COMPUTER NETWORK

Prof. Kirtankumar Rathod
Dept. of Computer Science
ISHLS, Indus University

INTRODUCTION

- A computer network is a telecommunications network that allows computers to exchange data.
- The physical connection between networked computing devices is established using either cable media or wireless media.
- The best-known computer network is the internet.

COMPUTER NETWORK

- A collection of computing devices that are connected in various ways in order to communicate and share resources.
- Usually, the connections between computers in a network are made using physical wires or cables.
- However, some connections are **wireless**, using radio waves or infrared signals.

TYPES OF NETWORK

- Based on the size and the coverage area, networks are categorized into the following types:
  1. Personal Area Network (PAN)
  2. Local Area Network (LAN)
  3. Metropolitan Area Network (MAN)
  4. Wide Area Network (WAN)

PERSONAL AREA NETWORK (PAN)

- A personal area network (PAN) is a computer network used for communication among computer and different information technological devices close to one person.

- It is a small network established for communication between different devices, such as laptops, computers, mobiles, and PDAs.

- A pan may include wired and wireless devices.

- The reach of a pan typically extends to 10 meters.

LOCAL AREA NETWORK(LAN)

- A local area network (LAN) is a network that connects computers and devices in a limited geographical area such as a home, school, office building, or closely positioned group of buildings.

- Each computer or device on the network is a node.

- Wired LANs are most likely based on Ethernet technology.

Metropolitan Area Network

- It is relatively larger than LAN and extends across a city or a metropolitan.

- It is created by connecting two or more LANs located at different locations in a city.

WIDE AREA NETWORK(WAN)

- A wide area network (WAN) is a computer network that covers a large geographic area such as a city, country, or spans even intercontinental distances.

- A WAN uses a communications channel that combines many types of media such as telephone lines, cables, and air waves.

- One of the most prominent examples of the existing wans is the Internet.

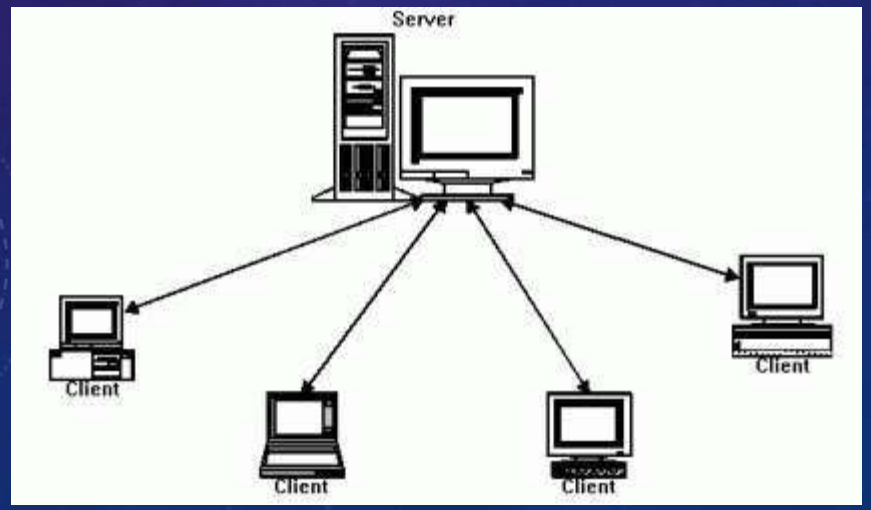
ARCHITECTURE

- The architecture of a network is a logical design that determines how the devices in the network communicate.
- The commonly used architectures for computer networks are:

1. Client-server architecture
2. Peer-to-peer architecture

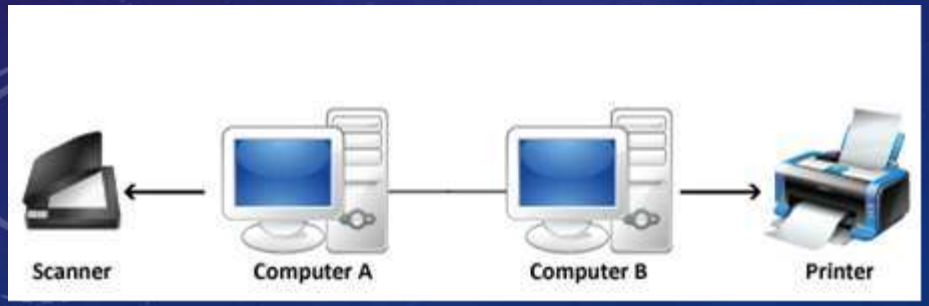
CLIENT-SERVER ARCHITECTURE

- On a network built using the client-server architecture, the devices communicate to other devices through a central computer referred to as a server.
- The server is a terminal with high processing power, which provides services for the other computers on the network.
- The client is a terminal that accesses the resources available on a server.



PEER-TO-PEER ARCHITECTURE

- On a network built using the peer-to-peer architecture, no specific distinction exists between a client and a server.
- Any node can provide a service as well as send a request for a service from another node on the network.
- The peer-to-peer network architecture allows sharing of resources, data, and users.
- Each node on the network has full control over the network resources.

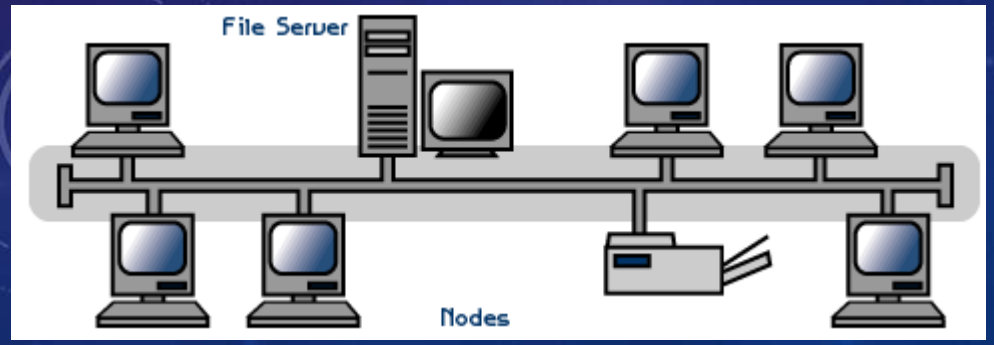


NETWORK TOPOLOGY

- The pattern of interconnection of nodes in a network is called the Topology.
- This layout also determines the manner in which information is exchanged within the network.
- The different types of network topologies that can be used to set up a network are:
  1. Bus Topology
  2. Star Topology
  3. Ring Topology
  4. Mesh Topology
  5. Tree Topology
  6. Hybrid Topology

BUS TOPOLOGY

- Popular topology for data network.
- Single transmission medium onto which various nodes are attached.
- Normally coaxial cable is used.
- Terminators at both end of BUS absorb signal, removing it from BUS.



STAR TOPOLOGY

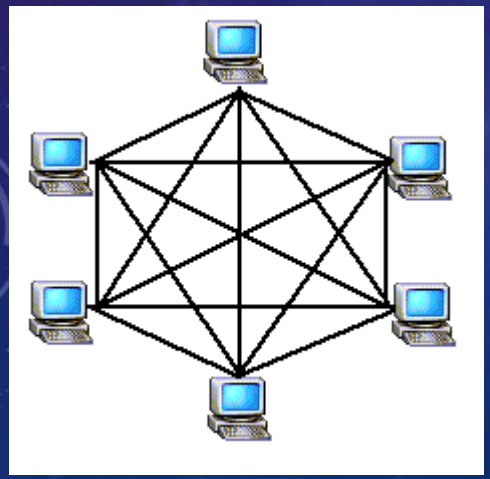
- The star topology connects nodes over a network using a central control unit called the hub.
- You can easily add nodes to a star-based network by attaching the required nodes to the hub.
- Setting up a star topology requires a lot of cabling because all the nodes have to connect to the hub.

RING TOPOLOGY

- The ring topology connects the nodes on a network through a point- to-point connection.
- Data is accepted from one neighboring node transmitted to other.
- Data travels in one direction.
- If one of the nodes on the network stops, the entire network stops functioning.

MESH TOPOLOGY

- Each node is connected to more than one node.
- This provide an alternate route mechanism.
- Excellent for long distance networking.
- Supports back-up and rerouting.
- Used in large internetworking environments with stars, rings and buses as nodes .

