Debugging and Profiling Lab

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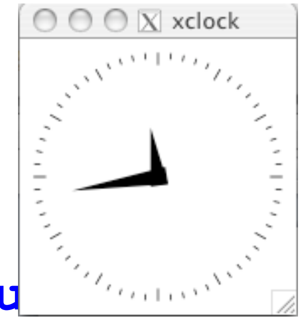
Setup



- Login to stampede or lonestar:
  - **`ssh -X username@lonestar.tacc.utexas.edu`**
- Make sure you can export graphics to your laptop screen:
  - **`xclock`**

  If you do not see a clock, contact an instructor
- Get the lab files:
  - **`https://bitbucket.org/VictorEijkhout/parallel-computing-book`**
  - **`booksources/projects-public/debug_lab`**

DEBUGGING LAB

Finding a deadlock with DDT

- In this example we will use **DDT** to debug a code that deadlocks.

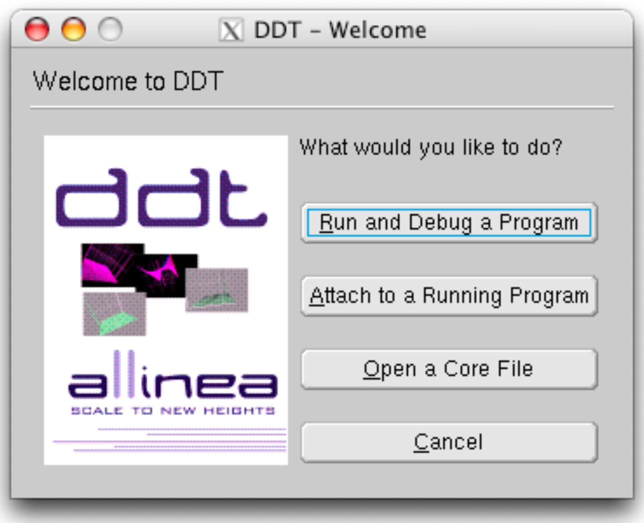
- Compile the deadlock example:
```
% cd debug_lab
% mpicc -g -O0 ./deadlock.c
```

- Load the DDT module:
```
% module load ddt
```

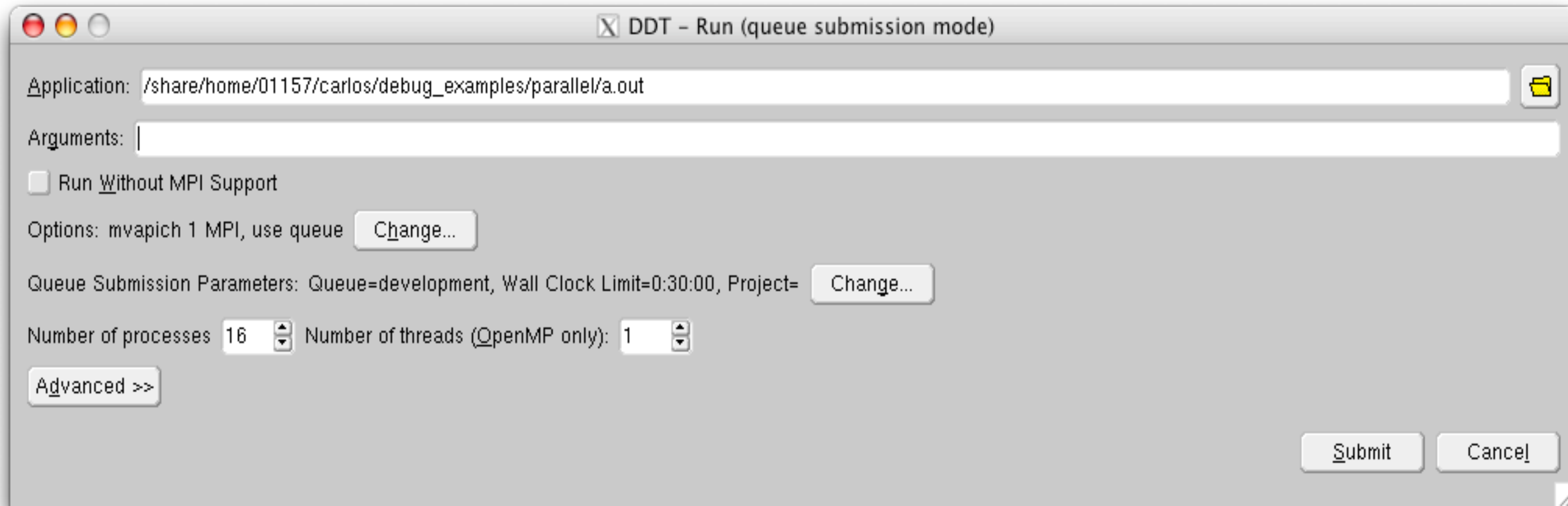
- Start up DDT:
```
% ddt ./a.out
```

Configure DDT: Welcome

When you see the welcome screen below click the button that says “Run and Debug a Program”.



