HPC Advanced: Filesystems

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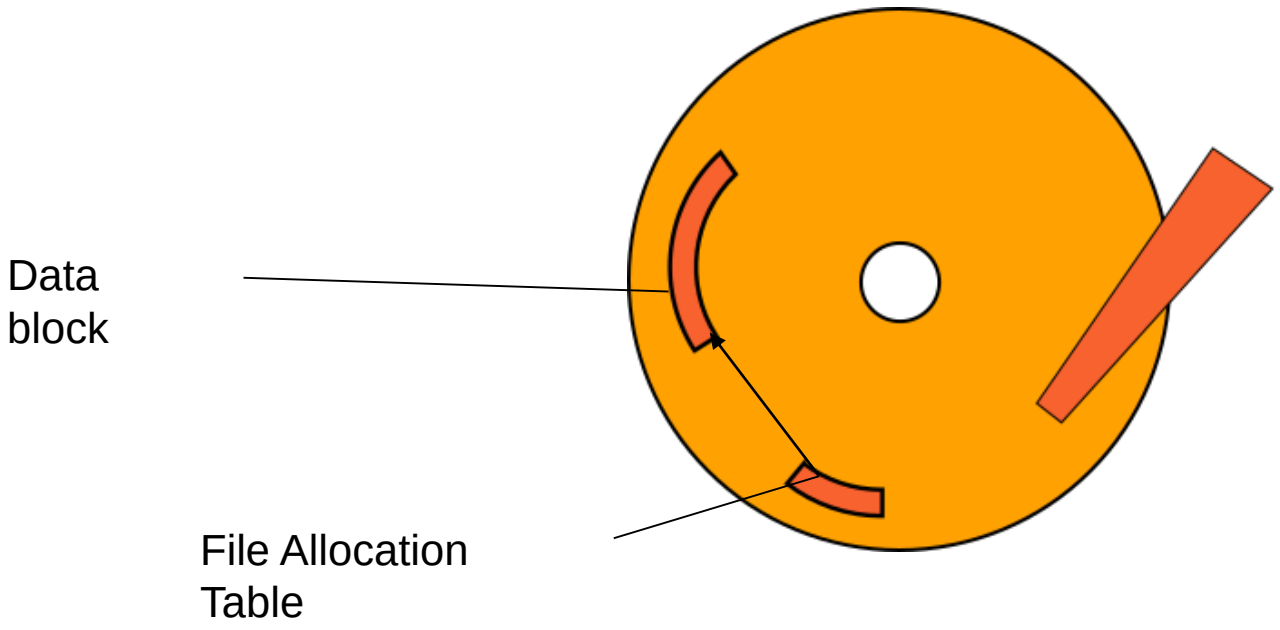
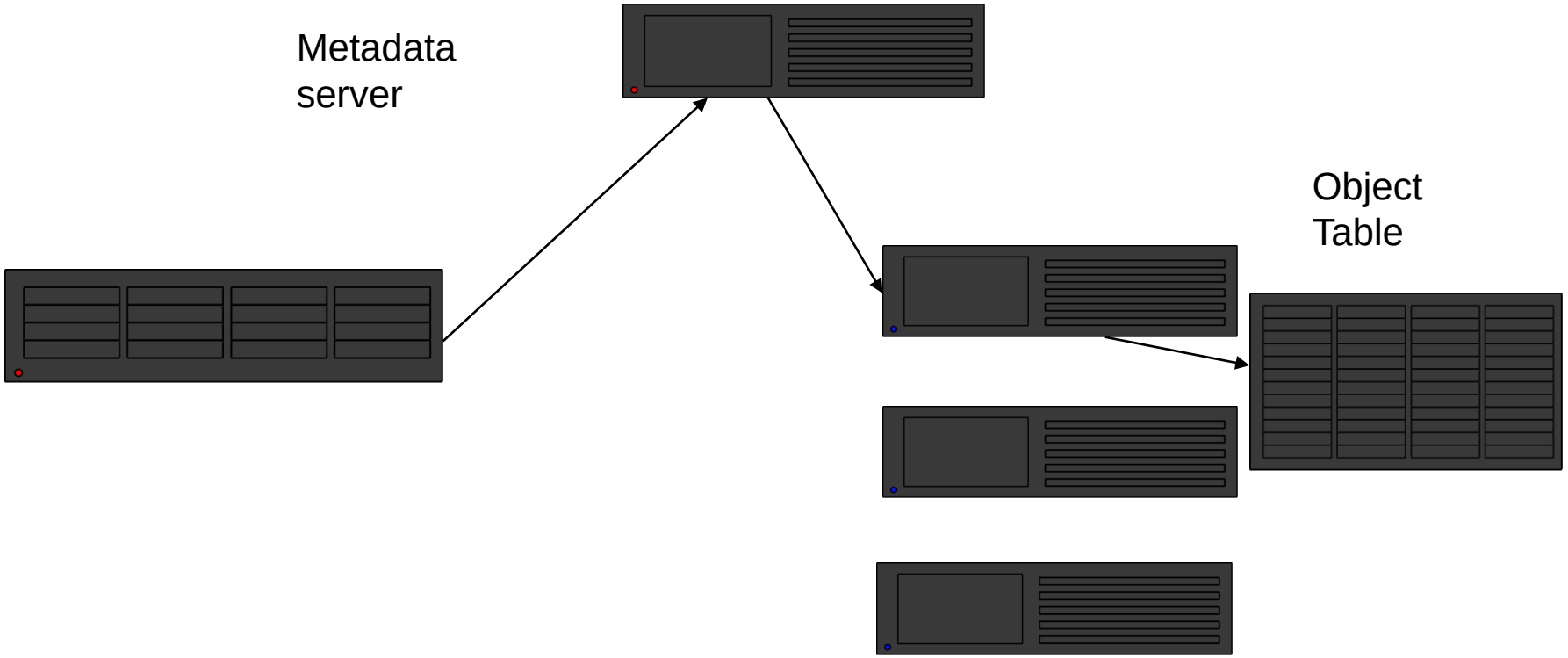
Filesystems

