Assignment #4 and #5 – Hybrid Programming: MPI + Threads Assignment on Blue Gene/Q

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1 Assignment Description

For this **GROUP** assignment (up to 4 students), you are to develop a MPI-based C/C++ program which also uses Pthreads to perform the matrix multiplication application done in the last assignment. *Note, this is a "double" assignment intended to count double and make-up for not having an assignment on MPI_IO.*

Now, within each MPI task, you can spawn/create compute Pthreads that enable you to parallelize the computation of each matrix slice on a row-to-column basis. That is each thread within an MPI rank will perform the matrix multiplication for a whole row and column or multiple rows/ columns depending on the number of threads, etc.

Now, here is the key question: given a resource of 16 cores using the Blue Gene/Q, how best to allocate the right mix of MPI tasks and threads such that you get fastest execution time?

The possible configurations are:

- 64 MPI task with zero threads (you did this already).
- 32 MPI tasks each with 2 threads.
- 16 MPI tasks each with 4 threads.

- 8 MPI tasks with 8 threads each.
- 4 MPI tasks with 16 threads each.
- 2 MPI tasks with 32 threads each.
- 1 MPI task and 64 threads per node.

Note, the trade-off here is that you'll send fewer MPI messages which are memory copies as you reduce the MPI tasks and have more threads. With threads recall that within a given MPI task, all memory is shared so no memory copy is needed. So, what is the right mix of MPI tasks and Pthreads for the 64 node Blue Gene/Q configuration that yeilds the best performance.

Last, using the best performing MPI/thread configuration for the 1024x1024 matrix, what is the largest square matrix configuration you can run and still run finish within the 10 min job time limit? Can you do a 2048x2048 or even 8192x8192 ??

2 HAND-IN INSTRUCTIONS and GRADING CRITERIA

Leave your code and write-up in your **assignment4** subdirectory on your account on `kratos.cs.rpi.edu`. Note, we'll be using the following check list and point deductions when grading your assignments.

- **CORRECT SUBMISSION: 10 points.** Source code is inside your **assignment4** directory. The code compiles without errors.
- **CORRECT RESULT: 40 points.** The code produces the intended result.
- **ANALYSIS: 50 points**. Performance graph(s) are displayed with labels. An explanation of what the graphs represent is presented.
- **Other Point deductions:**
  - -5pts: no labels and no mention of labels.
  - -10pts: if only one graph presented.
  - -20pts: If no graphs exist.
  - -30pts: If no explanation (this is the main point of the project).
  - -3pts: If the scales on all of the graphs are the same.
  - -2pts: If the source code is not in a file, but in the pdf.