RED HAT
SUMMIT

GLUSTER CAN DO THAT!

Architecting and Performance Tuning Efficient Gluster Storage Pools

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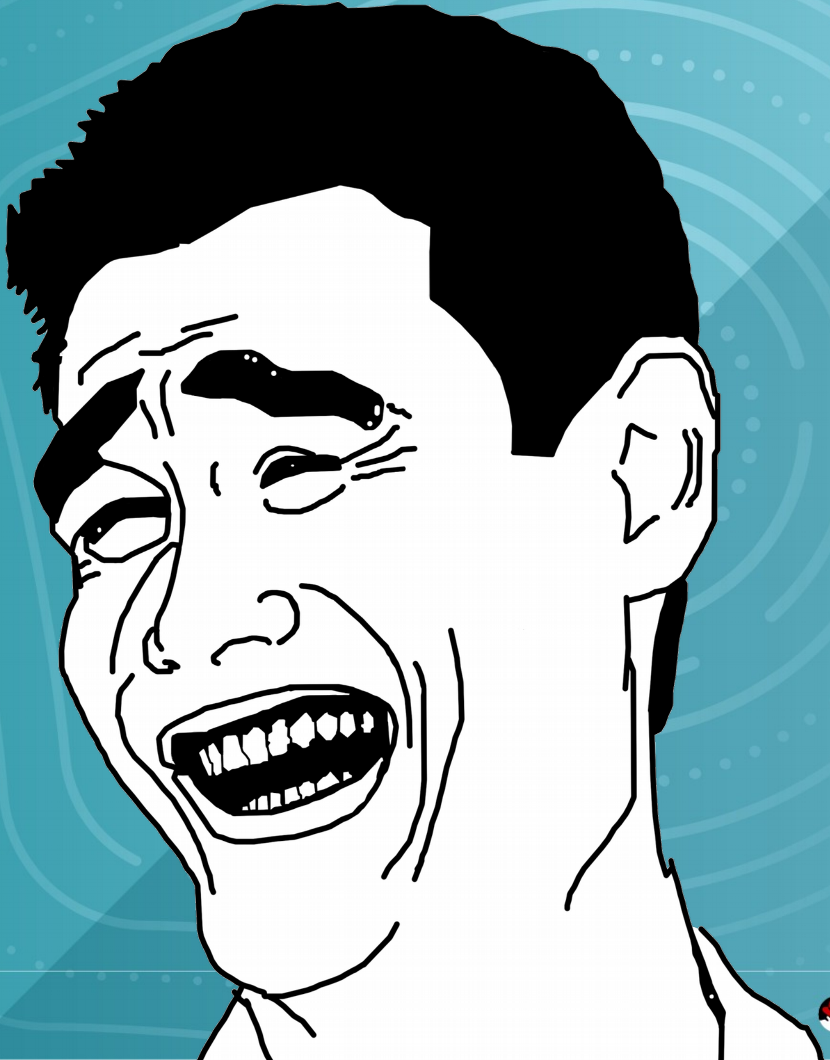
@bennyturns

2017-05-02

GLUSTER 101 IN 5 SECONDS



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.

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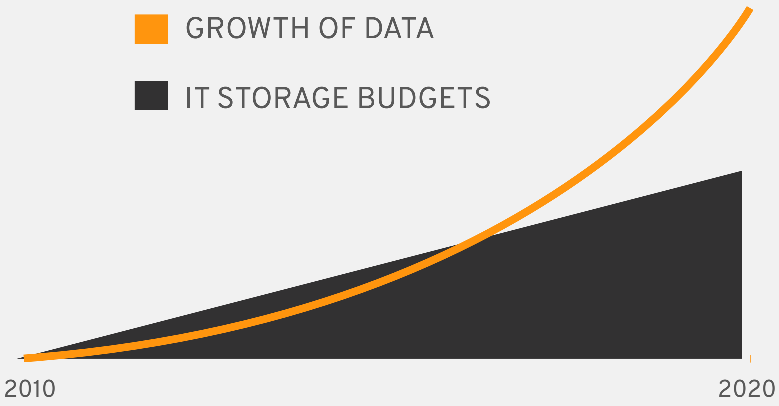
THE DATA STORAGE SHORTFALL



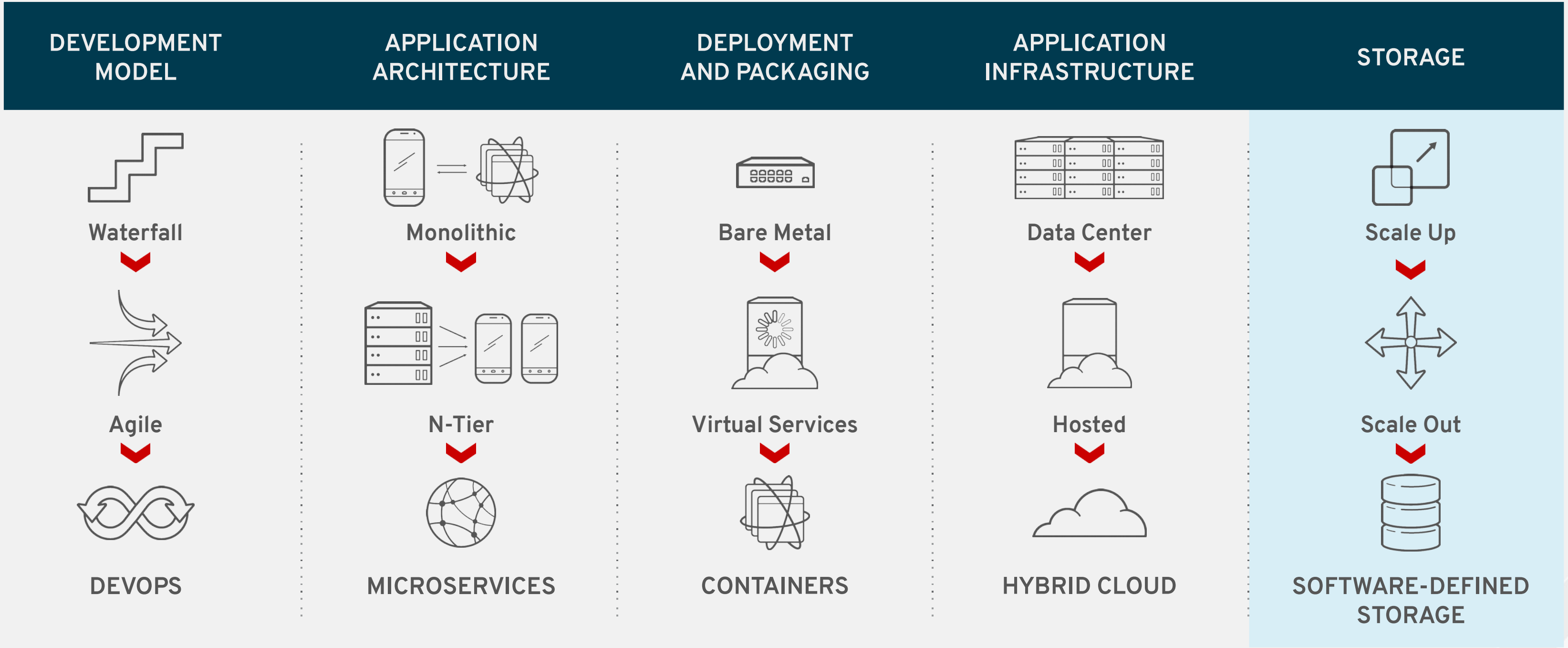
Data stores are growing exponentially, while IT budgets are not

HDDs are becoming more dense, but $/GB decline is slowing

Software and hardware advances are needed to close the gap

FLEXIBILITY IS CRUCIAL

THE DATACENTER IS CHANGING



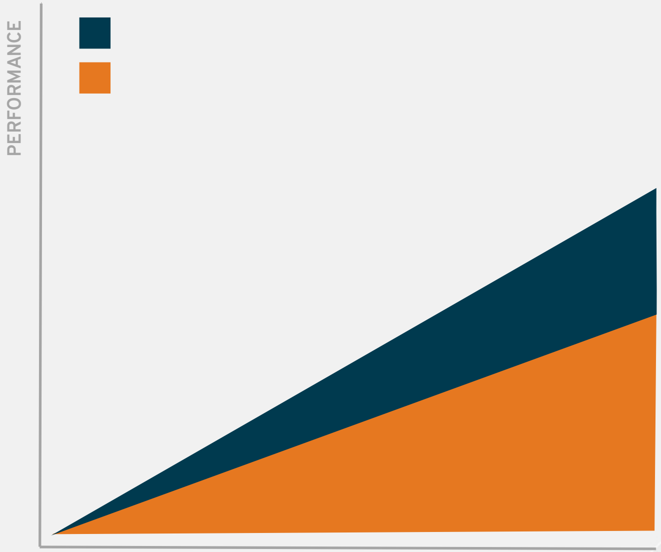
DEVELOPMENT MODEL	APPLICATION ARCHITECTURE	DEPLOYMENT AND PACKAGING	APPLICATION INFRASTRUCTURE	STORAGE
Waterfall	Monolithic	Bare Metal	Data Center	Scale Up
Agile	N-Tier	Virtual Services	Hosted	Scale Out
DEVOPS	MICROSERVICES	CONTAINERS	HYBRID CLOUD	SOFTWARE-DEFINED STORAGE

PERFORMANCE THAT SCALES

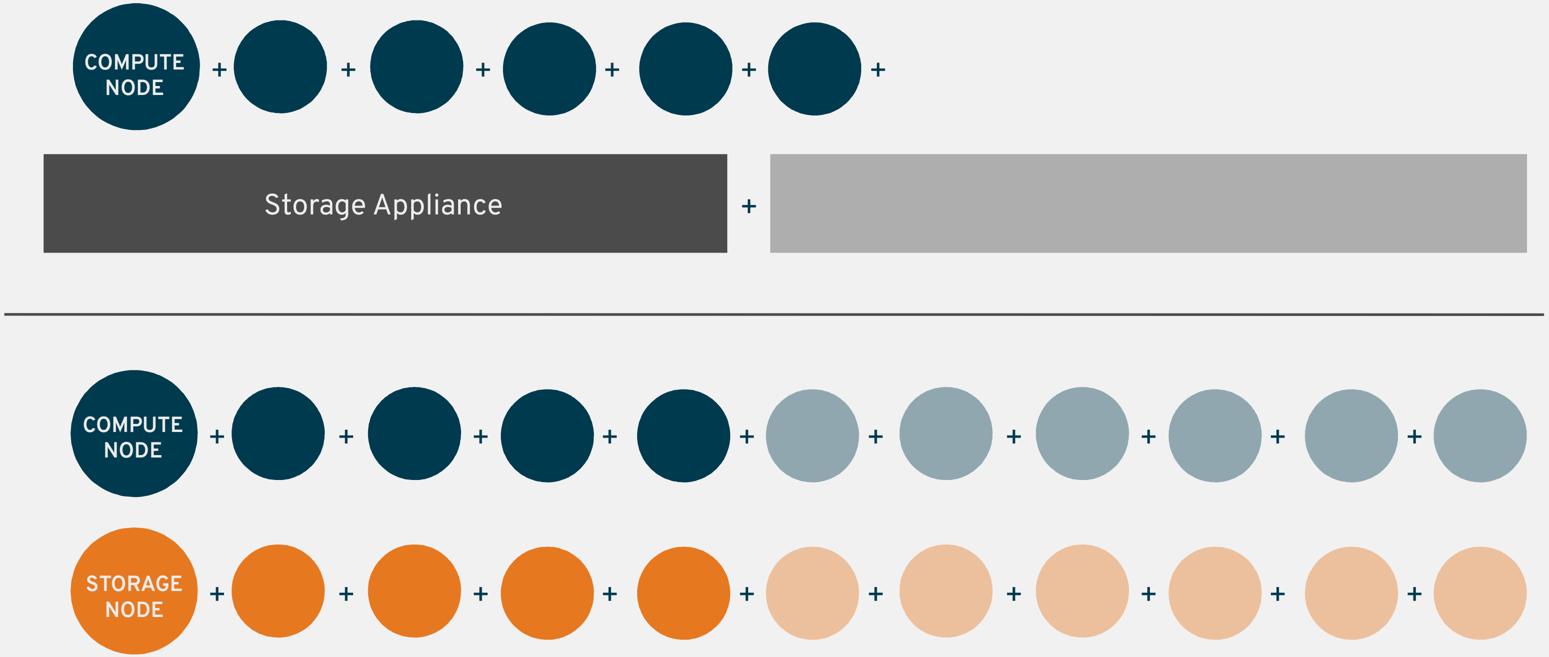
Performance should scale up as capacity does

Software-defined storage intelligently uses hardware to provide performance at very large scale.

