Debugging on the ALCF BG/Q and XC40 Systems

Computational Performance Workshop
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Ray Loy
ALCF

Argonne NATIONAL LABORATORY

INTERACTIVE RUNS FOR TESTS (BG/Q AND THETA)

- Submit an interactive job to the queue, e.g.
  - qsub –I –t 30 –n 512
- When job "runs", the nodes are allocated, and you get a (new) shell prompt.
- This shell behaves like the one in a Cobalt script job
  - BG/Q: Just one difference: do "wait-boot" before proceeding
  - Start your compute node run just like in a Cobalt script job.
    - BG/Q: runjob --block $COBALT_PARTNAME --np 512 –p 16 : myprogram.exe
    - Theta: aprun −N 64 −d 1 −j 1 −cc depth myprogram.exe
- When you exit the shell, the Cobalt job will end
- Note: When the Cobalt job runs out of time, there is no message.
  - *Runjob or aprun will fail.*
  - Check your job status with "qstat $COBALT_JOBID"

BG/Q LIGHTWEIGHT CORE FILES

- When run fails, look for core files
  - core.0, core.1, etc.
- Lightweight core files
  - One for each rank that failed *before job teardown*
  - Contain stack backtrace in *address* form
  - Decode to symbolic (useful!) form
- Environment settings to control core files
  - http://www.alcf.anl.gov/user-guides/core-file-settings

BG/Q LIGHTWEIGHT CORE FILE EXAMPLE

```
+++PARALLEL TOOLS CONSORTIUM LIGHTWEIGHT COREFILE FORMAT version 1.0
+++LCB 1.0
Program   : /gpfs/vesta-home/rloy/src/test/idie
[...]
+++ID Rank: 0, TGID: 1, Core: 0, HWTID:0 TID: 1 State: RUN
***FAULT Encountered unhandled signal 0x00000006 (6) (SIGABRT)
[...]
+++STACK
Frame Address     Saved Link Reg
0000001fbfffb700  0000000001001848
0000001fbfffb8c0  00000000010003e8
0000001fbfffb960  0000000001000438
[...]
---STACK
[...]
```

BG/Q: DECODING LIGHTWEIGHT CORE FILES

- bgq_stack [optional_exename] [corefile]

```
+++ID Rank: 0, TGID: 1, Core: 0, HWTID:0 TID: 1 State: RUN
0000000001001848
abort
/bgsys/drivers/V1R2M2/ppc64/toolchain/gnu/glibc-2.12.2/stdlib/abort.c:77

00000000010003e8
barfunc
/gpfs/vesta-home/rloy/src/test/idie.c:6

0000000001000438
foofunc
/gpfs/vesta-home/rloy/src/test/idie.c:12

0000000001000498
main
/gpfs/vesta-home/rloy/src/test/idie.c:19
[...]
```

BG/Q: COREPROCESSOR

- Useful when you have a large set of core files
  - Shows symbolic backtrace
  - Groups ranks that aborted in the same location together
  - *Can also attach to a running job to take snapshot*
- Location
  - coreprocessor.pl is in your default PATH
    - Attaching to running job does **not** require administrator
    - coreprocessor -nogui -snapshot=<filename> -j=<jobid>
      - Use the back-end (ibm.runjob) jobid from the .error file, not the Cobalt jobid
- Scalability limit
  - **Absolute maximum** 32K ranks. Practical limit lower.
- Instructions:
  - BG/Q Application Developer Redbook
    - http://www.redbooks.ibm.com/redpieces/abstracts/sg247948.html

COREPROCESSOR WINDOW

File Control Analyze Filter Sessions

Group Mode: Stack Traceback (condensed) Session 1 (MMC

```
0 :Compute Node (128)
1 :     0xffffffc (128)
2 :         __libc_start_main (32)
3 :             generic_start_main (32)
4 :                 main (16)
5 :                     Allgather (16)
6 :                         PMPI_Allgather (16)
7 :                             MPIDO_Allgather (8)
8 :                                 MPIDO_Allreduce (8)
9 :                                     MPID_Progress_wait (1)
10:                                         DCMF_CriticalSection_cycle (1)
9 :                                     MPID_Progress_wait (7)
10:                                         DCMF_Messager_advance (1)
11:                                             DCMF::Queueing::Lockbox::Device::advance() (1)
10:                                         DCMF_Messager_advance (1)
11:                                             DCMF::Queueing::Tree::Device::advance() (1)
10:                                         DCMF_Messager_advance (5)
11:                                             DCMF::DMA::Device::advance() (2)
12:                                                 DCMF::DMA::RecFifoGroup::advance() (2)
13:                                                     DMA_RecFifoSimplePollNormalFifoById (2)
11:                                             DCMF::DMA::Device::advance() (3)
7 :                             MPIDO_Allgather (8)
8 :                                 MPIDO_Allreduce (8)
9 :                                     MPIR_Allreduce (8)
10:                                         MPIC_Sendrecv (8)
11:                                             MPID_Progress_wait (8)
12:                                                 DCMF_Messager_advance (8)
13:                                                     DCMF::Queueing::GI::Device::advance() (1)
13:                                                     DCMF::DMA::Device::advance() (3)
14:                                                         DCMF::DMA::RecFifoGroup::advance() (3)
15:                                                             DMA_RecFifoSimplePollNormalFifoById (3)
```

