Using a cluster effectively
Scheduling and Job Management

• Log into Jasper.westgrid.ca:
  – ssh -X yourusername@jasper.westgrid.ca
  – use putty if you are working in windows

• Copy the working directory to your own and go into it.
  – cd scheduling-wg-2014

• You can find a copy of the slides and materials for this workshop in the following link
  https://www.westgrid.ca/events/scheduling_and_job_management_how_get_most_cluster
Using a cluster effectively

Scheduling and Job Management 2
PBS Jobs and memory

It is very important to specify memory correctly

• If you don’t ask for enough and your job uses more, your job will be killed.
• If you ask for too much, it will take a much longer time to schedule a job, and you will be wasting resources.
• If you ask for more memory than is available on the cluster your job will never run. The scheduling system will not stop you from submitting such a job or even warn you.
• If you don’t know how much memory your jobs will need ask for a large amount in your first job and run “checkjob –v –v <jobid>” or “qstat –f <jobid>”. Along other information, you should see how much memory your job used.
• If you don’t specify any memory then your job will get a very small default maximum memory (256MB on Jasper).
PBS Jobs and memory

• Always ask for slightly less than total memory on node as some memory is used for OS, and your job will not start until enough memory is available.

• You may specify the maximum memory available to your job in one of 2 ways.
  – Ask for a total memory used by your jobs
    • #PBS –l mem=24000mb
  – Ask for memory used per process/core in your job
    • #PBS –l pmem=2000mb
PBS jobs and Features

• Sometimes nodes have certain properties: fast processor, bigger disk, SSD, Fast connection or they belong to certain research group. Such nodes are given a feature name by the sysadmin so you can ask for the nodes by feature name in your pbs job script.

• The Jasper cluster has 2 different node types with different types of Intel Xeon processors, the newer X5675 and the older L5420.

• If you would like to specify that your job only use the newer X5675 processors:
  — #PBS –l feature=X5675
PBS jobs and GPUS

• To request GPU use the nodes notation and add “:gpu=x” for
  – #PBS –l nodes=2:gpus=3:ppn=4

• Modern torque scheduling programs recognize GPUs as well as the state of the GPU.
Software licenses and generic resources

• Sometimes not only cluster hardware is required to be scheduled for a job but other resources as well, such as software licenses, telescope or other instrument time.

• To request generic resources or licenses:
  – #PBS -W x=GRES:MATLAB=2
  – #PBS -l other=MATLAB=2

• You can see the list of software licenses and generic resources available on the cluster with the “jobinfo -n” command.
## PBS script commands

<table>
<thead>
<tr>
<th>PBS script command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#PBS -l mem=4gb</td>
<td>Requests 4 GB of memory in total</td>
</tr>
<tr>
<td>#PBS –l pmem=4gb</td>
<td>Requests 4GB of memory per process</td>
</tr>
<tr>
<td>#PBS –l feature=X5675</td>
<td>Requests 1 procesor on node with feature X5675 which is the newer processor on Jasper</td>
</tr>
<tr>
<td>#PBS –l nodes=2:blue:ppn=2</td>
<td>Request 2 cores on each of 2 nodes with blue feature.</td>
</tr>
<tr>
<td>#PBS –l nodes=2:gpus=3:ppn=4</td>
<td>Request 4 cores and 2 gpus on each of 2 nodes</td>
</tr>
<tr>
<td>#PBS –l nodes=cl2n002+cl2n003</td>
<td>Requests 2 nodes cl2n002 and cl2n003</td>
</tr>
<tr>
<td>#PBS –l host=cl2n002</td>
<td>Requests host or node cl2n002</td>
</tr>
</tbody>
</table>
Memory, Features, Software licenses

BREAK FOR PRACTICE
Job Submission Requiring Full nodes

- Sometimes there is a need for exclusive access to guarantee that no other job will be running on the same nodes as your job.
- To guarantee that the job will only run on nodes with other jobs you own use:
  - `#PBS -l naccesspolicy=singleuser`
- To guarantee that the job will only run on nodes with no other Job use:
  - `#PBS -n`
  - `#PBS -l naccesspolicy=singlejob`
- To guarantee that the each part of the job will only run on a separate node without anything else running on that node use:
  - `#PBS -l naccesspolicy=singletask`
- Your group may get charged for using the whole node and not just the resources requested, and it may take a long time to gather resources needed for these special jobs.
Job submission multiple projects

• If you are part of two different WestGrid projects and are running jobs for both, you need to specify the accounting group for each project so that the correct priority of the job can be determined and so that the usage is “charged” to the correct group.
• In order to specify an accounting group for a Job use:
  – #PBS –A <accounting group>
• You can find more information about your accounting groups (RAPI) on the WestGrid’s accounts portal:
  – https://portal.westgrid.ca/user/my_account.php
• You can see your accounting group information with the “jobinfo –a” command.
Job dependencies

• If you want one job to start one after another finishes use the
  – qsub –W depend=afterok:<jobid1> job2.pbs

• If one can break apart a long job into several shorter jobs then the shorter jobs will often be able to be ran faster. This is also the technique to use if the required job runtime is longer than the maximum walltime allowed on the cluster.
  – jobn1= $( qsub job1.pbs )
  – qsub -W depend=afterok:$jobn1 job2.pbs
Prologue, Epilogue and Data staging

• Prologue script runs before your job starts for a maximum of 5 minutes.
  – #PBS -l prologue=/home/fujinaga/prologue.script

• Epilogue script runs after your job is finished for a maximum of 5 minutes.
  – #PBS -l epilogue=/home/fujinaga/epilogue.script

• These scripts are nice if you need to document some more information about the state of your job in the scheduling system.

• Jobs can resubmit themselves with an appropriate script in the epilogue on some systems.
#!/bin/sh

export MYOUTPUT="$HOME/$1-epilogue.out"

echo "Epilogue Args:
 echo "Job ID: $1"
 echo "User ID: $2"
 echo "Group ID: $3"
 echo "Job Name: $4"
 echo "Session ID: $5"
 echo "Resource List: $6"
 echo "Resources Used: $7"
 echo "Queue Name: $8"
 echo "Account String: $9"
 echo ""
 exit 0
Temporary available local storage

• Some software like Gaussian needs to write and read many small files to disk. The cluster (lustre) file system cannot do this well and this becomes a performance problem for the job and the cluster its running on.

• Each node has local disk, that is shared by all jobs running on the node. One specifies the requests the local storage via “#PBS –l file=1000mb”.

