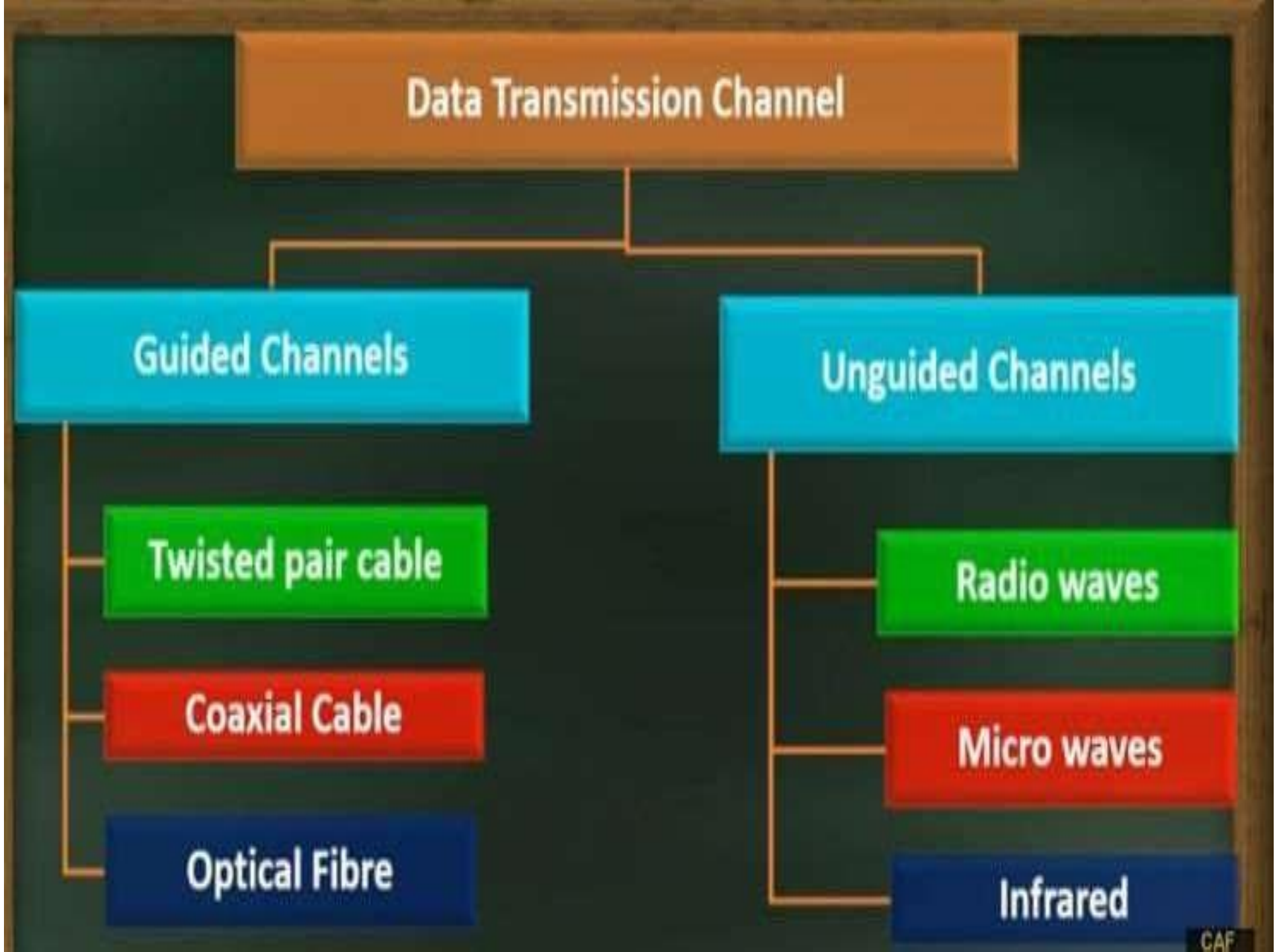
Transmission Media

Transmission Media

The physical path between transmitter and receiver.

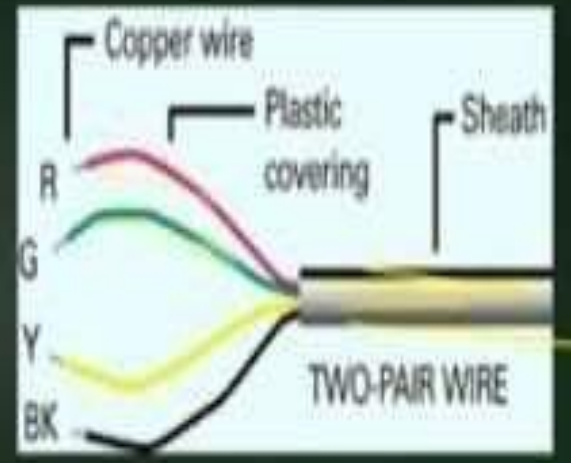
- **Repeaters or amplifiers** may be used to extend the length of the medium.
- Communication of electromagnetic waves is *guided* or *unguided.*


Data Transmission Channel
Guided Channels
Unguided Channels
Twisted pair cable
Coaxial Cable
Optical Fibre
Radio waves
Micro waves
Infrared

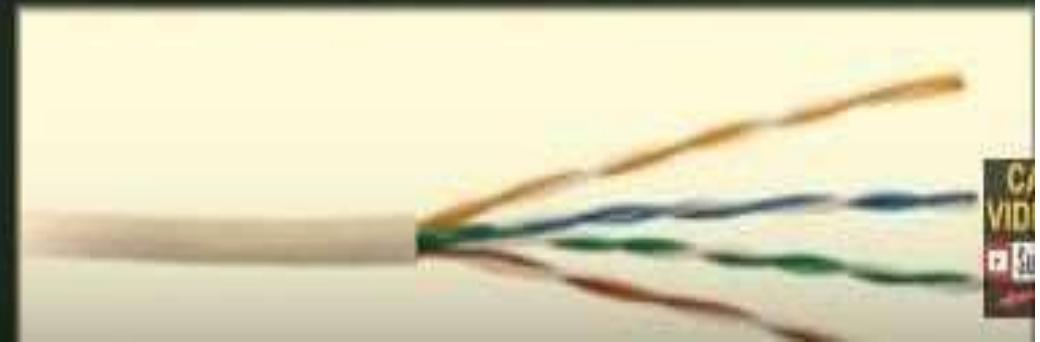
Guided Media

- Guided media provide a physical connection using wire or cable between two devices.
- A signal traveling through guided media is directed and contained within the physical limits of the medium

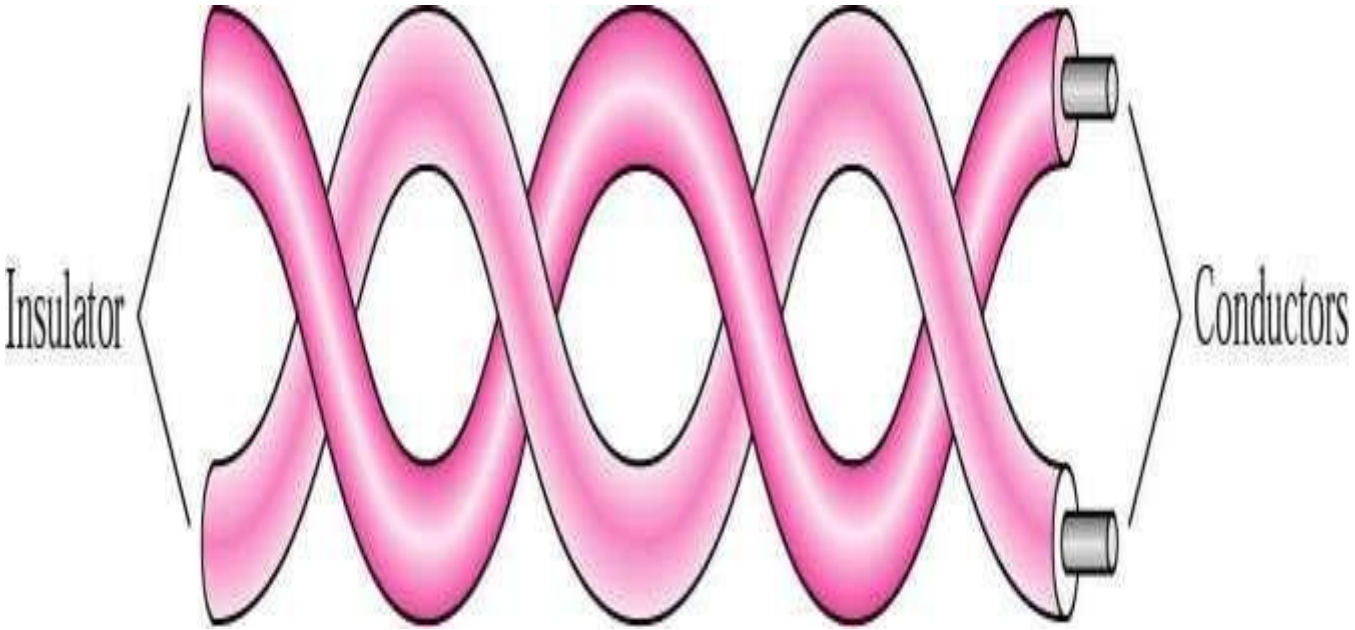
Twisted pair cable



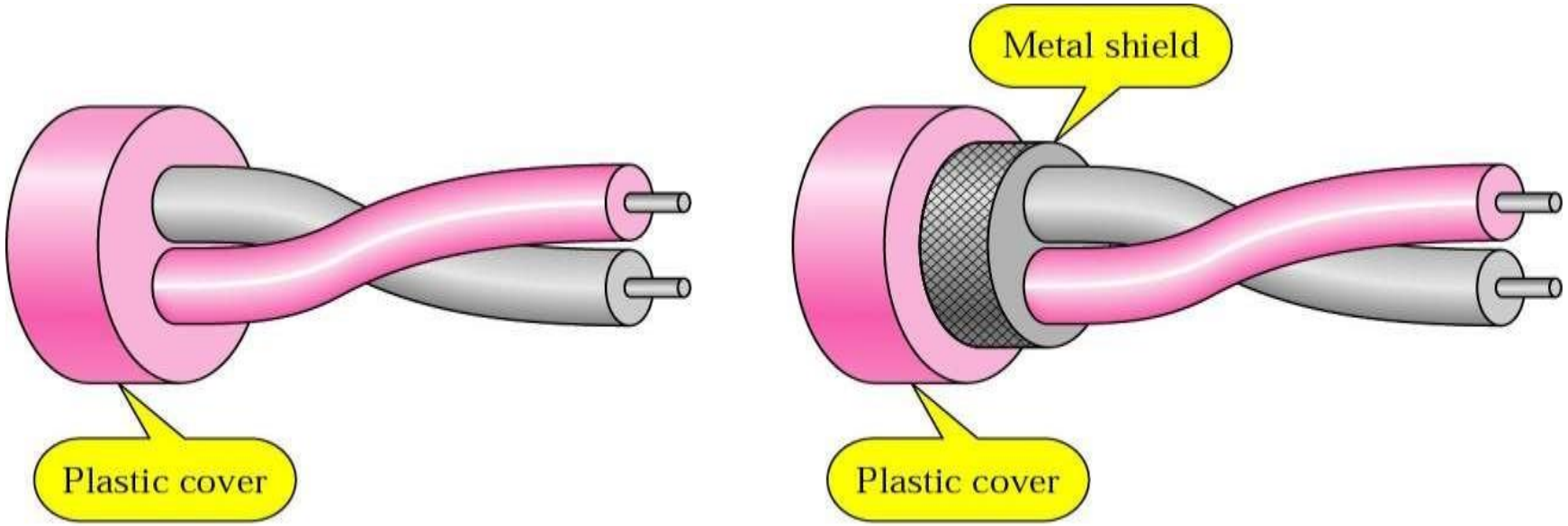
- This cable is the most commonly used and is cheaper than others.
- It is lightweight, cheap, can be installed easily, and they support many different types of network.
- A twisted pair cable consists of two conductors which are normally made of copper.
- Each conductor has its own plastic insulation typically 1 mm thick.
- These cables are twisted together.



Twisted-pair cable

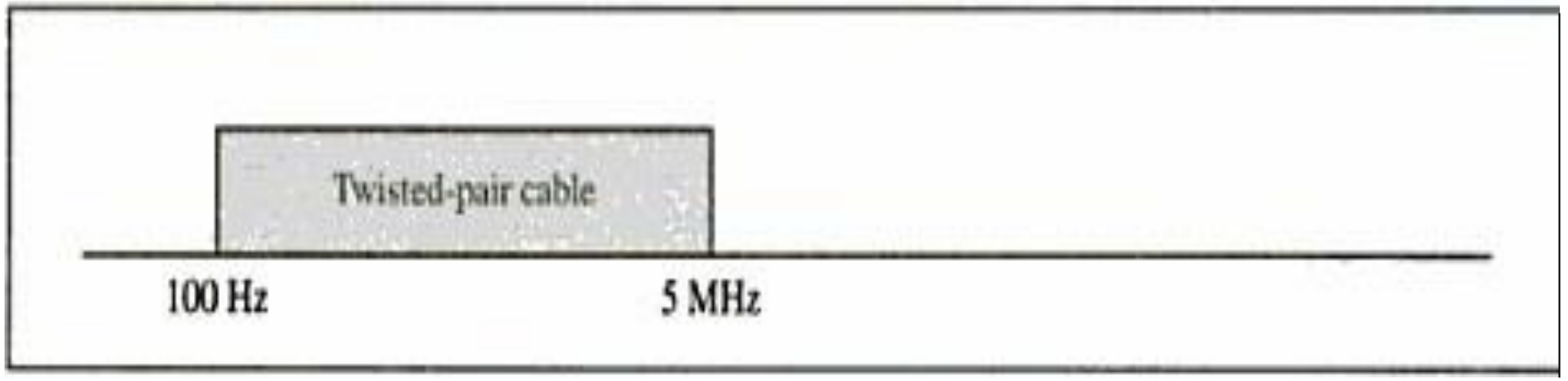


UTP and STP

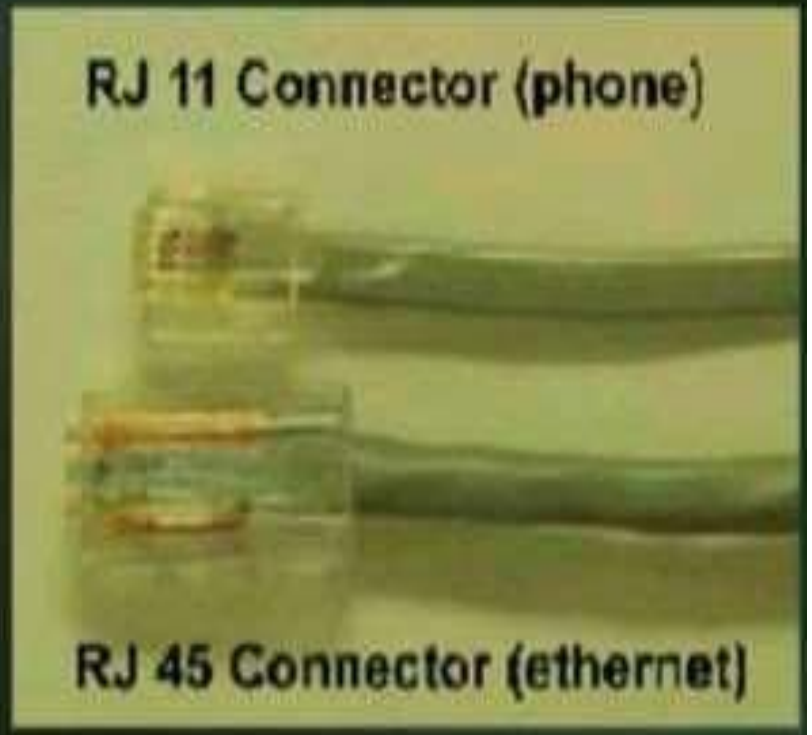


a. UTP

b. STP



Unshielded Twisted Pair Cable



- It is the most common type of telecommunication which consists of two conductors usually copper, each with its own colour plastic insulator.
- Identification is the reason behind coloured plastic insulation.
- UTP cables consist of 2 or 4 pairs of twisted cable. Cable with 2 pair use RJ-11 connector and 4 pair cable use RJ-45 connector.

Advantages :

- Installation is easy
- Flexible
- Cheap
- It has high speed capacity,
- 100 meter limit
- Higher grades of UTP are used in LAN technologies like Ethernet

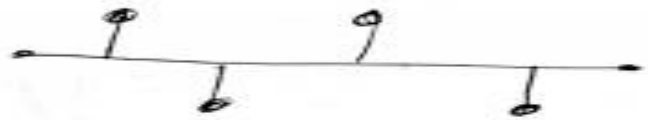
Cables.

(1) unshielded Twisted pair Cable

10 Base T, 100 Base T

10 Mbps

T - represent - 100 meter.



In 1sec - 10 Mbps data has been send.

Base → Broad band. / Base band.

Only one can send the data other wise collision take place.

attentual

coaxial cable.

- 10 Base 2 → 200m
- 10 Base 5 → 500m

fibers optics.

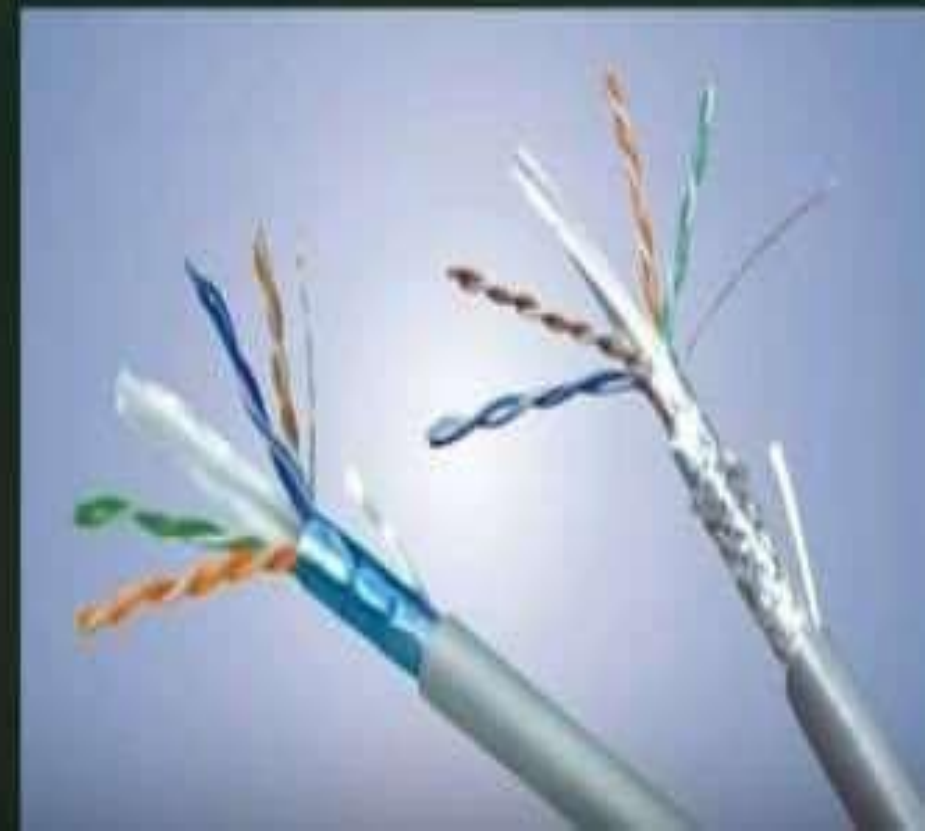
- 100 Base Fx.
  - ≃ 2km.

