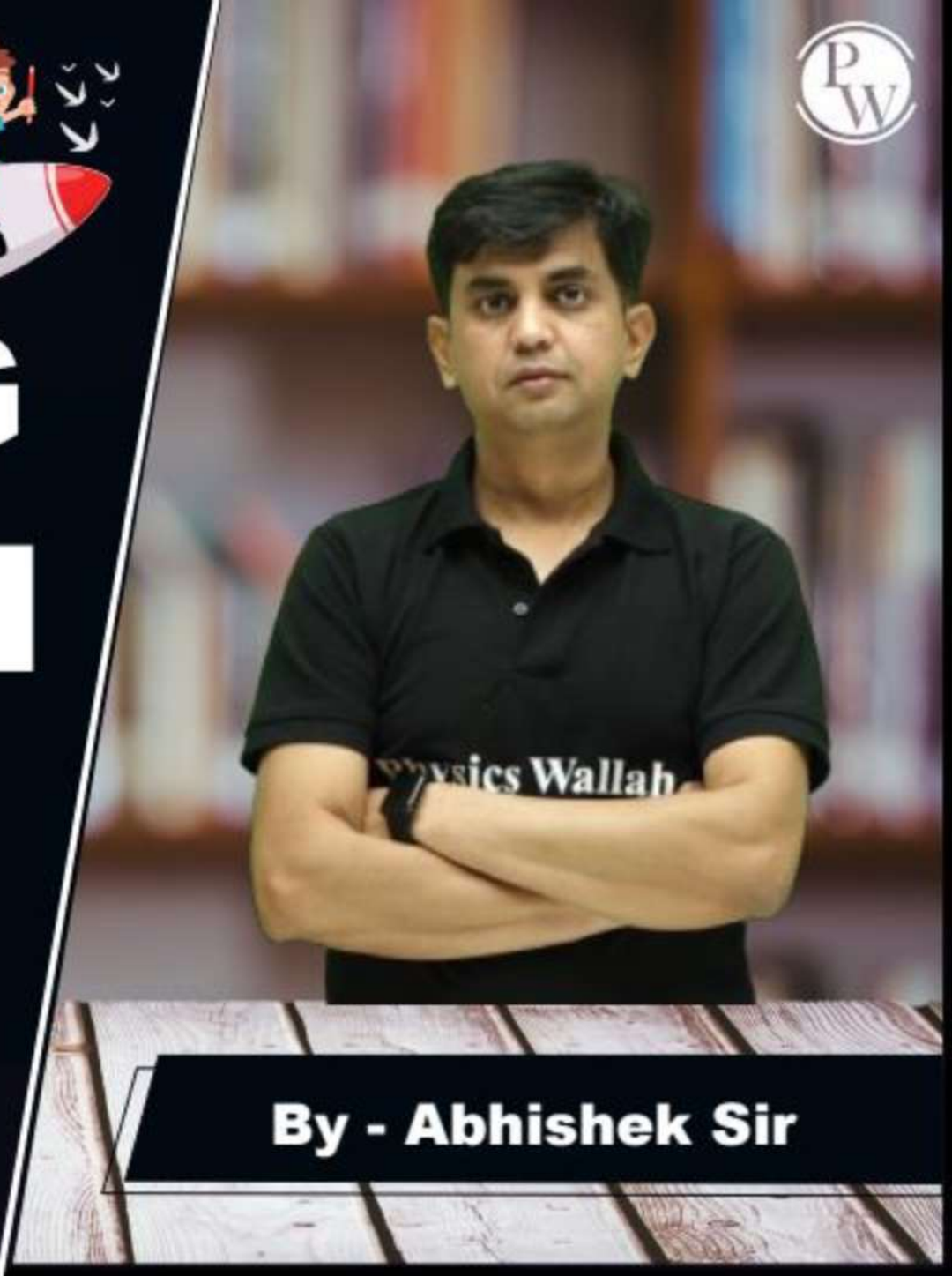
CS & IT ENGINEERING

Computer Network

MAC Layer

Lecture No. - 05



By - Abhishek Sir

Recap of Previous Lecture

Topic CSMA

Topic CSMA/CD

Topics to be Covered

Topic CSMA/CD

Topic Ethernet

ABOUT ME

Hello, I'm Abhishek

- GATE CS AIR - 96
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Topic : CSMA/CD

→ CSMA with Collision Detection

→ Applicable only for wired LAN (Bus topology)

