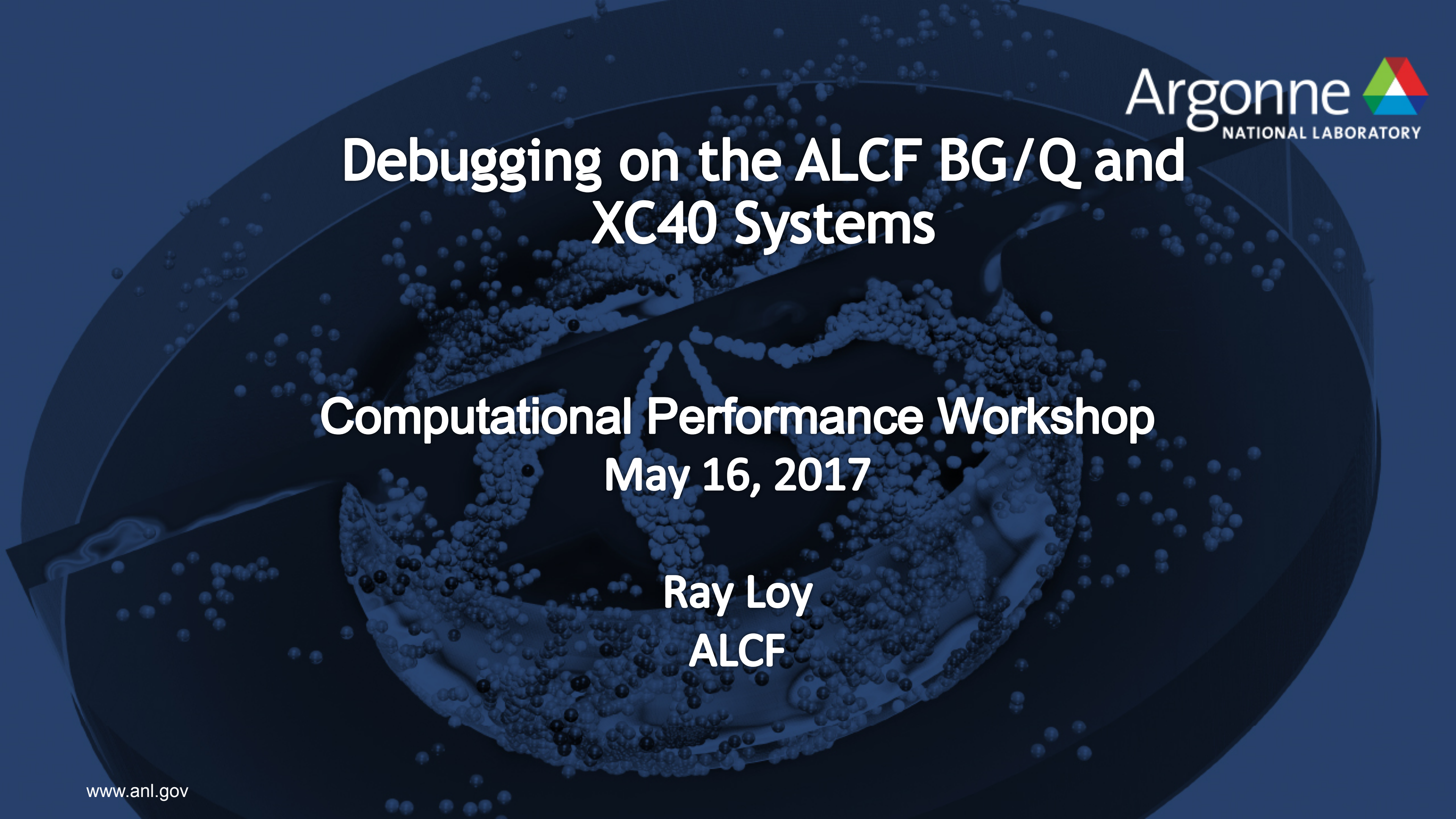

Debugging on the ALCF BG/Q and XC40 Systems

Computational Performance Workshop
May 16, 2017

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ALCF

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

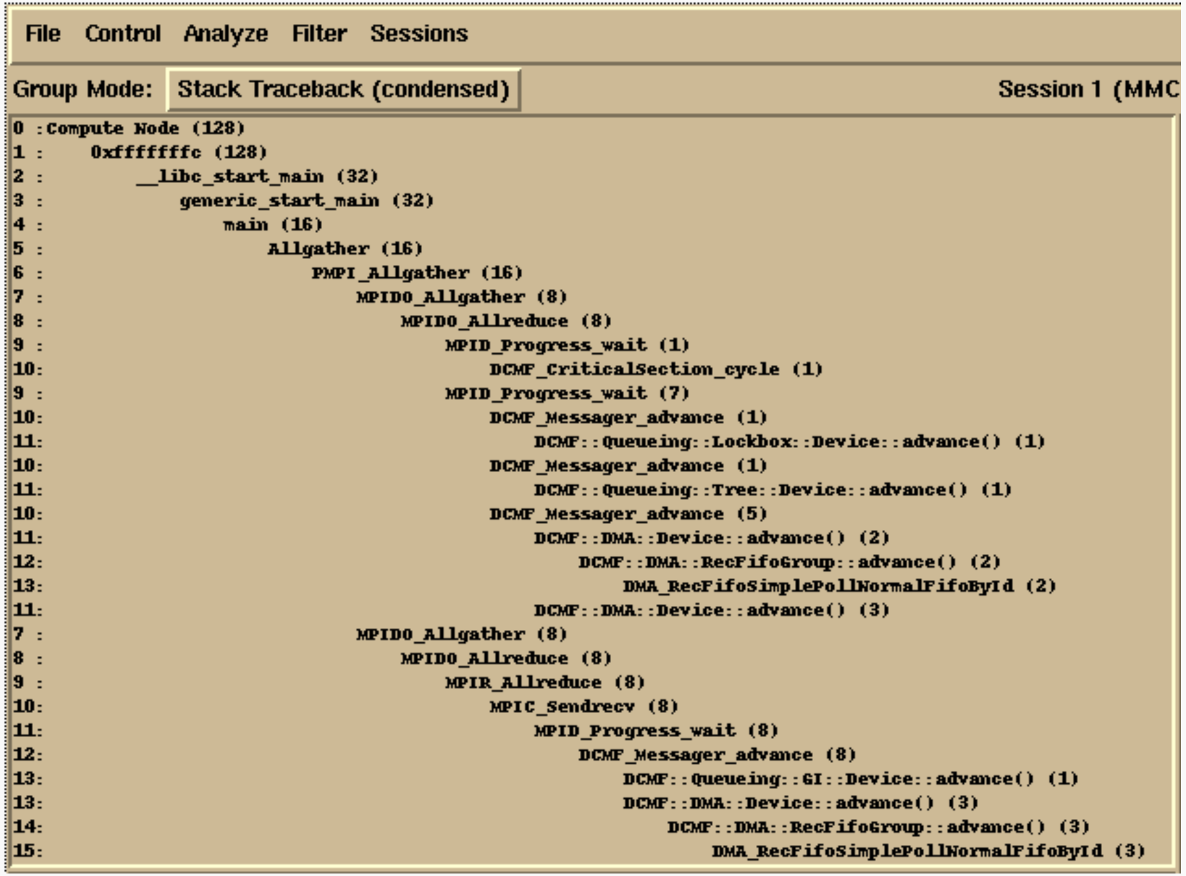
Scalability limit

- **Absolute maximum** 32K ranks. Practical limit lower.

Instructions:

- BG/Q Application Developer Redbook
  - http://www.redbooks.ibm.com/redpieces/abstracts/sg247948.html

