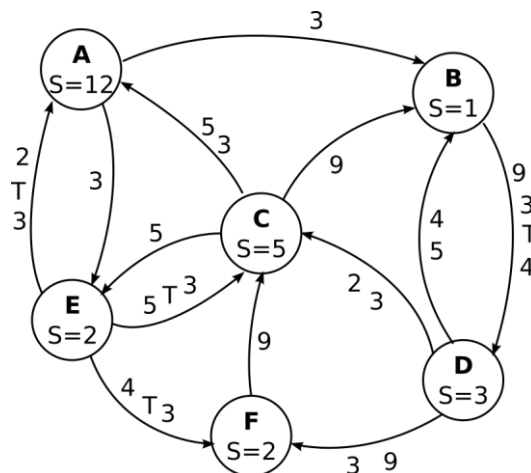




Rules:

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

1. Describe the various alternatives to synchronize physical clocks in a set of networked machines. Which method would you use to synchronize the 15 machines of a laboratory that is kept (for security reasons) disconnected from the Internet? Motivate your answer.
2. Describe the publish-subscribe model of communication, focusing on the architectural issues put in place to improve scalability. End by briefly describing how publish-subscribe differs with from message queuing.
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 12 and sending the tokens to processes B and E, which already processed them and sent out their own tokens. Assuming that no other operations occur apart those required to end the snapshot, show the state captured by every node at the end of the snapshot (local state and messages recorded for each link). In case multiple answers are possible, clarify the assumptions you made to provide your own answer.



4. Describe scalable reliable multicast in details, clarifying the problem it solves and the assumptions it makes. Imagine you had to implement a video conferencing system and imagine it should offer the possibility of sharing a presentation by uploading the presentation file (provided by the presenter) to the participants' machines. Would you use scalable reliable multicast to implement this service? Motivate your answer.

(continue...)

5. Consider a replicated datastore that contains integer variables, initially set to 0.

P0	W(y)1	R(x)0	R(y)1	W(x)1	R(x)2	W(y)3
P1	R(y)0	R(x)1	R(y)1	W(x)2	W(x)6	R(y)3
P2	W(x)4	R(y)1	R(x)4	R(x)1	R(y)3	R(x)2

Is the schedule above consistent with respect to the FIFO, causal, and sequential models? Motivate your answers.

6. Three peers (IDs = 1, 7, 14) participate in a circular DHT with finger table using the CHORD protocol. Assume that the DHT uses 4-bits to represent the node IDs and the Keys.
- Show the routing tables of the three peers.
 - Peer 7 wants to retrieve the value of an object having key 0. Show the exchange of messages required to search the desired value.
7. Consider secure channels in distributed systems and discuss:
- which guarantees they offer and why they are useful;
 - which assumptions they rely on;
 - which protocols can be used to implement them, presenting a high-level view of each protocol, its assumptions, and the benefits it brings.