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# CRUK CI HPC cluster introduction (I of III)

Using the Cambridge Institute's High  
Performance Computing Facilities



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# Overview

This brief course will give you two things:

1. A refresher on unix and an introduction to cluster computing
2. Basic instruction on using our scheduler
3. Some performance hints

It *won't* make you an expert on parallel computing and HPC, but will let you get to work.

This course has a practical component, for which you will need an ssh client and cluster account.

# Session I

- |   |                            |
|---|----------------------------|
| 1 | Unix refresher             |
| 2 | Cluster introduction       |
| 3 | Practical – unix processes |

# Session II

- |   |                            |
|---|----------------------------|
| 4 | Using the scheduler        |
| 5 | Practical – job submission |

# Session III

- |   |                        |
|---|------------------------|
| 6 | Some performance hints |
|---|------------------------|



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# Unix refresher

(we have a course if this is all  
new...)

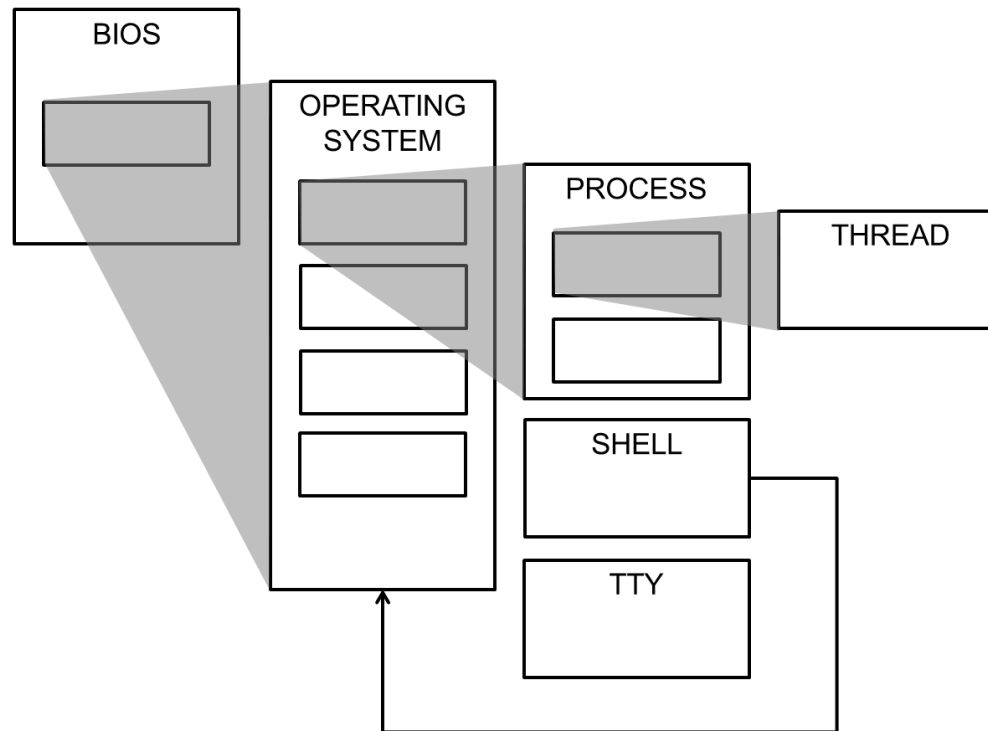


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# Operating Systems and Processes

'Unix' or 'linux' (or 'UNIX') is our *operating system* – the program that controls the processes and their access to the network, screen, etc.

