasure coded between 6 bricks with 2 bricks for redundancy. The files will be stored in one of these dispersed subvolumes. Therefore, even if we lose two bricks from each set, there is no data loss.

## Brick Configurations

The following table lists the brick layout details of multiple server/disk configurations for dispersed and distributed dispersed volumes.

**Table 28.1. Brick Configurations for Dispersed and Distributed Dispersed Volumes**

| Redundancy Level | Supported Configurations | Bricks per Server per Subvolume | Node Loss | Max brick failure count within a subvolume | Compatible Server Node count | Increment Size (no. of nodes) | Min number of sub-volumes | Total Spindles | Tolerated HDD Failure Percentage |
|---|---|---|---|---|---|---|---|---|---|
| **12 HDD Chassis** | | | | | | | | | |
| 2 | 4 + 2 | 2 | 1 | 2 | 3 | 3 | 6 | 36 | 33.33% |
| | | 1 | 2 | 2 | 6 | 6 | 12 | 72 | 33.33% |
| 4 | 8 + 4 | 4 | 1 | 4 | 3 | 3 | 3 | 36 | 33.33% |
| | | 2 | 2 | 4 | 6 | 6 | 6 | 72 | 33.33% |
| | | 1 | 4 | 4 | 12 | 12 | 12 | 144 | 33.33% |
| 3 | 8 + 3 | 1-2 | 1 | 3 | 6 | 6 | 6 | 72 | 25.00% |
| **24 HDD Chassis** | | | | | | | | | |
| 2 | 4 + 2 | 2 | 1 | 2 | 3 | 3 | 12 | 72 | 33.33% |
| | | 1 | 2 | 2 | 6 | 6 | 24 | 144 | 33.33% |
| 4 | 8 + 4 | 4 | 1 | 4 | 3 | 3 | 6 | 72 | 33.33% |
| | | 2 | 2 | 4 | 6 | 6 | 12 | 144 | 33.33% |
| | | 1 | 4 | 4 | 12 | 12 | 24 | 288 | 33.33% |
| **36 HDD Chassis** | | | | | | | | | |
| 2 | 4 + 2 | 2 | 1 | 2 | 3 | 3 | 18 | 108 | 33.33% |
| | | 1 | 2 | 2 | 6 | 6 | 36 | 216 | 33.33% |
| 4 | 8 + 4 | 4 | 1 | 4 | 3 | 3 | 9 | 108 | 33.33% |
| | | 2 | 2 | 4 | 6 | 6 | 18 | 216 | 33.33% |
| | | 1 | 4 | 4 | 12 | 12 | 36 | 432 | 33.33% |
| 3 | 8 + 3 | 1-2 | 1 | 3 | 6 | 6 | 19 | 216 | 26.39% |
| **60 HDD Chassis** | | | | | | | | | |
| 2 | 4 + 2 | 2 | 1 | 2 | 3 | 3 | 30 | 180 | 33.33% |
| | | 1 | 2 | 2 | 6 | 6 | 60 | 360 | 33.33% |
| 4 | 8 + 4 | 4 | 1 | 4 | 3 | 3 | 15 | 180 | 33.33% |

| Redundancy Level | Supported Configurations | Bricks per Server per Subvolume | Node Loss | Max brick failure count within a subvolume | Compatible Server Node count | Increment Size (no. of nodes) | Min number of sub-volumes | Total Spindles | Tolerated HDD Failure Percentage |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 2 | 4 | 6 | 6 | 30 | 360 | 33.33% |
| | | 1 | 4 | 4 | 12 | 12 | 60 | 720 | 33.33% |
| 3 | 8 + 3 | 1-2 | 1 | 3 | 6 | 6 | 32 | 360 | 26.67% |

### Example 1 - Dispersed 4+2 configuration on three servers

This example describes the configuration of three servers with each server attached with 12 HDD chassis to create a dispersed volume. In this example, each HDD is assumed as a single brick.

This example's brick configuration is explained in the row 1 of Table 28.1, “Brick Configurations for Dispersed and Distributed Dispersed Volumes”.

With this server-to-spindle ratio, 36 disks/spindles are allocated for the dispersed volume configuration. For example, to create a simple 4+2 dispersed volume using 6 spindles from the total disk pool, run the following command:

```
# gluster volume create test_vol disperse-data 4 redundancy 2 transport tcp
server1:/exp/brick1 server1:/exp/brick2 server2:/exp/brick3
server2:/exp/brick4 server3:/exp/brick5 server3:/exp/brick6
```

Run the **`gluster volume info`** command to view the volume information.

```
# gluster volume info test-volume
Volume Name: test-volume
Type: Disperse
Status: Started
Number of Bricks: 1 x (4 + 2) = 6
Transport-type: tcp
Bricks:
Brick1: server1:/exp/brick1
Brick2: server1:/exp/brick2
Brick3: server2:/exp/brick3
Brick4: server2:/exp/brick4
Brick5: server3:/exp/brick5
Brick6: server3:/exp/brick6
```

