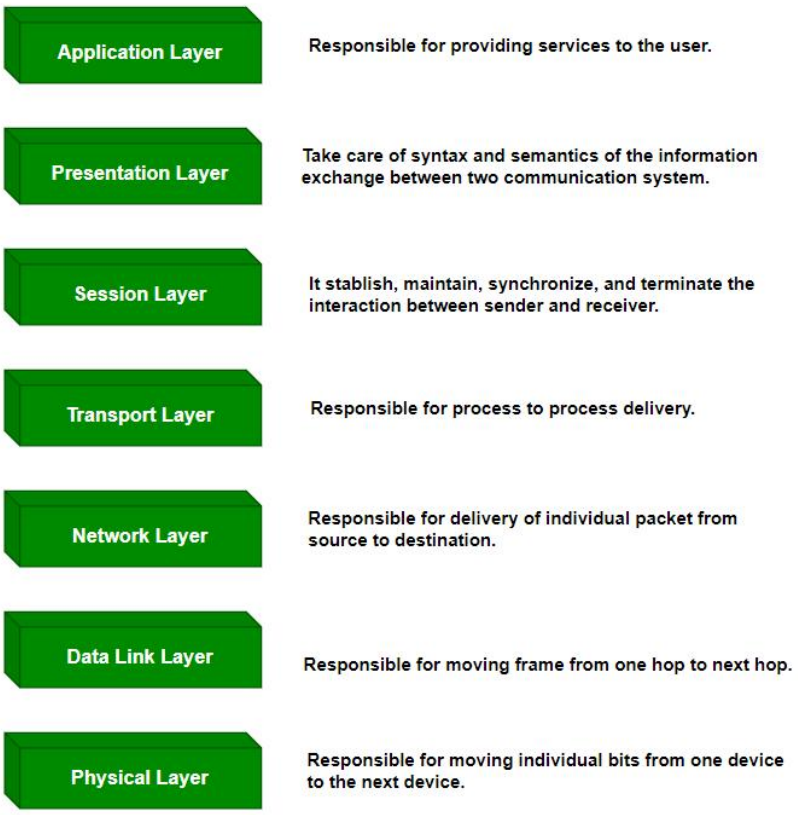
OSI Model? – Layers of OSI Model

OSI stands for Open Systems Interconnection , where open stands to say non-proprietary. It is a 7-layer architecture with each layer having specific functionality to perform. All these 7 layers work collaboratively to transmit the data from one person to another across the globe. The OSI reference model was developed by ISO – 'International Organization for Standardization ', in the year 1984.

The OSI model provides a theoretical foundation for understanding network communication . However, it is usually not directly implemented in its entirety in real-world networking hardware or software . Instead, specific protocols and technologies are often designed based on the principles outlined in the OSI model to facilitate efficient data transmission and networking operations.

What is OSI Model?

The OSI model, created in 1984 by ISO , is a reference framework that explains the process of transmitting data between computers. It is divided into seven layers that work together to carry out specialised network functions , allowing for a more systematic approach to networking.