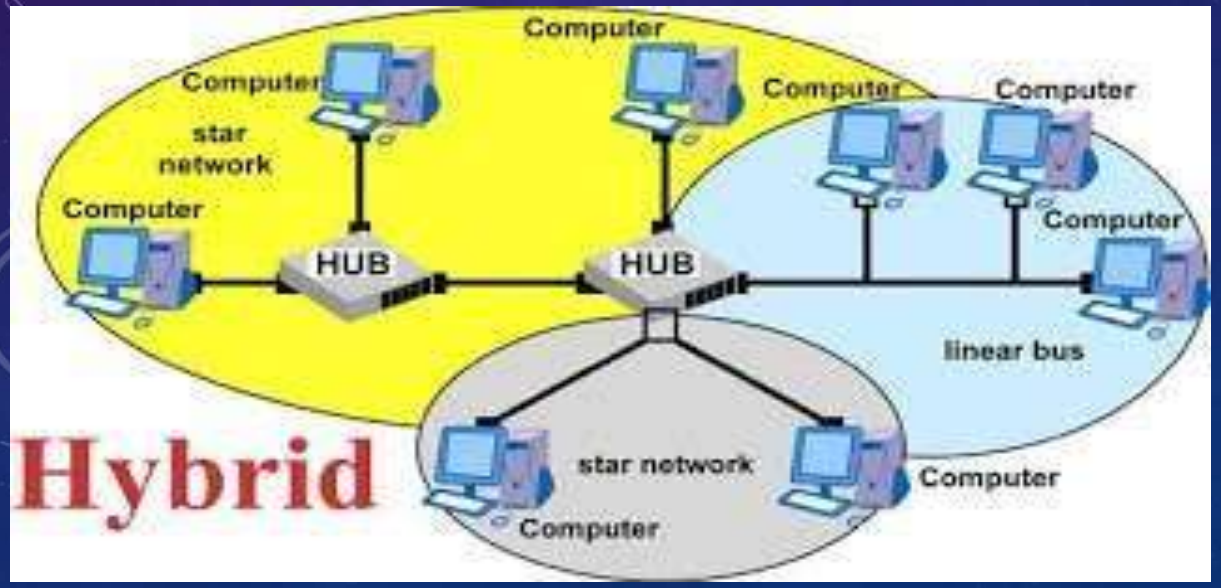


TREE TOPOLOGY

- The tree topology is created where the nodes are connected in a hierarchical manner.
- In tree topology, the device at the root is referred to as the parent for all the other nodes or devices in the network.
- The nodes below a parent node are referred to as child nodes.

HYBRID TOPOLOGY

- The hybrid topology can be a combination of two or more basic topologies, such as bus, ring, star, mesh, or tree.
- Hybrid networks combine more than two topologies, which, in turn, enable you to get advantages of the constituent topologies.



Guided & Unguided Media

Prof. Kirtankumar Rathod
Dept. of Computer Science
ISHLS, Indus University

Guided Media :

- Guided Transmission media uses a cabling system that guides the data signals along a specific path .

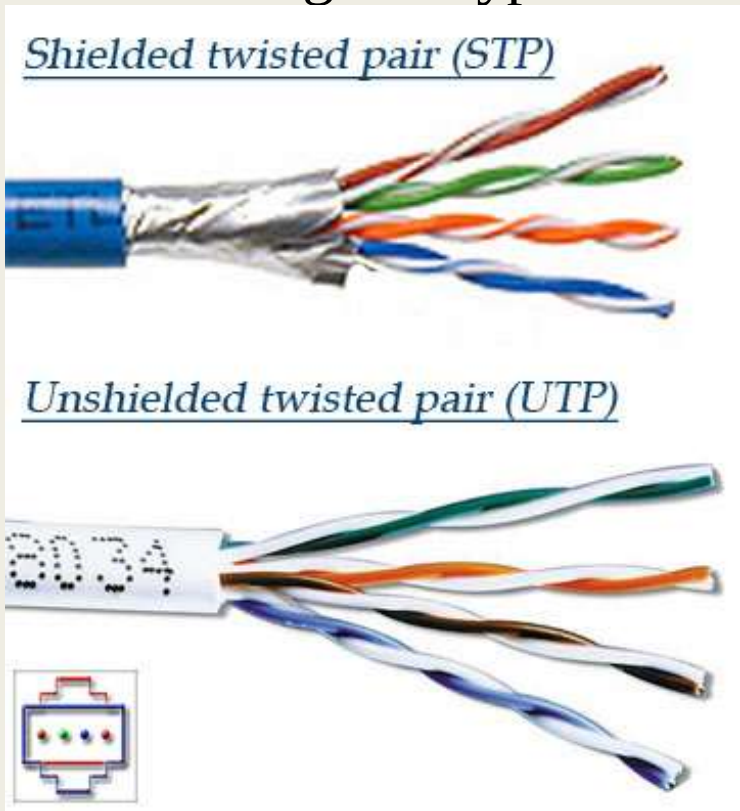
- The data signals are bound by the cabling system they don’t have any other way to go they have to pass through the given cable or wire.

- **Three Major Types**

1. Twisted Pair
2. Coaxial Cable
3. Optical Fiber

Twisted Pair Cable

- A twisted Pair consists of two insulated copper wires , twisted around each other in a continuous spiral .
- The purpose of twisting the wires is to reduce electrical interference.
- The twisted pair cable can be categorized into the following two types
    1. Unshielded Twisted Pair (UTP) Cable
    2. Shielded Twisted Pair (STP) Cable



Unshielded Twisted Pair (UTP) Cable

- The UTP consists of two copper conductors ,each having their own insulating material.
- The reason for placing twist in the pair of wires is to minimize the vulnerability of the twisted pair cable to external electrical noise.

  - **Advantages Of Unshielded Twisted Pair (UTP) Cable :**
    - 100 meter limit
    - Installation is easy

  - **Disadvantages Of Unshielded Twisted Pair (UTP) Cable :**
    - Bandwidth Limitations
    - Limited performance over distance

Shielded Twisted Pair (UTP) Cable

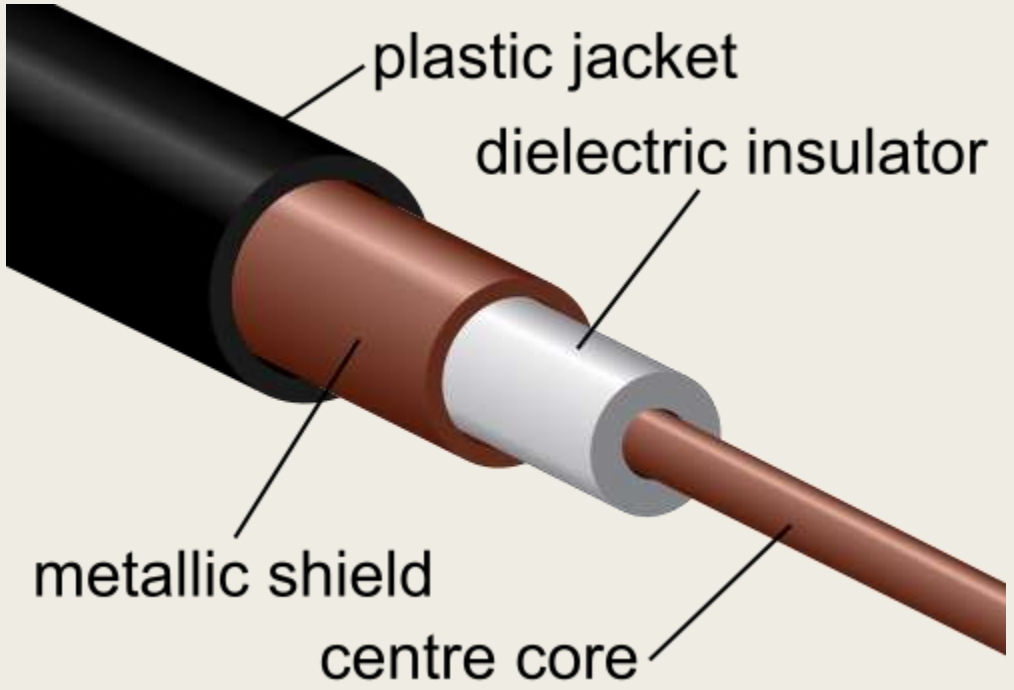
- An extra metallic on each pair.
- Pair of wires wound around each other placed inside a protective foil wrap.
- Provide better performance than UTP.

