

Programação em Sistemas Distribuídos

2016/17

MEI/MI/MSI

Final Exam (Época normal)

January 12, 2017

Total time: 2h30m

Number: _____ Name: _____

Instructions (please read and follow carefully):

1. This is a closed-book, closed-notes exam.
 2. **Be brief** and precise in your answers. You may be penalized for unnecessarily long answers. *Hint:* Only use the space provided. Condense your answer into its key points – avoid writing long essays! Again, you may incur penalties for long answers. So, please think before you answer.
 3. The total number of points is 20.
 4. Some questions may have more than one correct answer.
 5. Do not spend too much time on any one question. There are some simple questions that you can answer quickly. Come back to questions you cannot answer later if necessary.
 6. Try to answer every question (briefly) so as to accumulate at least partial credit.
 7. A blank page is attached at the end for your use as scratch paper.
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For Graders' Use Only

I. _____ / 6

II. _____ / 14

TOTAL _____ / 20

I. Multiple-choice questions (6 points)

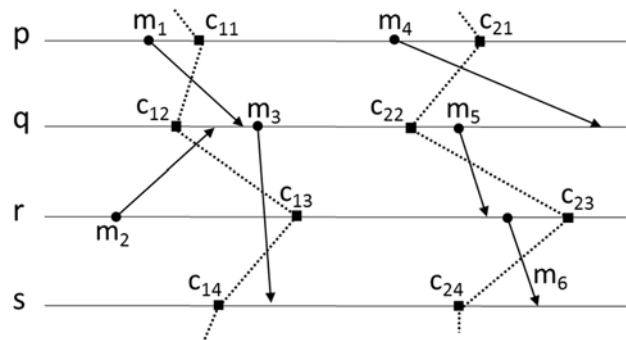
For each question there is only one correct answer. Please circle the correct answer.

(Grading: a correct answer is awarded 0,6 points; an incorrect answer is awarded -0,2 points).

1. Which of the following claims relative to distributed systems and architectures is **FALSE**?
 - (A) One of the advantages of distributed systems in comparison to centralized systems is that they make it easier to deal with scalability requirements.
 - (B) Real-time distributed systems are fundamentally characterized by being fast and by using networks with a large bandwidth.
 - (C) In synchronous distributed systems it is possible to assume that message delivery delays are always bounded and known.
 - (D) In asynchronous distributed systems, without synchronized clocks, it is still possible to build causal delivery protocols using logical clocks.

2. In a distributed system with **passive** replication, message diffusion:
 - (A) Can be unreliable, but with FIFO ordering.
 - (B) Must be reliable, but without ordering requirements.
 - (C) Can be unreliable, but with total ordering.
 - (D) Must be reliable and with total ordering.

3. Consider the following figure, which illustrates a set of messages exchanged between processes p, q, r and s (messages are delivered as soon as they are received). The figure also illustrates two global cuts, $c1 = \langle c_{11}, c_{12}, c_{13}, c_{14} \rangle$ and $c2 = \langle c_{21}, c_{22}, c_{23}, c_{24} \rangle$. It is correct to say that:
 - (A) Both cuts are inconsistent cuts.
 - (B) Cut c1 is inconsistent and cut c2 is consistent.
 - (C) Cut c1 is consistent and cut c2 is inconsistent.
 - (D) Both cuts are consistent cuts.



5. If two transactions are executed concurrently, possibly sharing some items, which of the following atomic transactions properties assures that the consistency of the result is similar to the one that would be achieved if the two transactions executed sequentially?
- (A) Atomicity.
 - (B) Consistency.
 - (C) Isolation.
 - (D) Durability.
6. In the **Google File System**:
- (A) The Master node is responsible to serialize all write requests.
 - (B) Files are split in chunks that are replicated in Chunk Servers using passive replication.
 - (C) The Master node keeps a disk log with information about the location of all chunks.
 - (D) To improve the throughput, clients broadcast write requests to all Chunk Servers.
7. The **Transactional** distributed system model can be characterized as being typically:
- (A) Space coupled, time coupled and synchronized.
 - (B) Space uncoupled, time uncoupled and synchronized.
 - (C) Space uncoupled, time coupled and synchronized.
 - (D) Space uncoupled, time coupled and non-synchronized.
8. The **Publish/Subscribe** communication model is characterized by:
- (A) Requiring publishers and subscribers to be simultaneously active.
 - (B) Requiring replicated event brokers.
 - (C) Ensuring reliable delivery of events.
 - (D) Allowing events to be filtered at the sender or at the receiver.
9. When using NTP **in round-trip mode** to synchronize local clocks, it is true that:
- (A) There is a master node that periodically disseminates the current time.
 - (B) The master node must always be above stratum 2.
 - (C) The synchronized clocks can be precise, but it is not possible to ensure accuracy.
 - (D) The achievable precision depends on the variance of message delays.
10. When using **ephemeral znodes** within Zookeeper, it is true that:
- (A) The *process* method must be implemented, to be called when such znodes are removed.
 - (B) Such znodes must be created under the path “/EPHEMERAL/”
 - (C) Such znodes cannot have any child nodes.
 - (D) Such znodes are automatically removed when their contents are read by some client.

II. Development questions (14 points)

1. [1,5] Explain how distribution can be exploited as a strategy to improve availability in a distributed computing system.
2. [2] Total ordering is fundamental in many distributed systems.
 - a) [1] When a communication protocol is said to provide total ordering, what does it mean?
 - b) [1] Give an example of a distributed system/application in which total ordering is necessary.

3. [1,5] One possible approach for the implementation of fault-tolerant total order broadcast is by using Δ -protocols.
 - a) [0,5] What are the conditions (assumptions) under which Δ -protocols can be used? Justify.
 - b) [1] Describe the fundamental steps of a protocol (sender and receiver side) for total order broadcast using a Δ -protocol.
4. [1,5] Characterize the view synchrony property of group communication systems and explain why it is so important when building distributed systems.

5. [2] Consider the replicated shared variable x , such that initially $x=0$. Three processes, $p1$, $p2$ and $p3$, each access a different replica to read and write the value of x . The code executed by each of the processes is the following:

$p1$	$p2$	$p3$
$x=1;$	$x=2;$	$x=3;$
$x=4;$	$b=x;$	$c=x;$
$a=x;$	$x=5;$	

- a) [1] Considering that the replicated variable x is implemented with sequential consistency, when the three processes complete their execution is it possible to have $a=2$, $b=1$ and $c=3$? Justify.

- b) [1] What about $a=5$, $b=2$ and $c=4$? Justify.

6. [1,5] Consider a Chat system. Describe the fundamental differences when implementing such system using a centralized server or using the peer-to-peer paradigm.

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