HW #2 Solution

1) Text #8 BISync

Last 2 Data Bytes are DLE ETX

```
... DLE    DLE   DLE    ETX    ETX
     ↑      ↑     ↑      ↑      ↑
   escape  data escape  data  End of text
```

2) Text #18 $M(x) = 11100011$

$C(x) = x^3 + 1 \equiv 1001$

a)

```
              11111100
1001 ) 11100011000
       1001
       ----
        1110
        1001
        ----
         1110
         1001
         ----
          1111
          1001
          ----
           1101
           1001
           ----
            1000
            1001
            ------
            000100
```

Remainder is 100

Transmit

$T(x) = \underbrace{11100011}_{M(x)}\underbrace{100}_{\text{remainder}}$

b) Receiver receives 01100011100

```
               1101110
1001 ) 01100011100
        1001
        ----
         1010
         1001
         ----
           1111
           1001
           ----
            1101
            1001  →  01000
                      1001
                     -----
                     00010  remainder
```

Remainder of 010 Indicates an error occurred

3) text #20 $c(x)=1101$

a) $p=110$ find quotient of $p+000$ and $p+111$ divide by $C=1101$

```
          100
1101 | 110000
       1101
        0100
```

$q=100$

```
         100
1101 | 110 111
       1101
        0011
```

$q=100$

} Same, does not matter if we add all 1's or all 0's

This holds for other p's as well

b) i) find q for $p=011$

```
        000010
1101 | 011000
        1101
         010
```

$\boxed{q=010}$

find q for $p=111$

```
           101
1101 | 111 000
       110 1
       001 100
         1 101
          0001
```

$\boxed{q=101}$

ii) find $C\times q$ for $p=010$, $q=011$

```
   1101
    011
   ----
   1101
  1101
 0000
 ------
 010111
```

$\boxed{C\times q = 010\underline{111}}$

find $c\times q$ for $p=011$, $q=010$

```
   1101
    010
   ----
   0000
  1101
 0000
 ------
 011010
```

$\boxed{C\times q = 011\underline{010}}$

find Cxq for p=110, q=100

```
     1101
      100
   ------
     0000
    0000
   1101
  -------
  110100
```

$\boxed{Cxq = 110\underline{100}}$

find Cxq for p=111, q=101 found earlier

```
     1101
      101
   ------
     1101
    0000
   1101
  -------
  111001
```

$\boxed{Cxq = 111\underline{001}}$

c) Divide 101 001 011 001 100 by C

```
                                q for p=101   q for p=111
                    110 <-- 101 <-- 011  100 <-- q for p=110
        1101 | 101001 011 001 100
Cxq for  -->   101110
p=101          ------
               000111 011
      Next P -->  111001
Cxq for  -->      111001
p=111             ---------
           Next P -->  010 001
                       010 111  <-- cxq for p=010
                       -------
                        110 100
                        110 100 <-- cxq for p=110
                        -------
                              0
```

Perform division 3 bits at a time. faster way to Check The CRC

answer is $\boxed{110\ 101\ 011\ 100}$

4) Text #23 ARQ 40,000 m point-to-point

a) one way prop delay $\frac{40{,}000\ m}{2\times10^{8}\ m/s} = \boxed{200\mu s}$