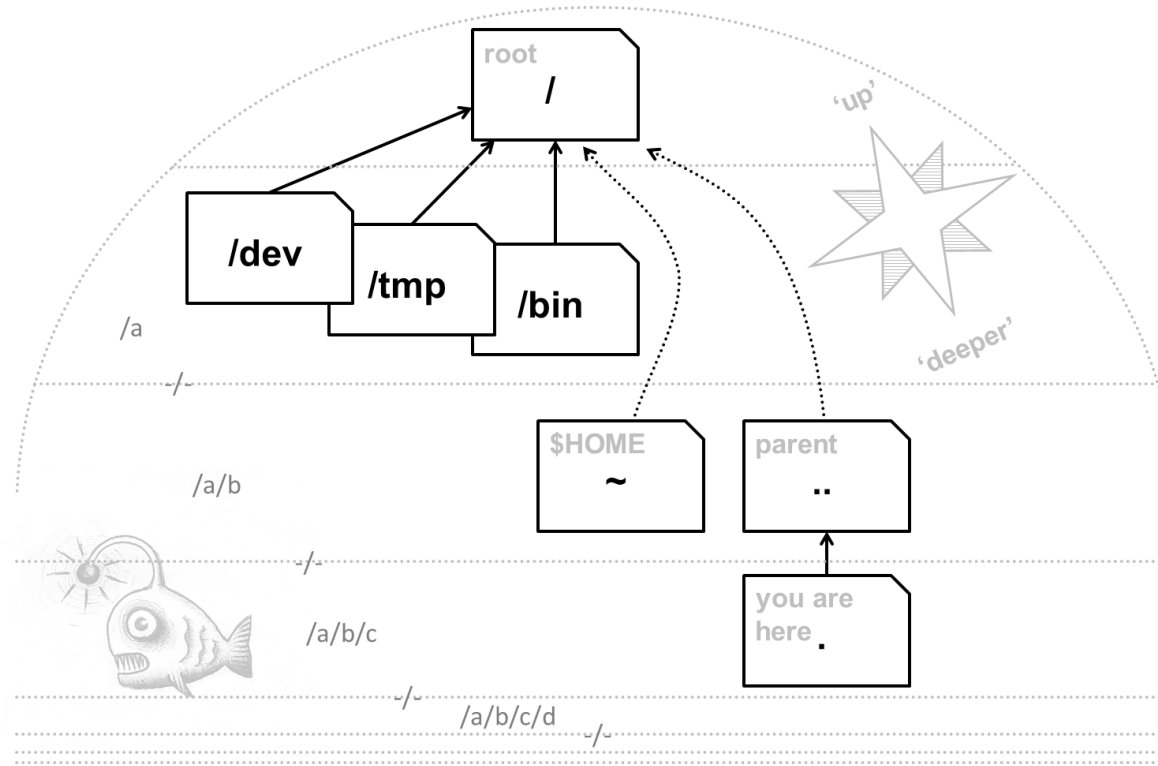
The shell is a *process* – it happens to be one that can see its own OS, which is one of the reasons it's so useful.





