



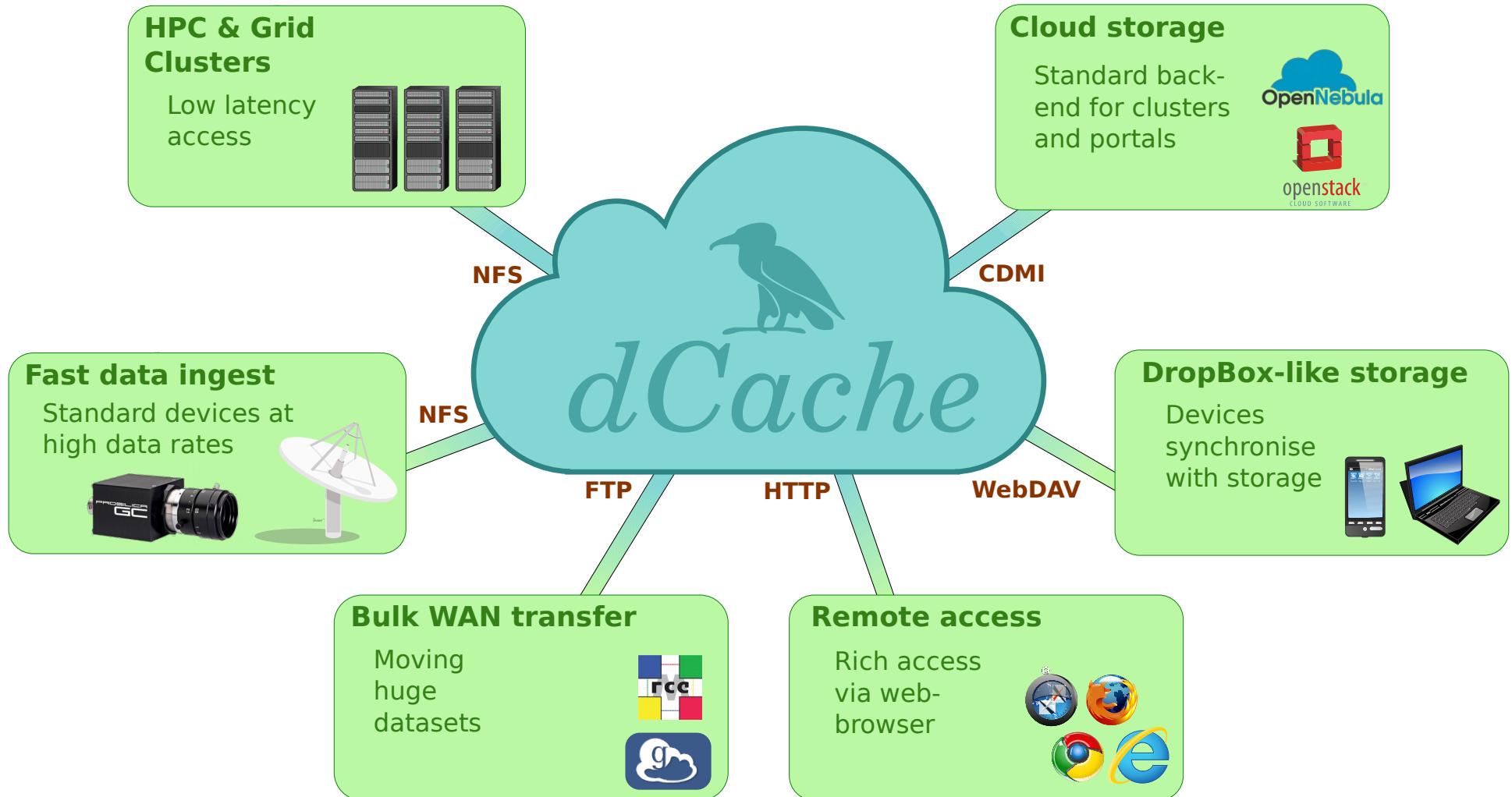
pNFS - two years in production

Tigran Mkrtchyan for dCache Team





Problem domains



the mission

“... to provide a system for storing and retrieving huge amounts of data, distributed among a large number of heterogeneous server nodes, under a single virtual filesystem tree with a variety of standard access methods.”