- Filesystems consist of two parts:
  - Metadata – where is my data
  - Content – the data itself



Lustre

- Same basic concept
- Built to scale



NFS

- For comparison:

- Metadata and object data in same place
  - Reading excessively prevents access
- No ability to spread load
  - No ability to server multiple clients efficiently

- Reason for ‘No datasets on /home’ recommendation

Lustre

- 6xOSS
- 6x6xOST

- 1x MDS (+redundant)
  - Major bottleneck for distributed filesystem

Lustre

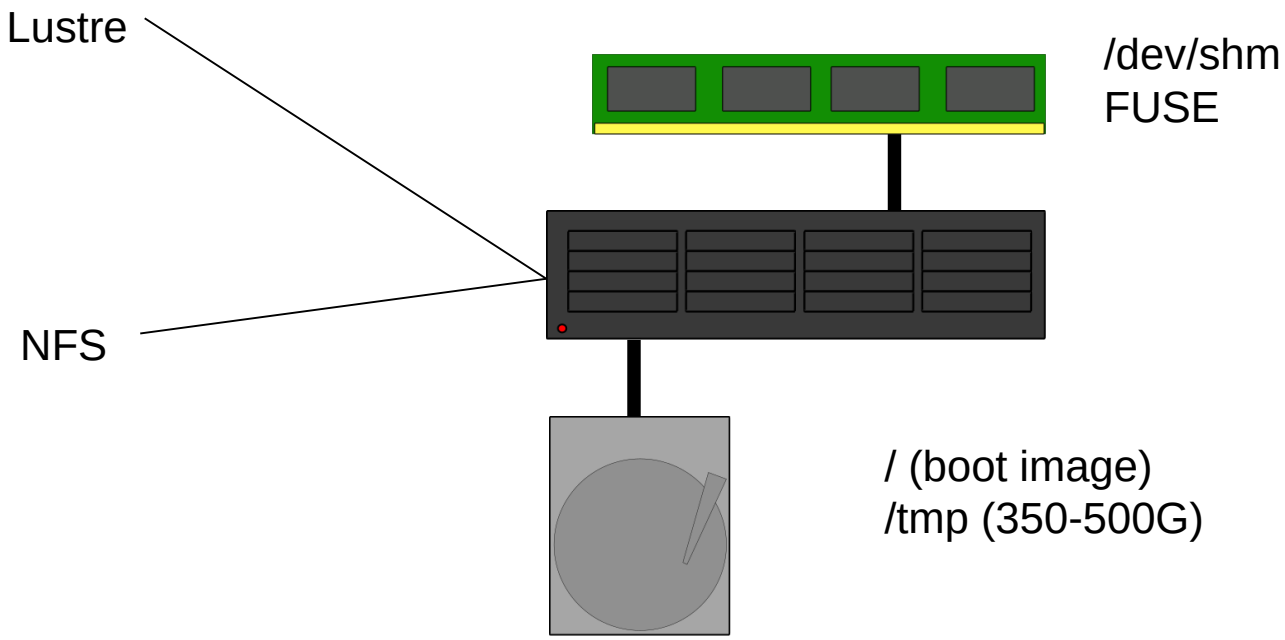
- 100G in 1x file:
  - 1x access MDS
  - 1x access OST
    - Bottleneck is OST disk read speed (~500MB/s)

- 100G in 1000x files
  - 1000x access MDS
  - 1000x access OST
    - Bottleneck is MDS access rate (~300 iops/s)
      - Drastically affects other users!

Small File Workarounds

- Try to avoid using small (<1Mb) files individually
  -
  - If you can't:
- If it's small (<32G), use shared memory
- If it's bigger (<350G), use /tmp

Local Storage



Local Storage

- CAVEAT:
- If you use local storage

PLEASE CLEAN IT UP

- I can’t know what your job specifically has written, especially if there’s more jobs of your own running there
  - Thus there’s no automatic way to remove local files
  - This INCLUDES /dev/shm!

