# Resit Distributed Algorithms

Free University Amsterdam, 25 August 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.)

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

1. Give an example to show that the Chandy-Lamport snapshot algorithm fails if channels are not FIFO. (6 pts)

2. Suppose that Lamport's logical clock would only take into account basic messages (and not the control messages of Rana's algorithm). Give an example to show that then Rana's algorithm could incorrectly detect termination. (12 pts)

3. Consider the following bidirectional ring network:
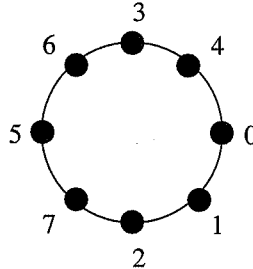
   Describe in detail how Franklin's algorithm elects a leader. (6 pts)

4. Consider a connected anonymous network G 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.)* (8 pts)

   (b) Determine the chance that your algorithm elects exactly one leader. (5 pts)

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

5. In the t-Byzantine robust synchronizer of Lamport and Melliar-Smith, a correct process p accepts a local clock value of another process q if it differs no more than δ from its own clock value, at the moment of synchronization. Explain why this synchronizer has precision $\frac{3t}{N}\delta$ (versus precision $\frac{2t}{N}\delta$ of the Mahaney-Schneider synchronizer). (15 pts)

6. Explain in detail why Raymond's algorithm for mutual exclusion provides *no starvation*. (10 pts)

7. Consider a processor with one (preemptive) periodic task $(0, 7, 5)$, and with the EDF scheduler.

   (a) What is the maximum utilization rate $\tilde{u}_s$ for the total bandwidth server? (3 pts)

   (b) Suppose (preemptive) aperiodic jobs A_1, A_2 and A_3 arrive at times 3, 8 and 13, with execution times 1, 2 and 1, respectively. Show how these aperiodic jobs are executed in case of the total bandwidth server with $\tilde{u}_s$ maximal. (Give the subsequent deadlines for the total bandwidth server.) (10 pts)

8. Let preemptive jobs J_1, J_2 and J_3 arrive at times 2, 1 and 0, respectively, with execution time 2. Let the priorities be $J_1 > J_2 > J_3$. Let J_1 and J_3 use resource R for their entire execution. The jobs are executed using priority ceiling.

   How are the three jobs executed if the arrival of J_1 is known from the start? And how are they executed if the arrival of J_1 is not known before time 2? (9 pts)