CRC

Wednesday, February 16, 2022 8:27 AM

Sender

dataword — 1001

divisor — 1011

CRC = ?

(length of divisor − 1)

quotient

length of divisor = 4

```
            1010
     1011 ) 1001 000
            1011
  XOR       X0100
             0000
  XOR        X1000
               1011
               X0110
                0000
                X110  ← CRC
```

XOR

00 — 0
01 — 1
11 — 0
10 — 1

Codeword $\boxed{1001110}$

Receiver :-

```
            101
     1011 ) 1001110
            1011
            X0101
              0000
             X1011
               1011
               X0000   Remainder
```

$\boxed{1001}$ dataword

if second bit is corrupted

```
            1111
     1011 ) 1101110
            1011 11 1
```

is corrupted

```
1011 ) 1101110
       1011
       ----
       x1101
        1011
        ----
        x1101
         1011
         ----
         x1100
          1011
          ----
          x111  <- Remainder
```

discard data

Question:-

dataword - 1101011111

divisor - 10011
(Generator)

CRC - ?

codeword - ?

Polynomial Representation

datawords -

1 0 1 1 0 0 0 0 1 1 0 0 0 1 1

divisor - 1010001000 1

OR

datawords - 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

$\Rightarrow x^{19} + 1 \qquad + 1 \cdot x^0$

6 5 4 3 2 1 0 position

	6	5	4	3	2	1	0	position
dataword —	1	0	0	0	0	1	1	

$$\Rightarrow 1\cdot x^6 + \underline{0\cdot x^5} + \underline{0\, x^4} + \underline{0\cdot x^3} + \underline{0\cdot x^2} + 1\cdot x^1 + 1\cdot x^0$$

$$\Rightarrow x^6 + x + 1$$

Checksum

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Checksum:-

Sender

7
11
12
0
6
$\overline{}$
36

(7, 11, 12, 0, 6, 36)

Receiver

$\left.\begin{matrix}7\\11\\12\\0\\6\end{matrix}\right\}36$

Checksum = 36

Accepted

II

7
11
12
0
6
$\overline{}$
Sum = 36

Checksum = -36 (complement)

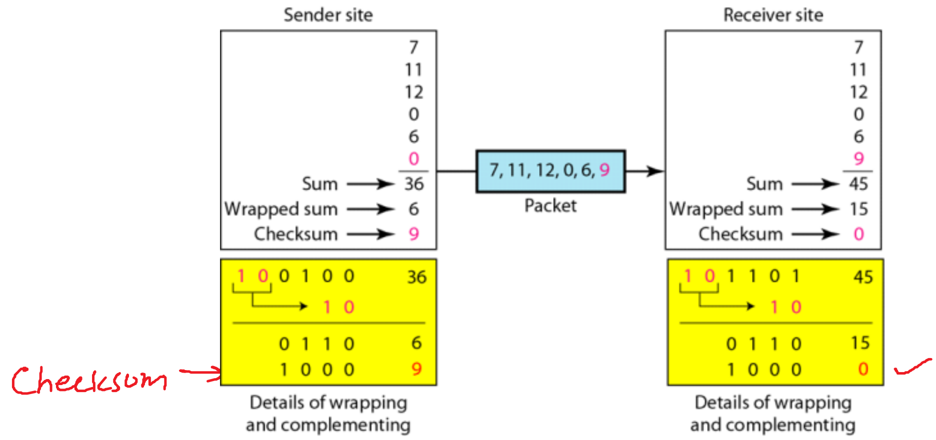
(7, 11, 12, 0, 6, -36)

