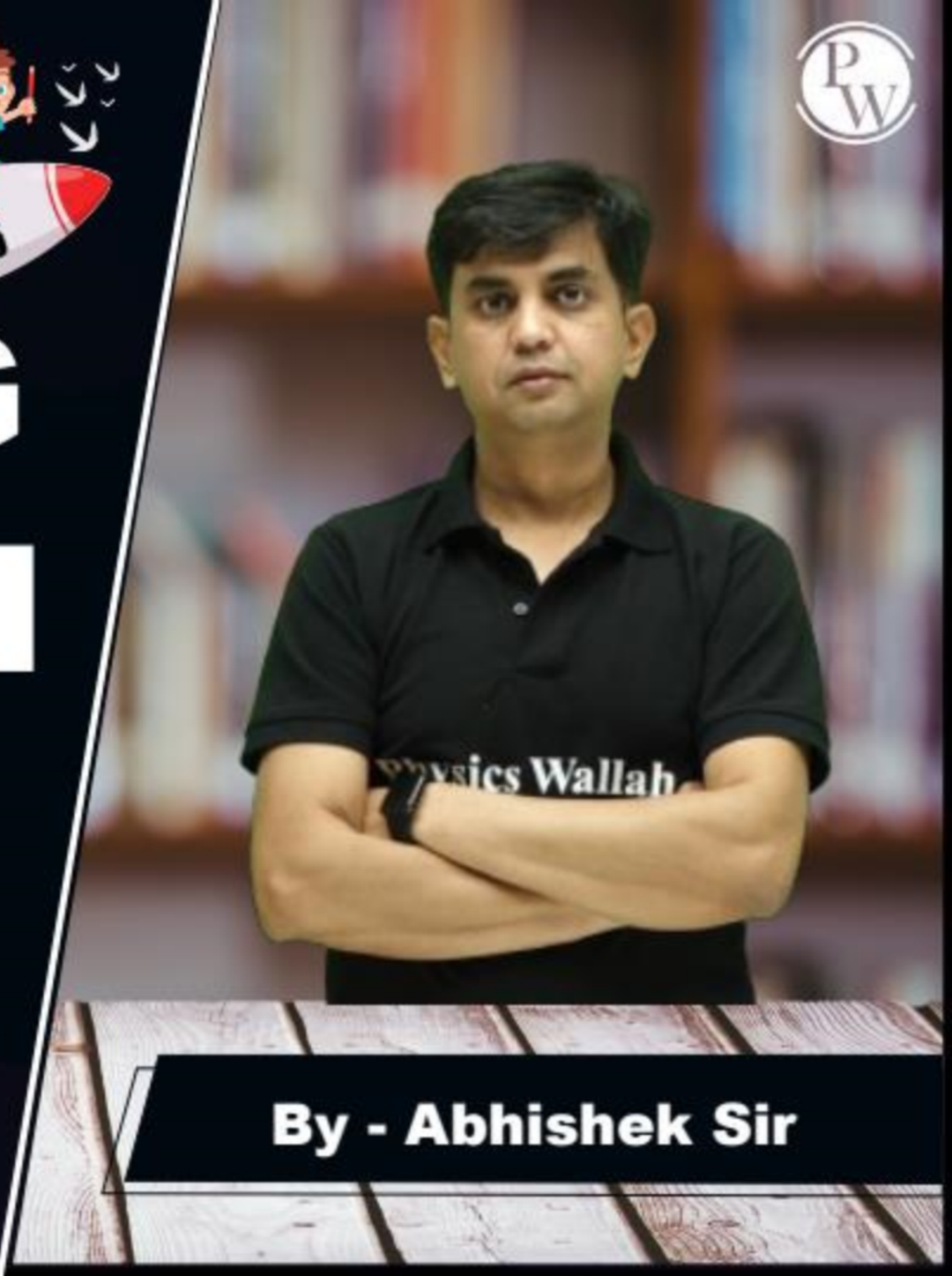
CS & IT ENGINEERING

Computer Network

MAC Layer

Lecture No. - 01



By - Abhishek Sir

Recap of Previous Lecture

Topic Selective Repeat ARQ

Topic Packet Error Probability

Topics to be Covered

- Topic: Media Access Control
- Topic: Multiple-access protocol
- Topic: ALOHA

ABOUT ME

Hello, I'm Abhishek

- GATE CS AIR - 96
- M.Tech (CS) - IIT Kharagpur
- 12 years of GATE CS teaching experience

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#Q. Consider a 128×10^3 bits/second satellite communication link with one-way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgment. The minimum number of bits required for the sequence number field to achieve 100% utilization is _____.

