Demystifying Gluster

GlusterFS and RHS for the SysAdmin

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Agenda

- Technology Overview
- Scaling Up and Out
- A Peek at GlusterFS Logic
- Redundancy and Fault Tolerance
- Data Access
- General Administration
- Use Cases
- Common Pitfalls

Technology Overview

Demystifying Gluster

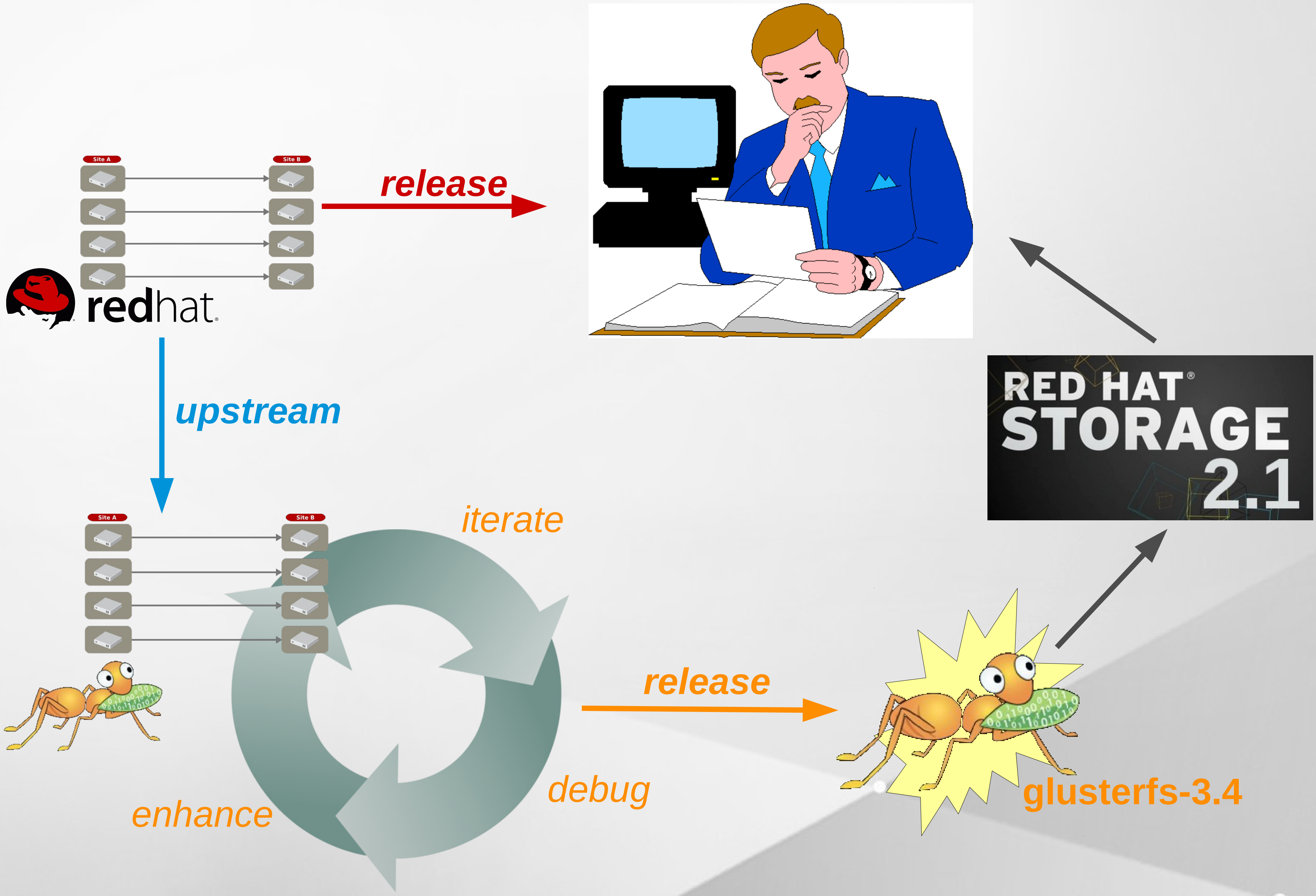
GlusterFS and RHS for the SysAdmin

What is GlusterFS?

- Scalable, general-purpose storage platform
  - POSIX-y Distributed File System
  - Object storage (swift)
  - Distributed block storage (qemu)
  - Flexible storage (libgfapi)
- No Metadata Server
- Heterogeneous Commodity Hardware
- Standards-Based – Clients, Applications, Networks
- Flexible and Agile Scaling
  - Capacity – Petabytes and beyond
  - Performance – Thousands of Clients

What is Red Hat Storage?

- Enterprise Implementation of GlusterFS
- Software Appliance
- Bare Metal Installation
- Built on RHEL + XFS
- Subscription Model
- Storage Software Appliance
  - Datacenter and Private Cloud Deployments
- Virtual Storage Appliance
  - Amazon Web Services Public Cloud Deployments



release

upstream

iterate

debug

enhance

release

glusterfs-3.4

GlusterFS vs. Traditional Solutions

- A basic NAS has limited scalability and redundancy
- Other distributed filesystems limited by metadata
- SAN is costly & complicated but high performance & scalable
- GlusterFS =
  - Linear Scaling
  - Minimal Overhead
  - High Redundancy
  - Simple and Inexpensive Deployment

Technology Stack

Terminology

- Brick
  - A filesystem mountpoint
  - A unit of storage used as a GlusterFS building block
- Translator
  - Logic between the bits and the Global Namespace
  - Layered to provide GlusterFS functionality
- Volume
  - Bricks combined and passed through translators
- Node / Peer
  - Server running the gluster daemon and sharing volumes

Disk, LVM, and Filesystems

- Direct-Attached Storage (DAS)
  -or-
- Just a Bunch Of Disks (JBOD)
- Hardware RAID
  - *RHS: RAID 6 required*
- Logical Volume Management (LVM)
- XFS, EXT3/4, BTRFS
  - Extended attributes support required
  - *RHS: XFS required*

Gluster Components

- `glusterd`
  - Elastic volume management daemon
  - Runs on all export servers
  - Interfaced through `gluster` CLI
- `glusterfsd`
  - GlusterFS brick daemon
  - One process for each brick
  - Managed by `glusterd`