Additionally, you can convert the dispersed volume to a distributed dispersed volume in increments of 4+2. Add six bricks from the disk pool using the following command:

```
# gluster volume add-brick test_vol server1:/exp/brick7 server1:/exp/brick8
server2:/exp/brick9 server2:/exp4/brick10 server3:/exp5/brick11
server3:/exp6/brick12
```

Run the **`gluster volume info`** command to view distributed dispersed volume information.

```
# gluster volume info test-volume
Volume Name: test-volume
Type: Distributed-Disperse
Status: Started
Number of Bricks: 2 x (4 + 2) = 12
Transport-type: tcp
Bricks:
Brick1: server1:/exp/brick1
Brick2: server1:/exp/brick2
Brick3: server2:/exp/brick3
Brick4: server2:/exp/brick4
Brick5: server3:/exp/brick5
Brick6: server3:/exp/brick6
Brick7: server1:/exp/brick7
Brick8: server1:/exp/brick8
Brick9: server2:/exp/brick9
Brick10: server2:/exp/brick10
Brick11: server3:/exp/brick11
Brick12: server3:/exp/brick12
```

Using this configuration example, you can create configuration combinations of 6 X (4 +2 ) distributed dispersed volumes. This example configuration has tolerance up to 12 brick failures.

### Example 2 - Dispersed 8+4 configuration on three servers

The following diagram illustrates a dispersed 8+4 configuration on three servers as explained in the row 3 of Table 28.1, “Brick Configurations for Dispersed and Distributed Dispersed Volumes” The command to create the disperse volume for this configuration:.

```
# gluster volume create test_vol disperse-data 8 redundancy 4 transport tcp
server1:/exp/brick1 server1:/exp/brick2 server1:/exp/brick3
server1:/exp/brick4 server2:/exp/brick1 server2:/exp/brick2
server2:/exp/brick3 server2:/exp/brick4 server3:/exp/brick1
server3:/exp/brick2 server3:/exp/brick3 server3:/exp/brick4
server1:/exp/brick5 server1:/exp/brick6 server1:/exp/brick7
server1:/exp/brick8 server2:/exp/brick5 server2:/exp/brick6
server2:/exp/brick7 server2:/exp/brick8  server3:/exp/brick5
server3:/exp/brick6 server3:/exp/brick7 server3:/exp/brick8
server1:/exp/brick9 server1:/exp/brick10 server1:/exp/brick11
server1:/exp/brick12 server2:/exp/brick9 server2:/exp/brick10
server2:/exp/brick11 server2:/exp/brick12 server3:/exp/brick9
server3:/exp/brick10 server3:/exp/brick11 server3:/exp/brick12
```


**Figure 28.1. Example Configuration of 8+4 Dispersed Volume Configuration**

In this example, there are **m** bricks (refer to section Section 6.8, “Creating Dispersed Volumes” for information on **n = k+m** equation) from a dispersed subvolume on each server. If you add more than **m** bricks from a dispersed subvolume on server **S,** and if the server **S** goes down, data will be unavailable.

If **S** (a single column in the above diagram) goes down, there is no data loss, but if there is any additional hardware failure, either another node going down or a storage device failure, there would be immediate data loss.

### Example 3 - Dispersed 4+2 configuration on six servers

The following diagram illustrates dispersed 4+2 configuration on six servers and each server with 12-disk-per-server configuration as explained in the row 2 of Table 28.1, “Brick Configurations for Dispersed and Distributed Dispersed Volumes”. The command to create the disperse volume for this configuration:

```
# gluster volume create test_vol disperse-data 4 redundancy 2 transport tcp
server1:/exp/brick1 server2:/exp/brick1 server3:/exp/brick1
server4:/exp/brick1 server5:/exp/brick1
server6:/exp/brick1server1:/exp/brick2 server2:/exp/brick2
server3:/exp/brick2 server4:/exp/brick2 server5:/exp/brick2
server6:/exp/brick2 server1:/exp/brick3 server2:/exp/brick3
```

```
server3:/exp/brick3 server4:/exp/brick3 server5:/exp/brick3
server6:/exp/brick3 server1:/exp/brick4 server2:/exp/brick4
server3:/exp/brick4 server4:/exp/brick4 server5:/exp/brick4
server6:/exp/brick4 server1:/exp/brick5 server2:/exp/brick5
server3:/exp/brick5 server4:/exp/brick5 server5:/exp/brick5
server6:/exp/brick5 server1:/exp/brick6 server2:/exp/brick6
server3:/exp/brick6 server4:/exp/brick6 server5:/exp/brick6
server6:/exp/brick6 server1:/exp/brick7 server2:/exp/brick7
server3:/exp/brick7 server4:/exp/brick7 server5:/exp/brick7
server6:/exp/brick7 server1:/exp/brick8 server2:/exp/brick8
server3:/exp/brick8 server4:/exp/brick8 server5:/exp/brick8
server6:/exp/brick8 server1:/exp/brick9 server2:/exp/brick9
server3:/exp/brick9 server4:/exp/brick9 server5:/exp/brick9
server6:/exp/brick9 server1:/exp/brick10 server2:/exp/brick10
server3:/exp/brick10 server4:/exp/brick10 server5:/exp/brick10
server6:/exp/brick10 server1:/exp/brick11 server2:/exp/brick11
server3:/exp/brick11 server4:/exp/brick11 server5:/exp/brick11
server6:/exp/brick11 server1:/exp/brick12 server2:/exp/brick12
server3:/exp/brick12 server4:/exp/brick12 server5:/exp/brick12
server6:/exp/brick12
```