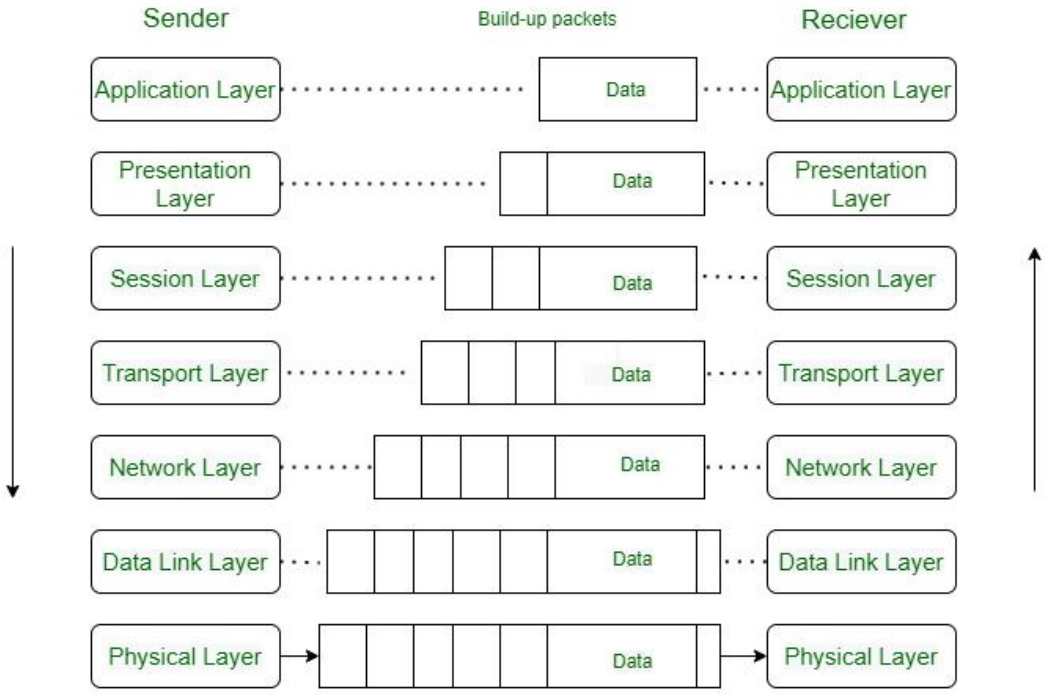
Data Flow In OSI Model

When we transfer information from one device to another, it travels through 7 layers of OSI model. First data travels down through 7 layers from the sender's end and then climbs back 7 layers on the receiver's end.

Data flows through the OSI model in a step-by-step process:

Application Layer: Applications create the data.
Presentation Layer: Data is formatted and encrypted.
Session Layer: Connections are established and managed.
Transport Layer: Data is broken into segments for reliable delivery.
Network Layer : Segments are packaged into packets and routed.
Data Link Layer: Packets are framed and sent to the next device.
Physical Layer: Frames are converted into bits and transmitted physically.

Each layer adds specific information to ensure the data reaches its destination correctly, and these steps are reversed upon arrival.



Let's look at it with an Example:

Luffy sends an e-mail to his friend Zoro.

Step 1: Luffy interacts with e-mail application like Gmail , outlook , etc. Writes his email to send. (This happens in Layer 7: Application layer)

Step 2: Mail application prepares for data transmission like encrypting data and formatting it for transmission. (This happens in Layer 6: Presentation Layer)

Step 3: There is a connection established between the sender and receiver on the internet. (This happens in Layer 5: Session Layer)

Step 4: Email data is broken into smaller segments. It adds sequence number and error-checking information to maintain the reliability of the information. (This happens in Layer 4: Transport Layer)

Step 5: Addressing of packets is done in order to find the best route for transfer. (This happens in Layer 3: Network Layer)

Step 6: Data packets are encapsulated into frames, then MAC address is added for local devices and then it checks for error using error detection. (This happens in Layer 2: Data Link Layer)

Step 7: Lastly Frames are transmitted in the form of electrical/ optical signals over a physical network medium like ethernet cable or WiFi.

After the email reaches the receiver i.e. Zoro, the process will reverse and decrypt the e-mail content. At last, the email will be shown on Zoro's email client.

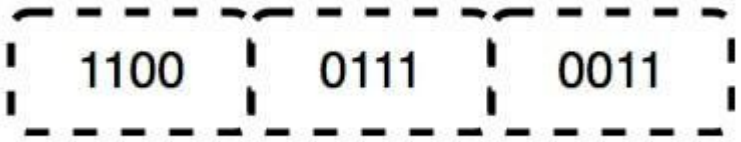
What Are The 7 Layers of The OSI Model?

The OSI model consists of seven abstraction layers arranged in a top-down order:

Physical Layer
Data Link Layer
Network Layer
Transport Layer
Session Layer
Presentation Layer
Application Layer

Physical Layer – Layer 1

The lowest layer of the OSI reference model is the physical layer. It is responsible for the actual physical connection between the devices. The physical layer contains information in the form of bits. It is responsible for transmitting individual bits from one node to the next. When receiving data, this layer will get the signal received and convert it into 0s and 1s and send them to the Data Link layer, which will put the frame back together.



Note:

- Hub, Repeater, Modem, and Cables are Physical Layer devices.

- Network Layer, Data Link Layer, and Physical Layer are also known as Lower Layers or Hardware Layers.

Data Link Layer (DLL) – Layer 2

The data link layer is responsible for the node-to-node delivery of the message. The main function of this layer is to make sure data transfer is error-free from one node to another, over the physical layer. When a packet arrives in a network, it is the responsibility of the DLL to transmit it to the Host using its MAC address.