• There is a directory created for each job when it is run. When the job finished this directory is automatically erased. The directory name is $TMPDIR. A example of using the temporary local storage:

```
#PBS –l file=1000mb
cd $TMPDIR
<run my job >
mkdir $HOME/$PBS_JOBID/
cp <file I wish to save> $HOME/$PBS_JOBID/
```
### PBS script commands

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<tr>
<td><code>#PBS -l naccesspolicy=singleuser</code></td>
<td>Requests to only run on nodes with other jobs of same user</td>
</tr>
<tr>
<td><code>#PBS -l naccesspolicy=singlejob</code></td>
<td>Requests to only run on nodes with no other jobs</td>
</tr>
<tr>
<td><code>#PBS -l naccesspolicy=singletask</code></td>
<td>Requests that the each part of the job will only run on a separate node without anything else running on that node.</td>
</tr>
<tr>
<td><code>#PBS -A &lt;accounting group&gt;</code></td>
<td>Requests that a specific accounting group be used for this job</td>
</tr>
<tr>
<td><code>#PBS -W x=GRES:MATLAB=2</code></td>
<td>Requests 2 units of a generic resource or software license MATLAB</td>
</tr>
<tr>
<td><code>#PBS -l other=MATLAB=2</code></td>
<td></td>
</tr>
<tr>
<td><code>qsub -W depend=afterok:&lt;job1id&gt; j2.pbs</code></td>
<td>Job 2 that depends on job1 and will not start until job1 completes successfully.</td>
</tr>
<tr>
<td><code>#PBS -l epilogue=/home/fujinaga/epilogue.script</code></td>
<td>Runs epilogue script for maximum of 5 minutes after job is complete.</td>
</tr>
<tr>
<td><code>#PBS -l prologue=/home/fujinaga/prologue.script</code></td>
<td>Runs prologue script for maximum of 5 minutes before job is complete.</td>
</tr>
<tr>
<td><code>#PBS -l nodes=5:ppn=12+nodes=1:ppn=1</code></td>
<td>Requests 5 nodes with 12 processors each and a single node with 1 core.</td>
</tr>
</tbody>
</table>
# PBS Environment Variables

<table>
<thead>
<tr>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBS_JOBNAME</td>
<td>User specified job name</td>
</tr>
<tr>
<td>PBS_ARRAYID</td>
<td>Job array index for this job</td>
</tr>
<tr>
<td>PBS_GPUFILE</td>
<td>list of GPUs allocated to the job located 1 per line: &lt;host&gt;-gpu&lt;number&gt;</td>
</tr>
<tr>
<td>PBS_O_WORKDIR</td>
<td>Job's submission directory</td>
</tr>
<tr>
<td>PBS_TASKNUM</td>
<td>Number of tasks requested</td>
</tr>
<tr>
<td>PBS_O_HOME</td>
<td>Home directory of submitting user</td>
</tr>
<tr>
<td>PBS_JOBID</td>
<td>Unique pbs job id</td>
</tr>
<tr>
<td>PBS_NUM_NODES</td>
<td>Number of nodes allocated to the job</td>
</tr>
<tr>
<td>PBS_NUM_PPN</td>
<td>Number of procs per node allocated to the job</td>
</tr>
<tr>
<td>PBS_O_HOST</td>
<td>Host on which job script is currently running</td>
</tr>
<tr>
<td>PBS_QUEUE</td>
<td>Job queue</td>
</tr>
<tr>
<td>PBS_NODEFILE</td>
<td>File containing line delimited list on nodes allocated to the job</td>
</tr>
<tr>
<td>PBS_O_PATH</td>
<td>Path variable used to locate executables within job script</td>
</tr>
</tbody>
</table>
BREAK FOR PRACTICE
## Getting information on your Job

<table>
<thead>
<tr>
<th>Command</th>
<th>What its used for</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>jobinfo -j</code></td>
<td>List all your jobs and their state</td>
</tr>
<tr>
<td><code>qstat -t -u $USER</code></td>
<td>List all your array jobs and the subcomponents and their state.</td>
</tr>
<tr>
<td><code>qstat -a</code></td>
<td>List all jobs on the system and their state.</td>
</tr>
<tr>
<td><code>qstat -r</code></td>
<td>List all running jobs on the system.</td>
</tr>
<tr>
<td><code>showq</code></td>
<td>List all jobs on the system and their state.</td>
</tr>
<tr>
<td><code>showq -i</code></td>
<td>List all jobs being considered for scheduling and their priority</td>
</tr>
<tr>
<td><code>showq -b</code></td>
<td>Lists all blocked (unable to be run) jobs</td>
</tr>
<tr>
<td><code>qstat -f &lt;Jobid&gt;</code></td>
<td>List detailed information on Job</td>
</tr>
<tr>
<td><code>checkjob &lt;Jobid&gt;</code></td>
<td>List detailed information on Job</td>
</tr>
<tr>
<td><code>checkjob -v -v &lt;Jobid&gt;</code></td>
<td>List detailed information on Job, including history and why it is not running now on each node.</td>
</tr>
<tr>
<td>JobID</td>
<td>State</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>4534909</td>
<td>Running</td>
</tr>
<tr>
<td>4533685</td>
<td>Idle</td>
</tr>
<tr>
<td>4533540</td>
<td>Idle</td>
</tr>
<tr>
<td>4533615</td>
<td>Idle</td>
</tr>
<tr>
<td>4533632</td>
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<tr>
<td>4533639</td>
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<tr>
<td>4533657</td>
<td>Idle</td>
</tr>
<tr>
<td>4533679</td>
<td>Idle</td>
</tr>
<tr>
<td>4533686</td>
<td>Idle</td>
</tr>
</tbody>
</table>
```
[kamil@jasper ~]$ qstat -t -u kamil

jasper-usradm.westgrid.ca:

<table>
<thead>
<tr>
<th>Job ID</th>
<th>Username</th>
<th>Queue</th>
<th>Jobname</th>
<th>SessID</th>
<th>NDS</th>
<th>TSK</th>
<th>Req'd Memory</th>
<th>Req'd Time</th>
<th>S</th>
<th>Elap Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>4533749[349]</td>
<td>jasper-us</td>
<td>kamil</td>
<td>&quot;sumrate&quot;-349</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>20024</td>
<td>24:59:00</td>
<td>Q</td>
<td>--</td>
</tr>
<tr>
<td>4533749[350]</td>
<td>jasper-us</td>
<td>kamil</td>
<td>&quot;sumrate&quot;-350</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>20024</td>
<td>24:59:00</td>
<td>Q</td>
<td>--</td>
</tr>
<tr>
<td>4533749[351]</td>
<td>jasper-us</td>
<td>kamil</td>
<td>&quot;sumrate&quot;-351</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>20024</td>
<td>24:59:00</td>
<td>Q</td>
<td>--</td>
</tr>
<tr>
<td>4533749[352]</td>
<td>jasper-us</td>
<td>kamil</td>
<td>&quot;sumrate&quot;-352</td>
<td>32041</td>
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<td>09:40:14</td>
</tr>
<tr>
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<td>kamil</td>
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<tr>
<td>4533749[354]</td>
<td>jasper-us</td>
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<td>&quot;sumrate&quot;-354</td>
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</tr>
<tr>
<td>4533749[355]</td>
<td>jasper-us</td>
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<td>&quot;sumrate&quot;-355</td>
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<td>09:40:12</td>
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<tr>
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<td>20024</td>
<td>24:59:00</td>
<td>R</td>
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</tbody>
</table>
```
```plaintext
hungabee:~ # qstat -a

hungabee:

<table>
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<th>Job ID</th>
<th>Username</th>
<th>Queue</th>
<th>Jobname</th>
<th>SessID</th>
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<th>Memory</th>
<th>Time</th>
<th>S Time</th>
<th>Elap</th>
<th>Req'd Time</th>
<th>Req'd Memory</th>
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<tbody>
<tr>
<td>25571.hungabee</td>
<td>fujinaga</td>
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<td>Alliaria.RunAllP</td>
<td>909496</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>72:00</td>
<td>R 32:30</td>
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<td>1</td>
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<td>runscript.hungab</td>
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<td>hiru</td>
<td>f_rpx10_c64_f100</td>
<td>979724</td>
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<td>--</td>
<td>12:00</td>
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<td>08:00</td>
<td>R 01:04</td>
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</table>
```
```
![](Hungabee.png)

