4 Marks :

Que : What is Internetworking?

- Internetworking started as a way to connect disparate types of computer networking technology. Computer network term is used to describe two or more computers that are linked to each other.

- When two or more computer LANs or WANs or computer network segments are connected using devices such as a router and configure by logical addressing scheme with a protocol such as IP, then it is called as computer internetworking.

- Internetworking is a term used by Cisco. Any interconnection among or between public, private, commercial, industrial, or governmental computer networks may also be defined as an internetwork or "Internetworking".

- In modern practice, the interconnected computer networks or Internetworking use the Internet Protocol. Two architectural models are commonly used to describe the protocols and methods used in internetworking. The standard reference model for internetworking is Open Systems Interconnection (OSI).
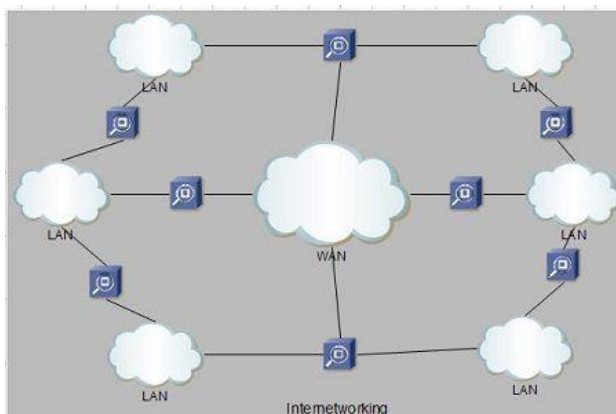
Que : Advantages and Disadvantages of Internetworking

Advantages of Internetworking	Disadvantages of Internetworking
It provides great Accessibility to information.	Sometimes, the internet gives Complexity and False Information.
It inculcates easy and faster communication.	Unavailability in bad weather.
People would gain knowledge and obtain loads of information about services.	It leads to the insecurity of information and data loss.
It permits online payments and digital marketing.	It has a bigger Workload and Complex Designing.
It is efficient for business & organizational growth.	It is very expensive when done at the organizational level.
It leads to mass communication among people to spread awareness.	It produces more threats, cyber-attacks, harassment, and violations.
It facilitates social networks to increase development and collaboration.	Increase hate and fake information which can lead to mental health issues.
It provides more security in the banking sector and feasible solutions to issues.	Reliability and security are there, but as the internet is public and worldwide connected, there are chances that issues(viruses, threats) can occur.

Que : Tell about the Physical Layer with suitable example.

- The physical layer is the first and lowest layer from the bottom of the 7-layered OSI model and delivers security to hardware. This layer is in charge of data transmission over the physical medium. It is the most complex layer in the OSI model.
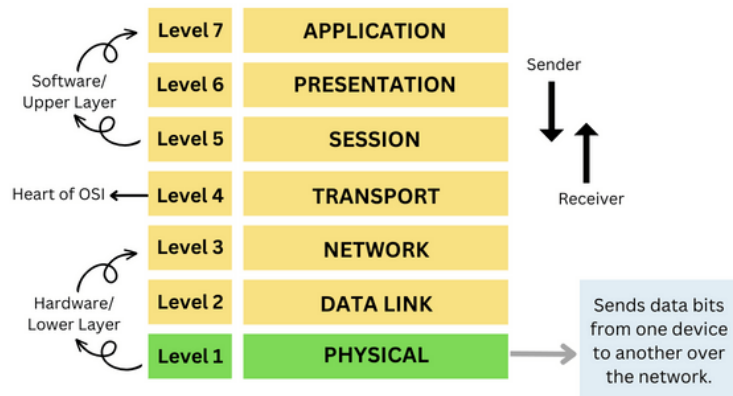
The OSI Model: Physical Layer

The physical layer converts the data frame received from the data link layer into bits, i.e., in terms of ones and zeros. It maintains the data quality by implementing the required protocols on different network modes and maintaining the bit rate through data transfer using a wired or wireless medium.

Attributes of the physical layer:

The physical layer has several attributes that are implemented in the OSI model:

1. Signals: The data is first converted to a signal for efficient data transmission. There are two kinds of signals:

- Analog Signals: These signals are continuous waveforms in nature and are represented by continuous electromagnetic waves for the transmission of data.
  - Digital Signals: These signals are discrete in nature and represent network pulses and digital data from the upper layers.

2. Transmission media: Data is carried from source to destination with the help of transmission media. There are two sorts of transmission media:

- Wired Media: The connection is established with the help of cables. For example, fiber optic cables, coaxial cables, and twisted pair cables.
- Wireless Media: The connection is established using a wireless communication network. For example, Wi-Fi, Bluetooth, etc.

3. Data Flow: It describes the rate of data flow and the transmission time frame. The factors affecting the data flow are as follows:

- Encoding: Encoding data for transmission on the channel.
- Error-Rate: Receiving erroneous data due to noise in transmission.
- Bandwidth: The rate of transmission of data in the channel.

Que : Demonstrate the Layered technology of Networking.

o The main aim of the layered architecture is to divide the design into small pieces.
o Each lower layer adds its services to the higher layer to provide a full set of services to manage communications and run the applications.
o It provides modularity and clear interfaces, i.e., provides interaction between subsystems.
o It ensures the independence between layers by providing the services from lower to higher layer without defining how the services are implemented. Therefore, any modification in a layer will not affect the other layers.
o The number of layers, functions, contents of each layer will vary from network to network. However, the purpose of each layer is to provide the service from lower to a higher layer and hiding the details from the layers of how the services are implemented.
o The basic elements of layered architecture are services, protocols, and interfaces.
   o Service: It is a set of actions that a layer provides to the higher layer.
   o Protocol: It defines a set of rules that a layer uses to exchange the information with peer entity. These rules mainly concern about both the contents and order of the messages used.
   o Interface: It is a way through which the message is transferred from one layer to another layer.
o In a layer n architecture, layer n on one machine will have a communication with the layer n on another machine and the rules used in a conversation are known as a layer-n protocol.

An example of the five-layered architecture.
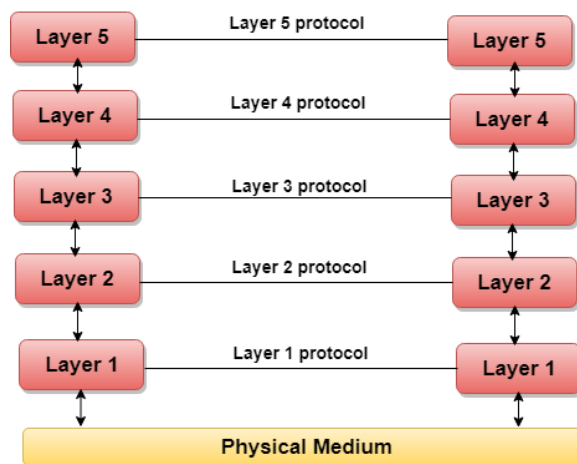
o In case of layered architecture, no data is transferred from layer n of one machine to layer n of another machine. Instead, each layer passes the data to the layer immediately just below it, until the lowest layer is reached.
o Below layer 1 is the physical medium through which the actual communication takes place.

- In a layered architecture, unmanageable tasks are divided into several small and manageable tasks.
- The data is passed from the upper layer to lower layer through an interface. A Layered architecture provides a clean-cut interface so that minimum information is shared among different layers. It also ensures that the implementation of one layer can be easily replaced by another implementation.
- A set of layers and protocols is known as network architecture.

Que : Illustrate about Open system Interconnection

- The open systems interconnection (OSI) model is a conceptual model created by the International Organization for Standardization which enables diverse communication systems to communicate using standard protocols.

- It was the first standard model for network communications, adopted by all major computer and telecommunication companies in the early 1980s

- The modern Internet is not based on OSI, but on the simpler TCP/IP model. However, the OSI 7-layer model is still widely used, as it helps visualize and communicate how networks operate, and helps isolate and troubleshoot networking problems.

- The OSI model is divided into two layers: upper layers and lower layers.
- The upper layer of the OSI model mainly deals with the application related issues, and they are implemented only in the software. The application layer is closest to the end user. Both the end user and the application layer interact with the software applications. An upper layer refers to the layer just above another layer.
- The lower layer of the OSI model deals with the data transport issues. The data link layer and the physical layer are implemented in hardware and software. The physical layer is the lowest layer of the OSI model and is closest to the physical medium. The physical layer is mainly responsible for placing the information on the physical medium.

