

Distribuerade system fk
Tentamen 2019-08-23

Dag, Tid, Sal: August 23rd 2019, 14:00-18:00, M building

Kursansvarig: Philippos Tsigas (Tel: 772 5409)

Hjälpmedel: Inga

Totalt Poängtal: 61

Betygsgränser:

CTH: 3:a 30 p, 4:a 38 p, 5:a 48 p

GU: Godkänd 30p, Väl godkänd 48 p

Instructions

- Please answer in English, if possible.
If you have very big difficulty with that, though, you may answer in Swedish.
- **Do not forget to write your personal number and if you are a GU or CTH student and at which “linje”.**
- Please start answering each assignment on a new page; number the pages and use only one side of each sheet of paper.
- Please write in a tidy manner and explain (briefly) your answers.
- Students must **not** write their personal number on the answer sheets since the exam is anonymous; they shall write that **only** on the name slip area that they will seal.

LYCKA TILL !!!!

1. (5 points) First describe Gifford's quorum consensus method for replication. Does a quorum system exist, which still works although all nodes of a specific quorum fail? Give an example or prove its nonexistence.
2. (4 points) Is Total Order Broadcast (TOB) equivalent to Consensus? If no, explain why not. If yes, explain (with pseudo code/high level description) how the two are equivalent, and how can one be implemented using the other.
3. (5 points) In the following, we consider a library as a special kind of a storage system. Let's consider the following scenario: Moa has borrowed a book on distributed systems a while ago. Now she returns the book at the library's front desk. Afterwards, she wants to borrow another book about motivating students drinking coffee. Therefore, she checks the library's index. Thereby, she notices that the book she has just returned is still assigned to her and not yet available. Afterwards she decides to buy some coffee for the next exercise lesson at the library's cafeteria, and then rechecks the index. Now the book about distributed systems is listed again.
 1. Which of the consistencies listed below are violated assuming there were no other clients in the library except Moa?
 2. Which of the consistencies listed below are (for sure) violated when above assumption does not hold (i.e. other clients might have borrowed and returned an arbitrary number of books while Moa was in the library)?

Consistencies to consider:

- Linearizability
- Sequential Consistency

4. (13 points) A connected bidirectional asynchronous network of n processes with identities has diameter D and may contain zero or more "evil" processes. Fortunately, the evil processes, if they exist, are not Byzantine, and will correctly execute any code we provide for them. Suppose that all processes wake up at time 0 and start whatever protocol we have given them. Suppose that each process initially knows whether it is evil, and knows the identities of all of its neighbors. However, the processes do not know the number of processes n or the diameter of the network D . Give a protocol that allows every process to correctly return the number of "evil" processes. Your protocol should only return a value once for each process (no converging to the correct answer after an initial wrong guess). Discuss and prove correctness and the time complexity of your algorithm.

Clarification: You get 10 points for a correct answer and 3 extra points if your algorithm terminates in $O(D)$ time.

5. (14 points) Describe and provide pseudo-code of a general resource allocation algorithms for distributed systems. Processes communicate via point-to-point message passing communication. No failures are considered. Discuss and provide a correctness proof of your algorithm together with its time complexity.

Clarification: You get 10 points for a correct answer and 4 extra points if the complexity of your algorithm is polynomial on the maximum number of conflicts per resource.

6. (10 points) Which type of faults are called Byzantine faults? Prove that it is impossible to reach agreement in a system with three processes if one of them is Byzantine faulty. How can the above proof be generalised for a system with n processes?
7. (10 points) Each statement is either true or false. A correct answer gives 1 point, a wrong answer gives -1 point, no answer gives 0 points. Overall you cannot get less than 0 points for this question.
1. There exists a symmetric leader election algorithm.
A. True B. False
 2. There exist a symmetric solution for the resource allocation problem.
A. True B. False
 3. A solution to the consensus problem can solve the mutual exclusion problem.
A. True B. False
 4. Causal consistency implies Sequential Consistency.
A. True B. False
 5. Linearizability implies Causal Consistency.
A. True B. False
 6. Linearizability implies Sequential Consistency.
A. True B. False
 7. In an asynchronous system, where only one processor might crash, consensus is solvable.
A. True B. False
 8. The higher the quorum of an operation the higher the availability of this operation.
A. True B. False
 9. The 3 Phase Commit protocol was introduced to improve the latency of the 2 Phase Commit protocol in executions where no faults take place.
A. True B. False
 10. 3PC was introduced to handle undetected message losses.
A. True B. False