Disadvantages :

- Bandwidth is low when compared with Coaxial Cable
- Provides less protection from interference.

Shielded Twisted Pair Cable

- This cable has a metal foil or braided-mesh covering which encases each pair of insulated conductors.



- Electromagnetic noise penetration is prevented by metal casing.
- Shielding also eliminates crosstalk
- It is faster the unshielded and coaxial cable.
- It is more expensive than coaxial and unshielded twisted pair.

Advantages :

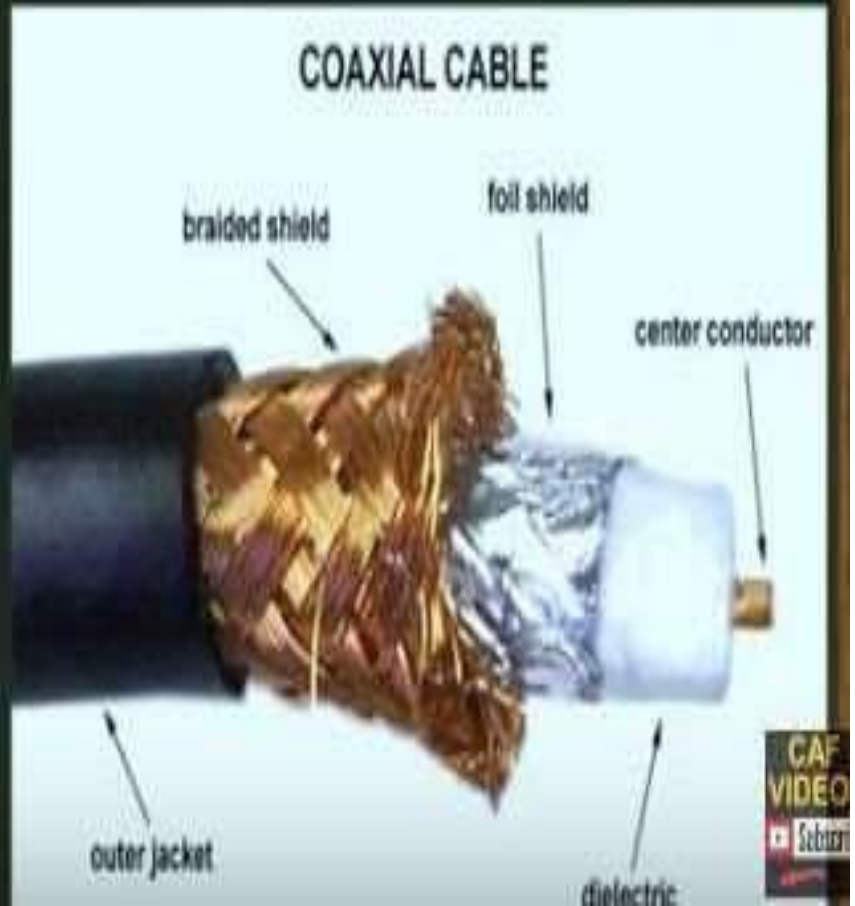
- Easy to install
- Performance is adequate
- Can be used for Analog or Digital transmission
- Increases the signalling rate
- Higher capacity than unshielded twisted pair
- Eliminates crosstalk

Disadvantages :

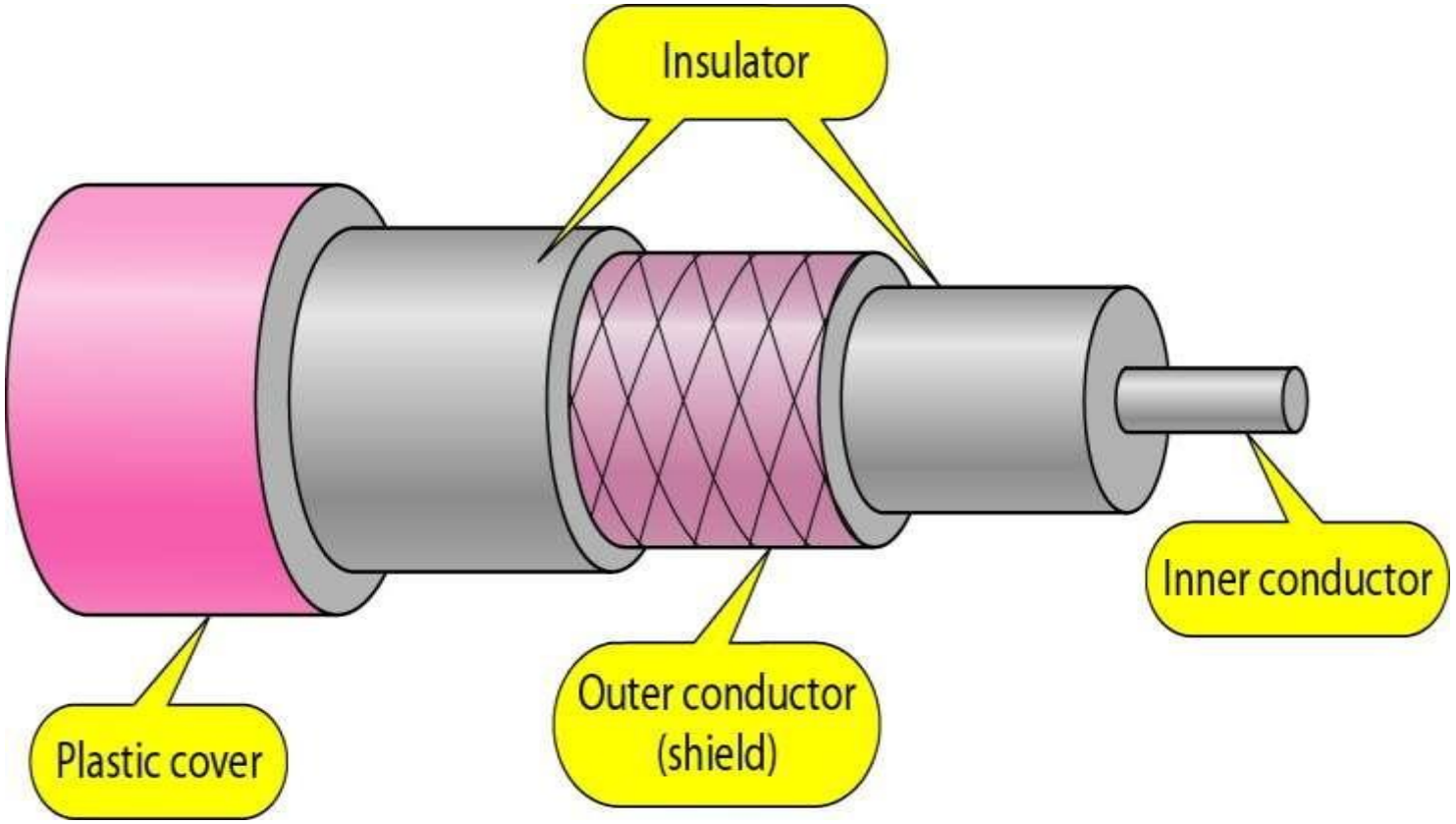
- Difficult to manufacture
- Heavy

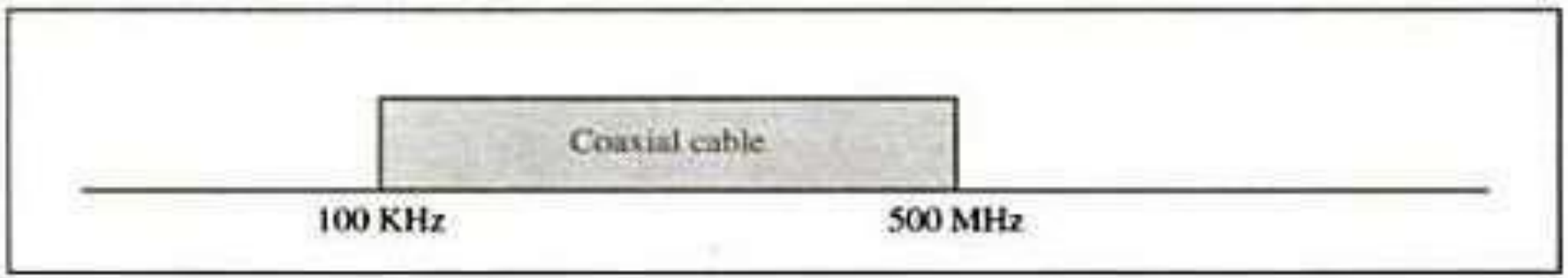
Coaxial Cable

- Copper is used in this as centre conductor which can be a solid wire or a standard one.
- It is surrounded by PVC installation, a sheath which is encased in an



Coaxial Cable



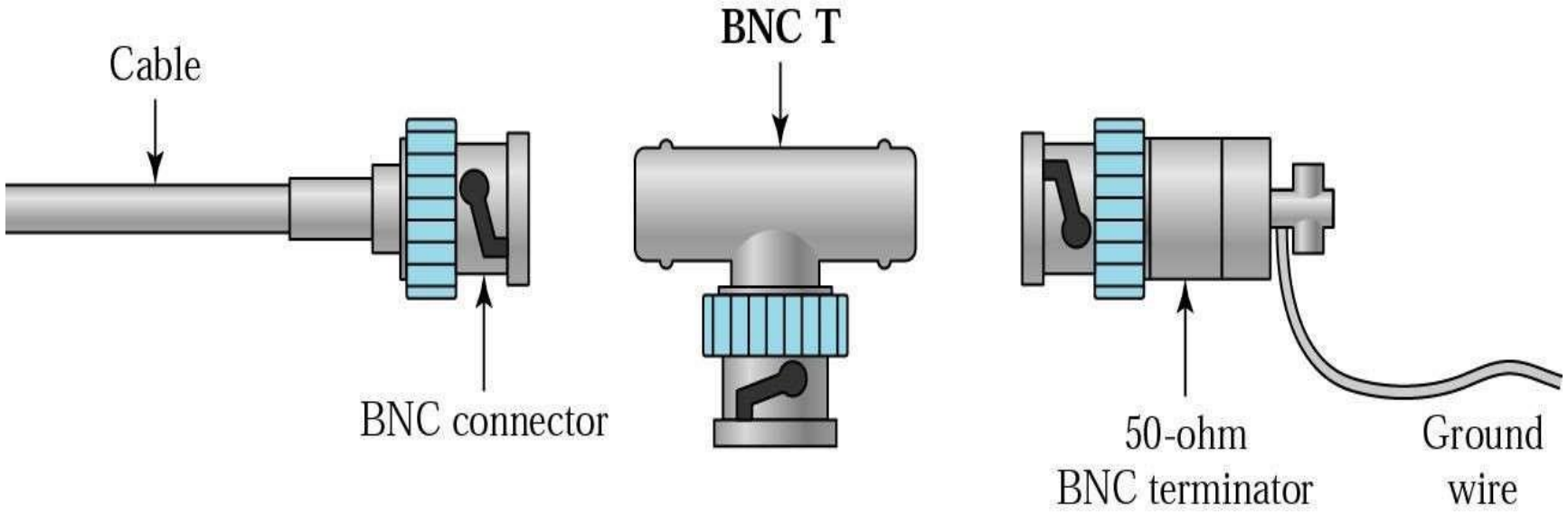


BNC connectors

•To connect coaxial cable to devices, it is necessary to use coaxial connectors. The most common type of connector is the Bayone-Neill-Concelman, or BNC, connectors.

There are three types: the BNC connector, the BNC T connector, the BNC terminator.

Applications include cable TV networks, and some traditional Ethernet LANs like 10Base-2, or 10-Base5.



outer conductor of metal foil, braid or both.

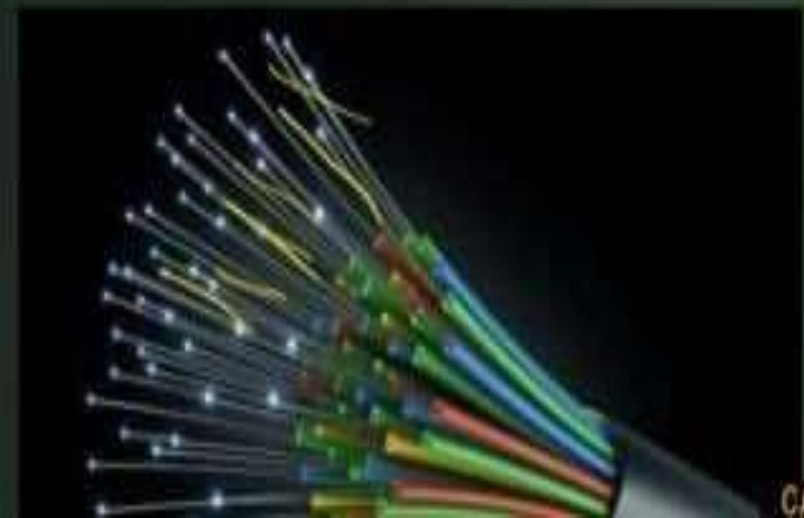
- Outer metallic wrapping is used as a shield against noise and as the second conductor which completes the circuit.
- The outer conductor is also encased in an insulating sheath.
- The outermost part is the plastic cover which protects the whole cable.

Advantages :

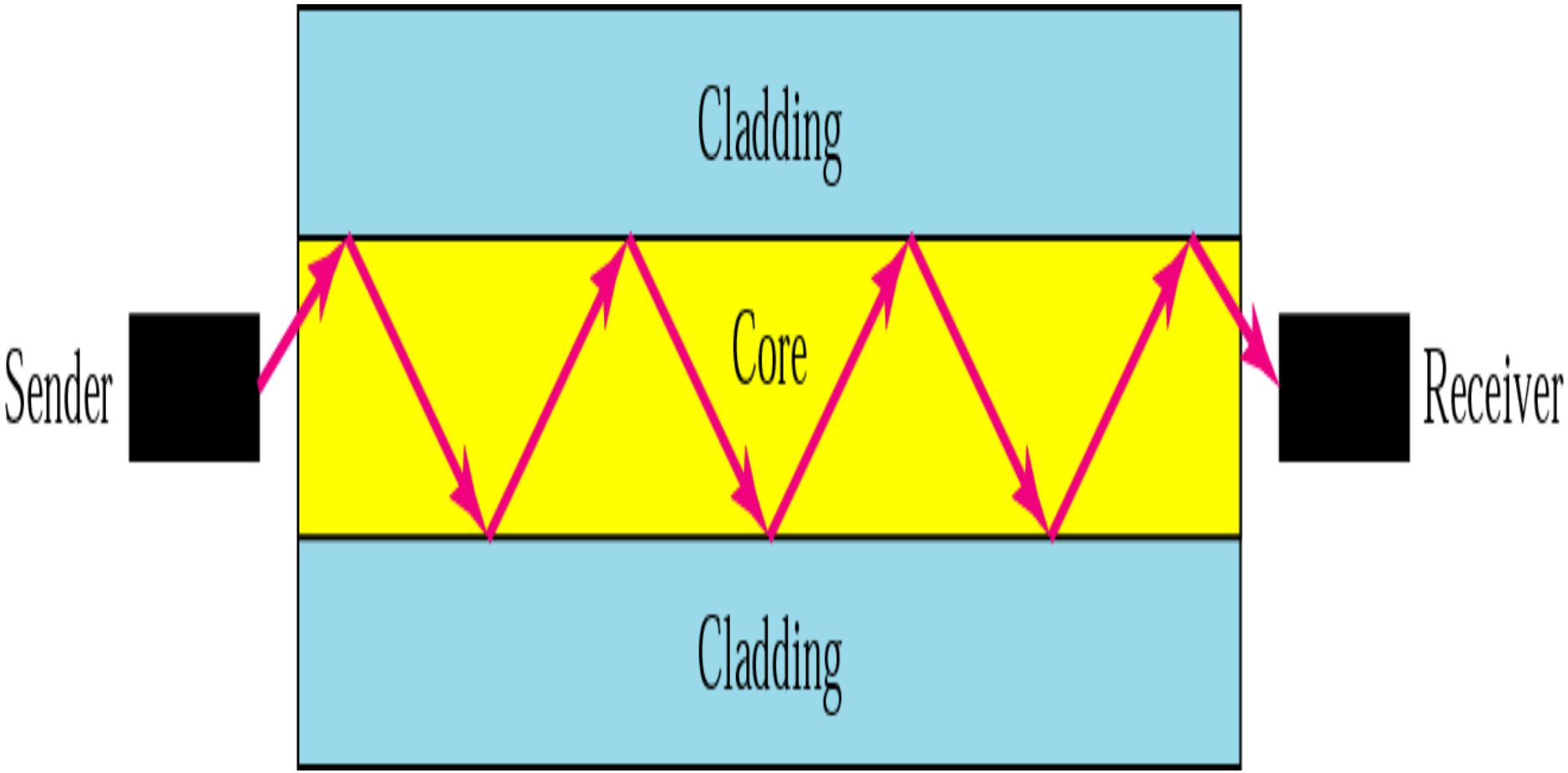
- Bandwidth is high
- Used in long distance telephone lines.
- Transmits digital signals at a very high rate of 10Mbps.
- Much higher noise immunity

