

OSI Model

Lecture 2



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- OSI – Open System Interconnection Reference Model
 - An abstract description for layered communications and computer network protocol design
- International Standards Organisation (ISO) started development of the OSI framework architecture in 1978
- The OSI Model divides network architecture into **seven layers**



OSI Design Principles

- Each layer should perform a well defined function.
- The function of each layer should be chosen according to the internationally standardized protocols.
- The number of layers should be large enough that distinct functions should not be put in the same layer and small enough that the architecture does not become very complex.

Note: different OSI layers utilize abstraction (i.e. the layers are differentiated by their function and not by tangible physically observable differences)

OSI Model

7 Layers

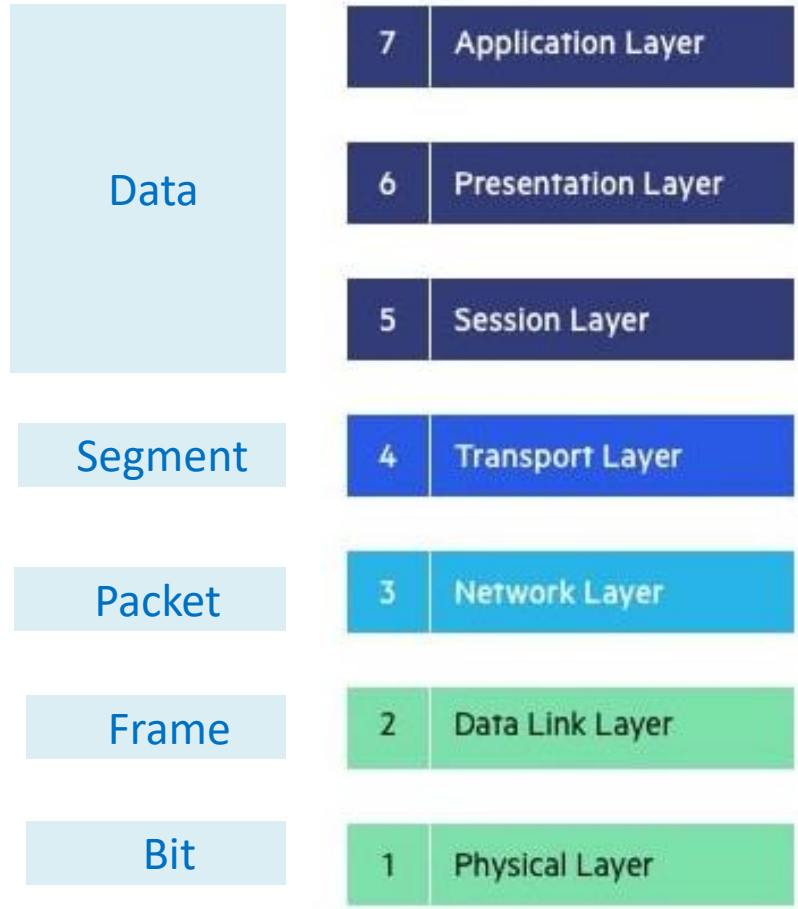


7	Application Layer	Human-computer interaction layer, where applications access network services
6	Presentation Layer	Ensures that data is in a usable format and where data encryption takes place
5	Session Layer	Maintains connections and is responsible for controlling ports and sessions
4	Transport Layer	Controls reliability of a given link with flow control, segmentation and error control
3	Network Layer	Determines the data paths, logical addressing
2	Data Link Layer	defines the format of data on the network and carries out physical addressing
1	Physical Layer	Transmits raw bit streams over the physical medium such as cables