coreprocessor window



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

```
0 :Compute Node (128)
1 :    0xfffffffc (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 and Intel compilers will link in ATP automatically

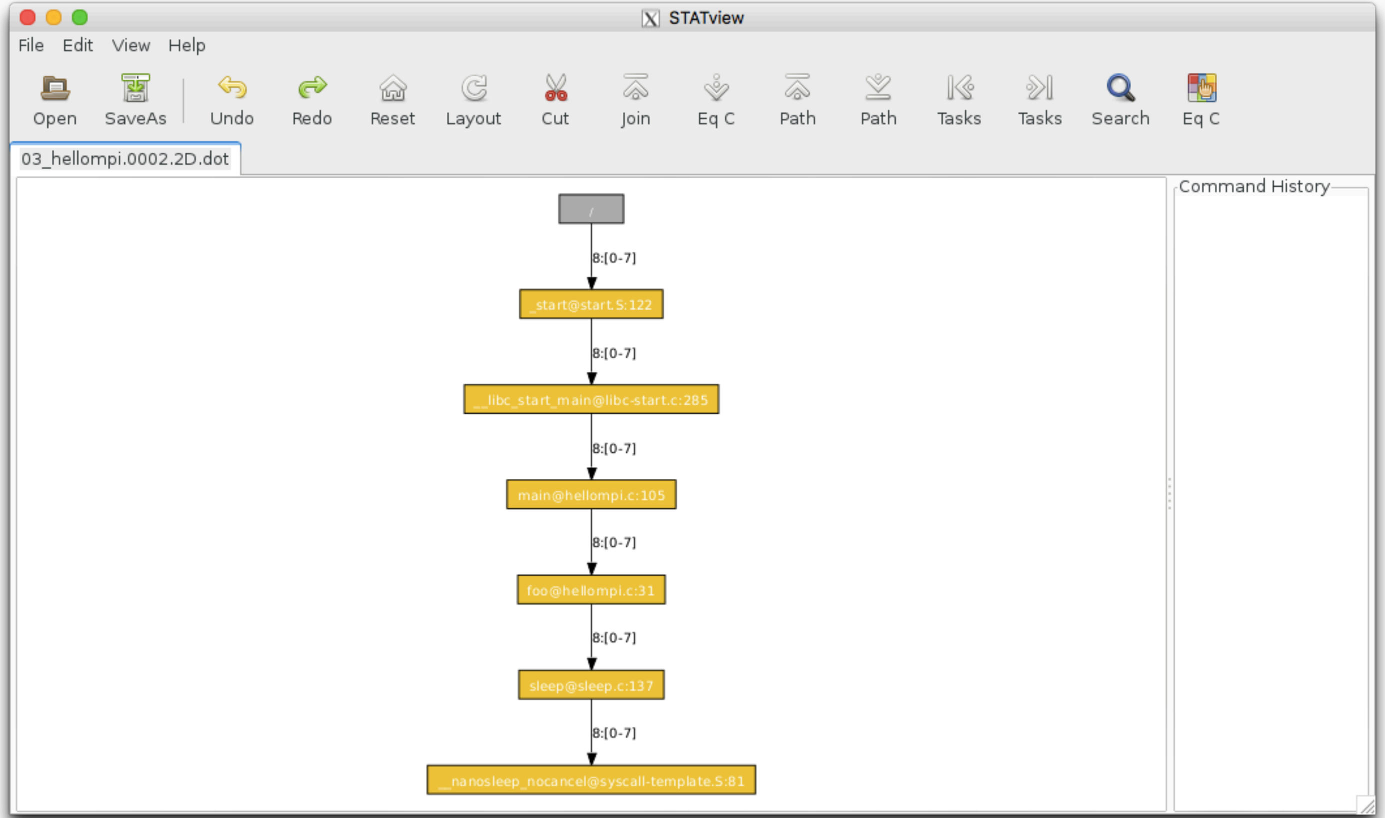
Set environment before running your app

– export ATP_ENABLED=1

– aprun ...

STAT-VIEW

module load stat



THETA: STAT

While program is running (e.g. deadlocked), you can generate a merged backtrace snapshot showing where your program is.

On the MOM node, invoke "stat-cl *pid*" where *pid* is the aprun pid

In job script (or interactive job shell)

- hostname   # identify the MOM node you are on
- module unload xalt   # xalt wraps aprun resulting in 2 processes named "aprun"