[GATE-2016, Set-2, 2-Mark]

Solution:-

Packet Size = 1 KB = 2^{13} bits $= 2^{10} * 8$ bits

Bandwidth = $128 * 10^3$ bits / sec $= 2^7 * 10^3$ bits/sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{2^{13} \text{ bits}}{2^7 * 10^3 \text{ bits / sec}} = 64 \text{ ms} = 2^6 * 10^{-3} \text{ sec}$$

$t_p = 150$ ms

Cycle time = $(t_x + 2 * t_p)$ = 364 ms

$= (64 + 2 * 150)$ ms

$$\text{Optimal Window Size (N)} = \left\lceil \frac{\text{Cycle Time (RTT)}}{\text{Transmission delay}} \right\rceil = \left\lceil \frac{364\,ms}{64\,ms} \right\rceil = 6$$

For Selective Repeat ARQ :

$$\text{Total number of sequences} = (N + N) = 2 * N = 2 * 6 = 12$$

Minimum number of bits required for sequence number field

$$= \lceil \log_2 [\text{Total number of sequences}] \rceil \text{ bits}$$

$$= \lceil \log_2(12) \rceil \text{ bits} = 4 \text{ bits}$$

Ans = 4

#Q. Consider a selective repeat sliding window protocol that uses a frame size of 1 KB to send data on a 1.5 Mbps link with a one-way latency of 50 msec. To achieve a link utilization of 60%, the minimum number of bits required to represent the sequence number field is _____.

[GATE-2014, Set-1, 2-Mark]

Solution:-

Packet Size = 1 KB = 2^{13} bits

Bandwidth = 1.5 Mbps = $1.5 * 10^6$ bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{2^{13} \text{ bits}}{1.5 * 10^6 \text{ bits / sec}} = 5.461 \text{ ms}$$

$t_p = 50$ ms

Cycle time = $(t_x + 2 * t_p)$ = 105.461 ms

To achieve 60% utilization ($\eta = 3/5$) in ~~Go Back 127 ARQ~~ Selective Repeat ARQ

$$\text{Efficiency } (\eta) = \frac{N * \text{ Transmission delay}}{\text{Cycle Time}}$$

$$\frac{3}{5} = \frac{N * t_x}{\text{cycle time}}$$

$$N = \left\lceil \frac{3 * \text{Cycle Time}}{5 * \text{Transmission delay}} \right\rceil$$

$$= \left\lceil \frac{3 * \text{cycle time}}{5 * t_x} \right\rceil$$

$$= \left\lceil \frac{3 * 105.461\,ms}{5 * 5.461\,ms} \right\rceil = \lceil 11.58 \rceil = 12$$

For Selective Repeat ARQ :

Total number of sequences = (N + N) = 2 * N = 2 * 12 = 24

Minimum number of bits required for sequence number field

$$= \lceil \log_2 [\text{Total number of sequences}] \rceil \text{ bits}$$

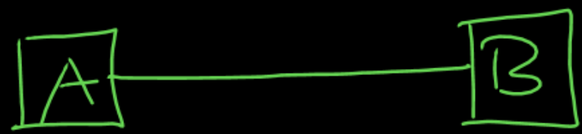
$$= \lceil \log_2 (24) \rceil \text{ bits} = 5 \text{ bits}$$

Ans = 5

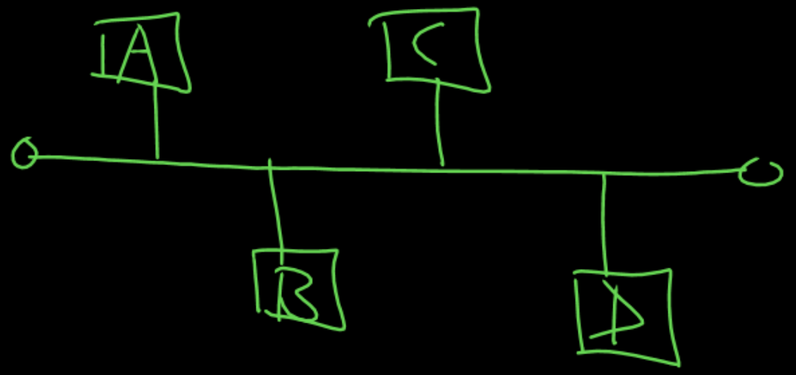
Topic : Line Configuration

Attachment of communication devices to a link.

