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



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

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

0111111011010111110111011101111001110111110110011111110

1. Which encoding scheme is more efficient, Manchester or 4B/5B with NRZI? Why?
2. 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 |  |  |

1. Compute the checksum for the following data.

01101110 11011001 11101101 00101100 11110100 01011010 01111000 11000011 11111000 00001100

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