Sourav.

01/02/17

Divisor - $d(x)$

Generator func. - $g(x)$

Remainder - $r(x)$.

$d(x)$

$\downarrow$

$c(x) \longrightarrow c'(x)$.

If error is introduced

$\frac{c(x)}{g(x)} \xrightarrow{\text{remainder}} 0$.

$c(x) + e(x) = c'(x)$.

↳ distorted form of the codeword

Received codeword $= \frac{c(x) + e(x)}{g(x)}$.

whether syndrome is zero or not is dependent on.

$\frac{e(x)}{g(x)}$ part.

$s(x) = 0$. → a) No bits are corrupted

b) Some are corrupted but undetected.

eg $16/4$ ✓ → $20/4$ ✓ ✗

↳ but has an error of 4 bits

$s(x) \neq 0$ → one or more bits are corrupted.

$g(x)$ such that $e(x)$ is detected completely.

Single bit error ⇒ $e(x) = x^i$. $i = 0$ to max. length of msg.

eg 10000 x^4

100. x^2 ✗.

To detect error $g(x)$ will be of two terms.

($x^0 = 1$ is necessary).

$x + 1$.

x^3 → $i < 3$ error detected (only).

x^1 → All. $r(x) = 0$.

Syndrome value is checked before being either accepted or rejected.

For correction → position of bit changed is required

$d_{min} > 2t$ — t-bit error.

$d_{min} = 2t+1$.

② CRC. (important for DLL).

eg (slide).

$\rightarrow 7+7+2 = 16$.

Through division opn → redundant bits are created.

multiply : AND } binary division.

Subtract : XOR.

Remainder is appended to dataword.

No. of 0's appended before division is dataword length − 1.

Disadvantage → if multiple of dataword then remainder'll always be zero and detection becomes difficult.

③ Checksum -

↳ for transport and network layer usage.

Divide message into equal size, let m-bits and then to entire message m-bits redundant block is added.

$1001 \xrightarrow[\text{form}]{\text{polynomial}} 1.x^3 + 0.x^2 + 0.x^1 + 1.x^0$

$= x^3 + 1$.

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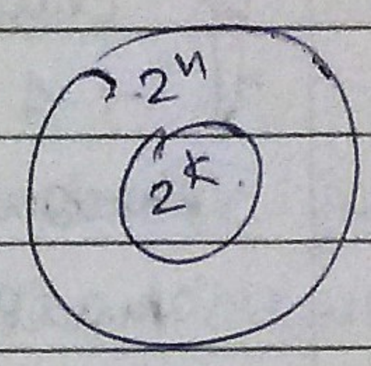
Block coding

blocks of equal size (let k bits).
each block has some redundant bits. then $n = k + r$.

2^k datawords → data block.
2^n codewords → data + red. bits.
(2^k valid out of them)



$2^n - 2^k$ → invalid codewords.
valid → accepted.
invalid → rejected.

Parity Check
Cyclic Redundancy check.
check sum. (n/w or transport layer).
} Technique to check.

7/01/17

Hamming Distance

calculate dist. b/w 2 binary strings of equal size.

$d_{min} > s$ (no. of bits changed)
↳ another valid codeword.

eg. 011 → 111. $d = 1$
011 → 000. $d = 2$ ✓ valid codeword.
$d_{min} = s + 1$.

① Parity check.
Even parity → even no. of 1's.
Odd parity → odd no. of 1's.
Single bit is added to block.
Most common, least complex.

Two isolated single bit error.

- $\frac{x^i + x^j}{g(x)}$ → remainder ≠ 0. then error.

$= \frac{x^i(x^{i-j}+1)}{g(x)}$ → such that it cannot divide x^t+1 $(0 \le t < n)$ only then error is detected.

$x+1$ → not able to detect adjacent errors.

$x^i + x^{i-1}$

$x^i(1+x)$ → divisible.

x^4+1 → not able to detect errors which are 4 places apart

x^7+x^6+1 → a third term is necessary to detect.