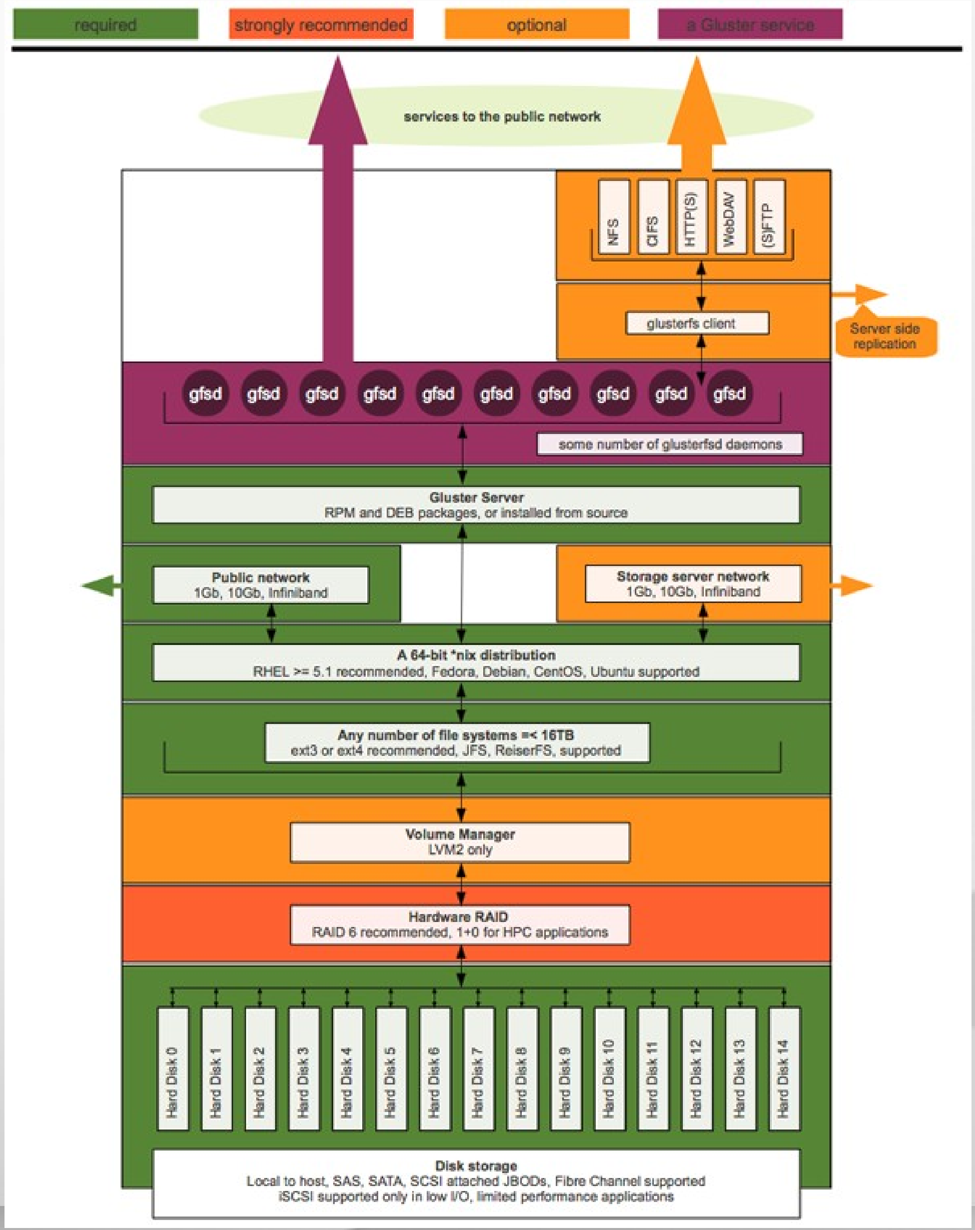
Gluster Components

- `glusterfs`
  - NFS server daemon
  - FUSE client daemon
- `mount.glusterfs`
  - FUSE native mount tool
- `gluster`
  - Gluster Console Manager (CLI)

Data Access Overview

- GlusterFS Native Client
  - Filesystem in Userspace (FUSE)
- NFS
  - Built-in Service
- SMB/CIFS
  - Samba server required
- Unified File and Object (UFO)
  - Simultaneous object-based access
- NEW! libgfapi flexible abstracted storage

Putting it All Together



required

strongly recommended

optional

a Gluster service

services to the public network

NFS

CIFS

HTTP(S)

WebDAV

(S)FTP

glusterfs client

Server side replication

gfsd gfsd gfsd gfsd gfsd gfsd gfsd gfsd gfsd gfsd

some number of glusterfsd daemons

Gluster Server
RPM and DEB packages, or installed from source

Public network
1Gb, 10Gb, Infiniband

Storage server network
1Gb, 10Gb, Infiniband

A 64-bit *nix distribution
RHEL >= 5.1 recommended, Fedora, Debian, CentOS, Ubuntu supported

Any number of file systems =< 16TB
ext3 or ext4 recommended, JFS, ReiserFS, supported

Volume Manager
LVM2 only

Hardware RAID
RAID 6 recommended, 1+0 for HPC applications

Hard Disk 0

Hard Disk 1

Hard Disk 2

Hard Disk 3

Hard Disk 4

Hard Disk 5

Hard Disk 6

Hard Disk 7

Hard Disk 8

Hard Disk 9

Hard Disk 10

Hard Disk 11

Hard Disk 12

Hard Disk 13

Hard Disk 14

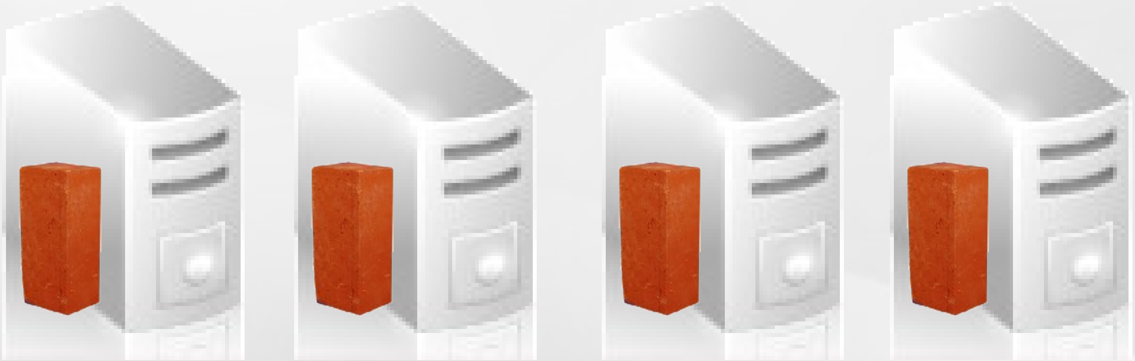
Disk storage
Local to host, SAS, SATA, SCSI attached JBODs, Fibre Channel supported
iSCSI supported only in low I/O, limited performance applications

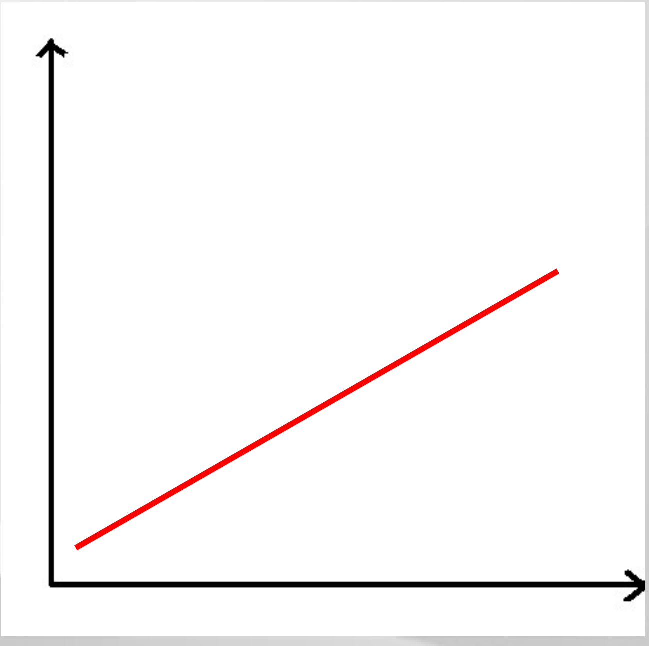
Scaling Up

- Add disks and filesystems to a node
- Expand a GlusterFS volume by adding bricks