```

```bash
hungabee:~ # qstat -r

hungabee:

<table>
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<tr>
<th>Job ID</th>
<th>Username</th>
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<th>SessID</th>
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<td>25659.hungabee</td>
<td>kamil</td>
<td>hiru</td>
<td>f_rpx10_c128_f10</td>
<td>979813</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>12:00</td>
<td>R 06:22</td>
</tr>
<tr>
<td>25663.hungabee</td>
<td>tmcguire</td>
<td>hiru</td>
<td>E1e4eta70N3</td>
<td>100673</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>08:00</td>
<td>R 01:04</td>
</tr>
</tbody>
</table>
showq

hungabee:~ # showq

**active jobs**

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCs</th>
<th>REMAINING</th>
<th>STARTTIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>25658</td>
<td>fujinaga</td>
<td>Running</td>
<td>64</td>
<td>5:11:32</td>
<td>Thu Apr 10 03:51:16</td>
</tr>
<tr>
<td>25663</td>
<td>kamil</td>
<td>Running</td>
<td>64</td>
<td>6:29:27</td>
<td>Thu Apr 10 09:09:11</td>
</tr>
<tr>
<td>25571</td>
<td>tmguire</td>
<td>Running</td>
<td>512</td>
<td>1:15:03:42</td>
<td>Wed Apr 9 01:43:26</td>
</tr>
</tbody>
</table>

4 active jobs  
640 of 2048 processors in use by local jobs (31.25%)  
80 of 256 nodes active (31.25%)

**eligible jobs**

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCs</th>
<th>WCLIMIT</th>
<th>QUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>25660</td>
<td>fujinaga</td>
<td>Idle</td>
<td>256</td>
<td>12:00:00</td>
<td>Thu Apr 10 03:51:27</td>
</tr>
</tbody>
</table>

1 eligible jobs

**blocked jobs**

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCs</th>
<th>WCLIMIT</th>
<th>QUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>25680</td>
<td>jyang</td>
<td>Deferred</td>
<td>1</td>
<td>3:00:00:00</td>
<td>Thu Apr 10 10:35:37</td>
</tr>
</tbody>
</table>

1 blocked jobs

Total jobs: 5
showq -b

[root@jasper etc]# showq -b

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCS</th>
<th>WCLIMIT</th>
<th>QUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>4508818</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:33</td>
</tr>
<tr>
<td>4508848</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:40</td>
</tr>
<tr>
<td>4508849</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:40</td>
</tr>
<tr>
<td>4508851</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:41</td>
</tr>
<tr>
<td>4508891</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:51</td>
</tr>
<tr>
<td>4508910</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:55</td>
</tr>
<tr>
<td>4515387[74]</td>
<td>tmcguire</td>
<td>Idle</td>
<td>5</td>
<td>3:00:00:00</td>
<td>Sat Apr 5 12:27:59</td>
</tr>
<tr>
<td>4522606</td>
<td>jyang</td>
<td>Deferred</td>
<td>12</td>
<td>00:01:00</td>
<td>Mon Apr 7 11:52:34</td>
</tr>
<tr>
<td>4522614</td>
<td>jyang</td>
<td>Deferred</td>
<td>12</td>
<td>00:01:00</td>
<td>Mon Apr 7 11:58:07</td>
</tr>
<tr>
<td>4523361</td>
<td>tmah</td>
<td>Deferred</td>
<td>4</td>
<td>3:00:00:00</td>
<td>Mon Apr 7 15:07:24</td>
</tr>
</tbody>
</table>

...  

3426 blocked jobs

Total jobs: 3426
jobinfo -i or showq -i

[root@jasper etc]# showq -i

<table>
<thead>
<tr>
<th>JOBID</th>
<th>PRIORITY</th>
<th>XFACTOR</th>
<th>Q</th>
<th>USERNAME</th>
<th>GROUP</th>
<th>PROCS</th>
<th>WCLIMIT</th>
<th>CLASS</th>
<th>SYSTEMQUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>4534230*</td>
<td>10435</td>
<td>1.1</td>
<td>-</td>
<td>fujinaga</td>
<td>fujinaga</td>
<td>16</td>
<td>10:30:00</td>
<td>batch</td>
<td>Thu Apr 10 10:11:42</td>
</tr>
<tr>
<td>4534231*</td>
<td>10432</td>
<td>1.1</td>
<td>-</td>
<td>fujinaga</td>
<td>fujinaga</td>
<td>16</td>
<td>10:30:00</td>
<td>batch</td>
<td>Thu Apr 10 10:11:42</td>
</tr>
<tr>
<td>4533750[482]*</td>
<td>9491</td>
<td>1.4</td>
<td>-</td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533750[404]*</td>
<td>9474</td>
<td>1.4</td>
<td>-</td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533750[405]*</td>
<td>9470</td>
<td>1.4</td>
<td>-</td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533184*</td>
<td>-1122</td>
<td>1.3</td>
<td>-</td>
<td>jyang</td>
<td>jyang</td>
<td>12</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr 9 15:31:32</td>
</tr>
<tr>
<td>4534262*</td>
<td>-1133</td>
<td>1.2</td>
<td>-</td>
<td>tmcguire</td>
<td>tmcguire</td>
<td>8</td>
<td>2:00:00</td>
<td>batch</td>
<td>Thu Apr 10 10:27:59</td>
</tr>
<tr>
<td>4533181*</td>
<td>-1182</td>
<td>1.3</td>
<td>-</td>
<td>jyang</td>
<td>jyang</td>
<td>12</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr 9 15:31:09</td>
</tr>
<tr>
<td>4533188[539]*</td>
<td>-82797</td>
<td>1.3</td>
<td>-</td>
<td>tmah</td>
<td>tmah</td>
<td>5</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr 9 15:36:01</td>
</tr>
</tbody>
</table>

9 eligible jobs

Total jobs: 9
qstat -f

[kamil@cl2n234 testwrapper]$ qstat -f 508.cl2n234
Job Id: 508.cl2n234

  Job_Name = partest-lq.pbs
  Job_Owner = kamil@cl2n234
  job_state = Q
  queue = parallel
  server = cl2n234
  Checkpoint = u
  ctime = Thu Apr 10 13:15:43 2014

Error_Path = cl2n234:/lustre/home/kamil/test/pbs/jasper/testwrapper/partest-lq.pbs.e508
  Hold_Types = n
  Join_Path = n
  Keep_Files = n
  Mail_Points = abe
  Mail_Users = kamil@ualberta.ca
  mtime = Thu Apr 10 13:15:43 2014
  Output_Path = cl2n234:/lustre/home/kamil/test/pbs/jasper/testwrapper/partest-lq.pbs.o508
  Priority = 0
  qtime = Thu Apr 10 13:15:43 2014
qstat –f (continued)

Rerunable = True
Resource_List.nodect = 1
Resource_List.nodes = 1:ppn=12
Resource_List.pmem = 256mb
Resource_List.walltime = 03:00:00
Shell_Path_List = /bin/sh
Variable_List = PBS_O_QUEUE=parallel,PBS_O_HOME=/home/kamil,
                 PBS_O_LOGNAME=kamil,
                 PBS_O_PATH=/usr/kerberos/bin:/usr/local/bin:/bin:/usr/bin:/lustre/jasper/software/jobinfo/jobinfo/bin:/opt/sgi/sgimc/bin:/opt/moab/moab-version/bin:/opt/moab/moab-version/sbin:/var/spool/torque/torque-version/bin,PBS_O_MAIL=/var/spool/mail/kamil,PBS_O_SHELL=/bin/bash,
                 PBS_O_LANG=en_US.UTF-8,
                 PBS_O_WORKDIR=/lustre/home/kamil/test/pbs/jasper/testwrapper,
                 PBS_O_HOST=cl2n234,PBS_O_SERVER=cl2n234
etime = Thu Apr 10 13:15:43 2014
submit_args = partest-lq.pbs
fault_tolerant = False
job_radix = 0
submit_host = cl2n234
checkjob <jobid>

[root@cl2n234 torque-setup]# checkjob 508
job 508

AName: partest-lq.pbs
State: Idle
Creds: user:kamil group:kamil account:ndz-983-aa class:parallel
WallTime: 00:00:00 of 3:00:00
BecameEligible: Thu Apr 10 13:18:14
SubmitTime: Thu Apr 10 13:15:43
(Time Queued Total: 00:20:16 Eligible: 00:20:08)

TemplateSets: DEFAULT
NodeMatchPolicy: EXACTNODE
Total Requested Tasks: 12
checkjob <jobid> (continued)

Req[0] TaskCount: 12 Partition: ALL
Memory >= 256M Disk >= 0 Swap >= 0
Dedicated Resources Per Task: PROCS: 1 MEM: 256M

SystemID: Moab
SystemJID: 508
Notification Events: JobStart,JobEnd,JobFail
Notification Address: kamil@ualberta.ca

Flags: RESTARTABLE
Attr: checkpoint
StartPriority: -88787
cl2n236 available: 12 tasks supported
cl2n235 available: 12 tasks supported
NOTE: job can run in partition torque (24 procs available 12 procs required)
Checkjob -v -v <jobid>

[kamil@jasper ~]$ checkjob -v -v 4535115
job 4535115 (RM job '4535115.jasper-usradm.westgrid.ca')
AName: jRC.egsinp_w193
State: Idle
Creds: user:kamil group:kamil account:cas-124-aa class:batch
WallTime: 00:00:00 of 1:06:00:00
SubmitTime: Thu Apr 10 13:31:02
(Time Queued Total: 00:08:04 Eligible: 00:00:10)

TemplateSets: DEFAULT
NodeMatchPolicy: EXACTNODE
Total Requested Tasks: 1
Total Requested Nodes: 1

Req[0] TaskCount: 1 Partition: ALL
Memory >= 2048M Disk >= 0 Swap >= 0
Available Memory >= 0 Available Swap >= 0
Dedicated Resources Per Task: PROCS: 1 MEM: 2048M SWAP: 2048M
NodeSet=ONEOF:FEATURE:X5675-QDR:X5675-DDR:L5420-DDR
NodeCount: 1
SystemID: Moab
SystemJID: 4535115
Notification Events: JobFail
Checkjob -v -v <jobid> (continued)

UMask: 0000

OutputFile: jasper.westgrid.ca:/home/kamil/EGSnrc/codes/dosxyznrnc_noB/
ProfilePhantom02IC10_10x10_Emean5_9MeVMonoAltPrimColModFFMT50Ang08KMNRCEgsinp_w193.eo

ErrorFile: jasper.westgrid.ca:/home/kamil/EGSnrc/codes/dosxyznrnc_noB/
ProfilePhantom02IC10_10x10_Emean5_9MeVMonoAltPrimColModFFMT50Ang08KMNRCEgsinp_w193.eo


Partition List: [ALL]
SrcRM: jasper-usradm DstRM: jasper-usradm DstRMJID: 4535115.jasper-usradm.westgrid.ca

Submit Args: -j eo -l pmem=2gb,vmem=2gb -e ProfilePhantom02IC10_10x10_Emean5_9MeVMonoAltPrimColModFFMT50Ang08KMNRCEgsinp_w193.eo -N jRC.egsinp_w193 -l walltime=30:00:00

Flags: RESTARTABLE
Attr: checkpoint

StartPriority: -11066

Priority Analysis:

<table>
<thead>
<tr>
<th>Job</th>
<th>PRIORITY*</th>
<th>Cred(Class)</th>
<th>FS(Accnt)</th>
<th>Serv(QTime)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1(1) 1000(1) 1(-1)</td>
<td>100.0(-11.1) 0.0(0.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4535115 -11067 0.0(0.0) 100.0(-11.1) 0.0(0.0) 0.0(0.0)

Node Availability for Partition jasper-usradm ---------
Node Availability for Partition jasper-usradm --------

