Storage War stories

35+ years of data loss experiments

Steven Ellis - Red Hat

LINUXCONFAU

Agenda

A little bit of history

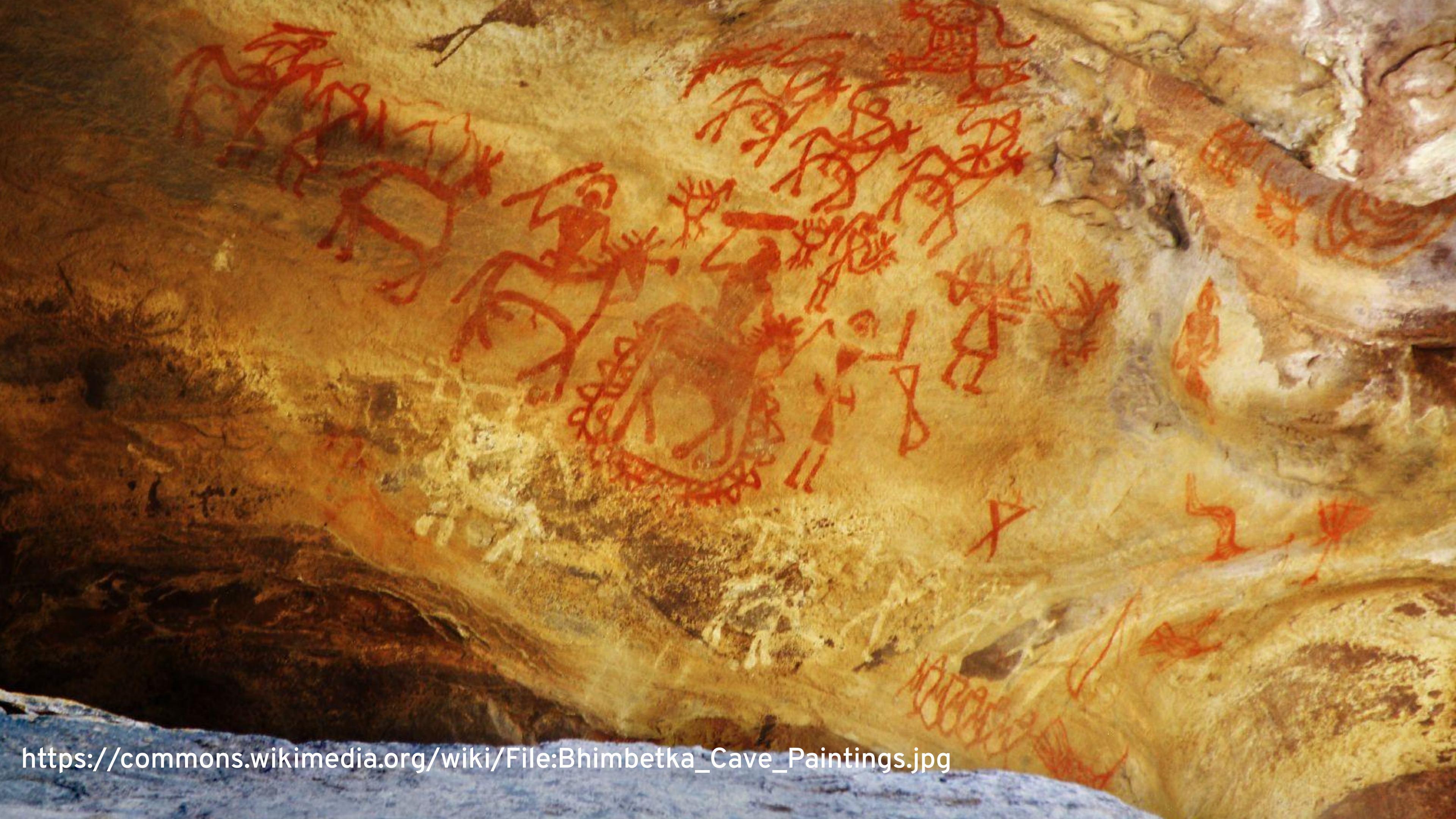
- Including some technology overviews

War Stories

- Names have been changed to protect the “innocent”

