Prepared by: Nandini Goyal
Intern at Celebal Technologies
Department: Cloud Infra & Security
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R&D Document

Working of All Layers in OSI Model

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Introduction

The Open Systems Interconnection (OSI) model is a conceptual framework that standardises the functions of a telecommunication or computing system into seven distinct layers. It was adopted by the *International Organization for Standardization* (ISO) as an international standard in 1984. Even prior to this in the early 1908s, it had become an unofficial industry standard, having already been adopted by all major computer and telecommunication companies. Each layer has specific functions and interacts with the layers above and below it to facilitate end-to-end communication.

Overview

The OSI model consists of seven layers: Physical, Data Link, Network, Transport, Session, Presentation, and Application. These layers help network engineers, developers, and security professionals conceptualise and troubleshoot network behaviour efficiently. Each layer communicates with the one directly above and below it.

Layers	Function	Protocols
APPLICATION	Manages User requestand Files	DNS, FTP, Gopher, HTTP, NFS, NTP, SMPP, SM TP, DHCP, SNMP,
PRESENTATION	Data Conversion and File Types	MIME, XDR, TLS, SSL
SESSION	Data Synchronization	NetBIOS, SAP, SIP, L2TP, PPTP
TRANSPORT	Error Checking and Segmentation	TCP, UDP, SCTP, DOCP
NETWORK	Routing and Logical Addressing	IPu4, IPv6, ICMP, IPsec, IGMP, IPX
DATA LINK	MAC and Logical Link Control(LLC)	ATM, SDLC, HDLC, ARP, IEEE 802.3, Frame Relay, ITU-T G.hn DLL, PPP, X.25
PHYSICAL	Physical Hardwareand Cabling	DSL, IEEE 802.3, IEEE 802.11, IEEE 802.15, IEEE 802.16, IEEE 1394, USB, Bluetooth

Layers of the OSI Model

1. Physical Layer

A. Functionality: The Physical Layer is responsible for the transmission and reception of raw bit streams over a physical medium.

B. Key Tasks:

- Defines physical characteristics such as connectors, cables, and electrical signals (e.g., voltage levels, signal timing).
- Handles transmission of bits (0s and 1s) over mediums like copper wires, fiber optics, or wireless signals.
- Examples: Ethernet cables, USB cables, Wi-Fi signals.

C. Devices: Hubs, repeaters, cables, connectors.

B. Protocols/Standards: USB, Bluetooth, IEEE 802.3 (Ethernet).

2. Data Link Layer

A. Functionality: Ensures reliable data transfer between two directly connected nodes, handling error detection and correction

B. Key Tasks:

- Frames data received from the Network Layer and prepares it for the Physical Layer.
- Provides error-free transfer using techniques like CRC (Cyclic Redundancy Check).
- Manages access to the physical medium (e.g., via MAC addresses in Ethernet).
- Divided into two sub-layers: Logical Link Control (LLC) and Media Access Control (MAC).

C. Devices: Switches, bridges, network interface cards (NICs).

D. Protocols/Standards: Ethernet (IEEE 802.3), PPP, HDLC.

3. Network Layer

A. Functionality: Manages device addressing, routing, and forwarding of data packets across different networks.

B. Key Tasks:

- Determines the best path for data transfer using routing protocols.

- Assigns logical addresses (e.g., IP addresses) to devices.
- Handles packet fragmentation and reassembly if needed.

C. Devices: Routers, Layer 3 switches.

D. Protocols/Standards: IP (IPv4, IPv6), ICMP, IPsec.

4. Transport Layer

A. Functionality: Provides reliable data transfer services, ensuring data is delivered without errors, in sequence, and without loss or duplication.

B. Key Tasks:

- Segments data from the Session Layer and reassembles it at the destination.
- Offers error detection, flow control, and retransmission of lost packets.
- Supports connection-oriented (TCP) and connectionless (UDP) communication.

C. Devices: Gateways, firewalls (though primarily operate at higher layers).

D. Protocols: TCP, UDP.

5. Session Layer

A. Functionality: Establishes, manages, and terminates communication sessions between applications.

B. Key Tasks:

- Sets up and maintains connections (sessions) between devices.
- Handles session recovery (e.g., resuming interrupted sessions).
- Synchronises data exchange between applications.

