Politecnico di Milano
090950 – Distributed Systems

Prof. G. Cugola – January 17th, 2024

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.

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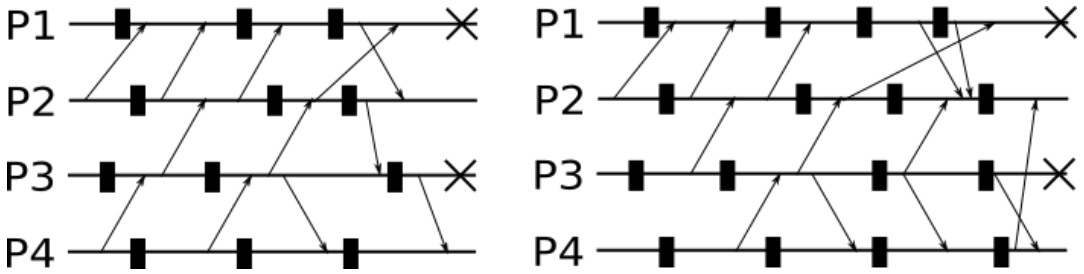
1. First describe the publish-subscribe model of communication, then compare it with RPC focusing on the following characteristics: addressing (unicast vs multicast and implicit vs explicit), synchronicity, persistency. Finally, explain how a generic DHT can be used to implement a distributed publish-subscribe dispatching service. Which is the main limitation of this implementation approach?

2. Describe the concept of structured naming and how a structured naming system can be implemented through a hierarchy of servers. Explain also why the same hierarchy of servers does not performs equally well in presence of flat names.

3. Calculate the recovery line for the two diagrams below using the rollback-dependency graph for the first one, the checkpoint dependency graph for the second one. **Finally, explain when this kind of graphs are used and how the data to build them is collected.**



4. Describe the floodset algorithm. Which problem does it solve? Under which assumptions? Why those assumptions are fundamental (use counterexamples). Optional: Prove its correctness.

5. Consider the above schedule of read and write operations on a replicated data store. Which values of x and y is P2 allowed to read in the position marked with “?”, in the cases in which the store adopts a FIFO, causal, and sequential consistency model, respectively? Motivate your answers.

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	R(x) 4
P2	R(y) 3	R(x) 4	**?**		

6. Three peers (IDs = 4, 9, 12) 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. (a) Show the routing tables of the three peers. (b) Peer 4 wants to retrieve the value of an object having key 5. Show the exchange of messages required to search the desired value.

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, consistency, fault-tolerance.