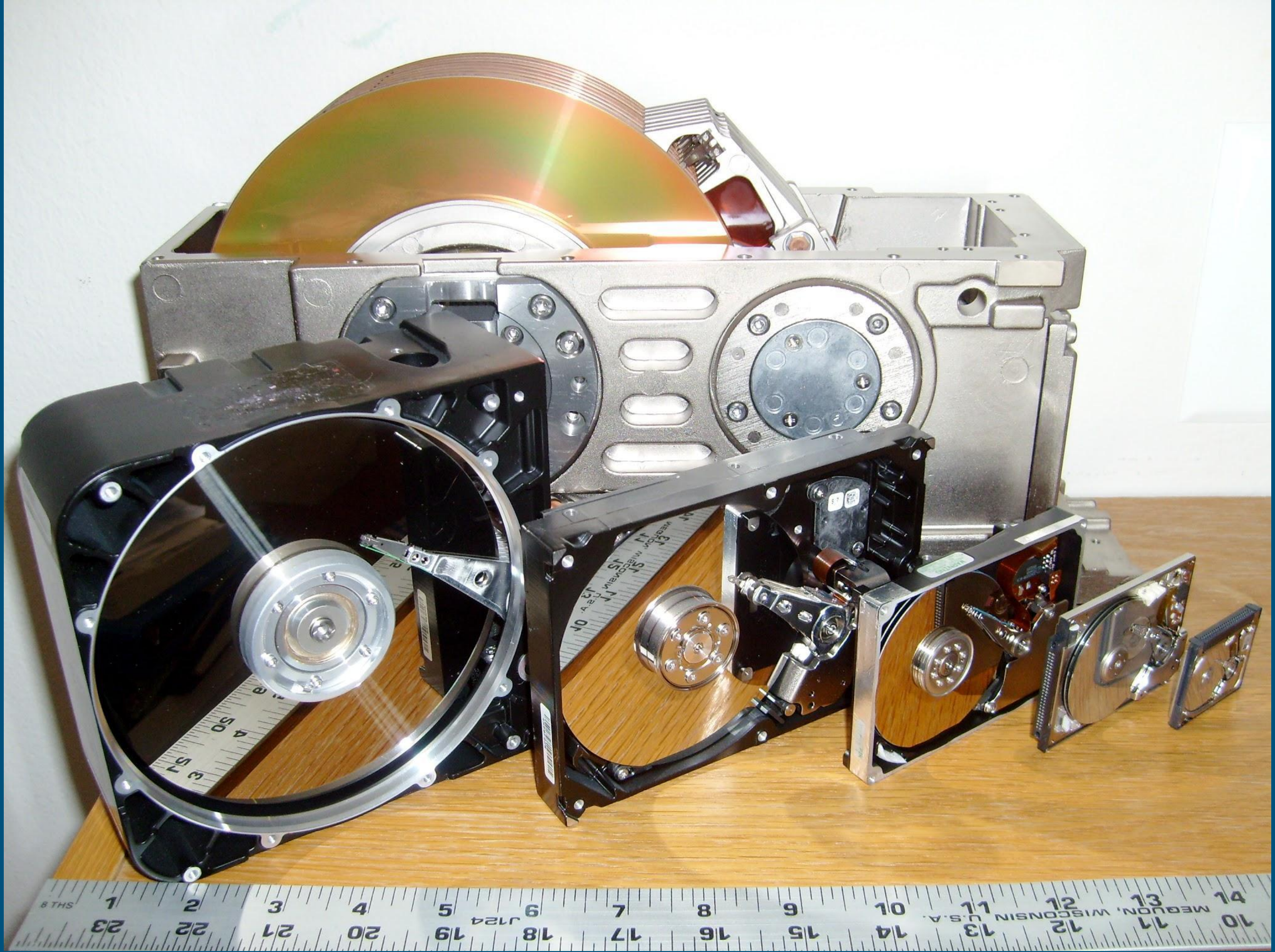
A couple of tips and tricks along the way