OSI Model

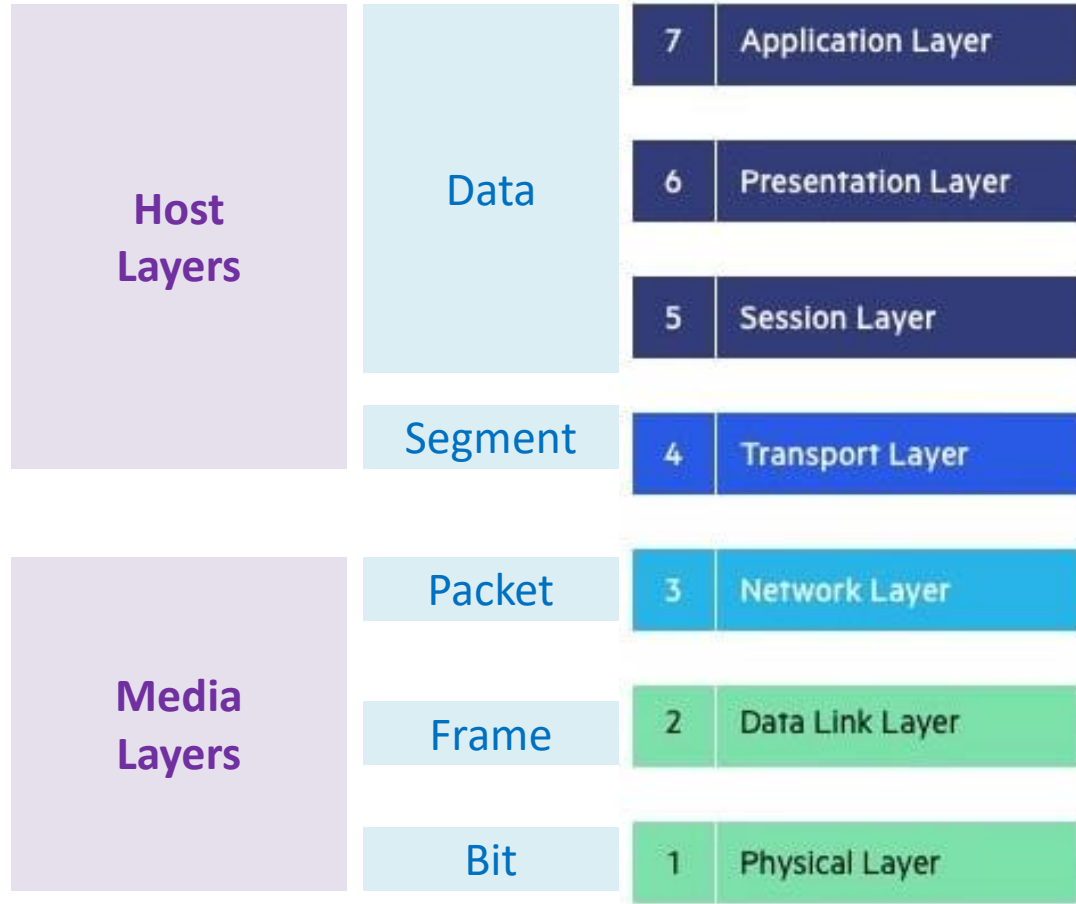
7 Layers – Data Units



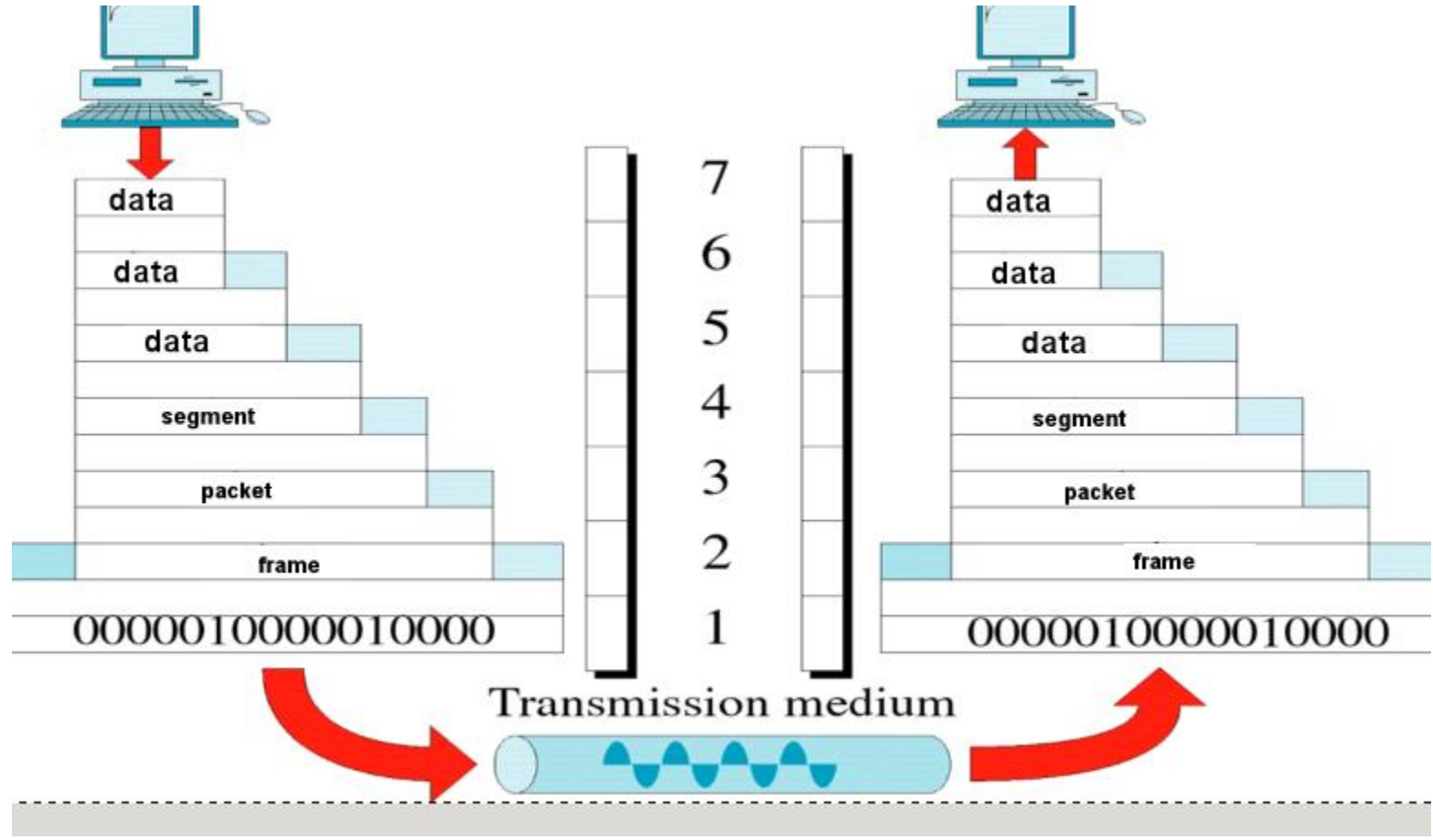
Note: segments, packets and frames are all forms of data (data which are all combinations of bits)

OSI Model 7 Layers [3]

