Exam Distributed Algorithms

Vrije Universiteit Amsterdam, 1 June 2022, 18:45-21:30

(You may use the textbook Distributed Algorithms: An Intuitive Approach. *Use of slides, notes, laptop, calculator is* not *allowed.)*

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

1. Suppose that in a run of the Bracha-Toueg deadlock detection algorithm, some NOTIFY, DONE, GRANT, or ACK message is in transit. Explain why the initiator of this run can then not yet have received a DONE from all neighbors to which it sent a NOTIFY. (14 pts)

2. Adapt the tree election algorithm so that the *initiator* with the largest ID becomes the leader. (9 pts)

3. Suppose that, at some point in the Gallager-Humblet-Spira minimum spanning tree algorithm, a process p receives a message $\langle \textbf{test}, fn, \ell \rangle$ through channel pq, where p's fragment has a different name than fn and at least level ℓ. Explain why p can send an **accept** message to q without fear that p and q are in the same fragment. (13 pts)

4. There is no Las Vegas algorithm for termination detection on anonymous networks.

   Why can the Shavit-Francez termination detection algorithm not be carried over to anonymous networks? That is, where do you run into problems? (12 pts)

5. Explain how a logical clock could be used to make the Walter-Welch-Vaidya mutual exclusion algorithm for MANETs operate correctly if edges are not FIFO. (14 pts)

6. Consider a distributed transaction with one coordinator and three cohorts. Give two computations of the two-phase commit protocol in which crashed processes must resume their execution before agreement can be reached on whether the transaction commits, one in which all participants vote **yes** and one in which one cohort votes **no**. Also show how these two computations could proceed in the case of the three-phase commit protocol. (14 pts)

7. Consider the Winternitz signature scheme with $k = 11$ and $\ell = 3$. Let 10010101100 be the hash of Alice's message to Bob. Explain how Alice signs her message, taking into account the checksum, and how Bob verifies this signature. (14 pts)