Kalyani Government Engineering College

LAYERS OF OSI MODEL IN A NETWORK

Computer Networks

PCC-CS602

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Introduction - Overview of OSI Model

The **OSI (Open Systems Interconnection)** model is a conceptual framework that describes **how information travels between devices on a network**. It's like a seven-layer cake, with each layer handling a specific task in getting data from point A to point B.

- Framework for understanding network communication
- Developed by the **International Organization for Standardization (ISO)**

Why is it important?

- **Standardization:** It provides a common language for network devices and software from different vendors to communicate, promoting interoperability.
- **Troubleshooting**: By understanding which layer an issue occurs in, you can narrow down the cause and fix it more efficiently.
- **Communication:** Facilitates clear communication between different network components

- **Learning Tool**: It serves as a foundation for understanding various networking concepts and protocols.

Purpose of OSI Model

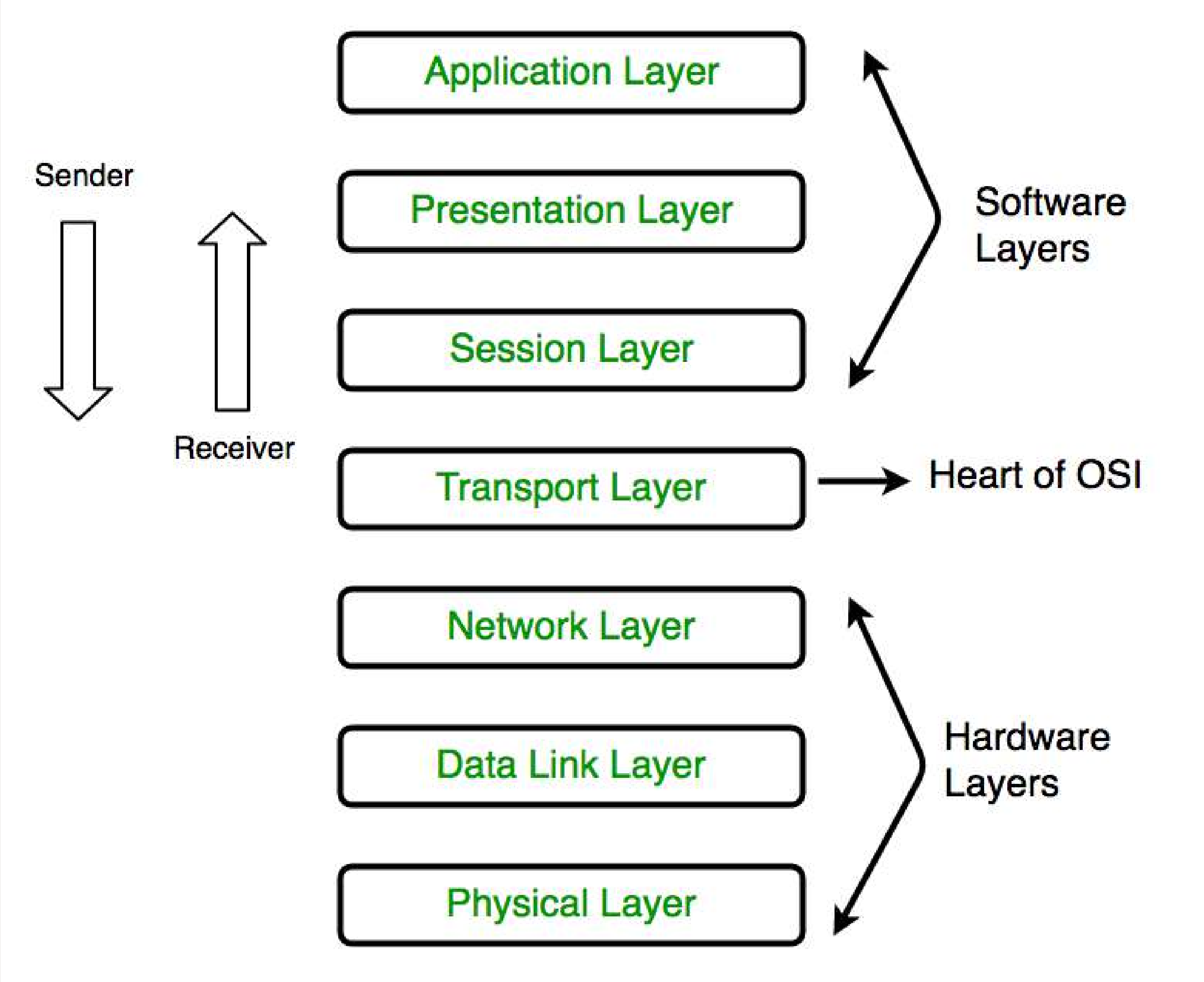
- ***Why OSI Model was Developed:***
  - **Diverse Systems Integration**: Addresses the need for integrating diverse computer systems and networks.
  - **Communication Standardization**: Developed to standardize communication protocols across different manufacturers and technologies.

