



Introduction to Gadi — Part II

Almost Everything About Jobs

NCI Training

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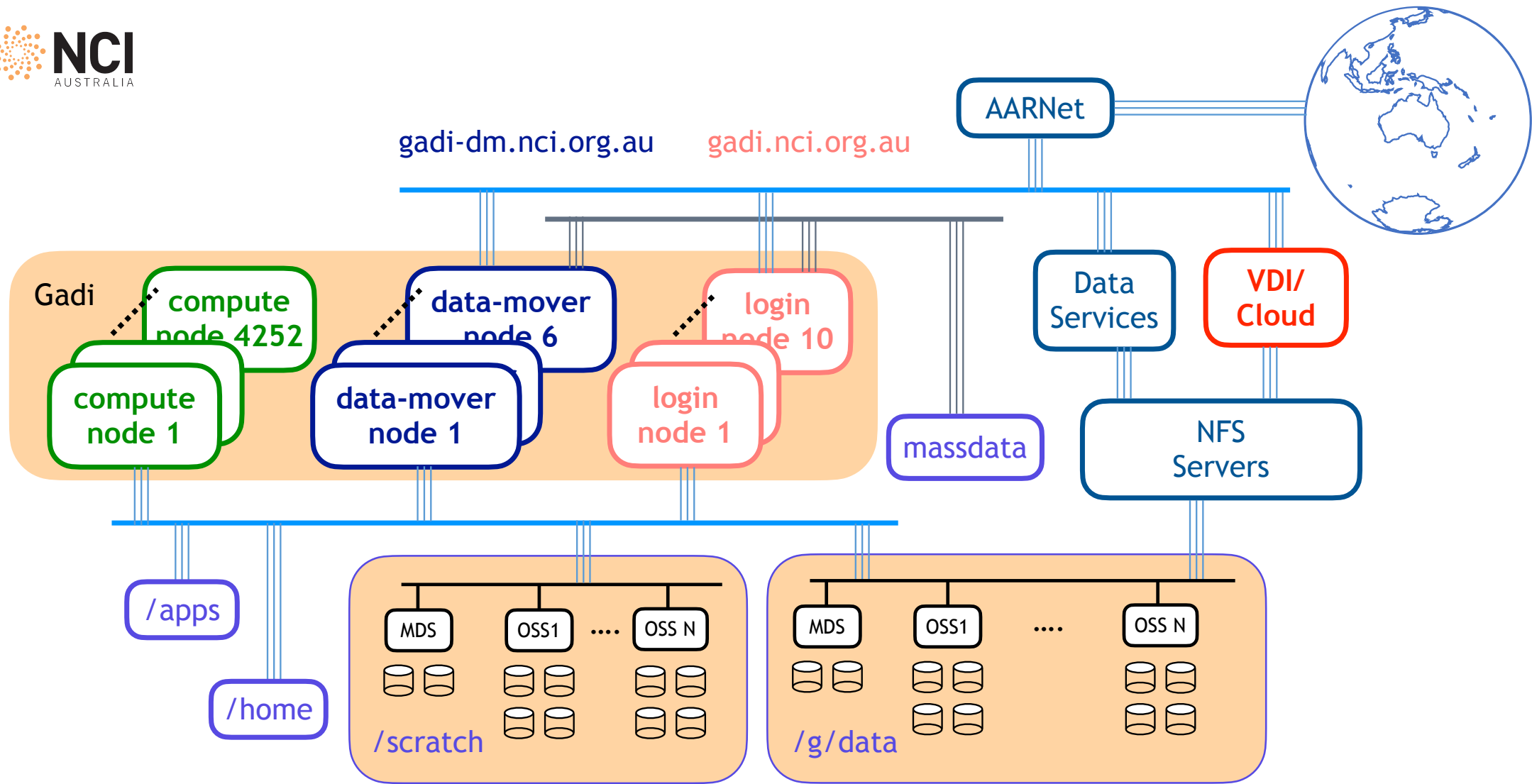
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Agenda

- Second half of [Welcome to Gadi](#) opus page
- Three sections
 - Part I [Review]
 - Compute grant
 - Software applications
 - Jobs [Continued]
 - More about submission options and status monitoring
 - Resource utilisation
- Exercise/Examples + Key points + Q&A

[Review] Intro To Gadi Part I

Resources and Basic Job Submission/Monitoring



Submit Jobs and Monitor Status

```
cp /scratch/public/yxs900/gutentag.sh ./
qsub gutentag.sh
qstat -u $USER -sw
qstat -fx <jobid>
cat <jobname>.o<jobid>
```

- qsub, qstat, qdel all launch requests to PBS server
 - run with frequency $< 1/600$ Hz
- Each job has two logs: `$PBS_JOBNAME.e$PBS_JOBID` and `$PBS_JOBNAME.o$PBS_JOBID`
- Queue, resource request (CPU, memory, walltime) \rightarrow SU cost

Job Submission Script

```
$ cat /scratch/public/yxs900/gutentag.sh
```

```
#!/bin/bash
```

```
#PBS -P c25
```