b) Suitable timeout for ARQ

$1 RTT = 400\mu s$

so any value greater than 400μs could work,

in general 1.5 to 2RTT would be typical

or $\boxed{600 \text{ to } 800\ \mu s}$ This answer is purely subjective

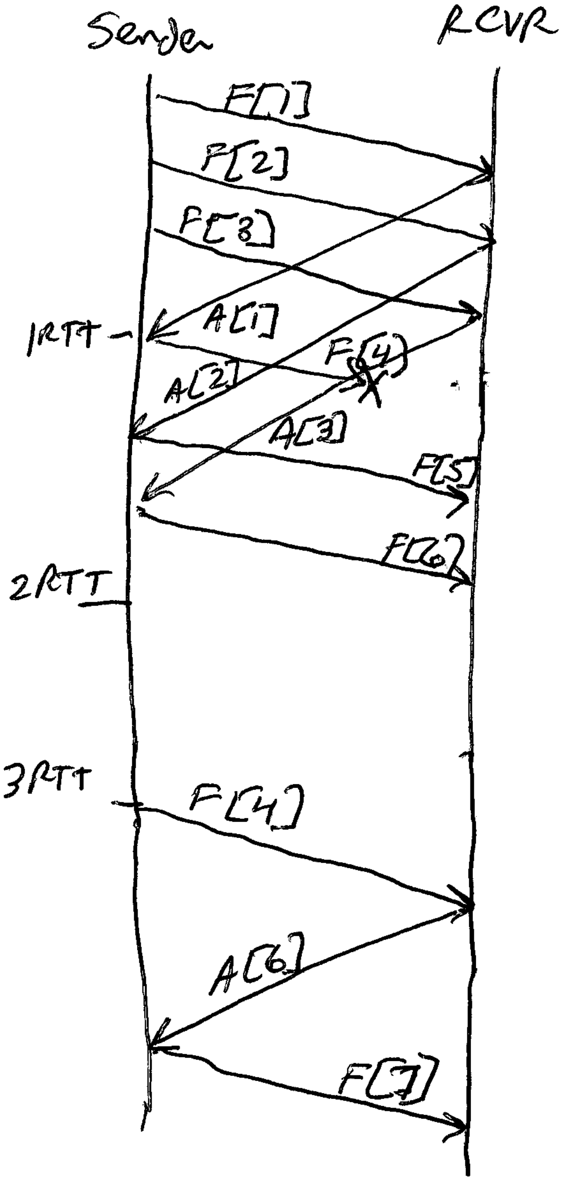
c) This time is based on the prop delay only, it does NOT take into account any delays possible at the node (other links may be keeping it busy and preventing it from transmitting)