Two categories of
layers



Data Exchange in OSI Model



Layer 1 - Physical Layer



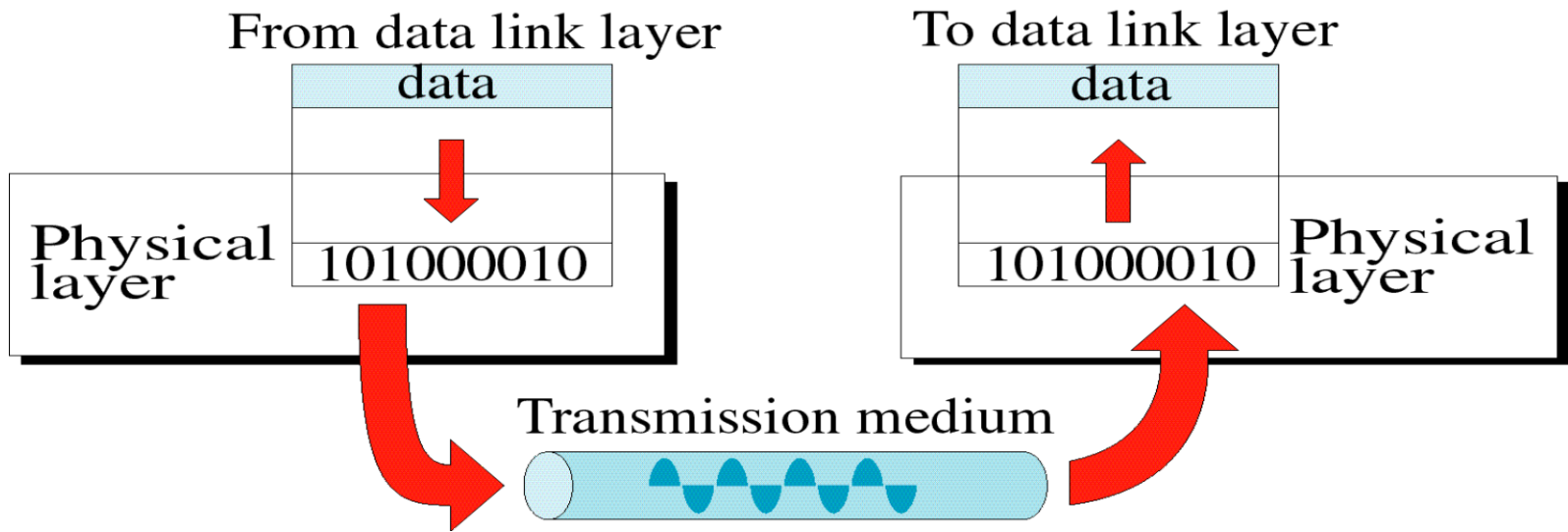
- Bottom layer of the OSI model
- Defines electrical and physical specifications for devices
 - Defines relationship between a device and a physical medium
- Concerned with transmitting bits over a communication channel

Physical Layer Functions



- Transforms bits into signals (Modulation, or conversion between bits and signals)
- Establishment and termination of a device to a communication medium
- Defines transmission rate, flow control etc. among multiple users
- Provides physical topologies

Physical Layer



Layer 2 - Data Link

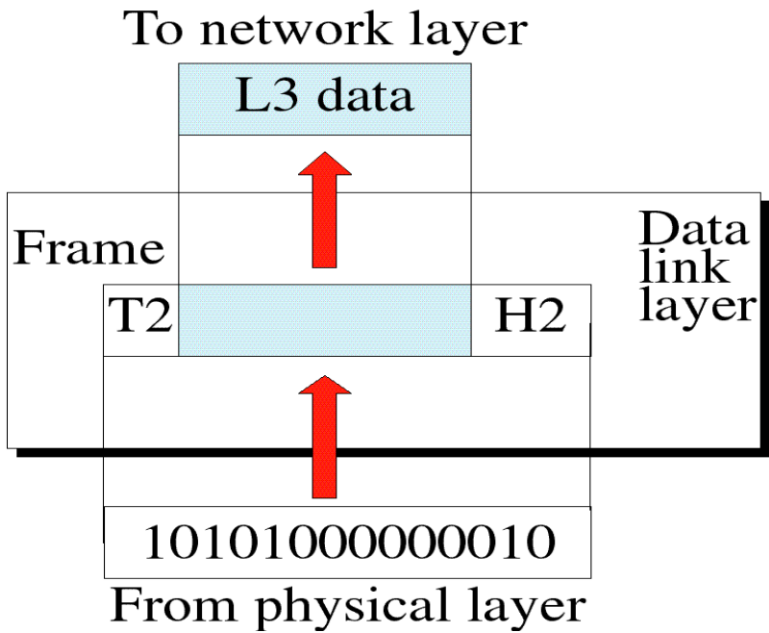
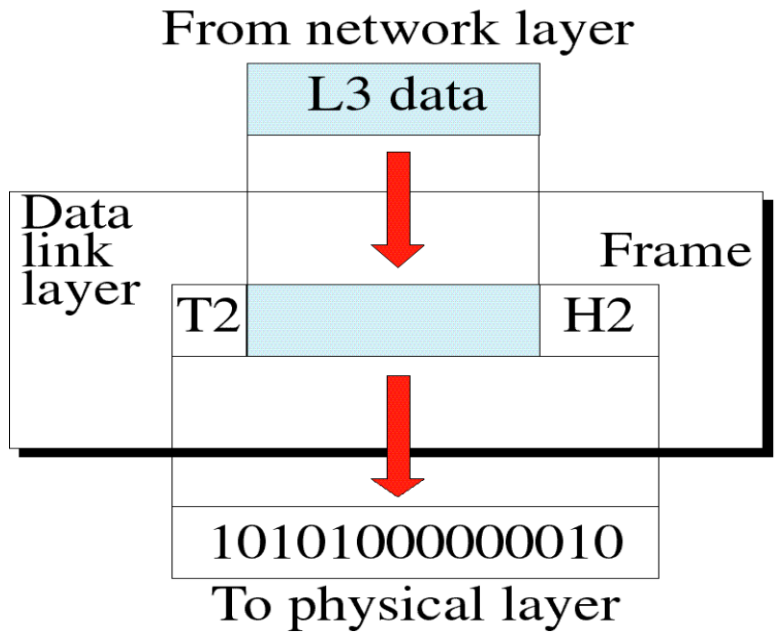