Local Storage

- /dev/shm means Shared Memory
  - Traditionally for transferring data between processes quickly
  - Can be abused for quick filesystem storage
  - 50% max ram size (32G/512G max capacity)

  - Counts against memory usage for job
  - Typical IO ~1Gb/s

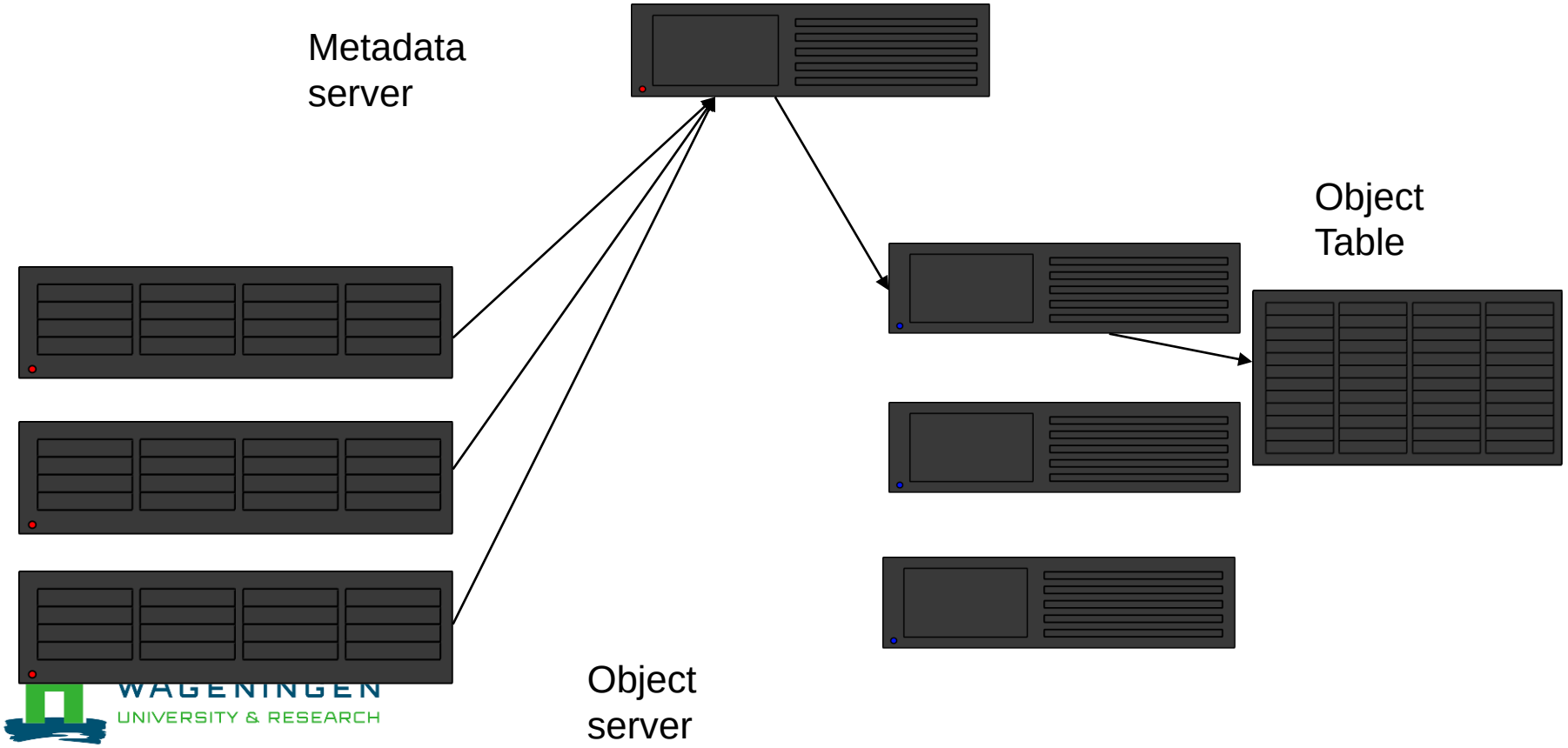
Local Storage

- /tmp locally present on compute node
  - Small size disk – high RPM + high iops
- Nodes installed onto this disk (~20G)
  - Rest available for tmp

- But – you still have to copy data to and from this location
  - If consists of small files – still problems!
    - tar + untar is your friend