BG/Q: GDB

- A single gdb client can connect to single rank of your job
- BG/Q Limitations
  - Each instance of gdb client counts as a "debug tool"
  - Only 4 tools may be connected to a job
    - *At most 4 ranks can be examined*
- Start a debug session using ***qsub –I*** (interactive job)
  - qsub –I –q default –t 30 –n 64
  - See Redbook for more info on starting gdb with runjob
- gdb can also load a compute-node **binary** corefile
  - *Use extreme caution when generating binary corefiles*
- Generally a parallel debugger (e.g. DDT) will be more useful

THETA

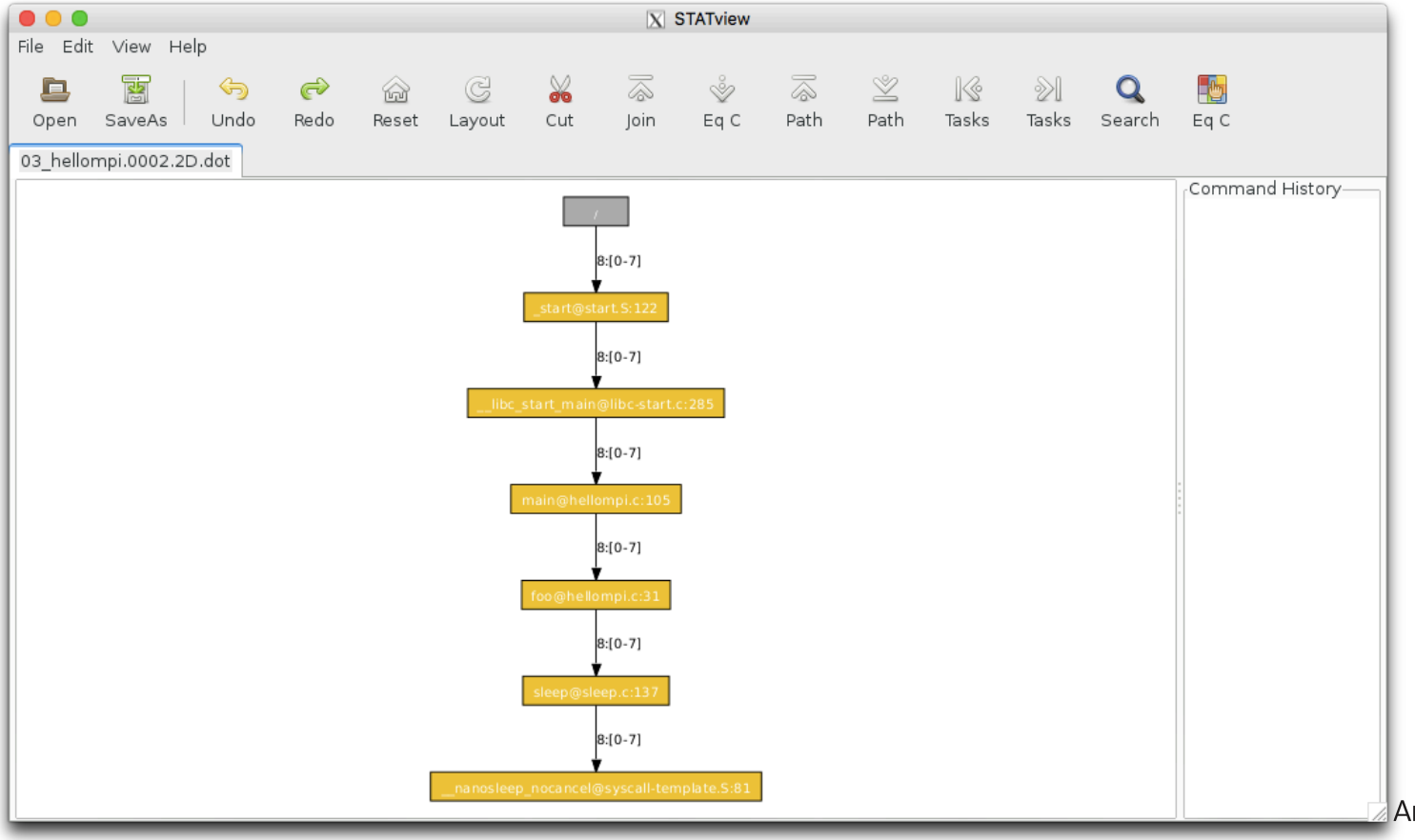
- *Will come back to DDT on BG/Q later*

THETA: ATP

- ATP = Abnormal Termination Processing
  - generates a STAT format merged stack backtrace (file atpMergedBT.dot)
  - view the backtrace file with **stat-view**

