26/08/22 → Tut

Reliable N/W → Devices working without Intersection

- → Ensure bits.
- → failure of Packets
- → Physical link cuts.

Performance

→ Bandwidth → is the number of bits transfered in unit time

→ Latency → Delay

Delay

→ Transmission Delay (T_t) – The time required to put the data packet in the outgoing link. By

Factors :-
1) B/W → 1 bps
2) D/S → 10 bits.

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1b → 1s
10b → 10s.

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

2) Propagation Delay (T_p) :- The time required to receive the last bit on the receiver side.

factors :-
:) distance
:) velocity

$$T_p = \frac{d}{V}$$

RTT (Round Time) : $2T_p$

$$T_t + T_p + T_q + T_{PD}$$

(T_q : queuing delay; T_{PD} : Processing delay)

Q.1) Consider a P-P link 4km length at what B/w would be the propagation delay equal to Transmission delay for 100 Byte Packet (at a speed of 2×10^8 m/s).

$$\frac{8 \times 100}{B} = \frac{4 \times 10^3}{2 \times 10^8}$$

$$B = 4 \times 10^7 \text{ bps}$$
$$= 40 \text{ Mbps}$$

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Q.2) $T_t = T_p$

$$\frac{L}{B} = \frac{d}{V}$$

$$\frac{512 \times 8}{B} = \frac{4 \times 10^3}{2 \times 10^8}$$

$$B = 2048 \times 10^5 \text{ bps}$$
$$= 204.8 \text{ Mbps}.$$

Q.3 Calculate the total time required to send 100KB file ?
Assume : Packet size 1KB and an RTT of 50ms and an initial 2×RTT of "handshaking" before data sent 8/40 = 1.5Mbps.

$$RTT = T_t + T_p$$

$$T_t = \frac{8 \times 10^3}{1.5 \times 10^6}$$
$$= 5.33 \times 10^{-3}$$
$$= 5.33 \text{ ms}$$

$$T_p = \frac{1000 \times 10^3 \times 8}{1.5 \times 10^6}$$
$$= 5.33 \text{ s}$$

$$T_p = R_{TT} - T_t$$
$$= 44.77 \text{ ms}$$

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→

Total Time = $T_t + 2 \times RTT + T_p$

= 5.33 + 0.1 + 0.025 = 5.455 s

$RTT = 2T_p$

$T_p = \frac{RTT}{2} = \frac{50ms}{2}$

$= \frac{0.1}{2} = 0.05$

$= \frac{50 \times 10^{-3}}{2} =$

Q.4)

Total time = $T_t + T_p + 2 \times RTT$

= 0.8 + 0.004 + 0.016 sec

= 0.820 sec

$T_t = \frac{1600 \times 10^3 \times 8}{10 \times 10^6}$ = 0.8 sec.

$2 \times RTT = 16 \times 10^{-3} = 0.016$ s

$T_p = \frac{RTT}{2} \Rightarrow \frac{8 \times 10^{-3}}{2} = 0.004$

20 km — 0

$\frac{20 km}{3 \times 10}$ Page:

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(T_t)

(5) Consider a N/w with average source & destination 20 Km apart & one way delay is of 100 μs. At what data rate does the RTT equals to T_t for a 1Kb packet?