- aprun ...

During the run, ssh to the same MOM node

- ps –u *username*   # Determine pid of aprun
- module load stat
- DISPLAY="" stat-cl *pid*

Optional

- aprun ... &
- echo "aprun pid is $!"
- wait

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, Cooley (not supported on BG/Q)

Environment

– BG/Q: softenv key “+ddt”

– Theta: module load forge/18.0.2 (/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

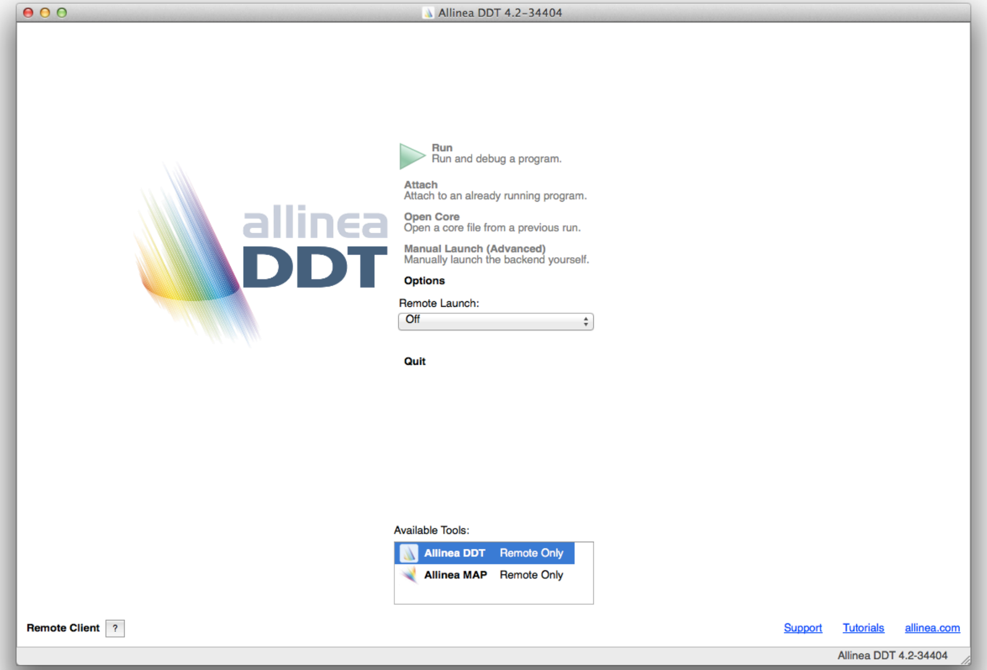
Run from login node

– Need X11 server on your laptop and ssh –X forwarding

– Run ddt and let it submit job through GUI

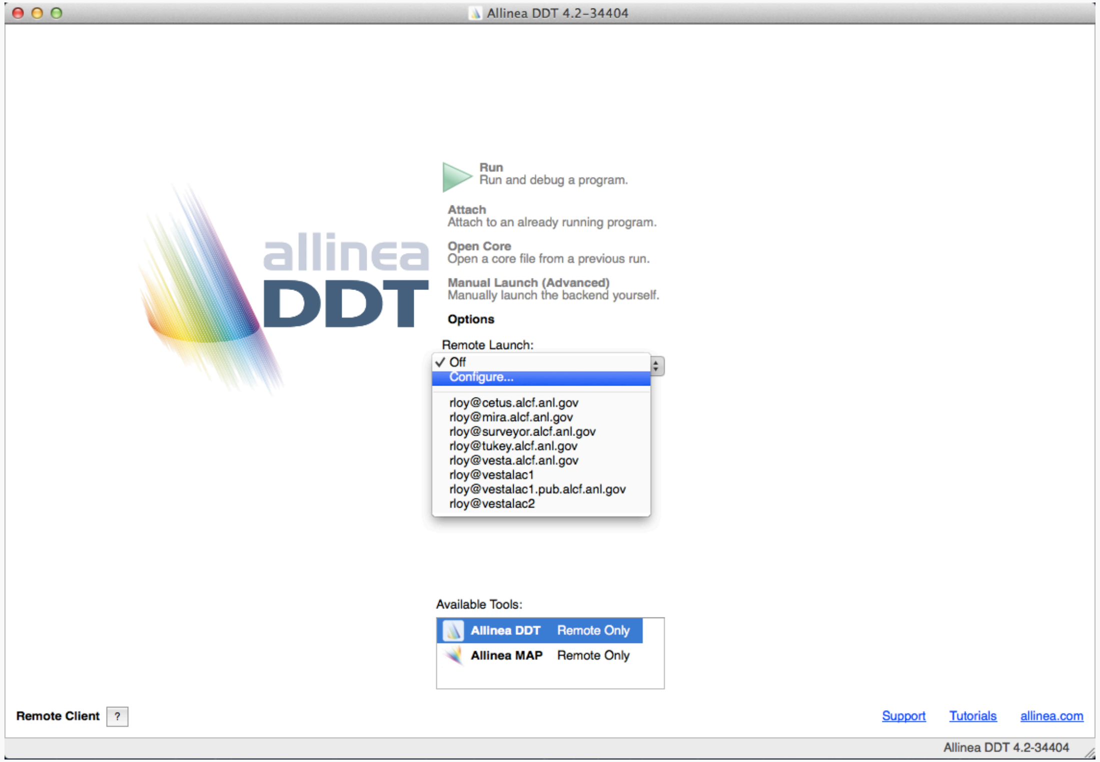
DDT Remote Client (0)

GUI looks just like the X11 Client



