Computer Science 72010

Parallel and Distributed Computation and Advanced Operating Systems

Midterm

1. Write an IOA that elects a leader in a network by choosing the process with the smallest id. The process automaton should be defined with parameters id and nbrs (for neighbors):
   automaton Leader(id:Int, nbrs:Set[Int])
   Each process is connected by two channels an incoming channel and an outgoing channel, to each of its neighbors.

2. Write an IOA representing a lossy (or duplicating, or reordering, or a combination) channel, i.e., one that loses (or duplicates, or reorders) messages. Make sure that it can lose (or duplicate, or reorder) *any* message (in any order).

3. Write a forwarding algortihm as an IOA that uses both the spanning-tree and the mac-address-table, and guarantees that each message gets to its destination and that no message cycles forever. You may assume that the process represents a switch and that it knows which ports are blocked. You should assume that the mac-address-table is empty initially, and entries are added when messages are received from hosts.

4. What 5 network layers are commonly used in the Internet, and what does each layer do?

5. Suppose that the attached diagram of a switched LAN represents a collection of subnets (clouds) connected by Cisco switches, (square boxes) whose MAC addresses are given by the numbers in the boxes. Assume that edges are bidirectional and have weight 1.

   a) Label the root switch; the root port on each switch; the designated ports; and the blocked ports.

   b) What would the mac-address-table entries be for swiches 1 and 2 after the following messages have been sent:
      From 4 to 3
      From 5 to 4
   Assume that the mac-address-tables are initially null.

   c) Suppose that messages can be forwarded while the spanning tree is being constructed (i.e., during the listening and learning phases), and that the learning bridge algorithm is run while the spanning tree algorithm is running. Describe a sequence of messages that will cause mac-address-table entries to be set in a way that some switch can never get a message to some other switch.

6. Consider a collection of networks connected by Cisco switches, running the spanning tree algorithm. Define a root path as a sequence of switches $s_1, s_2, ..., s_n$ such that the root

port of s_i is connected to s_{i+1}. (Note that s_{i+1} is closer to the root than s_i.) Let M be the switch with the smallest MAC address in a network. Assume that the switches operate in rounds, such that each switch sends a BPDU to each neighbor at every round. Prove by induction that after r rounds, if switch s is at distance r from M, that s has its root equal to M and there is a root path from s to M.

7. Construct counter-examples to the following statements:
    a. The Cisco spanning tree algorithm computes a minimum weight spanning tree.
    b. Using the learning bridge algorithm (without the spanning tree algorithm) guarantees that messages follow the shortest path from source to destination.
    c. The Route Information Protocol guarantees that no messages will be forwarded in cycles.
    d. The Open Shortest Path First protocol guarantees that no messages will be forwarded in cycles.

Switched LAN