Software Defined Storage with Gluster

Customer Convergence Raleigh
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Technical Account Manager - FSI
February 7th, 2019

Agenda

- Software Defined Storage
  - Why?
  - What is it?
- Red Hat Gluster Storage (RHGS)
  - Concepts
  - Architecture
  - Features
- Applications
  - General Applications
  - Container Native Storage
  - Red Hat Storage One
  - Sample Customers
- Demo

Software Defined Storage

The Data Explosion

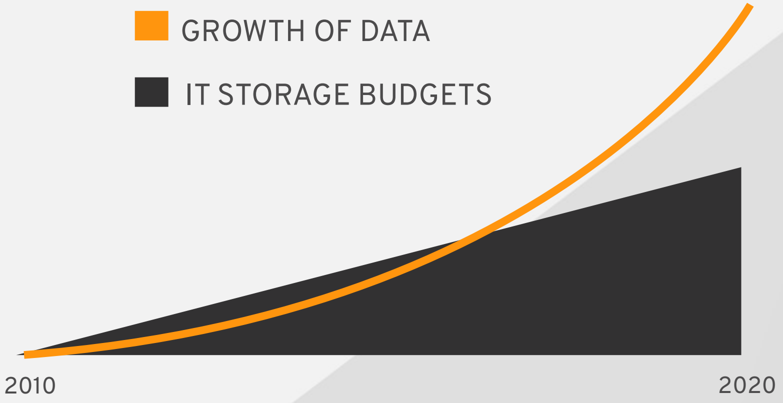
WEB, MOBILE, SOCIAL MEDIA, CLOUD
Our digital assets have grown exponentially due to web scale services like Facebook, Flickr, Snapchat, YouTube, and Netflix.

VIDEO ON-DEMAND SERVICES
Rapid growth of video on-demand has culminated in 50% of households using this service.

MEDIA AND ENTERTAINMENT INDUSTRIES
A staggering amount of content is created during today's optimized production processes.

MEDICAL INDUSTRY
Medical imaging needs are vast, and regulatory requirements can be demanding.

The Data Storage Shortfall



- Data stores are growing exponentially, while IT budgets are not
- HDDs are becoming more dense, but $/GB decline is slowing
- Software and hardware advances are needed to close the gap

The Datacenter is Changing

DEVELOPMENT MODEL	APPLICATION ARCHITECTURE	DEPLOYMENT AND PACKAGING	APPLICATION INFRASTRUCTURE	STORAGE
Waterfall	Monolithic	Bare Metal	Data Center	Scale Up
Agile	N-Tier	Virtual Services	Hosted	Scale Out
DEVOPS	MICROSERVICES	CONTAINERS	HYBRID CLOUD	SOFTWARE-DEFINED STORAGE

What is Software Defined Storage?

SERVER-BASED

CENTRALIZED CONTROL

OPEN ECOSYSTEM

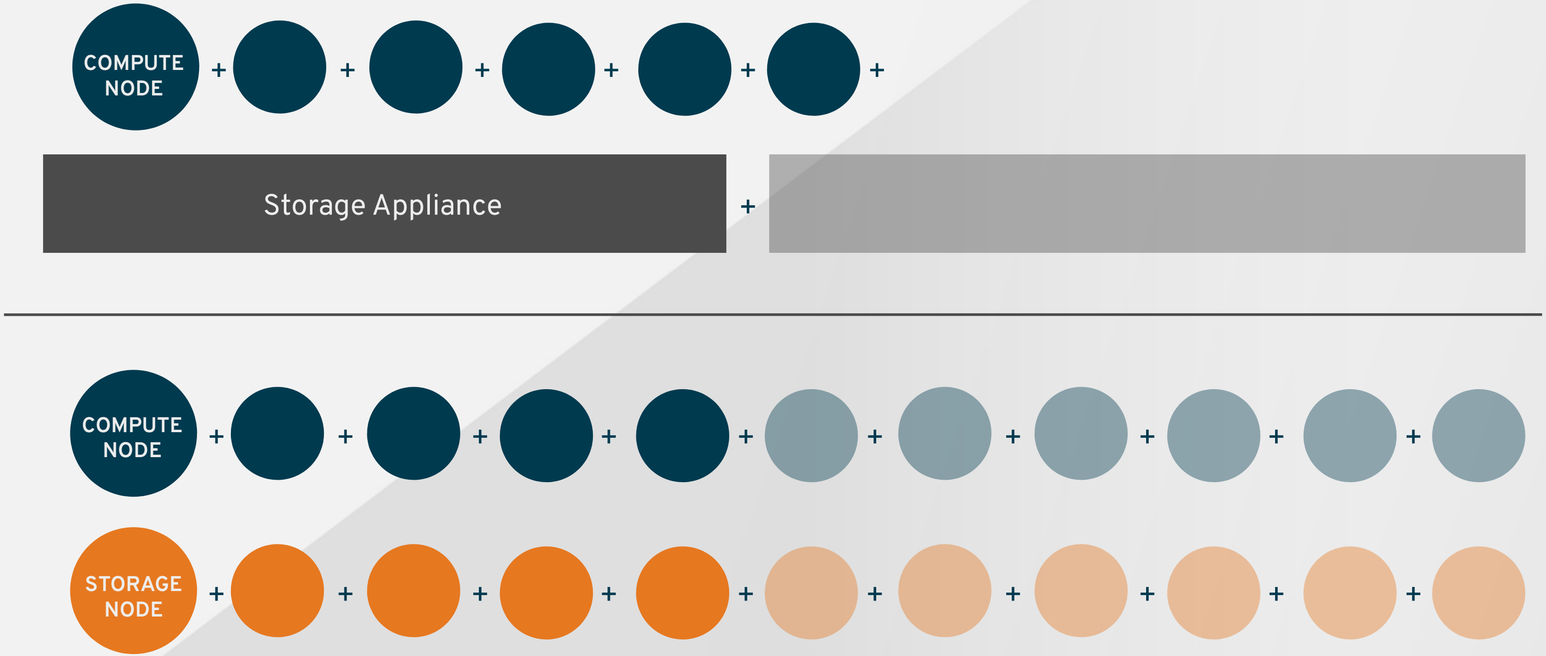
Industry Standard Hardware

Standardization makes storage more convenient

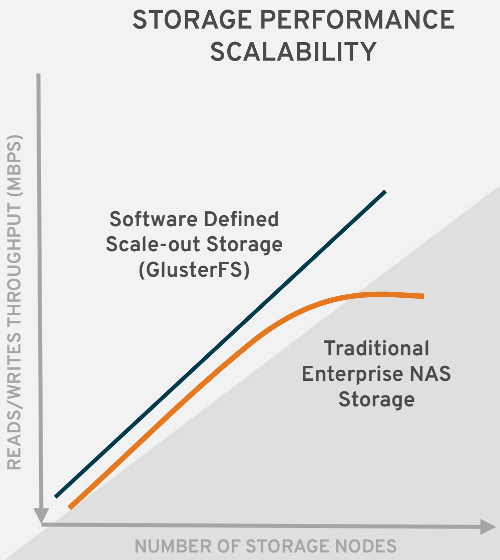
Customers can build clusters using standard hardware from existing vendors that's perfect for their workload.