DDT Remote Client (1)

Select "configure" to add a new remote host


Allinea DDT 4.2-34404

Run
Run and debug a program.

Attach
Attach to an already running program.

Open Core
Open a core file from a previous run.

Manual Launch (Advanced)
Manually launch the backend yourself.

Options

Remote Launch:

✓ Off
Configure...

rloy@cetus.alcf.anl.gov
rloy@mira.alcf.anl.gov
rloy@surveyor.alcf.anl.gov
rloy@tukey.alcf.anl.gov
rloy@vesta.alcf.anl.gov
rloy@vestalac1
rloy@vestalac1.pub.alcf.anl.gov
rloy@vestalac2

Available Tools:

Allinea DDT	Remote Only
Allinea MAP	Remote Only

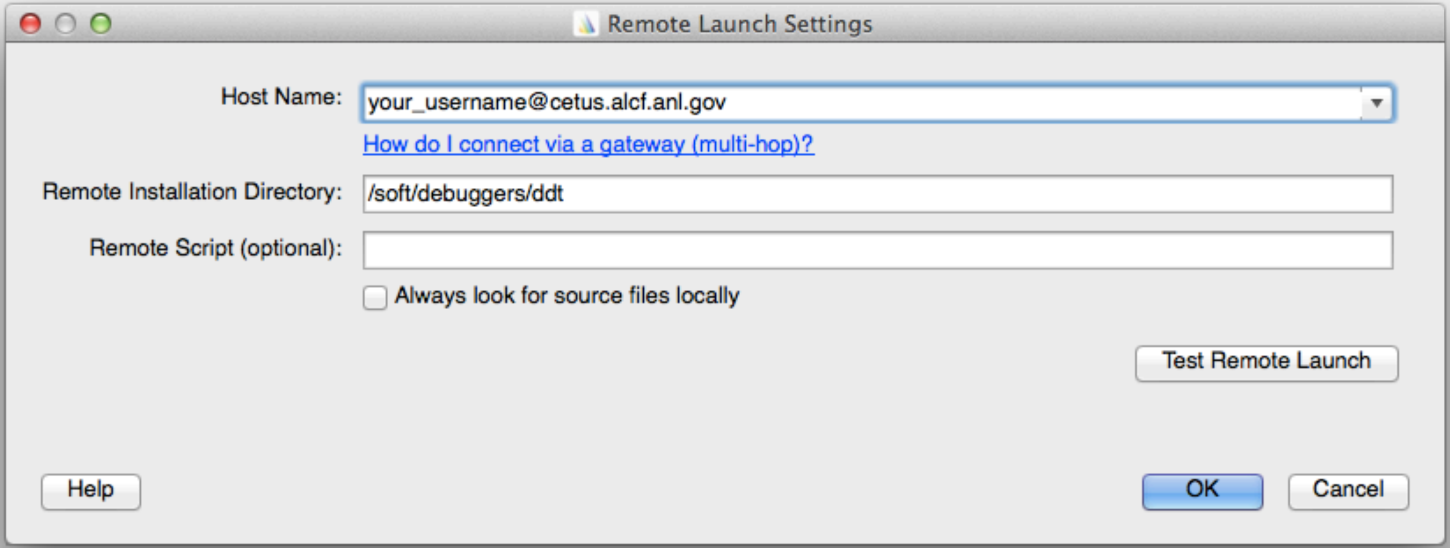
Remote Client ?

Support Tutorials allinea.com

Allinea DDT 4.2-34404