- **Advantages Of Shielded Twisted Pair (UTP) Cable :**
  - Easy to install
  - Can be used for Analog or digital transmission

- **Disadvantages Of Shielded Twisted Pair (UTP) Cable :**
  - Difficult to manufacture
  - Heavy

Coaxial Cable

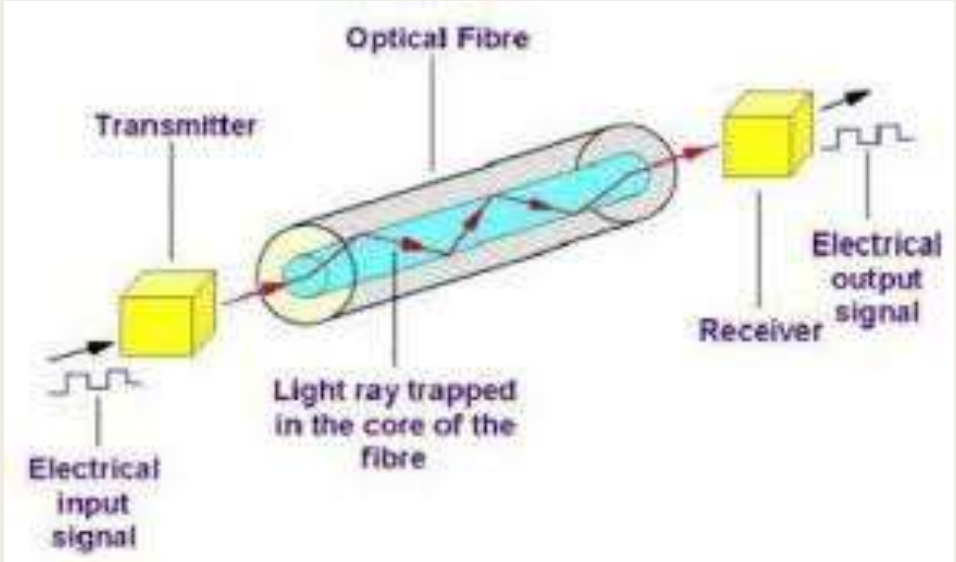
- Coaxial cables are the most common basic transmission lines .
- They are used to transmit electrical energy or signals .
- A coaxial cable consist of two conductors separated by a dielectric material .



Optical Fiber:

- An optical fiber is a flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair.

- Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than electrical cables.



Unguided Media

- Unguided media transport electromagnetic waves without using a physical conductor.
- This type of Communication often referred to as wireless communication. Wireless transmission can be used as the medium in both LAN and WAN environments.
- Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them. Unguided signals can travel from the source to the destination in many ways.
- **Three Major Types**

1. Radio Waves
2. Micro Waves
3. Infrared

Radio Waves

- Electromagnetic waves ranging in frequencies between 3 KHz and 1 GHz are normally called radio waves.
- Radio waves are omnidirectional. When an antenna transmits radio waves, they are propagated in all directions.
- Radio waves, particularly those waves that propagate in the sky mode, can travel long distances.
- Radio waves, particularly those of low and medium frequencies, can penetrate walls.
- AM and FM radio , television, and maritime radio are examples of multicasting.

Microwave

- Electromagnetic waves having frequencies between 1 and 300 GHz are called micro waves .
- Microwave signals are used to transmit data without the use of cables .
- Very high-frequency microwaves cannot penetrate walls.
- It is line-of-sight transmission , which means the signal travels in straight line free of material obstacles .
- Microwaves need unidirectional antennas that send out signals in one direction.
- Two types of antennas are used for microwave communication
  1. Dish antenna
  2. Horn Antenna

Infrared Wave

- Infrared waves, with frequencies from 300 GHz to 400 THz .
- It can be used for short range communication such as data transfer between two cell phones in one room .
- The infrared light transmits data through the air and can propagate throughout a room , but will not penetrate walls .
- We cannot use infrared waves outside a building because the sun's rays contain infrared waves that can interfere with the communication.

Open System Interconnection Model

Prof. Kirtankumar Rathod
Dept. of Computer Science
ISHLS, Indus University

WHAT IS A PROTOCOL?

- It is a formal description of message formats and the rules that two computers must follow in order to exchange messages.

- This set of rules describes how data is transmitted over a network.

WHY ARE PROTOCOLS NEEDED?

- Protocols are needed for communication between any two devices.
  - In what **format** will the messages be transmitted?
  - At what **speed** should messages be transmitted?
  - What to do if **errors** take place?
  - What to do if parts of a message are **lost**?

OPEN SYSTEMS INTERCONNECT (OSI)

- Developed by International Standards Organization (ISO).
- “Open” means the concepts are non- proprietary; can be used by anyone.
- OSI is not a protocol. It is a model for understanding and designing a network architecture that is flexible and robust.

OPEN SYSTEMS INTERCONNECT (OSI)

- The OSI model describes how data flows from one computer, through a network to another computer

- The OSI model divides the tasks involved with moving information between networked computers into 7 smaller, more manageable sub-task .

- Each layer is reasonably self-contained so that the tasks assigned to each layer can be implemented independently.

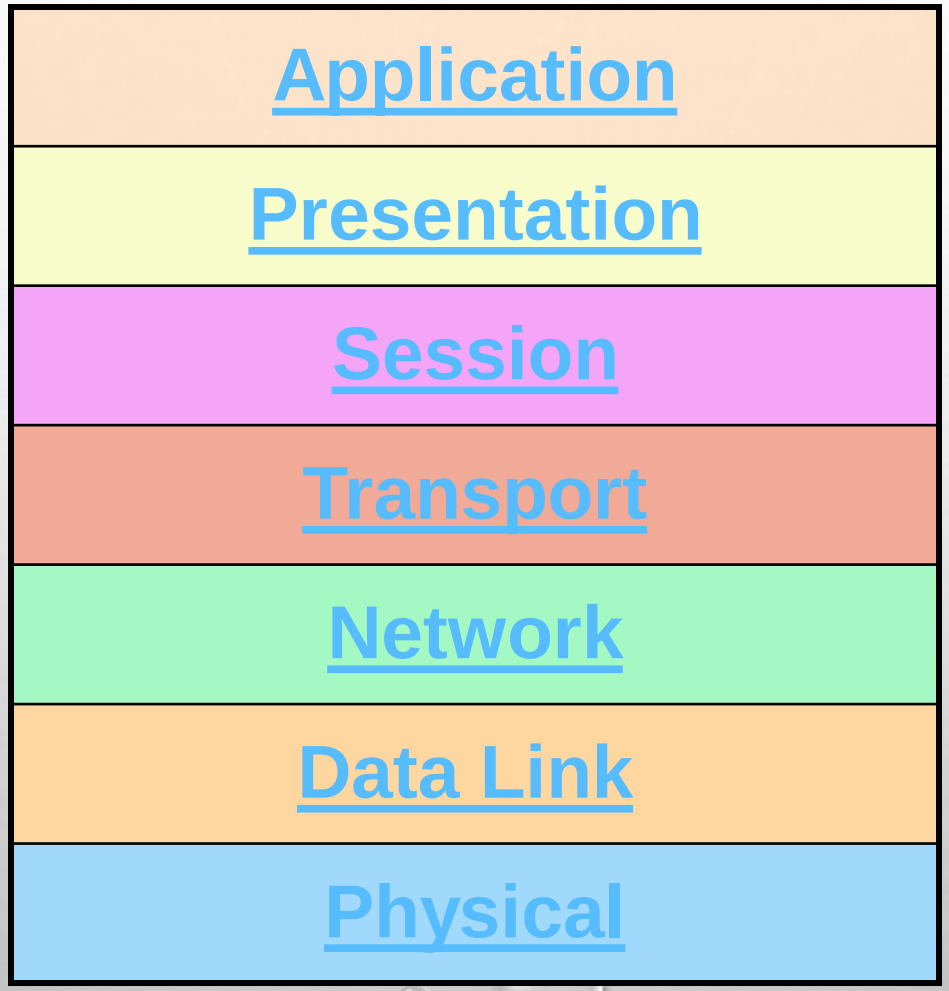
CONCEPT OF SERVICES AND PROTOCOLS

- A service is a set of operations that a layer provides to the layer above it.
- Service defines what operations the layer is prepared to perform.
- A service relates to the interface between two layers – the lower layer is service provider and the upper layer is service user.