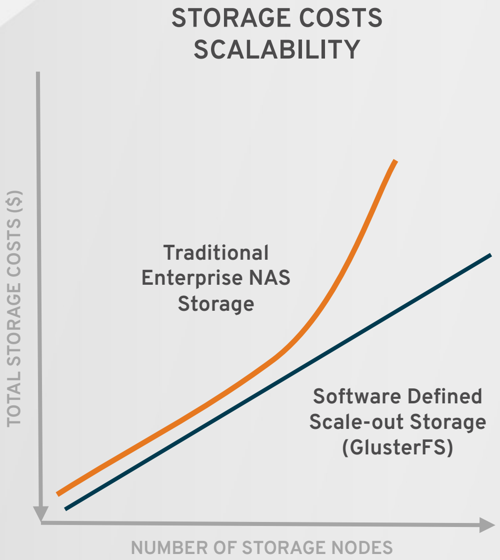
- Clusters can be performance-optimized, capacity-optimized, or throughput-optimized
- Need capacity? Add more disks. Too slow? Add more servers.
- Clusters can become larger or smaller with no downtime

Virtualized Storage Scales Better



Comparing Throughput and Costs at Scale



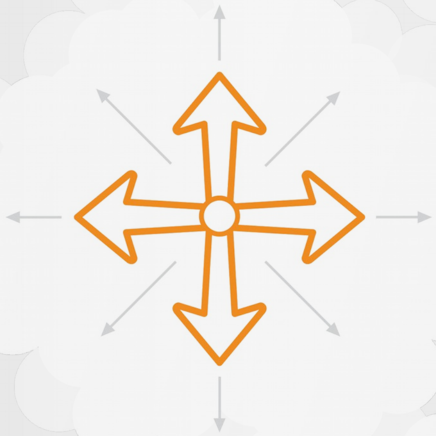


The Robustness of Software

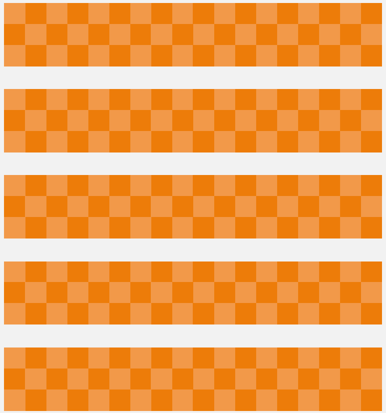
Software can do things hardware can't

Storage services based on software are more flexible than hardware-based implementations

- Can be deployed on bare metal, inside containers, inside VMs, or in the public cloud
- Can deploy on a single server, or thousands, and can be upgraded and reconfigured on the fly
- Grows and shrinks programmatically to meet changing demands

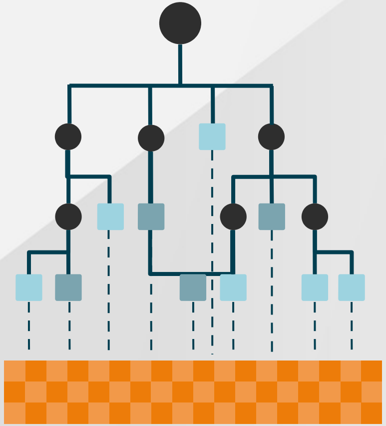


Different Kinds of Storage



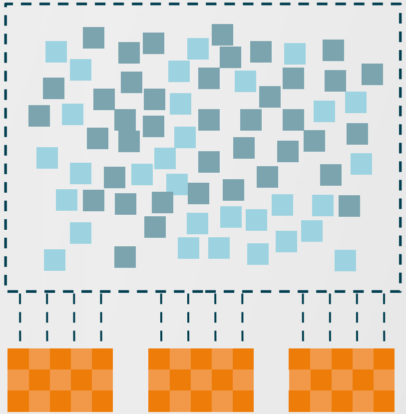
BLOCK STORAGE

Data as sequential uniform **blocks**



FILE STORAGE

Data as buckets of hierarchical **folders and files**



OBJECT STORAGE

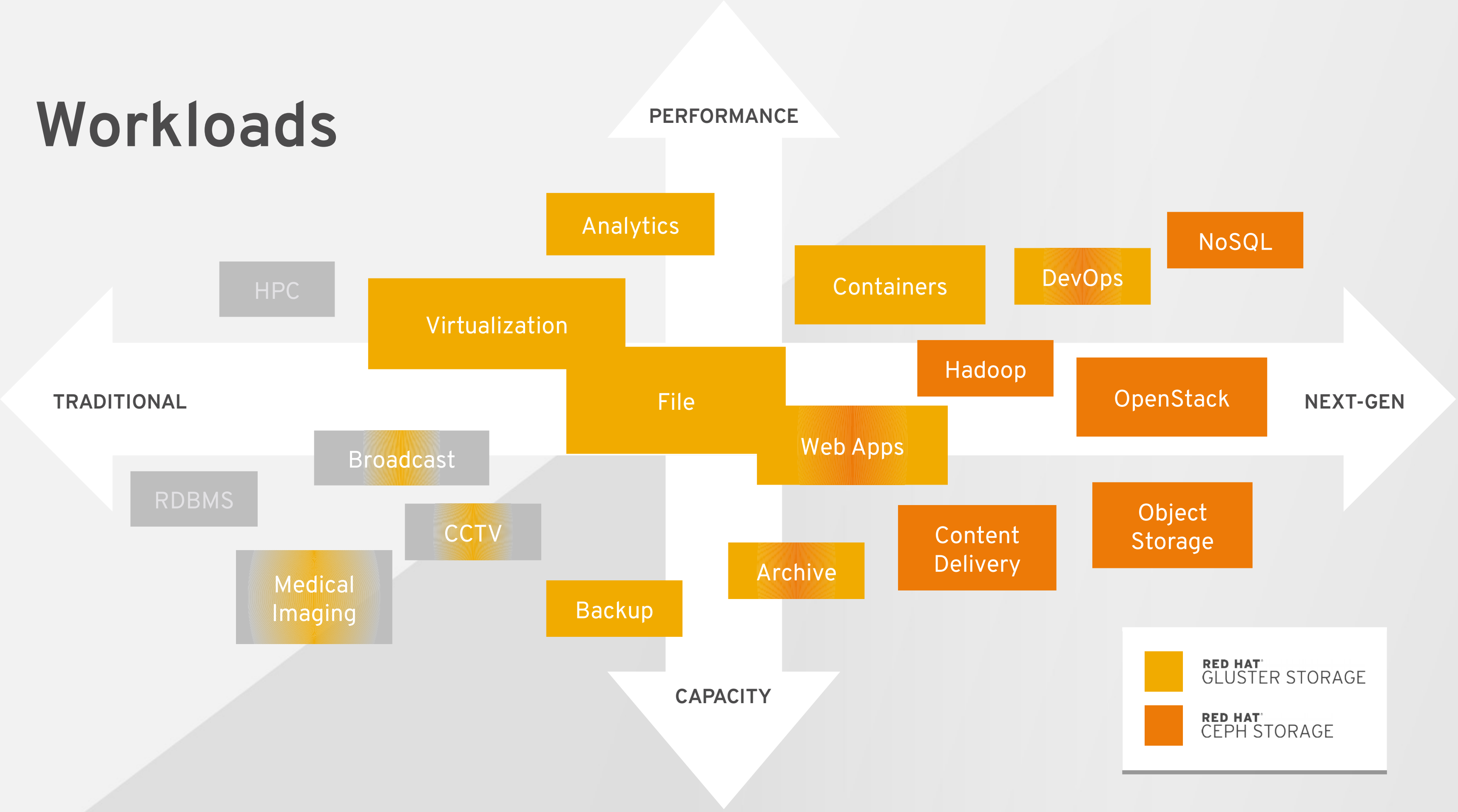
Data as a predictably mapped, loosely structured cluster of **objects**