- Traditional appliances perform better when they are empty than they do when they are full of disks
- Performance in software-defined storage clusters improves as clusters get larger, not the other way around
- Intel, SanDisk, Fujitsu, and Mellanox regularly contribute performance optimizations



VIRTUALIZED STORAGE SCALES BETTER

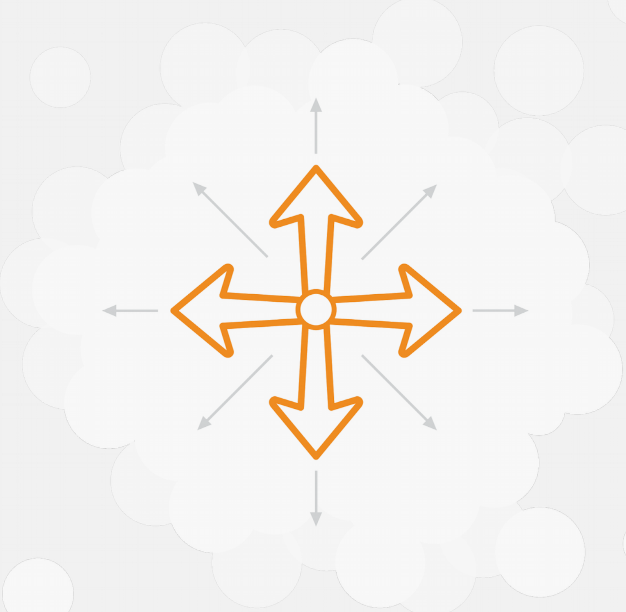


THE ROBUSTNESS OF SOFTWARE

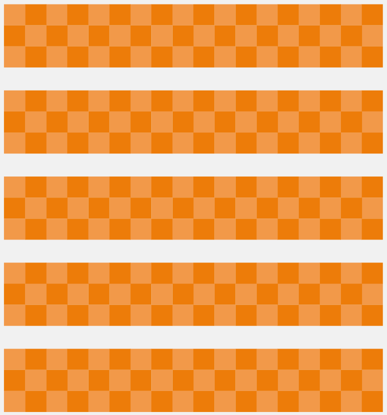
Software can do things hardware can’t

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

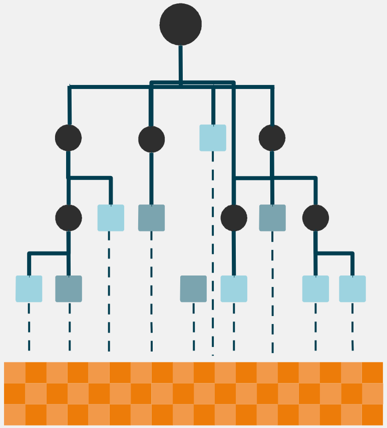


DIFFERENT KINDS OF STORAGE



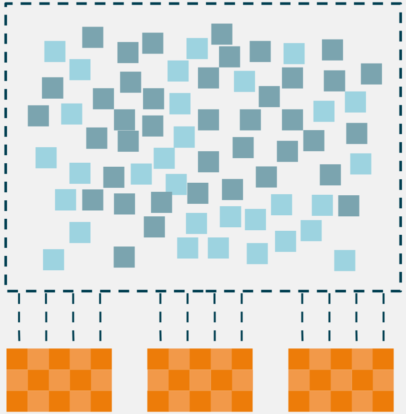
BLOCK STORAGE

Data as sequential uniform **blocks**



FILE STORAGE

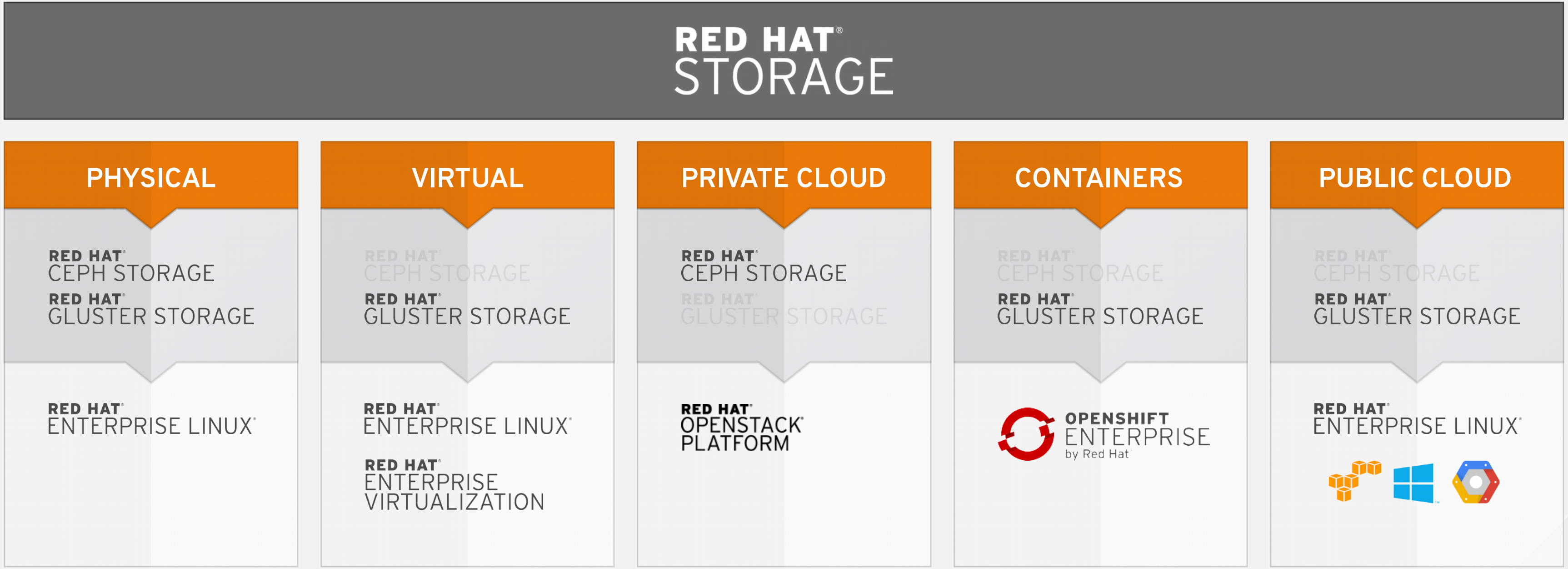
Data as buckets of hierarchical **folders and files**



OBJECT STORAGE

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

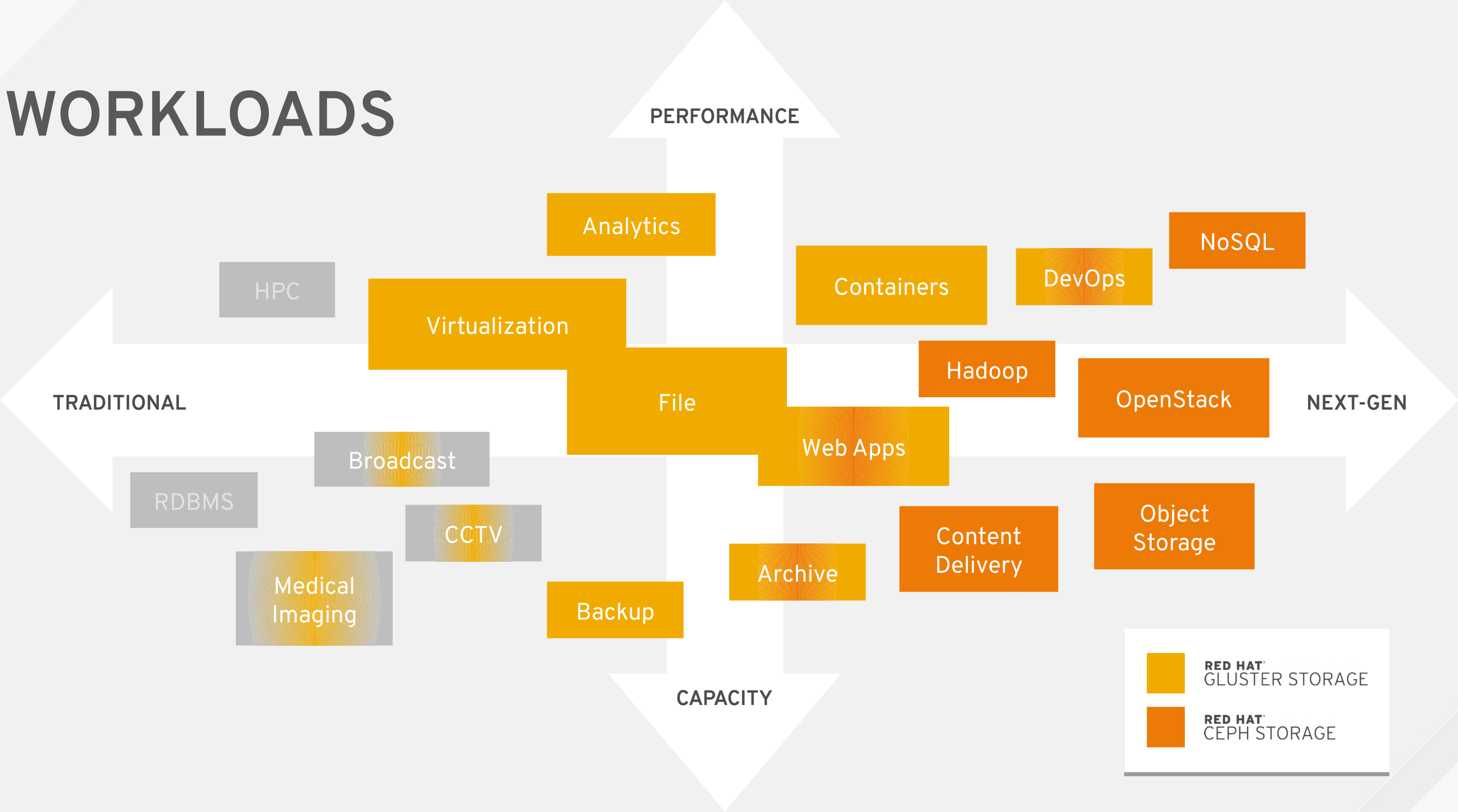
HOW STORAGE FITS



RED HAT® STORAGE

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

WORKLOADS



🟨 RED HAT® GLUSTER STORAGE

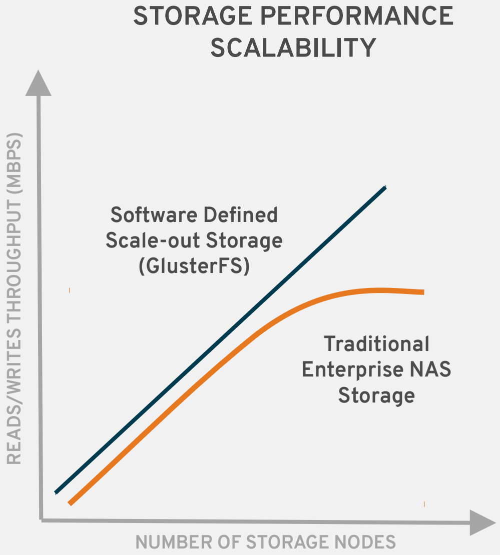
🟧 RED HAT® CEPH STORAGE

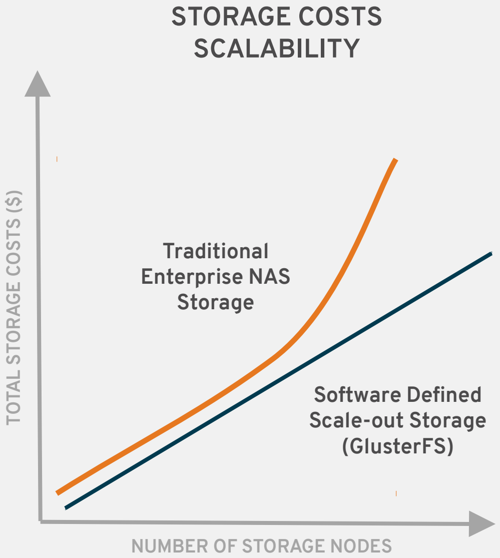
RED HAT GLUSTER STORAGE

Open source, software-defined storage for unstructured file data at petabyte scale

- Media, video
- Machine, Log Data
- GeoSpatial
- Persistent Storage
- Documents

COMPARING THROUGHPUT AND COSTS AT SCALE

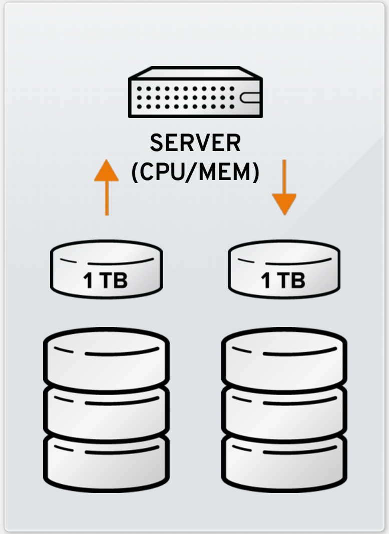




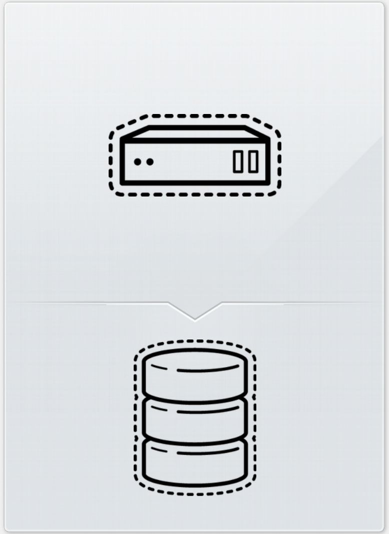
WHAT IS A SYSTEM?