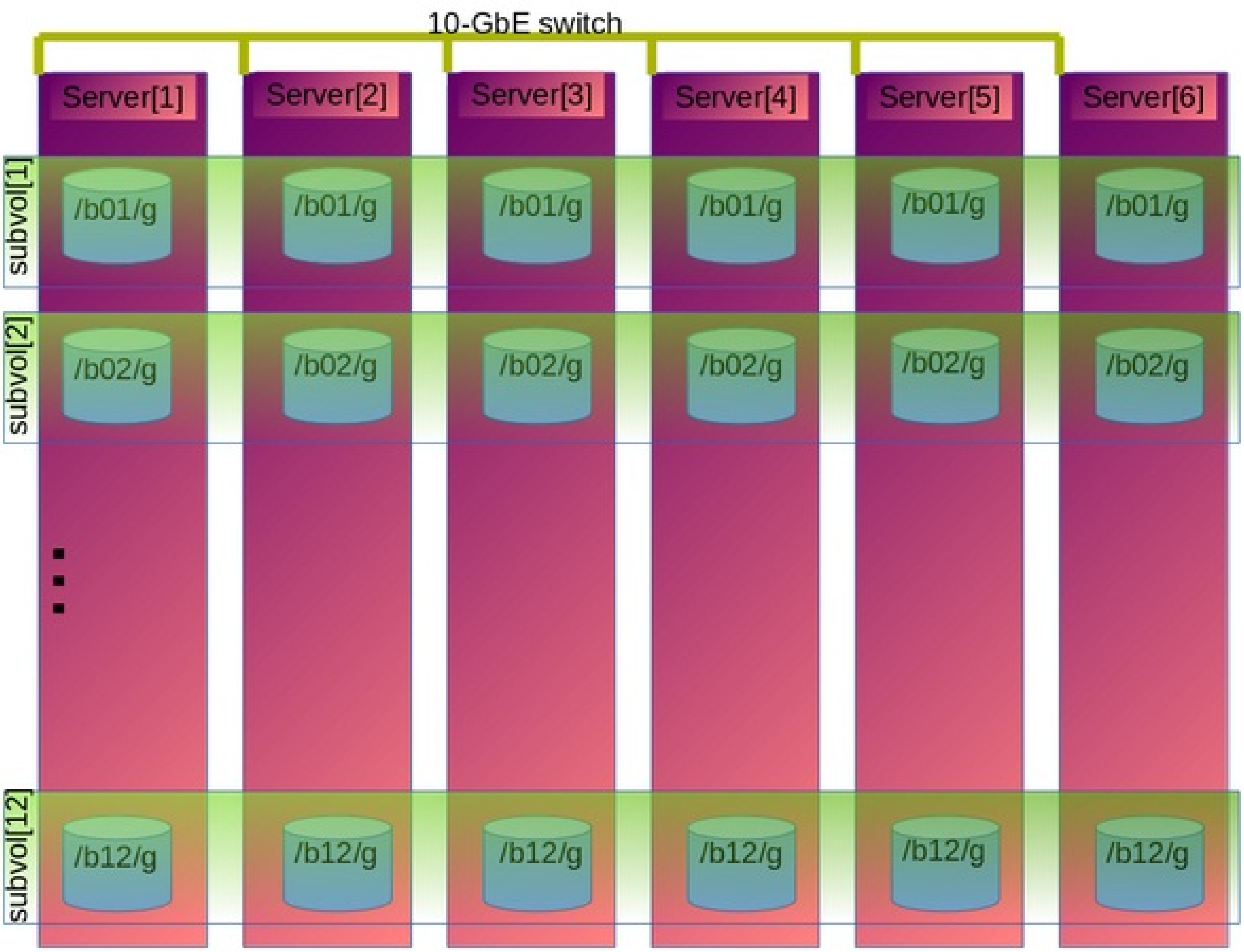



**Figure 28.2. Example Configuration of 4+2 Dispersed Volume Configuration**

## Redundancy Comparison

The following chart illustrates the redundancy comparison of all supported dispersed volume configurations.

