Unit : 2

The Reference Model for Network Communication

Prepared By:

J B VALA

Computer Engineering Department, AVPTI, RAJKOT

Course Outcome

After completion of this unit, students will be able to…

Differentiate OSI and TCP/IP Models

Learning outcome

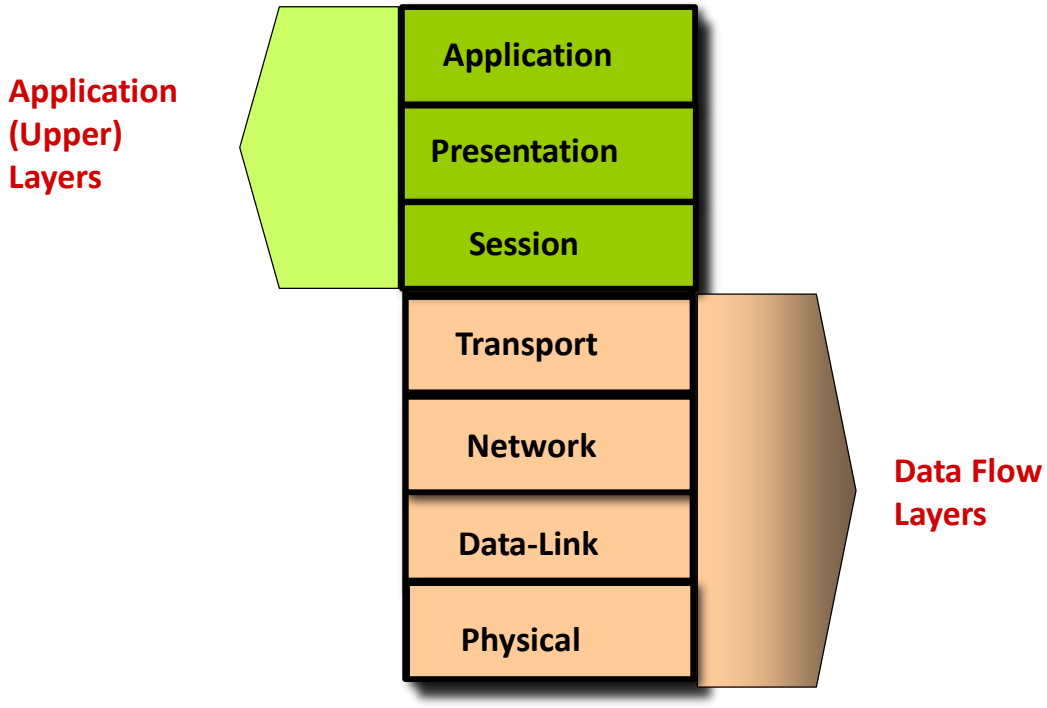
- After completion of this session, students will be able *to list all layers of OSI and TCP/IP model.*

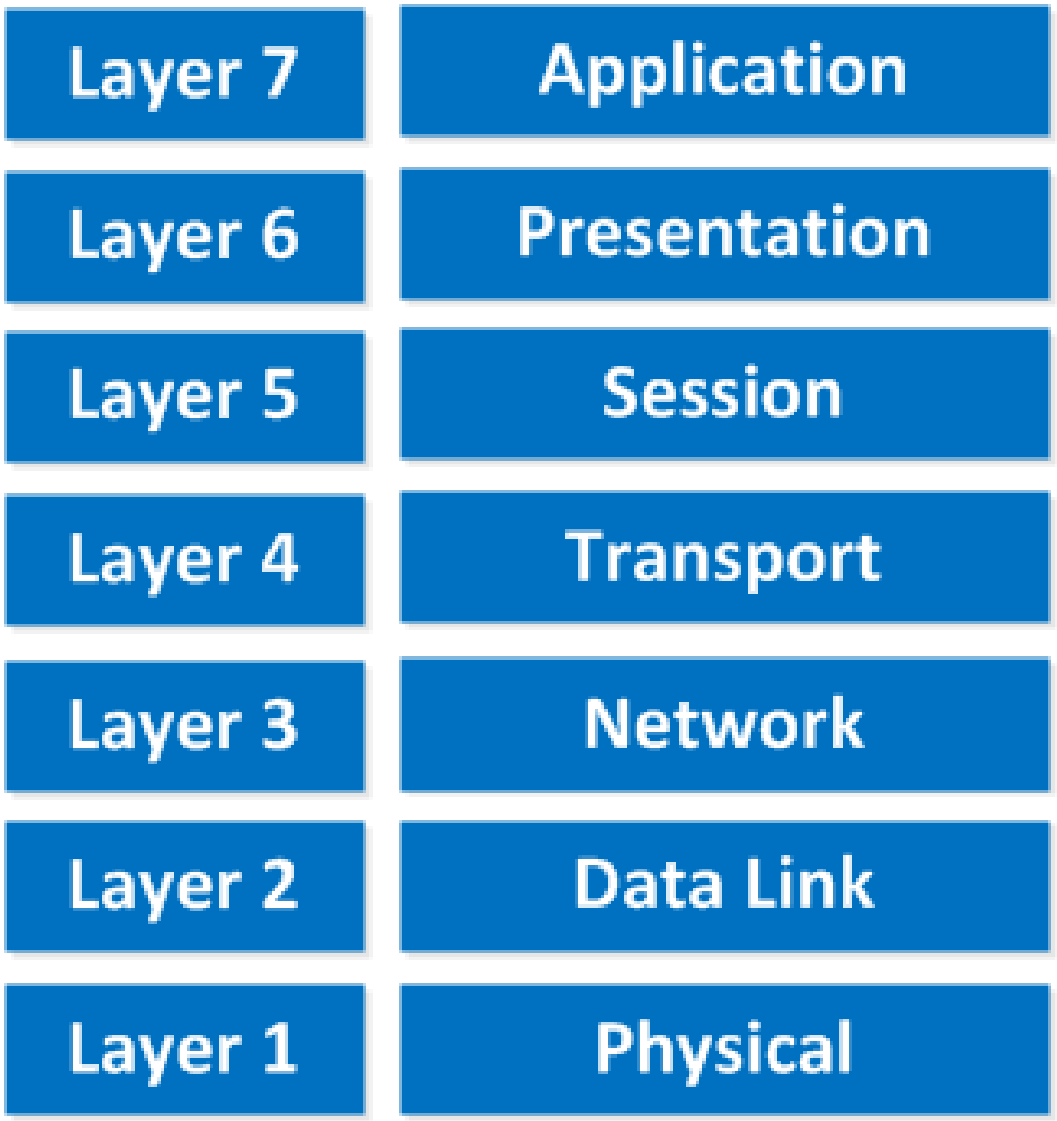
2.1 OSI Model

- OSI is an *Open System Interconnection* model. The OSI model is developed by ISO.
- An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture.
- The purpose of the OSI model is to show how to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software.
- The OSI model is NOT a protocol.
- It is a model for understanding and designing a network architecture that is flexible, robust, and interoperable.
- The OSI model has seven different separated layers each of which defines a part of the process of moving information across a network.

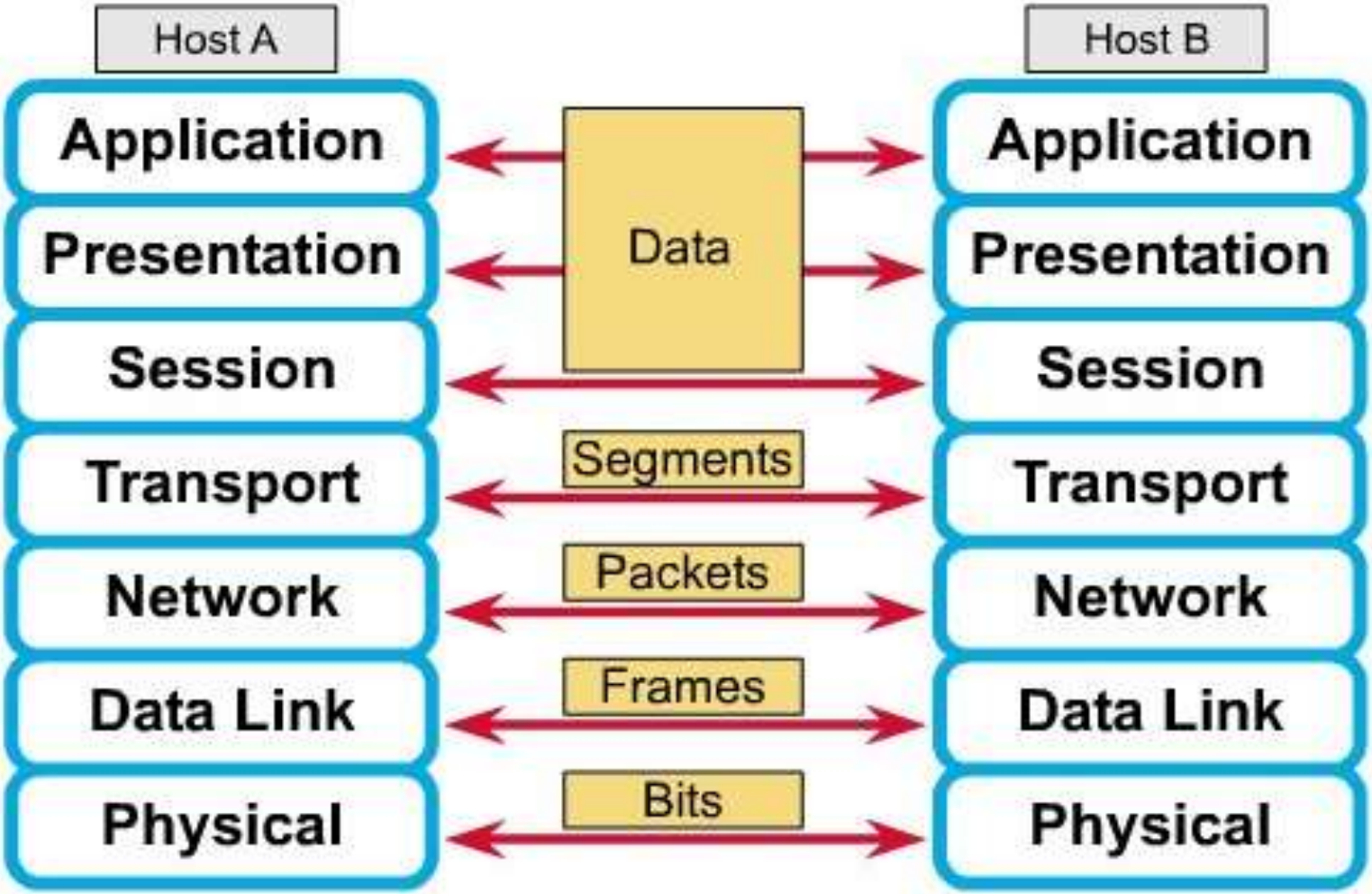
- Each layer uses the services provided by below layer and provide an interface to the upper layer.
- **Physical, Data link, Network, Transport, Session, Presentation and Application** are the main seven layers of OSI model.