16 Sep. 2000

Michael Ernst, Patrick Fuhrmann, Martin Gasthuber, Rainer Mankel

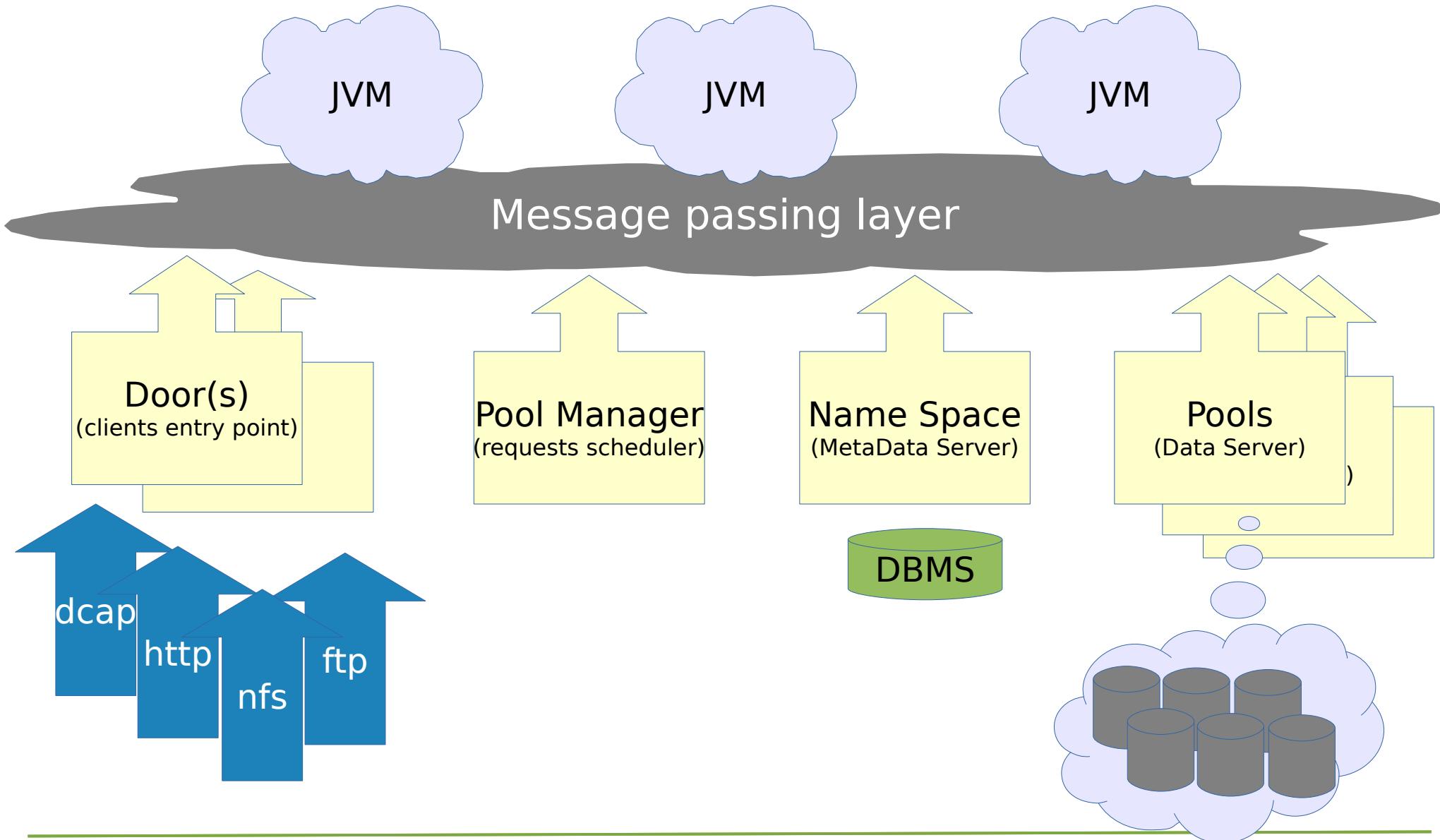
pnfs problem statement

“...Separating storage data flow from file system control flow effectively moves the bottleneck away from the single endpoint of an NFS server and distributes it across the bisectional bandwidth of the storage network between the cluster nodes and storage devices.”