→ Sense before transmit

→ Sense while (during) transmission

→ No any feedback (acknowledgment) from receiver

Topic : CSMA/CD

→ To detect collision,
minimum frame transmission delay should be
greater than equal to (maximum) round trip propagation delay.

frame transmission delay >= round trip propagation delay

$$t_x >= 2*t_p$$

#Q. A network with CSMA/CD protocol in the MAC layer is running at 1 Gbps over a 1 km cable with no repeaters. The signal speed in the cable is 2×10^8 m/sec. The minimum frame size for this network should be

[GATE 2004]

(A) 10000 bits

(B) 10000 bytes

(C) 5000 bits

(D) 5000 bytes

$t_x \geq 2t_p$

(CSMA/CD)

Ans : A

Solution : $= (2 t_p) * \text{Bandwidth}$

Minimum frame size = 2 * (Distance / Signal Speed) * Bandwidth

= 2 * (1 km / 2×10^8 m/sec) * 1 Gbps

= 2 * (10^3 m / 2×10^8 m/sec) * 10^9 bits/sec

= 10000 bits $= 10^4$ bits

= 1250 bytes

#Q. The minimum frame size required for a CSMA/CD based computer network running at 1 Gbps on a 200 m cable with a link speed of 2×10^8 m/s is :

[GATE 2008]

(A) 125 bytes

(B) 250 bytes

(C) 500 bytes

(D) None of these

CSMA/CD

$t_x \geq 2t_p$

For min^m Frame Size

$t_x = 2t_p$

Ans: B

Solution :

Minimum frame size = 2 * (Distance / Signal Speed) * Bandwidth

= 2 * (200 m / 2 x 10^8 m/sec) * 1 Gbps

= 2 * (200 m / 2 x 10^8 m/sec) * 10^9 bits/sec

= 2000 bits

= 250 bytes

#Q. A network has a data transmission bandwidth of 20×10^6 bits per second. It uses CSMA/CD in the MAC layer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is _____ bytes.

[GATE 2016]

Solution :

Minimum frame size = $(2 * t_p) *$ Bandwidth

$= 2 *$ 40 microsec $*$ $20 * 10^6$ bits / second

$= 2 * 40 * 10^{-6}$ second $* 20 * 10^6$ bits / second

= 1600 bits $= 2 * 40 * 20$ bits

= 200 bytes

Ans = 200

#Q. Consider a CSMA/CD network that transmits data at a rate of 100 Mbps (10^8 bits per second) over a 1 km (kilometre) cable with no repeaters. If the minimum frame size required for this network is 1250 bytes, what is the signal speed (km/sec) in the cable?

[GATE 2015]

CSMA/CD

$t_x \geq 2 t_p$

$$\left(\frac{\text{min FrameSize}}{\text{Bandwidth}}\right) = 2 * \left(\frac{\text{Distance}}{\text{Signal Speed}}\right)$$

(A) 8000

(B) 10000

(C) 16000

(D) 20000

Ans: D

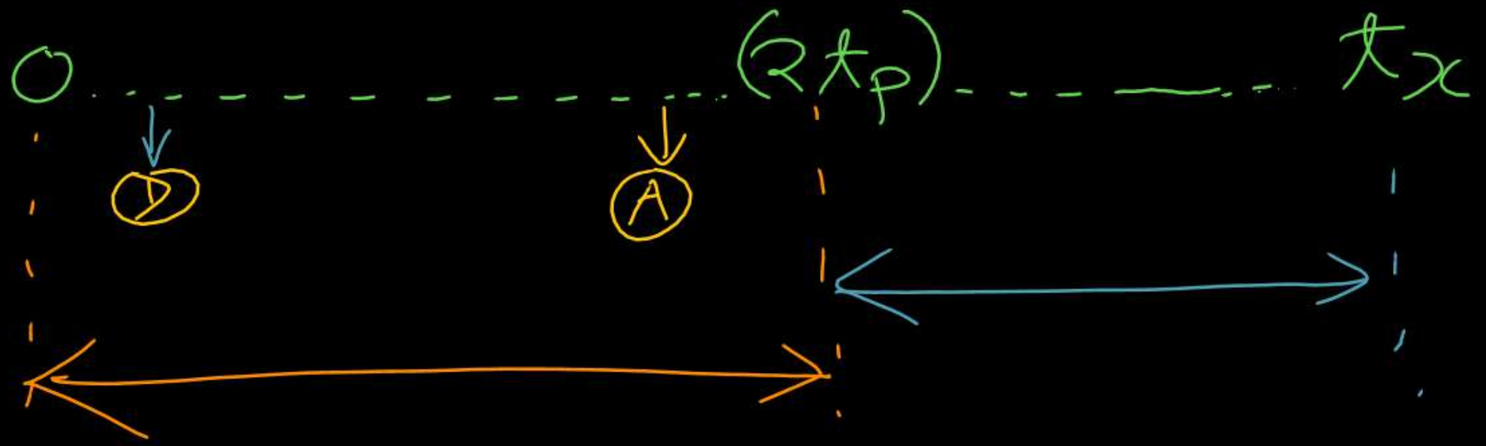
Solution :

