CS & IT ENGINEERING

Computer Network

Flow Control

Lecture No. - 01

By - Abhishek Sir

Recap of Previous Lecture

Topic Hamming Distance

Topics to be Covered

Topic Network Delay

Topic End to end Delay

ABOUT ME

Hello, I'm Abhishek

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- 12 years of GATE CS teaching experience

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Topic : Network Delays

Four types of network delays :

1. Transmission delay
2. Propagation delay
3. Queuing delay
4. Processing delay

Topic : Transmission Delay

→ Transmission Time / Delay [t_x] (in seconds)

→ Time required to transmit a packet over a link

$$\boxed{\text{Transmission Delay} = \frac{\text{Packet Size}}{\text{Data Transfer Rate}}}$$

Bandwidth = D.T.R. = No. of bits transmitted per sec

Topic : Packet Size

→ Packet Length or Frame Size

→ Number of bits or bytes in one packet

→ Size of Data (Digital) (Base-2)

$1\ KB = 2^{10}$ bytes

$1\ MB = 2^{20}$ bytes

$1\ GB = 2^{30}$ bytes

$1\ TB = 2^{40}$ bytes

B → Byte

b → bit

Topic : Data Transfer Rate

→ Data Transfer Rate or Bandwidth

→ Number of bits or bytes transmitted per seconds (Bit Rate)

→ Number of signals generated into channel per seconds (Baud Rate)

→ Count or Frequency

→ Data Transfer Rate (Analog) (Base-10)

1 Kbps = 10^3 bits per second

1 Mbps = 10^6 bits per second

1 Gbps = 10^9 bits per second

1 Tbps = 10^{12} bits per second

1 KBps = 10^3 bytes per sec

$\boxed{\text{Bit Rate vs Baud Rate}}$

Topic : Network Delays

→ 1 second = 10^3 milliseconds (ms)

= 10^6 microseconds (μs)

= 10^9 nanoseconds (ns)

= 10^{12} picoseconds (ps)

10^{-3} sec = 1 ms

	Analog	Digital
1 K	10^3	2^{10}
1 M	10^6	2^{20}
1 G	10^9	2^{30}

Example 1 :-

Consider frame size is 1000 bytes and bandwidth of a link is 1Mbps, then calculate transmission delay in milliseconds ?

$$\left[t_x = ? \right]$$

Example 1 :-

Consider frame size is 1000 bytes and bandwidth of a link is 1Mbps, then calculate transmission delay in milliseconds ?

Solution :

Frame Size = 1000 bytes = $8 * 10^3$ bits

Bandwidth = 1 Mbps = 10^6 bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{8 * 10^3 \text{ bits}}{10^6 \text{ bits / sec}} = 8 \text{ ms} = 8 * 10^{-3} \text{ sec}$$

$\boxed{\text{Ans} = 8}$

Example 2 :-

Consider packet size is 4 KB and data transfer rate of a link is 256 Kbps, then Calculate transmission delay in milliseconds ?

Example 2 :-

Consider packet size is 4 KB and data transfer rate of a link is 256 Kbps, then Calculate transmission delay in milliseconds ?

Solution :

Frame Size = 4 KB = 2^{15} bits $= 2^2 * KB = 2^2 * 2^{10}$ Byte $= 2^2 * 2^{10} * 2^3$ bit

Bandwidth = 256 Kbps = $2^8 * 10^3$ bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{2^{15} \text{ bits}}{2^8 * 10^3 \text{ bits / sec}} = 128 \text{ ms} = 2^7 * 10^{-3} \text{ sec}$$

$\boxed{\text{Ans} = 128}$

Topic : Propagation Delay

→ Propagation Time / Delay [t_p] (in seconds)

→ Time required to travel a signal (bit) from one end to other end of a link

→ One-way

$$\boxed{\text{Propagation Delay} = \frac{\text{Distance}}{\text{Signal Speed}}}$$

* Signal propagation speed

Example 3 :-

Consider distance between two host is 200 meter and signal speed of a link is 10^5 meter per second then calculate propagation delay in milliseconds ?

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Consider distance between two host is 200 meter and signal speed of a link is 10^5 meter per second then calculate propagation delay in milliseconds ?

Solution :

Distance = 200 meter

Signal Speed = 10^5 meter / sec

$$t_p = \frac{\text{Distance}}{\text{Signal Speed}} = \frac{200 \text{ meter}}{10^5 \text{ meter / sec}} = 2 \text{ ms} = 2 * 10^{-3} \text{ sec}$$

$\boxed{\text{Ans} = 2}$

Example 4 :-

Consider distance between two host is 2 Km and signal speed of a link is 5 microsecond per Km then calculate propagation delay in microseconds ?

Distance = 2 Km

Signal speed = 5 μs / Km

Example 4 :-

Consider distance between two host is 2 Km and signal speed of a link is 5 microsecond per Km then calculate propagation delay in microseconds ?