pnfs problem statement

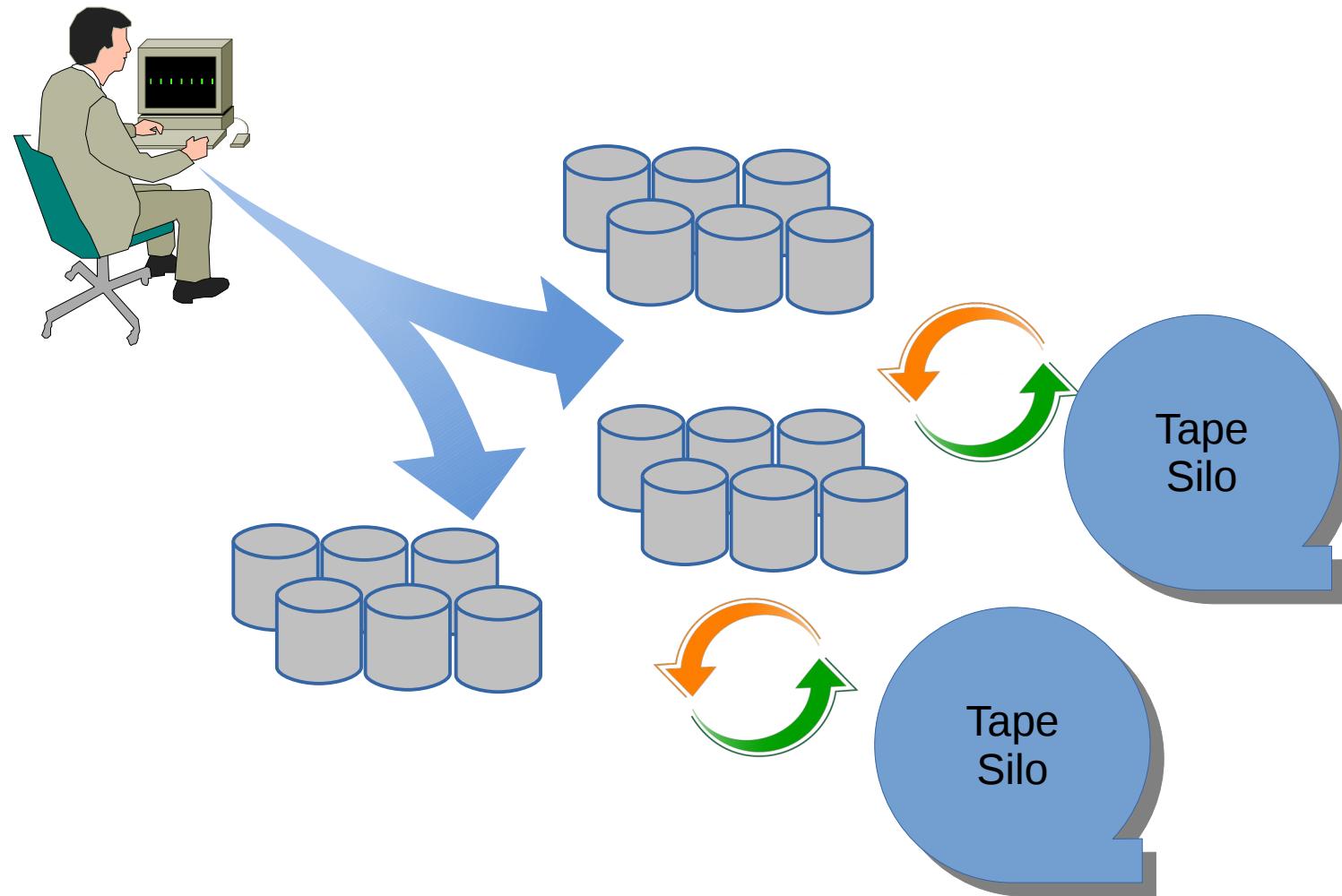
Garth Gibson et al., July 2004

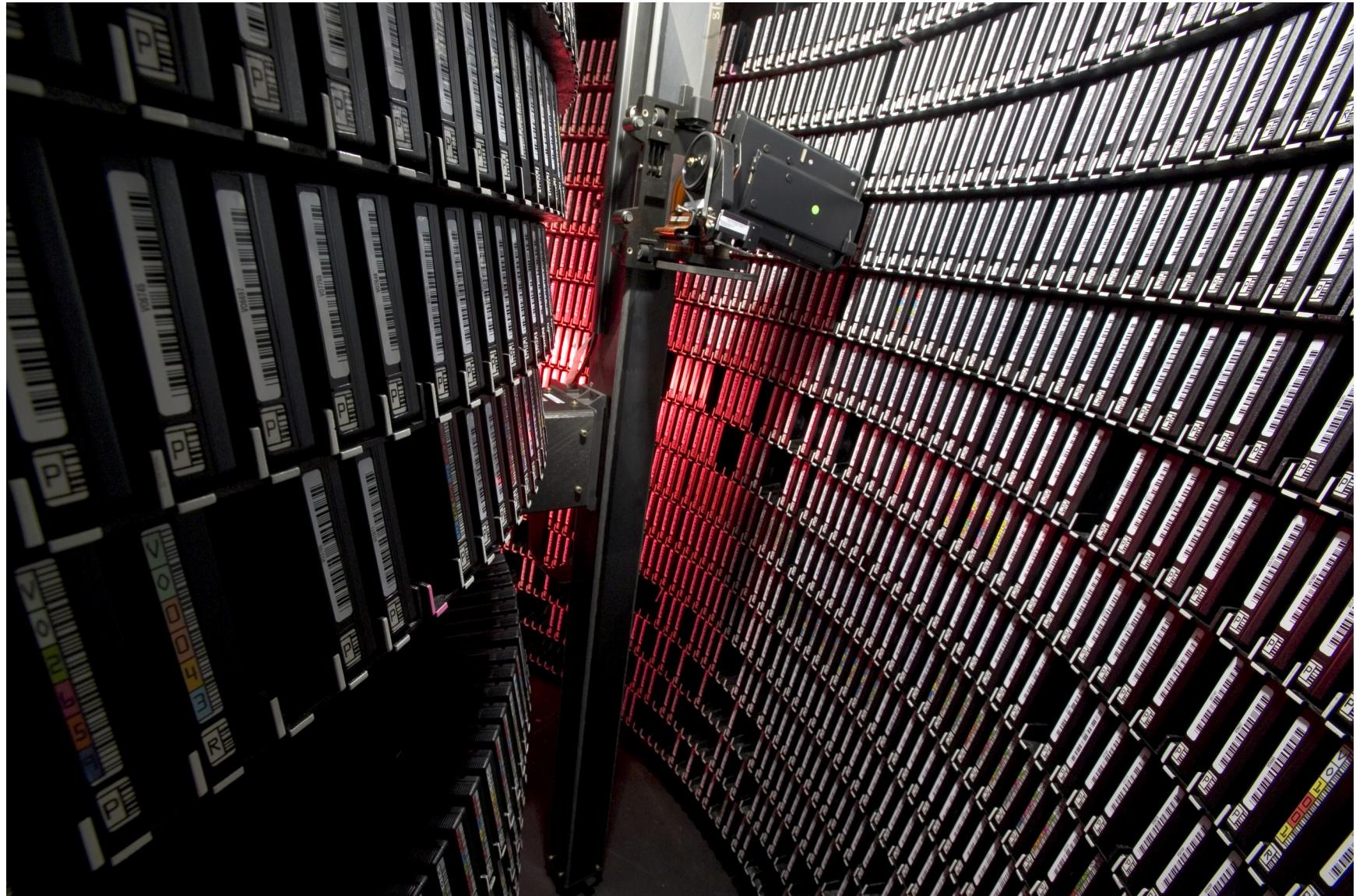
dCache in one slide



Tape migration

Disk <-> Tape migration behaves similar to write-back cache:



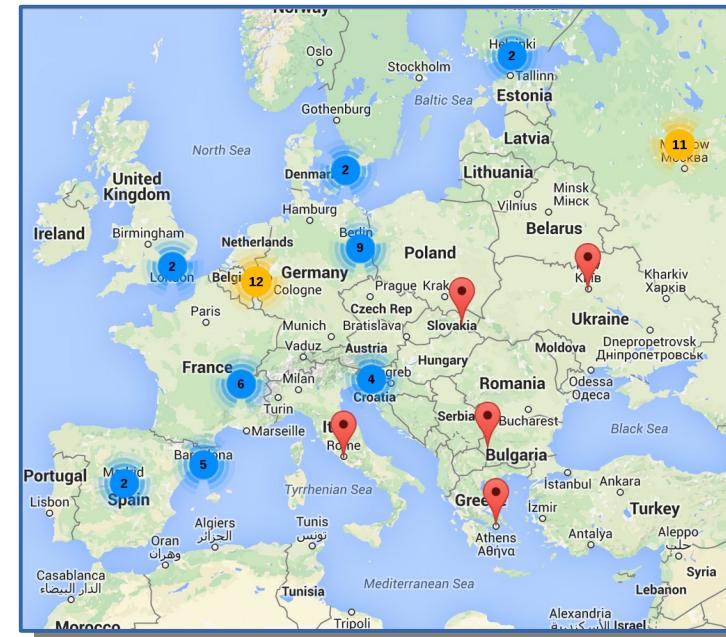
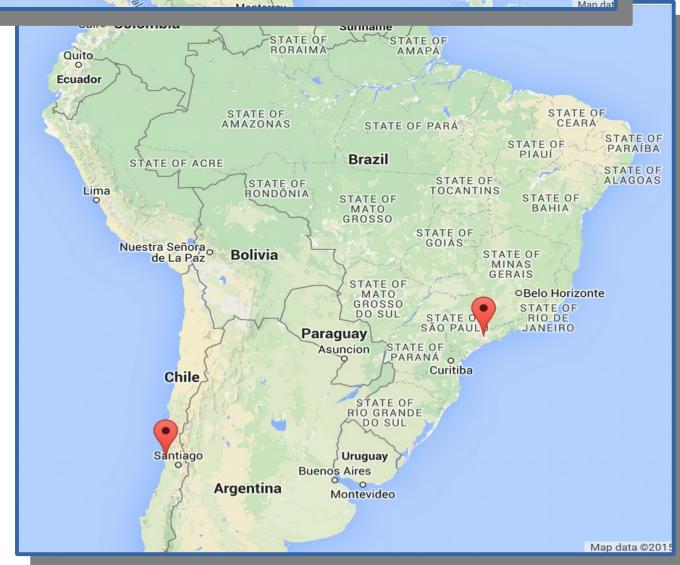
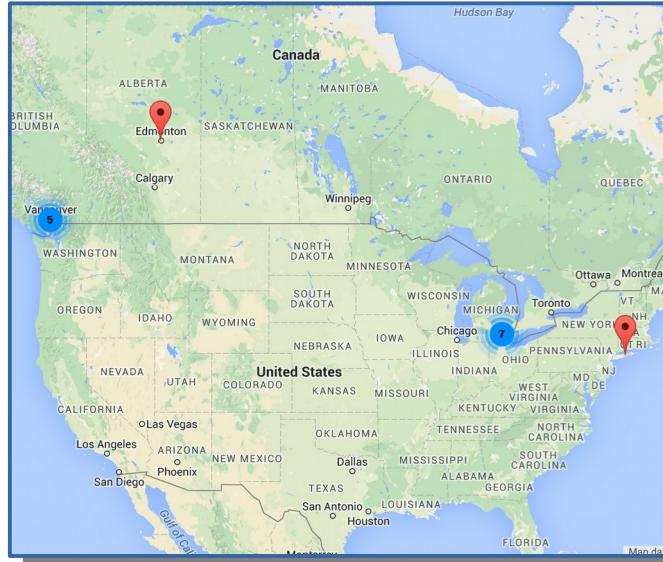


Some Numbers

- ~10PB in total
- ~1200 DS (~300 hosts)
- ~10K Cores (~800 hosts)
 - SL6 (RHEL6)
 - handful RHEL7
- ~ 400 TB per day (~90% read)