Project Ownership

```
#PBS -q copyq
```

```
#PBS -l ncpus=1
```

```
#PBS -l mem=2GB
```

```
#PBS -l walltime=02:00:00
```

Resource Requests → Reserved SU

```
#PBS -l storage=scratch/z00+gdata/c25
```

```
#PBS -l wd
```

```
hostname
```

```
export DSTDIR=/g/data/c25/yxs900/job_archive
```

```
export SOURCEDIR=/scratch/z00/yxs900/benchmarks/python/tensorflow
```

```
cp -vr $SOURCEDIR $DSTDIR > ${PBS_JOBID}.log
```



Compute Grant

Schemes and Reserved Service Units

Monitoring Compute Grant and Usage

- Project compute allocation status
 - `nci_account -P $PROJECT`
- Look into schemes and per-user usage
 - `nci_account -P $PROJECT -v`
- Look at previous quarters
 - `nci_account -P $PROJECT -v -p 2020.q4`

\$ nci_account -P xy12

Usage Report: Project=xy12 Period=2021.q1

```
=====
Grant:    410.00 KSU
Used:     270.46 KSU
Reserved: 110.59 KSU
Avail:    28.95 KSU
```

\$ nci_account -P xy12 -v

Usage Report: Project=xy12 Period=2021.q1

```
=====
Grant:    410.00 KSU
Used:     270.46 KSU
Reserved: 110.59 KSU
Avail:    28.95 KSU
```

Stakeholder	Grant	Used	Avail
MAS	200.00 KSU	185.88 KSU	14.12 KSU
UNSW	210.00 KSU	195.17 KSU	14.83 KSU

User	Used	Reserved
abc123	260.46 KSU	110.59 KSU
xyz321	10.00 KSU	0.00 SU

\$ nci_account -P xy12 -p 2020.q4

Usage Report: Project=xy12 Period=2020.q4

```
=====
Grant:    200.00 KSU
Used:     177.29 KSU
Reserved: 0.00 SU
Avail:    22.71 KSU
```

\$ nci_account -P xy12 -v -p 2020.q4

Usage Report: Project=xy12 Period=2020.q4

```
=====
Grant:    200.00 KSU
Used:     177.29 KSU
Reserved: 0.00 SU
Avail:    22.71 KSU
```

Stakeholder	Grant	Used	Avail
MAS	0.00 SU	0.00 SU	0.00 SU
UNSW	200.00 KSU	177.29 KSU	22.71 KSU

User	Used	Reserved
abc123	98.45 KSU	0.00 SU
xyz321	36.35 KSU	0.00 SU
aa1234	34.77 KSU	0.00 SU
bb4321	7.72 KSU	0.00 SU

Monitoring Compute Grant and Usage

- Project can receive compute grant from multiple schemes
- One SU
 - supports a single CPU core job submitted to normal queue with up to 4GiB memory request to run for 30 minutes
 - has the nominal value of 4 cents for grant application purpose

Extended Reading <https://opus.nci.org.au/display/Help/2.2+Job+Cost+Examples>

Q&A

- To apply for compute grant
 - Lead CIs can contact scheme manager for topups
 - Supervisors propose project to scheme through my.nci.org.au
 - Submit application to NCMAS, ANUMAS or ALCG
- Reserved SUs
 - Calculated according to request, not usage
 - Jobs across billing boundary reserve SUs in both quarters
 - Request as close to the job usage as possible
- Other questions?

Job Submission Script

```
$ cat /scratch/public/yxs900/gutentag.sh
```

```
#!/bin/bash
```

```
#PBS -P c25
```

```
#PBS -q copyq
```

```
#PBS -l ncpus=1
```

```
#PBS -l mem=2GB
```

```
#PBS -l walltime=02:00:00
```

```
#PBS -l storage=scratch/z00+gdata/c25
```

```
#PBS -l wd
```

```
hostname
```

```
export DSTDIR=/g/data/c25/yxs900/job_archive
```

```
export SOURCEDIR=/scratch/z00/yxs900/benchmarks/python/tensorflow
```

```
cp -vr $SOURCEDIR $DSTDIR > ${PBS_JOBID}.log
```

Actual Tasks: hostname, cp

Other applications?

A horizontal band of a colorful, abstract microscopic image, possibly a cross-section of a biological specimen, with various shades of red, orange, yellow, and blue.

Applications

Environment Modules and Software Groups

Module Environment

- Try the following module commands
 - `module avail python3`
 - `module list`
 - `module show python3/3.8.5`
 - `module load python3/3.8.5` [check changes in PATH etc.]
 - `module unload python3` [check changes in PATH etc.]

