**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 failure model for a distributed system in general (i.e., for processes and channels). Which is the most common type of failure for channels? Why this type of failures, which are very hard to manage for processes, are not so relevant/problematic for channels?

2. Describe the publish-subscribe communication model.

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 processes B, C 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).
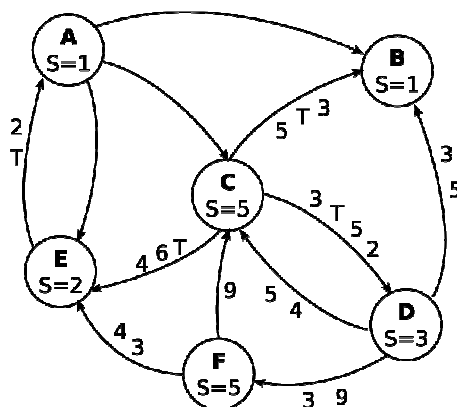
4. Describe the problem of agreement in a group of processes under the various conditions (type of admitted failures, synchronous vs. Asynchronous systems, etc.).

5. Consider the following schedule over 2 variables (both initialized at zero):

   P0 R(x)0 W(y)1 W(x)3 R(y)2
   P1 W(x)1 R(y)1 R(y)2 W(y)3
   P2 R(y)0 W(x)2 R(y)2 R(y)3
   P3 R(x)2 W(y)2 R(y)2 R(x)2

   Is it FIFO/causal/sequential consistent? If not, can you remove just one operation and make it consistent?

6. Describe and compare the primary-based consistency protocols, describing pros and cons for each of these approaches to client-centric consistency.

7. Describe the BitTorrent protocol in detail, in particular the "choking" mechanisms: what problem is tackled by this approach? Is this problem treated also by any of the other p2p protocols that you studied?