- ***Importance in Standardizing Network Communication:***
  - **Global Interoperability:** Ensures devices from different vendors can communicate seamlessly.
  - **Ease of Integration:** Facilitates the integration of new technologies into existing network infrastructures.
  - **Simplifies Troubleshooting:** Standardization aids in troubleshooting and **diagnosing network issues** effectively.

- ***Points to Note :***
  - The OSI model is a reference model, not a strict implementation. Real-world protocols often combine functionalities from multiple layers.
  - The more widely used **TCP/IP model** has a different layer structure but serves a similar purpose.

The 7 Layers

- **Physical**: Deals with the physical transmission of data **(cables, connectors, voltages)**.
- **Data Link:** Ensures reliable data transmission on a single network segment **(MAC addresses, error checking).**
- **Network**: Routes data packets across different networks **(IP addresses, routing protocols).**
- **Transport**: Provides reliable end-to-end data transfer between applications **(TCP, UDP).**
- **Session:** Establishes, manages, and terminates communication sessions between devices.
- **Presentation:** Handles data format and **encryption/decryption.**
- **Application**: Provides services directly to user applications **(email, web browsing, file transfer).**

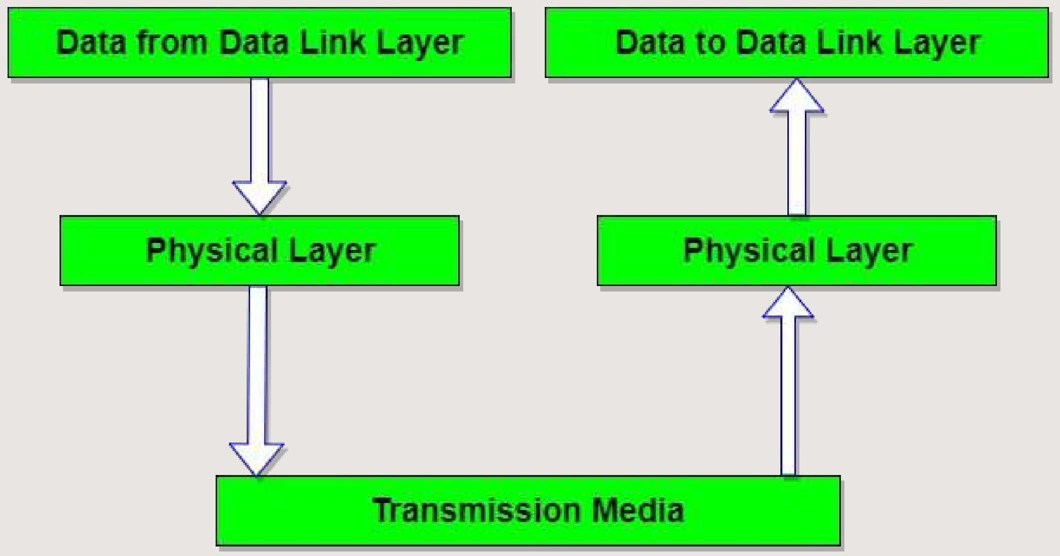


Layer 1 - Physical Layer

- **Lowest layer of the OSI Model.**
- Concerned with the actual hardware transmission and reception of **raw data bits.**

Key Responsibilities

- **Defines:** Electrical, mechanical, and procedural characteristics for data transmission
- **Manages:** Physical connections, data encoding/decoding, signal transmission
- **Ensures:** Reliable and efficient data transfer at the hardware level.