```
cl1n001    rejected: Reserved (wlcg_ops1.69217) allocationpriority=0.00
cl1n002    rejected: Reserved (wlcg_ops2.69218) allocationpriority=0.00
cl2n002    rejected: Memory allocationpriority=0.00
cl2n003    rejected: Memory allocationpriority=0.00
cl2n028    rejected: State (Busy) allocationpriority=0.00
cl2n029    rejected: State (Busy) allocationpriority=0.00
cl2n030    rejected: Memory allocationpriority=0.00
cl2n031    rejected: Memory allocationpriority=0.00
...
```

**NOTE:** job req cannot run in partition jasper-usradm (available procs do not meet requirements: 0 of 1 procs found)
idle procs: 354 feasible procs: 0

Node Rejection Summary: [Memory: 128][State: 284][Reserved: 4]

**BLOCK MSG:** job 4535115 violates idle HARD MAXIJOB limit of 5 for user kamil partition ALL (Req: 1 InUse: 5) (recorded at last scheduling iteration)
Demonstration on cluster

- SSH cluster and show all the following commands and how to interpret them
  - `jobinfo -j`
  - `qstat -t -u $USER`
  - `qstat -a`
  - `qstat -r`
  - `showq`
  - `showq -i`
  - `showq -b`
  - `qstat -f <jobid>`
  - `Checkjob <jobid>`
  - `Checkjob -v -v <jobid>`
BREAK FOR PRACTICE

Job information practice
Priority

• Can be positive or negative.
• Only relative priority matters.
• Jobs with highest or least negative priority get reservation to run first.
• Highest priority job may not run first.
  A job which is using a small amount of resources that are in great supply may easily run before a high priority job requesting scarce or already used resources.
• In WestGrid priority is determined per group via “fairshare” and how long your job sits in the queue
• “showq -i” or “jobinfo -i” will show priority of your job
“jobinfo –i” and “showq –i”

[root@jasper etc]# showq -i

eligible jobs----------------------

<table>
<thead>
<tr>
<th>JOBID</th>
<th>PRIORITY</th>
<th>XFACTOR</th>
<th>Q</th>
<th>USERNAME</th>
<th>GROUP</th>
<th>PROCS</th>
<th>WCLIMIT</th>
<th>CLASS</th>
<th>SYSTEMQUEUEUTIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>4534230*</td>
<td>-435</td>
<td>1.1</td>
<td>-</td>
<td>fujinaga</td>
<td>fujinaga</td>
<td>16</td>
<td>10:30:00</td>
<td>batch</td>
<td>Thu Apr 10 10:11:42</td>
</tr>
<tr>
<td>4534231*</td>
<td>-437</td>
<td>1.1</td>
<td>-</td>
<td>fujinaga</td>
<td>fujinaga</td>
<td>16</td>
<td>10:30:00</td>
<td>batch</td>
<td>Thu Apr 10 10:11:42</td>
</tr>
<tr>
<td>4533750[482]*</td>
<td>-900</td>
<td>1.4</td>
<td>-</td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533750[404]*</td>
<td>-902</td>
<td>1.4</td>
<td>-</td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533184*</td>
<td>-1122</td>
<td>1.3</td>
<td>-</td>
<td>jyang</td>
<td>jyang</td>
<td>12</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr 9 15:31:32</td>
</tr>
<tr>
<td>4534262*</td>
<td>-1133</td>
<td>1.2</td>
<td>-</td>
<td>tmcguire</td>
<td>tmcguire</td>
<td>8</td>
<td>2:00:00:00</td>
<td>batch</td>
<td>Thu Apr 10 10:27:59</td>
</tr>
<tr>
<td>4533181*</td>
<td>-1182</td>
<td>1.3</td>
<td>-</td>
<td>jyang</td>
<td>jyang</td>
<td>12</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr 9 15:31:09</td>
</tr>
<tr>
<td>4533188[539]*</td>
<td>-82797</td>
<td>1.3</td>
<td>-</td>
<td>tmah</td>
<td>tmah</td>
<td>5</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr 9 15:36:01</td>
</tr>
</tbody>
</table>

9 eligible jobs
Total jobs: 9

• Notice that every jobs priority is negative this is a ordinary state, the job with the least negative priority has the highest priority
• “showq -i” and “jobinfo -i” are the same command
• Jobinfo is a number of different user commands that where created by WestGrid to simplify things.
Fairshare

- Fairshare is a mechanism that allows historical resource utilization information to be incorporated into job feasibility and priority decisions.

- In WestGrid fairshare compares your group’s target usage to your group’s actual usage during a time period. If your group has used less than your group share you are given higher priority, if your group used more than its share, the priority from fairshare will be negative.
• Fair share usage is weighted by when the usage occurred. Recent usage is more important than usage at the end of the period.
Fairshare trees

• It is possible for project leader to divide the target allocations of resources for the group.
• Your priority is determined by a combination of your group’s usage compared to your group’s target usage, as well as your individual usage in the group compared to your individual target in the group.
• The priority of anyone's job will primarily be influenced by the group’s rather than the individual’s usage and target.
Group’s Status: “jobsinfo –f”

• To get your group’s target and actual usage:
  – jobinfo -f

• To see information for all your groups
  – jobinfo -a

• To see your group’s target and historical usage
  – jobinfo -v –f
Here we see that accounting group **ndz-983-ab** has used weighted average of **44.81** cores while only having a target of **0.97** cores. Of the total resources used by the group **95.52 %** were used by user **jyang** who was only allocate **33.33%** of the groups target.
Historical usage and Group Status:

```
jobinfo -v -f
```

```
[kamil@jasper ~]$ jobinfo -v -f

FairShare Information

Depth: 15 intervals   Interval Length: 2:00:00:00   Decay Rate: 0.90

FS Policy: DEDICATEDPS%
System FS Settings:  Target Usage: 0.00

FSInterval % Target 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
FSWeight ------- ------- 1.0000 0.9000 0.8100 0.7290 0.6561 0.5905 0.5314 0.4783 0.4305 0.3874 0.3487 0.3138 0.2824 0.2542 0.2288

TotalUsage 100.00 ------- 89633.9 208850.1 208427.8 208427.4 208243.2 208981.2 209635.3 209477.7 208477.8 208218.8 208266.9 208622.4 208818.8 208512.8 208129.9

USER
---------
jyang  0.80 ------- 0.15 0.03 ------- ------- 1.80 1.29 1.97 1.90 1.84 1.04 ------- 1.07 0.58 0.14
kamil  0.00 ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- -------
tmah   0.04 ------- ------- ------- ------- 0.01 0.04 0.04 0.03 0.02 ------- ------- ------- ------- 0.46 0.33

ACCT
---------
ndz-983-aa  0.84 ------- 0.15 0.03 ------- 0.01 1.84 1.34 2.00 1.92 1.84 1.04 1.04 1.04 0.5

Share Tree Overview for partition 'ALL'