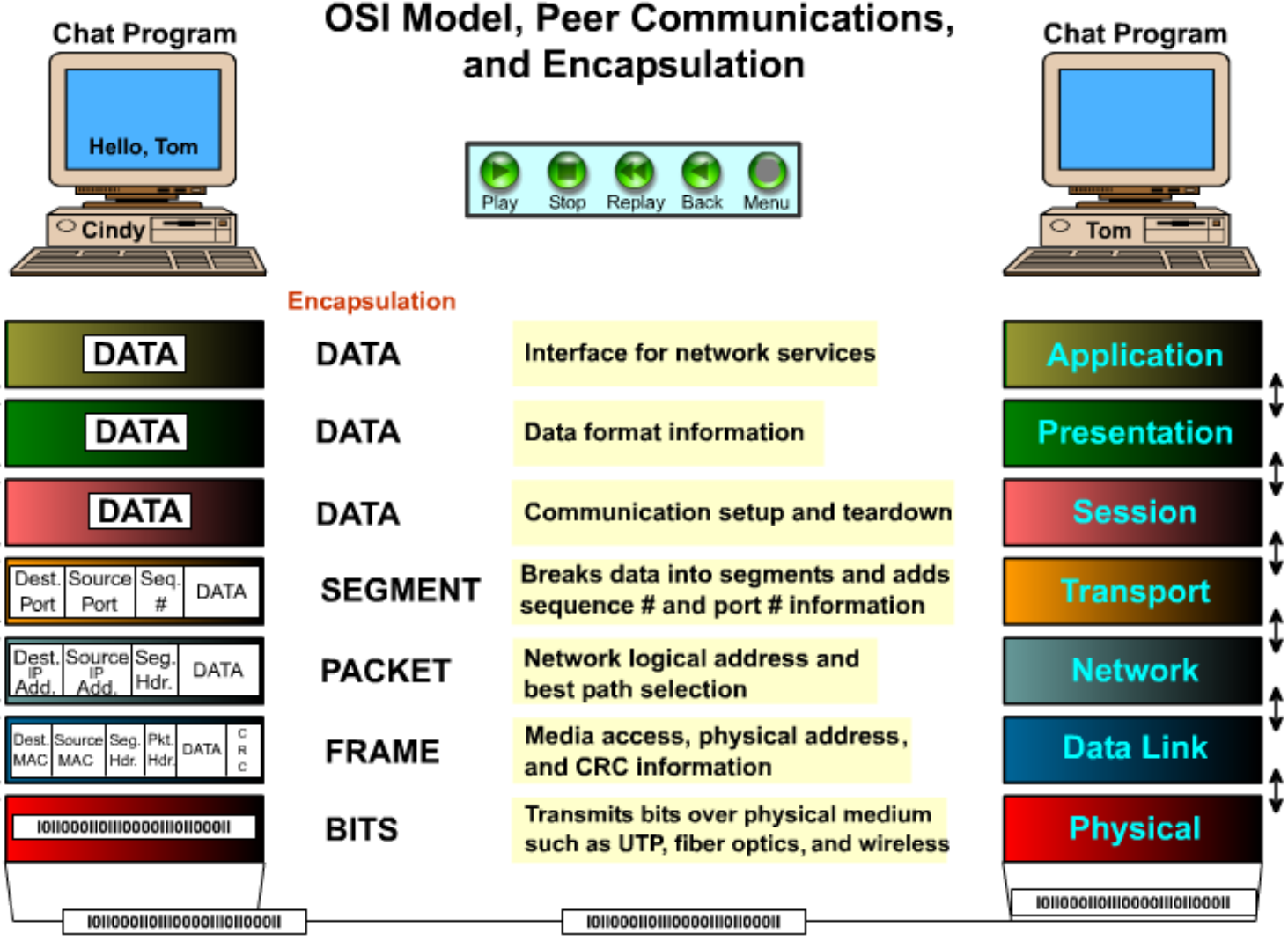
CONCEPT OF SERVICES AND PROTOCOLS

- A protocol is a set of rules governing the format and meaning of the packets.
- Protocols relate to packets sent between peer entities on different machines.
- Entities use protocols.

THE LAYERS OF THE OSI MODEL

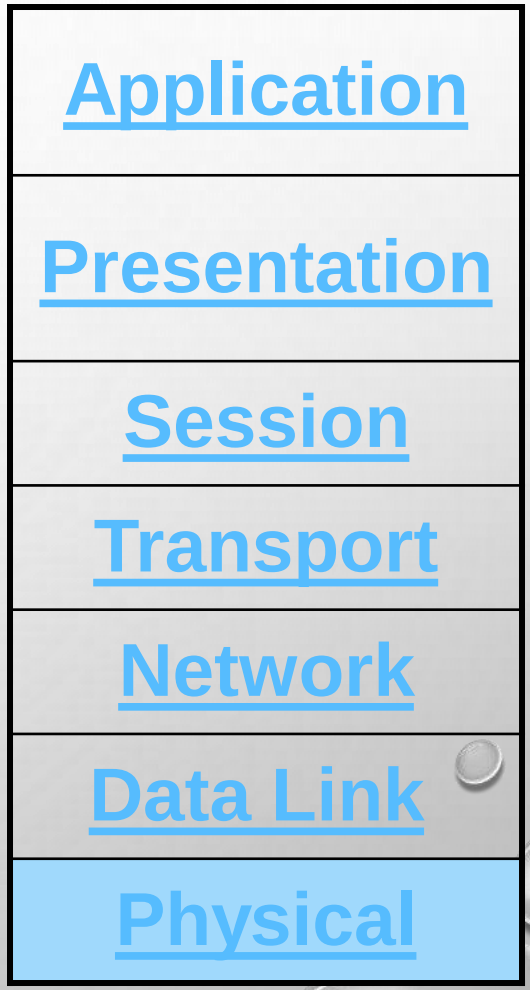


OSI Model, Peer Communications, and Encapsulation

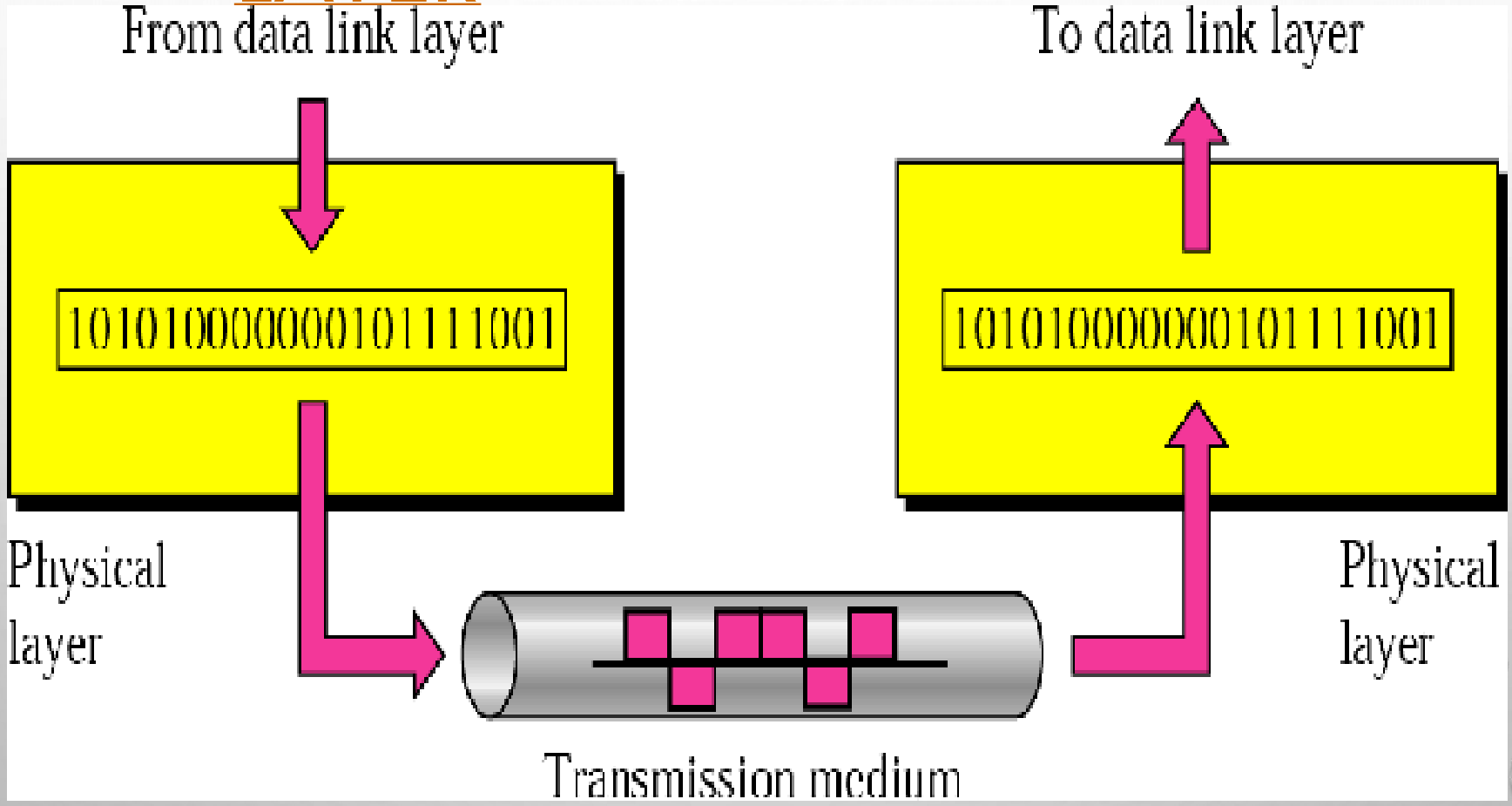


PHYSICAL LAYER

- Specifications for the physical components of the network.
- Functions of Physical Layer:
  - Bit representation – encode bits into electrical or optical signals
  - Transmission rate – The number of bits sent each second
  - Physical characteristics of transmission media
  - Synchronizing the sender and receiver clocks
  - Transmission mode – simplex, half-duplex, full duplex
  - Physical Topology – how devices are connected – ring, star, mesh, bus topology