7
11
12
0
6
-36
$\overline{}$
0 → Accepted

21 ⇒ 10101 ⇒

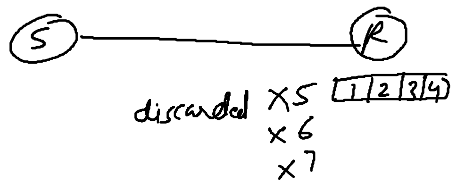
$$\begin{array}{r} 0101 \\ +\ \ 1 \\ \hline \boxed{0110} \end{array}$$

comp → 1001


Sender site
7
11
12
0
6
0
Sum → 36
Wrapped sum → 6
Checksum → 9
1 0 0 1 0 0 36
1 0
0 1 1 0 6
1 0 0 0 9
Details of wrapping and complementing
Checksum
7, 11, 12, 0, 6, 9
Packet
Receiver site
7
11
12
0
6
9
Sum → 45
Wrapped sum → 15
Checksum → 0
1 0 1 1 0 1 45
1 0
0 1 1 0 15
1 0 0 0 0
Details of wrapping and complementing

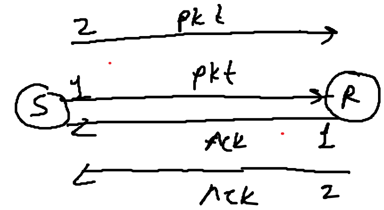
Flow control and error control

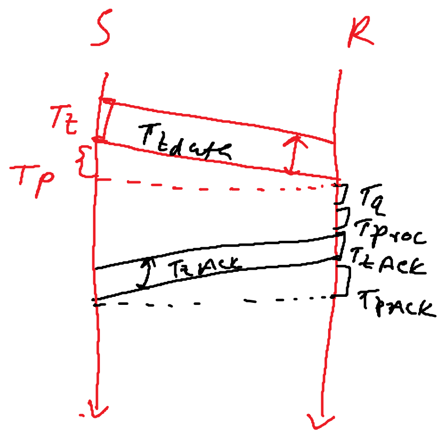
Friday, February 18, 2022 8:35 AM



solution ⇒

Stop & wait





$T_t =$

$T_p =$

(1 pck) delay =

Negligible

$= T_{t\,data} + \underline{T_p} + \cancel{T_q} + \cancel{T_{proc}} + T_{t\,ACK} + \underline{T_p}$

$= T_{t\,data} + 2T_p + \cancel{T_{t\,ACK}} = 0$

Total time = $T_t + 2T_p$
(one pkt)

$T_t = \dfrac{L}{B}$

$T_p = \dfrac{d}{S}$

η (efficiency) $= \dfrac{\text{useful time}}{\text{Total time}}$

$= \dfrac{T_t}{T_t + 2T_p}$

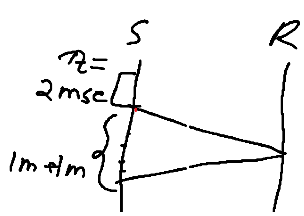
$\Rightarrow \dfrac{1}{1 + 2\,T_p/T_t}$

$\eta \Rightarrow \boxed{\dfrac{1}{1+2a}}$

where $a = \dfrac{T_p}{T_t}$

Ex

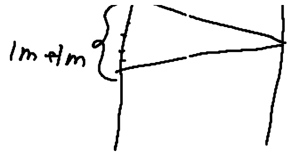
$T_t = 2$ msec $\qquad T_p = 1$ msec



RTT=2Tp

$\eta = \dfrac{1}{1+2a} = \dfrac{1}{1 + 2 * \dfrac{T_p}{T_t}}$

$= \dfrac{1}{1 + 2 * 1}$



RTT=2Tp

1000 □

S ⟷ R 1km

S ⟷ R 100 km

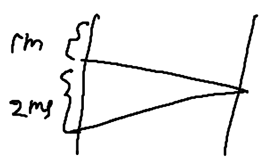
$$= \frac{1}{1+2*\frac{1}{2}}$$

$$= \frac{1}{2} = 50\%$$

$T_t = 1ms \qquad T_p = 1ms$

$$\eta = \frac{1}{1+2a} = \frac{1}{1+2\times\frac{1}{1}} = \frac{1}{3}$$

wait



ex $\eta \geq 50\%$

$$\frac{T_t}{T_t+2T_p} \geq \frac{1}{2}$$

$$2T_t \geq T_t + 2T_p$$

$$T_t \geq 2*T_p$$

$$\frac{L}{B} \geq 2*T_p$$

$$\Rightarrow L \geq \underline{2*T_p*B}$$

Throughput $= \boxed{\eta \times B}$

$B = 4$ mbps

$\eta = 50\%$

Throughput $= \frac{1}{2} \times 4$

$= 2$ mbps

Throughput = "No of bits we are actually able to xfer per sec using S&W protocol."