~50% of LHC data around the world

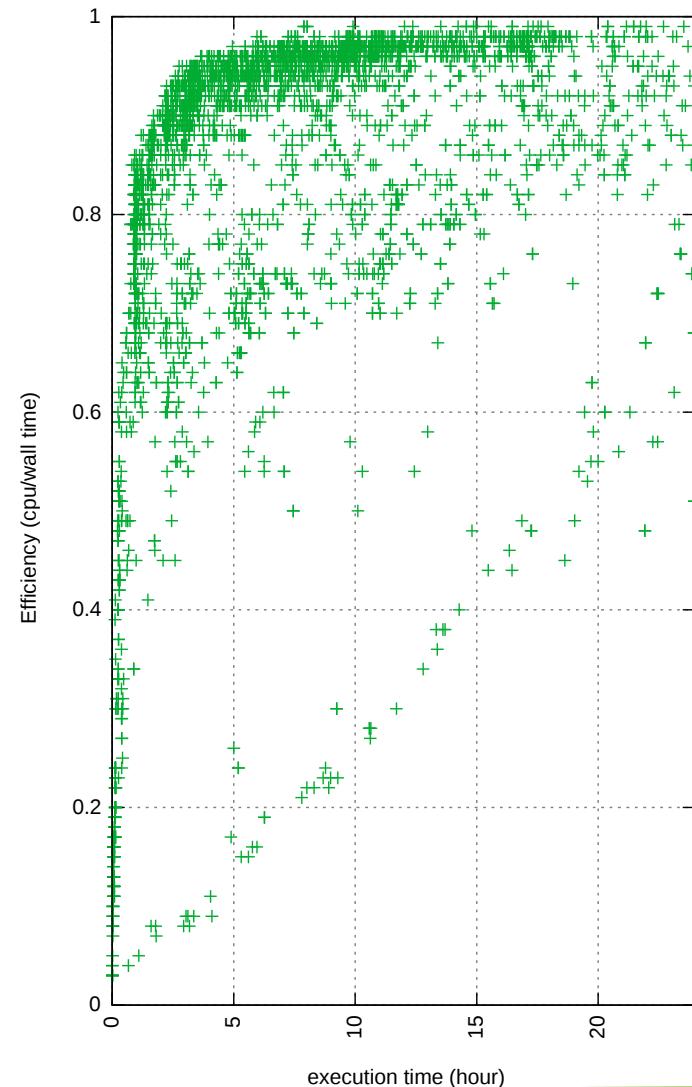




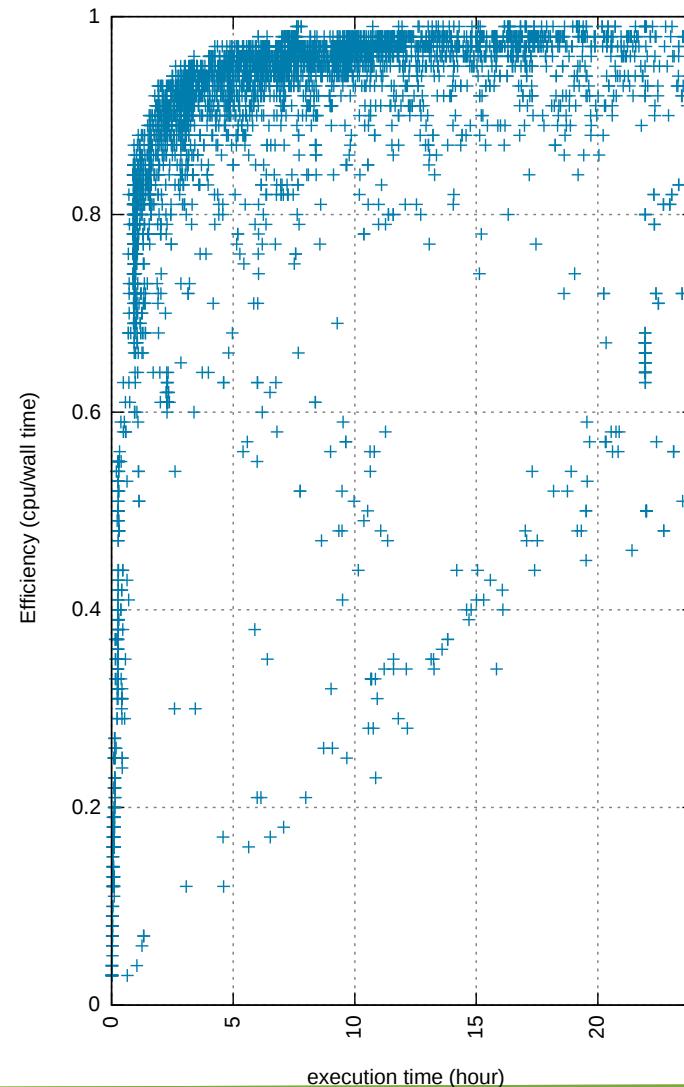
Job Efficiency

CMS job efficiency by access protocol

NFSv4.1/pNFS

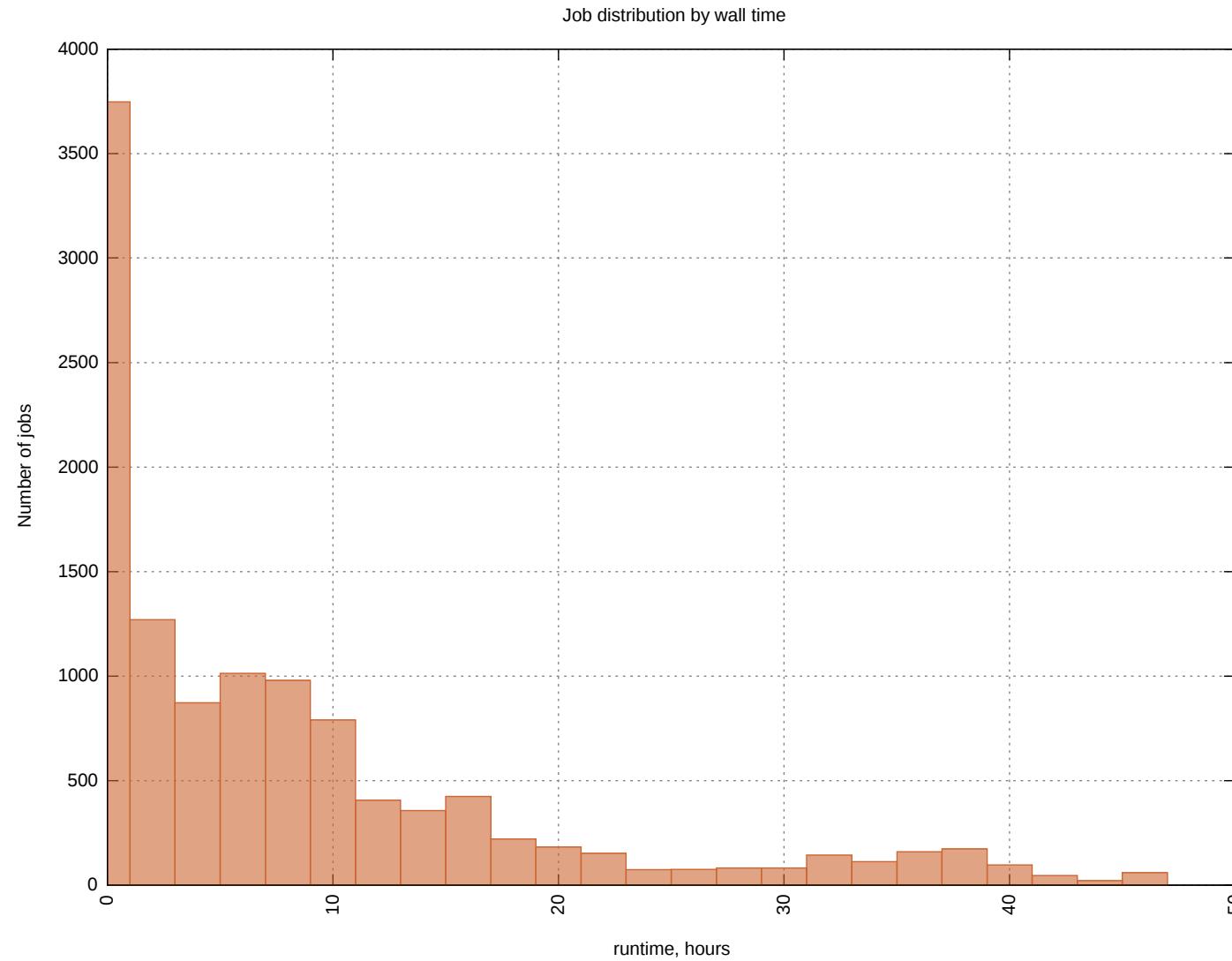


DCAP



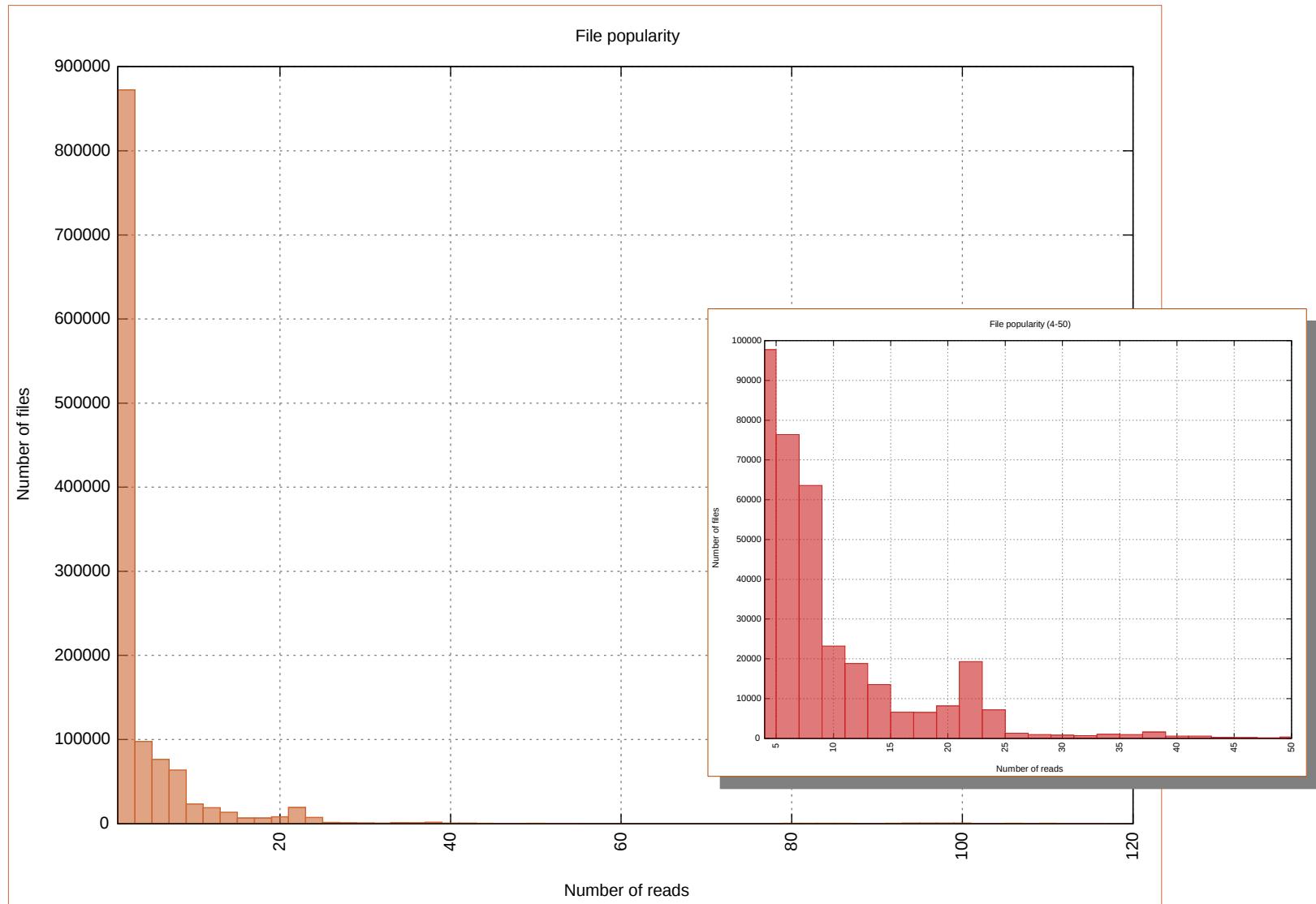


Job distribution by runtime





File Popularity



www.nobelprize.org/nobel_prizes/physics/laureates/2013/

Physics Prizes  2013 

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Photo: A. Mahmoud
François Englert
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Peter W. Higgs
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The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"


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Operational experience

- performs well as long as it running
- Hard to get under control when fails
 - mostly to understand '**WHY?**'