Scaling Out

- Add GlusterFS nodes to trusted pool
- Add filesystems as new bricks



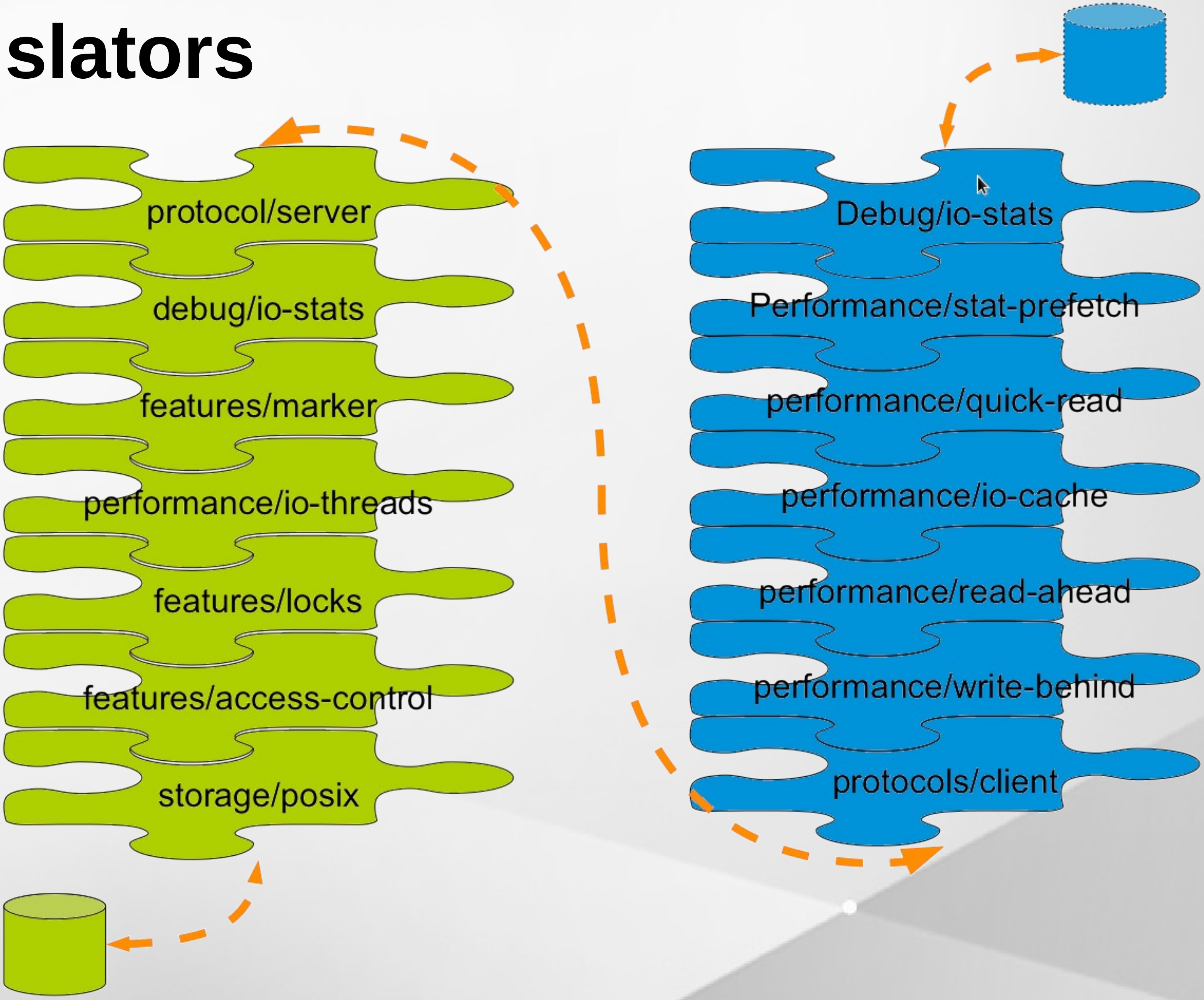


Under the Hood

Elastic Hash Algorithm

- No central metadata
  - No Performance Bottleneck
  - Eliminates risk scenarios
- Location hashed intelligently on path and filename
  - Unique identifiers, similar to md5sum
