Homework #2 (Due Sept. 26)

Attention: All homework should be submitted electronically via CourseWeb. Please compose your answers with Word or LaTeX, and submit a single pdf file with the name as "PittID_hw##.pdf". Photographs of handwritting will not be accepted (except for graphs).

1. Assume that a task, T, is composed of two subtasks, T_0 and T_1 . The execution time of subtask T_1 on one processor is t_1 but it can be further divided into any number of equal subtasks that can execute in parallel. The execution time of subtask T_0 on one processor is t_0 and it cannot be further subdivided. Moreover, T_0 has to finish execution before T_1 can start execution.

   (a) What is the maximum speedup and efficiency of executing T, assuming that you have P processors.

   (b) What is the maximum speedup and efficiency of executing T, assuming that you have unlimited number of processors.

   (c) Derive the maximum speedup S_{max} as a function of a, where $a = \frac{t_0}{(t_0+t_1)}$ is the serial proportion of the computation that cannot execute in parallel.

2. The X-Y deterministic routing algorithm given in the slides is for routing on an NxN 2-dimensional mesh without wrap-around links. Guided by this algorithm, give an X-Y-Z deterministic routing algorithm for an NxNxN 3-dimensional mesh with wrap-around links.

3. Consider the summation of the elements of a very large vector on a 2 GHz processor. Each cache line in that processor has 16 words (64 bytes) and the memory latency in the system is equivalent to 80 processor clock cycles.

   (a) Assume that the processor can execute one addition every clock cycle, what is the minimum memory bandwidth that will allow the processor to achieve peak performance in the case of perfect operand prefetching?

   (b) If no prefetching is performed, what is the maximum achievable performance (as a fraction of the peak performance) even if we assume an infinite memory bandwidth?

4. Suppose we have a traditional 2d mesh network of size NxN (also known as planar mesh).

   (a) Describe a mapping of an NxN 2d torus into this network with a load of 1. What is the minimal congestion and dilation?

   (b) Describe a mapping of a star with 9 nodes (including the central node) into this network with a load of 1. What is the minimal congestion and dilation?

5. What is the transmission time for a message of length 32 Bytes if the network delay is 500 nsec and bandwidth is 100 MB/sec?