OSI Model : The OSI 7 Layers

Characteristics of OSI Model
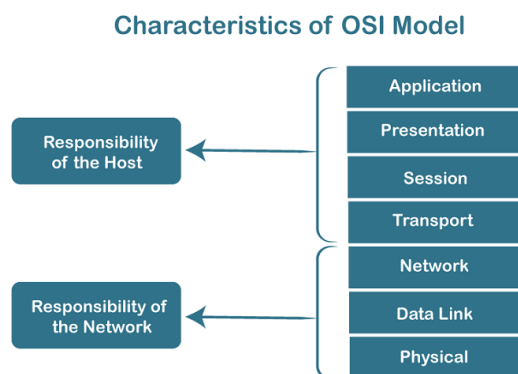
Que : Summarise the concept Network Layer and its functions.

Network Layer
- The Network Layer is the third layer of the OSI model.
- It handles the service requests from the transport layer and further forwards the service request to the data link layer.
- The network layer translates the logical addresses into physical addresses
- It determines the route from the source to the destination and also manages the traffic problems such as switching, routing and controls the congestion of data packets.
- The main role of the network layer is to move the packets from sending host to the receiving host.

The main functions performed by the network layer are:

- Routing: When a packet reaches the router's input link, the router will move the packets to the router's output link. For example, a packet from S1 to R1 must be forwarded to the next router on the path to S2.
- Logical Addressing: The data link layer implements the physical addressing and network layer implements the logical addressing. Logical addressing is also used to distinguish between source and destination system. The network layer adds a header to the packet which includes the logical addresses of both the sender and the receiver.
- Internetworking: This is the main role of the network layer that it provides the logical connection between different types of networks.
- Fragmentation: The fragmentation is a process of breaking the packets into the smallest individual data units that travel through different networks.

Que : Illustrate the Datalink layer with its functions

Data Link Layer is second layer of OSI Layered Model. This layer is one of the most complicated layers and has complex functionalities and liabilities. Data link layer hides the details of underlying hardware and represents itself to upper layer as the medium to communicate.

Data link layer is responsible for converting data stream to signals bit by bit and to send that over the underlying hardware.

At the receiving end, Data link layer picks up data from hardware which are in the form of electrical signals, assembles them in a recognizable frame format, and hands over to upper layer.

Data link layer has two sub-layers:

- **Logical Link Control**: It deals with protocols, flow-control, and error control
- **Media Access Control:** It deals with actual control of media

Functionality of Data-link Layer

Data link layer does many tasks on behalf of upper layer. These are:

Framing
Data-link layer takes packets from Network Layer and encapsulates them into Frames.Then, it sends each frame bit-by-bit on the hardware. At receiver' end, data link layer picks up signals from hardware and assembles them into frames.

- **Addressing**
Data-link layer provides layer-2 hardware addressing mechanism. Hardware address is assumed to be unique on the link. It is encoded into hardware at the time of manufacturing.

- **Synchronization**
When data frames are sent on the link, both machines must be synchronized in order to transfer to take place.

- **Error Control**
Sometimes signals may have encountered problem in transition and the bits are flipped.These errors are detected and attempted to recover actual data bits. It also provides error reporting mechanism to the sender.

- **Flow Control**
Stations on same link may have different speed or capacity. Data-link layer ensures flow control that enables both machine to exchange data on same speed.

- **Multi-Access**
When host on the shared link tries to transfer the data, it has a high probability of collision. Data-link layer provides mechanism such as CSMA/CD to equip capability of accessing a shared media among multiple Systems.

**Que : Build about Internetworking models with neat diagram**

- A collection of individual networks which are connected by intermediate networking devices and functioning as a single large network is called as an Internetwork. and When two or more networks are connected with each other by using devices like router is called Internetworking.
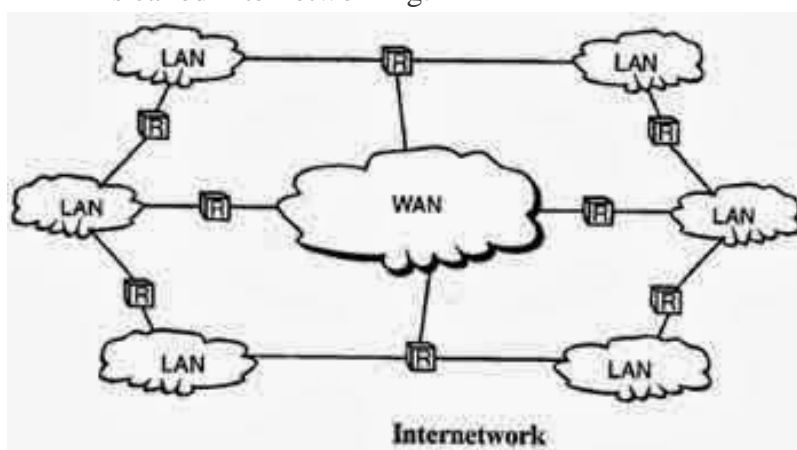
Internetwork

Internetworking Models

- There are two primary models which are most commonly used to describe the methods used in internetworking. They also give the working of protocols used for communication.
- The first one is the Open Source Interconnection (OSI) model which was developed by International Organization for Standardization (ISO). It provides a detailed description of protocols function using layering from hardware to software interface in user application. Internetworking comes at the Network Layer (Layer 3) of this model.

OSI model layers are shown below :
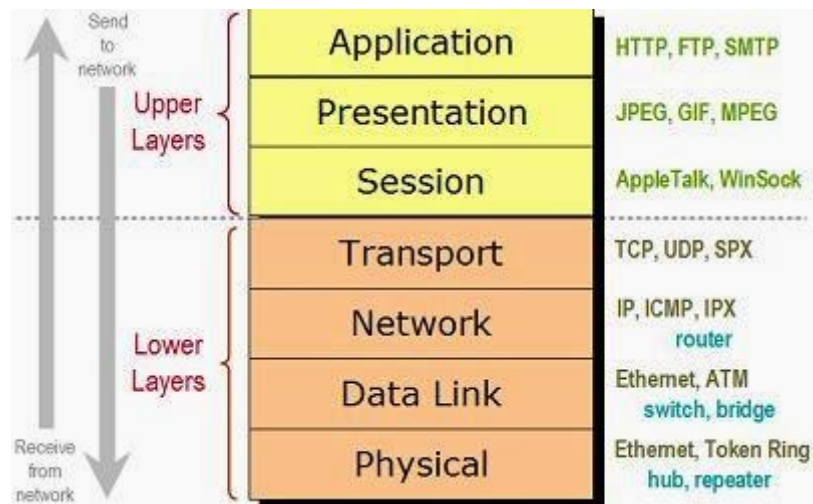

OSI MODEL

- This reference model describes how data from the software application from one computer moves through the network media to reach the software application in another computer. This model consist of 7 layers; each layer identifies and describes particular network functions. The model was developed by ISO in 1984 and is now considered the reference model for inter-computer communications.

TCP/IP MODEL

- The other one is TCP/IP Model also Known as DOD Model. It is similar to OSI model, as it also appears as a layered model, but uses much less description. It was the first model to try and put network communications in a layered format. The internet layer protocols of the model facilitate the internetworking.

**TCP/IP model layers are shown below :**
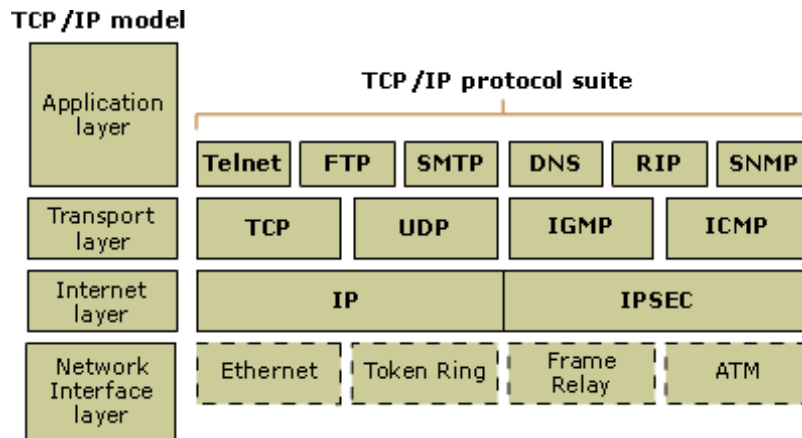
TCP/IP MODEL

- TCP /IP was first seen in 1973, later in 1978 divided into distinct protocols: TCP and IP. In 1983 TCP /IP was officially named as the primary protocol suite for data transportation on the Arpanet (Advanced Research Project Agency Network) which was created by ARPA for DOD (Department of Defense).

