1. (2 pts each) Write a short response to the following:
   (a) What is the primary difference between circuit switching and packet switching?
   In circuit switching, messages flow over end-to-end connections that are set up and last for a relatively long period of time. In packet switching, messages are broken into segments that are dynamically routed through the network.

   (b) In a client/server arrangement, which node makes the request?
   Client

   (c) What do we call the process of adding protocol header information to a segment of data?
   Encapsulation

   (d) Of simple parity, 2D parity, checksum, and CRC, which ones can be used to correct errors?
   Only 2D parity

   (e) Name the three components of network delay.
   Propagation Delay (or Latency), Transmission delay, Queueing Delay

   (f) How can a modem have a bit rate that is four times its baud rate?
   Use 4 signal tones with each representing 2 data bits.

   (g) What is the primary advantage of the Sliding Window Algorithm over the ARQ algorithm?
   SWS "fills the pipe" while ARQ usually has low link utilization.

   (h) What do IP, TCP, and UDP stand for?
   Internet Protocol, Transmission Control Protocol, User Datagram Protocol

   (i) Why does the BISYNC protocol need no field for body size?
   BISYNC uses sentinel bytes to delimit the body

   (j) If someone told you about a "200Base3" Ethernet, what would you assume about it?
   200 Mbps, segments up to 300 m long

   (k) For what types of applications might you prefer to use "Thicknet" over "Cat 5"?
   If you need high reliability, especially in a noisy (electrically) environment. Or if you needed longer segment runs between repeaters.

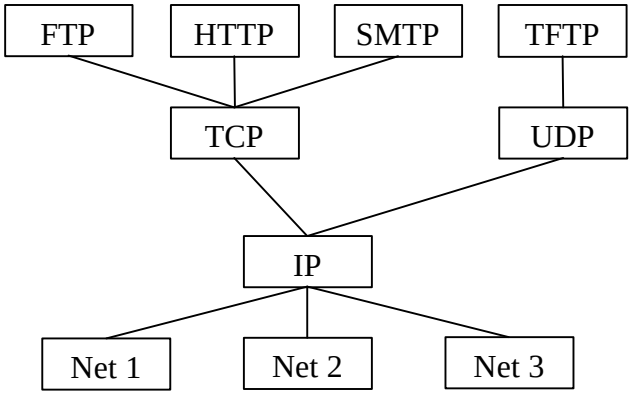
   (l) Where might you use an Ethernet Network Adaptor in the promiscuous mode?
   In a network monitor (or "sniffer")

   (m) What is IEEE 802.3? IEEE 802.5?
   The Ethernet and Token Ring standards, respectively

2. (10 pts) What is the minimum network delay for 10 MB packets transmitted 100 Km over a 1 Mbps fiber link?

   Minimum network delay = Propagation delay + Transmission delay
   = (distance / c) + (packet size / Bandwidth)
   = ($100x10^3$m / $2x10^8$mps) + (10x2^{20} Bytes x 8 bits per Byte / $1x10^6$bps)
   Using 2^{20} ~= $1.05x10^6$
   = ($50x10^{-5}$) + (10x$1.05x10^6$ x 8 / $1x10^6$) s
   = 50x10-5 + 10x1.05x8 s
   = 84.0005 s

3. Answer the following:
   (a) (4 pts) Sketch the TCP/IP protocol "stack".

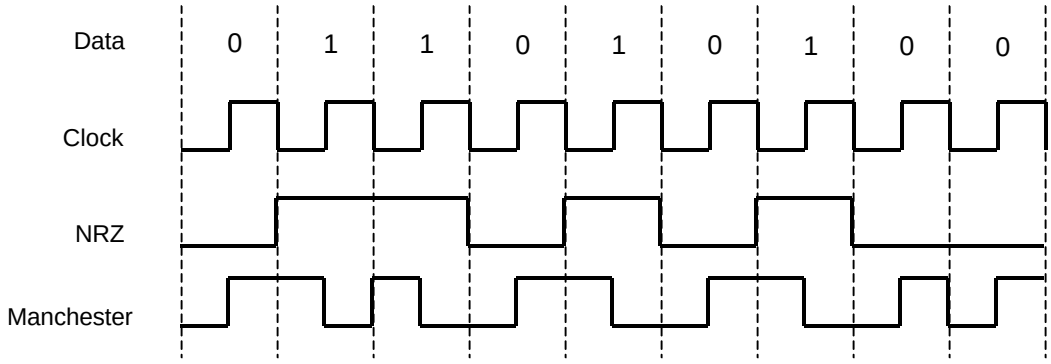


I accepted any variant of this that correctly placed TCP, UPD, IP, and the Application and Network Protocol Layers. I also accepted the "stairstep" representation of the stack.