OSI Model Overview





OSI reference model



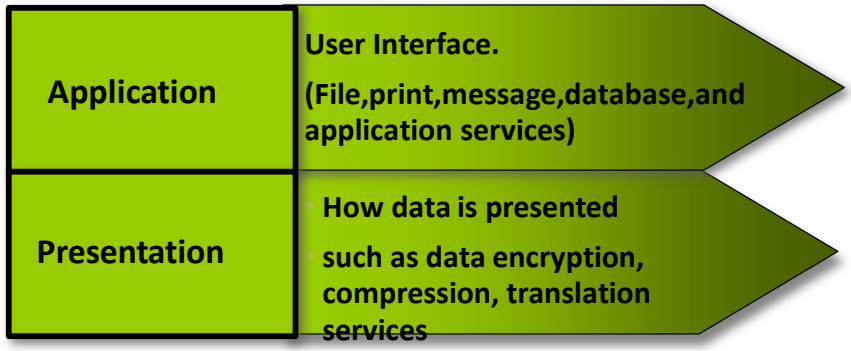
OSI reference model with host to host communication

Role of Application Layers

Examples

Telnet, TFTP, FTP NFS,
SMTP, LPD,
X WINDOW, SNMP,
DNS, DHCP/BootP

Role of Application Layers



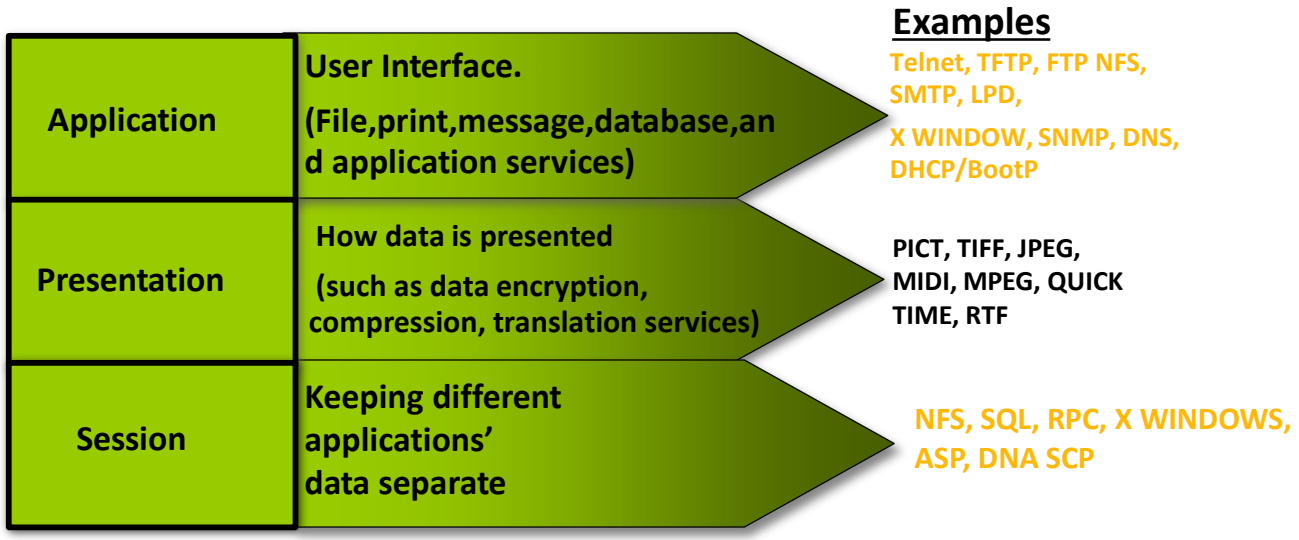
Examples

Telnet, TFTP, FTP NFS, SMTP, LPD,

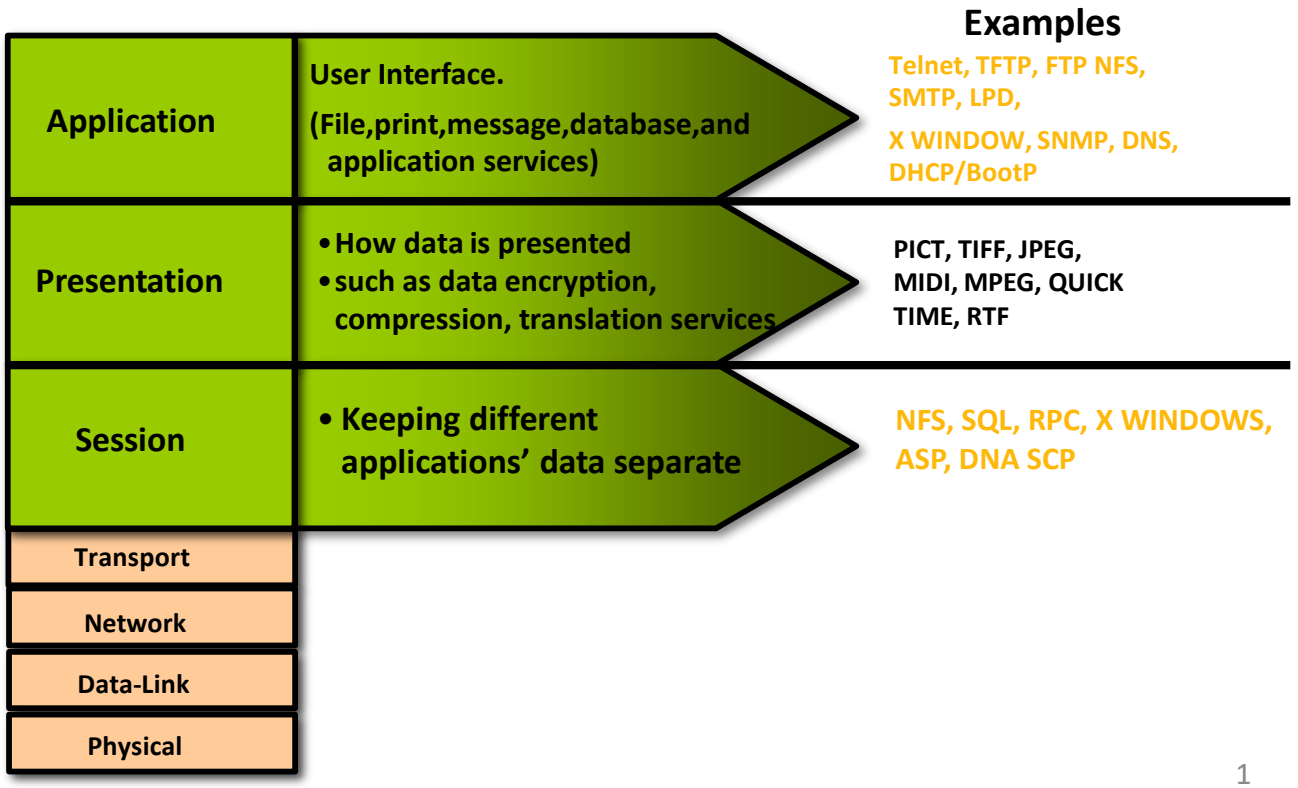
X WINDOW, SNMP, DNS, DHCP/BootP

PICT, TIFF, JPEG, MIDI, MPEG, QUICK TIME, RTF

Role of Application Layers



Role of Application Layers