Configure DDT: Job Submision

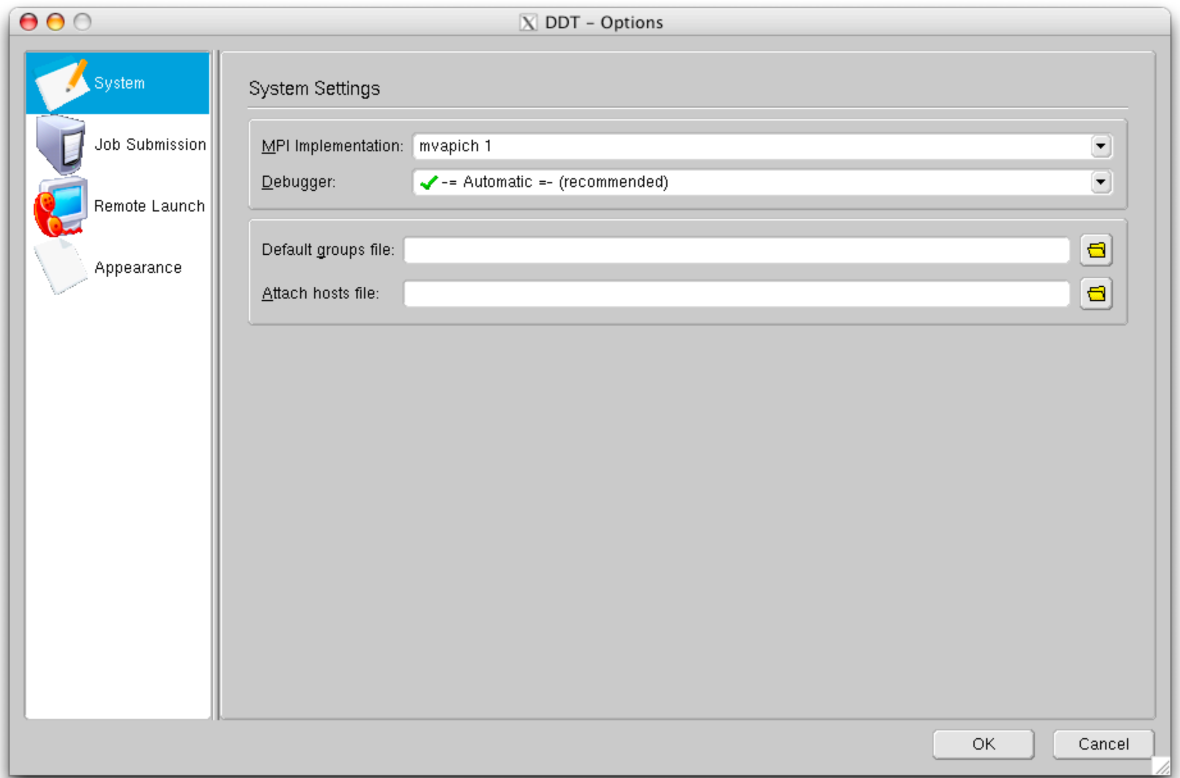


Don't click submit yet! We need to configure:

- General Options
- Queue Submission Parameters
- Processor and thread number
- Advanced Options