<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Target</th>
<th>(FSFACTOR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>westgrid</td>
<td>4100.00</td>
<td>4100.00</td>
<td>(node: 4275414629.43) (0.00)</td>
</tr>
<tr>
<td>- ndz-983-ab</td>
<td>44.35</td>
<td>0.97</td>
<td>(acct: 46249839.86) (-14.14)</td>
</tr>
<tr>
<td></td>
<td>kamil</td>
<td>0.00</td>
<td>33.33</td>
</tr>
<tr>
<td></td>
<td>- jyang</td>
<td>95.53</td>
<td>33.33</td>
</tr>
<tr>
<td></td>
<td>- tmah</td>
<td>4.47</td>
<td>33.33</td>
</tr>
</tbody>
</table>
```
jobinfo –a

Viewing multiple accounting groups and allocations

[kamil@jasper ~]$ jobinfo -a
Share Tree Overview for partition 'ALL'

<table>
<thead>
<tr>
<th>Name</th>
<th>Usage</th>
<th>Target</th>
<th>(FSFACTOR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>westgrid</td>
<td>4100.00</td>
<td>4100.00</td>
<td>node: 4274626401.16 (0.00)</td>
</tr>
<tr>
<td>ndz-983-aa</td>
<td>0.00</td>
<td>0.97</td>
<td>acct: 0.00 (0.31)</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>100.00</td>
<td>user: 0.00 (1.62)</td>
</tr>
<tr>
<td>ndz-983-ab</td>
<td>44.81</td>
<td>0.97</td>
<td>acct: 46192399.80 (-14.29)</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>33.33</td>
<td>user: 44124561.07 (-15.10)</td>
</tr>
<tr>
<td></td>
<td>95.52</td>
<td>33.33</td>
<td>user: 2067838.73 (-13.91)</td>
</tr>
<tr>
<td></td>
<td>4.48</td>
<td>33.33</td>
<td>user: 0.00 (-13.85)</td>
</tr>
</tbody>
</table>

• Here we see user kamil is a member of two accounting groups ndz-983-aa and ndz-983-ab.

• Accounting group ndz-983-aa has been an allocated target of 0.97 cores and has used 0.

• Accounting group ndz-983-ab also has an allocation of 0.97 cores but has used 44.81, mostly by user jyang.
Multiple allocations/accounting groups

• Occurs when group gets a RAC (Resource Allocation Committee) allocation and therefore a new allocation that becomes the default allocation.

• Occurs when a user is part of multiple Compute Canada research groups. One can select the default allocation, even a default allocation per cluster and send an email to support@westgrid.ca.

• In order to specify a accounting group to charge and figure out the priority use the following example in your job submission script.
  — #PBS -A <accounting group>
Allocations

• What does an allocation usually mean?
  – If you request average resources continually through the time period and run jobs, you are guaranteed to get at least your allocated resources over the time period (year).

• What if I have not applied for an allocation?
  – you have a default allocation
Allocations

• It is impossible for an allocation to be defined as: “Any time you ask for the resources allocated you will receive them”.
  – If 2 users are given 50% of a cluster each, and both don’t start running jobs until the 6th month they both cannot get the same cluster

• Unless an extraordinary situation exits allocation will not mean that the specified resources are available sitting idle.
  – Funding agencies don’t like to see resources sitting idle
  – An example of a extraordinary situation would be an Tsunami warning center which may need to have an allocation sitting idle so that when a earthquake occurs they can compute which beaches get hit and concentrate first responder resources to save lives.
Allocations on WestGrid

• Compute Canada (CC) Resource Allocation Committee (RAC) is a Committee of researchers that evaluate proposed allocations on the basis of scientific merits and resources available. There is also a preliminary technical evaluation which evaluates the application on technical merits, job requirements. The technical evaluation reports its findings and recommendations to the RAC.

• Allocations are for done yearly, the RAC call for proposals goes out every September.

• For more information see: https://www.westgrid.ca/support/accounts/resource_allocations
Getting information on you and your group

<table>
<thead>
<tr>
<th>Command</th>
<th>What its used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>showq -i</td>
<td>Show a list of jobs that are considered for scheduling and their priority</td>
</tr>
<tr>
<td>jobinfo -i</td>
<td></td>
</tr>
<tr>
<td>jobinfo -f</td>
<td>To get your group’s target and actual usage:</td>
</tr>
<tr>
<td>jobsinfo -v -f</td>
<td>Same as above but also shows group’s target and historical usage</td>
</tr>
<tr>
<td>jobinfo -a</td>
<td>To see your group’s target and actual usage information for all groups</td>
</tr>
</tbody>
</table>
Priority for your job
Compare it to other job
Fairshare target allocation to your group
Your groups usage by members

BREAK FOR PRACTICE
Usage limits on a cluster

There are 2 types of usage limits:

• Usage limits that prevent the scheduling system from being overloaded.

• Usage limits that prevent the first user from monopolizing the cluster by starting jobs on all resources of a cluster which will run for a long period of time.
Usage limits

Usage limits that prevent scheduling system from being overloaded. These limit are per user:

• Limit maximum running jobs (2880 on Jasper)
• Limit maximum queued jobs (3000 on Jasper)
• Limit maximum jobs in a array job (2880 on Jasper)
• Limit on the number of jobs that will be evaluated if they can be scheduled during each scheduling cycle. The remaining jobs are ignored.
  – This limit is 5 jobs on the Jasper cluster.
  – Scheduling cycle is run every few minutes.
  – After the first 5 jobs start to run, the next 5 are considered.
  – If your first 5 jobs cannot run your remaining jobs will not even be evaluated even if they can run.
Usage limits

Usage limits that prevent the first user from taking unfair advantage.

• The processor seconds a job requests is the number of processors/cores requested multiplied by the walltime (which is the requested runtime) in seconds.

• There is a per user maximum limit of the sum of processor seconds of all running jobs.

• This allows users to take advantage of an empty cluster by running many short jobs, but not take an unfair advantage by running long jobs on all the resources denying anybody else the opportunity to run any other jobs for a long time.

• The per user maximum limit of processor seconds for running jobs on Jasper MAXPS=248832000, which is 2880 processor days; If you submit 72 hour long jobs you can only use 960 processors at a time.
Reservations

Special Reservation
Reservations

• Used for many purposes
  – Used to schedule outages: Security patch that requires an reboot
  – Used to reserve resources for special occasions, such as a workshop
  – Each job also creates reservations

• One can see reservations on a cluster via showres command

• One can see reservations by cluster node showres -n
Reservations and short serial jobs
Reservations on Jasper
(standing rolling)

• We have created some standing special reservations for parallel jobs which use 12 cores per node on the newer nodes on Jasper. These reservations are for created so that serial jobs cannot block parallel jobs from running for longer than 6 hours.

• Serial Jobs less than 6 hours long can run any of the 400 Jasper nodes but long serial jobs can run only on the 160 older nodes.
There are 4 types of Job holds

1. **User** holds are set by user and can be removed by the user.

2. **System** holds are set by administrator

3. **Batch** holds are created by the scheduling system when it keeps failing to run a job

4. **Defer** holds are temporary holds lasting (1 hour on jasper) placed by the scheduling system when it can’t run a job, after (24 on jasper) times a job has been deferred the hold is changed to a permanent batch hold.

- To find if a job is being held run the following command “checkjob <jobid> | grep Holds”

- One can also see Deferred state of jobs in the queue by running the command “showq”
Topology

• As more devices are added to a system the ability to have high bandwidth and low latency communication between every device to every other device becomes at first expensive and the impossible.

• This effect is true between cores on a chip, memory on a machine, chips on boards, gpus, as well as nodes in a cluster.

• The workaround is topology, only certain set resources are connected with high bandwidth, low latency, non blocking connections with each other, but the connection to other resources of lower bandwidth, higher latency, larger blocking factor.

• The result is that jobs running on certain sets of resources are faster than running on others, and the scheduling system needs to take this into account.

• This problem will be a much bigger in the future.
• New nodes (blue) are connected by non blocking 40Gb network to each other.
• Older nodes (green) are connected to each other via 20Gb 1:2 blocking network.
• Jobs with processes running on both switches would have less than a 40\textsuperscript{th} of the bandwidth than jobs running on any single switch. Jasper is set up such that jobs can run only on one switch or the other.
• If you wish to create a job that will run using the unused processors on the cluster you need to limit yourself to unused processors on a single switch.
Topology on Hungabee

Cost of on socket communication = 10
Cost of inter-socket communication
or to hub chip on blade +=3
Cost of going off blade +=20
Cost each black line +=7
Cost each colored line +=7.5

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Socket</th>
</tr>
</thead>
<tbody>
<tr>
<td>⚾️</td>
<td>Blade</td>
</tr>
<tr>
<td>🎨</td>
<td>IRU</td>
</tr>
</tbody>
</table>

|   | 10 |
|   | 13 = 10 + 3 |
|   | 40 = (10 + 3 + 20) + 7 |
|   | 48 = (10 + 3 + 20) + 2*(7.5) |
|   | 55 = (10 + 3 + 20) + 2*(7.5) + 7 |
|   | 63 = (10 + 3 + 20) + 4*(7.5) |
|   | 70 = (10 + 3 + 20) + 4*(7.5) + 7 |
Topology on Hungabee

- Communication between cores and memory on hungabee’s uv1000 compute node is faster and more abundant on adjacent connected resources than on the other side of the machine. The scheduling system needs to take this into account and schedule your jobs to runs on adjacent/connected resources.
- The topology of hungabee uv1000 machine is strange, odd even blade pairs, all blades in a chassis, all even and all odd blades are connected to each other more closely than other combinations.
- The topology results in strange effects, a job using 2 of 128 blades will stop a job requiring ½ of the machine (64 blades from running), but will not stop a 66 blade job from starting, the reverse is also true: a 64 blade job will stop a 2 blade job from starting but not a 3 blade job.
- The only way to know if your job should be starting but isn’t is to take the “mdiag –n” or “jobinfo –n” output and compare it to topology diagram and see if there is enough empty resources, appropriately connected for your job to start.
- **Tip:** Don’t have your jobs ask for ½ the machine, use less than ½ or slightly more, and it will be scheduled quicker.
Getting information on your Cluster
showbf

[kamil@jasper ~]$ showbf

<table>
<thead>
<tr>
<th>Partition</th>
<th>Tasks</th>
<th>Nodes</th>
<th>Duration</th>
<th>StartOffset</th>
<th>StartDate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>88</td>
<td>34</td>
<td>3:31:14</td>
<td>00:00:00</td>
<td>11:18:13_04/15</td>
</tr>
<tr>
<td>ALL</td>
<td>78</td>
<td>32</td>
<td>5:18:15</td>
<td>00:00:00</td>
<td>11:18:13_04/15</td>
</tr>
<tr>
<td>ALL</td>
<td>73</td>
<td>31</td>
<td>11:43:31</td>
<td>00:00:00</td>
<td>11:18:13_04/15</td>
</tr>
<tr>
<td>ALL</td>
<td>72</td>
<td>30</td>
<td>1:20:18:21</td>
<td>00:00:00</td>
<td>11:18:13_04/15</td>
</tr>
<tr>
<td>ALL</td>
<td>71</td>
<td>29</td>
<td>INFINITY</td>
<td>00:00:00</td>
<td>11:18:13_04/15</td>
</tr>
</tbody>
</table>

- Showbf show how many cores are not being used by running jobs this instant and for how long, (There are reservations in the future that will make use of these cores.).

- **Note:** showbf is deceptive, the available cores are serial jobs only, and there may be no memory available to go with these unused processors.
jobinfo -n, (mdiag -n)

[kamil@jasper ~]$ jobinfo -n
compute node summary

<table>
<thead>
<tr>
<th>Name</th>
<th>State</th>
<th>Procs</th>
<th>Memory</th>
<th>Opsys</th>
</tr>
</thead>
<tbody>
<tr>
<td>cl1n001</td>
<td>Running</td>
<td>2:8</td>
<td>16053:16053</td>
<td>linux</td>
</tr>
<tr>
<td>cl1n002</td>
<td>Running</td>
<td>1:8</td>
<td>16053:16053</td>
<td>linux</td>
</tr>
<tr>
<td>cl2n002</td>
<td>Running</td>
<td>3:12</td>
<td>24097:24097</td>
<td>linux</td>
</tr>
<tr>
<td>cl2n003</td>
<td>Running</td>
<td>3:12</td>
<td>24097:24097</td>
<td>linux</td>
</tr>
<tr>
<td>cl2n004</td>
<td>Busy</td>
<td>0:12</td>
<td>24097:24097</td>
<td>linux</td>
</tr>
<tr>
<td>cl2n005</td>
<td>Busy</td>
<td>0:12</td>
<td>24097:24097</td>
<td>linux</td>
</tr>
<tr>
<td>cl2n006</td>
<td>Idle</td>
<td>12:12</td>
<td>24097:24097</td>
<td>linux</td>
</tr>
<tr>
<td>cl2n007</td>
<td>Idle</td>
<td>12:12</td>
<td>24097:24097</td>
<td>linux</td>
</tr>
</tbody>
</table>

... ----- --- 96:4352 9881578:9898888 ----- 

Total Nodes: 416 (Active: 406  Idle: 0  Down: 10)

pbsnodes -ln

[kamil@jasper ~]$ pbsnodes -ln

cl2n197 offline              failing power supply - SGI case #2985138
cl2n198 offline              sister node of cl2n197
cl2n199 offline              sister node of cl2n197
cl2n200 offline              sister node of cl2n197
cl2n233 down,offline         Test Cluster: Login node
cl2n234 down,offline         Test Cluster: Moab server node
cl2n235 down,offline         Test Cluster: compute node
cl2n236 down,offline         Test Cluster: compute node
cl1n044 offline              failing disk
cl1n064 offline              failing disk

- Shows which nodes are down and offline
pbsnodes -a

[kamil@jasper ~]$ pbsnodes -a
cl2n003
  state = free
  np = 12
  properties = X5675, snoplus, X5675-QDR
  ntype = cluster
  jobs = 0/4551757.jasper-usradm.westgrid.ca, 1/4555493.jasper-usradm.westgrid.ca, 2/4555493.jasper-usradm.westgrid.ca, 3/4555493.jasper-usradm.westgrid.ca, 4/4555493.jasper-usradm.westgrid.ca, 5/4555493.jasper-usradm.westgrid.ca, 6/4555493.jasper-usradm.westgrid.ca, 7/4557809.jasper-usradm.westgrid.ca, 8/4557809.jasper-usradm.westgrid.ca
  status = rectime=1397581888, varattr=, jobs=4551757.jasper-usradm.westgrid.ca
  4555493.jasper-usradm.westgrid.ca
  4557809.jasper-usradm.westgrid.ca
  state=free, netload=511214867232, gres=, loadave=8.99, ncpus=12, physmem=24675848kB, availmem=39398048kB, totmem=41059840kB, idletime=10807394, nusers=3, nsessions=3, sessions=85623233, uname=Linux cl2n003 2.6.18-274.el5 #1 SMP Fri Jul 22 04:43:29 EDT 2011 x86_64, opsys=linux
  mom_service_port = 15002
  mom_manager_port = 15003

cl2n204

pbsnodes -a gives detailed information on all the nodes, node by node: memory used and available, load, its features/properties, and jobs running on the node
showq

hungabee:~ # showq

**active jobs**

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCS</th>
<th>REMAINING</th>
<th>STARTTIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>25658</td>
<td>fujinaga</td>
<td>Running</td>
<td>64</td>
<td>5:11:32</td>
<td>Thu Apr 10 03:51:16</td>
</tr>
<tr>
<td>25663</td>
<td>kamil</td>
<td>Running</td>
<td>64</td>
<td>6:29:27</td>
<td>Thu Apr 10 09:09:11</td>
</tr>
<tr>
<td>25571</td>
<td>tmcguire</td>
<td>Running</td>
<td>512</td>
<td>1:15:03:42</td>
<td>Wed Apr  9 01:43:26</td>
</tr>
</tbody>
</table>

4 active jobs

640 of 2048 processors in use by local jobs (31.25%)
80 of 256 nodes active (31.25%)

**eligible jobs**

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCS</th>
<th>WCLIMIT</th>
<th>QUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>25660</td>
<td>fujinaga</td>
<td>Idle</td>
<td>256</td>
<td>12:00:00</td>
<td>Thu Apr 10 03:51:27</td>
</tr>
</tbody>
</table>

1 eligible jobs

**blocked jobs**

<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCS</th>
<th>WCLIMIT</th>
<th>QUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>25680</td>
<td>jyang</td>
<td>Deferred</td>
<td>1</td>
<td>3:00:00:00</td>
<td>Thu Apr 10 10:35:37</td>
</tr>
</tbody>
</table>

1 blocked jobs

Total jobs: 5
```
[root@jasper etc]# showq -b