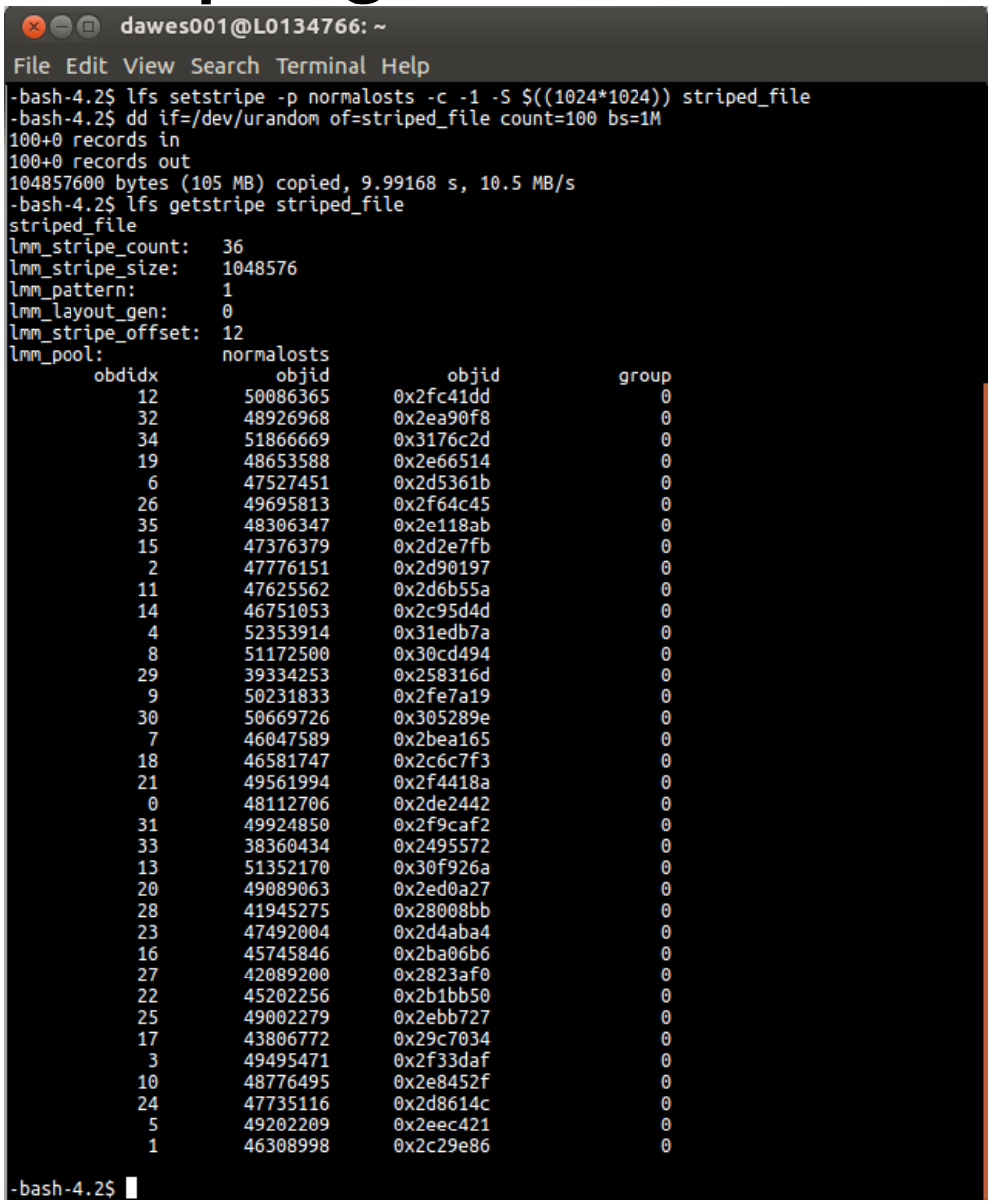
Large File Workarounds

- One file – one location – one disk
  - Bottleneck



Lustre striping

- Using lfs setstripe
- Set stripe size and count
- Spreads file over multiple OSTs
-
- MUST BE pool = normalposts



