Data Communication Networks
HW 1: Physical Layer

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Problem 1 (10 pts)

Assume a network with these conditions. The call setup time is t_{setup} sec, the propagation delay is t_{prop} sec per hop, the packet size is P bits, and the transmission rate of each link is R bps.

(a) Compute the delay, from the first bit transmitted to the last bit received, in sending an M-bit message over a K-hop path in a circuit-switched network and in a packet-switched network. In packet switching, the queuing delay of each hop is t_{queue} (The packet header size is H bits).

(b) For $M = 100$, $H = 8$, $R = 56$ Kbps, $t_{prop} = 1.5$ ms, $t_{queue} = 0.4$ ms and $K = 3$ in packet switching mode, calculate the minimum possible transmission time.

Problem 2 (15 pts)

Suppose two hosts are separated by 20000 kilometers and are connected by a direct link of R = 2 Mbps. Suppose the propagation speed over the link is 2.5×10^8 meters/sec.

(a) Calculate the bandwidth-delay product.

(b) Consider sending a file of 800,000 bits from source to destination. Suppose the file is sent continuously as one message. What is the maximum number of bits that will be in the link at any given time?

(c) Provide an interpretation of the bandwidth-delay product.

(d) Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.

Problem 3 (15 pts)

We sent 6 packets of data, one after another, through the channel below. The box in the figure depicts a routing device and when sending the first packet, the queue in the routing device is completely vacant. The passing times $(T_B - T_A)$ of these packets were recorded, but when saving the values, their order was lost. The values are $\{10$ ms, 2.8 ms, 2.4 ms, 3 ms, 4 ms, 5.5 ms$\}$. Calculate the average queuing delay.

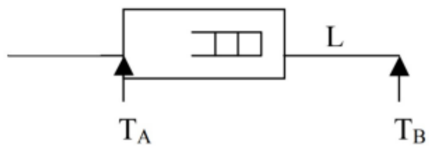


Figure 1: channel

Problem 4 (10 pts)

Suppose an operator is allocated 2.5 MHz of spectrum. The operator provides service that requires a 60 KHz half-duplex channel per each served user. A gaurd band of 30 KHz is needed between any two adjacent channels.
What is the maximum number of users that this operator could serve simultanerosly?

Problem 5 (10 pts)

Suppose that we have a channel with a bandwidth of 200 kHz and also that the SNR of the receiver is 40dB. How many T1, T2, E1, and E2 signals can be sent through this channel?

Problem 6 (10 pts)

Suppose that A, B, and C are simultaneously transmitting bits, using a CDMA system with the chip sequence of below:
A=(-1 -1 -1 +1 +1 -1 +1 +1)
B=(-1 -1 +1 -1 +1 +1 +1 -1)
C=(-1 +1 -1 +1 +1 +1 -1 -1)
D=(-1 +1 -1 -1 -1 -1 +1 -1)
Add another station (E) so that stations can still transmit signals simultaneously.
Find sequence chip of this scenario:
A and E send +1 bit.
C sends -1 bit.
others send 0 bit.

Problem 7 (15 pts)

In a bitstream consider that the probability of having a 0 is five times having a 1.

(a) Compare the power of bitstreams encoded with (i) Manchester encoding, (ii) NRZ(with 0 amplitude for 0), (iii) NRZI (with 0 amplitude for 0) and, (iv) AMI (Amplitude Mark Inversion, also called Bipolar encoding).

(b) For each one of the aforementioned encodings, identify whether it can have problems regarding clock synchronization with:

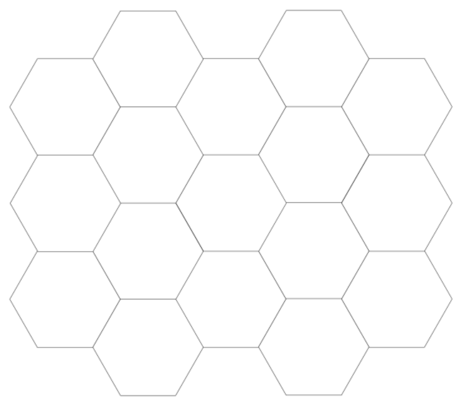
- Long strings of conservative 0s
- Long strings of conservative 1s

Problem 8 (15 pts)

Consider a T1 carrier and answer the following questions:

(a) If a T1 carrier system slips and loses track of where it is, it tries to resynchronize using the first bit in each frame. How many frames will have to be inspected on average to resynchronize with a probability of 0.001 of being wrong?

(b) We want to create cellular networks to provide call service to subscribers. To do this, we divide the area into hexagonal cells with the same area. We have 840 separate frequency bands and each frequency band can transmit one T1 carrier. The use of similar frequency bands is prohibited in adjacent cells. What is the maximum number of frequency bands that can be assigned to each cell? In this case, how many subscribers are served by one cell?



What Should I Do?

You must upload a pdf file containing your homework answers (*DN_HW1_StudentNumber.pdf*) for this assignment.