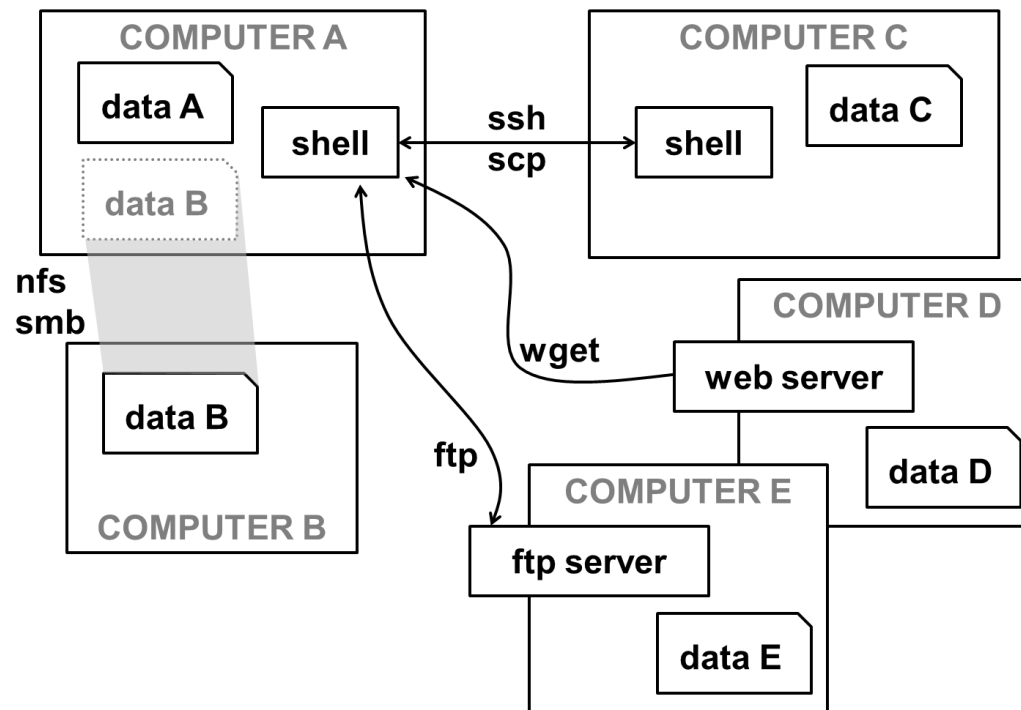
# Navigation concepts

You need to be able to navigate without a GUI.  
Fortunately some things are always in the same place.  
Unix file systems are trees, *with the roots at the top*.



