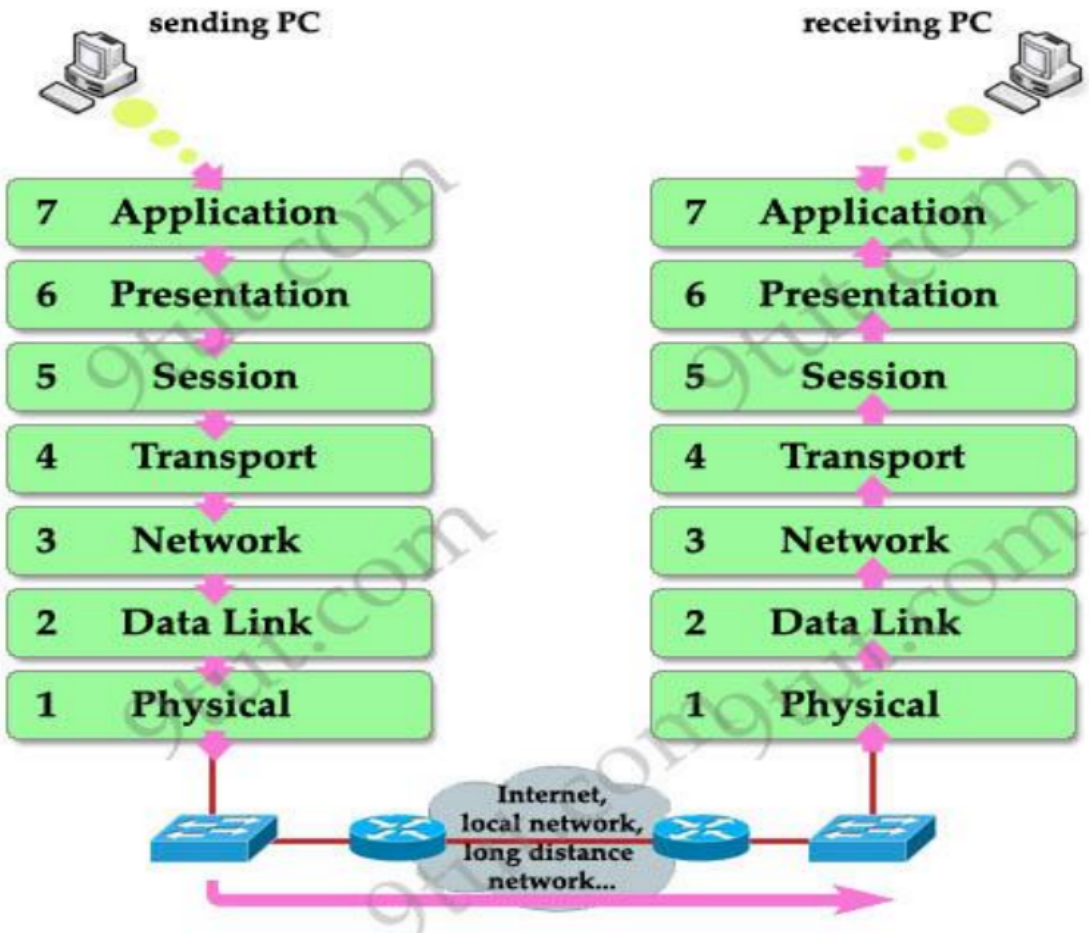
OSI MODEL

OSI stands for **Open Systems Interconnection**. It has been developed by ISO – **'International Organization of Standardization'**, in the year 1984. 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.



OSI Model - The Upper Layers

The top three layers of the OSI model are often referred to as the **upper layers**:

- Layer-7 - **Application** layer
- Layer-6 - **Presentation** layer
- Layer-5 - **Session** layer

OSI Model - The Application Layer

The **Application layer (Layer-7)** provides the interface between the user application and the network. A web browser and an email client are examples of user applications.

The user application itself *does not* reside at the Application layer - the *protocol* does. The user interacts with the application, which in turn interacts with the application protocol.