Where to begin?



https://commons.wikimedia.org/wiki/File:Bhimbetka_Cave_Paintings.jpg

By Paul R. Potts - Provided by Author, CC BY-SA 3.0 us, https://commons.wikimedia.org/w/index.php?curid=4676174



Common Disk Connection Protocols

SAS	12Gbps Serial Attached SCSI - Enterprise drives based on SCSI command set
NL-SAS	12Gbps SAS Controller with SATA based media, disk and performance
SATA	Upto 6Gbps SATA - Mostly consumer based on Parallel ATA command set
SCSI	Physical Interface and command set
IDE	8.3 MB/s - 133 MB/s - Parallel ATA command set

Enterprise Direct Connection Protocols

SAS	12Gbps Serial Attached SCSI - Enterprise drives based on SCSI command set
SATA	6Gbps SATA - Mostly consumer based on Parallel ATA command set
PCIe	31.5 Gbps PCIe 3.0 x4 - typically uses NVMe command set
M.2	Form factor that can use SATA or PCIe (NVMe)

Data Protection Techniques

RAID Parity and striping across block devices to create sets of redundancy

EC Erasure coding saves data in fragments with parity across different locations

Mirror Storage array level synchronous and asynchronous mirroring of data (DR/BC)

Multipath Redundant network paths from host to storage (dual HBA/NIC at host)

Cache Battery or super-capacitor backed up cache

Block Storage Network - SAN

Storage Array

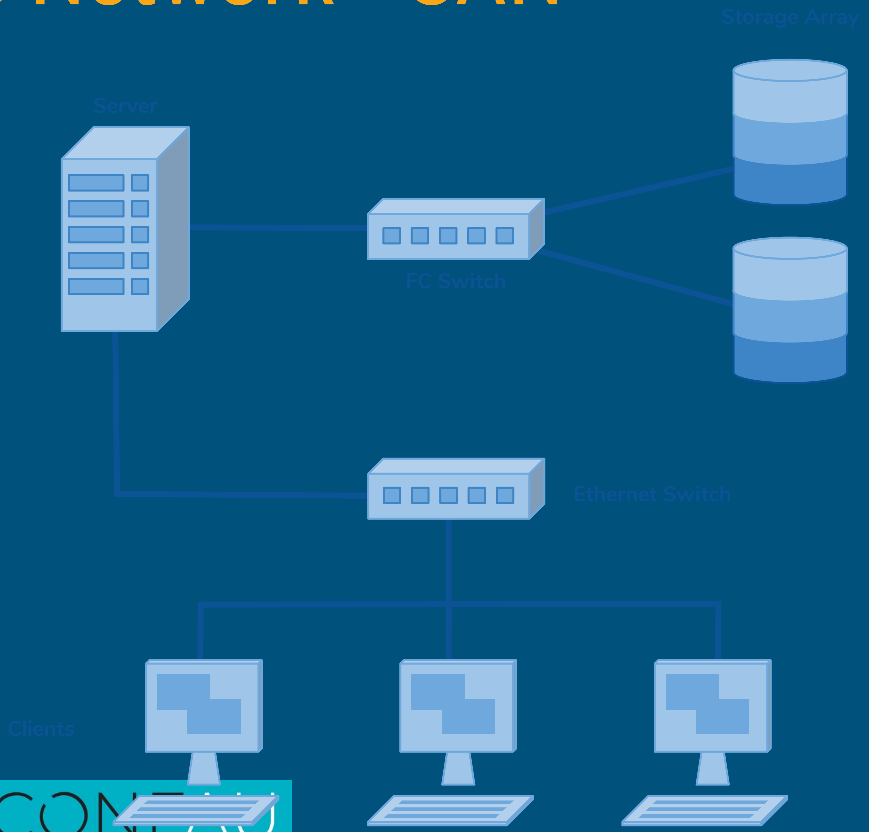
Modular or monolithic, Intelligent controllers