Module Environment

- Modules on Gadi are named as `<software>/<version>`
 - always load a specific version of the software application under interest
 - ``module load <software>`` loads the default version which changes over time
- When loading modules
 - add to search path
 - load prerequisite modules [`intel-mkl/2020.2.254` for `python3/3.8.5`]
 - set configurations to define how the application runs
 - handle conflicts

```
$ module avail gromacs
----- /apps/Modules/modulefiles -----
gromacs/2018.3      gromacs/2019.3-gpuvolta  gromacs/2020.1-gpuvolta  gromacs/2020.3-gpuvolta
gromacs/2018.3-plumed  gromacs/2019.3-plumed  gromacs/2020.1-plumed  gromacs/2021
gromacs/2019.3      gromacs/2020.1      gromacs/2020.3      gromacs/2021-gpuvolta
```

```
$ module list
Currently Loaded Modulefiles:
 1) pbs
```

```
$ module show gromacs/2021
-----
/apps/Modules/modulefiles/gromacs/2021:

prepend-path      PATH /apps/gromacs/2021/bin
prepend-path      C_INCLUDE_PATH /apps/gromacs/2021/include
prepend-path      CPLUS_INCLUDE_PATH /apps/gromacs/2021/include
prepend-path      CPATH /apps/gromacs/2021/include
prepend-path      FPATH /apps/gromacs/2021/include
prepend-path      LIBRARY_PATH /apps/gromacs/2021/lib64
prepend-path      LD_LIBRARY_PATH /apps/gromacs/2021/lib64
prepend-path      LD_RUN_PATH /apps/gromacs/2021/lib64
prepend-path      MANPATH /apps/gromacs/2021/share/man
prepend-path      PKG_CONFIG_PATH /apps/gromacs/2021/lib64/pkgconfig
module            load openmpi/4.0.3
conflict          gromacs
setenv            GROMACS_BASE /apps/gromacs/2021
setenv            GROMACS_ROOT /apps/gromacs/2021
setenv            GROMACS_VERSION 2021
module-whatis     {gromacs, version 2021}
-----
```

```
$ module load gromacs
Loading gromacs/2021-gpuvolta
  Loading requirement: openmpi/4.0.3
```

```
$ module list
Currently Loaded Modulefiles:
 1) pbs  2) openmpi/4.0.3(default)  3) gromacs/2021-gpuvolta
```

```
$ module rm gromacs
$ module list
Currently Loaded Modulefiles:
 1) pbs  2) openmpi/4.0.3(default)
```

```
$ module load gromacs/2021
$ module list
Currently Loaded Modulefiles:
 1) pbs  2) openmpi/4.0.3(default)  3) gromacs/2021
```

```
$ module load gromacs/2020.1
MODULE ERROR DETECTED: GLOBALERR openmpi/4.0.2 cannot be loaded due to a conflict.
(Detailed error information and backtrace has been suppressed, set $MODULES_ERROR_BACKTRACE to
unsuppress.)
```

```
Loading openmpi/4.0.2
  ERROR: openmpi/4.0.2 cannot be loaded due to a conflict.
  HINT: Might try "module unload openmpi" first.
```

```
MODULE ERROR DETECTED: GLOBALERRTOP Load of requirement openmpi/4.0.2 failed
(Detailed error information and backtrace has been suppressed, set $MODULES_ERROR_BACKTRACE to
unsuppress.)
```

```
Loading gromacs/2020.1
  ERROR: Load of requirement openmpi/4.0.2 failed
```

```
$ module rm openmpi gromacs
$ module list
Currently Loaded Modulefiles:
 1) pbs
$ module load gromacs/2020.1
Loading gromacs/2020.1
  Loading requirement: openmpi/4.0.2
```


Licence Module and Software Group

- Restricted Modules available to specific group of users
- Software groups control access to license modules
 - Example: matlab, ansys
- License Modules tell the application where to checkout license
- Software groups control access to applications
 - Example: vasp

```
$ module avail matlab
----- /apps/Modules/restricted-modulefiles/matlab_anu -----
matlab_licence/anu

----- /apps/Modules/restricted-modulefiles/matlab_usyd -----
matlab_licence/usyd

----- /apps/Modules/restricted-modulefiles/matlab_vu -----
matlab_licence/vu

----- /apps/Modules/restricted-modulefiles/matlab_utas -----
matlab_licence/utas

----- /apps/Modules/modulefiles -----
matlab/R2019b
```

```
$ ls -ltrah /apps/Modules/restricted-modulefiles/matlab_anu
total 12K
drwxrwx---+ 2 apps z30 4.0K Feb 3 2020 matlab_licence
drwxrwx---+ 3 apps z30 4.0K Feb 3 2020 .
drwxrwxr-x. 27 apps apps 4.0K Feb 19 09:35 ..
```

```
$ getfacl !$
getfacl /apps/Modules/restricted-modulefiles/matlab_anu
getfacl: Removing leading '/' from absolute path names
# file: apps/Modules/restricted-modulefiles/matlab_anu
# owner: apps
# group: z30
user::rwx
group::rwx
group:matlab_anu:r-x
mask::rwx
other:---
```

```
$ module show matlab_licence/anu
-----
/apps/Modules/restricted-modulefiles/matlab_anu/matlab_licence/anu:

setenv      MLM_LICENSE_FILE 12345678@xxxxxxx.anu.edu.au
conflict    matlab_licence
module-whatis {matlab_licence, version anu}
-----
```

```
$ module show matlab/R2019b
-----
/apps/Modules/modulefiles/matlab/R2019b:

prepend-path PATH /apps/matlab/R2019b/bin
setenv       MATLAB /apps/matlab/R2019b
prepend-path LD_LIBRARY_PATH /apps/matlab/R2019b/bin/glnxa64
prepend-path LD_LIBRARY_PATH /apps/matlab/R2019b/runtime/glnxa64
prepend-path LD_LIBRARY_PATH /apps/matlab/R2019b/sys/os/glnxa64
conflict     matlab
setenv       MATLAB_BASE /apps/matlab/R2019b
setenv       MATLAB_ROOT /apps/matlab/R2019b
setenv       MATLAB_VERSION R2019b
module-whatis {matlab, version R2019b}
-----
```

```
$ getfacl /apps/matlab/R2019b/bin
getfacl: Removing leading '/' from absolute path names
# file: apps/matlab/R2019b/bin
# owner: apps
# group: apps
user::rwx
group::rwx
other::r-x
```

```
$ module show vasp
-----
/apps/Modules/modulefiles/vasp/6.1.0:

prepend-path PATH /apps/vasp/6.1.0/bin
conflict     vasp
setenv       VASP_BASE /apps/vasp/6.1.0
setenv       VASP_ROOT /apps/vasp/6.1.0
setenv       VASP_VERSION 6.1.0
module-whatis {vasp, version 6.1.0}
-----
```

```
$ getfacl /apps/vasp/6.1.0/bin
getfacl: Removing leading '/' from absolute path names
# file: apps/vasp/6.1.0/bin
# owner: apps
# group: apps
user::rwx
group::rwx
group:vasp5:r-x
mask::rwx
other:---
```