- i.e. the node could be congested

HW#2 Solution

5) Text #31 SWS=RWS=3 Timeout=2RTT

a) Lose Frame 4

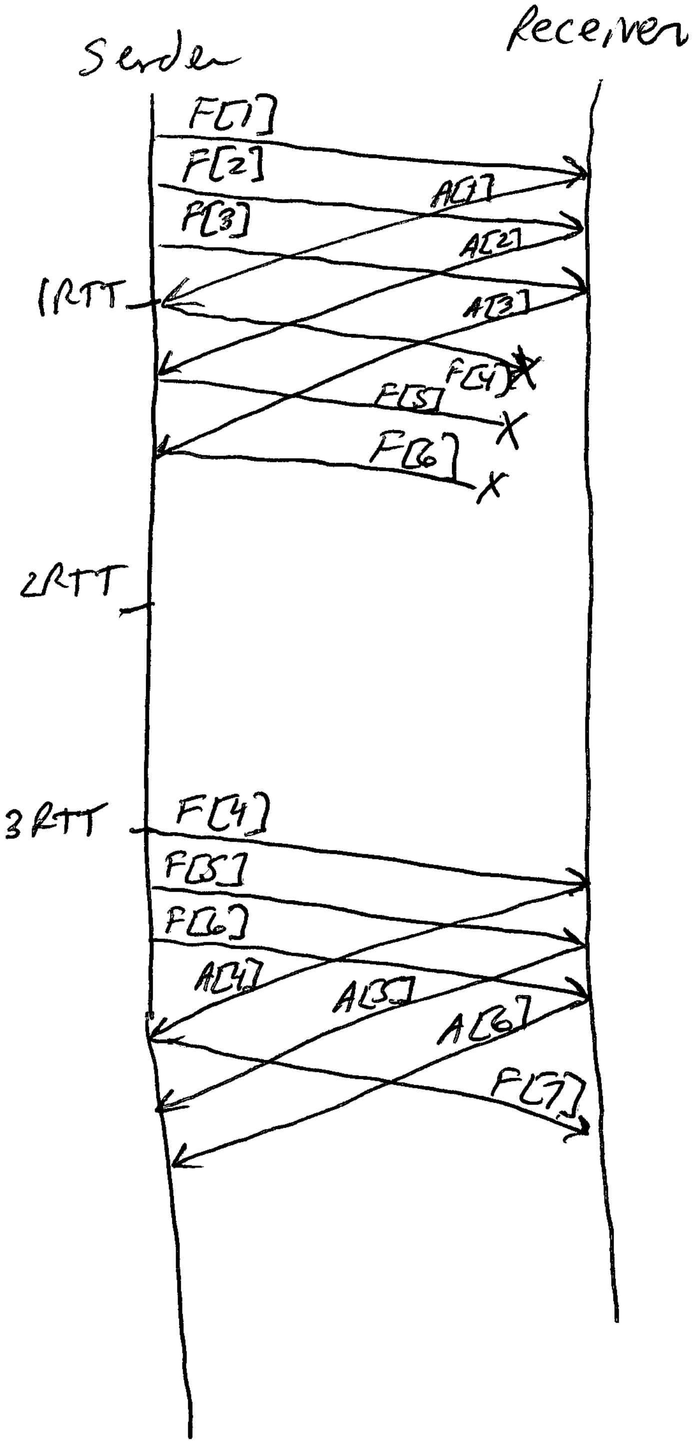

Sender
RCVR
F[1]
F[2]
F[3]
1RTT
A[1]
F[4]
X
A[2]
A[3]
F[5]
F[6]
2RTT
3RTT
F[4]
A[6]
F[7]

A - Ack
F - Frame

Receiver Needs Frame 4 before Sending an Ack

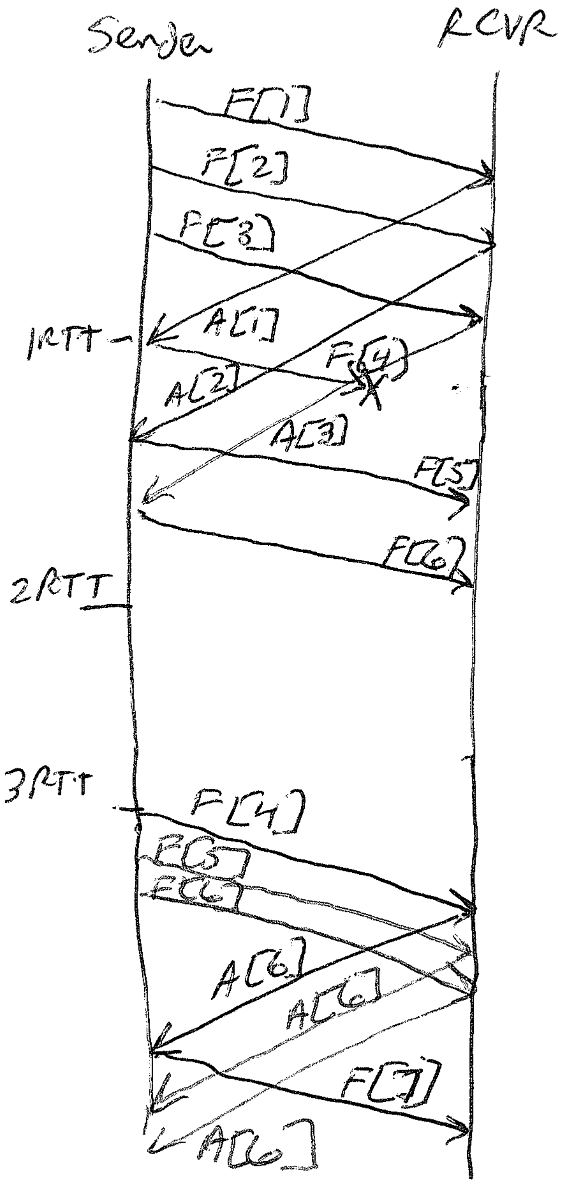
If A[6] Does not get back in time it is Possible for Frame[5] and/or Frame[6] to be retransmitted as well

