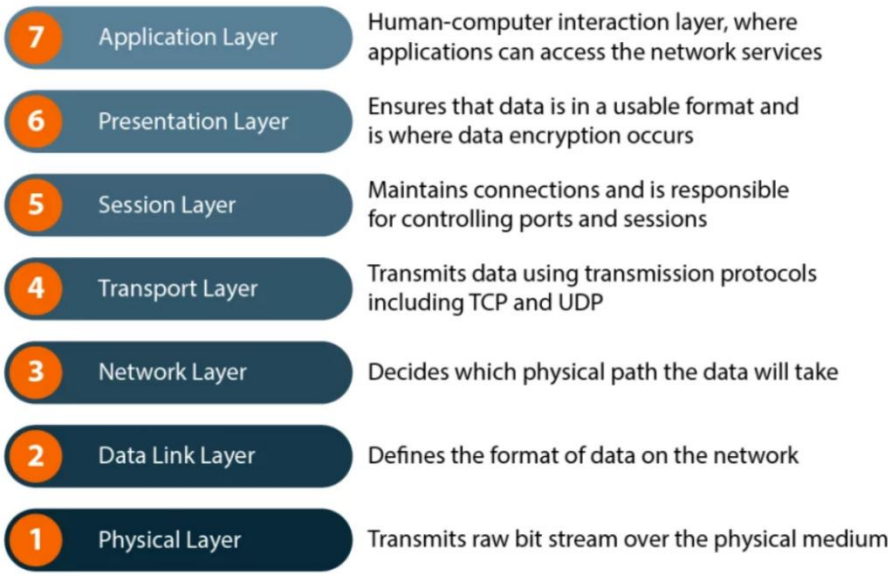
OSI (Open Systems Interconnection) Model – Detailed Notes

Introduction to OSI Model

The **OSI Model (Open Systems Interconnection Model)** was developed by the **International Organization for Standardization (ISO)** in **1984**.
It is a **conceptual framework** that describes how data is transmitted over a network in **seven layers**, each performing a specific role.

The main purpose of the OSI model is to:

- Help different systems communicate using **standard protocols**.
- Make it easier to understand **how network communication works**.
- Allow developers to design **interoperable network hardware and software**.



The 7 Layers of the OSI Model

The OSI model is divided into **two main groups**:

1. Upper Layers (Layers 7–5):

Deal with **application issues** and are close to the **end user**.

- Layer 7: Application
- Layer 6: Presentation
- Layer 5: Session

2. Lower Layers (Layers 4–1):

Handle **data transport** and **physical transmission**.

- Layer 4: Transport
- Layer 3: Network
- Layer 2: Data Link
- Layer 1: Physical

Layer 7: Application Layer

Main Function:

