# CSC/ECE 570 Sections 001

# Spring 2021

# Homework #4

**Keywords:** Flow control, Data Link Layer, Media Access, contention protocols, Ethernet

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## Instructions

* You can do this homework in groups of two (at most). Only one submission per group.
* The total number of points is 48.
* You must answer all questions for full credit.
* Use only this paper for your answers, in the space provided.
* The due date is as posted on the web page (please submit your answers through Moodle).

# Questions: Answer the following questions. Justify your answers and be as precise as possible. Do not make unnecessary assumptions.

**[1] [4 points]** In the discussion of ARQ protocol in Section 3.3.3, a scenario was outlined that resulted in the receiver accepting two copies of the same frame due to a loss of acknowledgement frame. Is it possible that a receiver may accept multiple copies of the same frame when none of the frames (message or acknowledgement) are lost?

Ans.

Yes, it is possible. The reason is that an acknowledgement frame may arrive correctly, but after the sender’s timer has expired. This can happen if the receiver gets delayed in sending the acknowledgement frame, because its CPU is overloaded processing other jobs in the system. Or if acknowledgement is lost.

**[2] [4 points]** A channel has a bit rate of 16 kbps and a propagation delay of 40 msec. For what range of frame sizes does stop-and-wait give an efficiency of at least 50%?

Ans.

Efficiency will be 50% when the time required to transmit the frame equals the round-trip propagation delay. At a transmission rate of 16 bits/msec, 640 bits takes 40 mssec. For frame sizes above 640 bits, stop-and-wait is reasonably efficient.

**[3] [4 points]** A 2000-km-long T1 trunk is used to transmit 64-byte frames using protocol 5. If the propagation speed is 10 μsec/km, how many bits should the sequence numbers be?

Ans.

For Go Back to N:

* ‘N’ buffers are maintained on sender side and
* 1 buffer is maintained on receiver side

So, we need unique N + 1 sequence numbers.

So, the bits required would be Ceil log2(N+1) bits to represent these numbers.

Now let us find what the N should be.

* Since the propagation delay is 10 μsec/km, which means for 1 km it takes 10 μsec travel from one end to another.
* So, for 2000 km it would take 2000\*6 μsec to travel from one end to another end, which is 12000 μsec of total propagation delay.
* So RTT would be 2 \* 12000

So, to achieve full capacity, sender must keep on transmitting for this time.

T1 trunk has a 1.544 Mbps transmission speed and is full duplex.

This means,

* In 1 sec, 1.544 \* 106 bits can be loaded on link
* Or 1,000,000 μsec, 1.544 \* 106 bits can be loaded on link
* Or in 1 μsec, 1.544 \* 106 / 1000000 bits can be loaded on link
* So, in 2 \* 12000 μsec, 1.544 \* 106 \* 2 \* 12000 / 1000000 bits can be loaded on link
* Which comes to 37056 bits or 4632 bytes

Frame size is given as 64 bytes. So, 4632/64 packets or 72 packets can be sent

So, our N is 72 packets, so N + 1 is 73 packets

Bits needed for Ceil log273 which is 7 bits.

**[4]** **[4 points]** The distance from earth to a distant planet is approximately 9 × 1010 m. What is the channel utilization if a stop-and-wait protocol is used for frame transmission on a 64 Mbps point-to-point link? Assume that the frame size is 32 KB and the speed of light is 3 × 108 m/s.

Ans.

Link utilization = (1*/*(1 + 2*BD*))  
BD = bandwidth-delay product / frame size delay = (9 × 1010)*/*(3 × 108) = 300 sec

bandwidth-delay product = 64 ×300 = 19.2 Gb

*BD* = 19200000 */* 256 = 75000  
So, link utilization is 6.67 × 10−4 %

**[5]** **[4 points]** In the previous problem, suppose a sliding window protocol is used instead. For what send window size will the link utilization be 100%? You may ignore the protocol processing times at the sender and the receiver.

Ans.

For a send window size *w*, link utilization is *w/*(1 + 2*BD*). So, for 100% link utilization, *w* = 150001.

**[6] [4 points]** A large population of ALOHA users manages to generate 60 requests/sec, including both originals and retransmissions. Time is slotted in units of 60 msec.

