Computer Networks
Written Assignment I

1. To transmit a file of size 10MB from a source to a destination, sender breaks the file into pieces of size X bytes and puts it in a packet with header size 10 bytes. Assume byte error probability is 10^{-6}. Sender re-transmits the packet if a minimum of 1 bit has an error. How many bits are sent by the sender to deliver the entire file without error? What value of X minimizes the total number of bits.

2. Station A wants to send a file of size 5Gb to station B. The link is 1Gbps and the probability that a bit gets corrupted is 10^{-9}. If the packet has bit error, the sender transmits that packet again. The packets are sent back to back. Sender immediately knows if a packet sent has error and resends it. Find the average number of bits transmitted in total to successfully send the file from A to B in following cases. Hint: use the following approximation: $(1-x)^y \approx e^{-xy}$, if $x \ll 1, y \gg 1$. Assume 1Gb=10^9bits and 1Mb=10^6 bits.
    a. The whole file is sent as 1 packet.
    b. The file is sent as 10 packets each of size 500 Mb.
    c. The file is sent as files each of size L bits. What is the minimum value of L which minimizes the number of bits to transmit the whole file?
    d. Assume that each packet has an overhead of M bits. Assume M=1Kb and is added to the content of the packet. Now repeat part c and find optimum L. (example: if the file is sent as 10 packets, then the total number of transmitted bits is "5Gb+10M" if there is no error.

3. Consider station A and B connecting over a link of length 30km. The bit rate of the link is 1 Gbps. How long does it take to send a packet of size 10Kb and receive the acknowledgment packet? The size of acknowledgment packet is 1Kb. Acknowledgment is sent after complete reception of file.`

4. Consider two stations A and B connecting to each other through an intermediate switch. The links connecting the stations to the switch are 10Gbps links. Stations and switch use a single store-and-forward in the path, and packet size is 10000 bits. Assume that each link introduces a propagation delay of 1 μs. Calculate the latency (from first bit sent from A to last bit received by B) for the following cases:
    a. The switch begins retransmitting immediately after it has finished receiving the entire packet.
    b. Assume that the switch implements "cut-through" switching: It is able to begin retransmitting the packet after the first 100 bits have been received.

5. To transmit a file of size 1MB from a source to a destination, 5 nodes between source and destination are used (6 back to back links). File is spilt into packets of size 1000B. The length of the links are 2.5km. Wave travels at speed of 2.5×10^8 at the links. The transmission rate of the links is 1MB/sec. Find the total time required to transmit the file from the source to the destination. The packets are send back to back with no gap. The switches receive a packet entirely and then forwards it.

6. Two nodes are connected to each other with an Ethernet cable in distance 25 Km. The wave propagates in the cable with speed 2.5×10^8 m/sec. The data rates of the link is 1Gbps. The packet length is 100 bytes and the ack packets is 25 bytes. If the sender and receiver use stop and wait, what is the throughput in bit per seconds if error probability is 0.2 for packet and 0.05 ack?v

7. Consider selective repeat algorithm where packet transmission time is 1 msec, propagation' delay is 5 msec, ack transmission time is close to zero, and packet error probability is 0.1. Window size of transmitter is 3 while buffer size of receiver is 2. It is a mixed of selective repeat and go back *N*. Time-out time is equal to the round trip time. Find the system throughput.

8. Consider GoBackN algorithm where packet transmission time is 1 msec, propagation' delay is 5 msec, ack transmission time is close to zero, and packet error probability is 0.1 for packet of ack. Window size of transmitter is 12. Time-out time is equal to the round trip time (12 msec). Find the system throughput.

9. Consider two nodes connected to each other with propagation delay 0.5 ms while data packet transmission time is 150 μsec and ACK packet transmission time is 50 μsec. The sender and receiver employ stop and wait protocol. The data or ack packet error probability is 0.1. Find the system throughput in the following cases
    a. Assume sender packet time-out time is 1.1 times the round trip time.
    b. Assume the time-out is equal to round trip time and the receiver imposes a random delay between the time it receives a data packet until it starts transmission of ACK. The delay is a uniform random variable in [0 μsec 100 μsec].
    c. Repeat part b but consider a selective repeat with window size 3. Time-out is equal to round trip time.
    d. Assume sender packet time-out is 1.1 times the round trip time. The receiver imposes a random delay between the time it receives a data packet until it starts transmission of ACK. The delay is a uniform random variable in [0 μsec 200 μ sec].