The Data Link Layer is divided into two sublayers:

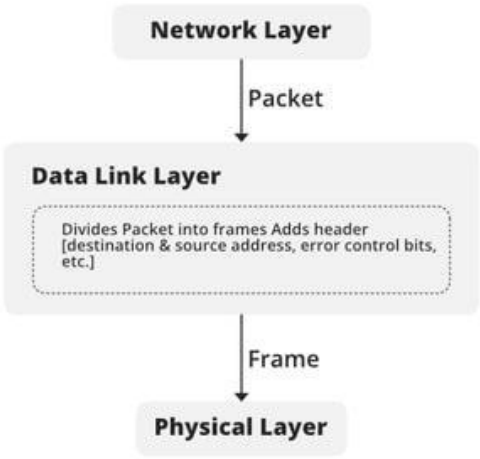
- Logical Link Control (LLC)
- Media Access Control (MAC)

The packet received from the Network layer is further divided into frames depending on the frame size of the NIC(Network Interface Card). DLL also encapsulates Sender and Receiver's MAC address in the header.

The Receiver's MAC address is obtained by placing an ARP(Address Resolution Protocol) request onto the wire asking "Who has that IP address?" and the destination host will reply with its MAC address.

Functions of the Data Link Layer

Framing: Framing is a function of the data link layer. It provides a way for a sender to transmit a set of bits that are meaningful to the receiver. This can be accomplished by attaching special bit patterns to the beginning and end of the frame.
Physical Addressing: After creating frames, the Data link layer adds physical addresses (MAC addresses) of the sender and/or receiver in the header of each frame.
Error Control: The data link layer provides the mechanism of error control in which it detects and retransmits damaged or lost frames.
Flow Control: The data rate must be constant on both sides else the data may get corrupted thus, flow control coordinates the amount of data that can be sent before receiving an acknowledgment.
Access Control: When a single communication channel is shared by multiple devices, the MAC sub-layer of the data link layer helps to determine which device has control over the channel at a given time.



Note:

- Packet in the Data Link layer is referred to as Frame.
- Data Link layer is handled by the NIC (Network Interface Card) and device drivers of host machines.
- Switch & Bridge are Data Link Layer devices.

Network Layer – Layer 3

The network layer works for the transmission of data from one host to the other located in different networks. It also takes care of packet routing i.e. selection of the shortest path to transmit the packet, from the number of routes available. The sender & receiver's IP address es are placed in the header by the network layer.

Functions of the Network Layer

Routing: The network layer protocols determine which route is suitable from source to destination. This function of the network layer is known as routing.
Logical Addressing: To identify each device inter-network uniquely, the network layer defines an addressing scheme. The sender & receiver's IP addresses are placed in the header by the network layer. Such an address distinguishes each device uniquely and universally.

Note:

- Segment in the Network layer is referred to as Packet.
- Network layer is implemented by networking devices such as routers and switches.

Transport Layer – Layer 4

The transport layer provides services to the application layer and takes services from the network layer. The data in the transport layer is referred to as Segments . It is responsible for the end-to-end delivery of the complete message. The transport layer

also provides the acknowledgment of the successful data transmission and re-transmits the data if an error is found.

At the sender's side: The transport layer receives the formatted data from the upper layers, performs Segmentation , and also implements Flow and error control to ensure proper data transmission. It also adds Source and Destination port number s in its header and forwards the segmented data to the Network Layer.

Note:
The sender needs to know the port number associated with the receiver's application.

Generally, this destination port number is configured, either by default or manually. For example, when a web application requests a web server, it typically uses port number 80, because this is the default port assigned to web applications. Many applications have default ports assigned.

At the receiver's side: Transport Layer reads the port number from its header and forwards the Data which it has received to the respective application. It also performs sequencing and reassembling of the segmented data.

Functions of the Transport Layer

Segmentation and Reassembly: This layer accepts the message from the (session) layer, and breaks the message into smaller units. Each of the segments produced has a header associated with it. The transport layer at the destination station reassembles the message.
Service Point Addressing: To deliver the message to the correct process, the transport layer header includes a type of address called service point address or port address. Thus by specifying this address, the transport layer makes sure that the message is delivered to the correct process.

Services Provided by Transport Layer
- Connection-Oriented Service
- Connectionless Service

1. **Connection-Oriented Service:** It is a three-phase process that includes:

- Connection Establishment
- Data Transfer
- Termination/disconnection

In this type of transmission, the receiving device sends an acknowledgment, back to the source after a packet or group of packets is received. This type of transmission is reliable and secure.