Que : Identify the three layers of host responsbility in Reference model :

Application Layer
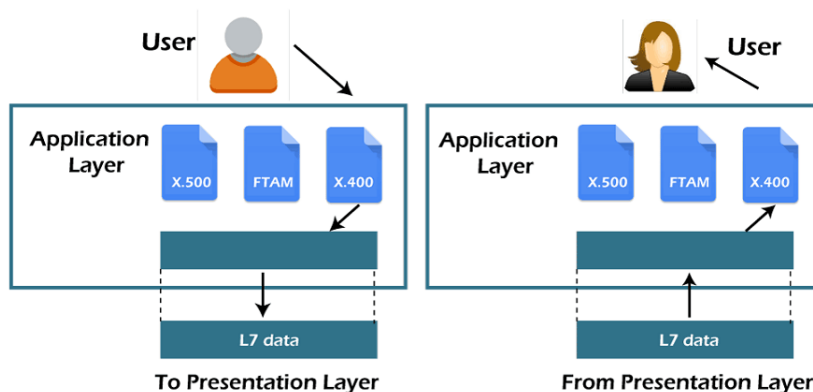
o An application layer serves as a window for users and application processes to access network service.

o It handles issues such as network transparency, resource allocation, etc.

o An application layer is not an application, but it performs the application layer functions.

o This layer provides the network services to the end-users.

Functions of Application layer:

o File transfer, access, and management (FTAM): An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.

o Mail services: An application layer provides the facility for email forwarding and storage.

- Directory services: An application provides the distributed database sources and is used to provide that global information about various objects.
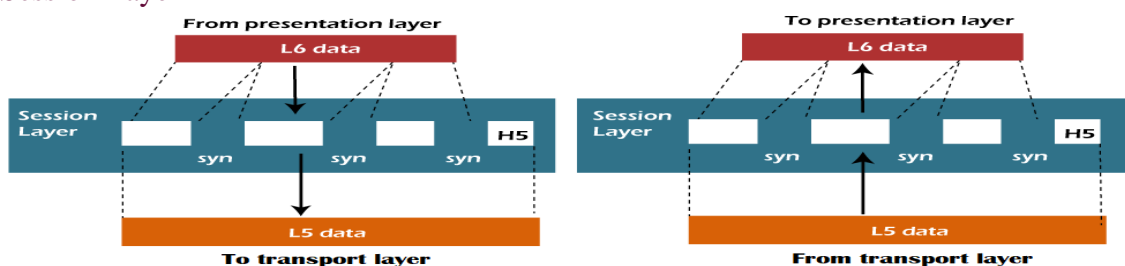
Presentation Layer
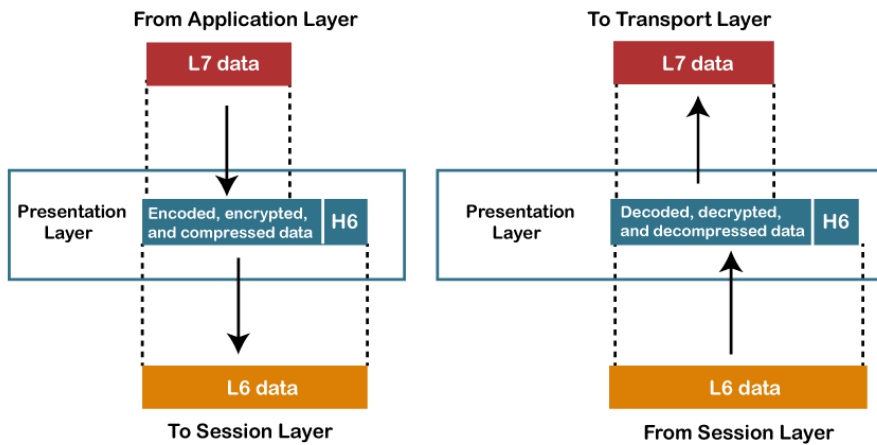
- A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.
- It acts as a data translator for a network.
- This layer is a part of the operating system that converts the data from one presentation format to another format.
- The Presentation layer is also known as the syntax layer.

Functions of Presentation layer:

- Translation: The processes in two systems exchange the information in the form of character strings, numbers and so on. Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.
- Encryption: Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.
- Compression: Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video

Session Layer

o It is a layer 3 in the OSI model.
o The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.

Functions of Session layer:
o Dialog control: Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.
o Synchronization: Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.

Que : List out the Advantages of Reference model
Ans :

- It is a truly generic model.
- The OSI model works as a standard model in data communication.
- OSI model is helpful if you want to buy the required software or hardware to build your own network.
- Layers in the OSI model architectures can be distinguished and every layer has its own importance according to their interfaces, services, and protocols.
- The OSI divides the all process of data communication into simpler and smaller
- The protocols are hidden in the OSI model, so any protocols can be implemented in the OSI model. OSI model is a standard model, so it can adapt all features of other protocols.
- Component development
  o Concept of Modularity
  o Design of the network
  o Troubleshooting of the network
- The OSI model increases the learnability of the network.

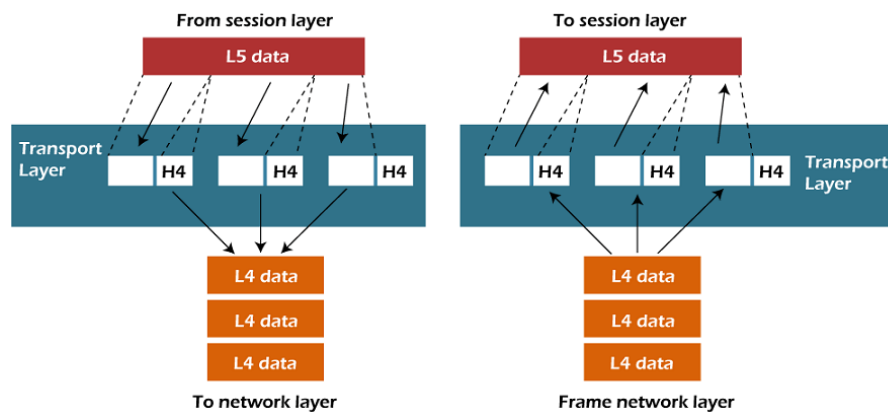**Que : List out the Disadvantages of Reference model**
Answer :
1. The OSI model is a theoretical model. Sometimes it can be a difficulty if the appropriate technology is not available.
2. The OSI restricts its practical implementation.
3. The OSI model is a very complex model.
4. The initial implementation of the OSI model is slow.
5. The initial implementation of the OSI model is costly.
6. There is an interdependence among the OSI layers. OSI layers cannot work in parallel. Each upcoming layer needs to wait to receive the data from its predecessor layer. For an example the application layer receives the data from the presentation layer and the presentation layer needs to wait to receive the data from the session layer and so on.

7. Some layers like the presentation layer and session layer have very little functionality when practically deployed.
8. The duplication of services in various layers is a problem in the OSI model. Some Services are offered by multiple layers. Some of these services are mentioned below;
- Flow control
- Error control
- addressing etc.
1. The OSI model is a theoretical model and does not offer appropriate solutions for the practical implementation of the networks.
2. The OSI model did not fulfill the practical needs. So the OSI model was labeled as inferior quality.

Que : Explain about Transport layer with neat diagram
Answer :

Transport Layer

- o The Transport layer is a Layer 4 ensures that messages are transmitted in the order in which they are sent and there is no duplication of data.
- o The main responsibility of the transport layer is to transfer the data completely.
- o It receives the data from the upper layer and converts them into smaller units known as segments.
- o This layer can be termed as an end-to-end layer as it provides a point-to-point connection between source and destination to deliver the data reliably.

The two protocols used in this layer are:

Transmission Control Protocol

- o It is a standard protocol that allows the systems to communicate over the internet.
- o It establishes and maintains a connection between hosts.
- o When data is sent over the TCP connection, then the TCP protocol divides the data into smaller units known as segments. Each segment travels over the

internet using multiple routes, and they arrive in different orders at the destination. The transmission control protocol reorders the packets in the correct order at the receiving end.

