Directions:

* All work must be done using Word, Visio, or Excel. No hand-written or hand-drawn work will be graded. Likewise, no pictures will be graded.

1. What is the total time required to send a 50 GB file from Host A to Host B over the below TCP/IP network using Ethernet?

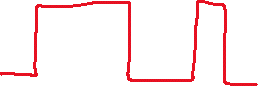
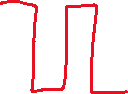
* The links have the following distance and bandwidth
  1. An 80 m copper link has a 100 Mbps bandwidth
  2. A 2,800 km fiber link has a 20 Gbps bandwidth
  3. A 3,500 km fiber link as a 120 Gbps bandwidth
  4. A 30m copper link has a 80 Mbps bandwidth
* Each switch is a store-and-forward switch that introduces the following delays between packets
  + Switch 1 introduces a 60 µs delay between packets
  + Switch 2 introduces a 50 µs delay between packets
  + Switch 3 introduces a 70 µs delay between packets
* A 2 RTT handshake is needed before data can be transmitted
* Your answer should be shown in seconds and be accurate to one tenth of a microsecond

Answered in Excel as seen below: 7,844,327.160474 seconds.



1. Show the NRZ encoding for the following bit pattern.



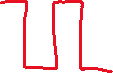
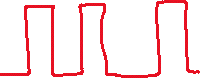


1. Show the 4B/5B encoding and then draw the resulting NRZI signal for the following bit sequence. Assume the NRZI sequence starts high.

1011 1101 0101 1101

A picture containing table

Description automatically generated



1. If the following frame arrived on a link using PPP, what is the actual data that was transmitted? (You do not need to show the binary/octal/hex representation of any character)

STX DLE ETX A DLE ETX B C DLE STX D ETX

The actual data transmitted in this frame is A ETX B C STX D.

1. The following HDLC frame was received by a host. Does it have an error or not? If so, explain the error.

0111111011010111110111011101111001110111110110011111110

There is an error in this frame. Because HDLC will do bit stuffing to prevent 6 consecutive 1s from occurring in the frame, we know the only area that will have 6 consecutive 1s is the beginning or ending special delimiter. However, in this case, we have 7 consecutive 1s where the end delimiter should be. Since 6 consecutive 1s is the absolute most we would ever expect, having 7 1s in a row means this frame is erroneous.

1. Which encoding scheme is more efficient, Manchester or 4B/5B with NRZI? Why?

4b/5b with NRZI is more efficient than Manchester encoding because Manchester requires twice the bandwidth since each bit in the signal requires two transitions, as opposed to the minimal number of transitions in NRZI. NRZI’s only downfall is it doesn’t have a solution for consecutive 0s, but 4b/5b solves that problem because the most consecutive 0s in 4b/5b is 3.

1. What would the CRC be for the following message? Use the CRC-3-GSM polynomial. Show your work in the table below. Expand the table as necessary

M(x) 1101 1011 1000

|  |  |  |
| --- | --- | --- |
|  | X1 | X0 |
| T(x) |  |  |
| C(x) |  |  |
| XOR |  |  |

The calculated CRC is 111



1. Compute the checksum for the following data.

01101110 11011001 11101101 00101100 11110100 01011010 01111000 11000011 11111000 00001100

First, we add the first 16 bits to the second 16 bits:

0 0110 1110 1101 1001

0 1110 1101 0010 1100

1 0101 1100 0000 0101

0 0000 0000 0000 0001

0 0101 1100 0000 0110

Now, we add the next 16 bits to this result:

0 0101 1100 0000 0110

0 1111 0100 0101 1010

1 0101 0000 0110 0000

0 0000 0000 0000 0001

0 0101 0000 0110 0001

Now, we add the next 16 bits to this result:

0 0101 0000 0110 0001

0 0111 1000 1100 0011

0 1100 1001 0010 0100

And finally, we add the last 16 bits to this result:

0 1100 1001 0010 0100

0 1111 1000 0000 1100

1 1100 0001 0011 0000

0 0000 0000 0000 0001

0 1100 0001 0011 0001

Now we must bitwise negate the sum, so we end with:

0 0011 1110 1100 1110

1. Using Visio, draw the timeline for a sliding window algorithm where SWS = RWS = 5. Use a timeout interval of 2 RTTs. Show the successful transmission and acknowledgement of Frames 1 thru 8. Assume that on the first attempt Frame 4 is transmitted, it is lost before it gets to the receiver. On the second attempt, Frame 4 is successfully transmitted and received.

Solved in Visio:

Chart

Description automatically generated with medium confidence

1. What is the maximum number of bits that could be in a 10 Gbps fiber link that is 1 kilometer long?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Delay x Bandwidth (round trip) |  |  | Link Length (Meter) | Bandwidth (bps) | Optical |
| 100,000 | bits |  | 1,000 | 10,000,000,000 | 200,000,000 |

Therefore, we can have at most 100,000 bits in this circuit.