2. **Connectionless service:** It is a one-phase process and includes Data Transfer. In this type of transmission, the receiver does not acknowledge receipt of a packet. This approach allows for much faster communication between devices. Connection-oriented service is more reliable than connectionless Service.

Note:

- Data in the Transport Layer is called Segments .
- Transport layer is operated by the Operating System. It is a part of the OS and communicates with the Application Layer by making system calls.
- The transport layer is called as Heart of the OSI model.
- Device or Protocol Use : TCP, UDP NetBIOS, PPTP

Session Layer – Layer 5

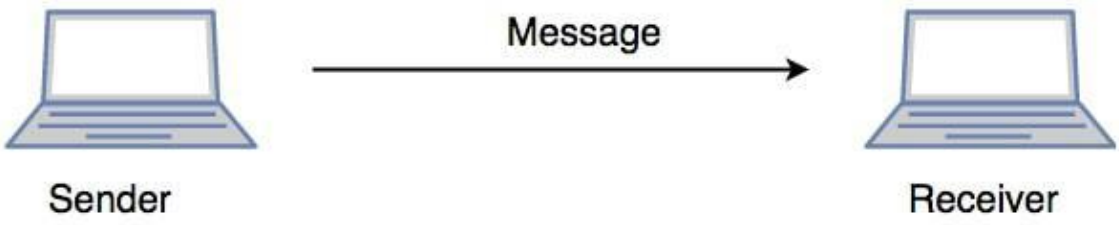
This layer is responsible for the establishment of connection, maintenance of sessions, and authentication, and also ensures security.

Functions of the Session Layer

Session Establishment, Maintenance, and Termination: The layer allows the two processes to establish, use, and terminate a connection.
Synchronization: This layer allows a process to add checkpoints that are considered synchronization points in the data. These synchronization points help to identify the error so that the data is re-synchronized properly, and ends of the messages are not cut prematurely and data loss is avoided.
Dialog Controller: The session layer allows two systems to start communication with each other in half-duplex or full-duplex.

Example

Let us consider a scenario where a user wants to send a message through some Messenger application running in their browser. The " Messenger " here acts as the application layer which provides the user with an interface to create the data. This message or so-called Data is compressed, optionally encrypted (if the data is sensitive), and converted into bits (0's and 1's) so that it can be transmitted.



Presentation Layer – Layer 6

The presentation layer is also called the Translation layer . The data from the application layer is extracted here and manipulated as per the required format to transmit over the network.

Functions of the Presentation Layer

Translation: For example, ASCII to EBCDIC .
Encryption/ Decryption: Data encryption translates the data into another form or code. The encrypted data is known as the ciphertext and the decrypted data is known as plain text. A key value is used for encrypting as well as decrypting data.
Compression: Reduces the number of bits that need to be transmitted on the network.

Note: Device or Protocol Use: JPEG, MPEG, GIF.

Application Layer – Layer 7
At the very top of the OSI Reference Model stack of layers, we find the Application layer which is implemented by the network applications. These applications produce the data to be transferred over the network. This layer also serves as a window for the application services to access the network and for displaying the received information to the user.

Example: Application – Browsers, Skype Messenger, etc.

Note: The application Layer is also called Desktop Layer.
Device or Protocol Use : SMTP.

Functions of the Application Layer

The main functions of the application layer are given below.

Network Virtual Terminal(NVT): It allows a user to log on to a remote host.
File Transfer Access and Management(FTAM): This application allows a user to access files in a remote host, retrieve files in a remote host, and manage or control files from a remote computer.
Mail Services: Provide email service.
Directory Services: This application provides distributed database sources and access for global information about various objects and services.

OSI Model – Layer Architecture

Layer No	Layer Name	Responsibility	Information Form (Data Unit)	Device or Protocol
7	Application Layer	Helps in identifying the client and synchronizing communication.	Message	SMTP
6	Presentation Layer	Data from the application layer is extracted and manipulated in the required format for transmission.	Message	JPEG , MPEG , GIF
5	Session Layer	Establishes Connection, Maintenance, Ensures Authentication and Ensures security.	Message (or encrypted message)	Gateway
4	Transport Layer	Take Service from Network Layer and provide it to the Application Layer.	Segment	Firewall
3	Network Layer	Transmission of data from one host to another, located in different networks.	Packet	Router
2	Data Link Layer	Node to Node Delivery of Message.	Frame	Switch , Bridge
1	Physical Layer	Establishing Physical Connections between Devices.	Bits	Hub , Repeater , Modem , Cables