b) Lose Frames 4, 5 and 6

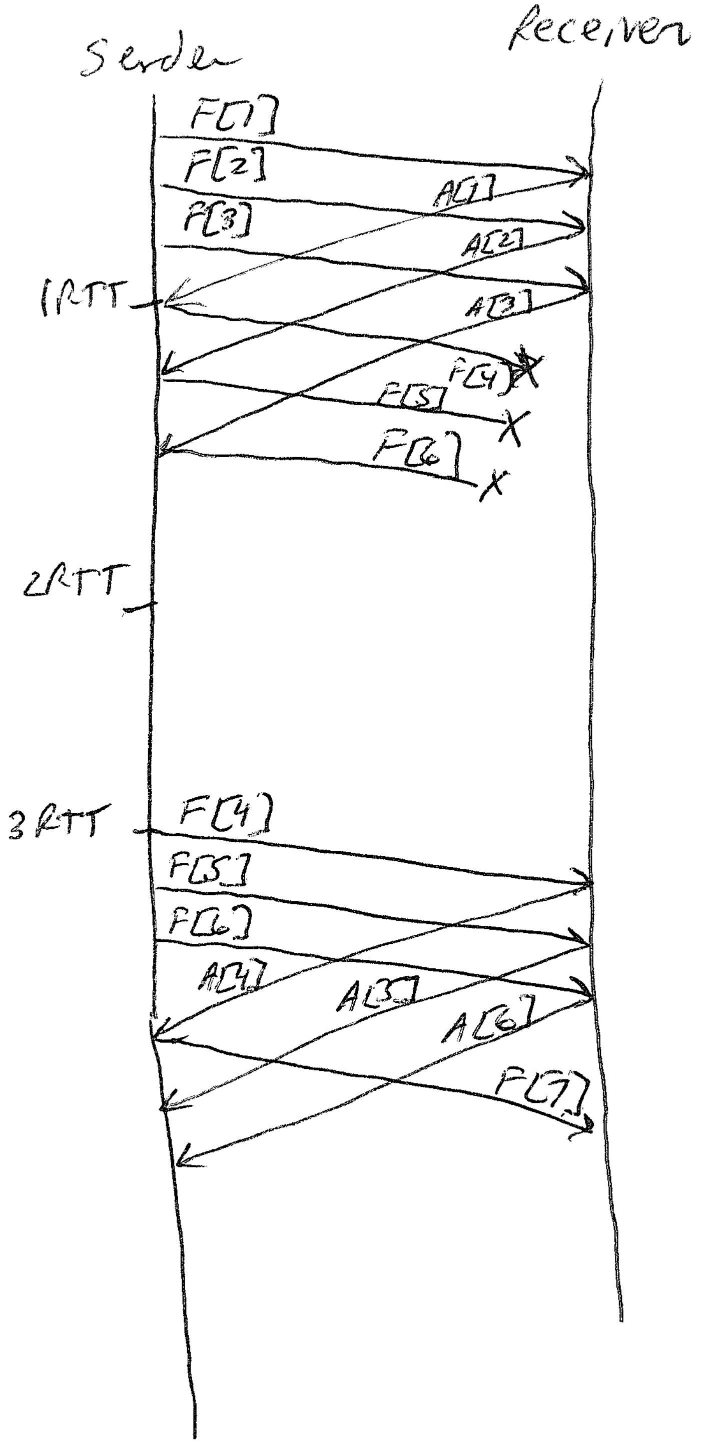

Sender
Receiver
F[1]
F[2]
A[1]
F[3]
A[2]
1RTT
A[3]
F[4]
X
F[5]
X
F[6]
X
2RTT
3RTT
F[4]
F[5]
F[6]
A[4]
A[5]
A[6]
F[7]

5) Text #31 SWS = RWS = 3 Timeout = 2RTT

a) Lose Frame 4


Sender
RCVR
F[1]
F[2]
F[3]
1RTT
A[1]
F[4]
A[2]
A[3]
F[5]
F[6]
2RTT
3RTT
F[4]
F[5]
F[6]
A[6]
A[6]
F[7]
A[6]

b) Lose Frames 4, 5 and 6


Sender
Receiver
F[1]
F[2]
A[1]
F[3]
A[2]
1RTT
A[3]
F[4]
F[5]
F[6]
2RTT
3RTT
F[4]
F[5]
F[6]
A[4]
A[5]
A[6]
F[7]

A - ACK
F - Frame

Receiver needs Frame 4 before sending an ACK

If A[6] does not get back in time it is possible for Frame[5] and/or Frame[6] to be retransmitted as well — They will timeout and must be resent as well