- Link your app with ATP
  - Before linking, make sure the "atp" module is loaded (check using *module list*)
  - Cray compiler will link in ATP automatically
  - Intel compiler needs a work-around for now:
    - `_Wl,_T/opt/cray/pe/cce/8.5.2/craylibs/x86_64/2.23.1.cce.ld`

STAT-VIEW


STATview
File
Edit
View
Help
Open
SaveAs
Undo
Redo
Reset
Layout
Cut
Join
Eq C
Path
Path
Tasks
Tasks
Search
Eq C
03_hellompi.0002.2D.dot
Command History
/
8:[0-7]
_start@start.S:122
8:[0-7]
__libc_start_main@libc-start.c:285
8:[0-7]
main@hellompi.c:105
8:[0-7]
foo@hellompi.c:31
8:[0-7]
sleep@sleep.c:137
8:[0-7]
__nanosleep_nocancel@syscall-template.S:81

THETA: STAT

- While program is running (e.g. deadlocked), you can generate a merged backtrace snapshot showing where your program is.
- module load stat
- On the MOM node, invoke "stat-cl *pid*" where *pid* is the aprun pid
- Method 1:
  - In your job script, run "hostname" to output the MOM node's hostname
  - During the run, read the MOM hostname from your output file, ssh to that hostname, use ps to determind the pid of your aprun, then invoke stat-cl on that pid
- Method 2:
  - Use the example job script in /soft/debuggers/stat/job-stat.sh
    - Modify the aprun command to run what you need
  - When the job is running, run the command "touch STAT_NOW". The script will check for this file's existence every 60 seconds. If it sees the file, it will generate a STAT snapshot. You can create multiple snapshots.

LGDB

- lgdb connects a gdb to each rank and provides a text interface
- module load cray-lgdb
- Modify your script job.sh to mark your aprun:

```
#cray_debug_start
aprun -n 1 -N 1 -d 1 -j 1 a.out
#cray_debug_end
```

- lgdb
  - launch $a(8) --qsub=job.sh a.out
    - Submits job.sh to run 8 ranks, your executable is a.out
- Useful commands
  - backtrace (bt), continue (cont), break, print
  - See "man lgdb"

ALLINEA DDT

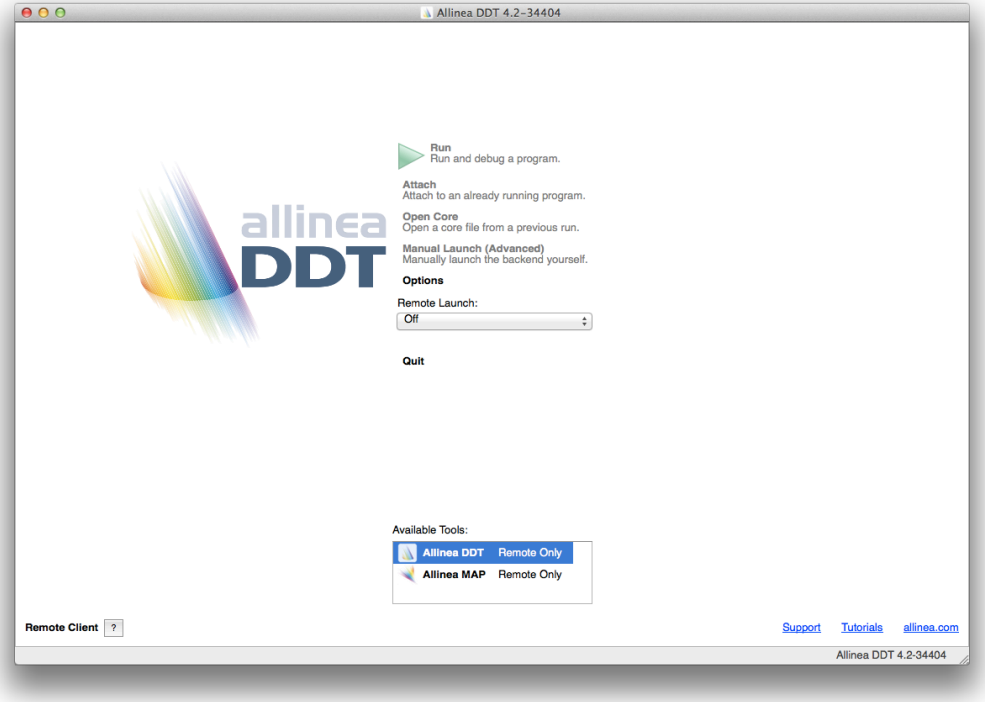
- **BG/Q, Theta, Cooley**
  - MAP available on Theta (not supported on BG/Q)
- Environment
  - BG/Q: softenv key "+ddt"
  - Theta: module load forge/7.0 (/soft/environment/modules/modulefiles)
- Compiling your code
  - Compile –g –O0
  - Note: XL compiler option -qsmp=omp also turns on optimization within OMP constructs. To override, use "noopt", e.g.
    - -qsmp=omp:noauto:noopt
- More details:
  - http://www.alcf.anl.gov/user-guides/allinea-ddt