blocked jobs------------------------
<table>
<thead>
<tr>
<th>JOBID</th>
<th>USERNAME</th>
<th>STATE</th>
<th>PROCs</th>
<th>WCLIMIT</th>
<th>QUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>4508818</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:33</td>
</tr>
<tr>
<td>4508848</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:40</td>
</tr>
<tr>
<td>4508849</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:40</td>
</tr>
<tr>
<td>4508851</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:41</td>
</tr>
<tr>
<td>4508891</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:41</td>
</tr>
<tr>
<td>4508910</td>
<td>fujinaga</td>
<td>BatchHold</td>
<td>1</td>
<td>1:12:00:00</td>
<td>Fri Apr 4 07:15:55</td>
</tr>
<tr>
<td>4515387</td>
<td>tmcguire</td>
<td>Idle</td>
<td>5</td>
<td>3:00:00:00</td>
<td>Sat Apr 5 12:27:59</td>
</tr>
<tr>
<td>4522606</td>
<td>jyang</td>
<td>Deferred</td>
<td>12</td>
<td>00:01:00</td>
<td>Mon Apr 7 11:52:34</td>
</tr>
<tr>
<td>4522614</td>
<td>jyang</td>
<td>Deferred</td>
<td>12</td>
<td>00:01:00</td>
<td>Mon Apr 7 11:58:07</td>
</tr>
<tr>
<td>4523361</td>
<td>tmah</td>
<td>Deferred</td>
<td>4</td>
<td>3:00:00:00</td>
<td>Mon Apr 7 15:07:24</td>
</tr>
</tbody>
</table>
...