Q&A

- Join software group on my.nci.org.au
 - read project description before submit the membership request
 - wait for 30 minutes after the approval to allow membership synchronised throughout systems
- Other questions?

Jobs

More Submission Options

Submit an Interactive Job

```
qsub -I -lstorage=gdata/c25+scratch/x11,wd job.sh
```

- Add PBS directives so that the job
 - sends you email at start: `-M <abc123>@<gmail.com> -m abe`
 - waits until matlab licenses is available: `-lsoftware=matlab_<unsw>`
 - redirects STDOUT and STDERR into the specific log(s):
 - `-e err.log -o /scratch/c25/abc123/Logs/`
 - `-j eo`
 - waits until 1:55pm to start: `-a 202103181355`

Extended Reading <https://opus.nci.org.au/display/Help/PBS+Directives+Explained>

Q&A

- Why my job has waited so long [qstat -u \$USER -Esw]
 - Project doesn't have sufficient allocation to run job
 - Waiting for software licenses
 - Job would not finish before dedicated time
 - Job held, too many failed attempts to run
- Why my job failed [look into the error log]
 - File/directory not found [check -lstorage]
 - Exceeding jobfs/memory/walltime limit
 - Disk quota exceeded [lquota, nci-files-report, quota]
- Other questions?

Jobs

Monitoring How Well the Job Runs

Resource Utilisation Rate

```
nqstat_anu <jobID1> <jobID2> ...
```

					%CPU	WallTime	Time Lim	RSS	mem	memlim	cpus
12345678	R	abc123	x11	myTest	33	10:53:56	20:00:00	58.7GB	58.7GB	200GB	96
19145286	R	abc123	x11	atmos_ma	96	01:32:41	03:30:00	369GB	369GB	2625GB	768
19149497	R	abc123	x11	coupled.	84	00:34:25	04:30:00	320GB	320GB	1440GB	720
19149708	R	abc123	x11	netcdf_c	71	00:36:30	02:00:00	12.0GB	12.0GB	12.0GB	1
19150248	R	abc123	x11	atmos_ma	86	00:22:27	03:30:00	345GB	345GB	2625GB	768

If under use, look into the job

```
qcat -e <jobID>
```

```
qps -Lopid,nlwp,lwp,stat,sgi_p,pcpu,cputime,comm <jobID>
```

- ``qcat`` : print the job's standard streams
 - `-e/-o` for standard error/out stream
 - `-s` for submission script
- ``qps`` : take a snapshot of the current processes in the job
 - launches a ``ps`` query on each node hosting the job
 - accepts most flags ``ps`` would take

```
$ nqstat_anu 12345678
```

				%CPU	WallTime	Time Lim	RSS	mem	memlim	cpus	
12345678	R	abc123	x11	myTest	0	10:59:39	48:00:00	228MB	228MB	180GB	96

```
$ qps -Lopid,nlwp,lwp,stat,sgi_p,pcpu,cputime,comm 12345678
```

```
Node 0 (gadi-cpu-clx-2962):
```

PID	NLWP	LWP	STAT	P	%CPU	TIME	COMMAND
232633	1	232633	Ss	*	0.0	00:00:00	bash
232641	1	232641	S	*	0.0	00:00:00	pbs_demux
232682	1	232682	S	*	0.0	00:00:00	12345678.gadi-p
232697	4	232697	Sl	*	0.0	00:00:00	mpirun
232697	4	232702	Sl	*	0.0	00:00:00	mpirun
232697	4	232703	Sl	*	0.0	00:00:00	mpirun
232697	4	232704	Sl	*	0.0	00:00:00	mpirun

```
Node 1 (gadi-cpu-clx-2971):
```

