Programação em Sistemas Distribuídos

2014/15

MEI/MI/MSI

Final Exam (Época Recorrência)

February 4, 2015

Total time: 120 minutes

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.

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. Consider a distributed system based on thin-clients HTTP. It is true that thin-clients HTTP:

    (A) Emerged to exploit the computational power of PCs, which are low cost and of generic use.
    (B) Almost do not execute any code: they just provide an interface for accessing the service.
    (C) Are hard to manage, because every time there is a change in the service it is necessary to upgrade the code on the clients.
    (D) Are essentially built according to a client/server architecture based on RPC.

2. Consider the following figure, which illustrates a set of message exchanged between processes q, r and s. The figure illustrates a protocol with the ordering property(ies) of:
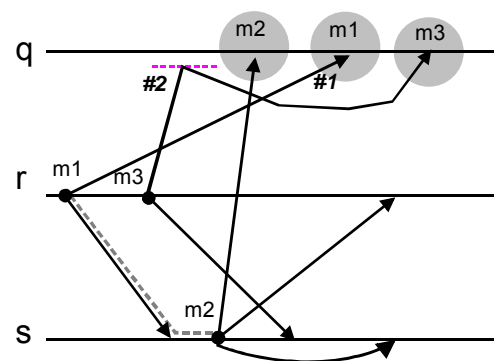
    (A) Total.
    (B) FIFO.
    (C) FIFO and Causal.
    (D) FIFO, Causal and Total.

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 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:
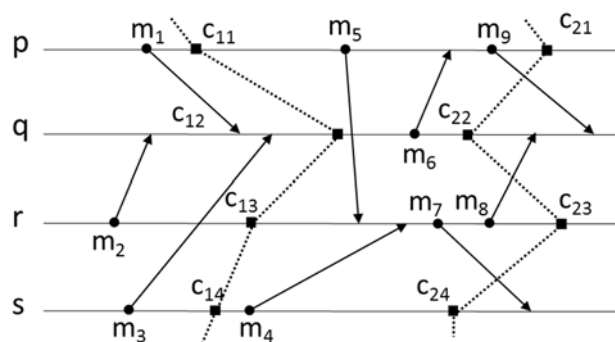
    (A) Both cuts are strongly consistent cuts.
    (B) Cut c1 is strongly consistent and cut c2 is consistent.
    (C) Cut c1 is consistent and cut c2 is inconsistent.
    (D) Both cuts are consistent cuts.

4. Which of the following statements is true for the sequential consistency model:

    (A) Sequential consistency is sufficient to guarantee the state convergence of replicates registers.
    (B) To achieve sequential consistency it is enough that concurrent accesses to replicated registers are FIFO ordered.
    (C) Sequential consistency is achieved as long as write operations are totally ordered.
    (D) To achieve sequential consistency it is necessary to use the Two-Phase Commit protocol.

5. Concerning the NFS distributed file system, it is correct to say that:

   (A) It provides fault tolerance and availability despite server crashes.
   (B) It is a stateful file system, because the server keeps track of files currently opened by clients.
   (C) It is optimized for sequential access to large files.
   (D) It provides migration transparency, although this requires the file system to be remounted.

6. Consider a system with synchronized clocks using NTP, where the NTP server is equipped with a GPS receiver for synchronizing its own clock. In this system, it is true that:

   (A) All clocks will provide accuracy.
   (B) All clocks will provide precision.
   (C) All clocks will provide both accuracy and precision.
   (D) The master clock will provide both accuracy and precision and the remaining clocks will only provide precision.

7. In a distributed transactional system the mechanism that guarantees the Atomicity property of transactions is:

   (A) Two-Phase Commit (2PC).
   (B) Two-Phase Lock (2PL).
   (C) Roll-back.
   (D) Serialization.

8. Consider the different interaction models in distributed systems. Which of the following sentences is TRUE?

   (A) Communication with RPC is asymmetric and usually implies that the client will block.
   (B) Group communication services are particularly useful to build distributed file systems.
   (C) Group communication services cannot be used to implement the client/server communication.
   (D) The message bus or Publish/Subscribe communication model can be achieved using group communication services, with publishers in one group and subscribers in another group.

9. In the peer-to-peer communication model, it is true that:

   (A) Despite all nodes operating in a distributed fashion, there is always a centralized node controlling the overlay topology.
   (B) Information is typically broadcast through the overlay network, so that all peers can receive it.
   (C) It is very appropriate for file sharing and distribution of contents, but is not appropriate for interactive applications.
   (D) When a structured peer-to-peer approach is used, it is always possible to locate existing objects, but there is a management overhead to maintain the overlay network.

10. When using Zookeeper, the method that allows retrieving data from a node is:

   (A) getData.
   (B) read.
   (C) watch.
   (D) readNode.

II. Development questions (14 points)

1. [2] Explain how distribution can be exploited as a strategy to improve file access, despite the information being possible spread across many nodes in the system.

2. [2] Explain how passive replication works and why it is not possible to use it to tolerate value faults.

3. [2] Describe a protocol that secures total message ordering, indicating specific assumptions that must be made for the protocol to be correct, if any.

4. [2] Explain in detail what is the view synchrony property and why it is useful for distributed applications. You may provide a graphical example.

5. [2] Consider a distributed system based on AFS. Consider also that a client wants to open a file in the AFS space that <u>is currently present in the local cache, but has an invalid CBP</u>. Choosing **only the actions that you believe are convenient**, from the list below, write the correct order (e.g. [234761]) of the actions that are executed when the cliente opens the file.

      1: Venus locally checks if the CBP is valid

      2: Vice cancels the CBP

      3: Venus requests the file to the Vice

      4: Venus contacts the Vice to check the validity of the CBP

      5: Vice sends the first block of the file

      6: Venus checks if the file is on the cache

      7: File is opened as a local file

      8: Vice sends the complete file

      9: Venus installs the copy of the file in the shared AFS space

Correct order:	

6. [2,5] Consider that you are proposed to develop a multi-party interactive game, in which all participants have the same view of the game.

a) [1,5] If you could choose the programming model to develop the game, which model would you select, among the following: client/server single-threaded; client/server multi-threaded; distributed shared memory; group-based; atomic transactions; peer-to-peer. Justify carefully.

b) [1] Make a sketch of the system architecture, including the involved entities (i.e., nodes and their function) and the possible interactions (what messages are exchanged). Complement the sketch with the necessary explanations. You may use the extra space in the last blank page

7. [1,5] Explain how you would implement node failure detection with Zookeeper.

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