THE OSI MODEL

# ABSTRACT

This research and development (R&D) document is about the Open Systems Interconnection (OSI) Model, which describes the working of each layer in network communication. In this document, there are theoretical discussions which show the working, examples, and protocols of the OSI model.

# OBJECTIVE

* To explore the working and functionality of each OSI Layer.
* To see how each layer communicates with its neighbouring layers.
* Mapping protocols such as (TCP,IP,HTTP etc..) to each layer.

# INTRODUCTION

The Open System Interconnection (OSI) model is a standardized model which was then adopted by the International Organization for Standardization (ISO) in 1984. The OSI model describes the process of communication between all the nodes in a network. The model divides the process into seven individual layers. Each layer performs specific functions and supports the layers which are above them and offers services to the layers which are below. The three lowest layers focus on passing traffic through the network to an end system. The top four layers come into play in the end system to complete the process.

Today, the OSI model is used to define networking architecture.

## An Overview of OSI Model:

| Layer 7 | Application layer |
| --- | --- |
| Layer 6 | Presentation layer |
| Layer 5 | Session layer |
| Layer 4 | Transport layer |
| Layer 3 | Network layer |
| Layer 2 | Data Link layer |
| Layer 1 | Physical layer |

## Layer Wise Functional Analysis :-

**Layer 7-** **Application layer**

The application layer offers an interface to the end user on a device connected to a network. This layer is visible to the user, in the sense of loading an application (like Web browser or email), The data is presented to the user through this layer and it is also responsible for initiating network communication.

Working:

* Opening a website or sending an email by a user triggers the application layer to start communication.
* It uses the correct protocol depending on the user’s command.
* When you use the web browser, it makes an HTTP GET or POST request.
* SMTP is used to format and send messages through emails.
* When you use the www.example.com destination domain, the layer will trigger a DNS query which then resolves the domain name to IP address.
* When the request is set, it goes through the presentation layer and falls to the layers beneath for encoding and physical delivery.
* On receiving time, the application layer interprets the data incoming and passes it to the right user application.

Example:

User enters any domain ex(www.example.com).

* HTTP GET request is sent by the browser to get the webpage information.
* A DNS query sent to check for the domain’s address first.
* The application layer organizes the data and gives it to the layers below.

**Protocols used here**: HTTP, FTP, SMTP, DNS.

**Layer 6-** **Presentation layer**

It is the Presentation Layer’s role to organize, secure and compress data before transmitting it. In this way, information from the sender is presented by which both systems can interpret without knowing each other’s internal framework.

Working:

* In this step, the data coming from the Application Layer is changed into a standardized form to be sent over the network.
* It is able to change characters into ASCII or binary formats using encoding.
* Encryption and decryption take place here and secure your communication (i,e., TLS is used in HTTPS).
* It also compresses the data and then decompresses it again when the data reaches the destination.
* On receiving data, the presentation layer removes all changes by decompressing it, and making it ready for the Session layer.

Example:

To reach a secure website, a user uses https://www.example.com.

* The data sent in HTTP is secured over the network with TLS/SSL.
* It is the Presentation Layer that handles the process of encryption.
* Then it decrypts the data at the destination.

**Protocols used here are** TLS, SSL, MIME, XDR, JPEG, GIF, MP4, ASCII, EBCDIC

**Layer 5-** **Session layer**

The session layer offers a number of different services, such as establishing the communication session, monitoring and terminating it between two applications. It makes sure that data exchanged is well organized and synchronized which allows reliable communication over two devices.

Working:

* A session is made when a client accesses a server.
* The session layer is in charge of deciding if communication between the devices occurs half-duplex or full-duplex.
* It records the bytes transferred, so that there is no risk of losing data.
* If no acknowledgment or receipt of data comes, the sender will send it again.
* It is also possible for the session layer to add synchronization points (checkpoints) so recovery is possible in case there is failure.
* Once communication ends, it terminates the session.

Example:

If someone accesses another server remotely by using SSH or Telnet.

* There is a session formed between the client and server.
* Data is synchronized while exchange.
* After the user logs out of the system, the session terminates.