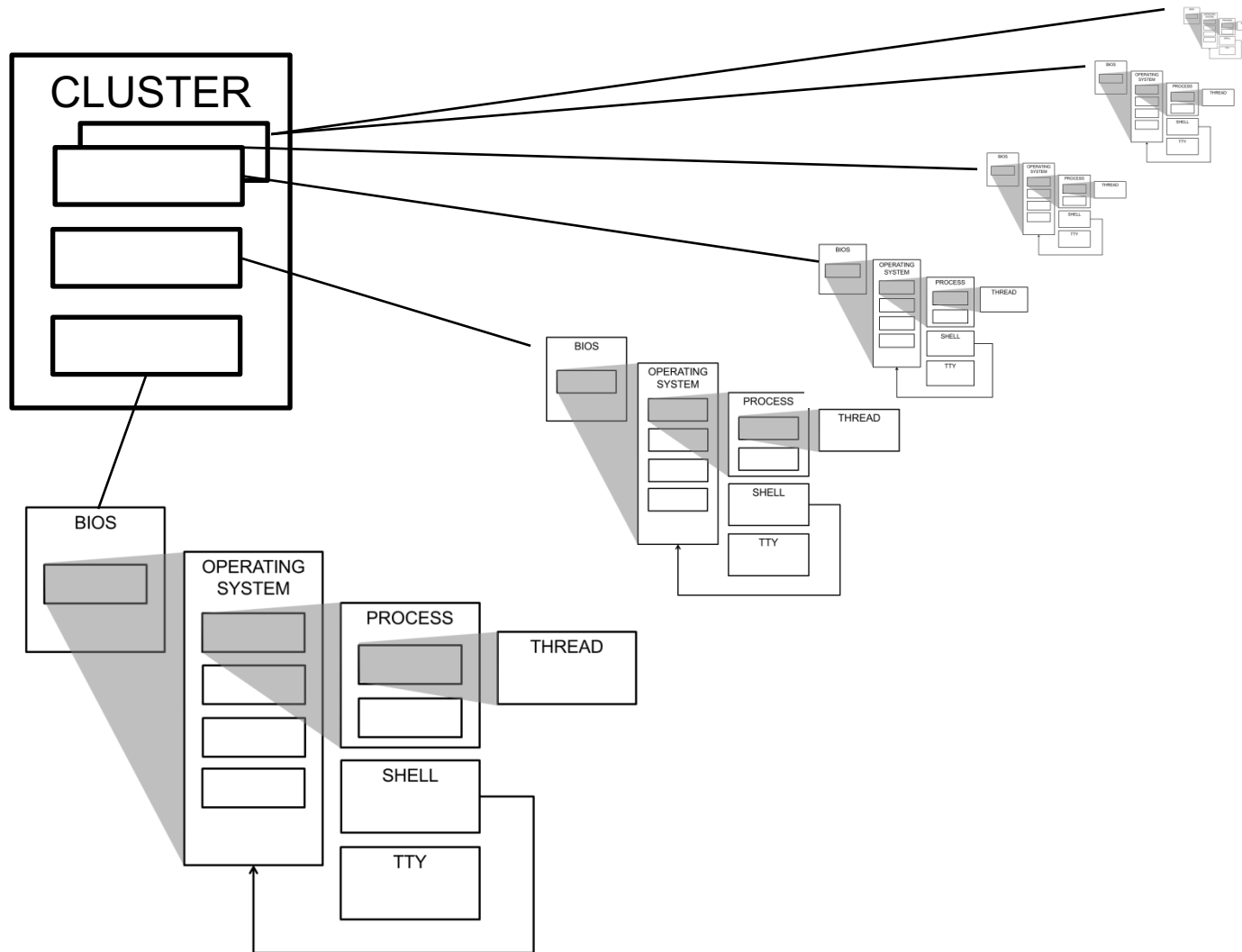
# Moving data, or yourself

Most of the ways of moving data around the internet were developed for Unix first. You also have the option of going to where the data is, with a remote shell.



# A cluster is just many computers together...

Each one with its own OS, processes, and shell environments.





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# CRUK CI HPC cluster



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## Key Cluster-related Staff

Nigel Berryman (Head of IT & SC)

Marc O'Brien (Technical Architect)

Charles Thomson (IT Specialist)

Jon Marshall (Systems Administrator)

## CRUK CI IT & SC Help Desk

Use the usual helpdesk route for day-to-day problems – if an issue is affecting you it may be affecting many people.

[helpdesk-it@cruk.cam.ac.uk](mailto:helpdesk-it@cruk.cam.ac.uk)

