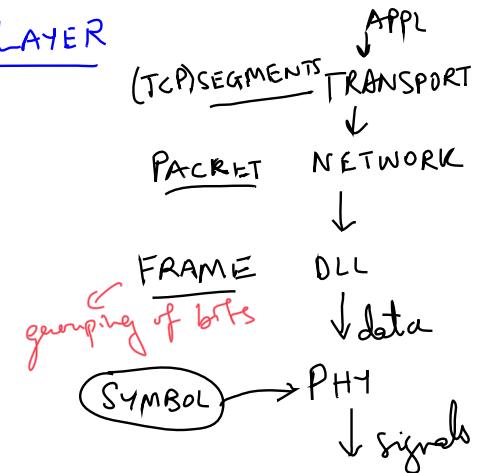


DATA LINK LAYER

bits | 0 1 0 0 | 0 0 0 1 | 0 0 0 1 0
 ↓
 meaning



bits:

0100100 - 0100.

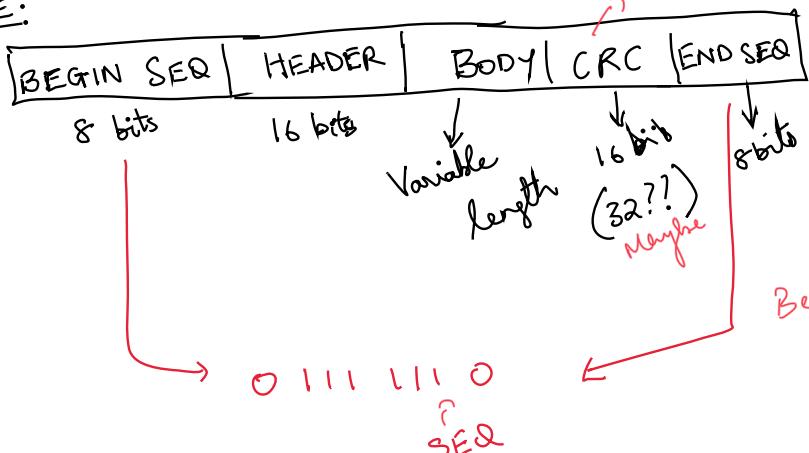
starts

ends

Header?

HDLC: High-Level DATA LINK CONTROL → used IN WANS
Header:

FRAME:



Begin and end seq are same

SEQ SEQ SEQ SEQ, ^{SEQ?} HEADER, BODY, CRC, SEQ, SEQ

Problem of SEO & appears
in [HE ..., CNE]

SEQ SEQ . SEQ , HEADER

↓
No data to send helps in (CLOCK SYNCHRON.)

done

Bit Stuffing

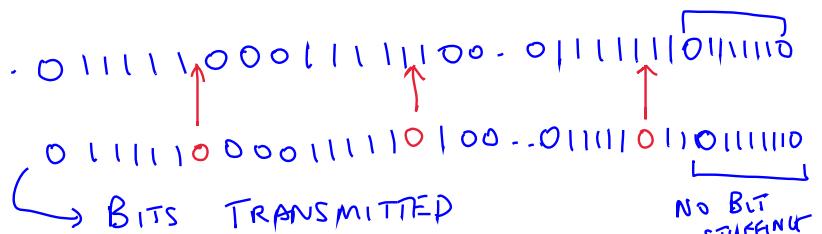
BODY(BITS): 010-.. 0111110-----

insert bits to
ensure SEL does not
overrun

ALGORITHM (BIT STUFFING) → AT SENDER

If see 5 consec. 1s then insert a zero after them

Ex: Actual bits AT SENDER
before stuffing



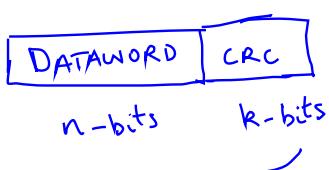
AT RECEIVER

Assuming : IF FIVE IS OCCUR, THEN REMOVE "STUFFED" BIT (0) FOLLOWING THEM
NO BIT ERROR

At Receiver

IF
 0 1 1 1 1 |
 5 is |
 0 ⇒ assume due to bit stuffing and remove
 1 0 ⇒ assume END SEQ
 1 1 ⇒ assume ERROR and DISCARD entire frame
 We discard everything until we see
 SEQ again.

