# Networking Principles and layered architecture

- Data Communications and Networking:
  - A Communications Model
- Data Communications:
  - Evolution of network
  - Requirements
  - Applications
  - Network Topology (Line configuration, Data Flow),
- Protocols and Standards, Network Models (OSI, TCP/IP)

# DEFINTION & APPLICATIONS

## DEFINTION:

- A computer network is defined as a group of two or more computer systems linked together. It is done to enable the computers to communicate and share available resources.
- Many types of computer networks, including the following: LAN, MAN, WAN, CAN, PAN, HAN….
- Network benefits: Sharing and Connectivity
- **APPLICATIONS:**
  - **Sharing of resources such as printers.**
  - **Sharing of expensive software's and database.**
  - **Communication from one computer to another computer**
  - **Exchange of data and information among users via network.**
  - **Sharing of information over geographically wide areas.**

# Network Benefits: SHARING RESOURCES

- Types of resources are:

1. **Hardware:** A network allows users to share many hardware devices such as printers, modems, fax machines, CD ROM, players, etc.

**2. Software**: sharing software resources reduces the cost of software installation, saves space on hard disk.

# OTHER BENEFITS OF COMPUTER NETWORK

- Increased speed
- Reduced cost
- Improved security
- Centralized software managements
- Electronic mail
- Flexible access

# DISDAVATAGES OF NETWORKS

- High cost of installation
- Requires time for administration
- Failure of server
- Cable faults

# DATA COMMUNICATIONS

**DC-** is the exchange of data between two devices by means of any transmission medium.

**Characteristics:**

**1.Delivery,**
**2. Accuracy and**
**3. Timeliness.**

1. The data must be delivered to the correct destination.
2. The data must be delivered accurately. i.e. without alteration.
3. The system must deliver data in a timely manner.
   e.g. Real time application.

# Network

- **Network**: Is a group or system of interconnected people or things.
- Example: "the company has a network of 20 branches“.
- Computer Networks: A network is defined as a group of two or more computer systems linked together. There are many types of computer networks: LAN, MAN, WAN, CAN, PAN, HAN……

# *Network Characteristics*

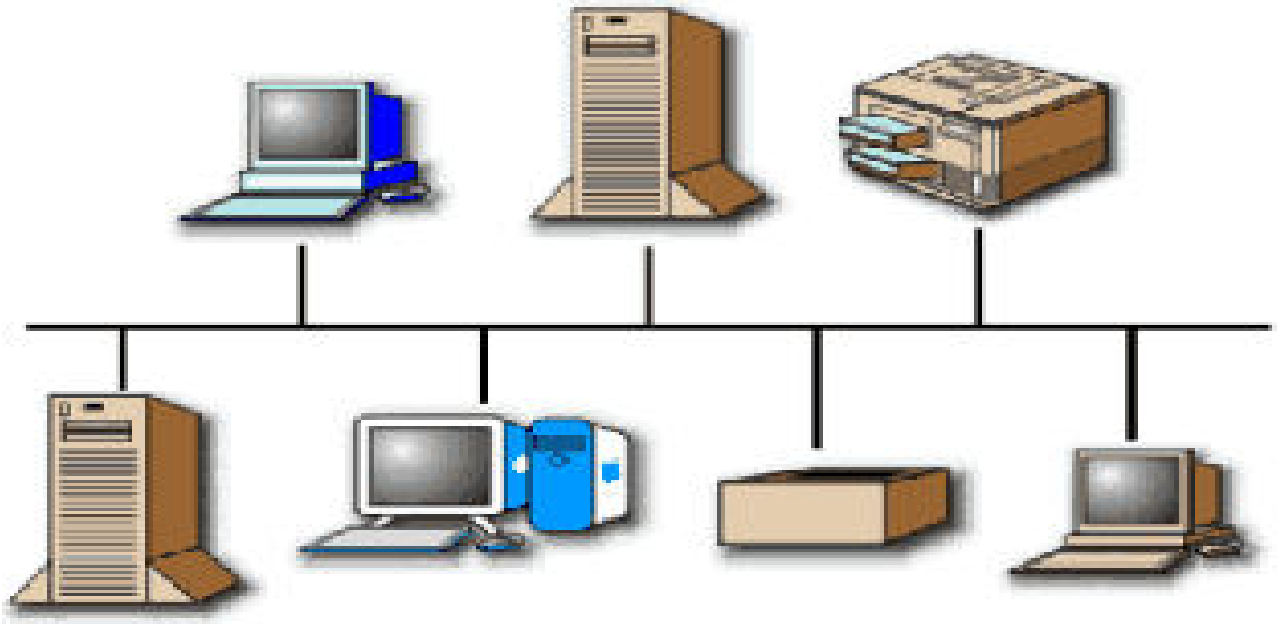
- **Topology** : The geometric arrangement of a computer system.
- **Protocol** : The protocol defines a common set of rules and signals that computers on the network use to communicate. One of the most popular protocols for LANs is called *Ethernet*.
- **Architecture** : Networks can be broadly classified as using either a peer to peer or client/server architecture.

# Network Goals:

- Resource sharing.
- High reliability.
- Saving Money and Time consuming

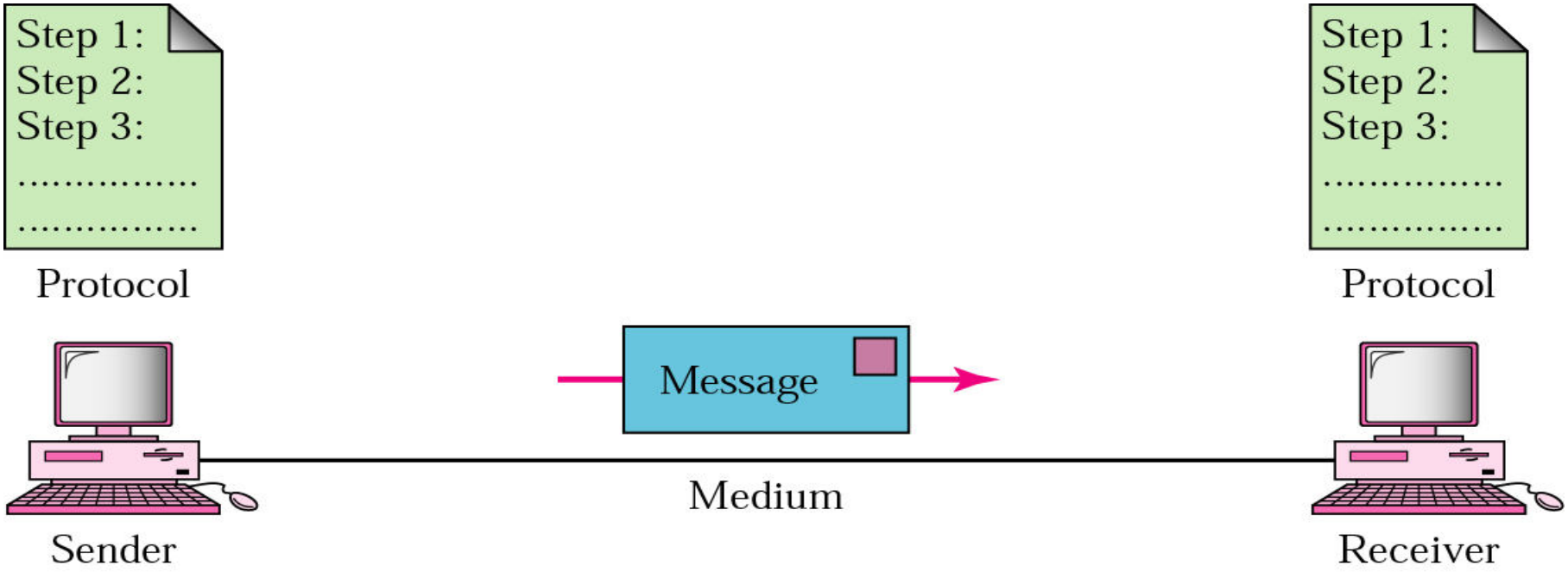
# What is a Network?

- A network is a set of devices (node) connected by media links.
- A computer network may be defined as an interconnected collection of autonomous computers.
- A network is a collection of computers, printers, routers, switches, and other devices that are able to communicate with each other over some transmission media.



# Components of data Communication:

1.Message, 2.Sender, 3.Receiver, 4.Medium and 5.Protocol.



# Components of data Communication

**Message :** It is the data to be communicated. It consists of text, numbers, pictures, sound, or video or any combination of these.

**Sender :** It is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera.

**Receiver :** It is the device that receiver the message. It can be a computer, workstation, telephone, and television.

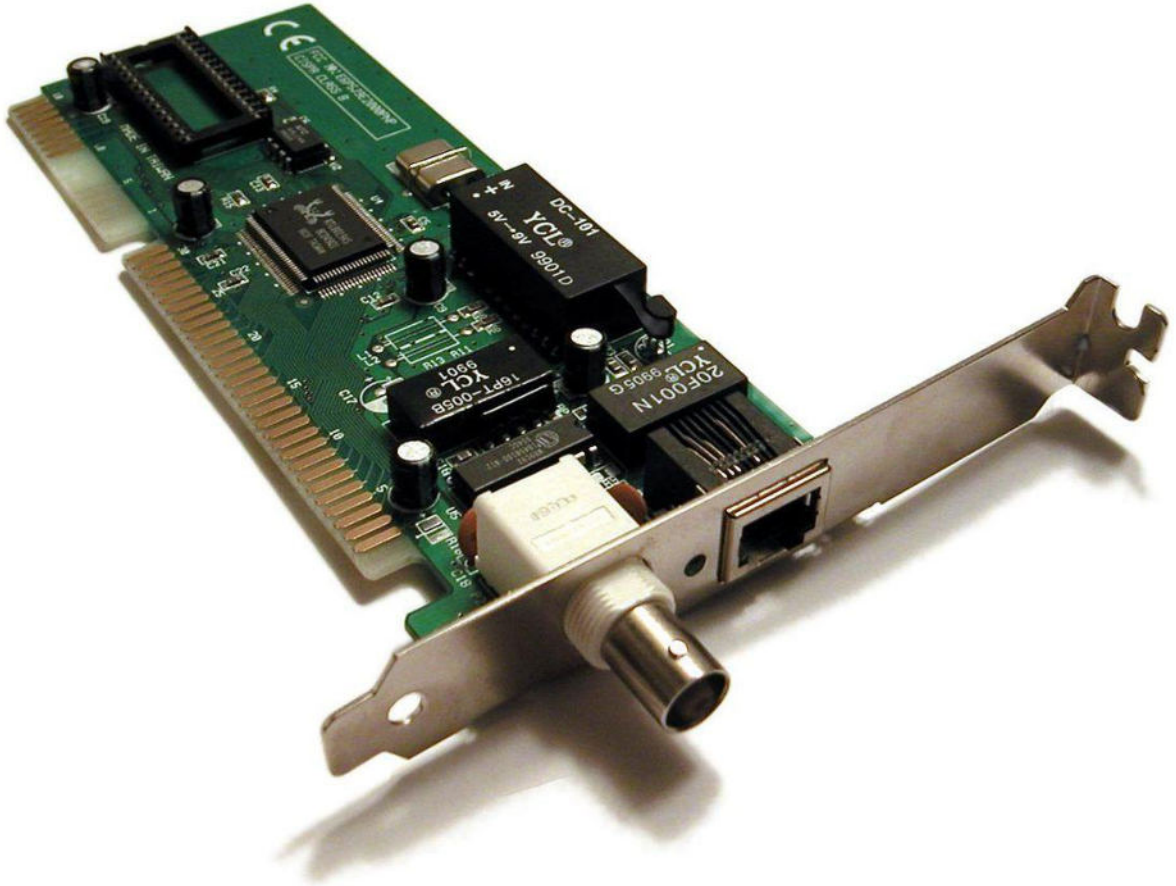
**Medium :** Transmission medium is the physical path by which a message travels from sender to receiver. Example it consists of twisted pair wire, co axial cable, fiber optical, laser or radio waves.

**Protocol:** It is a set of rules that govern data communication. Without a protocol two devices are connected but not

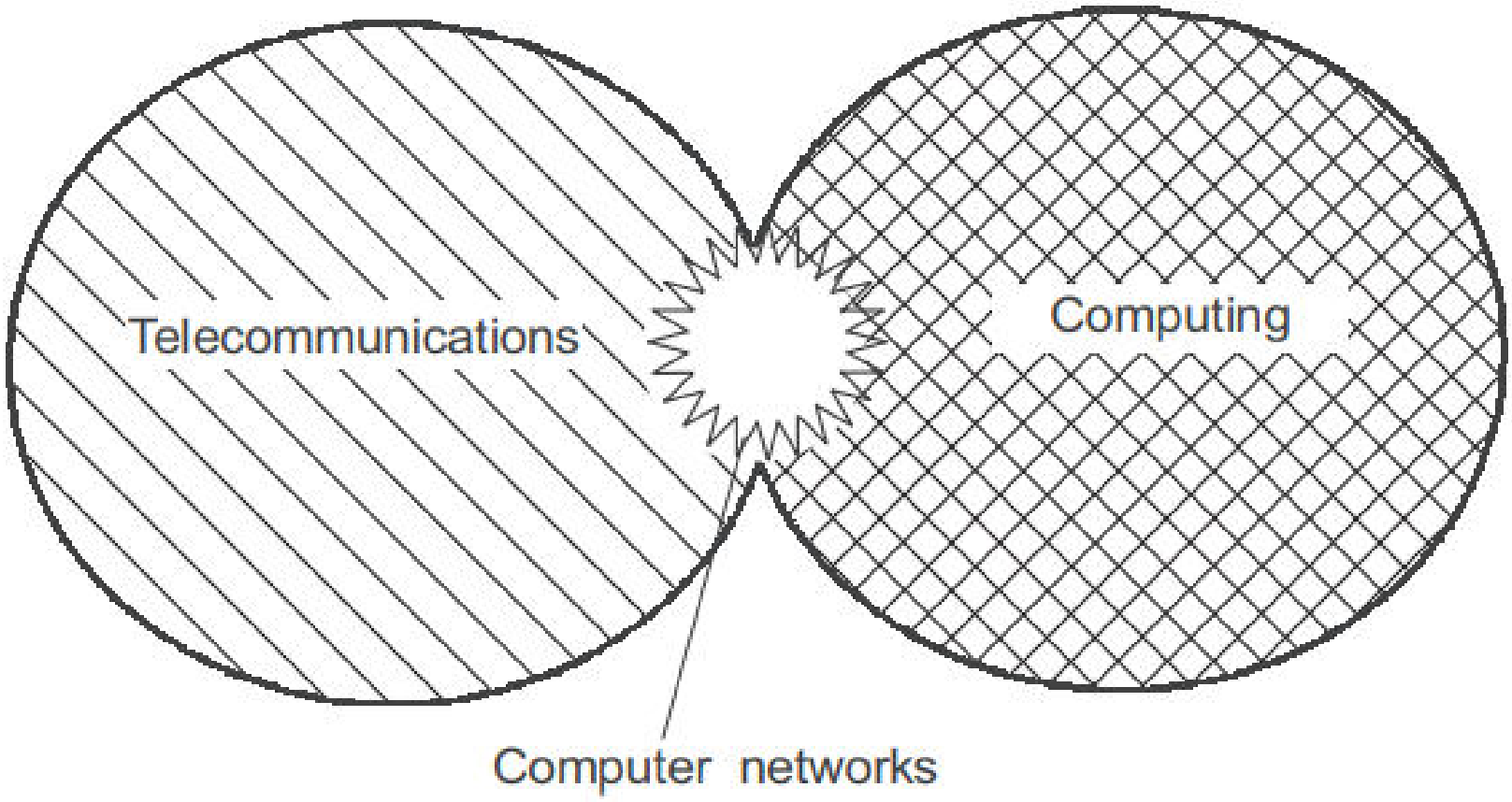
# COMPONENTS OF COMPUTER NETWORK

- Two or more computers
- Cables as links between the computers
- A network interfacing card(NIC) on each computer
- Switches
- Software called operating system(OS)

# Network interfacing card(NIC)



# 1. Evolution of network



# Evol....Roots of Computer networks

- Computer networks: transmitting information over along distances. This implementation is done by various methods of data encoding and multiplexing in telecommunications systems.
- Batch processing systems: 1950
- Multiterminal systems: Prototype of the computer network(1960).

# Batch processing systems

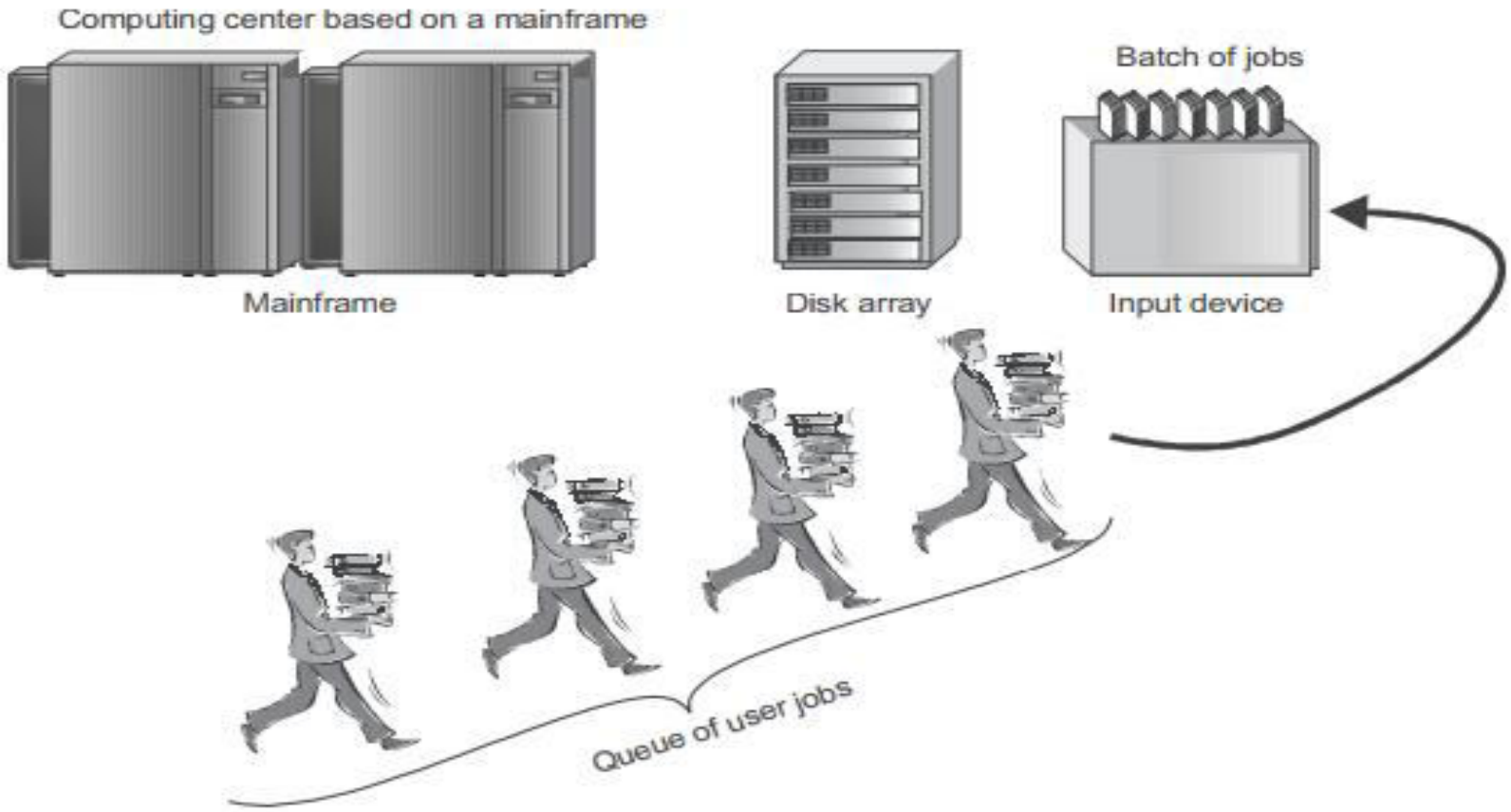



Figure 1.2 **Centralized system based on a mainframe**

# Multiterminal systems

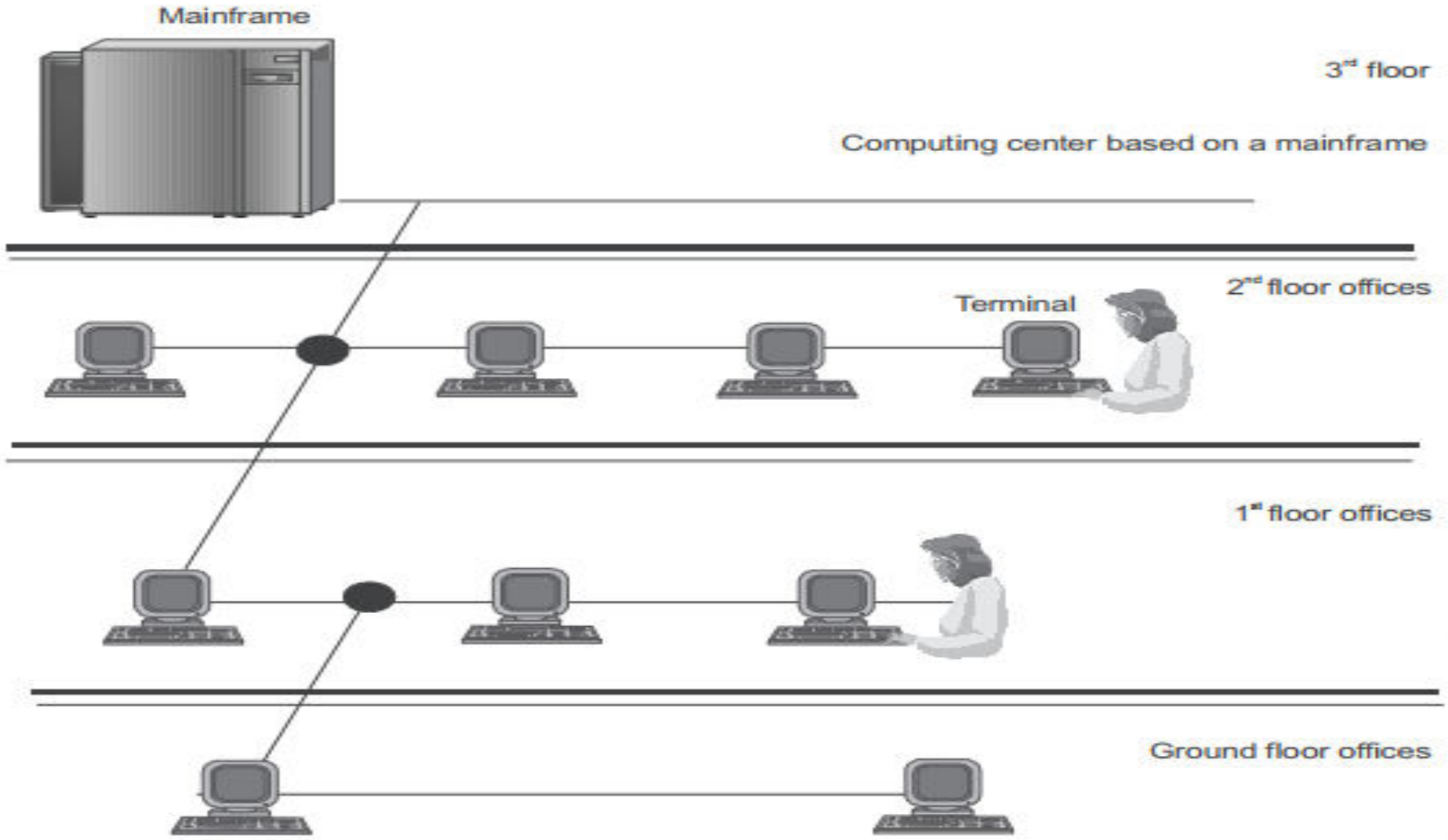



Figure 1.3 Multiterminal system as a prototype of a computer network

# Evol…First Computer Networks

- First WAN:
  - Multilayer architecture of communications protocols
  - Packet switching technology
  - Packet routing heterogeneous networks

# 2. Data Communications: Requirements

Sent Mail - dr.punithak@gm | (2) WhatsApp | Prime Video: MMOF | Mail - punitha.k@vit.ac.in | 6 Data Communication Requ

Not secure | dicom.nema.org/dicom/2013/output/chtml/part18/chapter_6.html

Apps | Extensions | Gmail | Google | INDIANBANK INTE... | Skanda Shasti Kava... | Punitha K - Outlook... | google.com | VOOT - Watch Free... | vt | Reading list

| 6 Data Communication Requirements | | |
|---|---|---|
| Prev | | Next |

## 6 Data Communication Requirements

### 6.1 Interaction


**Figure 6-1. Interaction Diagram**

The interaction shall be as shown in Figure 6-1.

Multiple communications modes are possible:

- URI based using HTTP Get: WADO-URI request
- Web Services (WS) using HTTP Post: WADO-WS, either:
  a. DICOM Requester (Retrieve Imaging Document Set)
  b. Rendered Requester (Retrieve Rendered Imaging Document Set)
  c. Metadata Requester (Retrieve Imaging Document Set Metadata)

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# 3. Applications of Networks:

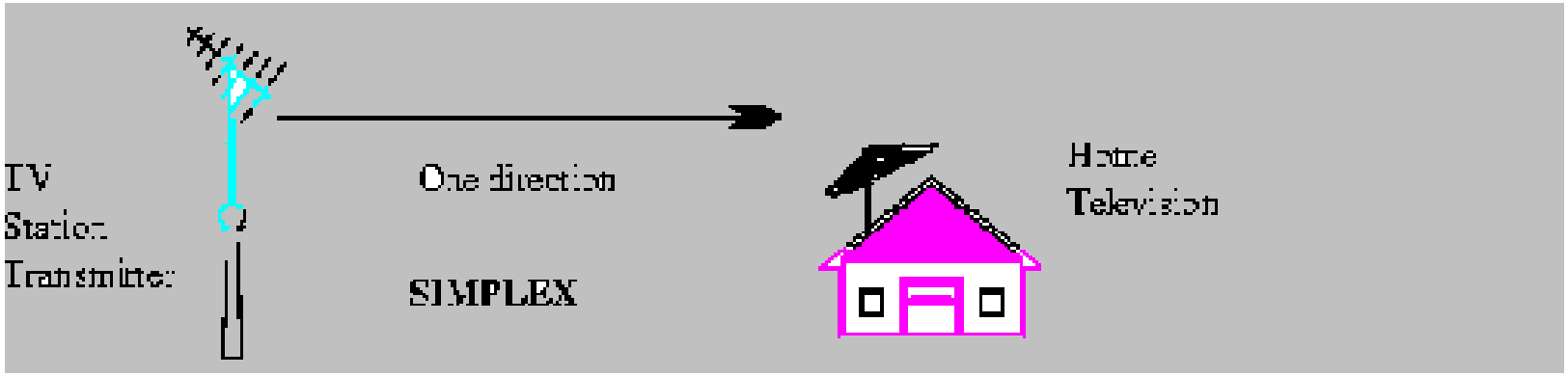
- Electronic messaging. (E-Mail)
- Electronic data Interchange. ( E-Com.).
- Teleconferencing.
- Cellular Telephone.
- Cable TV.
- On-line Marketing , Sales, ticket reservations (boats, hotels, theaters)
- Financial Services. (E- Cash).
- Manufacturing.
- Information Services.

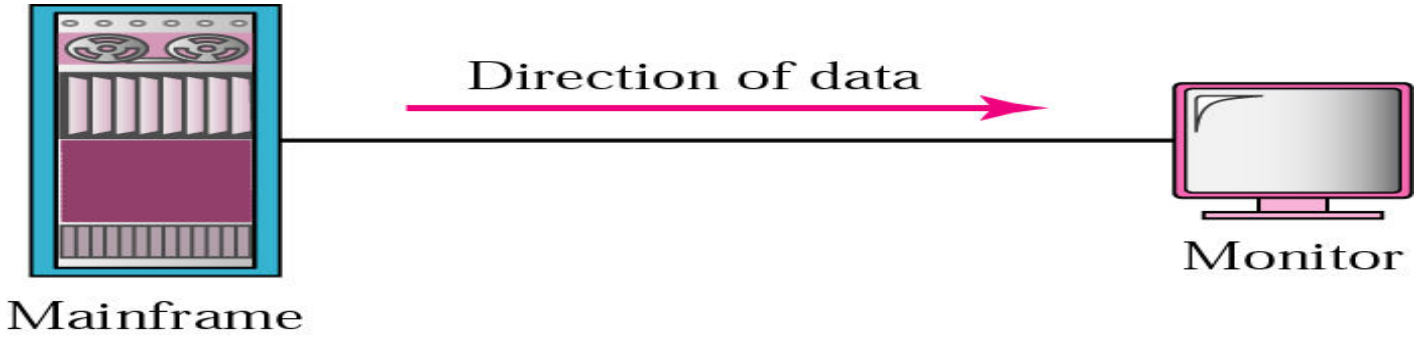
# DIRECTION OF DATA FLOW

# DIRECTION OF DATA FLOW:

## Simplex:

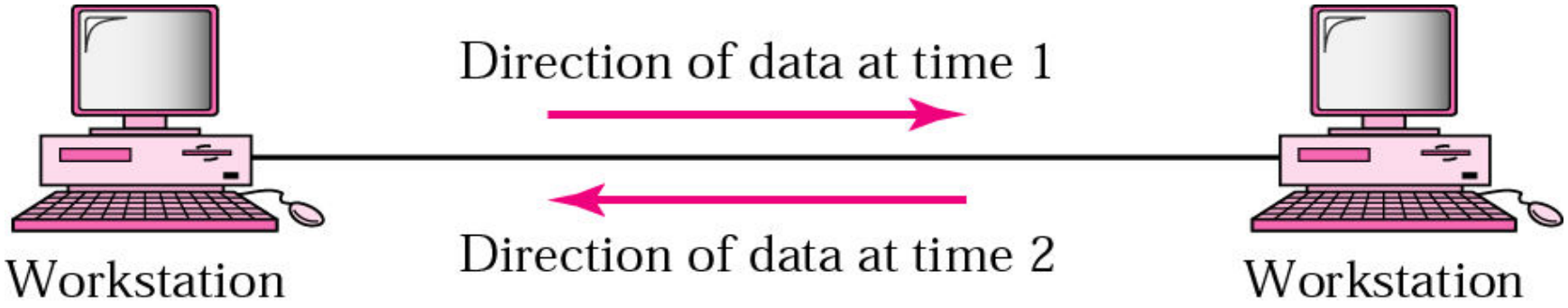
Data flows in only one direction on the data communication line (medium). E.g. Radio and Television broadcasts. They go from the TV station to your home television.



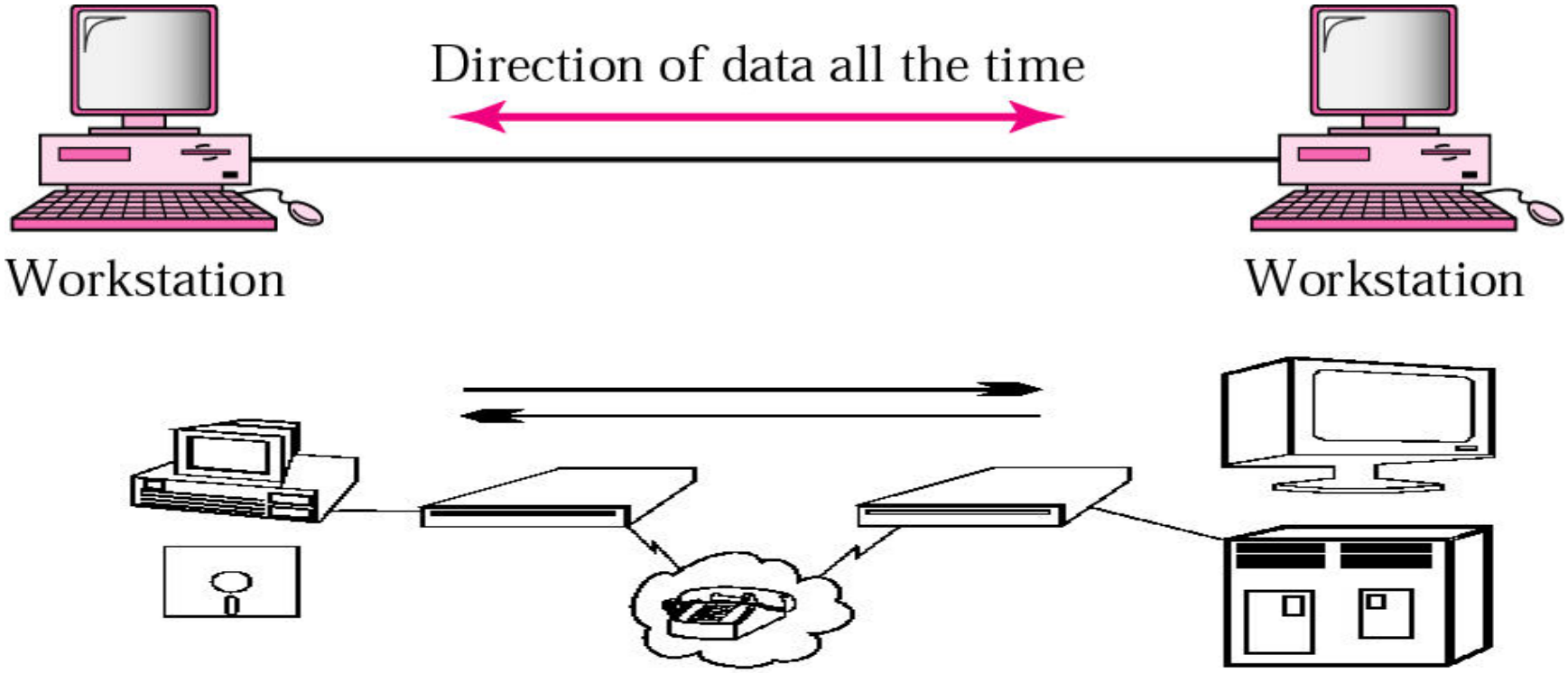
# Half-Duplex:

Data flows in both directions but only one direction at a time on the data communication line. Ex. Conversation on walkie-talkies is a half-duplex data flow. Each person takes turns talking. If both talk at once - nothing occurs!




# Full-Duplex:

Data flows in both directions simultaneously at the same time.
Ex. Modems are configured to flow data in both directions.