Optical Fibre

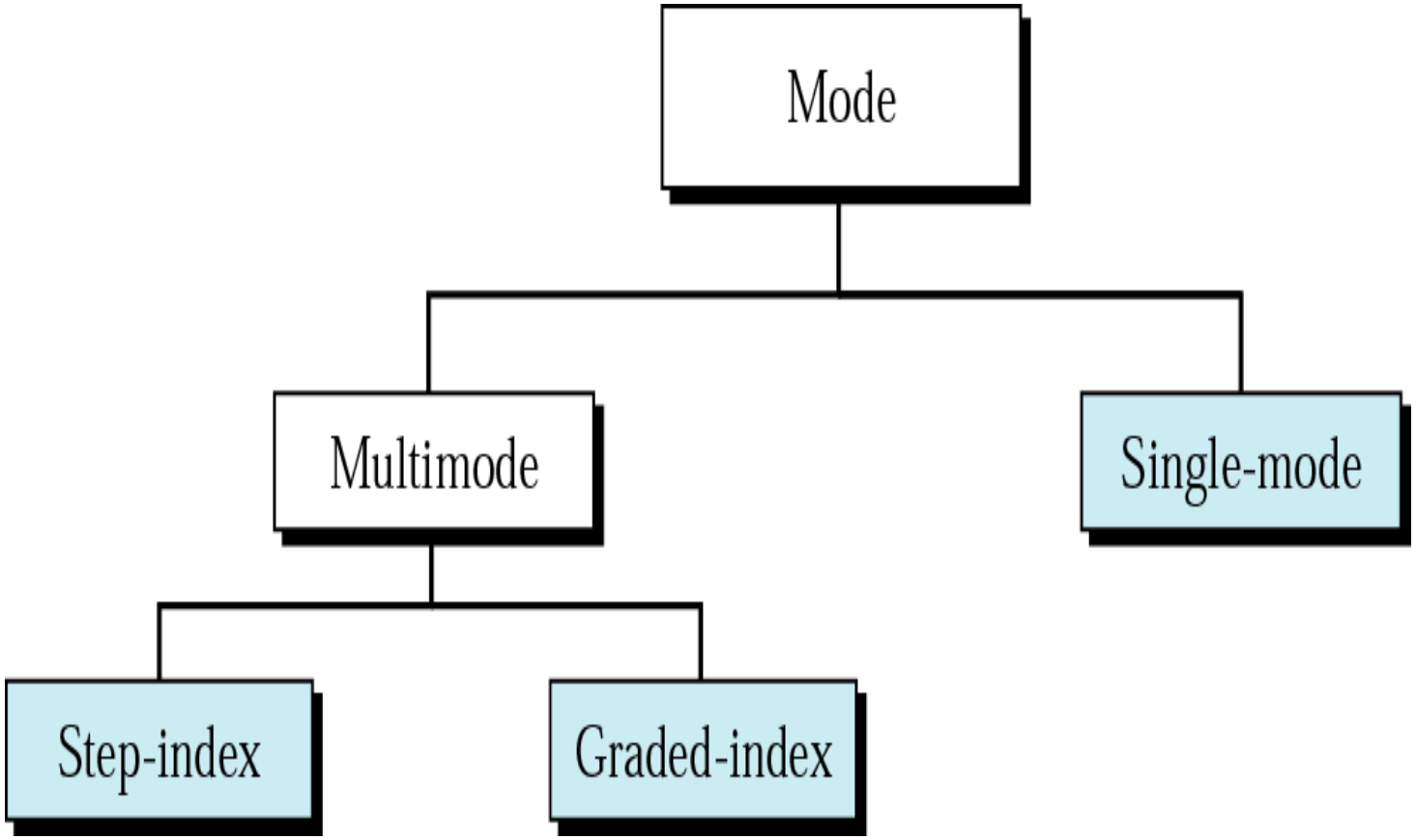
- A technology that uses glass (or plastic) threads (fibres) to transmit data.
- A fibre optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.
- Fibre optic cable has bandwidth more than 2 gbps (Gigabytes per Second)



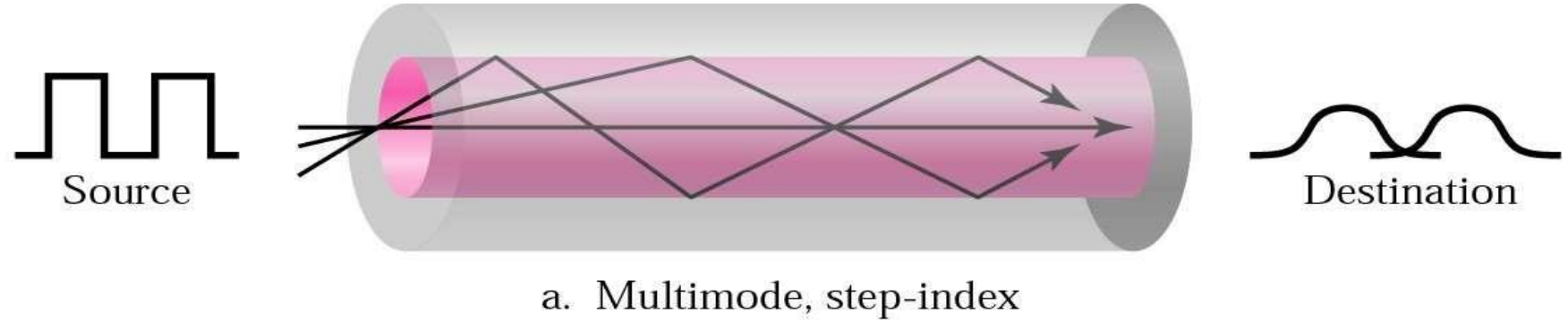
Optical fibers



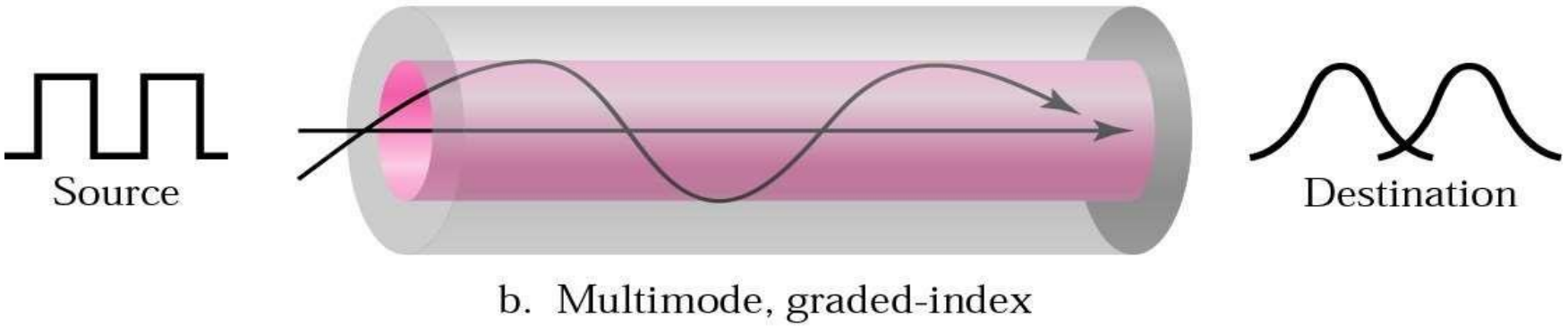
Propagation Modes (Types of Optical Fiber)



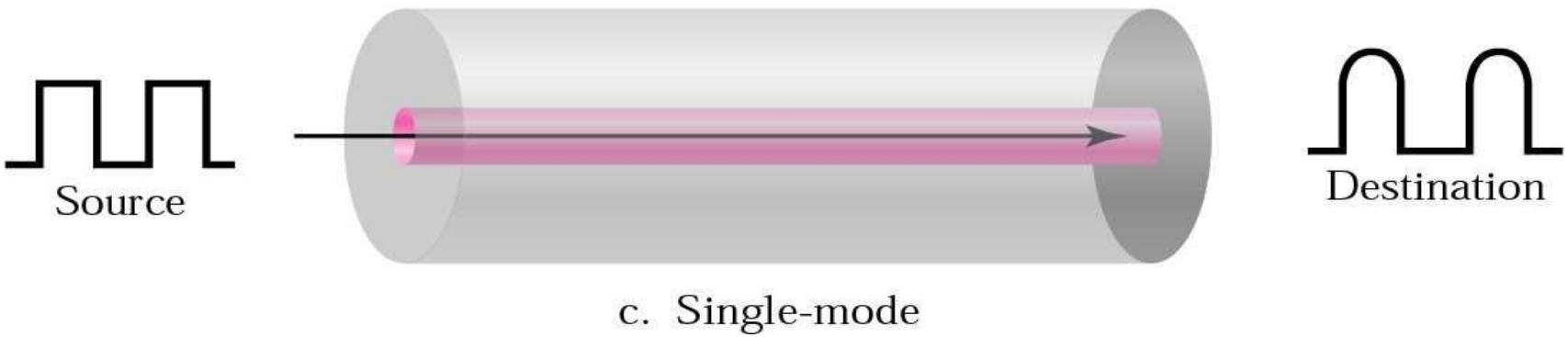
Propagation Modes



a. Multimode, step-index



b. Multimode, graded-index



c. Single-mode

Step-Index Multimode Fiber vs Graded-Index Multimode Fiber

From all the above, the step-index multimode fiber and graded-index multimode fiber mainly differ in the following aspects:

Feature	Step-Index Multimode Fiber	Graded-Index Multimode Fiber
Bandwidth Size	Lower bandwidth	Higher bandwidth
Diameter of the Core	50-200 μm	About 50 μm
Application Scenarios	Normally used in short-distance (within a few kilometers) and low-speed (8 Mb/s or less) communication systems	Usually used in medium-distance (10~20 km) and relatively higher-speed (34~140 Mb/s) communication systems
Data Transmission Form	Light propagates in the shape of a zigzag along the fiber/core axis	Light travels forward in the form of sinusoidal oscillation/curves
Modal Dispersion	Affects the transmission capacity of the fiber and limits the relay distance	Greatly decreased dispersion than step-index multimode fiber, making a higher bandwidth
Performance	Relatively worse	Relatively better
Cost	Lower	Higher

Advantages

- Provides high quality transmission of signals at very high speed.
- Used for both analog and digital signals.
- These cables are much lighter than the copper cables
- Its transmission distance is greater than the twisted pair and it can run for 50Kms without regeneration.
- These are not affected by electromagnetic interference, so noise and distortion is very less.

Disadvantages

- It needs expertise which is not available everywhere. So it is difficult to install.
- Propagation of light is unidirectional and we need two fibers for bidirectional communication.
- It is expensive because the cables and interfaces used are relatively expensive.

Unguided Media

- Unguided media is used for transmitting the signal without any physical media.
- It transports electromagnetic waves and is often called wireless communication.
- Signals are broadcast through air and received by all who have devices to receive them.

Radio waves

- Radio frequency (RF) waves are easy to generate, can travel long distances, and can penetrate buildings easily, so they are widely used for communication, both indoors and outdoors.
- Radio waves also are omnidirectional, meaning that they travel in all directions from the source, so the transmitter and receiver do not have to be carefully aligned physically.

- Radio waves can be received both inside and outside the building.
- Radio waves are very useful in multicasting and hence used in AM and FM radios, cordless phones and paging.
- If the communication is between single source and destination then it is called unicast;
- on the other hand, if one source is transmitting signal and any destination that is in the range may be able to reach it then it is called broadcast.

- Multicast is when a source transmits a signal for some specific group of destinations which may be more than one.

Bluetooth

- Bluetooth is a very popular application of short wave length radio transmission in the frequency band of 2400 to 2480 MHz.
- It is a proprietary wireless technology standard used for exchanging data over short distances in mobile phones and other related devices.

It allows wireless devices to be connected to wireless host which may be a computer over short distances. You may have it for transferring data between a mobile phone and a computer provided both have Bluetooth technology.

Microwave Transmission

- Travels in straight lines and therefore narrowly focused concentrating all the energy into a beam.
- Periodic repeaters are necessary for long distances.
- For transmitting and receiving, antennas should be aligned accurately.
- Can not penetrate through buildings.

- It operates in the GHz range with data rates in order of hundreds o

  Mbps per channel.

- Telecommunication carriers and TV stations are the primary users

  microwave transmission.

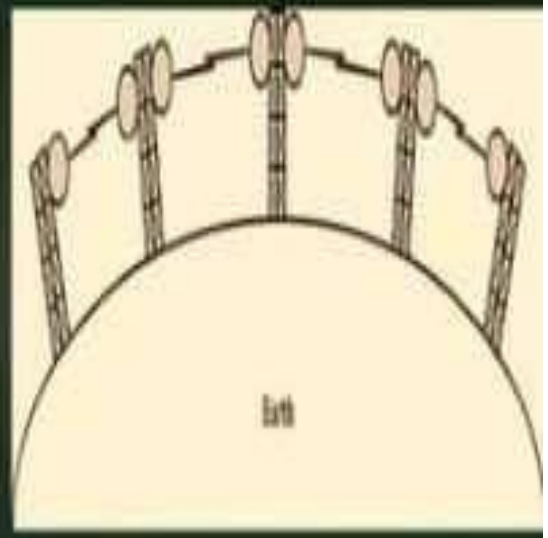
- Before fiber optics, for decades these microwaves formed the hear

  of the long-distance telephone transmission system.

Types of microwave communication systems

1. Terrestrial
2. Satellite

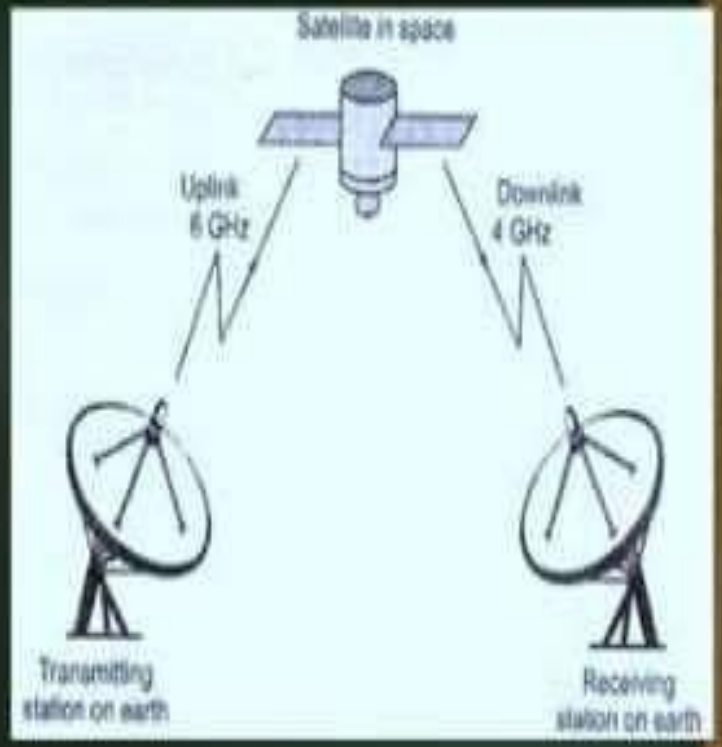
Terrestrial Microwave



- The terrestrial microwave transmission typically uses the radio frequency spectrum 2 to 40 GHz.
- The transmitter is a parabolic dish (shaped like a bowl) and is mounted as high as possible to get the best frequency and transmission.
- An unblocked line of sight must be available between the source and the receiver.

- Terrestrial microwaves are used for both radio (voice) and television transmission.
- It can be expensive to adhere to the 30-mile line of sight requirement.
- The towers and repeaters can be fairly costly and there is a risk of interference from aeroplanes, birds and rain.

Satellite Microwave



- This is a microwave relay station which is placed in outer space.
- The satellites are launched either by rockets or space shuttles carry them.
- The signals transmitted by earth stations are received, amplified, and retransmitted to other earth stations by the satellite.
- These are positioned 3600KM above the equator with an orbit

speed that exactly matches the rotation speed of the earth.

- As the satellite is positioned in a geo-synchronous orbit, it is stationery relative to earth and always stays over the same point on the ground. This is usually done to allow ground stations to aim antenna at a fixed point in the sky.
- Transmitting station can receive back its own transmission and check whether the satellite has transmitted information correctly.
- A single microwave relay station which is visible from any point.

- Satellite manufacturing cost is very high
- Cost of launching satellite is very expensive
- Transmission highly depends on whether conditions, it can go down in bad weather

Infrared

- Infrared signals range between 300 Giga-Hertz to 400 Tera-Hertz.
- These can be used for short range communication.

- High range infrared rays cannot be used for long range communication as it cannot penetrate walls.
- Infrared signals are generated and received using optical transceivers.
- Infrared systems represent a cheap alternative to most other methods, because there is no cabling involved and the necessary equipment is relatively cheap.
- However, applications are limited because of distance limitations (of about one kilometer).

- It cannot be used outside building as rays of sun contain infrared which leads to interference in communication.
- Infrared having wide bandwidth can be used to transmit digital data with a very high data rate.

THANK YOU

The OSI Model

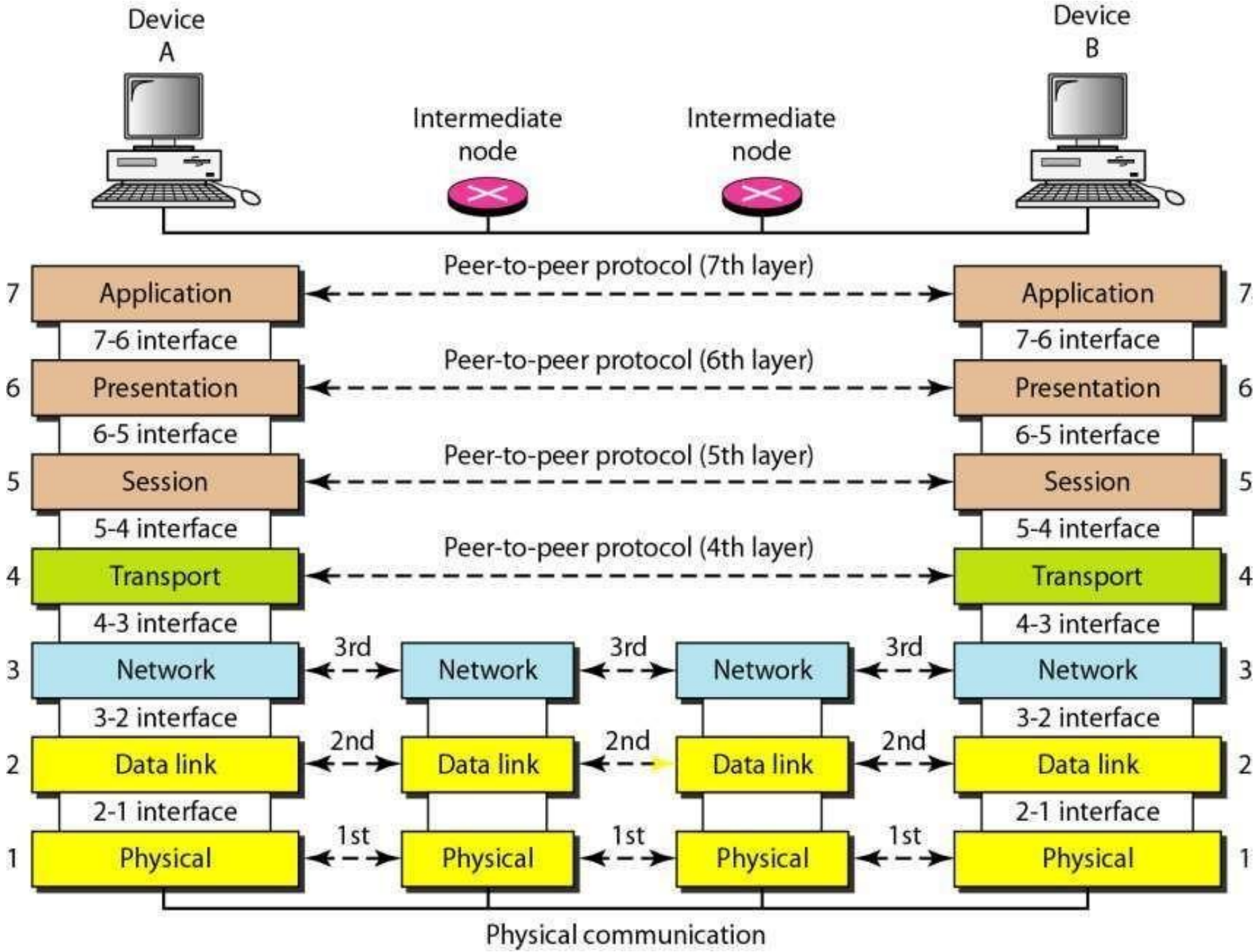
Open System Interconnection (OSI) model
Introduce in 1983
Adopted by ISO in 1984
ISO- International Standard Organization.

