Computer Networks: Upper OSI Layers Application/ Session/ Presentation

1. Application Layer (Layer 7)

The **Application layer** is the layer closest to the end user. It acts as the **interface** between network applications and the underlying network. Network applications enable users to easily send and receive data. The protocols at this layer help programs running on the source and destination hosts exchange data. In the **TCP/IP model**, the Application layer performs the functions of the upper three layers (Application, Presentation, and Session) of the OSI model.

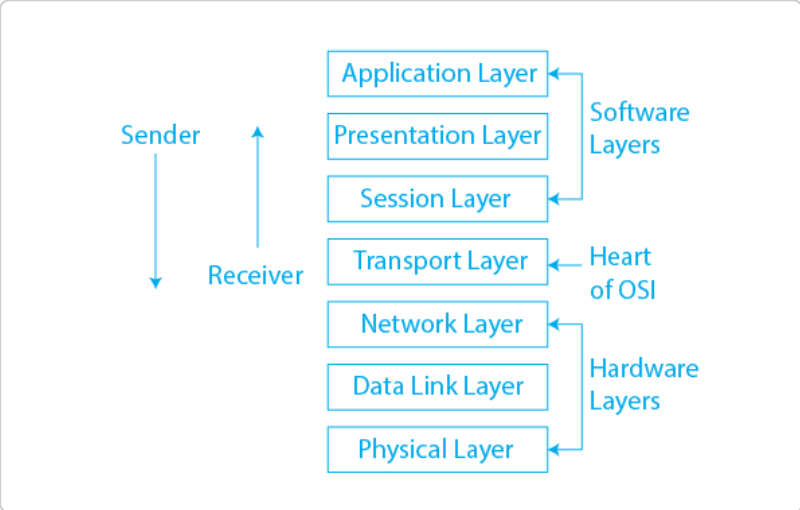

Figure 1: Common Application Layer Protocols grouped by service (Name System, Host Config, Email, File Transfer, Web).

i. Application Layer Protocols

There are many common protocols that operate at the Application layer, facilitating various services for the end-user:

- **HTTP** (Hypertext Transfer Protocol) and **HTTPS** (Secure HTTP) for web browsing.
- **FTP** (File Transfer Protocol) and **TFTP** (Trivial File Transfer Protocol) for file transfer.
- **DNS** (Domain Name System) for name resolution.
- **SMTP** (Simple Mail Transfer Protocol), **POP** (Post Office Protocol), and **IMAP** (Internet Message Access Protocol) for email.

ii.DNS Server Functionality

The **DNS** is a host name to **IP address translation service**. It is implemented as a distributed database in a hierarchy of name servers. It automatically converts the names we type in a web browser (like a URL) to the specific IP address of the web server hosting that site. This conversion process is essential for Internet communication.

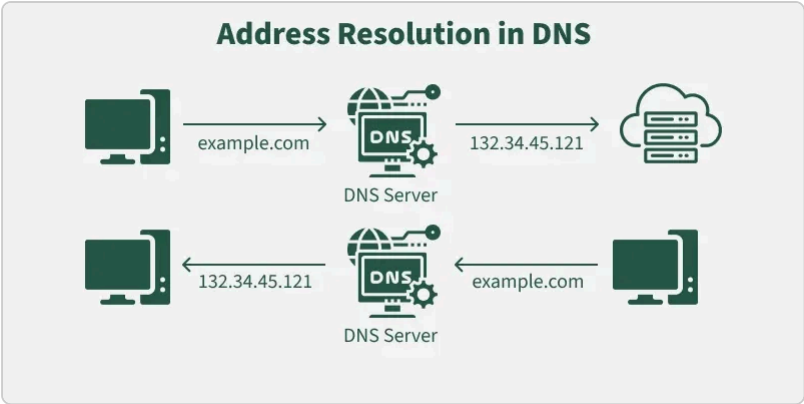

Figure 2: A host requesting and receiving the IP address for a domain name from a name server.

iii. Email Protocols (SMTP, POP3, IMAP)

Email delivery relies on a unique addressing system consisting of a **local part** (mailbox address on the server) and a **domain name** (mail server name), separated by the '@' sign. Mail servers use protocols to handle messages:

- **SMTP:** A Connection Oriented protocol used by mail servers to **send and receive** email messages. User-level applications typically use it **only for sending** messages.
- **POP3:** Used by email clients to **retrieve** emails from a mail server. It is simple but typically only supports **one mail server** per mailbox.
- **IMAP:** Used to **retrieve** emails and is designed to handle messages from **multiple mail servers**. Both IMAP and POP3 are supported by modern email clients like Gmail and Outlook.

