

Midterm Example - Fall 2021

- Partial and unsatisfactory answer/solution will receive a fraction of the points, whereas excellent answers may exceed the indicated points.
- Use of books/notes is forbidden.
- Indicate name and UCI ID number in ALL the solution sheets. Number the solution sheets and indicate total number of sheets (*e.g.*, first sheet 1/3, second sheet 2/3, third sheet 3/3).

S1 Consider an application infrequently generating short bursts of traffic. Is circuit switching or packet switching a better choice? Please motivate your answer.

Packet switching is the best option in case of bursty traffic followed by periods of inactivity.

- Efficient use of the channel resources. The long messages can be broken into smaller chunks of data (*i.e.* packets) which allows for better sharing channel resources. In circuit switching networks, the resources are reserved for the duration of the communication.
- More robust. Packet switching networks provide different paths for packets. This makes them robust against potential router failures. In circuit switching networks, the circuit/path between any two nodes is fixed and if the circuit fails, the recovery will most likely requires infrastructure fixes.

Also, packet switching networks support store and forward transmission which makes them robust against router's failures. Circuit switching networks does not support store and forwarding.

S2 List and describe the sources of delay experienced by a packet from the moment it arrives at a router to the moment it reaches the following one.

The packet suffers from several types of delay:

- Nodal processing delay. It's the time required to examine the packet's header to determine where to direct the packet.
- Queuing delay. The time that the packet waits to be transmitted into the link. It can go from 0 to the time that takes the router to dispatch the packets that arrived earlier.
- Transmission delay. The time that a packet uses to be transmitted. If we denote the length of the packet by L bits, and the transmission rate of the link from router A to router B by R bits/sec. The transmission delay is L/R .
- Propagation delay. The time required to propagate from the beginning of the link from router A to router B. The bit propagates at the propagation speed of the link.

S3 Describe the architecture and basic operations of file sharing applications. Is it a peer-to-peer or client-server architecture? Is there any strategy used to maximize the reliability of file transfer.

The file sharing applications have two functionalities:

1) Searching for the file which usually uses a client-server architecture. This is the first operation that a new peer will do. It will contact the server to get information about the available peers. Once the new peer knows which peers can establish a connection, the file transfer functionality starts.

2) File transfer which uses peer-to-peer architecture. The connection established with other peers is direct and therefore, peer-to-peer. Once the connection is established, the new peer will request "chunks" of the file that is searching. The peer that is acting as server will listen and serve the requests for chunks that the peer has. This communication takes place via TCP.

To maximize the reliability of file transfer, the BitTorrent program allows the peer acting as client determine which chunk requests first, e.g. the rarest first. While the peer acting as server determines the rate, e.g the number of connections, maximum rate.

S4 Describe the difference between peer-to-peer and client-server architecture.

In the client-server architecture the nodes can be clients or servers, but not both. Each role is defined as follows:

- The client request content.
- The client must know the server name or address.
- The server listens to the client's requests.
- The server replies with content.

Peer-to-peer architecture allows all the nodes to be both client and server:

- As a client, the node must have some way to find the peers that are acting as servers, but also has the desired content.
- As a server, the node must have some way for advertising availability and content to the other peers.

The flexibility of the peer-to-peer architecture allows us to easily scale systems which is contrary to the client-server architecture.

S5 Discuss the advantages and disadvantages of persistent and non-persistent connection model in HTTP.

HTTP with Non-Persistent Connections:

- Advantage: the objects of the HTTP page can be sent in parallel using multiple TCP connections.
- Disadvantage: consumes the server's resources by maintaining several TCP connections per client.

HTTP with Persistent Connections:

- Advantage: the whole HTTP page can be downloaded using a single TCP connection which saves the server's computational resources.
- Disadvantage: HTTP objects are sent serially.

S6 A Poisson process generates events at rate λ . Each event is discarded with probability p . What is the rate of the resulting process?

- $(1 - p)/\lambda$
- p/λ
- $(1 - p)\lambda$ **is the correct answer**
- $p\lambda$

S7 State the memoryless property of exponential distribution in the form of conditional probabilities.

Let X be the arrival time between packets which is exponentially distributed with rate λ , i.e., the rate of packet arrivals is λ pkt/s. The probability of receiving a packet after t seconds is $P(X > t) = e^{-\lambda t}$. Now imagine that starting at time 0, we observe the channel for s seconds and during the observing time (after s seconds have passed), no packets have arrived. Now what is the probability of receiving a packet after the original t seconds mark knowing that no packets have arrive in the last s seconds? Let's define a new variable Y which defines the remaining time until the next packet arrive. Starting at time s , what is the probability of receiving a packet after t seconds? The answer is $P(Y > t | X > s) = e^{-\lambda t}$. In other words, we don't have to look at the history (past

observations of events) of the system to determine the probability of receiving the next packet; X and Y have the exact same exponential distribution.