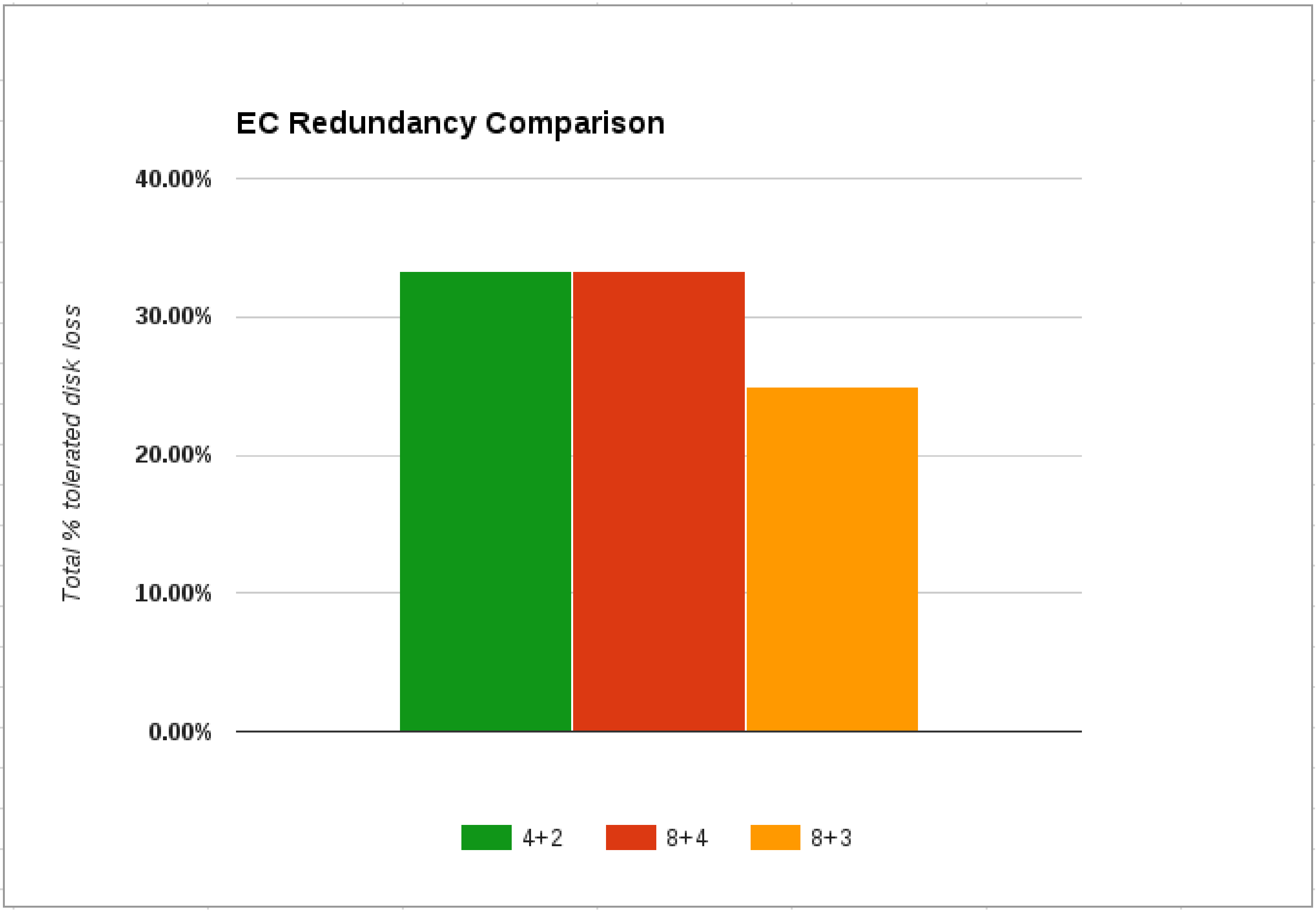



**Figure 28.3. Illustration of the redundancy comparison**

# Chapter 29. Nagios Configuration Files

Auto-discovery creates folders and files as part of configuring Red Hat Gluster Storage nodes for monitoring. All nodes in the trusted storage pool are configured as hosts in Nagios. The Host and Hostgroup configurations are also generated for trusted storage pool with cluster name. Ensure that the following files and folders are created with the details described to verify the Nagios configurations generated using Auto-discovery.