- The “Elastic” Part
  - Files assigned to virtual volumes
  - Virtual volumes assigned to multiple bricks
  - Volumes easily reassigned on the fly

Translators



Basic Volumes

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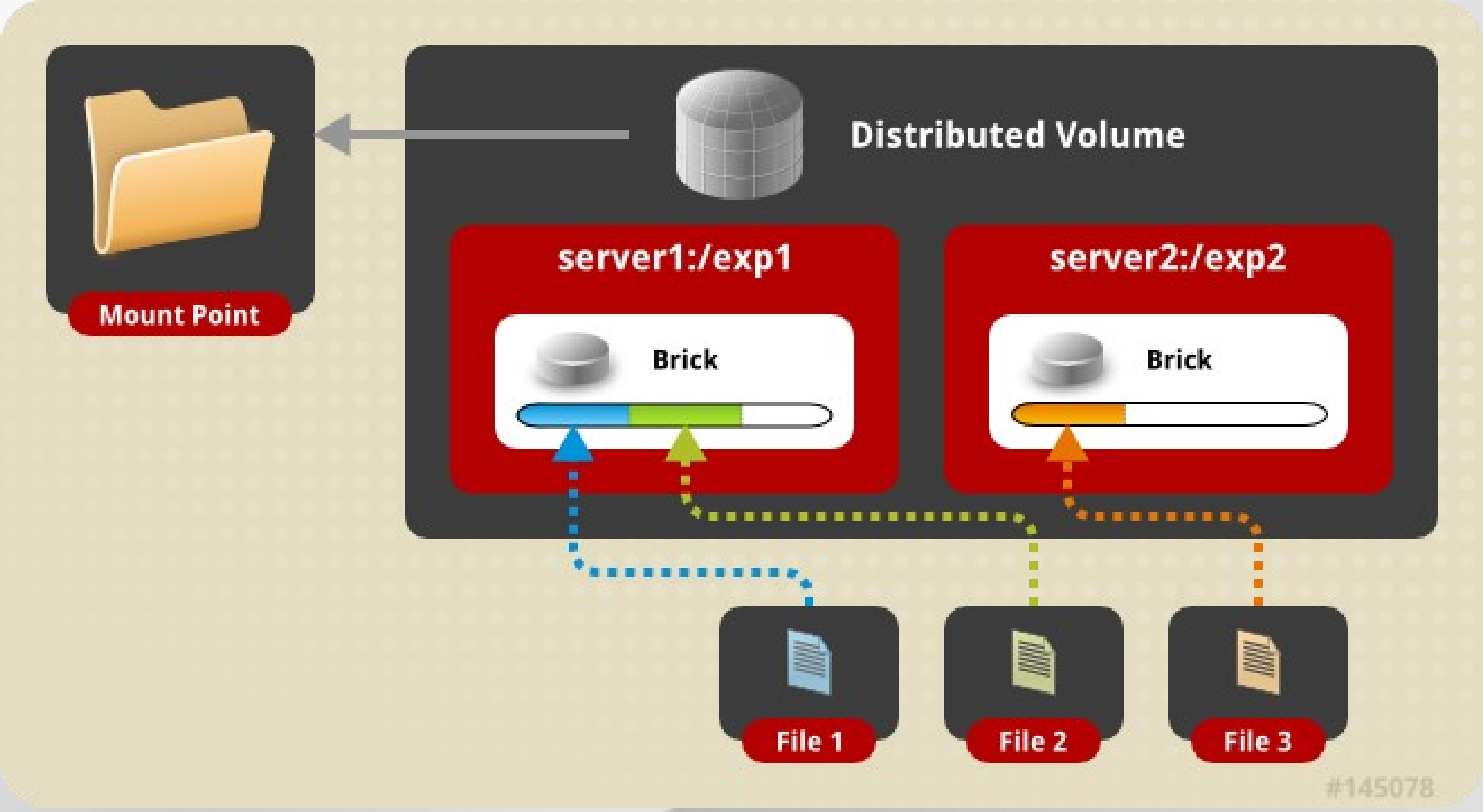
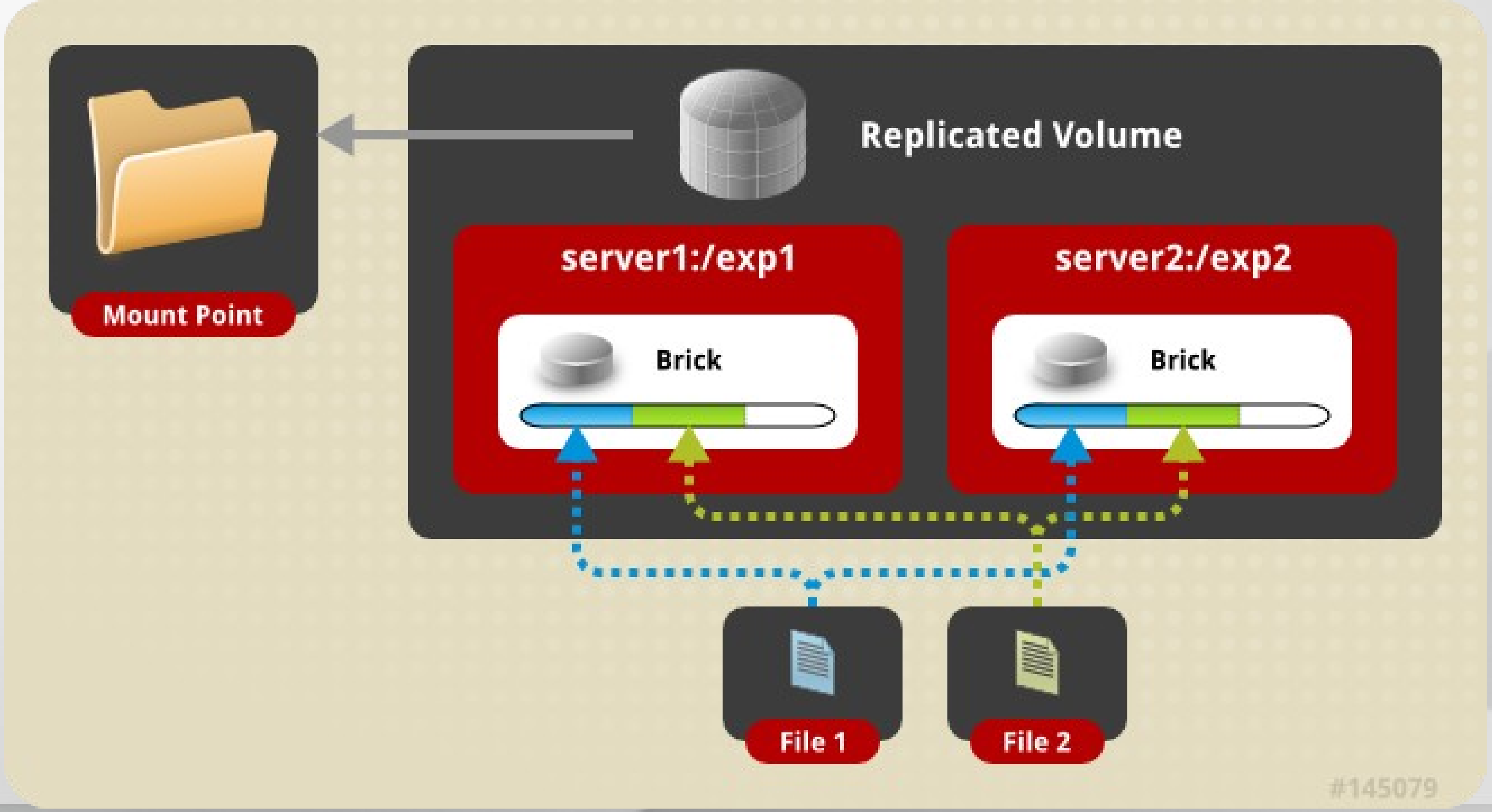
Distributed Volume