Redundant multi pathing, dedicated network

FC, iSCSI, FCoE, NVMe, IB

Block Characteristics:

- Very fast
- Data written in blocks
- Not human friendly
- Complex addressing



File Storage Network - NAS

Storage Array (Filer)

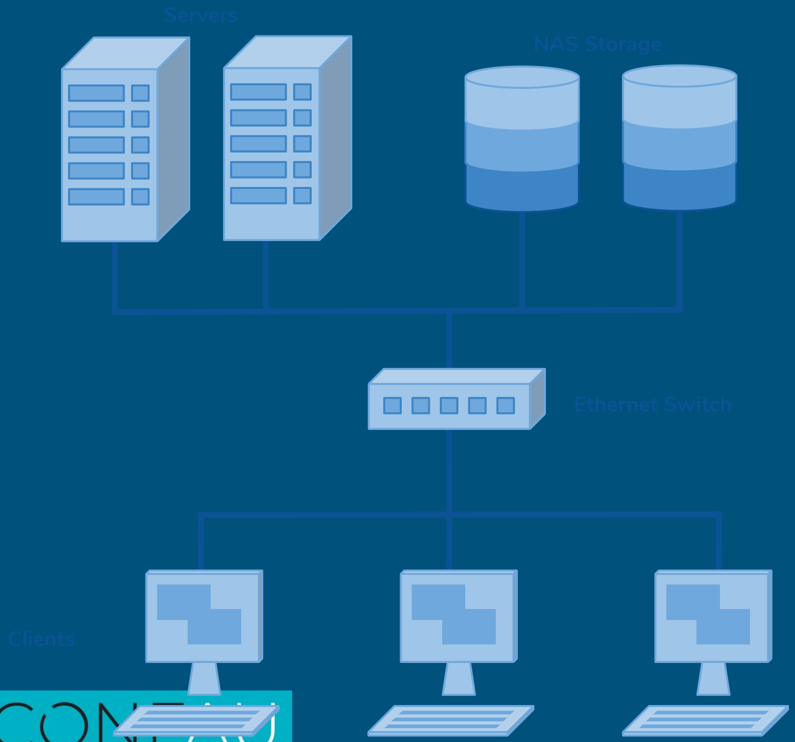
Usually Modular, Intelligent controllers

Redundancy via dedicated or existing ethernet network

NFS, CIFS

File Characteristics:

- Pretty fast
- Data written in files
- Human friendly paths
- Standard networking



