Computer Networks

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1.OSI model & function of each Layer.

- There are many users who use computer network and are located all over the world.
- For national and worldwide data communication, systems must be developed which are compatible to communicate with each other.
- ISO has developed this.

- ISO stands for **International organization of Standardization**.

- This is called a model for **Open System Interconnection** (OSI) and is commonly known as OSI model.

- The ISO-OSI model is a seven layer (7 Layer)architecture developed in 1984

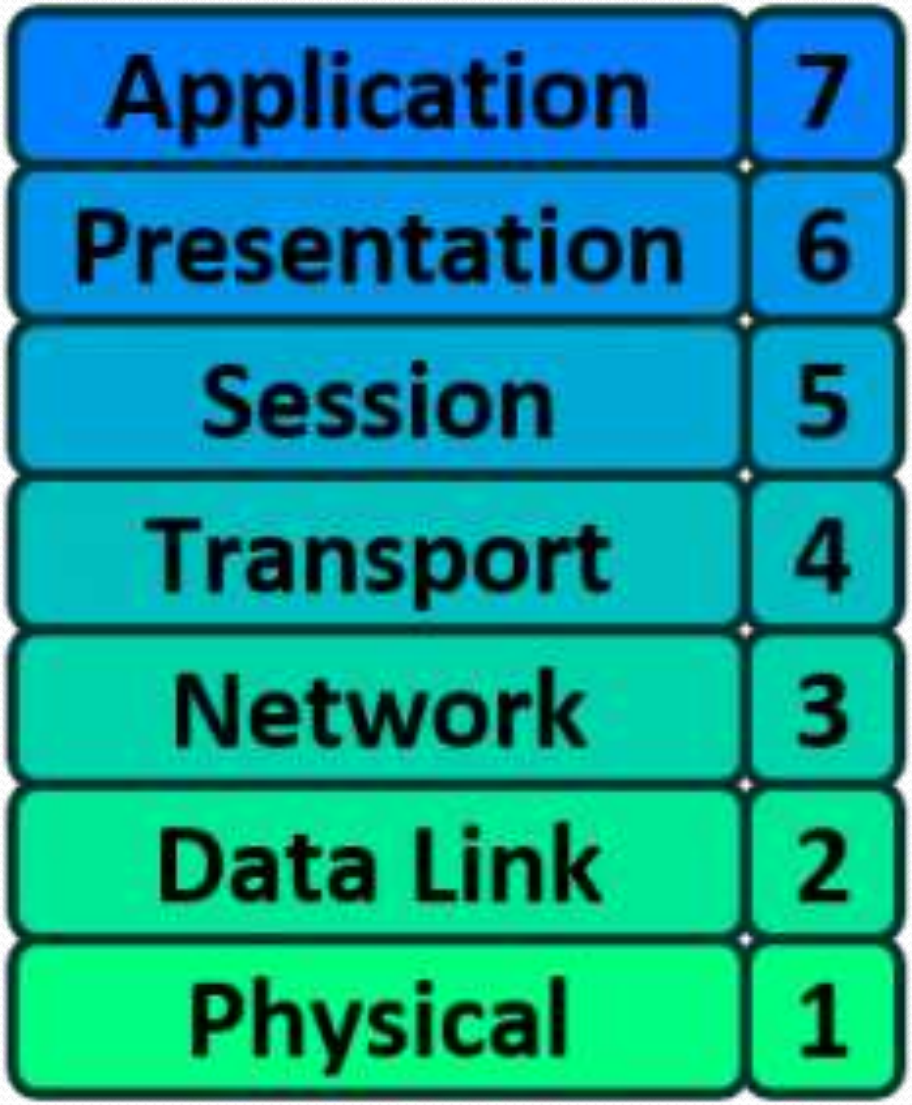
- To reduce the design complexity, most of the networks are organized as a series of **layers or levels, each one build upon one below it.**

- The basic idea of a layered architecture is *to divide the design into small pieces.*