- In **`/etc/nagios/gluster/`** directory, a new directory **`Cluster-Name`** is created with the name provided as **`Cluster-Name`** while executing **`configure-gluster-nagios`** command for auto-discovery. All configurations created by auto-discovery for the cluster are added in this folder.
- In **`/etc/nagios/gluster/Cluster-Name`** directory, a configuration file, **`Cluster-Name.cfg`** is generated. This file has the host and hostgroup configurations for the cluster. This also contains service configuration for all the cluster/volume level services.

  The following Nagios object definitions are generated in **`Cluster-Name.cfg`** file:

  - A hostgroup configuration with **`hostgroup_name`** as cluster name.
  - A host configuration with **`host_name`** as cluster name.
  - The following service configurations are generated for cluster monitoring:
    - A *Cluster - Quorum* service to monitor the cluster quorum.
    - A *Cluster Utilization* service to monitor overall utilization of volumes in the cluster. This is created only if there is any volume present in the cluster.
    - A *Cluster Auto Config* service to periodically synchronize the configurations in Nagios with Red Hat Gluster Storage trusted storage pool.
  - The following service configurations are generated for each volume in the trusted storage pool:
    - A Volume Status- *Volume-Name* service to monitor the status of the volume.
    - A Volume Utilization - *Volume-Name* service to monitor the utilization statistics of the volume.
    - A Volume Quota - *Volume-Name* service to monitor the Quota status of the volume, if Quota is enabled for the volume.
    - A Volume Self-Heal - *Volume-Name* service to monitor the Self-Heal status of the volume, if the volume is of type replicate or distributed-replicate.
    - A Volume Geo-Replication - *Volume-Name* service to monitor the Geo Replication status of the volume, if Geo-replication is configured for the volume.
- In **`/etc/nagios/gluster/Cluster-Name`** directory, a configuration file with name **`Host-Name.cfg`** is generated for each node in the cluster. This file has the host configuration for the node and service configuration for bricks from the particular node. The following Nagios object definitions are generated in **`Host-name.cfg`**.

  - A host configuration which has *Cluster-Name* in the **`hostgroups`** field.
  - The following services are created for each brick in the node:
    - A *Brick Utilization - brick-path* service to monitor the utilization of the brick.
    - A *Brick - brick-path* service to monitor the brick status.

**Table 29.1. Nagios Configuration Files**

| File Name | Description |
|---|---|
| `/etc/nagios/nagios.cfg` | Main Nagios configuration file. |
| `/etc/nagios/cgi.cfg` | CGI configuration file. |
| `/etc/httpd/conf.d/nagios.conf` | Nagios configuration for httpd. |
| `/etc/nagios/passwd` | Password file for Nagios users. |
| `/etc/nagios/nrpe.cfg` | NRPE configuration file. |
| `/etc/nagios/gluster/gluster-contacts.cfg` | Email notification configuration file. |
| `/etc/nagios/gluster/gluster-host-services.cfg` | Services configuration file that's applied to every Red Hat Gluster Storage node. |
| `/etc/nagios/gluster/gluster-host-groups.cfg` | Host group templates for a Red Hat Gluster Storage trusted storage pool. |
| `/etc/nagios/gluster/gluster-commands.cfg` | Command definitions file for Red Hat Gluster Storage Monitoring related commands. |
| `/etc/nagios/gluster/gluster-templates.cfg` | Template definitions for Red Hat Gluster Storage hosts and services. |
| `/etc/nagios/gluster/snmpmanagers.conf` | SNMP notification configuration file with the IP address and community name of SNMP managers where traps need to be sent. |

# Chapter 30. Manually Recovering File Split-brain

This chapter provides steps to manually recover from split-brain.

1. Run the following command to obtain the path of the file that is in split-brain:

   ```
   # gluster volume heal VOLNAME info split-brain
   ```

   From the command output, identify the files for which file operations performed from the client keep failing with Input/Output error.

2. Close the applications that opened split-brain file from the mount point. If you are using a virtual machine, you must power off the machine.

3. Obtain and verify the AFR changelog extended attributes of the file using the **getfattr** command. Then identify the type of split-brain to determine which of the bricks contains the 'good copy' of the file.

   ```
   getfattr -d -m . -e hex <file-path-on-brick>
   ```

   For example,

   ```
   # getfattr -d -e hex -m. brick-a/file.txt
   \#file: brick-a/file.txt
   security.selinux=0x726f6f743a6f626a6563745f723a66696c655f743a733000
   trusted.afr.vol-client-2=0x000000000000000000000000
   trusted.afr.vol-client-3=0x000000000200000000000000
   trusted.gfid=0x307a5c9efddd4e7c96e94fd4bcdcbd1b
   ```

   The extended attributes with **trusted.afr.*VOLNAME*volname-client-<subvolume-index>** are used by AFR to maintain changelog of the file. The values of the **trusted.afr.*VOLNAME*volname-client-<subvolume-index>** are calculated by the glusterFS client (FUSE or NFS-server) processes. When the glusterFS client modifies a file or directory, the client contacts each brick and updates the changelog extended attribute according to the response of the brick.