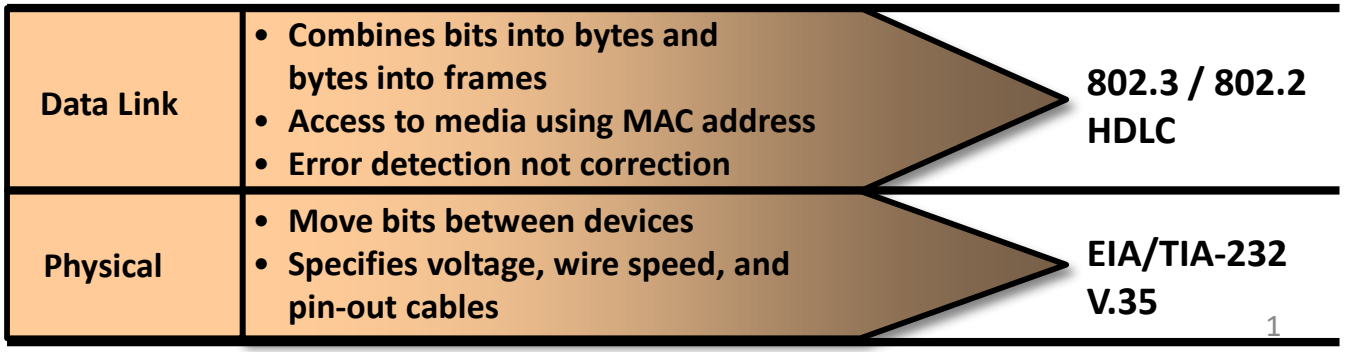


Role of Data Flow Layers

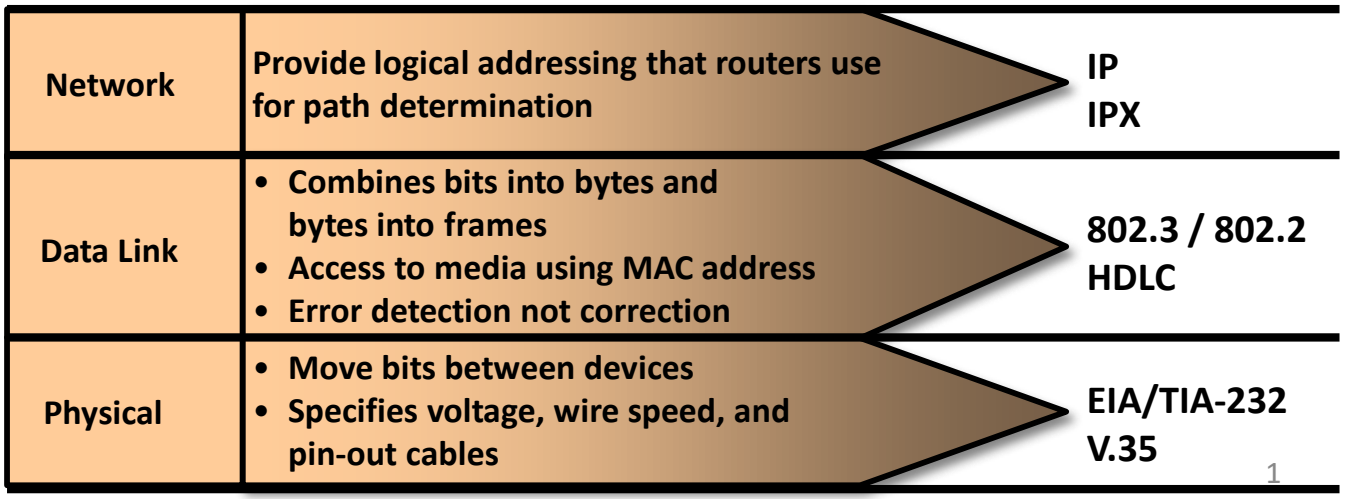
Examples

Role of Data Flow Layers

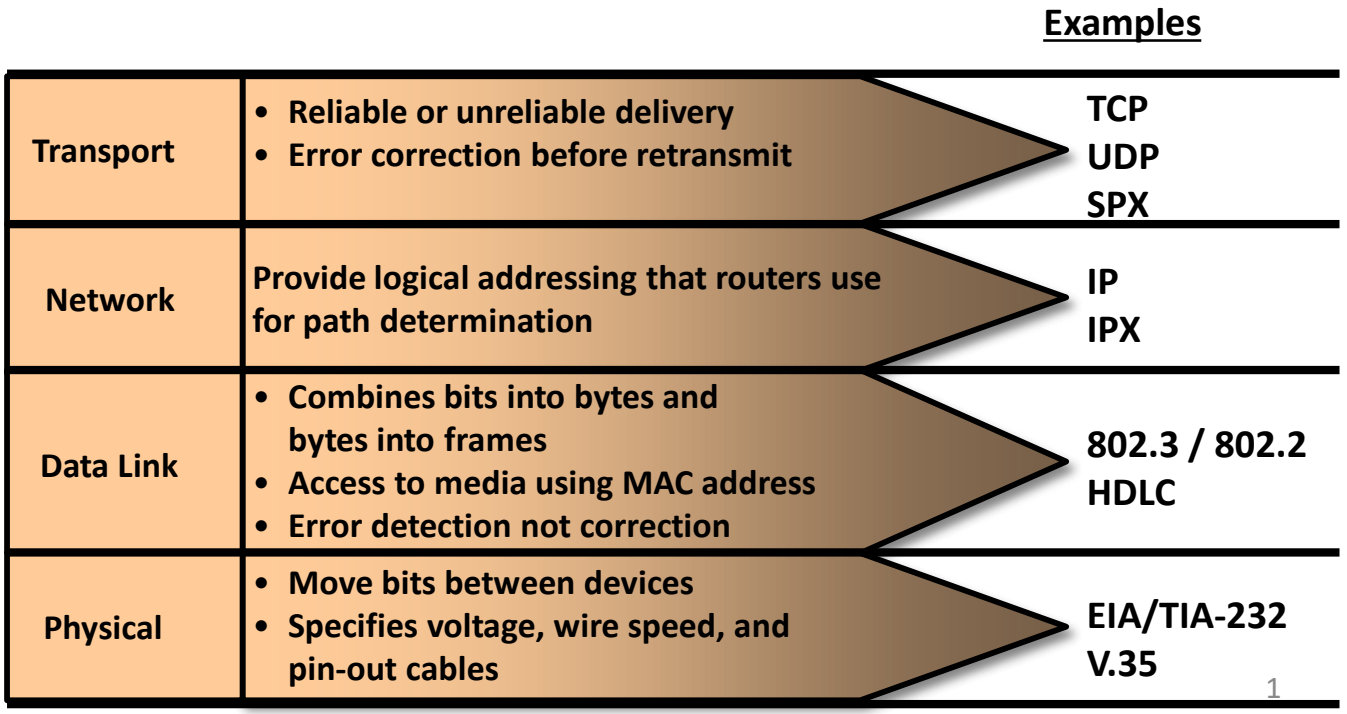
Examples



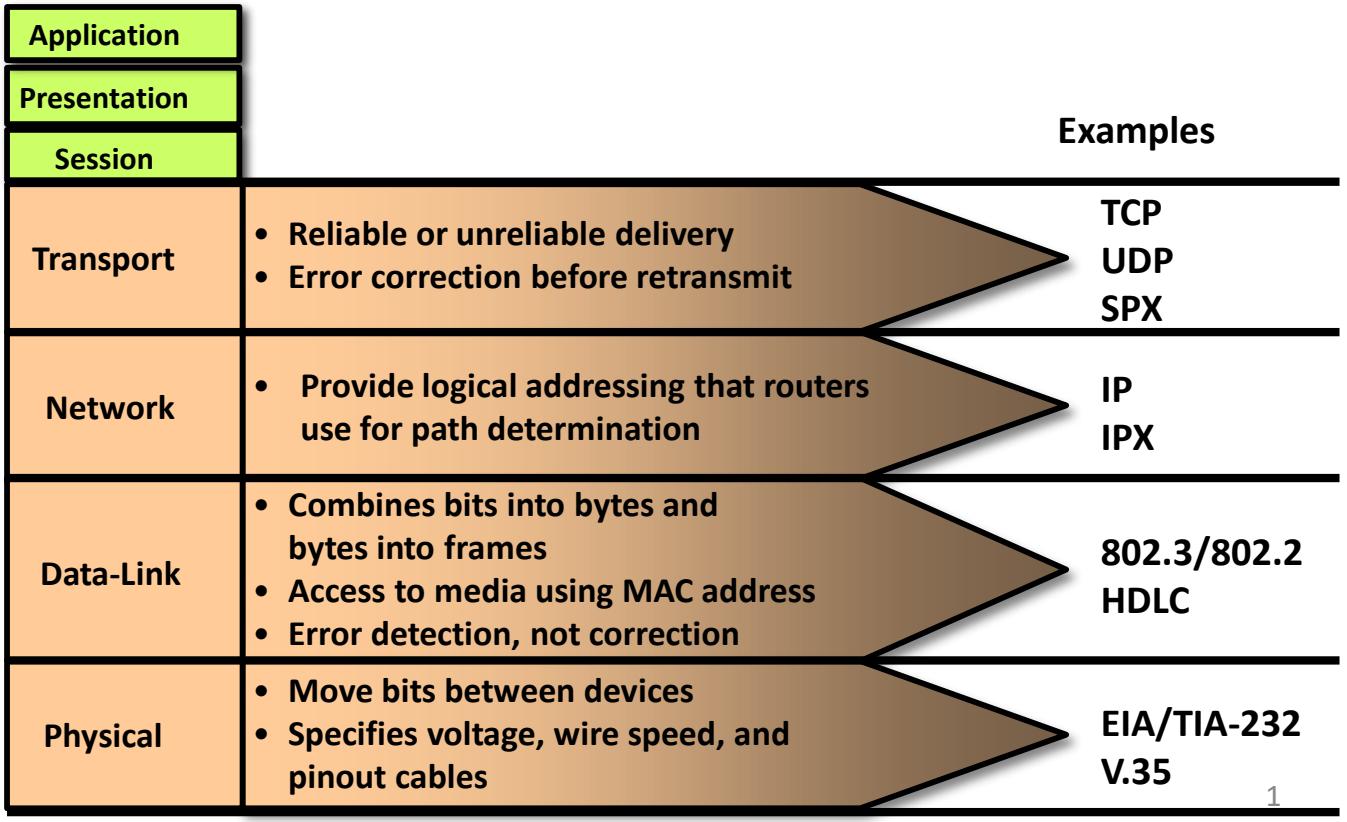
Role of Data Flow Layers



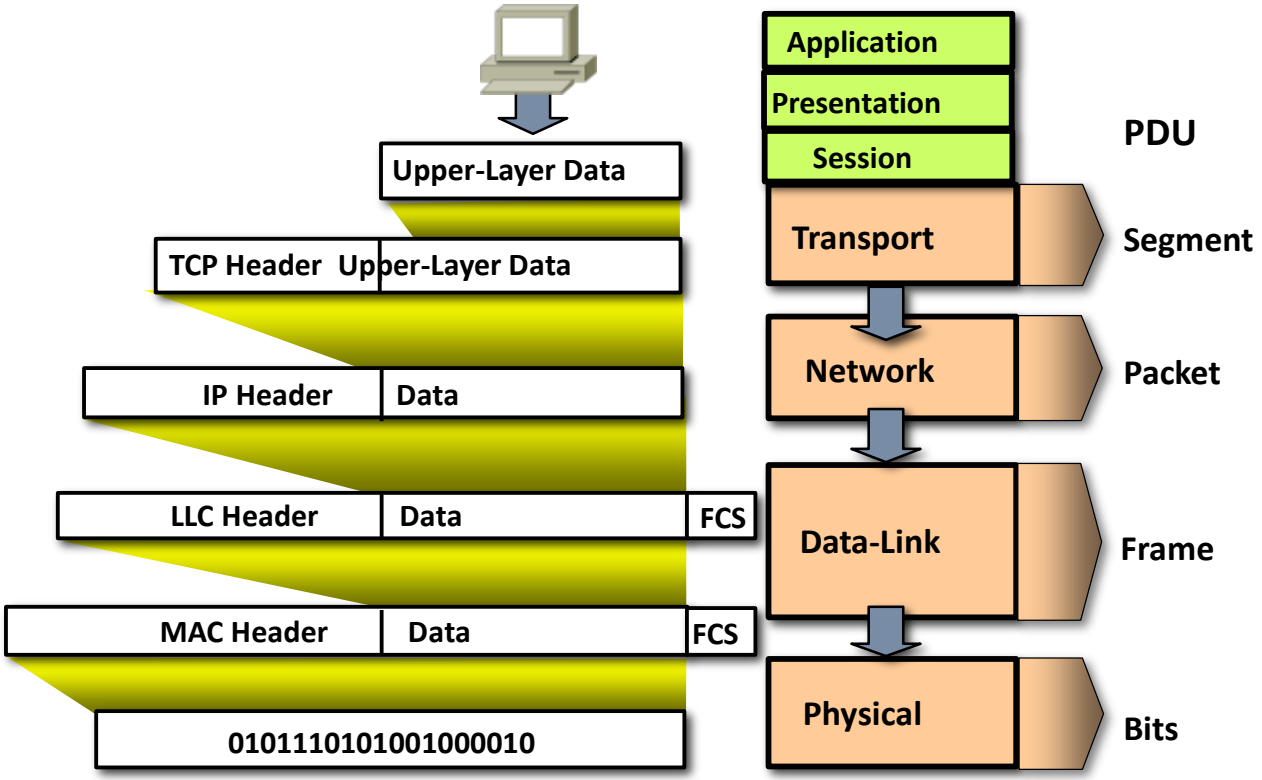
Role of Data Flow Layers



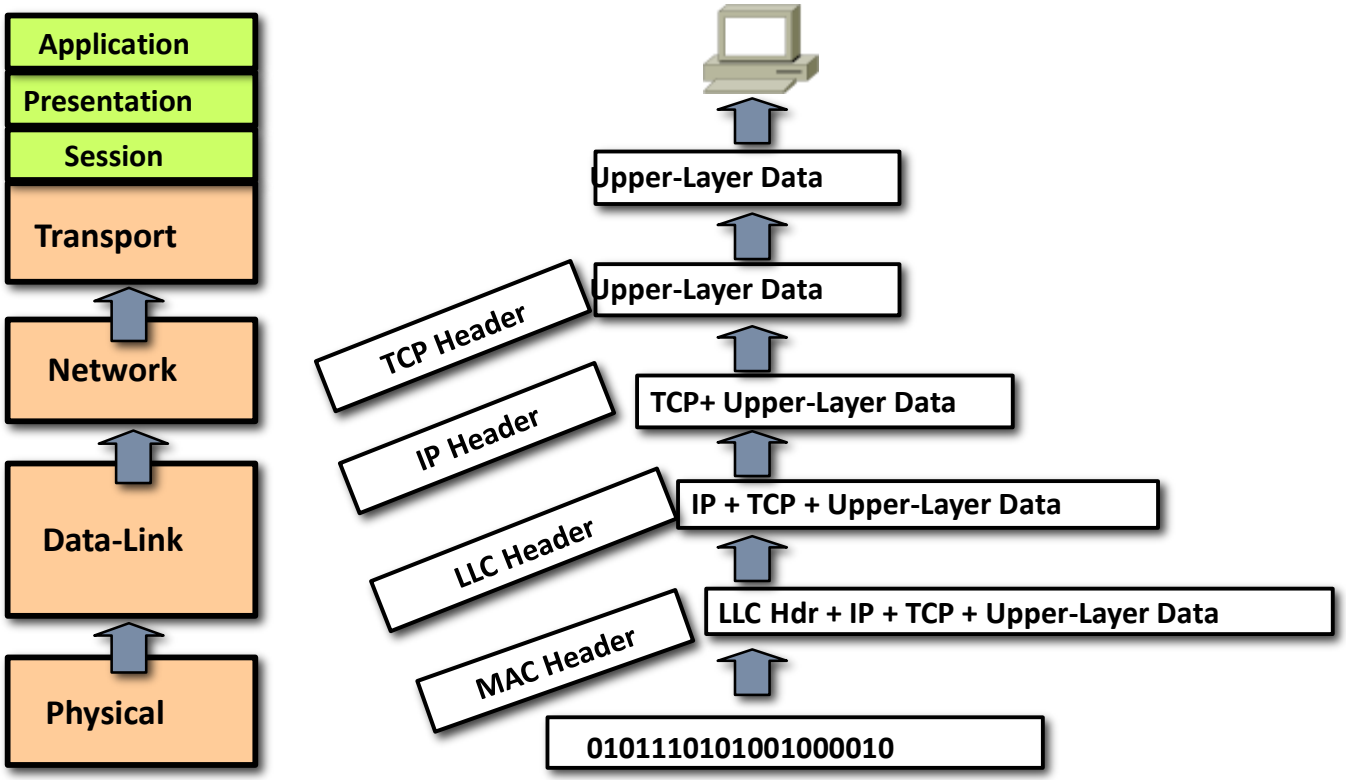
Role of Data Flow Layers



Encapsulating Data



De-encapsulating Data



Learning outcome

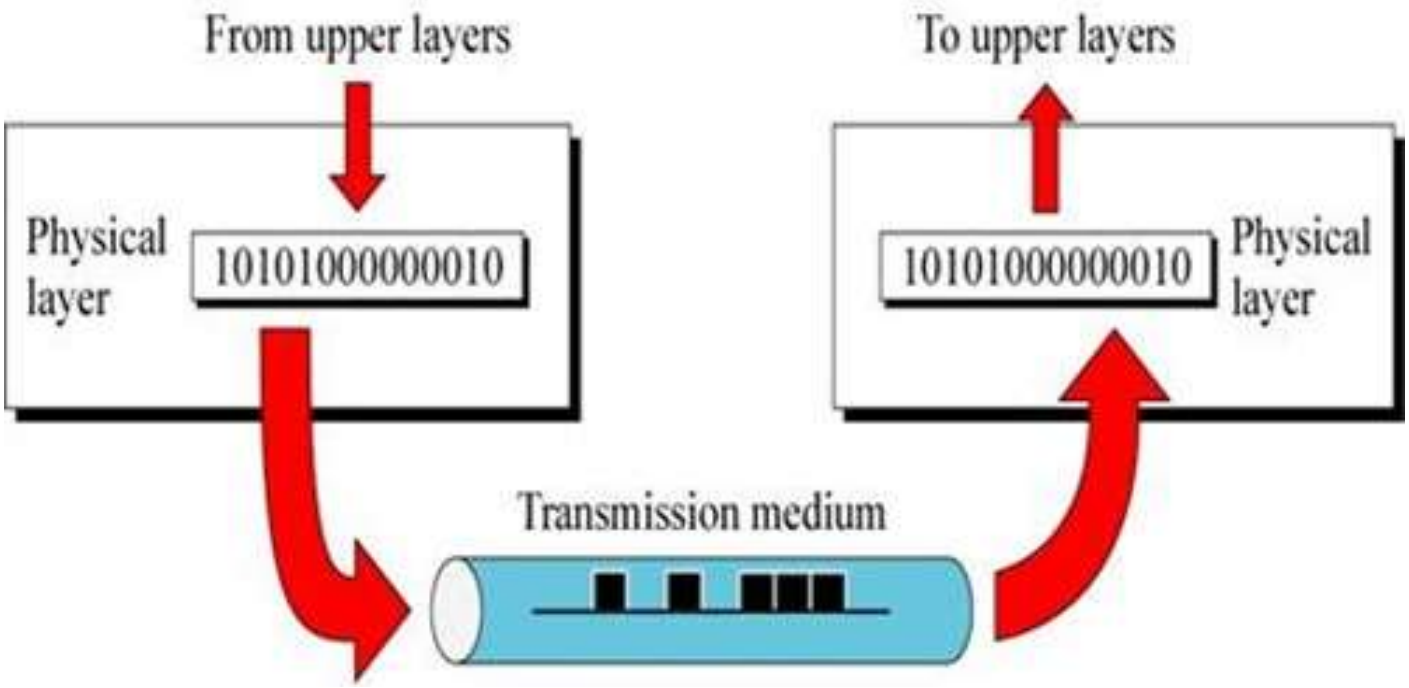
- After completion of this session, students will be able to *Describe functions of each layer of OSI reference model.*

Following are the functions of each layer

❖ Physical Layer

- **The layer is responsible for movement of individual bits from one hop (node) to next hop.**
- It is the lowest layer or first layer of the OSI model.
- It is concerned with the transmission of raw bits over a communication channel.
- At receiver side, It accept incoming stream of data and passes to the upper layer and also accept frames from upper layer (data link) and converts into bits.
- Data unit at this layer is → '**bit'**.

