EC3850 29 Oct 1998
Name: Key TEST 1

1. (25) Short Answers:

a. (7) Name all of the layers of the OSI network protocol architecture model.

Physical, Data Link, Network, Transport, Session, Presentation, Application

b. (9) Assume that a telephone-line channel is equalized to allow bandpass data transmission over a frequency range of 600 to 3000 Hz. The available bandwidth is 2400 Hz with a center frequency of 1800 Hz. Will this bandwidth be adequate to achieve 9600 bps using 32-level signaling and $r = 0.1$? Show your work.

For multilevel signaling:

$$B_T = \left(\frac{1+r}{\log_2 M}\right) R = \left(\frac{1+0.1}{\log_2 32}\right) 9600$$

$$= \frac{1.1}{5} 9600 = 2112 < 2400$$

Yes

(See problem 4.13)

c. (9) Two stations communicate via a 155 Mbps suboceanic cable with a propagation delay of 27 ms. Using HDLC frames of total length 1500 bits with 3-bit sequence numbers and standard addressing, what is the maximum possible data throughput (not counting overhead bits)? Please indicate what method of error control is being used. (See problem 6.20)

Time to transmit 1st frame and receive an ACK =

$$2 t_{prop} + t_{frame} = 2 \cdot .027 + \frac{1500}{155(10)^6}$$

$$= 0.054 + \underbrace{9.7(10)^{-6}}_{\text{NEGLIGIBLE}} = 0.054$$

HDLC has a 24 bit header + 24 bit trailer

$\Rightarrow$ 48 overhead bits $\Rightarrow$ 1500 - 48 = 1452 data bits

IF YOU CHOSE GO-BACK-N: max $N = 2^K - 1 = 7$

$$\text{Throughput} = \frac{7 \cdot 1452}{0.054} = 188 \text{ kbps}$$

IF YOU CHOSE SELECTIVE REJECT: max $N = 2^{K-1} = 4$

$$\text{Throughput} = \frac{4 \cdot 1452}{0.054} = 108 \text{ kbps}$$

2. (25) Multiple choice. Please circle the correct answer.

a. (3) Which of the following protocols is not derived from HDLC?

a. LAPB b. PPP c. SLIP d. LLC

b. (3) Which type of optical fiber is the least expensive to install?

a. Category 3 b. Multi-mode c. Cladding d. Single-mode

c. (3) A 1.544 Mbps statistical multiplexer has 100 stations attached by 64 Kbps lines. Each station transmits an average of 9% of the time. What is the utilization of the multiplexer?

a. 37.3% b.8.9% c. Overutilized (>1) d. 3.7%

d. (3) Signal balancing represents a trade-off in:

a. signal frequency b. signal gain
c. data rate d. propagation delay

e. (3) The standard that defines implementation of Local Area Networks is:

a. IEEE 803 b. IEEE 820 c. IETF 803 d. IEEE 802

f. (2) This new multiplexing technique will facilitate the extremely high data rates of the future:

a. FDM b. CDM c. WDM d. ATM

g. (3) . Which of the following requires the most sophisticated logic to implement?

a. Go-Back-N b. Stop and Wait c. Selective Reject d. Stop-N-Go-Back

h. (2) Timing jitter is a significant concern within a ring LAN topology compared to other topologies.

a. True b. False

i. (3) UTP stands for:

a. Unguided Twisted Pair b. Unshielded Twisted Pair
c. Unanswerable Test Problems d. Uniform Tension Pair

j. (2) SONET, DS-1 and ISDN are all standards based on synchonous time division multiplexing.