Minimum Signal Speed = 2 * Distance * (Bandwidth / Frame size)

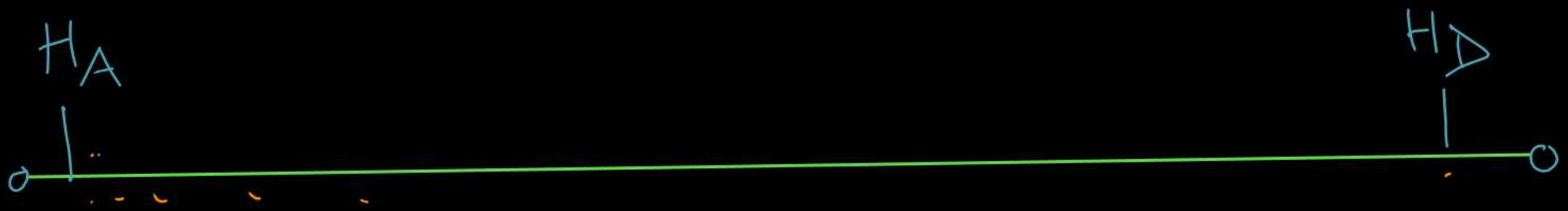
= 2 * 1 km * (100 Mbps / 1250 bytes)

= 2 * 1 km * (10^8 bits per second / 10^4 bits)

= 20000 km per second = $2 * 10^4$ km per sec



$$t_x \geq 2t_p$$



Topic : Jam Signal

→ Jamming signal 32-bits or 48-bits (min^m size)

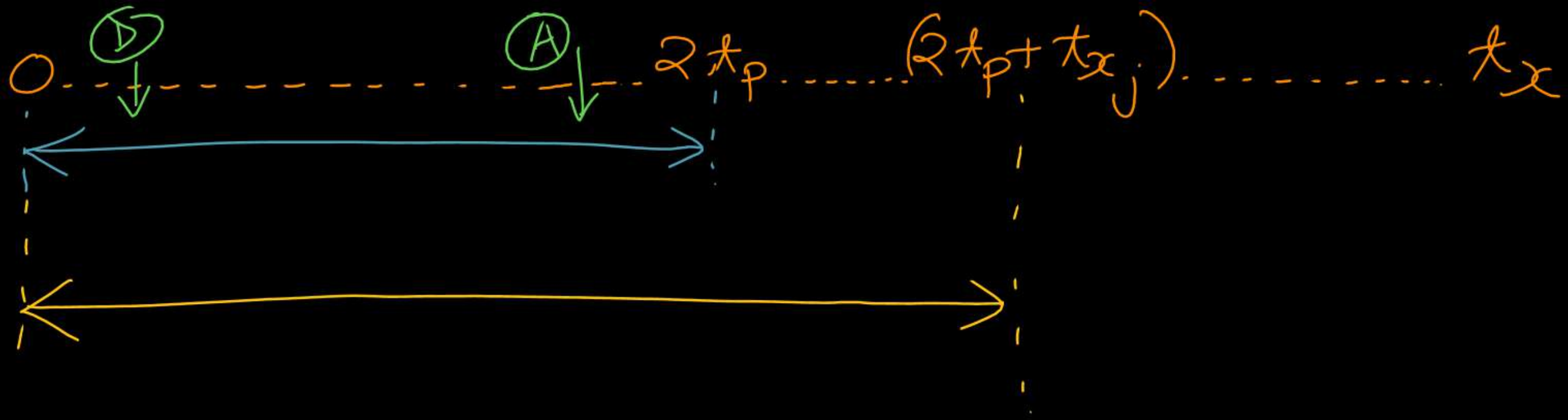
→ Transmitter transmit jam signal when collision detected