**Protocols used here are** NetBIOS, PPTP, SAP, SOCKS, ASP, SQL, ZIP.

**Layer 4-** **Transport layer**

The transport layer of the OSI model, provides end-to-end communication between end devices across a network. It makes sure that all parts of the data are delivered, in the correct sequence, and are correct. It gives both connection-based (TCP) and connectionless (UDP) services , depending on the way an application needs to communicate.

Working:

* It is the transport layer’s job to divide big data into smaller segments to allow for easier transmission.
* To make sure a reliable connection is established in TCP (connection-oriented), three way handshake (SYN, SYN-ACK, and ACK) is used.
* Every segment is labeled with a sequence number to verify and notice if any segments are missing.
* When there are errors in sending data or some packets are dropped, the data is retransmitted.
* It uses a windowing mechanism to perform flow control.
* When the transmission is done, the connection is closed under control.
* You can send information with UDP, without the need of establishing connection but it does not ensure delivery.

Example:

A file is sent onto the internet with the help of TCP.

* Transport layer divides the file into segments.
* TCP connection is formed by initiating a handshake.
* All the segment parts are sent, tracked properly and reassembled correctly at the receiving end.

**Protocols used here are** TCP, UDP,SPX, RSVP.

**Layer 3-** **Network layer**

The Network Layer deals with logical addresses and routing of data across several networks that are connected. Data packets can make their way from the source to the destination, even though they might be on different networks.

Working:

* Helps in identifying the source and destination IP address by assigning them the logical address.
* Data is split and sent using routing protocols.
* Packets are forwarded between networks by using routers.
* When data packets are larger than supported by the network (layer 2), it performs the fragmentation process and then reassembles them at the receiving end.
* Routing tables and routing protocols(such as OSPF and RIP) helps discover and update paths on its own.
* Provides subnetting to assist with effective control for IP address management.

Example:

If a client is accessing a server on a different network.

* The network layer reviews the destination’s IP address.
* A router decides the best path and route the packet with the help of routing protocols.
* If required, the data is fragmented prior to sending to the data link layer.

**Protocols used here are** IP, ICMP, IGMP, IPsec, RIP, OSPF.

**Layer 2- Data Link layer**

It is the Data Link Layer that handles node to node communication and physical addressing within the network. Devices can access the physical network with the help of Network Interface Card (NIC), send streams of data, and detect errors to ensure reliable data transfer between each device on the network.

Working:

* Each device on the same LAN gets identified using its unique MAC address.
* Before transmission data is formatted into frames.
* Makes it possible to identify errors with the help of CRC (Cyclic Redundancy Check).
* At this layer switches and bridges operate to examine and forward traffic using each device’s MAC address.
* Controls when several machines use the medium and making it sure collisions do not happen.
* Monitors the frames and performs retransmission if an error happens before the frame is received at the physical layer.

Example:

A computer sends information to another device that is connected on the same LAN.

* In an ethernet frame the data is encapsulated with the device MAC address.
* The switch gets the MAC address and sends it to the frame accordingly.

**Protocols used here are** Ethernet, PPP, ARP, HDLC, Frame Relay, IEEE 802.3, IEEE 802.11

**Layer 1- Physical layer**

It is the Physical Layer that specifies the hardware elements that let binary data (0s and 1s) move through a cable or other physical medium. It makes data transfer over cables, wireless links, or optical fibers.

Working:

* Physical layer sends bits (0s and 1s)in the form of electrical pulses, light signals, or radio waves.
* It encodes the bits into signals that are suitable for transmission.
* At this layer, NICs, hubs, and repeaters handle the job of transmitting, amplifying, or restoring signal traffic.
* It sets out the details regarding the cables, connectors (for example, RJ-45 connectors), and the way the pins are organized.
* The Physical Layer’s only concern is movement of raw bits between a network.
* Radio waves and antennas are used here to transfer signals in wireless communication.

Example:

If data is sent over Ethernet cables.

* The information stored in the data is translated into electric pulses which are then transmitted through the RJ-45 connector.
* The NIC within the receiving end translates the signals back into bits.

**Components/Media used:** Some of the types of cables that you can use are Twisted pair (Cat5e, Cat6), fiber optic, Coaxial, RJ-45 connectors, Network Interface Cards, Hubs, Repeaters, and wireless radios.