- o User Datagram Protocol
    - o User Datagram Protocol is a transport layer protocol.
    - o It is an unreliable transport protocol as in this case receiver does not send any acknowledgment when the packet is received, the sender does not wait for any acknowledgment. Therefore, this makes a protocol unreliable.

6 Marks :
**Que : Tell about Internetworking with Examples of Internetworking**

- Networks under same administration are generally scattered geographically. There may exist requirement of connecting two different networks of same kind as well as of different kinds. Routing between two networks is called internetworking.
- Networks can be considered different based on various parameters such as, Protocol, topology, Layer-2 network and addressing scheme.
- In internetworking, routers have knowledge of each other's address and addresses beyond them. They can be statically configured go on different network or they can learn by using internetworking routing protocol.
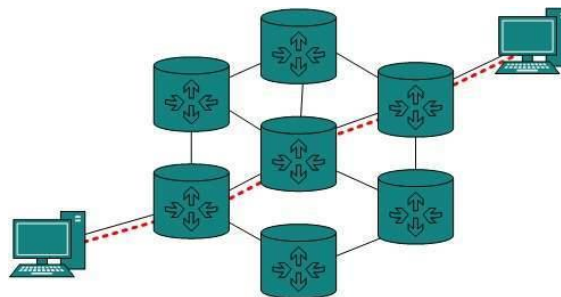
Routing protocols which are used within an organization or administration are called Interior Gateway Protocols or IGP. RIP, OSPF are examples of IGP. Routing between different organizations or administrations may have Exterior Gateway Protocol, and there is only one EGP i.e. Border Gateway Protocol.

Tunneling

Tunneling is a mechanism by which two or more same networks communicate with each other, by passing intermediate networking complexities. Tunneling is configured at both ends.

Tunneling: Virtual Direct Link
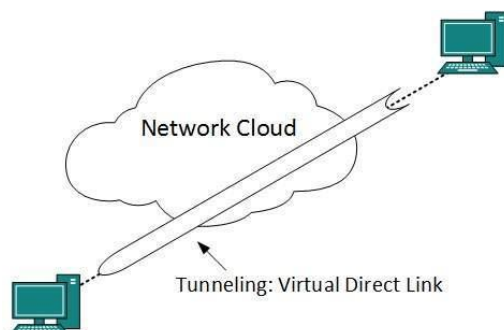
- When the data enters from one end of Tunnel, it is tagged. This tagged data is then routed inside the intermediate or transit network to reach the other end of Tunnel. When data exists the Tunnel its tag is removed and delivered to the other part of the network.
- Both ends seem as if they are directly connected and tagging makes data travel through transit network without any modifications.

Packet Fragmentation

- If a packet with DF (don't fragment) bit set to 1 comes to a router which can not handle the packet because of its length, the packet is dropped.
- When a packet is received by a router has its MF (more fragments) bit set to 1, the router then knows that it is a fragmented packet and parts of the original packet is on the way.
- If packet is fragmented too small, the overhead is increases. If the packet is fragmented too large, intermediate router may not be able to process it and it might get dropped.
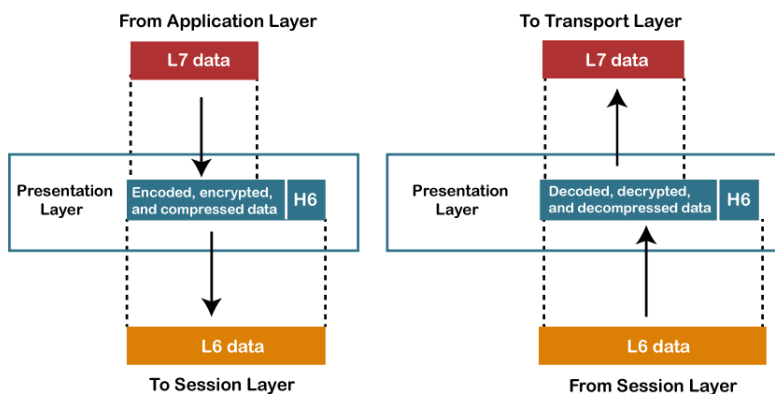
Que : List out any five difference between Internet and Intranet

S.NO	Internet	Intranet
1.	Internet is used to connect different networks of computers simultaneously.	Intranet is owned by private firms.
2.	On the internet, there are multiple users.	On an intranet, there are limited users.
3.	Internet is unsafe.	Intranet is safe.
4.	On the internet, there is more number of visitors.	In the intranet, there is less number of visitors.
5.	Internet is a public network.	Intranet is a private network.
6.	Anyone can access the Internet.	In this, anyone can't access the Intranet.
7.	The Internet provides unlimited information.	Intranet provides limited information.
8.	Using Social media on your phone or researching resources via Google.	A company used to communicate internally with its employees and share information
9.	The Internet is a global network that connects millions of devices and computers worldwide.	An intranet is a private network that connects devices and computers within an organization.
10.	It is open to everyone and allows access to public information, such as websites and online services.	An intranet is only accessible to authorized users within the organization.

11.	It is used for communication, sharing of information, e-commerce, education, entertainment, and other purposes.	An intranet is primarily used for internal communication, collaboration, and information sharing within an organization.
12.	Users can access the Internet from any location with an Internet connection and a compatible device.	Access to an intranet is restricted to authorized users within the organization and is typically limited to specific devices and locations.
13.	Security measures, such as firewalls, encryption, and secure sockets layer (SSL) protocols, are used to protect against threats like hacking, viruses, and malware.	Intranets employ similar security measures to protect against unauthorized access and ensure the privacy and integrity of shared data.
14.	The Internet is a public network that is not owned by any particular organization or group.	Intranets are private networks that are owned and managed by the organization that uses them.
15.	Examples of Internet-based services include email, social media, search engines, and online shopping sites.	Examples of intranet-based services include internal communications, knowledge management systems, and collaboration tools

Que : Illustrate about the presentation layer

Presentation Layer

- o A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.
- o It acts as a data translator for a network.
- o This layer is a part of the operating system that converts the data from one presentation format to another format.
- o The Presentation layer is also known as the syntax layer.

Functions of Presentation layer:

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o **Compression:** Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.

Que : Examine the Application Layer with its advantages amd disadvantages
Application Layer
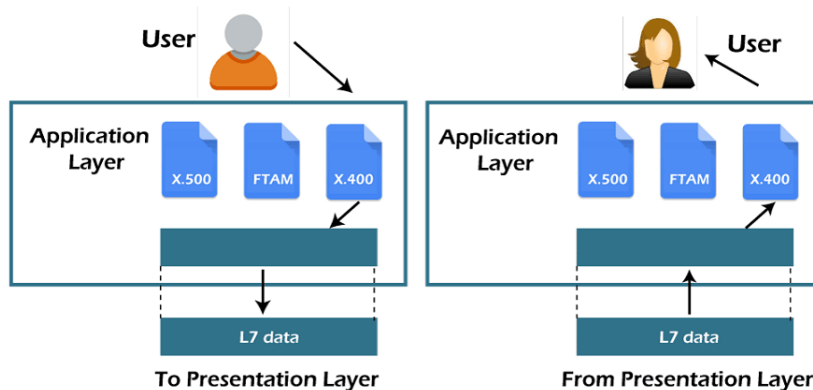
o An application layer serves as a window for users and application processes to access network service.

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o This layer provides the network services to the end-users.
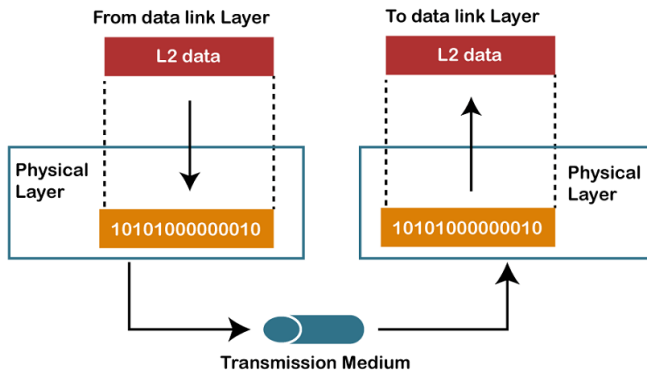
Advantages :

- To ensure smooth communication, application layer protocols are implemented the same on source host and destination host.
- The Application Layer protocol defines process for both parties which are involved in communication.
- These protocols define the type of message being sent or received from any side (either source host or destination host).
- These protocols also define basic syntax of the message being forwarded or retrieved.

