វិទ្យាស្ថានបច្ចេកវិទ្យាកម្ពុជា
INSTITUTE OF TECHNOLOGY OF CAMBODIA

Department of Information and Communication Engineering

# DATA COMMUNICATIONS & NETWORK MODELS

TEL-L01

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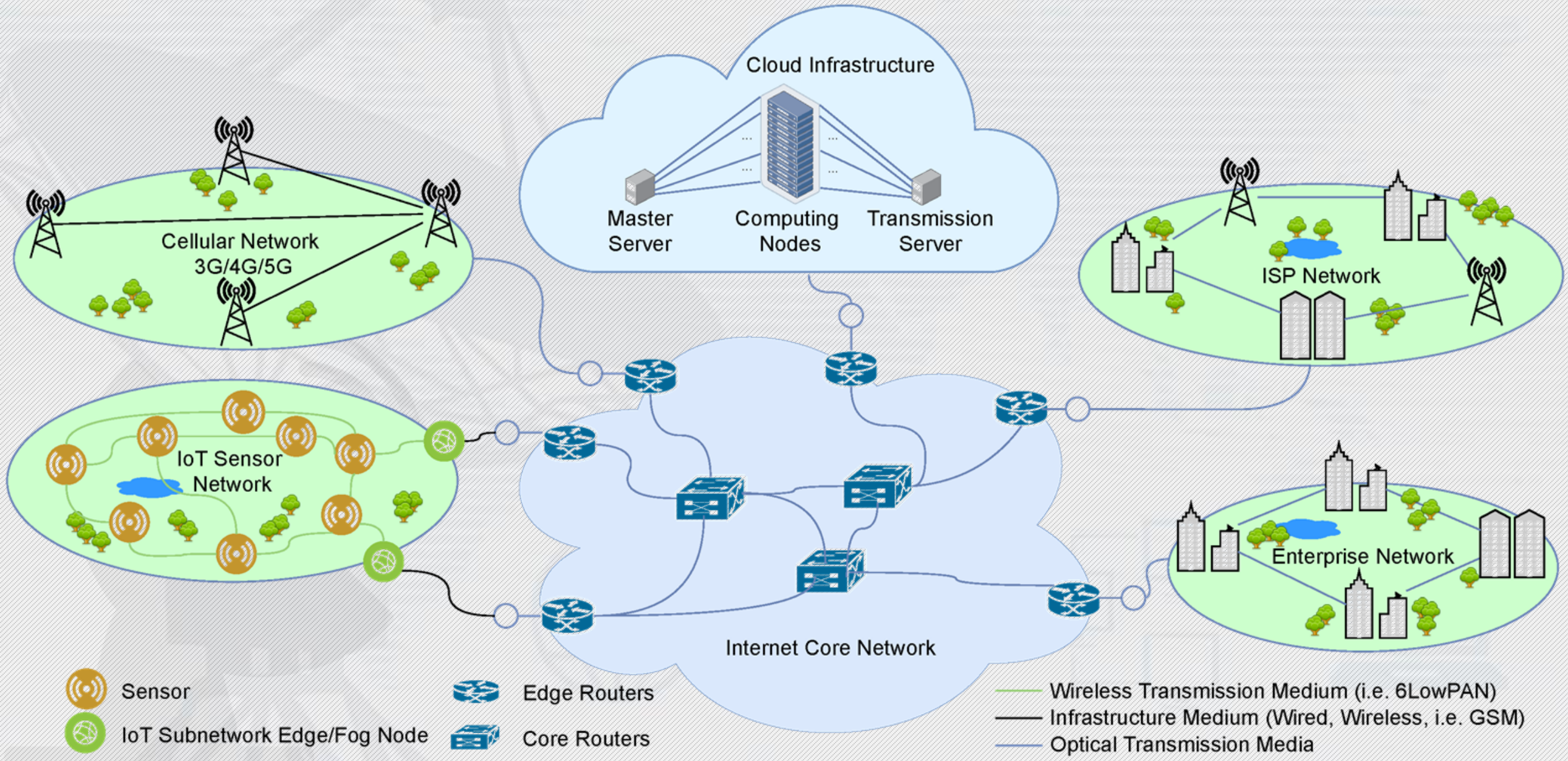
# TELECOMMUNICATION