The OSI Model

- An ISO (International standard Organization) that covers all aspects of network communications is the **Open System Interconnection (OSI) model**.
- An open system is a model that allows any two different systems to communicate regardless of their underlying architecture (hardware or software).
- The OSI model is not a protocol; it is model for understanding and designing a network architecture that is flexible, robust and interoperable.

- The OSI model is a layered framework for the design of network systems that allows for communication across all types of computer systems.
- The OSI model is built of seven ordered layers:

1. **(Layer 1) Physical layer**
2. **(Layer 2) Data link layer**
3. **(Layer 3) Network layer**
4. **(Layer 4) Transport layer**
5. **(Layer 5) Session layer**
6. **(Layer 6) Presentation layer**
7. **(Layer 7) Application layer**

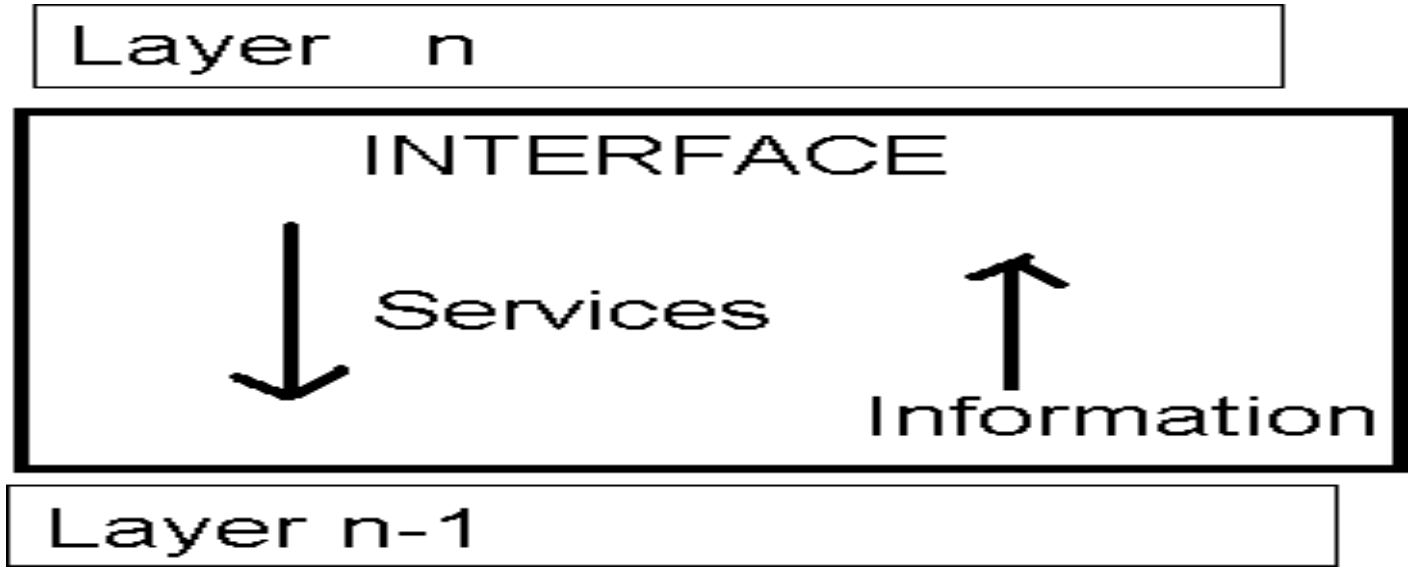

Device A
Device B
Intermediate node
Intermediate node
Peer-to-peer protocol (7th layer)
Peer-to-peer protocol (6th layer)
Peer-to-peer protocol (5th layer)
Peer-to-peer protocol (4th layer)
7
Application
7-6 interface
6
Presentation
6-5 interface
5
Session
5-4 interface
4
Transport
4-3 interface
3
Network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

Peer-to-Peer Process

- Within a single machine, each layer calls upon services of the layer just below it.
- Layer 3, for example, uses the services provided by layer 2 and provides services for layer 4.
- Between machines, layer x on one machine communicates with layer x on another machine, by using a protocol (**this is Peer-to-Peer Process**).
- Communication between machines is therefore a peer-to-peer process using protocols appropriate to a given layer.

Interfaces between Layers

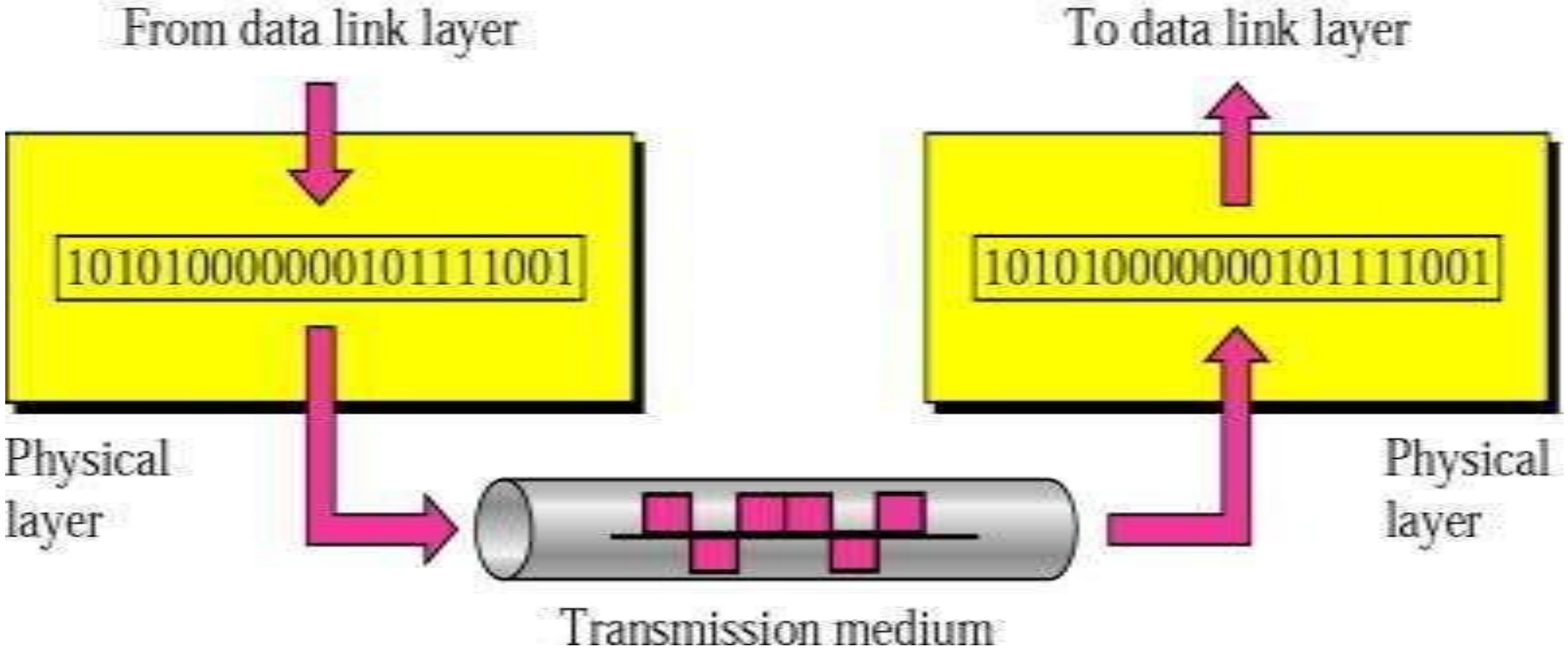
- There is an interface between each pair of adjacent layers. This interface defines what information and services a layer must provide for the layer above it.



Functions of Layers

1. Physical Layer

The physical layer is responsible for transmitting ***individual bits*** *from one node to the next.*



Physical Layer

Segment

Data (Hi !)

Packet

Source IP	Destination IP	Segment

Frame

Source MAC	Destination MAC	Packet	FCS

TRANSPORT LAYER

NETWORK LAYER

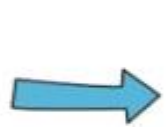
DATA LINK LAYER

APPLICATION LAYER

1001011101101100101110110111011

BITs

BITs



SIGNALS

AIR

MEDIA

SIGNALS

Physical layer

The physical layer is concerned with the following:

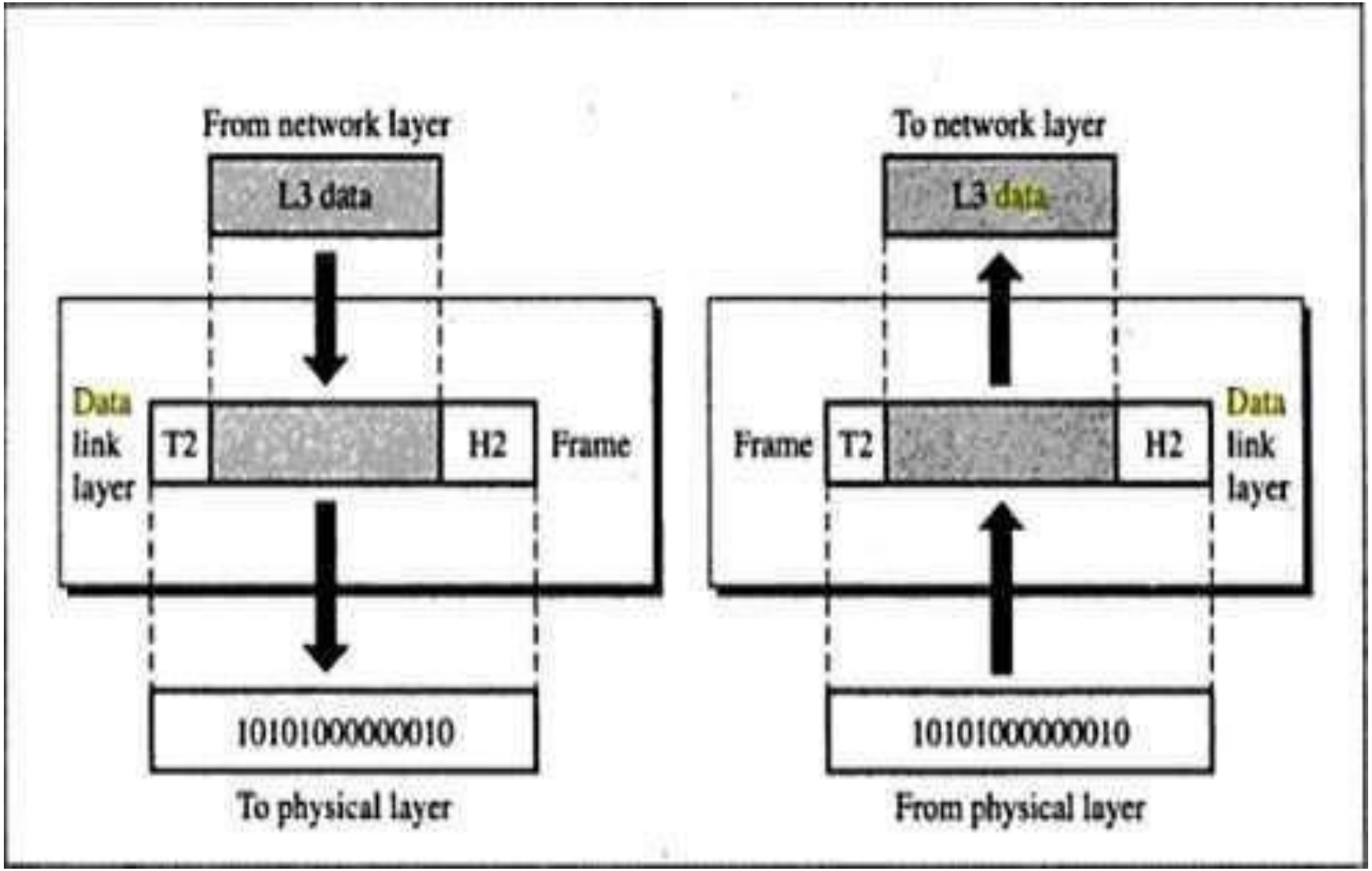
- **Physical characteristics of interfaces and media:** It define the type of transmission media
- **Representation of the bits:** the physical layer data consist of a stream of bits(0,1). The transmitted bits must be encoded into signals – **electrical or optical**. The physical layer defines the type of **encoding**.
- **Data rate:** The physical layer defines the **transmission rate**, the number of bits sent each second.

Physical Layer

- Line configuration: the physical layer is concerned with the connection of devices to the medium.
- Physical topology – Ring, star
- Transmission Mode - Simplex, Half duplex Full Duplex

2. Data Link Layer

- It is responsible for **node-to-node** delivery of data.

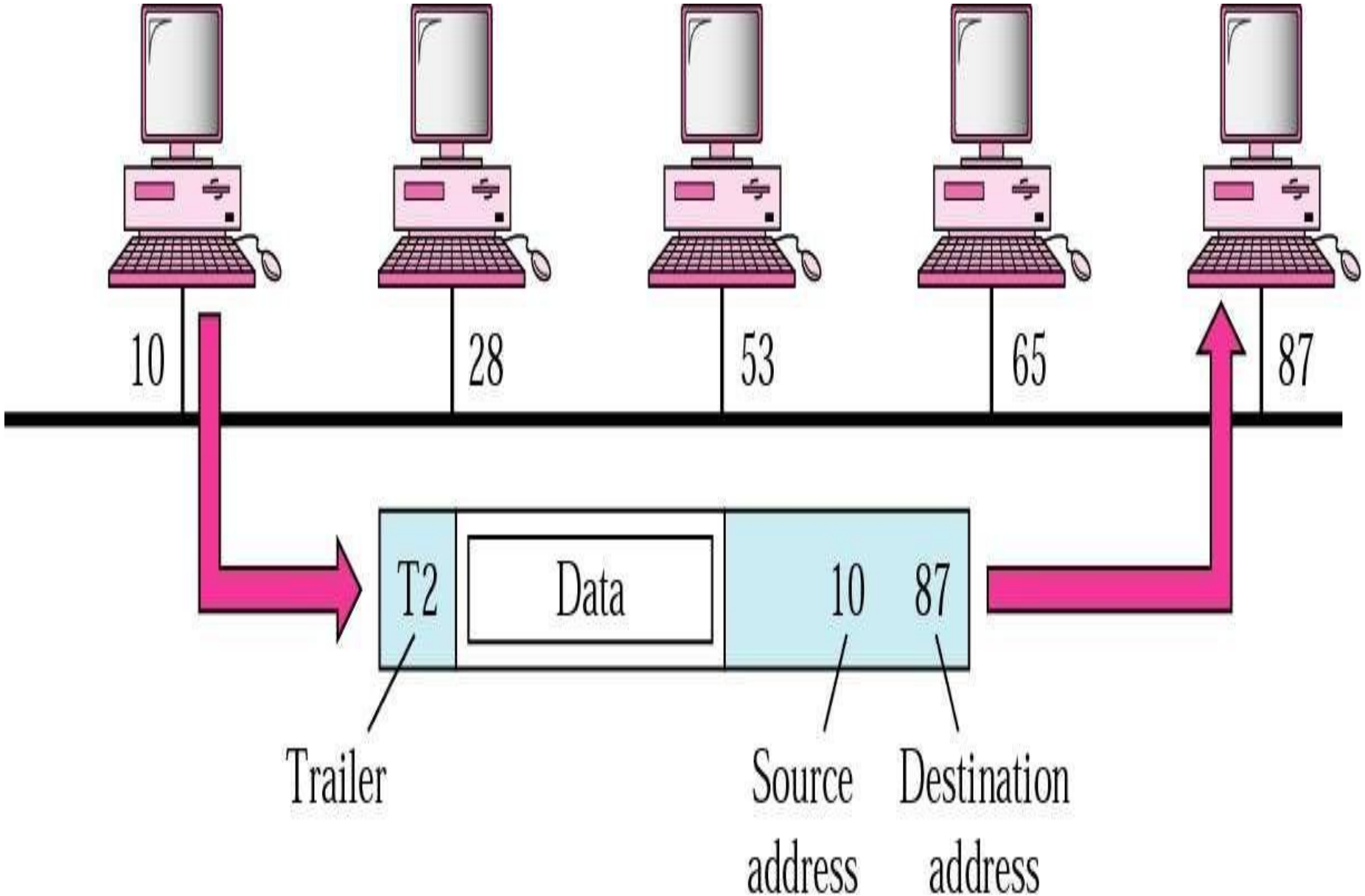


Functions of the Data Link Layer:

- Framing. The data link layer divides the **stream of bits** received from the network layer into data units called **frames**.

- Physical addressing. If frames are to be distributed to different systems on the network, the data link layer adds a header to the frame to define the physical address of the sender (source address) and/or receiver (destination address) of the frame.

- If the frame is intended for a system outside the sender's network, the receiver address is the address of the device that connects one network to the next.