- Responsible for node-to-node delivery of data
- Provides functional and procedural means to transfer data between network entities
- Detects and possibly corrects errors that may occur in physical layer
- Receives data from network layer and creates **frames**, adds physical addresses to these frames and pass them to physical layer



- It consist of 2 sub-layers:
 - Logical Link Layer (LLC) : Defines the methods and provides addressing information for communication between network devices.
 - Repackages data and adds a new header
 - Medium Access Control (MAC): establishes and maintains links between communicating devices.

Data Link Layer



Data Link - Functions



- **Framing** – DLL divides the bits received from network layer into frames
- **Physical Addressing** – DLL adds physical addresses of the sender/receiver (MAC address) in the header of each frame
- **Flow Control** – prevents fast senders from drowning the slow receiver.
- **Error Control** – detects and retransmits damaged or lost frames
- **Access Control** – determines which device has control over a channel when a single communication channel is shared by multiple devices



Layer 3 - Network Layer

- Provides functional and procedural means of transferring variable length data sequences from a source to a destination via one or more networks, while maintaining the quality of service requested by the transport layer.
- If two systems are attached to different networks like routers, then the network layer is used
- The network layer ensures the packet gets from its source to final destination.

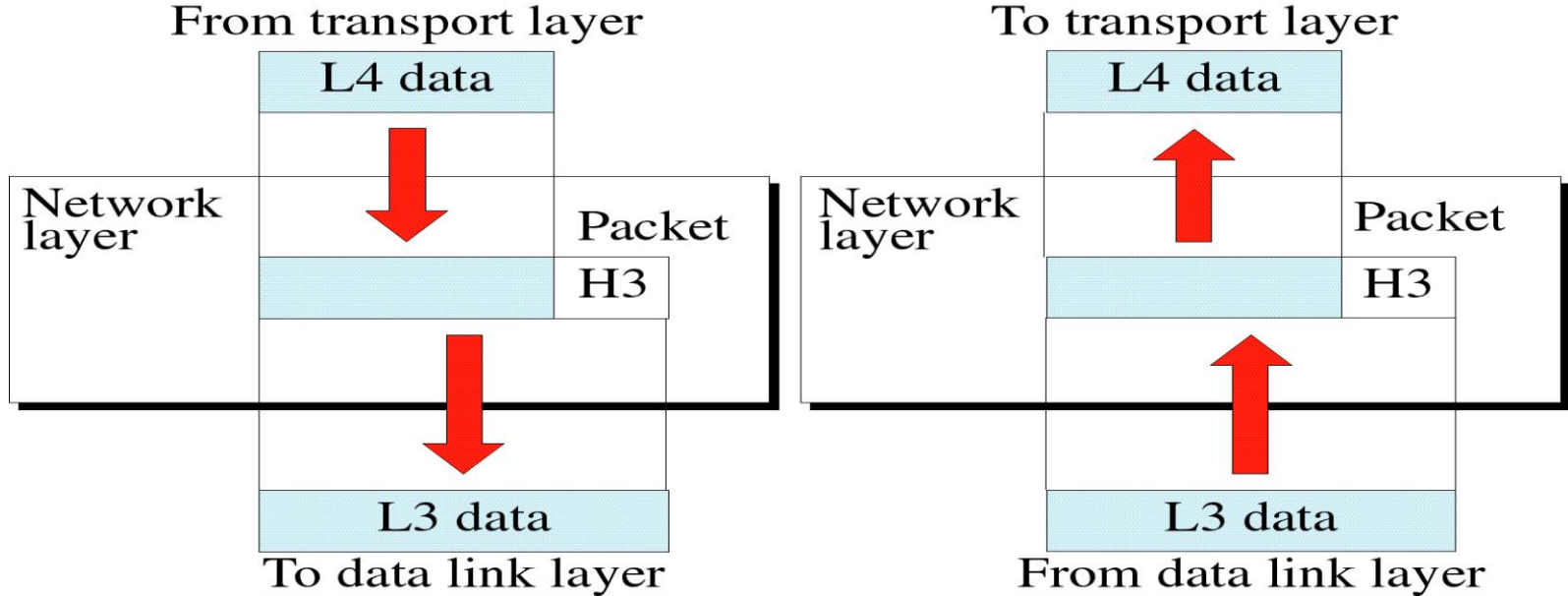
Network Layer - Functions



Routers operate at this layer – sending data throughout the extended network and making the Internet possible

- Internetworking
- Logical addressing
- Network routing
- Packet fragmentation and reassembly
- Delivery error reporting

Network Layer



Layer 4 - Transport Layer



- Responsible for end-to-end communication (and not delivery which is a function of network layer) between application processes on different hosts

Transport Layer

- Controls reliability of a given link through **flow control**, **segmentation**/desegmentation, and **error control**
 - Enables host to send and receive error corrected data, packets or messages over a network and is the network component that allows multiplexing.
 - (multiplexing: a technique which can combine and send multiple communication signals over a single medium (cable))
 - segmentation: data from the session layer is divided into segments, as such on the transport layer, data is referred to as segments