Odd no. of errors.

$g(x)$ must contain a factor $x+1$

Sending data along with redundant bits in a manner such that corrupted bits positions are identified, only then error correction is possible.

For real time multimedia application, FEC (Forward error correction) is necessary, since we cannot wait for the ~~pro~~ transmitted data. (to avoid delay).

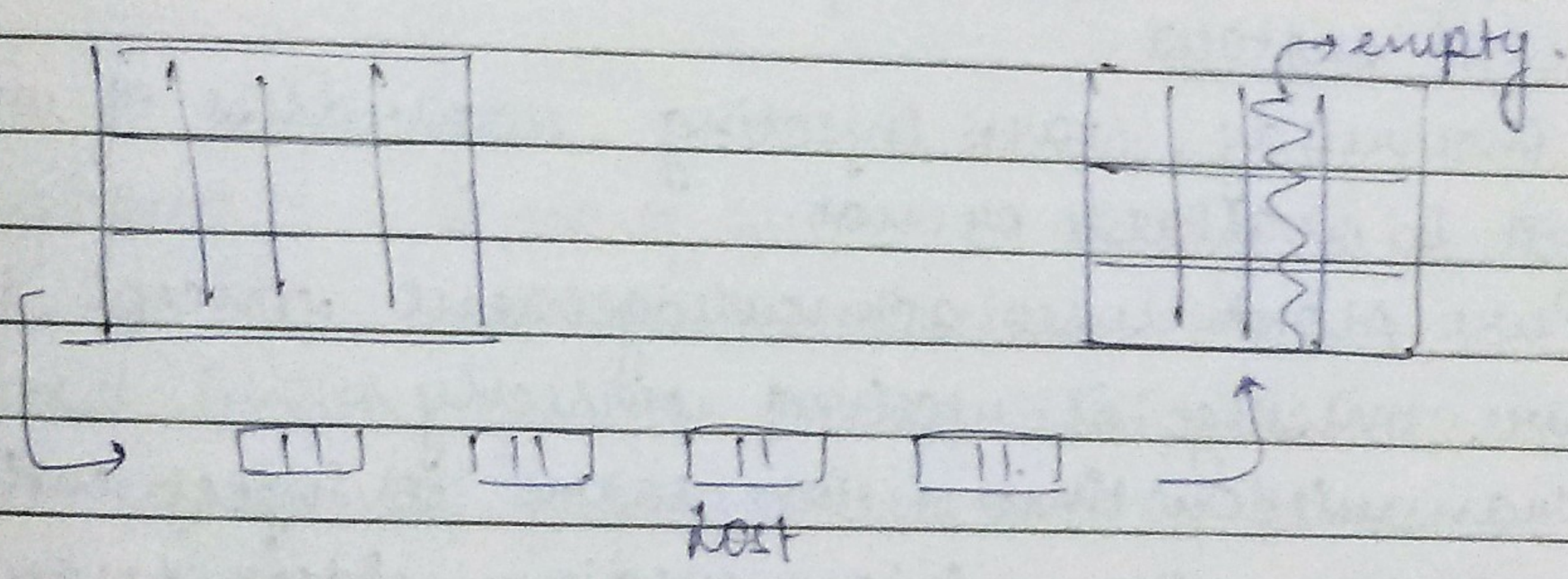
→ Error correction is done by receiver and not the sender.

Using XOR operation :

Divide message into N-blocks of equal size
Append a block of that size and then XOR of all should give some particular ans. (even/odd parity/ anything else).
Then at receivers side the XOR opn should give the same answer.
If particular block is lost during transmission, it can be detected by XOR opn

Chunk Interleaving :

If any packet is lost, a column would go missing at receivers side. Hence detected



Media Access Control (MAC).

DLL → physical address.

Not dedicated might lead to collision.
Shared medium requires MAC to ensure control of the medium to avoid collision.