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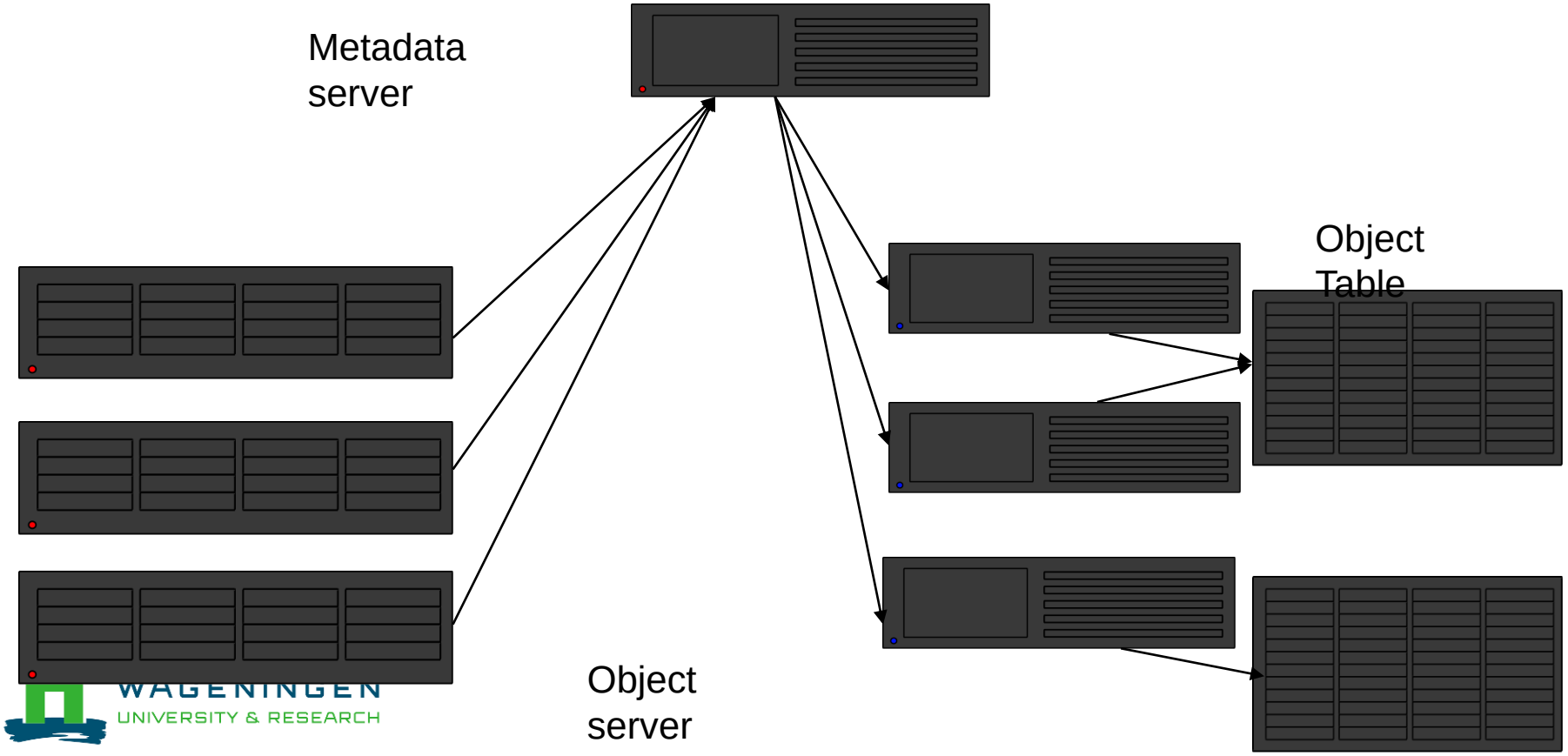
Large File Workarounds

- No longer bottlenecked on multiple section reads



Other Filesystems

- /archive on nfs01 – data on ISILON
  - WUR only
-
- FUSE:
  - sshfs – mounts to remote fileservers
  - archivemount – technical curiosity only
    - Performance v. poor

HPC Advanced: SLURM

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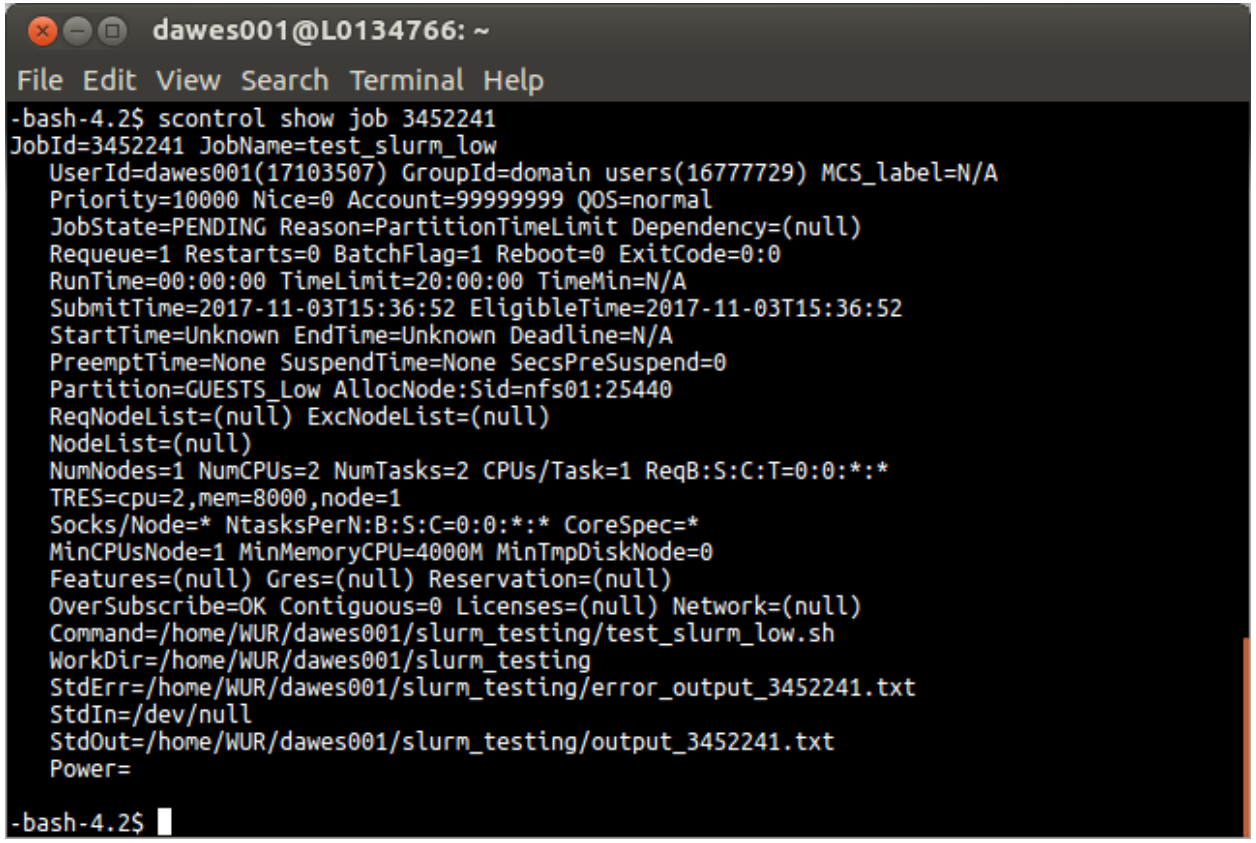
Scontrol