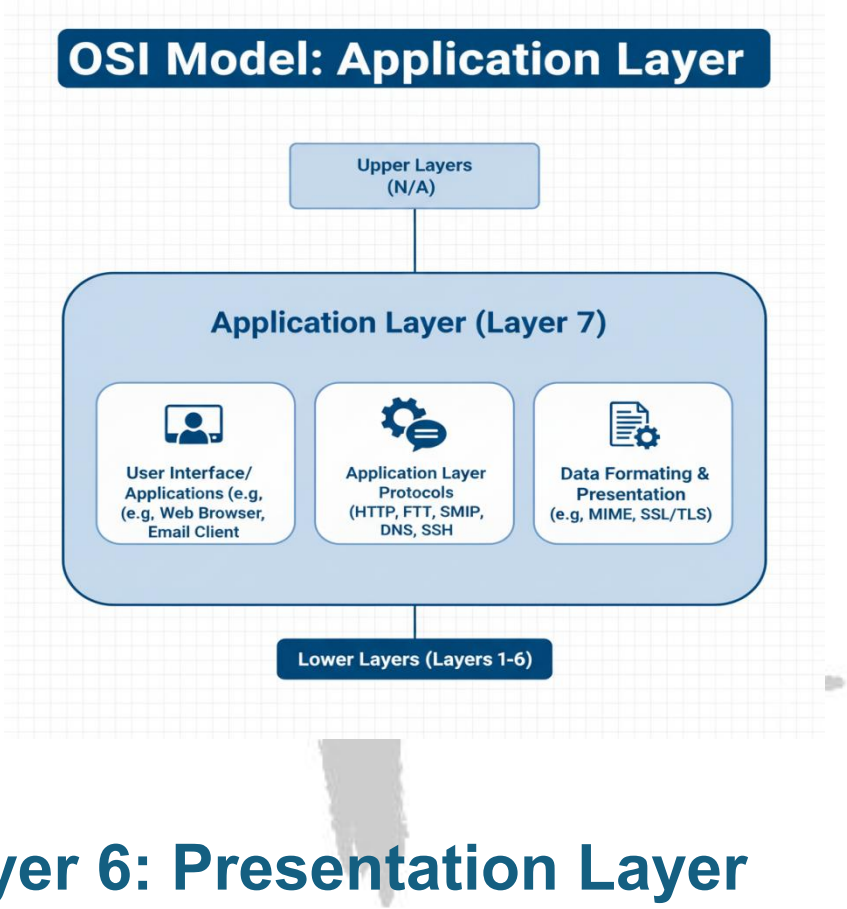
This is the **closest layer to the user**. It interacts directly with software applications to provide communication services.

Key Responsibilities:

- Provides **network services** such as file transfer, email, web browsing.
- **User interface** for network communication.
- Identifies communication partners and determines service availability.

Examples of Protocols:

- **HTTP/HTTPS:** Web browsing
- **FTP:** File transfer
- **SMTP/POP3/IMAP:** Email communication
- **DNS:** Domain name to IP resolution
- **Telnet/SSH:** Remote login



Layer 6: Presentation Layer

Main Function:

Acts as a **translator** between the application and network formats.
It ensures data is in a usable format for the receiving application.

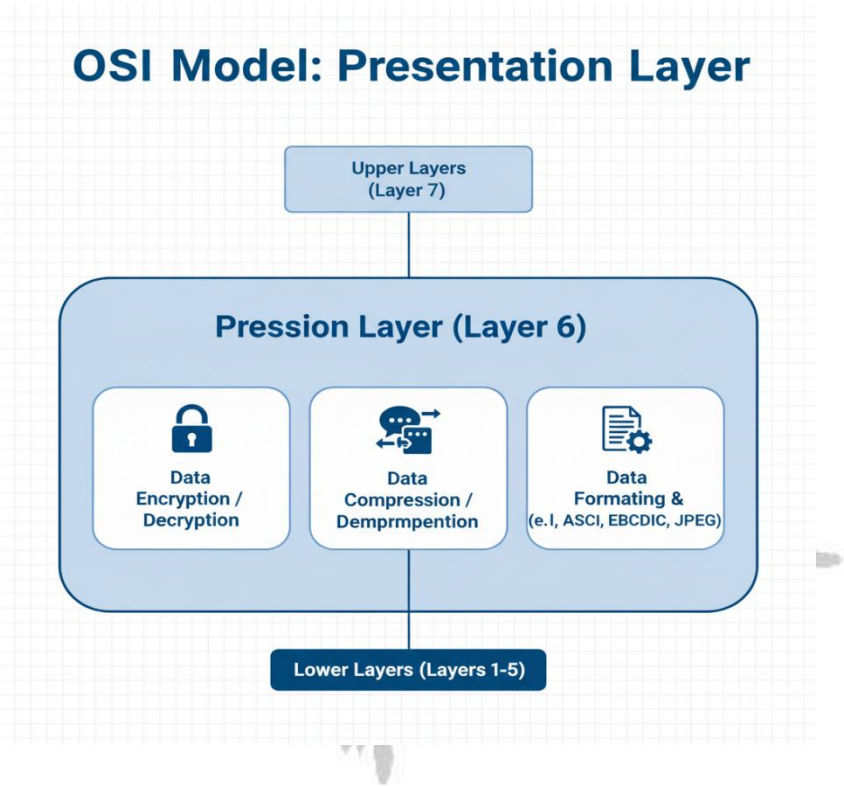
Key Responsibilities:

- **Data Translation:** Converts data between application and network formats (e.g., ASCII ↔ EBCDIC).

