

LINKÖPINGS TEKNISKA HÖGSKOLA  
Institutionen för datavetenskap  
Petru Eles

**Tentamen i kursen**  
**Distribuerade System- TDDD25**  
**2017-03-13, kl. 14-18**

**Hjälpmedel:**

Engelsk ordbok.

**Supporting material:**

English dictionary.

**Poänggränser:**

Maximal poäng är 40.  
För godkänt krävs sammanlagt  
21 poäng.

**Points:**

Maximum points: 40.  
In order to pass the exam you need a  
total of minimum 21 points.

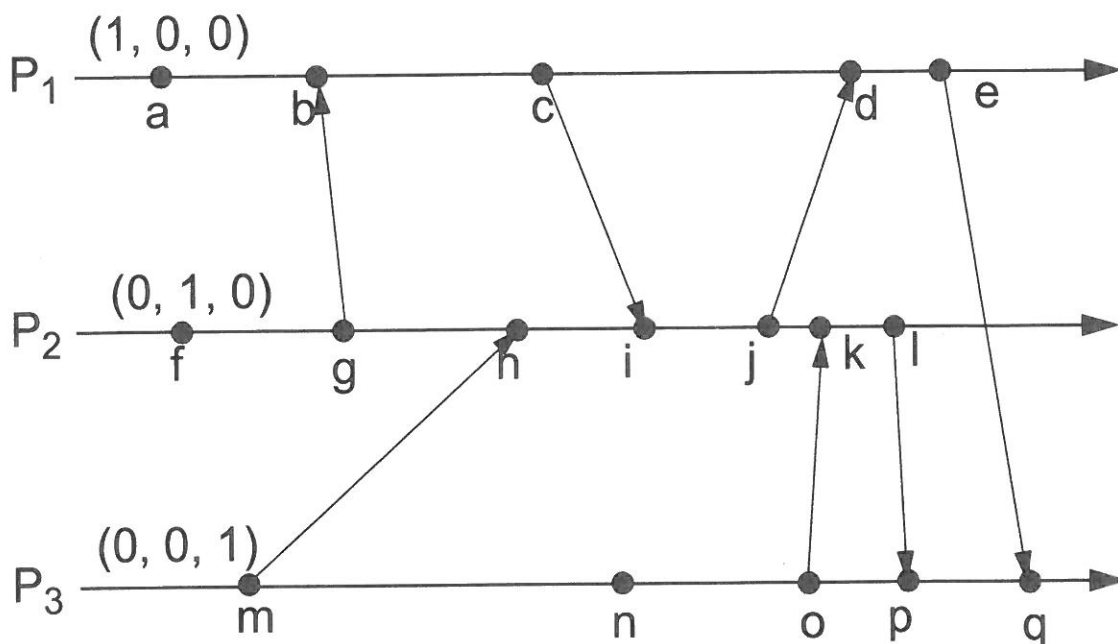
**Jourhavande lärare:**

Petru Eles, tel. 0703681396

**Good luck !!!**

**Tentamen i kursen Distribuerade System -TDDD25, 2017-03-13 kl. 14-18**  
**Du kan skriva på svenska eller engelska!**

1. What means transparency in a distributed system? We have defined seven aspects of transparency. Enumerate and explain at least five of them. (3p)
  
2. Synchronous and asynchronous distributed systems. What are their main features and what are the consequences of these features? (2p)
  
3. BitTorrent and Napster:
  - a) Explain how each of them works; illustrate by a figure indicating the successive steps performed for access.
  - b) Compare the two. (3p)
  
4. We have identified an important limitation of Lamport's logical clocks (the other one, related to the lack of total ordering is not so important).
  - a) What is that limitation? Illustrate by an example.
  - b) Show, using the same example, how vector clocks solve that problem. (3p)
  
5. Consider the following set of events:



Assign the missing vector clock values to the events.

(3p)

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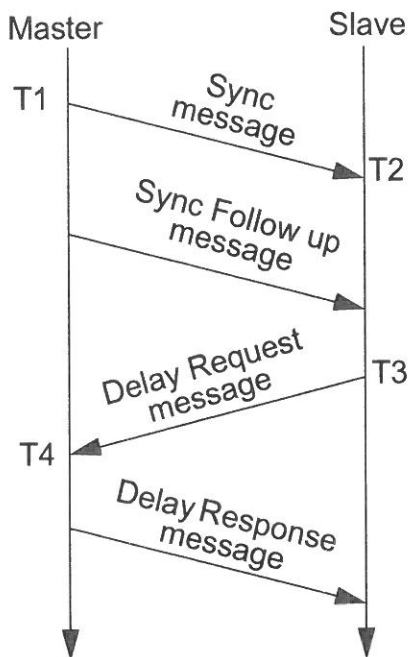
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6. We have introduced a theorem saying that a cut is consistent “if and only if no two cut events are causally related”.
- Illustrate the theorem with two examples (one showing a consistent cut and the other an inconsistent one). Use figures!
  - Show, for each example, how the theorem applies.
- (3p)
7. Consider mutual exclusion with the Ricart-Agrawala algorithm (the first algorithm, not using a token). Imagine three processes:  $P_0$ ,  $P_1$ , and  $P_2$ .  $P_1$  and  $P_2$  are requesting the same resource, and the timestamp of the requests is (6, 1) and (5, 2) respectively. Illustrate the sequence of messages exchanged (use figures). Who gets the resource first?
- (3p)
8. What is the basic idea behind the token based distributed mutual exclusion algorithm by Ricart-Agrawala (the second algorithm)? Consider how mutual exclusion is guaranteed and how the token is passed after a process has left the critical section. How many messages are passed in order a process to get permission to a critical section? Compare this number of messages with those needed with the token ring based algorithm. In what circumstances would you prefer Ricart-Agrawala-second and token ring, respectively (think at how frequently processes need the resource)?
- (3p)
- 9.
- Define total and causal ordering of requests. Illustrate by an example.
  - How can total ordering be implemented using a central sequencer?
  - Consider total ordering based on distributed agreement (no central sequencer); consider one front end and several replica managers.  
In this case, the replica managers, after receiving a request, send back to the front end a *cuid*. What does the front end send back to the replica managers after receiving the *cuid* from each replica manager? How does the front end calculate the value it sends back?
  - What happens if a replica manager crashes before sending to the front end the *cuid* for a request it received?
- (4p)
10. What is the basic idea with voting protocols for updating replicated data? How do they work? Consider a set of 12 replica managers. Define two voting protocols. One for a situation when the number of writes is relatively large compared to that of reads, and the other for the reverse situation. Give examples of read and write quorums (use figures).

(3p)

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11. The Byzantine Generals Problem: show how agreement is not or is possible for three and for four participants respectively, in the case one of the generals (not the commander) is a traitor (illustrate the exchange of messages with figures). (3p)
12. What does it mean by external and internal synchronization of physical clocks? What does it mean by centralised and distributed synchronisation algorithms? (2p)
13. You know the maximum drift rate of the clocks on two processors and the maximal allowed skew between them. How do you determine the maximum interval between two successive synchronizations between the clocks? Consider both the case when after synchronisation the clocks are perfectly aligned and the case when after synchronisation there exists an offset  $\Phi$  between the clocks. (2p)



14. The figure shows the message exchange performed for clock synchronisation in the Precision Time Protocol (PTP). (3p)
- What is the role of the "Sync Follow up message"? Why is it needed?
  - What information is the "Delay Response message" carrying?
  - Once the values T1, T2, T3, T4 are known, how is the clock update performed?