- Files “evenly” spread across bricks
- *Similar* to file-level RAID 0
- Server/Disk failure could be catastrophic



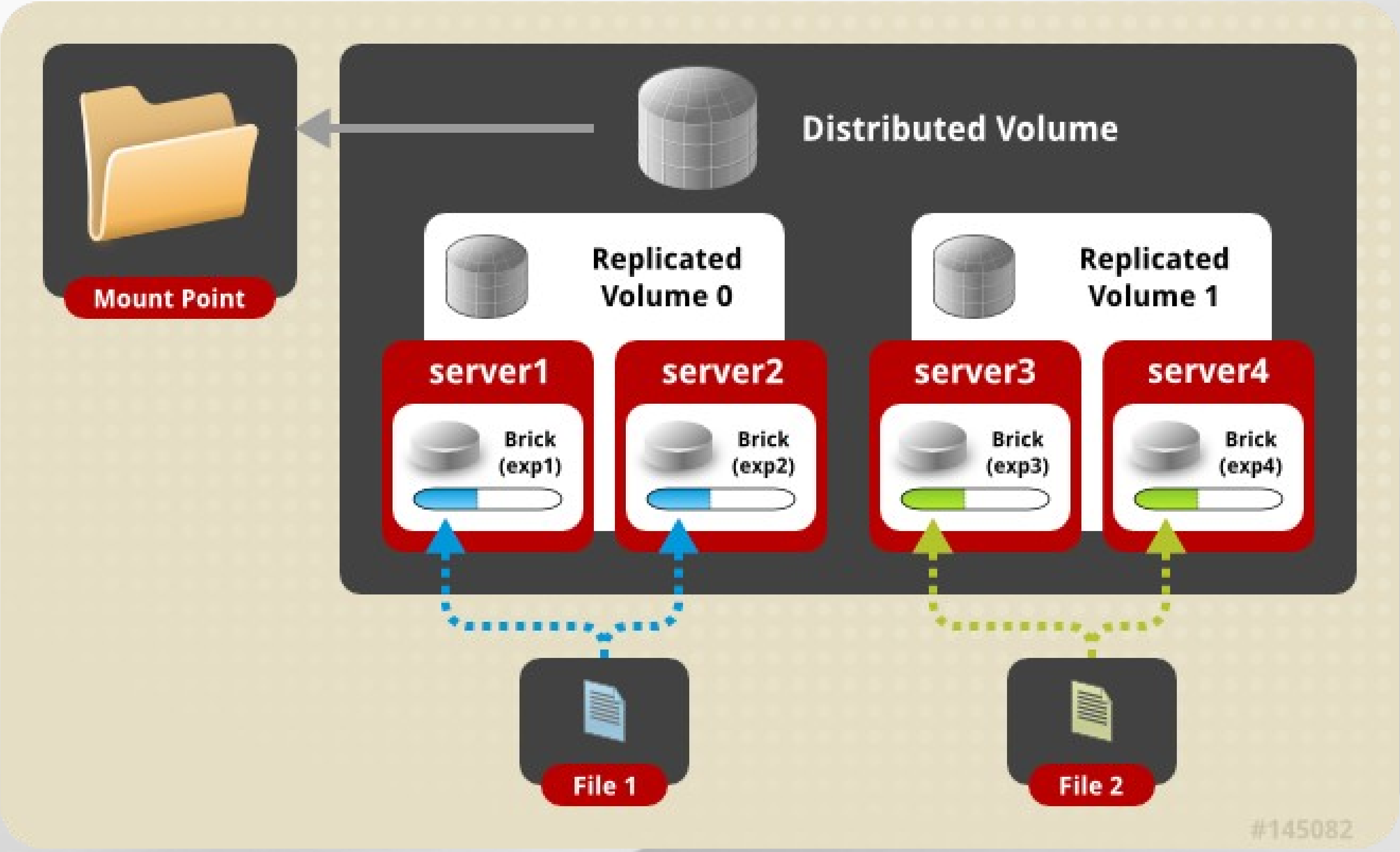
Replicated Volume

- Copies files to multiple bricks
- *Similar* to file-level RAID 1



Distributed Replicated Volume

- Distributes files across replicated bricks



Layered Functionality

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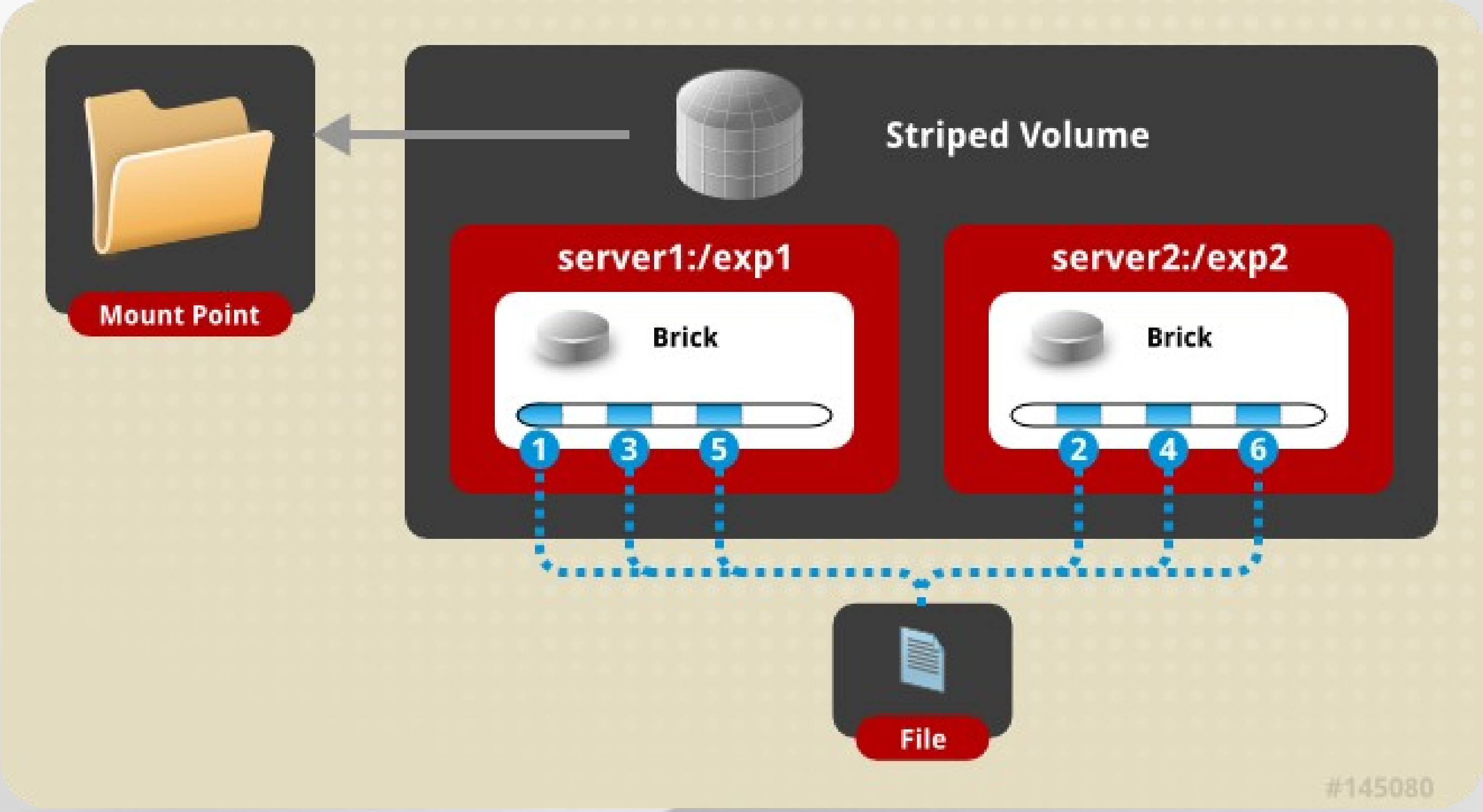
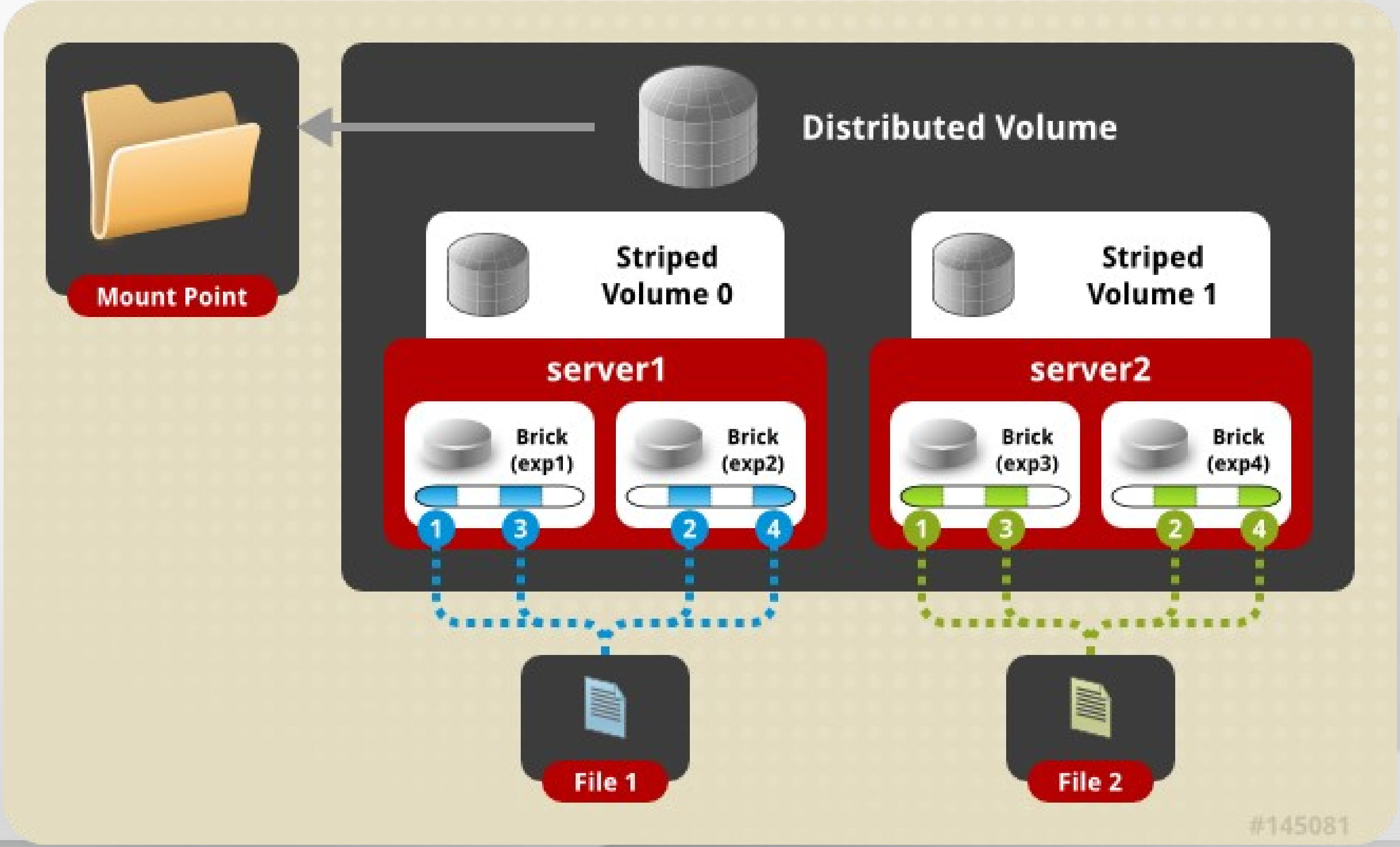
Striped Volumes

- Individual files split among bricks
- *Similar* to block-level RAID 0
- *Limited Use Cases* – HPC Pre/Post Processing