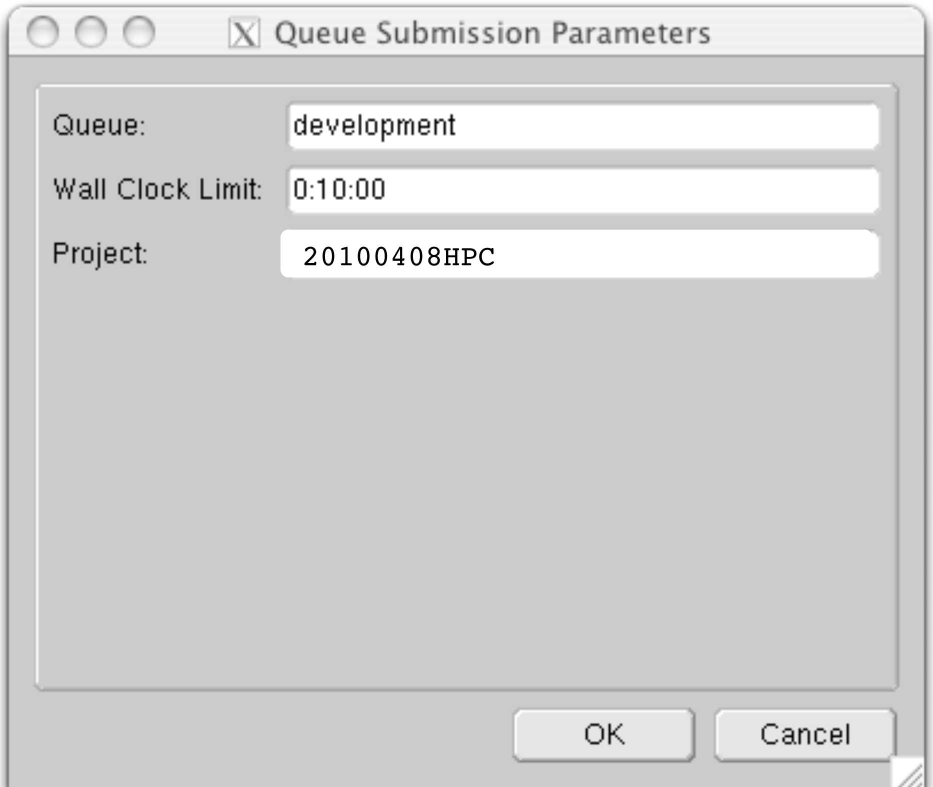
Click on Options -> Change

Configure DDT: Options



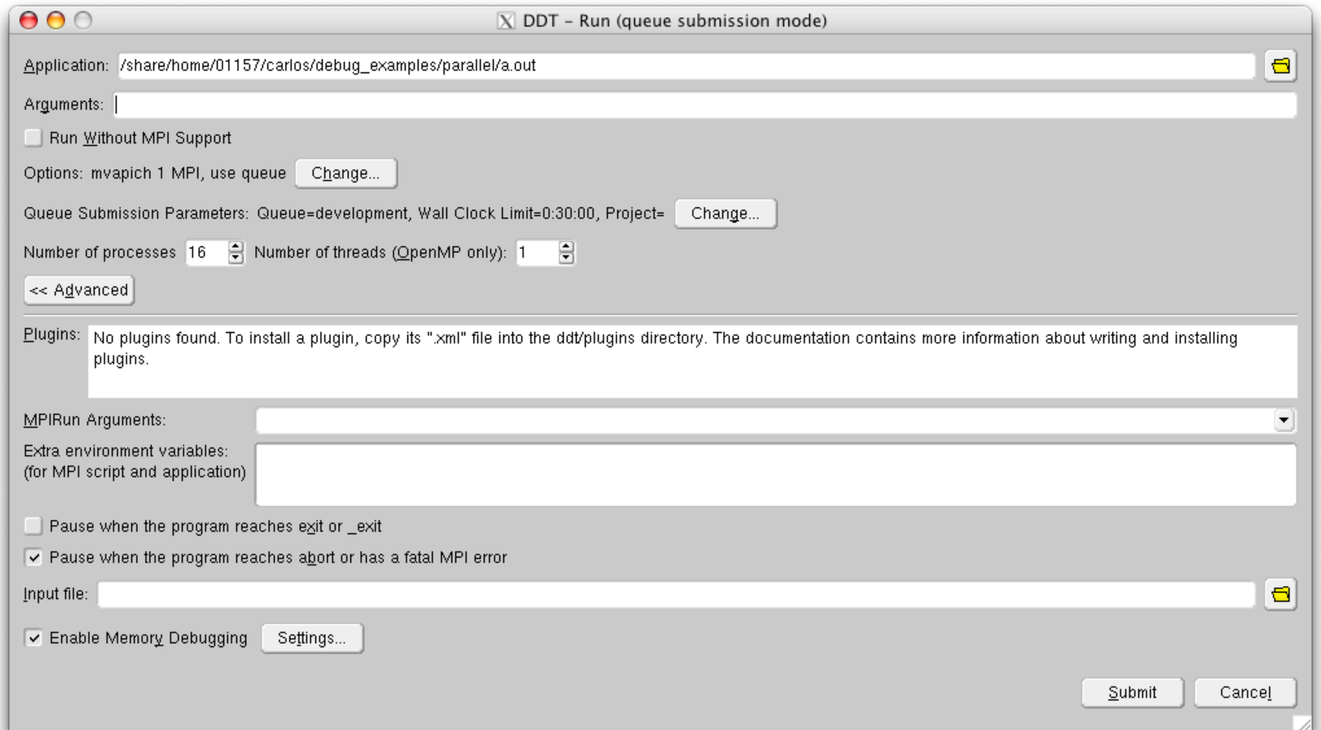
- Choose the correct version of MPI
  - mvapich 1
  - mvapich 2
  - openMPI
- Leave the default MPI (mvapich 2)
- Leave Debugger on the Automatic setting