- **Encryption/Decryption:** Ensures data security during transmission (e.g., SSL/TLS).
- **Compression/Decompression:** Reduces data size for faster transmission.

Examples of Standards and Protocols:

- JPEG, PNG (Image formats)
- MPEG, MP3 (Media formats)
- SSL/TLS (Secure communication)
- ASCII, Unicode (Character encoding)



Layer 5: Session Layer

Main Function:

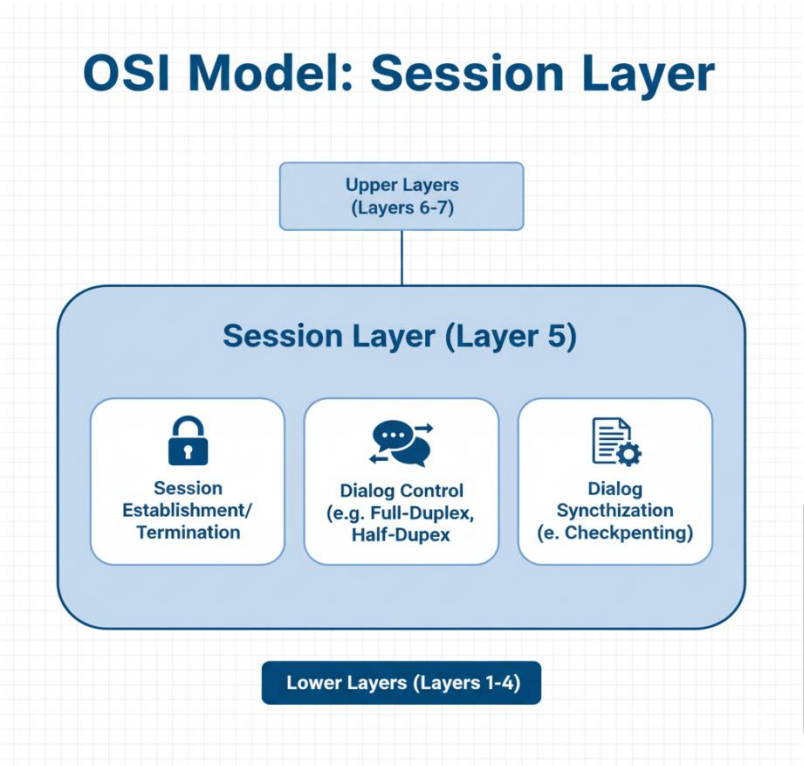
Manages **sessions (connections)** between two devices or applications.
A session is a continuous exchange of information that may include multiple transmissions.

Key Responsibilities:

- **Session Establishment:** Starts and manages communication sessions.
- **Session Maintenance:** Keeps the connection alive and synchronized.
- **Session Termination:** Gracefully ends communication when done.
- **Synchronization:** Adds checkpoints in data streams for recovery after failure.

Examples of Protocols:

- NetBIOS
- RPC (Remote Procedure Call)
- PPTP (Point-to-Point Tunneling Protocol)



Layer 4: Transport Layer

Main Function:

Responsible for **reliable delivery** of data between two devices or hosts.
It ensures complete data transfer with **error checking, segmentation, and reassembly**.

Key Responsibilities:

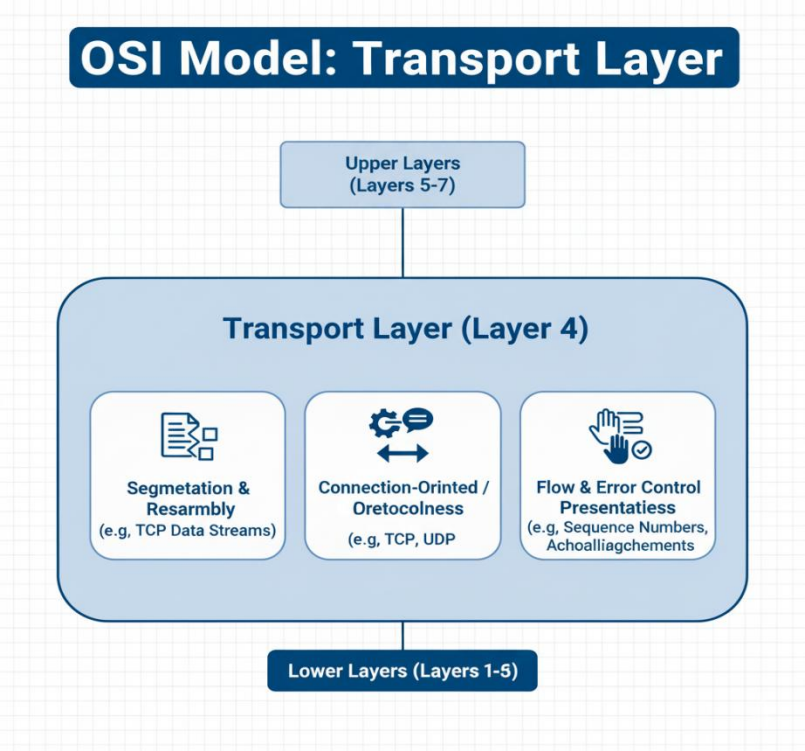
- **Segmentation:** Divides data into smaller segments for transmission.
- **Error Control:** Checks for errors and requests retransmission if needed.
- **Flow Control:** Prevents the sender from overwhelming the receiver.
- **Connection Management:** Establishes, maintains, and terminates connections.

Transport Layer Protocols:

1. **TCP (Transmission Control Protocol):**
    a. Connection-oriented (requires acknowledgment)
    b. Reliable and accurate
    c. Used for applications like email, web browsing (HTTP, SMTP)
2. **UDP (User Datagram Protocol):**
    a. Connectionless (no acknowledgment)
    b. Fast but less reliable
    c. Used for video streaming, online gaming, VoIP

Devices Used:

- Gateways (handle layer 4 and above)



Layer 3: Network Layer

Main Function:

Determines how data is sent from **one network to another**. It handles **logical addressing** and **routing**.

Key Responsibilities:

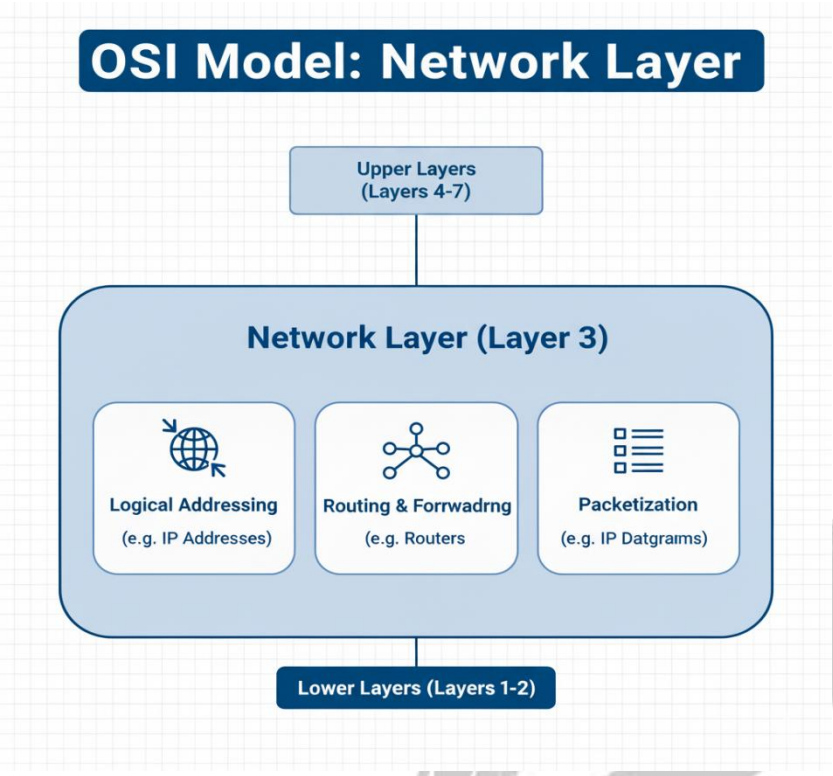
- **Logical Addressing:** Assigns IP addresses to identify devices on the network.
- **Routing:** Determines the best path for data to travel from source to destination.
- **Packet Forwarding:** Moves packets through routers toward their destination.
- **Fragmentation and Reassembly:** Divides large packets into smaller ones if necessary.