Logical link control sublayer - DL control sublayer.

Connectionless connection oriented.

MAC - transmission through
- broadcasting.
- framing/deframing

Shared medium.

→ If multiple nodes are ready to inject frame and there is no control, then all of them may start injecting frames simultaneously. This leads to collision.

→ To avoid collision, MAC sublayer exists.

Multiple access protocols:-

1) Random access - contention oriented. (no supervision, all nodes are of same level)
2) controlled access
3) channelization. (bandwidth is channelized and each band is given to a node)

① ALOHA protocol.

Once ready, starts injecting regardless of whether it is available or not.

Pure ALOHA uses acknowledgement concept, to make sure message is received correctly.

Transmission time → time taken to inject entire frame into the transmission medium. (depends on frame size)

If not received correctly then retransmission occurs. (after time out period)

Time out period = 2 × time taken by node frame to move from one pt to another.

Once a collision occurs, it repeats forever.

Wait for random time period after time has expired and then retransmission occurs.

$t_f + \Delta + r_1$

$t_f + \Delta + r_2$ ← will be different

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kmax → no. of times you can try for retransmission of frame.
random no. → 0 to $2^k - 1$.
ready with frame but waiting for certain time period before retransmitting → backoff time.
$R \times T_p$. or $R \times T_{fr}$.
More unsuccessful → more randomness → more waiting period.
Vulnerable time period → when a node has started injecting a frame, during that time no other node should start injecting other frame, it is v.tp for the frame being injected. $= 2 \times T_{fr}$.
Max. channel utilisation/throughput = 18%.

$$S = Ge^{-2G}$$

throughput ↲ ↳ no. of frames ready to be transmitted at a particular time.
Slotted ALOHA → time period divided into slots, which is equal to frame transmission time.
Frame injection can begin only at beginning of the time slot.
Vulnerable time period is halved. $= T_{fr}$. $= 37\%$.

Frame size = 200 bits. Channel capacity = 200kbps
V. Tp for Pure = 2ms.
V. Tp for Slotted = 1ms.

CSMA protocol
Sense before transmit.
(Carrier sense multiple access)
Because of propogation delay, collision might occur

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Persistence methods:

1 persistent prob. = 1

non persistent

p persistent prob = p

(2)

03/02/17 Numerable time - time period nobody should be sending to avoid collision
= Propogation time.

No current → start injecting → not listening further

CD → collision detection. Action taken after detection

Reframing → not entending noise part.

Sense and transmit together

Idleness is connection point where the node is present.

Wait for the next time slot; while retransmitting also wait for a certain random number.

Wait for the backoff time (when not busy).

CSMA/CA → collision avoidance.

Doing something in advance.

Primarily used for wireless connection.

Waiting for IFS (Interframe space)

For time being, let IFS = Propogation delay.

Waiting for time slot (out).

2 time periods, Because on sensing the idle channel then we should be waiting for atleast Prop^n delay

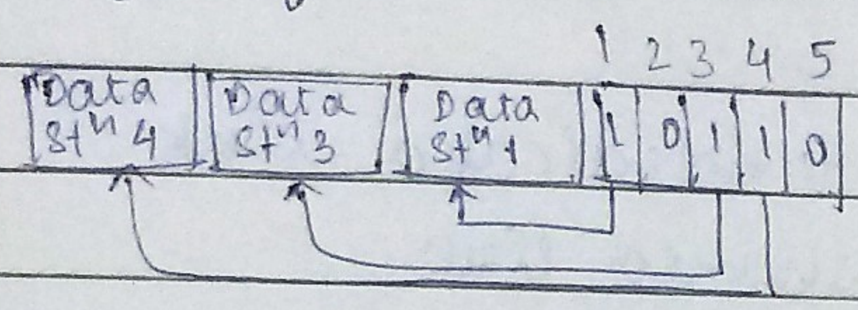
If (still idle) → then how of nodes are in use and whether you're allowed to use it or not depends on no. of trials.