01223 769600

# Cluster1

Ethernet

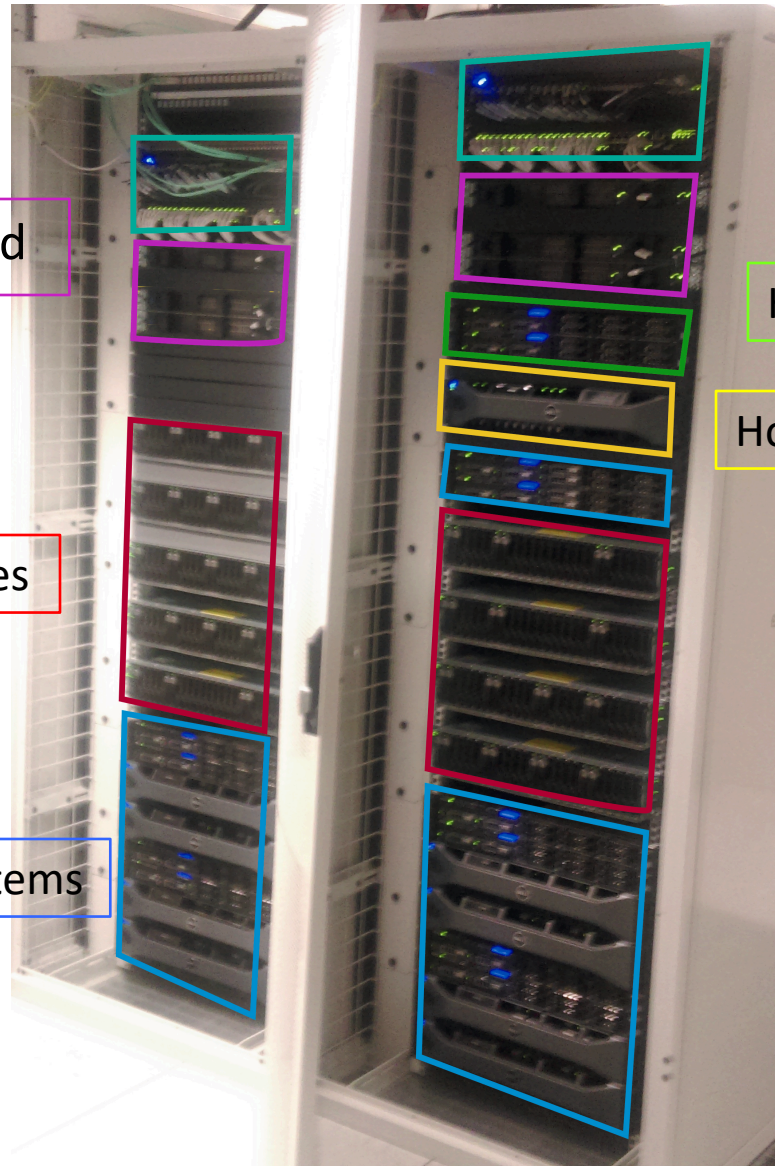
Infiniband

Compute Blades

Lustre file systems

Headnodes

Home storage



# CRUK CI HPC Cluster Specifications

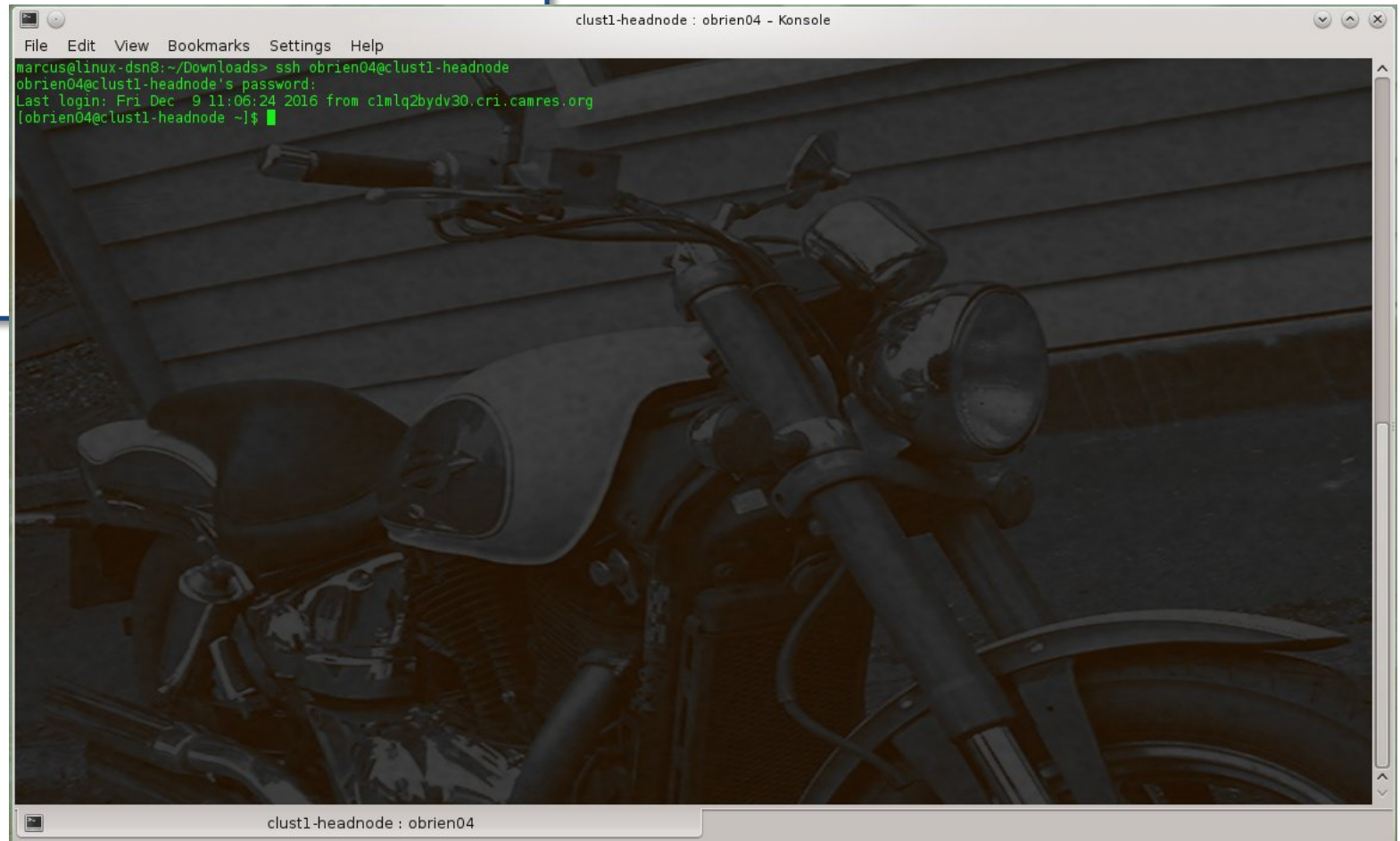
- 33 compute nodes
- 2 x 20 core Intel Broadwell CPUs
- 1320 cores
- 320 GB RAM per node
- 2 x 196TB Lustre parallel file-systems
- Job scheduler (SLURM)
- CentOS 7.3