10
28
53
65
87
T2
Data
10
87
Trailer
Source address
Destination address

- Flow Control. If the rate at which the data are absorbed by the receiver is less than the rate produced in the sender, the data link layer imposes a flow control mechanism to prevent overwhelming the receiver.
- Error control. The data link layer adds reliability to the physical layer by adding mechanisms to detect and retransmit damaged or lost frames. Error control is normally achieved through a trailer to the end of the frame.

- Access Control. When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any time.

Data Packets from
Network Layer

Data Link Layer

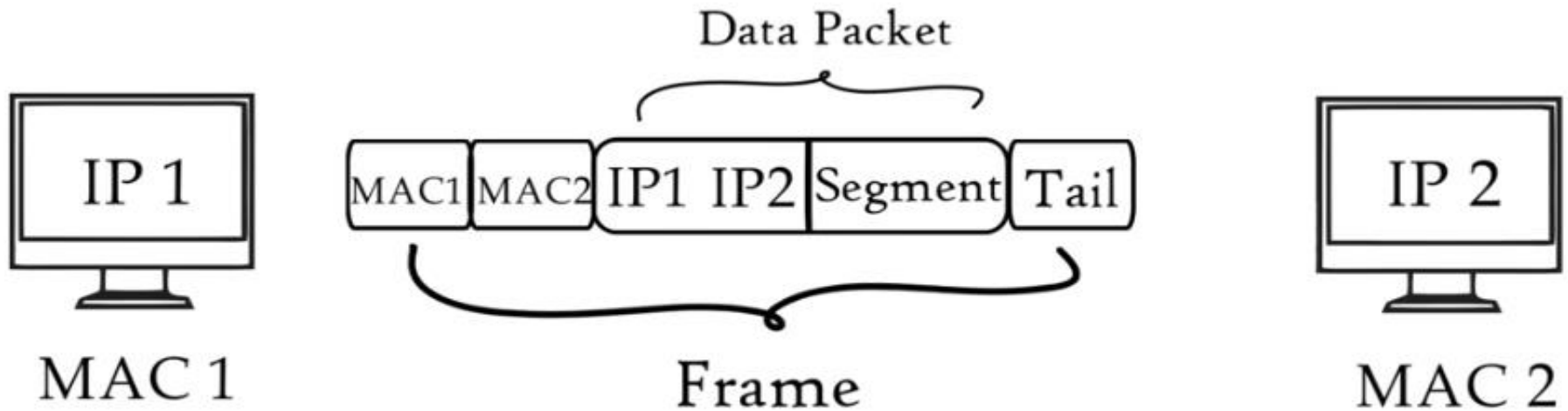
- Logical addressing : Network layer

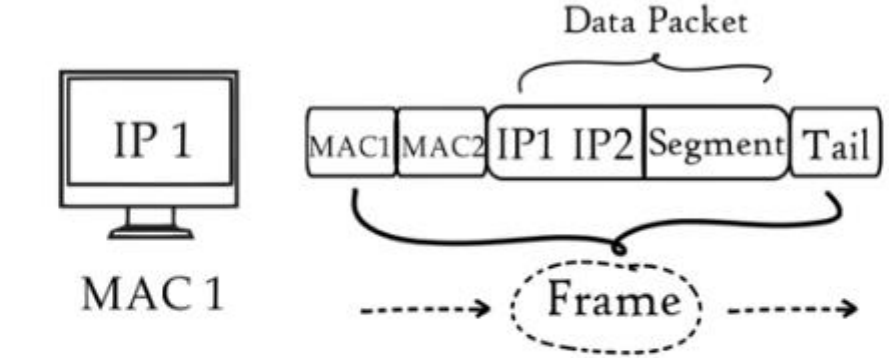
- Physical addressing

Data Link Layer

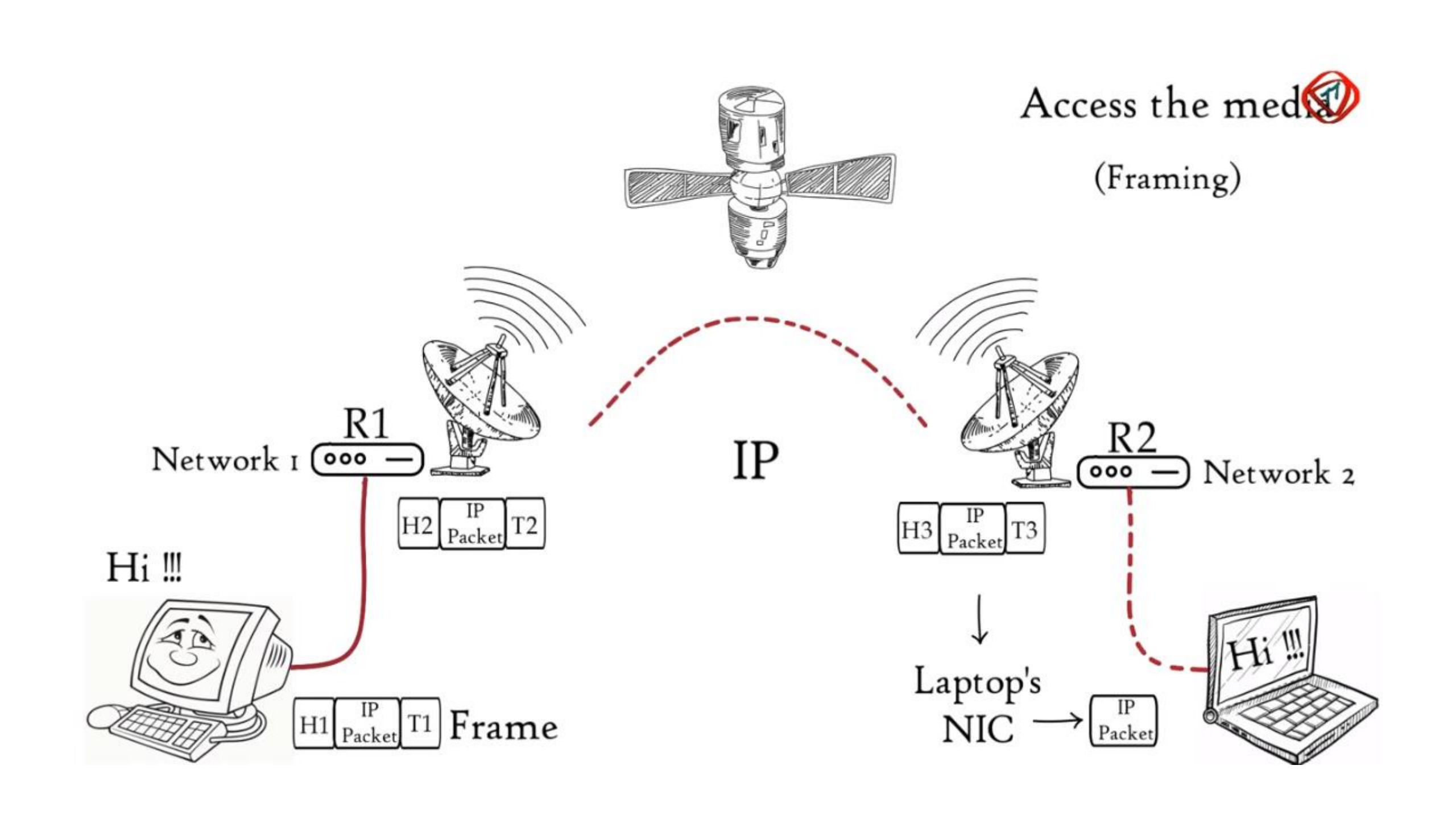
- Logical addressing : Network layer

- Physical addressing : Data Link layer




Data Packet
IP 1
MAC1
MAC2
IP1
IP2
Segment
Tail
IP 2
MAC 1
Frame
MAC 2
62.34.DF.3A.87.C9
45.34.DF.3A.87.99

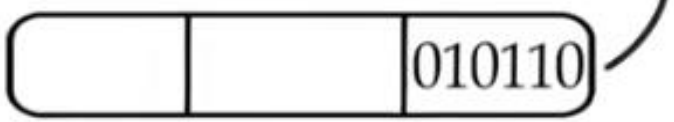

Network 1
NIC
Media
NIC
Network 2


Access the media
(Framing)
R1
Network 1
IP
R2
Network 2
H2
IP Packet
T2
H3
IP Packet
T3
Hi !!!
H1
IP Packet
T1
Frame
Laptop's NIC
IP Packet
Hi !!!

Controls how data is placed and received from the media

(Media Access Control)

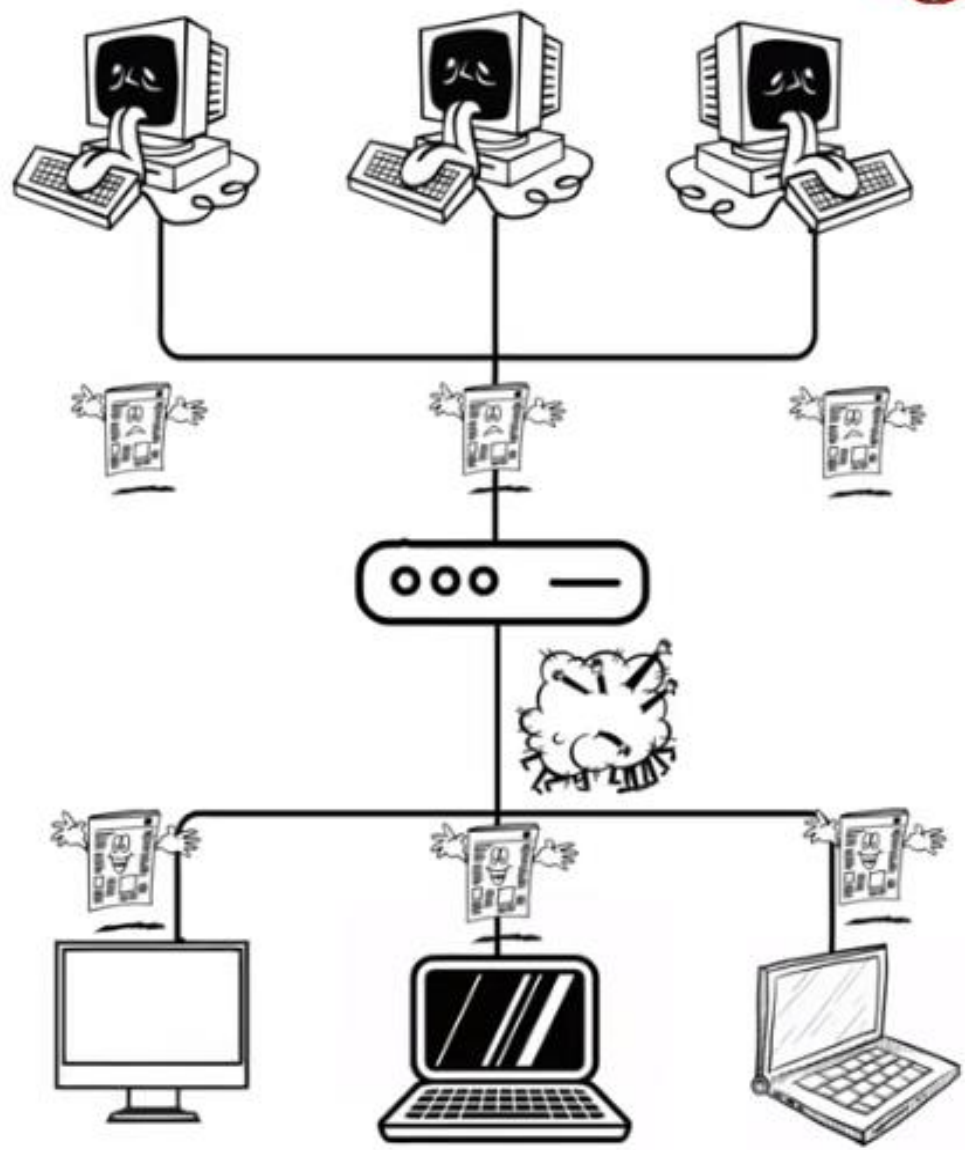
(Error Detection)



DATA LINK LAYER

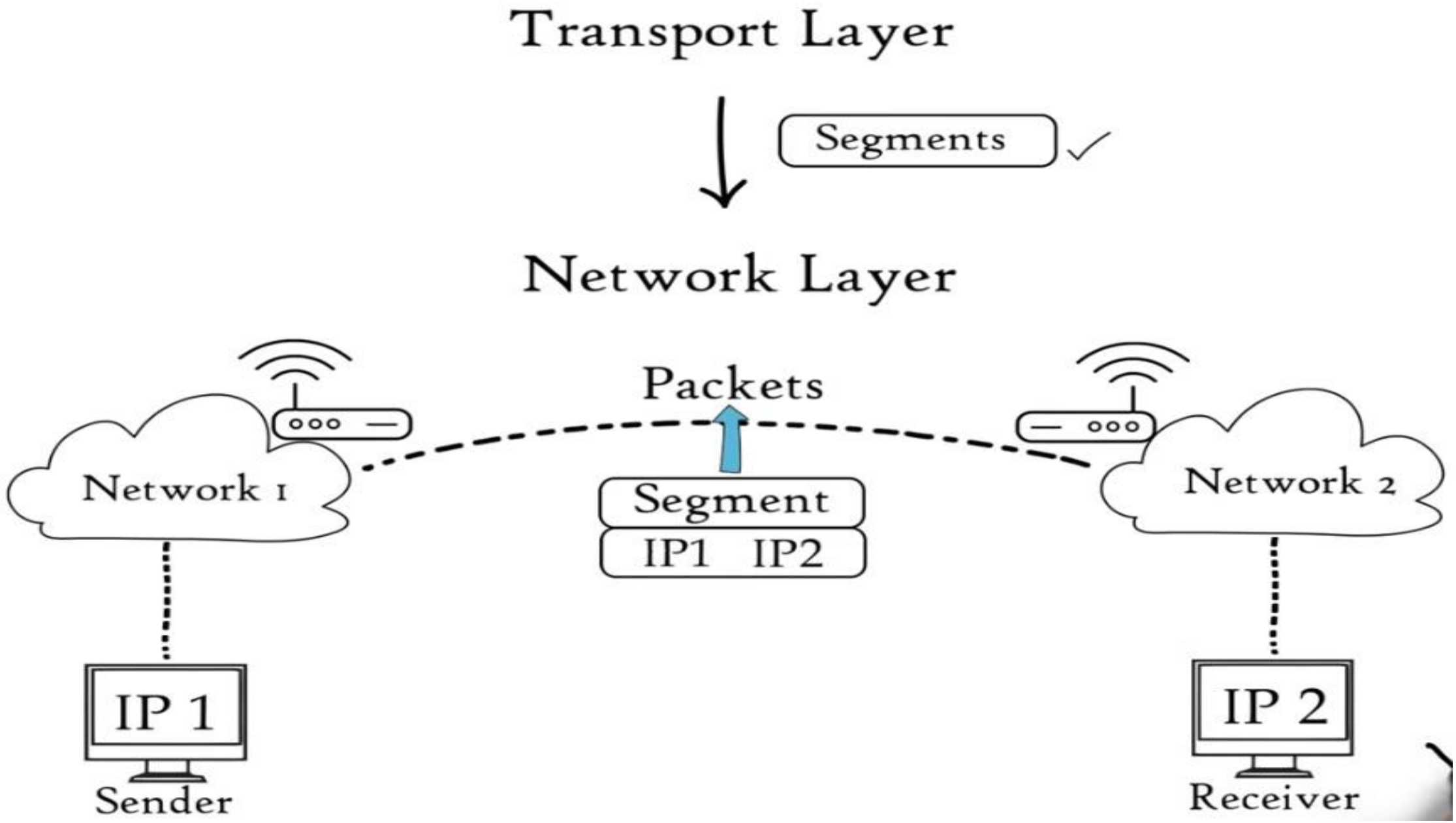
CSMA

LAN Cable, Optical Fiber, Air



3. Network Layer

- The Network layer is responsible for the **source-to-destination +++delivery of a packet** possible across multiple networks.
- It converts **Frames into packets.**
- If **two systems are connected to the same link**, there is usually **no need for a network layer**. However, if the two systems are attached to different networks, there is often a need for the network layer to accomplish source-to-destination delivery.