1. Point-to-Point
   -> Dedicated link between two device



2. Multipoint (Multidrop)
   -> More than two devices share a single link
   -> Broadcast medium (One Sender and rest all are Receiver)
   -> Example : Bus topology or Wireless



Topic : Data Link Layer

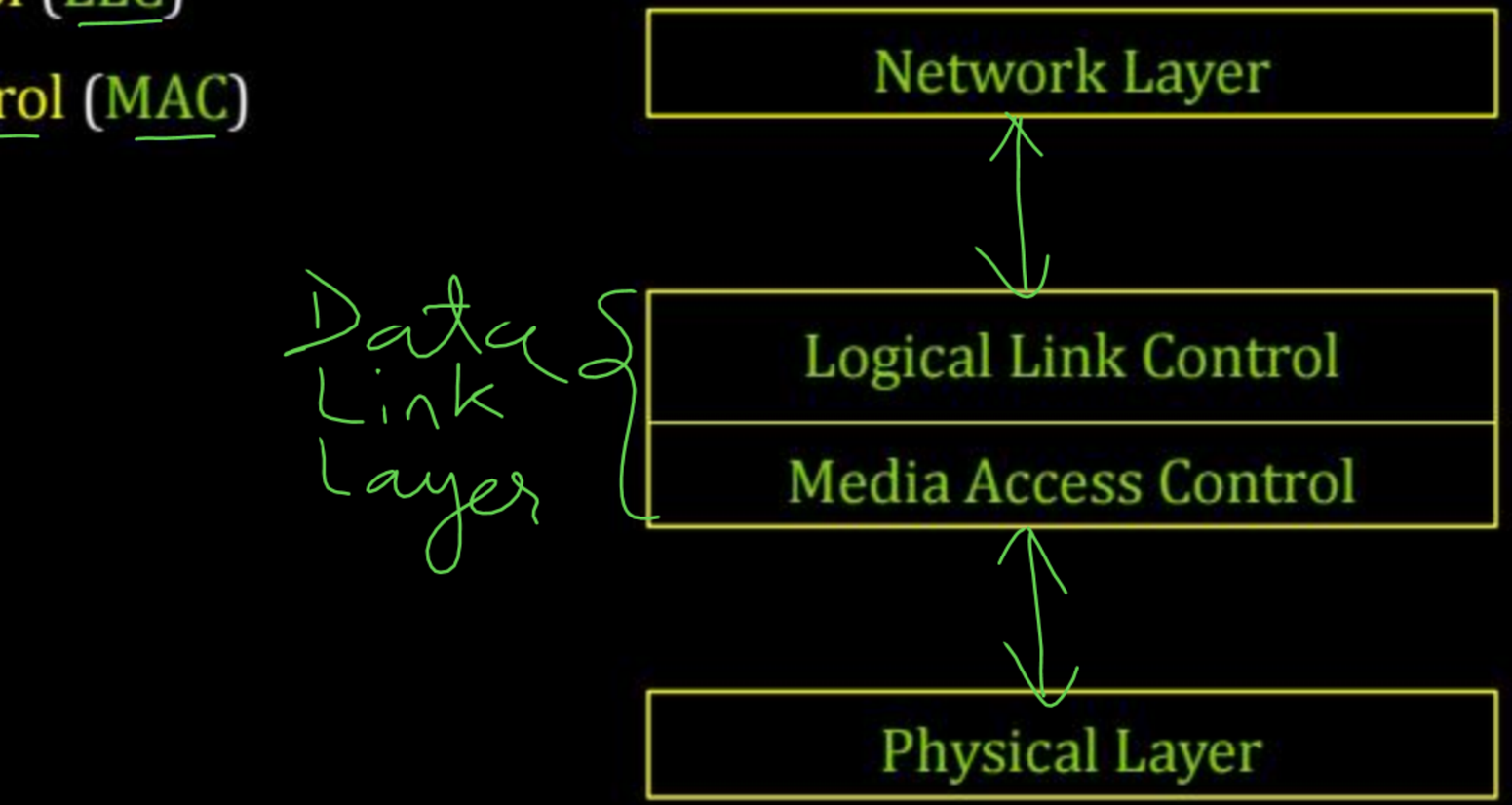
Data link layer services :

1. Framing
2. Error Control
3. Flow Control : Point to Point Link
4. Access Control : Multipoint

Topic : Data Link Layer

Data link layer is divided into two sub layers :

1. Logical link control (LLC)
2. Media access control (MAC)



Topic : Logical Link Control

-> The upper sub layer

-> Responsible for data link control

-> Flow and Error control

Topic : Media Access Control

-> The lower sub layer

-> Determine "who can access the media"
[in multipoint (multidrop) line configuration]