PHYSICAL LAYER

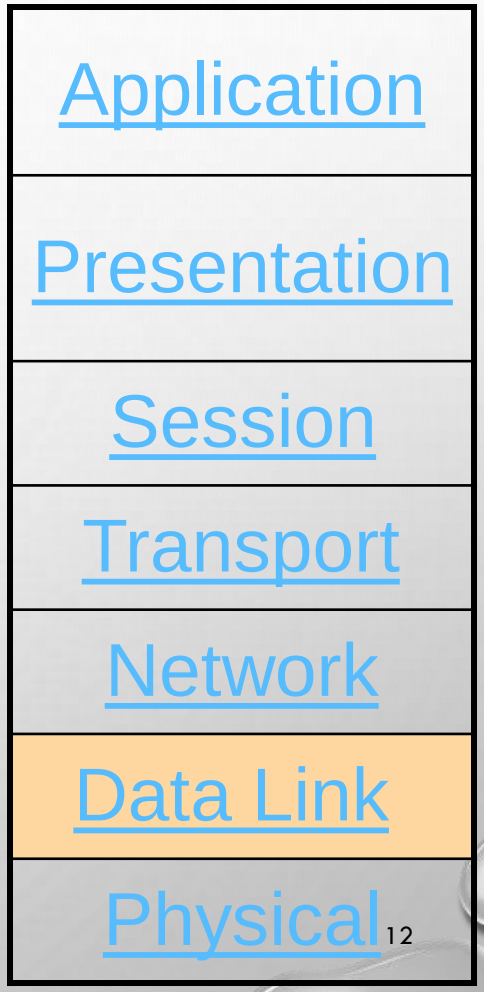


DATA LINK LAYER

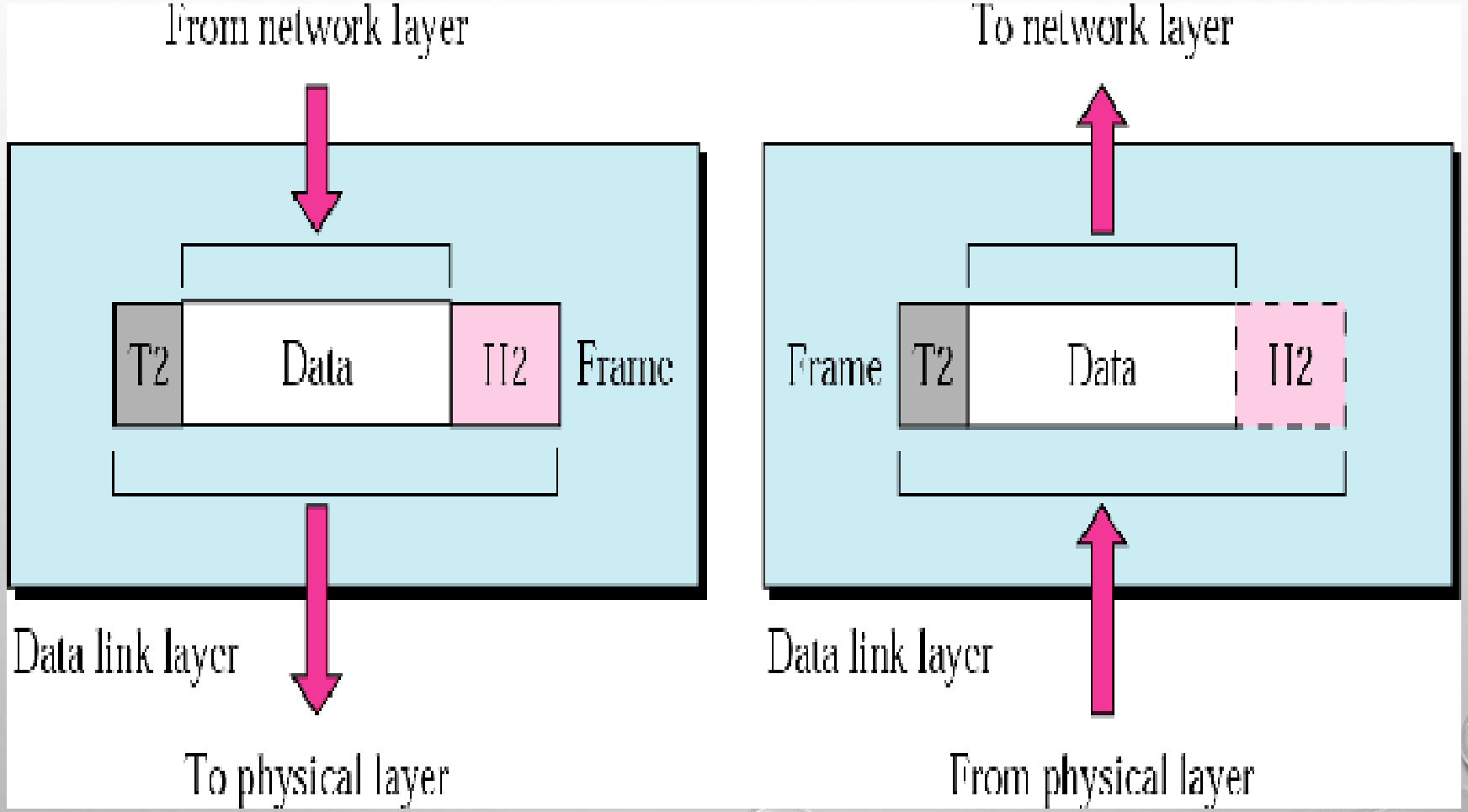
Responsible for delivery of data between two systems on the same network

Main functions of this layer are:

- Framing – divides the stream of bits received from network layer into manageable data units called frames.
- Physical Addressing – Add a header to the frame to define the physical address of the source and the destination machines.
- Flow control – Impose a flow control – control rate at which data is transmitted so as not to flood the receiver (Feedback-based flow control)
- Error Control – Adds mechanisms to detect and retransmit damaged or lost frames. This is achieved by adding a trailer to the end of a frame