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


Remote Launch Settings

Host Name: your_username@cetus.alcf.anl.gov

How do I connect via a gateway (multi-hop)?

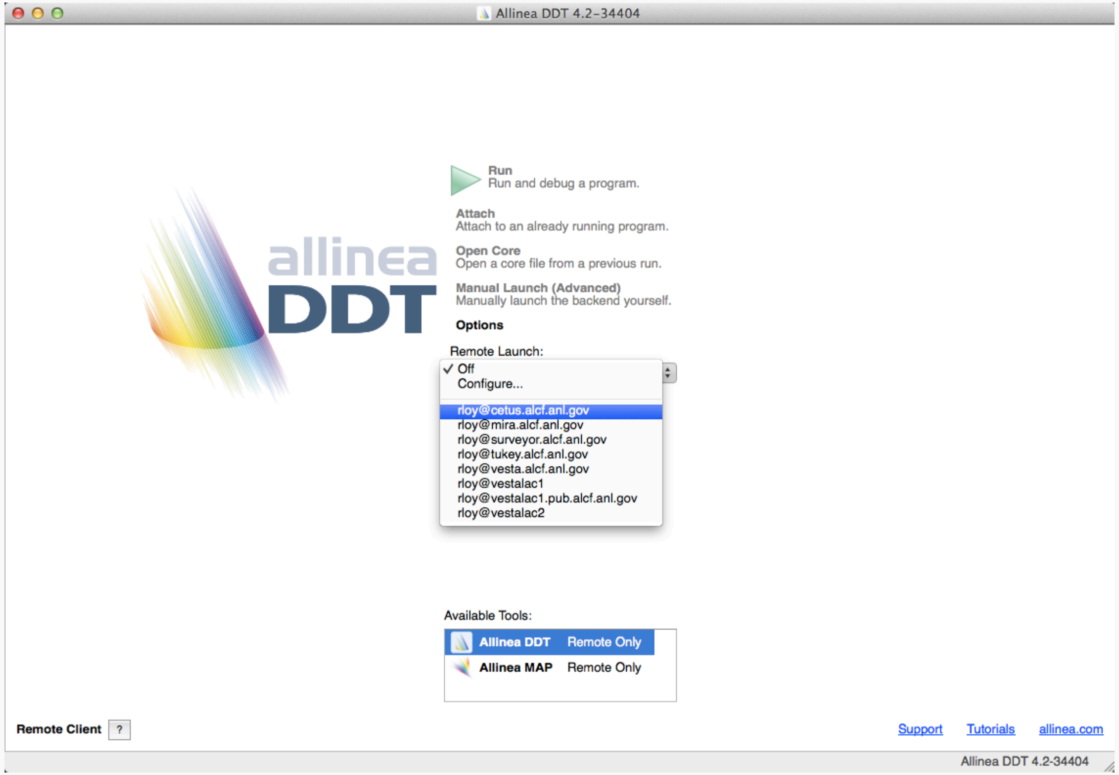
Remote Installation Directory: /soft/debuggers/ddt

Remote Script (optional):

[ ] Always look for source files locally

DDT Remote Client (3)

Now that it is defined, select remote machine



Allinea DDT 4.2-34404

Run
Run and debug a program.

Attach
Attach to an already running program.

Open Core
Open a core file from a previous run.

Manual Launch (Advanced)
Manually launch the backend yourself.

Options

Remote Launch:

✓ Off
Configure...
rloy@cetus.alcf.anl.gov
rloy@mira.alcf.anl.gov
rloy@surveyor.alcf.anl.gov