Physical Layer



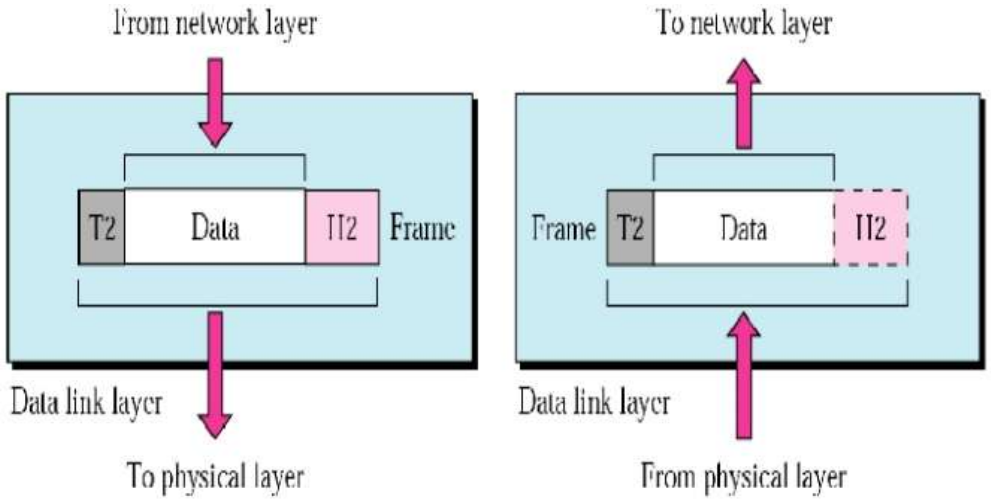
➥ **Functions of Physical layer**

- It carries signals to higher layers
- It defines the physical topology of a network.
- It defines the direction of transmission between two devises: *Simplex, Half duplex and Full duplex.*
- It encodes the bit streams into electric signals.

- Hardware used at this layer are: hub, NIC, modem, Repeater .

❖ Data Link Layer

- **The layer is responsible for moving frames from one hop (node) to next hop.**
- It is the second layer of the OSI model in which raw bits are grouped into frames.
- It makes the physical layer appear error free to upper layer (network).
- It uses CRC (Cyclic Redundancy Check) to detect errors.
- Data unit at this layer is → '**frame**'.

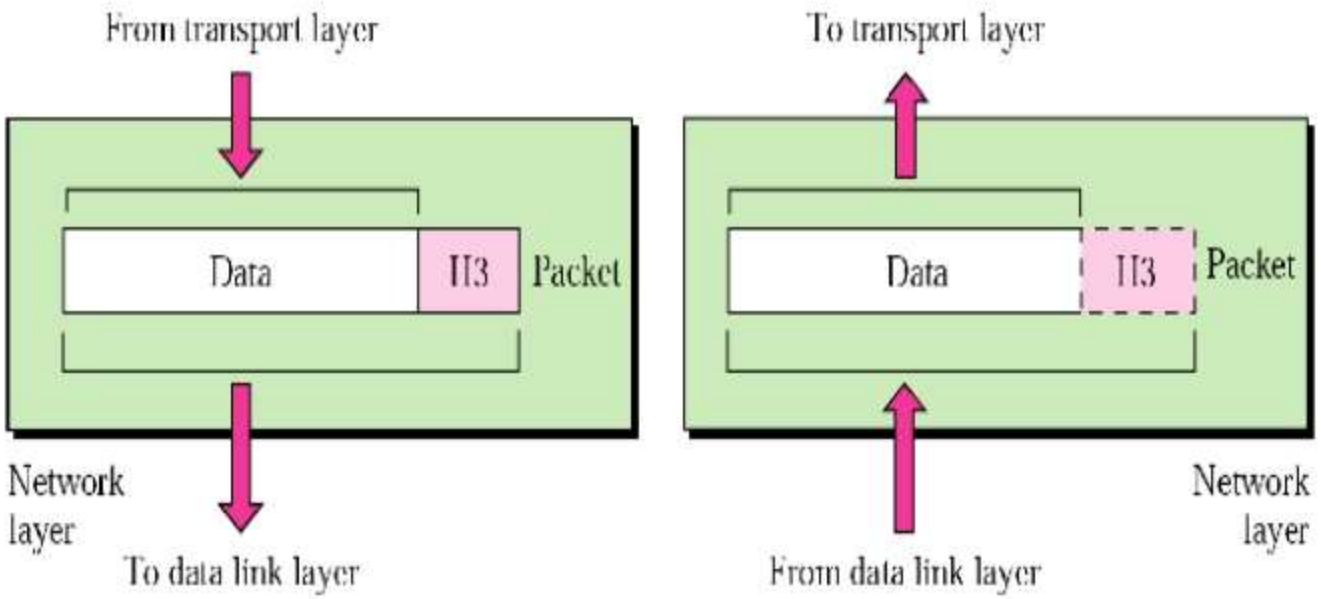


- **Functions of Data Link layer**
  - *Framing:* converts packets received from network layers into frames and also converts bits from physical layer into frames.
  - *Flow control:* it provides data flow control when sender and receiver have different data rates.
  - *Physical addressing:* when frames are sent to different LANs, this layer adds sender and receiver address into header.
  - *Error control:* it provides facility of error control to retransmit the damaged and lost frames.
- **Data link layer has two sub layers**
  - Logical Link Control (LLC) → it deals with protocols, flow control and error control.
  - Media Access Control (MAC) → it deals with the control of medium.

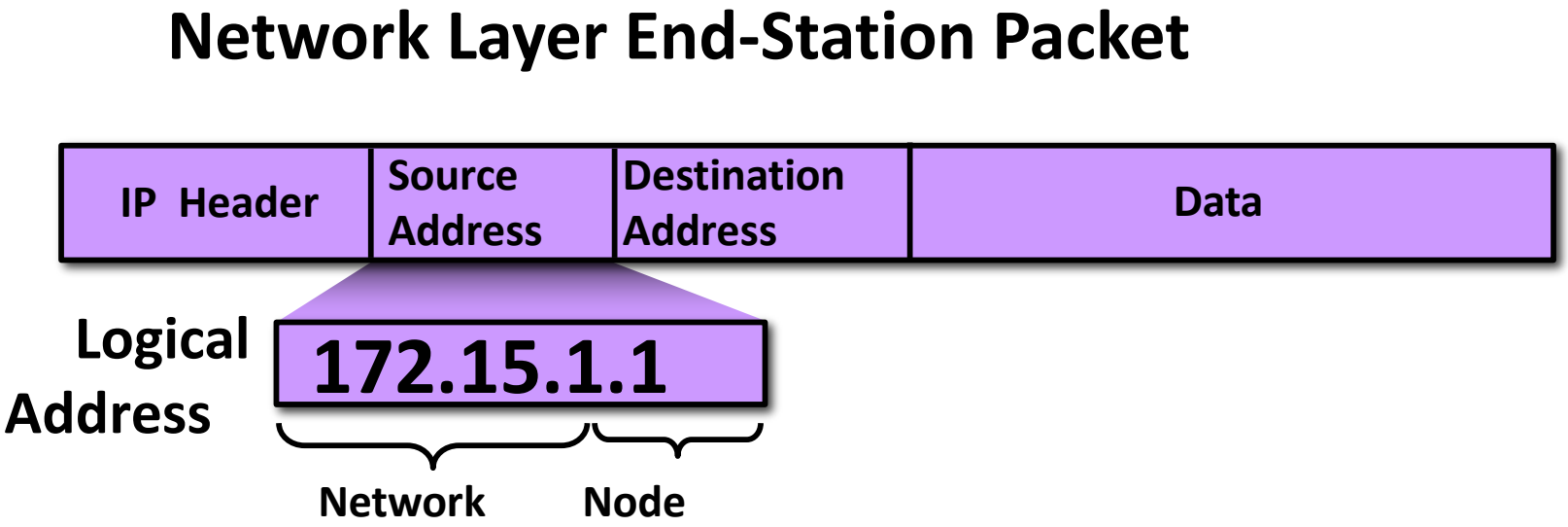
- Hardware used at this layers are: switch, gateway, firewall, proxy servers etc.
- Protocols and standards of this layer are:
  - PPP (Point to point protocol)
  - PPTP (Point to point tunneling protocol)
  - L2TP (Layer2 Tunneling Protocol)
  - SLIP (Serial Line Internet Protocol) etc.

❖ Network Layer

- **It is responsible for the delivery of packets from source host to destination host.**
- The network layer is responsible for the source-to-destination delivery of a packet across *multiple networks* (links).



Network Layer (cont.)