C. Examples: NetBIOS, RPC, PPTP.

D. Protocols/Standards: Named Pipes, NetBIOS.

6. Presentation Layer

A. Functionality: Translates data between the application layer and the network format, ensuring data is in a usable format.

B. Key Tasks:

- Performs data encryption, compression, and translation (e.g., converting EBCDIC to ASCII).
- Handles data formatting for different systems (e.g., XML, JSON).
- Ensures data privacy through encryption (e.g., SSL/TLS).

C. Examples: JPEG, MPEG, SSL, TLS.

D. Protocols/Standards: SSL/TLS, MIME.

7. Application Layer

A. Functionality: Provides network services directly to end-user applications, enabling user interaction with the network.

B. Key Tasks:

- Supports application-level protocols for services like email, file transfer, and web browsing.
- Acts as an interface between the user and the network.
- Does not include the applications themselves but the protocols they use.

C. Examples: Web browsers, email clients.

D. Protocols/Standards: HTTP, FTP, SMTP, DNS, Telnet.

Interaction Between Layers

- **Data Flow**: Data starts at the Application Layer, encapsulated at each lower layer (adding headers/trailers), and transmitted via the Physical Layer. The receiving device reverses this process, de-encapsulating data up to the Application Layer.
- **Encapsulation**: Each layer adds its own header (and sometimes trailer) to the data, creating protocol data units (PDUs): segments (Transport), packets (Network), frames (Data Link), and bits (Physical).

Advantages of the OSI Model

- **Standardisation**: Provides a universal framework that ensures interoperability among diverse systems and vendors.
- **Modularity**: Divides complex network processes into manageable layers, simplifying design, implementation, and troubleshooting.

- **Flexibility**: Allows updates or changes to one layer without affecting others, facilitating technological advancements.
- **Interoperability**: Enables different systems and protocols to work together by adhering to a common model.
- **Troubleshooting**: Simplifies diagnosing network issues by isolating problems to specific layers.
- **Education and Learning**: Offers a clear, structured way to teach and understand networking concepts.

Real-World Applications

- Network troubleshooting often involves checking which OSI layer is malfunctioning.
- Firewalls and routers operate at specific layers (e.g., routers at Layer 3, firewalls at Layer 4+).
- Web developers use Application Layer protocols (e.g., HTTP) daily.
- Network security depends heavily on understanding each layer for threat mitigation.

Future Trends and Relevance of the OSI Model

The OSI Model remains relevant as networking technologies evolve, adapting to emerging trends and future requirements:

- **Integration with 5G and Beyond**: The Physical and Data Link Layers are critical for supporting high-speed, low-latency 5G networks and future 6G technologies, which demand advanced modulation and error correction techniques.
- **IoT and Edge Computing**: The OSI Model provides a framework for standardising communication in Internet of Things (IoT) devices, where lightweight protocols at the Application Layer and efficient routing at the Network Layer are essential for edge computing environments.
- **Software-Defined Networking (SDN)**: SDN separates control and data planes, aligning with the OSI Model's layered approach, particularly at the Network and Data Link Layers, to enable programmable and scalable networks.
- **Quantum Networking**: Emerging quantum communication technologies will rely on the OSI Model's Physical Layer for quantum signal transmission and higher layers for secure data exchange, such as quantum key distribution (QKD) protocols.
- **Enhanced Security**: The Presentation Layer's role in encryption (e.g., TLS) will expand with post-quantum cryptography to address future security threats in quantum computing environments.

- **AI-Driven Networking**: Artificial Intelligence (AI) and machine learning will optimise routing (Network Layer) and session management (Session Layer), improving network efficiency and automation.
- **Interoperability in Heterogeneous Networks**: As networks become more diverse (e.g., satellite, mesh, and hybrid networks), the OSI Model's standardised layers ensure seamless integration and communication across varied systems.

Conclusion

The OSI model provides a standardised framework for network communication, ensuring interoperability and modularity. Its advantages make it a cornerstone of networking, while its adaptability ensures continued relevance in future technologies like 5G, IoT, SDN, and quantum networking. The model's layered structure supports innovation while maintaining a clear blueprint for network design and troubleshooting.

References

- TutorialsPoint: OSI Model
- GeeksforGeeks Networking Articles
- https://study-ccna.com/osi-tcp-ip-models/
- https://www.webopedia.com/definitions/7-layers-of-osi-model/