How Storage Fits

RED HAT® STORAGE

PHYSICAL	VIRTUAL	PRIVATE CLOUD	CONTAINERS	PUBLIC CLOUD
RED HAT® CEPH STORAGE	RED HAT® CEPH STORAGE	RED HAT® CEPH STORAGE	RED HAT® CEPH STORAGE	RED HAT® CEPH STORAGE
RED HAT® GLUSTER STORAGE	RED HAT® GLUSTER STORAGE	RED HAT® GLUSTER STORAGE	RED HAT® GLUSTER STORAGE	RED HAT® GLUSTER STORAGE
RED HAT® ENTERPRISE LINUX®	RED HAT® ENTERPRISE LINUX®	RED HAT® OPENSTACK® PLATFORM	OPENSHIFT ENTERPRISE by Red Hat	RED HAT® ENTERPRISE LINUX®
	RED HAT® ENTERPRISE VIRTUALIZATION			

Workloads


PERFORMANCE
CAPACITY
TRADITIONAL
NEXT-GEN
Analytics
HPC
Virtualization
Containers
DevOps
NoSQL
Hadoop
OpenStack
File
Web Apps
Broadcast
RDBMS
CCTV
Medical Imaging
Backup
Archive
Content Delivery
Object Storage
RED HAT GLUSTER STORAGE
RED HAT CEPH STORAGE

Red Hat Gluster Storage (RHGS)

Red Hat Gluster Storage

Half the price for comparable features & greater flexibility

RED HAT® GLUSTER STORAGE

KEY STRENGTHS

- Straightforward, adaptable, embeddable architecture
- Competitive TCO
- Experience of large-scale production customers
- Thriving community

Open source, distributed, scalable, software-defined storage with enterprise-grade capabilities

Security
In-flight encryption
At-rest encryption
SELinux enforcing

Data Services
NFS/SMB access
Snapshots
Clones
Quotas
Mirroring
Tiering

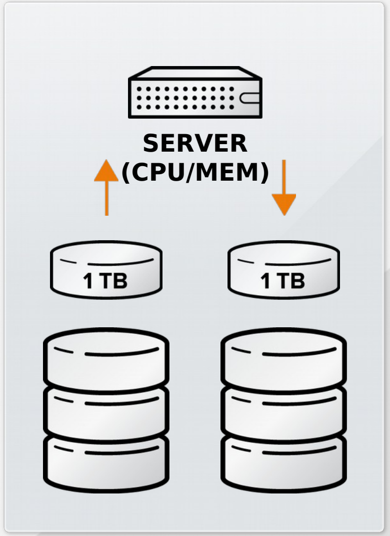
Data Integrity
Erasure coding
Replication
Geo-replication
Self-healing
Bit-rot detection

Architecture & Terms

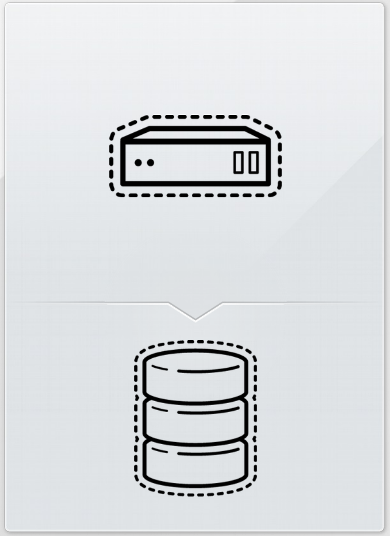
What is a system?