# LEARNING MAP

# LEARNING OBJECTIVES

- Discuss some general ideas related to both data communications and networking.
- Then, defines the components and types of data exchanged in different types of networks.
- Introduces network and defines their criteria and structure, include network topologies.
- Introduces the concept of protocol layering by using two scenarios.
- Discusses the five layers of the TCP/IP protocol suite and gives a brief discussion of OSI model.

# LECTURE CONTENTS




1 INTRODUCTION TO DATA COMMS

2 NETWORK TYPES AND MODELS

3 PROTOCOL LAYERING

4 TCP/IP PROTOCOL SUITE

5 THE OSI MODELS

6 SUMMARY & HOMEWROK

**The effectiveness of a data communications system depend on four fundamental characteristics:**

**1. Delivery**

The system must deliver data to the correct destination and data must be received by the intended device or user and only by that devices or user.

**2. Accuracy**

The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

**3. Timeliness**

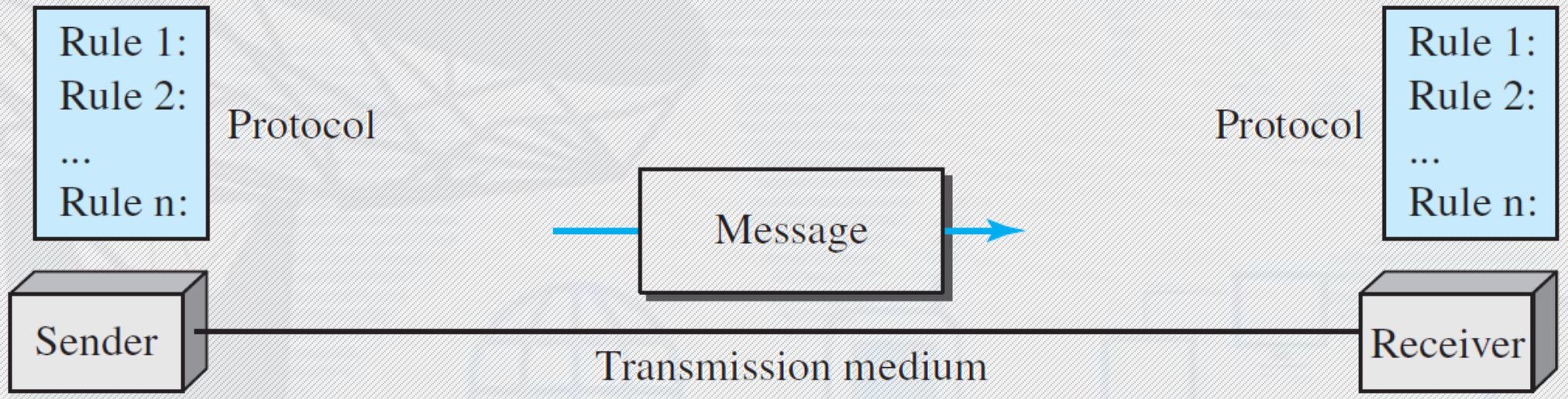
The system must deliver data in a timely manner, delivered late are useless. In the case of timely delivery means delivering data as they are produced and without significant delay, called real-time transmission.