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2. Presentation Layer (Layer 6)

The **Presentation layer** is primarily concerned with the **format of the data** presented to the Application layer. It ensures that the information sent by the application layer of one system is readable by the application layer of another system. It handles the structural differences in data representation between systems.

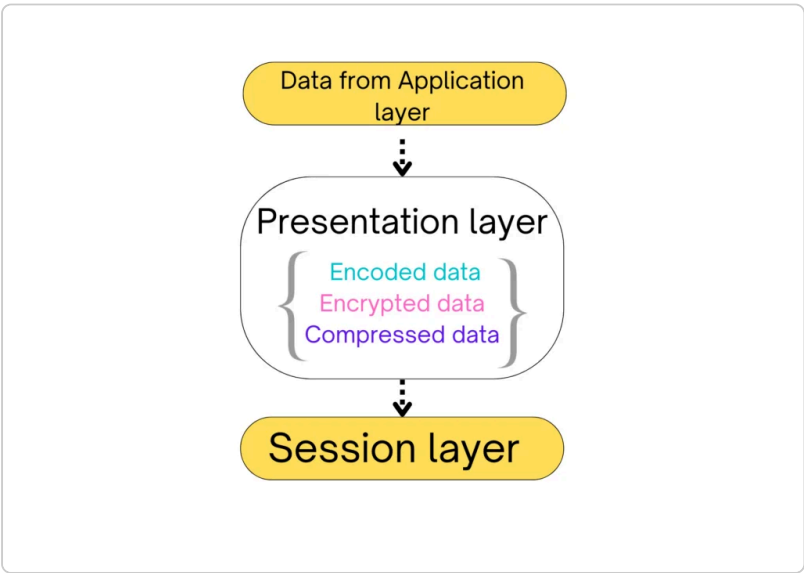

Figure 3: Illustration of Translation, Compression, and Encryption/Decryption as Presentation Layer functions.

i. Translation of Data

Different computer systems may use different encoding schemes (e.g., ASCII, EBCDIC). The Presentation layer handles the **translation** of data formats so that the receiving application can understand the data sent by the source application. For instance, it can translate data from an ASCII representation to an EBCDIC representation.

*Original Data → **Translation** → Standard Format → **Decryption** → Final Application Data*

ii. Data Compression and Encryption

Two other critical functions of this layer involve data preparation for efficient and secure transfer:

- **Compression:** Reduces the number of bits in the data to improve transmission speed. Compression can be **Lossy** (data is lost, often used for multimedia) or **Lossless** (no data is lost).
- **Encryption/Decryption: Encryption** converts data into another form (ciphertext) to ensure privacy and security during transmission. The receiver's Presentation layer performs **Decryption** to return the data to its original, readable form. Protocols like **SSL** (Secure Sockets Layer) operate at or just below this layer to secure data transfer.

iii. Comparison of Data Transmission Functions

Function	Purpose	Example
Translation	To ensure different systems can read each other's data formats.	ASCII to EBCDIC conversion.
Compression	To reduce data size for faster transmission.	Lossy (JPEG) or Lossless (ZIP).
Encryption	To secure data by converting it into an unreadable form.	Using SSL/TLS to send a password.