ALLINEA DDT STARTUP (BG AND THETA)

- Run using remote client (RECOMMENDED)
  - Download and install Mac or Windows "Remote client" from http://www.allinea.com/products/download-allinea-ddt-and-allinea-map
  - Optional: use ssh master mode so you only need log in once per session
    - Note: supported on Mac OS/X; not supported in Windows <= XP (? for >XP)
    - ~/.ssh/config
      - ControlMaster auto
      - ControlPath ~/.ssh/master-%r@%h:%p
- Run from login node
  - Need X11 server on your laptop and ssh –X forwarding
  - Run ddt and let it submit job through GUI

DDT REMOTE CLIENT (0)

GUI LOOKS JUST LIKE THE X11 CLIENT



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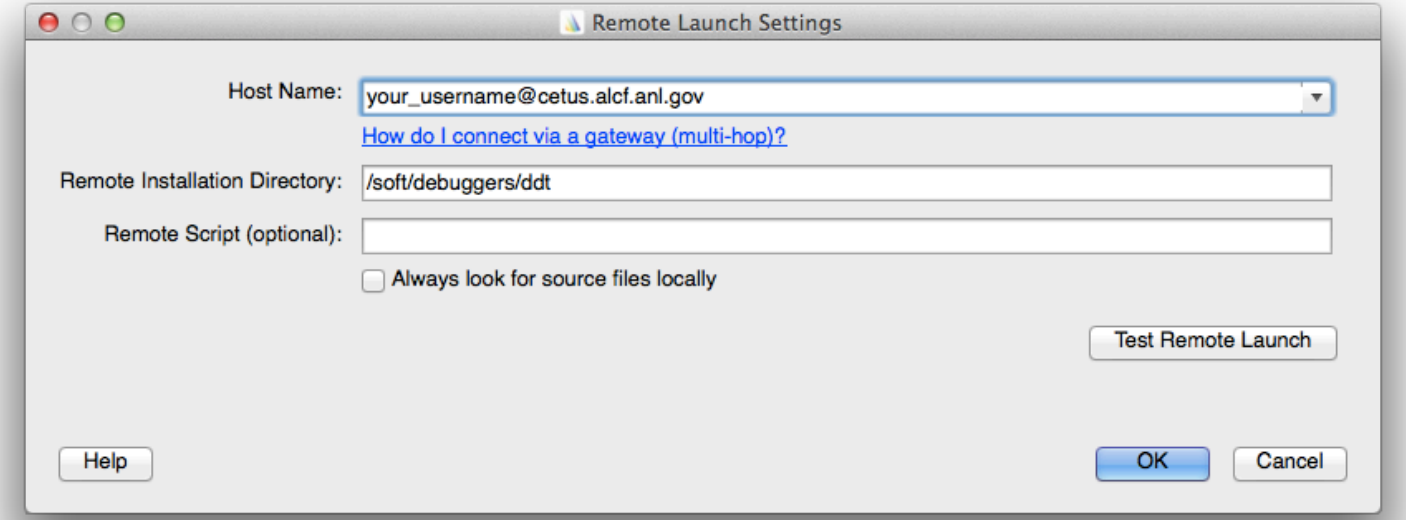
DDT REMOTE CLIENT (1)

SELECT "CONFIGURE" TO ADD A NEW REMOTE HOST

DDT REMOTE CLIENT (2)

NOTE: THIS REMOTE INSTALLATION DIRECTORY IS THE DEFAULT VERSION OF DDT, CORRESPONDING TO +DDT OR MODULE CLICK "TEST REMOTE LAUNCH" TO VERIFY