(b) (3 pts) Explain what purpose IP, TCP, and UDP each serve.
IP provides a single packet-oriented interface to multiple networks, potentially with different protocols. TCP implements a reliable byte-steam channel. UDP implements an unreliable byte-stream channel.

(c) (3 pts) What layers of the OSI architecture do IP and TCP correspond to?
IP roughly corresponds to the Network layer, TCP to the Transport layer.

4. Encode the bit string '011010100' using:
   (a) (5 pts) NRZ
   (b) (5 pts) Manchester encoding



5. A link uses the Sliding Window Algorithm we discussed in class. Given these states of the sender at times t=12 and t=13,

At t=12:		At t=13:	
	S		S
LAR →	1		1
	2		2
	3 → Data (frame 3)		3
LFS →	4		4 ← ACK (frame 4)
	5		5

(a) (3 pts) What is the Send Window Size?
LFS-LAR = 3

(b) (4 pts) What do you know about the transmission of frame 3?
Since at t=12, we're sending frame 3 and at t=13, we get an ACK for frame 4, we know that frame 3 is being sent after frame 4. This means that a preceding send of frame 3 must have failed and that the transmission at t=12 is a re-send which succeeds (if it had failed, we would not get the frame 4 ACK).

(c) (3 pts) What are the new values of LAR and LFS at t=13?
LAR=4, LFS=7

6. Answer the following questions about Point-to-point protocols:
(a) (5 pts) Assume you are receiving the data segment of a BISYNC frame. Decode the following, identifying the end of the data segment:

```
Byte n:   DLE
Byte n+1: DLE
Byte n+2: DLE
Byte n+3: ETX
Byte n+4: ETX
```

DLE ETX ETX (The first ETX is the end of the data segment – I'll also accept the second ETX, which is the sentinel byte marking the end of the data segment.

(b) (5 pts) Assume you are receiving the data segment of an HDLC frame. Decode the following, identifying the end of the data segment:

```
Byte n:    0 1 0 1 1 0 0 0
Byte n+1:  1 1 0 0 0 1 1 1
Byte n+2:  1 1 0 1 0 0 1 1
Byte n+3:  1 1 1 1 0 0 1 1
Byte n+4:  0 1 1 1 1 1 1 0
```

```
                                        |<- stuffed 0 removed
0 1 0 1 1 0 0 0 1 1 0 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0
                                            |end marker     |
```

note, the remainder of the bits fall after the end marker

7. Answer the following questions about the "10Base__" Ethernets:
(a) (4 pts) Sketch the frame format.

Preamble (8 Bytes)	Dest Addr (6 Bytes)	Source Addr (6 Bytes)	Len (2)	Body (46 to 1500 Bytes)	CRC (4 Bytes)

(b) (2 pts) What are two special addresses and what do they do?
FF : FF : FF : FF : FF : FF --- Broadcast
Any address with the high-order bit set -- Multicast

(c) (1 pt) What do we mean when we say that the Ethernet uses "Carrier Sense"?
That nodes can detect when the network is busy

(d) (3 pts) If we developed a new 10Base__ Ethernet specification that increased the allowable total cable length from 2500m, would the minimum frame length be more likely to decrease or to increase?
Increase

(e) (4 pts) Write the steps in the Ethernet MAC Transmit Algorithm.