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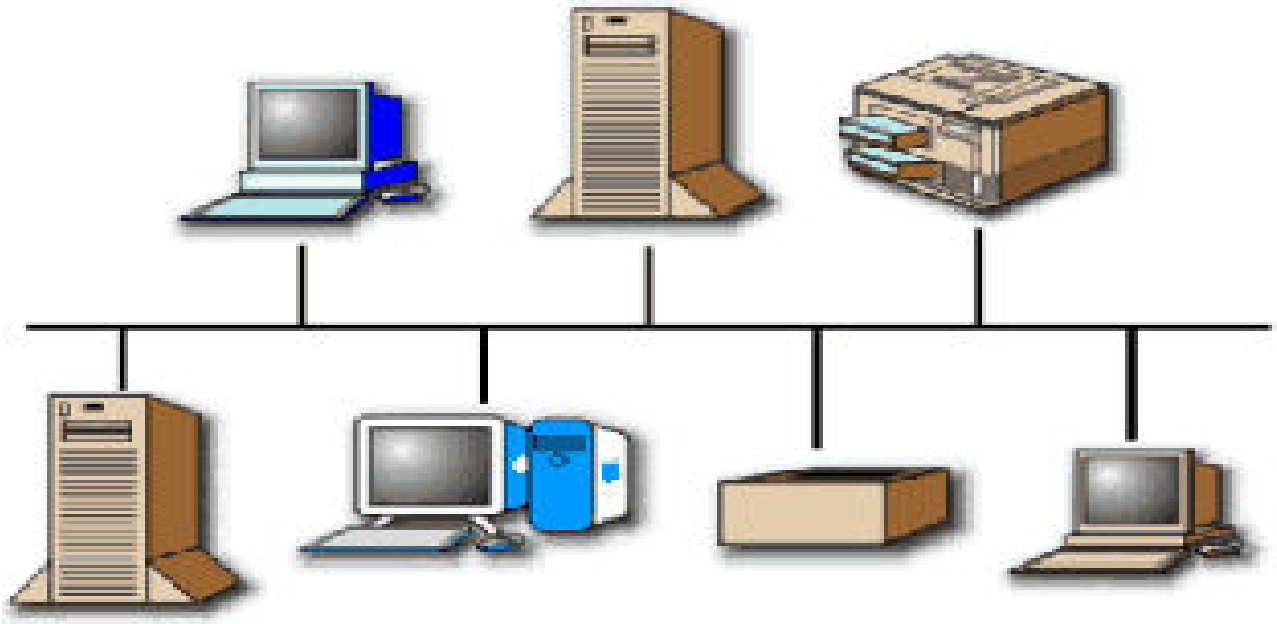
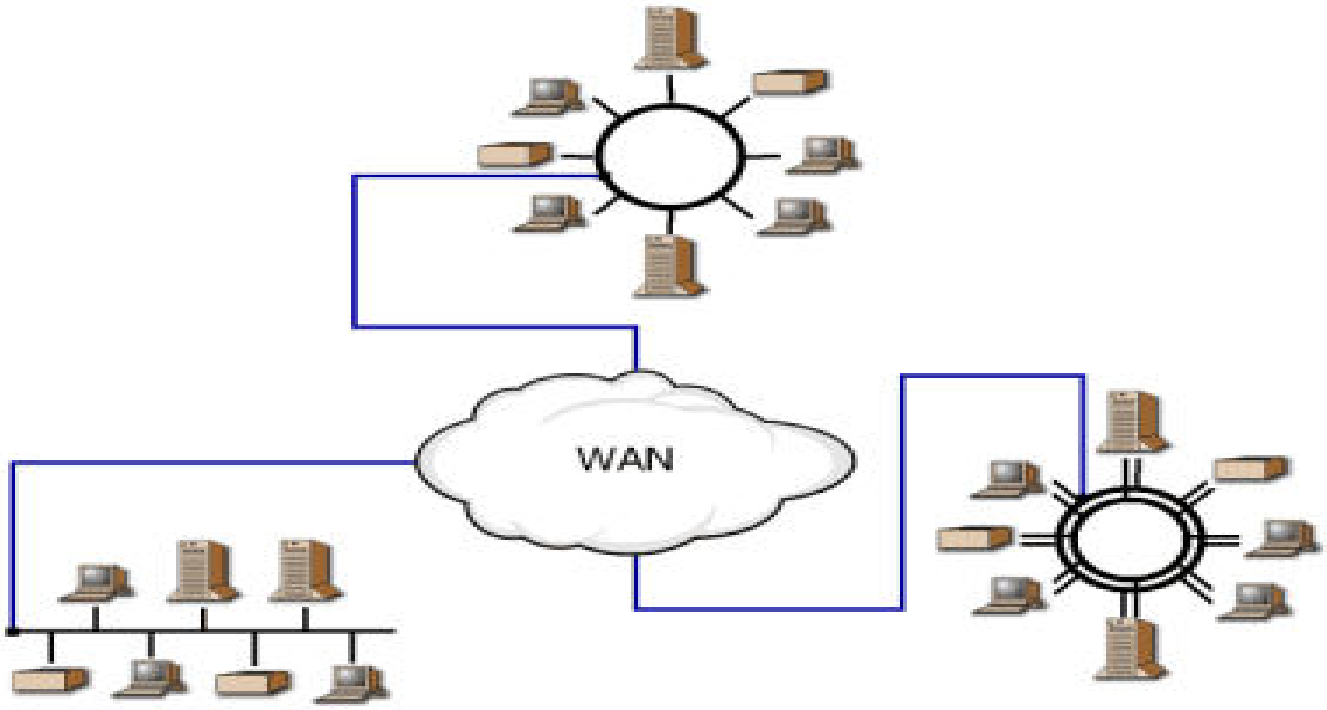
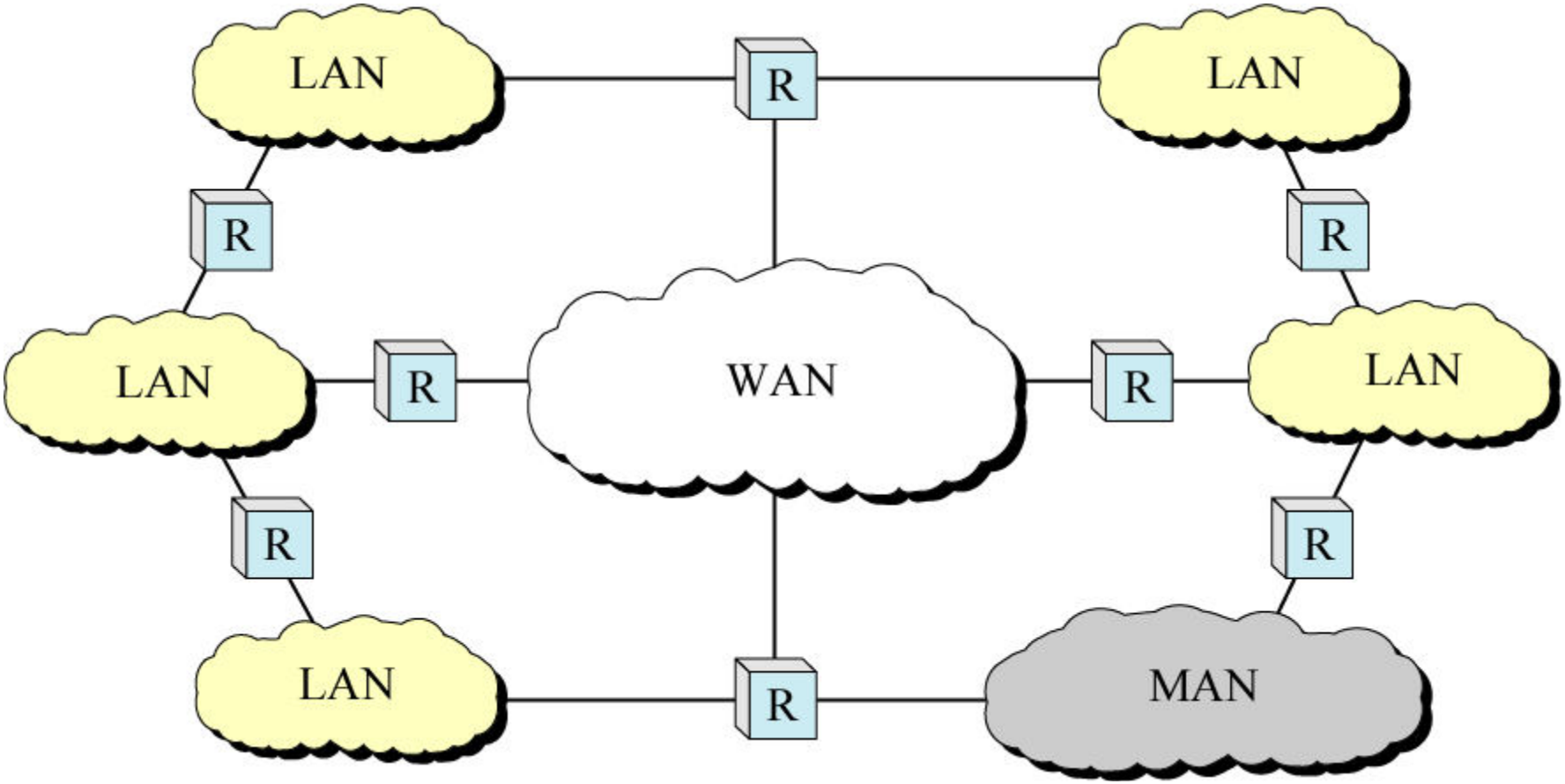


# What is an Internetwork?
# (i.e. Networks of Networks)

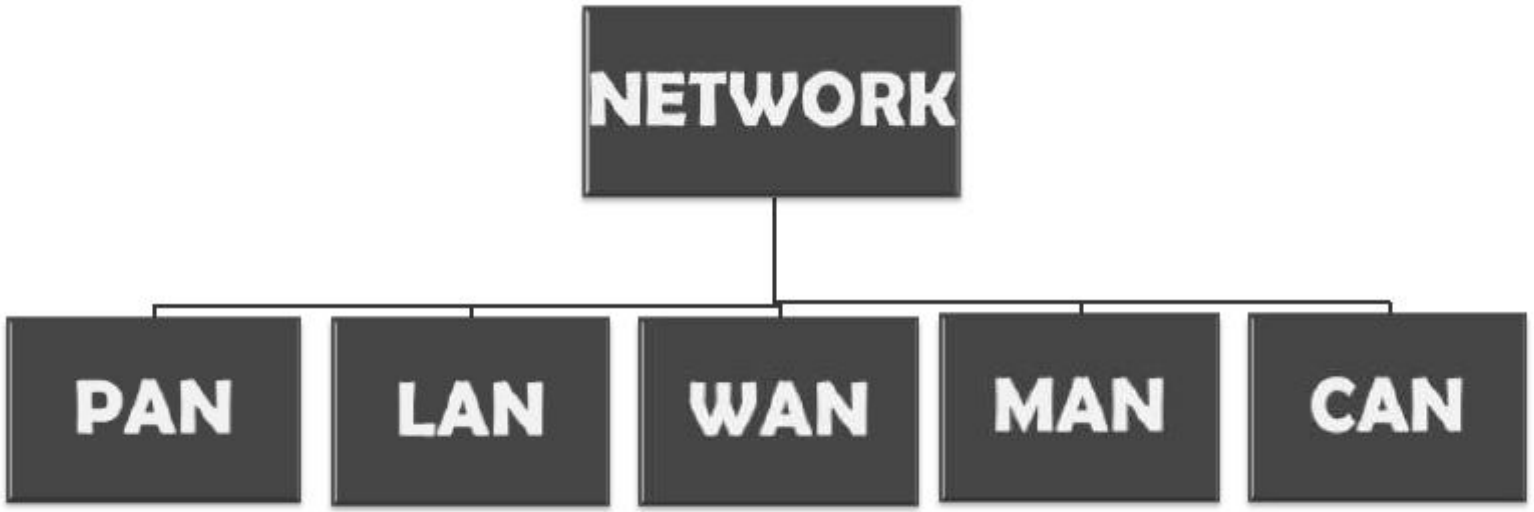
- An **Internetwork** is a collection of independent remote networks, LANs and WANs, and their connecting devices. They function together as one large network sharing connectivity resources.



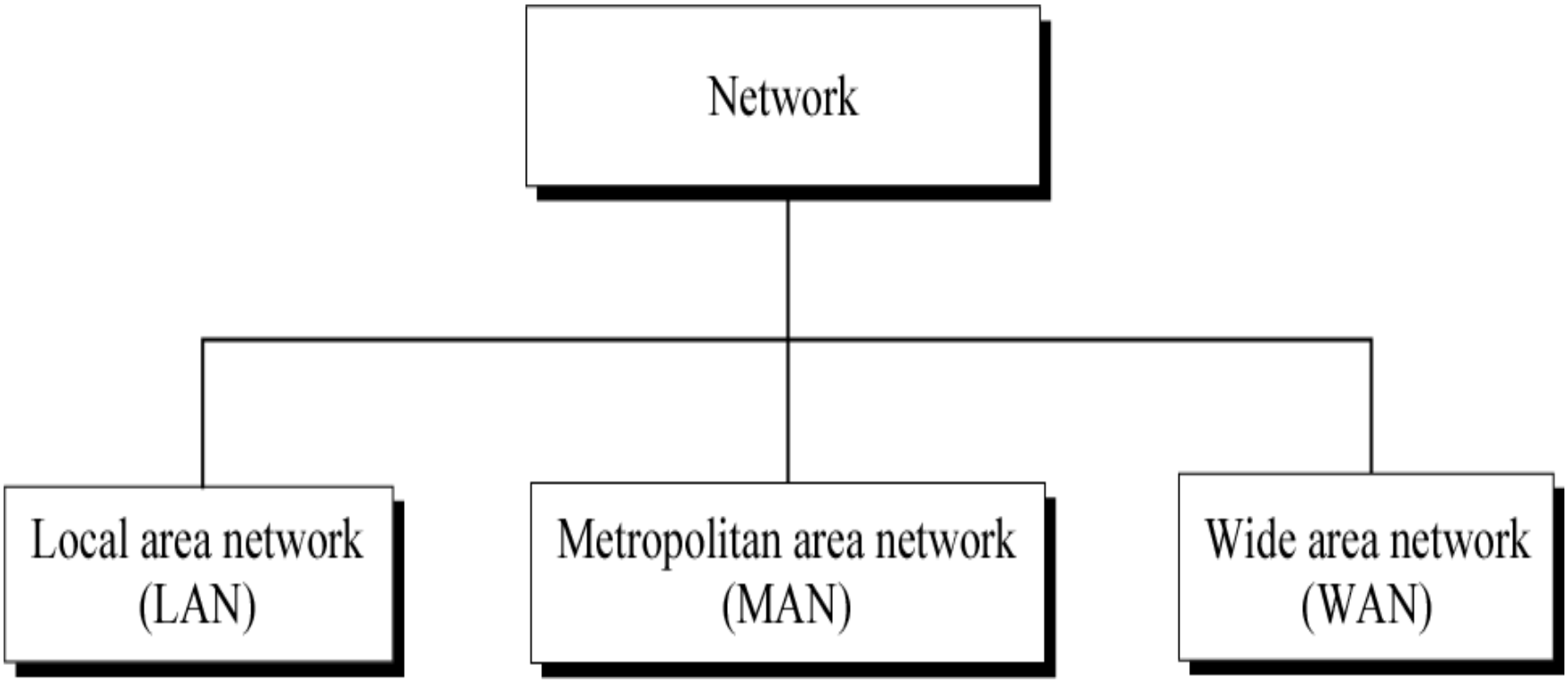
# Internetwork (Internet)



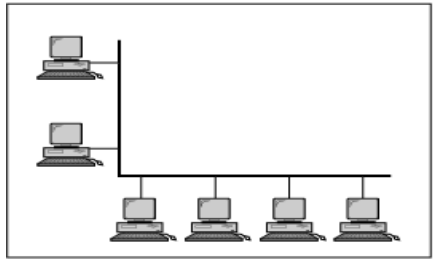
# CLASSIFICATION OF AREA BY THEIR GEOGRAPHY



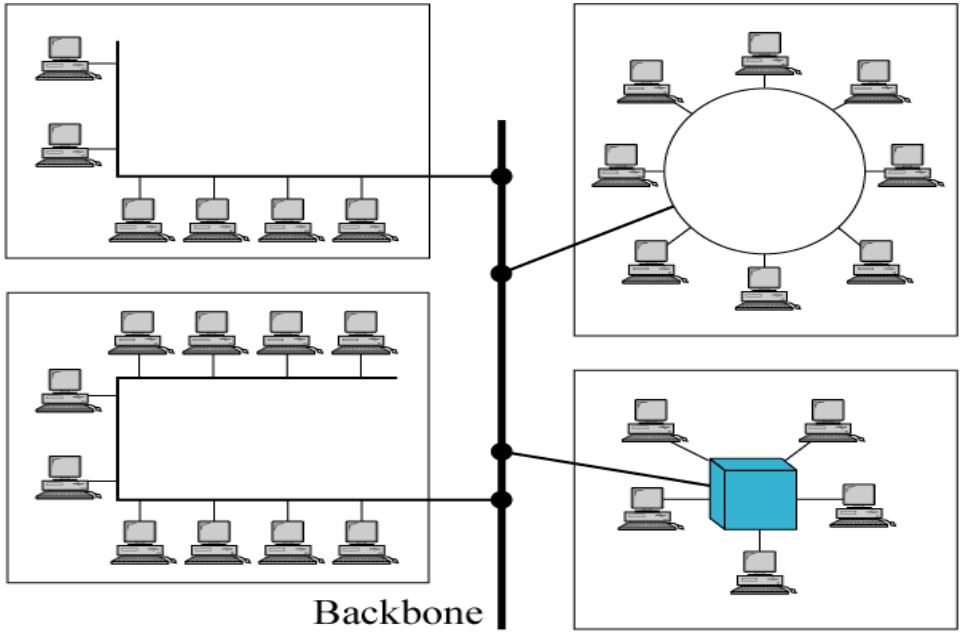
# Categories of Networks



# LAN – Local Area Network



a. Single-building LAN




b. Multiple-building LAN

The network can be categorized based on **its size, its ownership, the distance it covers, and its physical architecture.**

## Interprocessor Distance:

**1. LAN :**

10m – Room, 100m - Building and 1km or 2 km – upto Campus.

# LAN ( Local Area Network )

- It covers a small geographical area with in a building or up to a few kilometers outside
- They are widely used to connect PC with in a office.
- LAN has distinguished from other networks by three characters.
  - size
  - their transmission technology
  - their Topology
- LAN run at speeds of 10 Mbps to 100 Mbps. or (100/1000Mbps)
- Different Topologies will be used for LAN Connectivity.
  - Bus / RING

- IEEE 802.3 known as Ethernet is an typical example for LAN

# Advantages of LAN :

LAN provides a cost-effective multi-user computer environment.

A LAN is suited to any type of application.

Any number of users can be accommodated.

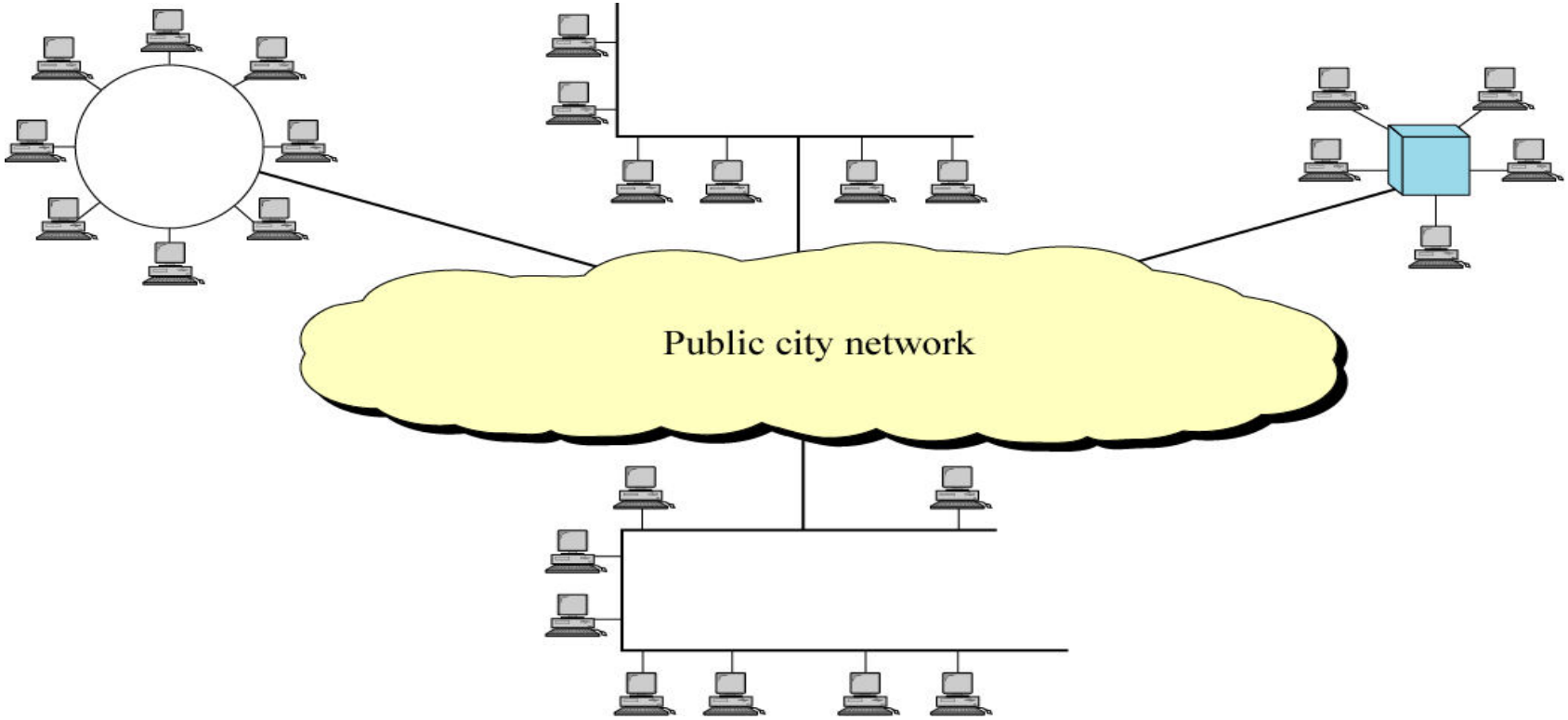
It is flexible and growth-oriented.

Data transfer rates in the 4 to 10 Mbps range.

Today speeds are normally 100 or 1000 Mbps.

It provide data integrity.

# MAN ( Metropolitan  Area Network )




**2. MAN.**

10km or 20 km – upto City level.

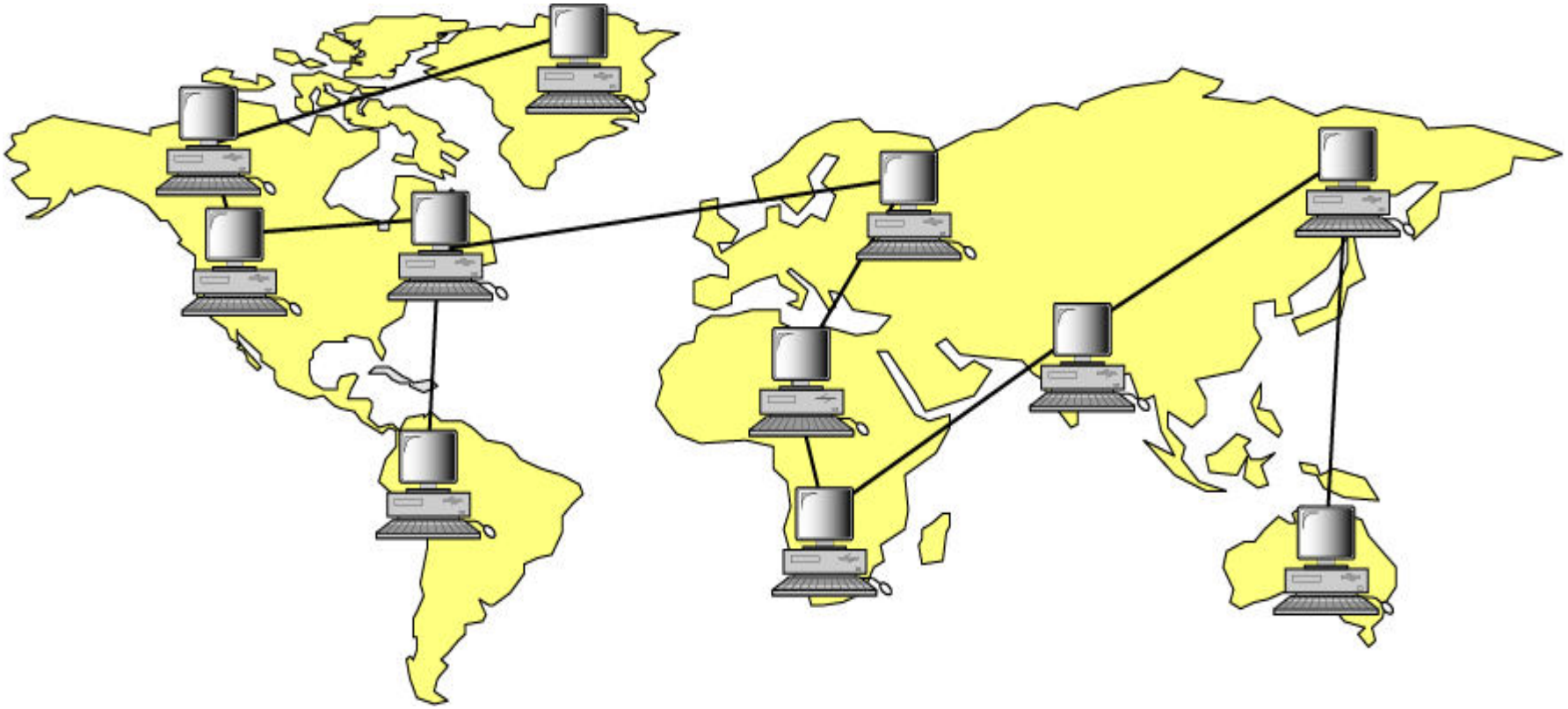
# MAN ( Metropolitan Area Network )

- MAN is a bigger network covers a group of nearby offices in a city .up to 10 – 20 kilometers range.
- MAN supports both voice and data. The typical example is Local Cable Network..
- LAN has distinguished from other networks by two characters.
  - standard that is adopted by them.
  - DQDB ( Distributed Queue Dual Bus ) – 802.6
- MAN run at speeds of 150 Mbps.
- Typical Topology will be used for MAN Connectivity.
  - BUS
- IEEE 802.6 known as Ethernet is an typical example for LAN.
- It may be a single network such as a cable TV network or it may be a means of connecting a number of LANs into a large network so that resources may be shared LAN-to-LAN as well as device-to-device.

# MAN ( Metropolitan  Area Network ) – Cont…

- MAN provides the transfer rates from 34 to 150 Mbps.
- A MAN is designed with two unidirectional buses.
- Each Bus is independent of the other in the transfer of traffic.
- The topology can be designed as an open bus or closed bus configuration.
- It can be support both data and voice.
- The high speed links between LANs within a MAN are made possible by fiber-optic connection.

# WAN - ( Wide Area Network )

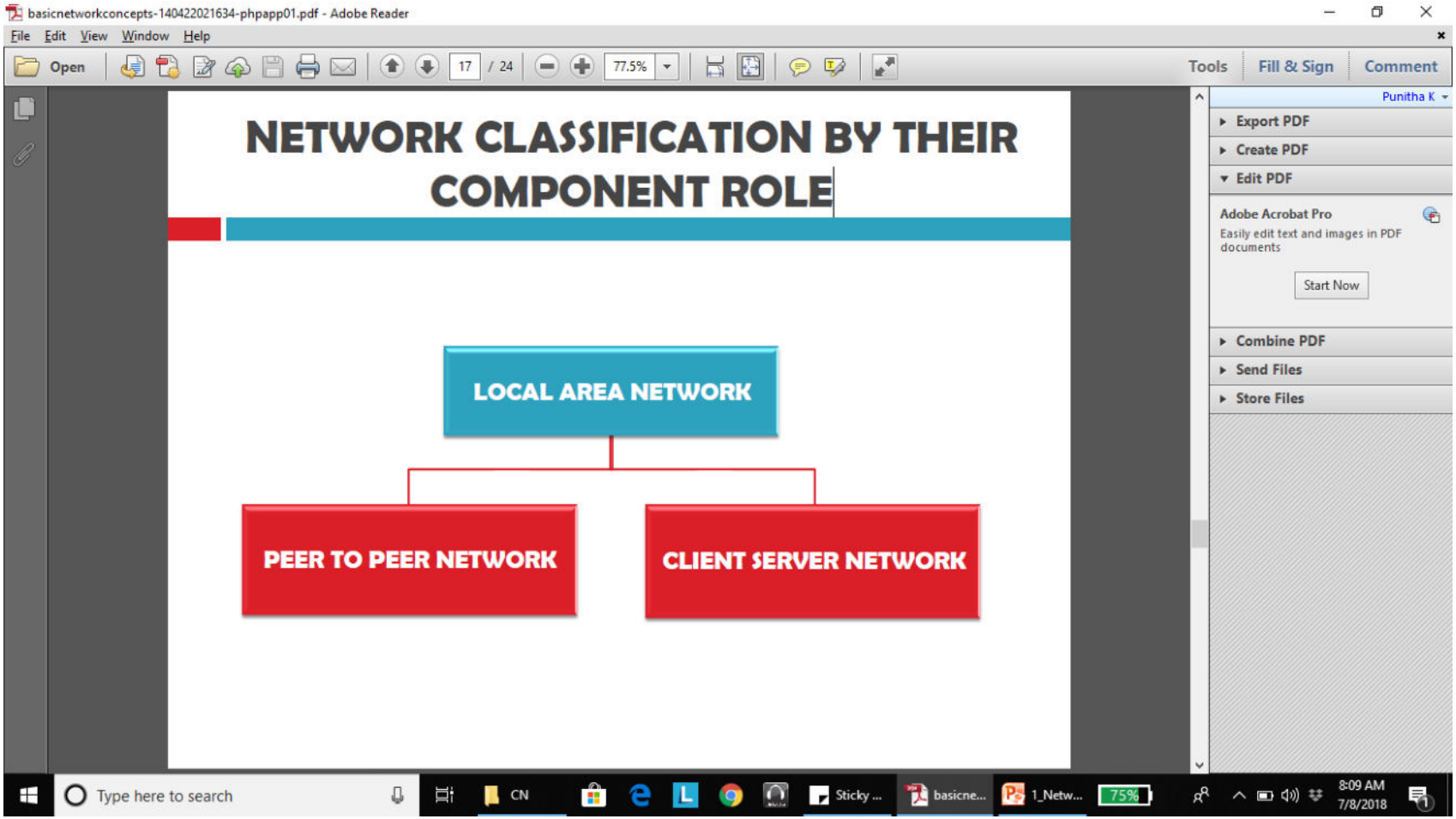


**3. WAN : -** 100km – upto Country level , 1000km – upto continent and 10,000km – upto Planet level.( The Internet).

# WAN ( Wide Area Network )

- WAN covers a large geographical area , country or continent.
- Hosts / Subnet
- The job of the Subnet is to carry the messages from host to host. subnet is an area in which the actual communication takes place.
- Subnet Consists of Two Distinct Components.
  - Transmission Lines
  - Switching Elements ( Specialized Systems )
- Packet Switched Nodes / Router
- Inside the Subnet routers have a connectivity among themselves.
- Store and Forward Concept
- All the Topologies are applicable
- Works at 100 Mbps to 1000 Mbps.

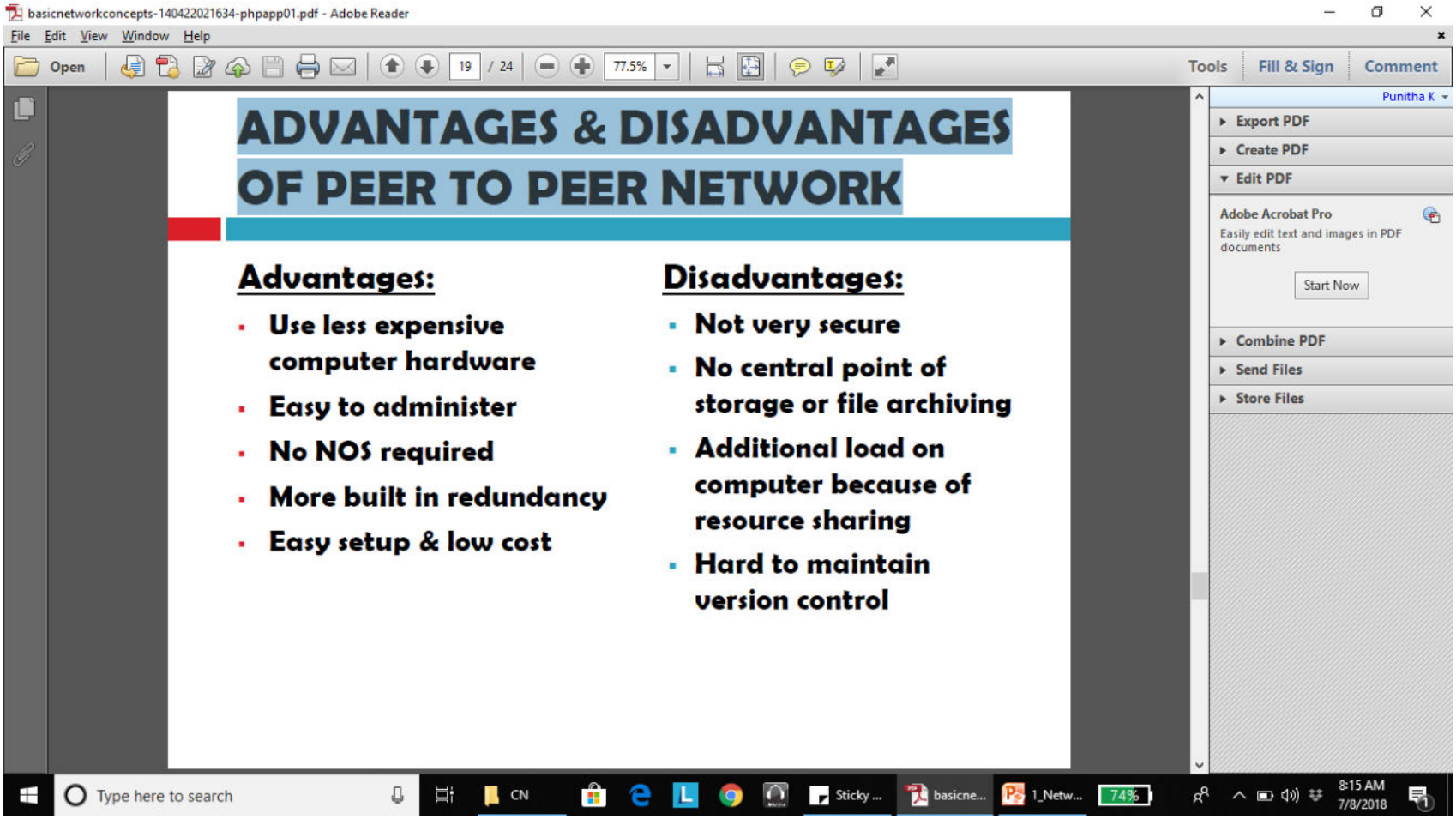
# NETWORK CLASSIFICATION BY THEIR COMPONENT ROLE

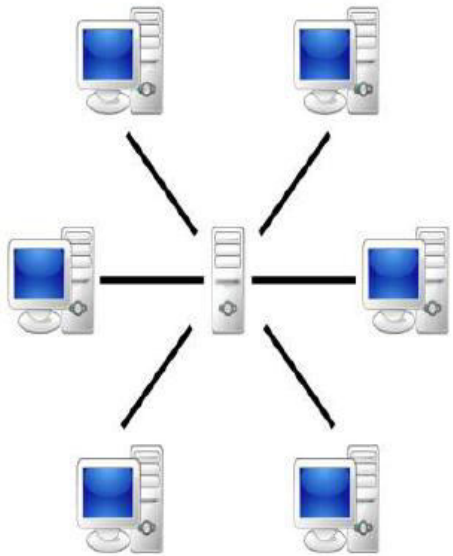


# PEER TO PEER NETWORK

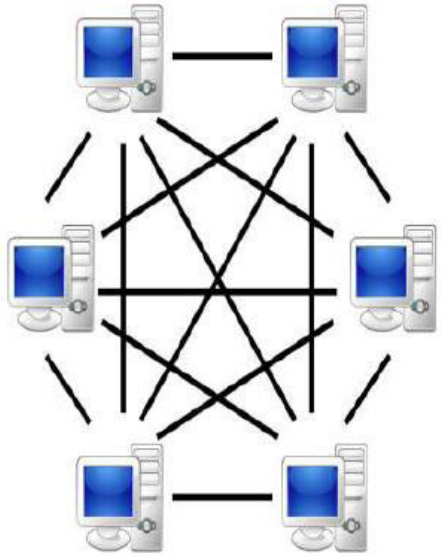
- In peer to peer network each computer is responsible for making its own resources available to other computers on the network.
- Each computer is responsible for setting up and maintaining its own security for these resources.
- Each computer is responsible for accessing the required network resources from peer to peer relationships.
- This network is useful for a small network containing less than 10 computers on a single LAN. Each computer can function as both client and server and do not have a central control system.
- There are no servers in peer network. Peer networks are amplified into home group.

# ADVANTAGES & DISADVANTAGES OF PEER TO PEER NETWORK





Server-based



P2P-network

# CLIENT/SERVER NETWORK

- In client-server network relationships, certain computers act as server and other act as clients. A server is simply a computer, that available the network resources and provides service to other computers when they request it. A client is the computer running a program that requests the service from a server.
- Local area network(LAN) is based on client server network relationship.
- A client-server network is one n which all available network resources such as files, directories, applications and shared devices, are centrally managed and hosted and then are accessed by client.
- Client serve network are defined by the presence of servers on a network that provide security and administration of the network.