Configure DDT: Queue Parameters



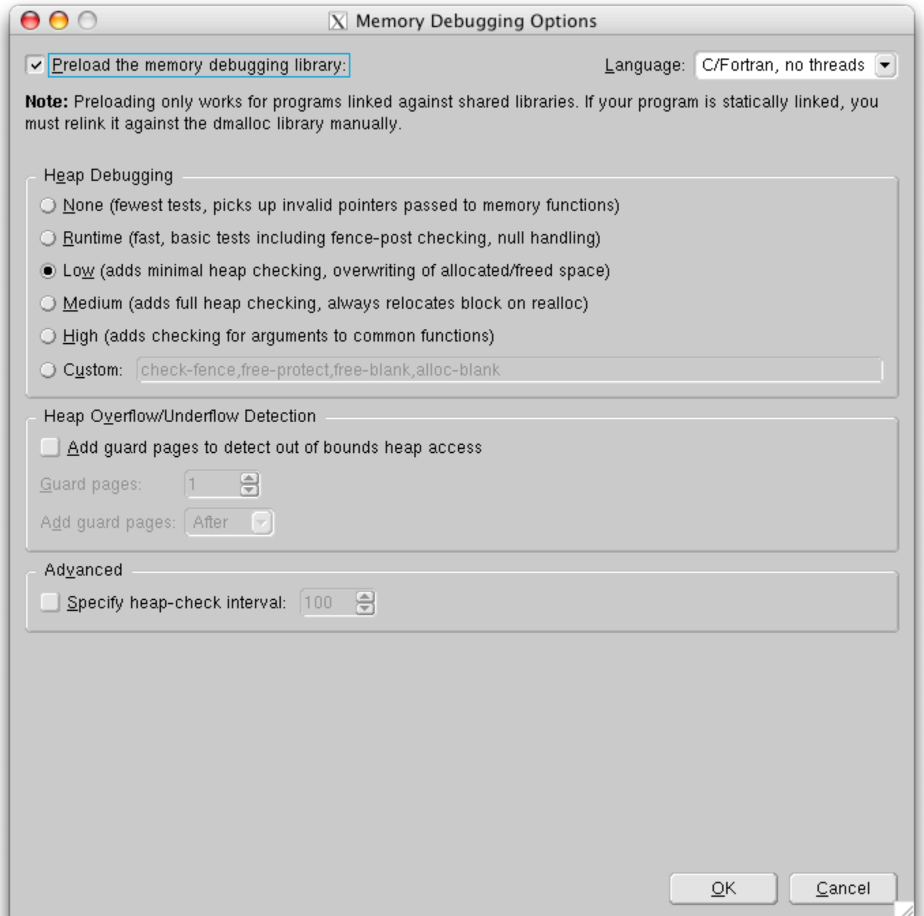
- Choose the “development” queue
- Set the Wall Clock Limit to 10 minutes (H:MM:SS)
- Set your project code - for this class use TACC-PCSE
- Click OK and double check that you have selected 12/16 CPUs / 1 thread in the main Job Submission window.

Configure DDT: Memory Checks



- Open the Advanced tab.
- Enable Memory Debugging (bottom left check box)
- Open the Memory Debug Settings

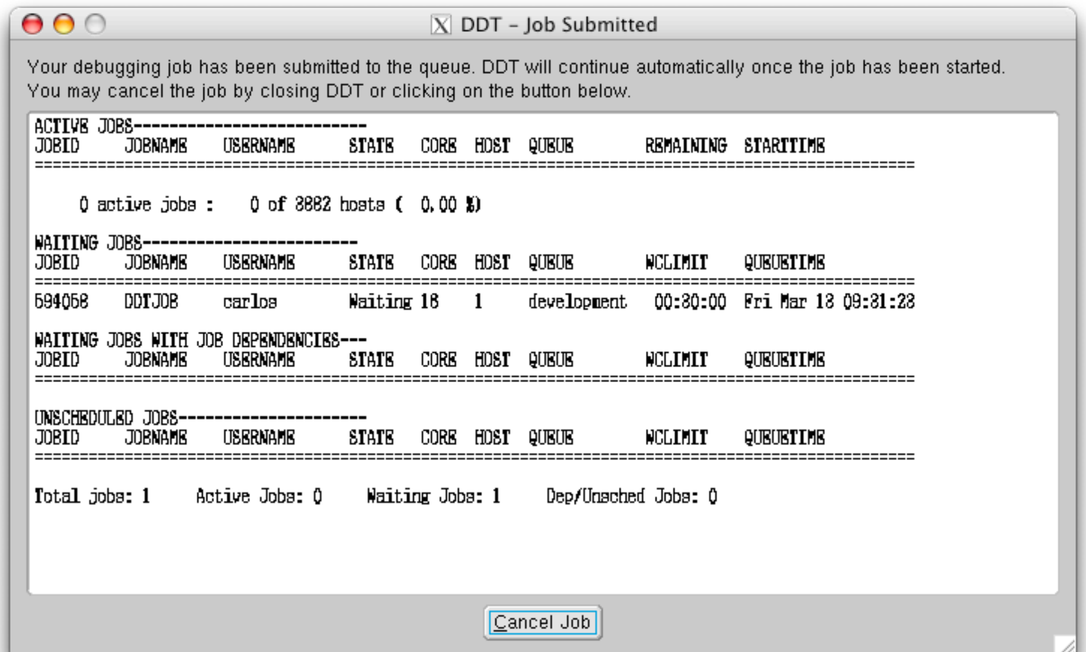
Configure DDT: Memory Options



- Change the Heap Debugging option from the default **Runtime** to **Low**
- Even the option None provides some memory checking
- Leave Heap and Advanced unchecked