Object Storage - Cloud

Content Addressable Storage

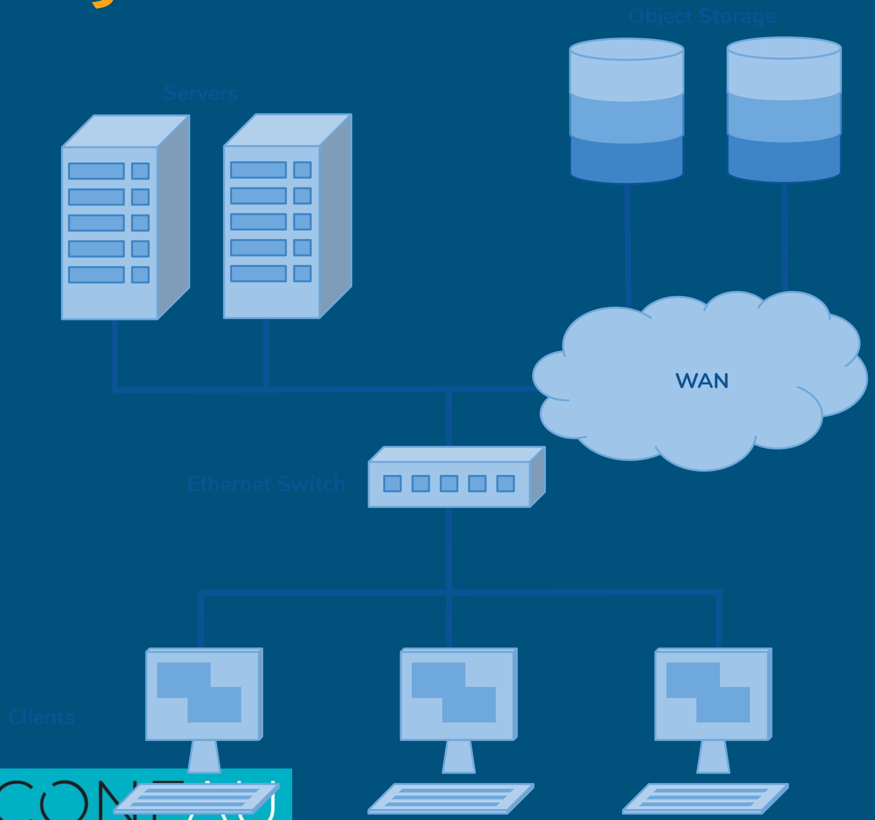
Usually massively scale-out

Redundancy via multiple data copies

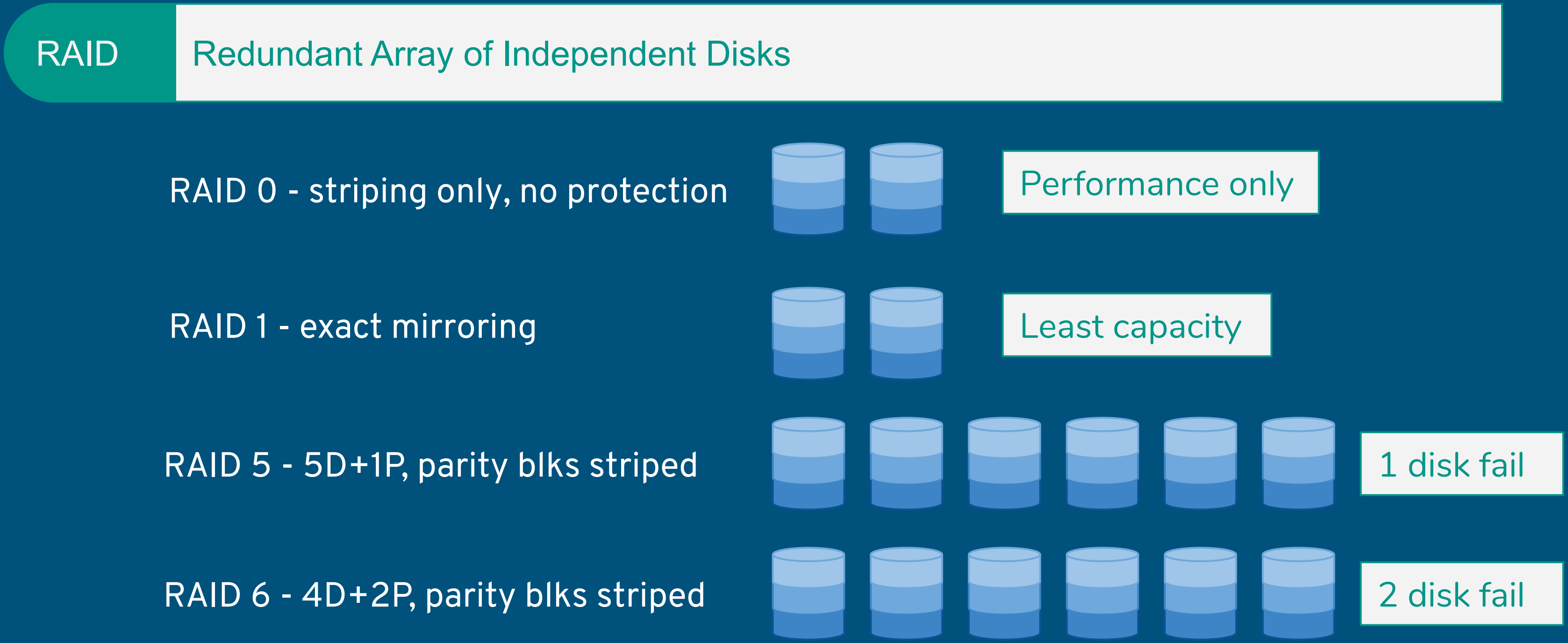
REST API (http), Swift, S3

Object Characteristics:

- Not usually fast
- Data written in objects
- Eventually consistent
- Human friendly metadata
- Cloud networking



Data Protection Techniques



RAID — Redundant Array of Independent Disks

RAID 0 - striping only, no protection — Performance only

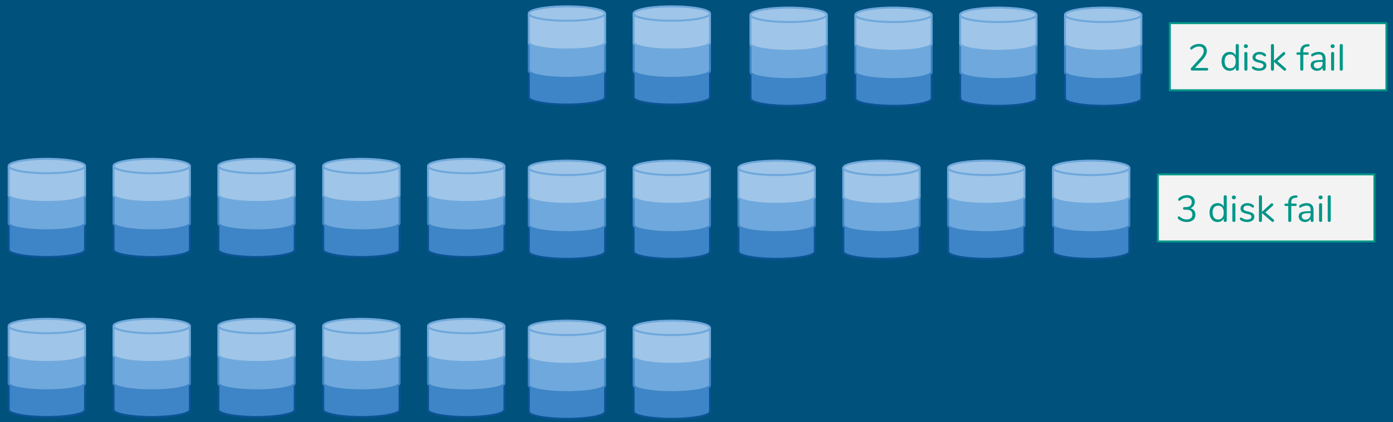
RAID 1 - exact mirroring — Least capacity

RAID 5 - 5D+1P, parity blks striped — 1 disk fail

RAID 6 - 4D+2P, parity blks striped — 2 disk fail

Data Protection Techniques

EC | Erasure Coding - K + M



EC 4+2

2 disk fail

EC 8+3

3 disk fail

Data Optimisation/Reduction

Compression Algo to reduce redundant blocks, whitespace etc (unstructured data)

Deduplication Avoids storing duplicate blocks (CPU intensive, rehydration, mapping)

Storage Vendor Terms

- RAW Storage
- Usable storage
- Effective storage

- Decimal GB vs GiB

Can I fsck that for you?

35+ years ago

ENERGY EFFICIENT AND
ANTI-RESONANCE
CASSETTE MECHANISM
B
XLII
POSITION HIGH
90
maxell

Beware aging / legacy storage

Bit Rot

Disk Rot

Flash failure

Mould

Old Interfaces (IDE / SCSI)

Hardware failure

Old Filesystems

HDDs > SSDs

TRIM is critical to Flash Storage performance

- Allows for elegant wear leveling

Makes it nearly impossible to recover “deleted data”

- On a HDD a deleted file is “often” just unlinked from the filesystem

Data recovery tips

Isopropyl Alcohol + lint free cloths

- Dust / oils can kill an optical drive

USB based dongles to reduce reboots

- CD/DVD Drive
- Floppy Drives
- IDE Drive
- SATA

NAS / SAN / External USB for initial archive

- I prefer locally attached USB-3 drives

Linux tools

- SystemRescueCd / UltimateBootCD
    - http://www.system-rescue-cd.org/
    - https://www.ultimatebootcd.com/
- ddrescue
- lzop
    - Fast lightweight compression
- testdisk / photorec
    - Recovery of filesystems and individual files off failed media