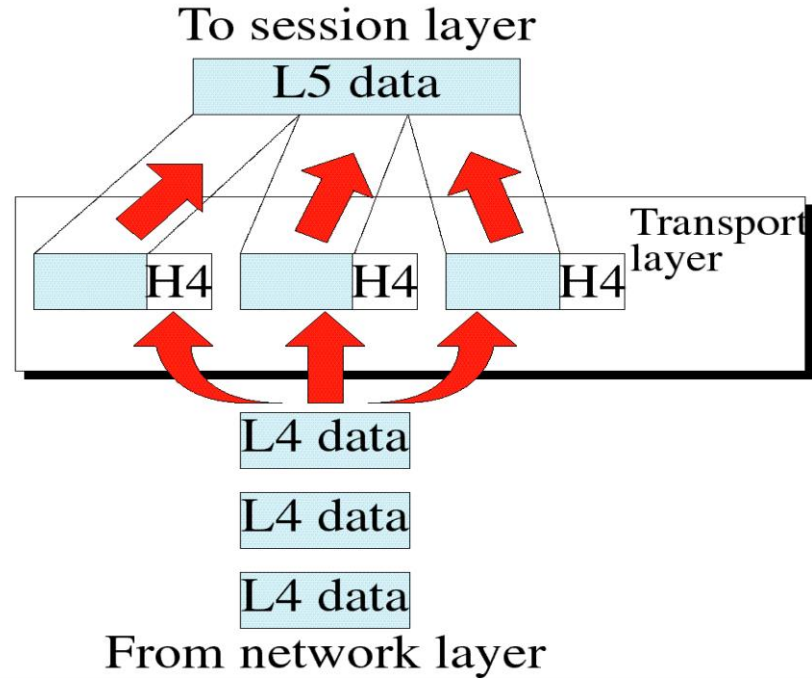
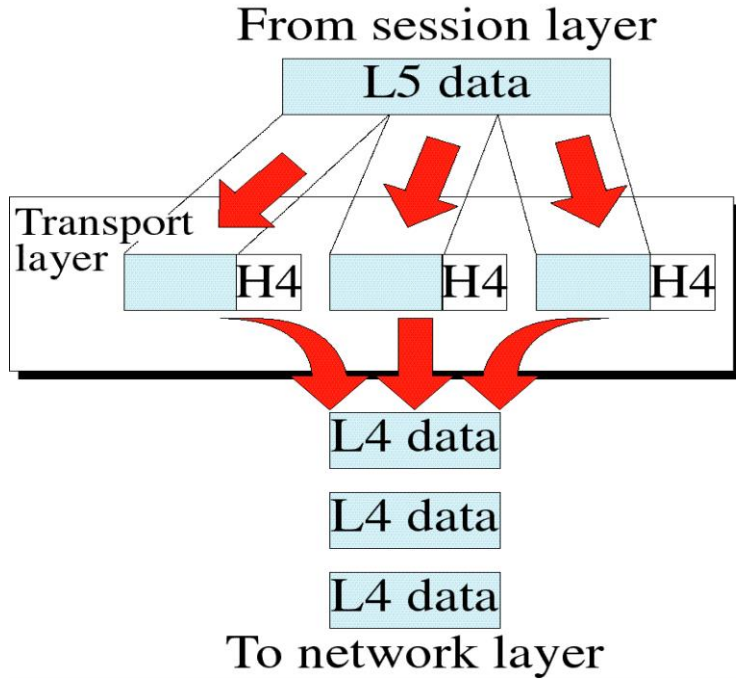
Transport Layer



- Looks after delivery of an entire message considering all its packets and makes sure that all packets are in order. On the other hand the network layer (layer 3) treats each packet independently
- At the source side, TL receives a message from the upper layer and divides the message into segments (packets for the network layer), TL then reassembles these packets again into a message at the destination side.



Transport Layer



Transport Layer



- Transport Layer provides two types of services:

Connection Oriented Transmission: In this type of transmission the receiving devices sends an acknowledge back to the source after a packet or group of packet is received. It is a slower transmission method. The Protocol in use here is TCP

Connectionless Transmission: In this type of transmission the receiving devices does not send an acknowledge back to the source. It is a faster transmission method. Protocol here is UDP



Transport Layer - Functions

- **Segmentation** (Breaking Down) of a message into packets & reassembly of packets into message.
- **Port addressing:** Computers run several processes. TL header includes a **port address** with each process.
- **Flow Control:** Flow control facility prevents the source from sending data packets faster than the destination can handle.
- **Error control:** TL ensures that the entire message arrives at the receiving TL **without error**.