Devices Used:

- Routers
- Layer 3 Switches

Examples of Protocols:

- IP (Internet Protocol – IPv4, IPv6)
- ICMP (Internet Control Message Protocol)
- RIP (Routing Information Protocol)
- OSPF (Open Shortest Path First)
- BGP (Border Gateway Protocol)



Layer 2: Data Link Layer

Main Function:

Provides **node-to-node communication** and handles **error detection** from the Physical layer.
It ensures that data frames are transmitted to the correct device on a LAN using **MAC addresses**.

Key Responsibilities:

- **Framing:** Converts raw bits into **frames**.
- **Addressing:** Uses **MAC (Media Access Control)** addresses for identifying devices.
- **Error Detection and Correction:** Detects errors (e.g., CRC) and sometimes corrects them.
- **Flow Control:** Ensures sender doesn't overwhelm the receiver.

Sub-layers:

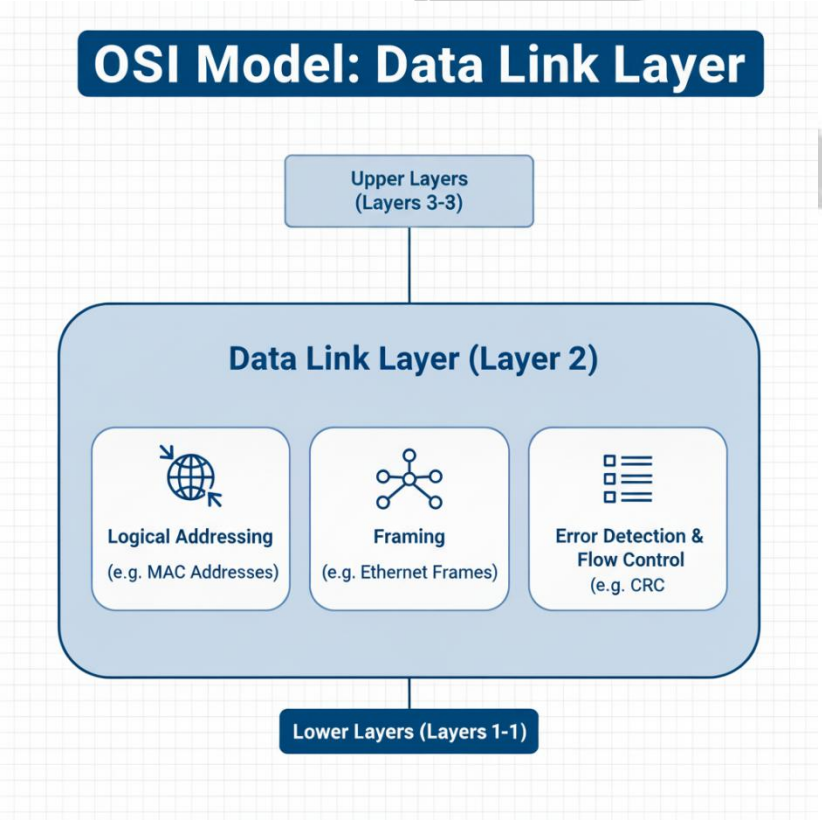
1. **LLC (Logical Link Control):** Controls frame synchronization and flow control.
2. **MAC (Media Access Control):** Manages access to the physical medium and uses MAC addresses.