Can be physical, virtual or cloud

PHYSICAL



VIRTUAL

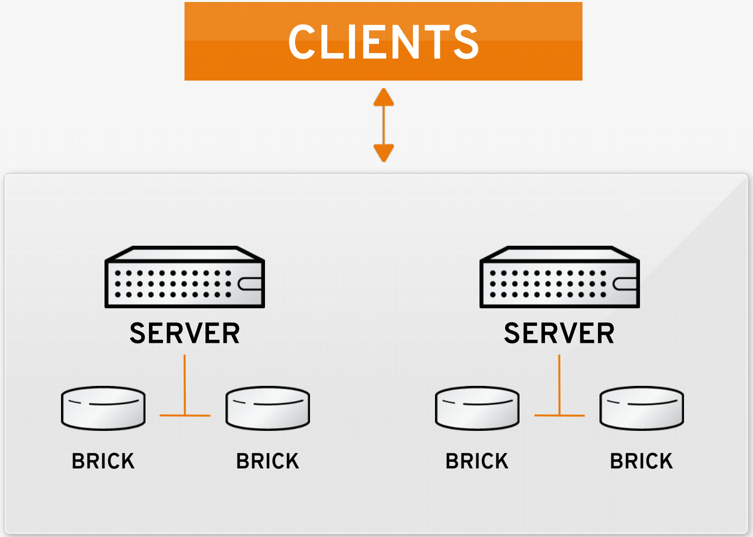


CLOUD

VOLUMES

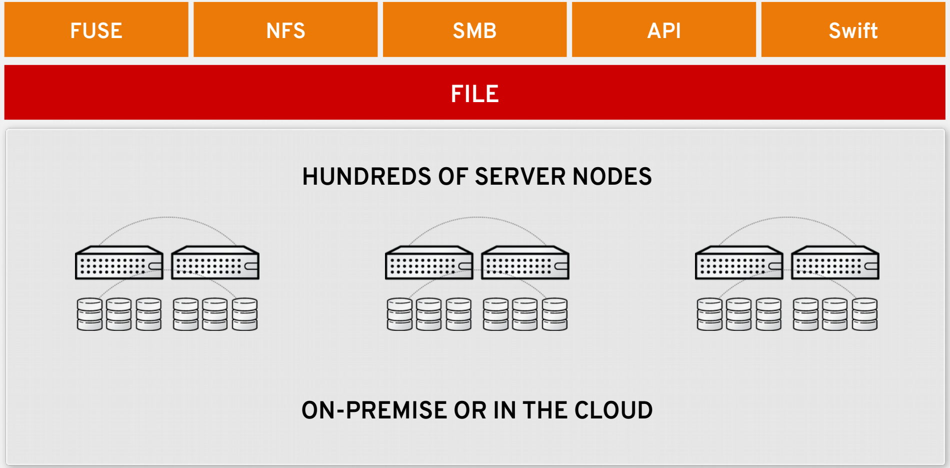
Bricks taken from multiple hosts become one addressable unit

- High availability as needed
- Load balanced data
- Managed by Gluster



MULTI-PROTOCOL ACCESS

Primarily accessed as scale-out file storage with optional Swift obj APIs



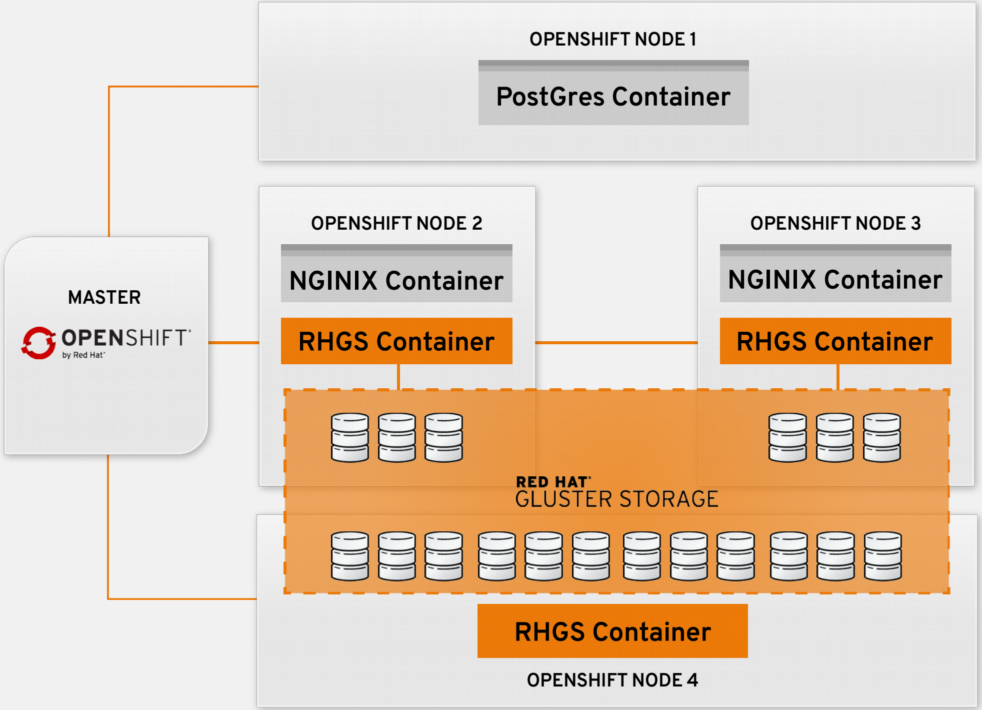
FUSE | NFS | SMB | API | Swift

FILE

HUNDREDS OF SERVER NODES

ON-PREMISE OR IN THE CLOUD

CONTAINER-NATIVE STORAGE



Lower TCO

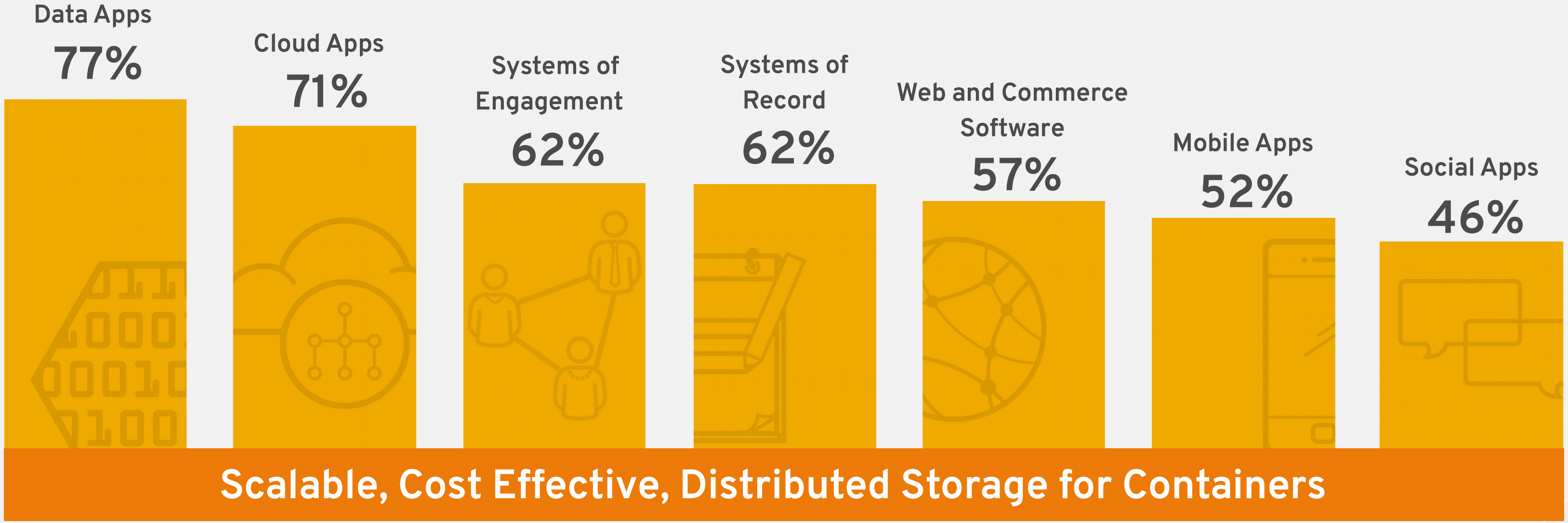
Unified Orchestration

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

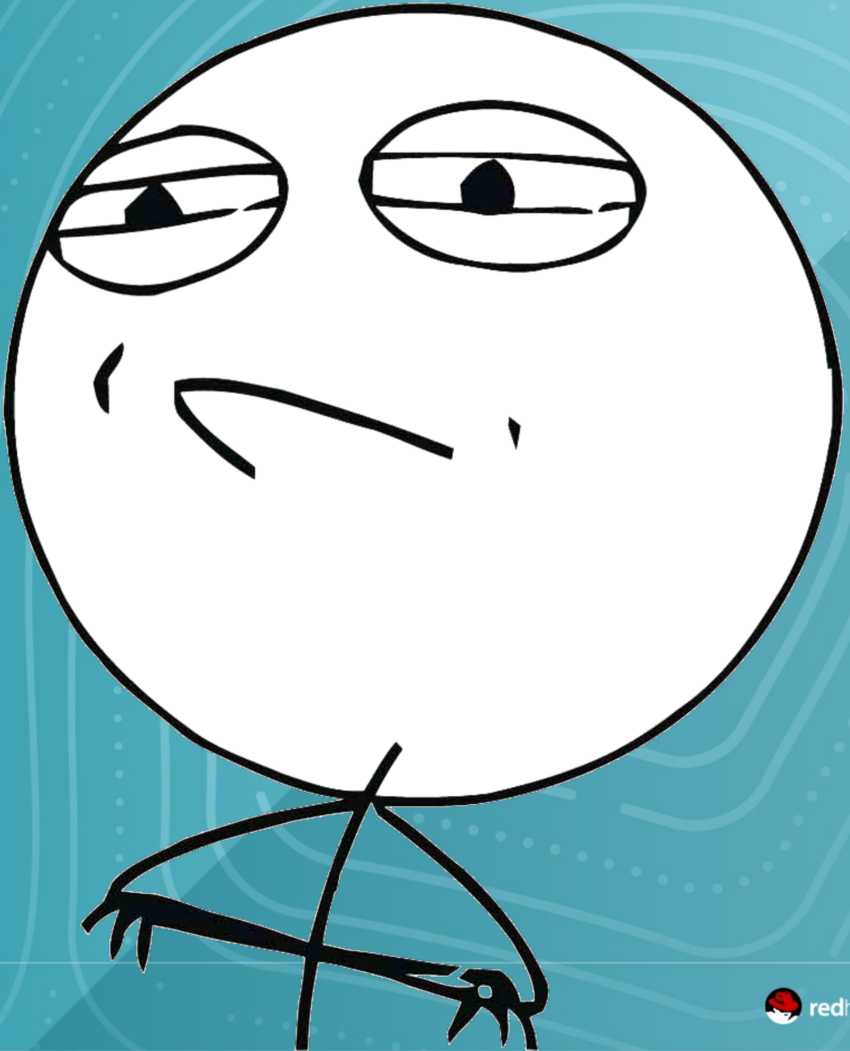
GOT IT?

NOT SURE IF YOU GOT IT?

https://people.redhat.com/dblack/summit2017

GLUSTER
CAN DO THAT!*

*If you build it right



A SIX-NODE POOL CAN PROCESS...

JPEG Web Image Files (32KB)

72x 7.2K HDD

1,700 JPEGs per second

or

Optimized 72x 7.2K HDD

12,000 JPEGs per second

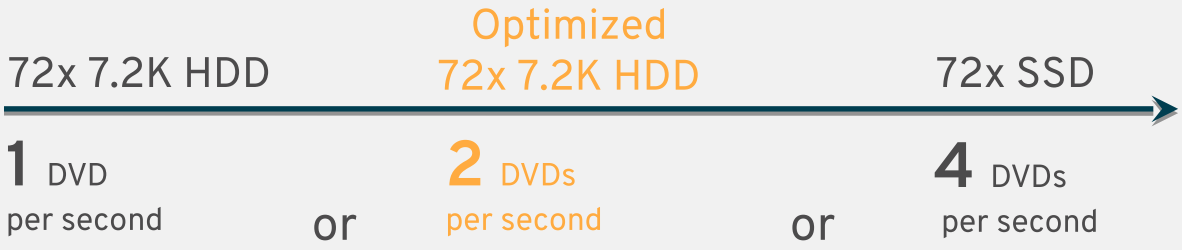
or

72x SSD

23,000 JPEGs per second

OR...

