Exam Distributed Algorithms

Free University Amsterdam, 26 May 2008, 8:45-11:30

(At this exam, you may use copies of the slides without handwritten comments. Answers can be given in English or Dutch. Use of textbook, handouts, laptop is not *allowed.)*

(The exercises in this exam sum up to 90 points; each student gets 10 points bonus.)

1. Give a transition system S and an assertion P such that P is a safety property but not an invariant of S. (5 pts)

2. Give a snapshot algorithm for undirected networks with non-FIFO channels, which uses (instead of piggybacking):

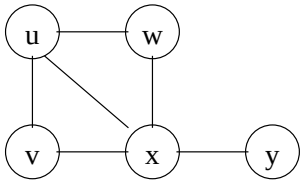
   (1) marker messages $\langle \mathbf{mkr}, n \rangle$, where n is the number of basic messages sent into a channel before the marker message;

   (2) acknowledgements; and

   (3) temporary (local) freezing of the basic computation.

   (15 pts)

3. Consider the following network:



   Apply Cidon's algorithm to traverse this network with a depth-first search, starting at u. Give one possible traversal, together with all messages that are being communicated during this traversal. Let at least once a process receive the token from one process, while earlier it forwarded the token to another process. (10 pts)

4. Consider the Gallager-Humblet-Spira algorithm for computing a minimal spanning tree in a graph in which all edges have a unique weight. Suppose that in a fragment (L, FN), a lowest-weight edge has just been reported at the core nodes, and at the same time a fragment (L', FN') with $L' < L$ connects to this fragment (so subsumes level L and name FN). How can we be sure that in the part (L', FN') there cannot be a lower-weight outgoing edge than the one just reported to the core nodes in (L, FN)? (15 pts)

5. Apply the Itai-Rodeh ring size algorithm to a unidirectional ring of size 3 in the following two cases:

   (a) Suppose that all three processes initially choose the same identity. Show that the algorithm computes ring size 2. (6 pts)

   (b) Suppose that only two processes initially choose the same identity. Show that the algorithm computes ring size 3. (9 pts)

6. Let $N = 7$ and $t = 2$, and let the general g and one lieutenant be Byzantine. Give a scenario of $Broadcast_g(7, 2)$ in which all correct lieutenants decide $major(\{\perp, 0, 0, 1, 1, 1\})$. (15 pts)

7. (a) Explain in detail why Fischer's mutual exclusion algorithm guarantees *mutual exclusion* and *no deadlock*. (9 pts)

   (b) Give an example to show that Fischer's mutual exclusion algorithm can give rise to *lockout* (6 pts)