Components

- **Hardware:** Cables (twisted-pair, fiber optic), Connectors (RJ-45, BNC), Network Interface Cards (NICs) and Hubs, Switches, Routers (physical interfaces)

- **Transmission Media:**
  - Wired: Copper cables, fiber optic
  - Wireless: Radio waves, microwaves

- **Devices:** Ethernet, USB, HDMI
- **Functions:** Bit transmission, physical topology establishment.

Layer 2 - Data Link Layer

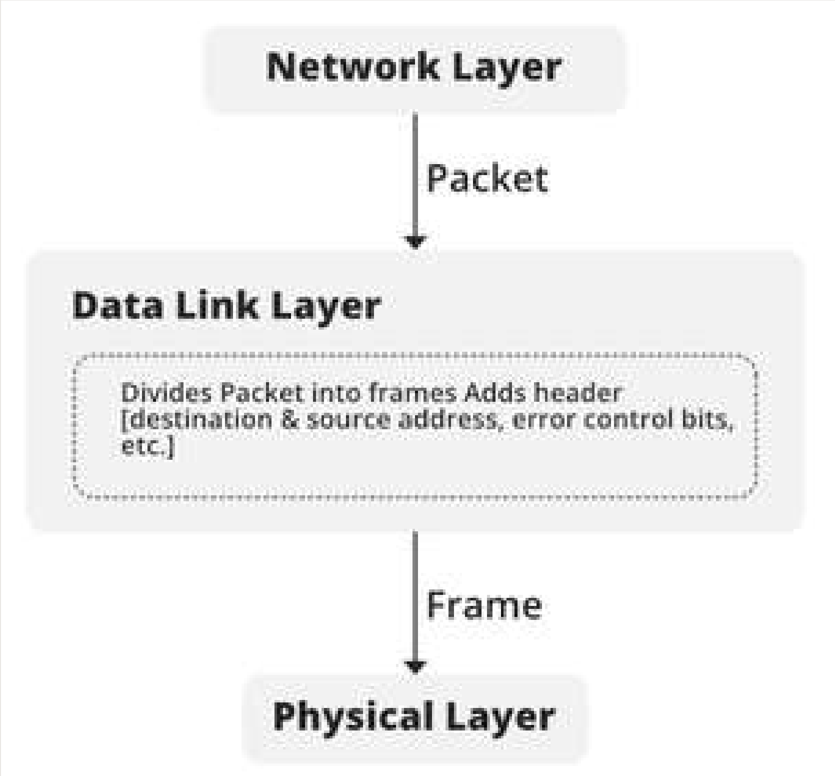
- **Second layer of the OSI Model.**
- Responsible for **reliable point-to-point** and **point-to-multipoint communication.**
- Layer 2 operates on a single network segment (e.g., one LAN).

Key Responsibilities

- **Framing:** Divides data into manageable packets with headers **(addresses, error checking)** and **trailers**.
- **Addressing:** Assigns unique MAC addresses to devices for identification and communication.
- **Error Detection & Correction:** Ensures data integrity during transmission **(checksums, error correction codes)**.
- **Flow Control:** Regulates data flow to prevent overwhelming the receiver (e.g., **stop-and-wait, CSMA/CD**).

Components

- **Network switches:** Connect and forward data frames based on MAC addresses.
- **Ethernet cards (NICs):** Enable devices to connect to wired networks.
- **Wi-Fi adapters:** Facilitate wireless network connectivity.
- **Point-to-Point Protocol (PPP):** Used for serial communication (dial-up, DSL).
- **Media Access Control (MAC) protocols:** Define rules for sharing the network medium (e.g., Ethernet, Wi-Fi).