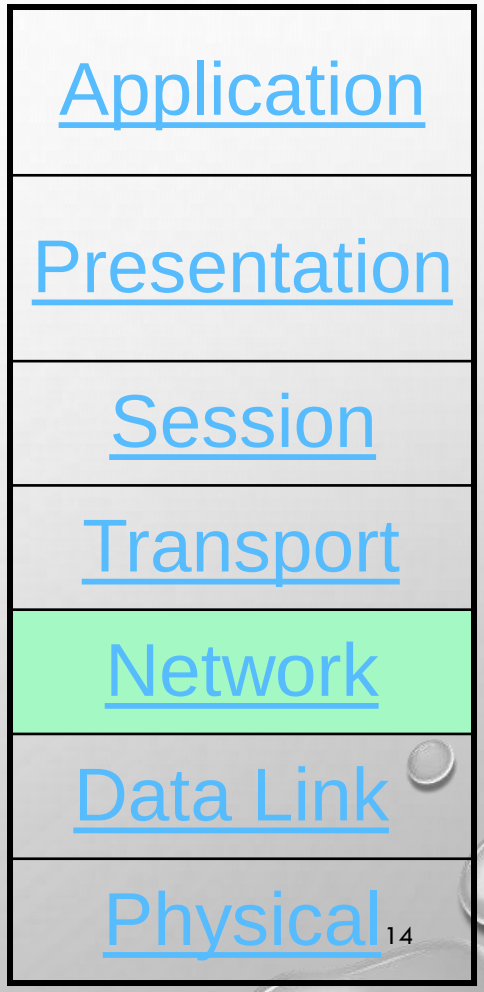
DATA LINK LAYER



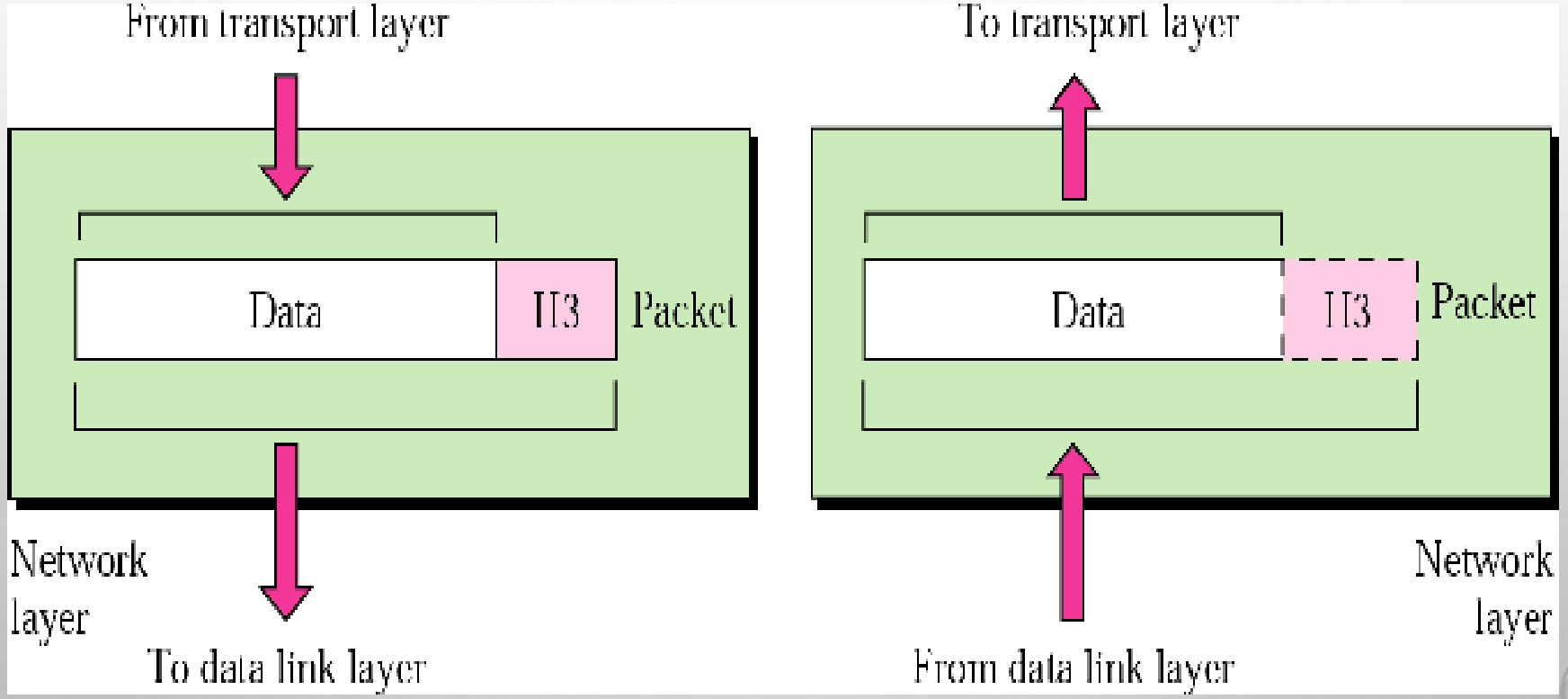
NETWORK LAYER

Main functions of this layer are:

- Responsible for delivery of packets across multiple networks
- Routing – Provide mechanisms to transmit data over independent networks that are linked together.
- Network layer is responsible only for delivery of individual packets and it does not recognize any relationship between those packets



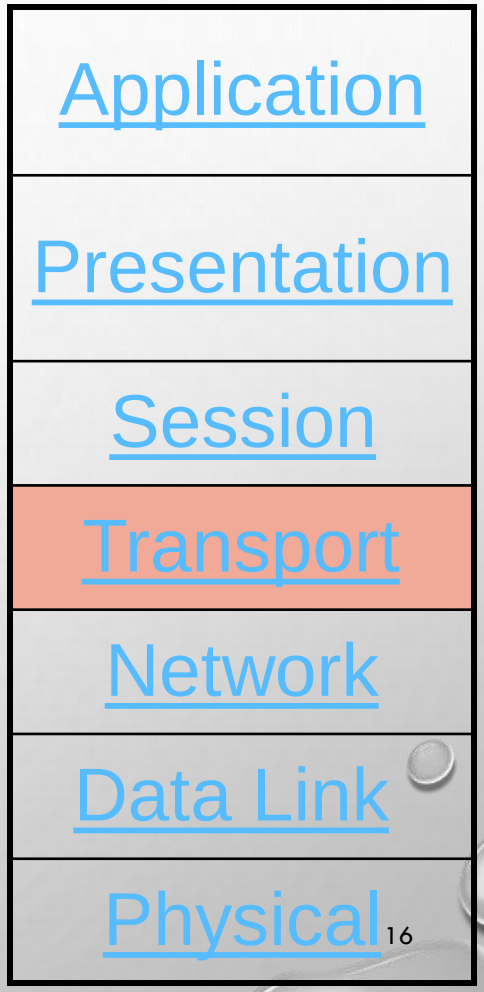
NETWORK LAYER



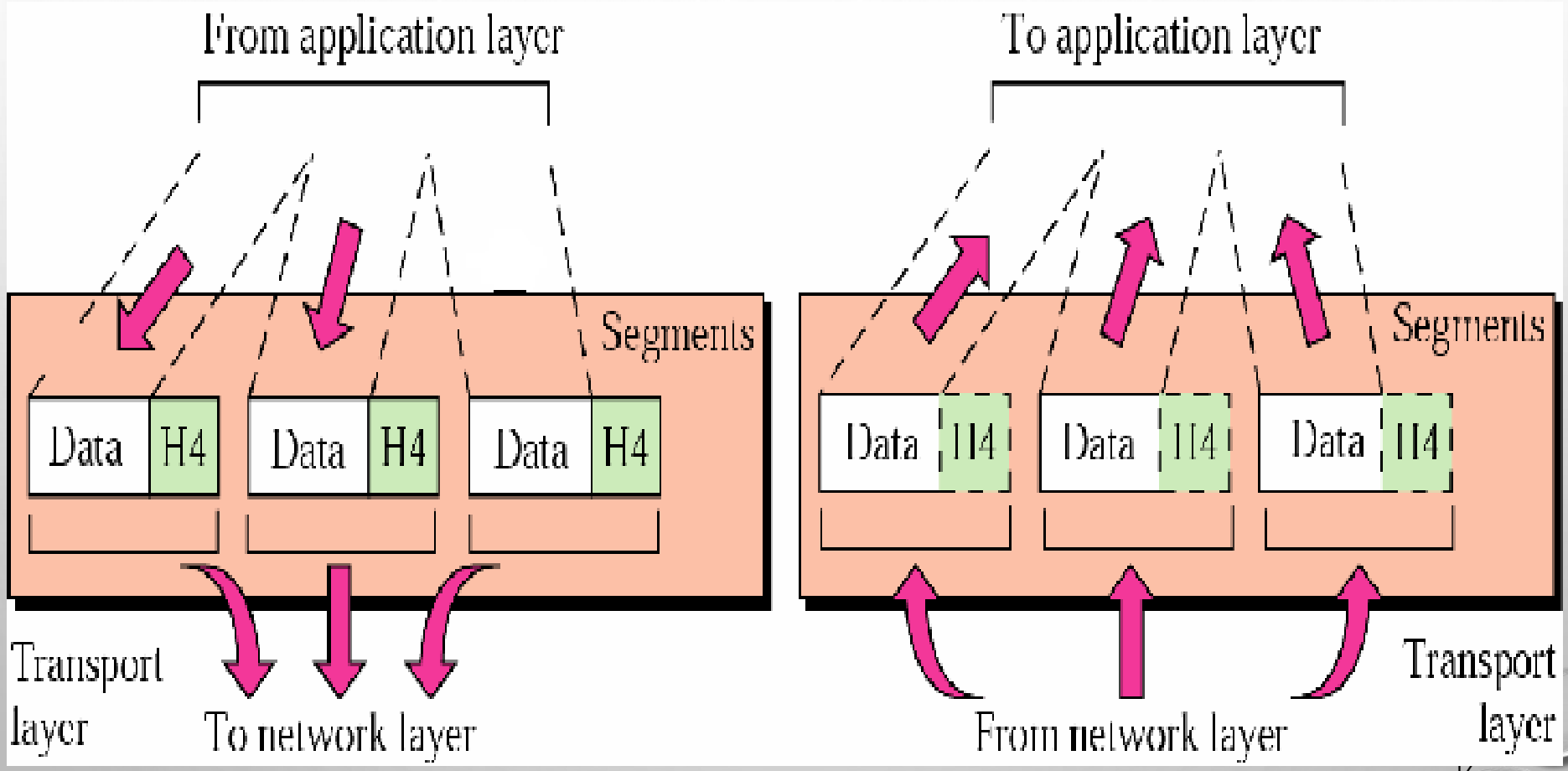
TRANSPORT LAYER

Main functions of this layer are:

- Responsible for source-to-destination delivery of the entire message
- Segmentation and reassembly – divide message into smaller segments, number them and transmit. Reassemble these messages at the receiving end.
- Error control – make sure that the entire message arrives without errors – else retransmit.