- These protocols define the way to send a message and the expected response.
- These protocols also define interaction with the next level.

Que : Explain in detail about Physical layer with its advantages amd disadvantages

Physical layer

o The main functionality of the physical layer is to transmit the individual bits from one node to another node.

o It is the lowest layer of the OSI model.

o It establishes, maintains and deactivates the physical connection.

o It specifies the mechanical, electrical and procedural network interface specifications.

Functions of a Physical layer:

o Line Configuration: It defines the way how two or more devices can be connected physically.

o Data Transmission: It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network.

o Topology: It defines the way how network devices are arranged.

o Signals: It determines the type of the signal used for transmitting the information.

Advantages of the Physical Layer

The physical layer deals with the physical aspect of the network. The major functions performed by the physical layer are as follows:

1. The data is transmitted in the physical layer bit by bit or symbol by symbol over a physical transmission medium.

2. The physical layer also gives a standardized interface to the transmission medium. It specifies the mechanical specifications of the physical connections in the networks.

3. The layer is also responsible for determining the electromagnetic compatibility of the medium

4. The cables that are used to connect the nodes in the networks. Based on the above properties defined by the physical layer, these cables vary too. They can be either

electrical or optical. They are only sometimes physical as they can be wireless communication links such as radio signals or free space optical communication.
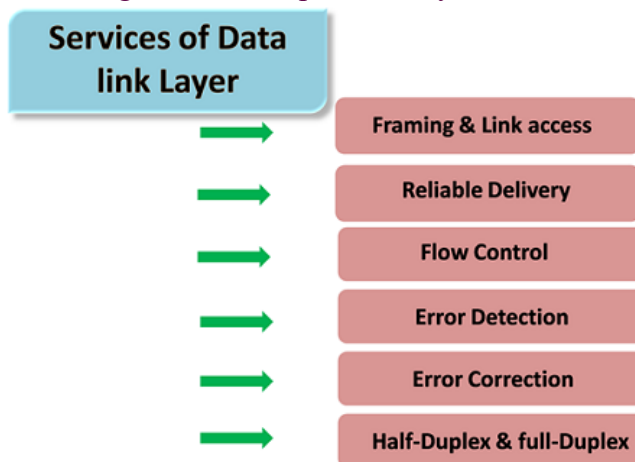
5. It also is responsible for performing the synchronization of bits. It has a clock that manages both the sender and receiver by synchronizing the data at the bit level.

6. It also helps in deciding the direction for transferring the data. The data can be transferred in one or both directions.

Que : Explain in detail about Data link layer with its advantages amd disadvantages

Data Link Layer

o In the OSI model, the data link layer is a 4th layer from the top and 2nd layer from the bottom.

o The main responsibility of the Data Link Layer is to transfer the datagram across an individual link.

o The Data link layer protocol defines the format of the packet exchanged across the nodes as well as the actions such as Error detection, retransmission, flow control, and random access.

o The Data Link Layer protocols are Ethernet, token ring, FDDI and PPP.

Following services are provided by the Data Link Layer:

Services of Data link Layer

→ Framing & Link access
→ Reliable Delivery
→ Flow Control
→ Error Detection
→ Error Correction
→ Half-Duplex & full-Duplex

Que : Discuss about the importance of Internetworking model

- Not only hardware, software also not supported for work the different computer brand. It became very difficult for all computer users to working without implementation of internetworking model in computer network. It is necessary then to make some common protocols for all vendors of computer. Before implementation of internetworking model in computer network, all vendors implements their own protocols on computer hardware and software.

- In networking OSI reference model became helpful. OSI reference model describes the flow of data between nodes in any network. Data from one computer application to another computer application transfer by following some common protocols. The OSI

reference layer also become beneficial for troubleshooting the network problems. TCP/IP and Three layered hierarchic model of Cisco became more helpful alongside the OSI reference model.

10 Marks :

Illustrate about OSI models with neat diagrams

OSI Model

- o OSI stands for Open System Interconnection is a reference model that describes how information from a software application in one computer moves through a physical medium to the software application in another computer.

- o OSI consists of seven layers, and each layer performs a particular network function.

- o OSI model was developed by the International Organization for Standardization (ISO) in 1984, and it is now considered as an architectural model for the inter-computer communications.

- o OSI model divides the whole task into seven smaller and manageable tasks. Each layer is assigned a particular task.

- o Each layer is self-contained, so that task assigned to each layer can be performed independently.
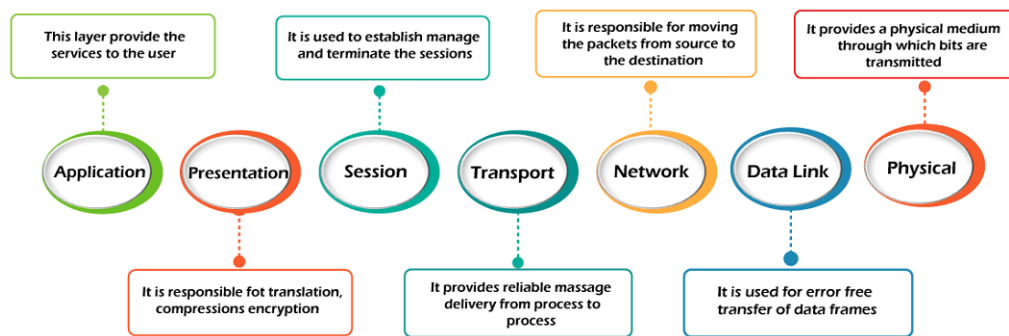
Characteristics of OSI Model:
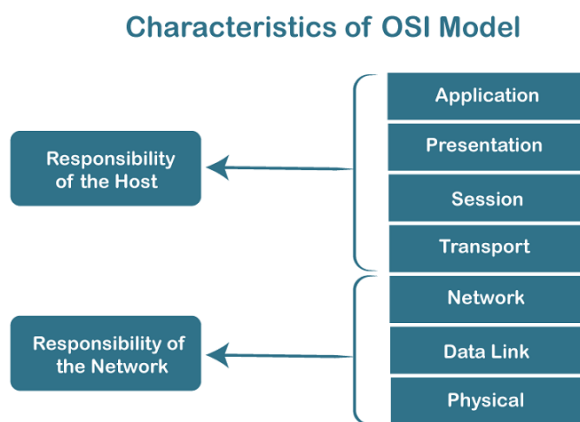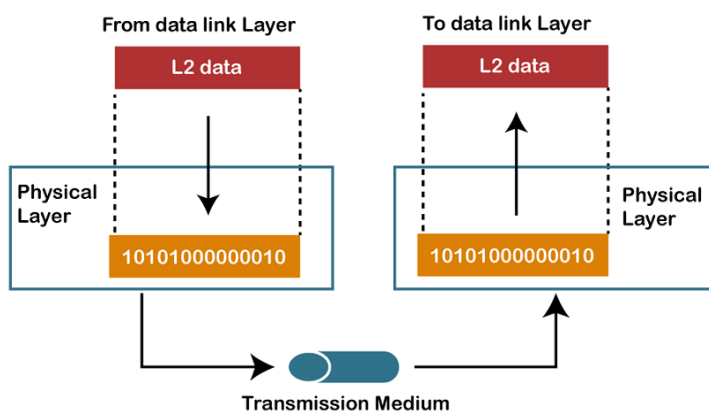

Characteristics of OSI Model

- o The OSI model is divided into two layers: upper layers and lower layers.

- o The upper layer of the OSI model mainly deals with the application related issues, and they are implemented only in the software. The application layer is closest to the end user. Both the end user and the application layer interact with the software applications. An upper layer refers to the layer just above another layer.

- o The lower layer of the OSI model deals with the data transport issues. The data link layer and the physical layer are implemented in hardware and software.

7 Layers of OSI Model : There are the seven OSI layers. Each layer has different functions. A list of seven layers are given below:

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

1) Physical layer

o The main functionality of the physical layer is to transmit the individual bits from one node to another node.
o It is the lowest layer of the OSI model.
o It establishes, maintains and deactivates the physical connection.
o It specifies the mechanical, electrical and procedural network interface specifications.