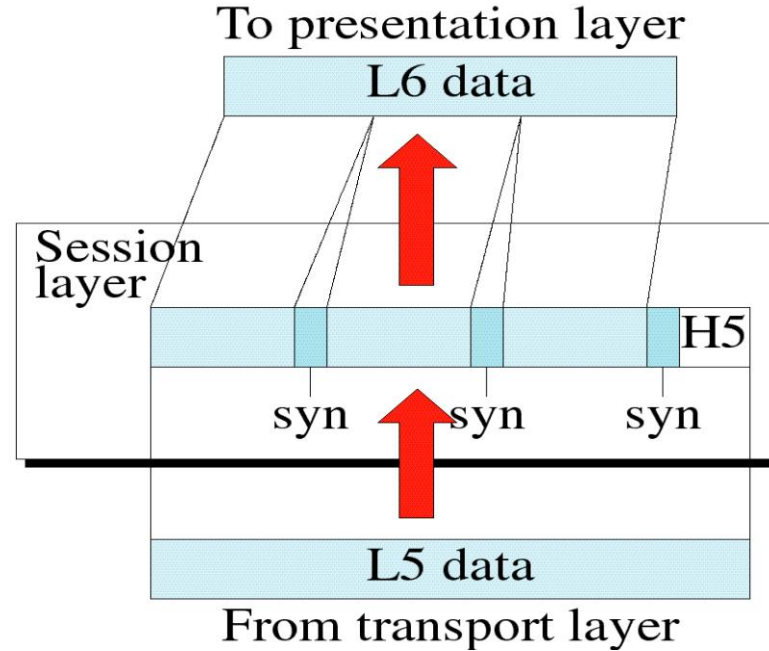
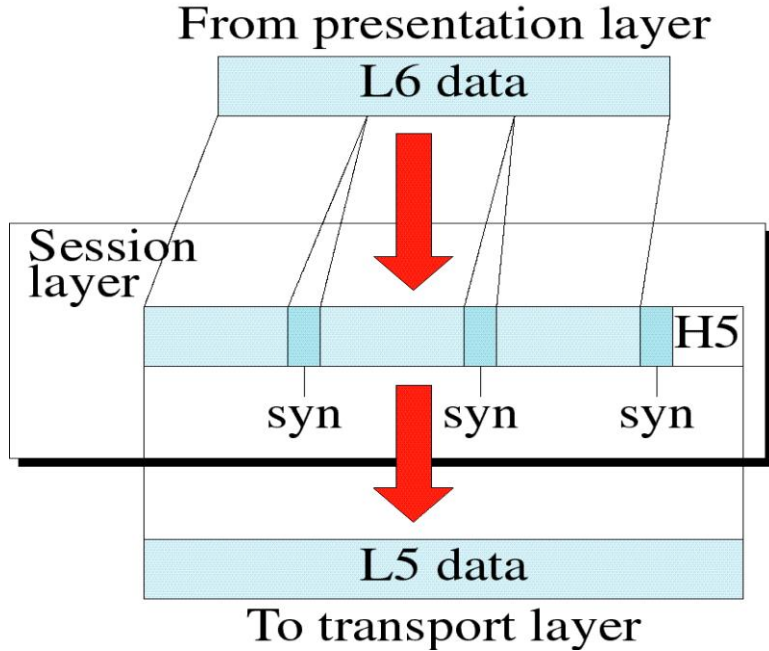
Layer 5 - Session Layer

- Controls connections called sessions between computers
 - connections also known as dialogues
- Establishes, manages and terminates the connections between the local and remote application
- Provides for full-duplex, half duplex or simplex operation, and establishes check-pointing, adjournment, termination, and restart procedures

*Exercise: describe check-pointing and adjournment regarding the OSI Session Layer