➥ **Functions of Network layer**

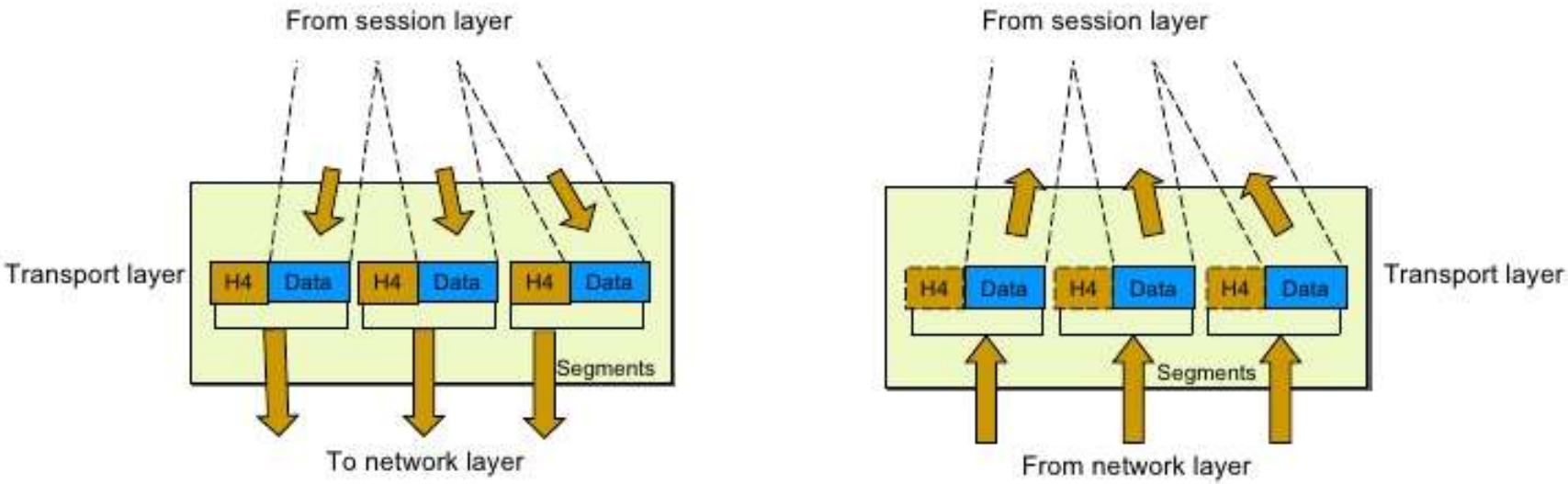
- *Logical addressing:* this layer adds a header into the packet includes logical address of sender and receiver.
- *Routing:* this layer route the packets to its final destination in internetwork.
- It provides quality of service management.
- It provides security, load balancing and link management.
- It provides connection oriented and connection less services to its upper layer (transport).

- Hardware used at this layer are: router, layer3 switch, firewall, proxy server, gateway etc.
- Protocols and standards of this layer are: ICMP, ARP, RARP, IPSec, IPv4/IPv6.

❖ Transport Layer

- **The transport layer is responsible for the delivery of a message from one process to another.**
- *It is responsible for source to destination delivery of a entire message, while network layer is responsible for source to destination delivery of individual packets.*
- Network layer doesn't recognize any relationship between packets, while in case of transport layer, it ensures that whole message arrives in order and it also checks error control and flow control.
- The data unit at this layer is → '**segment'.**

Transport Layer



- The transport layer segments and reassembles data into a data stream.
- Services located in the Transport layer both segment and reassemble data from upper-layer applications and unite it onto the same data stream.
- They provides end-to-end data transport services and can established a logical connection between the sending host and destination host on an internetwork.
- Transport layer user this two protocols :

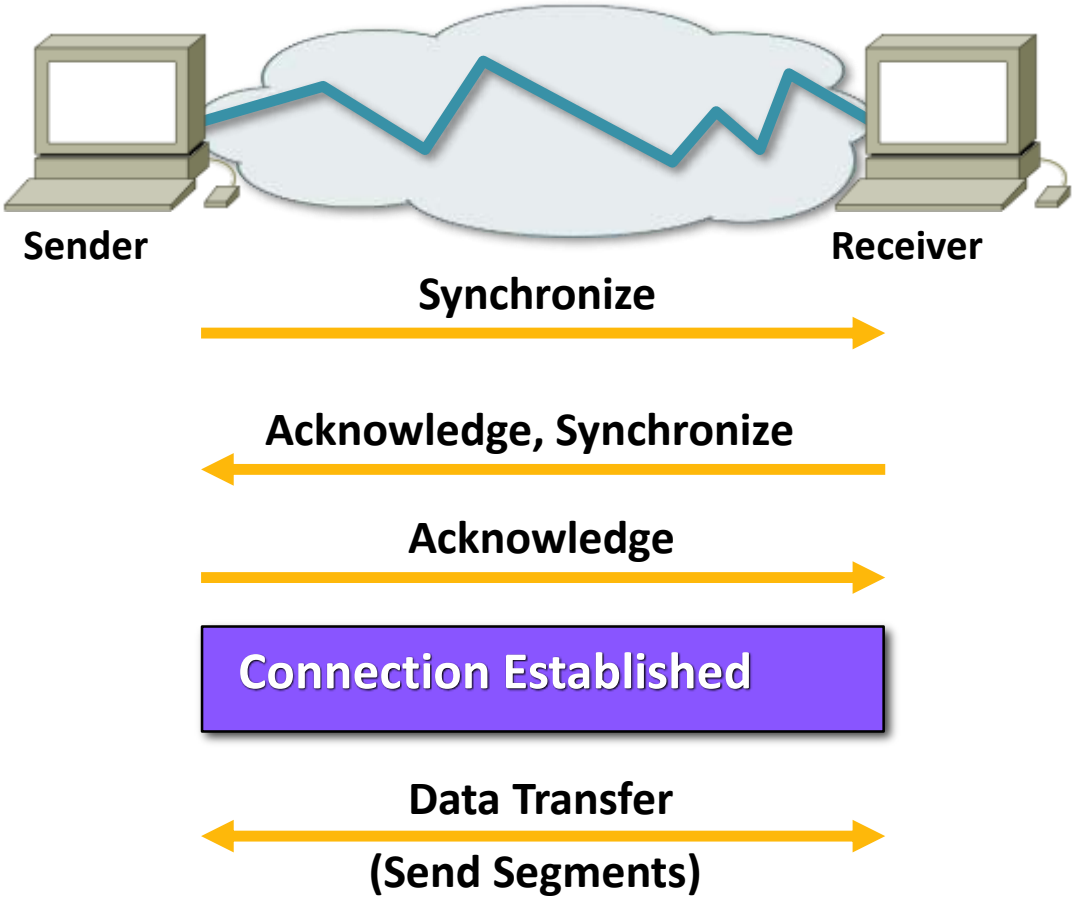
■ TCP, UDP.

- The Transport layer is responsible for providing mechanisms for multiplexing upper-layer applications, establishing sessions, and tearing down virtual circuits.
- The transport layer can be connectionless, or connection-oriented.

Connection-Oriented Communication

- In reliable transport operation, a device that wants to transmit set up a connection-oriented communication with a remote device by creating a session.
- The transmitting device first establishes a connection-oriented session with its peer system, which is called a call setup, or a tree-way handshake.
- Data is then transferred; when a call termination takes place to tear down the virtual circuit.