DVD
Movie Files
(4GB)



72x 7.2K HDD

1 DVD
per second

or

Optimized
72x 7.2K HDD

2 DVDs
per second

or

72x SSD

4 DVDs
per second

OR...

High-Def
CCTV Camera
Recording Streams

72x 7.2K HDD

200 CCTV streams
within latency threshold

or

Optimized
72x 7.2K HDD

500 CCTV streams
within latency threshold

or

72x SSD

? CCTV streams
within latency threshold

KI
KISS

KEEP
IT
SIMPLE,
STUPID

SWTWD

START

WITH

THE

WORKLOAD,

DUMMY

WHY DO YOU ASK THE WRONG QUESTIONS?

Delivered-To: dblack@redhat.com
From: [redacted]
Date: Fri, 31 Mar 2017 11:59:29 +0200
Subject: Pererformance testing with fio

…

One of the things [redacted] wants is see that gluster performs similarly to the [redacted] NFS system it is intended to replace.

Now I noticed the following:

- Doing a **simple test with dd** yields a write throughput of around 500MB/s, which for a rep 2 volume on a 10Gb connection is quite good.
- Doing a **read with dd** strangely yields slower throughput....

…

Delivered-To: dblack@redhat.com
From: [redacted]
Date: Sun, 5 Feb 2017 20:16:40 +0900
Subject: RHGS scale-out options

…
[redacted] plans to **add physical nodes to increase "performance"**
(currently is experiencing performance problem)
…
Current Env : 80 X 2-way distributed replicated vols on 6 nodes
To-Be : add 6 more nodes... becomes 80 X 2-way distributed replicated vols on 12 nodes

I'm not sure which one is the best way to increase performance.

1. extend current cluster from 6 to 12 nodes and add bricks from new 6 nodes into existing 80 vols
2. extend current cluster from 6 to 12 nodes and migrate some vols to new new 6 nodes.
3. create another RHGS gluster cluster with new 6 nodes and migrate some vols to new RHGS cluster
4. ??
…

Delivered-To: dblack@redhat.com
From: [redacted]
Date: Mon, 6 Mar 2017 10:54:17 -0800
Subject: Fwd: [redacted] server quote [redacted]

…
What are your calculations for the [redacted] NAS storage RFP?

[redacted] is asking for the **IOPS per drive / Raid Volume** for the design?

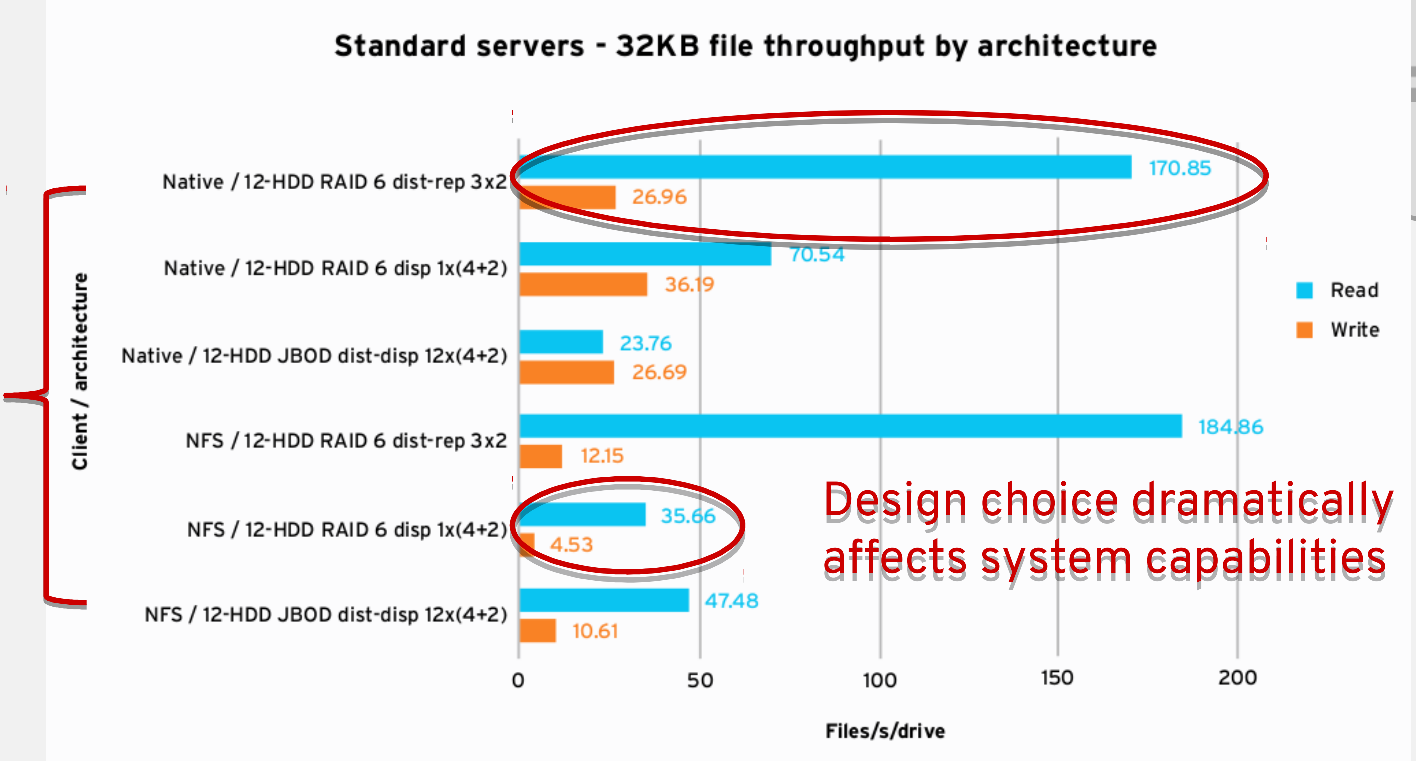
They would like to make sure they are getting **28,000 IOPs per site**.
…

---------- Forwarded message ----------
From: [redacted]
Date: Mon, Mar 6, 2017 at 10:45 AM

…
Thank you. The next question that I have is how many IOPS per drive (or per RAID volume, or per server), for 3.5” 7200RPM SATA drives, are you assuming. The requirement is for 28,000 IOPS at each site. Thanks.
…

THE WORKLOAD IS COMING

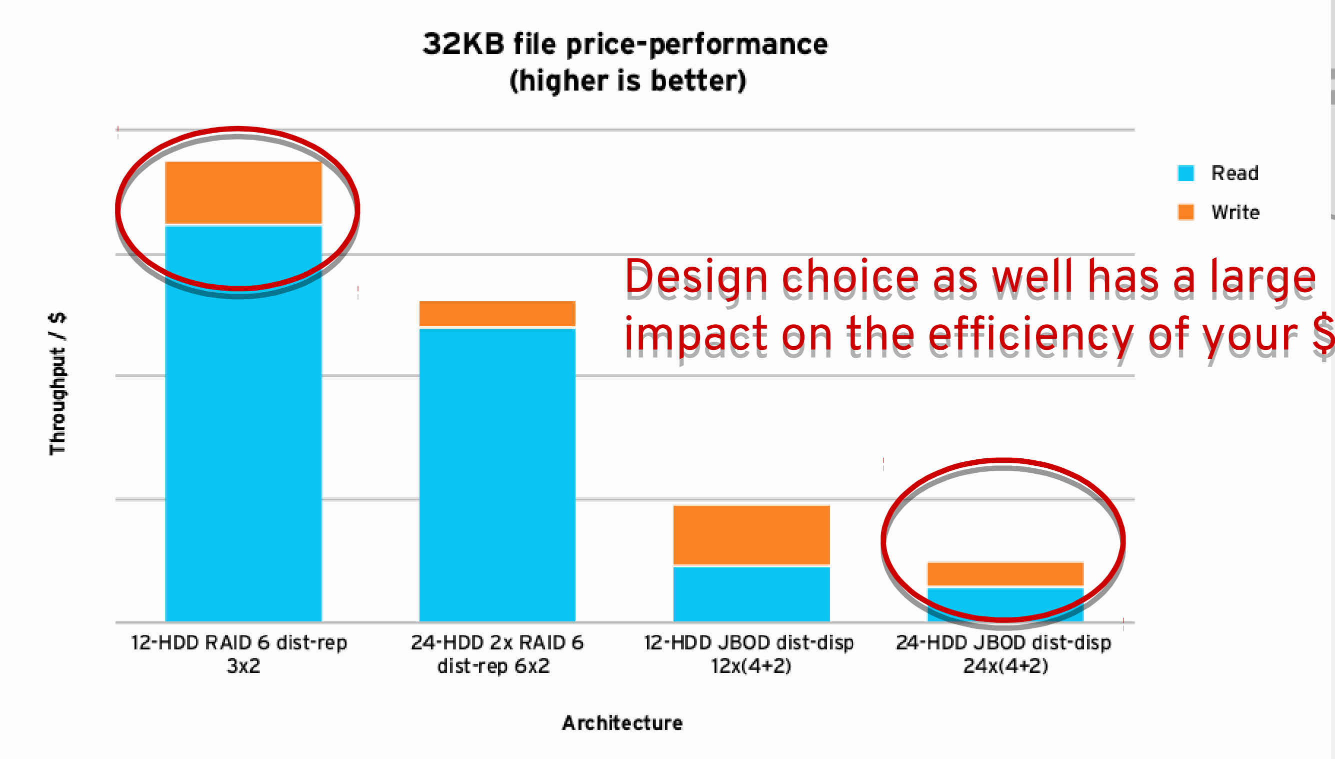
SMALL FILE JPEG WORKLOAD



Same Hardware

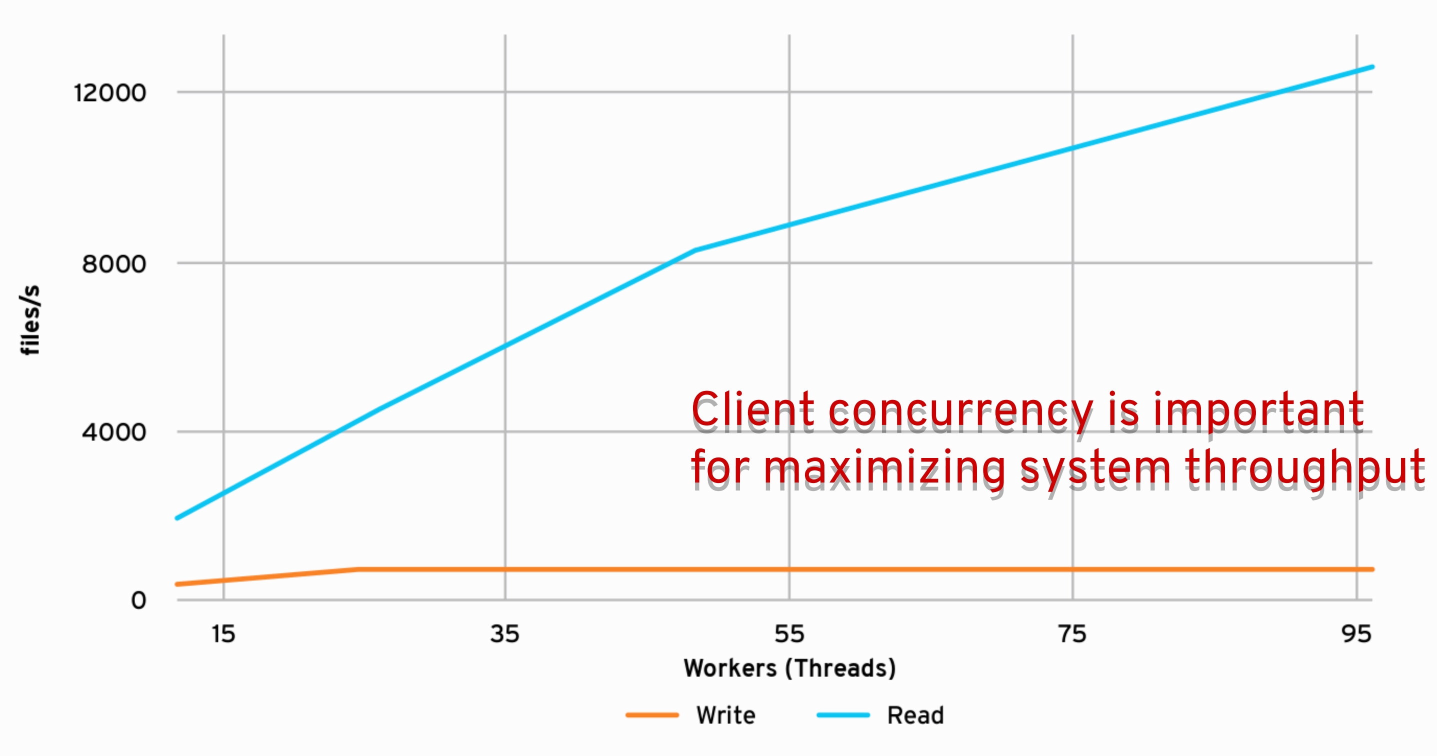
Design choice dramatically affects system capabilities

