Resit Distributed Algorithms

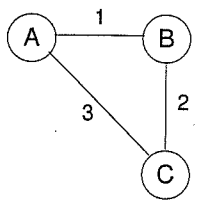
Free University Amsterdam, 27 August 2010, 8:45-11:30

(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. Suppose that in case of underflow in the weight-throwing termination detection algorithm, the process where the underflow occurs gives itself extra weight, and informs the initiator that there is additional weight in the system. Suppose that the process does not wait for an ack from the initiator. Give an example to show that then termination can be detected prematurely. (8 pts)

2. Perform the Gallager-Humblet-Spira algorithm on the following weighted graph:



   Give in full detail one possible execution to determine the minimal spanning tree. (12 pts)

3. Explain in detail why the worst-case message complexity of the Itai-Rodeh ring size algorithm is $O(N^3)$, where N is the size of the ring. (8 pts)

4. Consider a complete network G (i.e., there is a channel between each pair of different processes) of five processes. Let three processes hold the value 0, while two processes hold the value 1. Apply the Bracha-Toueg algorithm for 2-crash consensus to G. Give two scenarios: one scenario where all correct processes decide 0, and one scenario where all correct processes decide 1. (10 pts)

5. Suppose that in the ticket lock, *fetch-and-increment* is split into two atomic steps (a fetch and an increment). Give an example to show that then mutual exclusion is no longer guaranteed. (9 pts)

6. One part of the Arora-Gouda self-stabilizing leader election algorithm says that if $leader_i < leader_j$ where $j \in Neigh_i$ and $dist_j < K$, then

$$leader_i := leader_j \qquad father_i := j \qquad dist_i := dist_j + 1$$

Show that if the condition "and $dist_j < K$" were omitted here, then the algorithm might not stabilize. (12 pts)

7. Consider a processor with one periodic task $(0, 5, 3\frac{1}{3})$, and with the EDF scheduler.

   (a) Given a deferrable server with period $p_s = 3$, explain why the maximum execution time e_s is $\frac{5}{6}$. (6 pts)

   (b) Given a total bandwidth server, what is the maximum utilization rate $\tilde{u}_s$? (3 pts)

   (c) Suppose aperiodic jobs A_1, A_2 and A_3 arrive at times 3, 5 and 13, with execution times 1, 2 and 1, respectively. Explain in detail how these aperiodic jobs are executed in case of the deferrable server (with e_s maximal) and of the total bandwidth server (with $\tilde{u}_s$ maximal). (10 pts)

8. Show that indirect reference counting corresponds with Dijkstra-Scholten termination detection. (12 pts)