**4. Jitter**

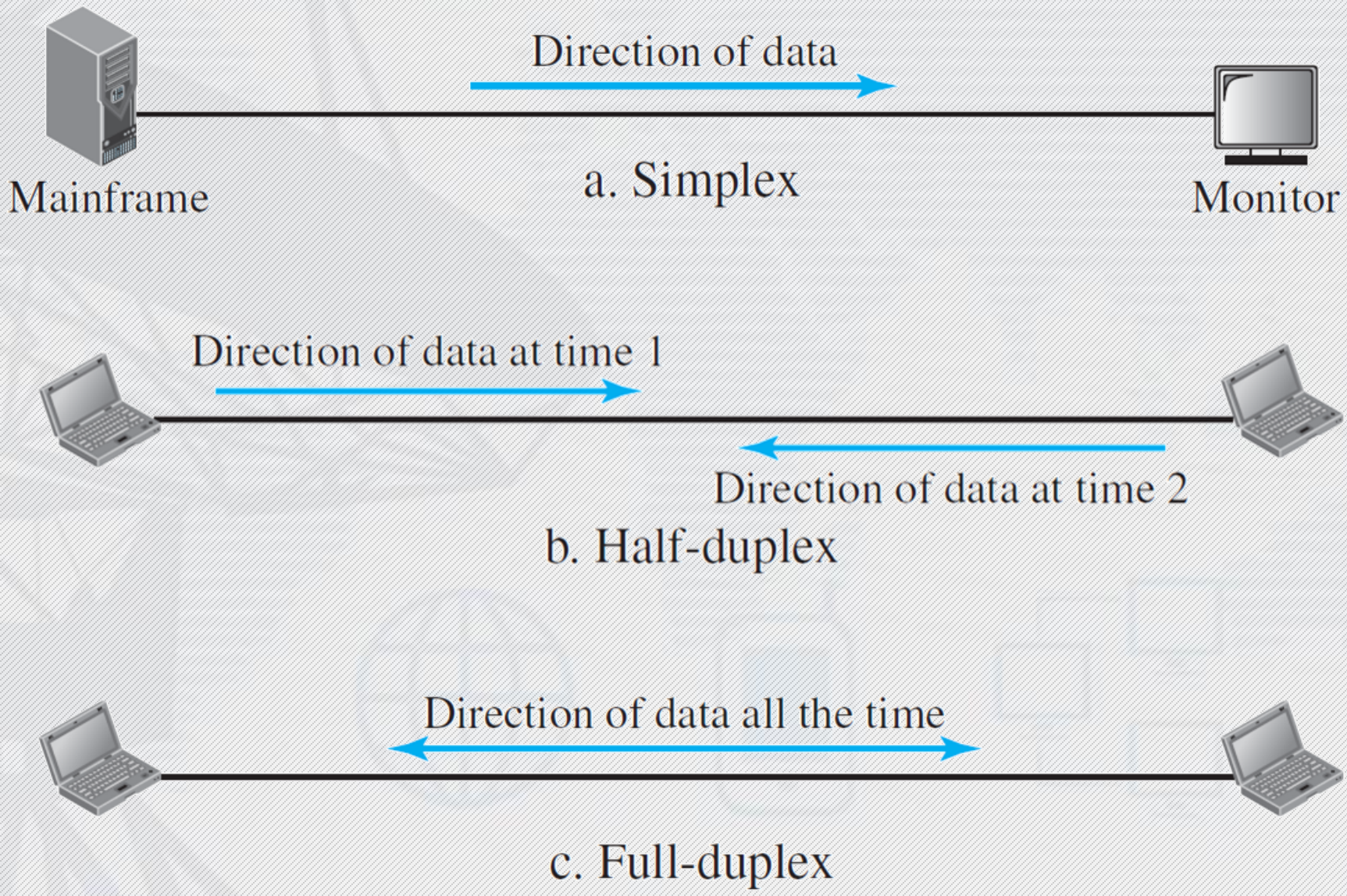
Refers to the variation in the packet arrival time. In the case of audio or video packets, it is the uneven delay in the delivery.

## Components

- A data communications system has five components: **Message**, **Sender**, **Receiver**, **Transmission Medium**, and **Protocol**.