SMALL FILE JPEG WORKLOAD



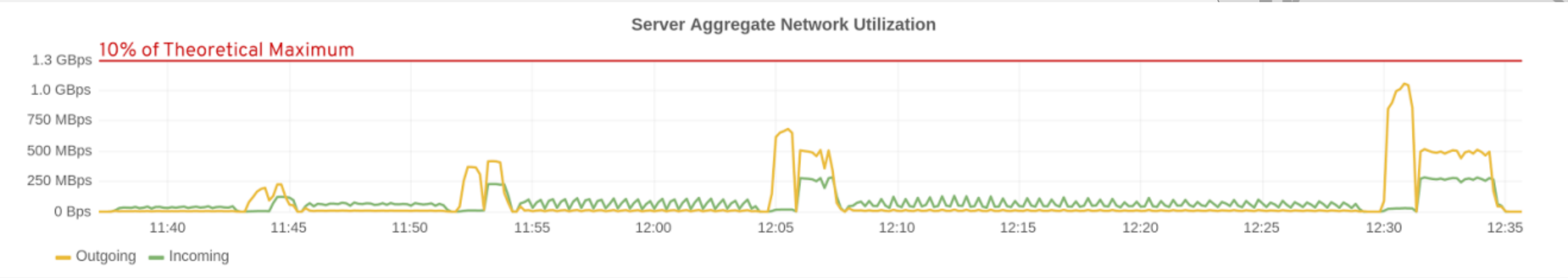
Design choice as well has a large impact on the efficiency of your $$

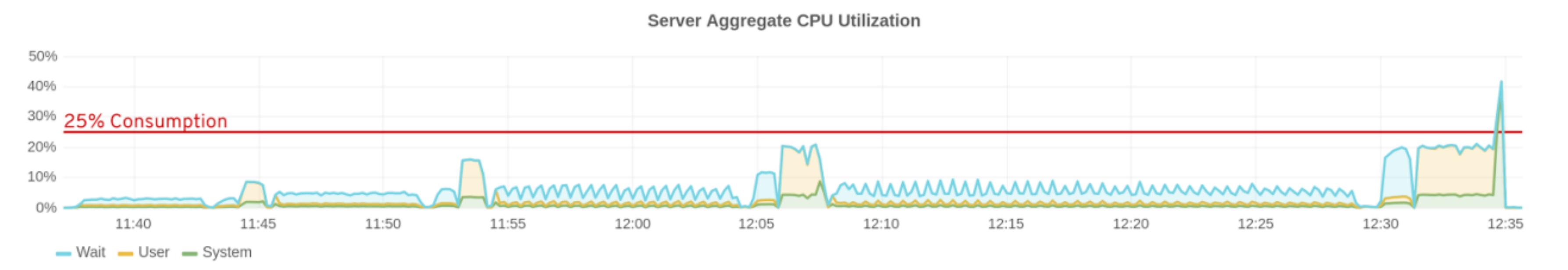
SMALL FILE JPEG WORKLOAD



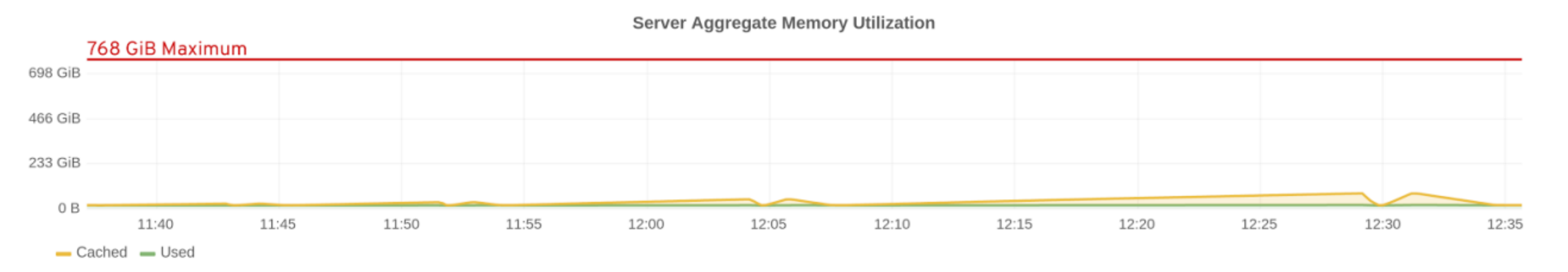
Client concurrency is important for maximizing system throughput

SMALL FILE JPEG WORKLOAD

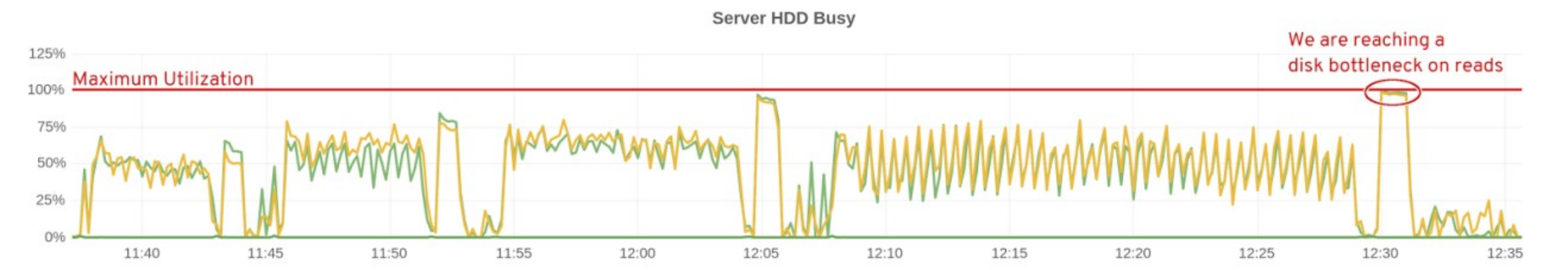




SMALL FILE JPEG WORKLOAD



768 GiB Maximum

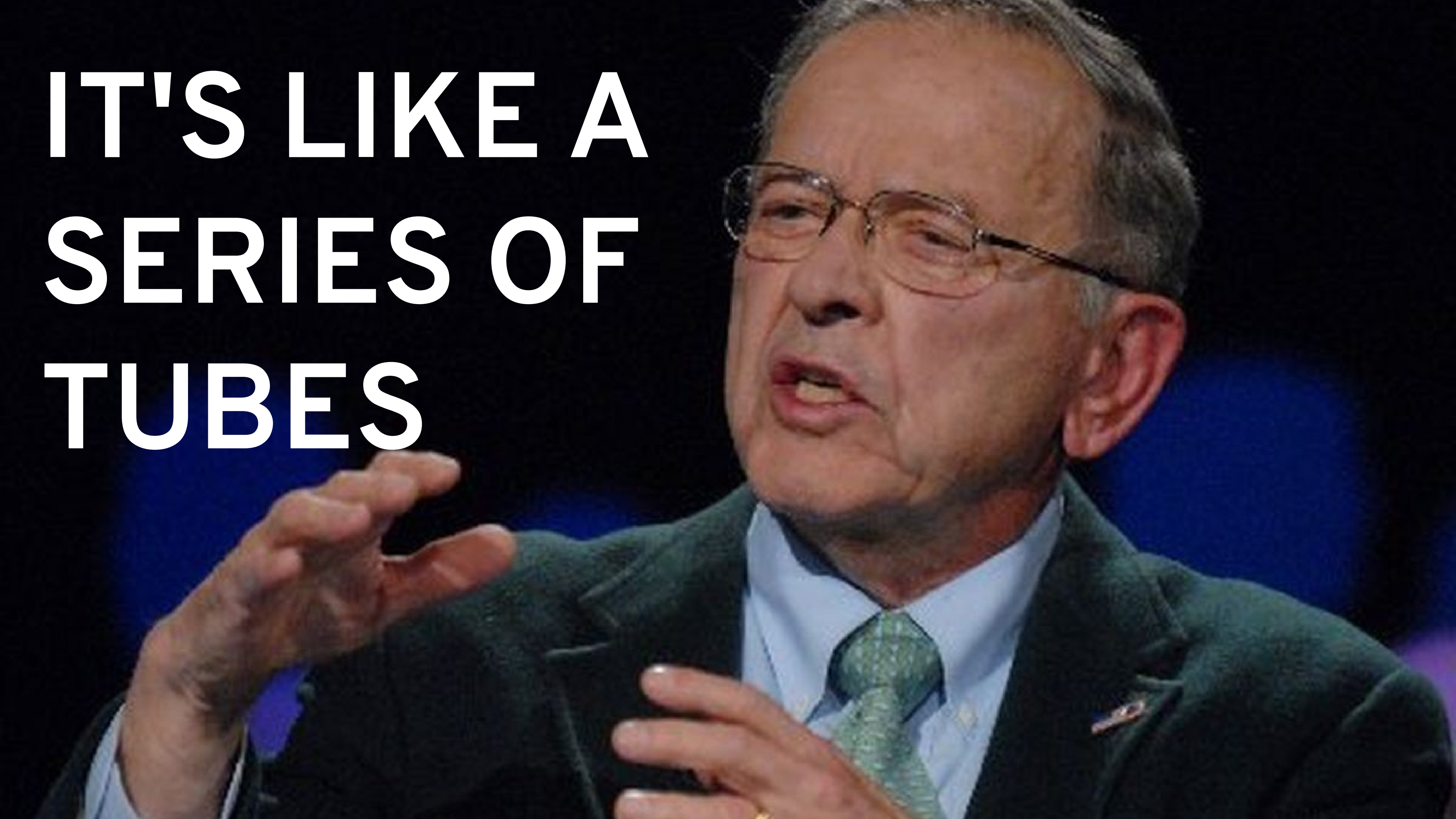


Maximum Utilization

We are reaching a disk bottleneck on reads

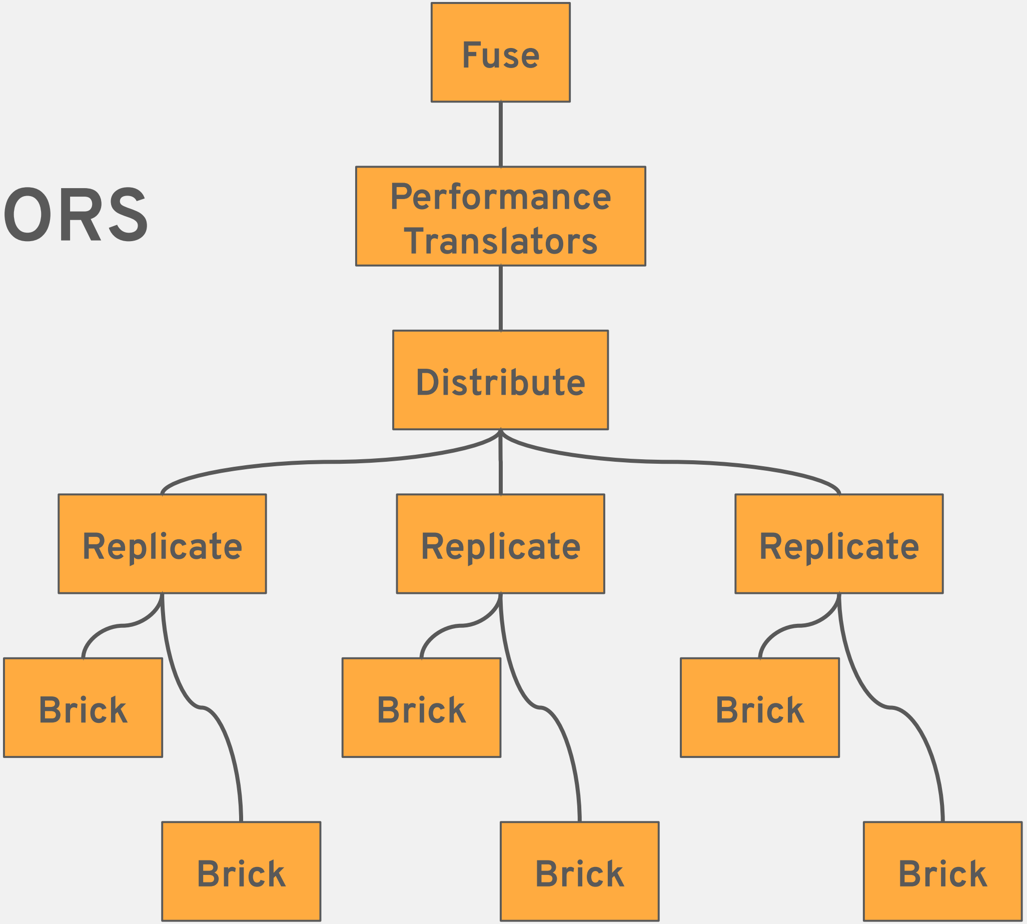
IF A FILE IS VERY VERY SMALL

IS IT STILL A FILE?