(% of collision determined)

IFS = minimum value → higher preference.
Instead of waiting for propog^n delay, directly can be transferred.

(2) Reservation

In that time period, if interested to send or not. Depending on nodes with yes, their frames'll be injected in the subsequent time period.
Divided in time slots (of unequal size)
Fixed size of reservation frames.



Reserving same before using transmission medium.
Accessing transmission of frames in controlled manner.

Polling

Out of all nodes connected, one is designated as master nodes and the others as slaves.
All communications are happenning b/w master node and router.
Polling is done whenever transmission medium is available.

Token Passing

Nodes are put into a logical sequence. Token is given to the 1st node as per this sequence, and subsequent transmissions and passing of token occurs.
Token is the frame in this case.

(3). FDMA
Transmission at a particular frequency.

TDMA
Transmission in designated time slots only

CDMA
Each one is allowed to transmit when need common channel.

06/02/17

→ Point to point link → dedicated link
Broadcast link → shared link.

→ Yes, two hosts in two different networks can've the same link layer address
↳ since network addresses'll be different.

→ Isolated network does not need network layer address, ∵ within the n/w communication is through data link layer address.
But if connection to internet occurs to access something then network layer is required.

→ Router works at n/w layer (layer 3 device). Directly can be connected. Router is req. when you've more than one paths to follow from source to destination.

→ Burst error needn't be contiguous.

→ Redund. bits = 3 bits.
Length of divisor = 4 bits.

→ 101 ✓ 100 some 1 none. Single bit error detection in CRC.
x^2+1 x^2 1

→ 10111 ✓ 111 ✗ odd no. of single bit error detection in CRC.

$(x^2+1)(x+1) = x^4+x^2+x+1$ x^2+x+1.
↳ should've a factor of $(x+1)$.

→ max effect of 2ms burst of noise.

$\times \frac{1500}{2\times10^{-3}} = 3$ $\qquad$ $\times \frac{12\times10^{3}}{2\times10^{-3}} = 24$.

→ 101001111 : dataword.

10111 = divisor (divide).

```
          111
10111 ) 101001111
        -10111
        00011111
          10111
          010001
          10111
          00110.
```

→ before each E and F put an ASCII char.

→ Remove stuffed bit that was added (after 5)

At six also it can be start and end.

→ 1000 bits. 1Mbps = 1ms T_v = 2ms.

→ To transmit the frame = adding all bits.

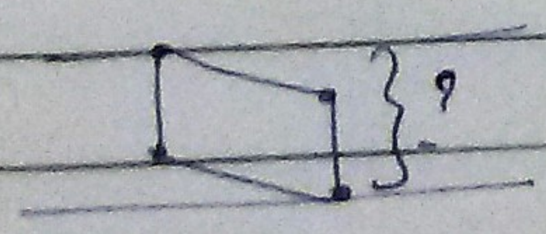
= 10μs. propog^n delay = 5μs.

(1) T_p = 5μs.

(2) T_t = 10μs

(3) Frame comes → t_1 Dying → ? when last bit reaches.

= (5 + 10) μs = 15μs.



PPP = connection oriented protocol
If simply put, then connection less
In token passing nobody is the boss

HDLC
unbalanced → there is one superior node
Balanced → whenever ready.
ABM (Asynchronous Balanced Mode).
ARM (Asynchronous Response Mode).
↳ hybrid.
↳ permission not required
↳ if channel is ideal, initiate.

Flag	control	Address	Information	FCS	Flag
8 bits	1 byte or 2 bytes length.	Destination nodes' address.	all gathered. (variable).	Error control (16 or 32 bits)	8 bits

Three types of frame.
1 Information (for transfer of data).
S Supervisory. (not data)
U Unnumbered (network management).
Sequence number → control field.
(Piggy Banking concept)