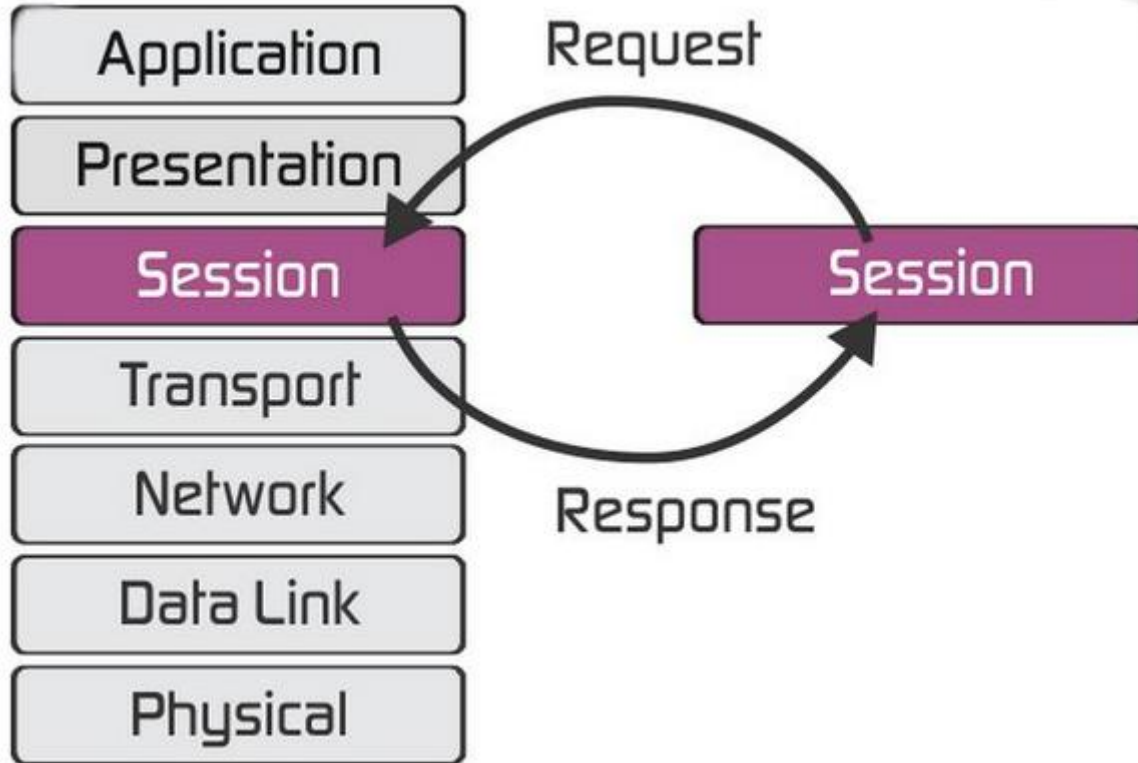


Session Layer





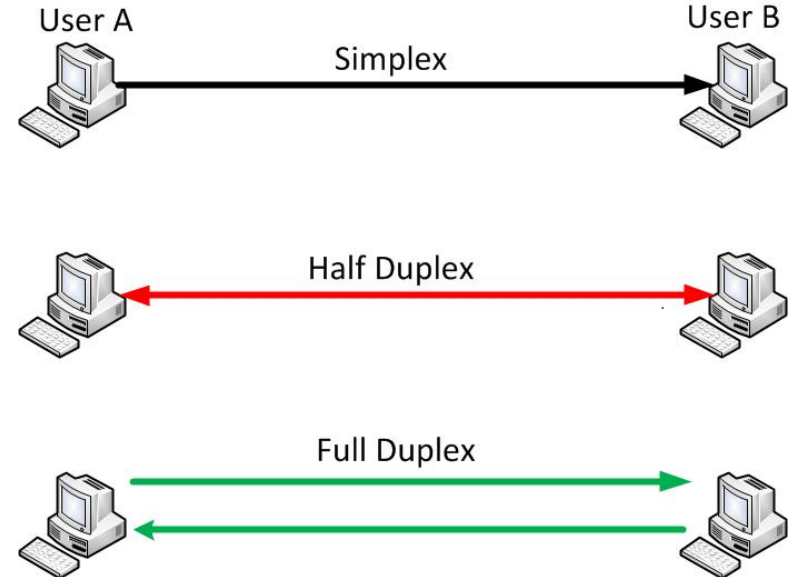
Session Layer





Session Layer - Functions

- Establishing, Maintaining and ending a session
- Determines the Type of Communication:
 - Full-Duplex - upload and Download simultaneously ..send & receive simultaneously
 - or Half-Duplex – send and then receive one after the other



Session Layer – Functions [2]



- **Dialog Control:** The Session layer determines *which device will communicate first and the amount of data* that will be sent.
- **Dialog separation:** The process of adding checkpoints to the stream of data is called dialog separation.
- It **establishes, manages and terminates** the connections between local and remote applications.



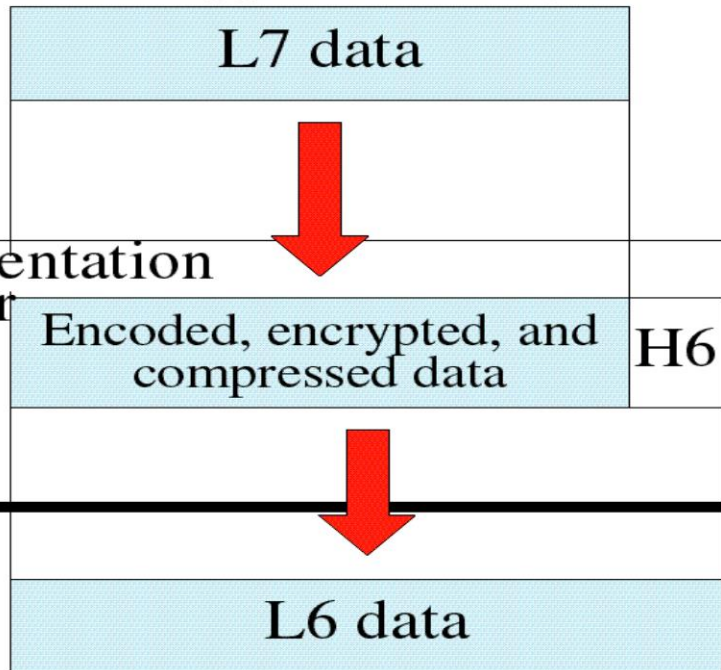
Layer 6 - Presentation layer

- This layer provides independence from differences in data representations by translating data from the application(s) to a network format, and vice versa.
- This layer formats and encrypts data to be sent across a network, providing freedom from compatibility problems.
- It is sometimes called the syntax layer.
- It is also responsible for data compression



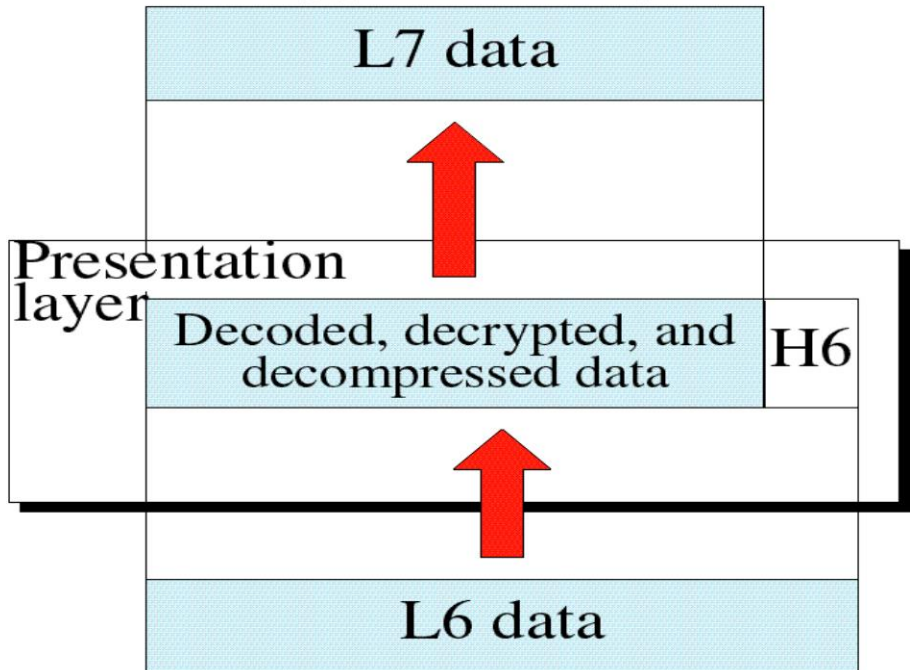
Presentation Layer

From application layer



To session layer

To application layer



From session layer

Layer 7 - Application layer



- The application layer is the OSI layer closest to the end user, as both the OSI Application layer and the user interact directly with the software application.
- Application layer functions include:
 - identifying communication partners,
 - determining resource availability,
 - synchronizing communication.