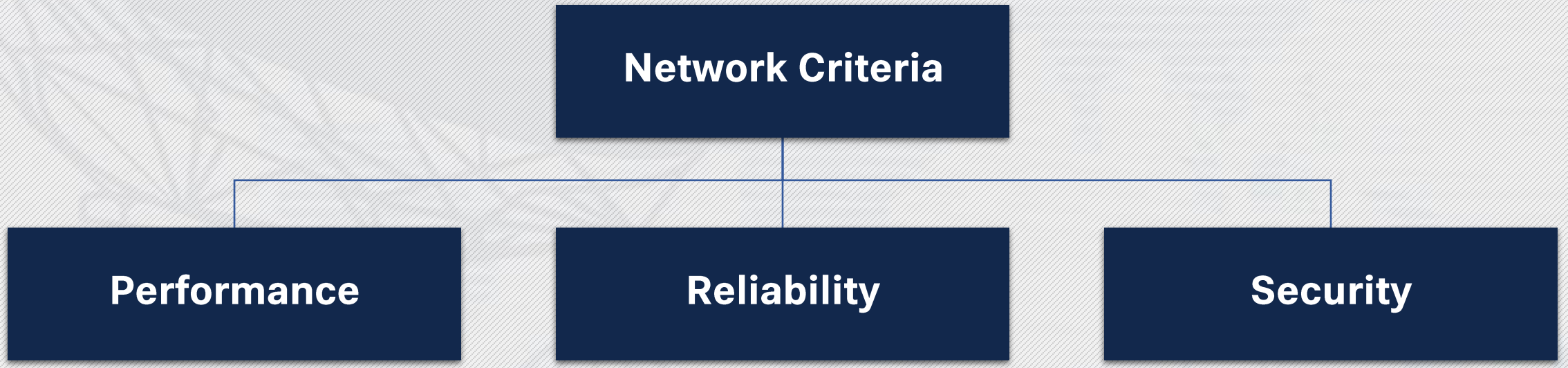


## Data Flow


Direction of data
Mainframe
Monitor
a. Simplex
Direction of data at time 1
Direction of data at time 2
b. Half-duplex
Direction of data all the time
c. Full-duplex

# 2. NETWORK TYPES AND MODELS

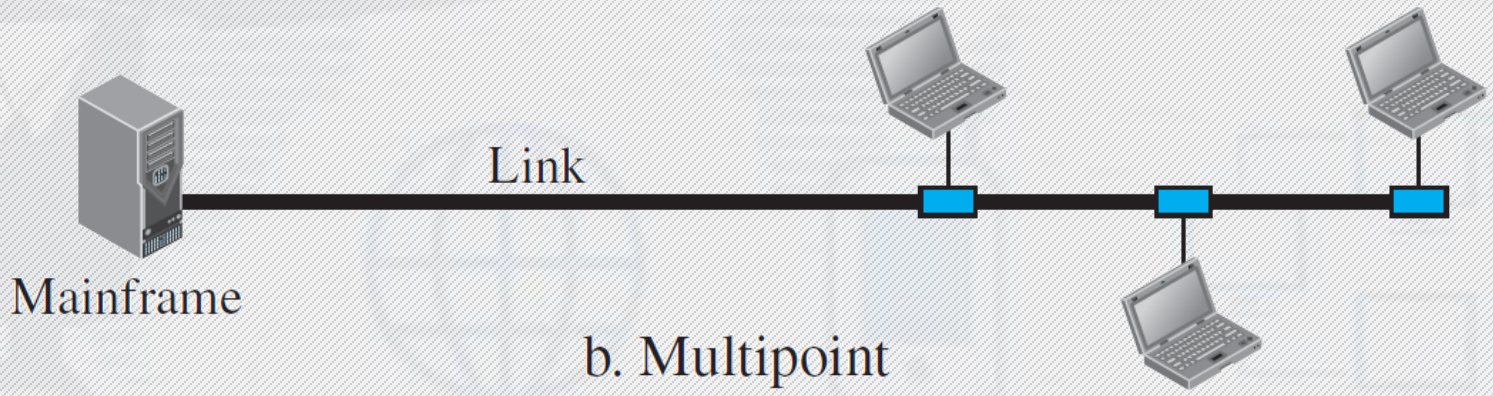
- A network is the interconnection of a set of devices capable of communication, a device can be a host (or an end system) and can also be a connecting device.