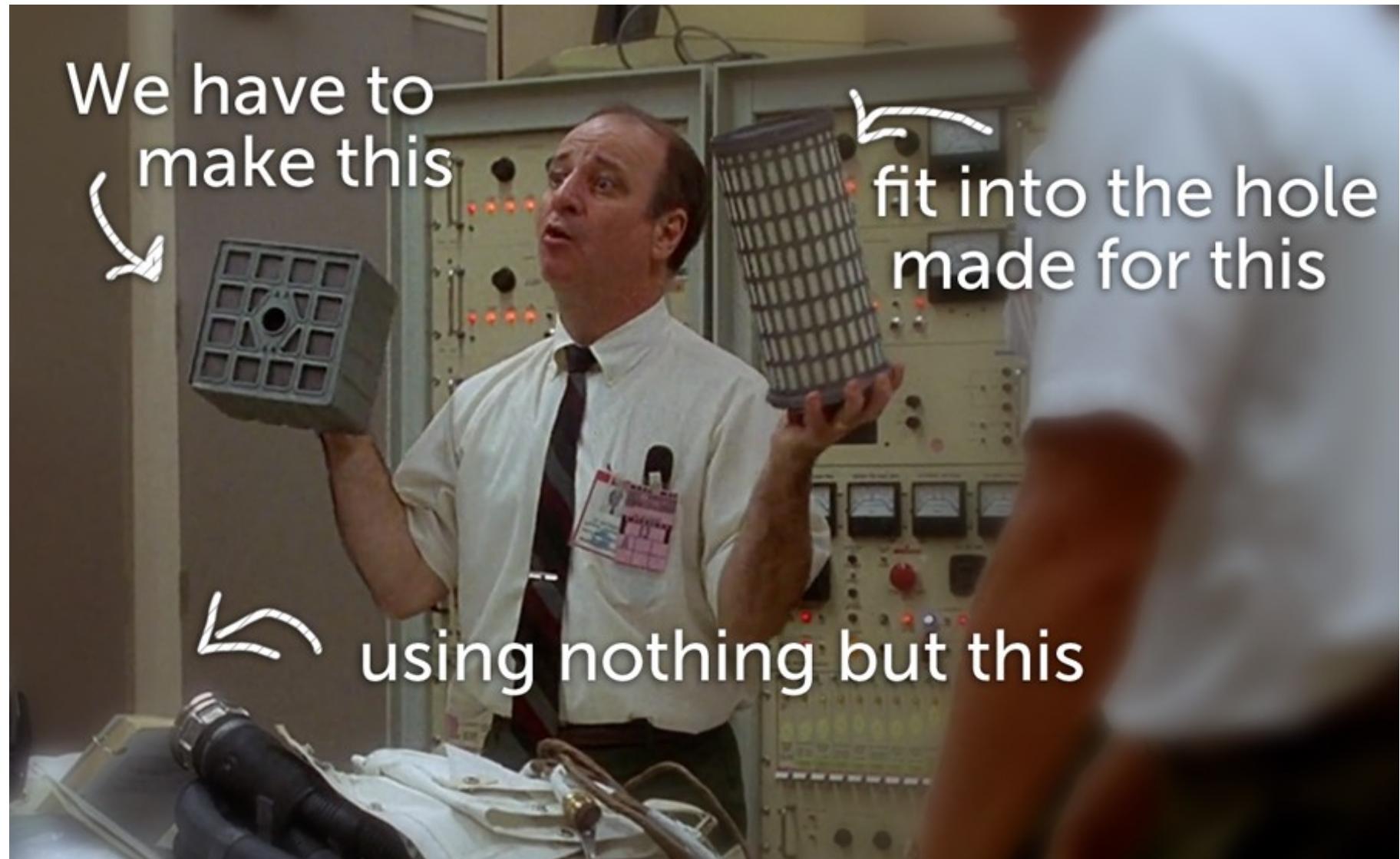


pNFS - two years in production
or

pNFS – 'p' for PAIN

Tigran Mkrtchyan for dCache Team





Observed problems

- Dual stack DS (IPv4 + IPv6)
- Multi-homed DS (more than one IPv4 address)
- DS behind firewall
- Unstable DS (Host, Disk, Network errors)
- Weak clients (VMs)
- Distributed nature (rule #1)
- Spec violation (infinite state recovery)
- DS blacklisting
- Stale kernel threads

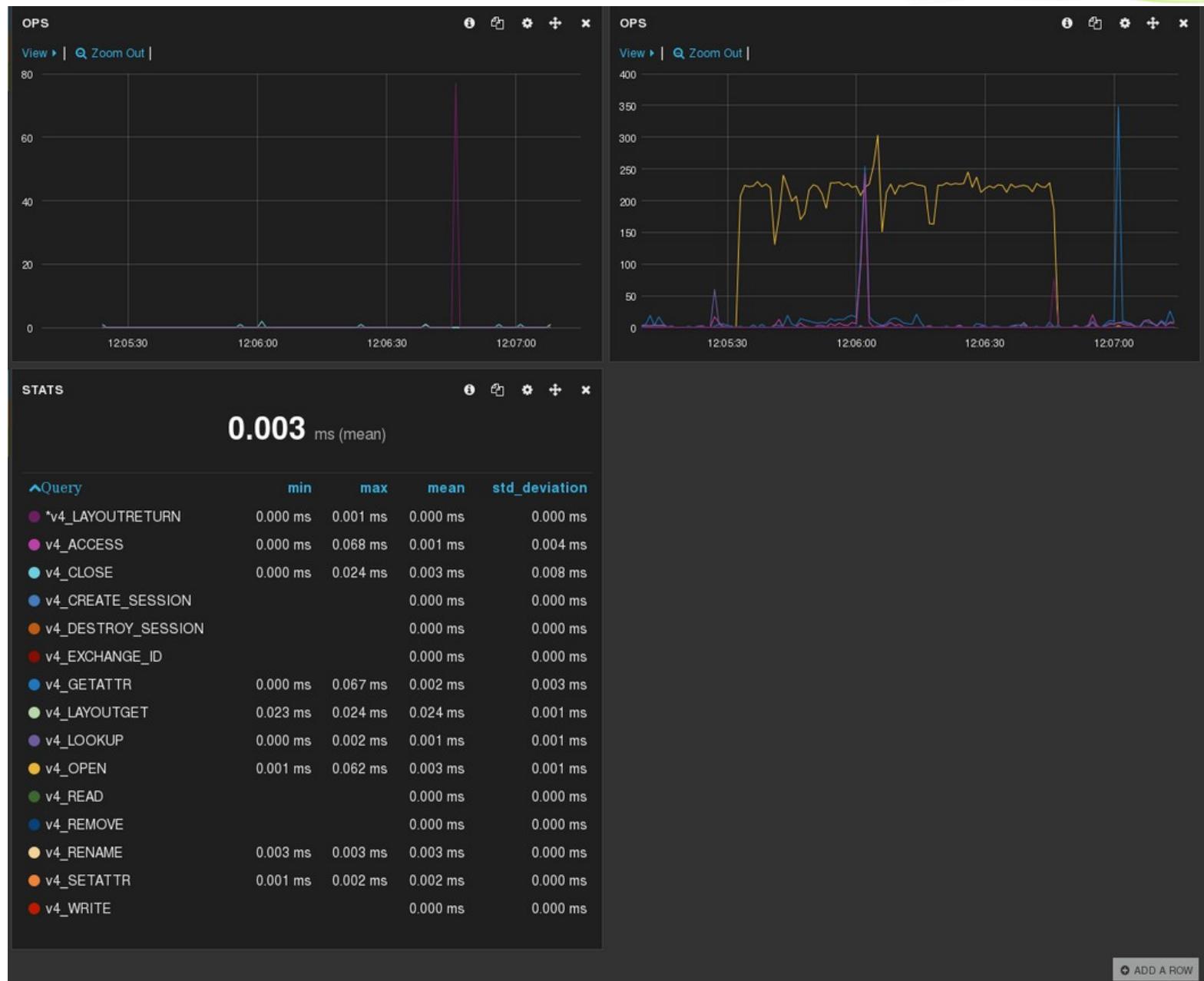
Conclusion

- We see us as a clear winners of pNFS
 - enables us to expose our storage system to standard clients
- No other commercial/opensource servers with comparable installations in production
- Most of the problems we was able to solve
- A new community get a posix-like access to shared storage
- RHEL6 (SL6) our main platform for next 4 yeas
- IPv6 slowly become a reality