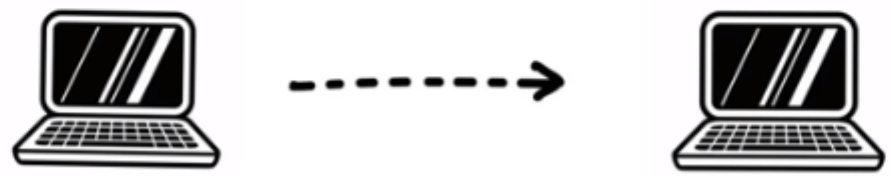

Transport Layer
Segments
Network Layer
Packets
Network 1
Segment
IP1 IP2
Network 2
IP 1
Sender
IP 2
Receiver

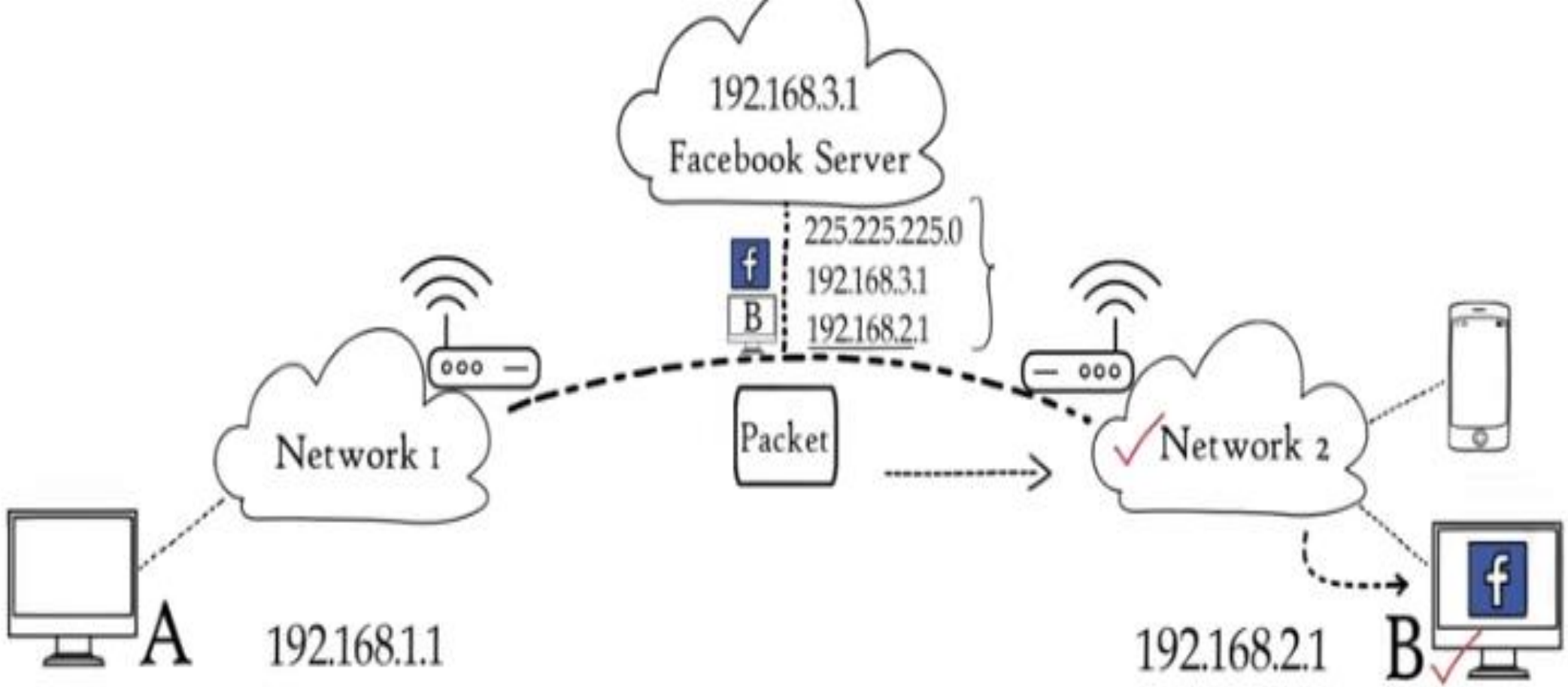
Logical Addressing

IPv4 & IPv6
+
Mask

Path determination

Routing



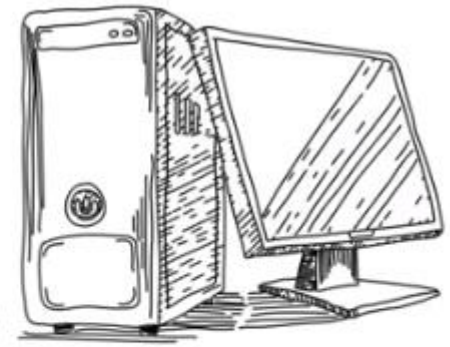

192.168.3.1
Facebook Server
225.225.225.0
192.168.3.1
192.168.2.1
B
Network 1
Packet
Network 2
A
192.168.1.1
192.168.2.1
B

Path determination

OSPF

BGP

IS-IS



Sender

or

Receiver

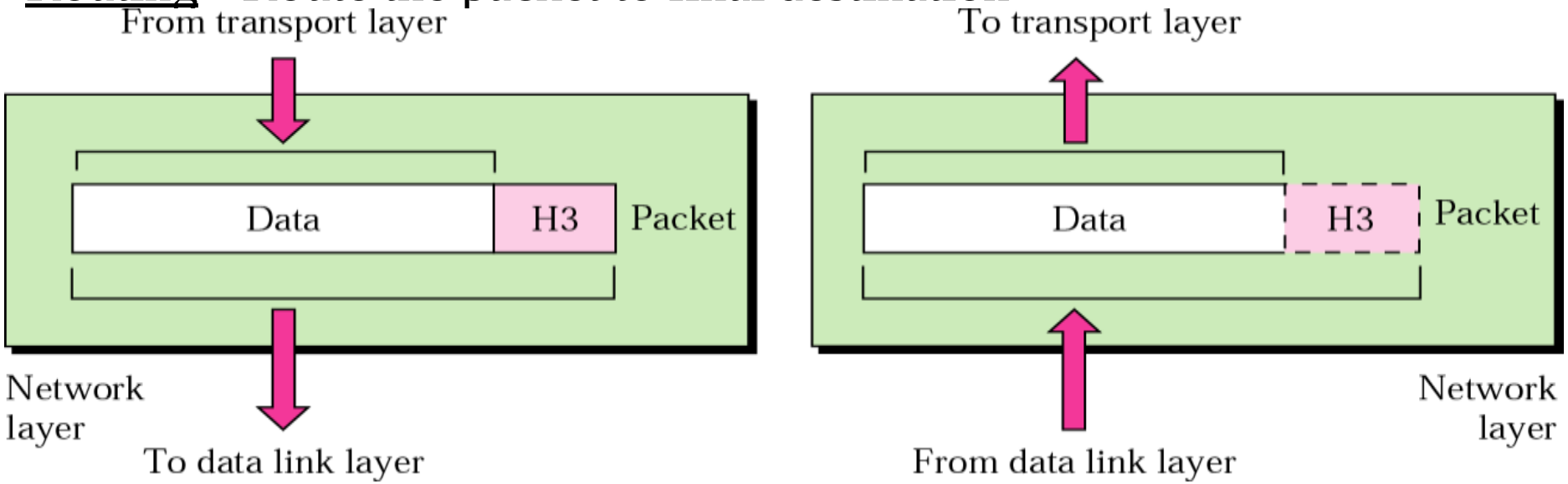
Network Layer

Functions:

•Logical addressing-Physical addressing (May change) handle addressing problem locally

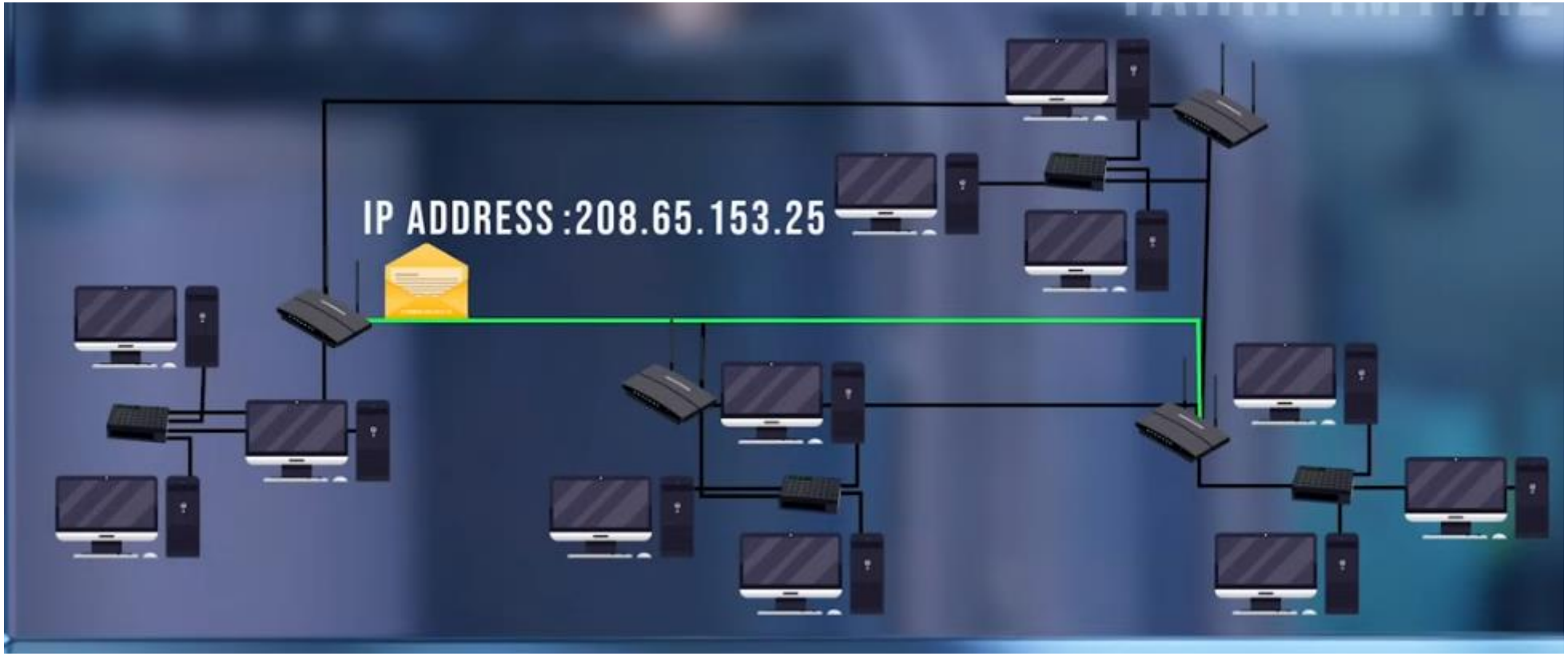
•If packet pass the network boundary, we need another addressing called logical addressing (Never change)

•Routing - Route the packet to final destination



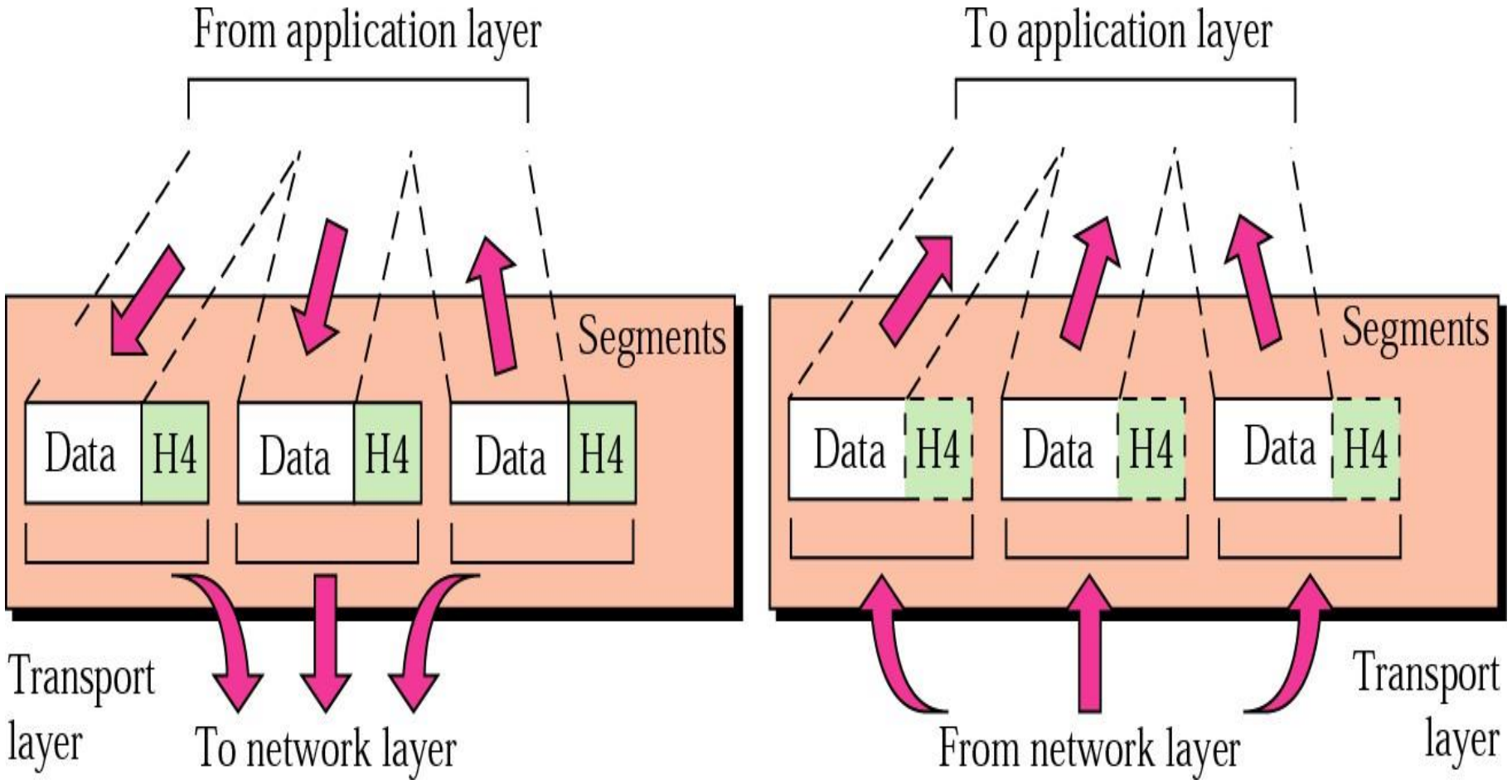
The network layer is responsible for the delivery of packets from the original source to the final destination.


4
Transport Layer
S2
3
Network Layer
S1
2
Data Link Layer
S1


IP ADDRESS :208.65.153.25

4. Transport Layer

- The transport layer is responsible for **process-to-process or end-end** delivery of the entire message.
- Transport layer is responsible to reliable communication through:Segmentation , Flow control & Error control
- The network layer oversees host-to-destination delivery of individual packets, it does not recognize any relationship between those packets.
- The transport layer ensures that the whole message arrives intact and in order, overseeing both error control and flow control at the process-to-process level.



The transport layer is responsible for delivery of a message from one process to another.

Functions of the Transport layer

Service point addressing:

Computer often run several processes (running programs) at the same time. Process-to-process delivery means delivery from a specific process on one computer to a specific process on the other.

- The transport layer header include a type of address called **port address**.
- The network layer gets each packet to the correct computer; the transport layer gets the entire message to the correct process on that computer.

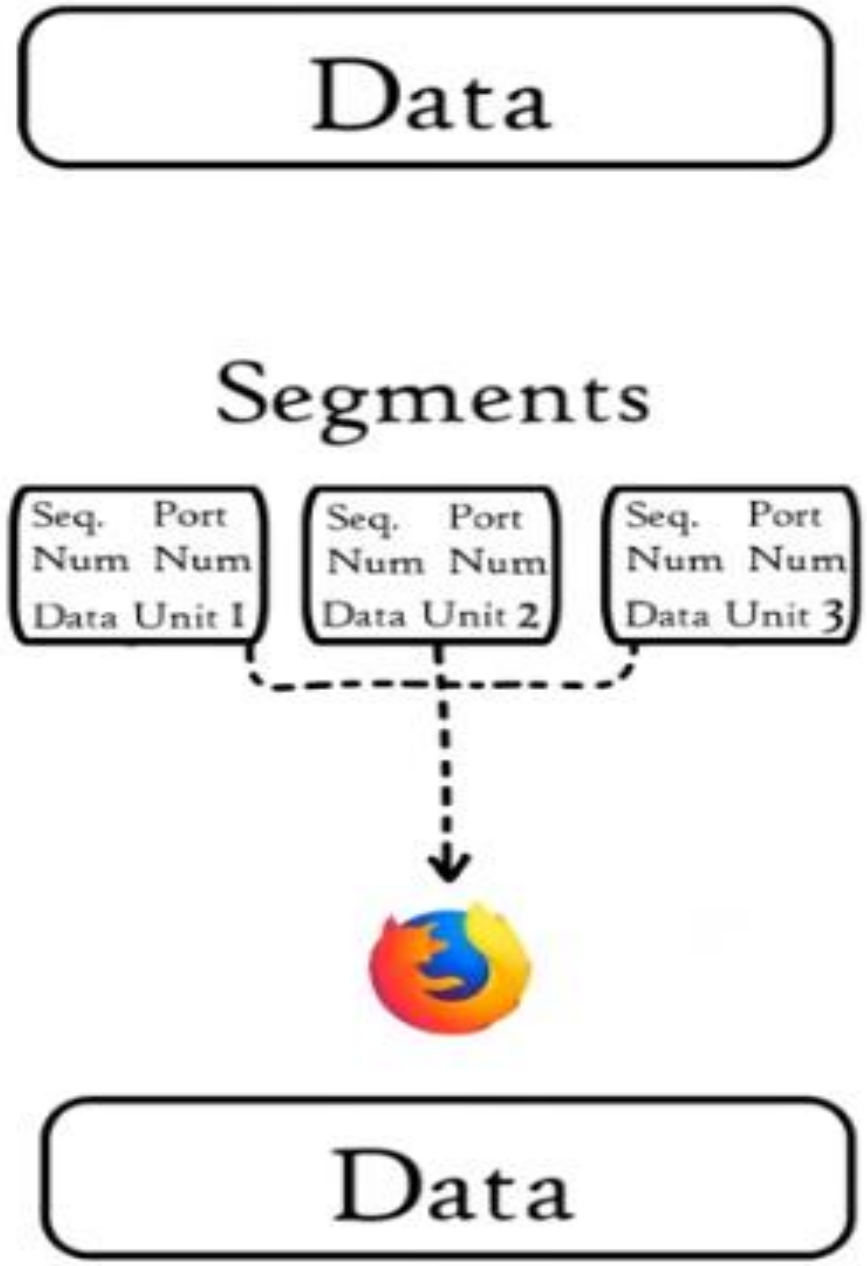
Total Port number: 65,536 are available

Cont..

,

- **Segmentation and reassembly**: a message is **divided into transmittable segments**, each having a **sequence number**. These numbers enable the transport layer to reassemble the message correctly upon arrival at the destination.
- **Connection control**: The transport layer can be either connectionless or connection-oriented.
- A connectionless transport layer treats each segment as an independent packet and delivers it to the transport layer at the destination machine.
- A connection-oriented transport layer makes a connection with the transport layer at the destination machine first before delivering the packets. After all the data are transferred, the connection is terminated.