$$RTT = T_t$$

$$RTT = \frac{L}{B}$$

$$T_t = ~~T_p~~$$

$$~~100 \times 10^{-6} = \frac{10^3 \times 8}{B}~~$$

$$B = ~~8 \times 10^{7} \text{ bps}~~$$

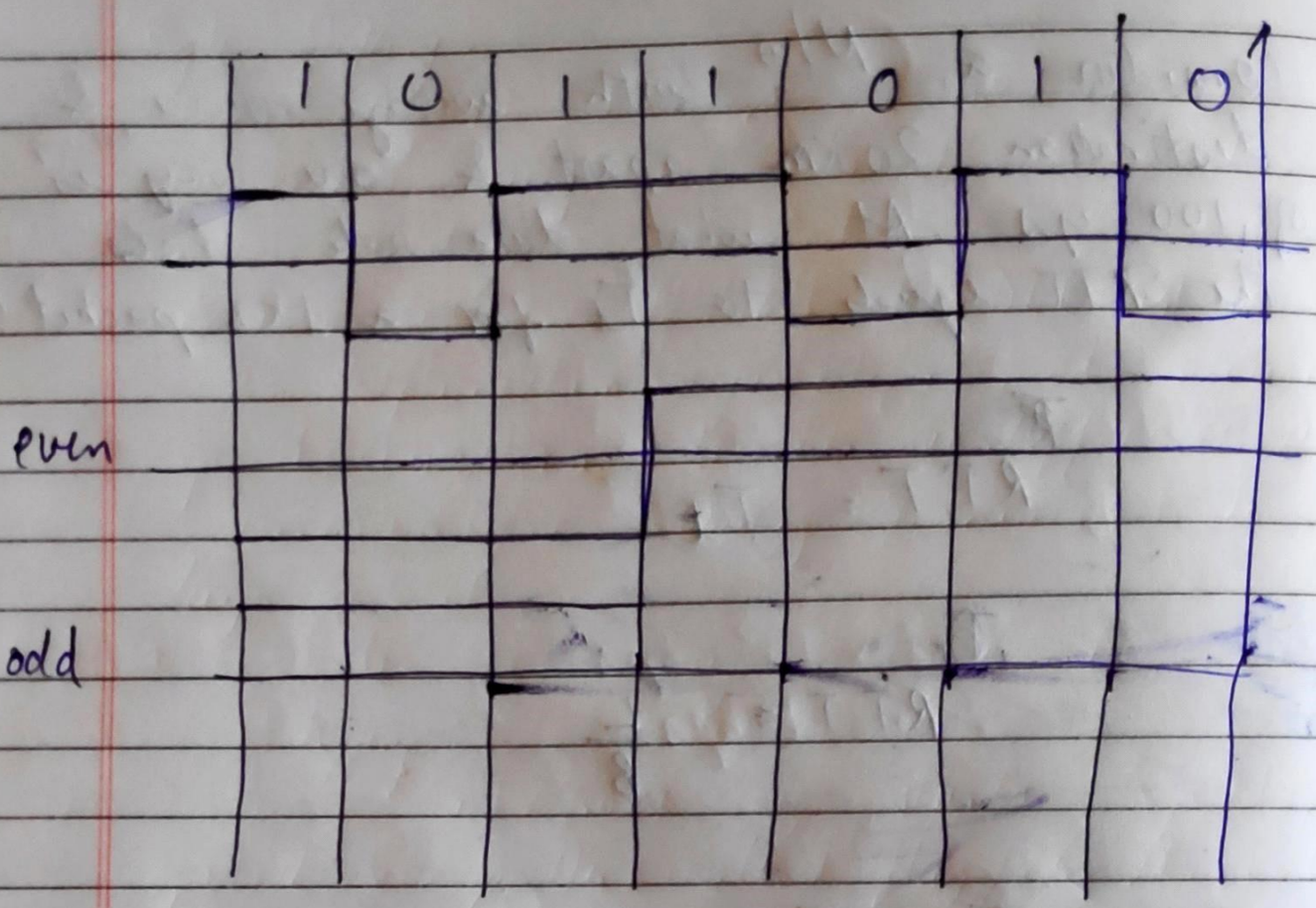
$$RTT = 2 T_p$$

$$2 \times 100 \times 10^{-6} = \frac{10^3 \times 8}{B}$$

$$\boxed{B = 40 \text{ Mbps}}$$

CO
ON POCO F1

CN



Data link layer
Framing Protocol:

- Byte oriented
  - Sentinel [BISYNC]
  - Byte counting [DDCMP]
- Bit oriented
  - Sentinel [HDLC]

Byte counting → DLB

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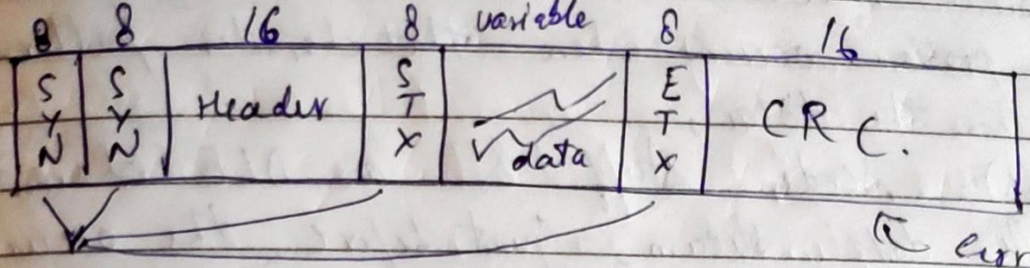
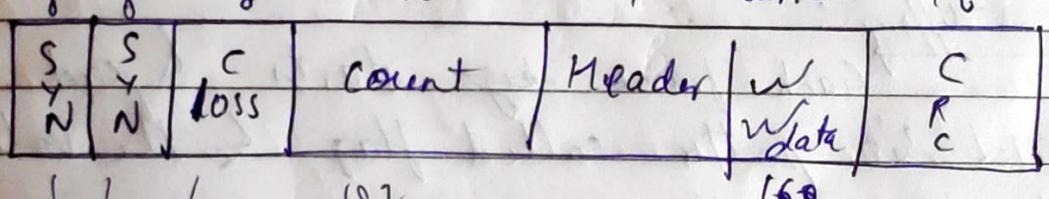
BISYNC



