Politecnico di Milano
090950 – Distributed Systems

Prof. G. Cugola – July 12th, 2024

Rules:

- You are **not allowed** to use books, notes, or other material.
- You can answer in Italian or English and use either pen or pencil.
- Total time for the test: 2 hours.

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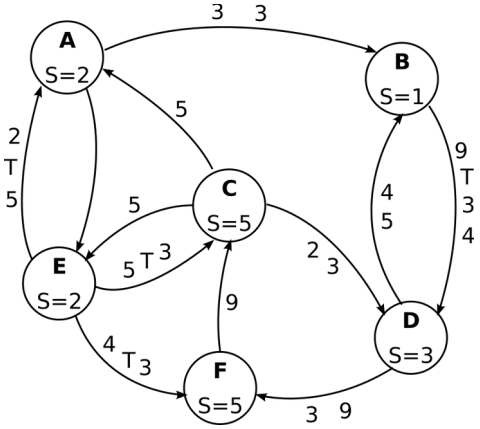
1. Consider RPC and RMI and focus on parameter passing. After describing how parameter passing works in the two systems, explain why passing parameters by reference is problematic in RPC, how RMI addresses these difficulties, and why, vice-versa, passing by value is a problem for RMI.

2. First describe attribute based naming in general, then explain why it does not scale as efficiently as structured naming.

3. Consider the system in figure, which is running a distributed snapshot. Suppose that every process works by adding the value held by the received messages to its internal state S. Process A started the snapshot, recording state 2 and sending the tokens to B and E, which already processed them and sent out their own tokens. Show the state captured by every node at the end of the snapshot (local state and messages recorded for each link). Clarify the assumptions you made.



4. Describe how scalar clocks can be used to implement a totally ordered multicast primitive. Clarify the assumptions required for the protocol to operate correctly.

5.

P0	W(x) 2	W(x) 5	R(x) 4	W(y) 3	
P1	W(y) 1	W(x) 4	R(y) 1	R(y) 3	
P2	R(y) 1	R(x) 2	R(y) 3	R(x) 4	R(x) 5

Consider the above schedule of read and write operations on a replicated data store. Is the schedule consistent with the FIFO, causal, and sequential consistency models? How do your answers change if you remove the last read (R(x) 5) from P2? Motivate your answers.

6. You are implementing a document lookup service. Each document has a key and the lookup service enables identifying the location (host) of a document given its key. Consider the following two scenarios: (1) the network consists of tens of thousands of hosts, and hosts may dynamically join/leave the network; (2) the network consists of less than a hundred hosts, and hosts never join/leave the network. In which of the two scenarios would you implement the lookup service using the Chord protocol and why? How would you implement the lookup service in the other scenario?

7. Consider a simple data store and two implementations: (a) the system is implemented using a single machine, (b) the system is replicated across 5 machines using the Raft consensus protocol to provide consistency across replicas. Compare the two implementations in terms of response time for client requests, replication consistency, fault-tolerance.