Application Layer – Functions



- **Identifying communication partners**
 - Determines the identity and availability of communication partners / communication applications for an application with data to transmit.
- **Determining resource availability**
 - Decide whether sufficient network or the requested communication exist.
- **Synchronizing communication**
 - All communication between applications requires cooperation that is managed by the application layer.



Application Layer – Implementation Examples

- Some examples of application layer implementations include
 - Hypertext Transfer Protocol (HTTP)
 - File Transfer Protocol (FTP)
 - Simple Mail Transfer Protocol (SMTP)

Introduction to TCP/IP



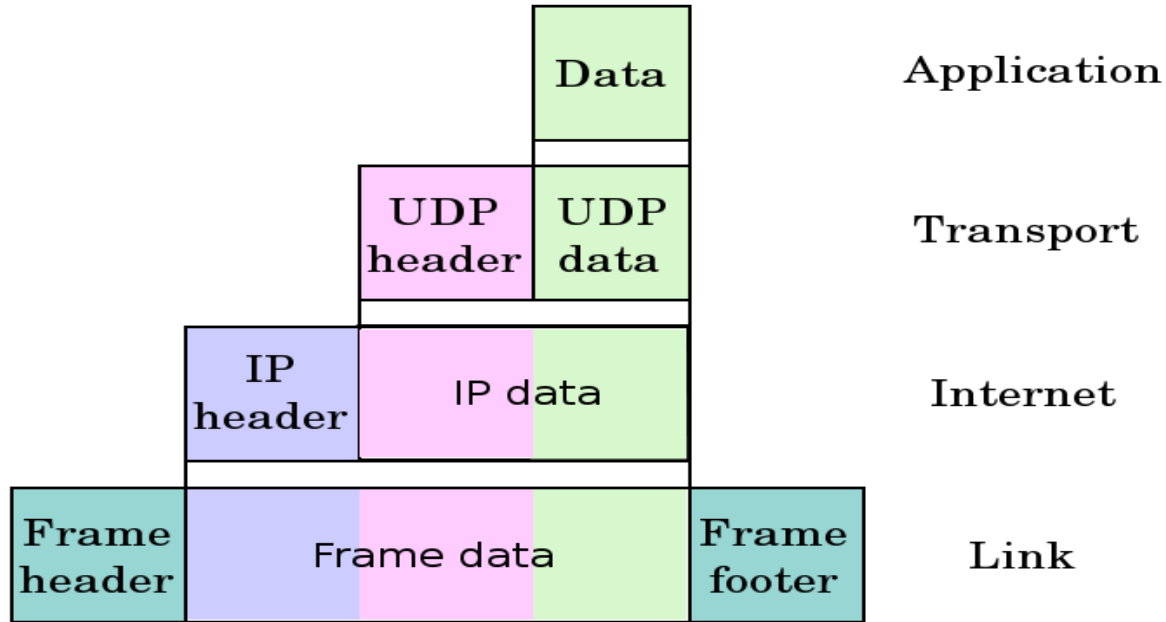
- The **Internet Protocol Suite** (commonly known as **TCP/IP**) is the set of communications protocols used for the Internet and other similar networks.
- It is named from two of the most important protocols in it:
 - the Transmission Control Protocol (TCP) and
 - the Internet Protocol (IP), which were the first two networking protocols defined in this standard.

OSI and TCP/IP Model - Layer Comparison



OSI Model	TCP/IP Model
Application Layer	Application Layer TELNET, FTP, SMTP, POP3, SNMP, NNTP, DNS, NIS, NFS, HTTP, ...
Presentation Layer	
Session Layer	
Transport Layer	Transport Layer TCP, UDP, ...
Network Layer	Internet Layer IP, ICMP, ARP, RARP, ...
Data Link Layer	Link Layer FDDI, Ethernet, ISDN, X.25, ...
Physical Layer	

TCP/IP Encapsulation



TCP/IP Some Protocol Examples



Layer	Protocol
<u>Application</u>	DNS , TFTP , TLS/SSL , FTP , Gopher , HTTP , IMAP , IRC , NNTP , POP3 , SIP , SMTP , SMPP , SNMP , SSH , Telnet , Echo , RTP , PNRP , rlogin , ENRP
	Routing protocols like BGP and RIP which run over TCP/UDP, may also be considered part of the Internet Layer.
<u>Transport</u>	TCP , UDP , DCCP , SCTP , IL , RUDP , RSVP
<u>Internet</u>	IP (IPv4 , IPv6), ICMP , IGMP , and ICMPv6
	OSPF for IPv4 was initially considered IP layer protocol since it runs per IP-subnet, but has been placed on the Link layer since RFC 2740 .
<u>Link</u>	ARP , RARP , OSPF (IPv4/IPv6), IS-IS , NDP