Standard 8-bit ASCII Character

error detection

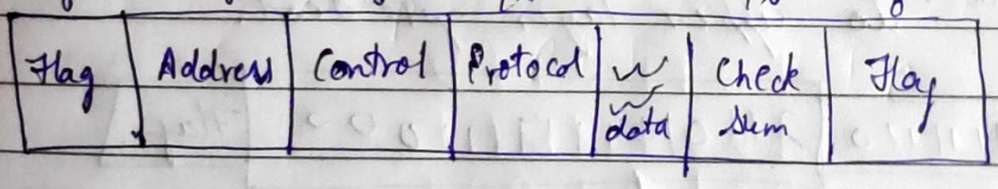
DDCMP



51
↓
7

HDLC (Bit oriented)

Flag = 01111110



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Byte Stuffing :

Since, ASCII characters are used as frame delimitor, The problem occurs when that character pattern occurs within the data,

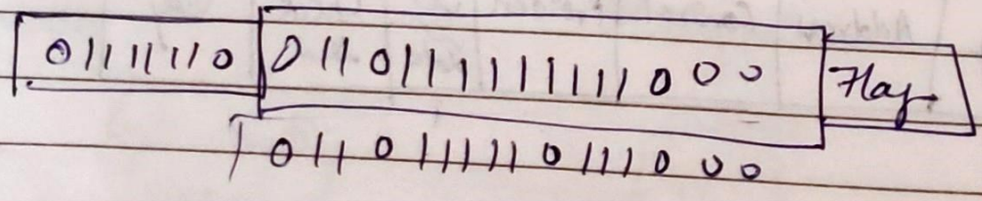
Sol.) Sender stuff & a DLE character into the data stream, just before the occurrence of special characters. Receiver unstuff the DLE character before passing frame to the upper layer protocol.

Bit Stuffing :

•) Each frame ~~big~~ starts & end with a special bit patter called flag & the value of flag is

•) Case 1. Whenever sender encounter 5 consecutive '1' in the data stream, it stuff a '0' after it.

•) When receiver recieve 5 consecutive '1' followed by a '0', it destuff '0' bit before passing the into to upper layer protocol.



Case 2: If the receiver receive 5 consecutive '1' followed by a '1' then it will check next bit, if next bit is '0', that will marked as end of the field, if next bit is '1', then it will be concluded that, the frame is received with error.

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Error Control

→ Detection (wired)

→ Correction (wireless)

Case 1:

Sent		Received
0 1 1 0 1 0 1 1	→	0 0 1 0 1 1

single bit - error.

Case 2:

0 1 1 0 1 0 1	→	0 0 1 0 1 0 1

6-bit burst error

Parity Check

applied on word → 8 / 16 / 32 ...

data Parity.

2D - parity can detect all errors. ~~in which~~ such 1bit, 2bit, 3bit is inward in the error and most upto 4bit error.

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Transmitter

Transmitter **Checksum algo:-**
The message is divided into (8 bits, 16 bits, 32 bits, 64 bits, ... k). Add all the ~~words~~ words using 1's compliment arithmetic. Take 1's compliment of the result & call it checksum, place checksum in message & transmit.

Reciever Divide the message into words including the checksum. Calculate the sum of all the words including checksum, using 1's compliment Arithmetic. Take 1's compliment of the result, if the result is 0 all 0, if the result is one 0 then accept discard.

10110110	10000011	11000011

```
  10110110
  10000011
 ----------
 100101001
     001
 ----------
  00101010
  11000011
 ----------
  11111101
 ----------
  00000010
 ----------
```

09/09/22

DLL Responsibility

C1 E

① Hop to Hop Delivery
- (Node to Node delivery)

$A_2 \rightarrow A_1$

DLL is enough to send.

② Flow Control

↳ Stop & wait
↳ Go Back N (GBN)
↳ Selectively repeat
$A_4 \rightarrow A_8$

Note
* Node to Node flow control → DLL
* $A_4 \rightarrow B_1$ → Transport layer.

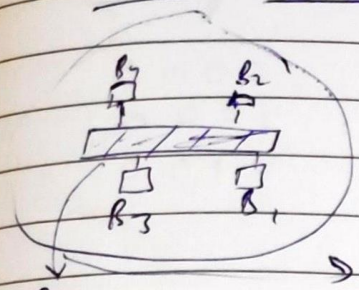
③ Error Control

A_2 ——→ B_1

100 — 100
101 → single bit error
111 → Burst error

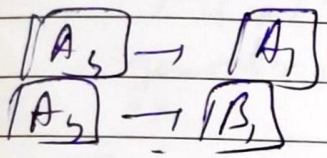
Method
① CRC (Cyclic Redundancy channel)
② Check sum
③ Parity Bit
④ Hamming code

