Exam Distributed Algorithms

VU University Amsterdam, 14 December 2015, 12:00-14:45

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

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

1. Adapt the Lai-Yang snapshot algorithm so that it supports multiple subsequent snapshots. (8 pts)

2. Consider the following computation of a basic algorithm on an undirected ring of size three, with processes p, q, and r, where p owns an object O. Initially, there is one O-pointer. First, p sends a message to q and r, both containing a created O-reference. Next, p deletes the O-pointer. At arrival of the message from p, q and r create an O-reference. Now q and r send a message to each other, both containing a duplicated O-reference, and delete their O-reference. At arrival of these messages, q and r create an O-reference again. Finally, q and r both delete their O-reference.

   Explain, for this particular computation, how it is detected by means of weighted reference counting that O has become garbage. (12 pts)

3. Give a computation of Frederickson's algorithm, on an undirected ring of size three and with $\ell = 2$, to show that a **forward** can be sent to a node that is not a child of the sender. (10 pts)

4. Argue why a congestion window may effectively double in size during every round trip time. (8 pts)

5. Give an example to show that the Gallager-Humblet-Spira minimal spanning tree algorithm could get into a deadlock if different channels were allowed to have the same weight. Argue that the deadlock in your example is avoided if a total order is imposed on channels with the same weight. (12 pts)

6. Argue that the fact that no Las Vegas algorithm exists for computing the size of an anonymous ring, implies that there is no Las Vegas algorithm for election in anonymous rings. (12 pts)

7. Let $N = 8$ and $k = 2$, and let three of the lieutenants be Byzantine. (The general g and the four other lieutenants are correct.) Give a computation of $Broadcast_g(8, 2)$ (and its subcalls) in which not all correct lieutenants decide for the same value. (16 pts)

8. Consider the Ricart-Agrawala mutual exclusion algorithm, with the Carvalho-Roucairol optimization. Suppose two processes p_0 and p_1 enter and exit their critical section, and concurrently want to become privileged again. Give two possible computations: one where p_1 doesn't ask permission from p_0 to enter its critical section, and one where p_0 and p_1 ask permission from each other before entering their critical section for the second time. (12 pts)