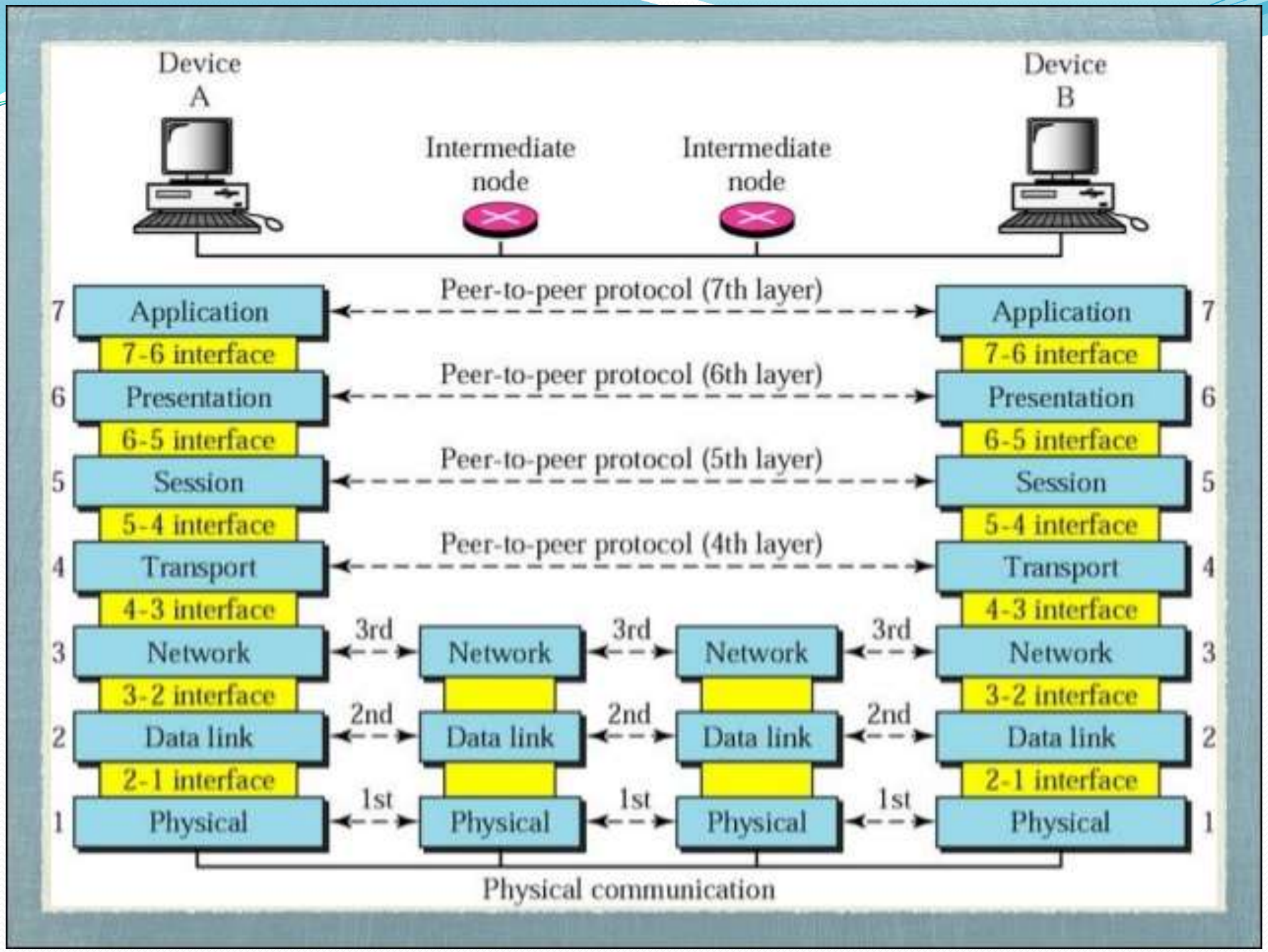
- Each layer adds to the services provided by the lower layers in such a way that the highest layer is provided has a full set of services.

- The basic elements of a layered model are
  - services
  - protocols
  - and interfaces.