Reliable Transport Layer Functions

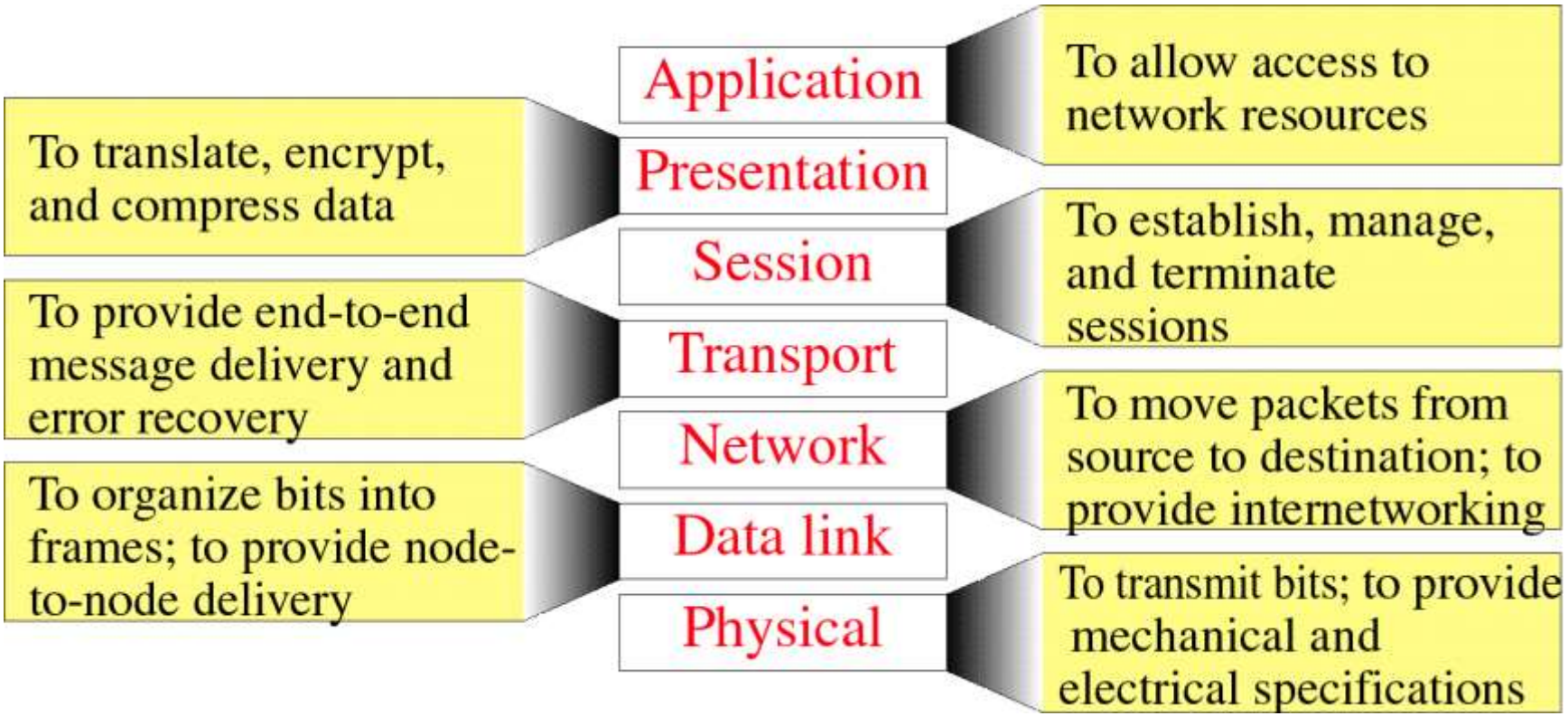


➥ **Functions of Transport layer**

- *Segmentation and reassembly:* a message divided into segments, each segment contains a sequence number which enables transport layer to reassemble at destination.
- *Synchronization of data:* this layer ensures that data must be received in the sequence in which it was sent.
- This layer provides error correction of data and ensures error free transmission.
- *Flow control:* this layer performs end-to-end flow control while data link layer do it across the link.
- *Connection control:* this layer performs connection less or connection oriented with the destination machine.

- Hardware used at this layer are: gateway, proxy server, content filtering firewall, etc.
- Protocols and standards of this layer are: TCP (Transmission Control Protocol) and UDP (User Datagram Protocol).

Summary of Layer Functions



Comparison Physical, Logical and Port Addresses

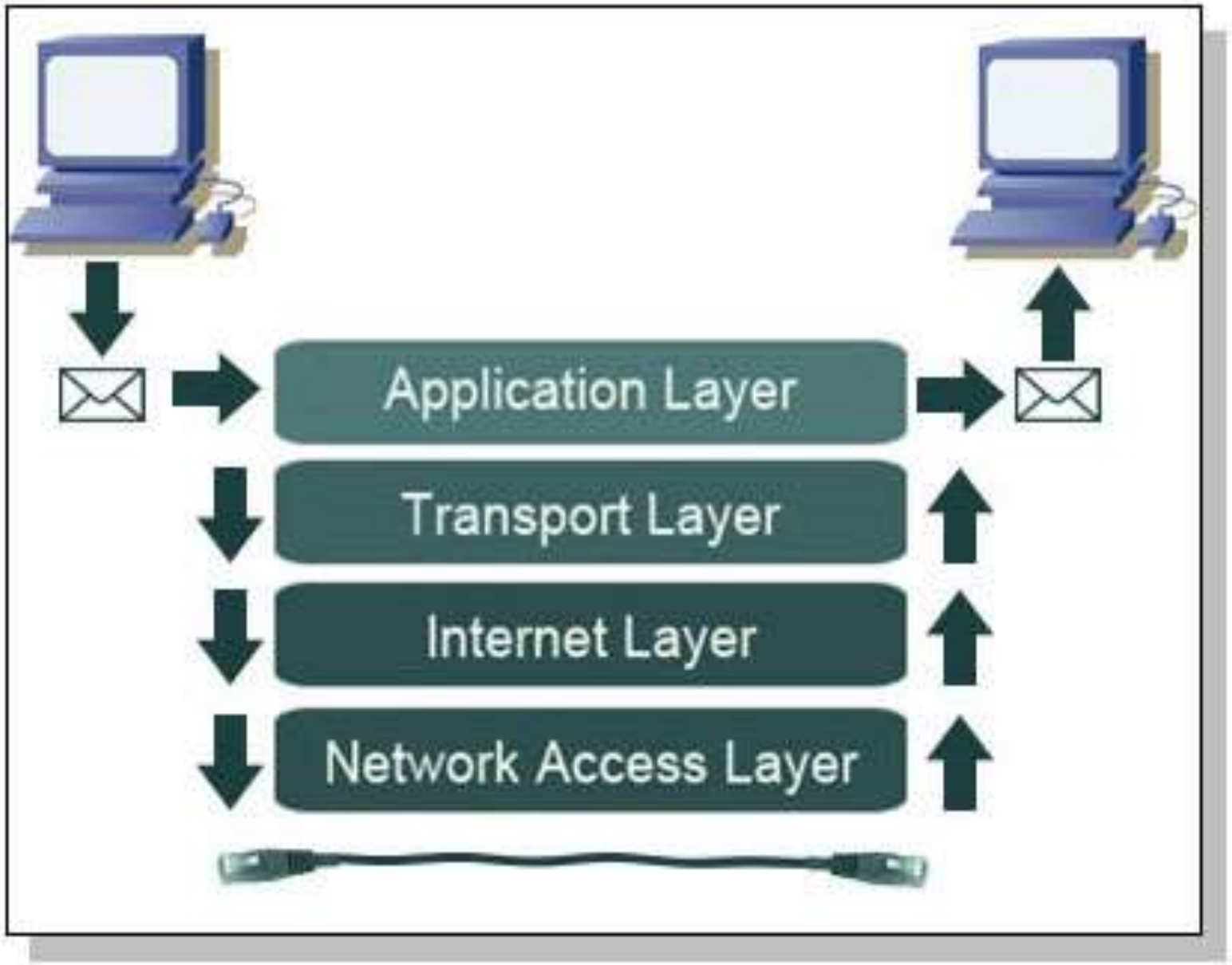
Features (Criteria)	Physical Address (MAC Address)	Logical IPv4 Address	Port Address
Layer in OSI Model	Data Link Layer (Layer 2)	Network Layer (Layer 3)	Transport Layer (Layer 4)
Scope	Local network segment	Across networks and internet	Within device and network
Format	Hexadecimal separated by colons or hyphens	Decimal separated by periods	16-bit unsigned integer
Uniqueness	Globally unique	Unique within a network	Unique within a device and network
Assignment	Hardcoded into hardware	Dynamically assigned	Not hardcoded, assigned dynamically
Purpose	Identifies network interface	Identifies device on a network	Identifies service or application
Examples	00:1A:2B:3C:4D:5E	192.168.1.1	80 (HTTP), 443 (HTTPS), etc.

Learning outcome

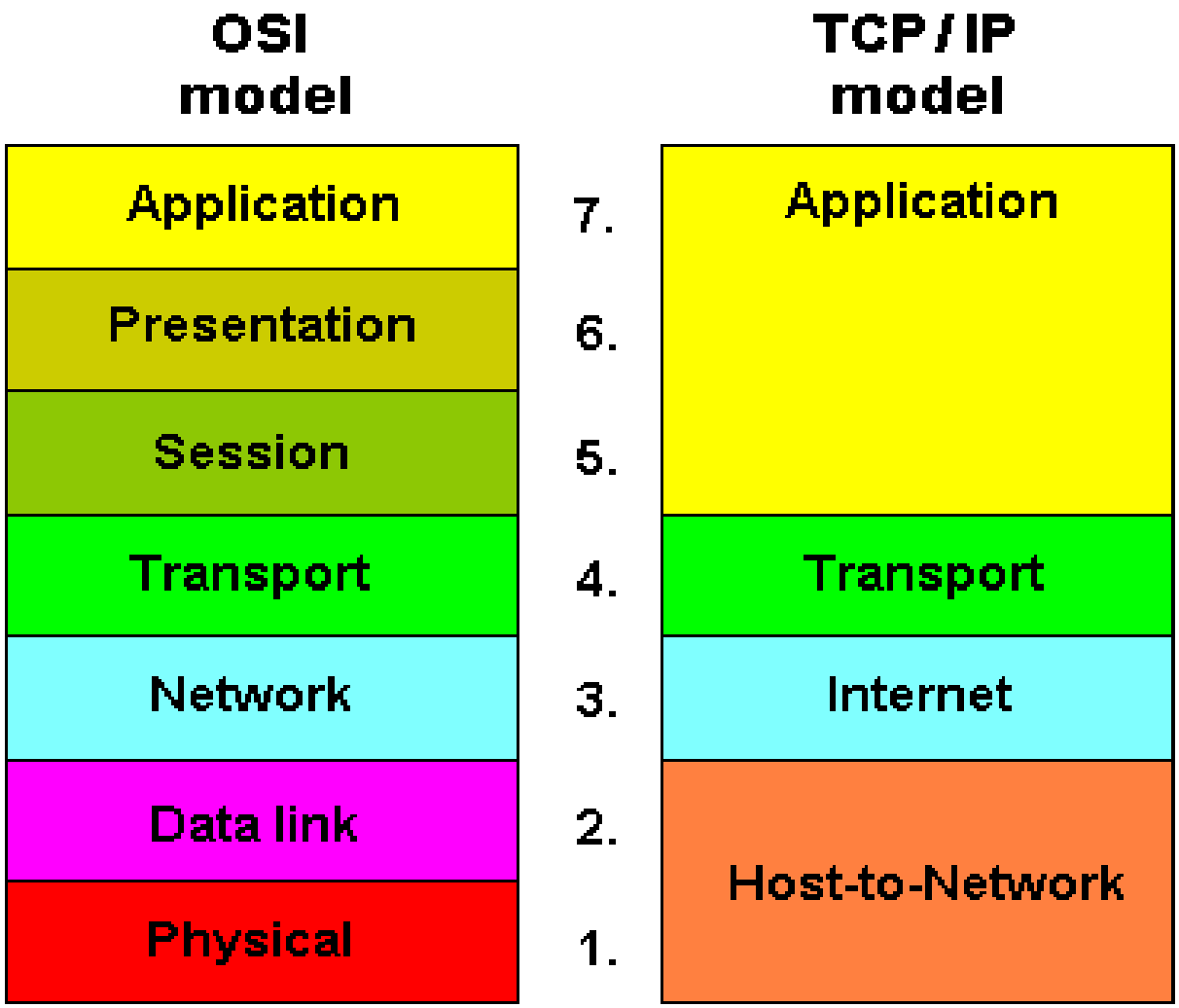
- After completion of this session, students will be able to *Compare OSI and TCP/IP model*

2.2 TCP/IP Model (Internet Model)

- TCP/IP stands for Transmission Control Protocol / Internet Protocol.
- TCP/IP model was developed before to the OSI model.
- Therefore, the layers in the TCP/IP protocol suite do not exactly match those in the OSI model.
- This model consist of set of protocols that allow communication across multiple different networks.
- There are mainly four layers in this model → Host-to-network layer (Link layer), Internet layer , Transport layer and Application layer.