PID	NLWP	LWP	STAT	P	%CPU	TIME	COMMAND
884675	3	884675	Ssl	*	0.0	00:00:00	orted
884675	3	884687	Ssl	*	0.0	00:00:00	orted
884675	3	884688	Ssl	*	0.0	00:00:00	orted

```
$ qcat -e 12345678
```

```
./myTest: error while loading shared libraries: libmkl_intel_lp64.so: cannot open  
shared object file: No such file or directory  
./myTest: error while loading shared libraries: libmkl_intel_lp64.so: cannot open  
shared object file: No such file or directory  
./myTest: error while loading shared libraries: libmkl_intel_lp64.so: cannot open  
shared object file: No such file or directory  
....
```

```
$ qcat -s 12345678
```

```
#!/bin/bash  
#PBS -N myTest  
#PBS -P c25  
#PBS -q normal  
#PBS -l walltime=48:00:00  
#PBS -l mem=180GB  
#PBS -l ncpus=96  
#PBS -l storage=gdata/c25  
#PBS -l wd  
  
module load openmpi/4.0.1  
mpirun -np $PBS_NCPUS ./myTest
```

\$ nqstat_anu 12345679

	%CPU	WallTime	Time Lim	RSS	mem	memlim	cpus
12345679 R abc123 x11 myTest	33	10:53:56	48:00:00	58.7GB	58.7GB	180GB	96

\$ myqps 12345679

qps

Node 0 (gadi-cpu-clx-1957):

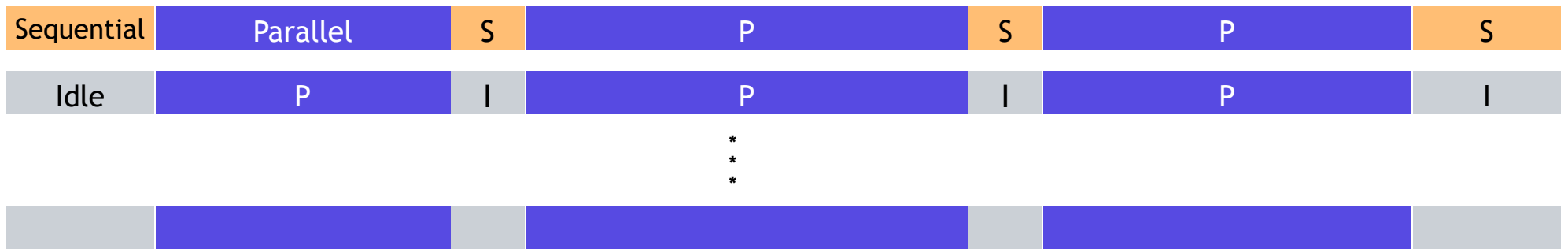
PID	NLWP	LWP	STAT	P	%CPU	TIME	COMMAND
186877	1	186877	Ss	*	0.0	00:00:00	bash
186885	1	186885	S	*	0.0	00:00:00	pbs_demux
186926	1	186926	S	*	0.0	00:00:00	12345679.gadi-p
186961	4	186961	Sl	*	0.0	00:00:00	mpirun
186961	4	186966	Sl	*	0.0	00:00:00	mpirun
186961	4	186967	Sl	*	0.0	00:00:00	mpirun
186961	4	186968	Sl	*	0.0	00:00:00	mpirun
186969	51	186969	Rl	47	90.1	09:56:32	myTest
186969	51	186972	Sl	*	0.0	00:00:00	myTest
186969	51	186975	Sl	*	0.0	00:00:00	myTest
186969	51	186978	Sl	*	0.1	00:00:50	myTest
186969	51	186980	Sl	*	32.6	03:36:20	myTest
186969	51	186981	Sl	*	32.1	03:32:56	myTest
186969	51	186982	Sl	*	32.9	03:38:02	myTest
186969	51	186983	Sl	*	33.1	03:39:17	myTest
186969	51	186984	Sl	*	33.3	03:40:34	myTest
186969	51	186985	Sl	*	32.7	03:37:01	myTest
186969	51	186986	Sl	*	32.9	03:38:07	myTest
186969	51	186987	Sl	*	33.2	03:39:55	myTest
186969	51	186988	Sl	*	32.2	03:33:36	myTest
186969	51	186989	Sl	*	32.1	03:33:06	myTest
186969	51	186990	Sl	*	32.8	03:37:37	myTest
186969	51	186991	Sl	*	33.3	03:40:34	myTest
186969	51	186992	Sl	*	32.8	03:37:33	myTest
186969	51	186993	Sl	*	33.0	03:38:57	myTest
186969	51	186994	Sl	*	32.8	03:37:06	myTest
186969	51	186995	Sl	*	32.7	03:36:59	myTest
186969	51	186996	Sl	*	32.5	03:35:26	myTest
186969	51	186997	Sl	*	32.8	03:37:36	myTest
186969	51	186998	Sl	*	32.7	03:36:36	myTest
186969	51	186999	Sl	*	32.4	03:34:42	myTest
186969	51	187000	Sl	*	31.6	03:29:19	myTest
186969	51	187001	Sl	*	32.6	03:36:03	myTest
186969	51	187002	Sl	*	32.3	03:33:55	myTest
186969	51	187003	Sl	*	33.1	03:39:09	myTest
186969	51	187004	Sl	*	32.7	03:36:36	myTest
186969	51	187005	Sl	*	33.0	03:38:30	myTest
186969	51	187006	Sl	*	33.0	03:38:28	myTest
186969	51	187007	Sl	*	33.2	03:39:45	myTest
186969	51	187008	Sl	*	33.2	03:39:59	myTest
186969	51	187009	Sl	*	32.3	03:34:23	myTest
186969	51	187010	Sl	*	33.8	03:44:10	myTest
186969	51	187011	Sl	*	32.8	03:37:39	myTest
186969	51	187012	Sl	*	33.3	03:40:27	myTest
186969	51	187013	Sl	*	32.5	03:35:44	myTest
186969	51	187014	Sl	*	32.8	03:37:40	myTest
186969	51	187015	Sl	*	32.9	03:38:15	myTest
186969	51	187016	Sl	*	33.3	03:40:45	myTest
186969	51	187017	Sl	*	33.1	03:39:29	myTest
186969	51	187018	Sl	*	32.5	03:35:23	myTest
186969	51	187019	Sl	*	33.0	03:38:32	myTest
186969	51	187020	Sl	*	32.3	03:34:22	myTest
186969	51	187021	Sl	*	32.4	03:34:33	myTest
186969	51	187022	Sl	*	32.7	03:36:36	myTest
186969	51	187023	Sl	*	33.4	03:41:14	myTest
186969	51	187024	Sl	*	33.2	03:40:24	myTest
186969	51	187025	Sl	*	32.1	03:32:52	myTest
186969	51	187026	Sl	*	33.5	03:42:04	myTest

