Ref. No.: Ex/PG/SWE/T/115A/2024

Jadavpur University
Department of Information technology
M.E. Software Engineering 1st Year 1st Semester - 2024
Subject: Network Technologies

Time: 3 Hours | Full Marks: 100

(Note: Answer must be brief and to the point, and answers of all parts of a question should be written together)

Attempt any ***five*** questions

Q.1

a. Design and describe an application-level protocol to be used between an automatic teller machine and a bank's centralized computer. Your protocol should allow a user's card and password to be verified, the account balance to be queried, and an account withdrawal to be made. Your protocol entities should be able to handle the all-too-common case in which there is not enough money in the account to cover the withdrawal. Specify your protocol by listing the messages exchanged and the action taken by the automatic teller machine or the bank's centralized computer on transmission and receipt of messages. Sketch with a diagram the operation of your protocol for the case of a simple withdrawal with no errors.

b. 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. Would a packet-switched network or circuit-switched network be more appropriate for this application? Why?

c. In most networks, the data link layer handles transmission error by requesting damaged frames to be retransmitted. If the probability of a frame's being damaged is p, what is the mean number of transmission required to send a frame if acknowledgements are never lost?

d. Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average delay for the N packets?

e. What are the disadvantages of connectionless service? In spite of the disadvantages, why do you like to use connectionless services? What actions you would like to take to eliminate the problems, but still use connectionless services?

6+3+4+4+3

Q.2

a. Suppose we want to transmit the message 1011001001001011 and protect it from errors using the CRC-8 polynomial x^8+x^2+x+1. Determine the message that should be transmitted. Suppose the leftmost bit of the message is inverted due to noise. What is the result of the receiver's CRC calculation?

b. Consider the go-back-n and selective repeat protocols. Suppose the sequence number space is of size k. What is the largest allowable sender window that will allow the receiver to correctly distinguish between original transmission and a retransmission for each of these protocols?

c. In a reliable data link protocol, the ACK packets flowing from the receiver to the sender do not have sequence numbers (although they have an ACK field that contains the sequence number of the packet acknowledged). Why is it that the ACK packets do not require sequence numbers?

d. Frames of 1000 bits are sent over a 106 bps duplex link between two hosts. The round trip propagation time is 25ms. Frames are to be transmitted into this link to maximally pack them in transit. What is the minimum number of bits required to represent sequence numbers distinctly?

e. If the maximum sequence number is 17, then obtain sender and receiver window size in case of selective repeat. What happens if sender and receiver window size are greater than that of obtained value?

(3+2)+3+3+5+4

Q.3

a. There are 10 stations in a time slotted LAN always having constant load and ready to transmit. During any contention slot each station transmits with a probability 0.1. If the average frame takes 122 msec to transmit, what is the channel efficiency, if round trip time is 51.2 micro seconds?

b. What advantage do you get by using by using binary exponential back off instead of fixed back off interval?

c. For a host machine that uses the token bucket algorithm for congestion control, the bucket has a capacity of 1 megabytes and the maximum output rate is 20 megabytes per second. Tokens arrive at a rate to sustain output at a rate of 10 megabytes per second. The machine needs to send 12 megabytes of data. What is the minimum time required to transmit entire data?

d. An IP datagram of size 1000 byte arrives at a router. The router has to forward this packet to a network whose MTU is 100 bytes. Assume that the size of the IP header is 20 bytes. How many fragments will be created by the router and what is the size of the last fragment?

e. If the data link layer can detect errors between hops, why do you think that we need another checking mechanism at the transport layer?

5+3+5+5+2

[Turn over

Q.4

a. The set of address from 29.18.0.0 to 29.18.127.255 has been aggregated to 29.18.0.0/17. However, there is a gap of 1024 unassigned address from 29.18.60.0 to 29.18.63.255 that are now suddenly assigned to a host using a different outgoing line. Is it now necessary to split up the aggregated into its constituent blocks, add the new block to the table, and then see if any re-aggregation is possible? If not, what can be done instead?

b. Consider building a CSMA/CD network running at 1 Gbps over a 1 Km cable with no repeaters. The signal speed in the cable is 200000 Km/s. What should be the minimum frame size?

c. A router has the following routes in its routing table:

Route	Outgoing Interface
10.0.0.0/08	E0
10.0.0.0/16	E1
10.0.1.0/24	S0
10.1.1.0/24	S1
10.1.0.0/16	S0
10.1.0.0/24	E1
10.1.1.1/32	S2

A packet arrives at the router with a destination address of 10.1.1.1. Which interface will the router use to forward that packet?

d. You are a network administrator and have been assigned the IP address of 201.222.5.0. You need to have 20 subnets with 5 hosts per subnet. What is the subnet mask, address of the first and last subnet and the broadcast address?

e. ARP only permits address resolution to occur on a single network. Could ARP send a request to and get a reply from a remote server using an IP datagram?

5+5+4+3+3

Q.5

a. How the following policies affect congestion in the network?
Retransmission, Out-of-order packet caching, and Flow control.

b. Consider three IP networks A, B, and C. Host H_A in network A sends messages each containing 180 bytes of application data to a host H_C in network C. The TCP layer prefixes a 20 byte header to the message. This passes through an intermediate network B. The maximum packet size, including 20 byte IP header, in each network is 1000, 100, and 1000 bytes respectively. The network A and network B are connected through a 1 Mbps link, while B and C are connected by a 512 kbps link. Assuming that the packets are correctly delivered, how many bytes, including headers are delivered to the IP layer at the destination for one application message, in the best case? What is the rate at which application data is transferred to host H_C?

c. Suppose host A reaches host B via routers R1 and R2. Fast retransmit is not used, and A calculates Timeout as 2×EstimatedRTT. Assume that the A→R1 and R2→B links have infinites bandwidth; the R1→R2 link, however, 1 second-per-packet bandwidth delay for data packets (though not ACKs). Describe a scenario in which the R1→R2 link is not 100% utilized, even though A always has data ready to send.

d. Suppose a small ISP X pays a larger ISP A to connect him to the rest of the Internet and also pays another ISP B to provide a fall-back connection to the Internet in the event that he losses connectivity via ISP A. ISP X learns of a path to some prefix via ISP A, should he advertise that path to ISP B? Why or why not?

e. Congestion control is better implementation in the network layer but Internet is implementing it transport layer. Why?

6+5+3+3+3

Q.6

a. If the MSS is 1 KB, what is the window size after:
i) Occurrence of timeout? and ii) Successfully sending four full windows of bytes after timeout?

b. Consider a client and a web server directly connected by one link of rate R, suppose the client wants to retrieve an object whose size is exactly equal to 15 S, where S is the maximum segment size (MSS). Denote the round-trip time between client and server as RTTI (assumed to be constant). Ignoring protocol headers, determine the time to retrieve the object when S/R<RTT and S/R>RTT.

c. What is the maximum data rate at which a host can send 1000 byte TCP payload if the packet lifetime is 100 seconds without having sequence number wrap-around? Assume TCP header of 20 bytes and IP header of 20 bytes.

d. TCP entity opens a connection and uses slow start. Approximately how many round-trip times are required before TCP can send N segments?

e. Lost TCP acknowledgements do not necessarily force retransmission. Why?

5+6+4+3+2