IT'S LIKE A SERIES OF TUBES

GLUSTER TRANSLATORS



```
struct xlator_fops fops = {
        .open           = ra_open,
        .create         = ra_create,
        .readv          = ra_readv,
        .writev         = ra_writev,
        .flush          = ra_flush,
        .fsync          = ra_fsync,
        .truncate       = ra_truncate,
        .ftruncate      = ra_ftruncate,
        .fstat          = ra_fstat,
        .discard        = ra_discard,
        .zerofill       = ra_zerofill,
};

struct volume_options options[] = {
        { .key  = {"force-atime-update"},
          .type = GF_OPTION_TYPE_BOOL,
          .default_value = "false"
        },
        { .key  = {"page-count"},
          .type = GF_OPTION_TYPE_INT,
          .min  = 1,
          .max  = 16,
          ...
```

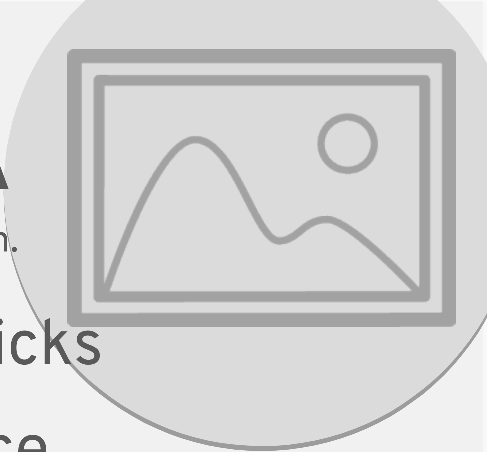
SMALL FILE AND METADATA WORKLOADS

What the Gluster community is doing:

- Improve efficiency of individual calls
- Store metadata in client cache
- Prefetch metadata
- Compound file operations
- Coming Soon! Negative lookups and parallel readdirp

TUNING FOR SMALL FILE & METADATA

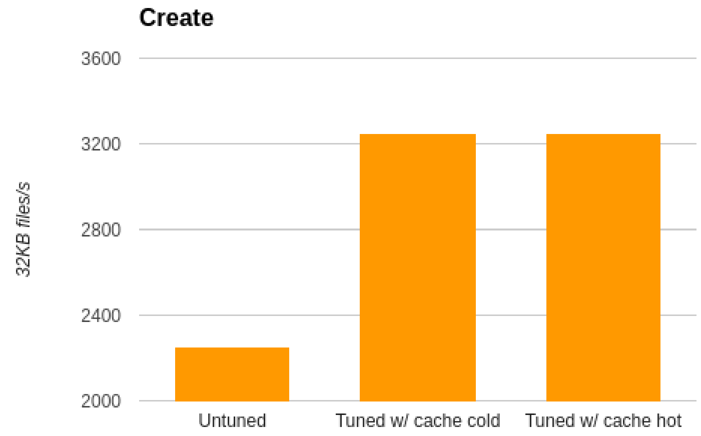
Since small file workloads are metadata intensive, I use the same tuning for both.

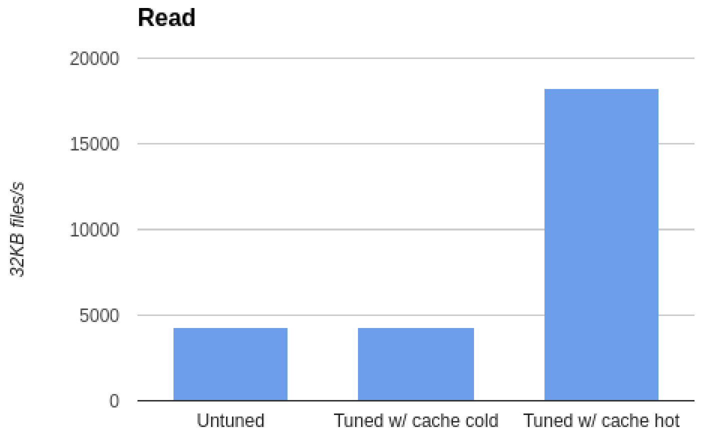


- RAID 10 or RAID 6 are recommended for bricks
- Tuned profile: rhgs-throughput-performance
- Event Threads = 4
- lookup-optimize = on
- Features.cache-invalidation = on
- Performance.stat-prefetch = on

SMALLFILE CREATES & READS

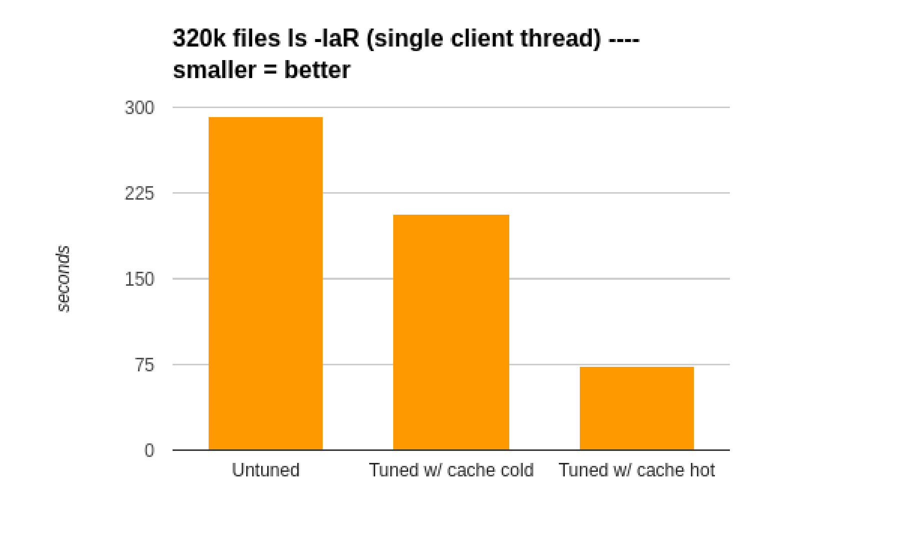
Create & read of 32 KB files
untuned vs tuned w/ cold cache vs tuned w/ hot cache



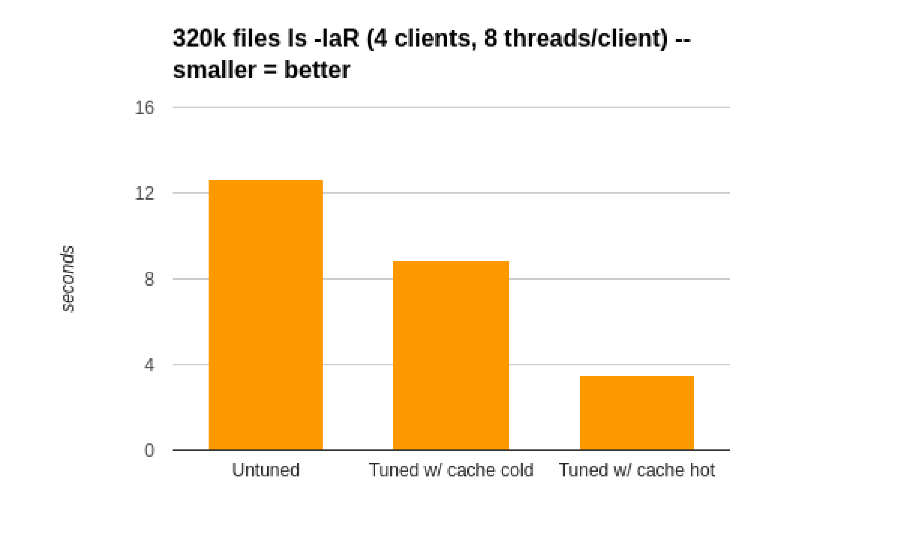


SMALLFILE METADATA WORKLOAD

Single and multi-threaded ls -l workloads
untuned vs tuned w/ cold cache vs tuned w/ hot cache