# ADVANTAGES AND DISADVANTAGES OF CLIENT-SERVER NETWORK

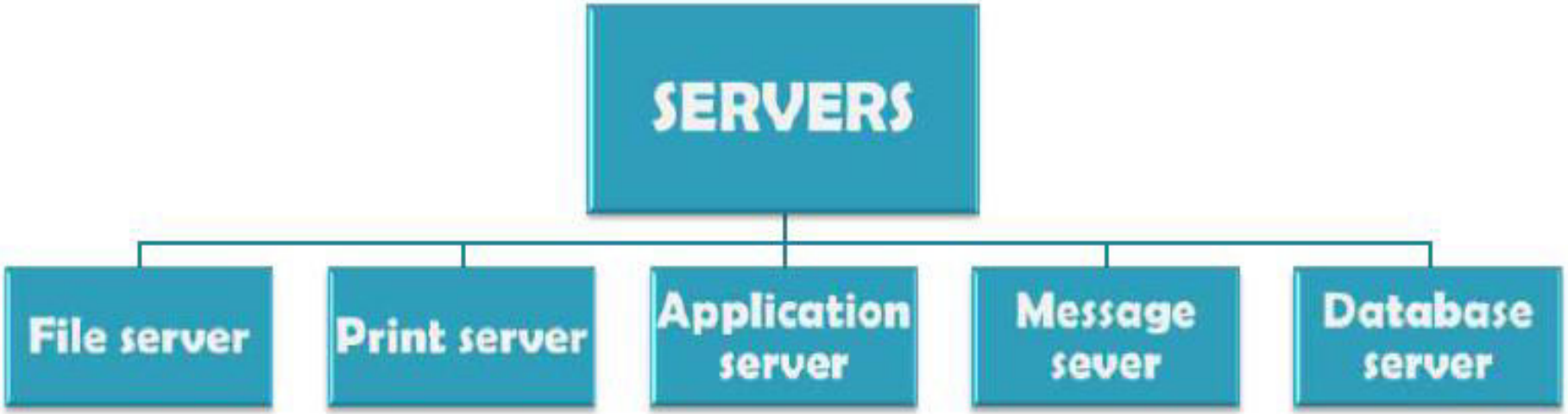
**Advantages:**

- Very secure
- Better performance
- Centralized backup
- very reliable

**Disadvantages:**

- requires professional administration
- More hardware-intensive
- More software intensive
- Expensive dedicated software

# TYPES OF SERVERS

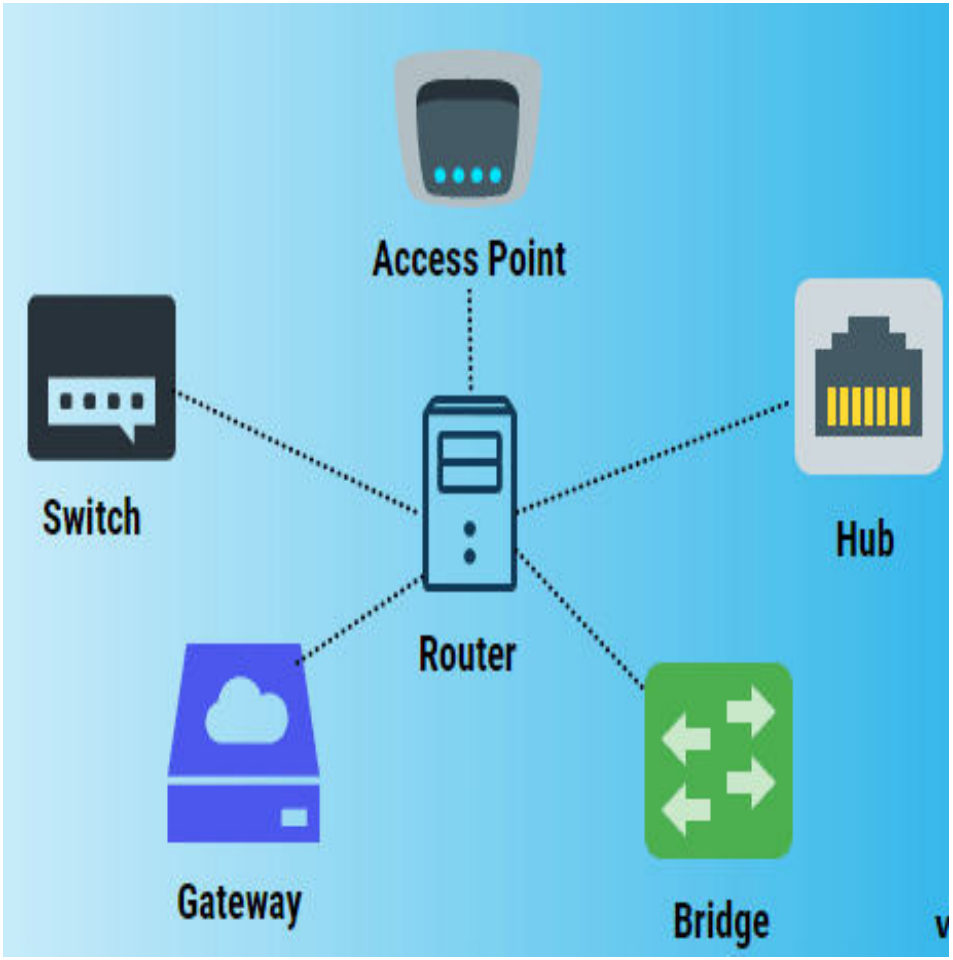


# TYPES OF SERVERS

- **File server**: provides services for storing, retrieving and moving data. User can read/write/exchange/manage files with help of file servers
- **Printer server**: used for controlling and managing printing on the network. It also offers the fax service to the network users.
- **Application server**: helps to share expensive software and additional computing power by the computers in a network.
- **Message server**: used to co-ordinate the interaction

# Types of network devices

- Hub
- Switch
- Router
- Bridge
- Gateway
- Modem
- Repeater
- Access Point



# REPEATER

- A repeater is an electronic device that amplifies the signal it receives.
- It receives a signal and retransmits it at a higher level or higher power so that the signal can cover longer distances, more than 100 meters for standard LAN cables.
- Repeaters work on the Physical layer.

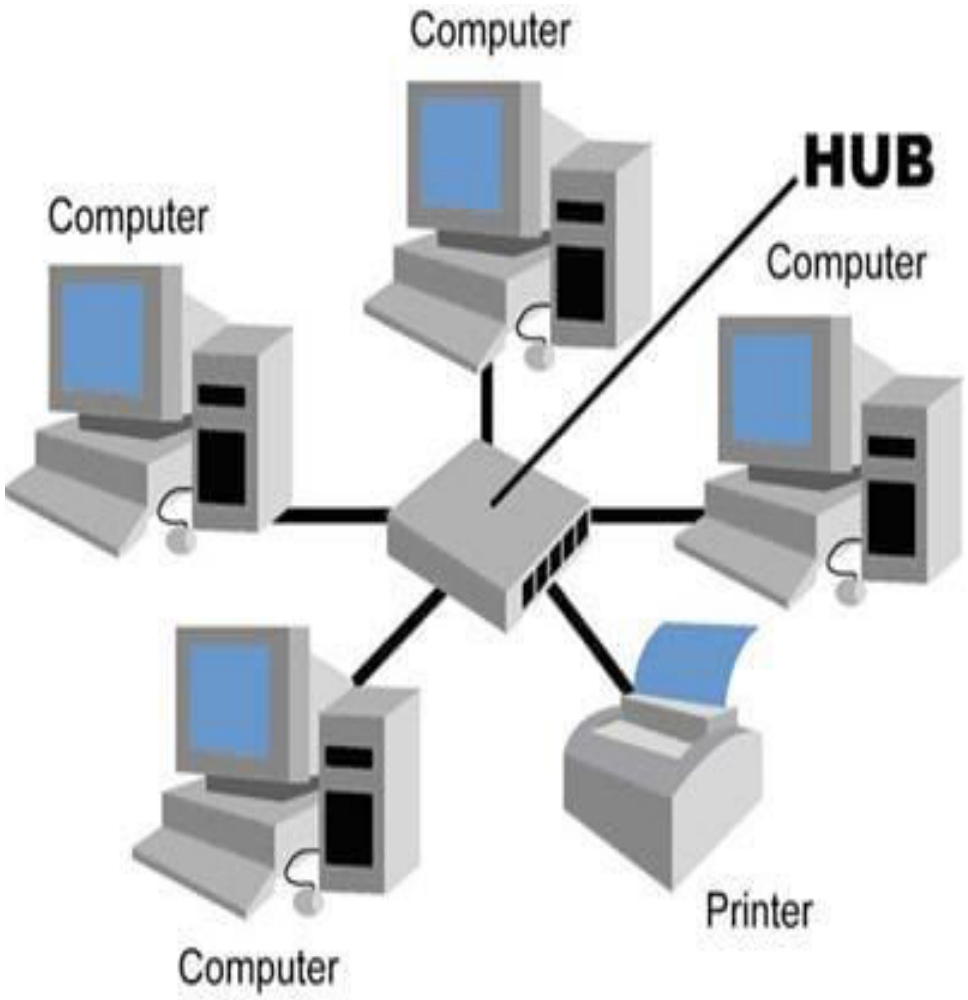
# REPEATER

# HUB

- Hubs connect multiple computer networking devices together.
- A hub also acts as a repeater in that it amplifies signals that deteriorate after traveling long distances over connecting cables.
- A hub is the simplest in the family of network connecting devices because it connects LAN components with identical protocols.

# HUB

# HUB


Computer
HUB
Computer
Computer
Computer
Computer
Printer

# Switch

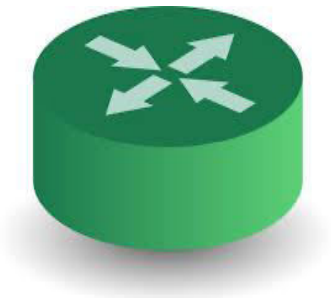
- Switches generally have a **more intelligent role than hubs**.
- A switch is a multiport device that improves network efficiency.
- The switch maintains limited routing information about nodes in the internal network, and it allows connections to systems like hubs or routers.
- Strands of LANs are usually connected using switches.
- Generally, switches **can read the hardware addresses of incoming packets** to transmit them to the appropriate destination.

# SWITCH

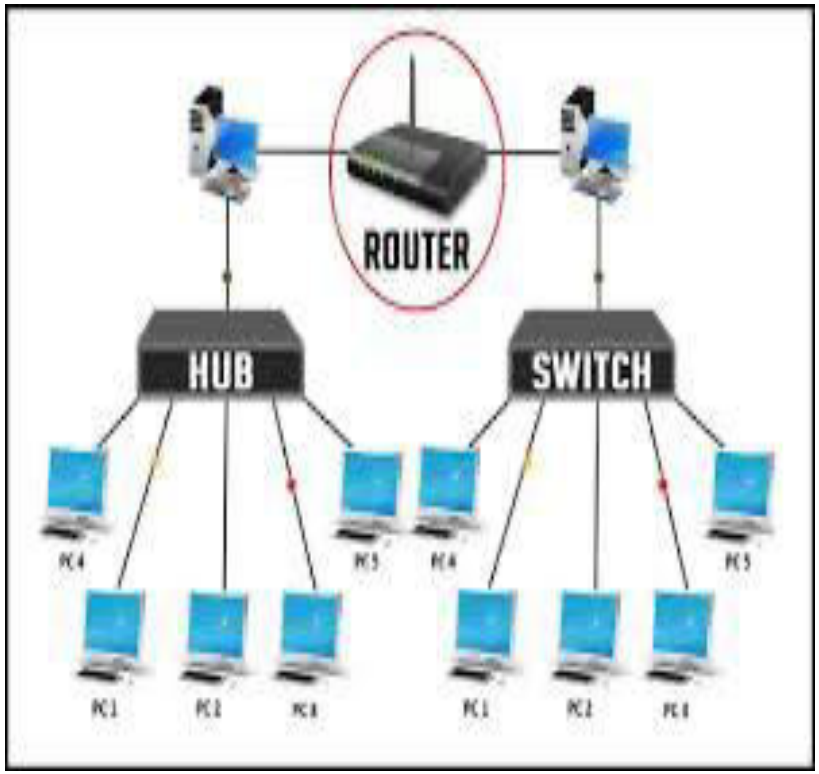
# ROUTER

- Routers help transmit packets to their destinations by charting a path through the sea of interconnected networking devices using different network topologies.
- **Routers are intelligent devices**, and they store information about the networks they're connected to.
- Routers are general-purpose devices that interconnect two or more heterogeneous networks.

# ROUTER



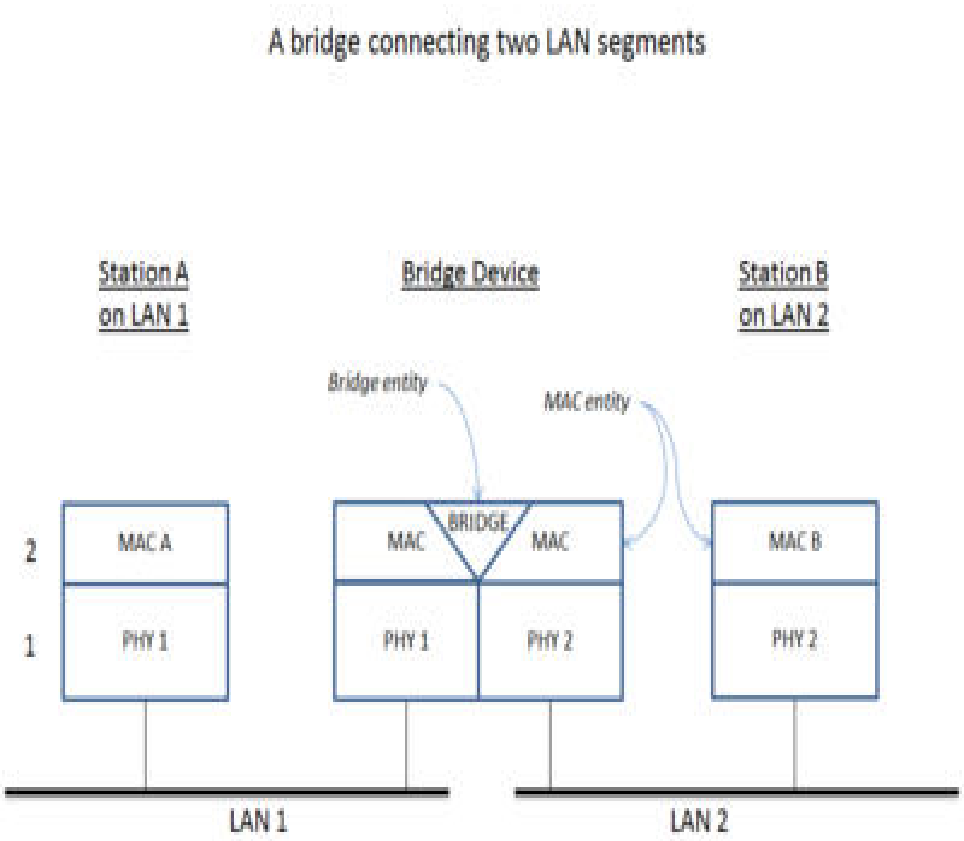

CISCO
Cisco 4400 Series


ROUTER
HUB
SWITCH
PC4
PC5
PC4
PC5
PC1
PC2
PC3
PC1
PC2
PC3

# BRIDGE

- Bridges are used to connect two or more hosts or network segments together.
- The basic role of bridges in network architecture is storing and forwarding frames between the different segments that the bridge connects.

# BRIDGE


A bridge connecting two LAN segments
Station A on LAN 1
Bridge Device
Station B on LAN 2
Bridge entity
MAC entity
2
1
MAC A
PHY 1
MAC
BRIDGE
MAC
PHY 1
PHY 2
MAC B
PHY 2
LAN 1
LAN 2


B&TON
B&TON
BT-950
Fiber Ethernet Media Converter

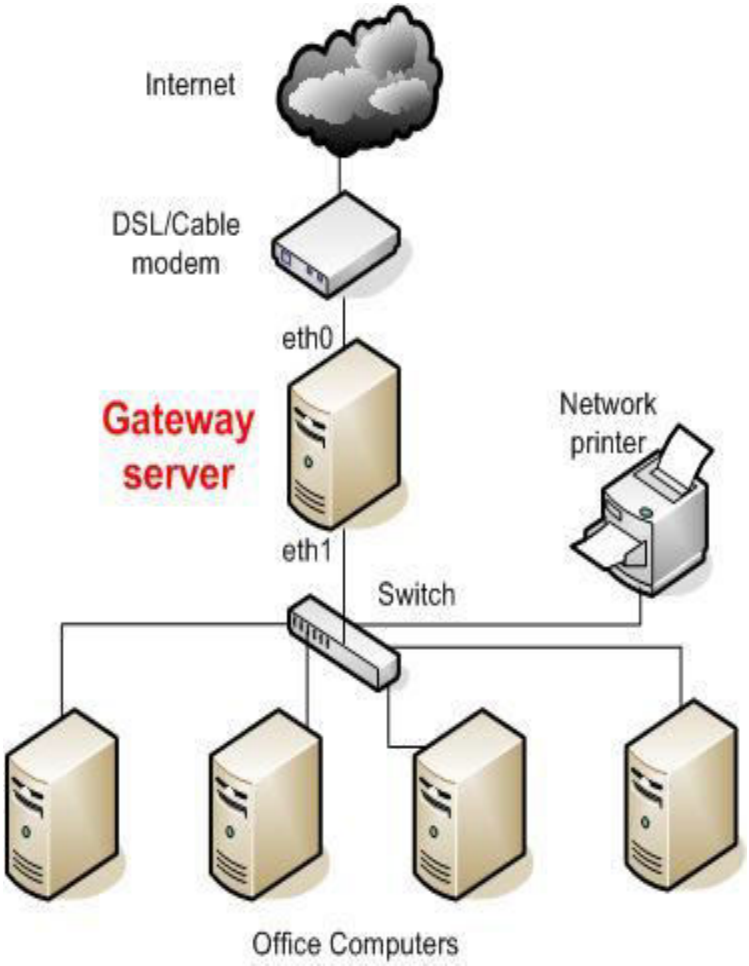
# GATEWAY

- Gateways normally work at the Transport and Session layers of the OSI model.
- Gateways provide translation between networking technologies such as Open System Interconnection (OSI) and Transmission Control Protocol/Internet Protocol (TCP/IP).
- Gateways connect two or more autonomous networks, each with its own routing algorithms, protocols, topology, domain name service, and network administration procedures and policies.

# GATEWAY…

- Gateways perform all of the functions of routers and more.
- In fact, a router with added translation functionality is a gateway.
- The function that does the translation between different network technologies is called a protocol converter.

# GATEWAY


Internet
DSL/Cable
modem
eth0
Gateway
server
Network
printer
eth1
Switch
Office Computers

# MODEM – Modulator+Demodulator

- Modems (modulators-demodulators) are used to transmit digital signals over analog telephone lines.
- Thus, digital signals are converted by the modem into analog signals of different frequencies and transmitted to a modem at the receiving location.
- The receiving modem performs the reverse transformation and provides a digital output to a device connected to a modem, usually a computer.
- Modems work on both the Physical and Data Link layers.

# MODEM

# ACCESS POINT

- While an access point (AP) can technically involve either a wired or wireless connection, it commonly means a wireless device.
- An AP works at the second OSI layer, the Data Link layer, and it can operate either as a bridge connecting a standard wired network to wireless devices or as a router passing data transmissions from one access point to another.
- Access points typically are separate network devices with a built-in antenna, transmitter and adapter.

# ACCESS POINT

# 4. Topology

- Network topology is the arrangement of the elements of a communication network. Network topology can be used to define or describe the arrangement of various types of telecommunication networks, including command and control radio networks, industrial field busses and computer networks.

POWERCERT VIDEOS

# Network TOPOLOGIES

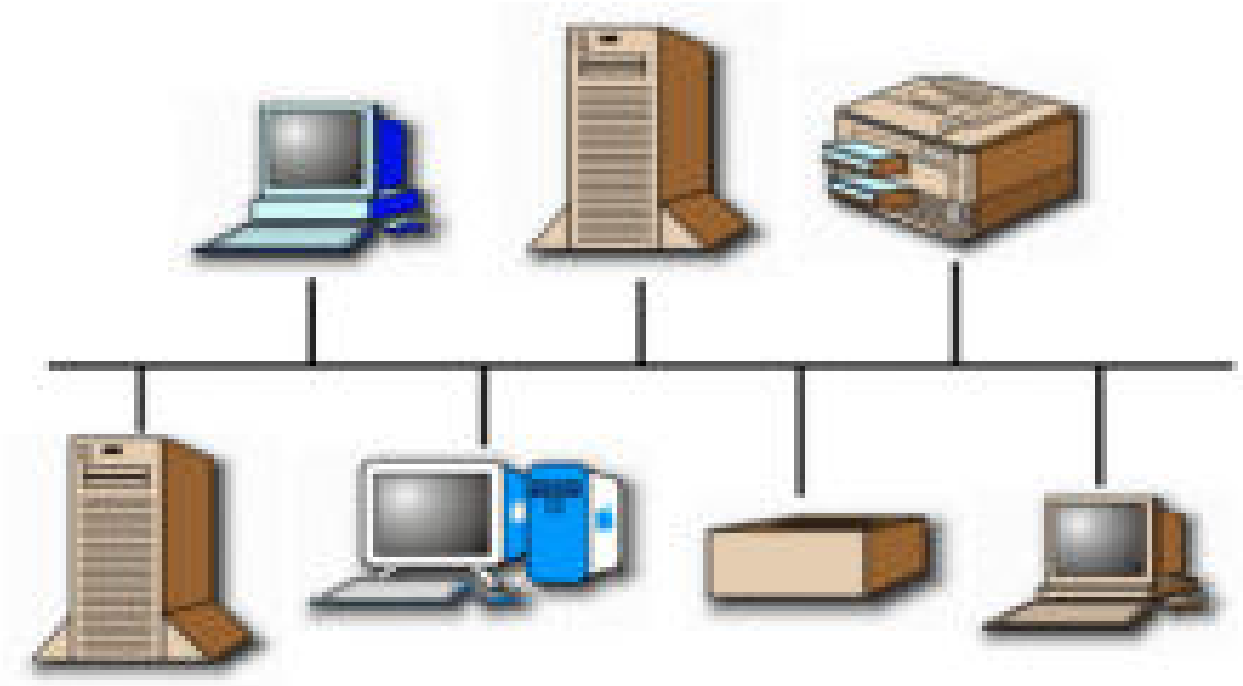
What are network topologies?

A topology is the layout of how a network communicates with different devices.

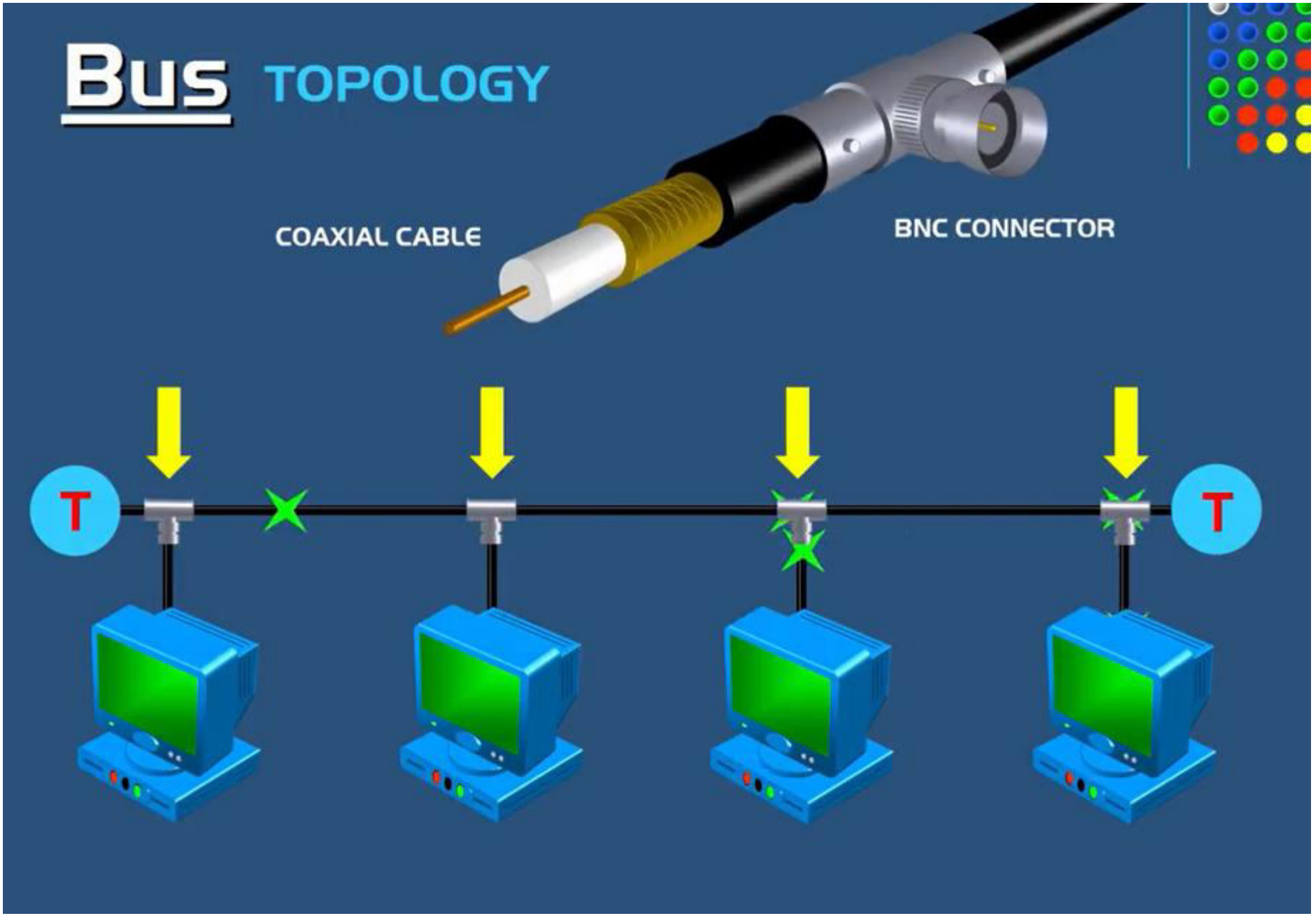
There are a couple of different categories of topologies.

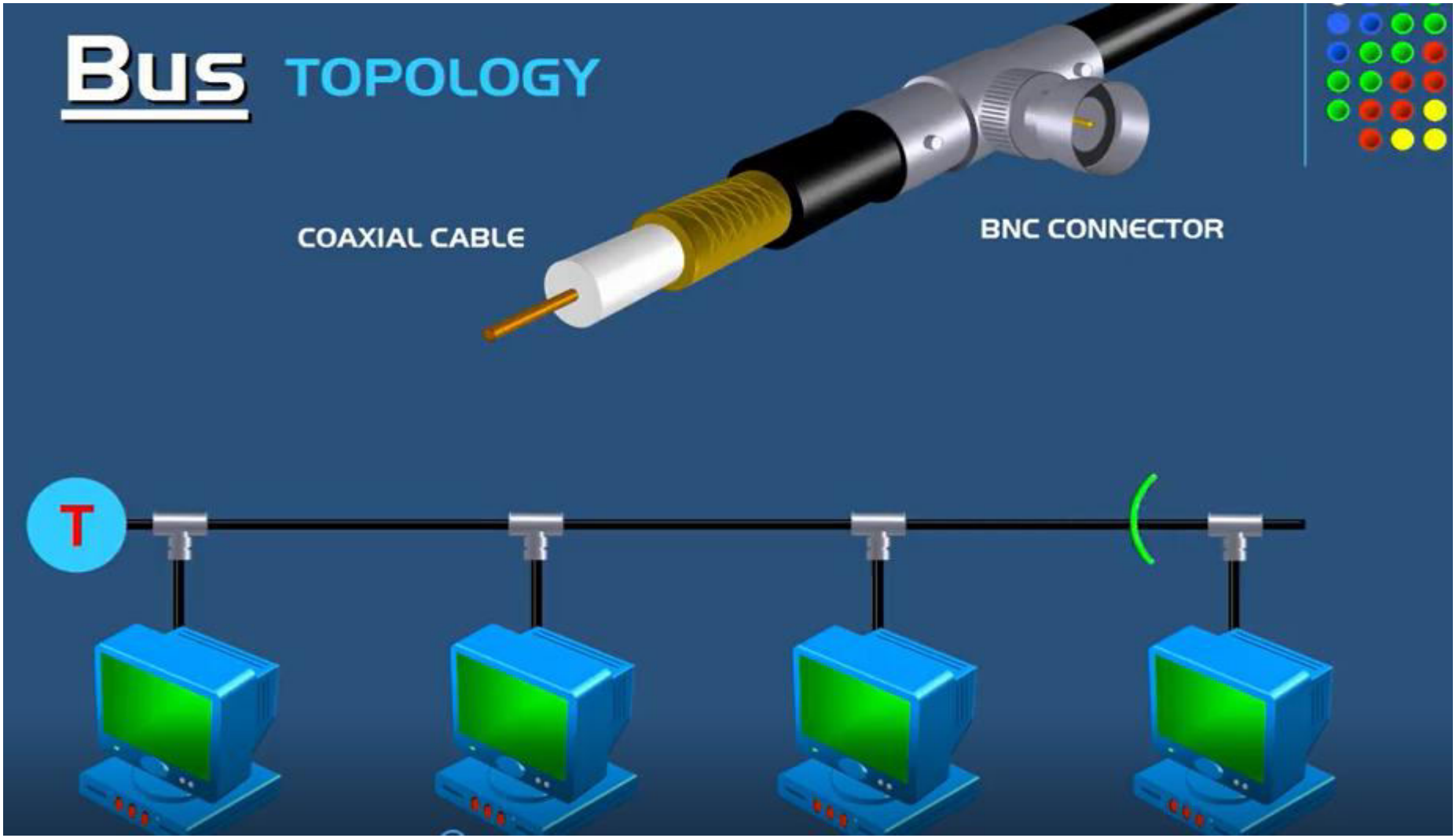
Wired and wireless.

# Bus Topology Network

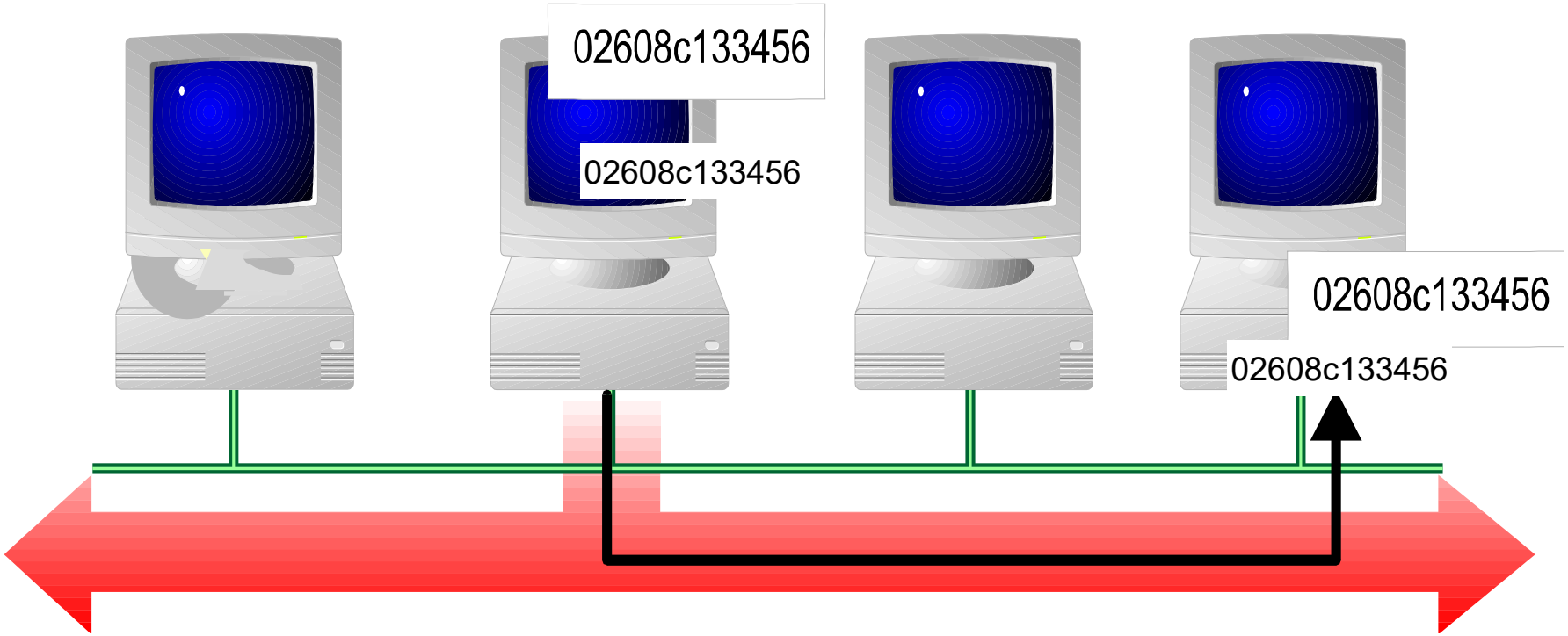


- A single cable connects each workstation in a linear, daisy-chained fashion.
* Signals are broadcasted to all stations, but stations only act on the frames addressed to them

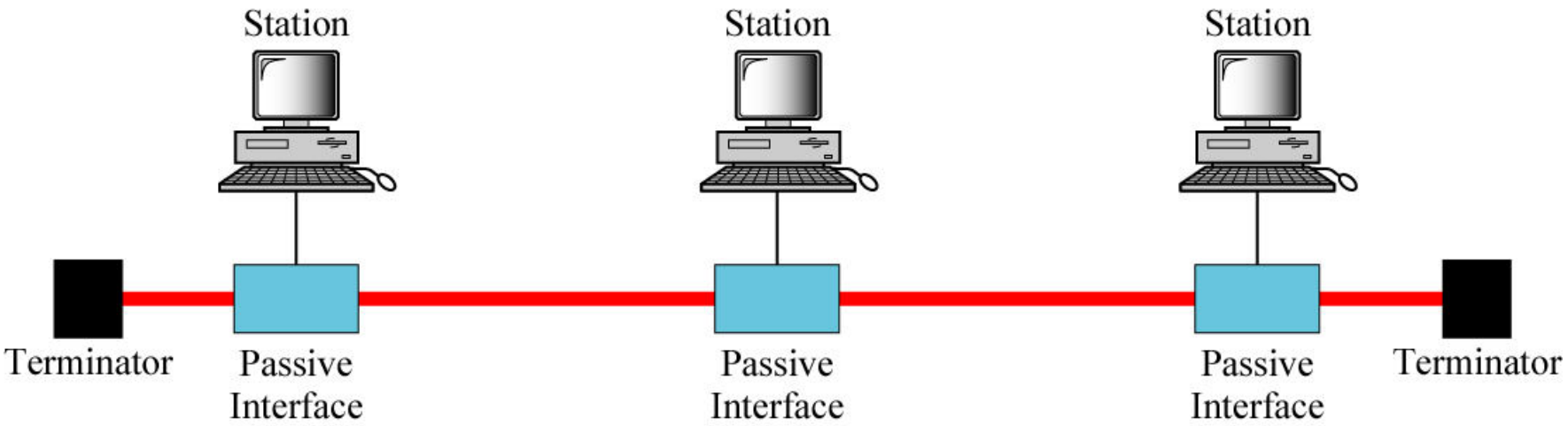

Bus TOPOLOGY
COAXIAL CABLE
BNC CONNECTOR
T
T


Bus TOPOLOGY
COAXIAL CABLE
BNC CONNECTOR
T

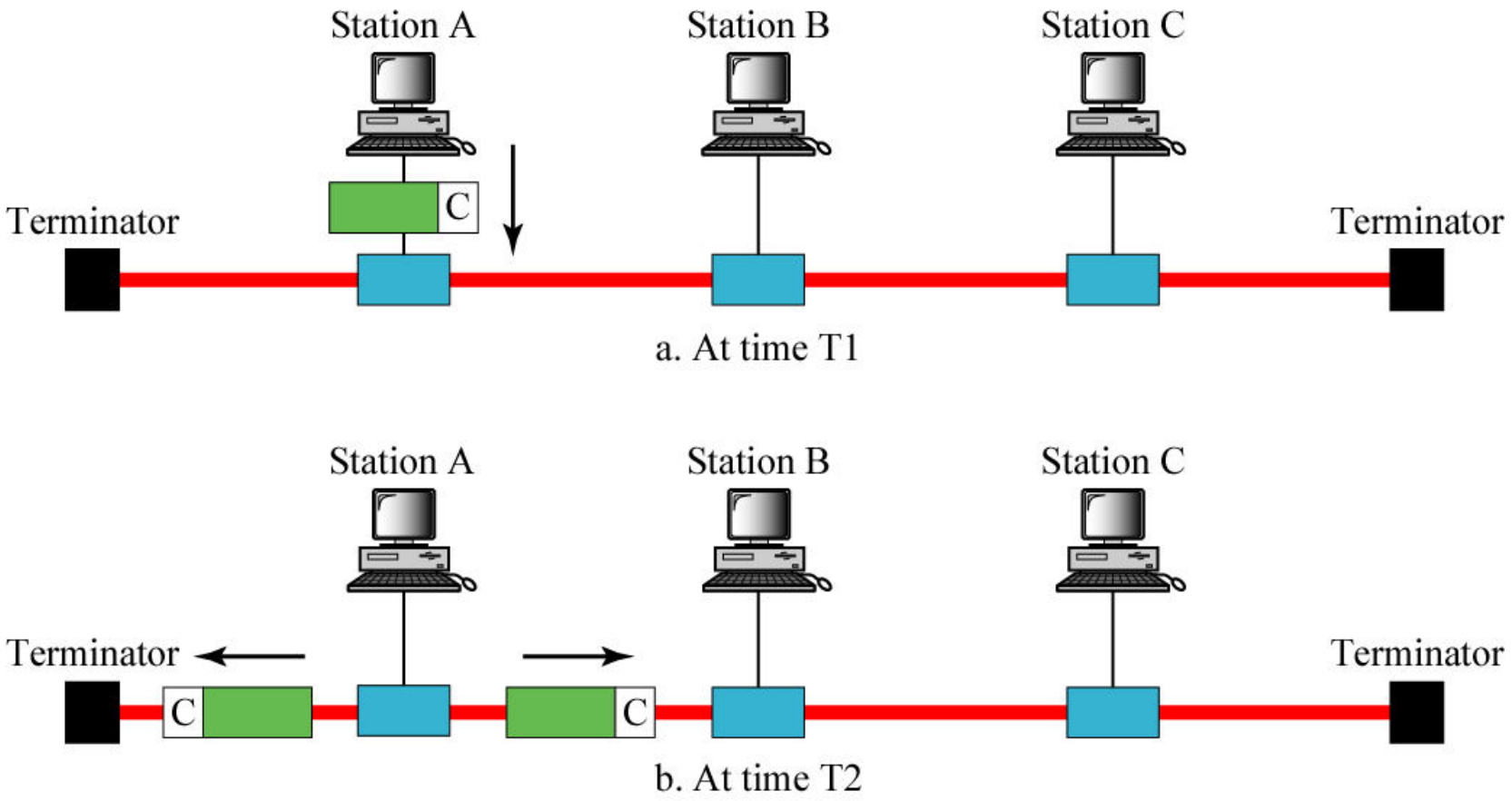
# Data is sent to all computers, but only the destination computer accepts