S & W protocol :

$$= \frac{L/B \times B}{T_t + 2T_p}$$

$$= \frac{T_t \times B}{T_t + 2T_p}$$

$$= \frac{1}{1+2a} \times B$$

$$= \boxed{\eta \times B}$$

Problems

Wednesday, February 23, 2022 9:03 AM

If the bandwidth of the line is 1.5 Mbps, RTT is 45 msec and packet size is 1 KB, then find the link utilization in stop and wait

$B = 1.5$ Mbps

$RTT = 45$ msec

$L = 1$ KB $(2^{10} \times 8$ bits$)$

$\eta = ?$ $\quad \dfrac{1}{1 + 2 \times \frac{T_p}{T_t}}$

(Bandwidth $\Rightarrow$ $1K = 10^3$, $1M = 10^6$, $1G = 10^9$

(Length $\Rightarrow$ $1K = 2^{10}$ bits, $1M = 2^{20}$ bits, $1G = 2^{30}$ bits

T_t (Transmission Delay) $= \dfrac{L}{B} = \dfrac{1\text{ KB}}{1.5\text{ Mbps}}$

$= \dfrac{2^{10} \times 8}{1.5 \times 10^6}$

$= 5.461$ ms

T_p (propagation delay) $\Rightarrow RTT = 2T_p$

$T_p = 45/2 = 22.5$ ms

$$\eta = \frac{1}{1 + 2 \times \frac{T_p}{T_t}}$$

$$= \frac{1}{1 + 2 \times \frac{22.5}{5.461}}$$

$$= \underline{\underline{10.8\ \%}}$$

A channel has a bit rate of 4 Kbps and one way propagation delay of 20 msec. The channel uses stop and wait protocol. The transmission time of the acknowledgement frame is negligible. To get a channel efficiency of at least 50%, the minimum frame size should be:

$B = 4 kbps$

$T_p = 20 msec$

$L = ?$

$\eta \geq 50$

$\Rightarrow \frac{1}{1+2a} \geq 50\%$

$\Rightarrow \frac{1}{1+2a} \geq \frac{1}{2}$

$2 \geq 1+2a$

$1 \geq 2a$

$1/2 \geq a$

$a \leq 1/2$

$\frac{T_p}{T_t} \leq 1/2$

$T_p \leq \frac{T_t}{2} \Rightarrow 20 \leq T_t/2$

$40 \leq T_t$

$T_t \geq 40$

$\frac{L}{B} \geq 40 \Rightarrow L \geq 40ms \times 4 kbps$

$L \geq 40 \times 10^{-3} \times 4 \times 10^{3} bps$

$L \geq \underline{\underline{160}}$ bits

Consider a MAN with average source and destination 20 Km apart and one way delay of 100 µsec. At what data rate does the round trip delay equals the transmission delay for a 1 KB packet?

$d = 20 km$

$T_p = 100\,\mu sec = (100 \times 10^{-6} s)$

$L = 1\,KB$

$\Rightarrow RTT = 1t$

$2T_p = T_t$

$2 \times 100 \times 10^{-6} = \frac{L}{B}$

$2 \times 100 \times 10^{-6} \times B = 1\,KB$

$B = \frac{2^{10}\,B}{2 \times 100 \times 10^{-6}}$

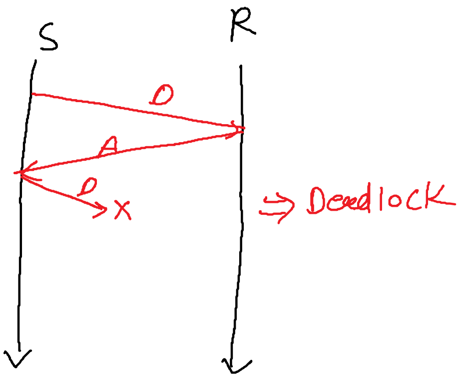
$B = \frac{2^{10} \times 10^{6}}{200} \Rightarrow 5.12\,MBPS$