- A **service** is a set of actions that a layer offers to another (higher) layer.
- A **Protocol** is a set of rules that a layer uses to exchange information.
- A **Interface** is communication between the layers.


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

- Layer 1,2 and 3 that is physical ,data and network layers are **Network Support Layers.**
- Layers 5,6 and 7 that is session,presentation and application layers are **User Support Layer.**
- Transport Layer links the network support layers and user support layers.


Device A
Device B
Intermediate node
Intermediate node
Peer-to-peer protocol (7th layer)
Peer-to-peer protocol (6th layer)
Peer-to-peer protocol (5th layer)
Peer-to-peer protocol (4th layer)
7 Application
7-6 interface
6 Presentation
6-5 interface
5 Session
5-4 interface
4 Transport
4-3 interface
3 Network
3-2 interface
2 Data link
2-1 interface
1 Physical
3rd
2nd
1st
Physical communication

Physical Layer:Layer 1

- Physical layer is the lowest layer of all. It is responsible for sending bits from one computer to another. This layer is not concerned with the meaning of the bits and deals with the physical connection to the network and with transmission.

- This layer defines electrical and physical details represented as 0 or a 1

Functions of Physical Layer:

- **Representation of Bits:** Data in this layer consists of stream of bits.

- **Data Rate:** This layer defines the rate of transmission which is the number of bits per second.

- **Synchronization:** It deals with the synchronization of the transmitter and receiver.

- **Interface:** The physical layer defines the transmission interface between **devices** and **transmission medium**.

- **Line Configuration:** This layer connects devices with the medium: **Point to Point** configuration and **Multipoint** configuration.

- **Topologies:** Devices must be connected using the following topologies: **Mesh, Star, Ring and Bus.**

- **Transmission Modes:** Physical Layer defines the direction of transmission between two devices: **Simplex, Half Duplex, Full Duplex.**

- Deals with **baseband and broadband transmission.**

Data Layer:Layer 2:

- Data link layer is most reliable node to node delivery of data. It forms frames from the packets that are received **from network layer** and gives it **to physical layer.**

- Error controlling is easily done. Error detection bits are used by the data link layer. It also corrects the errors.

FUNCTIONS OF DATA LINK LAYER:

- **Framing:** Frames are the streams of bits received from the network layer into manageable data units.
- **Physical Addressing:** The Data Link layer adds a header to the frame in order to define physical address of the sender or receiver of the frame, if the frames are to be distributed to different systems on the network.

- **Flow Control:** A flow control mechanism to avoid a fast transmitter from running a slow receiver by buffering the extra bit is provided by flow control. This prevents traffic jam at the receiver side.
- **Error Control:** Error control is achieved by adding a trailer at the end of the frame. Duplication of frames are also prevented by using this mechanism

- **Access Control:** Protocols of this layer determine which of the devices has control over the link at any given time.

Two Parts of Data Link Layer

- Data link layer is divided into two subparts
  - 1.Logical Link Control Layer (LLC)
  - 2.Media Access Control Layer (MAC)

Data Link Layer:LLC and MAC

- **LLC**:Logical Link Control layer is the upper layer of the two in data link layer.
- Essential for the communications between devices.
- Supports connection oriented and connectionless services both.
- **MAC**:Media Access Control is the lower layer.
- It is responsible for providing a method for station to gain access to the medium.

Layer 3: The Network Layer :

- It routes the signal through different channels from one node to other.
- It acts as a network controller. It manages the Subnet traffic.It decides by which route data should take.
- It divides the outgoing messages into **packets.**

Functions of Network Layer:Layer 3

- It translates logical network address into physical address.
- Routers and gateways operate in the network layer. Mechanism is provided by Network Layer for routing the packets to final destination.
- Connection services are provided.
- Breaks larger packets into small packets.

Layer 4:Transport Layer

- It decides if data transmission should be on parallel path or single path.
- It receives messages from the Session layer above it, convert the message into smaller units and passes it on to the Network layer.
- Transport layer breaks the message (data) into small **units** so that they are handled more efficiently by the network layer.