Can be physical, virtual or cloud

PHYSICAL



VIRTUAL



CLOUD

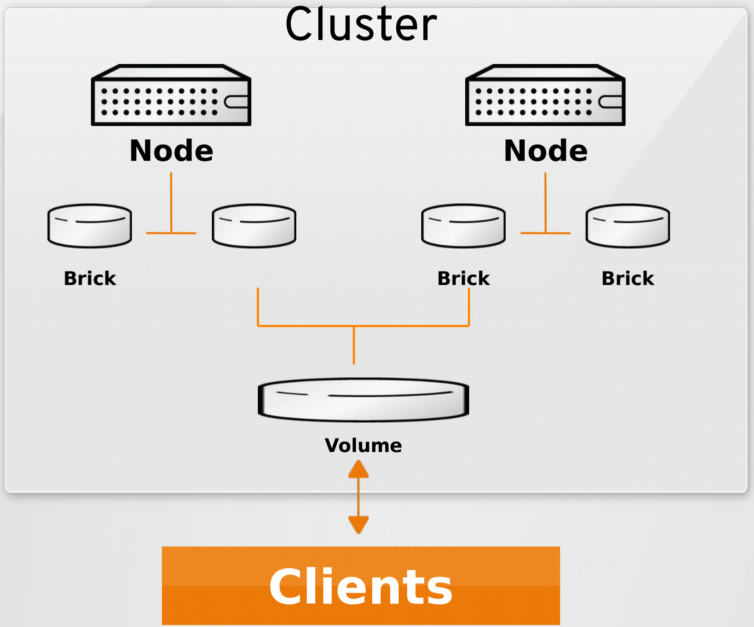
Clusters - Nodes – Bricks - Volumes

Cluster: Collection of peer systems

Node: System Participating in Cluster

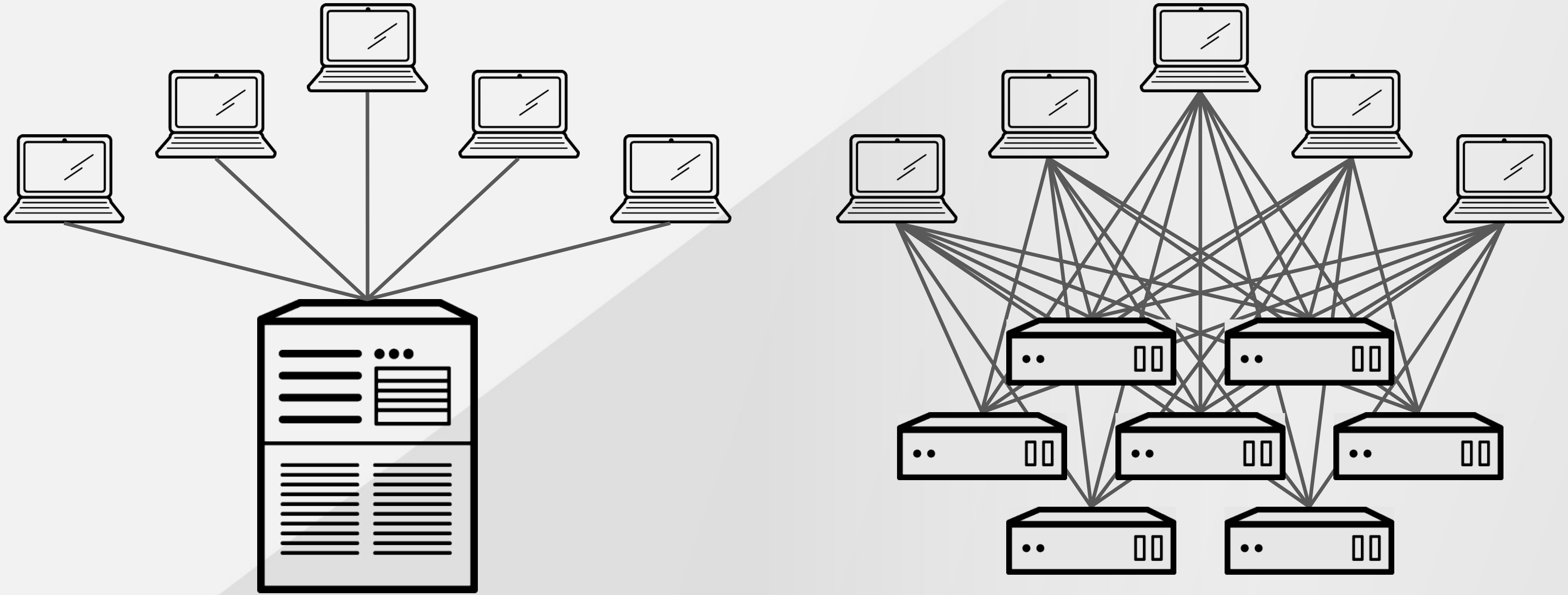
Brick: Any Linux Block Device

Volume: Bricks taken from one or more hosts presented as a single unit



How Does Gluster Do It?

The Data Placement Challenge



The Data Placement Challenge

Imagine a storage pool of thousands of data volumes

- How can we store data reproducibly?
- What happens if we add disks?
- What happens if a disk fails?
- How can we ensure data is written evenly across all volumes?

Elastic Hashing Algorithm

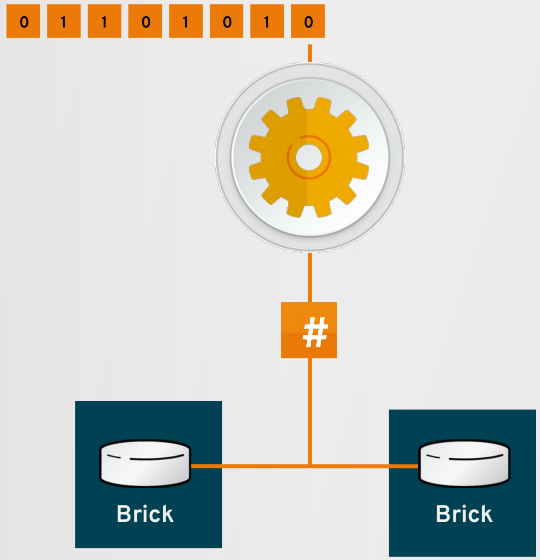
No metadata servers = No single point of failure

Elastic Hashing

- Enables petabyte scale
- Files assigned to virtual volumes
- Virtual volumes assigned to multiple bricks
- Volumes easily reassigned on-the-fly

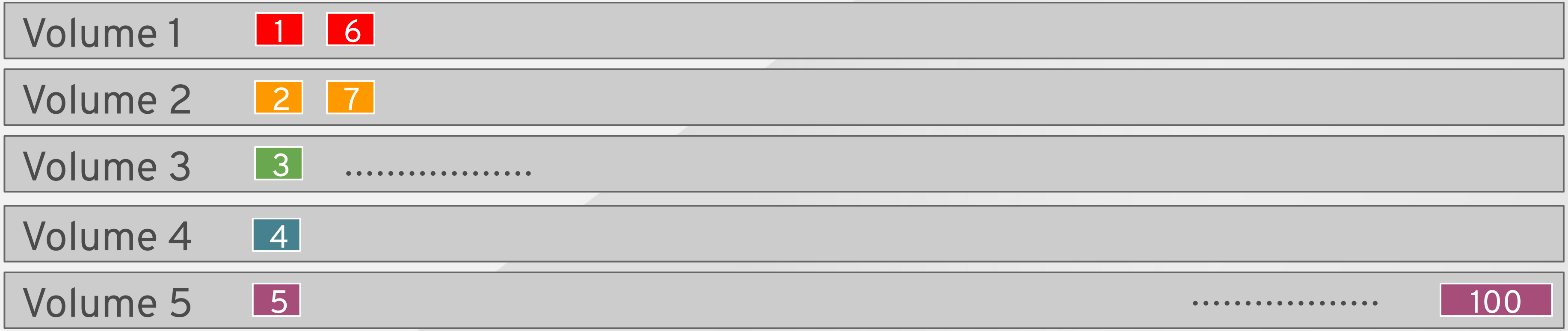
Location Hashed on Filename

- No performance bottleneck
- Eliminates risk scenarios



Simple Approach – Round Robin

How to store 100 objects on 5 disks



Round Robin works efficiently, but has a crucial bottleneck, central metdata

Hash-based Data Placement

Identifying Key (i.e., file name)

Calculated Hash:
6c7b0f12

Hash Ranges	00000000 - 33333333	33333334 - 66666666	66666667 - 99999999	9999999a - cccccccc	cccccccd - ffffffff

Data Volumes

Hash-based Data Placement

- Clients and daemons both use the hash algorithm to compute the object location (reading and writing)
- There is no centralized lookup table
- Enables massive scaling by cleanly distributing the work to all the clients and daemons
- Replication logic ensures data resilience

How Do We Maintain the Hash Tables?

Hash Ranges	00000000 - 55555555	55555556 - aaaaaaaa	aaaaaaab - ffffffff
Data Volumes			

Hash Ranges	00000000 - 33333333	33333334 - 66666666	66666667 - 99999999	9999999a - cccccccc	cccccccd - ffffffff
Data Volumes					

Distributing Data by Modulo

The actual distribution

Object ID	1	2	3	4	5	6	7	8	9	10	11	12
modulo(3)	1	2	0	1	2	0	1	2	0	1	2	0

So it seems we've found a solution to evenly distribute data and to easily retrieve it, BUT…

Distributing Data by Modulo

What happens if we add a disk?