$\Rightarrow 40.96\,mbps$

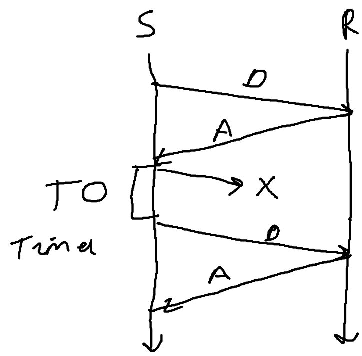
Stop and Wait ARQ (ERROR control)

Friday, February 25, 2022 8:41 AM

Data lost

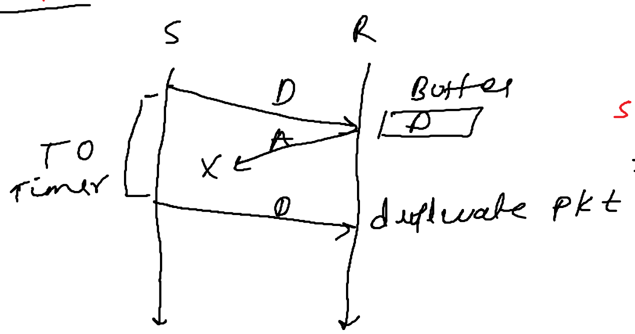


Solu^t ⇒



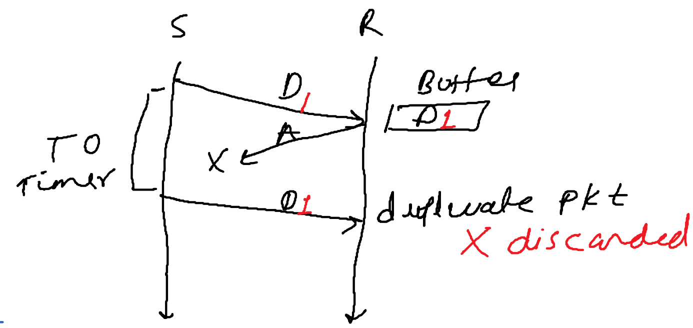
S/W ARQ ⇒ S&W + Time Out Timer

Ack lost



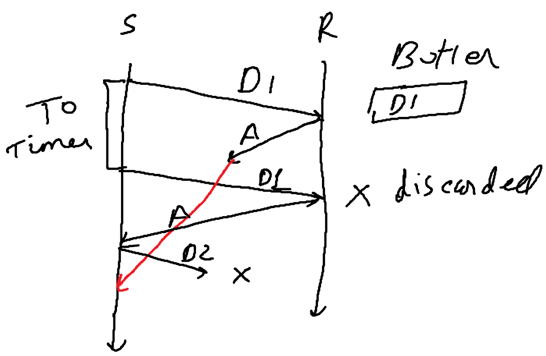
solu^t ⇒

lost

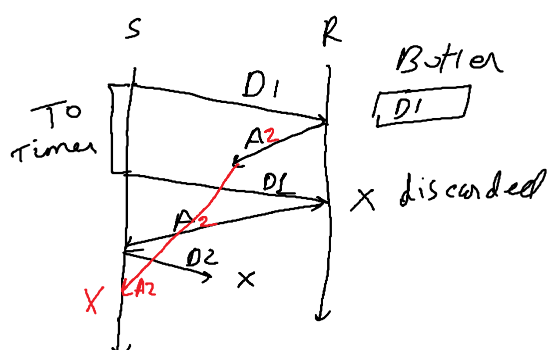


S&W + TO + Seq no to the data pkt

Delayed ACK



Sol ⇒



S&W + TO Timer + seq no to the data pkt

+ Seq to the ACK pkt

problems:- S&W ARQ

send = 10 pkt, every 4th pkt is lost

How many total no of pkt sender send ?

301 − 13
82 −
79 − 12
22 − 12

1 2 3 4 4 5 6 7 7 8 9 10 10 4 5 6 7

lost lost lost

= 13