Function of Transport Layer:Layer 4

- **Service Point Addressing :** Transport Layer header includes service point address which is port address.
- **Segmentation and Reassembling :** A message is divided into segments; each segment contains sequence number, which enables this layer in reassembling the message.

- **Flow Control :** In this layer, flow control is performed end to end.
- **Error Control :** Error Control is performed end to end in this layer to ensure that the complete message arrives at the receiving transport layer without any error. Error Correction is done through retransmission.

Layer 5: The Session Layer :

- Session layer manages and synchronize the conversation between two different applications.
- Transfer of data from source to destination session layer streams of data are marked and are resynchronized properly, so that the ends of the messages are not cut and data loss is avoided.

Functions of Session Layer:Layer 5

- **Dialog Control :** This layer allows two systems to start communication with each other in half-duplex or full-duplex.
- **Synchronization :** This layer allows a process to add checkpoints which are considered as synchronization points into stream of data.

- Example: If a system is sending a file of 800 pages, adding checkpoints after every 50 pages is recommended. This ensures that 50 page unit is successfully received and acknowledged. This is beneficial at the time of crash as if a crash happens at page number 110; there is no need to retransmit 1 to 100 pages.

Layer 6: The Presentation Layer :

- The primary goal of this layer is to take care of the syntax and semantics of the information exchanged between two communicating systems.
- Presentation layer takes care that the data is sent in such a way that the receiver will understand the information (data) and will be able to use the data.

Functions of Presentation Layer:Layer 6

- **Translation :** Before being transmitted, information in the form of characters and numbers should be changed to bit streams.
- **Encryption :** It carries out encryption at the transmitter and decryption at the receiver.
- **Compression :** It carries out data compression to reduce the bandwidth of the data to be transmitted. It is important in transmitting multimedia such as audio, video, text etc.

Layer 7: Application Layer :

- It is the topmost layer.
- Transferring of files disturbing the results to the user is also done in this layer. Mail services, directory services, network resource etc are services provided by application layer.
- This layer mainly holds application programs to act upon the received and to be sent data.

Functions of Application Layer:Layer 7

- **Mail Services :** This layer provides the basis for E-mail forwarding and storage.
- **Directory Services :** This layer provides access for global information about various services.
- **File Transfer, Access and Management (FTAM) :** It is a standard mechanism to access files and manages it.

Protocols at Application Layer

- HTTP:Hyper Text Transfer Protocol
- FTP:File Transfer Protocol
- SMTP:Simple Mail Transfer Protocol
- NFS:Network File Services
- NVT:Network Virtual Terminal

Merits of OSI

- OSI model distinguishes well between the services, interfaces and protocols.
- Protocols of OSI model are very well hidden.
- Protocols can be replaced by new protocols as technology changes.
- Supports connection oriented services as well as connectionless service.

Demerits of OSI

- Model was devised before the invention of protocols.
- Fitting of protocols is tedious task.
- It is just used as a reference model.