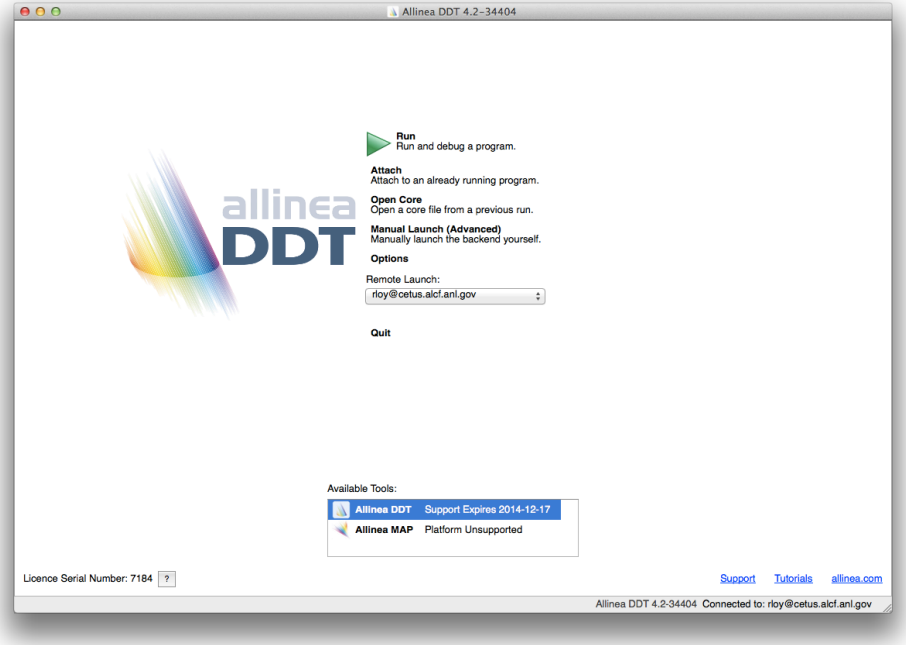


DDT REMOTE CLIENT (3)

NOW THAT IT IS DEFINED, SELECT REMOTE MACHINE

DDT (4)

CONNECTED (NOTE LICENSE INFO IN LOWER LEFT CORNER) FROM THIS POINT, REMOTE GUI WORKS SAME AS LOCAL



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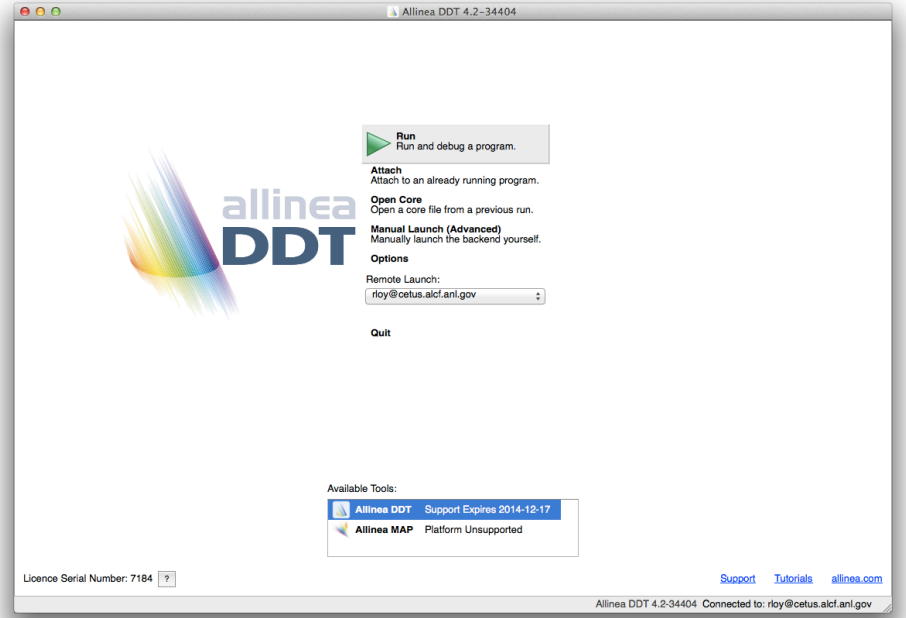
DDT STARTUP – REVERSE CONNECT (BG, THETA)

- Start remote client and connect to login node (or start X11 client on login node)
- In an ssh session to the login node
  - Run an interactive job (qsub –I)
    - BG/Q: Instead of runjob
      - ddt --connect --mpiargs="--block $COBALT_PARTNAME" --processes=8 -procs-per-node=16 myprog.exe
    - Theta: Instead of aprun ... myprog.exe
      - /soft/debuggers/forge/bin/ddt --connect aprun ... myprog.exe

- Likewise with Allinea MAP
  - Theta: /soft/debuggers/forge/bin/map --connect aprun ... myprog.exe
  - BG/Q: MAP is not supported on BG (but other perf tools available)