With 5 data volumes we get this distribution:

Object ID	1	2	3	4	5	6	7	8	9	10	11	12
modulo(3)	1	2	0	1	2	0	1	2	0	1	2	0

With 5 data volumes we get this distribution:

Object ID	1	2	3	4	5	6	7	8	9	10	11	12
modulo(5)	1	2	3	4	0	1	2	3	4	0	1	2

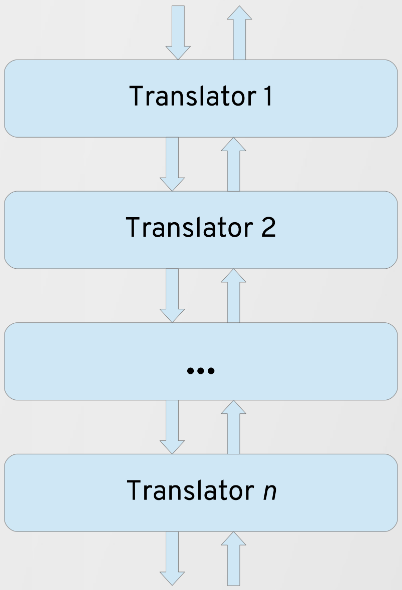
Every object with an ID > 3 needs to be relocated!

Layered Features

Translation Layers

Translation layers handle:

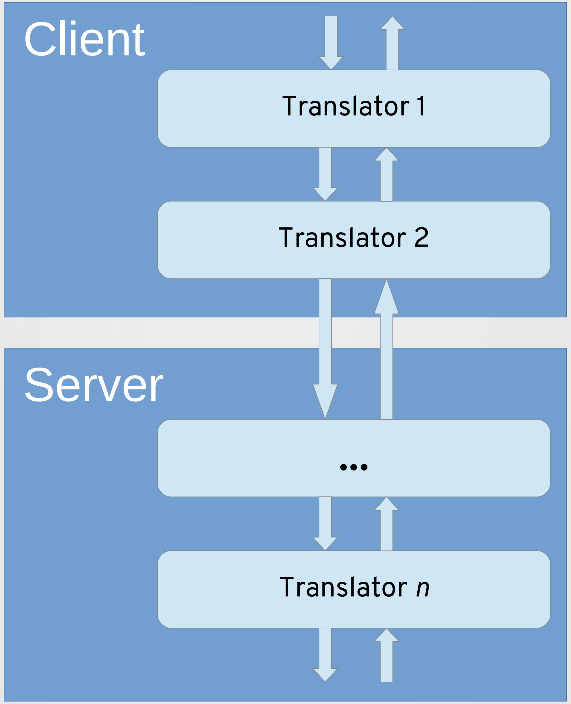
- Data resilience scheme is maintained (replication, erasure coding)
- Metadata is stored and tracked with the object
- Dynamic mapping from virtual volumes to data volumes
- Heal, Rebalance, Bitrot Detection, Geo-Replication, …
- Data translation hierarchy (protocols, encryption, performance, …)
- Health monitoring, alerting, and response



Server- and Client-Side Translators

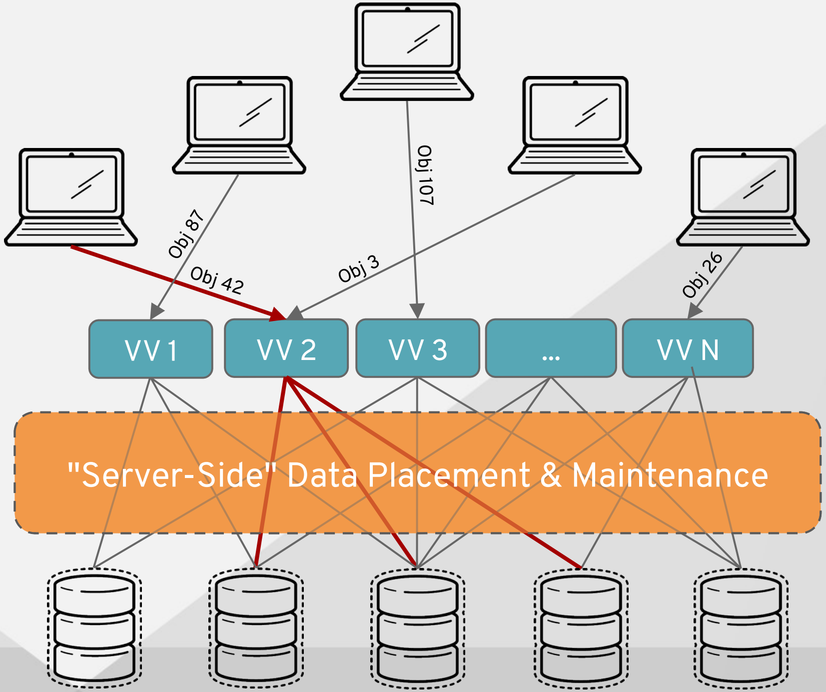
Translations layers may be distributed!

- Some layers in the translator stack may be implemented on the client
- Higher performance and efficiency



Virtual Data Volumes

Scale data volumes independently of data placement



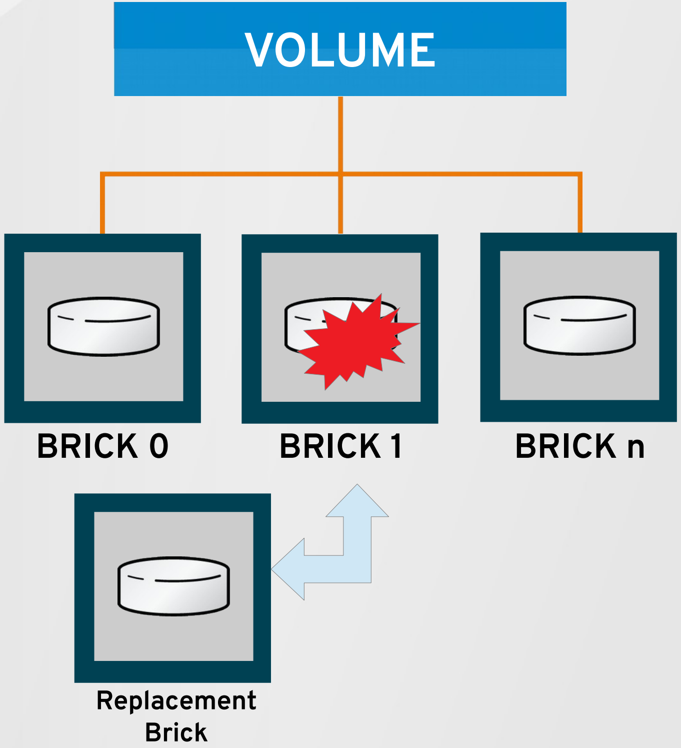
- Abstract layer between objects and data volumes
- Allows flexibility to handle replication or other data protection

Self Healing
Automatic Repair

- Automatic Repair of Files
  - As they are accessed
  - Periodic via Daemon

Scenarios:

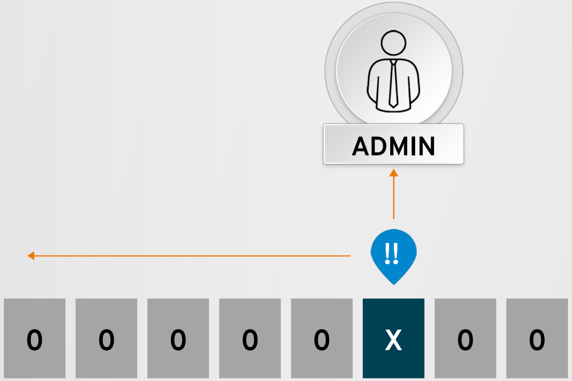
- Node offline
  - Bricks on node need to be caught up to current
- Node or brick loss
  - New brick needs to be completely rebuilt



Bit Rot Detection

Detecting silent data corruption

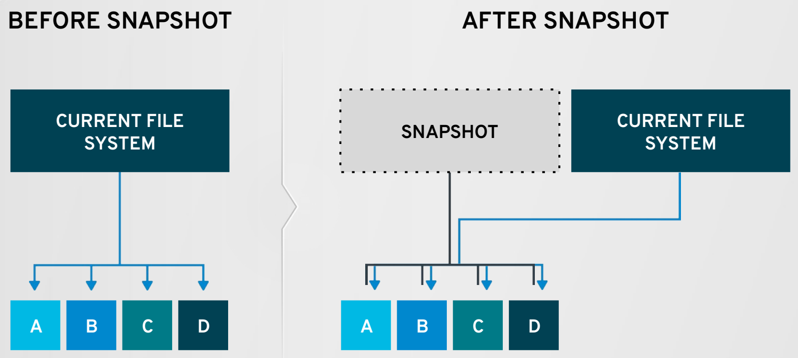
- Scans data periodically for bit rot
- Check sums are computed when files are accessed and compared against previously stored values
- On mismatch, an error is logged for the storage admin



Snapshots

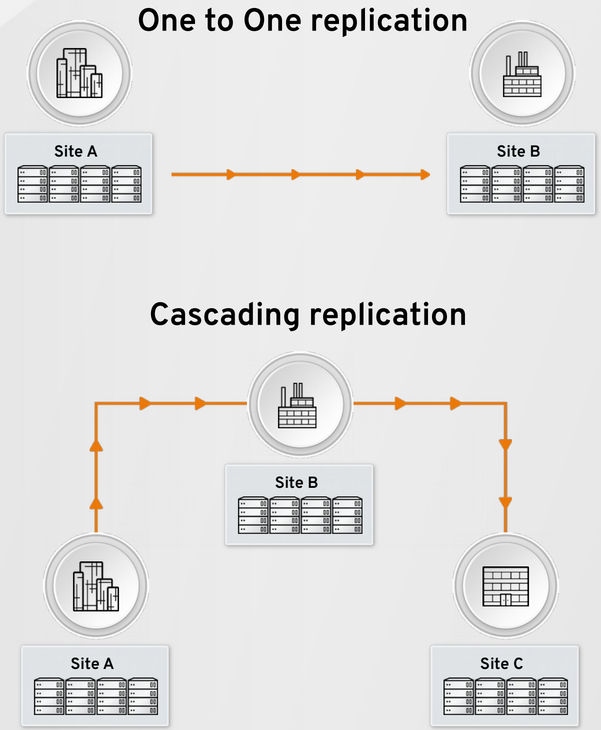
Storing point in time state of the cluster

- Volume level, ability to create, list, restore, and delete
- LVM2 based, operates only on thin-provisioned volumes
- User serviceable snapshots
- Crash consistent image



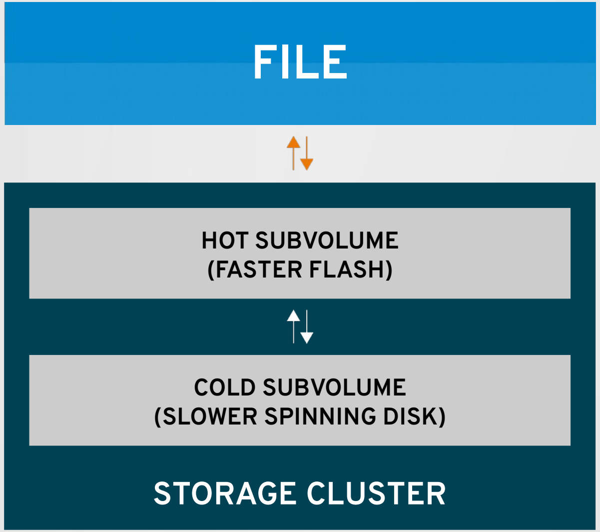
Geo Replication
Multi-site content distribution

- Asynchronous across LAN, WAN, or Internet
- Performance considerations:
  - Parallel transfers
  - Efficient source scanning
  - Pipelined and batched
  - File type/layout agnostic
- Continuous and incremental
- Failover and Fallback
- Configurations:
  - One-to-one or one-to-many
  - Cascading



Tiering

- Automated promotion and demotion of data between “hot” and “cold” sub volumes
- Based on frequency of access
- Cost-effective flash acceleration



Quotas

Volume and Directory Level Support

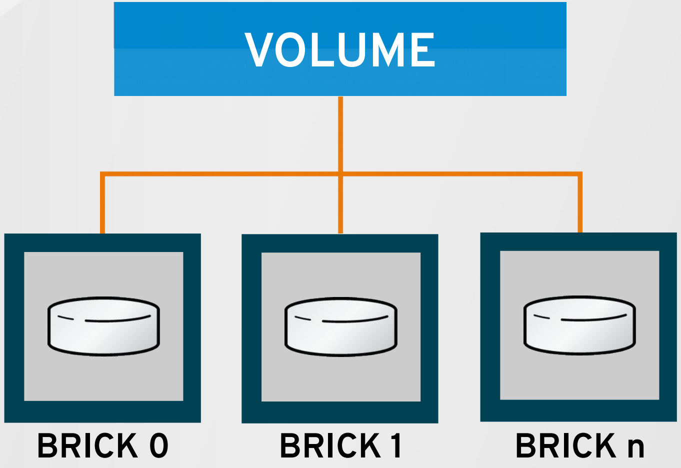
- Control disk utilization at both directory and volume level

Quota Limits

- Two levels of quota limits: Soft (default) and hard
- Warning messages issued on reaching soft quota limit
- Write failures with EDQUAT message after hard limit is reached

Global vs. Local Limits

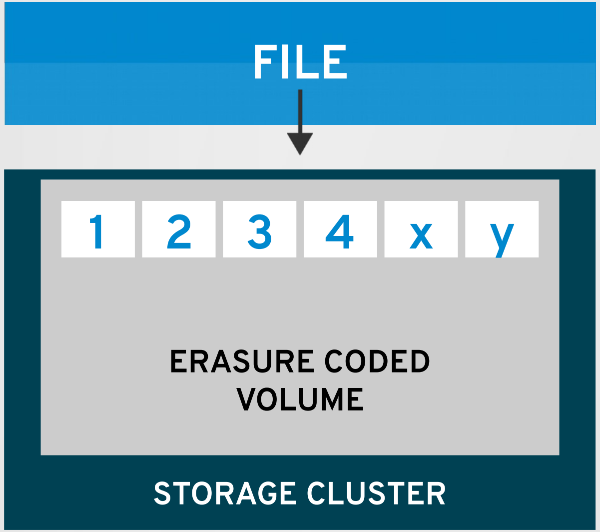
- Quota is global (per volume)
- Files are psuedo-randomly distributed across bricks