DDT: Job Queuing

Add any necessary arguments to the program (none for the example)
Click the Submit button. A new window will open:

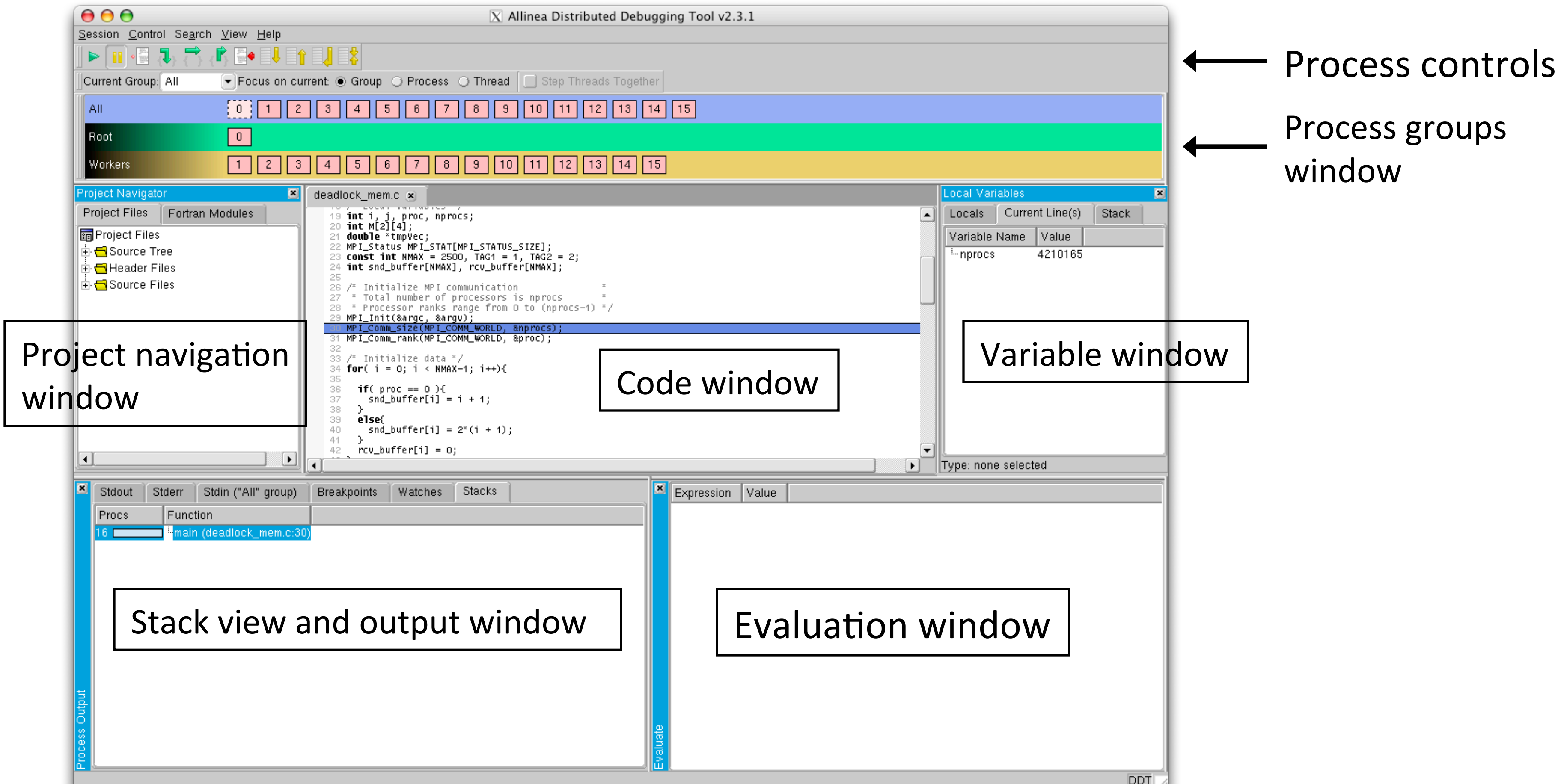


The job is submitted to the specified queue.

