Solutions to assignment #4

Computer Networks 1

1. In an acknowledged connectionless network, reliable delivery can be achieved through the use of ACK and NAK transmissions. Such protocols are suited for communication over networks in which higher layers are sensitive to loss and the underlying network is inherently unreliable with a significant probability of loss or error. Unacknowledged networks provide simpler and faster communication for networks that are inherently reliable or provide service to higher layers that can tolerate information loss.

2. Suppose that the data link control just transfers frames and does not implement error control. Find the probability that the *message* arrives without errors at station b.

   Let *p* be the probability that a frame incurs errors during transmission. We know the following:

   Message length = 10,000 bytes
   Maximum packet size = 1000 bytes
   Number of packets for transmission = 10

   The probability of a packet arriving error free at end system *Ppacket* = (1 - *p*)3. The probability that all packets arrive error free at end system b is *Perror* = [(1 - *p*)3]10= (1 - *p*)30 » e-30*p*.

   الف) Suppose that error recovery is carried out end to end and that if there are any errors, the entire message is retransmitted. How many times does the message have to be retransmitted on average?
   The average number of required transmissions = 1/ *Perror* = e30*p*.

   ب) Suppose that the error recovery is carried out end to end on a packet-by-packet basis. What is the total number of packet transmissions required to transfer the entire message?

   ج) The average number of transmissions per packet = 1/ *Ppacket* = e3*p*. The total number of packet
   transmissions is then 10/ *Ppacket* = 10e3*p*.

   As an example suppose p = .01, then the message retransmission approach requires 1.35 message transmissions. The packet transmission approach requires 1.03 message transmissions. Clearly packet-by-packet retransmission is better.

3. The main effect is that the expected time for transmission is reduced because when the error is detected a NAK is send and the sender can stop the transmission and initiate the retransmission of the frame. If the error is in the ACK then the sender will not have to wait for the time out. Always when there is an error in the ACK or NAK the last frame sent has to be retransmitted because the sender does not know if the frame was received with or without errors.

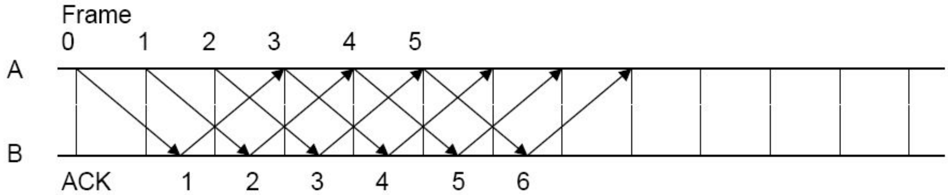
4. The propagation delay in an Ethernet LAN is negligible compared to the total transmission time of a packet from start to finish. Ignoring processing time and using the terminology in the chapter, we have:

$$t_o = t_f + t_{ack} = \frac{8(512+60)}{10\times10^6} + \frac{64}{10\times10^6} = 4.64\times10^{-4}$$

$$\eta_o = \frac{R_{eff}^0}{R} = \frac{\frac{n_f - n_o}{t_o}}{R} = \frac{\frac{8\times512}{4.64\times10^{-4}}}{10\times10^6} = 0.8828 = 88.3\%$$

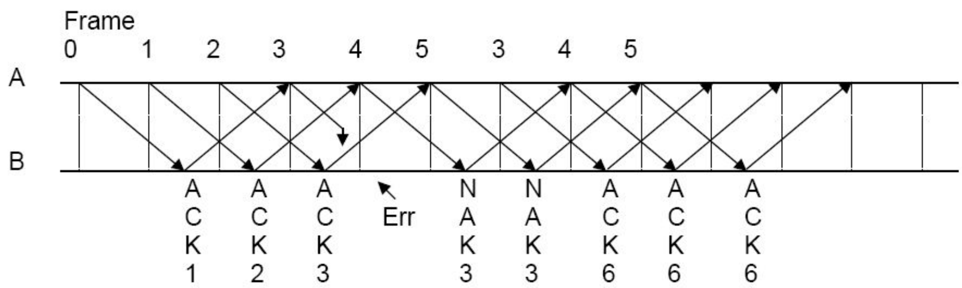
One more source of overhead occurs because the last packet is not full. However, this additional overhead accounts for a very small fraction of the total overhead and does not affect the above result.

5. الف) Station A sends six frames in a row, starting at t = 0. All frames are received correctly.



Tail of arrow: Initiates transmission at sender
Head of arrow: arrival of last bit at the receiver
Propagation delay = 0.5; Frame Length = 1; ACK Length = 1

ب) Station A sends six frame in a row, starting at t = 0. All frames are received correctly, except frame 3 is lost.



Tail of arrow: Initiates transmission at sender
Head of arrow: arrival of last bit at the receiver
Propagation delay = 0.5; Frame Length = 1; ACK Length = 1

6. Efficiency will be 50% when the time to transmit the frame equals the round-trip propagation delay. At a transmission rate of 4 bits/ms, 160 bits takes 40ms. For frame sizes above 160 bits, stop-and-wait is reasonably efficient.

7. To operate efficiently, the sequence space (actually, the send window size) must be large enough to allow the transmitter to keep transmitting until the first acknowledgement has been received. The propagation time is 18 ms. At T1 speed, which is 1.536 Mbps (excluding the 1 header bit), a 64-byte frame takes 0.300 msec. Therefore, the first frame fully arrives 18.3 msec after its transmission was started. The acknowledgement takes another 18 msec to get back, plus a small (negligible) time for the acknowledgement to arrive fully. In all, this time is 36.3 msec. The transmitter must have enough window space to keep going for 36.3 msec. A frame takes 0.3 ms, so it takes 121 frames to fill the pipe. Seven-bit sequence numbers are needed. There are four legal values per baud, so the bit rate is twice the baud rate. At
1200 baud, the data rate is 2400 bps.

8. Yes. It might lead to deadlock. Suppose that a batch of frames arrived correctly and were accepted. Then the receiver would advance its window. Now suppose that all the acknowledgements were lost. The sender would eventually time out and send the first frame again. The receiver would send a NAK. Suppose that this were lost. From that point on, the sender would keep timing out and sending a frame that had already been accepted, but the receiver would just ignore it. Setting the auxiliary timer results in a correct acknowledgement being sent back eventually instead, which resynchronizes.

9. Let t=0 denote the start of transmission. At t=1 msec, the first frame has been fully transmitted. At t=271 msec, the first frame has fully arrived. At t=272 msec, the frame acknowledging the first one has been fully sent. At t = 542 msec, the acknowledgement-bearing frame has fully arrived. Thus, the cycle is 542 msec. A total of k frames are sent in 542 msec, for an efficiency of k/542. Hence
(a) k = 1, efficiency = 1/542 = 0.18%
(b) k = 7, efficiency = 7/542 = 1.29%
(c) k = 4, efficiency = 4/542 = 0.74%