rloy@tukey.alcf.anl.gov
rloy@vesta.alcf.anl.gov
rloy@vestalac1
rloy@vestalac1.pub.alcf.anl.gov
rloy@vestalac2

Available Tools:

Allinea DDT	Remote Only
Allinea MAP	Remote Only

Remote Client ?

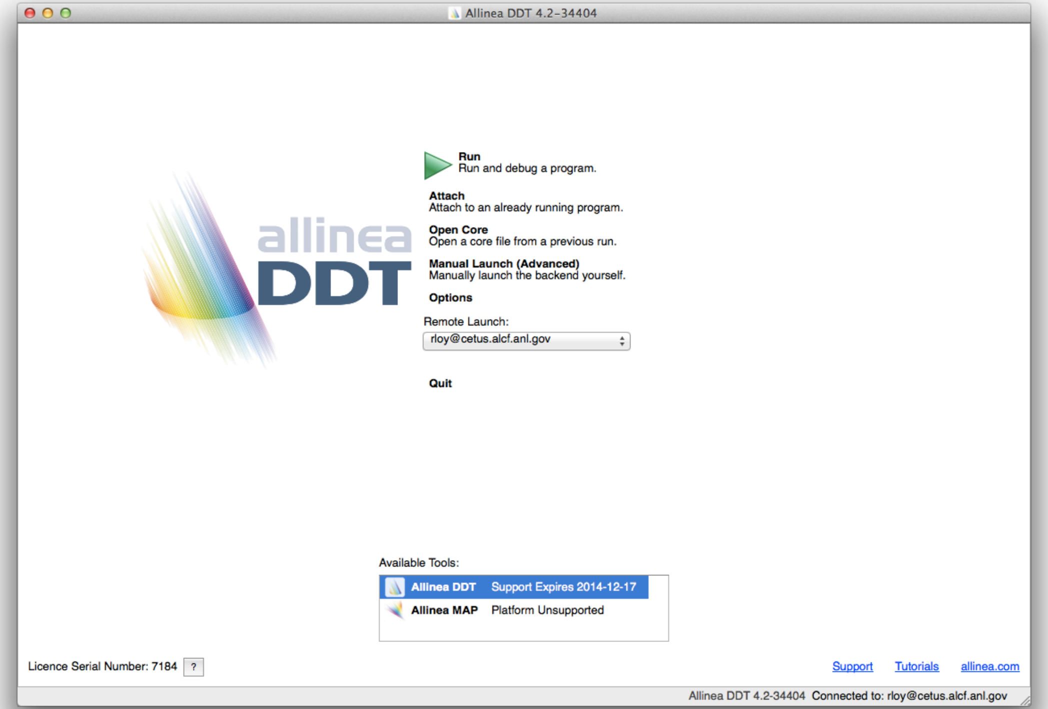
Support Tutorials allinea.com

Allinea DDT 4.2-34404

DDT (4)

Connected (note License info in lower left corner)

From this point, remote GUI works same as local



Run
Run and debug a program.

Attach
Attach to an already running program.

Open Core
Open a core file from a previous run.

Manual Launch (Advanced)
Manually launch the backend yourself.

Options

Remote Launch: rloy@cetus.alcf.anl.gov

Quit

Available Tools:

Allinea DDT	Support Expires 2014-12-17
Allinea MAP	Platform Unsupported