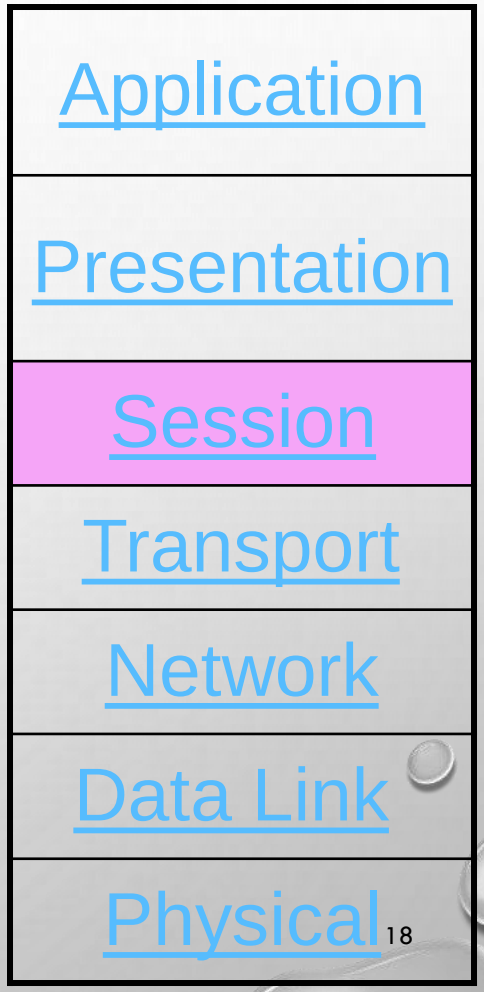
TRANSPORT LAYER



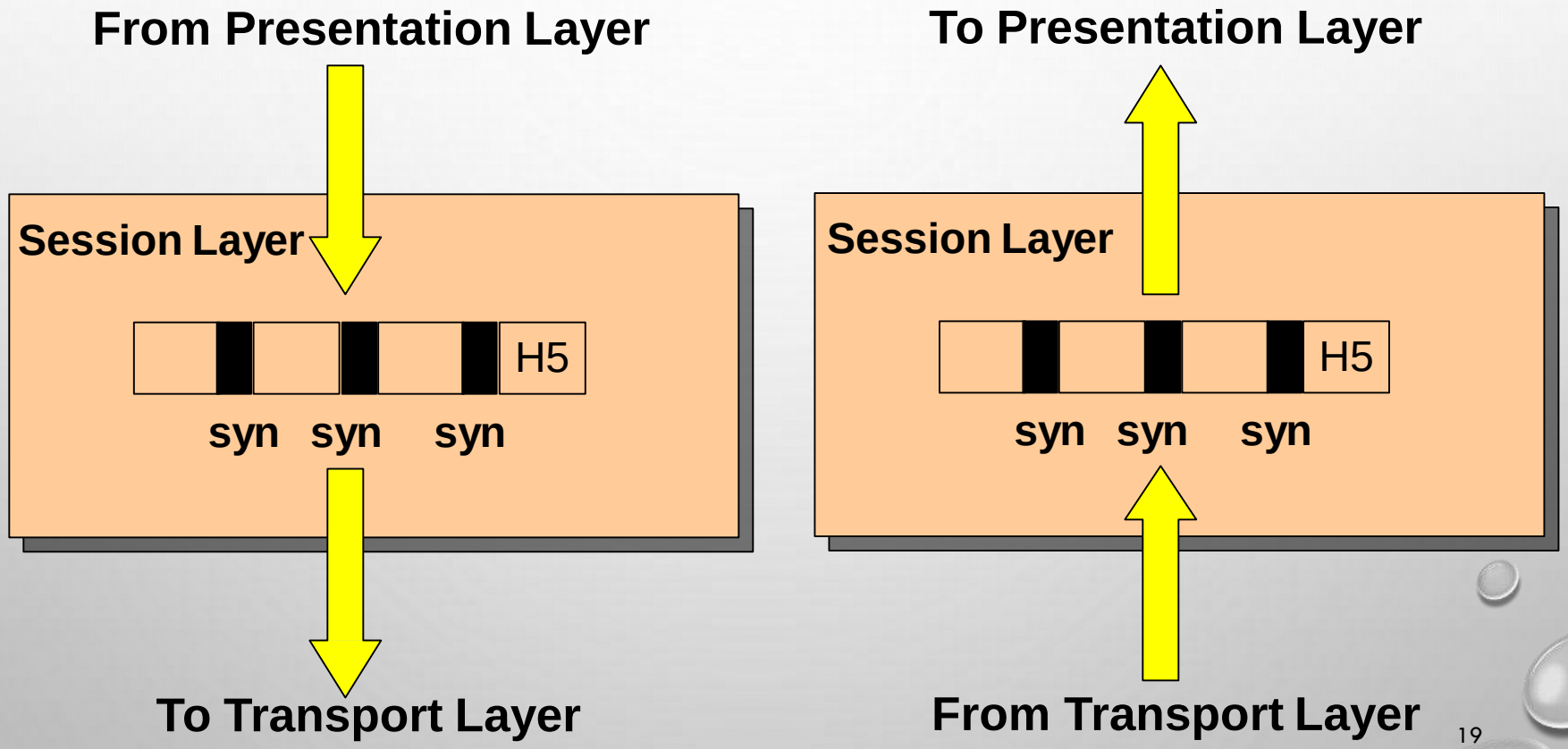
SESSION LAYER

Main functions of this layer are:

- Dialog control – allows two systems to enter into a dialog, keep a track of whose turn it is to transmit
- Synchronization – adds check points (synchronization points) into stream of data.



SESSION LAYER



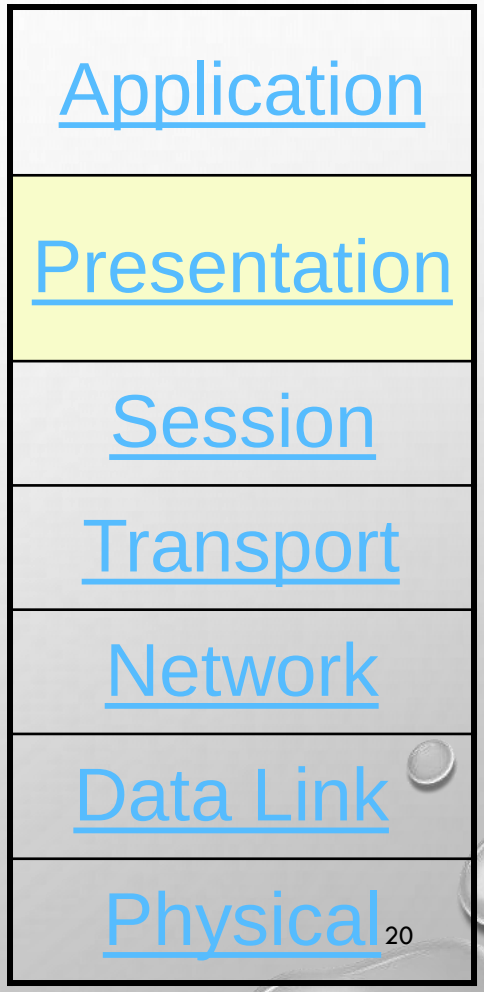
PRESENTATION LAYER

Responsibilities of this layer are:

- Translation

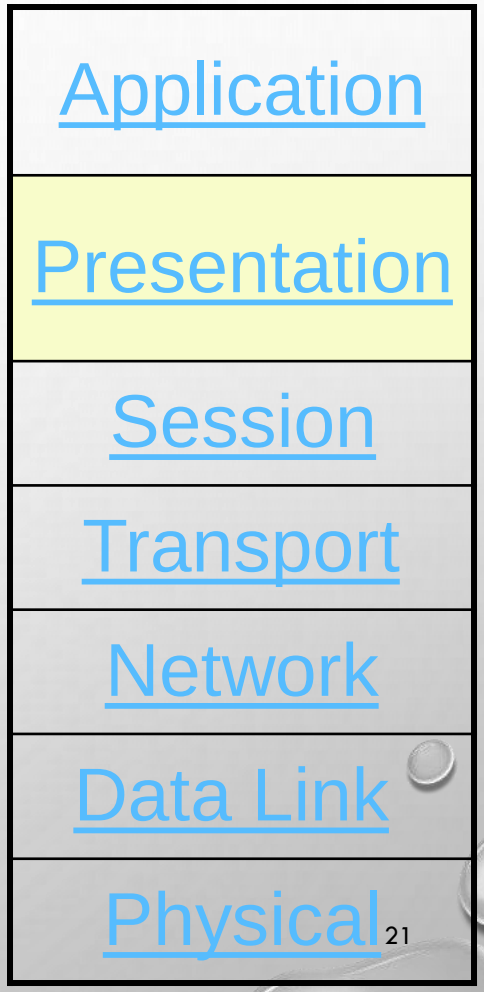
- DIFFERENT COMPUTERS USE DIFFERENT ENCODING SYSTEMS (BIT ORDER TRANSLATION)
- CONVERT DATA INTO A COMMON FORMAT BEFORE TRANSMITTING.
- SYNTAX REPRESENTS INFO SUCH AS CHARACTER CODES - HOW MANY BITS TO REPRESENT DATA – 8 OR 7 BITS

