

Discussion Questions

1. What advantages does TDM have over FDM in a circuit-switched network?
2. What advantage does a circuit-switched network have over a packet-switched network?
3. Consider sending a packet from a sending host to a receiving host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable?
4. What is an application layer message? A transport layer segment? A network-layer datagram? A link-layer frame?
5. In the above question how a unit of transmission is broken at one end and assembled at the other end? Example: How a transport layer segment is broken into datagrams at the sending end and assembled at the receiving end?
6. Briefly describe how the Internet's connection-oriented service provides reliable transport.
7. Suppose you are developing an application for the Internet. Would you have your application run over TCP or UDP? Elaborate.
8. The buffer in a router contains, on average, 256 kbytes of data. We find that the average length of a packet is 200 bytes, and that a packet is buffered, on average, 12ms by the router.
 - (a) Assuming that no packets are dropped by the router, what is the average arrival rate? Express your answer in bits per second.
 - (b) Now assume that because of a malfunction, the router arbitrarily and randomly drops 25% of the arriving packets. Assuming the same arrival rate as in part (a), what is the average delay of a packet in the router? Express your answer in milliseconds.
9. You are given a communication link that transmits R bits per second. The objective is to transmit a file of length L bits. The bits are sent in packets; P bits of the file are sent in each packet, except for the last which contains all the leftover bits. A header of length H bits is added to each packet before it is transmitted over the link. Consecutive packets must be

separated by at least G seconds. Write down an expression for the total time to transmit the file.

10. A FIFO queue has the following cumulative arrival process: $A(t) = 100 + t$. The outgoing link operates at 4bits/second. Each time the queue goes empty, the outgoing link goes idle until there are 100 bits in the queue, and starts operating again at 4bits/second. Write down expressions for the queue occupancy, $X(t)$, the time-average queue occupancy \bar{X} , and the delay of a single bit through the queue, $d(t)$.
11. Consider an application that transmits data at a steady rate (e.g., the sender generates one packet of N bits every k time units, where k is small and fixed). Also, when such an application starts, it will stay on for relatively long period of time.
 - (a) Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
 - (b) Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why or why not?