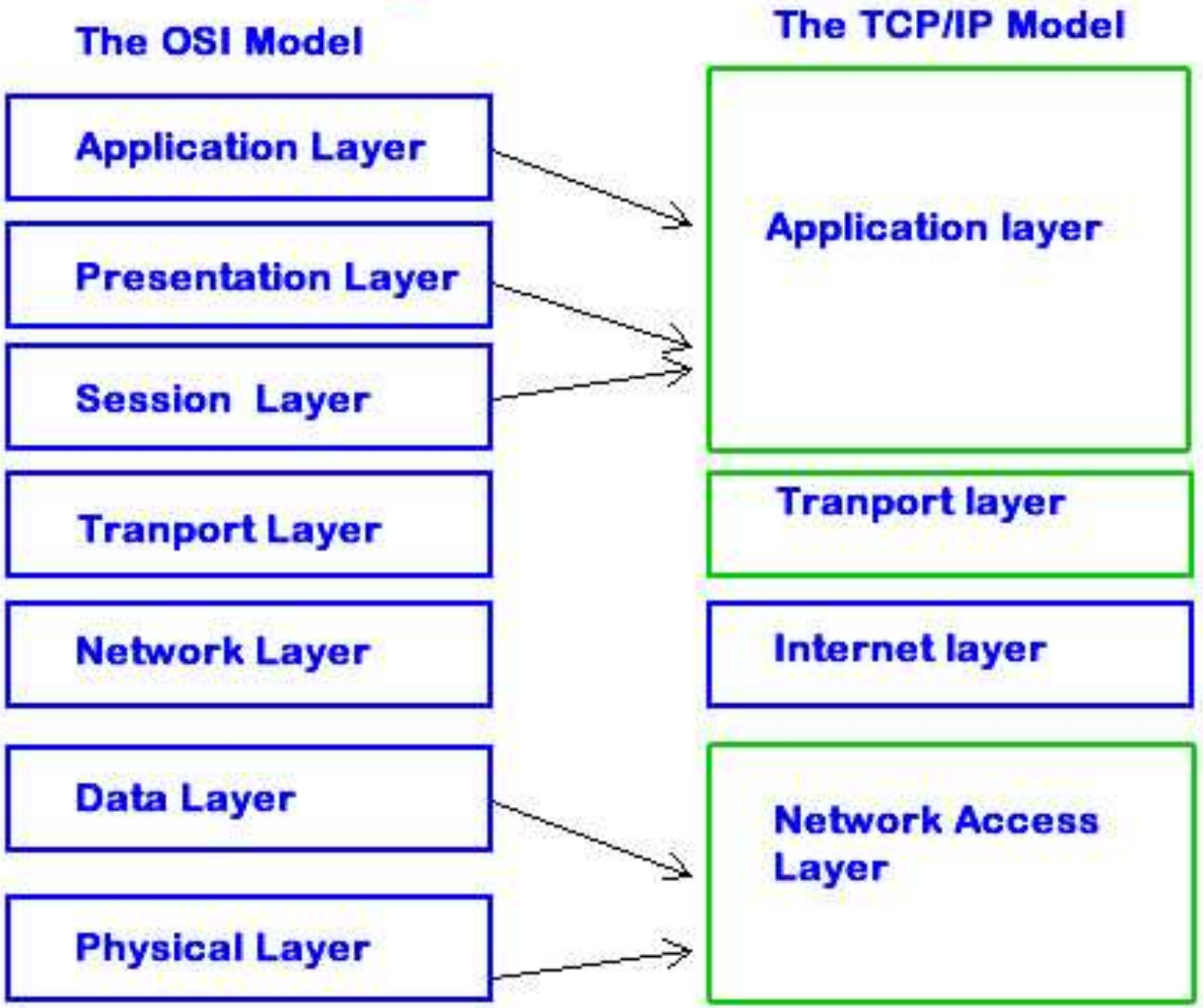
2.TCP/IP MODEL

- TCP/IP means Transmission Control Protocol and Internet Protocol. It is the network model used in the current Internet architecture as well. Protocols are set of rules which govern every possible communication over a network. These protocols describe the movement of data between the source and destination or the internet. These protocols offer simple naming and addressing schemes.

- TCP/IP that is Transmission Control Protocol and Internet Protocol was developed by Department of Defence's Project Research Agency (ARPA, later DARPA) as a part of a research project of network interconnection to connect remote machines.

- **Flexible architecture**: Adding more machines to a network was easy.
- **Robust**:Connections remained intact untill the source and destination machines were functioning.
- **Communication**:The overall idea was to allow one application on one computer send data packets another application running on different computer.

Contrasting the OSI and the TCP/IP Models



Layer 1: Host-to-network Layer

- Lowest layer of the all.
- Protocol is used to connect to the host, so that the packets can be sent over it.
- Varies from host to host and network to network.

Layer 2: Internet layer

- Selection of a packet switching network which is based on a connectionless internetwork layer is called a internet layer.
- It is the layer which holds the whole architecture together.
- It helps the packet to travel independently to the destination.
- Order in which packets are received is different from the way they are sent.
- IP (Internet Protocol) is used in this layer.