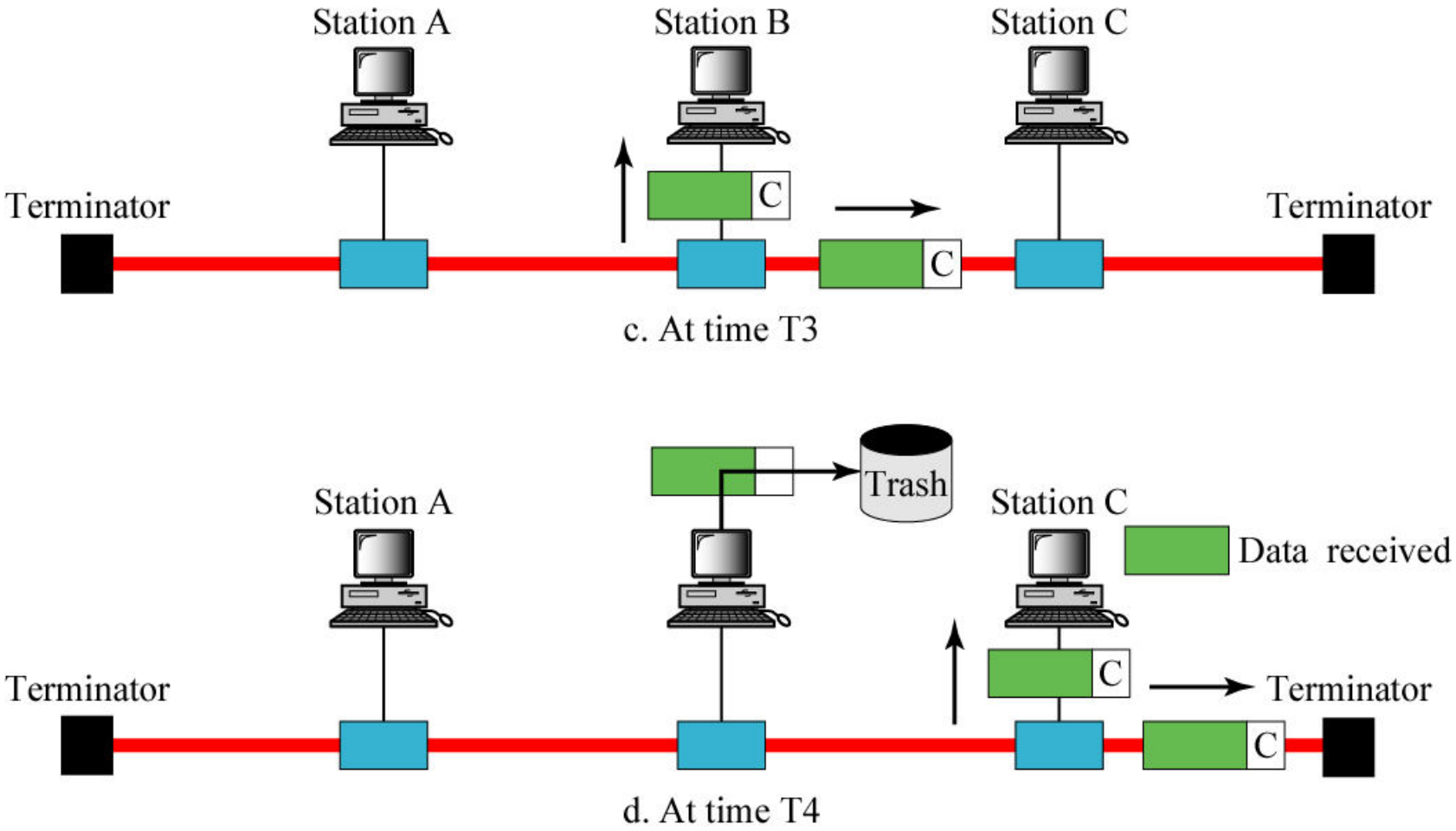
# Bus Topology



# Bus Topology Operation



# Bus Topology Operation



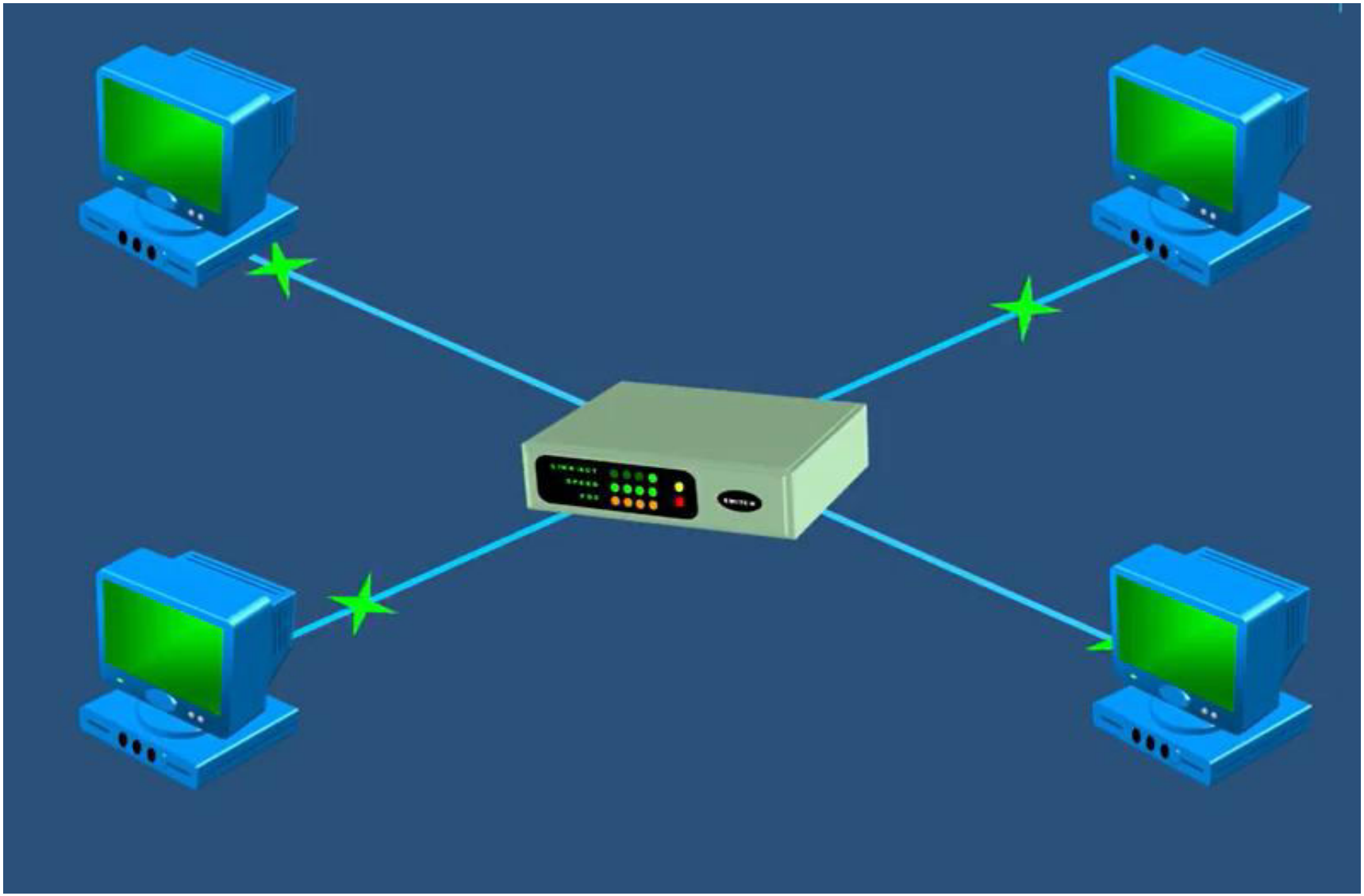
# Advantages and Disadvantages of Bus Topology

- Reliable in very small network.
- Easy to setup.
- Easy to extend the network with the help of repeaters.
- Easy to connect the segments with a barrel connector.

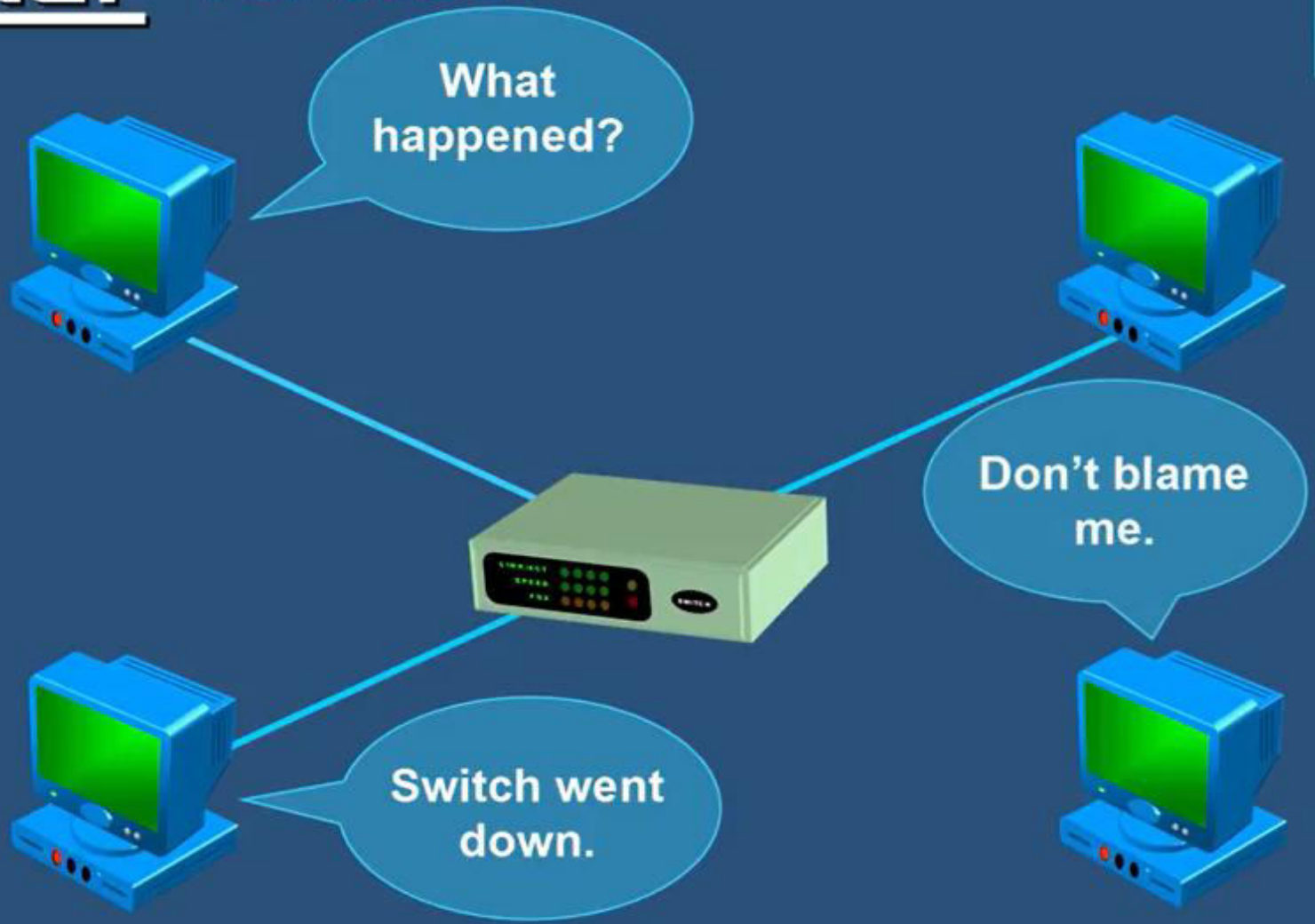
---

- Heavy network traffic will slow down the network.
- Each barrel connector weakens the signal.
- It is difficult to trouble shoot.
- Termination is required on both the end systems.
- Any break in the cable brings the entire network down

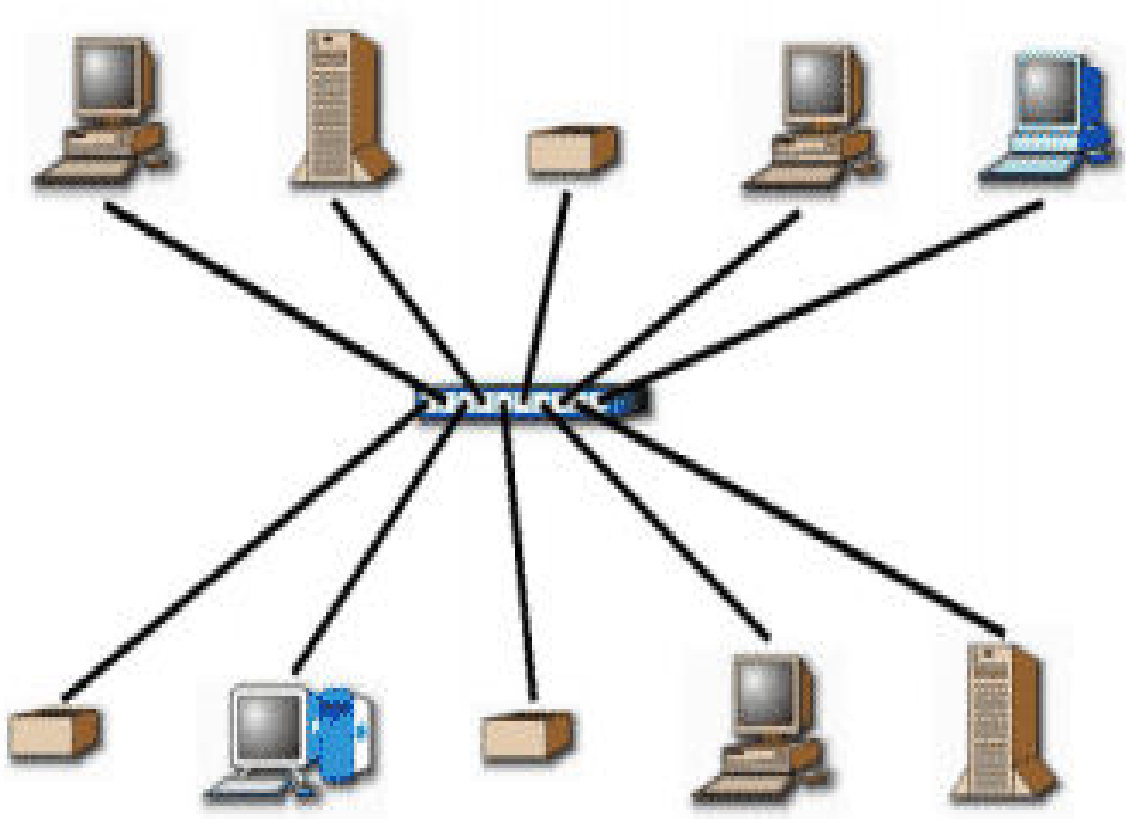
# Simple star network



# Star TOPOLOGY



# Simple star network



In a star topology, each station is connected to a central hub or concentrator that functions as a multi-port repeater. Each station broadcasts to all of the devices connected to the hub.

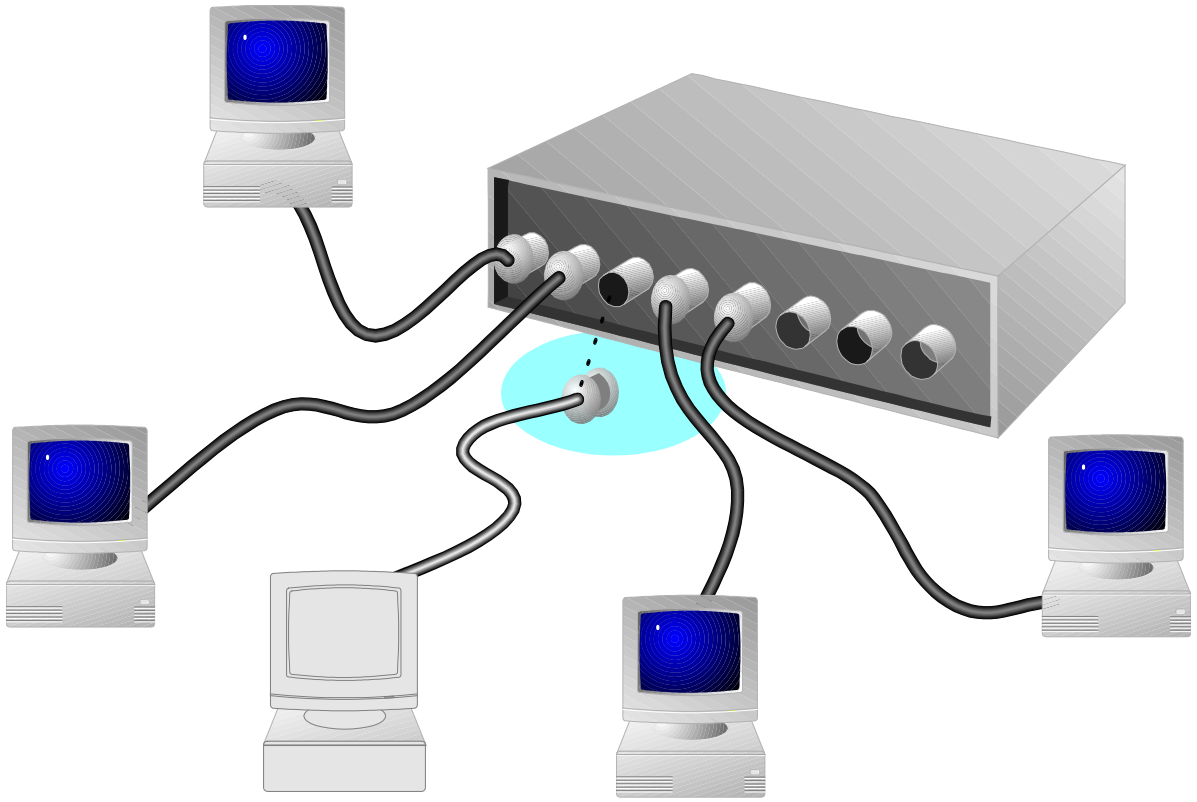
# Advantages and Disadvantages of Star Topology

- It easy to modify and add more computers in the network.
- Easy to trouble shoot.
- Single computer failure do not effect the network.
- Other cable types can be used in the same network.

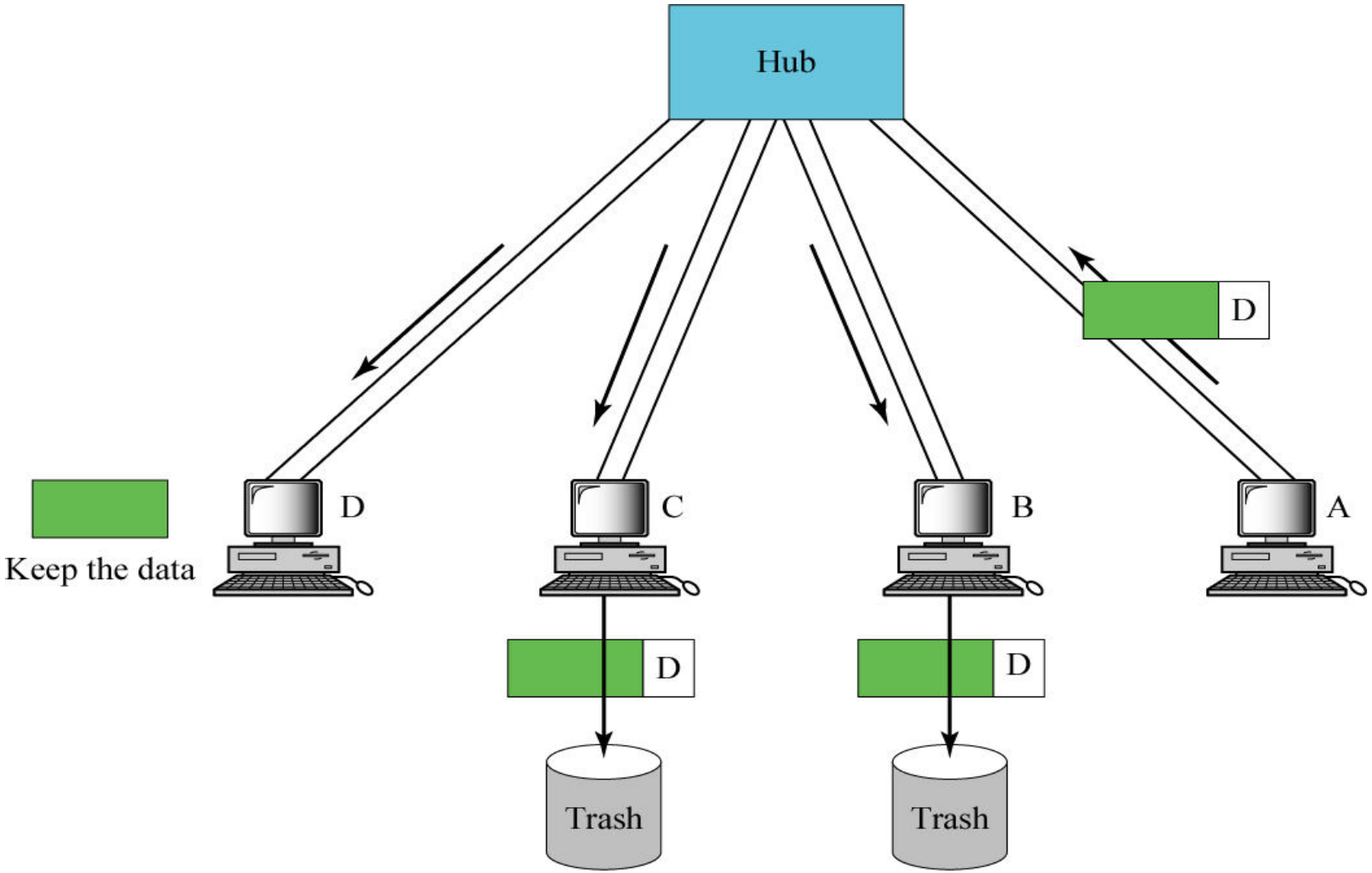
---

- If the central hub fail the network is down.
- Most of the star network require a central device to rebroadcast or switch the network traffic.
- Network cabling is more .

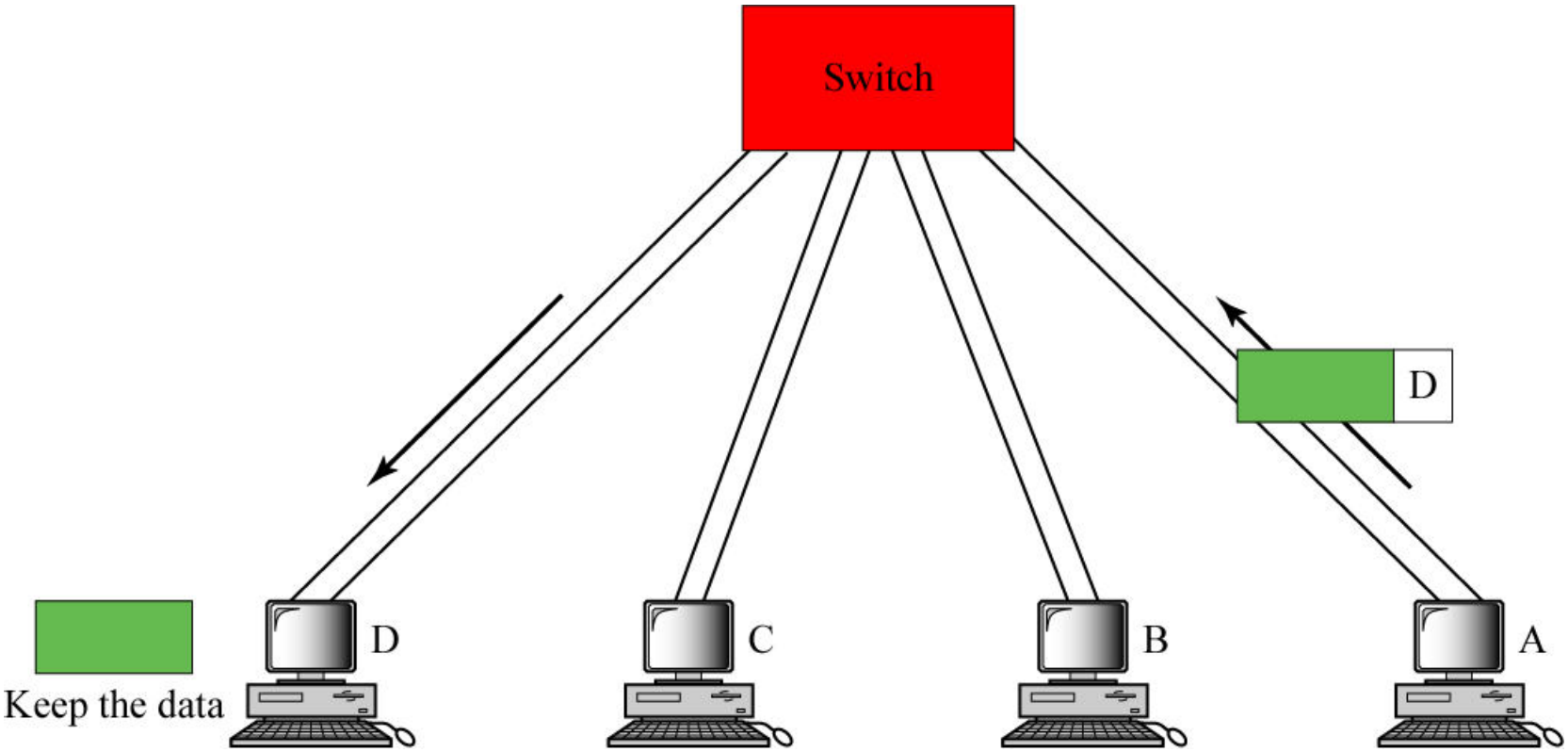
# A break or unplugged cable takes down the only unplugged computer



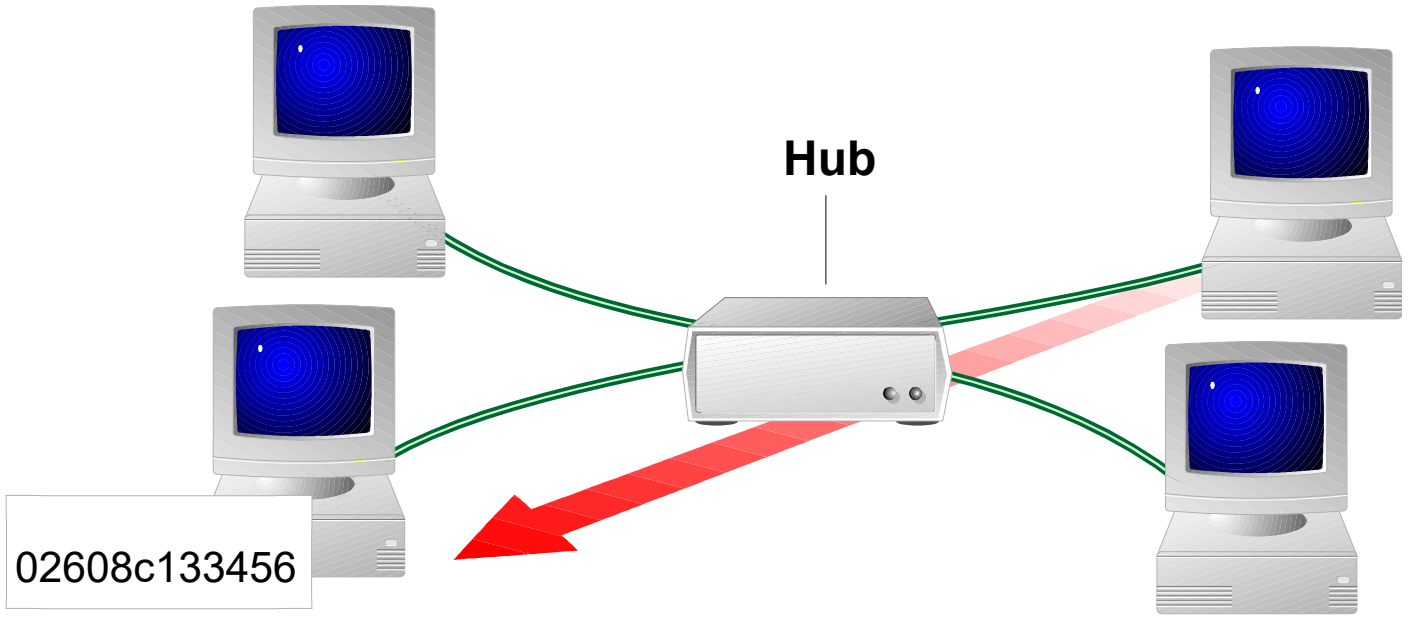
# Using a Hub in a Star Topology

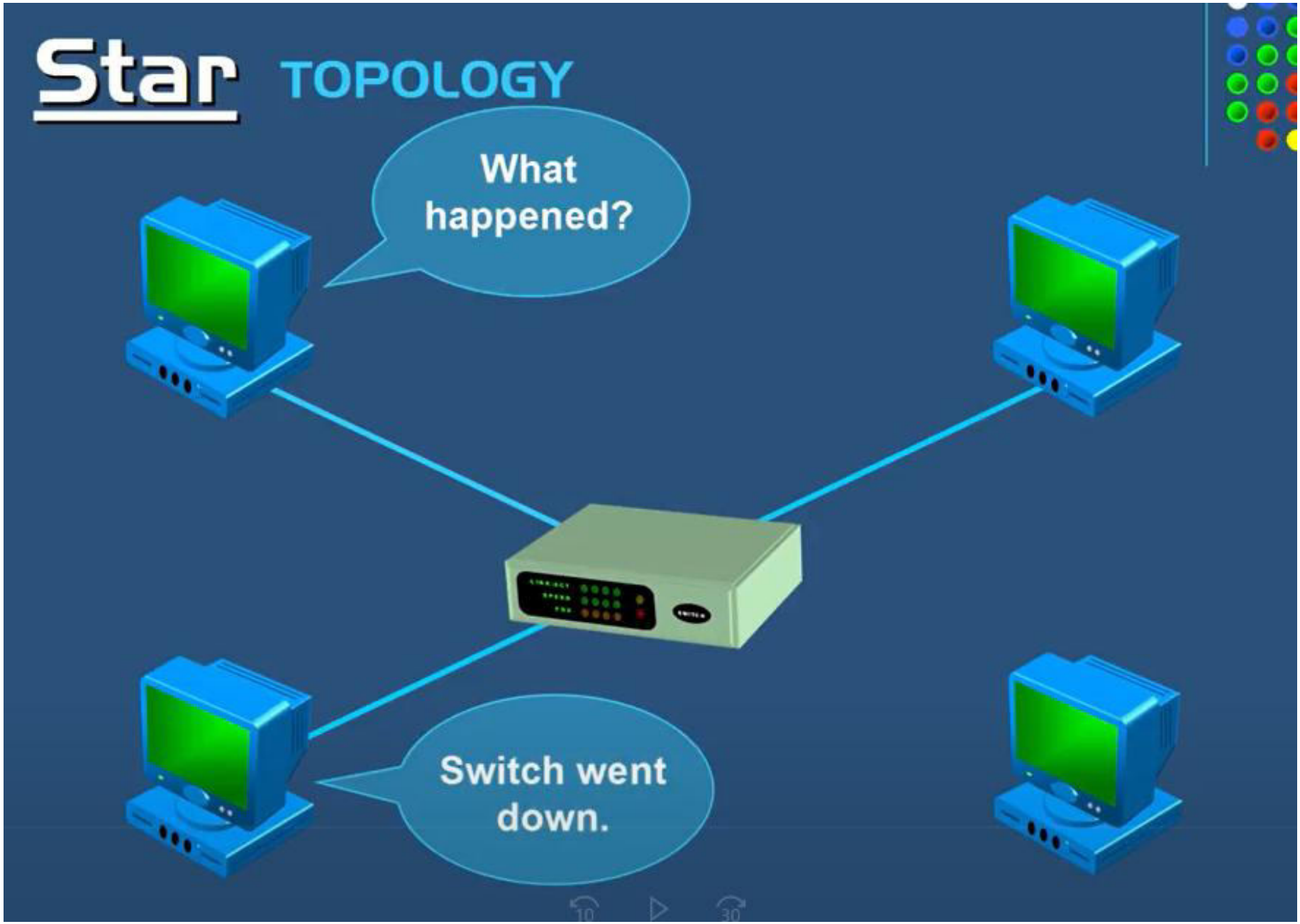


# Using a Switch in a Star Topology



# A hub is the central point in a star topology




Star TOPOLOGY
What happened?
Switch went down.

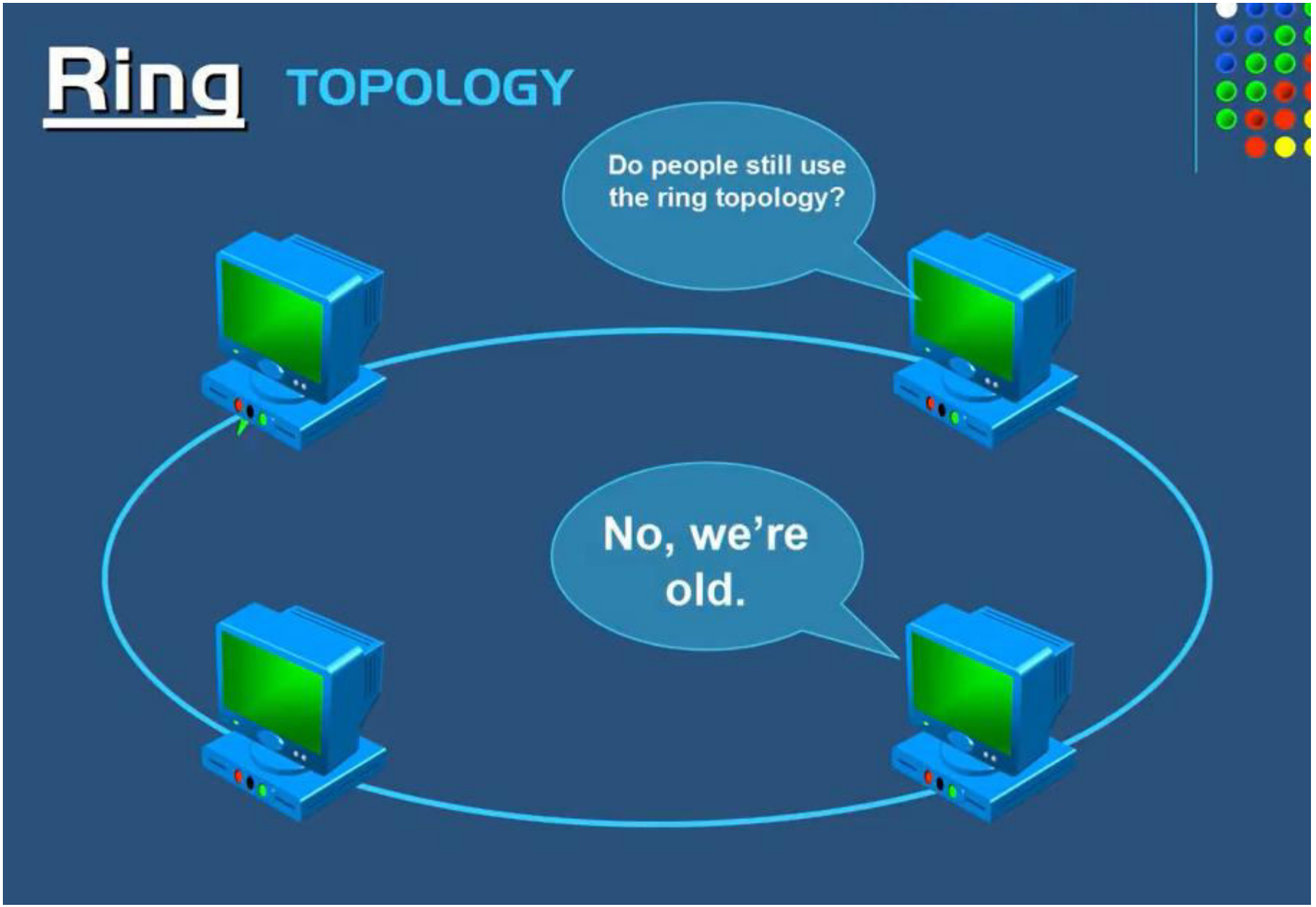
# Ring Topology

- A ring topology is a LAN architecture that consists of a series of devices connected to one another by unidirectional transmission links to form a single closed loops.

