UNIVERSITY OF CALIFORNIA, DAVIS

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EEC173B/ECS152C **Winter 2006**

Homework 4

1. **(20%) Investigation of WLAN throughput.**
   a) (5%) Consider an IEEE 802.11b network with nominal 11Mbps data rate. Assume you are the only user in the system that runs a specific application. Consider two cases:
      - A single TCP session is used to transmit the application data,
      - Four simultaneous TCP sessions are used to transmit the application data.

      Which approach achieves better throughput, and why?

   b) (5%) How and why does I-TCP isolate problems on the wireless link? What are the main drawbacks of this solution?

   c) (10%) Imagine a TCP session over wireless where the congestion window is fixed at 5 packets (congestion control is turned off and no fast retransmits). The receiver has infinite buffer and it sends an acknowledgment as soon as it receives a packet, i.e., acknowledgments are not deferred. Similarly sender transmits a packet as soon as it is allowed to. Each packet carries 1000 bytes and the time to transmit a packet is 2 ms. Assume that transmission of ACK takes negligible time. Note that the retransmission timer for a packet is started after the last bit of the packet is sent.
      TCP's retransmission scheme is similar to go-back-N protocol, but it uses cumulative acknowledgements, i.e., when a receiver sends an ACK with sequence number N, it implies that all bytes from 0 to N-1 have been received correctly.
      i. (5%) Suppose two *data* segments with byte sequence numbers 3000 and 15000 are lost once during the transmission. How many segments get retransmitted under each of the following conditions?
         - Round trip time = 100 ms, Timeout = 101 ms
         - Round trip time = 100 ms, Timeout = 152 ms

      ii. (5%) Suppose *acknowledgments* corresponding to the above data segments are lost instead of the data segments. How many segments get retransmitted under the above conditions?
         - Round trip time = 100 ms, Timeout = 101 ms
         - Round trip time = 100 ms, Timeout = 152 ms

2. **(30%) Ad Hoc Networks: Routing**.
   Today's mainstream proposals for ad hoc network routing are DSR and AODV protocols.
   a) (5%) What are the differences between AODV and the standard distance vector algorithm?

b) (5%) Would it be efficient to make use of AODV or DSR protocols for routing in today's Internet? Explain why.

c) (10%) Assume that you need to implement a messaging service in a mobile ad hoc network in which each user is sending messages at a rate of 1 message/10 minutes. Would you use AODV or DSR for message routing? Explain why and how. If Yes, explain how. If No, what would be your other proposals?

d) (5%) Consider the ad hoc network presented in Figure 1 where S runs DSR to find a route to D. Which route is most likely to be returned by the routing protocol? What is the minimum number of nodes that need to fail (or be compromised) in order to partition the network?

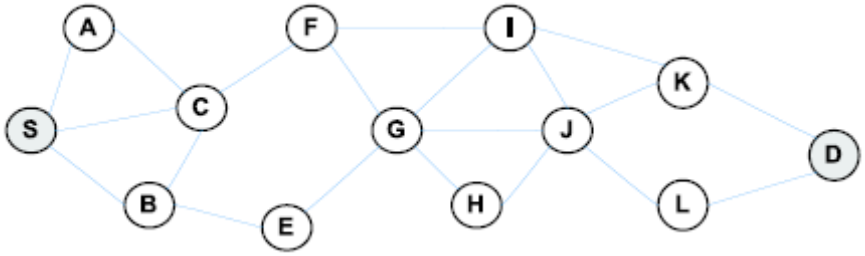

Figure 1

e) (5%) What are the benefits of location information for routing in ad hoc networks? Which problems arise?

3. **(20%) Ad Hoc Networks: Throughput**.
Explain how each of the following situations influences throughput.

a) (5%) The message sources and destinations are necessarily neighbors

b) (5%) The nodes send video traffic at a constant rate to randomly chosen destinations

c) (5%) The nodes communicate by occasionally sending messages (e.g., SMS) to randomly chosen destinations.

d) (5%) Nodes are mobile, but the application is not latency-sensitive.

4. (30%) Ad Hoc Networks: Security

a) (5%) Why is security important for routing? Describe one simple attack by which a single malicious node can disable all communication of its neighbors.

b) (9%) List at least 3 mechanisms of DSR that are prone to attacks. Explain why with examples of attacks.

c) (6%) Consider the scenario given in Figure 1. Describe two attacks that the attacker A (described in the previous question) can perform to disrupt the communication between S and D.

d) (5%) In order to encourage the intermediate nodes to forward its traffic, S pays an amount "to each node in the path. Describe an attack that allows the attacker A to earn more money than it deserves.

e) (5%) Consider an ad hoc network running a DSR protocol. If all nodes in the network share pairwise keys, and if all mutual communication between nodes is encrypted with the keys that they share (both packet headers and payload), does this make the network resistant to attacks? If yes, explain how. If no, describe the attacks that you believe can harm the network routing protocol operation.