## Physical Structures

- There are two possible types of connections in a network: **Point-to-Point connection** and **Multipoint connection**.

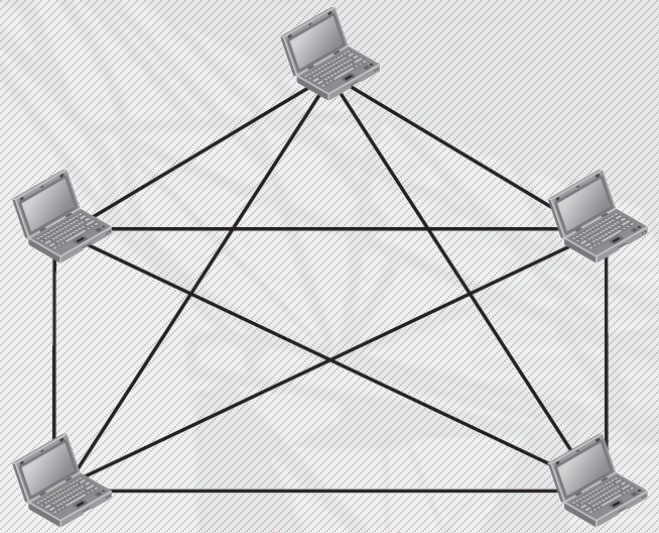
a. Point-to-point




b. Multipoint

## Network Topologies

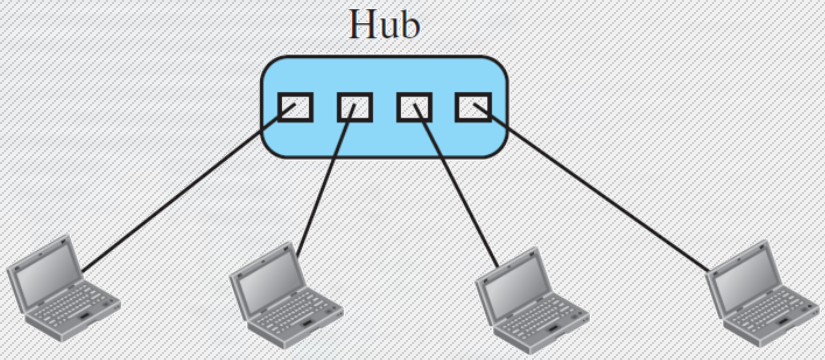
- The topology of a network is the geometric representation of the relationship of all the links and linking devices to one another.