Examples of Application layer protocols include:

- **FTP**, via an FTP client
- **HTTP**, via a web browser
- **POP3** and **SMTP**, via an email client
- **Telnet**

The Application layer provides a variety of functions:

- Identifies communication partners
- Determines resource availability
- Synchronizes communication

The Application layer interacts with the Presentation layer below it. As it is the top-most layer, it does not interact with any layers above it.

OSI Model - The Presentation Layer

The **Presentation layer (Layer-6)** controls the *formatting* and *syntax* of user data for the application layer. This ensures that data from the *sending* application can be understood by the *receiving* application.

Standards have been developed for the formatting of data types, such as text, images, audio, and video. Examples of Presentation layer formats include:

- **Text** - RTF, ASCII, EBCDIC
- **Images** - GIF, JPG, TIF
- **Audio** - MIDI, MP3, WAV
- **Movies** - MPEG, AVI, MOV

If two devices do not support the same format or syntax, the Presentation layer can provide **conversion** or **translation** services to facilitate communication.

Additionally, the Presentation layer can perform **encryption** and **compression** of data, as required. However, these functions can also be performed at lower layers as well. For example, the Network layer can perform encryption, using IPSec.

OSI Model - The Session Layer

The **Session layer (Layer-5)** is responsible for establishing, maintaining, and ultimately terminating *sessions* between devices. If a session is *broken,* this layer can attempt to recover the session.

OSI Model - The Lower Layers

The bottom four layers of the OSI model are often referred to as the **lower layers**:

- Layer-4 – **Transport** layer
- Layer-3 – **Network** layer
- Layer-2 – **Data-Link** layer
- Layer-1 – **Physical** layer

Protocols that operate at these layers control the end-to-end transport of data between devices, and are implemented in both software and hardware.

OSI Model - The Transport Layer

The **Transport layer (Layer-4)** does *not* actually send data, despite its name. Instead, this layer is responsible for the *reliable* transfer of data, by ensuring that data arrives at its destination error-free and in order.

Transport layer communication falls under two categories:

- **Connection-oriented** – requires that a connection with specific agreed-upon parameters be established before data is sent.
- **Connectionless** – requires no connection before data is sent.

Connection-oriented protocols provide several important services:

- **Segmentation and sequencing –** data is *segmented* into smaller pieces for transport. Each segment is assigned a *sequence number*, so that the receiving device can reassemble the data on arrival.
- **Connection establishment –** connections are established, maintained, and ultimately terminated between devices.
- **Acknowledgments –** receipt of data is confirmed through the use of *acknowledgments*. Otherwise, data is retransmitted, guaranteeing delivery.
- **Flow control** (or **windowing) –** data transfer rate is negotiated to prevent congestion.

The TCP/IP protocol suite incorporates two Transport layer protocols:

- **Transmission Control Protocol (TCP) –** connection-oriented
- **User Datagram Protocol (UDP) -** connectionless

OSI Model - The Network Layer

The **Network layer (Layer-3)** controls *internetwork* communication, and has two key responsibilities:

- **Logical addressing** – provides a unique address that identifies both the *host*, and the *network* that host exists on.
- **Routing** – determines the *best path* to a particular destination network, and then *routes* data accordingly.

Two of the most common Network layer protocols are:

- **Internet Protocol (IP)**
- Novell's **Internetwork Packet Exchange (IPX)**.

IPX is almost entirely deprecated. IP version 4 (IPv4) and IP version 6 (IPv6) are covered in nauseating detail in other guides.

OSI Model - The Data-Link Layer

While the Network layer is concerned with transporting data *between* networks, the **Data-Link layer (Layer-2)** is responsible for transporting data *within* a network.

The Data-Link layer consists of two sublayers:

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

The LLC sublayer serves as the intermediary between the physical link and all higher layer protocols. It ensures that protocols like IP can function regardless of what type of physical technology is being used.

Additionally, the LLC sublayer can perform flow-control and error-checking, though such functions are often provided by Transport layer protocols, such as TCP.

The MAC sublayer controls access to the physical medium, serving as mediator if multiple devices are competing for the same physical link. Data-link layer technologies have various methods of accomplishing this - **Ethernet** uses *Carrier Sense Multiple Access* with *Collision Detection (CSMA/CD)*, and **Token Ring** utilizes a *token*.