Solution :

Distance = 2 Km

Signal Speed = 5 μs / Km

$$t_p = \text{Distance} * \text{Signal Speed} = 2\ \text{Km} * 5\ \mu s / \text{Km} = 10\ \mu s$$

$$\boxed{\text{Ans} = 10}$$

Topic : Propagation Delay

→ if signal speed given in "meter per second"

$$\text{Propagation Delay} = \frac{\text{Distance}}{\text{Signal Speed}}$$

→ if signal speed given in "second per meter"

$$\text{Propagation Delay} = \text{Distance} \times \text{Signal Speed}$$

Topic : Round Trip Propagation Delay

→ Two-way

→ **2** * Propagation Time [**2** * t_p]

→ For a signal (bit)

#Q. Consider two hosts X and Y, connected by a single direct link of rate 10^6 bits/sec. The distance between the two hosts is 10,000 km and the propagation speed along the link is 2×10^8 m/s. Hosts X send a file of 50,000 bytes as one large message to hosts Y continuously. Let the transmission and propagation delays be p milliseconds and q milliseconds, respectively. Then the vales of p and q are:

[GATE 2017]

IIT-R

H.W.

(A) p = 50 and q = 100

(B) p = 50 and q = 400

(C) p = 100 and q = 50

(D) p = 400 and q = 50

Topic : Queuing Delay

→ Waiting time of a packet at input buffer, before processing

→ Cannot be determined

→ if not given, consider negligible

