

# Exam in Distributed Systems

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## Cover Sheet

This sheet should be handed in together with the exam.

Each problem must be solved on a separate sheet. Write your name on each sheet. Indicate below which questions you have answered.

Problem no.	Solution provided	Max	Your points
1		11	
2		8	
3		6	
4		8	
5		4	
6		7	
7		8	
8		6	
Total:		48/61	

Name : .....

Pers.no. : .....

## **Exam Rubric**

A mark of 50% is required for a pass, a 4 and 5 are distributed evenly. 85% is required for a VG. Answer can be in English or Swedish.

Each full answer should be started on a separate sheet. Please write your name and personal number on each sheet.

Students taking from F4Sy that is students on the 3 point version of the course only do questions 1-6.

I will not be able to come to the exam. If you are unsure about how to answer a question. Make some reasonable assumptions, state your assumptions and answer the exam.

The exam will be not be marked until earliest April 5th. (You have been warned).

## **Hjälpmedel:**

Pen, pencil, rular, rubber (eraser for people from the Antipodes) calculator.

## **General Comments**

I like examples and pictures. If you give interesting examples and draw useful pictures to illustrate any points that make. If you do all this you are more likely to get full points for the question.

Always show your workings when ever you do a calculation. If you do not show your workings then even if the answer is correct you will get 0 points.

## 1. General Questions on Distributed Systems

- (a) What problems to networks cause for synchronisation in a distributed system? **(2 points)**
- (b) Explain why it might be a problem to detect failure in a distributed system. **(1 points)**
- (c) Give two examples of where replication could be used in a distributed system, explain in each case why replication is a good thing. **(4 points)**
- (d) What is middleware in a distributed system and why is it used? **(2 points)**
- (e) Explain the different types of transparency that are desirable in a distributed system. **(2 points)**

## 2. Communication

- (a) Explain, with examples, the client server model. **(2 points)**
- (b) What are Client and Server Stubs and how are they used in remote procedure calls? Explain in detail how a remote procedure call is executed. **(4 points)**
- (c) When calling a remote procedure or method where a reference parameter is passed, what problems have to be solved and how are they solved? **(2 points)**

## 3. Clock Synchronisation

- (a) What is a leap second and why is it used? **(1 points)**
- (b) Explain Cristian's method for synchronizing clocks. **(2 points)**
- (c) Suppose that you have two clocks both with drift  $\rho = 10^{-4} \text{seconds/seconds}$ . Suppose that you want the clocks synchronised (show the same time with a difference of at most 0.5 seconds) within 0.5 of a second. How often should the clocks be resynchronised to achieve this? **(3 points)** (Obs. Show your workings, no workings no points for a correct or incorrect answer)

## 4. Logical Clocks

- (a) Suppose there are three processes  $A, B$  and  $C$ . All clock runs at the same rate but initially  $A$ 's clock reads 0,  $B$ 's clock reads 0 and  $C$ 's clock reads 5. At time 10 by  $A$ 's clock,  $A$  sends a

message to  $B$ , this message takes 2 units of time to reach  $B$ .  $B$  then waits one unit of time and then sends a message onto  $C$  which takes 3 units of time to reach  $C$ . At the same time at time 5 by  $B$ 's clock a message is sent to  $A$  this message takes one unit of time to reach  $A$ . Assuming that the system implements Lamport's timestamps (not vector timestamps) draw a picture illustrating the timestamps for the messages and explain how the timestamps are obtained. **(2 points)**

- (b) What does it mean for two events to be concurrent and what is the relation of the Lamport timestamps of the two events. **(2 points)**.
- (c) Is it possible for two events to have the same lamport timestamp? If it possible give an example, if it is not possible argue why it not possible. **(2 points)**.
- (d) Redo the first part of this question with vector timestamps **(2 points)**.

5. Explain in detail the ring algorithm for electing a leader. **(4 points)**.

6. Transactions.

- (a) With examples define what a transaction is. **(2 points)**
- (b) Explain what problems can happen there is no concurrency control where multiple transactions are being executed at the same time. **(3 points)** (Obs. **Give examples**).
- (c) Define what it means for an interleaving of two transactions to be serially equivalent? **(2 points)**

## Stop here if you are a TF student

7. Shared Memory.

- (a) What is strict consistency and why is not possible to achieve in a distributed system? **(3 points)**
- (b) Define causal-consistency. You must give examples. **(2 points)**
- (c) Is the following data store causally consistent? Explain your answer. **(1 points)**

A	W(x)a	W(x)b	
B		R(x)a	W(x)c
C			R(x)c R(x)b

(d) Explain with examples what release consistency is. (2 points)

8. Describe in detail the two phase commit algorithm. (6 points)