-> No any use, in point-to-point line configuration

-> Multiple access protocols

Media = Link

Topic : MAC Address

-> Identification of Source and Destination nodes of a packet

-> Physical adddress
[NIC : Network Interface Card]

-> 48 bits or 6 bytes

-> Should be unique, within a network

Topic : MAC Address

-> Two representation of MAC address :

1. Binary Representation [48-bits]
2. Hexadecimal Representation

   e.g. "ac:d1:b8:d5:59:0d"

-> Broadcast MAC address (Special MAC address) :

"ff:ff:ff:ff:ff:ff" [1111.....1111]

all 48 bits are one

Topic : Multiple Access Protocol

Interference :

-> Two or more simultanious transmssion by nodes

Collision :

-> if node receives two or more signals at same time

Topic : Multiple Access Protocol

Distributed algorithm :

-> Determine "how node shares channel"

-> Determine "when node can transmit"

-> Communication about channel sharing must use channel itself

-> Fully decentralized : No any special node to coordinate

Topic : Multiple Access Protocol

MAC protocols are divided into three categories :

1. Channel Partitioning : Static Allocation
2. Random Access : No any Allocation
3. Taking Turns : Dynamic Allocation

Topic : Channel Partitioning

-> Channelization protocols

-> Divide channel into smaller pieces
[Time slot, Frequncy or Code]

-> Allocate piece to node for exclusive use

Topic : Channel Partitioning

Channel partitioning MAC protocols are :

1. TDMA : Time-Division Multiple Access
2. FDMA : Frequency-Division Multiple Access
3. CDMA : Code-Division Multiple Access

Topic : Random Access

-> Channel is not divided
[unlike channel partitioning]

-> When node has packet to transmit

Topic : Random Access

-> Random Access MAC protocols are :

1. ALOHA
   -> Pure ALOHA and Slotted ALOHA
2. CSMA : Carrier Sense Multiple Access
   -> CSMA/CD [for wired] and CSMA/CA [for wireless]

Topic : Taking Turns

Channel partitioning

-> Static allocation

-> No chance of collision

-> Efficient at high traffic/load
[Inefficient at low traffic/load]

Random Access

-> No any allocation

-> Chance of collision

-> Efficient at low traffic/load
[Inefficient at high traffic/load]

Topic : Taking Turns

-> Controlled Access Protocol

-> Channnel allocated explicitly
[No chance of “collision”]

-> Dynamic allocation

Topic : Taking Turns

-> Controlled Access MAC protocols are :

1. Reservation
2. Polling
3. Token Passing

Topic : LAN Standards

→ IEEE 802.3 : Ethernet [Bus Topology => CSMA/CD]

→ IEEE 802.4 : Token Bus [Bus Topology => Token]

→ IEEE 802.5 : Token Ring [Ring Topology => Token]

→ IEEE 802.11 : Wireless [Wi-FI => CSMA/CA]

Topic : Pure ALOHA

-> When node has packet to transmit, it transmit immediately

-> Allow collision to happen
[recover via "retransmission"]

-> Use randomization in choosing "when to retransmit"
[Back-off time]

Topic : Pure ALOHA

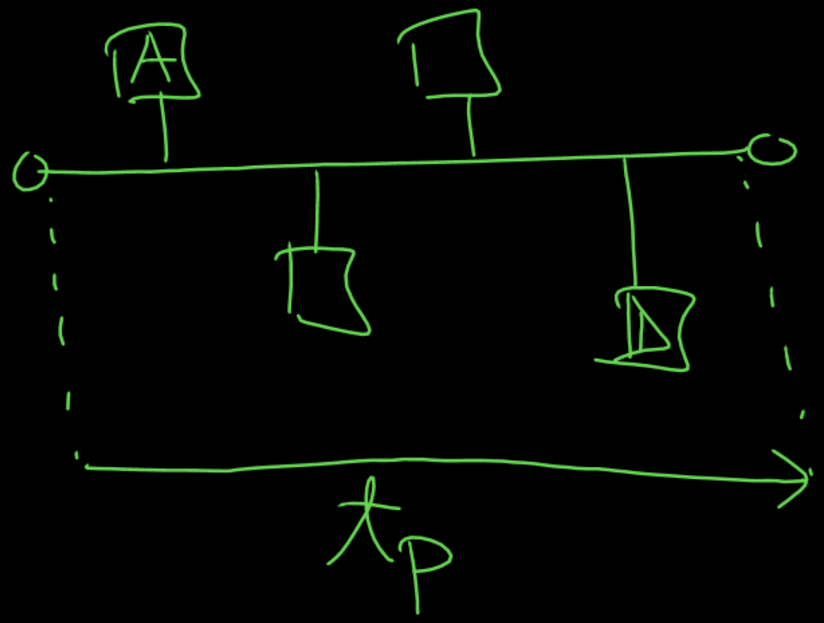
-> All frames are of equal size

-> Receiver send acknowledgement to Source
[for every correctly (without collision) received frame]

