

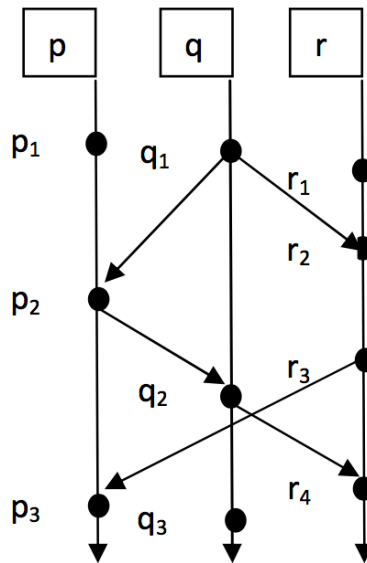
Tutorial 1: Introduction to Distributed Systems

1. Describe the key features of a Distributed System?
2. What is the difference between the following terms: *host*, *site*, *server*, *client*?
3. What is the difference between a *loosely-coupled* and a *tightly coupled* Distributed System? Give a real-world example of each.
4. The lecture notes state “a Distributed System has, by default, no global clock”. Explain why this is the case.
5. In what way are the concepts of *redundancy* and *reliability* related?
6. When would the use of concurrency for a processing task might be a disadvantage?
7. Why is middleware important? List the main benefits of using middleware.
8. Figure 1 below shows timelines for three processes: p, q and r. On each timeline, a number of events are shown. Arrows between timelines indicate a message being sent between processes.

Using Lamport’s concept of a “happens before” relation, identify all the events that:

- a) happen before p_3 .
- b) p_3 happens before
- c) are concurrent with p_3 .


Figure 1



9. What is the difference between a “logical clock” and a real-time clock.
10. In the system shown in Figure 1, a snapshot was taken that has recorded the following events: $\{p_1, p_2, q_1, q_2, r_1, r_2, r_3\}$. Is this a “consistent snapshot”? Explain your answer.
11. Three hosts are communicating with one another in a distributed system. Their clocks run at different speeds:
- Process A has a fast clock: $dC/dt = 1.1$ (i.e. it records 11 seconds for every 10 seconds of real time).
 - Process B has a perfect clock: $dC/dt = 1$ (i.e. it records 10 seconds for every 10 seconds of real time).
 - Process C has a slow clock: $dC/dt = 0.7$ (i.e. it records 7 seconds for every 10 seconds of real time).

The following messages are sent (T denotes real time in seconds).

- A sends a message to C at time $T=20$
- A sends a message to B at time $T=50$
- C sends a message to B at time $T=70$
- C sends a message to A at time $T=80$

- 
- B sends a message to C at time $T=90$

Assuming all messages take exactly 10 real-time seconds to arrive, what are the timestamps of the three processes if we use Lamport's algorithm to enforce a global logical clock?

(Hint: it will help to record the timestamp for each process at 10 second intervals)