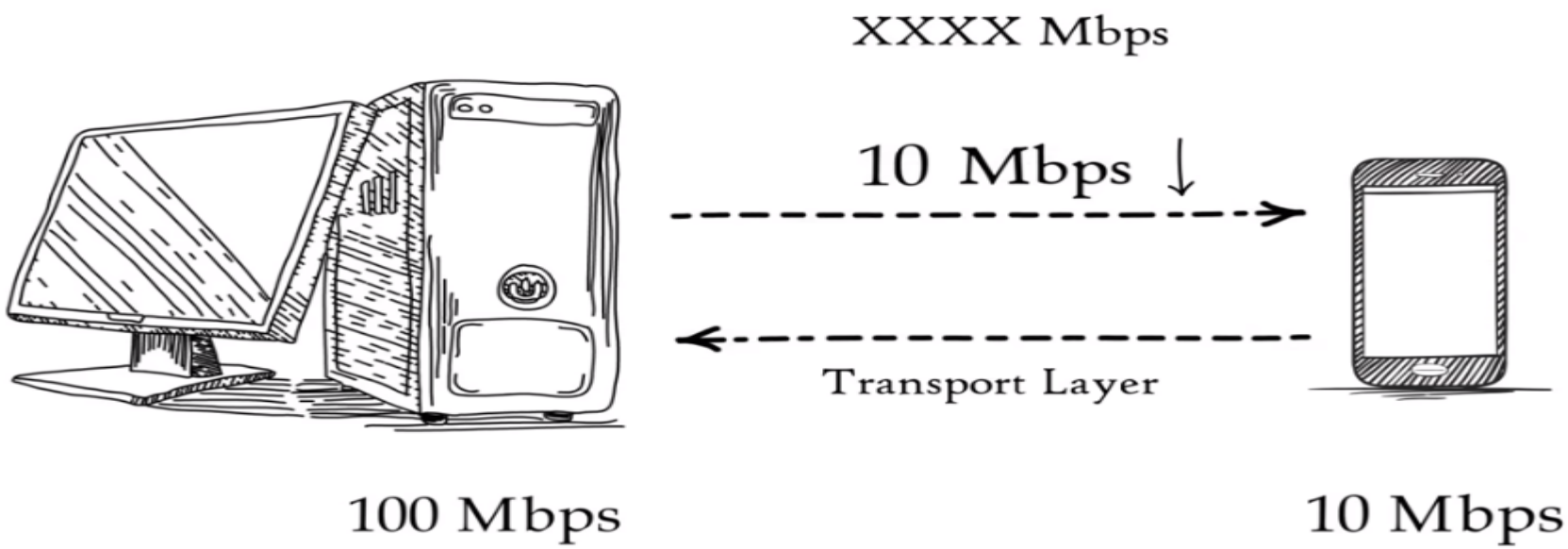

1. CONVERT DATA TO SEGMENTS
SEGMENT 1
SEGMENT 2

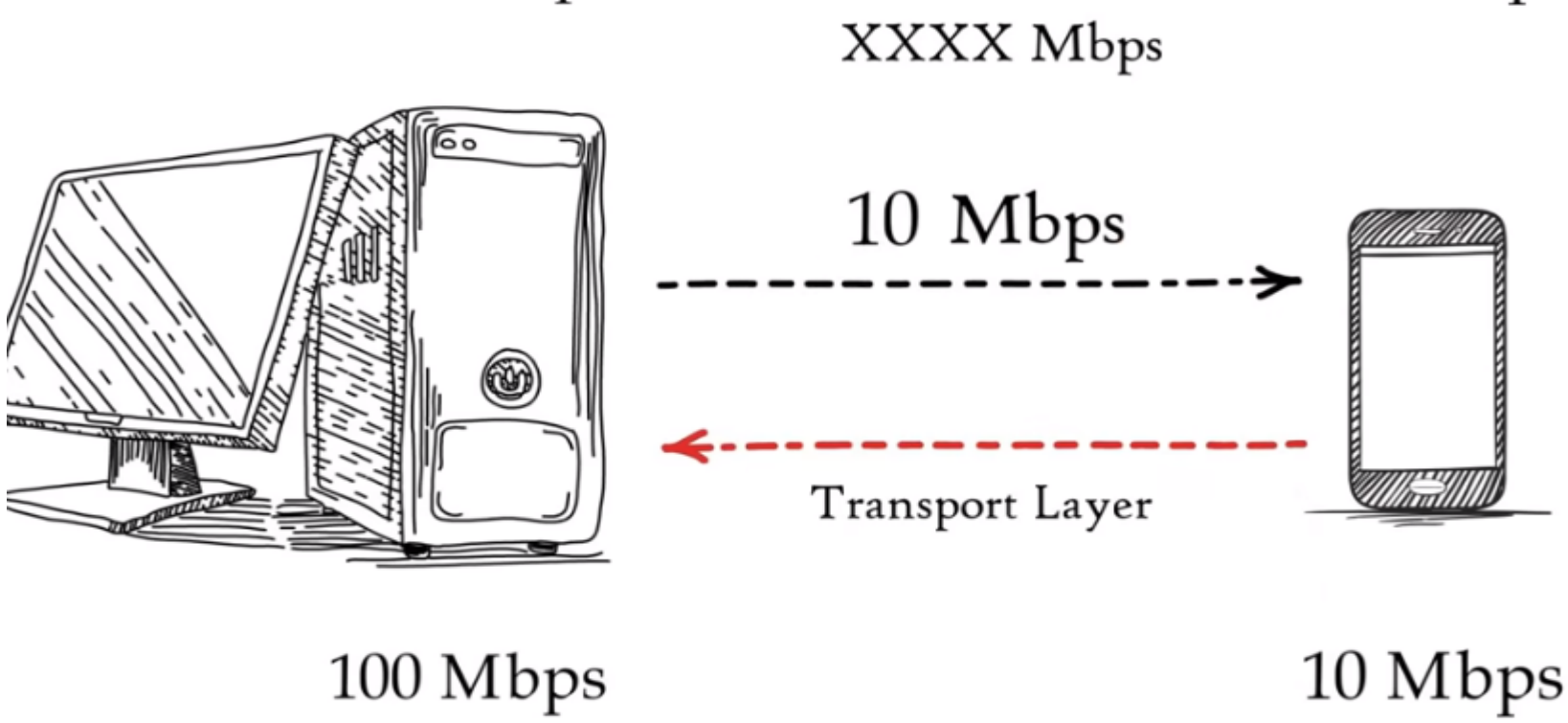

Data
Segments
Seq. Num
Port Num
Data Unit 1
Seq. Num
Port Num
Data Unit 2
Seq. Num
Port Num
Data Unit 3
Data

Functions of the transport layer

- **Flow control**: the transport layer performs a flow control end to end. The data link layer performs flow control across a single link.
- **Error control**: the transport layer performs error control end to end. The data link layer performs control across a single link.
- **Congestion control** concerns controlling traffic entry into a telecommunication networks so as to avoid congestive collapse by attempting to avoid oversubscription of any of the processing or link capabilities of the intermediate nodes and networks and taking resource reducing steps, such as reducing the rate of sending packets. It should not be confused with flow control, which prevents the sender from overwhelming the receiver.

Flow Control:

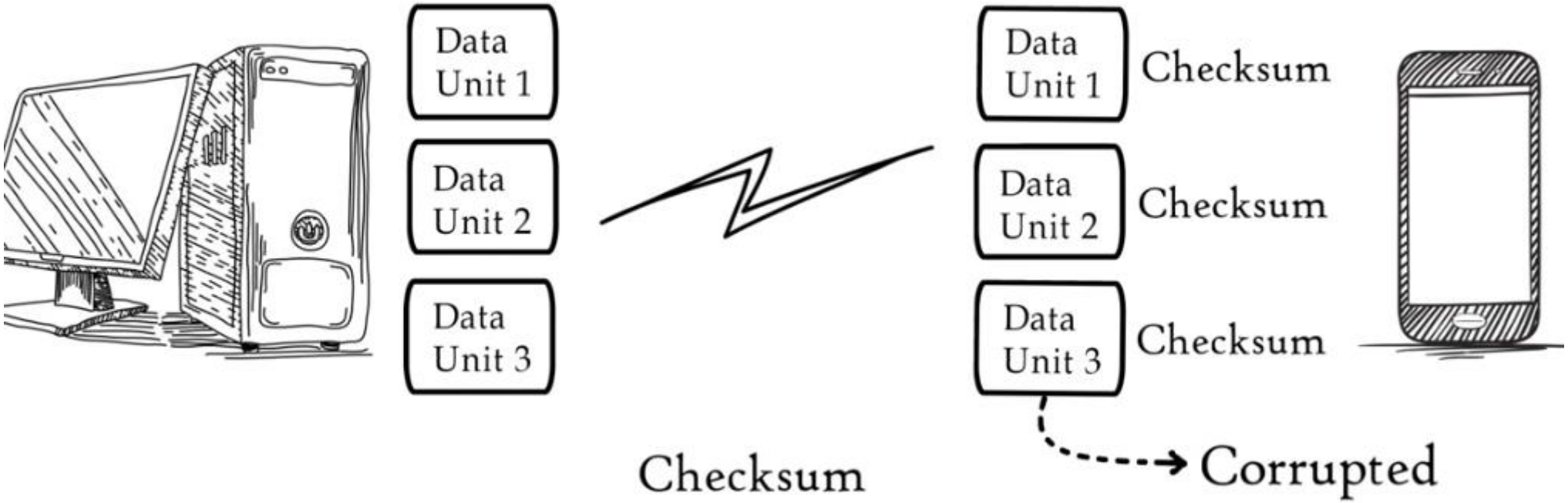




Error Control:

Automatic Repeat Request

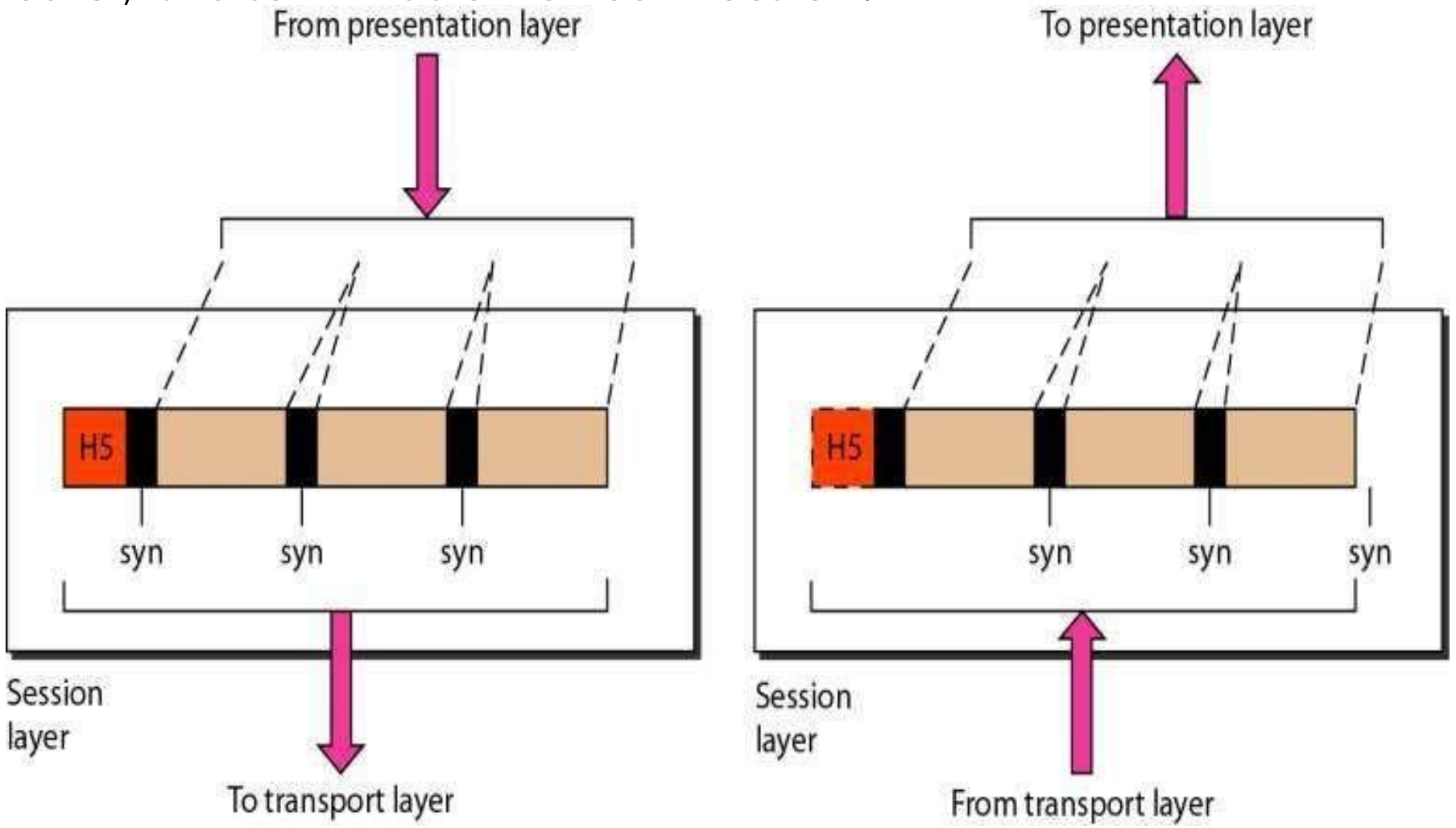
Automatic Repeat Request



Services:	Protocols:
- Connection-oriented Transmission	----------> Transmission Control Protocol (TCP)
- Connectionless Transmission	----------> User Datagram Protocol (UDP)

5. Session Layer

- The session layer is responsible for dialog control and synchronization. Setting up and managing connection to transfer and received the data. Followed by the termination of connection.

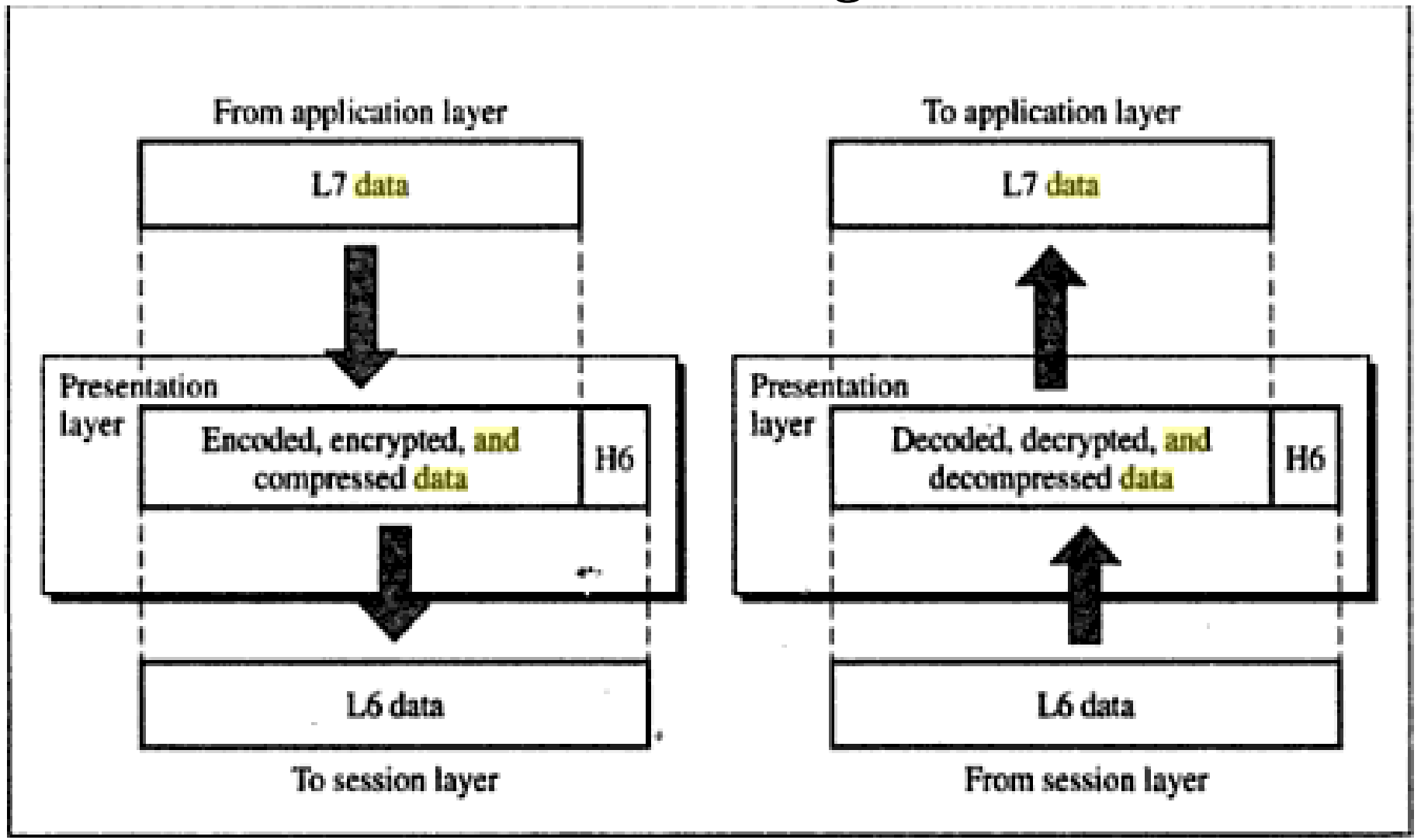


Functions of Session Layer

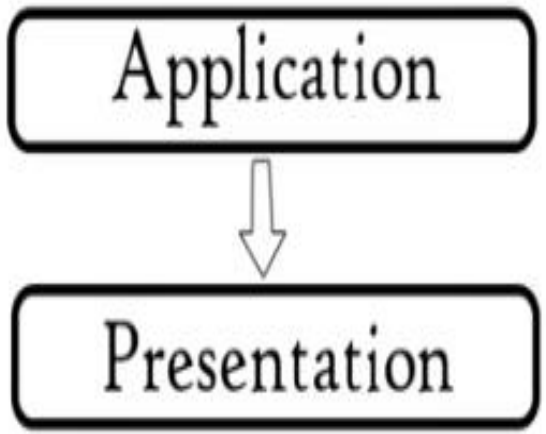
- **Decision Control**:- Half duplex, Full Duplex
- **Token management:** preventing two parties from attempting the same critical operation simultaneously
- **Synchronization**: Adding checkpoints to stream data.
- Ex: System sending 2000 pages.
- Add check point after each 100th page.
- So in case of failure no need to sent whole page.

6. Presentation Layer

- It is concerned with the syntax and semantics of the information exchanged b/w 2 devices.



Presentation Layer



Translation

DFGJUYRG
6457899541 2

eg. ASCII ⟶ EBCDIC

Data Compression

100011101101

1. Lossy
2. Lossless

Encryption

10101101

10011011

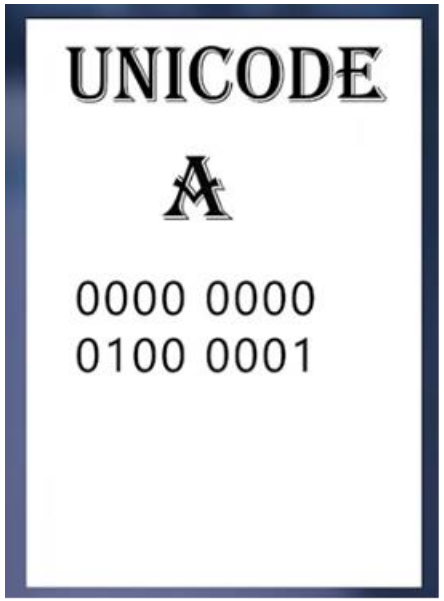
SSL

Secure Sockets Layer

Functions of Presentation Layer

- **Translation:** Interoperability b/w different encoding formats.
- **Encryption:** Converting plain to cipher text and vice versa.
- **Compression:** Reducing number of bits in multimedia data when transmitting.