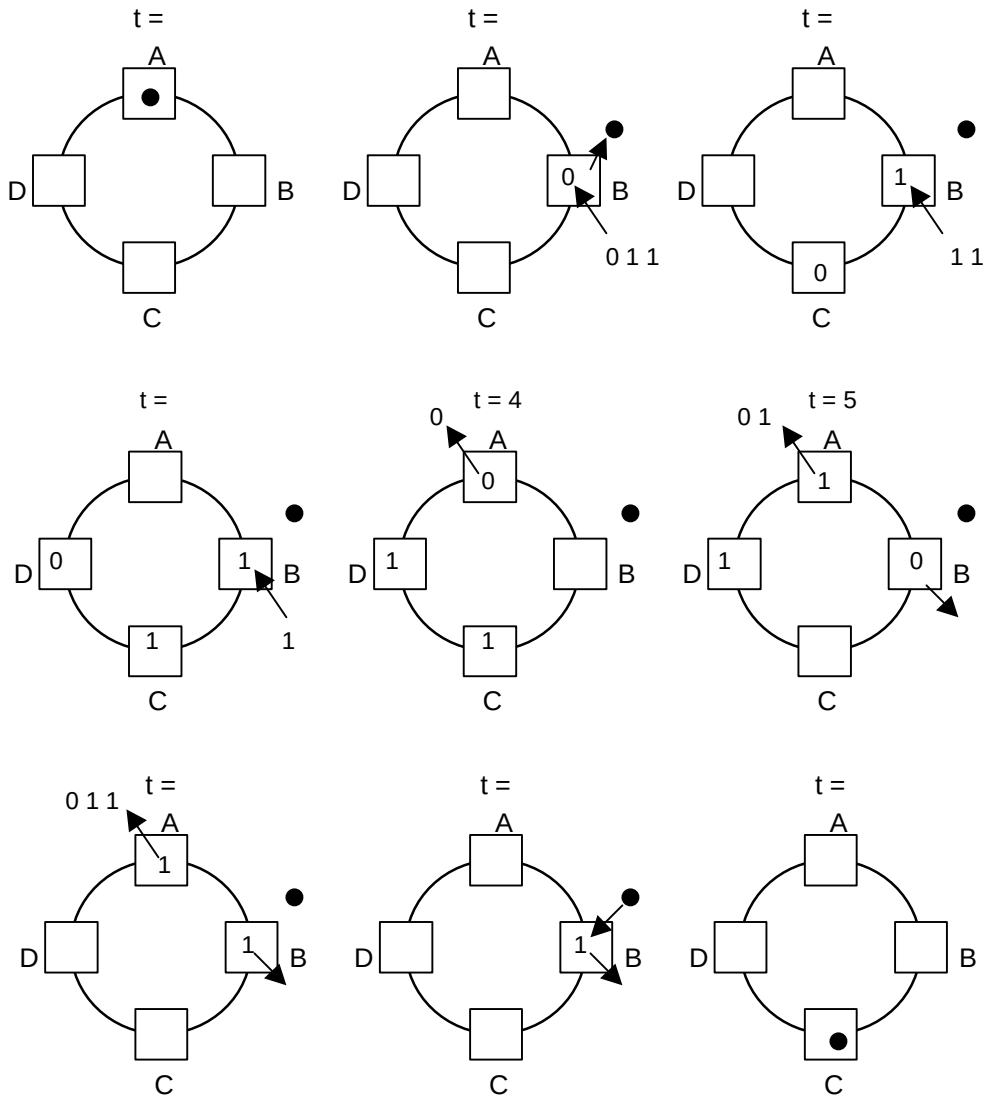
-- If the line is idle, send a frame

-- If the line is busy, wait until it is idle, then send immediately

-- If you are sending and there is a collision, send Jamming signal, then stop sending and wait according to the exponential backoff algorithm

8. (10 pts) For the Token Ring network shown below, show the network state for times 0,1,…8, given that:
   - Data moves clockwise one position at each time
   - Node B wants to send the bit string '0 1 1' to node A
   - At time 0, the token is at Node A.

   You may use a "one-bit token" as we did in the classroom example.



Bonus (10 pts)
I need to send a copy of a book to a friend who lives "m" Km away. I have three options for how I can send it:

(1) I can fax the pages of the book,
(2) I can transmit the book as a text file over a 1Kbps link,
(3) I can get my dog Red to carry the book to my friend in a dog backpack.

Assume:

- The fax machine runs at 14.4 Kbps and transmits 8x10 inch pages at a resolution of 72 pixels per inch (horizontally and vertically) and one bit per pixel.
- The book has 750 8x10 inch pages, each of which contains 3000 characters.
- Transmission latency is negligible.
- Red can run 10Km per hour.

Determine the following:

(a) Approximately how long, in hours, does it take to fax the book?
(b) Approximately how long, in hours, does it take to send the book as a text file?
(c) For what range of "m" is it fastest to use Red to deliver the textbook?

ANSWER:

(a):

Bits per page = (8x10) x (72x72) bits =~ 4.15×10^5 bits
Bits per book = 4.15×10^5 x 750 =~ 31.1×10^7 bits
Total fax time = (31.1×10^7 bits) / (14.4×10^3 bits/sec) =~ 2.16×10^4 sec =~ 6 hours

(b): Characters (bytes) per book = 3000 x 750 =~ 2.25×10^6
Bits per book = 2.25×10^6 x 8 =~18×10^6 bits
Total transmit time = (18×10^6 bits) / (1×10^3 bits/sec) = 18×10^3 sec =~ 5 hours

(c): If Red can deliver the book in less than 5 hours, he will be the fastest. In 5 hours, he can run 50 Km. So if m<50, it is fastest to use Red to deliver the book.

Quiz 1 Grades

Range = 42.7 – 108. Mean = 84.5

YOUR HOMEWORK SCORES TO DATE

#1 _____ /80

#2 _____ /30

#3 _____ /30

#4 _____ /20

If your records disagree, let me know

#4 _____ /20