CRC: Cyclic Redundancy Check



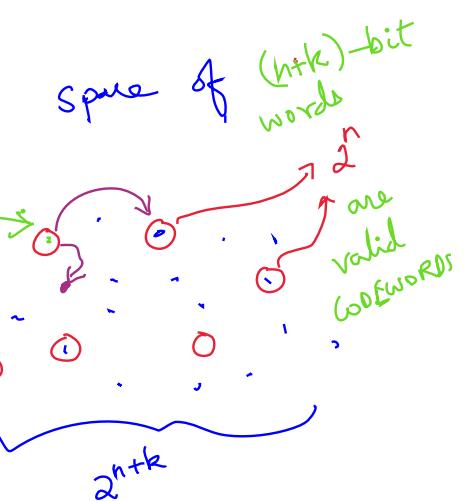
CODING THEORY

Function from
datoword to
codeword

$$2^n \rightarrow 2^{(n+k)}$$

Hamming distance
is kept high so
no overlap

SPACE of
datowords
 2^n



If there's no pre-image,
then there is bifurcation

→ Hamming graph

HAMMING DISTANCE:

Between 2 codewords: #bits which are different in the 2 codewords

Ex: $\begin{array}{cccccc} 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 \end{array}$ → Hamming distance = 2

Ham. distance of a code: minimum H.D. over all pairs of codewords

Galois Field GF(2):

Finite field with 2 elements 0, 1

Addition

+	0	1
0	0	1
1	1	0

x	0	1
0	0	0
1	0	1

Subtraction is

same as
addition

CRC: cyclic code
based on

if $a_0 a_1 \dots a_n \rightarrow$ is a codeword
bits

then $a_n a_0 a_1 \dots a_{n-1} \rightarrow$ is also a codeword

Generating a CRC

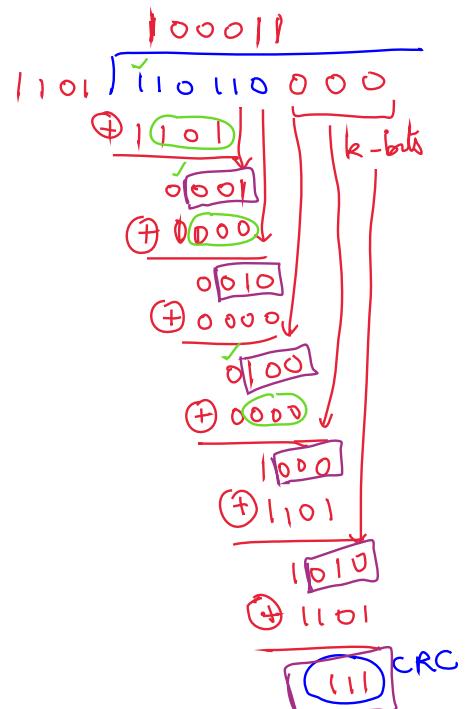
DIVISOR / GENERATOR: $k+1$ bits long

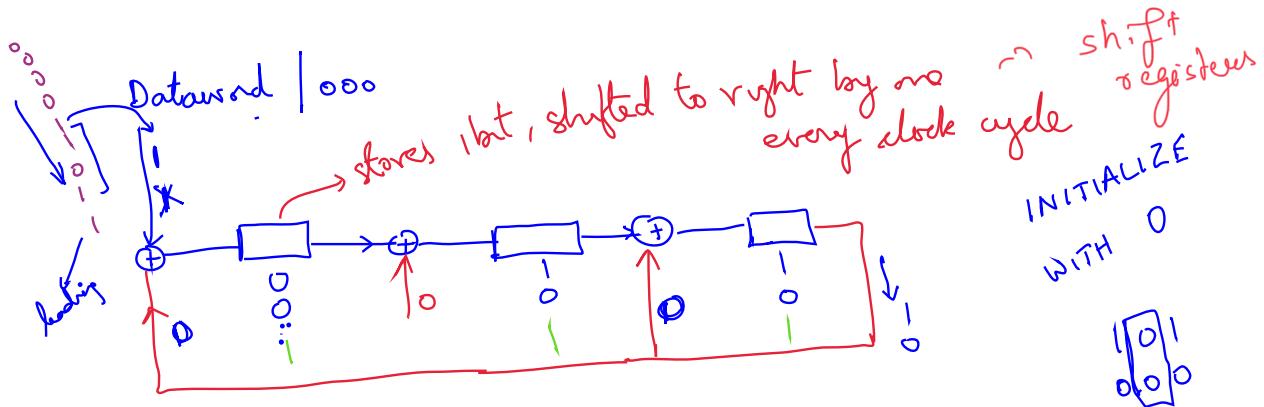
Ex: $k=3$, generated: 1101

dataword is 6 bits long ($n=6$)

data 110110

CODEWORD: $\underbrace{110110}_{\text{data}} \underbrace{111}_{\text{CRC}}$





Take last k bits of D_{k+m} , and ensure that
if leading bit = 1, then XOR with those k bits
else XOR with all zeros ($00\ldots 0$)
 $\frac{k}{m}$ -bits

At receiver,

Option 1:

Dataword | CRC

↓
Dataword | 000

CRC
wired

check if CRC generated
matches received CRC

Option

Dataword | CRC