→ To inform the other transmitting stations about the collision

$$t_x >= [\,2*t_p + t_{xj}\,]$$

$$t_{xj} = \frac{\text{Size of Jam Signal}}{\text{Bandwidth}}$$

t_{xj} : Transmission time for Jamming Signal



Min^m transmission time in CSMA/CD $= (2t_p + t_{x_j})$

#Q. Suppose the round trip propagation delay for a 10 Mbps Ethernet having 48-bit jamming signal is 46.4 μs. The minimum frame size is :

[GATE 2005]

(A) 94 bits

(B) 416 bits

(C) 464 bits

(D) 512 bits

Ans: D

$t_x \geq (2t_p + t_{x_j})$

$t_x \geq (\min^m \text{transmission time})$

Round trip propagation delay

$= 2t_p = 46.4\ \mu s = 46.4 * 10^{-6}\ sec$

Solution :

$$t_x = [2 * t_p + t_{xj}]$$

$$\text{Minimum frame size} = [2 * t_p + t_{xj}] * \text{Bandwidth}$$

$$= [46.4\ \mu s + (\text{Jam Signal Size} / \text{Bandwidth})] * \text{Bandwidth}$$

$$= [46.4\ \mu s * \text{Bandwidth} + \text{Jam Signal Size}]$$

$$= [46.4\ \mu s * 10\text{Mbps} + 48\ \text{bits}]$$

$$= [46.4\ \mu s * 10^7\ \text{bits/sec} + 48\ \text{bits}]$$

$$= [464\ \text{bits} + 48\ \text{bits}]$$

$$= 512\ \text{bits}$$

$$= 64\ \text{bytes}$$

Topic : Ethernet

→ IEEE 802.3

→ Based on 1 – persistent CSMA/CD

#Q. Consider an Ethernet segment with a transmission speed of 10^8 bits/sec and a maximum segment length of 500 meters. If the speed of propagation of the signal in the medium is 2×10^8 meters/sec, then the minimum frame size (*in bits*) required for collision detection is _____ .

[GATE-2024, Set-2, 2-Mark]

$t_x \geq 2t_p$

H.W

#Q. Determine the maximum length of the cable (in km) for transmitting data at a rate of 500 Mbps in an Ethernet LAN with frames of size 10,000 bits. Assume the signal speed in the cable to be 2,00,000 km/s.

[GATE 2013]

$(t_x \geq 2t_p)$

H.W.

(A) 1

(B) 2

(C) 2.5

(D) 5

Topic : Ethernet Standard

→ Thick Ethernet (Thicknet) : 10 BASE 5

→ Thin Ethernet (Thinnet) : 10 BASE 2

→ 10 Mbps Bandwidth (Baseband)

→ 500 meter / 200 meter (Segment Length)