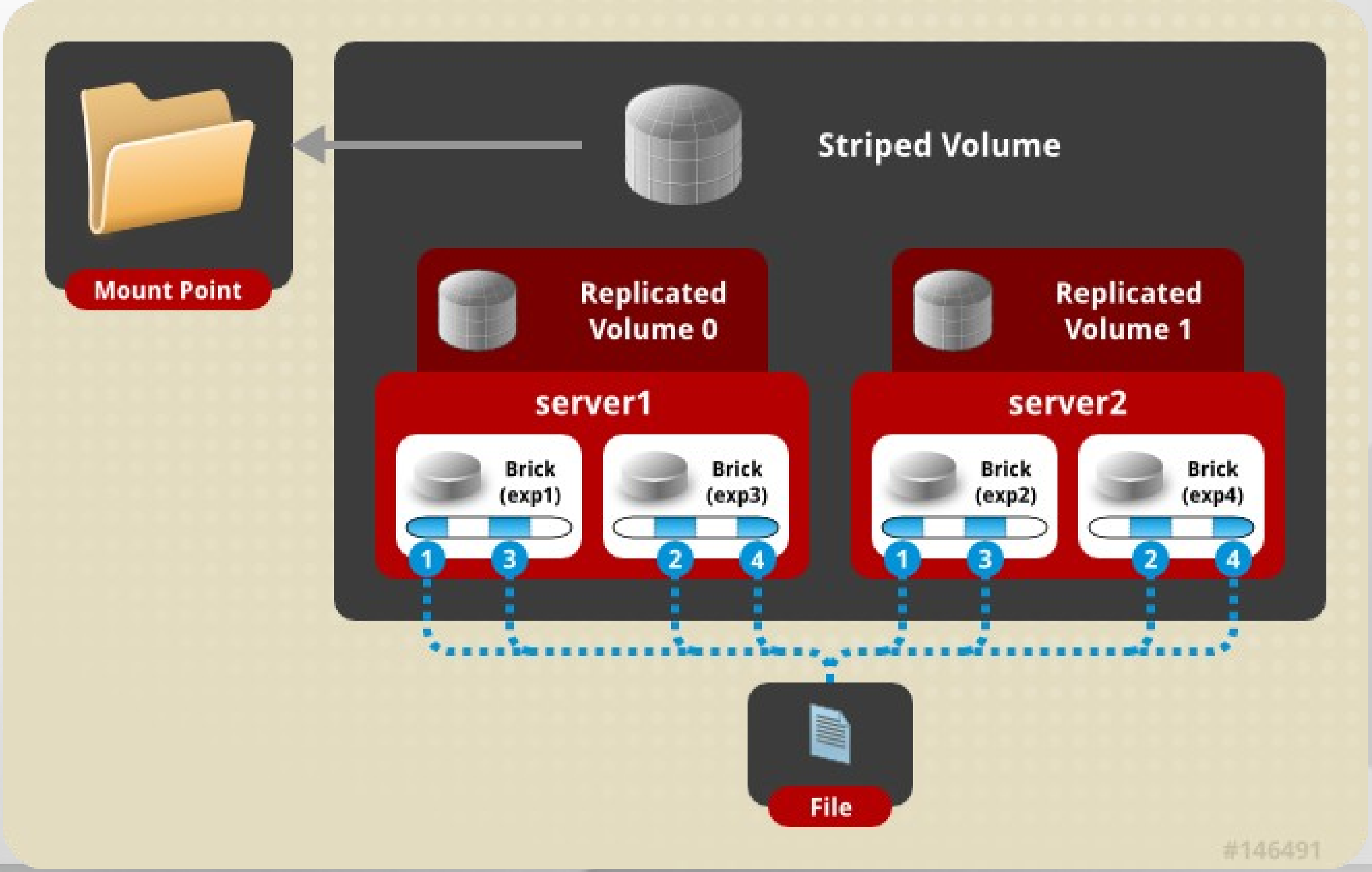
Distributed Striped Volume

- Files striped across two or more nodes
- Striping plus scalability



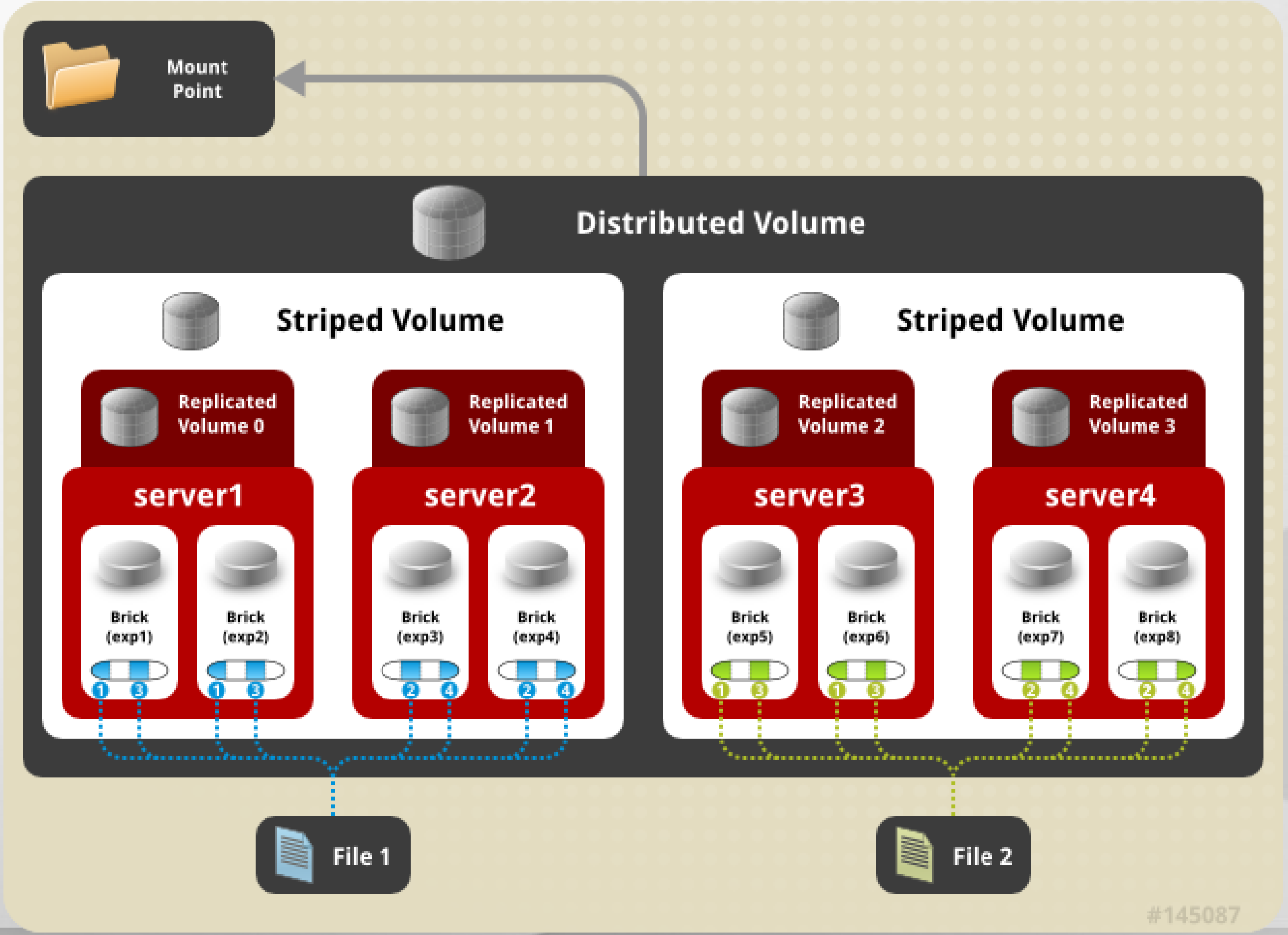
Striped Replicated Volume

- RHS 2.0 / GlusterFS 3.3+
- *Similar* to RAID 10 (1+0)



Distributed Striped Replicated Volume

- RHS 2.0 / GlusterFS 3.3+
- *Limited Use Cases* – Map Reduce



Asynchronous Offsite for DR and Archive

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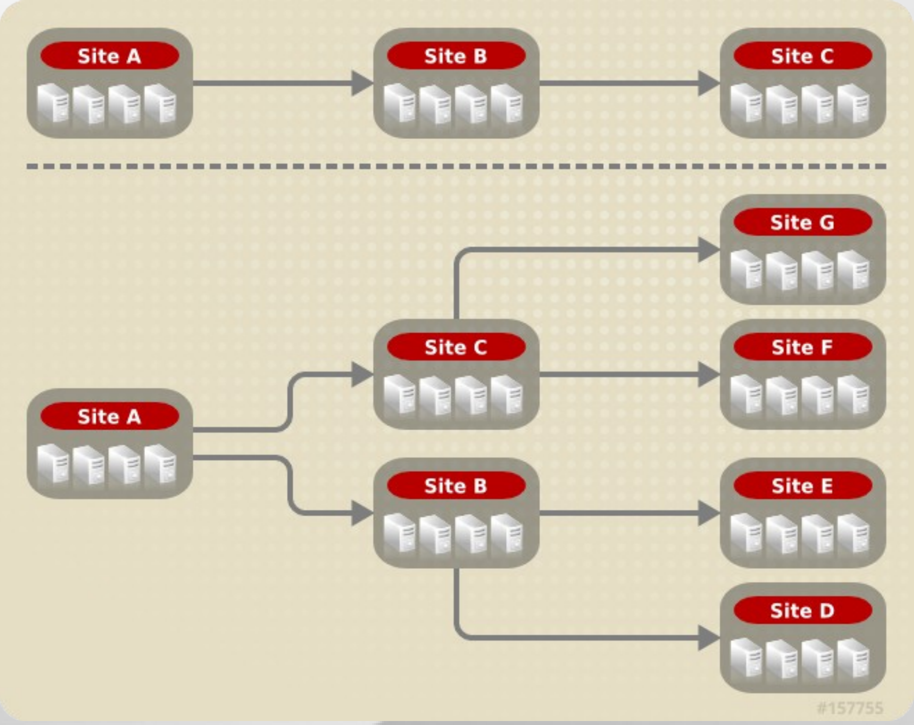
Geo Replication

- Asynchronous across LAN, WAN, or Internet
- Master-Slave model -- Cascading possible
- Continuous and incremental
- Data is passed between defined master and slave **only**



Replicated Volumes vs Geo-replication

Replicated Volumes	Geo-replication
Mirrors data across clusters	Mirrors data across geographically distributed clusters
Provides high-availability	Ensures backing up of data for disaster recovery
Synchronous replication (each and every file operation is sent across all the bricks)	Asynchronous replication (checks for the changes in files periodically and syncs them on detecting differences)

Data Access

GlusterFS Native Client (FUSE)

- FUSE kernel module allows the filesystem to be built and operated entirely in userspace
- Specify mount to any GlusterFS node
- Native Client fetches volfile from mount server, then communicates directly with all nodes to access data
- Recommended for high concurrency and high write performance
- Load is inherently balanced across distributed volumes

NFS

- Standard NFS v3 clients
  - *Note: Mount with `vers=3` option*
- Standard automounter is supported
- Mount to any node, or use a load balancer
- GlusterFS NFS server includes Network Lock Manager (NLM) to synchronize locks across clients
- Better performance for reading many small files from a single client
- Load balancing must be managed externally

NEW! libgfapi

- Introduced with GlusterFS 3.4
- User-space library for accessing data in GlusterFS
- Filesystem-like API
- Runs in application process
- no FUSE, no copies, no context switches
- ...but same volfiles, translators, etc.