Layer 3 - Network Layer

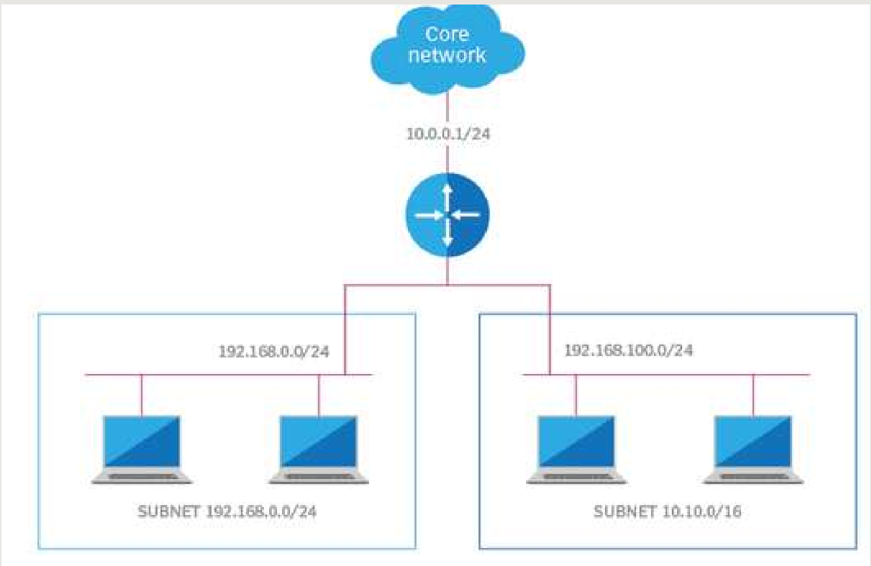
- **Third layer of the OSI Model.**
- Manages **logical addressing, packet forwarding,** and **routing decisions.**
- Layer 3 is crucial for troubleshooting network connectivity and path-related issues.

Key Responsibilities

- **Routing:** Determines the optimal path for data between source and destination.
- **Logical Addressing:** Assigns IP addresses to devices for global identification and routing.
- **Packet Forwarding:** Determines the best path for packets to reach their destination (routing protocols).
- **Internetworking:** Connects diverse networks and technologies seamlessly.
- **Subnet Masking:** Defines network and host portions of IP addresses for more granular control.

Components

- **IP protocols:** Define rules for formatting and transmitting data packets **(IPv4, IPv6).**
- **Routing protocols:** Determine the best paths for packets to travel **(RIP, OSPF, BGP).**
- **Subnetting:** Creates smaller logical networks within a larger physical network.
- **Network Address Translation (NAT):** Allows multiple devices to share a single public IP address.



Layer 4 - Transport Layer

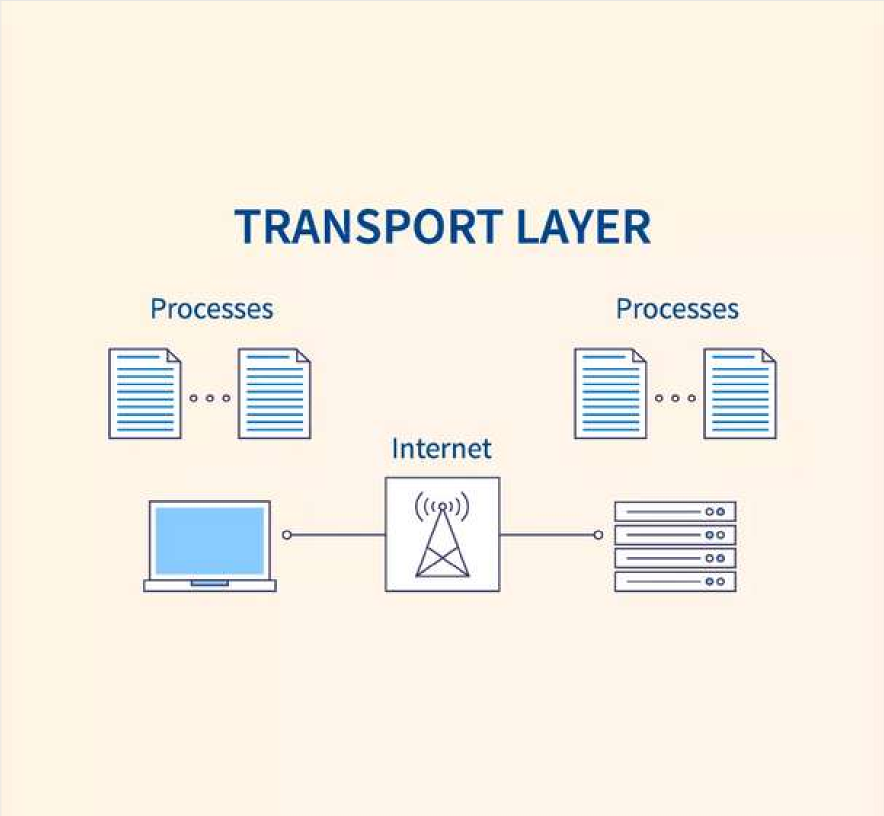
- **Fourth layer of the OSI Model.**
- Manages **end-to-end communication, ensuring reliable data transfer.**
- Layer 4 offers reliable communication for applications like file transfer, web browsing, and email.
- Bridges the gap between network services (Layer 3) and specific applications (Layer 5).