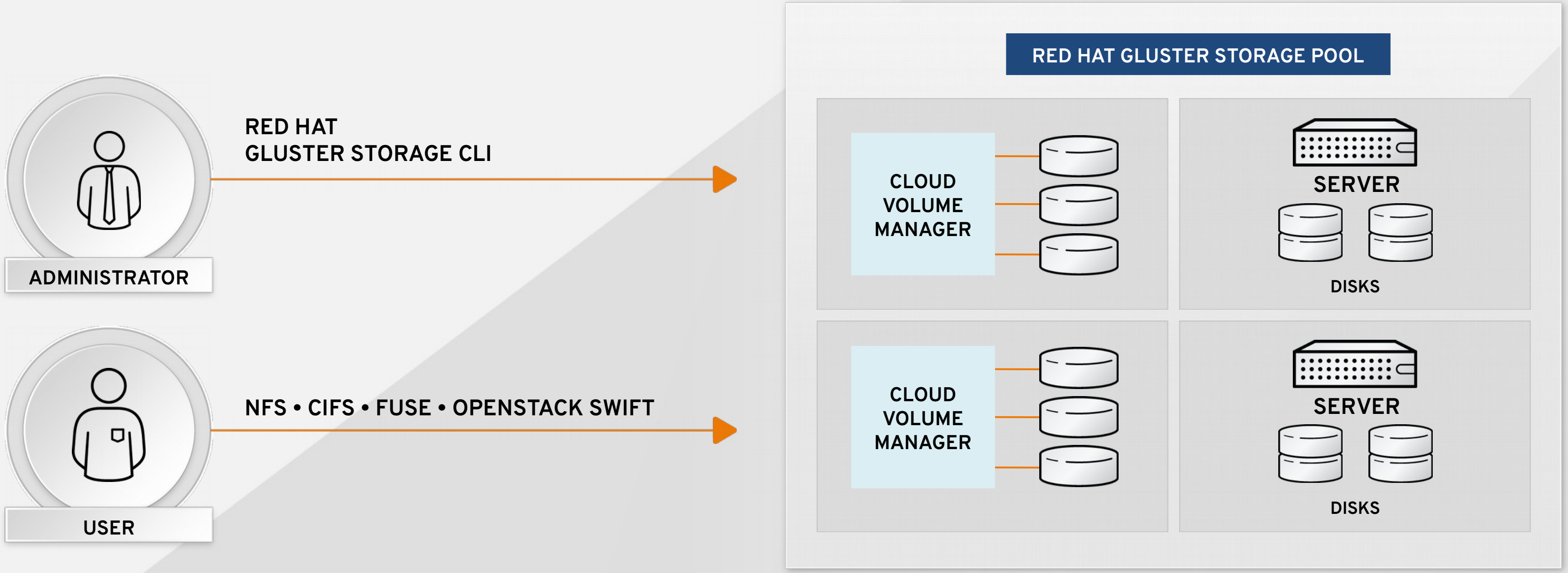
Erasure Coding

Storing data with less hardware

- Reconstruct corrupted or lost data
- Eliminates the need for RAID
- Consumes far less space than replication
- Appropriate for capacity-optimized use cases



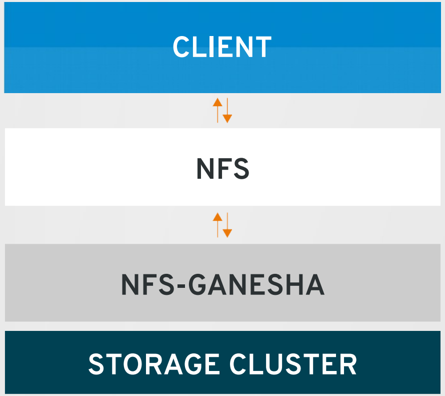
Multi Protocol Support



Security

Scalable NFSvs Client

- Client access with simplified failover and failback in the case of a node or network failure
- ACLs for additional security
- Kerberos authentication
- Dynamic export management



Network Encyption

- TLS/SSL for authentication and authorization
- Encryption in transit and transparent encryption (at rest)
- I/O encryption and management encryption

Applications

RED HAT GLUSTER STORAGE

Media, video

Machine, Log Data

GeoSpatial

Persistent Storage

Documents

A SIX-NODE CLUSTER CAN PROCESS...

JPEG Web Image Files (32KB)

72x 7.2K HDD		Optimized 72x 7.2K HDD		72x SSD
1700 JPEGs per second	or	**12,000** JPEGs per second	or	**23,000** JPEGs per second

OR...

DVD
Movie Files
(4GB)

72x 7.2K HDD		Optimized 72x 7.2K HDD		72x SSD
1 DVD per second	or	**2** DVDs per second	or	**4** DVDs per second

OR...

High-Def
CCTV Camera
Recording Streams

72x 7.2K HDD	Optimized 72x 7.2K HDD	72x SSD
200 CCTV streams within latency threshold	**500** CCTV streams within latency threshold	**?** CCTV streams within latency threshold

or

or

Red Hat Storage One

Pre-configured Storage Hardware and Software

TRADITIONAL DIY SOFTWARE-DEFINED STORAGE DEPLOYMENT

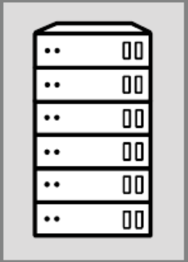
- Evaluate storage servers
- Evaluate storage software
- Optimize for target workload
- Conduct a proof of concept
- Procure and license at scale
- Install
- Manually deploy
- Multiple support contracts

OR...