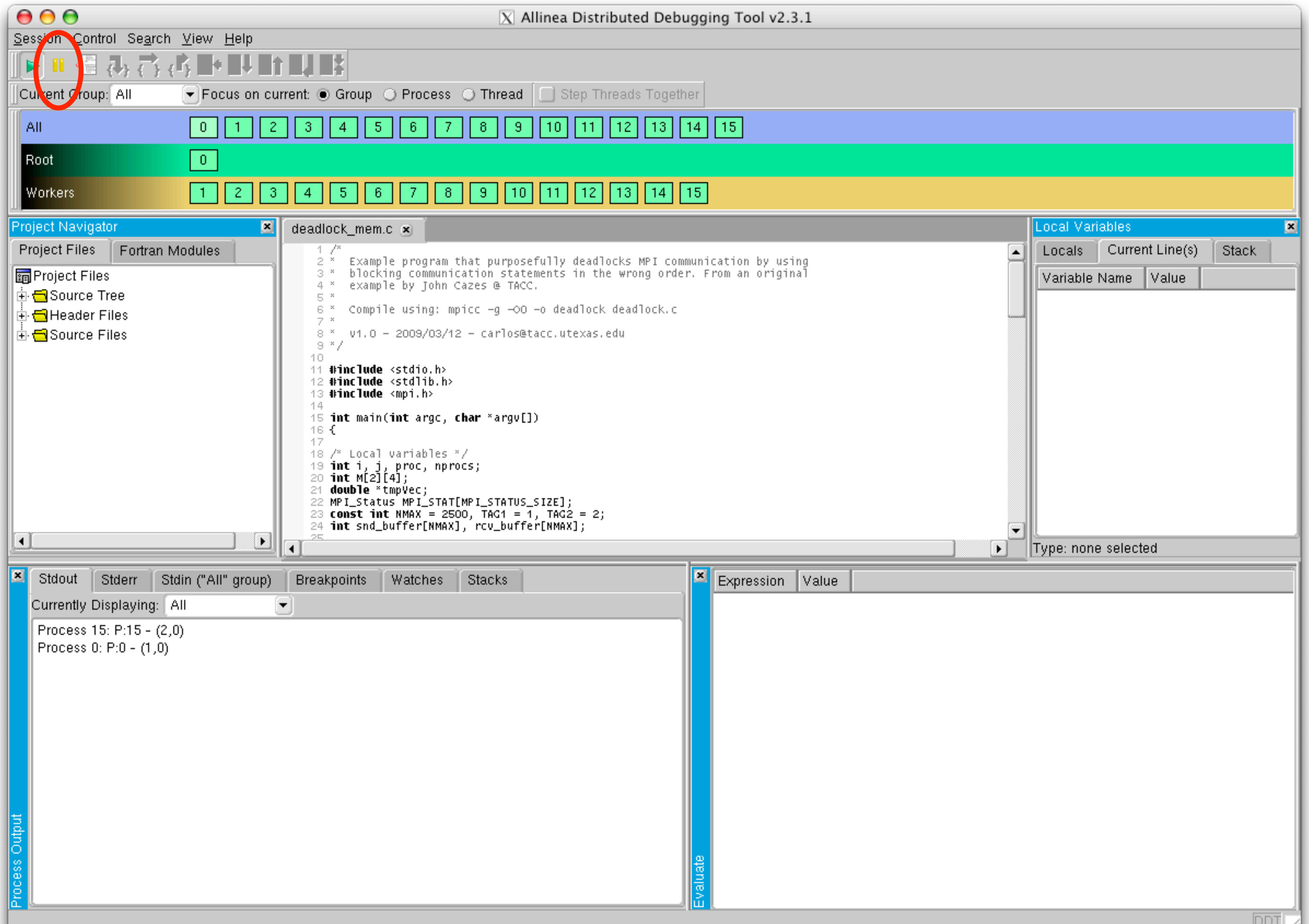
An automatically refreshing job status window appears.

The debug session will begin when the job starts.