Key Responsibilities

- **Segmenting & De-segmenting:** Breaks data into manageable segments for transmission and reassembles them at the destination.
- **Flow Control:** Regulates data flow to prevent overwhelming the receiver and network congestion.
- **Error Correction:** Ensures data integrity by detecting and correcting errors during transmission.
- **Connection Management:** Establishes, manages, and terminates connections between applications (connection-oriented vs. connectionless).

Components

- **Transport Layer protocols:** TCP for reliable, connection-oriented data transfer; UDP for fast, connectionless data delivery.
- **Port Numbers:** Port 80 for HTTP, Port 22 for SSH
- **Firewalls:** Filter incoming and outgoing traffic based on port numbers and security rules.



Layer 5-7: Session, Presentation, and Application Layers

- Layers 5 to 7 constitute the **upper layers** of the OSI Model.
- These layers often work together, not in isolation. An application might use multiple protocols across different layers.
- Primarily concerned with **user interfaces, data representation**, and application-level functions.

Layer 5 - Session Layer:

- **Functionality:** Manages sessions or connections between applications.
- **Example Protocols:** NetBIOS, RPC (Remote Procedure Call)

Layer 6 - Presentation Layer:

- **Functionality:** Translates data between application and network formats
- **Example Protocols:** SSL/TLS, JPEG, GIF

Layer 7 - Application Layer:

- **Functionality:** Provides network services directly to end-users or applications.
- **Example Protocols:** HTTP, FTP, SMTP

Interactions Between Layers

- The network isn't a solo act - it's a synchronized performance!
- Each OSI layer plays a crucial role, but their magic lies in how they seamlessly interact and communicate. Let's explore this harmony.

Key Points

- **Data encapsulation:** The process of adding headers and trailers at each layer

- Encapsulation ensures that data is properly formatted for transmission across the network.

- **Upward Communication:** Layers don't just send data down; they talk back too!. Error messages, flow control signals, and status updates travel upwards. This feedback loop ensures smooth communication and error handling.

Example: Email

- **Application layer** adds recipient address and content.
- **Presentation layer** might encrypt it.
- **Transport layer** segments it and adds port information.
- **Network layer** adds routing information like IP addresses.
- **Data Link layer** adds error checking and MAC addresses.
- **Physical layer** transmits the raw bits over the cable.