RED HAT STORAGE ONE BY SUPERMICRO

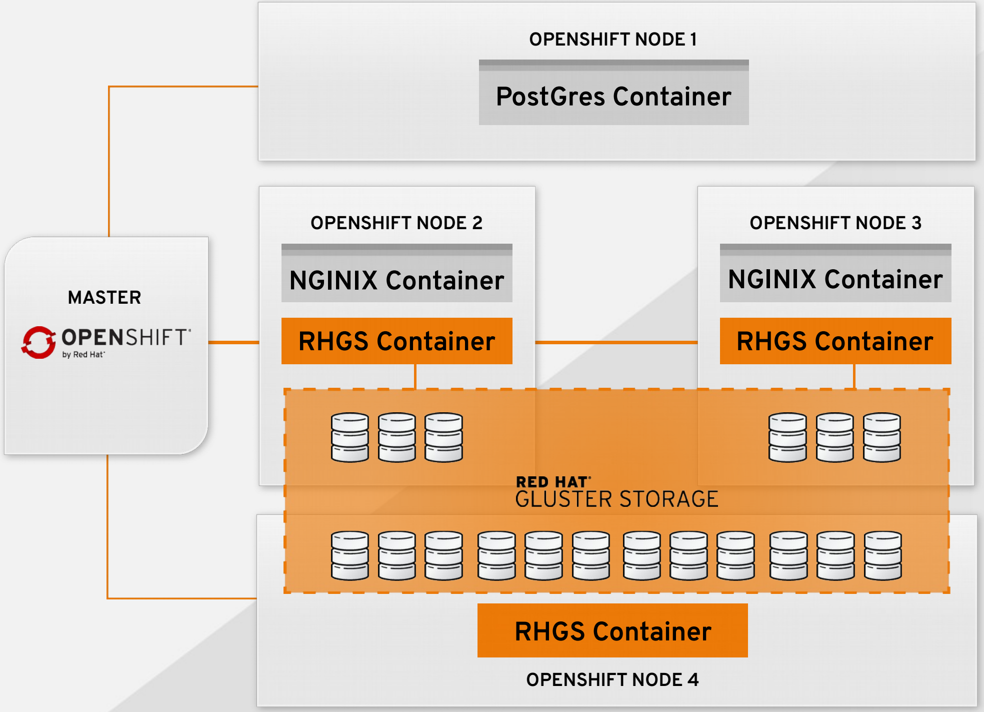
- Workload-optimized, tested, self-configuring, and ready in minutes
- Hundreds of terabytes to petaybtes of useable resilient Red Hat Gluster Storage
- Hardware, software, and support in a single Supermicro part number

General-purpose NAS



Content repositories

CONTAINER-NATIVE STORAGE



Lower TCO

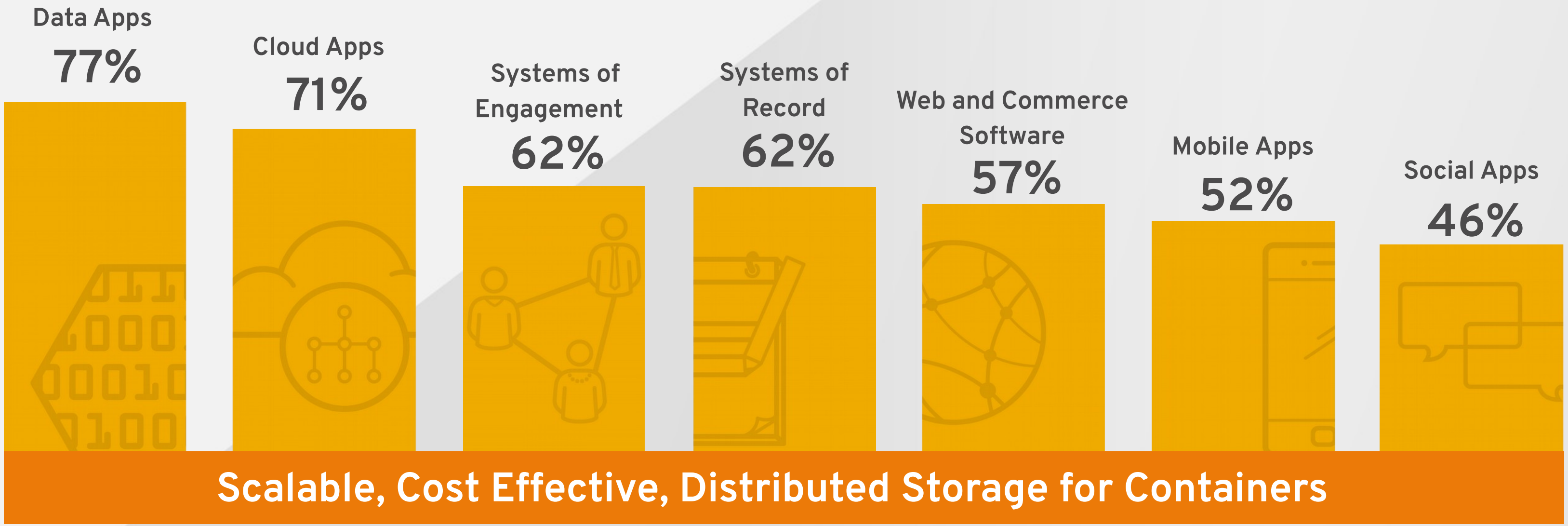
Unified Orchestration

Ease of Use

Greater control

WHY PERSISTENT STORAGE FOR CONTAINERS?

"For which workloads or application use cases have you used/do you anticipate to use containers?"



Base: 194 IT operations and development decision-makers at enterprise in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

Use Cases

IOPS OPTIMIZED	THROUGHPUT OPTIMIZED	COST/ CAPACITY OPTIMIZED
Use Case: MySQL	Use Case: Rich Media	Use Case: Active Archives

General SDS Hardware Performance & Sizing

Container Storage Center of Excellence

Joint Innovation With Partners
Performance and Sizing Guides

http://red.ht/2mg9kQ5

http://red.ht/2k6uYcg

“Red Hat worked with us the entire way as we designed and built our architectures, helping with best practices, design considerations and layout, performance testing, and migration.”

Mohit Anchlia
Architect, Intuit TurboTax

MANAGING UNSTRUCTURED FINANCIAL DATA AT WEB SCALE

BUSINESS CHALLENGE

Needed a fast, reliable and cost-effective storage solution to meet growing SaaS line of business

Tax returns and other data were being stored as BLOBs in an expensive Oracle Database

Replication required database hacks, disaster recovery was challenging

SOLUTION

Red Hat Gluster Storage

HP ProLiant DL2000 Multi Node Server

BENEFITS

Provides scalable on-demand storage for unstructured data

Cost-effective solution that leverages commodity hardware

Helps meet growing capacity and peak performance needs

Lets you achieve multisite DR strategy

“By standardizing on Red Hat Storage Server on commodity hardware, we were able to quickly scale our infrastructure to manage massive amounts of data while significantly decreasing our costs.”

David Yaffe
Technical Analyst, SaskTel

GATHERING TELCO BUSINESS INSIGHTS FROM MACHINE DATA

BUSINESS CHALLENGE

Storage and analysis of massive amounts of server and device logging information

Data analysis involved many separate tools and steps

Logical and physical silos led to high incident response times

Proprietary storage too expensive

SOLUTION

Red Hat Gluster Storage

Splunk Enterprise, HP servers

BENEFITS

CASIO®

"Our costs, including various procurement costs and operating fees, fell to less than half of what we had been before implementing Red Hat Storage Server. The solution's flexibility enabled us to build a storage environment using commodity servers and its ease of operational control was also a major advantage."

Kazuyasu Yamazaki

SCALABLE, COST-EFFECTIVE STORAGE FOR RED HAT VIRTUALIZATION

BUSINESS CHALLENGE

Virtualized server infrastructure, but storage costs negated server virtualization cost benefits

Traditional and proprietary systems also limited flexibility which resulted in further cost escalation

Eliminate vendor lock in

SOLUTION

Red Hat Gluster Storage & Red Hat Enterprise Virtualization

IBM System x servers

BENEFITS

Reduced storage costs by 50%

Standardizing on RHEV and RHS provided flexibility

Able to use commodity servers and centrally manage server and storage infrastructure

Demo

redhat®