Problem Set 7

Due: Thursday, May 15, 2008

Reading:

Chapters 17 and 21.
Lamport's "The Part-Time Parliament".
Dijkstra's paper on self-stabilization.
Chapter 2 of Dolev's book on self-stabilization.

Reading for next week:

Chapters 23-25.

Problems:

1. Exercise 17.10. Use Tempo for your algorithm.
2. In the first phase of the Paxos consensus algorithm, a participating process i performs a step whereby it abstains from an entire group of ballots at once; namely, the set B of all ballots whose identifiers are less than some particular proposed ballot identifier b, and that i has not already voted for. This set B may include ballots that have not yet been created.
   Suppose that, instead, process i simply abstained from all ballots in the set B that it knows have already been created. Does the algorithm still guarantee the agreement property? If so, give a convincing argument. If not, give a counterexample execution.
3. Consider the problem of establishing and maintaining a shortest-paths tree in a network with a distinguished root node i_0, and costs associated with the edges. The problem is similar to the one studied in Section 15.4 of the Lynch book, except that, now, we model the channels as registers; i.e., as Dolev does for his basic BFS spanning tree algorithm (see his Section 2.5). In this problem, we consider self-stabilizing algorithms to solve the shortest-paths problem.
   (a) Assume that the costs on the edges are fixed, and known by the processes at the endpoints, and that these costs do not get corrupted. Write code, either in Tempo-style or in Dolev's style, for a self-stabilizing algorithm that maintains a shortest-paths tree. Use of the Tempo front-end is not required. (That is, you can write in precondition-effect code without having to satisfy all Tempo syntax.)
   (b) Give a proof sketch that your algorithm works correctly; i.e., that it in fact stabilizes to a shortest-paths tree.
   (c) State and prove an upper bound on the stabilization time.
   (d) Describe how your algorithm (or a simple variation) can be used in a setting in which the costs on the edges change from time to time. State a theorem about the behavior of your algorithm in this setting. Be sure to state your assumptions clearly.
4. Exercise 24.14.