

University of Delaware  
Department of Electrical and Computer Engineering  
**ELEG652 - Principles of Parallel Architectures**  
Fall 2014  
*Prof. Guang R. Gao*

**Assignment 1**  
***Parallel Benchmarks***

Due on Friday Sept. 19<sup>th</sup>, 23:59

1. [10%] Search for and read the article that states Moore's Law:
  - a) Explain using your own words Moore's Law.
  - b) Explain and describe using charts how Moore's Law extends up to 2015
  
2. [30%] The TOP 500 is a widely recognized organization that lists the 500 supercomputers with the most performance in terms of absolute computational rate and computational efficiency (<http://www.top500.org/>):
  - a) What is the metric used to measure the performance?
  - b) How often the rank is updated?
  - c) Plot the performance of the fastest supercomputer vs time since 1993 and analyze the resulting chart.
  - d) Using the webpage's Statistics tool, generate plots over time for Architecture, Processor Generation, Cores per Socket, and Segment. According to the resulting graphs, where are supercomputers going according to these characteristics? Explain briefly.

The Green500 provides rankings of the most energy-efficient supercomputers in the world. They raise awareness about power consumption, promote alternative total cost of ownership performance metrics, and ensure that supercomputers only simulate climate change and not create it (<http://www.green500.org/>).

- e) Plot the efficiency of the top 5 supercomputers in the GREEN500 lists since November 2007, indicating their positions in the TOP500 on the same periods of time.
    - f) Plot the performance of the top 5 supercomputers in the TOP500 lists since November 2007, indicating their positions in the GREEN500 on the same periods of time.
    - g) What are your comments about the relationship between power consumption and performance on supercomputing?
  
3. [10%] Write a makefile for a hello program; you can use C or C++. The makefile should have the following rules:
  - a) An "all" rule that compiles the program and generates an executable named "hello".
  - b) A "run" rule that runs the program and redirects its output to a text file.
  - c) A "clean" rule that deletes the executable and the output files created by the previous rules.

Attach the makefile and source files to your homework.

4. [50%] Download the latest version of the Linpack benchmark from <http://www.netlib.org/benchmark/hpl/>:

a) Compile it:

- I. Change the permissions of the *make\_generic* file so that it can be executed.
- II. Execute *make\_generic*. It should create a *Makefile.UNKOWN*.
- III. In *Makefile.UNKOWN*, set the *TOPdir* variable to the directory where Linpack is.
- IV. Move *Makefile.UNKOWN* to the Linpack top directory.
- V. Make the benchmark using “make”. For this, you will need the MPI runtime and blas libraries, if you are working on your machine, you will have to install them, or if you are working on a machine that belongs to UD, please verify that they are available or notify the instructor if they are not available so that a solution can be found.
- VI. Run the tests as specified on the file *INSTALL* located in the top directory of Linpack.

b) Run Linpack: The file *TUNING* has information on how to modify the parameters of the benchmark:

- I. Find a range of problem sizes that will be meaningful to analyze the performance of a system as a function of problem size.
- II. Get a plot of performance as a function of problem size for the parameters previously found for two parallel systems: Your personal laptop or computer and any parallel machine that you have access to. Remember to include the machines’ specifications (processor, main memory, cache, frequency, etc.).
- III. Modify the parameters of the benchmark on each system to get as much performance (GFLOPS) as you can. With your report, provide a copy of the parameters you used and the results and please explain why you chose these parameters.

One of the EECIS machines that can be used is mlb:

- ssh [\\$NAME@mlb.acad.ece.udel.edu](mailto:$NAME@mlb.acad.ece.udel.edu)
- PATH=/usr/lib64/openmpi/bin/:\$PATH
- export LD\_LIBRARY\_PATH=/usr/lib64/openmpi/lib:/usr/lib64/:\$LD\_LIBRARY\_PATH

### **Submission:**

Submit a report with your answers using any IEEE Paper Template for the report. Remember to cite all your sources.

Include any source files you wrote (don’t include the Linpack source files or Latex files).

Send all the files as a single ZIP named *<YOUR\_NAME>-lab<NUMBER\_OF\_LAB>-eleg652-14f.zip* (e.g. *johndoe-lab1-eleg652-14f.zip*) to Jaime Arteaga [jaime@udel.edu](mailto:jaime@udel.edu) with subject *ELEG652-14F LAB1* before the specified deadline.