   **subvolume-index** is the **brick number - 1** of **gluster volume info *VOLNAME*** output.

   For example,

   ```
   # gluster volume info vol
   Volume Name: vol
   Type: Distributed-Replicate
   Volume ID: 4f2d7849-fbd6-40a2-b346-d13420978a01
   Status: Created
   Number of Bricks: 4 x 2 = 8
   Transport-type: tcp
   Bricks:
   brick-a: server1:/gfs/brick-a
   brick-b: server1:/gfs/brick-b
   brick-c: server1:/gfs/brick-c
   brick-d: server1:/gfs/brick-d
   ```

```
brick-e: server1:/gfs/brick-e
brick-f: server1:/gfs/brick-f
brick-g: server1:/gfs/brick-g
brick-h: server1:/gfs/brick-h
```

In the example above:

```
Brick              |    Replica set         |    Brick subvolume index
------------------------------------------------------------------
----------
-/gfs/brick-a      |       0                |       0
-/gfs/brick-b      |       0                |       1
-/gfs/brick-c      |       1                |       2
-/gfs/brick-d      |       1                |       3
-/gfs/brick-e      |       2                |       4
-/gfs/brick-f      |       2                |       5
-/gfs/brick-g      |       3                |       6
-/gfs/brick-h      |       3                |       7
```
```

Each file in a brick maintains the changelog of itself and that of the files present in all the other bricks in it's replica set as seen by that brick.

In the example volume given above, all files in brick-a will have 2 entries, one for itself and the other for the file present in it's replica pair. The following is the changelog for brick-b,

- trusted.afr.vol-client-0=0x000000000000000000000000 - is the changelog for itself (brick-a)
- trusted.afr.vol-client-1=0x000000000000000000000000 - changelog for brick-b as seen by brick-a

Likewise, all files in brick-b will have the following:

- trusted.afr.vol-client-0=0x000000000000000000000000 - changelog for brick-a as seen by brick-b
- trusted.afr.vol-client-1=0x000000000000000000000000 - changelog for itself (brick-b)

**Note**

From the release of Red Hat Gluster Storage 3.1, the files will **`not`** have an entry for itself, but only the changelog entry for the other bricks in the replica. For example, **`brick-a`** will only have **`trusted.afr.vol-client-1`** set and **`brick-b`** will only have **`trusted.afr.vol-client-0`** set. Interpreting the changelog remains same as explained below.

The same can be extended for other replica pairs.

### Interpreting changelog (approximate pending operation count) value

Each extended attribute has a value which is 24 hexa decimal digits. First 8 digits represent changelog of data. Second 8 digits represent changelog of metadata. Last 8 digits represent Changelog of directory entries.

Pictorially representing the same is as follows:
```

```
0x 000003d7 00000001 00000000110
        |        |        |
        |        |         \_ changelog of directory entries
        |         \_ changelog of metadata
         \ _ changelog of data
```

For directories, metadata and entry changelogs are valid. For regular files, data and metadata changelogs are valid. For special files like device files and so on, metadata changelog is valid. When a file split-brain happens it could be either be data split-brain or meta-data split-brain or both.

The following is an example of both data, metadata split-brain on the same file:

```
# getfattr -d -m . -e hex /gfs/brick-?/a
getfattr: Removing leading '/' from absolute path names
\#file: gfs/brick-a/a
trusted.afr.vol-client-0=0x000000000000000000000000
trusted.afr.vol-client-1=0x000003d70000000100000000
trusted.gfid=0x80acdbd886524f6fbefa21fc356fed57
\#file: gfs/brick-b/a
trusted.afr.vol-client-0=0x000003b00000000100000000
trusted.afr.vol-client-1=0x000000000000000000000000
trusted.gfid=0x80acdbd886524f6fbefa21fc356fed57
```

### Scrutinize the changelogs

The changelog extended attributes on file **/gfs/brick-a/a** are as follows:

- The first 8 digits of **trusted.afr.vol-client-0 are all zeros (0x00000000................)**,

  The first 8 digits of **trusted.afr.vol-client-1** are not all zeros (0x000003d7................).

  So the changelog on **/gfs/brick-a/a** implies that some data operations succeeded on itself but failed on **/gfs/brick-b/a**.

- The second 8 digits of **trusted.afr.vol-client-0 are all zeros (0x........00000000........)**, and the second 8 digits of **trusted.afr.vol-client-1** are not all zeros (0x........00000001........).

  So the changelog on **/gfs/brick-a/a** implies that some metadata operations succeeded on itself but failed on **/gfs/brick-b/a**.