Media Has Failed

USB based dongles don’t always behave well with failed Hard Drives

- Time to dig out / borrow some old hardware
- Boot original hardware with a USB Live OS Image

Always create a full copy of the original media

- ddrescue is your friend
- perform data recovery with a snapshot/copy of the backup
- Fail back to testdisk/photorec

Raid is not a backup mechanism

Raid 0/1/10/5/6 can be implemented via

- Hardware raid controllers
  - Proprietary or in kernel drivers
- “Fake Raid”
  - Really a software driver - dm-raid
- Software Raid
  - mdadm or LVM based

Going Mad with MDADM Pt 2

Original talk from Sys Admin Miniconf - LCA 2010 in Wellington

Pinpointing the issue

- RAID / HBA Adapter
  - Firmware Issues
    - updates that can trash a Raid array
    - Raid metadata incompatible with different firmware versions
  - Legacy Adapter
  - Conflict with motherboard chipset

MDADM can be your friend

- running XFS also helps

Going Mad with MDADM Pt 3

Problem - Hardware Raid Controller Failure

- No spare compatible hardware
  - Trade Me or Ebay was the only option for parts
- Used a Linux box with a SATA/SAS HBA
  - Raid metadata was detected by dm-raid
  - Raid array assembled into a running state
  - Data recovered onto replacement hardware

Going Mad with MDADM Pt 4

The Problem - recovering failed a RAID 5 array

Software Raid-5 set via mdadm

- 4 x 3TB Drives
- Marvel 88SE9230 PCI-e SATA HBA
- DMA errors under high I/O
    - Or during weekly raid consistency check
- 2 Drives were removed from Raid Set

BZs

- https://bugs.launchpad.net/ubuntu/+source/linux/+bug/1810239
- https://bugzilla.redhat.com/show_bug.cgi?id=1337313

Solution

1 - Change HBA

2 - Check the Raid Set

```
mdadm --detail /dev/md2
```

3 - Confirm Event of 3 disks is close enough

```
mdadm --examine /dev/sd[abd]2 | \
grep Event
```

4 - Force start a degraded array and cross fingers

4 - Consistency check on LVM and filesystems

Cluster fsck

I need HA storage for/because

Beware

- there are dragons ahead
- may you live in interesting time
- life is to short to build a cluster of two

What is the use case

- RTO / RPO
- Workload performance requirements
- Any latency issues

HA / DR / Backup

- HA isn't a backup mechanism
- DR with high or variable latency
- Fail over / Fail back

Cluster of two

- Is a problem waiting to happen
- 3rd quorum node / arbiter is critical

HA NFS

Approaches

- Active/Active
  - Requires a cluster aware file system
    - gpfs / gfs2
- Active / Passive
  - Shared storage over FC/iSCSI
  - Partition is only mounted on a single node
  - Pacemaker + VIP

Issues

- Application services are latency sensitive
  - Requirement sub 5ms
  - NFS failover is >= 30 seconds
- Scale
  - 2 node cluster couldn’t cope with workload
  - Had to scale to 3 nodes with considerable added complexity
- No Live migration
  - Environment was virtualised