Devices Used:

- Switches
- Bridges
- Network Interface Cards (NICs)

Examples of Protocols:

- Ethernet
- PPP (Point-to-Point Protocol)
- HDLC
- ARP (Address Resolution Protocol)



Layer 1: Physical Layer

Main Function:

The Physical Layer is responsible for **transmitting raw bits (0s and 1s)** over a physical medium like cables or radio waves.

Key Responsibilities:

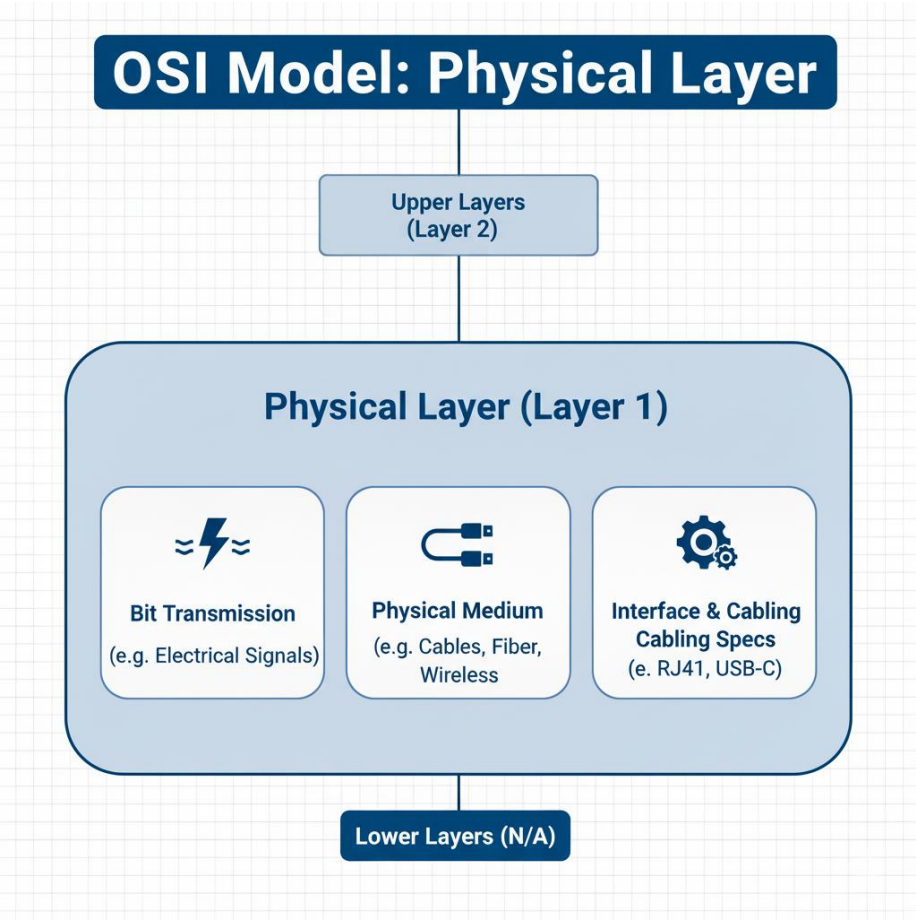
- Defines **hardware specifications** such as cables, connectors, voltages, and pin layouts.
- Converts **digital data** into **electrical, optical, or radio signals**.
- Controls **data transmission rate (bit rate)**.
- Handles **synchronization** of bits.
- Manages **topologies** (bus, star, ring, mesh, etc.).

Devices Used:

- Hubs
- Repeaters
- Network Interface Cards (NICs)
- Cables (Ethernet, fiber optic, coaxial)

Examples of Standards:

- Ethernet (IEEE 802.3)
- RS-232 (Serial communication)
- Bluetooth, Wi-Fi (Physical transmission media)


OSI Model: Physical Layer
Upper Layers
(Layer 2)
Physical Layer (Layer 1)
Bit Transmission
(e.g. Electrical Signals)
Physical Medium
(e.g. Cables, Fiber,
Wireless
Interface & Cabling
Cabling Specs
(e. RJ41, USB-C)
Lower Layers (N/A)