3426 blocked jobs
Total jobs: 3426
jobinfo -i  or showq -i

[root@jasper etc]# showq -i

eligible jobs----------------------

<table>
<thead>
<tr>
<th>JOBID</th>
<th>PRIORITY</th>
<th>XFACTOR</th>
<th>Q</th>
<th>USERNAME</th>
<th>GROUP</th>
<th>PROCS</th>
<th>WCLIMIT</th>
<th>CLASS</th>
<th>SYSTEMQUEUETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>4534230*</td>
<td>10435</td>
<td>1.1</td>
<td></td>
<td>fujinaga</td>
<td>fujinaga</td>
<td>16</td>
<td>10:30:00</td>
<td>batch</td>
<td>Thu Apr 10 10:11:42</td>
</tr>
<tr>
<td>4534231*</td>
<td>10432</td>
<td>1.1</td>
<td></td>
<td>fujinaga</td>
<td>fujinaga</td>
<td>16</td>
<td>10:30:00</td>
<td>batch</td>
<td>Thu Apr 10 10:11:42</td>
</tr>
<tr>
<td>4533750[482]*</td>
<td>9491</td>
<td>1.4</td>
<td></td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533750[404]*</td>
<td>9474</td>
<td>1.4</td>
<td></td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533750[405]*</td>
<td>9470</td>
<td>1.4</td>
<td></td>
<td>kamil</td>
<td>kamil</td>
<td>1</td>
<td>1:00:59:00</td>
<td>batch</td>
<td>Thu Apr 10 00:25:08</td>
</tr>
<tr>
<td>4533184*</td>
<td>-1122</td>
<td>1.3</td>
<td></td>
<td>jyang</td>
<td>jyang</td>
<td>12</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr  9 15:31:32</td>
</tr>
<tr>
<td>4534262*</td>
<td>-1133</td>
<td>1.2</td>
<td></td>
<td>tmcguire</td>
<td>tmcguire</td>
<td>8</td>
<td>2:00:00</td>
<td>batch</td>
<td>Thu Apr 10 10:27:59</td>
</tr>
<tr>
<td>4533181*</td>
<td>-1182</td>
<td>1.3</td>
<td></td>
<td>jyang</td>
<td>jyang</td>
<td>12</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr  9 15:31:09</td>
</tr>
<tr>
<td>4533188[539]*</td>
<td>-82797</td>
<td>1.3</td>
<td></td>
<td>tmah</td>
<td>tmah</td>
<td>5</td>
<td>3:00:00:00</td>
<td>batch</td>
<td>Wed Apr  9 15:36:01</td>
</tr>
</tbody>
</table>

9 eligible jobs

Total jobs: 9
## Getting information on your Cluster

<table>
<thead>
<tr>
<th>Command</th>
<th>What its used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>jobinfo –n</td>
<td>List the state of every node in the entire cluster.</td>
</tr>
<tr>
<td>(mdiat –n)</td>
<td></td>
</tr>
<tr>
<td>showq –i</td>
<td>Show a list of jobs that are considered for scheduling and their priority</td>
</tr>
<tr>
<td>jobinfo -i</td>
<td></td>
</tr>
<tr>
<td>pdsnodes –In</td>
<td>Lists offline or down nodes in the cluster</td>
</tr>
<tr>
<td>pbsnodes –a</td>
<td>List information on every node in the cluster</td>
</tr>
<tr>
<td>showbf</td>
<td>Shows how many idle resources are available at the moment and for how long will they be available.</td>
</tr>
<tr>
<td>showres</td>
<td>Shows reservations on system</td>
</tr>
<tr>
<td>showq -b</td>
<td>Show any holds on a job in the system</td>
</tr>
</tbody>
</table>
Why does my job not run?

• List of reasons your job is not running in order of probability.
  1. There is a problem with the job
  2. The Job is blocked
  3. Other jobs have greater priority
  4. Resources are not available
  5. There is a problem with the scheduling system or cluster.
Common Problems

• The Job request more resources than are available on the system or practice to run on the system.

• You have queued 5 or more large job that cannot run soon and then a large number of smaller jobs. Remember only the first 5 jobs (on Jasper) are able to be scheduled.
Problem with my job

1. Is the Job blocked? “showq -b”
   – Find out Why? “checkjob -v -v <jobid>”

2. Is the Job on hold?
   – Which type of hold? (User, System, Batch, Defered)
     • User hold means the user did it usually job is waiting for another jobs.
     • System hold means an administer did it, usually because your job is causing havoc on the system. You will have received an email about it.
     • Defer means means the scheduling system cannot temporarily run your job.
     • Batch hold means the scheduling system cannot run your job, the problem may be with your job, scheduling system, or node on the cluster
Is there a problem with my job?

3. What is my jobs priority? Compare it to other jobs on cluster run: “jobinfo -i”

If you have much lower priority find out why:

use: “jobinfo -v -f”

• Wait until priority improves over time.
• Ask fellow group members to run less.
• Ask for your professor to apply for a RAC allocation.
Is there a problem with my job?

4. If you have high priority and your job is queued check to see if the resources are available
   a. Use “mdiap -n” and “pbsnodes -ln” to see if there are enough resources available on enough nodes to start your job. Remember that you are not looking just that there are enough cores and memory available on the cluster. The question is can the cluster meet your job request. Is their enough nodes with both cores memory and other requested resources available to run the requested job?
   b. Check the WestGrid webpage to see if there is an outage scheduled.
Is there a problem with my job?

5. To test run the following commands:

- “qstat -f <jobid>” and “checkjob -v -v <jobid>”
- Read and analyze the output, pay special attention to the end of “checkjob –v –v” there is job history and list of nodes and why the job will not run on that node.
Send email to support@WestGrid.ca

- Make sure you always include the following at the beginning of the email:
  - Name of the cluster, jobid, userid
  - The location of the jobscript you submitted.
  - Any output or error of the job run.
  - Also make sure the name of the cluster is in the subject, ex: “job 123456 fails to run on the Jasper cluster”

- Brief but complete description of the problem.
- You should try to include the output of any commands like those described in the talk earlier. Please include any output of commands that you have run which convinced you there is a problem. A lot of these commands give the state of the job or cluster at the moment and this way we can analyze the situation as you saw it.
tarcejob <jobid>
(Administrator only)

[kamil@jasper ~]$ tracejob 4557912
/var/spool/torque//mom_logs/20140415: No such file or directory
/var/spool/torque//sched_logs/20140415: No such file or directory

Job: 4557912.jasper-usradm.westgrid.ca

04/15/2014 10:45:09  A  queue=batch
04/15/2014 10:49:31  S  Job Run at request of root@jasper-usradm.westgrid.ca
04/15/2014 10:49:31  A  user=kamil  group=kamil  jobname=run.pbs
queue=batch  ctime=1397580309  qtime=1397580309  etime=1397580309
start=1397580571

owner=kamil@jasper.westgrid.ca
exec_host=cl1n026/0+cl1n026/1+cl1n026/2+cl1n026/3+cl1n026/4+cl1n026/6
Resource_List.mem=5gb

Resource_List.neednodes=1:ppn=6
Resource_List.nodect=1  Resource_List.nodes=1:ppn=6
Resource_List.pmem=256mb

Resource_List.walltime=04:00:00
Scheduling in the future

• Many more levels of topology
• Enforcing exclusivity with granularity
• Data movement, backups, recovery, latency, bandwidth, move job to data not data job.
• Failure tolerant jobs and scheduling
• Power aware jobs and scheduling
• Scheduling provisioning of nodes
QUESTIONS?
The End