DDT (5) – BG/Q DIRECT JOB SUBMIT

CLICK "RUN" TO START A DEBUGGING SESSION



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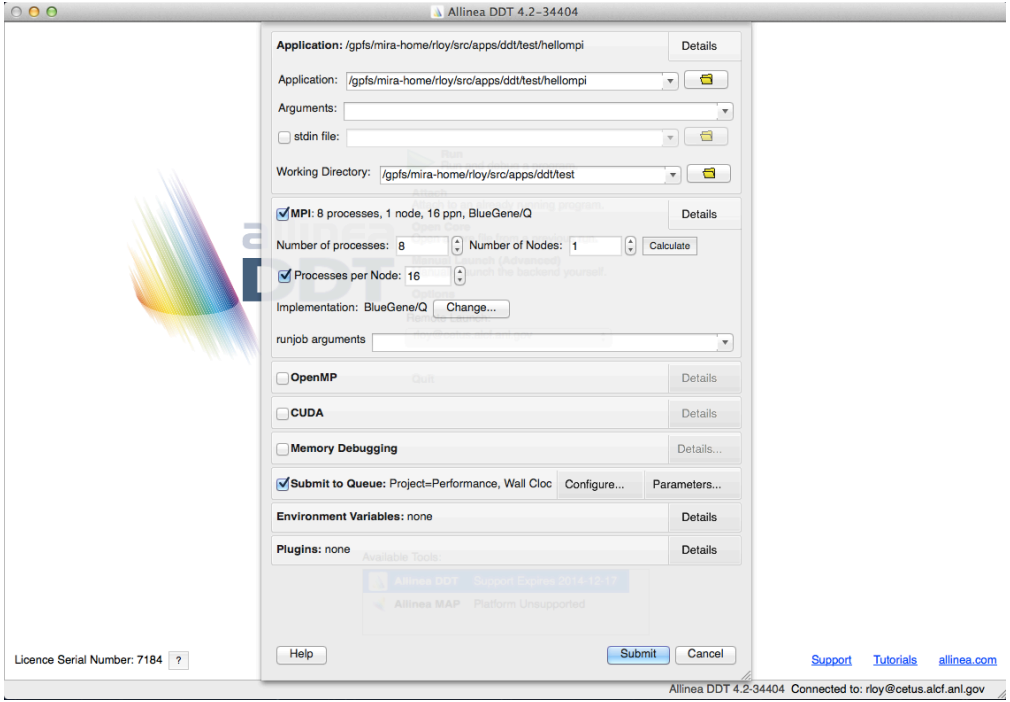
DDT (6) – BG/Q DIRECT JOB SUBMIT

REMEMBER TO SET WORKING DIRECTORY

IMPORTANT! ENABLE THE CHECKBOX "SUBMIT TO QUEUE"

- CLICK "CONFIGURE" AND "PARAMETERS" FOR ADDITIONAL SETTINGS



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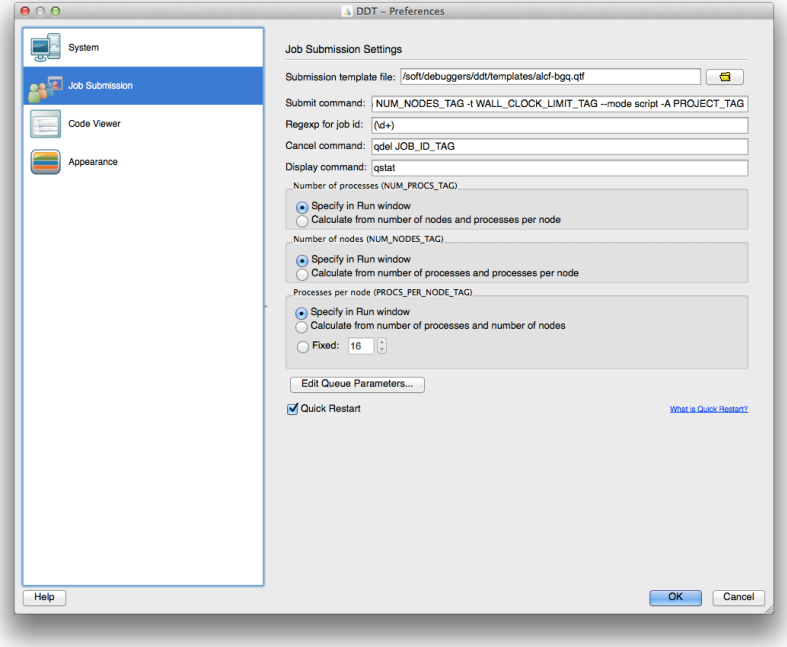
DDT (6.1) – BG/Q DIRECT JOB SUBMIT