# Accessing the HPC cluster

Login to the head node via secure shell (ssh)

```
[user@computer ~] ssh user@clustl-headnode
```

Login to your cluster account





## /home Directory

- 19TB file system shared over NFS4
- Intended for source code and common user applications & libraries
- Mounted on head node and all compute nodes
- Daily backed up

# Transfer data into and out of the cluster

Use SSH scp (SCoPy) to transfer data

Bulk transfers using rsync (delta-transfer algorithm)

```
user@laptop:~> scp -r data/ clust1-headnode:/scratchb/xxlab/  
file01.dat 100% 100KB 100.0KB/s 00:00  
file02.dat 100% 100KB 100.0KB/s 00:00  
file03.dat 100% 100KB 100.0KB/s 00:00  
  
user@laptop:~> rsync -av data/ clust1-headnode:/scratchb/xxlab/data  
sending incremental file list  
file01.dat  
file02.dat  
file03.dat  
sent 307464 bytes received 72 bytes 615072.00 bytes/sec  
total size is 307200 speedup is 1.00
```

# Cluster Storage

1. What's wrong with NFS or CIFS?
2. The Lustre parallel file-system
3. Working with Lustre

# The Problem

Extreme I/O demand on storage

- HPC cluster can have 10s to 1000s compute nodes
- x Many users
- x 1000s jobs
- + Millions of small and large files

Required shared filesystem

Breaks most filesystems !!!