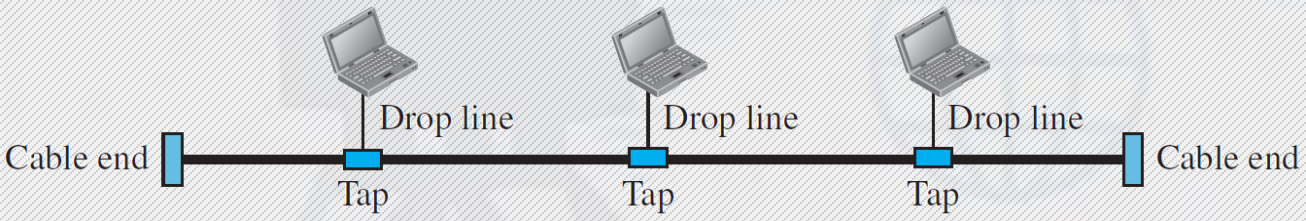
Mesh Topology

*Number of physical links in a fully mesh network with n nodes:*

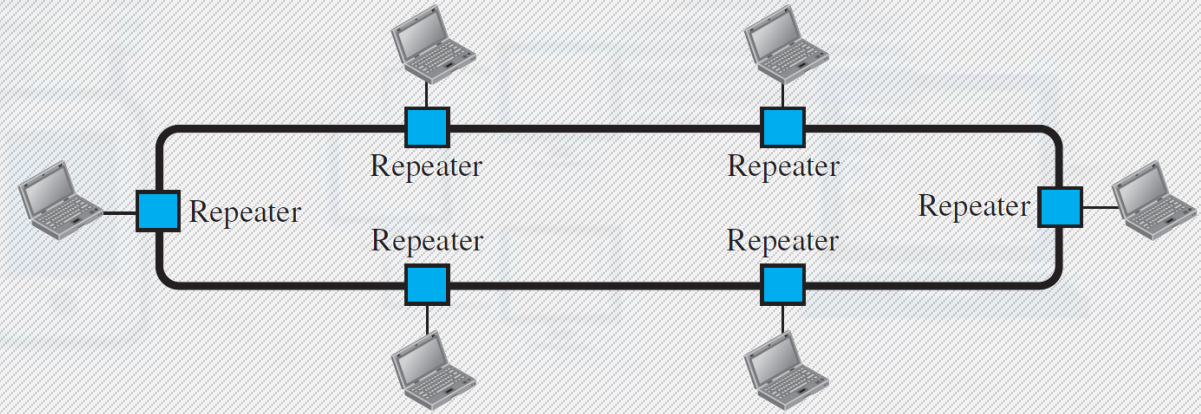
$$\frac{n(n-1)}{2}$$




Star Topology




Bus Topology



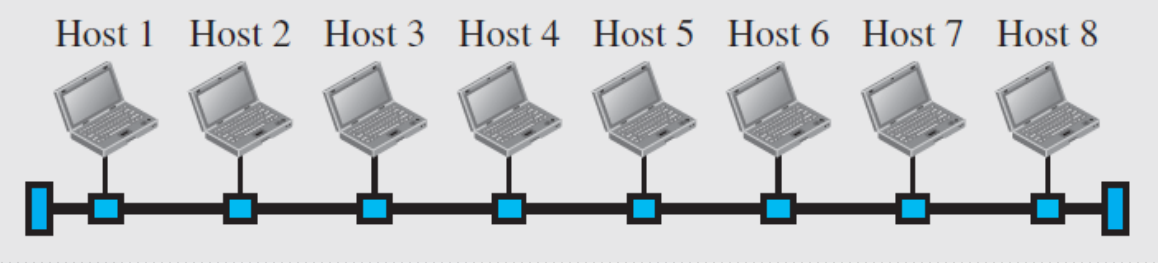

Ring Topology

## Network Types (LAN)

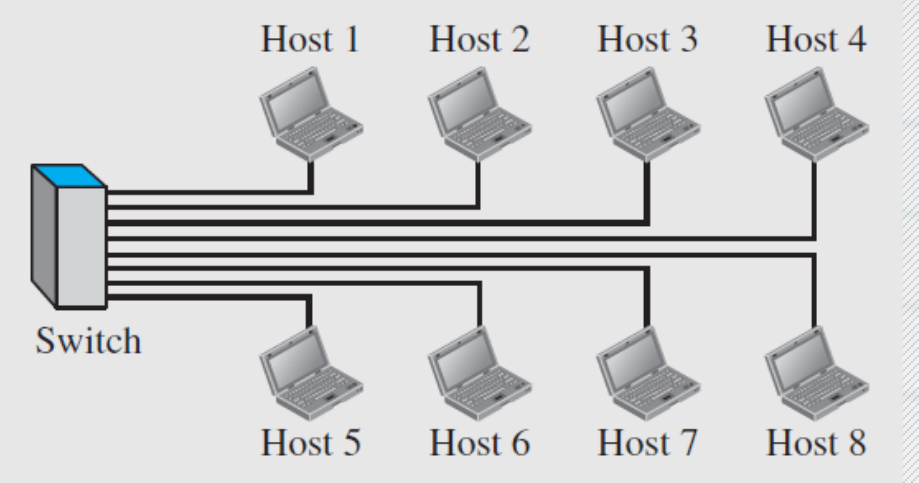
- LAN is usually privately owned and connects some hosts in a single office, building, or campus. A packet sent by a host to another host carries both source and destination host's addresses.