OSI Model - The Data-Link Layer (continued)

The Data-link layer *packages* the higher-layer data into **frames,** so that the data can be put onto the physical wire. This packaging process is referred to as **framing** or **encapsulation.**

The encapsulation type will vary depending on the underlying technology. Common Data-link layer technologies include following:

- Ethernet – the most common LAN data-link technology
- Token Ring – almost entirely deprecated
- FDDI (Fiber Distributed Data Interface)
- 802.11 Wireless
- Frame-Relay
- ATM (Asynchronous Transfer Mode)

The data-link frame contains the source and destination **hardware** (or **physical**) address. Hardware addresses uniquely identify a host within a network, and are often hardcoded onto physical network interfaces. However, hardware addresses contain no mechanism for differentiating one *network* from another, and can only identify a host *within* a network.

The most common hardware address is the Ethernet **MAC address.**

OSI Model - The Physical Layer

The **Physical layer (Layer-1)** controls the signaling and transferring of raw bits onto the physical medium. The Physical layer is closely related to the Data-link layer, as many technologies (such as Ethernet) contain both data-link and physical functions.

The Physical layer provides specifications for a variety of hardware:

- Cabling
- Connectors and transceivers
- Network interface cards (NICs)
- Wireless radios
- Hubs

Physical-layer devices and topologies are covered extensively in other guides.

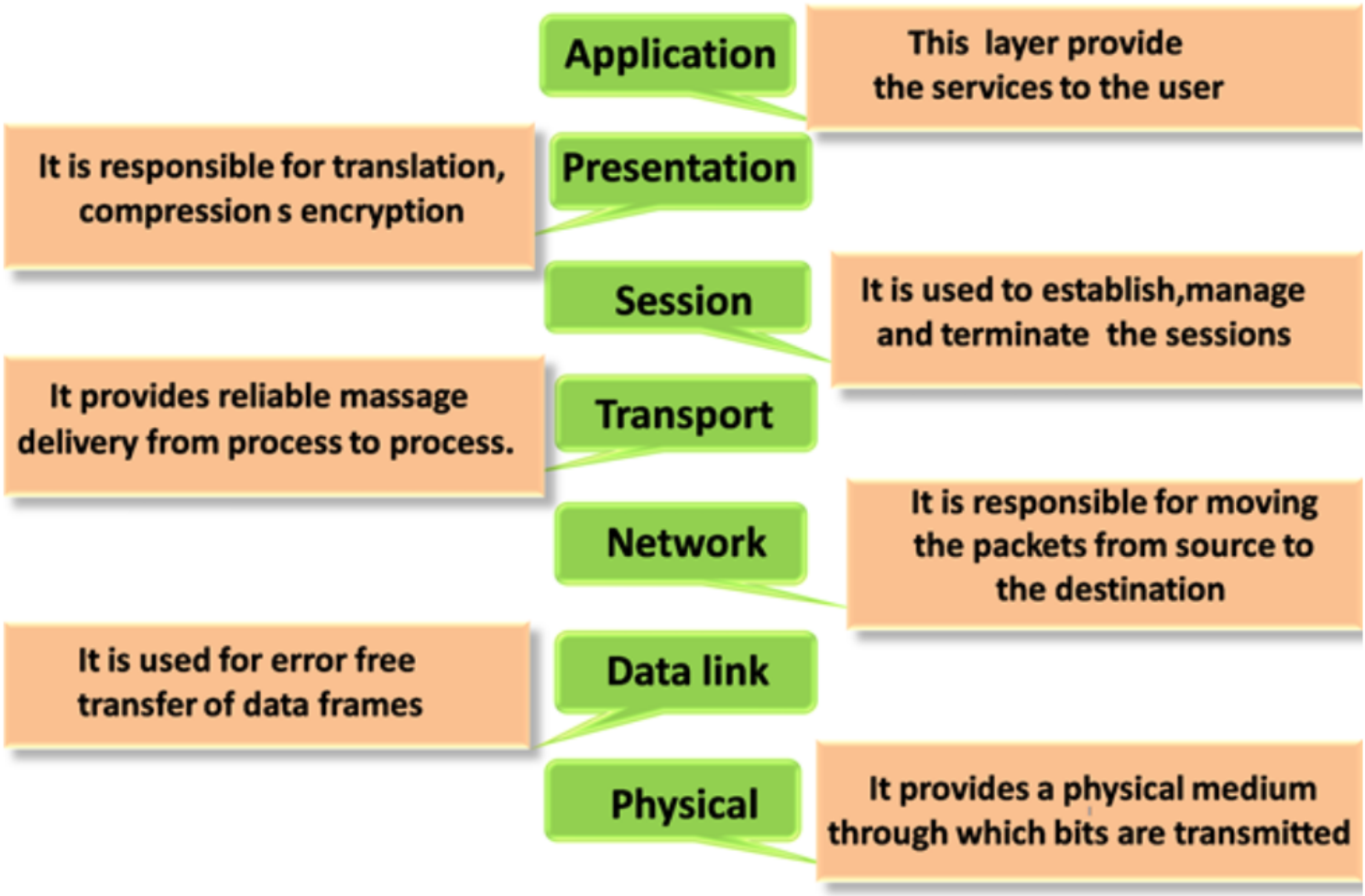
1. Physical Layer (Layer 1) :