Node 1 (gadi-cpu-clx-1975):

PID	NLWP	LWP	STAT	P	%CPU	TIME	COMMAND
174219	3	174219	Ssl	*	0.0	00:00:00	orted
174219	3	174231	Ssl	*	0.0	00:00:00	orted
174219	3	174232	Ssl	*	0.0	00:00:00	orted
174233	51	174233	Rl	3	88.7	09:47:10	myTest
174233	51	174236	Sl	*	0.0	00:00:00	myTest
174233	51	174239	Sl	*	0.0	00:00:00	myTest
174233	51	174242	Sl	*	0.1	00:00:51	myTest
174233	51	174244	Sl	*	31.5	03:28:34	myTest
174233	51	174245	Sl	*	31.2	03:26:32	myTest
174233	51	174246	Sl	*	31.0	03:25:46	myTest
174233	51	174247	Sl	*	31.5	03:28:41	myTest
174233	51	174248	Sl	*	31.7	03:30:12	myTest
174233	51	174249	Sl	*	31.3	03:27:16	myTest
174233	51	174250	Sl	*	30.9	03:24:32	myTest
174233	51	174251	Sl	*	31.1	03:26:24	myTest
174233	51	174252	Sl	*	31.4	03:27:57	myTest
174233	51	174253	Sl	*	31.1	03:25:51	myTest
174233	51	174254	Sl	*	30.7	03:23:32	myTest
174233	51	174255	Sl	*	31.6	03:29:31	myTest
174233	51	174256	Sl	*	31.6	03:29:31	myTest
174233	51	174257	Sl	*	31.3	03:27:34	myTest
174233	51	174258	Sl	*	31.6	03:29:41	myTest
174233	51	174259	Sl	*	31.5	03:28:43	myTest
174233	51	174260	Sl	*	31.3	03:27:15	myTest
174233	51	174261	Sl	*	31.5	03:28:31	myTest
174233	51	174262	Sl	*	31.4	03:27:50	myTest
174233	51	174263	Sl	*	31.7	03:30:09	myTest
174233	51	174264	Sl	*	31.7	03:29:51	myTest
174233	51	174265	Sl	*	31.4	03:28:21	myTest
174233	51	174266	Sl	*	31.4	03:28:06	myTest
174233	51	174267	Sl	*	31.4	03:28:16	myTest
174233	51	174268	Sl	*	31.3	03:27:45	myTest
174233	51	174269	Sl	*	31.4	03:28:10	myTest
174233	51	174270	Sl	*	31.6	03:29:09	myTest
174233	51	174271	Sl	*	31.6	03:29:38	myTest
174233	51	174272	Sl	*	31.2	03:26:37	myTest
174233	51	174273	Sl	*	31.5	03:28:45	myTest
174233	51	174274	Sl	*	31.6	03:29:41	myTest
174233	51	174275	Sl	*	31.0	03:25:45	myTest
174233	51	174276	Sl	*	31.0	03:25:25	myTest
174233	51	174277	Sl	*	31.0	03:25:37	myTest
174233	51	174278	Sl	*	31.4	03:27:53	myTest
174233	51	174279	Sl	*	31.4	03:28:02	myTest
174233	51	174280	Sl	*	31.0	03:25:15	myTest
174233	51	174281	Sl	*	31.4	03:27:53	myTest
174233	51	174282	Sl	*	31.4	03:28:13	myTest
174233	51	174283	Sl	*	31.4	03:28:18	myTest
174233	51	174284	Sl	*	31.1	03:26:11	myTest
174233	51	174285	Sl	*	31.4	03:27:50	myTest
174233	51	174286	Sl	*	31.3	03:27:44	myTest
174233	51	174287	Sl	*	31.0	03:25:33	myTest
174233	51	174288	Sl	*	31.0	03:25:35	myTest
174233	51	174289	Sl	*	31.3	03:27:22	myTest
174233	51	174290	Sl	*	31.5	03:28:44	myTest