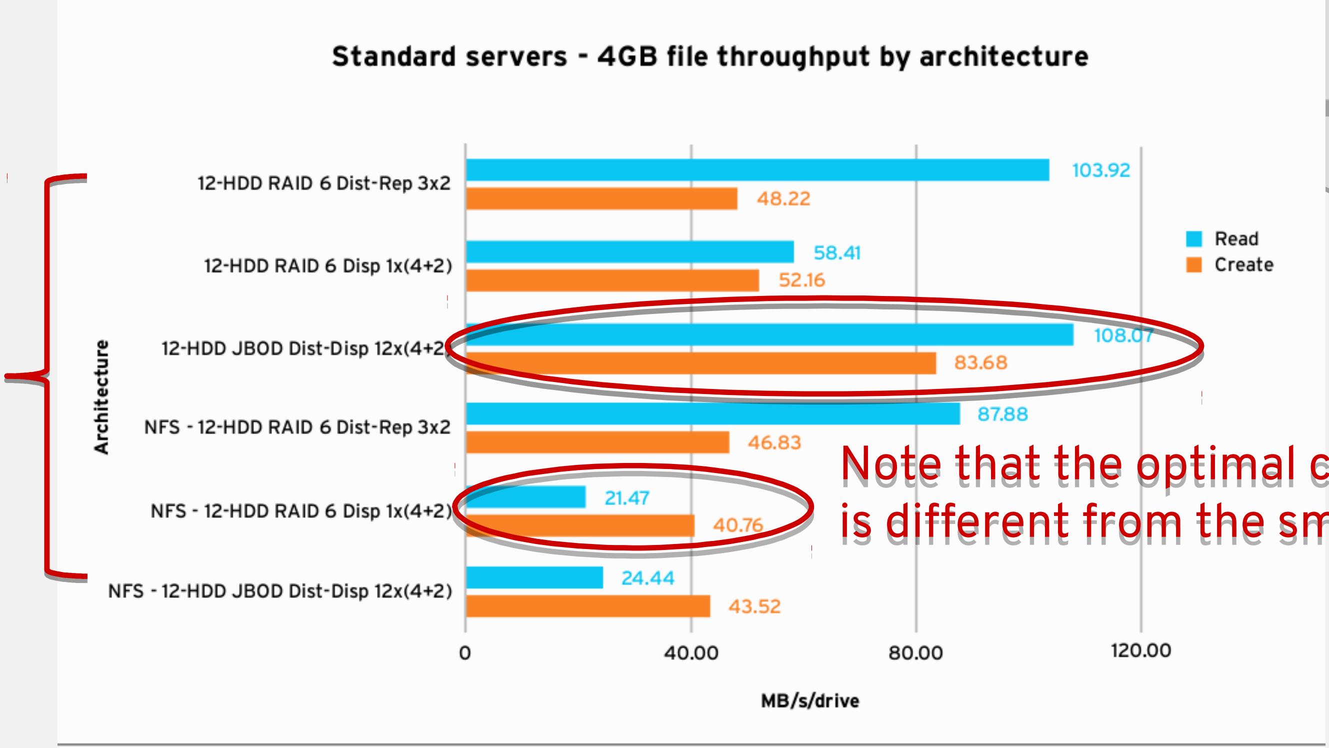


320k files ls -laR (single client thread) ----
smaller = better



320k files ls -laR (4 clients, 8 threads/client) --
smaller = better

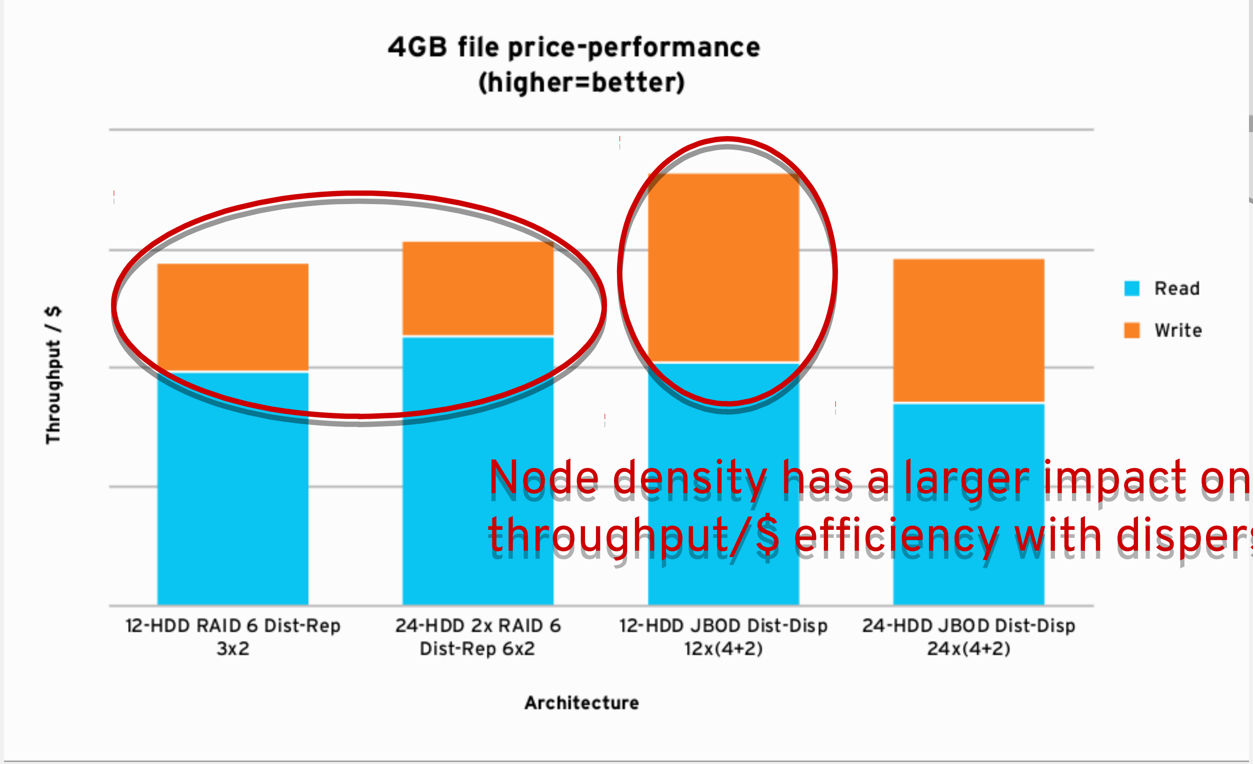
LARGE FILE DVD WORKLOAD



Same Hardware

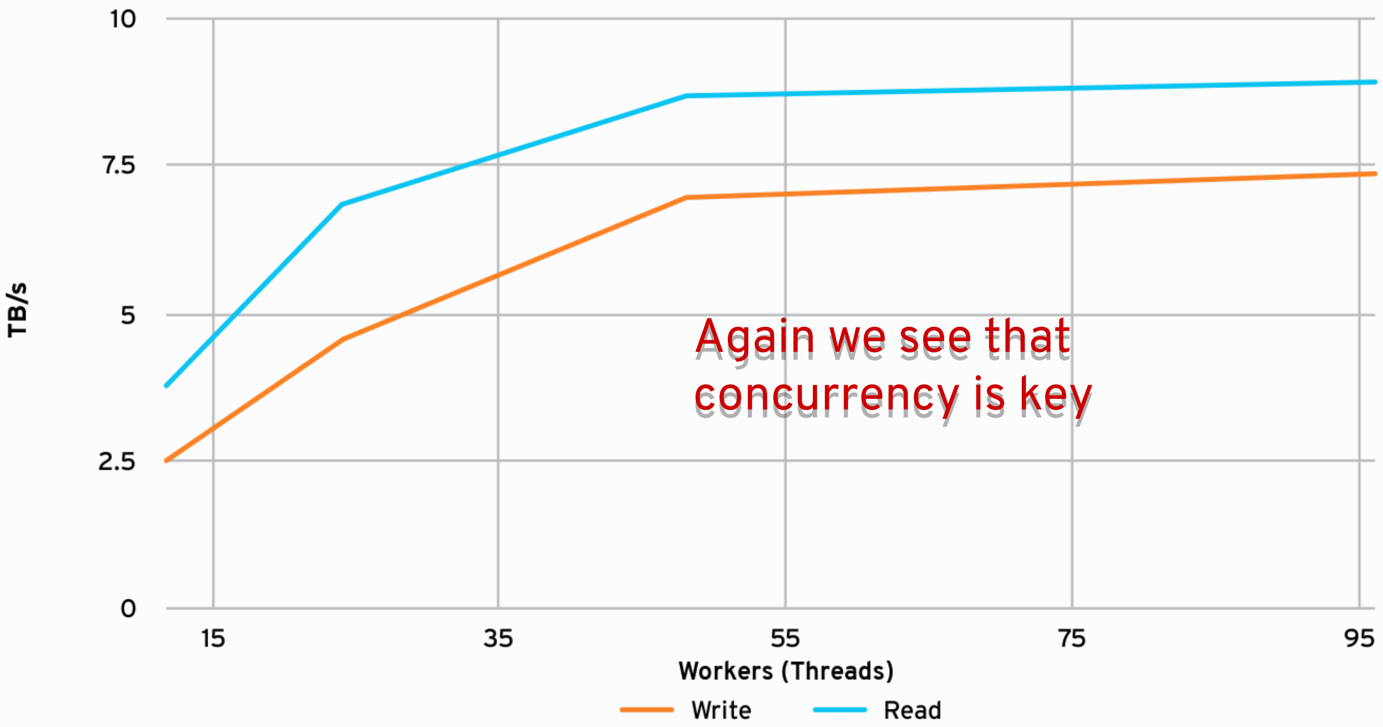
Note that the optimal configuration is different from the small file results

LARGE FILE DVD WORKLOAD



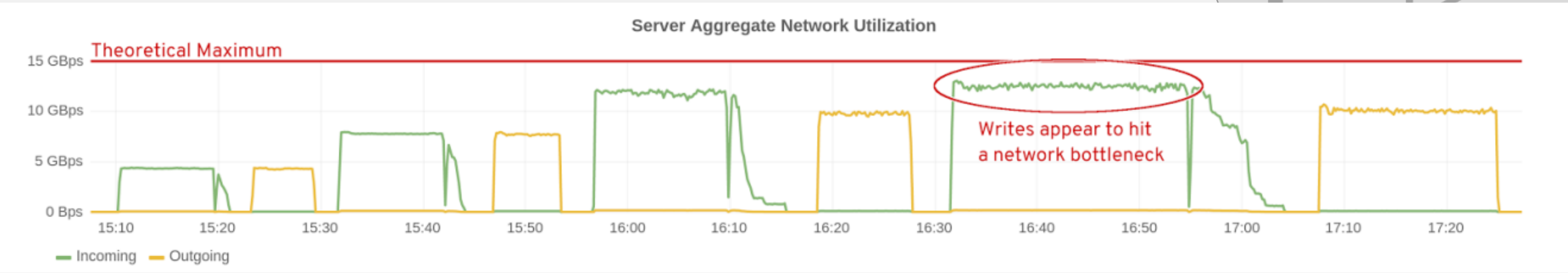
Node density has a larger impact on your throughput/$ efficiency with disperse volumes.

LARGE FILE DVD WORKLOAD



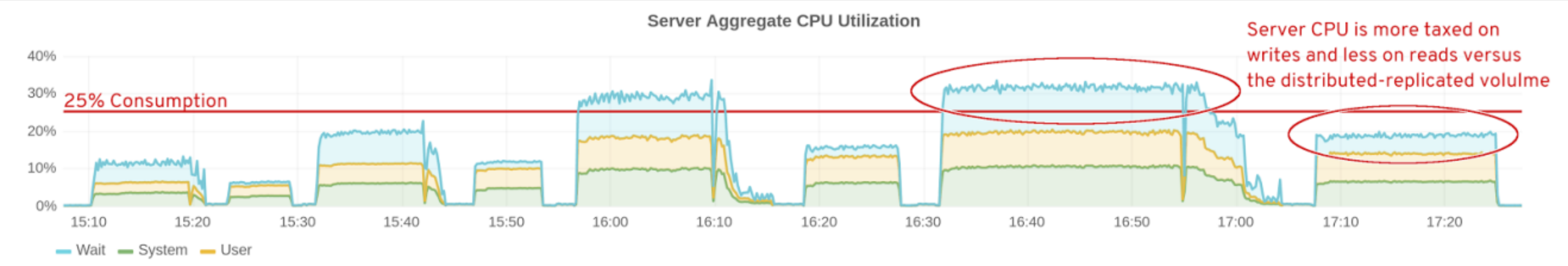
Again we see that concurrency is key

LARGE FILE DVD WORKLOAD


Server Aggregate Network Utilization

Theoretical Maximum

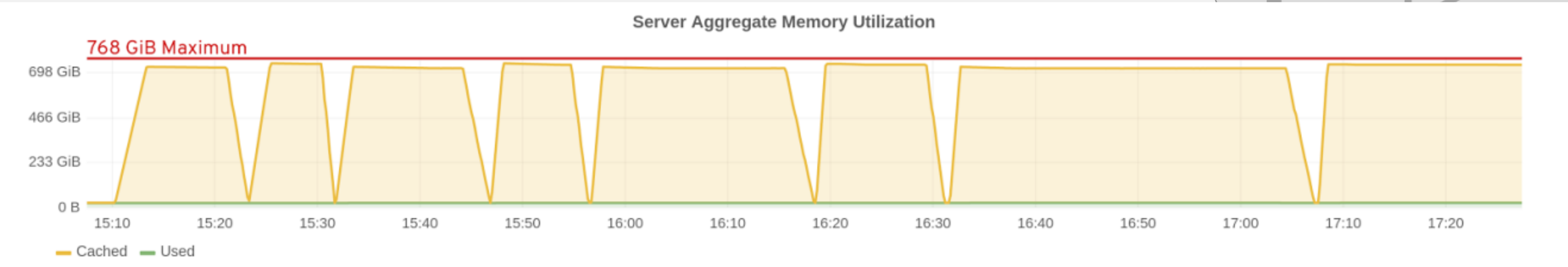
Writes appear to hit a network bottleneck


Server Aggregate CPU Utilization

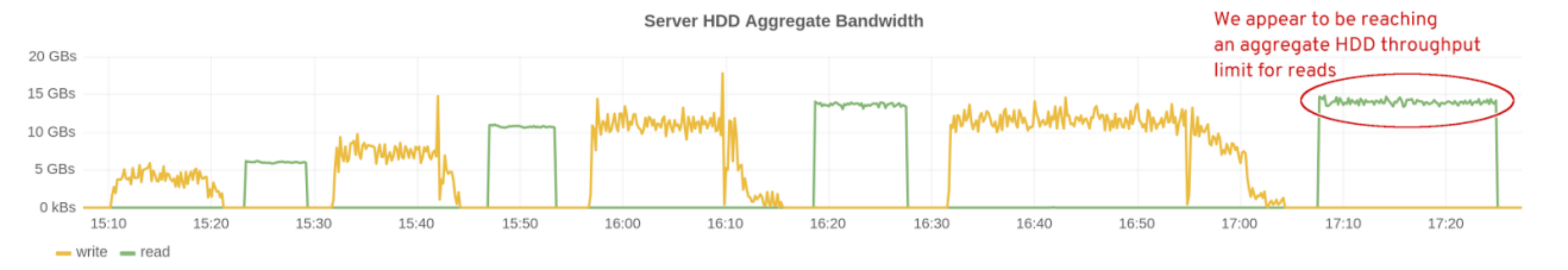
25% Consumption

Server CPU is more taxed on writes and less on reads versus the distributed-replicated volulme

LARGE FILE DVD WORKLOAD


Server Aggregate Memory Utilization

768 GiB Maximum


Server HDD Aggregate Bandwidth

We appear to be reaching an aggregate HDD throughput limit for reads

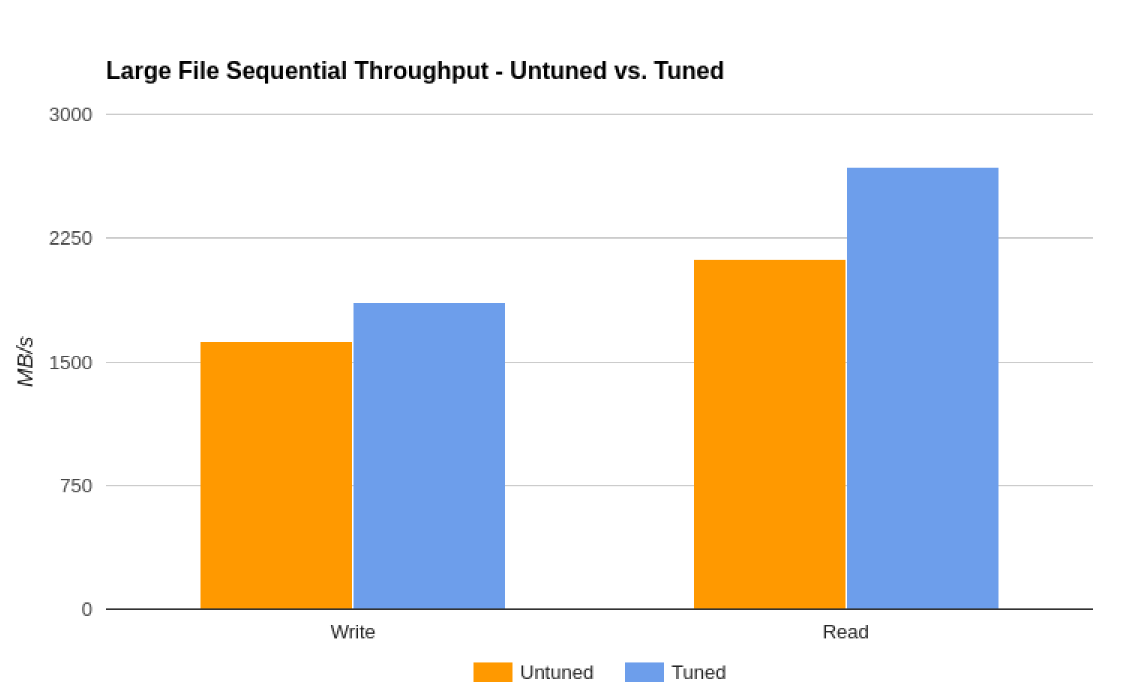
TUNING FOR LARGE FILE SEQUENTIAL

How Dustin got his performance gains from tuning!