Functions of a Physical layer:

o Line Configuration: It defines the way how two or more devices can be connected physically.
o Data Transmission: It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network.
o Topology: It defines the way how network devices are arranged.

o   Signals: It determines the type of the signal used for transmitting the information.

2) Data-Link Layer
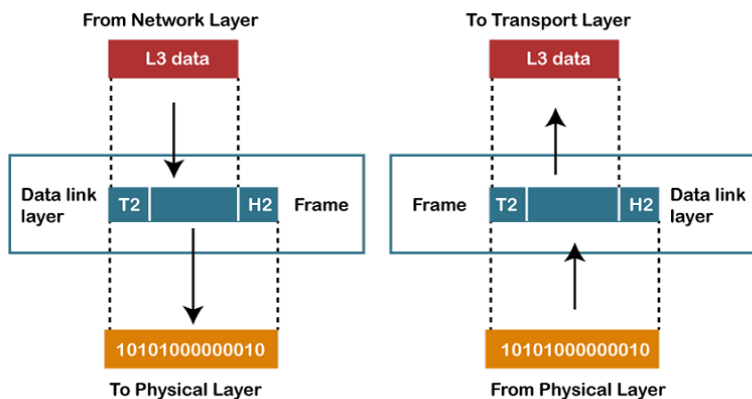
o   This layer is responsible for the error-free transfer of data frames.
o   It defines the format of the data on the network.
o   It provides a reliable and efficient communication between two or more devices.
o   It is mainly responsible for the unique identification of each device that resides on a local network.
o   It contains two sub-layers:
    o   Logical Link Control Layer
        o   It is responsible for transferring the packets to the Network layer of the receiver that is receiving.
        o   It identifies the address of the network layer protocol from the header.
        o   It also provides flow control.
    o   Media Access Control Layer
        o   A Media access control layer is a link between the Logical Link Control layer and the network's physical layer.
        o   It is used for transferring the packets over the network.

Functions of the Data-link layer

o   **Framing:** The data link layer translates the physical's raw bit stream into packets known as Frames. The Data link layer adds the header and trailer to the frame. The header which is added to the frame contains the hardware destination and source address.

o   **Physical Addressing**: The Data link layer adds a header to the frame that contains a destination address. The frame is transmitted to the destination address mentioned in the header.

- o **Flow Control:** Flow control is the main functionality of the Data-link layer. It is the technique through which the constant data rate is maintained on both the sides so that no data get corrupted. It ensures that the transmitting station such as a server with higher processing speed does not exceed the receiving station, with lower processing speed.
- o **Error Control:** Error control is achieved by adding a calculated value CRC (Cyclic Redundancy Check) that is placed to the Data link layer's trailer which is added to the message frame before it is sent to the physical layer. If any error seems to occurr, then the receiver sends the acknowledgment for the retransmission of the corrupted frames.
- o **Access Control:** When two or more devices are connected to the same communication channel, then the data link layer protocols are used to determine which device has control over the link at a given time.
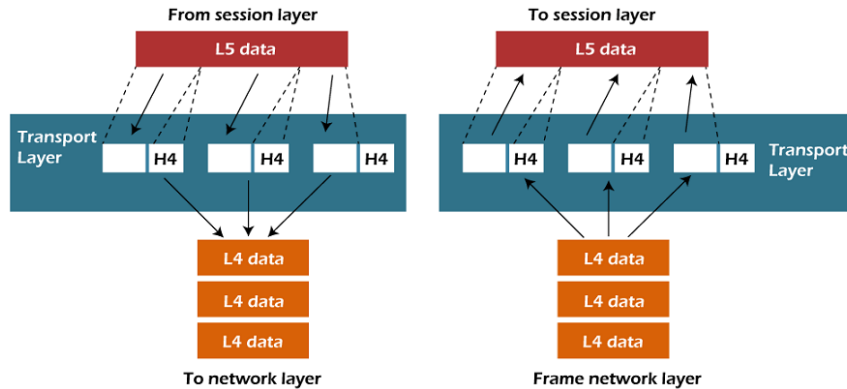
3) Network Layer
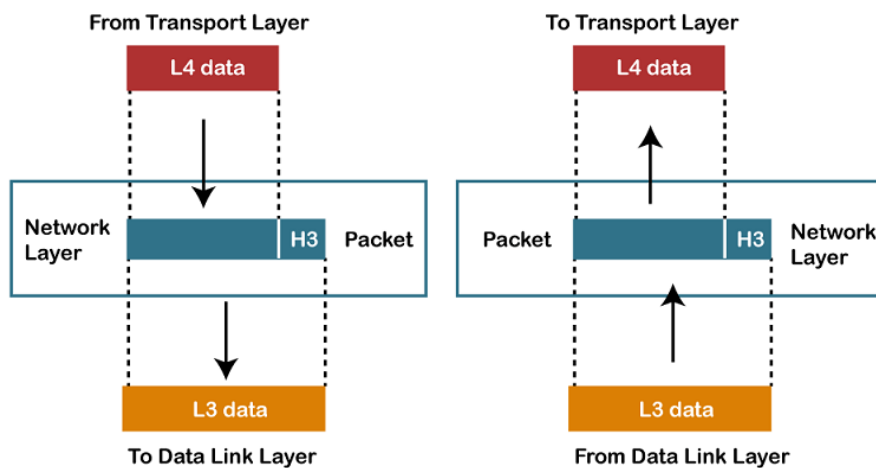
- o It is a layer 3 that manages device addressing, tracks the location of devices on the network.
- o It determines the best path to move data from source to the destination based on the network conditions, the priority of service, and other factors.
- o The Data link layer is responsible for routing and forwarding the packets.
- o Routers are the layer 3 devices, they are specified in this layer and used to provide the routing services within an internetwork.
- o The protocols used to route the network traffic are known as Network layer protocols. Examples of protocols are IP and Ipv6.

Functions of Network Layer:
- o Internetworking: An internetworking is the main responsibility of the network layer. It provides a logical connection between different devices.
- o Addressing: A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet.
- o Routing: Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination.

o Packetizing: A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP).

4) Transport Layer

o The Transport layer is a Layer 4 ensures that messages are transmitted in the order in which they are sent and there is no duplication of data.
o The main responsibility of the transport layer is to transfer the data completely.
o It receives the data from the upper layer and converts them into smaller units known as segments.
o This layer can be termed as an end-to-end layer as it provides a point-to-point connection between source and destination to deliver the data reliably.

The two protocols used in this layer are:
o Transmission Control Protocol
  o It is a standard protocol that allows the systems to communicate over the internet.
  o It establishes and maintains a connection between hosts.
  o When data is sent over the TCP connection, then the TCP protocol divides the data into smaller units known as segments. Each segment travels over the internet using multiple routes, and they arrive in different orders at the destination. The transmission control protocol reorders the packets in the correct order at the receiving end.
o User Datagram Protocol
  o User Datagram Protocol is a transport layer protocol.
  o It is an unreliable transport protocol as in this case receiver does not send any acknowledgment when the packet is received, the sender does not wait for any acknowledgment. Therefore, this makes a protocol unreliable.
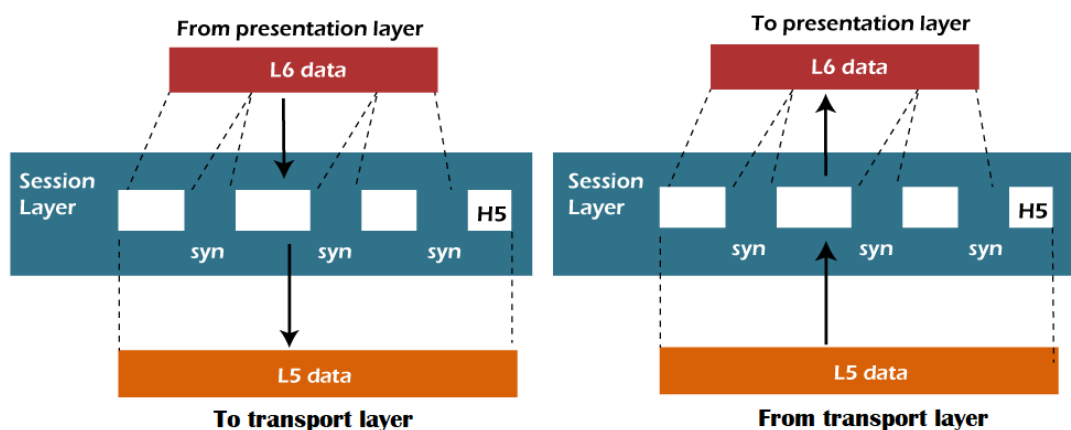
Functions of Transport Layer:
o **Service-point addressing**: Computers run several programs simultaneously due to this reason, the transmission of data from source to the destination not only from one

computer to another computer but also from one process to another process. The transport layer adds the header that contains the address known as a service-point address or port address