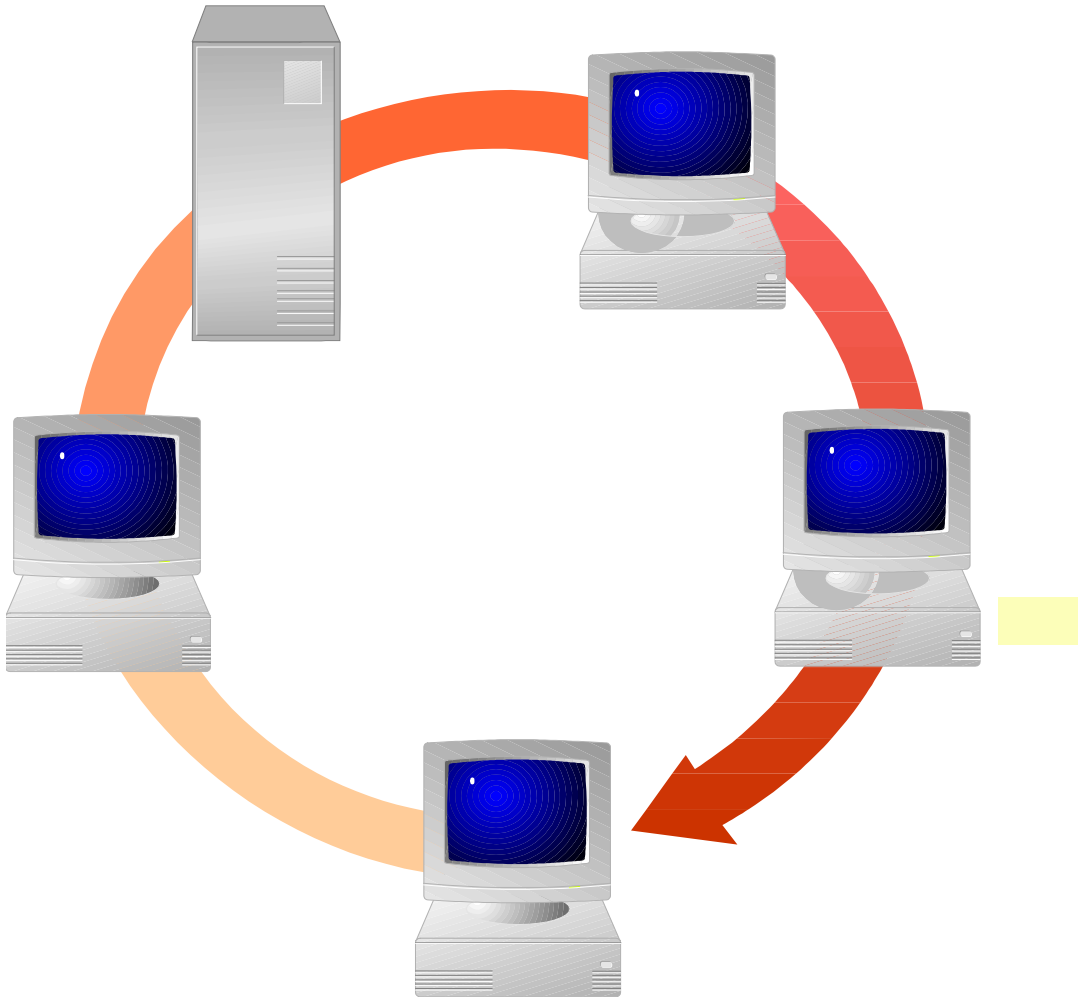
- In a ring network, every device has exactly two neighbors for communication purposes.

- All messages travel through a ring in the same direction (effectively either "clockwise" or "counterclockwise").

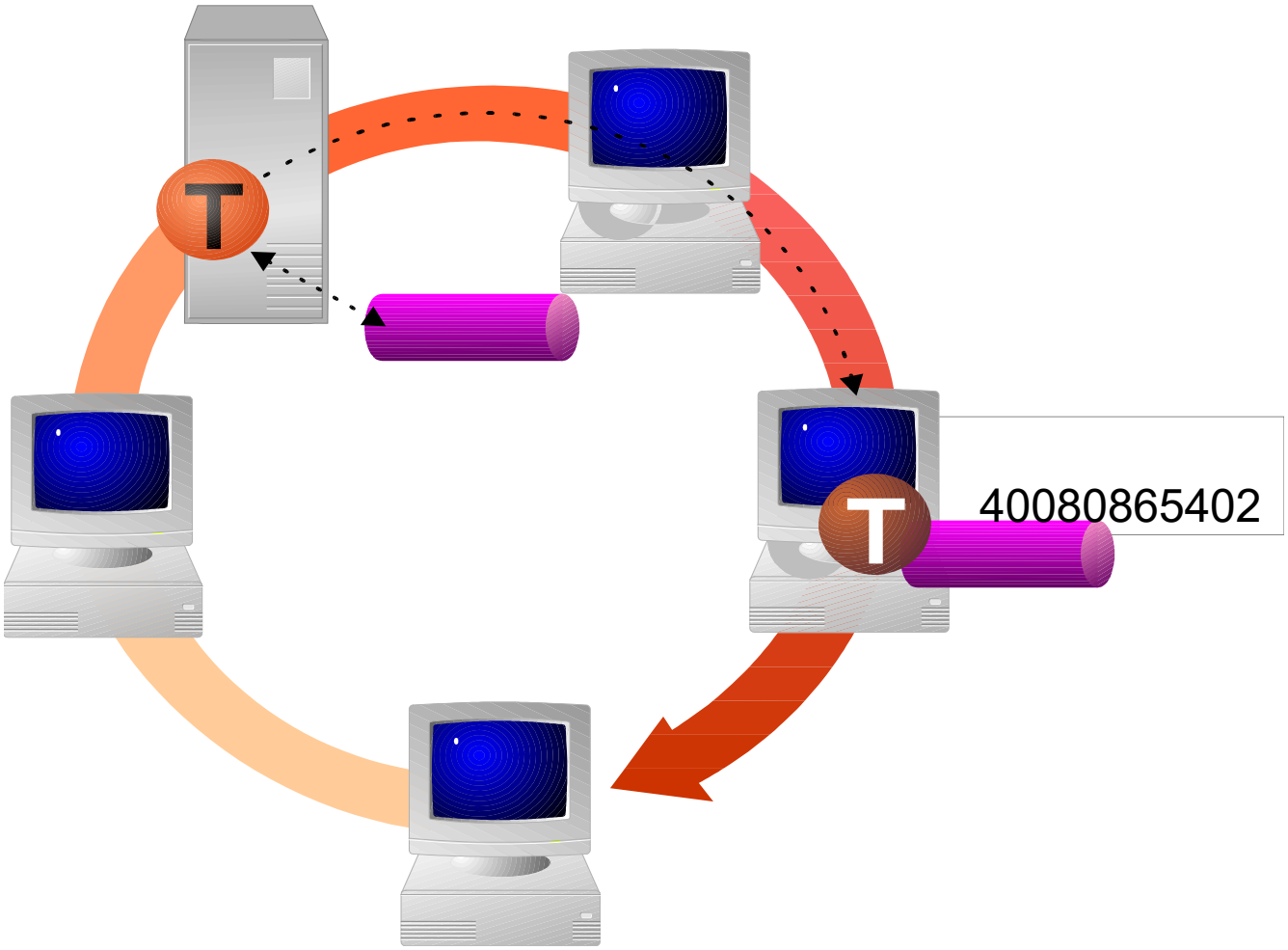
- A failure in any cable or device breaks the loop and can take down the entire network.


Ring TOPOLOGY
Do people still use the ring topology?
No, we're old.

# Simple Ring Network Showing Logical Ring



# A computer grabs the token and passes it around the ring



# Advantages and Disadvantages of Ring Topology

- No computers can monopolize the network because every computer is given equal access.
- The network traffic is in a single direction.

- If one computer fails the entire network is down.
- It is difficult to troubleshoot and also adding or removing the computers disrupts the network.
- Network reconfiguration is difficult.
- Difficult to diagnose faults.
- Topology affects the access protocol.

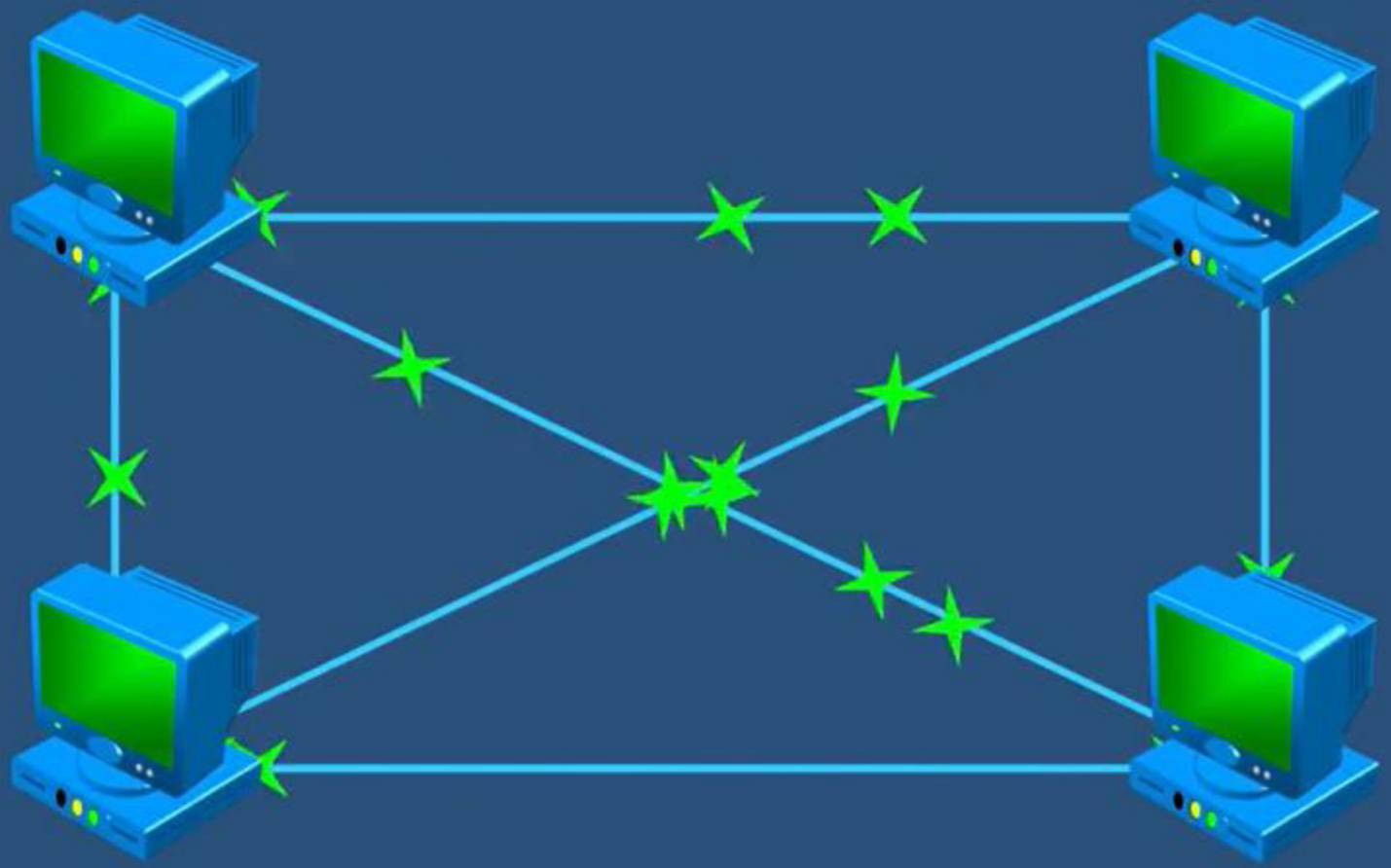
# Mesh Topology.

Mesh topologies involve the concept of *routes*. Unlike each of the previous topologies, messages sent on a mesh network can take any of several possible paths from source to destination.

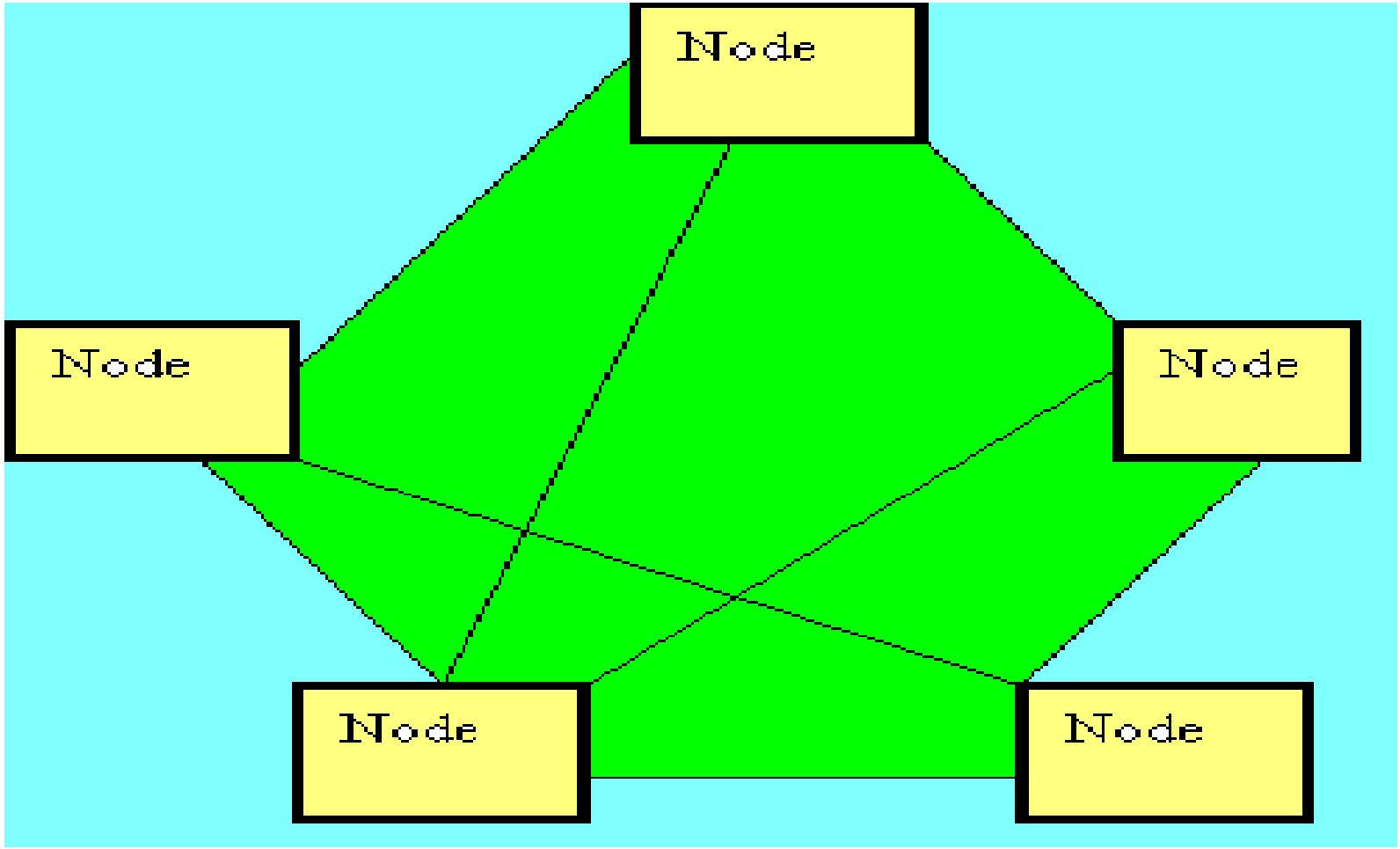
(Recall that in a ring, although two cable paths exist, messages can only travel in one direction.)

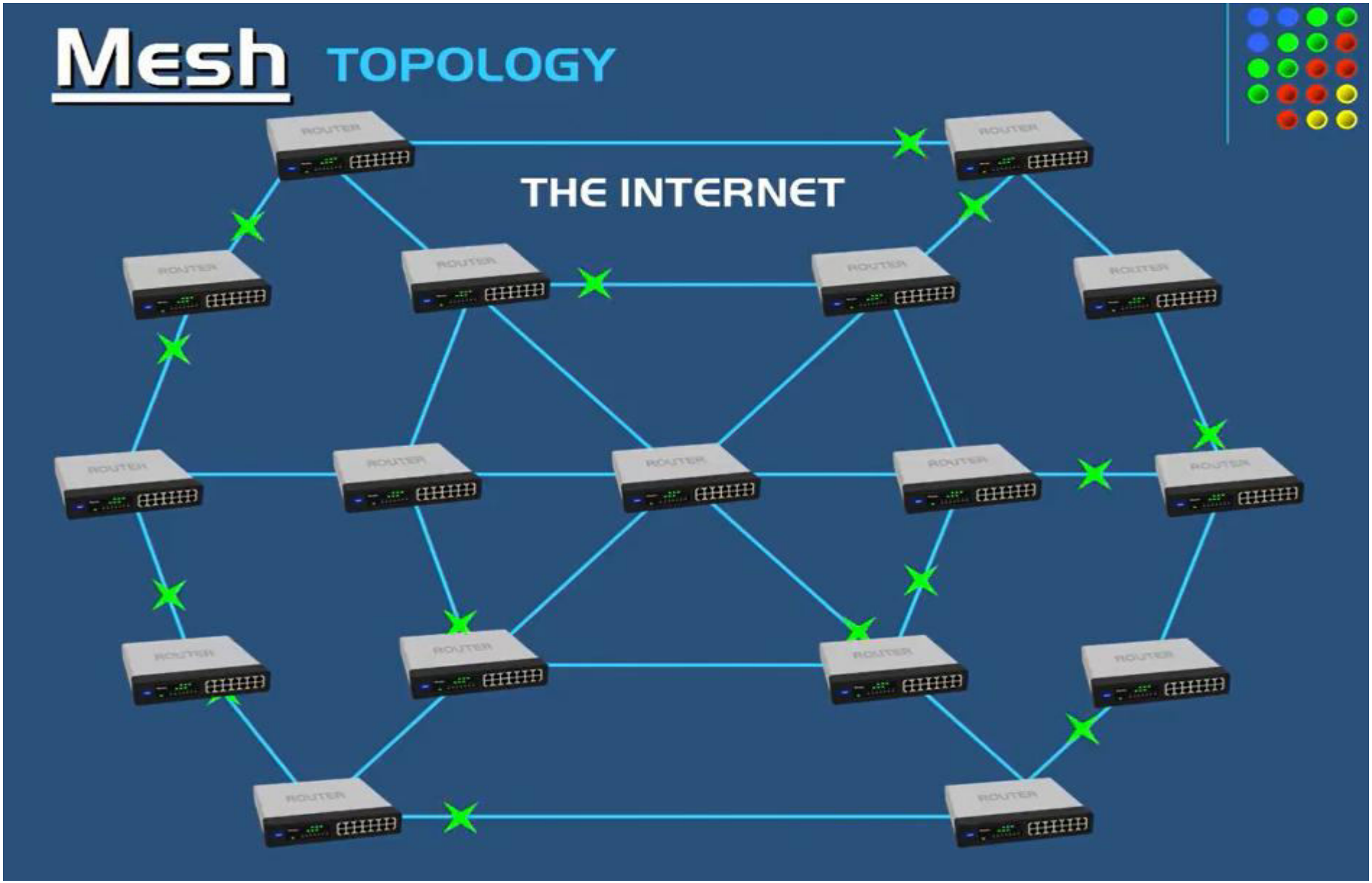
Some WANs, like the Internet, employ mesh routing.. Fig. **Mesh Topology**.

# Mesh TOPOLOGY



# Mesh Topology.

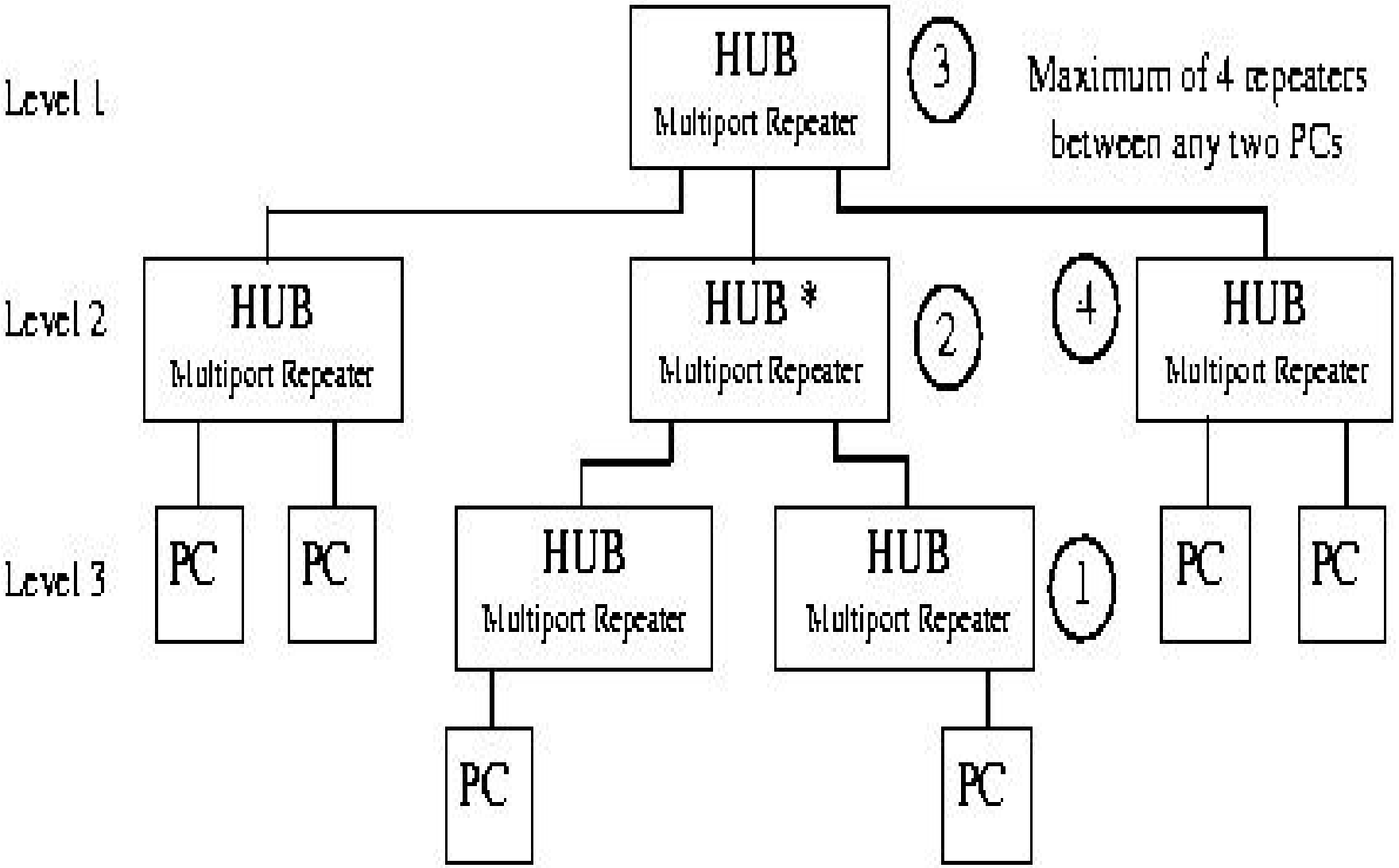



Mesh TOPOLOGY
THE INTERNET
ROUTER

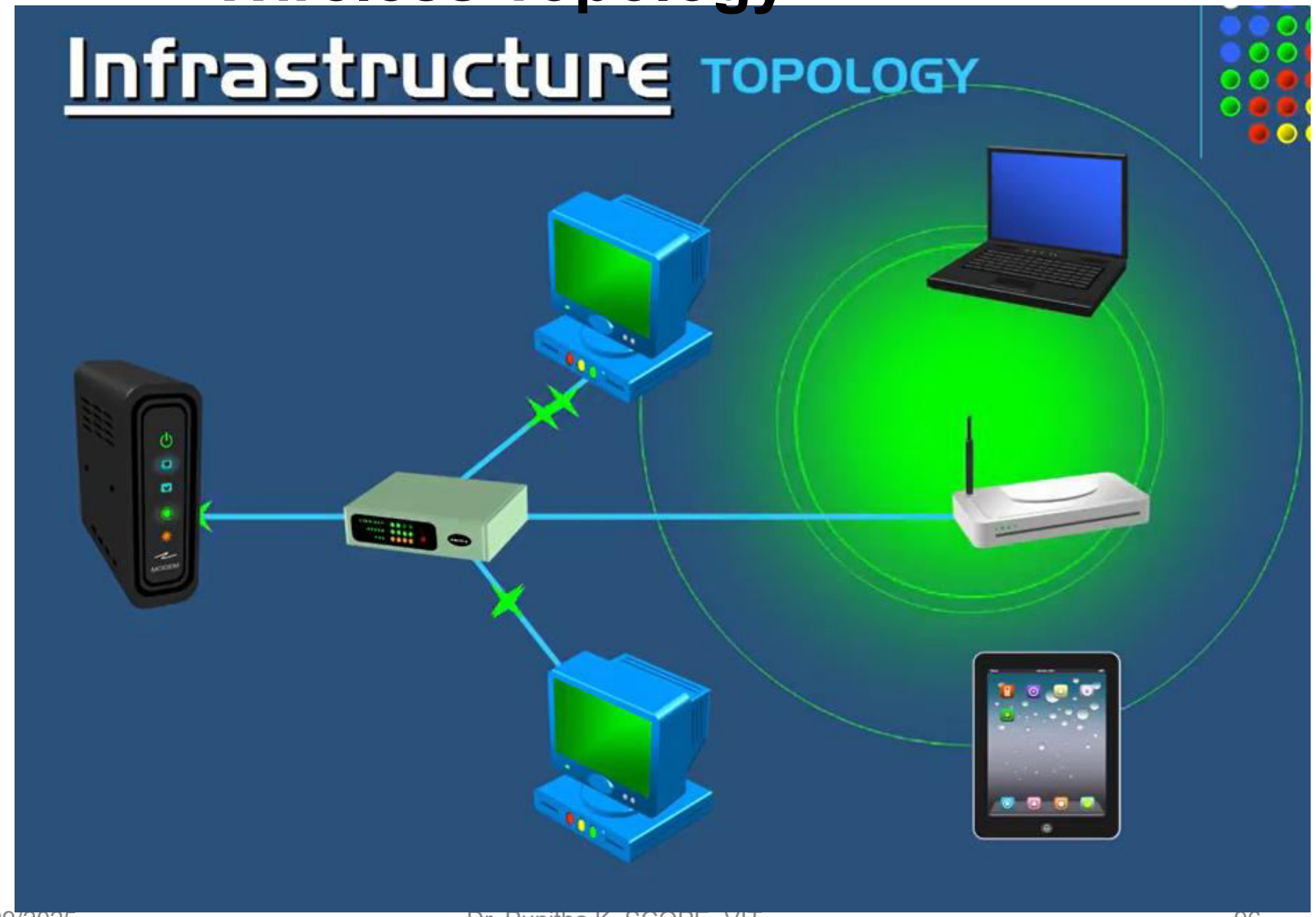
# Tree Topology :

Tree topologies integrate multiple star topologies together onto a bus. In its simplest form, only hub devices connect directly to the tree bus, and each hub functions as the "root" of a tree of devices. This bus/star hybrid approach supports future expandability of the network much better than a bus (limited in the number of devices due to the broadcast traffic it generates) or a star (limited by the number of hub ports) alone.

**Example** of tree topology can be seen in the cable TV. The main cable from the main office is divided into main branches with each branch divided into smaller branches and so on. The hubs are used when a cable is divided.

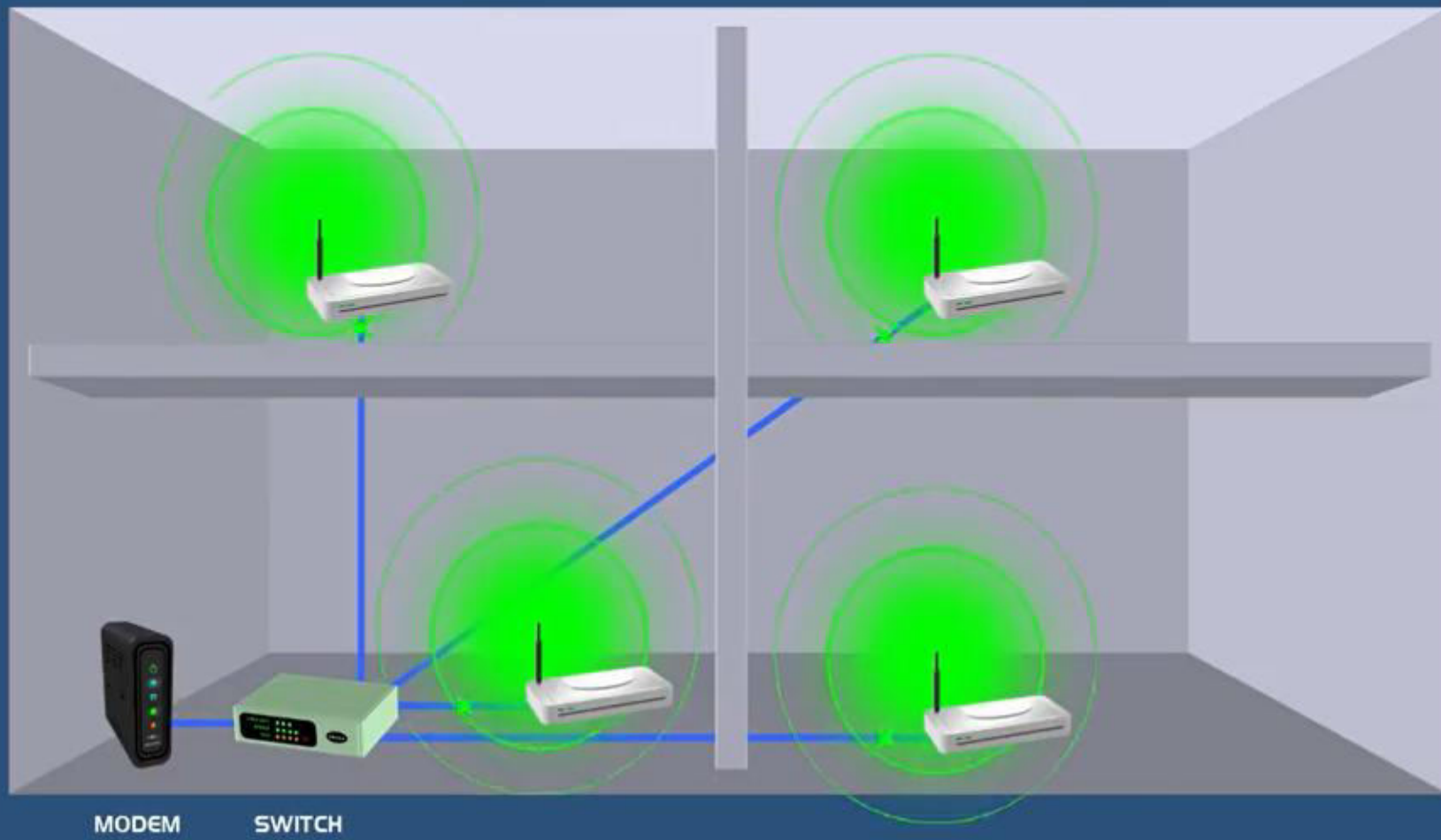

Level 1
HUB
Multiport Repeater
3
Maximum of 4 repeaters
between any two PCs
Level 2
HUB
Multiport Repeater
HUB *
Multiport Repeater
2
4
HUB
Multiport Repeater
Level 3
PC
PC
HUB
Multiport Repeater
HUB
Multiport Repeater
1
PC
PC
PC
PC

# Wireless Topology

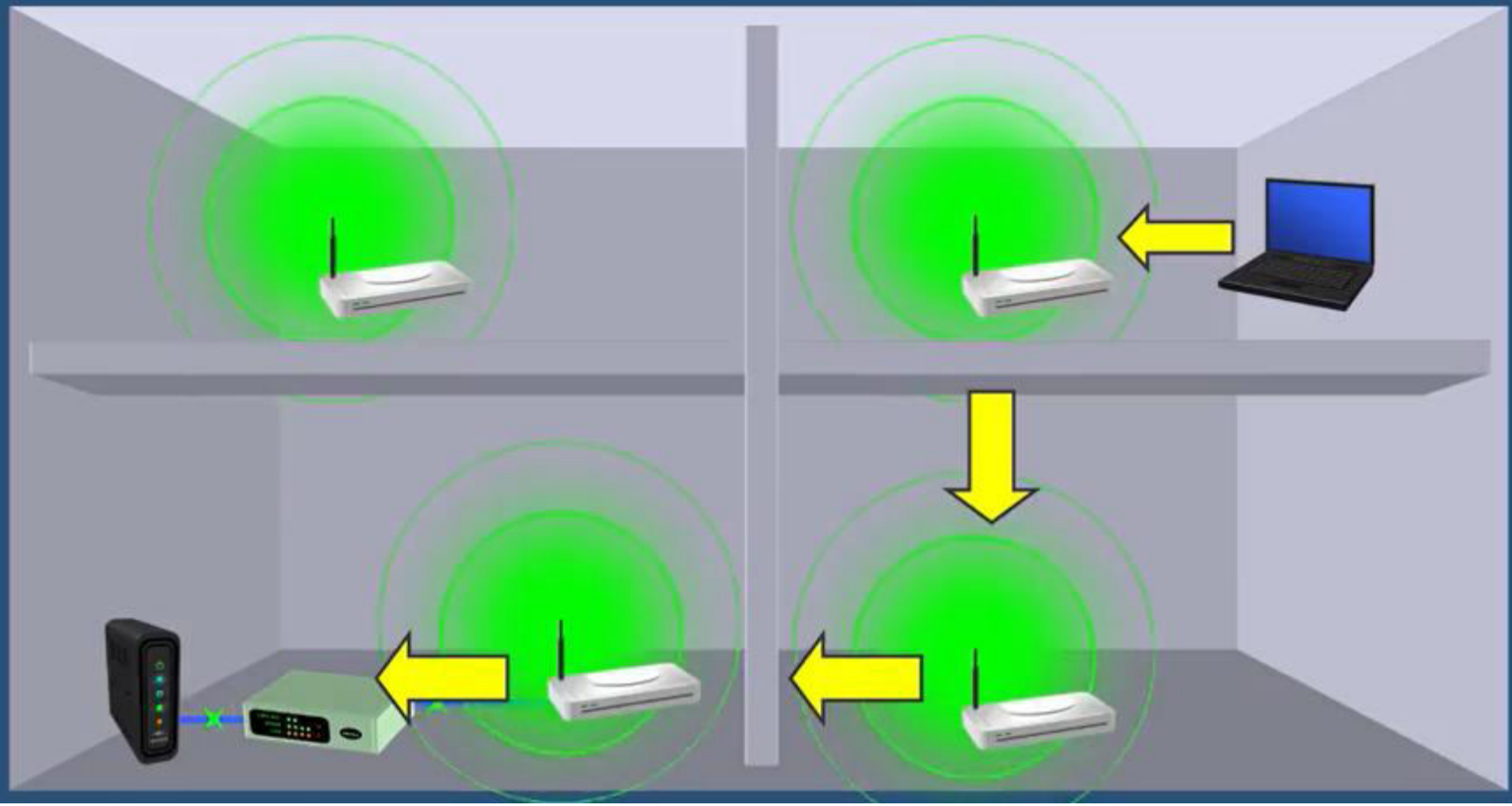



Ad hoc
TOPOLOGY
CABLES
SERVERS
ROUTERS
WAPs
LASER

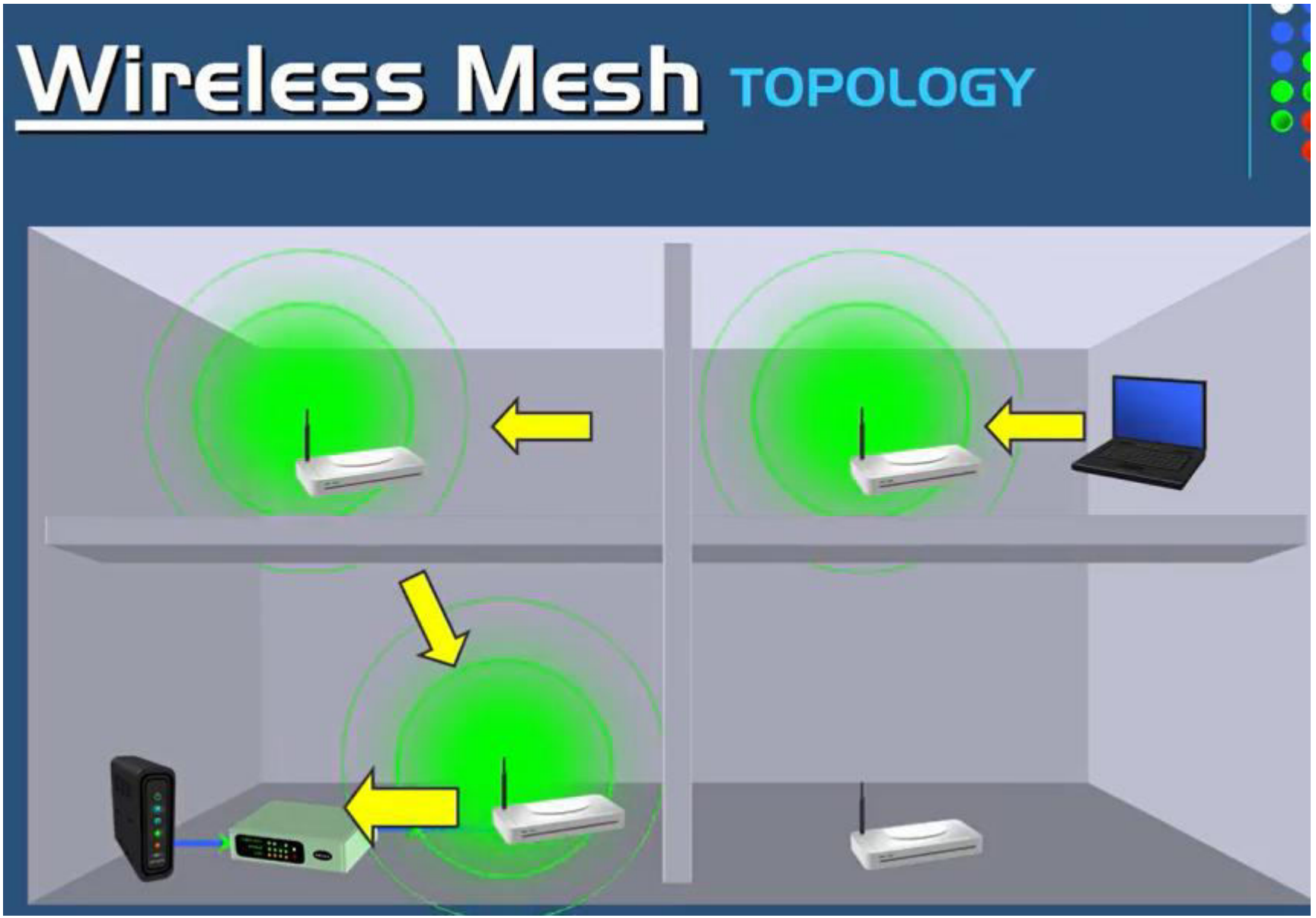
# Wireless Mesh TOPOLOGY



# Wireless Mesh TOPOLOGY



# Wireless Mesh TOPOLOGY



**Protocol :**

It is defined as a set of rules and regulations used for communication.