Topic : Processing Delay

→ Time required to process a packet after receiving

→ Based on CPU processing speed and packet size

→ if not given, consider negligible

Topic : End-to-End Delay

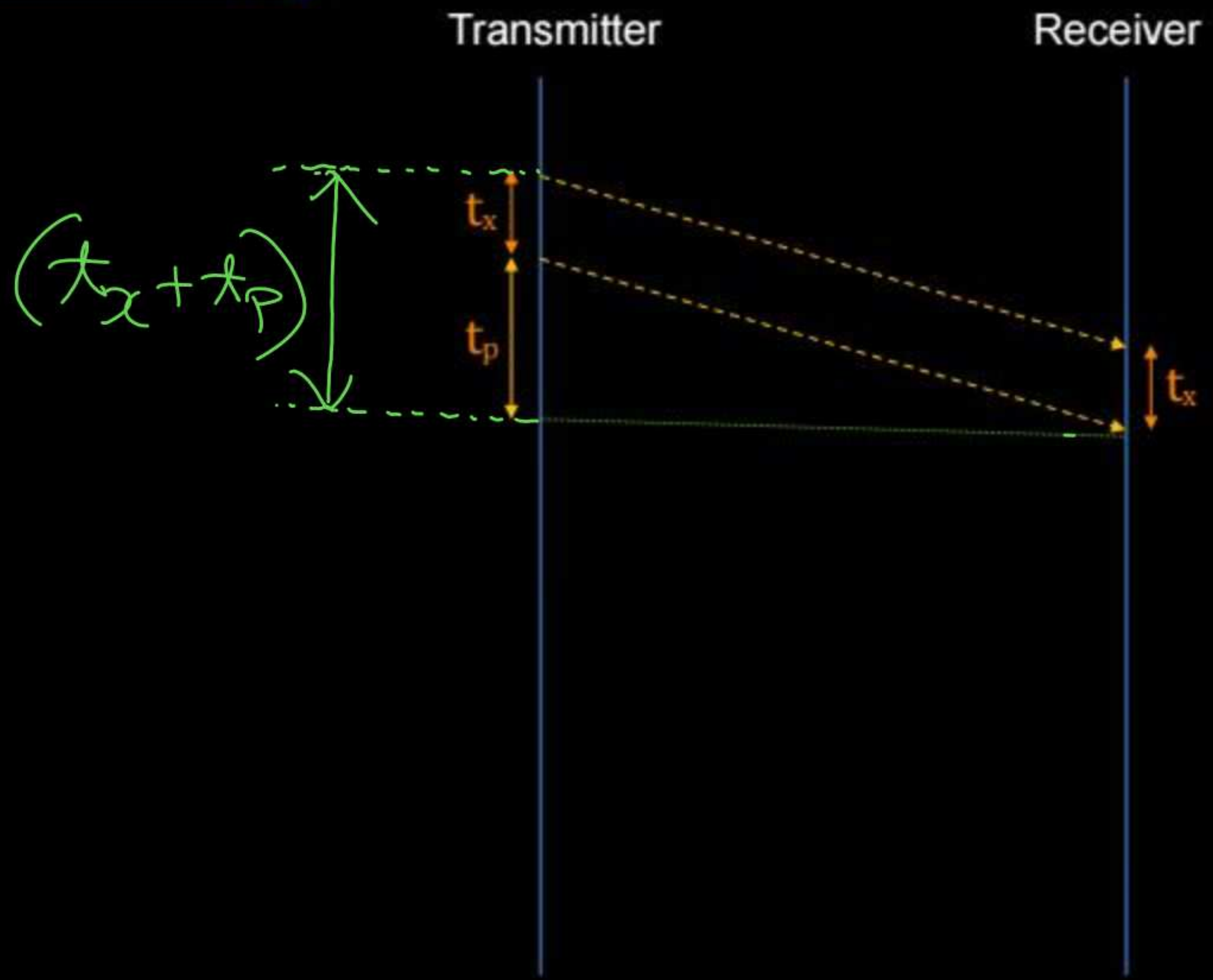
→ One-way delay

→ Time required for a packet to be transmitted from Transmitter to Receiver

End-to-end delay = Transmission delay + Propagation delay

$$= [t_x + t_p]$$

Topic : End-to-End Delay



#Q. Consider a 100 Mbps link between an earth station (sender) and a satellite (receiver) at an altitude of 2100 km. The signal propagates at a speed of 3×10^8 m/s. The time taken (in milliseconds, rounded off to two decimal places) for the receiver to completely receive a packet of 1000 bytes transmitted by the sender is ______.

[GATE-2022, 2-Marks]

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Topic : Network Delays

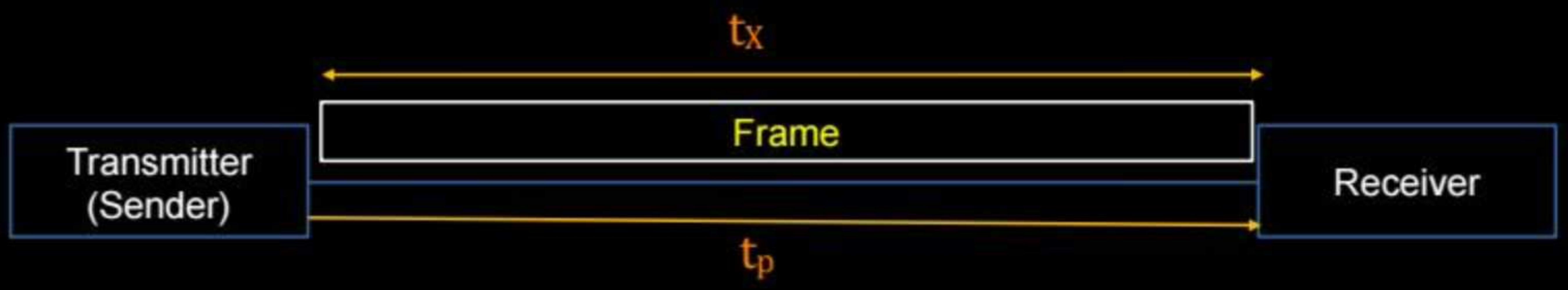
CASE I : $t_x < t_p$

Transmission delay < Propagation delay

Topic : Network Delays

CASE II : $t_x = t_p$

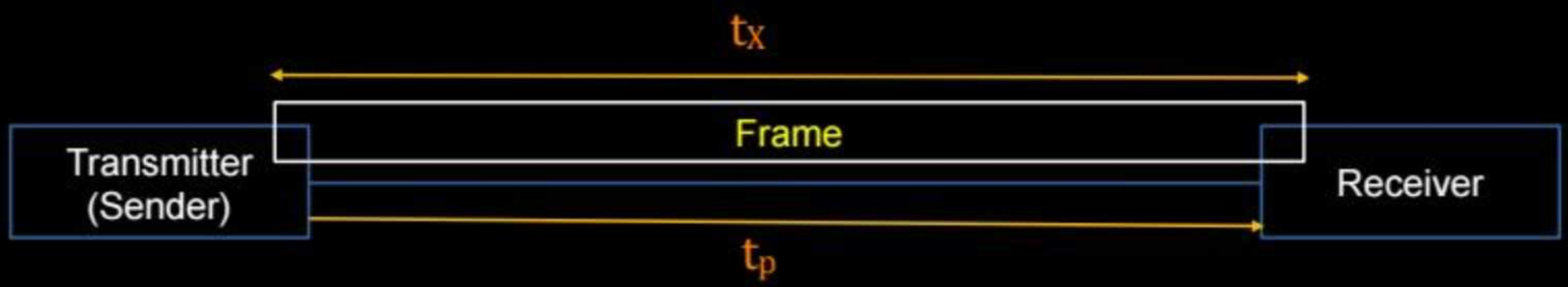
Transmission delay = Propagation delay



Topic : Network Delays

CASE III : $t_x > t_p$

Transmission delay > Propagation delay



2 mins Summary

Topic Network Delay

Topic End to end Delay

THANK - YOU