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3. Session Layer (Layer 5)

The **Session layer** is responsible for creating, managing, and terminating the **dialogs** (sessions) between the source and destination applications. It handles the mechanisms for coordinating the exchange of information.

i. Dialog Management

The main role of this layer is to handle the exchange of information needed to **initiate, keep active, and restart sessions**. This involves three key phases:

- **Establishment:** Creating the initial connection (dialog) between two applications.
- **Maintenance:** Keeping the dialog active, often by exchanging control messages or tokens.
- **Termination:** Gracefully ending the session when the applications are finished communicating.

ii. Synchronization and Checkpointing

An important function of the Session layer is to **restart sessions** that are disrupted or idle for a long period of time. This is often done through **synchronization** points or **checkpoints**.

$$Throughput \approx Data / (\Delta T - T_{delay})$$

iii. Multimedia and Network Applications

The Session layer is crucial for applications that require coordinated data exchange, particularly in the realm of **Networked Multimedia Applications**. Multimedia itself is defined as technology capable of processing textual data, audio, video, pictures, and animation. Networked multimedia applications, such as **video conferencing** or remote networking, rely on the Session layer to manage the real-time data flow and resynchronize if the connection quality drops.

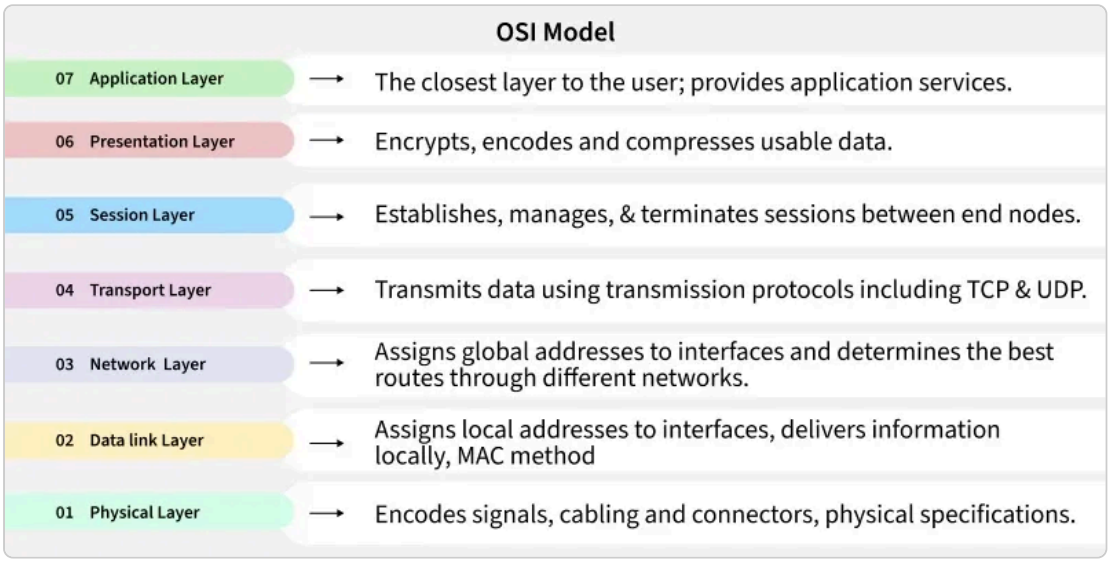

Figure 4: The top three layers (Application, Presentation, Session) of the OSI model.

The TCP/IP model simplifies this by combining the Session, Presentation, and Application layers into a single Application Layer, but the underlying functions of session management and data formatting still occur.

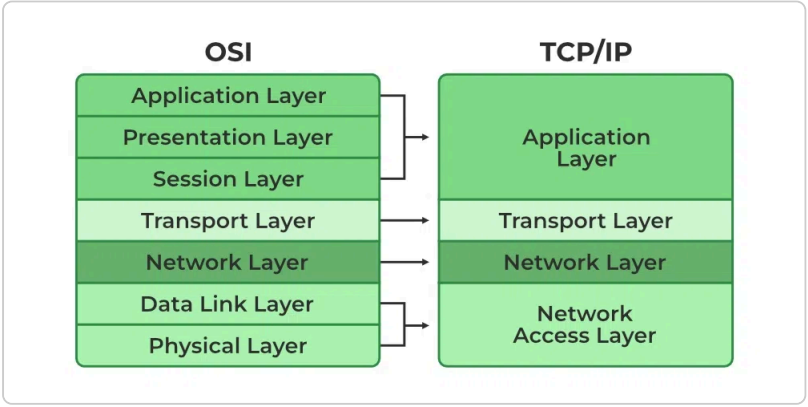

Figure 5: The relationship and functional overlap between the OSI and TCP/IP models, highlighting the upper layers.

Study hard! This note covers all the key concepts.