The changelog extended attributes on file **/gfs/brick-b/a** are as follows:

- The first 8 digits of **trusted.afr.vol-client-0** are not all zeros (0x000003b0................).

  The first 8 digits of **trusted.afr.vol-client-1** are all zeros (0x00000000................).

  So the changelog on **/gfs/brick-b/a** implies that some data operations succeeded on itself but failed on **/gfs/brick-a/a**.

- The second 8 digits of **trusted.afr.vol-client-0** are not all zeros (0x........00000001........)

  The second 8 digits of **trusted.afr.vol-client-1** are all zeros (0x........00000000........).

So the changelog on **/gfs/brick-b/a** implies that some metadata operations succeeded on itself but failed on **/gfs/brick-a/a**.

Here, both the copies have data, metadata changes that are not on the other file. Hence, it is both data and metadata split-brain.

### Deciding on the correct copy

You must inspect **stat** and **getfattr** output of the files to decide which metadata to retain and contents of the file to decide which data to retain. To continue with the example above, here, we are retaining the data of **/gfs/brick-a/a** and metadata of **/gfs/brick-b/a**.

### Resetting the relevant changelogs to resolve the split-brain

### Resolving data split-brain

You must change the changelog extended attributes on the files as if some data operations succeeded on **/gfs/brick-a/a** but failed on /gfs/brick-b/a. But **/gfs/brick-b/a** should **not** have any changelog showing data operations succeeded on **/gfs/brick-b/a** but failed on **/gfs/brick-a/a**. You must reset the data part of the changelog on **trusted.afr.vol-client-0** of **/gfs/brick-b/a**.

### Resolving metadata split-brain

You must change the changelog extended attributes on the files as if some metadata operations succeeded on **/gfs/brick-b/a** but failed on **/gfs/brick-a/a**. But **/gfs/brick-a/a** should **not** have any changelog which says some metadata operations succeeded on **/gfs/brick-a/a** but failed on **/gfs/brick-b/a**. You must reset metadata part of the changelog on **trusted.afr.vol-client-1** of **/gfs/brick-a/a**

Run the following commands to reset the extended attributes.

a. On **/gfs/brick-b/a**, for **trusted.afr.vol-client-0** **0x000003b00000000100000000** to **0x000000000000000100000000**, execute the following command:

```
# setfattr -n trusted.afr.vol-client-0 -v
0x000000000000000100000000 /gfs/brick-b/a
```

b. On **/gfs/brick-a/a**, for **trusted.afr.vol-client-1** **0x0000000000000000ffffffff** to **0x000003d70000000000000000**, execute the following command:

```
# setfattr -n trusted.afr.vol-client-1 -v
0x000003d70000000000000000 /gfs/brick-a/a
```

After you reset the extended attributes, the changelogs would look similar to the following:

```
# getfattr -d -m . -e hex /gfs/brick-?/a
getfattr: Removing leading '/' from absolute path names
\#file: gfs/brick-a/a
trusted.afr.vol-client-0=0x000000000000000000000000
trusted.afr.vol-client-1=0x000003d70000000000000000
trusted.gfid=0x80acdbd886524f6fbefa21fc356fed57
```

```
\#file: gfs/brick-b/a
trusted.afr.vol-client-0=0x000000000000000100000000
trusted.afr.vol-client-1=0x000000000000000000000000
trusted.gfid=0x80acdbd886524f6fbefa21fc356fed57
```

### Resolving Directory entry split-brain

AFR has the ability to conservatively merge different entries in the directories when there is a split-brain on directory. If on one brick directory **storage** has entries **1**, **2** and has entries **3**, **4** on the other brick then AFR will merge all of the entries in the directory to have **1, 2, 3, 4** entries in the same directory. But this may result in deleted files to re-appear in case the split-brain happens because of deletion of files on the directory. Split-brain resolution needs human intervention when there is at least one entry which has same file name but different **gfid** in that directory.

For example:

On **brick-a** the directory has 2 entries **file1** with **gfid_x** and **file2** . On **brick-b** directory has 2 entries **file1** with **gfid_y** and **file3**. Here the gfid's of **file1** on the bricks are different. These kinds of directory split-brain needs human intervention to resolve the issue. You must remove either **file1** on **brick-a** or the **file1** on **brick-b** to resolve the split-brain.

In addition, the corresponding **gfid-link** file must be removed. The **gfid-link** files are present in the .**glusterfs** directory in the top-level directory of the brick. If the gfid of the file is **0x307a5c9efddd4e7c96e94fd4bcdcbd1b** (the trusted.gfid extended attribute received from the **getfattr** command earlier), the gfid-link file can be found at **/gfs/brick-a/.glusterfs/30/7a/307a5c9efddd4e7c96e94fd4bcdcbd1b**.