The key elements are given below.

1.Syntax: Refers to the structure of data, meaning the order in which they are presented.

2. Semantics: The meaning of each section of bits.

3.Timing: Refers to two characteristics: - When data should be sent and how fast they can be sent.

# PROTOCALS AND STANDARDS:

This standard defines structured cabling, a telecommunication cabling system that can support virtually any voice, imaging or data applications that an end user chooses.

- Electronic Industries Association (EIA),
- Telecommunications Industry Association (TIA) and other leading telecommunication companies worked cooperatively to create ANSI/TIA/EIA-568-A standard for commercial buildings.

Standards:

Something established for use as a rule or basis of comparison in measuring or judging capacity, quantity, content, extent, value, quality, etc.

# Definitions

- Rules and conventions for the exchange of information
  - Open Systems
- Who makes the rules and conventions?
  - Many local, regional, and international organizations
  - ISO, ITU, IEEE, ANSI, ECMA

- **Open Systems Interconnection Standards (OSI)**
  - Packet Switched Public Data Network (PSPDN)
  - Circuit Switched Public Data Network (CSPDN)
  - Public Switched Telephone Network (PSTN)
  - Integrated Services Digital Network (ISDN)
  - Local Area Network (LAN)
- V-series
  - Connecting equipment to a Public Switched Telephone Network (PSTN)
- X-series
  - Connecting equipment to a Public Switched Data Network (PSDN)
- I-series
  - Connecting equipment to an Integrated Services Digital Network (ISDN)

# Standards Organizations

- ITU - **International Telecommunication Union** which develops worldwide standards for telecommunication technologies.
- CCITT **- Consultative Committee for International Telegraph and Telephone**. Responsible for development of Communication standards.
- IEEE - **Institute of Electrical and Electronic Engineers.**
- ISO **- International Standardization Organization**. Responsible for a wide range of standards including networking standards.

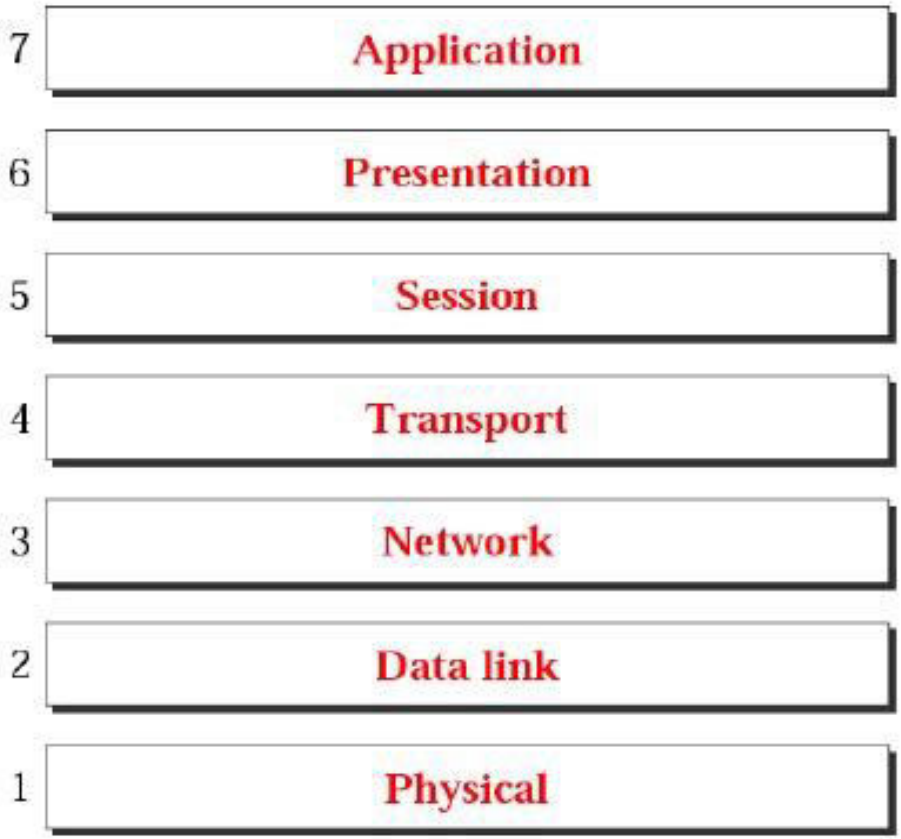
# Popular Protocols

- **TCP/IP** - Transmission Control Protocol/Internet Protocol. Name of suite of protocols to support the implementation of worldwide internet works.
- **X.25** - ITU's standard that defines how connections between terminal equipment and computers are maintained.
- **SMDS** - Switched Multi-megabit Data Service. High speed packet switched WAN networking technology offered by phone companies.

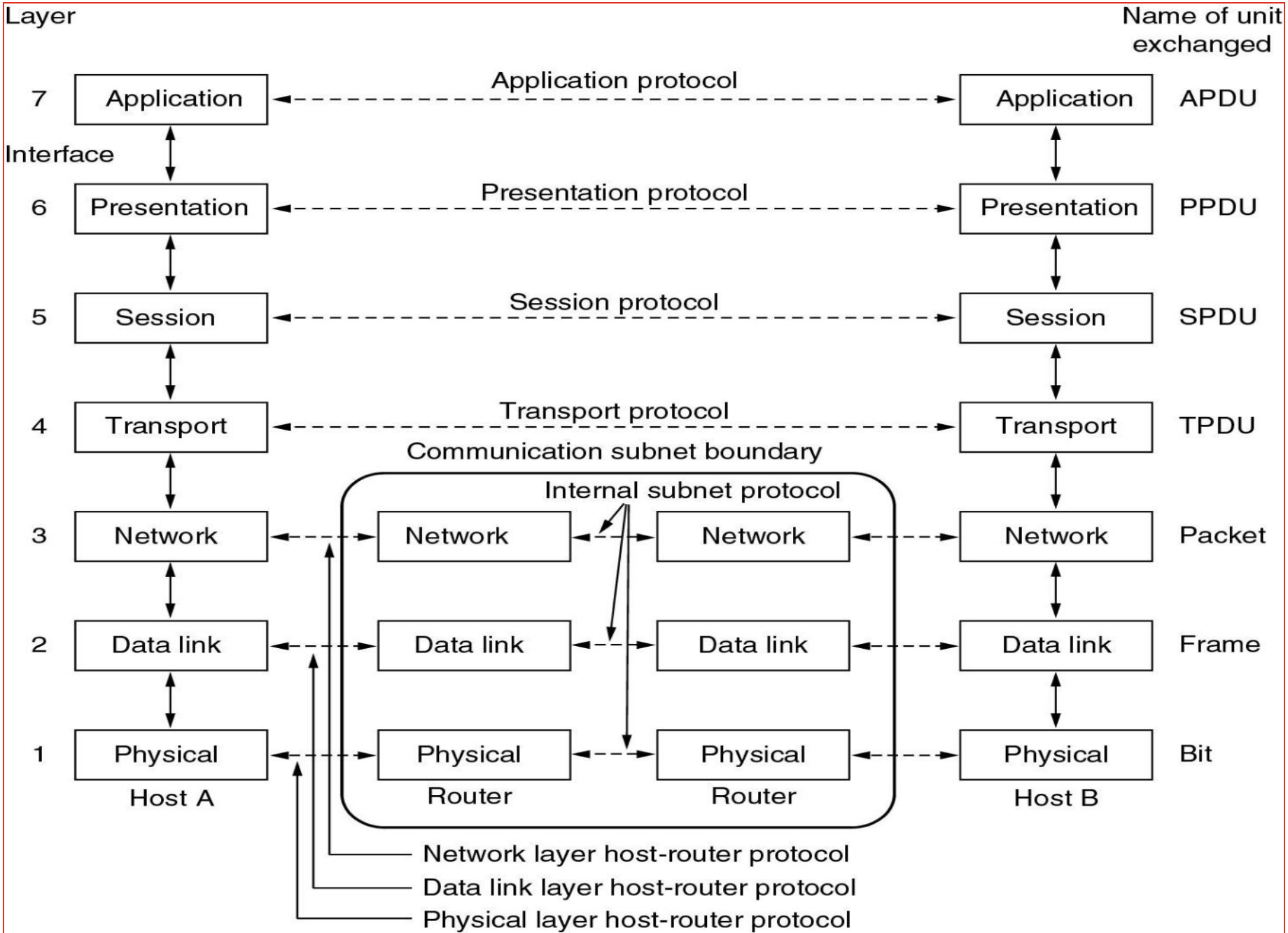
# Popular Protocols (Cont.)

- ISDN - Integrated Services Digital Network. Communication protocol offered by phone companies which allows phone networks to carry voice, video, and data.
- CDPD - Cellular Digital Packet Data. Standard for 2-way wireless data communication over high frequency cellular phone channels.
- DQDB - Distributed Queue Dual Bus. Data link layer protocol designed for metropolitan area networks.
- CDMA - Code Division Multiple Access.

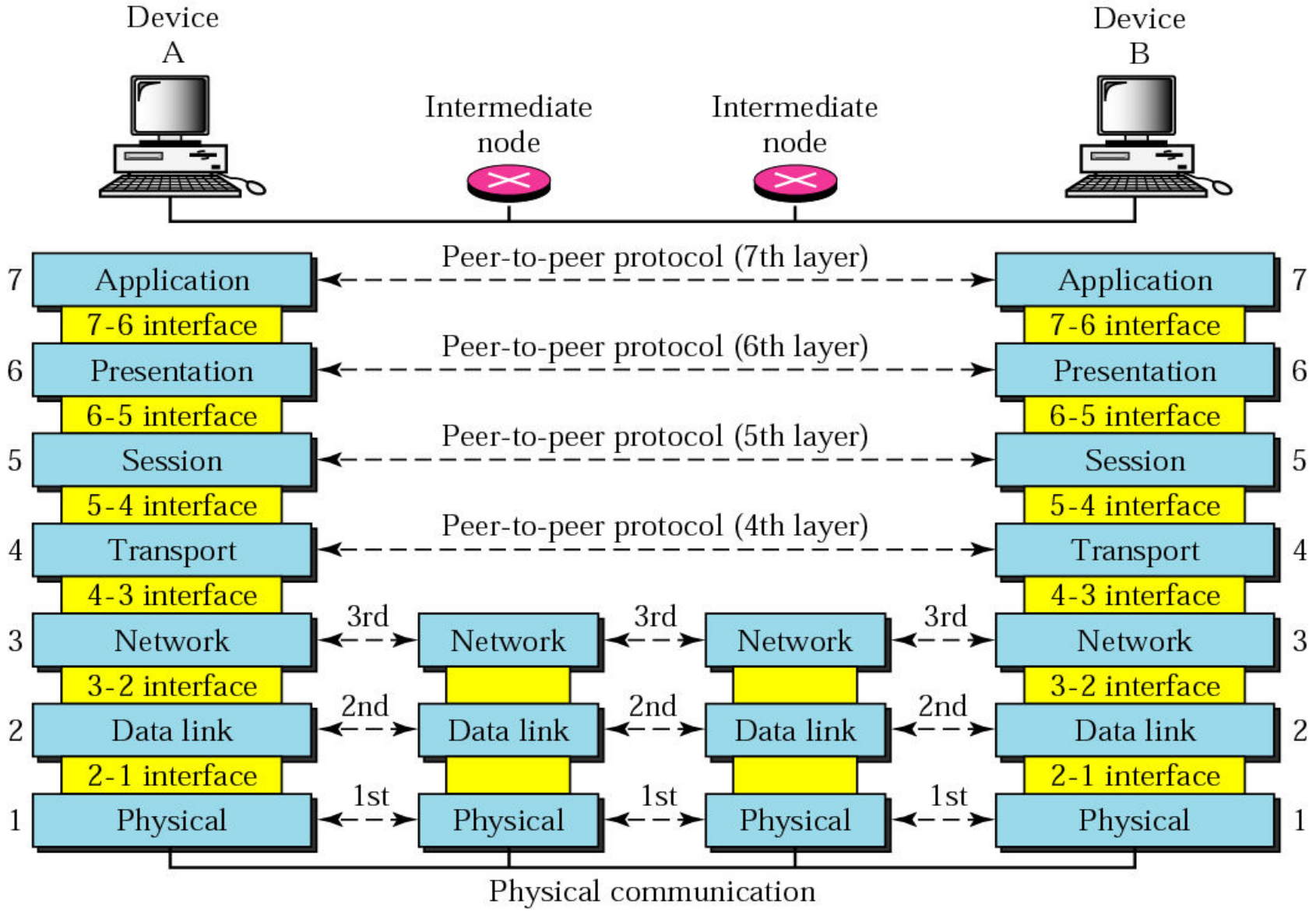
Figure 2.1 *The OSI model*



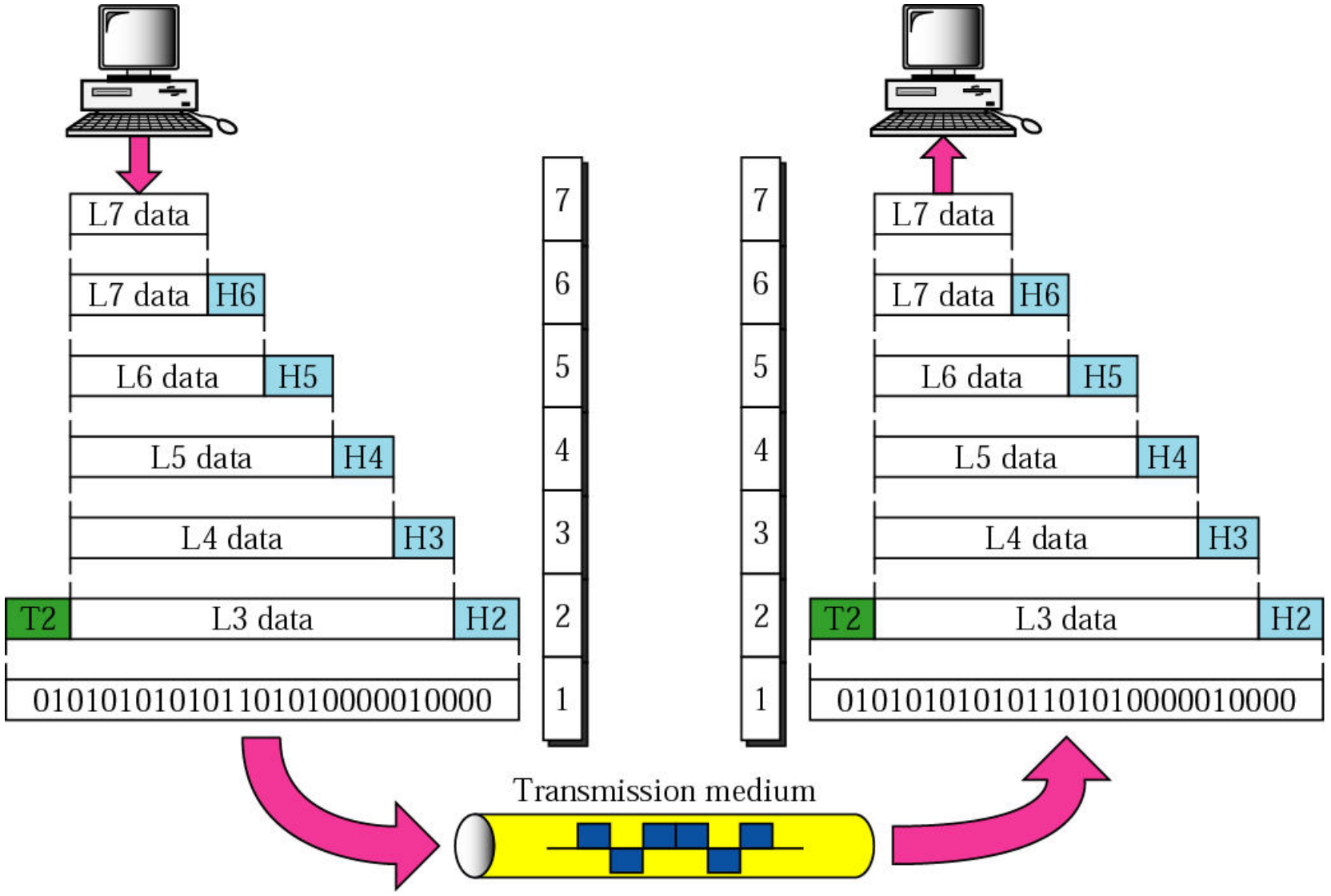
# OSI Reference Model



# OSI layers


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

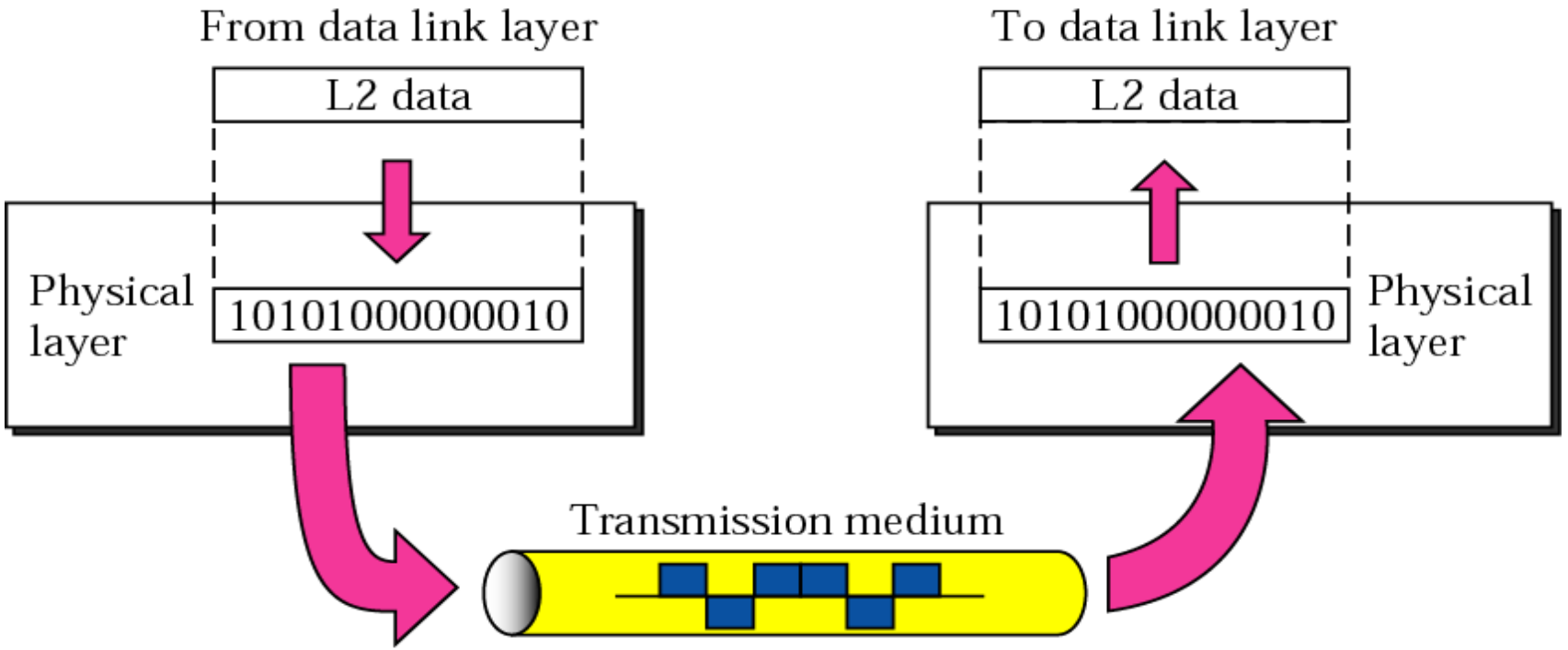
# An exchange using the OSI model



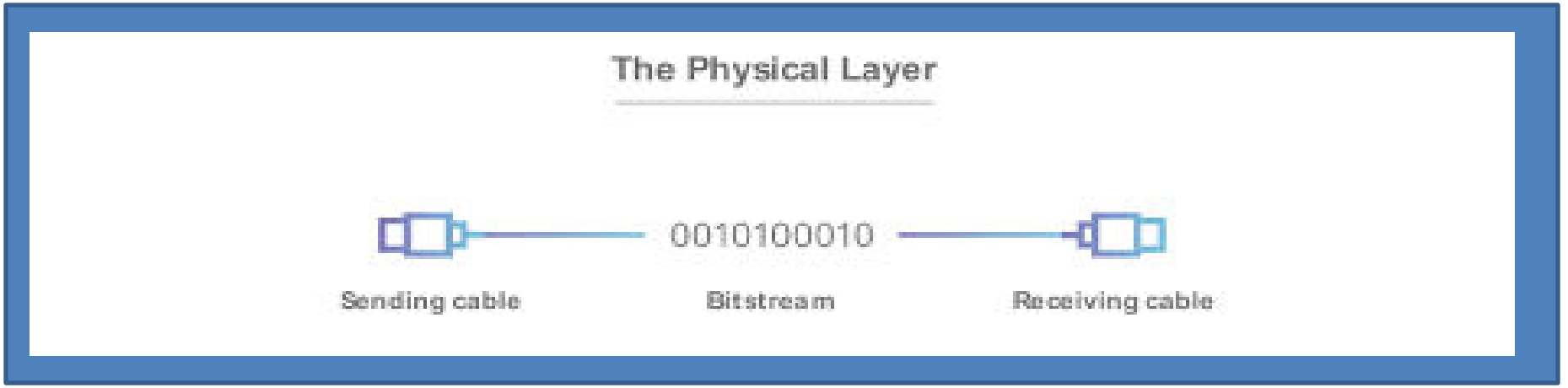
# Physical Layer

- The Physical layer is concerned with sending raw **bits** between adjacent nodes across the medium..
- The bits sent as 0's and 1's will be received as 0's and 1's only.
- The Physical layer has to take care of the following factors.
  - Signal Encoding : How are the bits 0 and 1 to be represented.
  - Medium : What is the medium used, and are its properties.
  - Signal type : Are analog signals used or digital.
  - Bandwidth : Which of base band or broadband communication used.
  - Whether the transmission is serial or parallel
  - What is the topology used

# Physical Layer



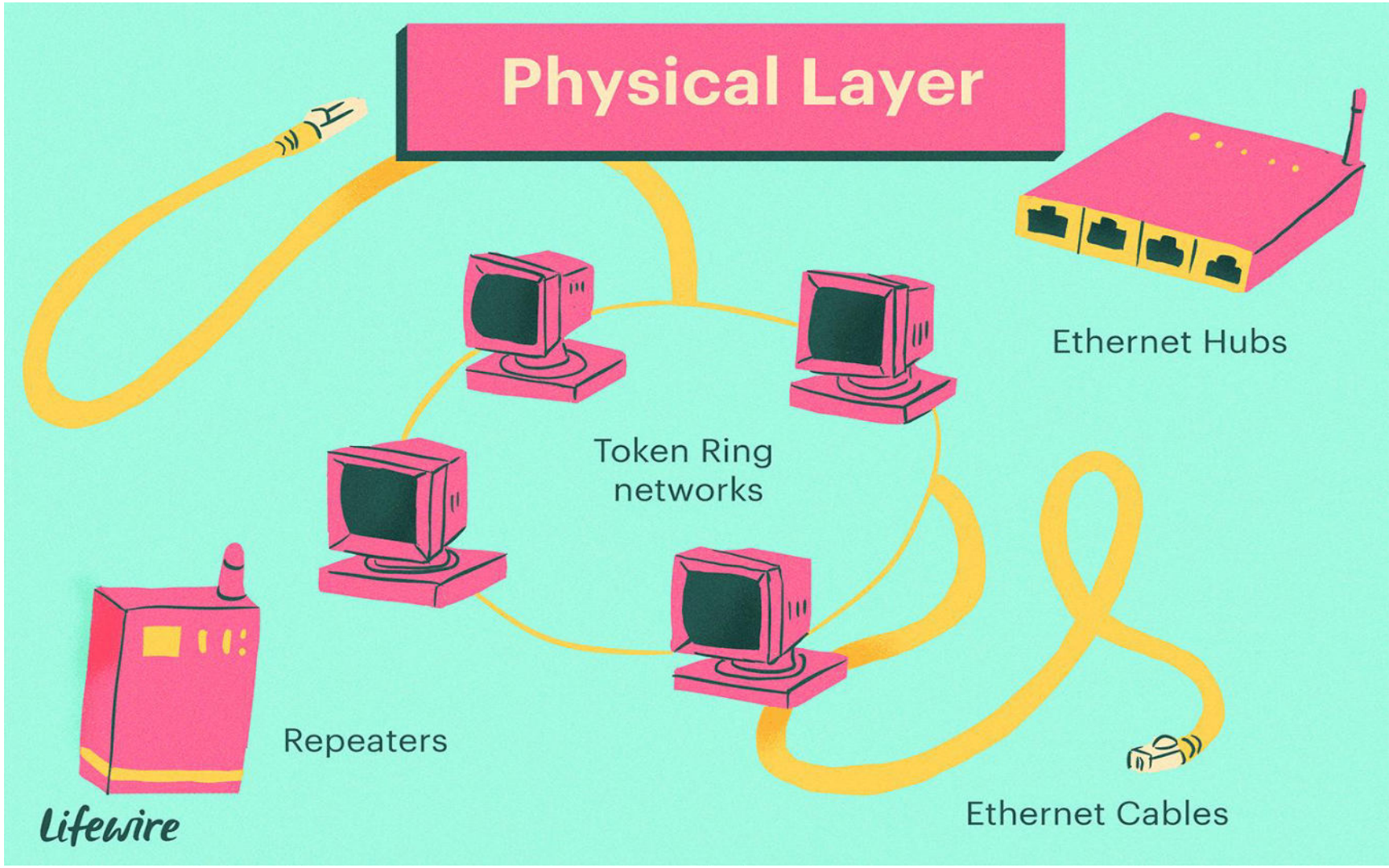
# Physical Layer



# Physical Layer

- Deals with mechanical, electrical and procedural interfacing
- Provides collision detection
- Specifies cables, connectors, and other components
- Transmits raw information over communication channel
- Establishes, maintains, and disconnects physical links
- Includes software device drivers for communication interfaces

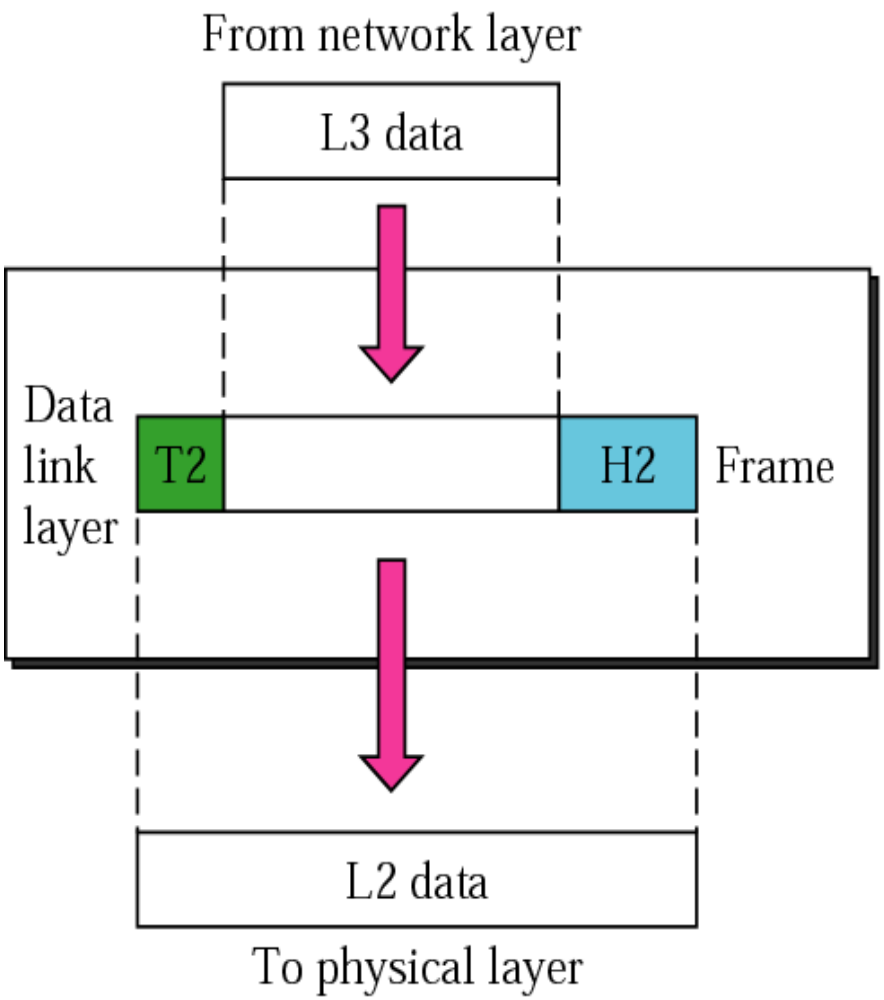
# Physical Layer

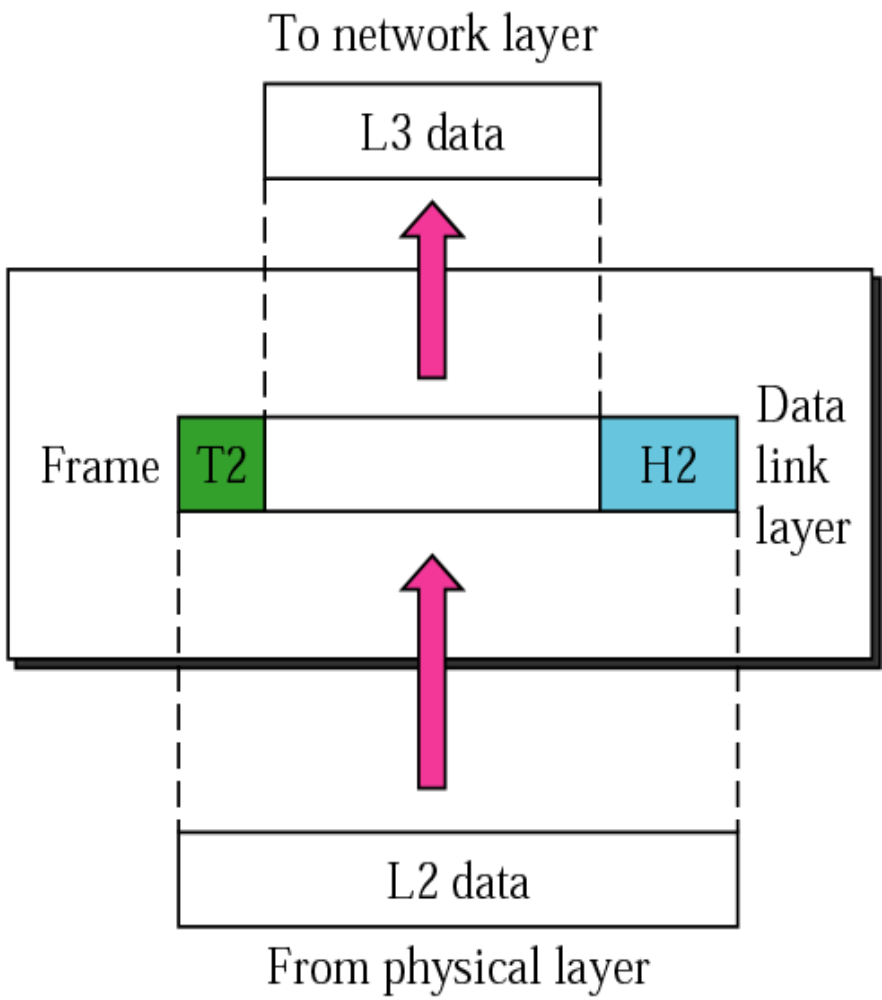


# DATA LINK LAYER

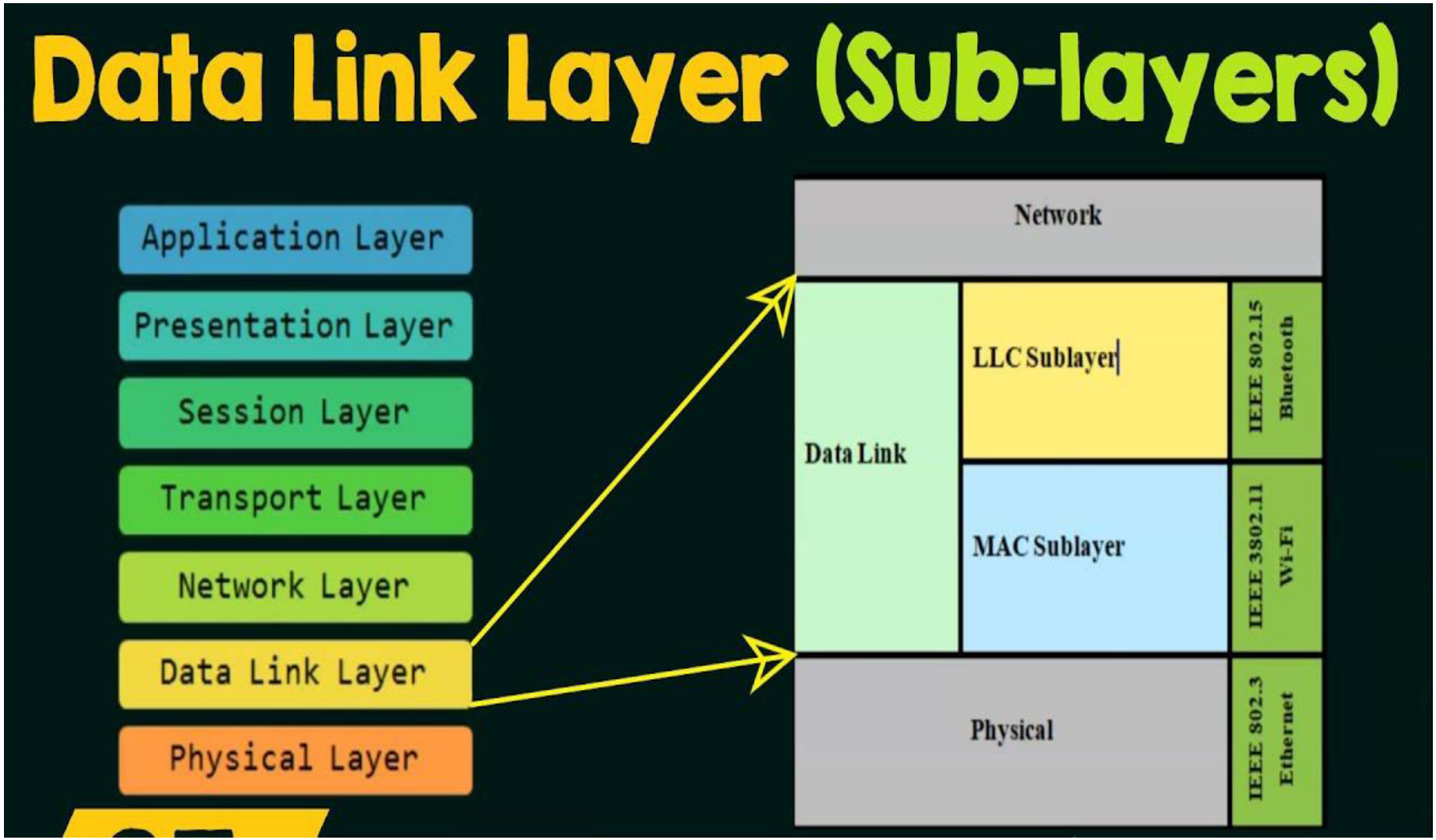
- It is responsible for transmitting a group of bits between the adjacent nodes called **Frames**.
- It has to construct the frame after receives the bits from the physical layer.
- The DLL has to check the CRC to ensure the correctness of the frame. If incorrect, it asks for retransmission.
- If the receiver is slow, then the transmitter has to make some agreement with the receiver to ensure correct delivery.
- Discarding of duplicate frames will be done at the receiving end.
- Retransmission will be done at the sending end only when necessary.
  - If the Timer has Elapsed
  - No Acknowledgement with in specified time.
  - if the ACK. Is damaged.
- DLL is divided in to two sub layers
  - **Logical Link Control**
  - **Medium Access Control**
- Headers and trailers are added , containing the physical addresses of the adjacent nodes.
- DLL has to handle the error detection and correction and deliver the undamaged frame **only at the network level.**

