

- Q.1 a) Assume a 100Mbps link of 10,000 meters in length with 5 nanoseconds per meter propagation delay. Assume constant length 400 byte data frames, 64 byte ACK frames, 10 microsecond of processing delay for each data frame, and 5 microseconds of processing time for each ACK. The sender always has data to send. Solve for link utilization (U) between a sender and a receiver assuming a stop and wait sliding window protocol. 6

Ans.

$$t_{pr} = 10,000 * 5e9 = 50 \text{ s}$$

$$t_{fr} = 8 * 400 / 100e6 = 32 \text{ s}$$

$$\text{Ack Delay : } t_{ack} = 8 * 64 / 100e6 = 5.12 \text{ s}$$

note that the processing delays are not negligible compared to these values so we must include them in our calculation of U...

$$U = t_{fr} / (t_{pr} + t_{fr} + t_{proc} + t_{ack} + t_{proc}) = 21\%$$

If t_{ack} and t_{proc} are neglected result would have been $U = 24\%$ which is more than 10% "off" from the real result confirming that to ignore these values would not have been correct to do

- b) Compare the efficiency of contention free protocols with respect to high and low network load. 6

Ans. Page 260 and 261 of Computer networks by andrew tanenbaum 4th edition

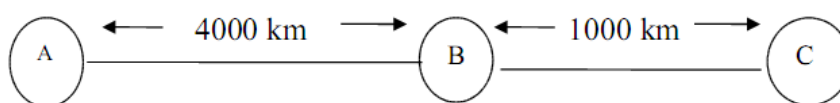
OR

- b) Explain the need of pipelining at data link layer with an example. 6

Ans. Page 217 of Computer networks by andrew tanenbaum 4th edition

- c) On what basis will you decide whether to use error detection or error correction technique at data link layer? Why is error control implemented at transport layer when it is already a part of data link layer? 6

- Q.2 a) In following figure frames are generated at node A and sent to node C through node B. 8



Determine the minimum transmission rate required between nodes B and C so that the buffers at node B are not flooded, based on the following:

- The data rate between A and B is 100 kbps.
- The propagation delay is 5 μ sec/km for both lines
- There are full duplex, errorfree lines between the nodes.
- All data frames are 1000 bits long; ACK frames are separate frames of negligible length.
- Between A and B, a sliding window protocol is used, with a window size of 3 (three).
- Between B and C, stop and wait is used.

Ans.

In order not to flood the buffers of B, the average number of frames entering and leaving B must be the same over a long interval.

A > B: Propagation time = $4000 \times 5 \text{ msec} = 20 \text{ msec}$

Transmission time per frame = $1000 / (100 \times 10^3) = 10 \text{ msec}$.

B > C: Propagation time = $1000 \times 5 \text{ msec} = 5 \text{ msec}$

Transmission time per frame = $x = 1000 / R$

R = data rate between B and C (unknown)

A can transmit three frames to B and then must wait for the acknowledgement of the first frame before transmitting additional frames. The first frame takes 10 msec to transmit; the last bit of the first frame arrives at B 20 msec after it was transmitted and therefore 30 msec after the frame transmission began. It will take an additional 20 msec for B's ack to return to A. Thus A can transmit three frames in 50 msec.

B can transmit one frame to C at a time. It takes $5 + x \text{ msec}$ for the frame to be received at C and an additional 5 msec for C's acknowledgement to return to A. Thus, B can transmit one frame every $10 + x \text{ msec}$, or three frames every $30 + 3x \text{ msec}$.

Thus:

$30 + 3x = 50$ $x = 6.66 \text{ msec}$ and $R = 1000 / x = 150 \text{ kbps}$.

- b) Assume CSMA/CD protocol. Find the minimum frame length for a 1Mbps bit rate and maximum network span of 10 kilometers with no repeaters. Assume a medium propagation delay of 4.5 nanoseconds per meter. Is CSMA/CD a reasonable protocol for a network of this span and bit rate? 6

Ans.