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.

The main functions of the physical layer are as follows –

- It defines the physical characteristics and functions of the physical devices and interfaces so that transmission can occur.
- It lays out the transmission medium and type of signal for transmitting the bits.
- It defines the procedure of encoding of the bits, for example, how many volts should represent a 0 bit and 1 bit in case of electrical signals.

- It states the data transmission rate, i.e., number of bits transmitted per second; and the duration of a bit, i.e., how long a bit stays.
- It defines the topology, i.e., physical layout, of the network devices.
- It also states the direction of transmission, i.e., whether the transmission is in simplex mode, half-duplex mode or full-duplex mode.


Application
This layer provide the services to the user
Presentation
It is responsible for translation, compression s encryption
Session
It is used to establish,manage and terminate the sessions
Transport
It provides reliable massage delivery from process to process.
Network
It is responsible for moving the packets from source to the destination
Data link
It is used for error free transfer of data frames
Physical
It provides a physical medium through which bits are transmitted

OSI Reference Model Example

A web browser serves as a good practical illustration of the OSI model and the TCP/IP protocol suite:

- The web browser serves as the user interface for accessing a website. The browser itself does not function at the **Application layer.** Instead, the web browser invokes the *Hyper Text Transfer Protocol (HTTP)* to interface with the remote web server, which is why *http://* precedes every web address.

- The Internet can provide data in a wide variety of *formats,* a function of the **Presentation layer**. Common formats on the Internet include *HTML, XML, PHP, GIF,* and *JPEG*. Any *encryption* or *compression* mechanisms used on a website are also considered a Presentation layer function.