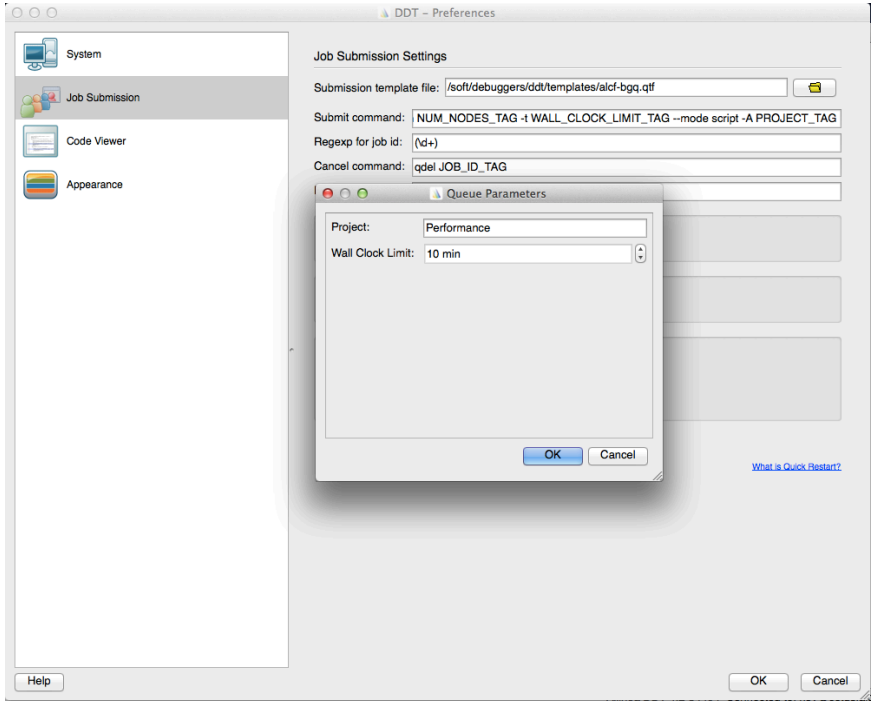
JOB SUBMISSION TAB

USE SUBMISSION TEMPLATE: /SOFT/DEBUGGERS/DDT/TEMPLATES/ALCF-BGQ.QTF



DDT (6.2) – BG/Q DIRECT JOB SUBMIT

REMEMBER TO SET YOUR PROJECT



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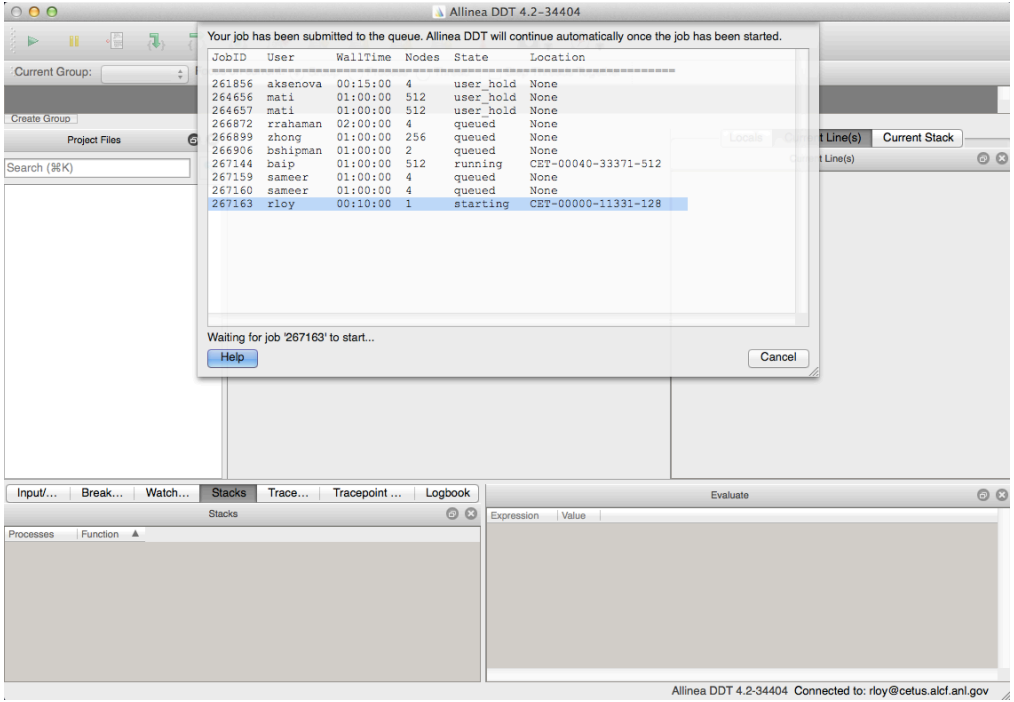
DDT (7) – BG/Q DIRECT JOB SUBMIT