Join-Fork Paradigm

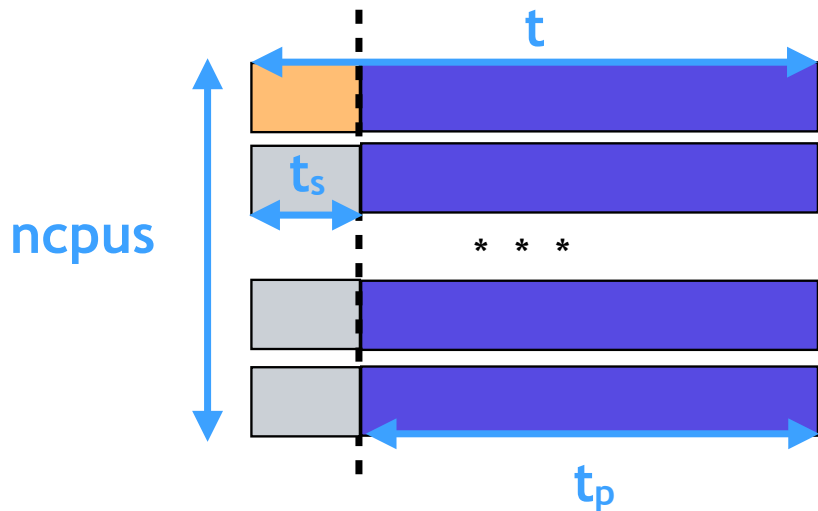
Node 0



Node 1



Theoretical CPU Utilisation Rate in a Ideal Case

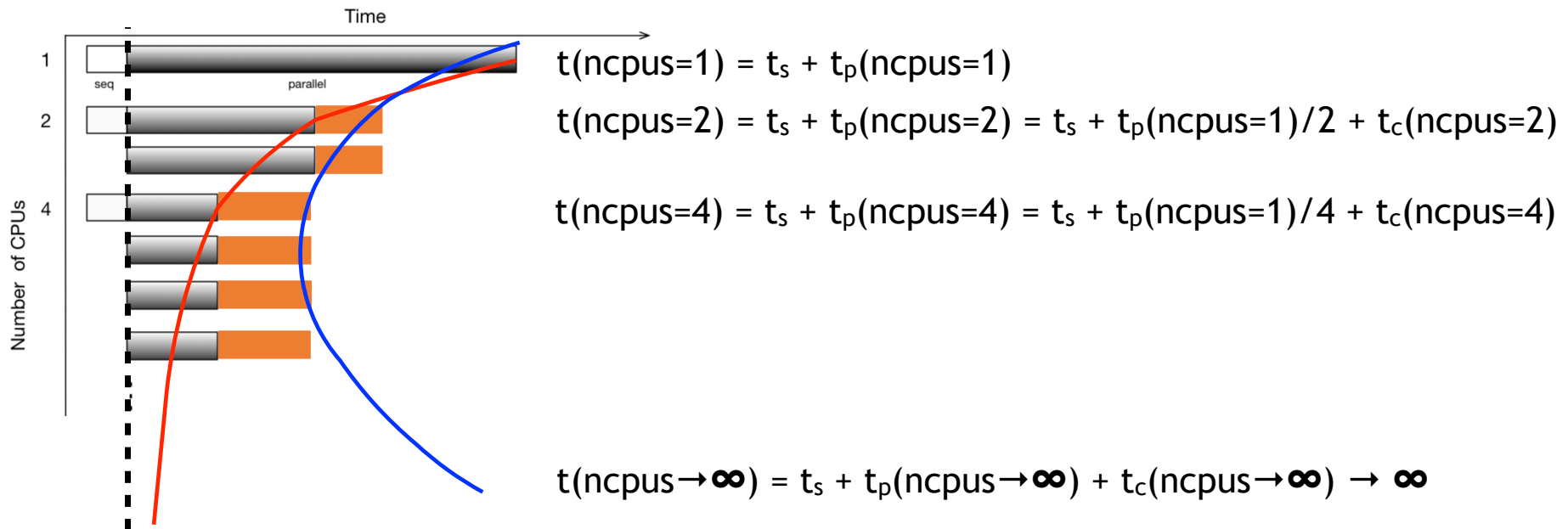


$$\eta(\text{ncpus}) = \frac{t_s + \text{ncpus} * t_p(\text{ncpus})}{\text{ncpus} * t(\text{ncpus})}$$

