Exam Distributed Algorithms

Free University Amsterdam, 29 May 2006, 12:00-14:45

(At this exam, you may use the book Introduction to Distributed Algorithms by Gerard Tel, and copies of the handouts and the slides without handwritten comments.)

(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. (6 pts)

2. Consider an undirected network of two processes p and q (with non-FIFO channels). The Lai-Yang algorithm is applied to take a snapshot. p sends basic messages m_1 and m_2 to q. Then it takes a local snapshot of its state, and sends piggybacked basic messages $\langle m_3, true\rangle$ and $\langle m_4, true\rangle$ to q. Let $\langle m_3, true\rangle$ arrive at q first, so before m_1 and m_2. How is the snapshot completed? (10 pts)

3. Consider Rana's termination detection algorithm. Suppose that Lamport's logical clock would only take into account the basic messages of the algorithm for which termination is detected (so not the control messages of Rana's algorithm). Give an example to show that then Rana's algorithm could incorrectly detect termination. (12 pts)

4. Give an example to show that the Gallager-Humblet-Spira algorithm can get into a deadlock if different edges have the same weight. (9 pts)

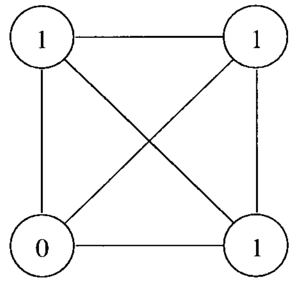
5. Consider a connected anonymous network G of with an arbitrary topology. The size of G is not known to its nodes.

   (a) Give a Monte Carlo algorithm for electing a leader in G. *(Advice: try to give a simple algorithm, with a low probability of terminating correctly.)* (9 pts)

   (b) Estimate the chance that your algorithm elects exactly one leader. (6 pts)

   (c) Would it be possible to give a Las Vegas algorithm for electing a leader in G? (Explain your answer.) (6 pts)

6. Apply the Bracha-Toueg algorithm for 1-Byzantine consensus to the network below.



Give an execution in which all correct processes decide 0. (12 pts)

7. Explain why the PetersonNP algorithm provides *no lockout.* (10 pts)

8. Consider a processor with one periodic task $(1, 3, 1)$. Suppose sporadic jobs S_1, S_2, S_3 and S_4 arrive at times 0, 1, 3 and 6, with execution times 1, 3, 1 and 2, and with deadlines 1, 12, 7 and 14, respectively. Which of them pass the acceptance test for sporadic jobs? (Explain your answer.) (10 pts)