T03: Data Link Layer I

Q1: Consider the case of transmitting 1250 Bytes frame over on a link with a delay of 200ms (millisecond) when the length of the link is 200km. Assume that acknowledgment packets are of negligible size, processing time at a node is negligible, and the link is error-free.

Calculate the transmission efficiency of following ARQ methods if the bandwidths and the lengths of the link are 1Kbps, 1Mbps, 1Gbps and 20Km, 200Km, 2000Km, 20000Km respectively.

a. Stop-and-wait ARQ?

b. Go-Back-N ARQ where W is large enough to keep the channel fully busy?

c. Selective-Repeat ARQ where W is 7?

Q2: Consider a sliding window protocol (Go-Back-N ARQ) used for flow control on a given data link where the data rate is 8,000 bits/second, the propagation delay is 0.25 second, and the frame size is 1600 bits. Assume that acknowledgment packets are of negligible size, processing time at a node is negligible, and the link is error-free. What is the minimum window size which will allow full utilization (efficiency) of the link?

Q3: Assume data in 8-bit words as shown below:

10011001 11100010 00100100 10000100

a. Calculate the checksum at the sender's end and the receiver's end

b. State an example of an error that checksum fails to detect?

Q4: Given the data word (1011011), or data polynomial $D(x) = x^6 + x^4 + x^3 + x^1 + 1$ and given the generator polynomial $G(x) = x + 1$?

a. Find the codeword C(x)

b. Assume the received message H (x) is

H(x) = C(x) + E(x), where E(x) is the error polynomial

i. When H(x) contains no errors show that H(x) is divisible by G(x)

ii. Determine whether the error is detectable when:

- $E(x) = 1$
- $E(x) = x + 1$
- $E(x) = x^3 + x$

Q5: Show **byte-stuffing & destuffing** steps for the following data bits if **PPP frame** is used?

0100000101111101010000100111111001010000011100000100011O

Q6 (Optional): In some networks the data link layer requests all damaged frames to be retransmitted. Assume that the acknowledgement frame is never lost. If the probability of a frame being damaged on a particular link is *p*, what is the normalized throughput of the link if stop-and-wait ARG is used?

[Hint: $\sum_{i=1}^{\infty}(i \times x^{i-1}) = \frac{1}{(1-x)^2} \quad for(-1 < x < 1)$]