- o **Segmentation and reassembly:** When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and each segment is assigned with a sequence number that uniquely identifies each segment.
- o **Connection control:** Transport layer provides two services Connection-oriented service and connectionless service. A connectionless service treats each segment as an individual packet, and they all travel in different routes to reach the destination.
- o **Flow control:** The transport layer also responsible for flow control but it is performed end-to-end rather than across a single link.
- o **Error control:** The transport layer is also responsible for Error control. Error control is performed end-to-end rather than across the single link. The sender transport layer ensures that message reach at the destination without any error.
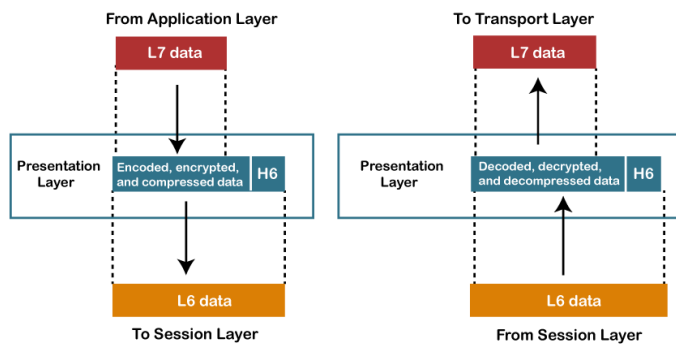
5) Session Layer

- o It is a layer 3 in the OSI model.
- o The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.

Functions of Session layer:

- o **Dialog control**: Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.
- o **Synchronization:** Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.
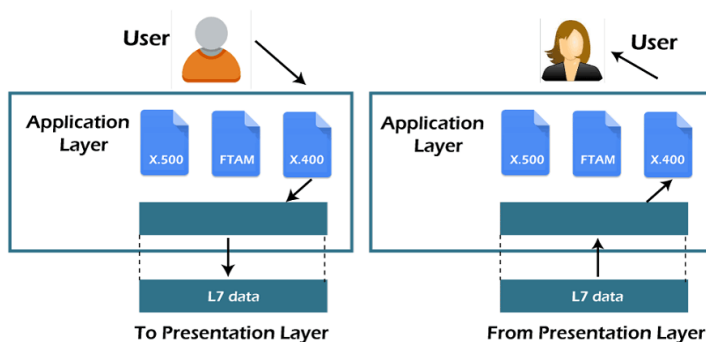
6) Presentation Layer

- o A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.
- o It acts as a data translator for a network.
- o This layer is a part of the operating system that converts the data from one presentation format to another format.
- o The Presentation layer is also known as the syntax layer.

Functions of Presentation layer:

- o **Translation:** The processes in two systems exchange the information in the form of character strings, numbers and so on. Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.
- o **Encryption:** Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.
- o **Compression:** Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.

7) Application Layer

- o An application layer serves as a window for users and application processes to access network service.

- o It handles issues such as network transparency, resource allocation, etc.
- o An application layer is not an application, but it performs the application layer functions.
- o This layer provides the network services to the end-users.

Functions of Application layer:

- o File transfer, access, and management (FTAM): An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.
- o Mail services: An application layer provides the facility for email forwarding and storage.
- o Directory services: An application provides the distributed database sources and is used to provide that global information about various objects.

Difference between OSI model and TCP / IP model

What is OSI model?

- The OSI stands for Open System Interconnection, which was developed in 1980s. It is a conceptual model used for network communication.
- This OSI model consists of seven layers, and each layer is connected to each other. The data moves down the OSI model, and each layer adds additional information. The data moves down until it reaches the last layer of the OSI model.
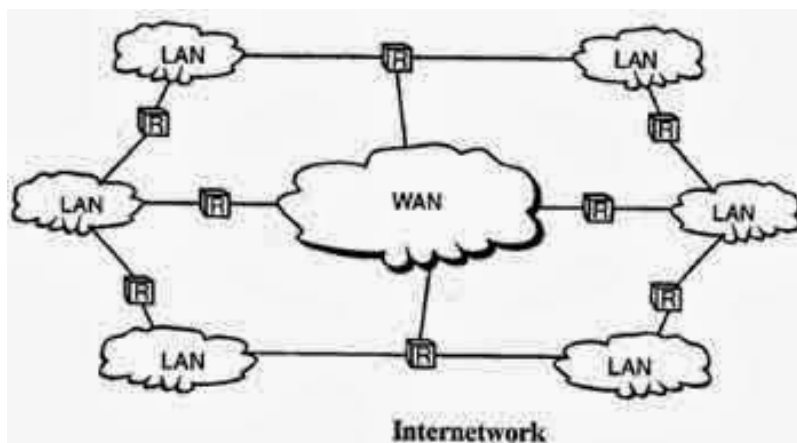
What is TCP/IP model?

- The TCP model stands for Transmission Control Protocol, whereas IP stands for Internet Protocol. A number of protocols that make the internet possibly comes under the TCP/IP model. This model consists of 4 layers. Now, we will look at the diagrammatic representation of the TCP/IP model.

OSI Model	TCP/IP Model
It stands for Open System Interconnection.	It stands for Transmission Control Protocol.
OSI model has been developed by ISO (International Standard Organization).	It was developed by ARPANET (Advanced Research Project Agency Network).
It is an independent standard and generic protocol used as a communication gateway between the network and the end user.	It consists of standard protocols that lead to the development of an internet. It is a communication protocol that provides the connection among the hosts.
In the OSI model, the transport layer provides a guarantee for the delivery of the packets.	The transport layer does not provide the surety for the delivery of packets. But still, we can say that it is a reliable model.

This model is based on a vertical approach.	This model is based on a horizontal approach.
In this model, the session and presentation layers are separated, i.e., both the layers are different.	In this model, the session and presentation layer are not different layers. Both layers are included in the application layer.
It is also known as a reference model through which various networks are built. For example, the TCP/IP model is built from the OSI model. It is also referred to as a guidance tool.	It is an implemented model of an OSI model.
In this model, the network layer provides both connection-oriented and connectionless service.	The network layer provides only connectionless service.
Protocols in the OSI model are hidden and can be easily replaced when the technology changes.	In this model, the protocol cannot be easily replaced.
It consists of 7 layers.	It consists of 4 layers.
OSI model defines the services, protocols, and interfaces as well as provides a proper distinction between them. It is protocol independent.	In the TCP/IP model, services, protocols, and interfaces are not properly separated. It is protocol dependent.
The usage of this model is very low.	This model is highly used.
It provides standardization to the devices like router, motherboard, switches, and other hardware devices.	It does not provide the standardization to the devices. It provides a connection between various computers.

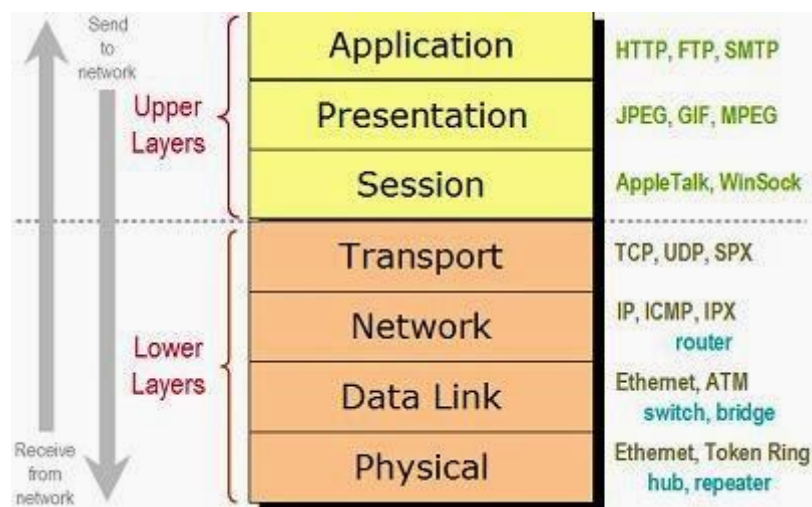**Explain in detail about Internetworking and its models**

- A collection of individual networks which are connected by intermediate networking devices and functioning as a single large network is called as an Internetwork. and When two or more networks are connected with each other by using devices like router is called Internetworking.