$\eta(\text{ncpus} \rightarrow \infty) \rightarrow 0$
given a constant $\text{ncpus} * t_p + t_s$

ncpus	tp	t	η
1	99	100	1
12	8.25	9.25	0.90
28	3.54	4.54	0.79
48	2.06	3.06	0.68
192	0.52	1.52	0.34

Execution Time Increases Beyond Sweet Point

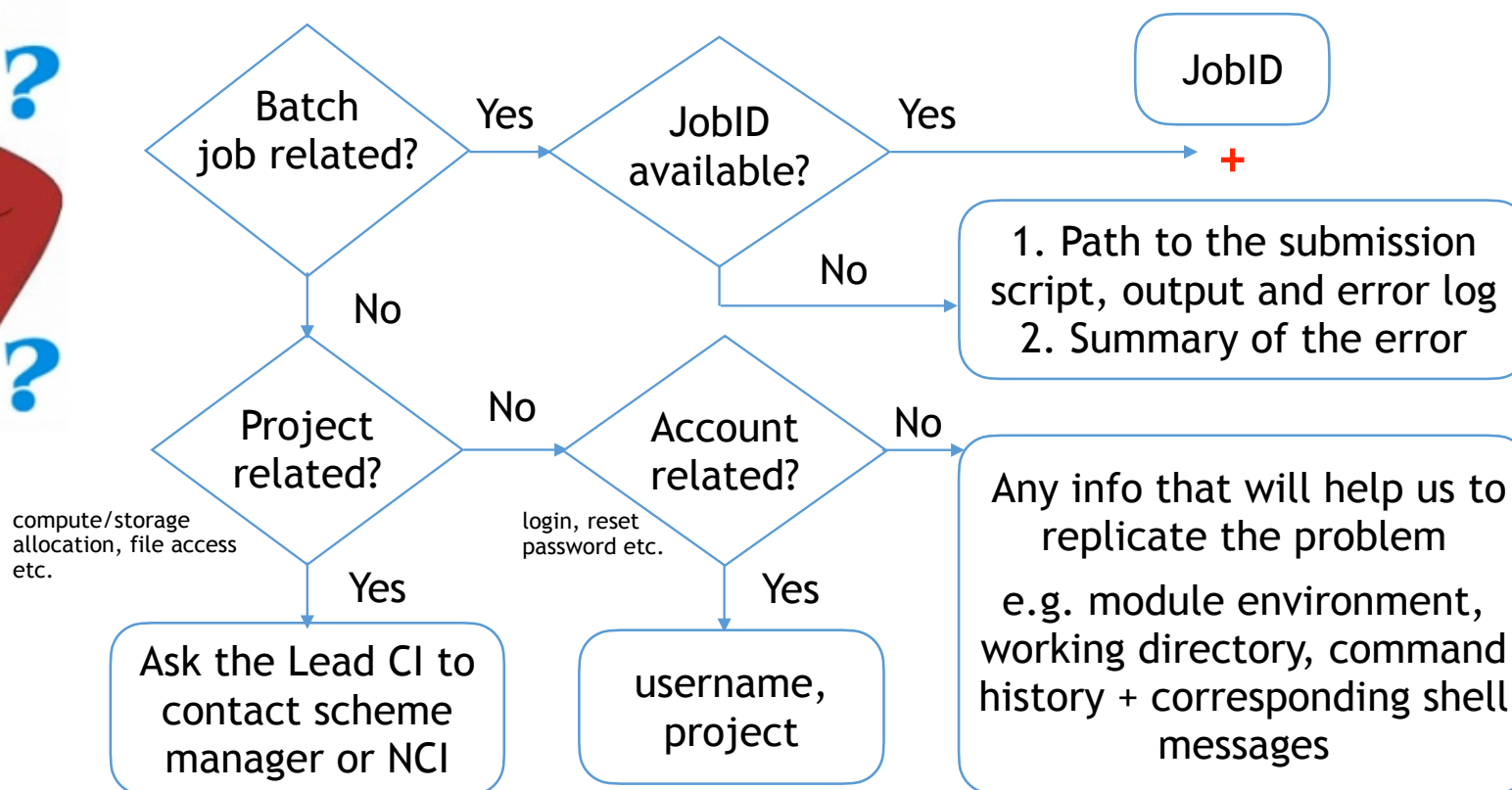




Help Desk

Asking Questions

An Example Flowchart



Any More Questions?

help@nci.org.au

A horizontal banner image showing a colorful, abstract microscopic view of tissue, likely stained with various dyes, showing intricate cellular structures and patterns in shades of red, blue, yellow, and orange.

Thank you

Next Intro Course is coming on 8 April