Minimum frame size for CSMA/CD is $2 \times T_{pr}$.

Propagation Delay : $T_{pr} = (4.5 \times 10^{-9}) \times (10 \times 10^3) = 4.5 \times 10^{-5} \text{ sec}$.

Thus, $(1.0 \times 10^6) \times (9.0 \times 10^{-5}) = 11.25 \text{ bytes}$.

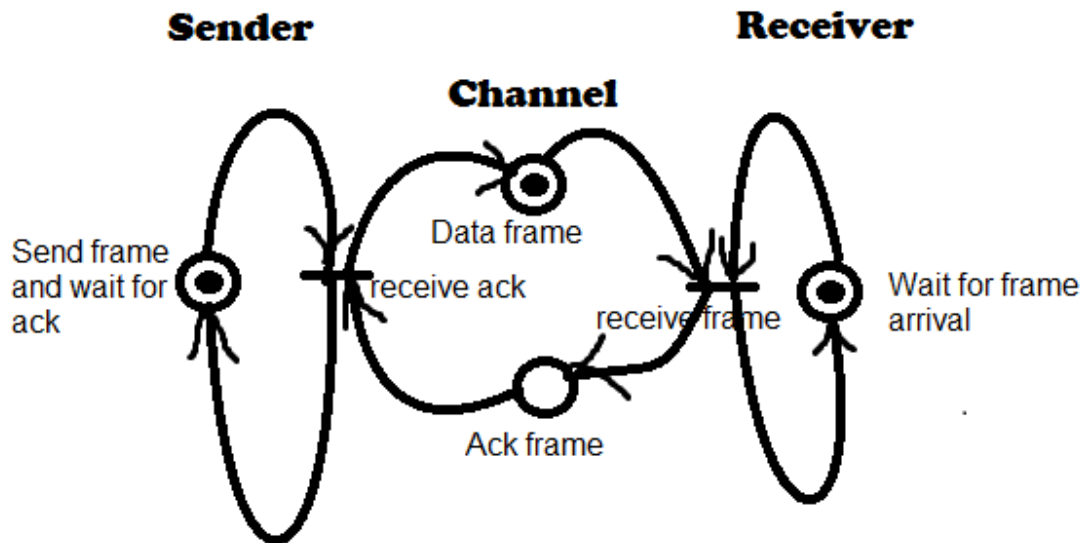
CSMA/CD would be a very reasonable protocol for a network of this span and speed since the minimum frame size is not "excessive" (e.g., larger than 64 bytes)

OR

- b) A bit stream 10011101 is transmitted using the standard CRC method described in the text. The generator polynomial is $x^3 + 1$. Show the actual bit string transmitted. Suppose the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. 6

- Q.3 a) i. What is the significance of time synchronization in communication protocols? 2
4
ii. Verify simplex stop and wait protocol for noiseless channel using Petrinet model.

Ans:



- b) A LAN uses Mok and Ward's version of binary countdown. At a certain instant, the ten stations have the virtual station numbers 8, 2, 4, 5, 1, 7, 3, 6, 9, and 0. The next three stations to send are 4, 3, and 9, in that order. What are the new virtual station numbers after all three have finished their transmissions? 6

Ans:

Initial	8, 2, 4, 5, 1, 7, 3, 6, 9, 0
4	8, 3, 0, 5, 2, 7, 4, 6, 9, 1
3	8, 0, 1, 5, 3, 7, 4, 6, 9, 2
9	9, 1, 2, 6, 4, 8, 5, 7, 0, 3

- c) 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 multiple of three suddenly become ready at once, how many bit slots are needed to resolve the contention? 6

Ans:

Slot Transmission

1. collision
2. collision
3. 3
4. 6
5. collision

6. collision

7. 9

8. 12

9. 15

Ans. 9 slots