(a) What is the chance of success on the first attempt?

(b) What is the probability of exactly k collisions and then a success?

(c) What is the expected number of transmission attempts needed?

Ans.

The channel traffic load rate G = 60 \* (60 \* 10-3) = 3 requests/slot. In one slot, k requests happen with the probability Gk \* e-G / k!

1. First attempt succeed with probability

Pr [no other request (new or retransmission) occurs within the first slot] = e-G = e-3 = 0.049.

1. If assuming that things happening in different slots are independent, the probability is

(1 – e-G)k \* e-G = 0.049 \* 0.951k

1. The expected number of transmissions needed:

E = traffic load / throughput = G/S = G/Ge-G = eG = 20.08

**[7] [4 points]** What is the length of a contention slot in CSMA/CD for (a) a 3-km twin-lead cable (signal propagation speed is 82% of the signal propagation speed in vacuum)?, and (b)

a 50-km multimode fiber optic cable (signal propagation speed is 65% of the signal

propagation speed in vacuum)?

Ans.

1. Propagation speed in twin lead = 2.46 \* 108 m/s.

Signal propagation speed = 0.82 \* 2.46 \* 108 m/s.

D = 3000 m

Tp = 3000 / 0.82 \* 2.46 \* 108 sec.

Contention Period 2Tp = (2 \* 3000) / (0.82 \* 2.46 \* 108) sec

1. Propagation speed in multimode fiber = 1.95 \* 108 m/s.

Signal Propagation speed = 0.65 \* 1.95 \* 108 m/s.

Contention Period = (2 \* 50000) / (0.65 \* 1.95 \* 108)sec.

**[8] [4 points]** How long does a station, s, have to wait in the worst case before it can start transmitting its frame over a LAN that uses the basic bit-map protocol?

Ans.

The worst case is where all stations want to send and *s* is the lowest-numbered station. Wait time *N* bit contention period + (*N* − 1) × *d* bit for transmission of frames. The total is -

*N* + (*N* − 1)*d* bit times.

**[9] [4 points]** In the binary countdown protocol, explain how a lower-numbered station may be

starved from sending a packet.

Ans.

If a higher-numbered station and a lower-numbered station have packets to send at the same time, the higher-numbered station will always win the bid. Thus, a lower-numbered station will be starved from sending its packets if there is a continuous stream of higher-numbered stations ready to send their packets.

**[10] [4 points]** Sixteen stations, numbered 1 through 16, are contending for the use of a shared channel by using the adaptive tree walk protocol. If all the stations whose addresses are prime numbers suddenly become ready at once, how many bit slots are needed to resolve the contention?

Ans.

Stations 2, 3, 5, 7, 11, and 13 want to send. Eleven slots are needed, with the contents of each slot being as follows:

Slot 1: 2, 3, 5, 7, 11, 13

Slot 2: 2, 3, 5, 7

Slot 3: 2, 3

Slot 4: 2

Slot 5: 3

Slot 6: 5, 7

Slot 7: 5

Slot 8: 7

Slot 9: 11, 13

Slot 10: 11

Slot 11: 13

**[11] [4 points]** Consider five wireless stations, A, B, C, D, and E. Station A can communicate with all other stations. B can communicate with A, C and E. C can communicate with A, B and D. D can communicate with A, C and E. E can communicate A, D and B.

(a) When A is sending to B, what other communications are possible?

(b) When B is sending to A, what other communications are possible?

(c) When B is sending to C, what other communications are possible?

Ans.

1. Since all stations will see *A*’s packet, it will interfere with receipt of any other packet by any other station. So, no other communication is possible in this case.
2. *B*/s packet will be seen by *E*, *A* and *C*, by not by D. Thus, *E* can send to *D*, or *A* can send to D, or *C* can send to *D* at the same time.
3. This scenario is same as (b).

**[12 [4 points]** What is the baud rate of classic 11-Mbps Ethernet?

Ans.

Classic Ethernet uses Manchester encoding, which means it has two signal periods per bit sent. The data rate is 11 Mbps, so the baud rate is twice that, or 22 megabaud.