SMB/CIFS

- NEW! In GlusterFS 3.4 – Samba + libgfapi
  - No need for local native client mount & re-export
  - Significant performance improvements with FUSE removed from the equation
- Must be setup on each node you wish to connect to via CIFS
- Load balancing must be managed externally

General Administration

Preparing a Brick

```
# lvcreate -L 100G -n lv_brick1 vg_server1
# mkfs -t xfs -i size=512 /dev/vg_server1/lv_brick1
# mkdir /brick1
# mount /dev/vg_server1/lv_brick1 /brick1
# echo '/dev/vg_server1/lv_brick1 /brick1 xfs defaults 1 2' >> /etc/fstab
```

Adding Nodes (peers) and Volumes

Peer Probe

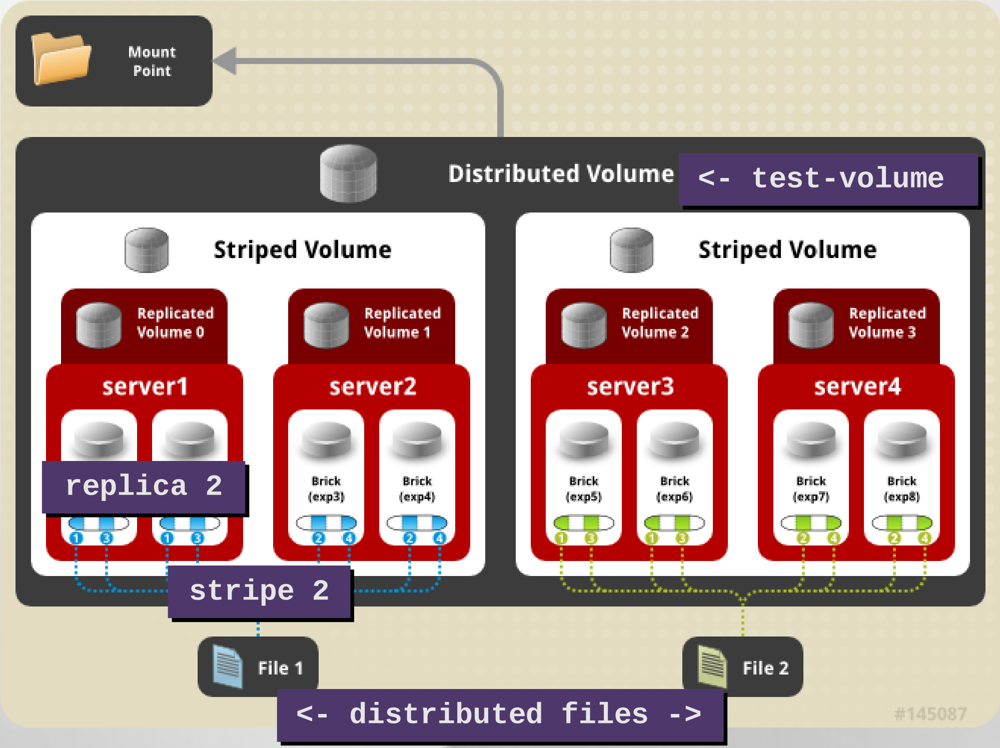
```
gluster> peer probe server3
gluster> peer status
Number of Peers: 2

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

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

Distributed Volume

```
gluster> volume create my-dist-vol server2:/brick2 server3:/brick3
gluster> volume info my-dist-vol
Volume Name: my-dist-vol
Type: Distribute
Status: Created
Number of Bricks: 2
Transport-type: tcp
Bricks:
Brick1: server2:/brick2
Brick2: server3:/brick3
gluster> volume start my-dist-vol
```

Distributed Striped Replicated Volume

```
gluster> volume create test-volume replica 2 stripe 2 transport tcp \
server1:/exp1 server1:/exp2 server2:/exp3 server2:/exp4 \
server3:/exp5 server3:/exp6 server4:/exp7 server4:/exp8
Multiple bricks of a replicate volume are present on the same server. This setup is not
optimal.
Do you still want to continue creating the volume?  (y/n) y
Creation of volume test-volume has been successful. Please start the volume to access
data.
```



Distributed Striped Replicated Volume

```
gluster> volume create test-volume stripe 2 replica 2 transport tcp \
server1:/exp1 server2:/exp3 server1:/exp2 server2:/exp4 \
server3:/exp5 server4:/exp7 server3:/exp6 server4:/exp8
Creation of volume test-volume has been successful. Please start the volume to access
data.
```

```
gluster> volume info test-volume

Volume Name: test-volume
Type: Distributed-Striped-Replicate
Volume ID: 8f8b8b59-d1a1-42fe-ae05-abe2537d0e2d
Status: Created
Number of Bricks: 2 x 2 x 2 = 8
Transport-type: tcp
Bricks:
Brick1: server1:/exp1
Brick2: server2:/exp3
Brick3: server1:/exp2
Brick4: server2:/exp4
Brick5: server3:/exp5
Brick6: server4:/exp7
Brick7: server3:/exp6
Brick8: server4:/exp8
```

Manipulating Bricks in a Volume

```
gluster> volume add-brick my-dist-vol server4:/brick4
```

```
gluster> volume rebalance my-dist-vol fix-layout start

gluster> volume rebalance my-dist-vol start
gluster> volume rebalance my-dist-vol status
     Node    Rebalanced-files          size       scanned      failures         status
---------         -----------   -----------   -----------   -----------   ------------
localhost                 112         15674           170            0       completed
10.16.156.72              140          3423           321            2       completed
```

```
gluster> volume remove-brick my-dist-vol server2:/brick2 start
gluster> volume remove-brick my-dist-vol server2:/brick2 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
gluster> volume remove-brick my-dist-vol server2:/brick2 commit
```

Migrating Data / Replacing Bricks

```
gluster> volume replace-brick my-dist-vol server3:/brick3 server5:/brick5 start
gluster> volume replace-brick my-dist-vol server3:/brick3 server5:/brick5 status
Current File = /usr/src/linux-headers-2.6.31-14/block/Makefile
Number of files migrated = 10567
Migration complete
gluster> volume replace-brick my-dist-vol server3:/brick3 server5:/brick5 commit
```

Volume Options

Auth

```
gluster> volume set my-dist-vol auth.allow 192.168.1.*
gluster> volume set my-dist-vol auth.reject 10.*
```

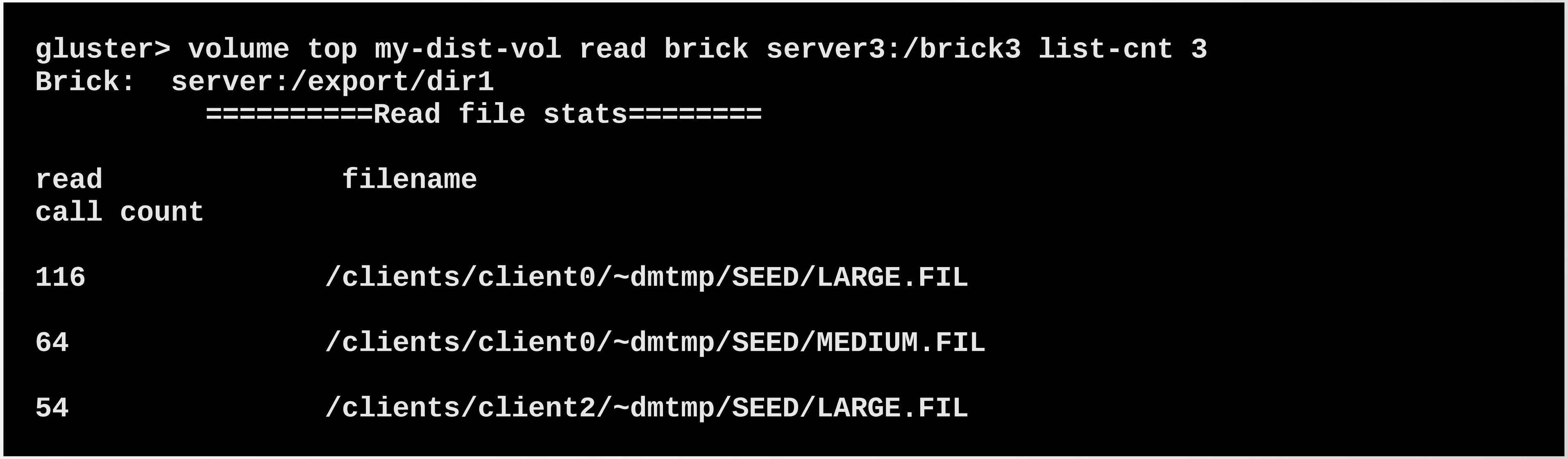
NFS

```
gluster> volume set my-dist-vol nfs.volume-access read-only
gluster> volume set my-dist-vol nfs.disable on
```

Other advanced options