- Compression – reduce number of bits to be transmitted



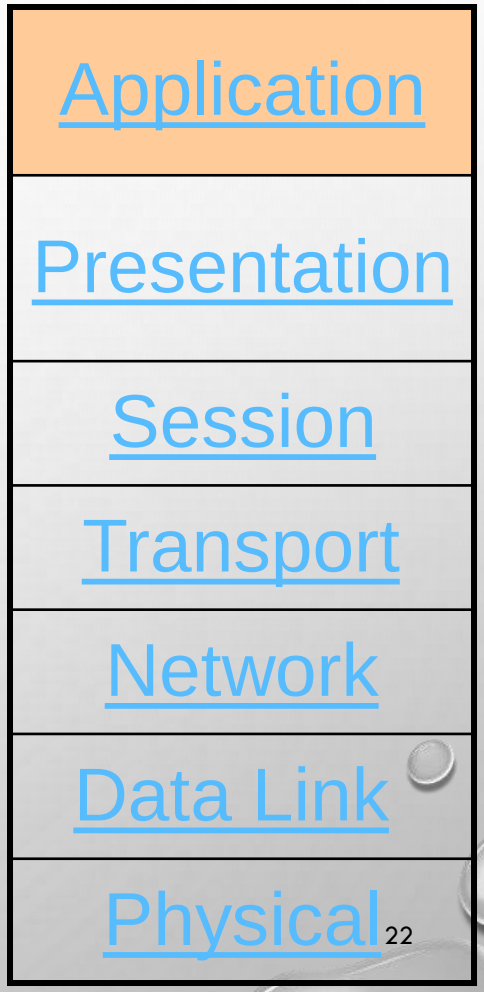
PRESENTATION LAYER

- Encryption – transform data into an unintelligible format at the sending end for data security
- Decryption – at the receiving end



APPLICATION LAYER

- Contains protocols that allow the users to access the network (FTP, HTTP, SMTP, etc)
- Does not include application programs such as email, browsers, word processing applications, etc.
- Protocols contain utilities and network-based services that support email via SMTP, Internet access via HTTP, file transfer via FTP, etc



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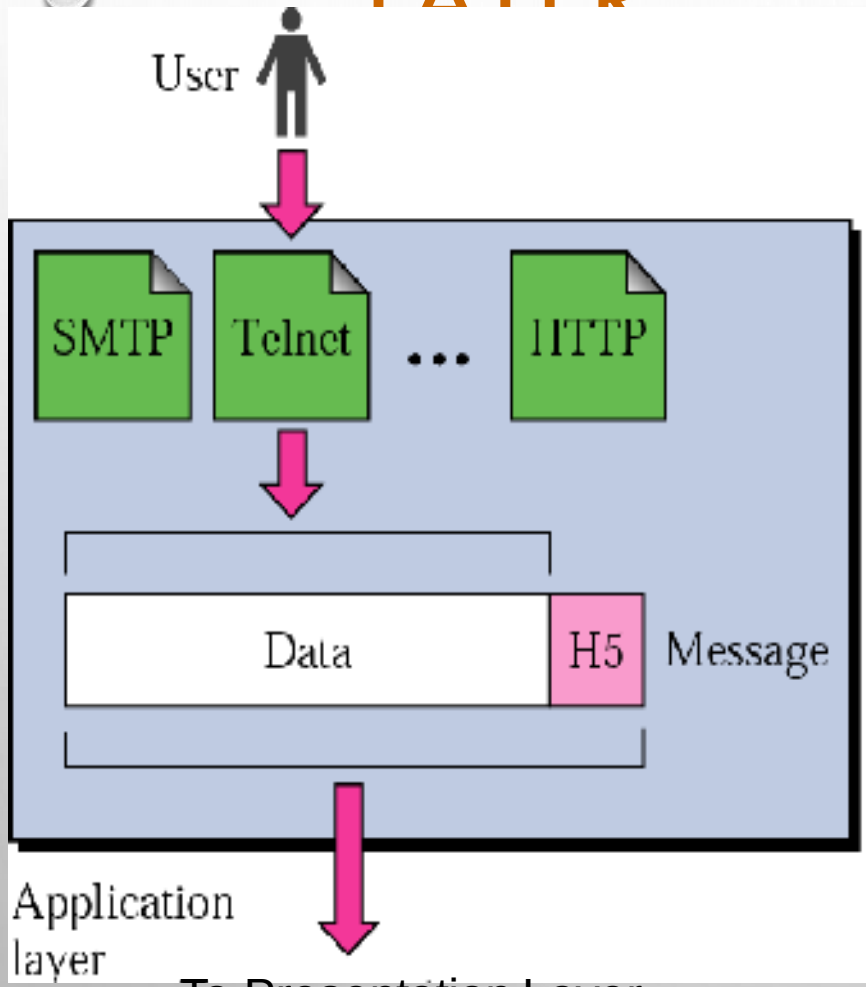
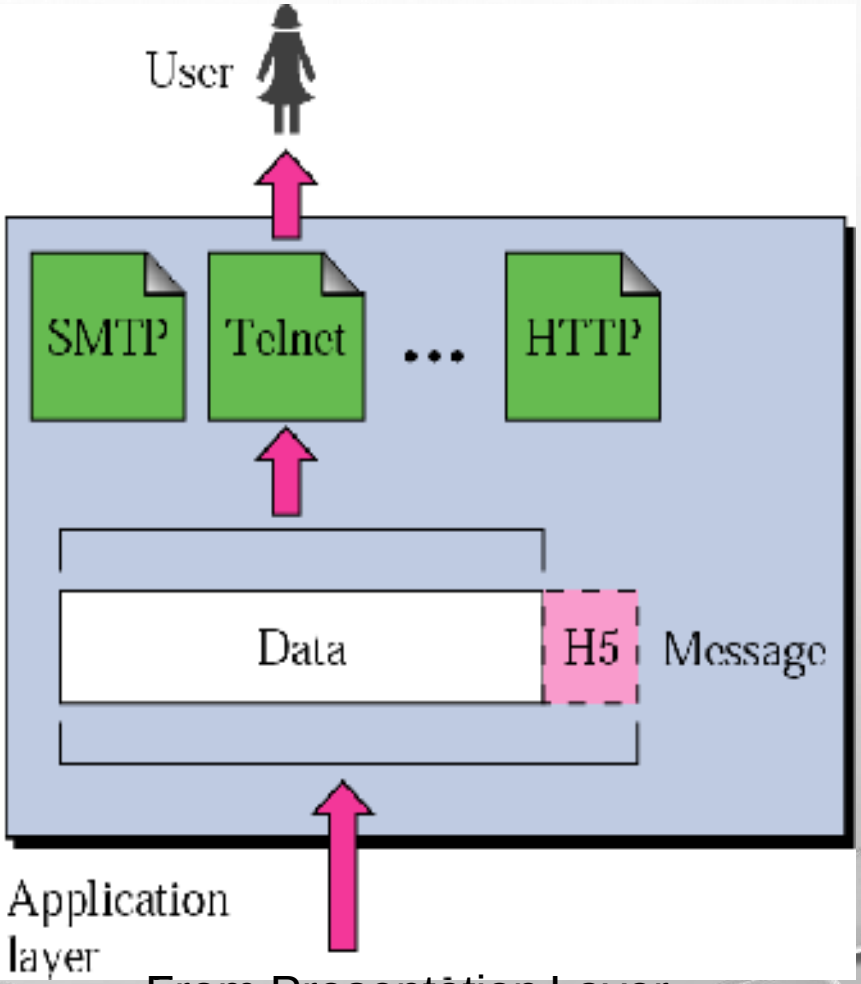


To Presentation Layer



From Presentation Layer

SUMMARY OF FUNCTIONS OF LAYERS