Homework 1 (due Feb. 13)

1. Calculate (a) node degree, (b) diameter, (c) the number of links, and (d) bisection width for an 2*n* by 2*n extended mesh* (a regular 2-D mesh with four additional diagonal connections, see page 207 of textbook) and a *balanced hypercube* (see The Balanced Hypercube: A Cube-Based System for Fault-Tolerant Applications, IEEE TC, April 1997, where bisection is defined as partition between nodes and their backups, i.e., even and odd nodes in the paper).

2. Exercise 3 (on notes): Q1

3. Exercise 3 (on notes): Q2

4. Define the *matrix logical clock* and its update rule for internal and external events (send and receive). Repeat 3 using the matrix logical clock. Show all details.

5. Apply the *global snapshot algorithm* to the following case: There two cities A (with population of 50K) and B (with population of 30K). **Right after** each hour, 1K amount of people move from A to B. They reach B exactly after 10 hours. Also, **right before** each hour, 2K amount of people move from B to A. They reach A exactly after 6 hours. If population calculation starts **exactly at** 1 am at A. Find out the corresponding snapshot which includes local state and channel state information, assuming people moving between A and B also starts at 1 am. Show all details, including termination time at each process.

6. Extend the global snapshot algorithm for the case when channel A to B is not FIFO. Consider two solutions, one is to use a *counter* at each messenger (marker), assuming there is only one path collecting A to B. When there are multiple paths from A to B, the other solution is to put a stamp F or T one each person moving among cities. For example, F is for a person left before local state count (i.e., at A in this case) and F is for a person left after local city count. Show all details, including the termination condition.