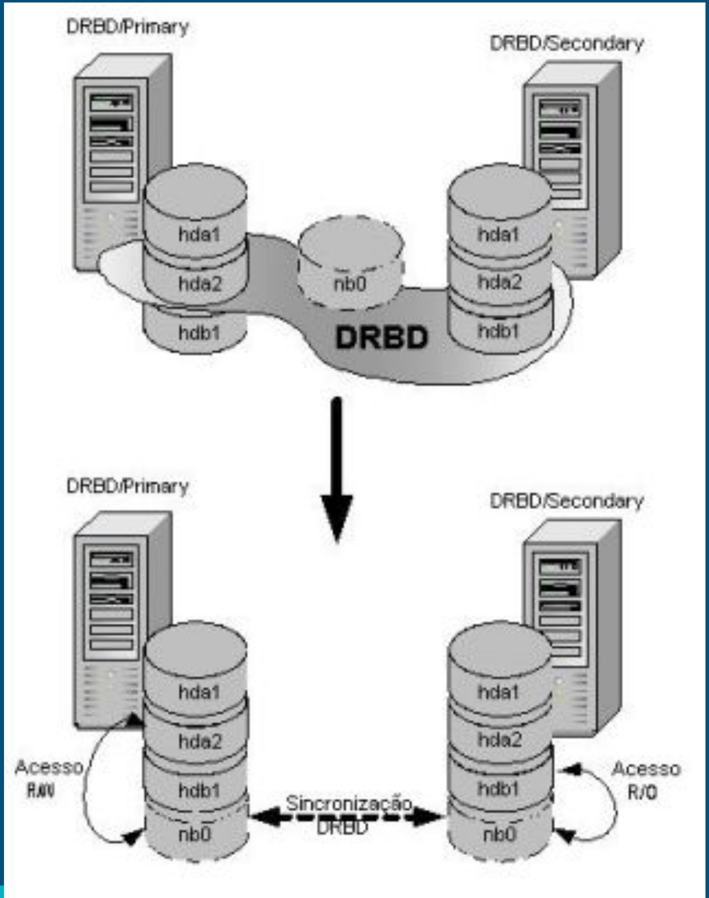
DRBDont

DRBD

- Distributed Replicated Block Device

DRBDont

- Maintenance can be (was) painful
- Fail back issues
- Cluster of 2



Multiple Single points of failure

Understand the requirements

- And the existing infrastructure
- Especially any SAN arrays
    - And the network infrastructure

Real cost of the solution

- What does an NFS head for the SAN cost
- vs project and operational cost of your “busy work”

Common statement is the existing storage infrastructure isn’t reliable or meet the RTO/RPO requirements of a project

- Secondary requirement is solution has to be virtualised

All Virtual infrastructure runs off the same SAN array

- But you need to meet a higher SLA

Software Defined Storage

Gluster

- Suits file centric workloads
- Simple to implement
- Can run virtually or on bare metal
- Scales elegantly
- Supports CIFS/NFS/pNFS
- **Can** avoid using the SAN

Ceph

- Object / Block / File
- Focused on bare metal
- See rook talk tomorrow for containers
- Vibrant community
- Replica 3 for performance
- Excellent EC implementation for scale

What the fsck!

Dust and Humidity

Existing machine room re-sized

- Shrunk to provide additional storage space
- New drywall installed
  - and sanded
- But they did install drop cloths over the racks

Outcome

- We had to vacuum out all the servers
- Almost every hard drive was replaced over next 9 months

Aircon unit leak

- Wet carpet in the machine room
- Temporary aircon couldn't deal with additional humidity from drying out carpets

Outcome

- Almost every hard drive failed over next 6 months

Expect the unexpected

Corrupted LVM

- Multiple LUNs from SAN
- Combined into a single VG via LVM

Issue - FC LUNs had been allocated to 2 systems

- No partition table was present
- Unix team had re-formatted the LUN
- LUN was in the middle of a Linux LVM VG

Recommendation - Always create a partition table

Corrupted filesystem

- xfs filesystem consistency issues
- Rebooting host inconsistent behavior

Issue - Poor grouping of LUNs

- Virtual Guests hosted on KVM
- Direct LUNs mapped to Virtual Guests
- Guests mounted wrong /var or /data

Recommendation

- Unique LV UUIDs & mount by UUID

Back to the future

Everything old is new again

You will always need more storage

HDDs (rust) aren’t dead (yet)

EDSFF for hyperdense flash storage

Persistent Memory

At some point TCO for Flash will drop below rust

Cloud players will continue to innovate

Questions?

sellis@redhat.com
http://people.redhat.com/sellis

LINUXCONFAU