JOB MUST GO THROUGH QUEUE



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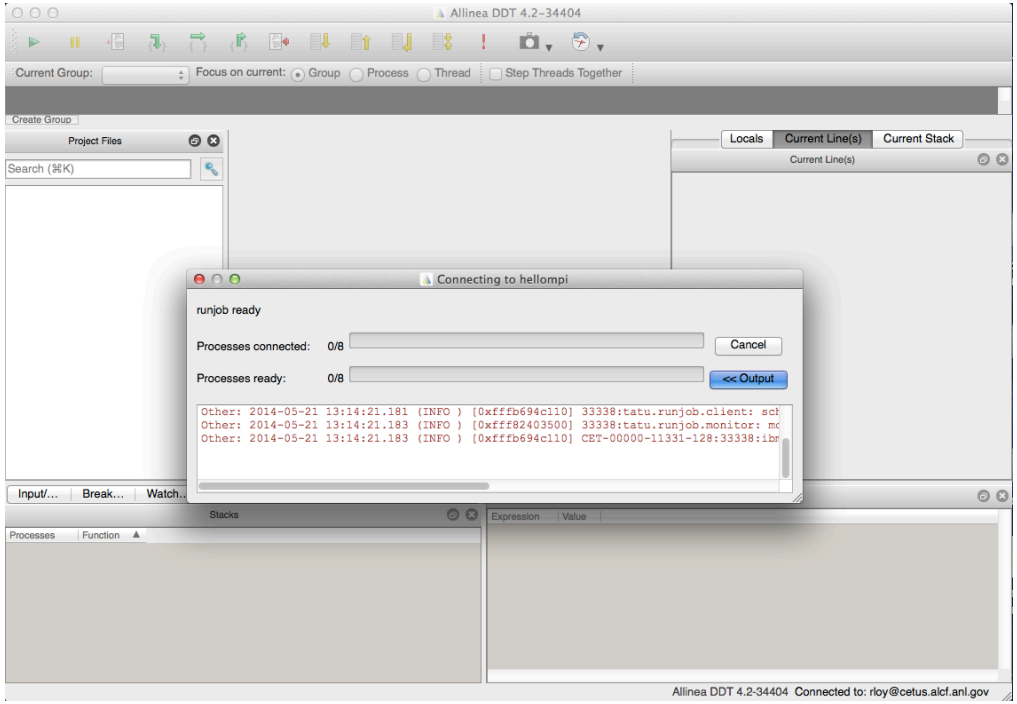
DDT (8) – REVERSE CONNECT OR DIRECT SUBMIT

WHEN JOB STARTS RUNNING, CONNECTION STATUS WILL SHOW



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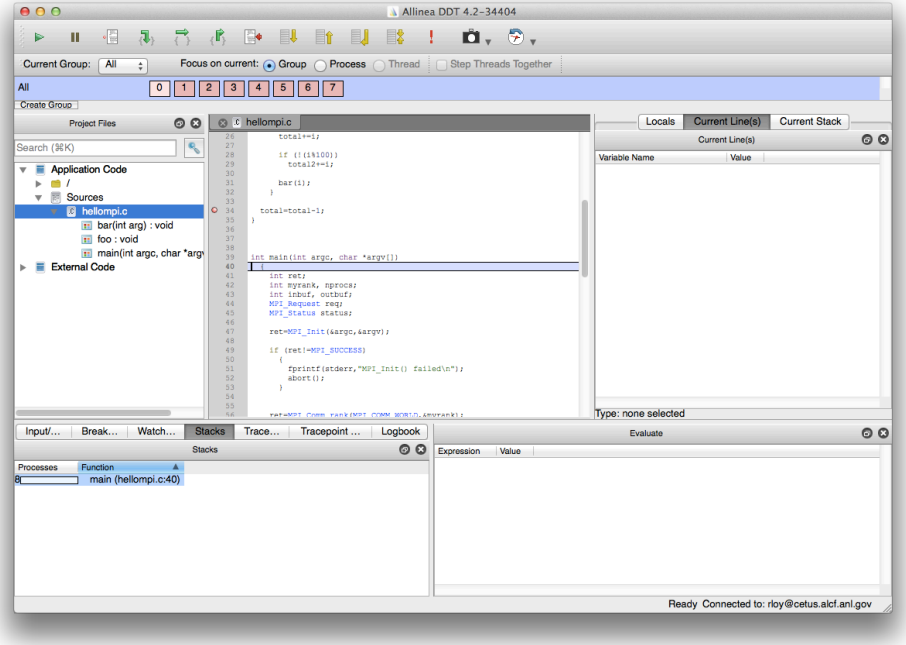
DDT (9)

READY TO DEBUG!



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QUESTIONS

- See also
  - http://www.alcf.anl.gov/user-guides/mira-cetus-vesta
    - Theta docs coming soon. For now, see Confluence (wiki)
  - support@alcf.anl.gov