DDT: The debug session



DDT: Program Hangs

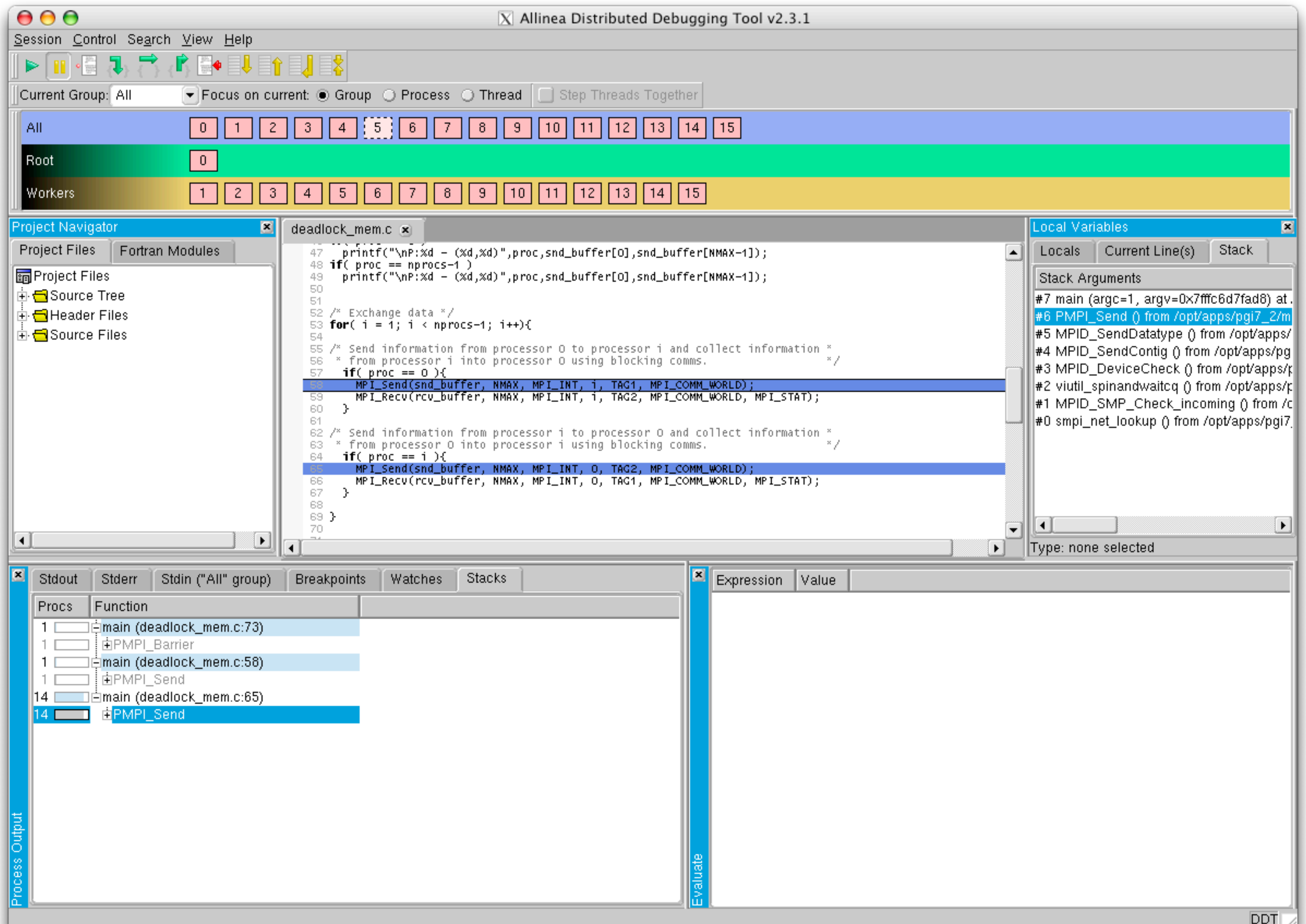


The output we expect does not appear in the Stdout window.

No active communication between procs.

Stop execution to analyze the program status (top left).

DDT: Stacks

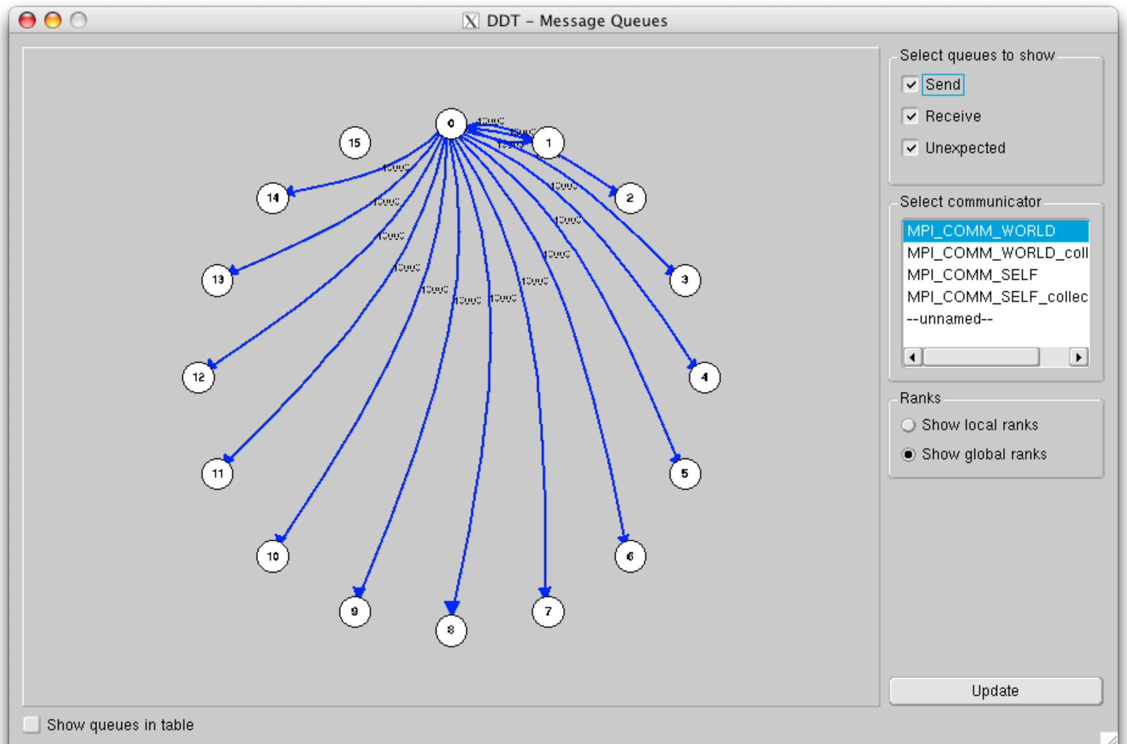


On the bottom left window select the Stacks view.