Application Layer
Transport Layer
Internet Layer
Network Access Layer

TCP / IP model



TCP / IP model (2)

Following are the functions of each layer

❖ **Link layer (host-to-network) layer**

- It is also called ‘network interface layer’.
- This layer provides mechanism of sending and receiving actual data.
- This layer is independent of network architecture and hardware.
- It controls hardware and media communication in the network.

❖ **Network layer (IP layer)**

- This layer defines the host addressing and routing.
- It finds best path across networks.
- IP (internet protocol) works on this layer. Including IP, this layer functioning with four supportive layers: ARP, RARP, ICMP and IGMP.
- Packets in the IP layer called ‘***datagram***’.
- The function of network layer is explained by following protocols

➥ **IP (Internetwork protocol)**

- It is connection less and unreliable protocol.
- It doesn’t provide error checking and packet tracing.

➥ **ARP (Address Resolution Protocol)**

- ARP is used to find the physical address of the node when the logical address (IP address) is known.

➥ **RARP (Reverse Address Resolution Protocol)**

- It is used to find the logical address of the node when its physical address is known.

➥ **ICMP (Internet Control Message Protocol)**

- It is network diagnostic and error reporting protocol.

➥ **IGMP (Internet Group Message Protocol)**

- It is used provide facility for multicast transmission.

❖ Transport layer

- *It supports communication of multiple devices across different networks.*
- It also defines how data should flow between different hosts.
- This layer ensures data delivery between hosts is in order or not and also it is responsible for end-to-end delivery.
- Major protocols of this layer are: TCP and UDP. Both these protocols are used for port-to-port communication.

➥ TCP (Transmission Control Protocol)

- It provides full transport layer services to application.
- It is ***connection oriented and reliable*** protocol. Means a connection must be established between both ends before transmission.
- The packet produced by TCP is called **'segment'**.

➥ **UDP (User Datagram Protocol)**

- It is simple, ***connection less and unrel***iable protocol.
- The packet produced by UDP is called **'datagram'**.

❖ **Application Layer**

- It is the final and highest layer in TCP/IP model which is equal to the combined session, presentation and application layer of OSI model.
- The functions of this model are explained by the following protocols.

➥ **SMTP (Simple Mail Transfer Protocol)**

- It is used to transfer electronic mail (E-mail) from one user to another.

➥ **HTTP (Hyper Text Transfer Protocol)**

- Is provides a standard for web users and servers to communicate.

➥ **FTP (File Transfer Protocol)**

- FTP is the most widely used protocol for file transfer over the network.
- It is reliable and simple.
- It uses TCP/IP for communication and it works on TCP port 21.

➥ **HTTP (Hyper Text Transfer Protocol)**

- Is provides a standard for web users and servers to communicate.

➥ **SNMP (Simple Network Management Protocol)**

- It provides a set of operations for monitoring and maintaining devices in the internet.

➥ **TELNET (Terminal Network)**

- It is a general purpose protocol used for remote login.

➥ **DNS (Domain Name Server)**

- It resolves an IP address into textual address for hosts connected over a network.

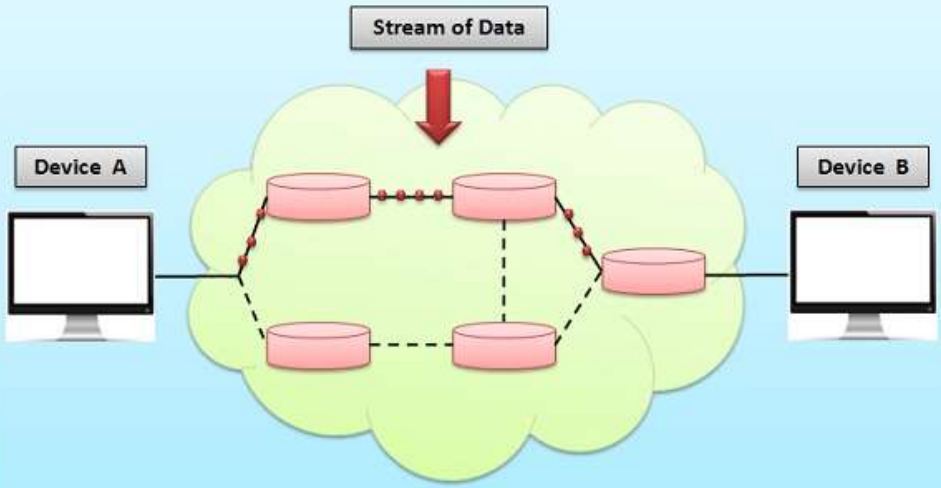
Learning outcome

- After completion of this session, students will be able to *differentiate between connection oriented and connectionless services/approach.*

2.3 Connection oriented v/s Connection less services

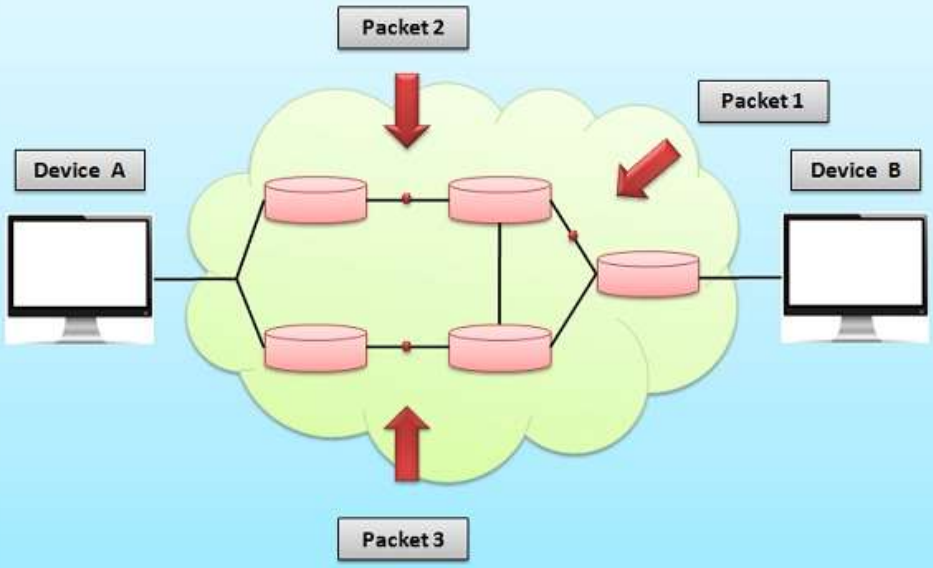
Connection oriented services	Connection less services
- In connection oriented service we have to establish a connection before starting the communication.	- No need to establish a connection in prior.
- it is more reliable	- It is less reliable
- Authentication is needed in it.	- Authentication is not needed.
- After sending, this service checks the message is received or not.	- there is no guarantee of a delivery of message.
- It is slower.	- It is faster.
- It is implemented using circuit switching.	- It is implemented using packet switching.
- Error correction and flow control provided in it.	- Error correction and flow control not provided.
- Example is telephone system.	- Example is postal system.
- Protocol: TCP (transmission control protocol)	- Protocol: Example: UDP (User Datagram Protocol)

Connection-oriented Communication



Solid line between device A and device B shows a dedicated link in which stream of data is travelling from device A to B. The specialty of this link is that receiver can send the acknowledgement also to the receiver about the status of packet.

Connectionless Communication



Learning outcome

- After completion of this session, students will be able to *compare OSI and TCP/IP model.*

2.4 Comparison of OSI and TCP/IP models

OSI	TCP/IP
- Full form: Open System Interconnection.	- Full form: Transmission Control Protocol / Internet Protocol.
- It has seven layers.	- It has four/five layers.
- OSI model developed after TCP/IP model.	- It is developed before OSI model.
- In this model, transport layer guarantees the delivery of packets.	- In this model, transport layer does not guarantees delivery of packets.
- It follows vertical approach.	- It follows horizontal approach.
- OSI model has separate presentation layer and session layer.	- TCP/IP model does not have separate presentation and session layer.
- Network layer in this model provides both connection less and connection oriented service.	- Network layer in this model provides only connection less service.
- In it, services, interface and protocols are clearly separated.	- In it, services, interface and protocols are not clearly separated.
- It is just a reference model.	- It is the implementation of OSI model.

Thank you...