# Data Link Layer



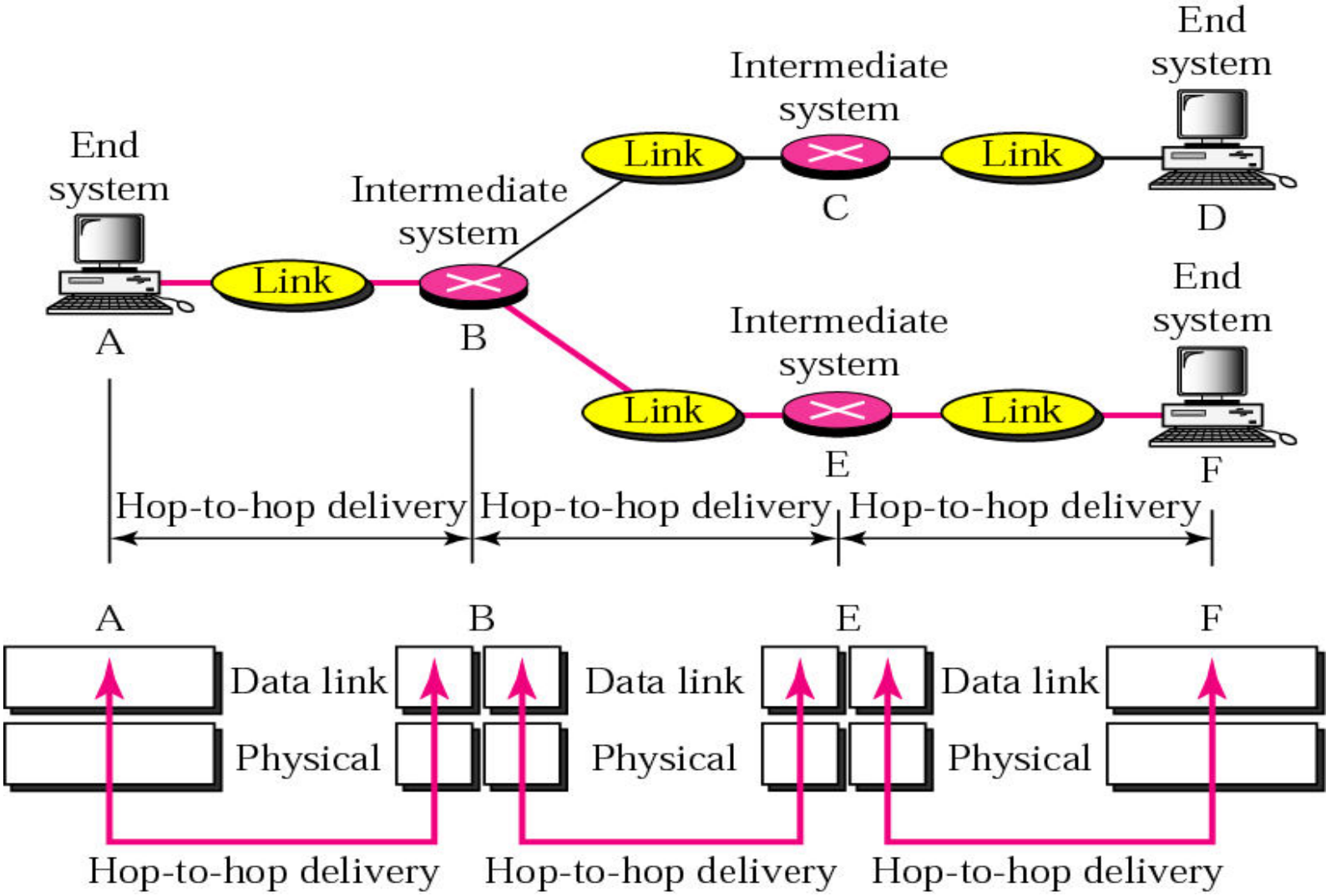
# Data Link Layer



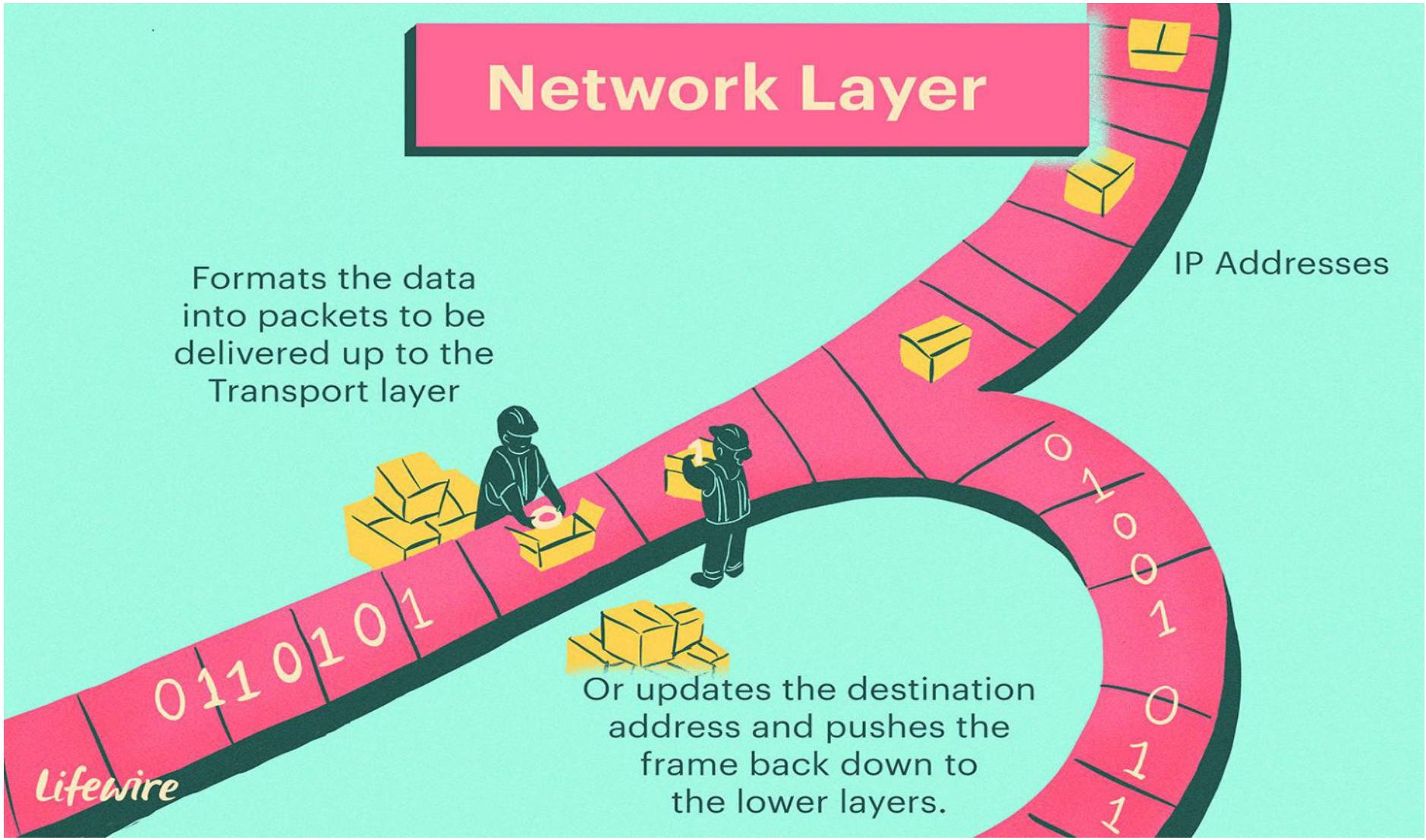
# Data Link Layer

- Provides reliable transfer of data.
- Breaks data (packets) into frames.
- Adds bits for error detection/correction.
- Manages access to and use of the channel.
- Solve problems caused by lost, damaged, and duplicate frames.
- Sends acknowledgments.
- Adds flags to indicate beginning and end of message.
- Connectionless or connection oriented services.
- IEEE MAC and LLC support.

# Node-to-node delivery



# NETWORK LAYER



# NETWORK LAYER

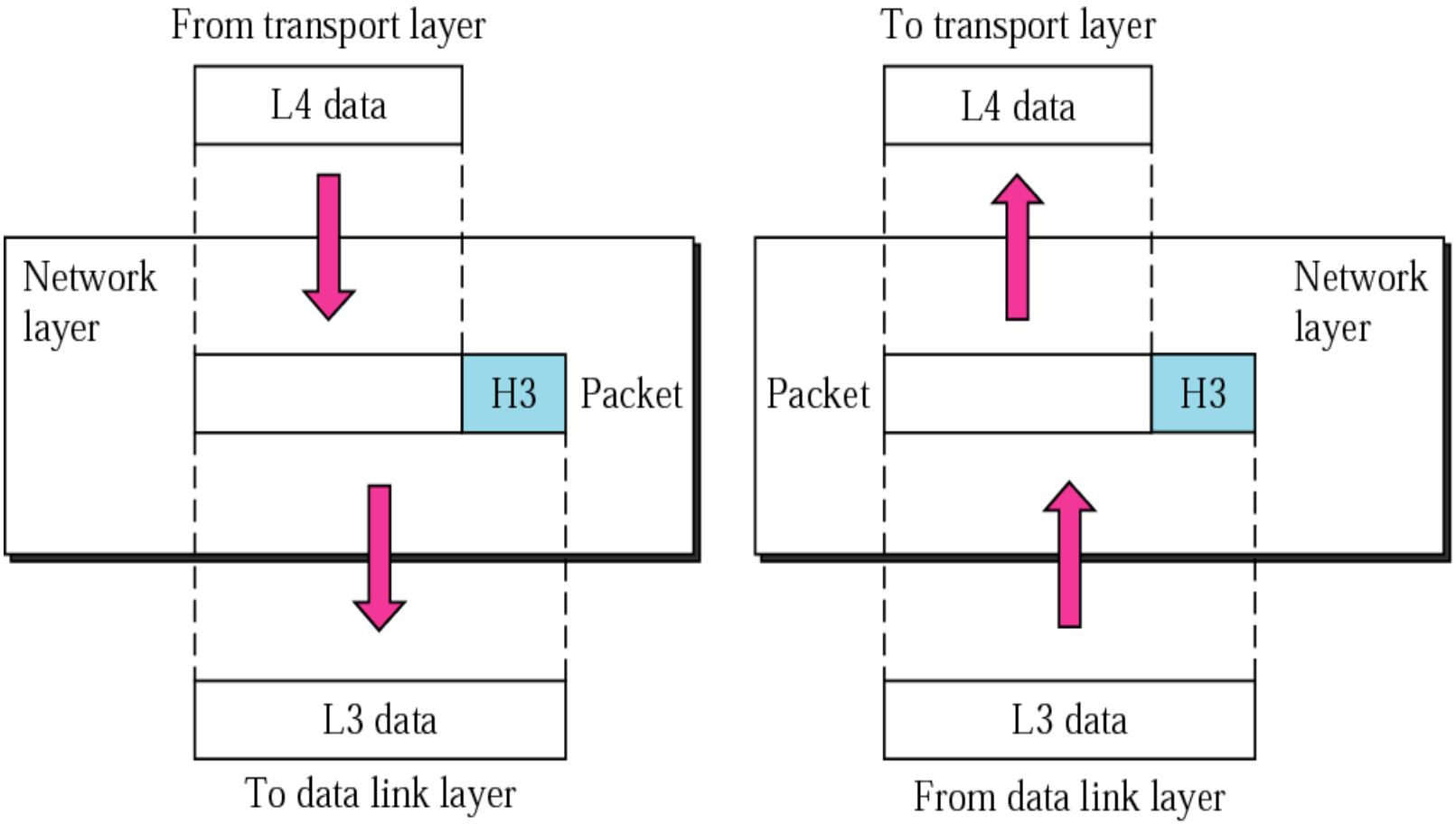
- It is responsible for routing a packet with in the subnet.

  i.e) from the source node to the destination node across multiple nodes in the same network or across multiple network.
- It is also responsible for tackling the **congestion problem** at a node, when there are too many packets stored at a node to be forwarded to the next node.
- It has to takes care of **controlling the flow of information**.
- Transmission of messages will be done by **Packets**.
- It offers two types of services .
  - **Virtual Circuit ( Telephone )**
    - Complete route should be established before transmission begins as first phase
    - Data transfer happens after that as second phase
    - Call termination as third phase
    - Order of delivering of messages will be maintained

# NETWORK LAYER – (Cont...)

- **Data Gram ( Postal )**
  - It can follow any route it wants. Selection of route is decided on availability.
  - Order of delivering of messages cant maintained.
- When there is only one small network based on broadcast , this layer is will do minimum functionality.
- It takes care of interpreting the logical addresses to physical addresses.

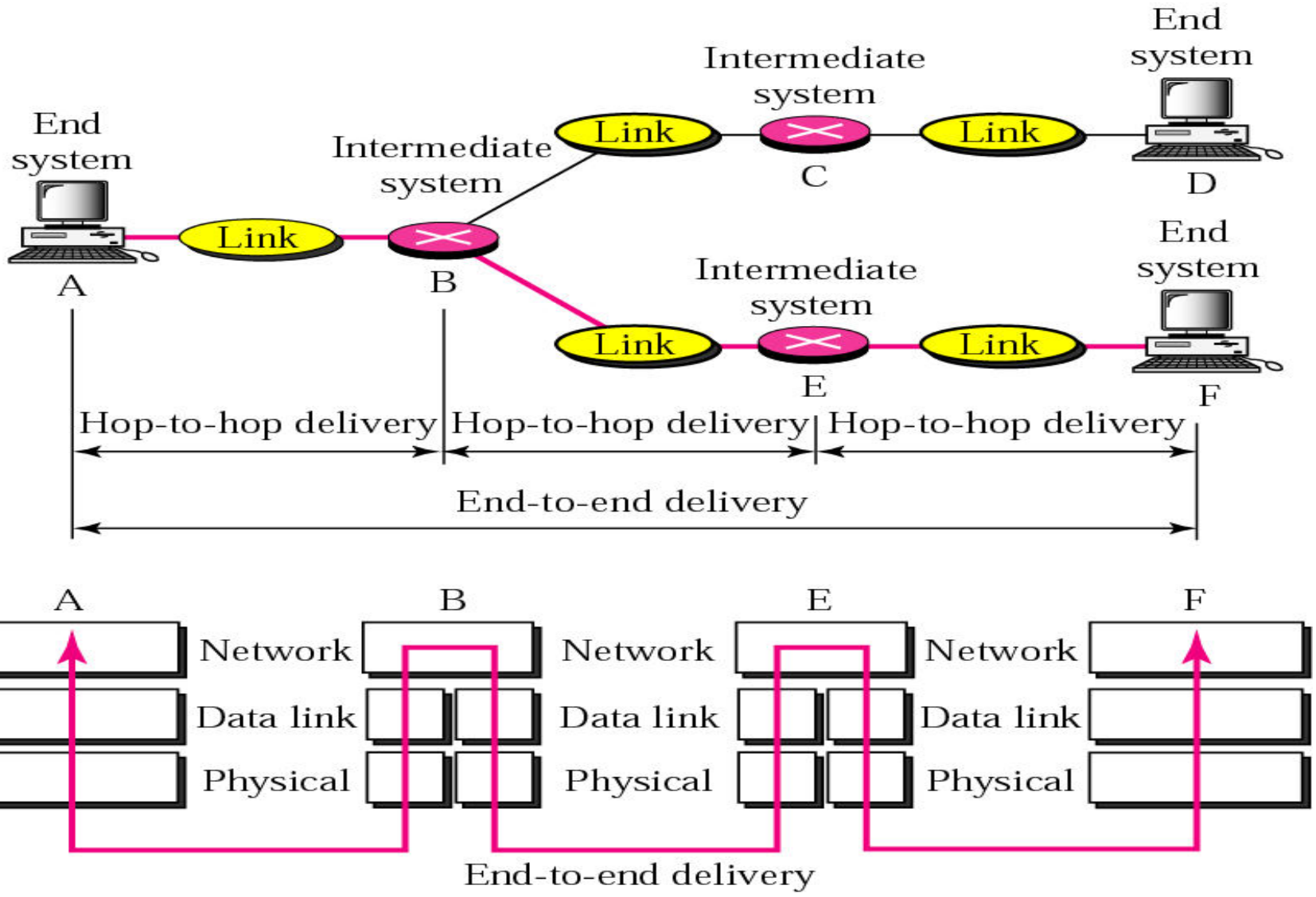
# Network Layer

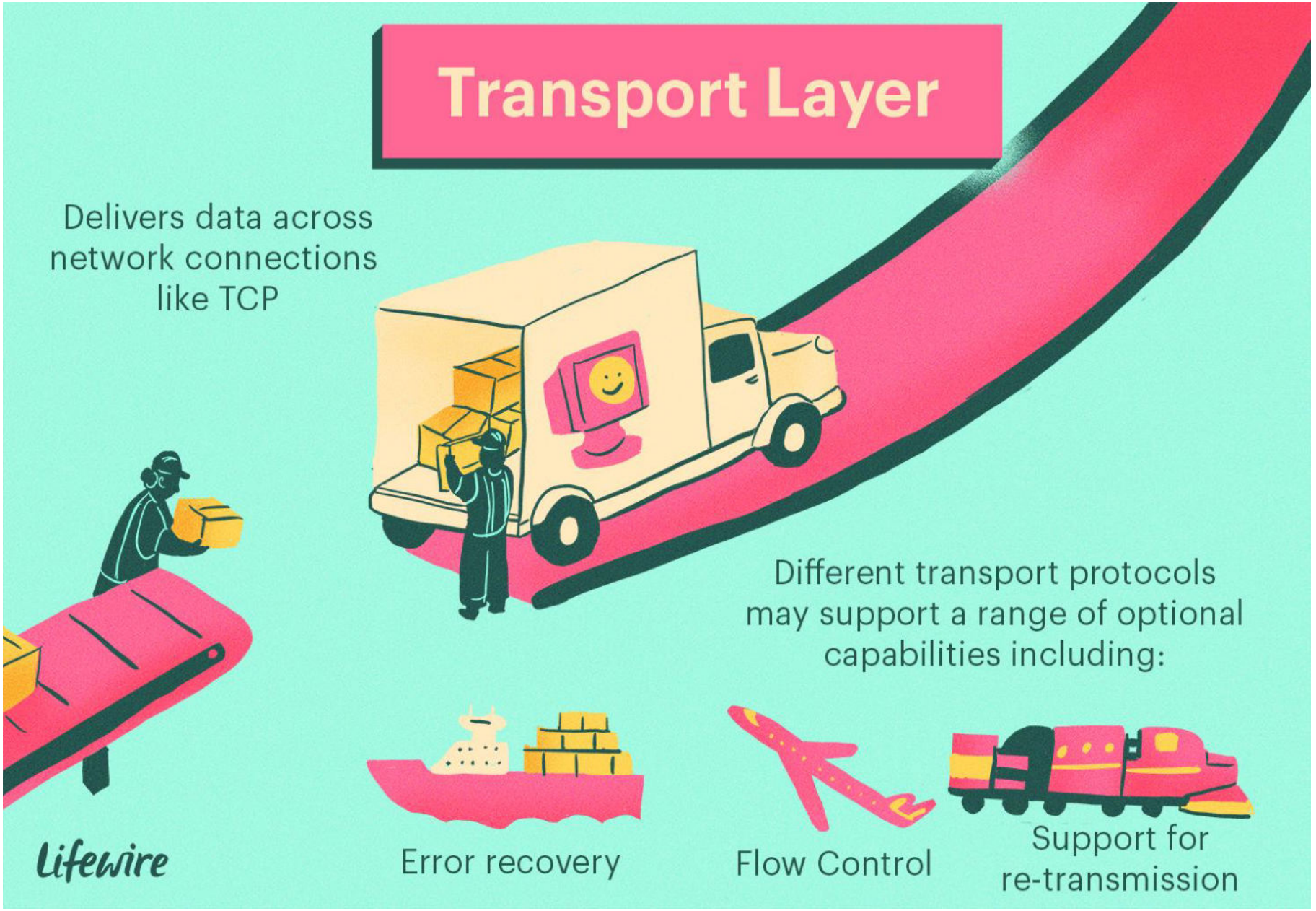


# Network Layer

- Establishes, maintains and terminates connections
- Determines how packets are routed
- Divides transport messages into packets and reassembles them
- Performs congestion control, flow control
- Provides virtual circuit or datagram services
- Recognizes message priorities
- Sends messages in proper order
- Handles internetworking

# End-to-end delivery

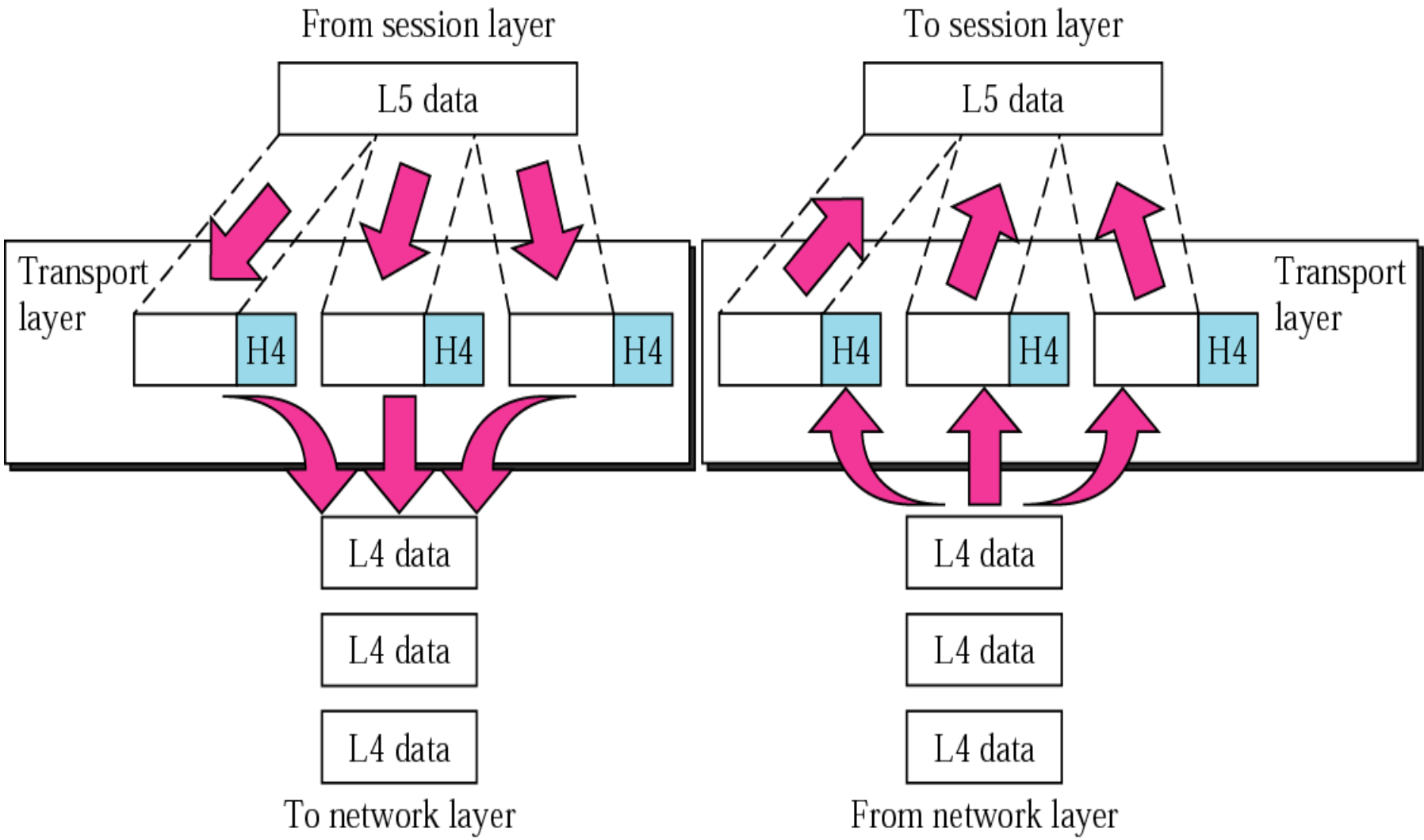



Transport Layer
Delivers data across network connections like TCP
Different transport protocols may support a range of optional capabilities including:
Error recovery
Flow Control
Support for re-transmission
Lifewire

# TRANSPORT LAYER

- The Transport layer is the first end-to-end layer.
- The Transport layer breaks the messages in to number of packets, numbers them by adding sequence numbers at the source , and uses the same at the destination to reassemble the original message.
- A header at the transport layer contains information that helps to send the messages to the corresponding layer at the destination node, although the messages broken in to packets may travel through a number of intermediate nodes.
- It ensures end – to –end error free delivery to the hosts.
- The transport layer ensures that the complete message arrives at the receiver , and in the proper order.
- The Transport layer enables communication between two applications running on different computers.
- The Transport layer receives data from the session layer on the source computer which needs to be sent to the other computer.
- The Transport layer might create a logical connection between the source and the destination for the duration of the complete message transfer.
- It provides multiple transport for data flow.

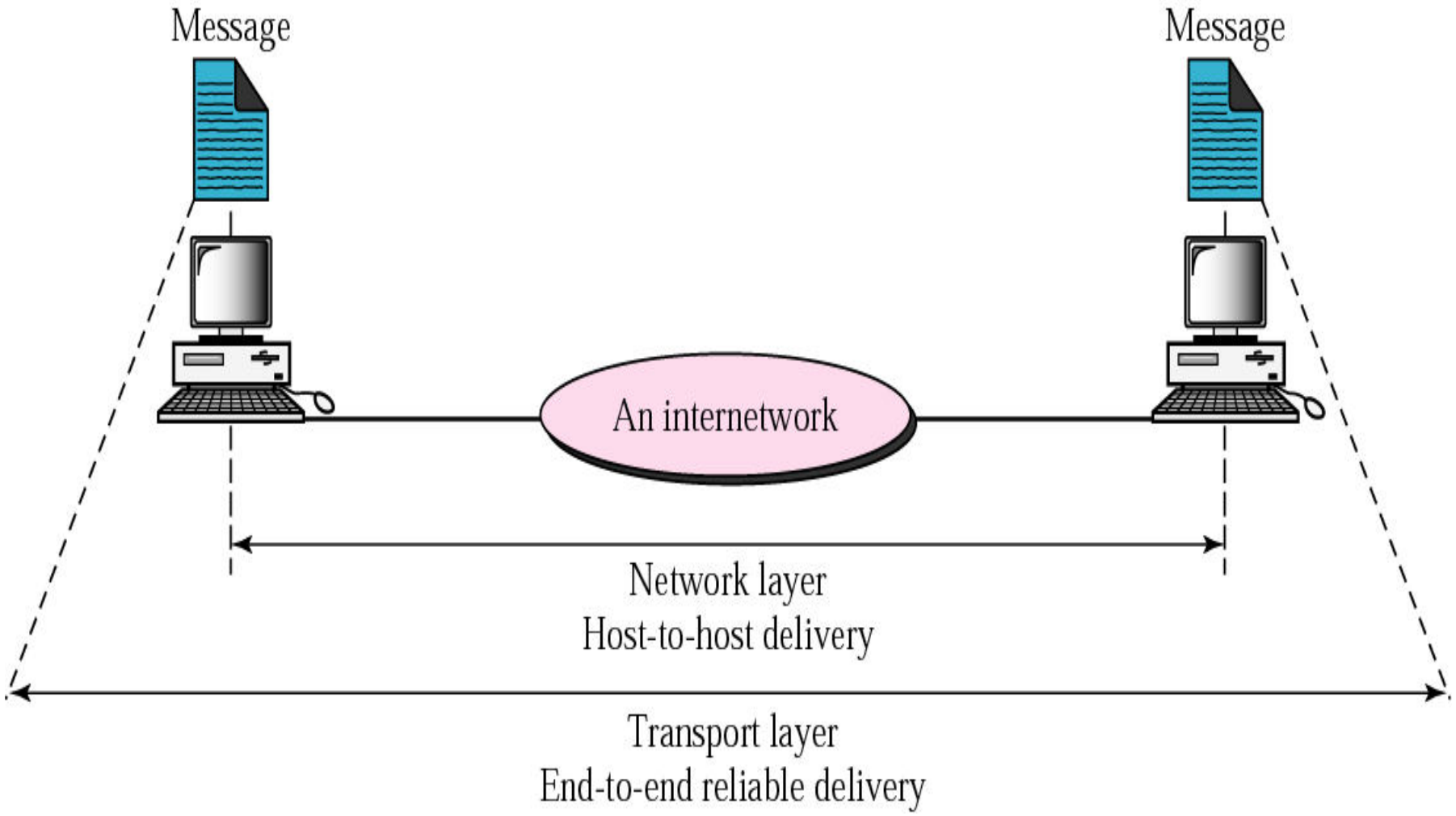
# Transport Layer



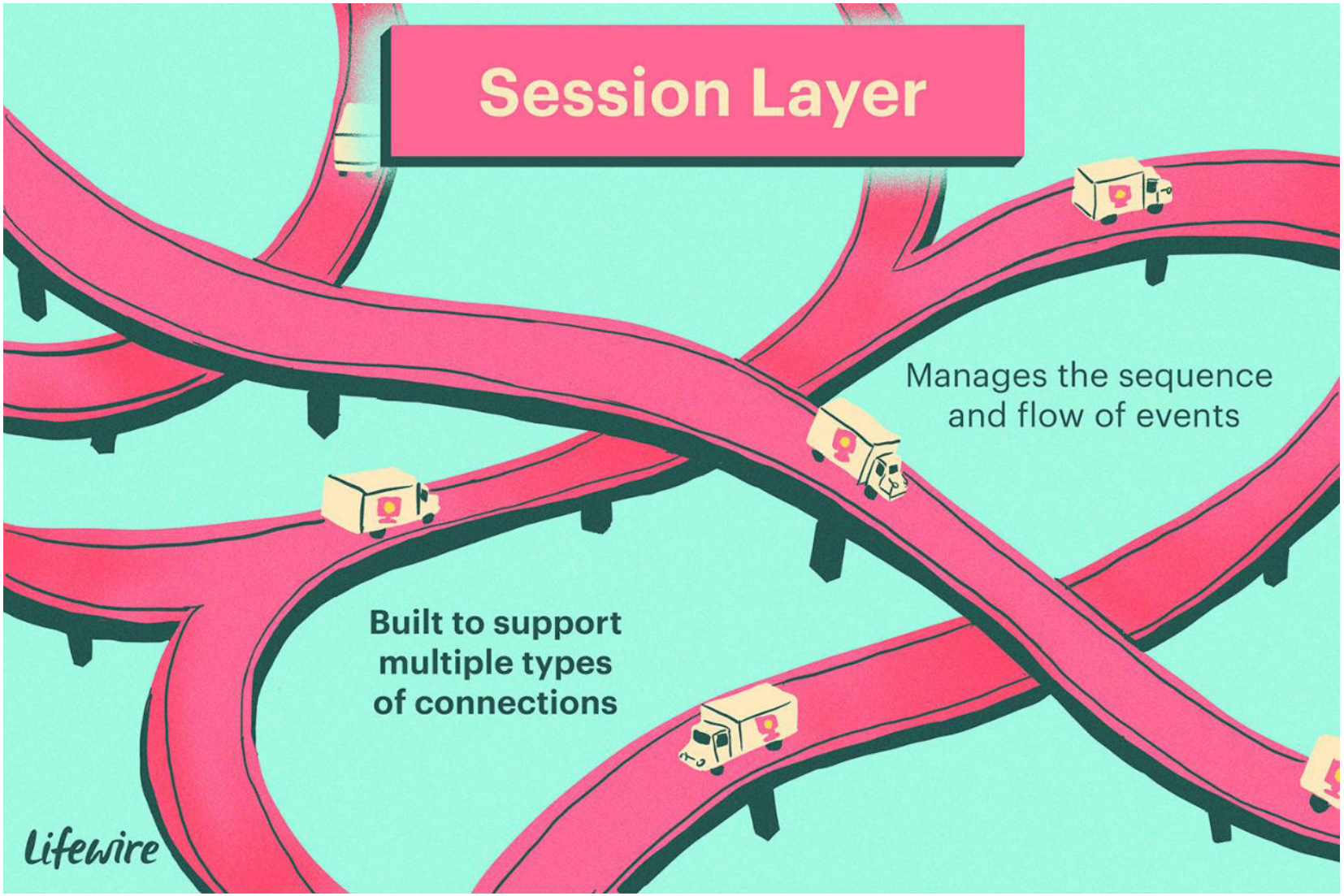
# Transport Layer

- Establishes reliable end-to-end transport session (error detection and recovery), once path has been established.
- Fragmentation of message into packets (if not handled by layer 3).
- Multiplexing of several sessions from same source and all going to same destination.
- Creates distinct (Different) network connections.
- Monitors quality of service.
- Disassembles and assembles session messages.
- Flow control (if not done by layer 3).