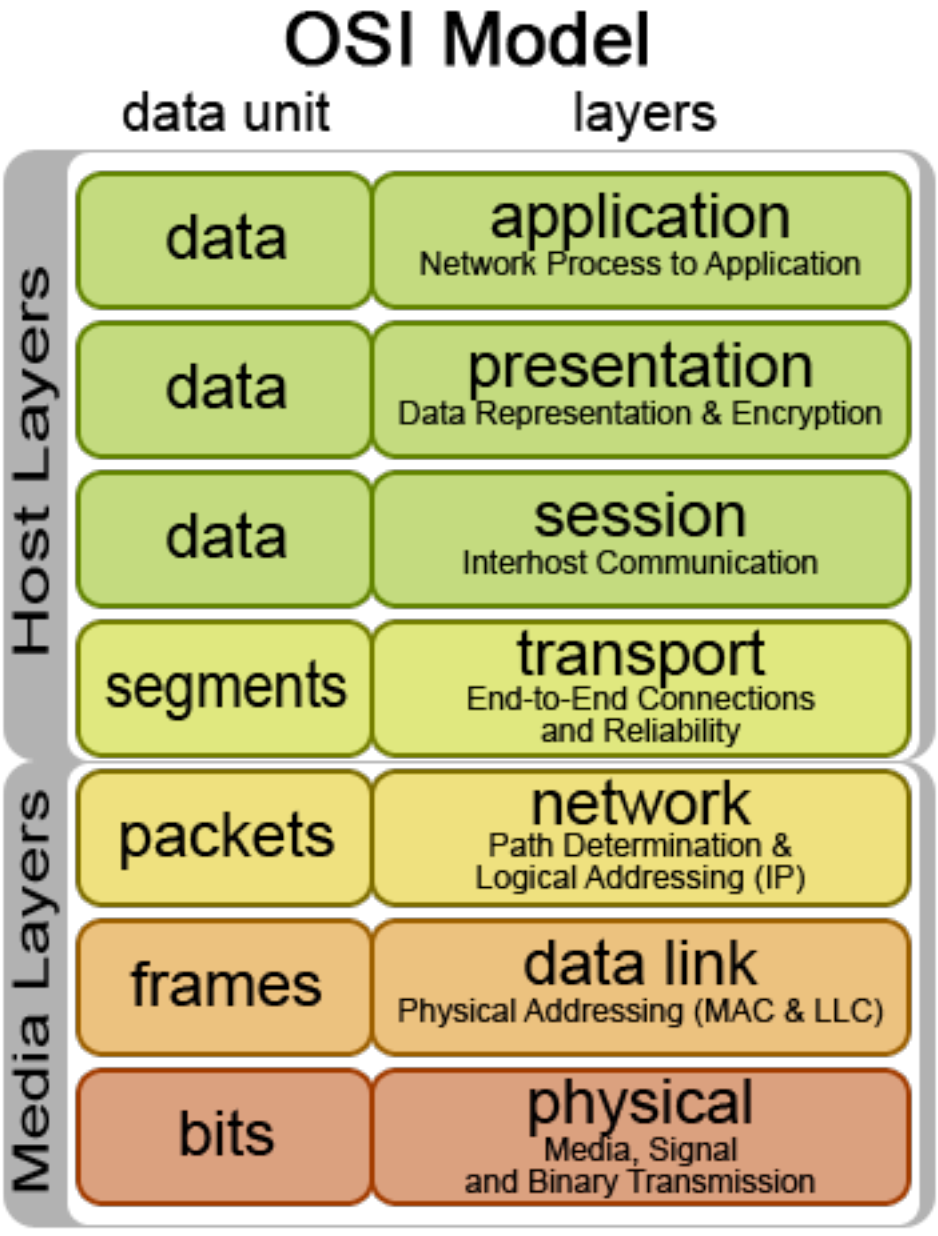
- The **Session layer** is responsible for establishing, maintaining, and terminating the session between devices, and determining whether the communication is *half-duplex* or *full-duplex*. However, the TCP/IP stack generally does not include session-layer protocols, and is reliant on lower-layer protocols to perform these functions.

- HTTP utilizes the *TCP* **Transport layer** protocol to ensure the reliable delivery of data. TCP establishes and maintains a connection from the client to the web server, and packages the higher-layer data into *segments.* A sequence number is assigned to each segment so that data can be reassembled upon arrival.

- The best path to *route* the data between the client and the web server is determined by *IP*, a **Network layer** protocol. IP is also responsible for the assigned logical addresses on the client and server, and for encapsulating segments into *packets.*

- Data cannot be sent directly to a logical address. As packets travel from network to network, IP addresses are translated to *hardware* addresses, which are a function of the **Data-Link layer**. The packets are encapsulated into *frames* to be placed onto the physical medium.

- The data is finally transferred onto the network medium at the **Physical layer**, in the form of raw bits. Signaling and encoding mechanisms are defined at this layer, as is the hardware that forms the physical connection between the client and the web server.


OSI Model
data unit
layers
Host Layers
data
application
Network Process to Application
data
presentation
Data Representation & Encryption
data
session
Interhost Communication
segments
transport
End-to-End Connections
and Reliability
Media Layers
packets
network
Path Determination &
Logical Addressing (IP)
frames
data link
Physical Addressing (MAC & LLC)
bits
physical
Media, Signal
and Binary Transmission