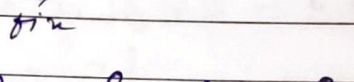
④ Access Control



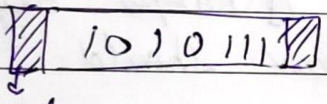
⇒ To avoid the Collision

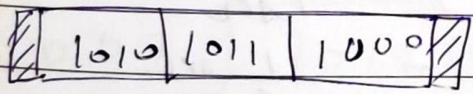
⑤ Physical layer (MAC Address)



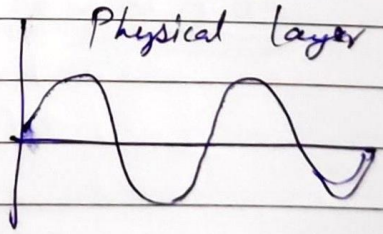


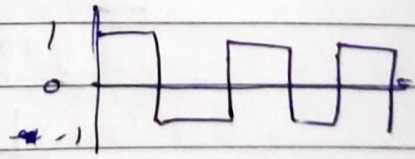
⑥ Framing





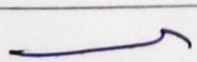
Data Link layer





⑦ Imp

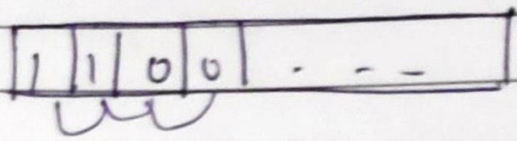
Sender
A1
1011



Receiver
B1
1011

(1)

Error Detection & Correction



Single bit error $0 \to 1$, $1 \to 0$

Length of Error

1 1 0 0 0

3 2 1 0

1 0 0 0 0

8

1 0 0 0 0 → 0

Q.) If the BW of a channel is 1Gbps then for how much max duration the error should

10^9 Bit → 1 sec

1 Bit → $\frac{1}{10^9}$ sec.

= 1 ns

$\therefore \frac{1}{1000}$ sec

$= \frac{1}{1000} \times 10^9 \Rightarrow 10^6$ Bits.

Hamming Distance

0000
0001
0010
⋮

→ XOR two number & count set bits

CRC

$M(x)$ = 1010101010 = 10 Bits

generator: $x^4 + x^3 + 1$

Divident = n+4

$1.x^4 + 1.x^3 + 0.x^2 + 0.x + 1.x^0$

= 11001

```
11001 ) 10101010100000
        11001
        011000
         11001
        0000110010
             11001
             00011000
                11001
                000010
```

Valid Code Word,

10101010000

Efficiency = $\frac{m}{m+r} \times 100$

$= \frac{10}{14} \times 100$

8). M(x) = 1000100

generator: $x^3 + x^2 + 1 \Rightarrow 1 \cdot x^3 + 1 \cdot x^2 + 0 \cdot x^1 + 1 x^0$

Calculate (r) ?

r = 1101

```
          ------------
1101 ) 1000100
       1101
       ----
        0101
        1101
        ----
        0100
         1101
         ----
         0001000
```

Hamming Code

$$2^r \geq m + r + 1$$

Ques → A 4 bit received hamming code 1010 find error bit parity P.

Position	7	6	5	4	3	2	1
bit	d_7	d_6	d_5	P_3	d_3	P_2	P_1

$m = 4$

$2^r \geq 4 + r + 1$

$m + r = 4 + 3 = 7$

$r = 3$

Step (1) Calculate the (r).

(2) Calculate valid code word

(3) Calculate parity

$P_1 = (1, 3, 5, 7, 9, 11)$

$(P_1, 0, 1, 1)$

$P_2 = (2, 3, 6, 7, 10, 11)$

$P_2, 0, 0, 1$

$P_2 = 1$

$P_3 = (4, 5, 6, 7)$

$= P_3, 1, 0, 1$

$P_3 = 0$

$P_4 = (8, 9, 10, 11)$

Valid code word

d_7	d_6	d_5	p_3	d_4	p_2	p_1
1	0	1	0	0	1	0

Q) $m = 1011011$

Find hamming code ?

$m = 7$

$2^M \geq 7 + M + 1$

$2^M \geq 8 + M$

$\boxed{M = 4}$

$m + M = 11$

Posn	11	10	9	8	7	6	5	4	3	2	1
Bit	1	0	1	p_4	1	0	1	p_3	1	p_2	p_1

$p_1 = (1, 3, 5, 7, 9, 11)$

$\Rightarrow$ even $\Rightarrow$ (1)

$p_2 = (2, 3, 6, 7, 10, 11)$

$\Rightarrow$ (1)

$p_3 = (3, 4, 5, 9, 10, 11)$ x

$p_3 = (4, 5, 6, 7)$

$\Rightarrow$ (0)

$p_4 = (8, 9, 10, 11)$

$\Rightarrow$ (0)