# Reliable end-to-end delivery of a message



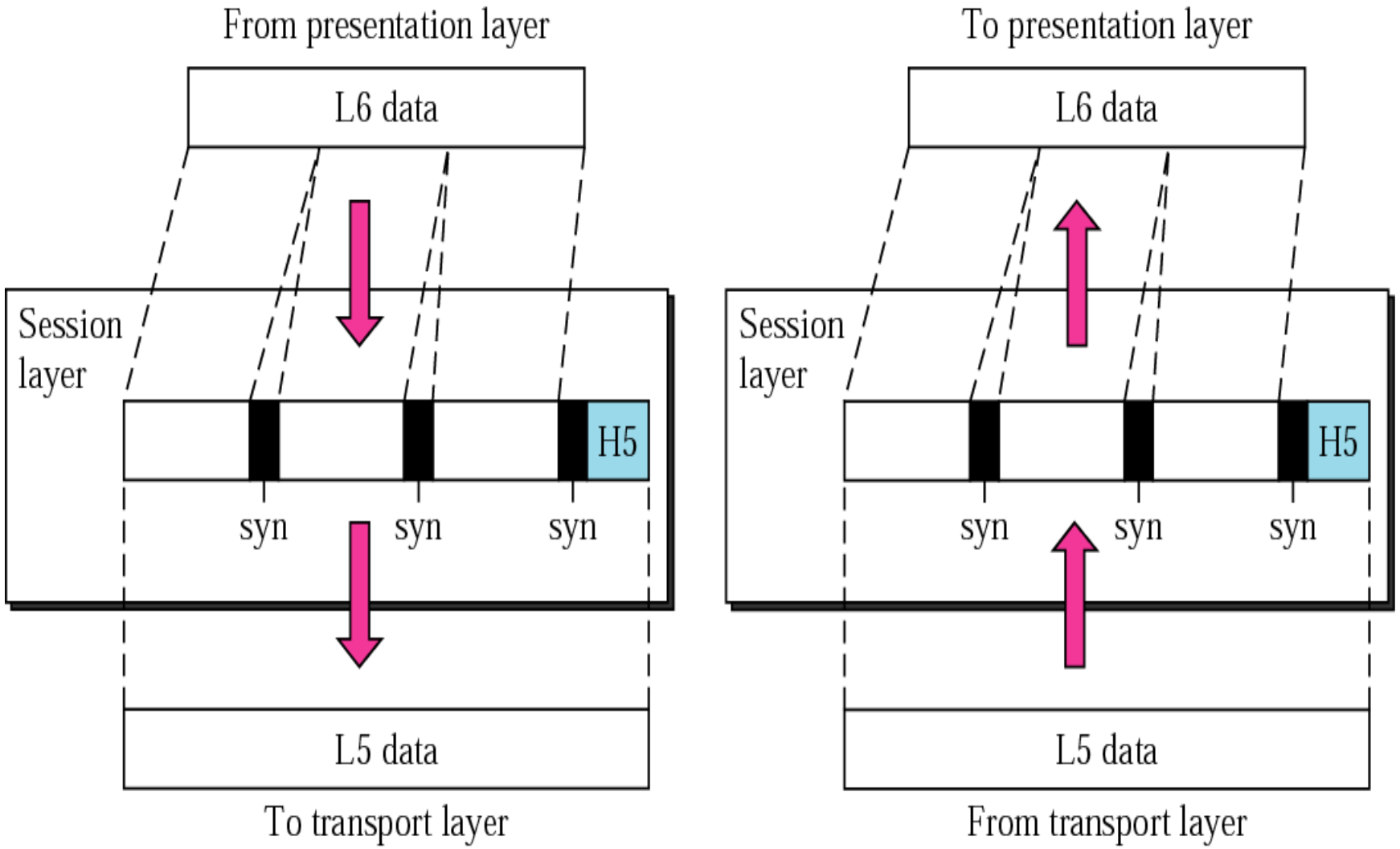
# SESSION LAYER



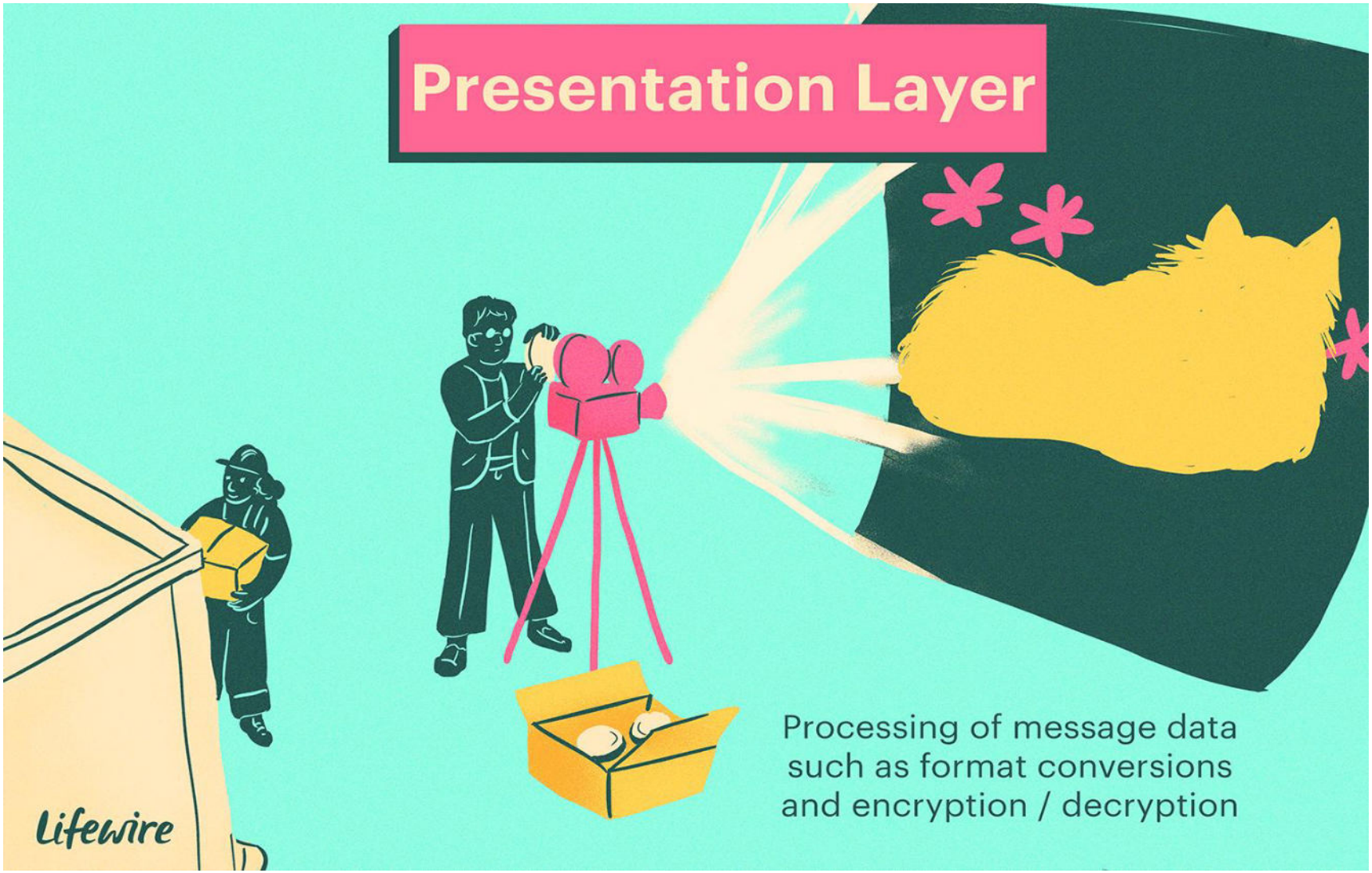
# SESSION LAYER

- **The Session layer is to establish , maintain and synchronize the interaction between two communicating nodes.**
- A connection between two ends is called a session.
- It is responsible for Remote Login Process.
- It makes sure that a session once established is closed only after the successful completion.
- **It divides a session into sub sessions for avoiding the retransmission of entire messages by adding the checkpoint feature.**
- **It decides the order in which data needs to be passed to the transport layer.**
- **It also decides which user application sends data , and at what point of time, and whether the communication is simplex, half-duplex, or full duplex.**

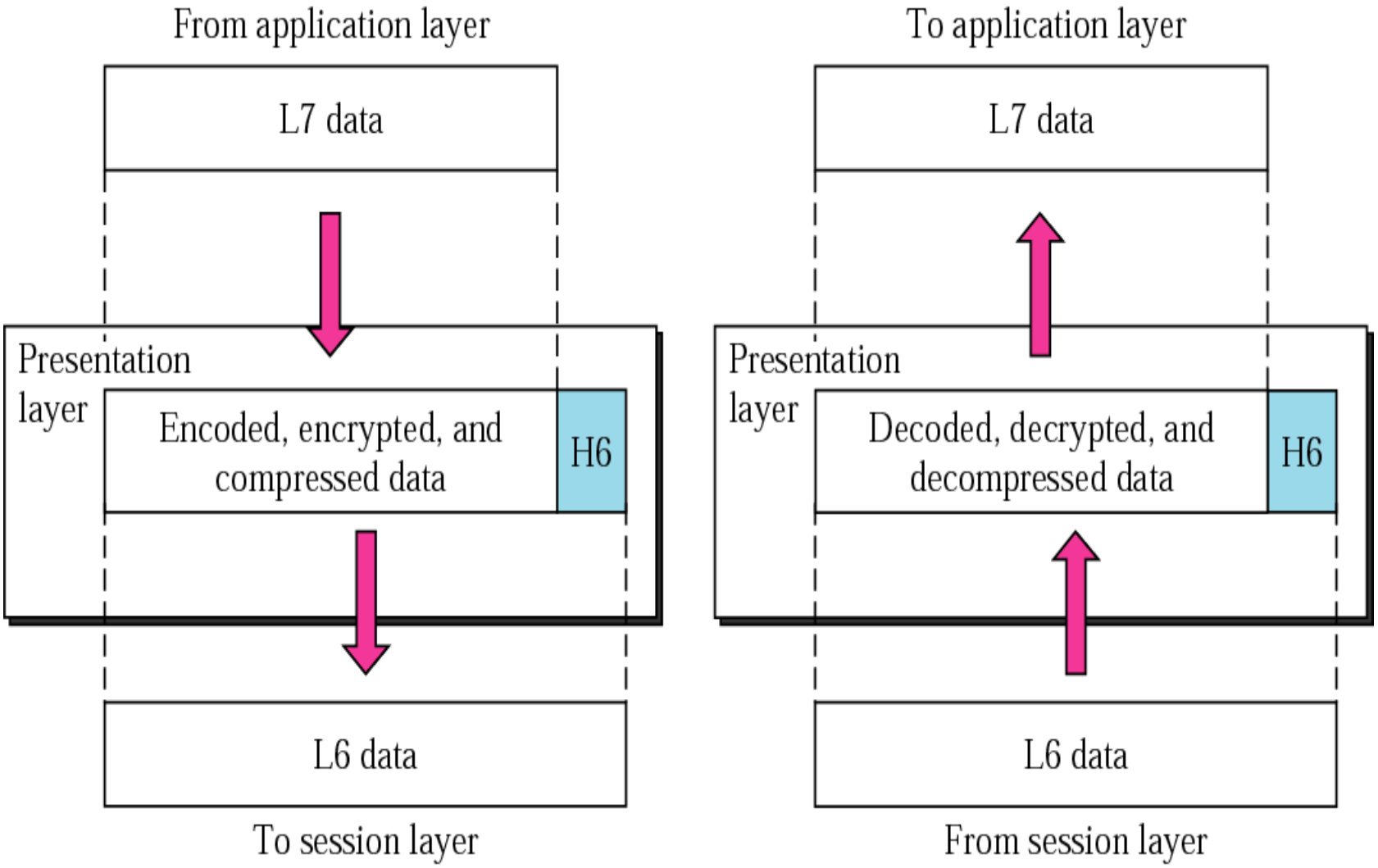
# Session Layer



# Presentation Layer



# Presentation Layer



# Presentation Layer

- The presentation layer is responsible for presenting data in the format the user can understand.
- The presentation layer can also provide security measures.
- It may encrypt data before sending it to the lower layers for transfer.
- The Presentation layer at the other end would decrypt the data after receiving it.
  - •Data encryption, security, compression and code conversion
  - •Make sure data is encoded in standard form (ASCII)
  - •Handles pass-through of services from session to application layer

# APPLICATION LAYER

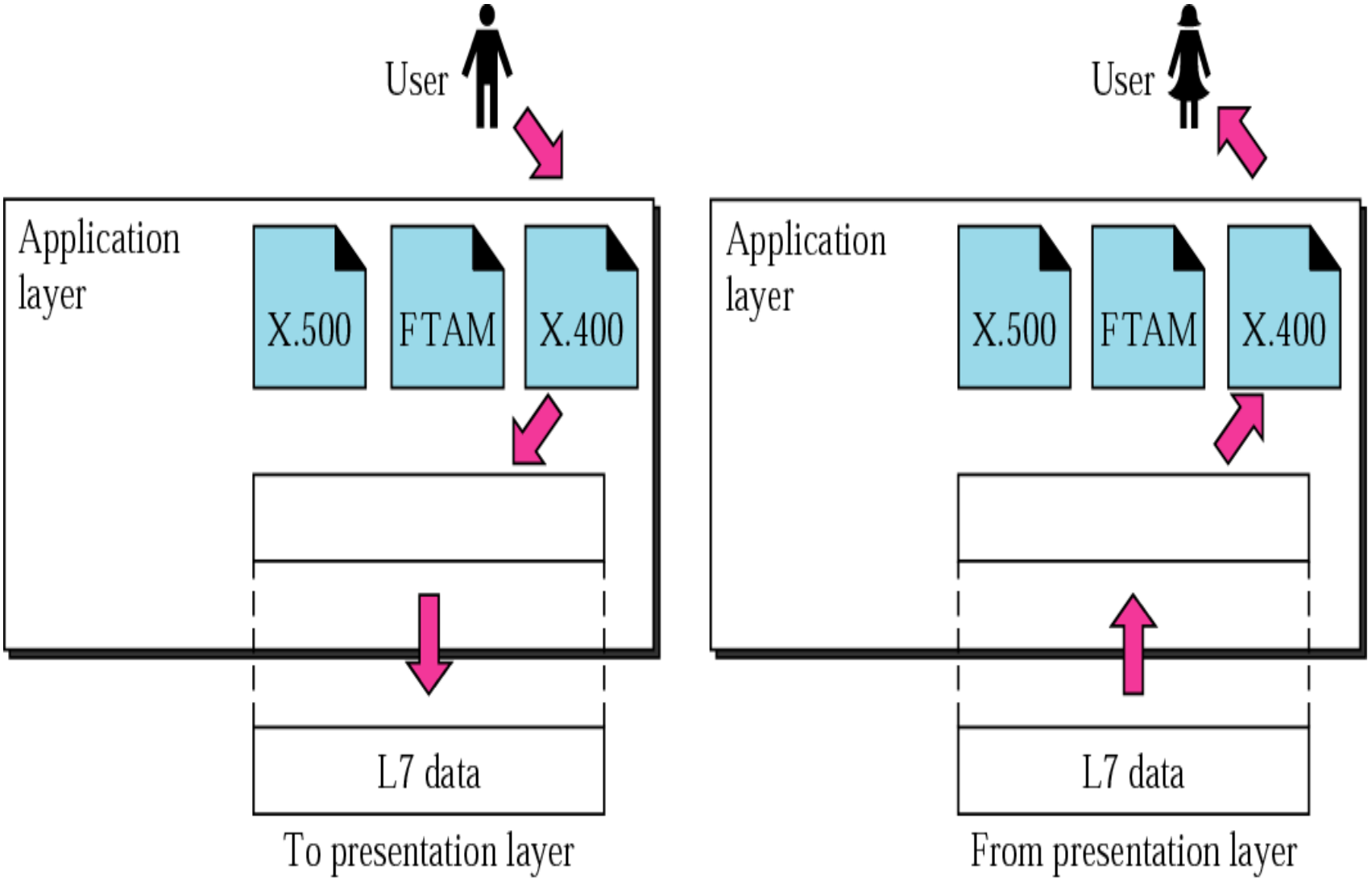
# APPLICATION LAYER

- Login, password check
- Agreement on semantics for information exchange
- File transfer, access and management
- Message handling, email
- Job transfer and manipulation
- Directory service
- System management
- Industry protocols
- Database access and management
- Virtual terminals

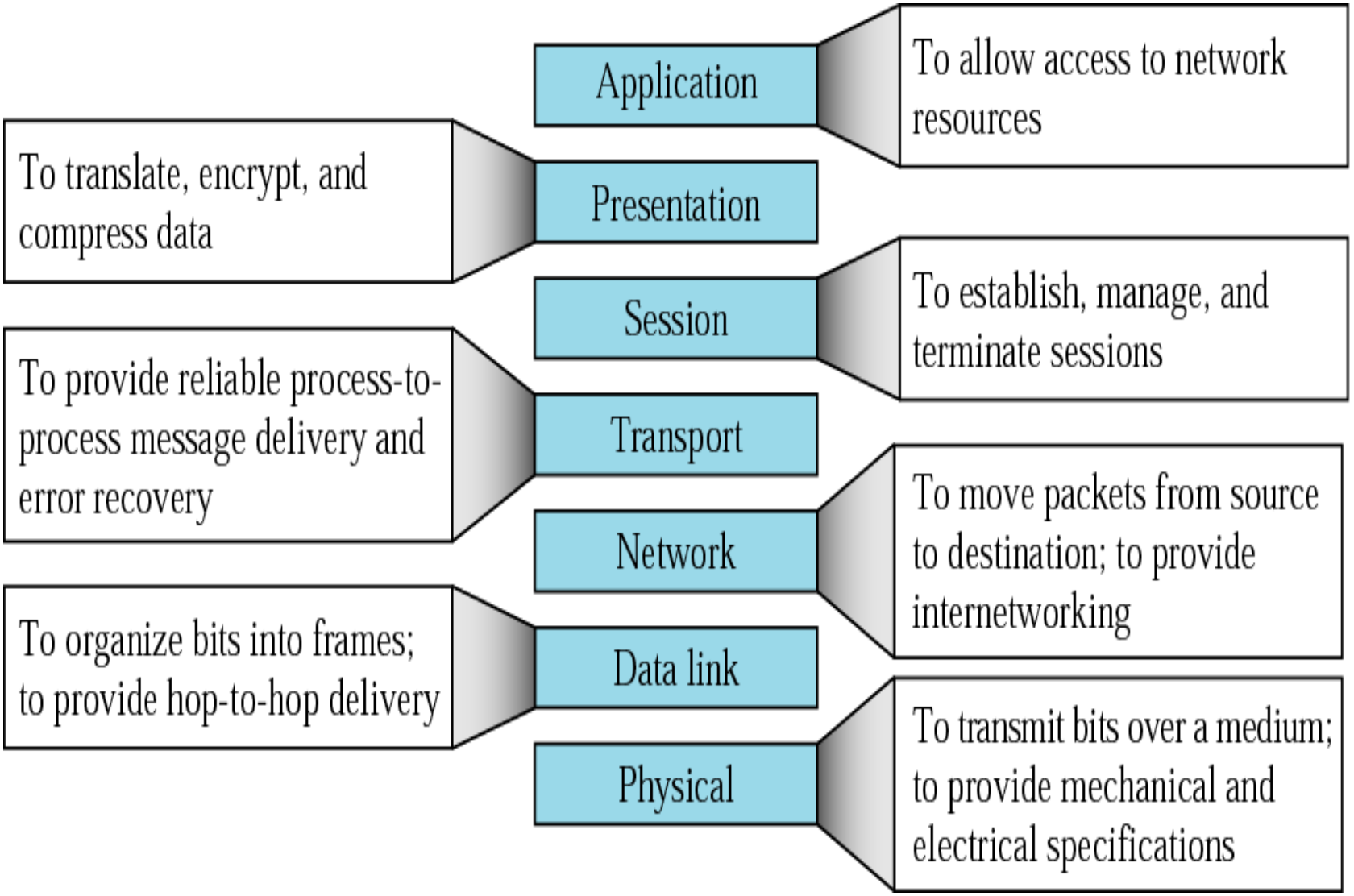
# APPLICATION LAYER – (Cont...)

- It is the topmost layer enables a user to access the network.
- This layer provides user interface for network applications such as remote login (TELNET) www, Remote File Transfer (FTP), Electronic Mail (E-Mail) and allows to access the remote data base.
- It allows a user to access, download or upload files from / to a remote host.
- It allows the user to use the mail services.
- Accessing the WebPages is also a utility of this layer.
- All the emulating software's are accessible in this layer.
- The user and the application programs interact with a physical network at this layer.
- All the user application tools available in this layer only.

# Application Layer

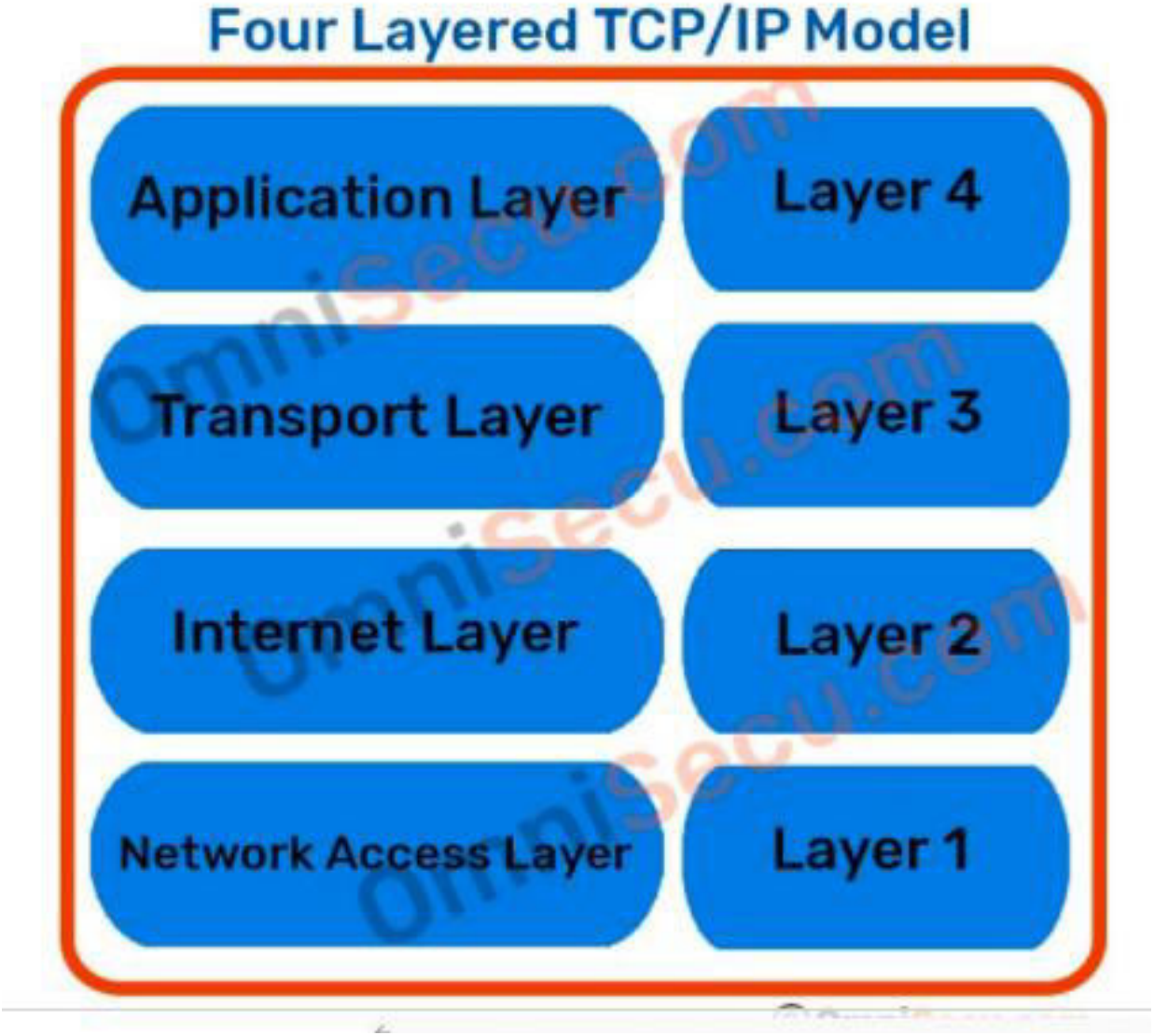


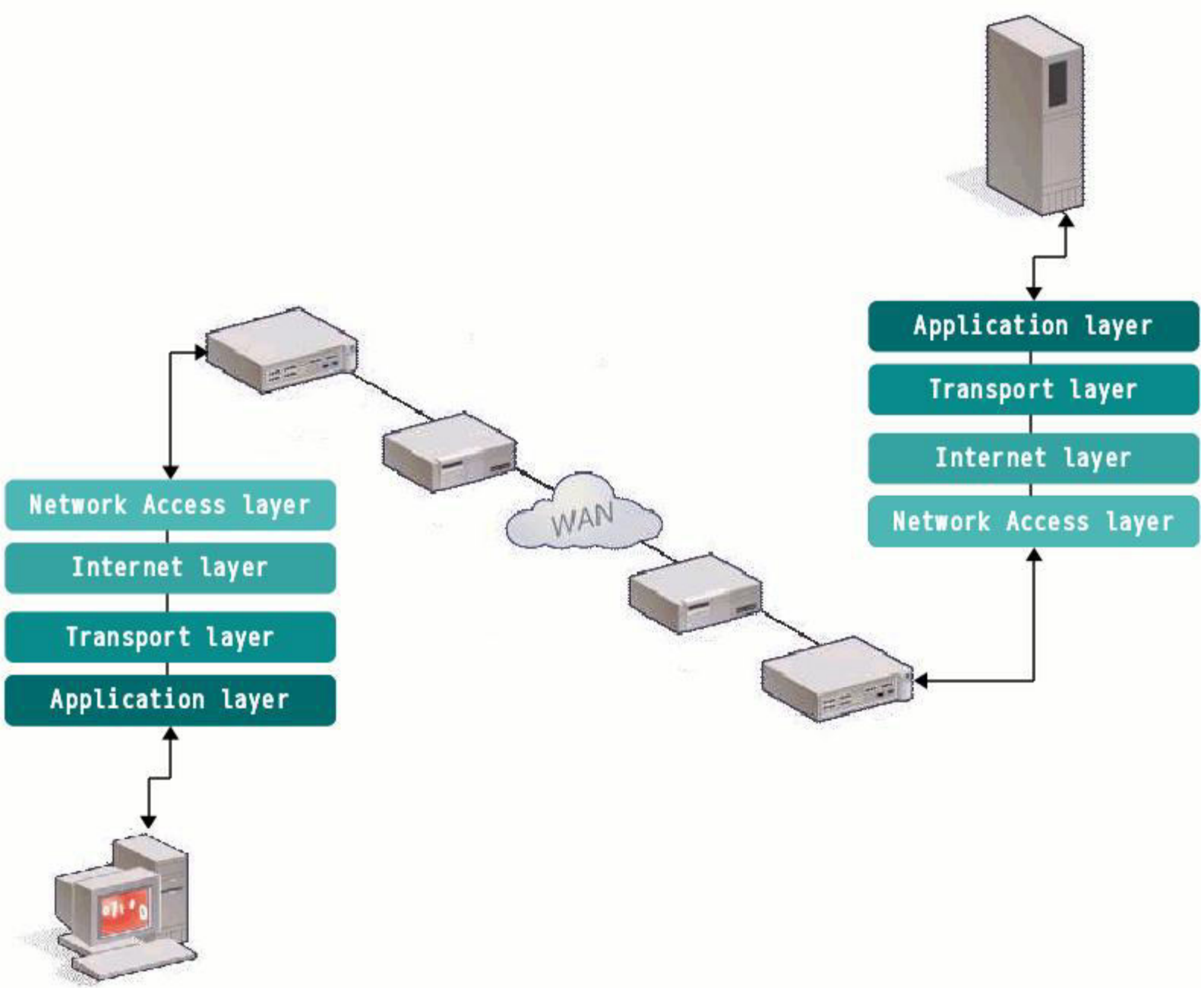
# Summary of layers



# TCP/IP Model

- The **OSI Model** was designed to describe the functions of the communication system by dividing the communication procedure into smaller and simpler components.
- TCP/IP model, it was designed and developed by Department of Defense (DoD) in 1960s and is based on standard protocols, Transmission Control Protocol/Internet Protocol.
- The **TCP/IP model** is a concise version of the OSI model. It contains four layers:
- Application Layer
- Transport Layer
- Internet Layer
- Network Access Layer

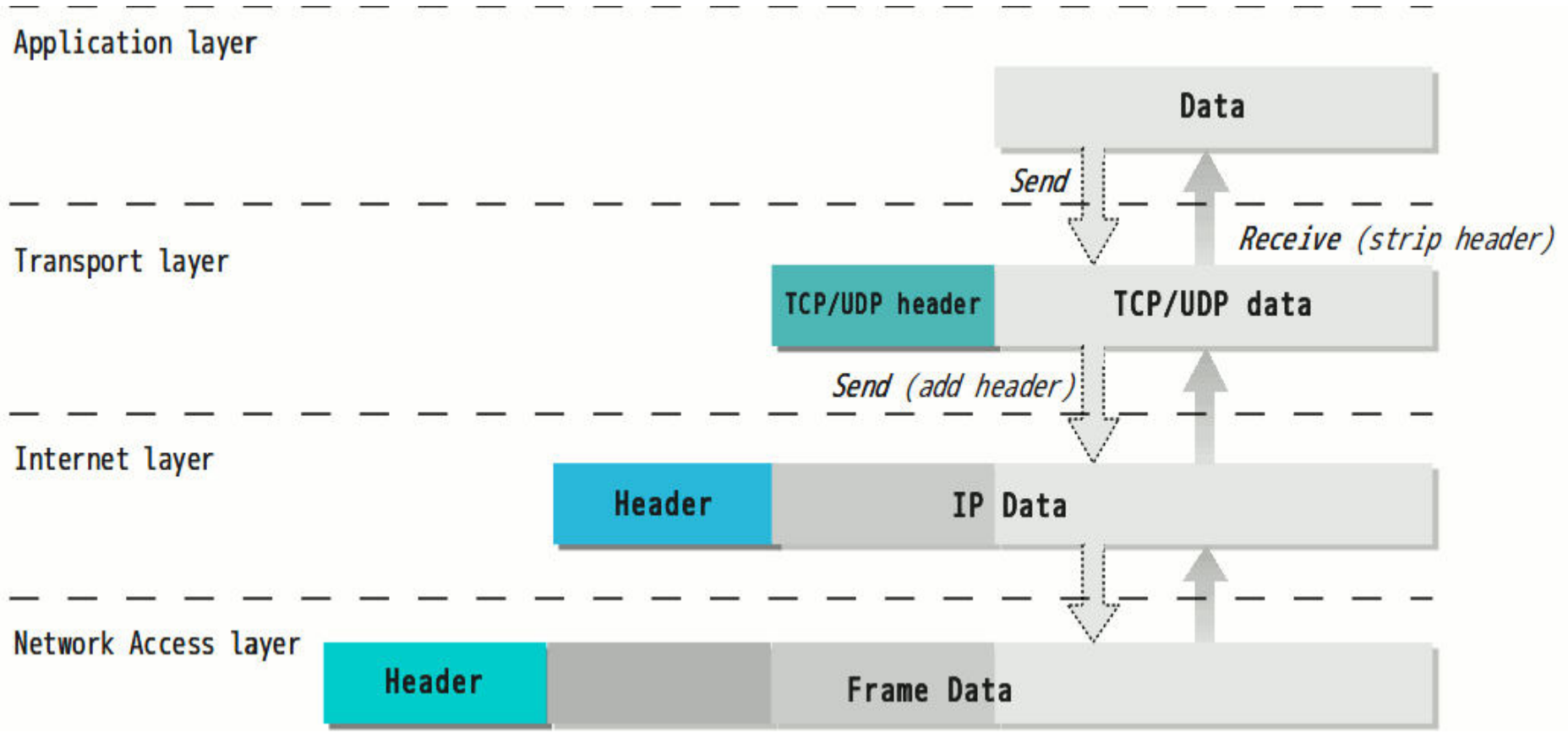

Four Layered TCP/IP Model
Application Layer
Layer 4
Transport Layer
Layer 3
Internet Layer
Layer 2
Network Access Layer
Layer 1


Application layer
Transport layer
Internet layer
Network Access layer
WAN
Network Access layer
Internet layer
Transport layer
Application layer

# Application layer

- This layer contains all application protocols that use the Transport layer.
- Application protocols include FTP, HTTP, DNS, NFS, SMTP, Telnet
- To send data, the application calls up a Transport layer protocol, such as TCP.

# Transport Layer



# Transport layer

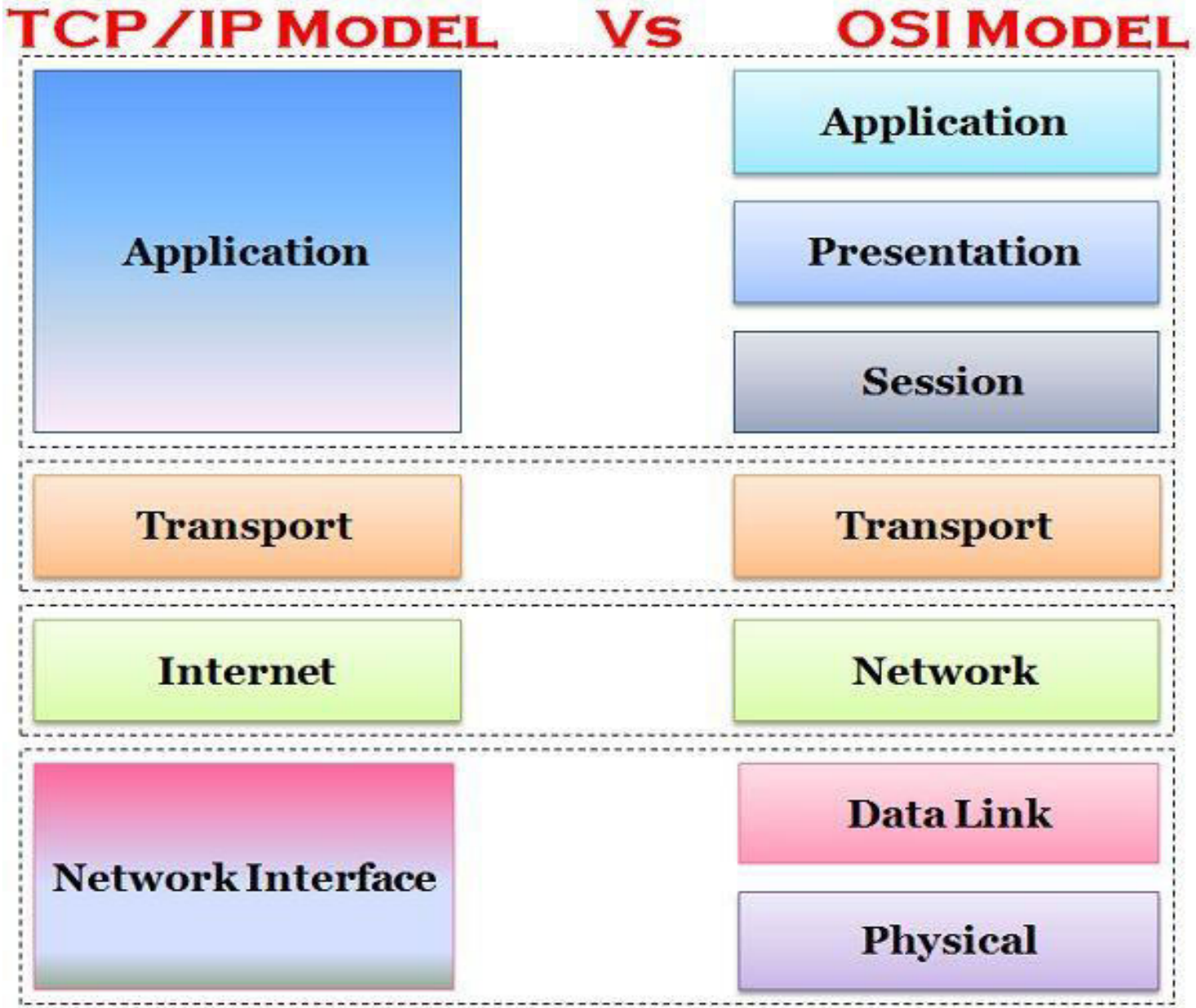
- TCP and UDP are the most important protocols in this layer, delivering data between application and internet layers.
- TCP provides reliable data delivery service with error detection and error correction. UPD provides a connectionless delivery service.
- When called by an application, TCP wraps the data into a TCP packet (also called TCP segment). contains a TCP header followed by the application data
- TCP then hands the packet to IP.
- TCP keeps track of what data belongs to what process.

# Internet layer

- This is above the Network Access layer, and it provides the packet delivery service on which TCP/IP networks are built.
- It provides a routing mechanism allowing for packets to be transmitted across one or more different networks.
- The Internet Protocol (IP) runs in this layer and provides a way to transport datagrams across the network.
- It is a connectionless protocol and does not provide error control, relying on protocols in the other layers to provide error detection and recovery.

# Network access layer

- Protocols in this layer are designed to move packets (IP datagrams) between the internet layer interface of two different hosts on the same physical link
- Network Interface:
  - Each networking device has a corresponding interface in the kernel
  - Ethernet interfaces: eth0, eth1
  - PPP interfaces: ppp0, ppp1 (Point-to-Point Protocol)
  - FDDI interfaces: fddi0, fddi1 (Fiber Distributed Data **Interface**)


TCP/IP MODEL
Vs
OSI MODEL
Application
Transport
Internet
Network Interface
Application
Presentation
Session
Transport
Network
Data Link
Physical

# 2.3 TCP/IP Protocol Suite

*The **TCP/IP protocol suite** is made of five layers: physical, data link, network, transport, and application. The first four layers provide physical standards, network interface, internetworking, and transport functions that correspond to the first four layers of the OSI model. The three topmost layers in the OSI model, however, are represented in TCP/IP by a single layer called the application layer.*

***The topics discussed in this section include:***

*Physical and Data Link Layers*
*Network Layer*
*Transport Layer*
*Application Layer*

Figure 2.20 *Port addresses*