Future plans

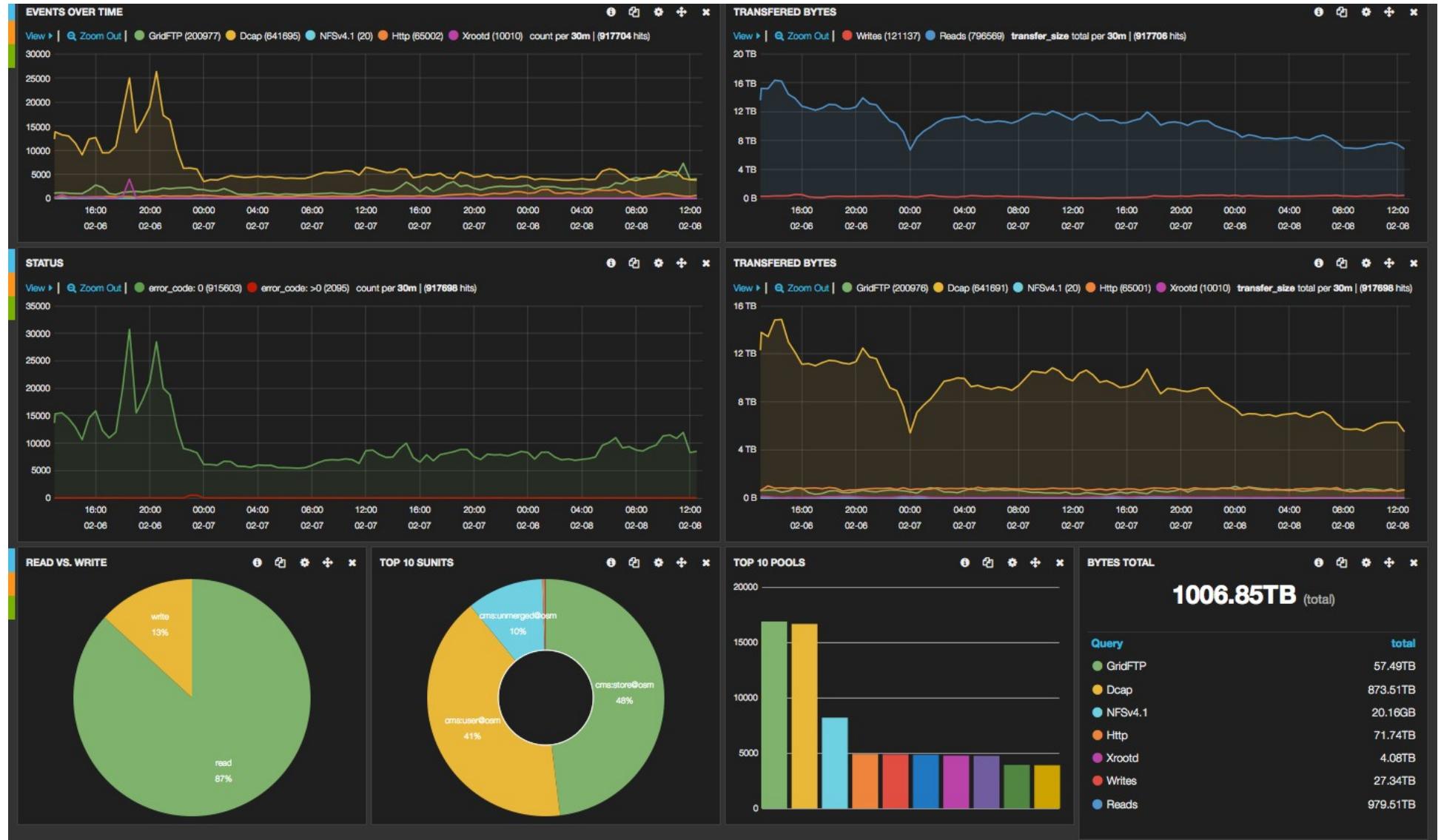
- Delegations
 - better experience for interactive users
- FlexFiles
 - Mirroring (especially on write)
 - error reporting
- Locks







Live view





Slides with Problems

IPv6

- Dual stack DS
 - Client doesn't support IPv6
 - Client takes first entry in multipath list
-
- Put IPv4 addresses before IPv6
 - RHEL6 client updated to pick first IPv4 address

IPv4

- Dual Home DS
- Client takes first entry in multipath list
- Discover interface which will be used and put it as a first in multipath list



pNFS!

- DSes behind firewall
- Implemented extra export option 'nopnfs'
 - always returns NFSERR_LAYOUTUNAVAILABLE



DS errors

- Host crash
- DISK errors
- Network
- Yes, yes....proxy-IO



Clients in a VM

- Client with limited resources
 - Client can't digest requested data
-
- Hmm...Session limits per client?
 - Physical host



Distributed Nature

- Network glitches
- All client (ALL!!!) fall-back to IO through MDS
- Interactive users unhappy
 - *And my phone rings*
- dedicated low-latency MDS for interactive users
- dedicated high-throughput MDS for cluster nodes

Infinite state recovery

- Client and server can't agree
 - Infinite state recovery loop
-
- added special command on MDS to forget the client
 - client tries reboot recovery

DS blacklisting

- client blacklists DS
- All access to that DS use proxy-io
- added special command on MDS to generate new device id



Spec is complicated

- Every time I read find something new
- Every time I re-read I understand differently
- tanks for Connectathons and Bakeathons to get it right





Job Efficiency

CMS job efficiency by access protocol