- RAID 6 or EC are recommended for bricks
- Tuned profile: rhs-high-throughput
  - Read-ahead on bricks
  - Deadline scheduler
  - vm.dirty-ratio
- Jumbo Frames
- Event Threads = 4
- Smallfile tuning may have some effect, especially with metadata operations.

LARGE FILE SEQUENTIAL

4 Servers, 4 Clients, 4 Workers/Client, 16GB File/Worker



SCOPING FOR LARGE FILE WORKLOADS

Now that you understand the workload, how can you size your cluster?

Formula for *guesstimating* large file performance:

Writes = (Slowest of NIC / DISK) / # replicas * .7(overhead)

1200 MB / 2 * .7 = 420 MB / sec

Reads = (Slowest of NIC / Disk) * .6(overhead)

1200 * .6 = 720 MB / sec

This is just a rule of thumb, actual results are highly dependant on hardware.

TAKEAWAYS FOR LARGE FILE WORKLOADS

EC on JBOD outperforms replica 2 on RAID 6 high worker concurrency workloads

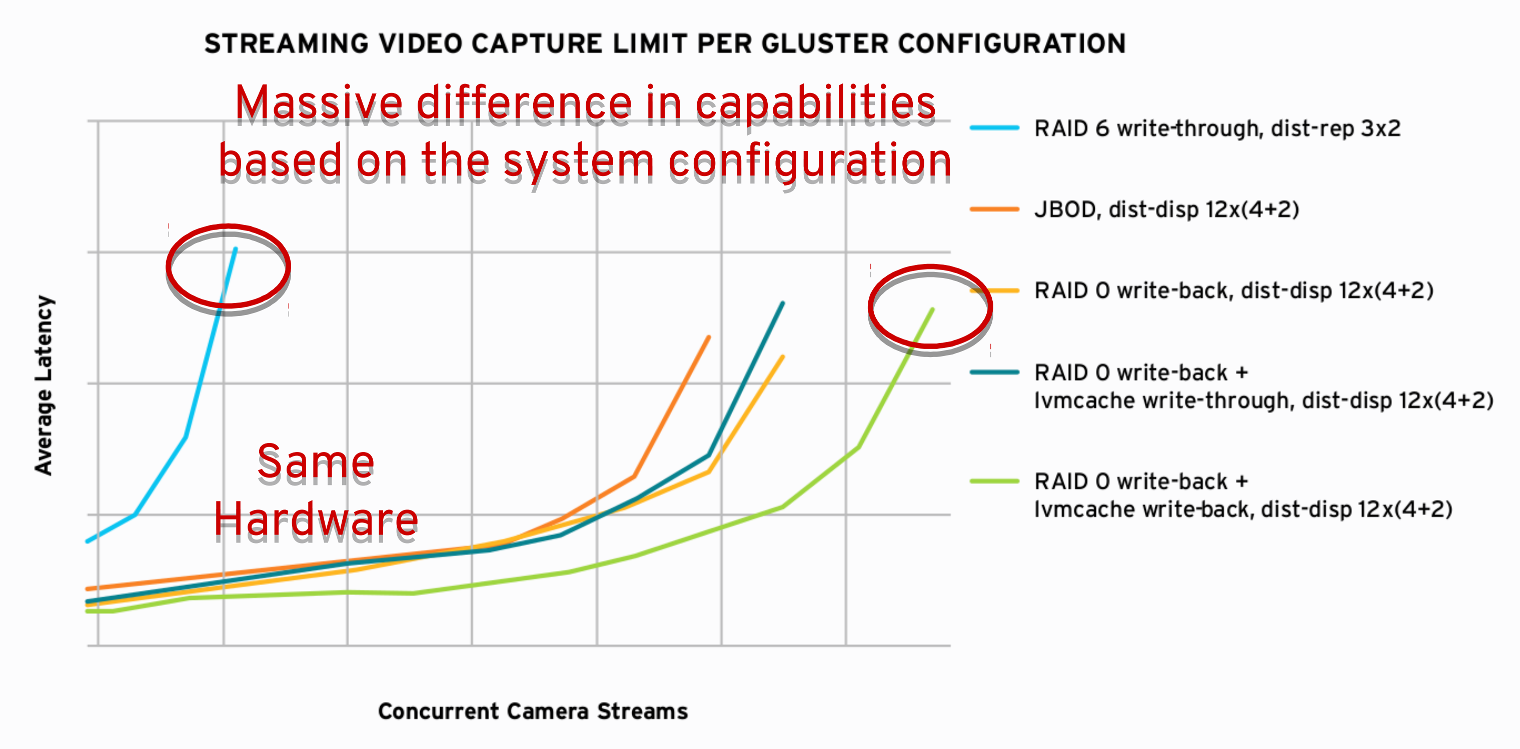
Replica 2 on RAID 6 outperforms EC on JBOD when there are less files / clients / threads and on single threaded workloads

Read ahead on block devices as well as jumbo frames provide the most performance benefit of the tunables

Again, start with the workload when designing your storage cluster. The proper brick architecture from the start will yield far better performance than any of the tunables mentioned. Design in a way that avoids problems, don’t try tune your way out of them.

YOUR WORKLOAD CAN'T BE SLOW IF YOU NEVER RUN IT

CCTV STREAMING WORKLOAD



STREAMING VIDEO CAPTURE LIMIT PER GLUSTER CONFIGURATION

Massive difference in capabilities based on the system configuration

Same Hardware

HYPERCONVERGED RHV / RHGS

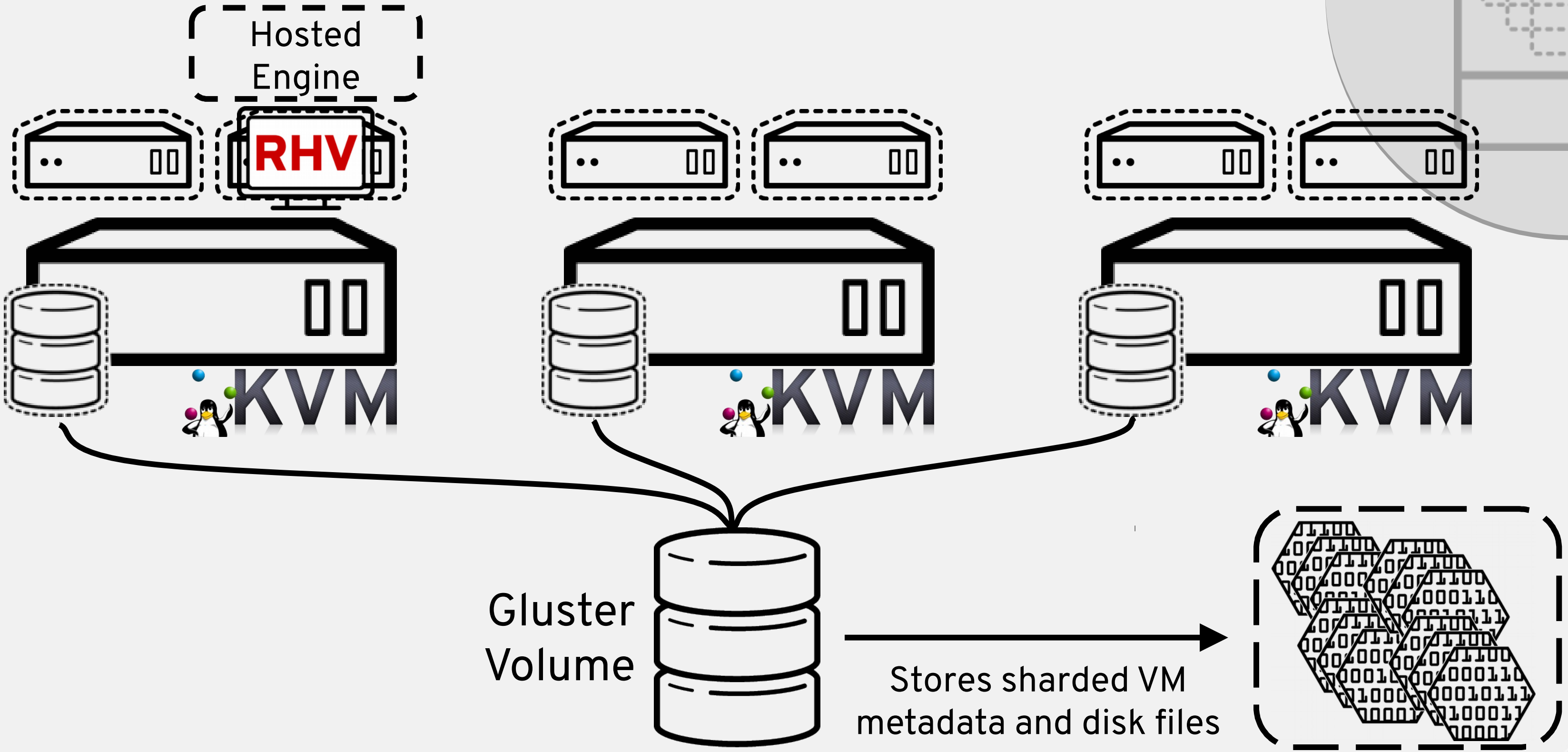
Setup Details

- Storage and compute on the same systems
- Cost advantage
- Management using the same linux based tools

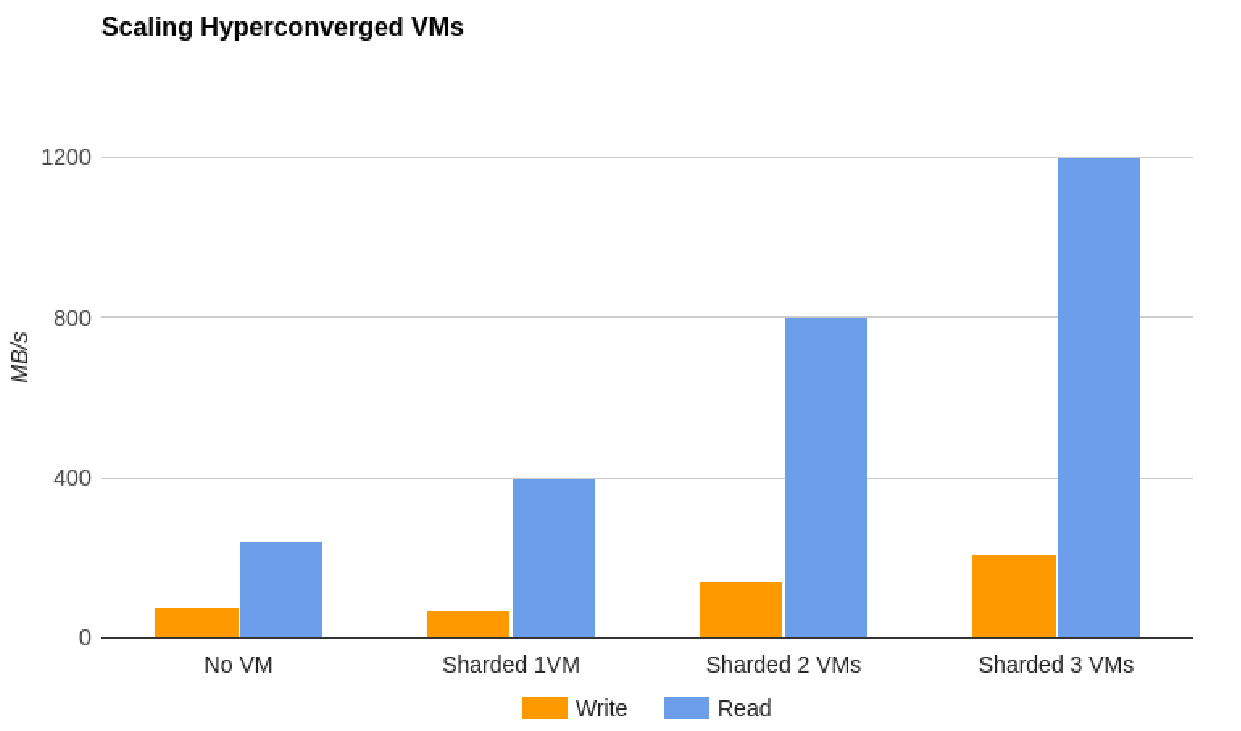
```
# gdeploy -c robo.conf

# hosted-engine --deploy --config-append=<path to hosted engine answer
file>
```

Hyperconverged Infrastructure Example Arch



VM PERFORMANCE



PERFORMANCE TEST TOOL - GBENCH

Gbench was used to gather the performance data

- https://github.com/gluster/gbench
- Wraps IOZone, smallfile, FIO
- Run multiple iterations and averages it
- Multi host capable

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SUMMIT

THANK YOU

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