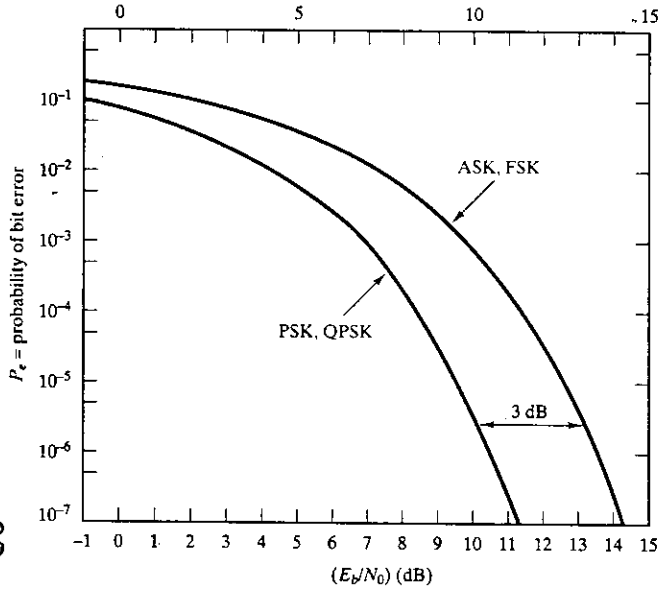
a. True b. False

3. (25) You are designing a network to run between two buildings separated by 180 m. Contractors have already installed a coax cable with a data rate of 155 Mbps and an transmission bandwith of 232.5 MHz using ASK modulation. The SNR of this line is 8.8 (9.44 dB). You are only allowed to transmit frames of length 15 bits.

a. (7) Using the plot at right determine the probability that any give frame is in error.

b. (10) Determine the best ARQ method to use based on line utilization. (Show all work)

c. (8) Determine which ARQ method should be used based on the average number of frames that must be transmitted in order to successfully transmit a single frame. (Show your work)



a. $\frac{E_b}{N_0} = \frac{S}{N} \cdot \frac{B_T}{R} = 8.8 \frac{(232(10)^6)}{(155(10)^6)}$

$= 13.2$

$\frac{E_b}{N_0}_{dB} = 10 \log_{10}(13.2) = 11.2$ dB

From plot (for ASK): $P_e \approx 10^{-4}$

$\Rightarrow P_r[\text{frame error}] = P = 1 - (1 - P_e)^L = 1 - (.9999)^{15} = 0.0015$

Note: Parts b & c below assume $N > 2a+1$ (easiest case)
Your choice of N will give different answers.

b. $a = \frac{Rd}{LV} = \frac{155(10)^6 \cdot 180}{15 \cdot 2(10)^8} = 9.3$

Go-back-N: $U = \frac{1-P}{1+2aP} = \frac{.9985}{1+2(9.3).0015} = 0.971$

Selective Reject: $U = 1 - P = 0.9985$ ←

Stop and Wait: $U = \frac{1-P}{1+2a} = \frac{.9985}{19.6} = 0.05$

Selective Reject gives the best U for max N

c. Go-back-N: $N_r = \frac{1}{U} = 1.03$

Selective Reject: $N_r = \frac{1}{U} = 1.002$

Stop & Wait: $N_r = \frac{1}{1-P} = 1.002$

Both Stop & Wait and Selective Reject require the lowest average retransmissions for max N

4. (25) The message 10010011 is transmitted over a 35 Mbps data link with a propagation time of 1 μs. The message includes a three bit sequence number. Go-Back-N ARQ is used.

a. (5) What is the maximum window size, N, that can be used?

b. (7) What is the minimum FCS length (in bits) that can be appended to the message that still achieves maximum utilization?

c. (3) Give a polynomial divisor in polynomial form which is suitable for use with this message.

d. (10) Find the FCS for the above message using the polynomial you gave in (c).

a. Go-back-N $\Rightarrow$ max $N = 2^K - 1 = 2^3 - 1 = 7$

b. Max utilization occurs when $N \geq 2a + 1$

$\Rightarrow 7 \geq 2\left(\frac{T_{prop}}{L/R}\right) + 1 = 2\left(\frac{10^{-6}}{L} \cdot 35(10)^6\right) + 1$

$\Rightarrow L \geq 11.67$, Choose $L = 12$ bits

8 message bits $\Rightarrow$ 4 bit FCS

c. P should be $4+1 = 5$ bits

An example of P is $x^4 + x^2 + 1$ (need at least x^4 in polynomial)

d.

```
          10110101
      ┌──────────
10101 │ 10010011 0000
        10101
        ─────
         11101
         10101
         ─────
          10001
          10101
          ─────
           10000
           10101
           ─────
            10100
            10101
            ─────
             0001   ← FCS
```