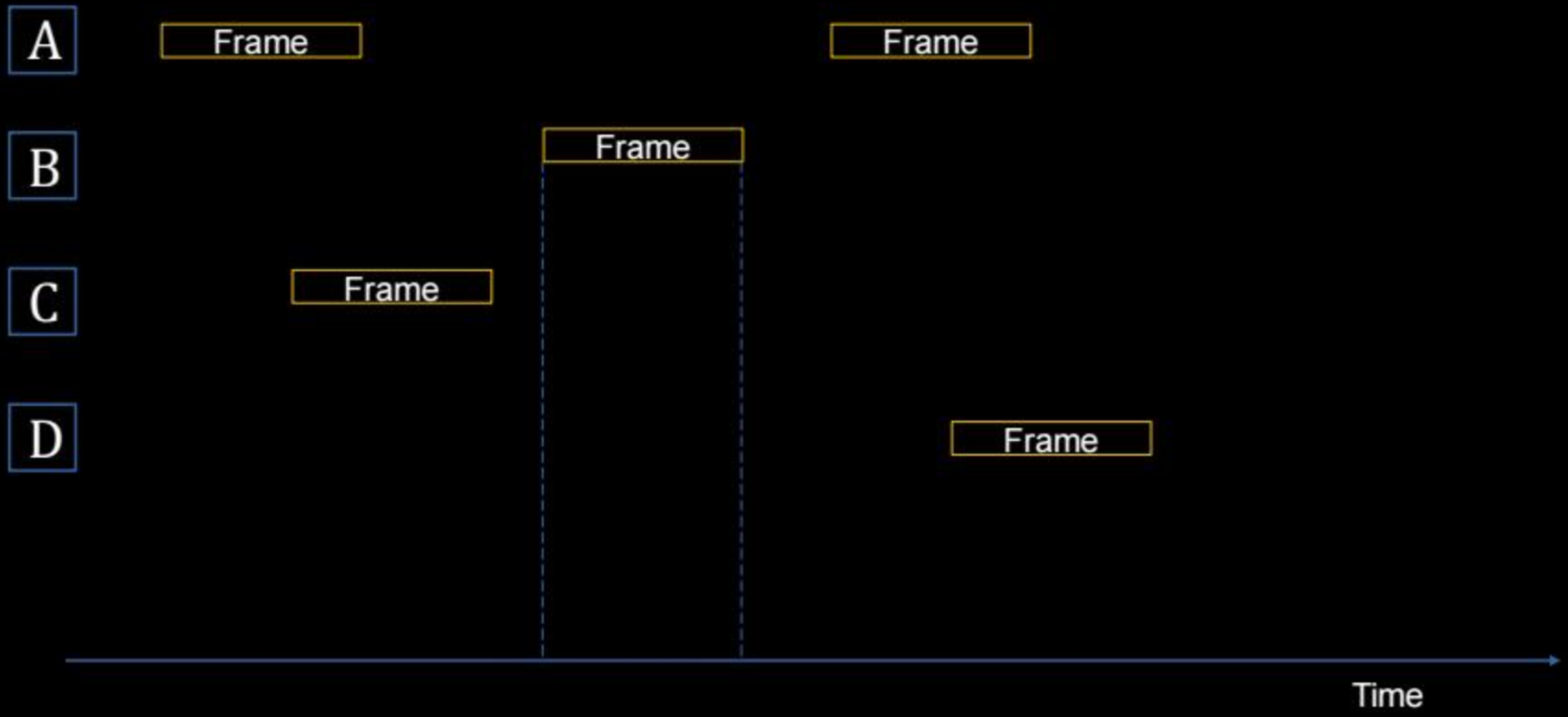
-> After transmitting a frame, Source wait for an ACK upto time-out

-> Time-out time = Round Trip Propagation Delay

$= 2t_p$



Topic : Pure ALOHA



2 mins Summary

Topic Media Access Control

Topic Multiple-access protocol

Topic ALOHA (Pure ALOHA)

THANK - YOU