Licence Serial Number: 7184 ?

Support Tutorials allinea.com

Allinea DDT 4.2-34404 Connected to: rloy@cetus.alcf.anl.gov

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

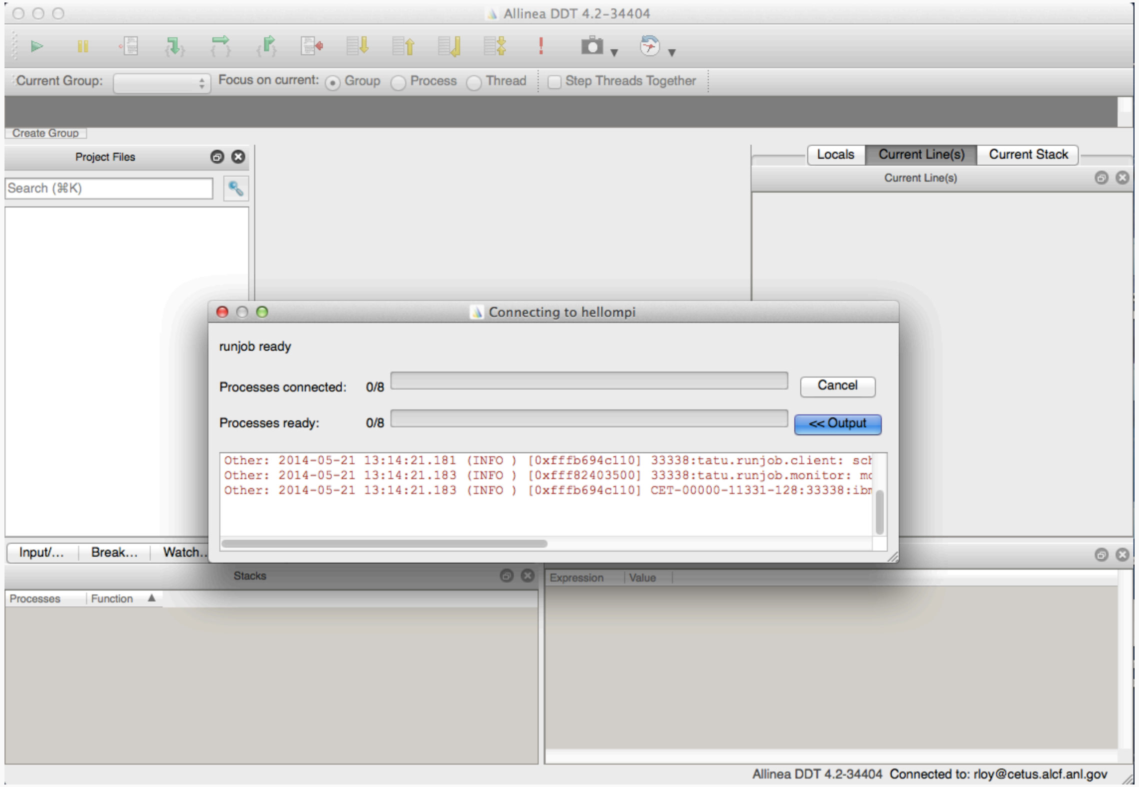
- Run an interactive job (qsub –I)
  - BG/Q: Instead of runjob
    - ddt --connect --mpiargs="--block $COBALT_PARTNAME" --processes=8 -procs-per-node=16 myprog.exe
  - Theta: Instead of aprun ... myprog.exe
    - /soft/debuggers/forge/bin/ddt --connect aprun ... myprog.exe

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

When job starts running, connection status will show



runjob ready

Processes connected: 0/8

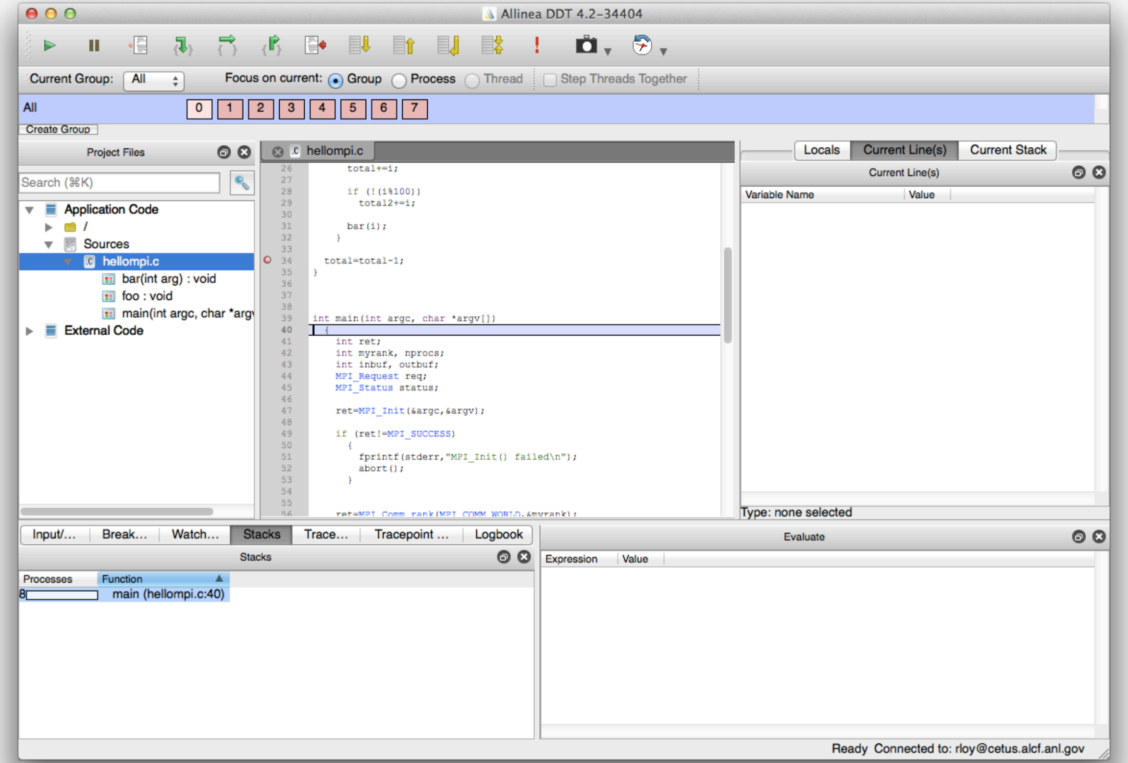
Processes ready: 0/8