Layer 3: Transport Layer

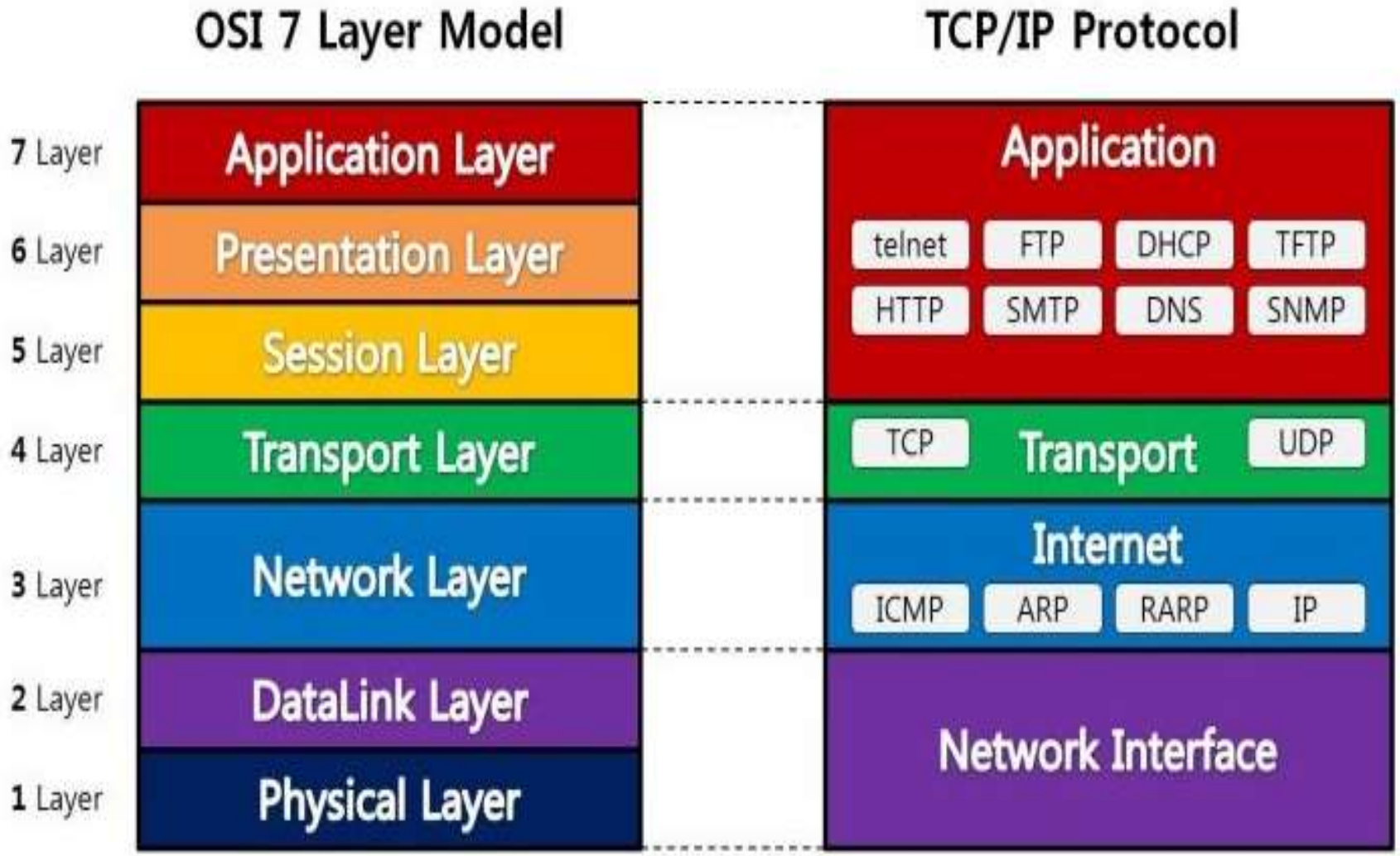
- It decides if data transmission should be on parallel path or single path.
- Functions such as multiplexing, segmenting or splitting on the data is done by transport layer.
- The applications can read and write to the transport layer.

