ID: A20447935 Data Link Layer

Name: Alan Palayil Assignment #2

1) The output after stuffing:

A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D

2) The maximum overhead in byte-stuffing algorithm is 2n. (where n is the number of bytes in the payload).

3) The data after de-stuffing:

0110 0111 1101 1110 1111 11

4) $16 = m \quad r = 2^r - 1 - r \quad \therefore r = 5$. Check bits are needed at positions 1, 2, 4, 8, 16.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111	10000	10001	10010	10011	10100	10101
P1	P2	1	P3	1	0	1	P4	0	0	1	1	0	0	1	P5	1	0	1	0	1

P1 is the parity bit for all bits in positions with a 2^0 term (3, 5, 7, 9, 11, 13, 15, 17, 19 & 21)

P1 ⇒ (1110101111). P1 = 0.

P2 is the parity bit for all bits in positions with a 2^1 term (3, 6, 7, 10, 11, 14, 15, 18, 19)

P2 ⇒ (1010101011). P2 = 1

P3 is the parity bit for all bits in positions with a 2^2 term (5, 6, 7, 12, 13, 14, 15, 20, 21)

P3 ⇒ (1011001011). P3 = 1

P4 is the parity bit for all bits in positions with a 2^3 term (9, 10, 11, 12, 13, 14, 15)

P4 ⇒ (0011001). P4 = 1

P5 is the parity bit for all bits in positions with a 2^4 term (17, 18, 19, 20, 21)

P5 ⇒ (10101). P5 = 1

The bit pattern transmitted for the message is 01111011001100111010101.

5) a) Bit stream is 10011101
Generated polynomial is 10101
Sender side binary division

```
10101 ) 100111010000 ( 1111
        10101
        -----
         11010
         10101
         -----
          1111
          10101
          -----
          10100
          10101
          -----
          01000  → CRC
```

In receiver side

```
10101 ) 100111011000 ( 1111
        10101
        -----
         11010
         10101
         -----
          11111
          10101
          -----
          10101
          10101
          -----
          00000  → all are '0'.
```

So there is no error bits.

b) If the third bit is inverted from the left during transmission. Then the receiver side the bit stream will be like this 10111011000 we can check if it has error. By following:

```
10101 ) 101111011000 ( 11
        10101
        -----
         10101
         10101
         -----
          01000  → It has to be '0' all but that is not occured.
```

∴ So, error can be checked, CRC method.

c) If the error message is a multiple of $G(x)$, then the error will not be detected. Examples are message will be all 0's, 10011100101, or 10010100100.

6) No. of frame = 8

∴ 0.6 % chance for attaining undamaged frames.

$p = (0.6)^8$

$= 0.0168$

The average trials of expected number of transmissions ahead successful reception $E = 1/p$

$E = \frac{1}{0.0168}$

$= 59.54 \simeq 60$ times.

7) 512 bytes × 8 bits/B = 4096 bits per frame.

$\frac{4096}{128000}$ bps = 32 msec to send one frame.

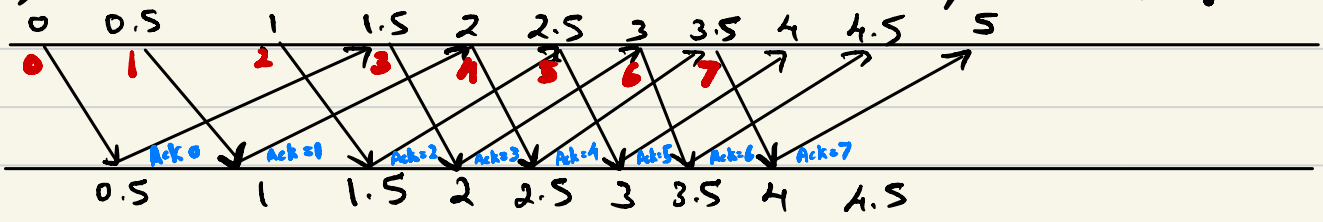
Round trip delay = 250 msec

∴ Window size 1 = $\frac{4096 \text{ bits}}{250 \text{ msec}} = 16.384 \times 10^3$ bps

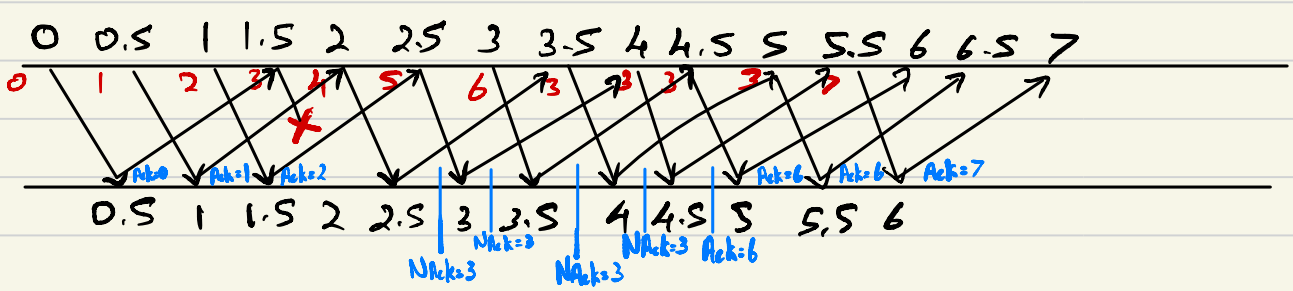
∴ Window size 7 = $16.384 \times 10^3 \times 7 = 114688$ bps

Window size 9 & greater : $16.384 \times 10^3 \times 9 = 147456$ bps but maximum capacity is 128 Kbps so for windows 15 & 127 it's 128 Kbps.

8) a) N = 7, time out = 2 , $t_{prop} = 0.5$, $ACK_{piggy} = 1$



b)


0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7
0 1 2 3 4 5 6 3 3 3 3 5 6
X
Ack=0
Ack=1
Ack=2
Ack=6
Ack=6
Ack=7
0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6
NAck=3
NAck=3
NAck=3
Ack=6