```
gluster> volume set my-dist-vol features.read-only on
gluster> volume set my-dist-vol performance.cache-size 67108864
```

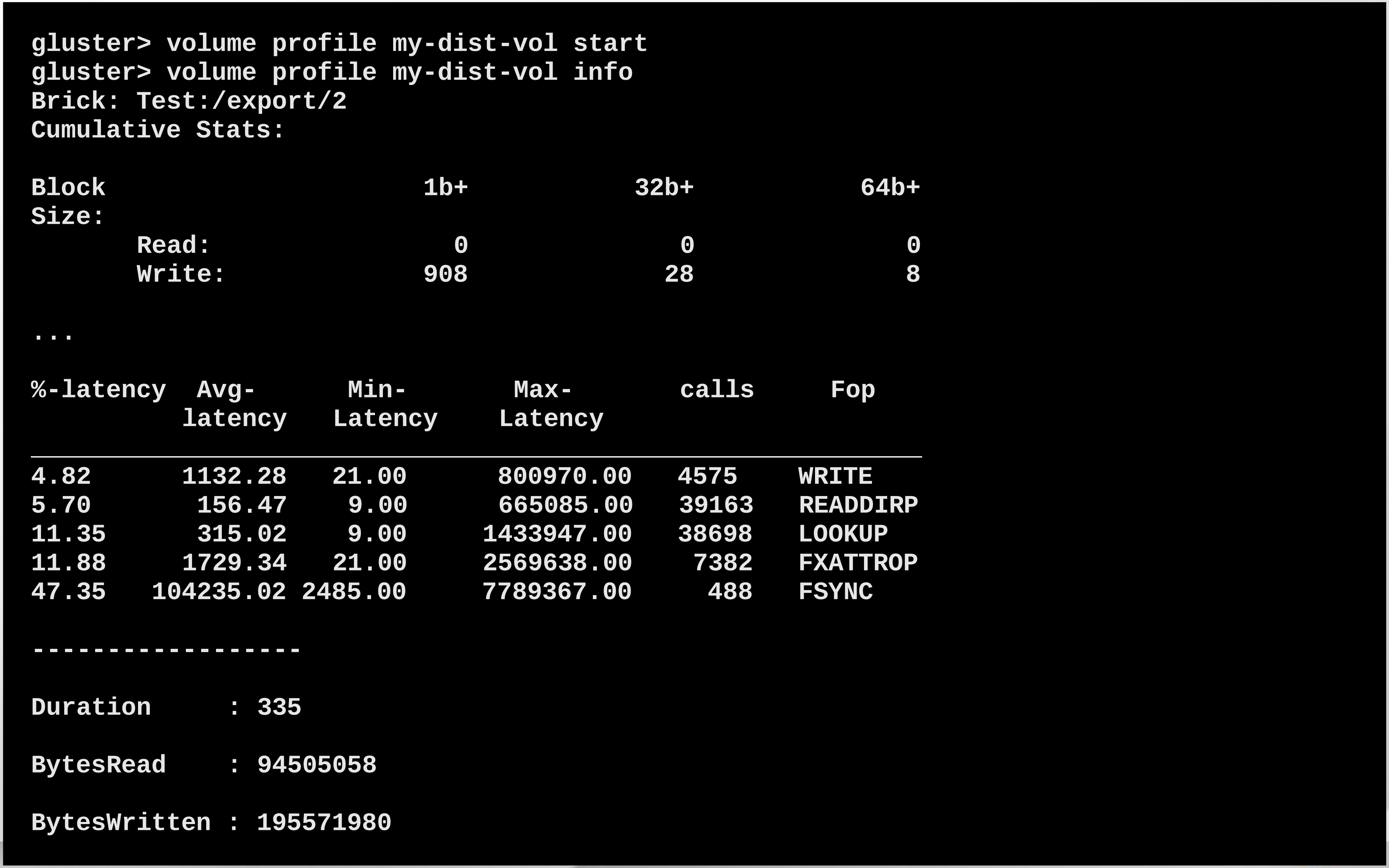
Volume Top Command



```
gluster> volume top my-dist-vol read brick server3:/brick3 list-cnt 3
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
```

- Many top commands are available for analysis of files, directories, and bricks
- Read and write performance test commands available
    - Perform active dd tests and measure throughput

Volume Profiling



```
gluster> volume profile my-dist-vol start
gluster> volume profile my-dist-vol info
Brick: Test:/export/2
Cumulative Stats:

Block                     1b+           32b+           64b+
Size:
       Read:                0              0              0
       Write:             908             28              8

...

%-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
```

Use Cases

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GlusterFS and RHS for the SysAdmin

Common Solutions

- Media / Content Distribution Network (CDN)
- Backup / Archive / Disaster Recovery (DR)
- Large Scale File Server
- Home directories
- High Performance Computing (HPC)
- Infrastructure as a Service (IaaS) storage layer

Hadoop – Map Reduce

- Access data within and outside of Hadoop
- No HDFS name node single point of failure / bottleneck
- Seamless replacement for HDFS
- Scales with the massive growth of big data

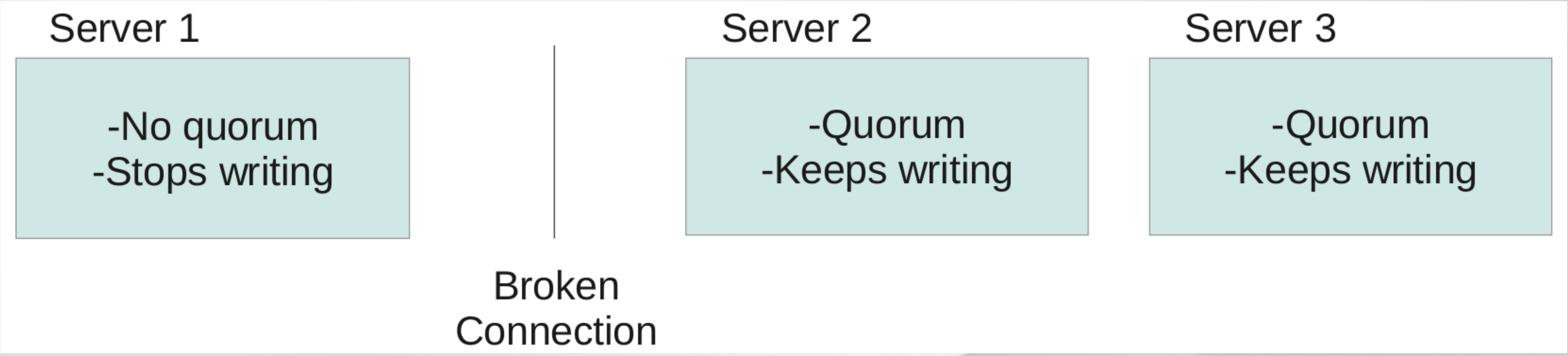
Common Pitfalls

Split-Brain Syndrome

- Communication lost between replicated peers
- Clients write separately to multiple copies of a file
- No automatic fix
  - May be subjective which copy is right – ALL may be!
  - Admin determines the “bad” copy and removes it
  - Self-heal will correct the volume
    - Trigger a recursive stat to initiate
    - Proactive self-healing in RHS 2.0 / GlusterFS 3.3

Quorum Enforcement

- Disallows writes (EROFS) on non-quorum peers
- Significantly reduces files affected by split-brain
- Preferred when data integrity is the priority
- Not preferred when application integrity is the priority



Server 1

-No quorum
-Stops writing

Broken
Connection

Server 2

-Quorum
-Keeps writing

Server 3

-Quorum
-Keeps writing

NEW! Server-Side Quorum

- In GlusterFS 3.3
  - Client-side
  - Replica set level
- NOW in GlusterFS 3.4
  - Server-side
  - Cluster-level (glusterd)

Your Storage Servers are Sacred!

- Don't touch the brick filesystems directly!
- They're Linux servers, but treat them like appliances
  - Separate security protocols
  - Separate access standards
- Don't let your Jr. Linux admins in!
  - A well-meaning sysadmin can quickly break your system or destroy your data

Do it!

Do it!

- Build a test environment in VMs in just minutes!
- Get the bits:
  - Fedora 19 has GlusterFS packages natively
  - RHS 2.1 RC ISO available on Red Hat Portal
  - Go upstream: www.gluster.org

Thank You!

Slides Available at: **http://people.redhat.com/ndevos/talks/**
(based on the slide deck from Dustin Black)

- **ndevos@redhat.com**

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- **RHS:**

  www.redhat.com/storage/
- **GlusterFS:**

  www.gluster.org
- **TAM:**
  access.redhat.com/support/

@Glusterorg

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