All processors seem to be stuck on a MPI_Send().

DDT: Message Queues

Go to View -> Message Queues



There are uncompleted Send messages everywhere!

You can double-check that all communications are in the "Unexpected queue" (select on top right)

This is characteristic of a deadlock.

Find the source of the deadlock in the code.

PARALLEL SCALABILITY LAB

Parallel Scalability: IPM

- In this example you will use **IPM** to evaluate the scalability of a matrix multiplication code.

- Load the IPM module:
  - **module load ipm**
  - **module list**

- Compile the matmult.c or matmult.f90 source with the **-g** flag:
  - `mpicc  -g./matmult.c`
  - `mpif90 -g./matmult.f90`

- Open the Sun Grid Engine script **ipm_job.sge** and make sure the following lines appear before the ibrun command is invoked:
  - `export LD_PRELOAD=$TACC_IPM_LIB/libipm.so`
  - `export IPM_REPORT=full`

Parallel Scalability: IPM

- Submit the job through the SGE queue system:
  - `qsub ./ipm_job.sge`

- When the job is done IPM will generate an xml file with a name like:
  - `username.1298314568.32191.0`

- Have a look at the basic text report by typing:
  - `ipm_parse username.1298314568.32191.0`

- You can also read the full text report:
  - `ipm_parse -full username.1298314568.32191.0`

Parallel Scalability: IPM

- Try transforming the output file to HTML:
  - `ipm_parse -html username.1298314568.32191.0`

- A new directory containing an **index.html** file will be created. You can copy this directory to your laptop and view the contents with any web browser.

- In your laptop, open the index.html file and explore the different performance data provided by IPM.

Parallel Scalability: mpiP

- In this example you will use **mpiP** to evaluate the scalability of a matrix multiplication code.
- Load the mpiP module:
  - **module load mpiP**
  - **module list**
- Compile the matmult.c or matmult.f90 source with the flags required to link in the mpiP library:
  - `mpicc  -g -L$TACC_MPIP_LIB -lmpiP -lbfd -liberty ./matmult.c`
  - `mpif90 -g -L$TACC_MPIP_LIB -lmpiP -lbfd -liberty ./matmult.f90`
- Set the environmental variables that control mpiP data collection behavior:
  - `setenv MPIP ‘-t 10 -k 2‘`

Parallel Scalability: mpiP

- Submit the job through the SGE queue system:
  - `qsub ./parallel_job.sge`
- The initial submission using 2 processing cores only (-pe 2way 16). Check execution and MPI times in the .mpiP file created.
- Change the submission script to use 4 cores (-pe 4way 16), 8 and 16, and build a table with the execution times.
- Does the execution time decrease linearly with the number of cores? Why?

SIZE	2 cores	4 cores	8 cores	16 cores
1000 x 1000				
2000 x 2000				

PROFILING LAB

Profiling with Tau: Compilation

- Load the papi and tau modules:
  - `module load papi`
  - `module load tau`
- Set the TAU_MAKEFILE environmental variable
  - `setenv TAU_MAKEFILE $TACC_TAU_LIB/Makefile.tau-multiplecounters-mpi-papi-pdt-pgi`
- If you have changed to the Intel compiler use instead:
  - `setenv TAU_MAKEFILE $TACC_TAU_LIB/Makefile.tau-icpc-multiplecounters-mpi-papi-pdt`
- Compile the matrix multiplication example using the Tau compiler wrappers:
  - `tau_cc.sh  matmult.c`
  - `tau_f90.sh matmult.f90`

Profiling with Tau: Job Script

- Open **tau_job.sge** and make sure the following lines - which define the hardware counters to measure- appear before the ibrun invocation:
  - `export COUNTER1=GET_TIME_OF_DAY`
  - `export COUNTER2=PAPI_FP_OPS`
  - `export COUNTER3=PAPI_L1_DCM`
- Submit the job through the batch queue system:
  - `qsub tau_job.sge`
- When the job completes execution you should have three new directories:
  - `MULTI__GET_TIME_OF_DAY`
  - `MULTI__PAPI_FP_OPS`
  - `MULTI__PAPI_L1_DCM`

Profiling with Tau: Analysis

- Analize the results:
  - `paraprof`
- Get used to the interface
  - Unstack the bars to get a clearer view
  - Open a window with the function names corresponding to each color
- Generate a derived metric that gives you the floating point operation to L1 data cache miss ratio
- Remember that you can copy these directories and analyze them in your own laptop as well