

# Ethernet Layers – Lecture Summary (Key Points)

## 1. Ethernet Overview

- Ethernet operates at **two layers of the network model**:
    - **Data Link Layer (Layer 2)**
    - **Physical Layer (Layer 1)**.
  - Ethernet technologies are defined by **IEEE 802.2 and IEEE 802.3 standards**.
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## 2. Data Link Layer

### Purpose of the Data Link Layer

- Responsible for communication between **Network Interface Cards (NICs)**.
  - Encapsulates **Layer 3 packets (IPv4 / IPv6)** into **Layer 2 frames**.
  - Provides access to the **physical media**.
  - Performs **error detection** and discards corrupted frames.
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### Data Link Sublayers

The Data Link Layer consists of two sublayers:

#### 1. Logical Link Control (LLC)

- Communicates with the **upper network layers**.
- Connects networking software with hardware.

#### 2. Media Access Control (MAC)

- Responsible for:
    - **Data encapsulation**
    - **Media access control**.
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## Router Layer 2 Functions

At each hop, a router performs four Layer 2 functions:

- Accepts a frame from the network medium.
  - De-encapsulates the frame to extract the packet.
  - Re-encapsulates the packet into a new frame.
  - Forwards the new frame to the next network segment.
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## 3. Network Topologies

### Types of Topologies

#### Physical Topology

- Shows the **physical connections between devices**.

#### Logical Topology

- Shows the **logical path of data transmission**.
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### WAN Topologies

Common WAN topologies include:

- **Point-to-Point**  
Direct connection between two devices.
  - **Hub and Spoke**  
Central device connects multiple branch sites.
  - **Mesh**  
Every device connects to all others for high availability.
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## LAN Topologies

Common LAN topologies:

- **Star**
  - **Extended Star**
  - **Bus**
  - **Ring.**
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## 4. Duplex Communication

### Half-Duplex

- Devices can **send or receive only one at a time.**
- Used in **legacy Ethernet and WLANs.**

### Full-Duplex

- Devices can **send and receive simultaneously.**
  - Used by **Ethernet switches.**
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## 5. Media Access Control Methods

### Contention-Based Access

Devices compete for the network medium.

Examples:

- **CSMA/CD** – used in legacy Ethernet networks.
- **CSMA/CA** – used in wireless networks.

### Controlled Access

- Each device gets a **specific time to transmit.**
  - Used in older technologies such as **Token Ring.**
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## 6. Data Link Frame

### Frame Structure

A frame consists of:

- **Header**
  - **Data**
  - **Trailer.**
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### Frame Fields

Important fields include:

1. Frame start and stop
  2. Source and destination addresses
  3. Type
  4. Control
  5. Data (payload)
  6. Error detection.
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### Layer 2 Address

- Also called **Physical Address.**
  - Stored in the **frame header.**
  - Used for **local delivery of frames.**
  - Updated by each device forwarding the frame.
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# 7. Physical Layer

## Purpose of the Physical Layer

- Transmits **bits across the network media**.
  - Converts frames into **signals** for transmission.
  - Signals can be electrical, optical, or wireless.
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## Physical Layer Components

Include:

- Network Interface Cards (NICs)
  - Interfaces and connectors
  - Network cables
  - Hardware devices.
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# 8. Encoding and Signaling

## Encoding

- Converts bit streams into a recognizable format.

Examples:

1. Manchester
2. 4B/5B
3. 8B/10B.

## Signaling

Represents bits using:

- Electrical signals (Copper cables)
  - Light pulses (Fiber optics)
  - Radio waves (Wireless).
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# 9. Bandwidth and Performance

## Bandwidth

- The capacity of a network medium to carry data.

Units:

1. bps
  2. Kbps
  3. Mbps
  4. Gbps
  5. Tbps.
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## Important Terms

- **Latency** – time required for data to travel.
  - **Throughput** – actual data transfer rate.
  - **Goodput** – usable data excluding overhead.
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# 10. Network Media Types

## Copper Cable

Advantages:

- Low cost
- Easy installation

Disadvantages:

- Signal attenuation over distance
  - Susceptible to interference (EMI/RFI).
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### Types of Copper Cable

- **UTP (Unshielded Twisted Pair)** – most common.
  - **STP (Shielded Twisted Pair)** – better protection but more expensive.
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## Fiber Optic Cable

Advantages:

- Very high bandwidth
- Long-distance transmission
- Immune to electromagnetic interference.

Uses **light pulses** to transmit data.

Types

- **Single-Mode Fiber**
  - **Multimode Fiber.**
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# 11. Wireless Media

## Characteristics

- Uses **radio or microwave signals**.
- Provides mobility and flexible connectivity.

Limitations:

- Interference
  - Security risks
  - Shared bandwidth.
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## Wireless Standards

Examples:

- **Wi-Fi (IEEE 802.11)**
- **Bluetooth (IEEE 802.15)**
- **WiMAX (IEEE 802.16)**
- **Zigbee (IEEE 802.15.4).**