dawes001@L0134766: ~
File Edit View Search Terminal Help
-bash-4.2$ scontrol show job 3452241
JobId=3452241 JobName=test_slurm_low
UserId=dawes001(17103507) GroupId=domain users(16777729) MCS_label=N/A
Priority=10000 Nice=0 Account=99999999 QOS=normal
JobState=PENDING Reason=PartitionTimeLimit Dependency=(null)
Requeue=1 Restarts=0 BatchFlag=1 Reboot=0 ExitCode=0:0
RunTime=00:00:00 TimeLimit=20:00:00 TimeMin=N/A
SubmitTime=2017-11-03T15:36:52 EligibleTime=2017-11-03T15:36:52
StartTime=Unknown EndTime=Unknown Deadline=N/A
PreemptTime=None SuspendTime=None SecsPreSuspend=0
Partition=GUESTS_Low AllocNode:Sid=nfs01:25440
ReqNodeList=(null) ExcNodeList=(null)
NodeList=(null)
NumNodes=1 NumCPUs=2 NumTasks=2 CPUs/Task=1 ReqB:S:C:T=0:0:*:*
TRES=cpu=2,mem=8000,node=1
Socks/Node=* NtasksPerN:B:S:C=0:0:*:* CoreSpec=*
MinCPUsNode=1 MinMemoryCPU=4000M MinTmpDiskNode=0
Features=(null) Gres=(null) Reservation=(null)
OverSubscribe=OK Contiguous=0 Licenses=(null) Network=(null)
Command=/home/WUR/dawes001/slurm_testing/test_slurm_low.sh
WorkDir=/home/WUR/dawes001/slurm_testing
StdErr=/home/WUR/dawes001/slurm_testing/error_output_3452241.txt
StdIn=/dev/null
StdOut=/home/WUR/dawes001/slurm_testing/output_3452241.txt
Power=
-bash-4.2$

scontrol details

- Priority
  - Scheduling priority given to job based on information in sprio
- JobState=PENDING
- Reason=PartitionTimeLimit
  - Descriptive reason why job isn’t starting

scontrol details

- SubmitTime/EligibleTime/StartTime/EndTime
  - (Start – Eligible) Rough queue length based on what Slurm expects jobs to take
  - Reason why job lengths are important
- NumNodes=1 NumCPUs=2 NumTasks=2 CPUs/Task=1
- TRES (Trackable Resources)
  - Check for what resources you've specified

scontrol update?

- Basically no – you can't change the requirements of a job after it's running
  - Except for TimeLimit – you may always **reduce** this
-
- But you can reduce the MinCPUNode/MinMemNode fields whilst job is pending

sbatch Options

- Unusual options you might not know…

--dependency

sbatch Dependencies

- after:job_id[:jobid...]
  - This job can begin execution after the specified jobs have **begun** execution.
- afterany:job_id[:jobid...]
  - This job can begin execution after the specified jobs have **ended**.
- afternotok:job_id[:jobid...]
  - This job can begin execution after the specified jobs have **terminated in some failed state** (non-zero exit code, node failure, timed out, etc).
- afterok:job_id[:jobid...]
  - This job can begin execution after the specified jobs have **successfully executed** (ran to completion with an exit code of zero).

sbatch Dependencies

- This allows you to submit multiple jobs in a chain
  - Not all the same size too, e.g.
  - small linear job to download/unpack (e.g. on normalmem)
  - Large assembly job (e.g. on fat)
  - Small packing job (e.g. on normalmem)

sbatch Dependencies

- expand:job_id
  - Resources allocated to this job should be used to expand the specified job. The job to expand must share the same QOS (Quality of Service) and partition. Gang scheduling of resources in the partition is also not supported.
- singleton
  - This job can begin execution after any previously launched jobs sharing the same job name and user have terminated.

sbatch Dependencies

- Singleton can be used to limit job rate
  - Name all in one ‘pool’ of jobs the same job-name
  - Only one will be executed at a time
- Don’t get excited about expand!
  - Can only add additional nodes to jobs
  - scontrol update jobid NumNodes=ALL

sbatch Options

- Unusual options you might not know…

--deadline

Deadlines

- You can opt to have a job fail if it will never get to finish before a certain time
- Can also be a good safety switch for massive job submission

sbatch Options

- Unusual options you might not know…

--tmp

Temporary Space

- You’re going to use /tmp for something
- You need X Mb of space
  -
  - --tmp=X
  -
- Will not execute job on node with less than X available space
- Reduces heartache from other lazy users

sbatch Options

- Unusual options you might not know…

--export

Environment Settings

- You are submitting jobs from a script and want to pass in some environment variable:

sbatch –export=”MYVAR=3”