# Lustre: Parallel Filesystem

Lustre is a massively parallel distributed file system

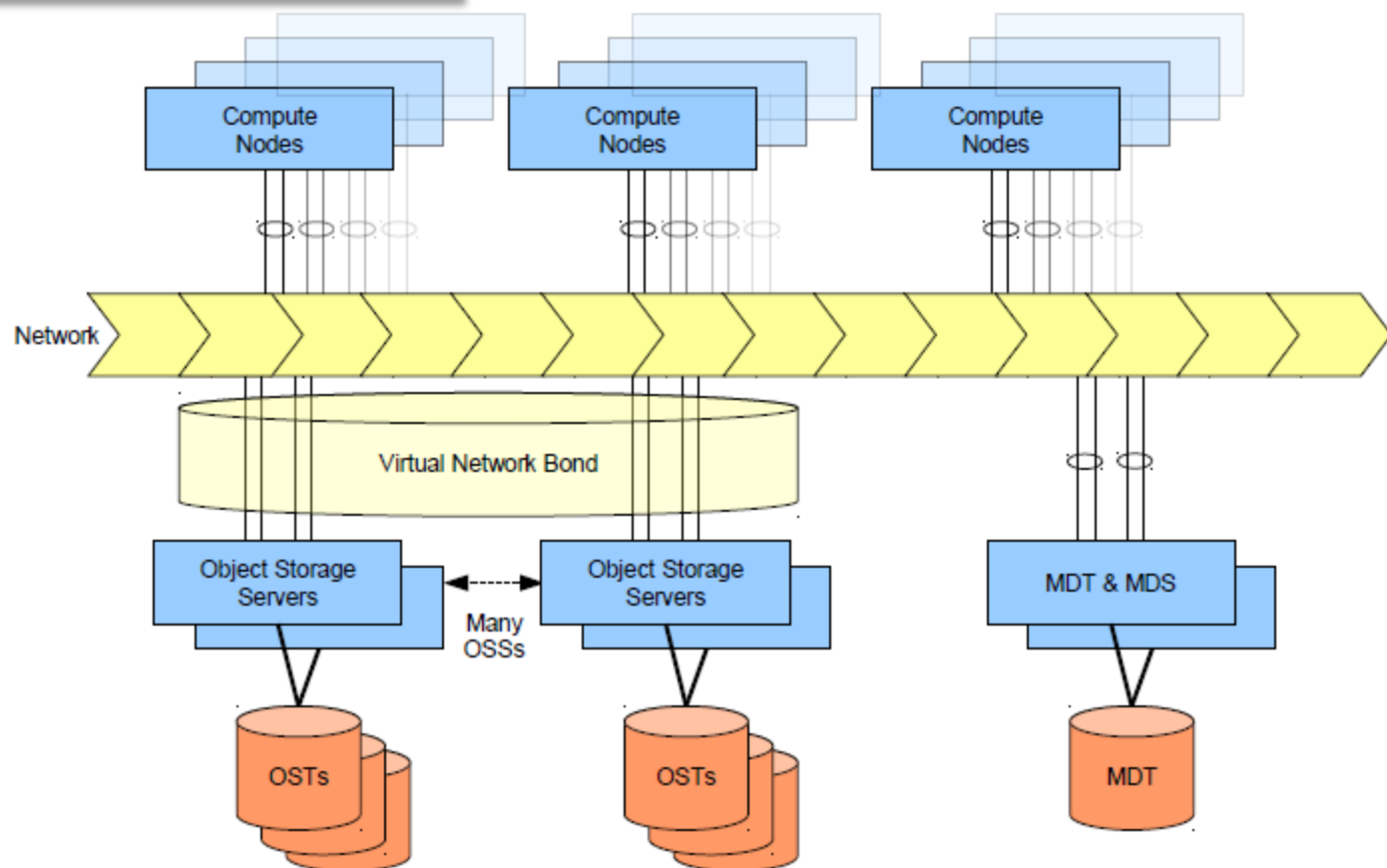
- Deployed in 7 out of 10 most powerful supercomputers
- POSIX compliant (ish!)

Lustre design paradigm concepts

- Separation of file meta-data and storage allocation
- Scalable data serving through parallel data striping
- Aggregate network bandwidth
- Distributed operation

.

## Lustre Architecture



# Lustre Quotas

- Lustre file system quotas are applied to each group
- Units in kilobytes (oddity)
- “quota” & “limit” of zero signifies no quota (as shown for user)

```
clust1-headnode ~ $ lfs quota /mnt/scratchb
Disk quotas for user user321 (uid 442255):
Filesystem kbytes quota limit grace files quota limit grace
/mnt/scratchb 275648748 0 0 - 984 0 0 -
Disk quotas for group xxlab (gid 987):
Filesystem kbytes quota limit grace files quota limit grace
/mnt/scratchb 3471466428 3600000000 4000000000 - 681541 0 0 -
```



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## Practical session I



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