Broad = Analog Signal

Base = Digital Signal

Topic : Ethernet

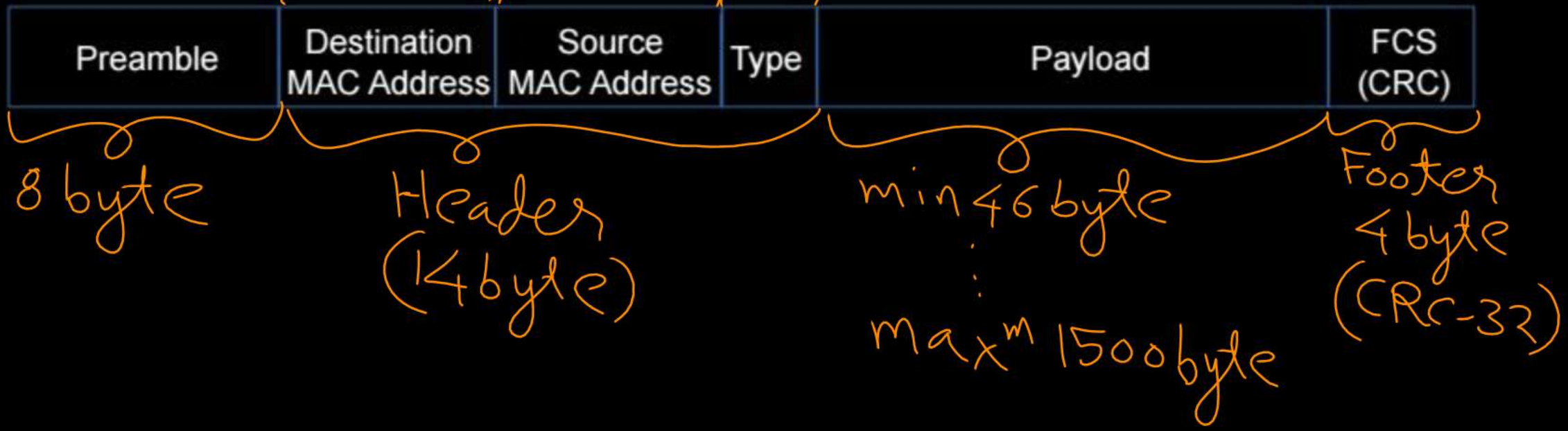
→ Minimum frame size : 64 Bytes

→ Maximum frame size : 1518 Bytes

→ Inter-frame gap between frames

→ Ethernet uses Jamming Signal

Topic : Ethernet Frame Format



Topic : Preamble

(8 byte)

→ 7 byte binary string of alternate 1 and 0 [10101010.....10]

→ Allowing receivers to synchronize their clock at the bit-level with the transmitter clock.

→ Preamble is followed by the one byte SFD

→ SFD ends with a 1 instead of 0 [10101011]

[To break the bit pattern of the preamble and signal the start of the actual frame]

Topic : Type (2 byte)

→ Specifies the protocol of the payload
[e.g IPv4, IPv6, ARP etc]

→ if Type < 46 :
then Type is size of data in payload field bytes

→ Size of padding = [46 – Type] bytes

Topic : FCS

→ Frame Check Sequence (FCS)

→ 32 bits (4 bytes)

→ CRC - 32

Topic : Exponential Backoff Algorithm

-> Binary Exponential Backoff Algoriithm

-> At k^{th} collision of perticular frame : [k = 1, 2, 3, ...]

if $k < 15$

then transmitter chooses a number R randomely in between 0 to $(2^i - 1)$ where $i = \min(k, 10)$

else

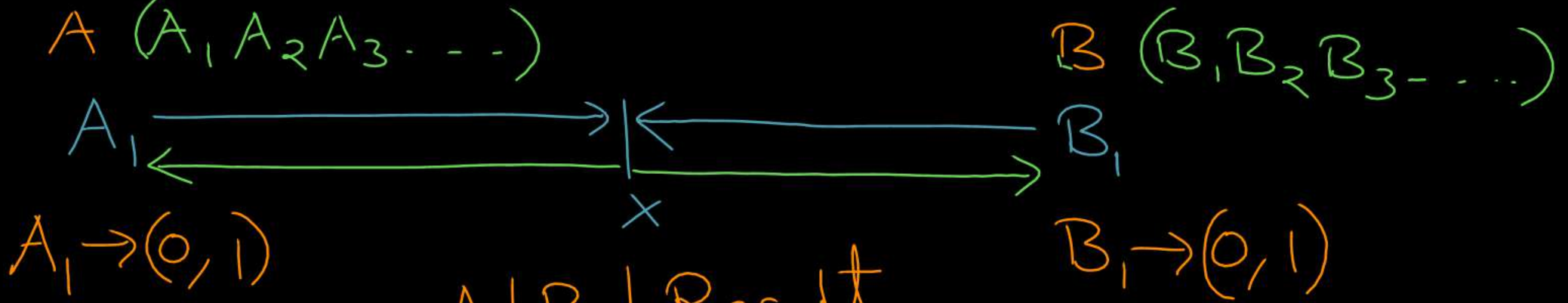
Abort the retransmission

-> Wait Time = $R * t_x$

-> Transmitter will sense the channel after Wait Time [for retransmission of the frame]

Example 6 :-

#Q. A and B are the only two stations on an Ethernet. Each has a steady queue of frames to send. Both A and B attempt to transmit a frame and collide, what is the probability that A wins the first backoff race?



A	B	Result
0	0	Again collied
1	1	
0	1	A win
1	0	B win

$$Ans = \frac{1}{4}$$

#Q. A and B are the only two stations on an Ethernet. Each has a steady queue of frames to send. Both A and B attempt to transmit a frame, collide, and A wins the first backoff race. At the end of this successful transmission by A, both A and B attempt to transmit and collide. The probability that A wins the second backoff race is:

[GATE 2004]

H.W.

(A) 0.5

(B) 0.625

(C) 0.75

(D) 1.0

2 mins Summary

Topic CSMA/CD

Topic Ethernet

THANK - YOU