Sistemas Distribuídos - MIEEC **14 November, 2019**
Mid-term (with "cheat sheet") **Duration: 120 min**

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1. **Justify all answers.**
2. **Answer questions 1 and 2 in one sheet of paper, and the remaining questions in another.**

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1 [3v] - Relative to Distributed Systems.

1.1- Explain the difference between Distributed Systems and Multiprocessors.

1.2- What do you understand as a Logical Clock and give an example.

1.3- What is an Epidemic Algorithm? Give an example and say briefly how it works.

2 [7v] - Consider a cell in an industrial system in which several machines cooperate under a distributed application. The communication requirements are heterogeneous, including sharing state among the machines with a period of 10 ms to the exchange of configuration and log files, exchanged sporadically with sizes that can reach a few MBs.

2.1- The transactions for sharing state use a publisher-subscriber middleware based on the UDP protocol. Is this a good option? Why?

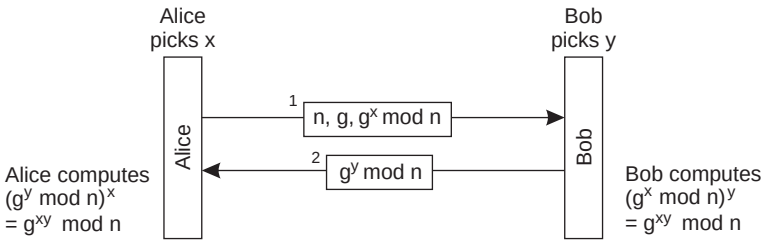
2.2- The machines frequently connect to a server from which they download the configuration to produce each new product. These connections can be concurrent, but the number of machines is between 10 and 20. Which internal architecture (iterative, threads, events) would suit the server better?

2.3- Meanwhile you decided to create a global time base using a distributed clock synchronization approach. The resulting precision is determined by the drift of the local clocks, the network delay jitter and the convergence factor. Explain what is the convergence factor?

2.4- Using the global clock, you decided to implement a TDMA layer that assigns each node an exclusive fixed duration time slot in a periodic cycle. To eliminate slots overlapping, it is necessary to force a gap (also known as guarding window) between consecutive slots. Explain why this gap is necessary and what should be its shortest width considering a precision of δ.

2.5- The machines send log files with events and their timestamps to another server. Given the precision δ of the global clock and considering it increments with a resolution of 2δ, what is the minimum difference between the timestamps of events in different machines that allows inferring order?

3 [2v]- Alice and Bob decided to use the **Diffie-Hellman protocol** to agree on a key for encrypting messages. For each of the following statements, write whether it is **true** or **false** and justify your answer.



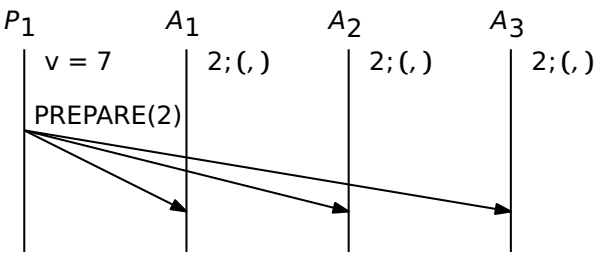
1. The security of this protocol **does not** depend on the secret values chosen by Alice and Bob (x and y, respectively) being small or large: all that is needed is that they be random.
2. After this message exchange, Alice knows that it has agreed a key with Bob.

4 [3v]- Consider the **bully algorithm** for leader election.

4.1- Assume that at some point, the processes with identifiers 2, 4 and 5 are operational, and process 2 is the leader. Furthermore, assume that at that time, process 3 recovers and begins the execution of the bully algorithm. Show the execution of this protocol, using a time diagram, assuming that there are no faults and that no other processes recover. Justify.

4.2- The bully algorithm uses timeouts to detect process failure. What timeout value should a process use to detect failure of the candidate to leader after the sending the HALT message (and before the following message prescribed by the protocol)? Justify.

5 [2v]- Consider the partial execution of the **Synod algorithm** shown.



5.1- Explain why the *acceptors* should not send a PROMISE message in response to the PREPARE.

5.2- Complete the execution, by drawing a time diagram, so that the initial value (7) of proposer P_1 is the decided value. Justify.

6 [3v]- Consider **primary-backup replication**.

6.1- This replication approach may be with our without **blocking**. Explain the difference between these two variants and, for each of them, present one advantage (with respect to the other).

Hint: Use a temporal diagram as an aid to your explanation.

6.2- Is the following statement true or false? Justify.

> The implementation of primary-backup replication with **view-synchronous communication**, gives us the advantage of non-blocking replication without its disadvantage.