Problem 1: Calculating Propagation Delay

📌 **Problem:**

A CSMA/CD network has two stations **A** and **B** that are **2 km apart**. The signal propagation speed in the medium is **2 × 10^8 m/s**.

Find the **propagation delay** (T_p).

Solution:

We use the formula:

$$T_p = \frac{\text{Distance}}{\text{Propagation Speed}}$$

Given:

- **Distance** = 2 km = **2000 m**
- **Propagation speed** = 2×10^8 m/s

$$T_p = \frac{2000}{2 \times 10^8}$$

$$\downarrow$$

$$T_p = 10\ \mu s$$

Problem 2: Collision Detection Time

📌 **Problem:**

In an Ethernet CSMA/CD network, two stations are **5 km apart.** The propagation speed is **2 × 10^8 m/s.**

What is the **minimum time** required for a station to detect a collision?

Solution:

The **minimum time to detect a collision** is:

$$T_{\text{collision}} = 2T_p$$

First, we calculate T_p:

$$T_p = \frac{\text{Distance}}{\text{Propagation Speed}} = \frac{5000}{2 \times 10^8}$$

$$T_p = 25 \ \mu\text{s}$$

Now, applying $2T_p$:

$$T_{\text{collision}} = 2 \times 25 = 50 \ \mu\text{s}$$

Answer: 50 µs

Problem 3: Minimum Frame Size in Ethernet

📌 **Problem:**

An Ethernet network has a maximum cable length of **2500 meters**, and the signal propagation speed is **2 × 10^8 m/s**. The data rate is **10 Mbps**. Find the **minimum frame size** required to ensure collision detection.

Solution:

Step 1: Calculate $2T_p$

$$T_p = \frac{\text{Distance}}{\text{Propagation Speed}} = \frac{2500}{2 \times 10^8}$$

$$T_p = 12.5\ \mu s$$

$$2T_p = 25\ \mu s$$

Step 2: Calculate Minimum Frame Size

Minimum frame size is:

$$\text{Frame Size} = \text{Data Rate} \times (2T_p)$$

$$= 10 \times 10^6 \times 25 \times 10^{-6}$$

$$= 250 \text{ bits} = 250/8 = 31.25 \text{ bytes}$$

Since Ethernet requires a **minimum frame size of 64 bytes**, this confirms that a **64-byte frame** is sufficient.

Answer: 64 bytes (standard minimum Ethernet frame size)

Problem 4: Time Required to Send a Frame

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📌 **Problem:**

A **1500-byte frame** is transmitted over a **100 Mbps** Ethernet network. How long does it take to send the entire frame?

Solution:

$$T_{fr} = \frac{\text{Frame Size}}{\text{Data Rate}}$$

Given:

- **Frame Size** = $1500 \times 8 = 12,000$ bits
- **Data Rate** = 100×10^6 bps

$$T_{fr} = \frac{12,000}{100 \times 10^6}$$

$$T_{fr} = 120\ \mu s$$

Answer: 120 µs

Problem 5: Maximum Transmission Distance Without Collision

📌 **Problem:**

A network operates at **1 Gbps**, and the minimum Ethernet frame size is **64 bytes**. The signal propagation speed is **2 × 10^8 m/s**. What is the maximum cable length to ensure collision detection?

Solution:

We need to find the **maximum propagation delay** T_p that satisfies:

$$T_{fr} \geq 2T_p$$

First, find T_{fr}:

$$T_{fr} = \frac{\text{Frame Size}}{\text{Data Rate}} = \frac{64 \times 8}{10^9}$$

$$T_{fr} = \frac{512}{10^9} = 0.512\ \mu s$$

Now, solving for **distance**:

10^9

Now, solving for **distance**:

$$2T_p \leq T_{fr}$$

$$2 \times \frac{D}{2 \times 10^8} \leq 0.512\ \mu s$$

$$D \leq (0.512 \times 10^{-6}) \times (2 \times 10^8)$$

$$D \leq 102.4\ \text{meters}$$

Answer: Maximum cable length = 102.4 meters