Internetwork

- There are two primary models which are most commonly used to describe the methods used in internetworking. They also give the working of protocols used for communication.
- The first one is the Open Source Interconnection (OSI) model which was developed by International Organization for Standardization (ISO). It provides a detailed description of protocols function using layering from hardware to software interface in user application. Internetworking comes at the Network Layer (Layer 3) of this model.

OSI model layers are shown below :

OSI MODEL

PHYSICAL LAYER

- The physical layer, the lowest layer of the OSI model, is concerned with the transmission and reception of the unstructured raw bit stream over a physical medium. Common devices used on this layer are Transceivers, Modems, Hubs, CSU/DSU and all forms of cables and connectors.

DATA LINK LAYER

- The data link layer provides error-free transfer of data frames from one node to another over the physical layer. There are different data link layer specifications which take care of different network and protocol characteristics, including physical addressing, network topology, error notification, sequencing of frames and flow control.

NETWORK LAYER

- The network layer controls the operation of the subnet, deciding which physical path the data should take based on network conditions, priority of service, and other factors. It provides the functions and procedures required to transfer variable length data sequence from a source host on one network to a destination host on another network.

TRANSPORT LAYER

- The transport layer ensures that messages are delivered error-free, in sequence, and with no losses or duplications. It provides transparent transfer of data between end users and also to provide reliable data transfer services to upper layer.
- Typically, the transport layer can accept relatively large messages, but there are strict message size limits imposed by the network (or lower) layer. Consequently, the transport layer must break up the messages into smaller units, or frames, prepending a header to each frame.

SESSION LAYER

·   Session establishment, maintenance and termination: allows two application processes on different machines to establish, use and terminate a connection, called a session.

·   Session support: performs the functions that allow these processes to communicate over the network, performing security, name recognition, logging, and so on.

PRESENTATION LAYER

The presentation layer formats the data to be presented to the application layer. It can be viewed as the translator for the network.

·   Character code translation: for example, ASCII to EBCDIC.

·   Data conversion: bit order, integer-floating point, and so on.

·   Data compression: reduces the number of bits that need to be transmitted on the network.

· **Data encryption:** encrypt data for security purposes. For example, password encryption.

APPLICATION LAYER

The application layer is the OSI layer closest to the end user, which means that both the OSI application layer and the user interact directly with the software application. Commonly used protocols for this layer are DNS, DHCP, FTP, HTTP, HTTPS, IMAP, LDAP, MIME, TFTP and SMTP. This layer contains a variety of commonly needed functions:

Resource sharing and device redirection

·   Remote file access

·   Remote printer access

·   Inter-process communication

·   Network management

·   Directory services

TCP/IP MODEL

The other one is TCP/IP Model also Known as DOD Model. It is similar to OSI model, as it also appears as a layered model, but uses much less description. It was the first model to try

and put network communications in a layered format. The internet layer protocols of the model facilitate the internetworking.

TCP/IP model layers are shown below :
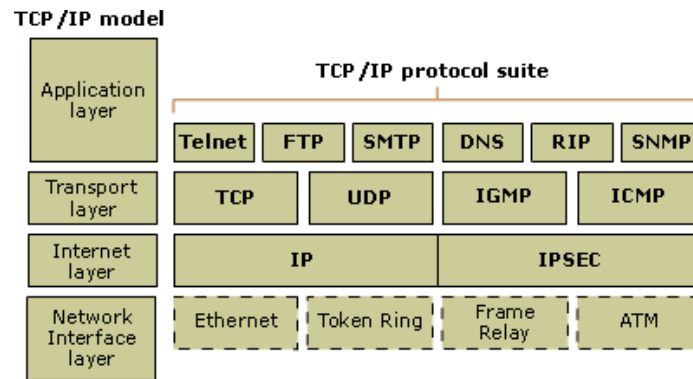
The DoD Model was the first model to try and put network communications in a layered format. It could not explain the exact communication process between networked computers. It consists of 4 layer as opposed to the OSI models 7 layers. A comparison of OSI model and TCP /IP or the DoD model is shown below:
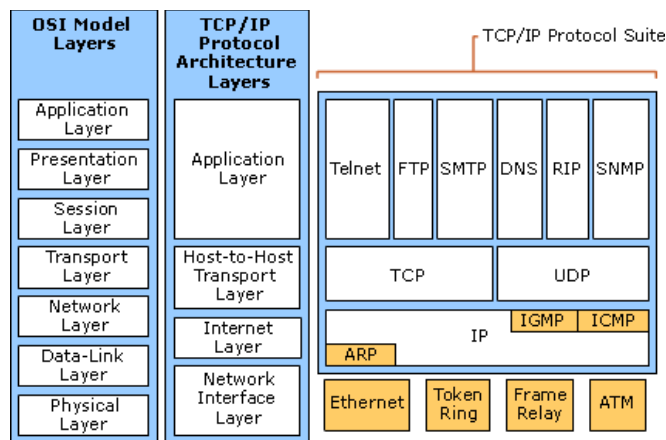
- **Process / Application layer:** There are huge number of protocols at the Process / Application layer to integrate the various activities and duties spanning focus of the OSI's corresponding top three layers. This layer defines protocols which are used for node-to-node application communications and to control user-interface specifications.

The most widely-known Application layer protocols are those used for the exchange of user information:

1. The Hypertext Transfer Protocol (HTTP) is used to transfer files that make up the Web pages of the World Wide Web.
2. The File Transfer Protocol (FTP) is used for interactive file transfer.
3. The Simple Mail Transfer Protocol (SMTP) is used for the transfer of mail messages and attachments.

4. Telnet, a terminal emulation protocol, is used for logging on remotely to network hosts. Additionally, the following Application layer protocols help facilitate the use and management of TCP/IP networks:

1. The Domain Name System (DNS) is used to resolve a host name to an IP address.
2. The Routing Information Protocol (RIP) is a routing protocol that routers use to exchange routing information on an IP internetwork.
3. The Simple Network Management Protocol (SNMP) is used between a network management console and network devices (routers, bridges, intelligent hubs) to collect and exchange network management information.

Host-to-Host layer: It corresponds to the functions of the OSI's Transport layer, defining protocols for setting up the level of transmission service for application. It relates to and handles issues such as creating reliable end-to-end communication and ensuring the error-free delivery of data. It handles packet sequencing and maintains data integrity. The core protocols of the Transport layer are Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).

1. TCP provides a one-to-one, connection-oriented, reliable communications service. TCP is responsible for the establishment of a TCP connection, the sequencing and acknowledgment of packets sent, and the recovery of packets lost during transmission.
2. UDP provides a one-to-one or one-to-many, connectionless, unreliable communications service. UDP is used when the amount of data to be transferred is small (such as the data that would fit into a single packet), when the overhead of establishing a TCP connection is not desired or when the applications or upper layer protocols provide reliable delivery.

Internet layer: It relates to the OSI's Network layer. In this layer protocols are designed to handle logical transmission of packets over the entire network. It also take care of the network identity of hosts by giving them an IP address and it handles the routing of packets among multiple networks. The core protocols of the Internet layer are IP, ARP, ICMP, and IGMP.

1. The Internet Protocol (IP) is a routable protocol responsible for IP addressing, routing, and the fragmentation and reassembly of packets.
2. The Address Resolution Protocol (ARP) is responsible for the resolution of the Internet layer address to the Network Interface layer address such as a hardware address.
3. The Internet Control Message Protocol (ICMP) is responsible for providing diagnostic functions and reporting errors due to the unsuccessful delivery of IP packets.
4. The Internet Group Management Protocol (IGMP) is responsible for the management of IP multicast groups.
- Network Layer: This layer implements the data exchange between the host and the network. The equivalent of the Data Link layer and Physical layers of the OSI model, the network access layer oversees hardware addressing and defines the protocols for physical transmission of data and defines rules for communication over different media used in networking.