- Transport layer adds header information to the data.
- Transport layer breaks the message (data) into small units so that they are handled more efficiently by the network layer.
- Transport layer also arrange the packets to be sent, in sequence.

Layer 4: Application Layer

- The TCP/IP specifications described a lot of applications that were at the top of the protocol stack. Some of them were TELNET, FTP, SMTP, DNS etc.
- TELNET is a two-way communication protocol which allows connecting to a remote machine and run applications on it.

- FTP(File Transfer Protocol) is a protocol, that allows File transfer amongst computer users connected over a network. It is reliable, simple and efficient.
- SMTP(Simple Mail Transport Protocol) is a protocol, which is used to transport electronic mail between a source and destination, directed via a route.
- DNS(Domain Name Server) resolves an IP address into a textual address for Hosts connected over a network.


OSI 7 Layer Model
TCP/IP Protocol
7 Layer
6 Layer
5 Layer
4 Layer
3 Layer
2 Layer
1 Layer
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
DataLink Layer
Physical Layer
Application
telnet
FTP
DHCP
TFTP
HTTP
SMTP
DNS
SNMP
TCP
Transport
UDP
Internet
ICMP
ARP
RARP
IP
Network Interface

PROTOCOLS used in TCP/IP

Sr no	Protocol	Full Form	Function
1	IP	Internetwork Protocol	Used by TCP/IP
2	ICMP	Internet Control Message Protocol	Control and error messages
3	IGMP	Internet Group Message Protocol	Unicasting and multicasting
4	ARP	Address Resolution Protocol	To know physical address
5	RARP	Reverse Address Resolution Protocol	To know internet address
6	TCP	Transmission Control Protocol	Connection oriented and reliable
7	UDP	User Datagram Protocol	Connectionless and unreliable

8	SMTP	Simple Mail Transfer Protocol	Deals with e-mails
9	FTP	File Transfer Protocol	Deals with files
10	TFTP	Trivial File Transfer Protocol	Read and write operations only
11	SNMP	Simple Network Management Protocol	Managing the network
12	TELNET	Terminal Network	Remote Login

3.Connection Oriented and Connectionless Services

- These are the two services given by the layers to layers above them. These services are :

1. Connection Oriented Service
2. Connectionless Services

Connection Oriented Services

- There is a sequence of operation to be followed by the users of connection oriented service. These are:
  - Connection is established
  - Information is sent
  - Connection is released

- In connection oriented service we have to establish a connection before starting the communication. When connection is established we send the message or the information and then we release the connection.
- Connection oriented service is more reliable than connectionless service. We can send the message in connection oriented service if there is an error at the receivers end. Example of connection oriented is TCP (Transmission Control Protocol) protocol.

Connectionless Services

- It is similar to the postal services, as it carries the full address where the message (letter) is to be carried. Each message is routed independently from source to destination. The order of message sent can be different from the order received.

- In connectionless the data is transferred in one direction from source to destination without checking that destination is still there or not or if it prepared to accept the message. Authentication is not needed in this. Example of Connectionless service is UDP (User Datagram Protocol) protocol.

Difference between Connection Oriented and Connectionless Services

Sr no.	Connection Oriented Services	Connectionless Services
1.	It needs authentication.	It doesnot need authentication.
2.	It gurantees a delivery	It doesnot gurantee a delivery
3.	It is more reliable	It not that reliable
4.	Connection Oriented is stream based	Connectionless is message based.

4.Comparison of OSI Reference Model and TCP/IP Reference Model

Sr no	OSI	TCP/IP
1.	OSI model Developed after TCP/IP	TCP/IP model Developed before OSI
2.	OSI model has 7 layers	TCP/IP has 4 layers
3.	OSI model developed before protocols of OSI were developed	TCP/IP model developed after protocols of TCP/IP were developed

4.	**OSI differentiates services,protocols and interfaces.**	**TCP/IP doesn't differentiate them.**
5.	Connection oriented and connectionless in network layer and connection oriented in transport layer in OSI model	Connection oriented and connectionless in transport layer and connection oriented in network layer in tcp/ip model