Translation: Interoperability b/w different encoding formats

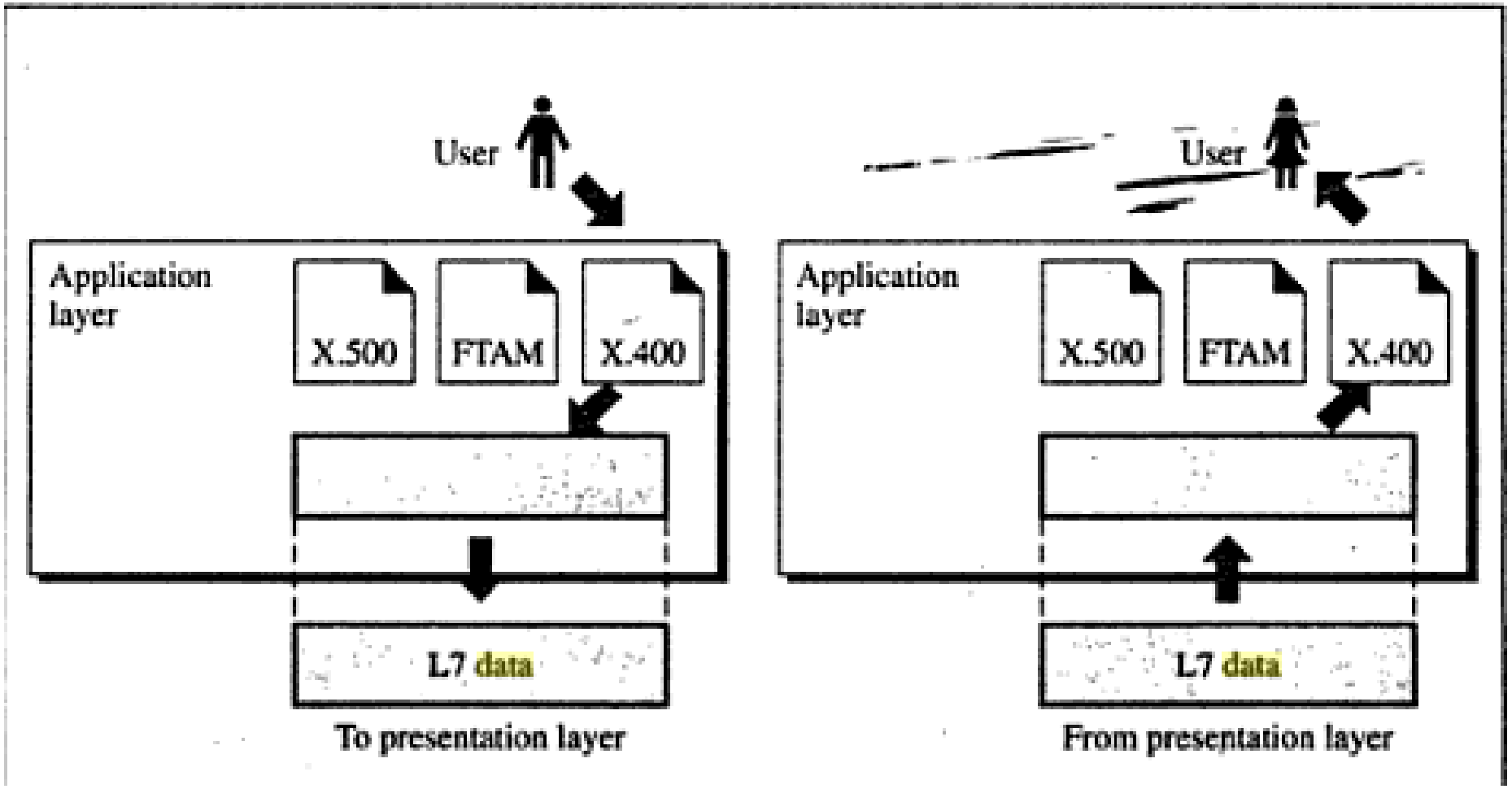


Encryption: Converting plain to cipher text and vice versa.

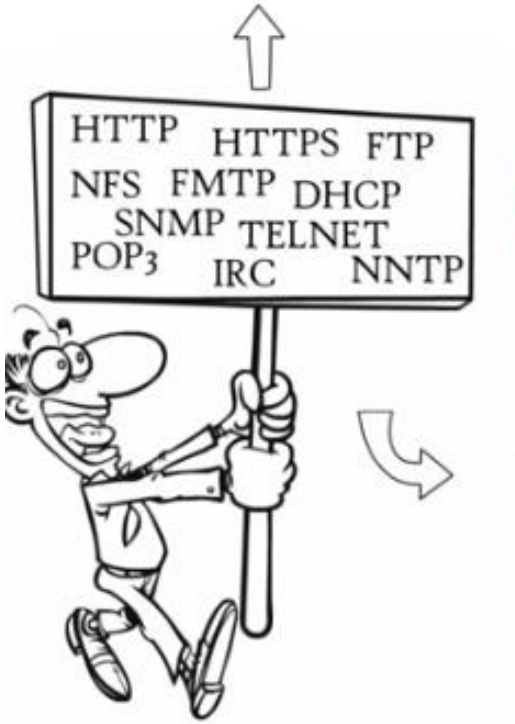
Compression: Reducing number of bits in multimedia data when transmitting.

7. Application layer

The application layer is responsible for providing services to the user. The **application layer** contains a variety of protocols that are commonly needed by users.



Application Layer: Network Applications



File Transfer

Web Surfing

Emails

Virtual Terminals

FTP

HTTP/S

SMTP

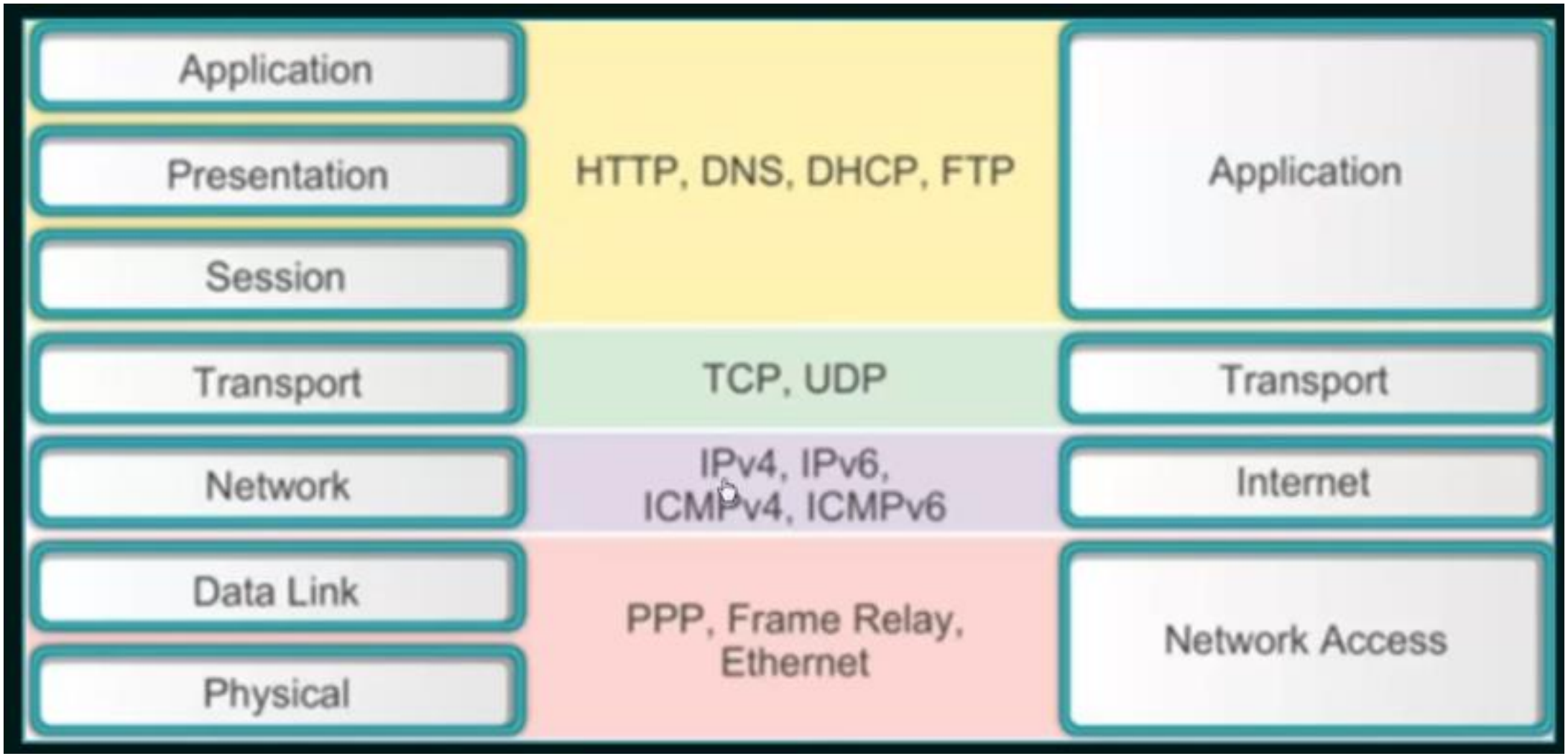
Telnet

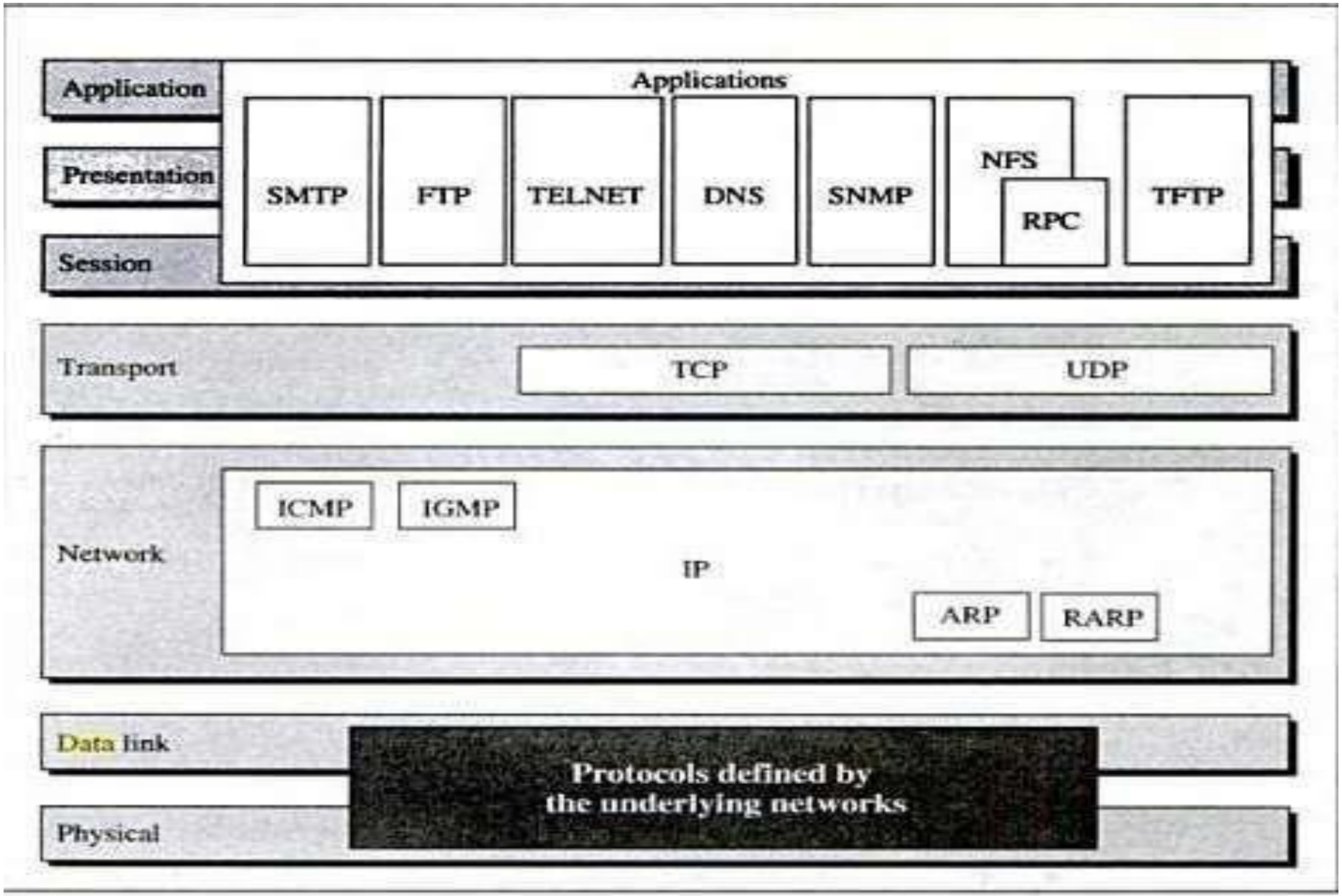
Functions of Application Layer

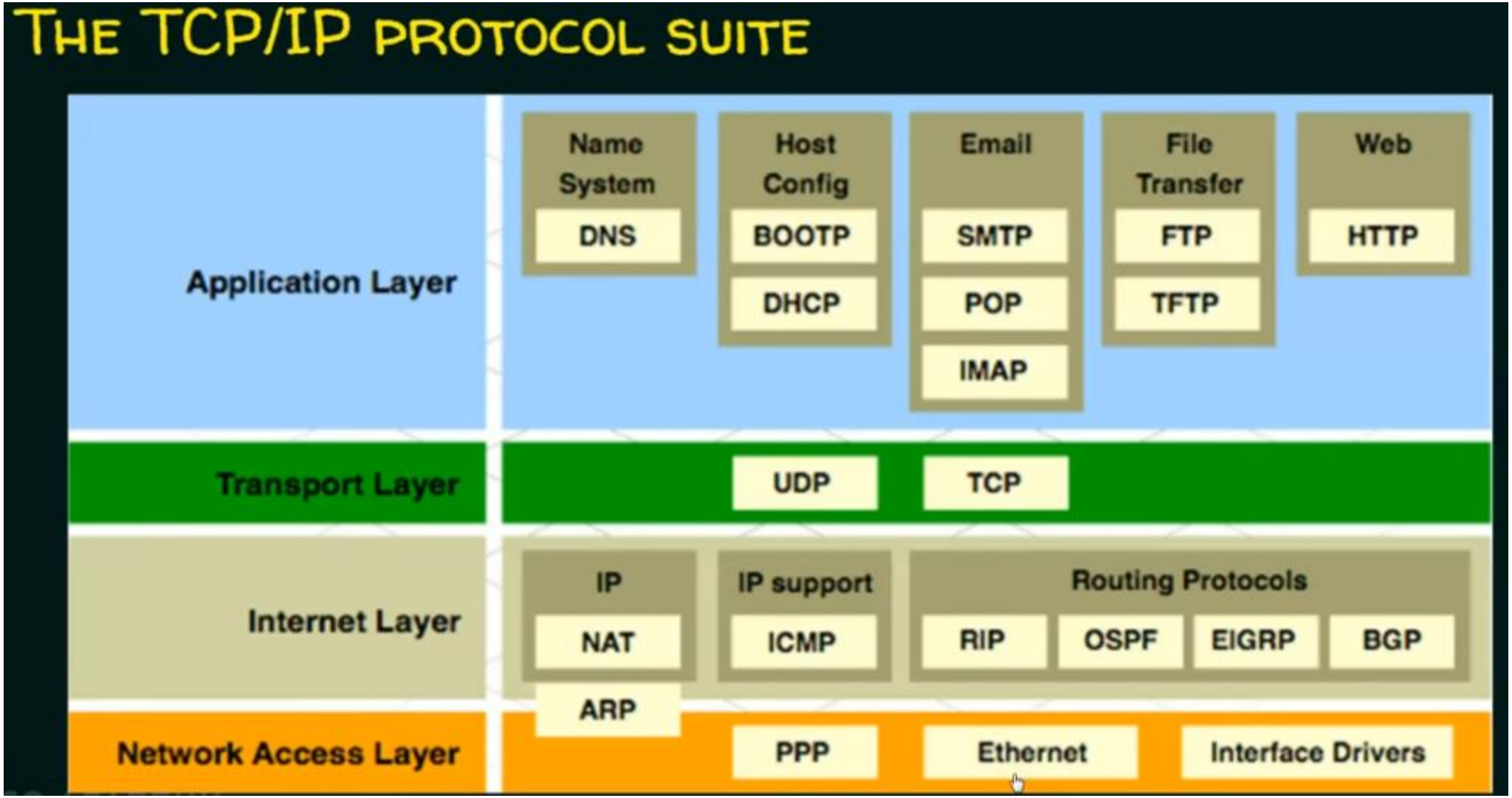
- It provides user access to network.
- X.500-Directory service.
- X.400-Message handling service.
- **FTAM-** File Transfer Access and management.
- Network Virtual Terminal.

TCP/IP Protocol

- Transmission Control Protocol / Internetworking Protocol is used in the internet and is developed **prior to the OSI** model.
- It would not match exactly with OSI model
- It is divided into layers.


Application
Presentation
Session
HTTP, DNS, DHCP, FTP
Application
Transport
TCP, UDP
Transport
Network
IPv4, IPv6,
ICMPv4, ICMPv6
Internet
Data Link
Physical
PPP, Frame Relay,
Ethernet
Network Access


Application
Presentation
Session
Applications
SMTP
FTP
TELNET
DNS
SNMP
NFS
RPC
TFTP
Transport
TCP
UDP
Network
ICMP
IGMP
IP
ARP
RARP
Data link
Physical
Protocols defined by
the underlying networks


THE TCP/IP PROTOCOL SUITE
Application Layer
Name System
DNS
Host Config
BOOTP
DHCP
Email
SMTP
POP
IMAP
File Transfer
FTP
TFTP
Web
HTTP
Transport Layer
UDP
TCP
Internet Layer
IP
NAT
ARP
IP support
ICMP
Routing Protocols
RIP
OSPF
EIGRP
BGP
Network Access Layer
PPP
Ethernet
Interface Drivers

- It contains relatively independent protocols that can mixed and matched with depend on needs of the system.

Protocol Data Unit (PDU)

Protocol Data Units (PDUs) are named according to the protocols of the TCP/IP suite: data, segment, packet, frame, and bits.

Application Layer – Data
Transport Layer – Segment
Network Layer – Packet
Data Link Layer – Frame
Physical Layer– Bits

Encapsulation

Email Data

Data | Data | Data

Transport header | Data

Network header | Transport header | Data

Frame header | Network header | Transport header | Data | Frame header

11000101010001011001010010101010 01

Data

Segment

Packet

Frame (medium dependent)

Bits

Passing down the stack.