```
Other: 2014-05-21 13:14:21.181 (INFO ) [0xfffb694c110] 33338:tatu.runjob.client: sch
Other: 2014-05-21 13:14:21.183 (INFO ) [0xfff82403500] 33338:tatu.runjob.monitor: mc
Other: 2014-05-21 13:14:21.183 (INFO ) [0xfffb694c110] CET-00000-11331-128:33338:ibn
```

Allinea DDT 4.2-34404 Connected to: rloy@cetus.alcf.anl.gov

DDT

Ready to debug!



Focus on current: [✓ Group] Process Thread

```
      total+=i;

      if (!(i%100))
        total2+=i;

      bar(i);
    }

  total=total-1;
}



int main(int argc, char *argv[])
  {
    int ret;
    int myrank, nprocs;
    int inbuf, outbuf;
    MPI_Request req;
    MPI_Status status;

    ret=MPI_Init(&argc,&argv);

    if (ret!=MPI_SUCCESS)
      {
        fprintf(stderr,"MPI_Init() failed\n");
        abort();
      }


    ret=MPI_Comm_rank(MPI_COMM_WORLD,&myrank);
```

Processes	Function
8	main (hellompi.c:40)

Ready Connected to: rloy@cetus.alcf.anl.gov

Questions

See also

– http://www.alcf.anl.gov/user-guides

– support@alcf.anl.gov