- You want to explicitly prevent your environment from tainting this job:

sbatch --export=NONE

sbatch Options

- Unusual options you might not know…

--open-mode

Append/Truncate

- #SBATCH –open-mode=append

- Will append to existing output/error files rather than overwriting them
- Great for extending jobs / repeating jobs

sbatch Options

- Unusual options you might not know…

--gres

Generic Resources

- Not so generic
- Mainly used for additional hardware plugins – Graphical Processing Units (GPUs) and Many Integrated Cores (MICs, e.g. Knights Landing)
  -
  - This is how you (could) specify GPU's if/when requested:
  -

#SBATCH –gres=gpu:1

sbatch Options

- Unusual options you might not know…

--signal

Signalling

- Slurm will send out signals to processes at a controlled time period before termination
  -
  - --signal=INT@120
  - Sends out a SIGINT (Interrupt) 120 seconds before job period expires
- Also can be done from scancel:
  -
  - scancel –signal USR1
  - Useful for sending signals in to get jobs to do things

sbatch Options

- Unusual options you might not know…

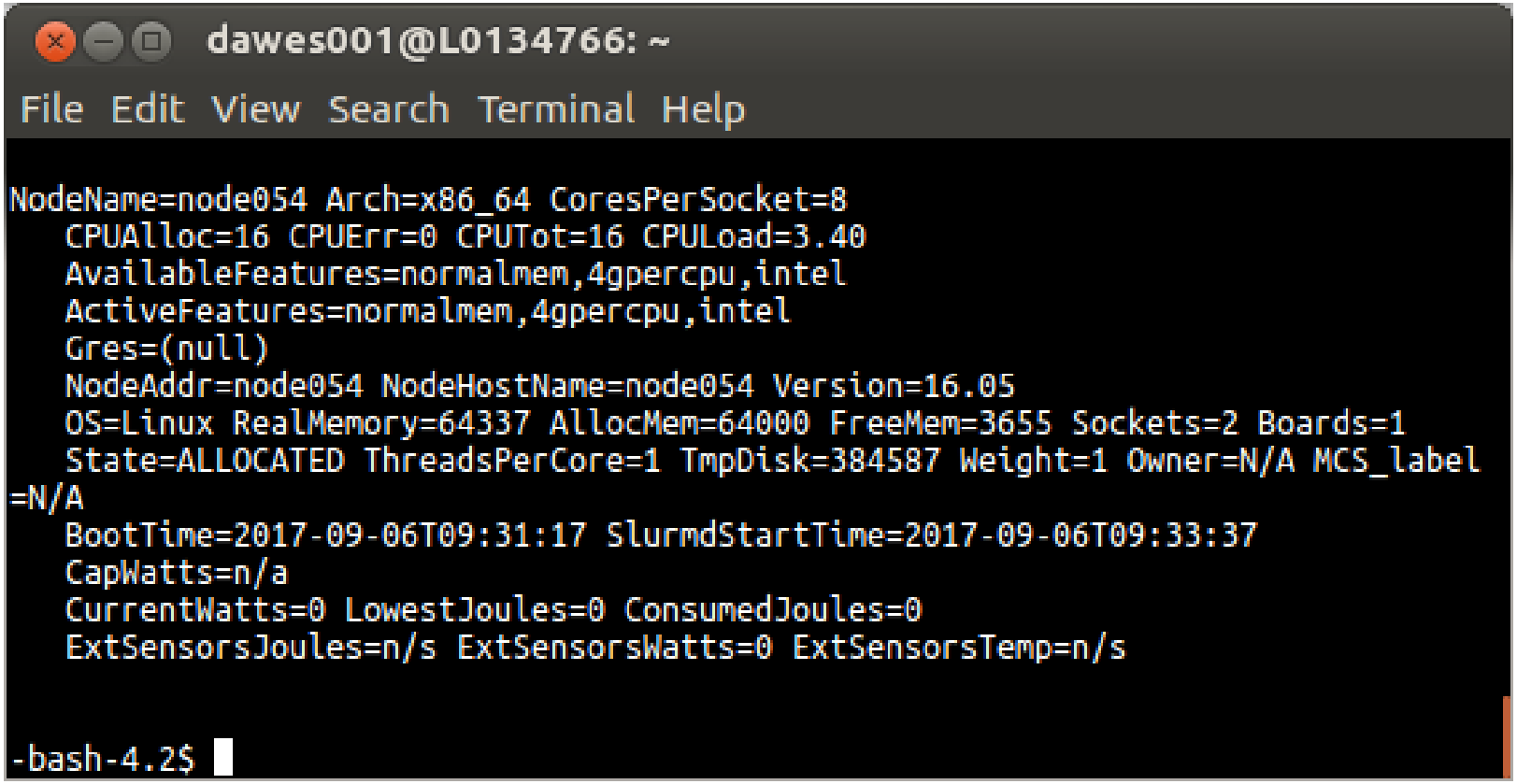
--constraint

Features

- Nodes are not uniform:
  - Normal nodes:
    - Intel CPUs
    - 4000M/CPU
  - Fat nodes:
    - AMD CPUs
    - 16000M/CPU
- May well be others besides in the future