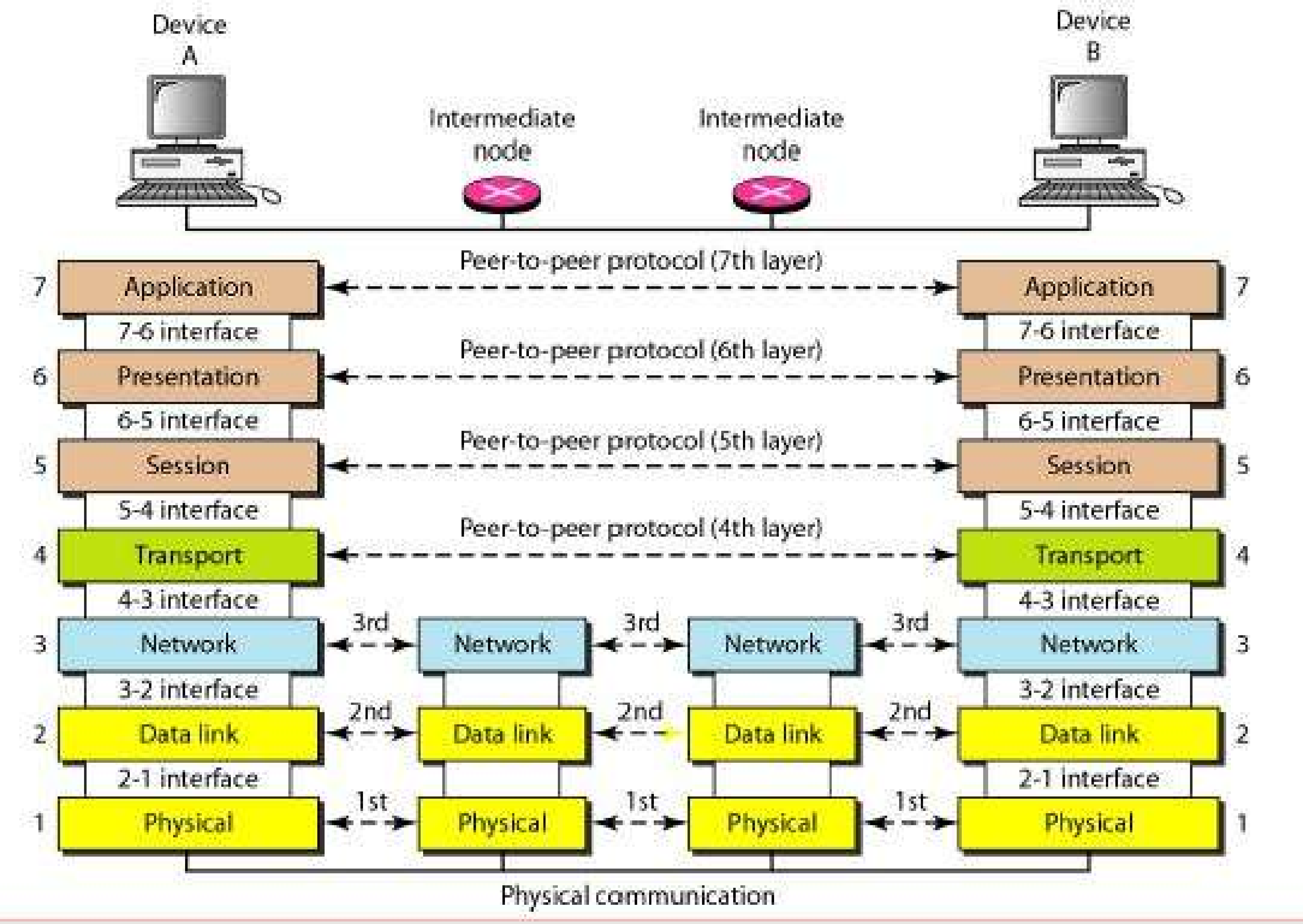


Fig. - Interactions Between Layers

Real-World Examples

- **Web browsing:** When you open a website, the **Application layer uses HTTP** to request the page. The **Transport layer segments** the data and ensures reliable delivery. The **Network layer routes** the packets across the internet. The **lower layers handle physical transmission**. Understanding these interactions helps diagnose slow loading times or connection errors.
- **Video conferencing:** During a video call, the **Session layer** manages the ongoing communication session. The **Presentation layer** might **compress** audio and video for efficient transmission. The **Transport layer ensures reliable data delivery.** Understanding these layers helps troubleshoot audio/video quality issues or call drops.
- **File transfer:** When you send a file, the **Application layer uses FTP** to initiate the transfer. The **Transport layer segments the file** and handles flow control. The **Network layer routes the packets**. The lower layers handle physical transmission. Understanding these layers helps diagnose issues like incomplete file transfers or slow upload/download speeds.

How Troubleshooting is simplified using OSI Model

- **Layer-specific Diagnosis:**
  - Allows for targeted problem identification and resolution.
  - Reduces the complexity of identifying the source of network issues.
- **Structured Approach:**
  - Troubleshooting follows a systematic approach based on OSI layers.
  - Minimizes confusion and speeds up the resolution process.

Conclusion

The OSI model, despite not being a strict implementation, offers a valuable framework for understanding network communication. By exploring its layers, we gain insights into:

- **Data flow**: How information travels from one device to another, broken down into manageable chunks and handled by specific functionalities.
- **Layer interactions:** The seamless collaboration between layers, like adding and removing instructions for smooth data delivery.
- **Troubleshooting:** A structured approach to diagnose network issues by pinpointing which layer might be causing the problem.

The OSI model is a foundational knowledge that opens doors to further exploration of network technologies and protocols.