General Submission Guidelines

Files. C or C++ code files, and a PDF report file should be submitted on Gradescope.

Submission Code Structure. Make a different sub-directory for each question with the name question#. Every question sub-directory should be independently buildable. You can re-use files through symlinks or relative paths in your Makefile. A simple flat structure is preferred. For example,

```
hw1
|--- question1
     |--- main.cpp
     +--- Makefile
+--- question2
     |--- main.cpp
     |--- worker.cpp
     +--- Makefile
```

Development and Testing. You can develop and test your code on your local machines with gcc. However, before submitting your homework, make sure your programs compile and run on mc18.cs.purdue.edu.

Grading. mc18 machine will be used for testing your code with GNU compiler. Output your results to `stdout` using `printf()` or `cout`. If your code needs a different build process other than the one we will use as default, you will have to include a Makefile in the question sub-directory with the default target being .

Extensions. No late submissions will be accepted, unless students have prior extensions from the instructors.

Homework Specific Guidelines

Build Command. By default, we will compile all of your C/ C++ files in each question sub-directory with the command `g++ *.cpp -o ./run`. All of your source files in the question's sub-directory will be built into an executable that outputs to `stdout`. If you do not want to include a faulty source file for grading, remove it from the sub-directory; otherwise it will fail the default build command.

If you do not want to us to use the default build command, include a Makefile in each question's sub-directory. However, it is recommended to use the simplest flat-file structure for your code as shown in the general submission guidelines and thus focus on experiments and results, not software engineering. You will still need to create sub-directories for questions. You can use any language other than C/ C++ if you want, but then you are required to include a shell script `run.sh` which would compile and execute the program using the language interpreter/ compiler for grading. Run-time is not a concern for this homework. Correctness is. For example, if you want to use Python, include a shell script that would execute the program for us.

Execution. If your program uses command line arguments or some sort of input, you need to explain how to use your program in your report PDF. It is preferable if you avoid command line arguments, or automate the inputs to these arguments in a Makefile target or shell script included with your submission (e.g. you can include a shell script called `run.sh` that runs the program with different command line arguments).

Output. We will execute your programs on mc18. Make sure your code compiles, runs, and does not throw errors like segfaults on the test environment.

Define the following three networks:

(a) a ring network of p processors, except, each processor has connections to the four counterclockwise neighbors.

(b) a mesh network of p processors, except, each processor also has k connections to randomly selected processors (for some parameter k)

(c) a tree network of p processors (the processors are at leaves and some processors repeat at higher levels of the tree – recall the description in class, and also in your slides and lecture videos). The processors also select k random processors and connect to them.

Answer the following questions in this context using simulations – i.e., if you are asked to compute the diameter, generate a large number of random pairs of nodes in the network and select the maximum distance; if you are asked to compute the bisection width, select a large number of equipartitions and find the minimum number of edge crossings.

Question 1. *(25 points)*

Estimate the diameters of networks (a), (b), and (c) for different values of p with $k = 4, 16$. Plot the estimated values as a function of p and fit an estimated function for the diameter.

Question 2. *(25 points)*

Estimate the bisection width of networks (a), (b), and (c) for different values of p with $k = 4, 16$.

Question 3. *(25 points)*

Map network (a) to network (b) using an identity mapping i.e., processor i in network (a) maps to processor i in network (b) (assume that processors are numbered row major in the mesh). Estimate the dilation and congestion of these mappings.

Question 4. *(25 points)*

Assume that each link in network (a) operates at 500Mb/s and each link in network (b) operates at 200Mb/s. Assume cut-through routing of messages and ignore the per-hop time. For $p = 64$ and $k = 4$, would you prefer network (a) or (b)? Repeat the question for $p = 1024$.