scontrol Features

- scontrol show nodes



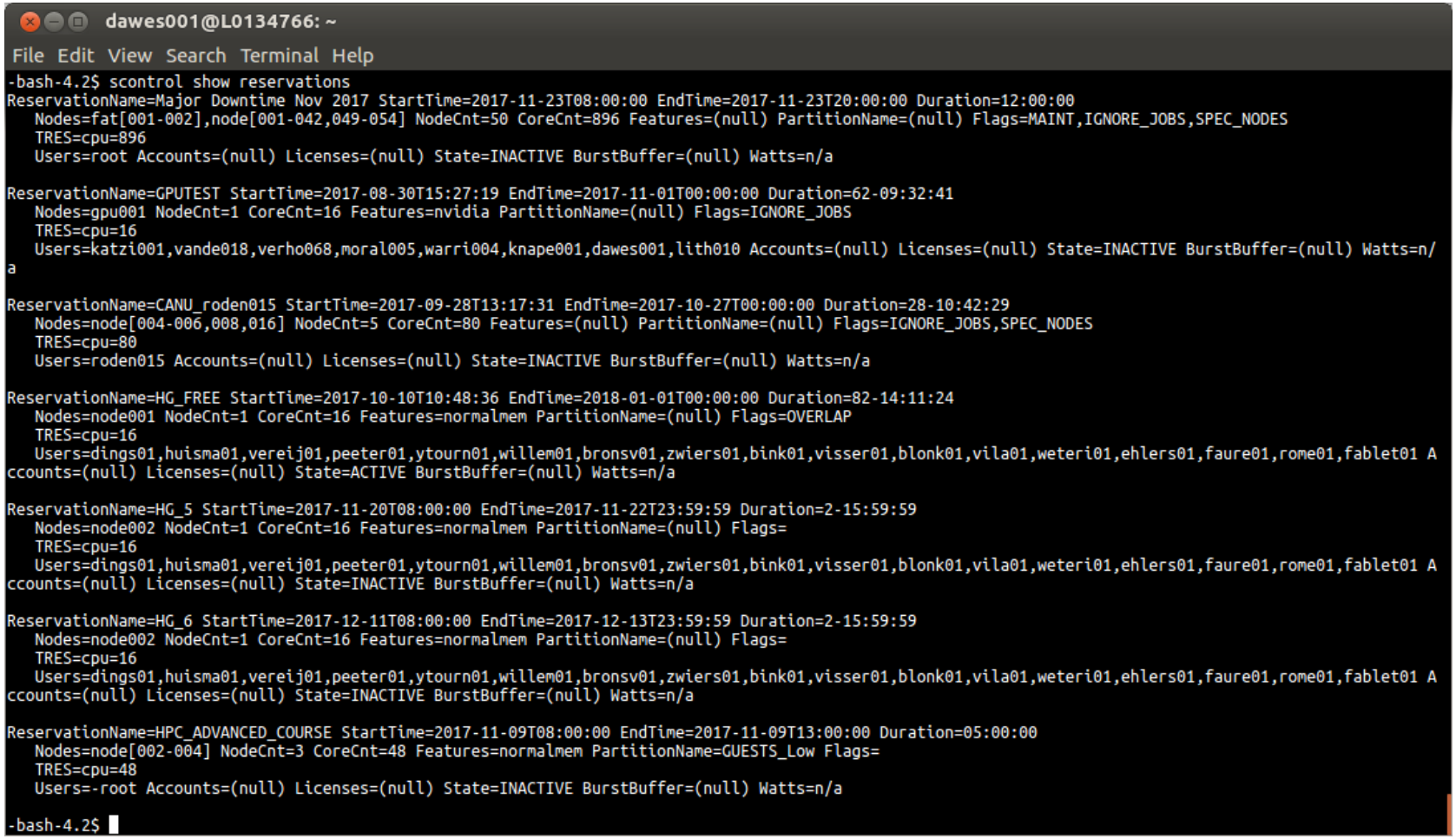
Features

- Can be combined:
  - "opteron&video"
    - AND
  - "fast|faster"
    - OR
  - [rack1|rack2|rack3|rack4]
    - EVERY part of this job must be in one rack

Reservations

- Some point in the future you need resources immediately
  - e.g. a course
  - A seminar
  - Time critical computation
- You can submit a job in advance, but you have to specify the result of that
  - How to proceed?

scontrol Reservations



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Reservations

- Need to be added by admin
- Can only be assigned to users, not groups
  - Can be hacked to follow groups – contingent on admin awareness
- Can only allocate entire nodes
  - Can allocate CPU's, but no memory – basically useless
- General policy – max 3 nodes

End slide or section heading

Text