> **Warning**
>
> Before deleting the **gfid-link**, you must ensure that there are no hard links to the file present on that brick. If hard-links exist, you must delete them.

4. Trigger self-heal by running the following command:

```
# ls -l <file-path-on-gluster-mount>
```

or

```
# gluster volume heal VOLNAME
```

# Appendix A. Revision History

| | | |
|---|---|---|
| **Revision 3.1-52** | **Tue May 10 2016** | **Laura Bailey** |

Removing all instances of unsupported option arbiter_count.
Minor edits to block zeroing.

| | | |
|---|---|---|
| **Revision 3.1-50** | **Mon May 09 2016** | **Bhavana Mohan** |

Bugs fixed for the 3.1.2 async release.

| | | |
|---|---|---|
| **Revision 3.1-48** | **Thu Mar 31 2016** | **Bhavana Mohan** |

Edited the AWS related chapter, BZ#1317488.

| | | |
|---|---|---|
| **Revision 3.1-45** | **Wed Mar 16 2016** | **Laura Bailey** |

Correcting notes about expanding replicated volumes, BZ#1317726.
Added detail to native client upgrade process, BZ#1310973.

| | | |
|---|---|---|
| **Revision 3.1-41** | **Fri Feb 26 2016** | **Bhavana Mohan** |

Version for the 3.1.2 GA.

| | | |
|---|---|---|
| **Revision 3.1-40** | **Thu Jan 14 2016** | **Sandra Mcardo** |

BZ-1283539: Added admonition note in the Adding Servers to the Trusted Storage Pool section.

| | | |
|---|---|---|
| **Revision 3.1-39** | **Tue Dec 22 2015** | **Laura Bailey** |

Corrections to bitrot restore procedure from bhubbard, BZ#1287921.

| | | |
|---|---|---|
| **Revision 3.1-38** | **Tue Dec 22 2015** | **Laura Bailey** |

Added further details to bitrot restore procedure, BZ#1287921.

| | | |
|---|---|---|
| **Revision 3.1-37** | **Tue Dec 15 2015** | **Laura Bailey** |

Rewrote process for restoring a corrupted file, BZ#1287921.

| | | |
|---|---|---|
| **Revision 3.1-36** | **Tue Dec 01 2015** | **Laura Bailey** |

Added further details to bitrot scrubber status command, BZ#1270819.
Corrected command syntax to add spaces after prompt indicator, BZ#1257135.

| | | |
|---|---|---|
| **Revision 3.1-34** | **Wed Nov 18 2015** | **Laura Bailey** |

Additional prerequisites for Object Store, BZ#1278787.
Corrected unit used to define metadata pool size, BZ#1262891.

| | | |
|---|---|---|
| **Revision 3.1-30** | **Fri Nov 06 2015** | **Laura Bailey** |

Synchronised firewall and port instructions, BZ#1265983.
Provided additional information about extended attributes, BZ#1257135.

| | | |
|---|---|---|
| **Revision 3.1-28** | **Mon Nov 02 2015** | **Bhavana Mohan** |

Fixed BZ#1270276, BZ#1270242, BZ#1266020, and BZ#1260106.

| | | |
|---|---|---|
| **Revision 3.1-27** | **Fri Oct 30 2015** | **Laura Bailey** |

Updated channel and repository details for native client, BZ#1267447.
Rewrote BitRot chapter and added details on status command, BZ#1270819.

| | | |
|---|---|---|
| **Revision 3.1-24** | **Thu Oct 01 2015** | **Bhavana Mohan** |

Version for 3.1 Update 1 GA release.

| | | |
|---|---|---|
| **Revision 3.1-23** | **Wed Sep 02 2015** | **Divya Muntimadugu** |

Fixed BZ#1245918

| | | |
|---|---|---|
| **Revision 3.1-22** | **Mon Aug 31 2015** | **Divya Muntimadugu** |

Fixed BZ#1254569 and BZ#1253240

| | | |
|---|---|---|
| **Revision 3.1-20** | **Wed Aug 05 2015** | **Anjana Suparna Sriram** |

Fixed BZ#1250028

| | | |
|---|---|---|
| **Revision 3.1-15** | **Tue Aug 04 2015** | **Rakesh Ghatvisave** |

Fixed BZ# 1217307

| | | |
|---|---|---|
| **Revision 3.1-14** | **Fri July 31 2015** | **Divya Muntimadugu** |

Fixed BZ# 1248016

| | | |
|---|---|---|
| **Revision 3.1-12** | **Wed July 29 2015** | **Ella Deon Ballard** |

Test rebuild.

| | | |
|---|---|---|
| **Revision 3.1-11** | **Wed July 29 2015** | **Divya Muntimadugu** |

Version for 3.1 GA release.