Problem Set 6, Part a

Due: Wednesday, May 17, 2006
Problem sets will be collected in class. Please hand in each problem on a separate page, with your name on it.

Reading

Middleware services	Malpani, Chen, Vaidya: Token circulation
	Chen, Welch: Self-stabilizing dynamic mutual exclusion
	Dolev, Schiller, Welch: Random walk for self-stabilizing group communication
Virtual objects	Dolev, Gilbert, et al.: GeoQuorums: implementing atomic memory in ad hoc networks
Compulsory protocols	Hatzis, Pentaris, et al.: Fundamental control algorithms in mobile networks
	Chatzigiannakis, et al.: Efficiency of distributed communication and control algorithms
	Chatzigiannakis, et al.: An efficient communication strategy for ad-hoc mobile networks
	Chatzigiannakis, et al.: An efficient routing protocol for hierarchical ad-hoc mobile networks

Reading for next week

Virtual nodes	Dolev, Gilbert, et al.: Virtual Mobile Nodes for Mobile Ad hoc Networks
	Dolev, Gilbert, et al.: Timed Virtual Stationary Automata
	Dolev, Lahiani, et al.: Self-stabilizing node location and routing
Data aggregation	Nath, Gibbons, et al.: Synopsis Diffusion for Robust Aggregation in Sensor Networks
	Shrivastava, Buragohain, et al.: New Aggregation Techniques for Sensor Networks
	Patt-Shamir: A note on efficient aggregate queries in sensor networks
	Angluin, Aspnes, et al.: Computation with mobile finite state sensors
	Angluin, Aspnes, et al.: Stably computable properties of network graphs

Problems

1. Malpani, Chen, and Vaidya give an example to demonstrate that their Least Recency token-circulation algorithm can generate exponential-length traversals in some graphs. They also show an exponential upper bound. However, in simulations, the LR algorithm seems to exhibit *linear* traversal lengths.
   (a) Describe some classes of graphs for which you can prove a linear upper bound on traversal length for LR.
   (b) Describe as large a class of graphs as you can for which you can prove a polynomial upper bound on traversal length.
2. We studied two self-stabilizing algorithms this week, one for mutual exclusion, and the other for group membership and multicast.
   (a) Describe informally the ideas that are used in these algorithms which are specifically for the purpose of achieving self-stabilization.
   (b) (Open question) Using similar ideas, can you design a good self-stabilizing algorithm for k-exclusion in mobile networks?
   (c) (Open question) What about a self-stabilizing leader election algorithm for mobile networks?

3. The GeoQuorums paper describes a way of implementing virtual objects based on a strong assumption about communication: nodes in the vicinity of a virtual object's location can communicate reliably among themselves, using totally-ordered broadcast. Real networks, however, typically do not satisfy this assumption.

   (a) Discuss possible ways of ensuring (or at least approximating) this assumption over a real wireless broadcast network.

   (b) Assuming that it is hard to guarantee totally-ordered reliable broadcast, discuss other possible ways you might try to implement reliable virtual objects over a real wireless broadcast network.

4. Explain (quantitatively, qualitatively, or both) the advantages of the Snake versus the Runners protocol as a basis for message routing in mobile ad hoc networks. You may assume that the network graph is a two-dimensional grid and that the sender S and receiver R are performing random walks on the network graph.