a) A packet sent from one host to another was received by all hosts.

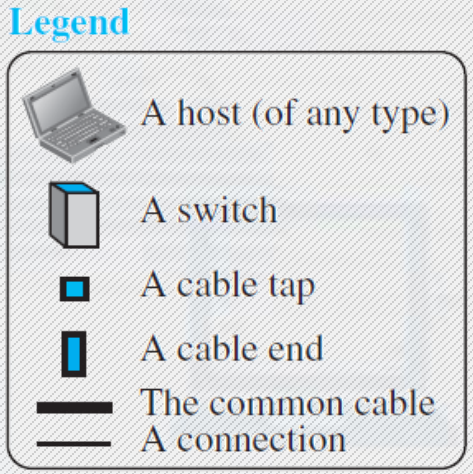
b) Recognize the destination address and guide to its destination without sending it to all other hosts.




a. LAN with a common cable (past)

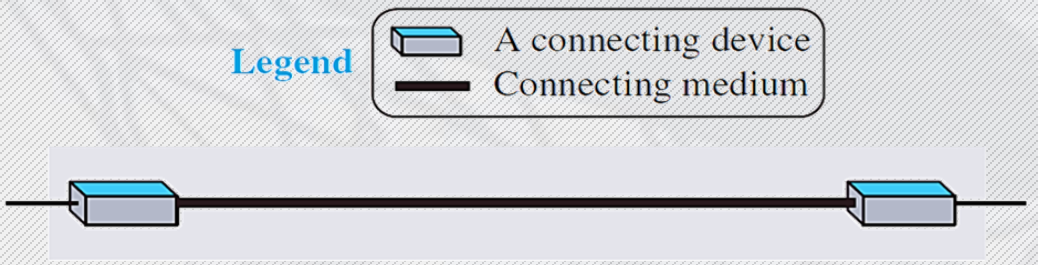



b. LAN with a switch (today)

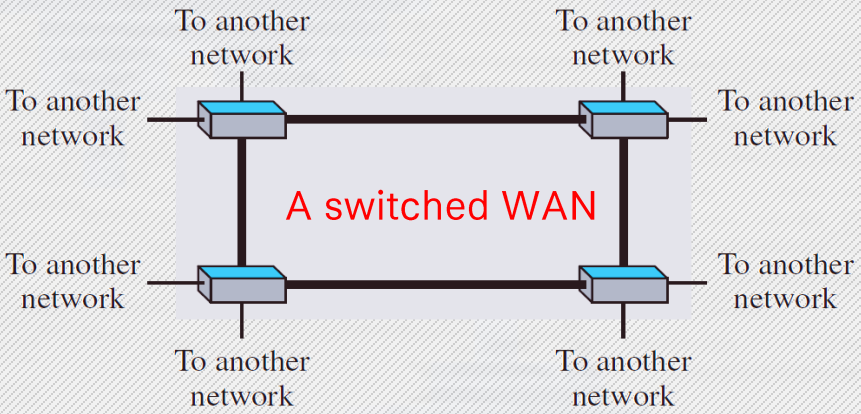


## Network Types (WAN)

- WAN is also an interconnection of devices capable of communication; which has a wider geographical span, spanning a town, a state, a country, or even the world. A WAN interconnects connecting devices such as **switches**, **routers**, or **modems**.

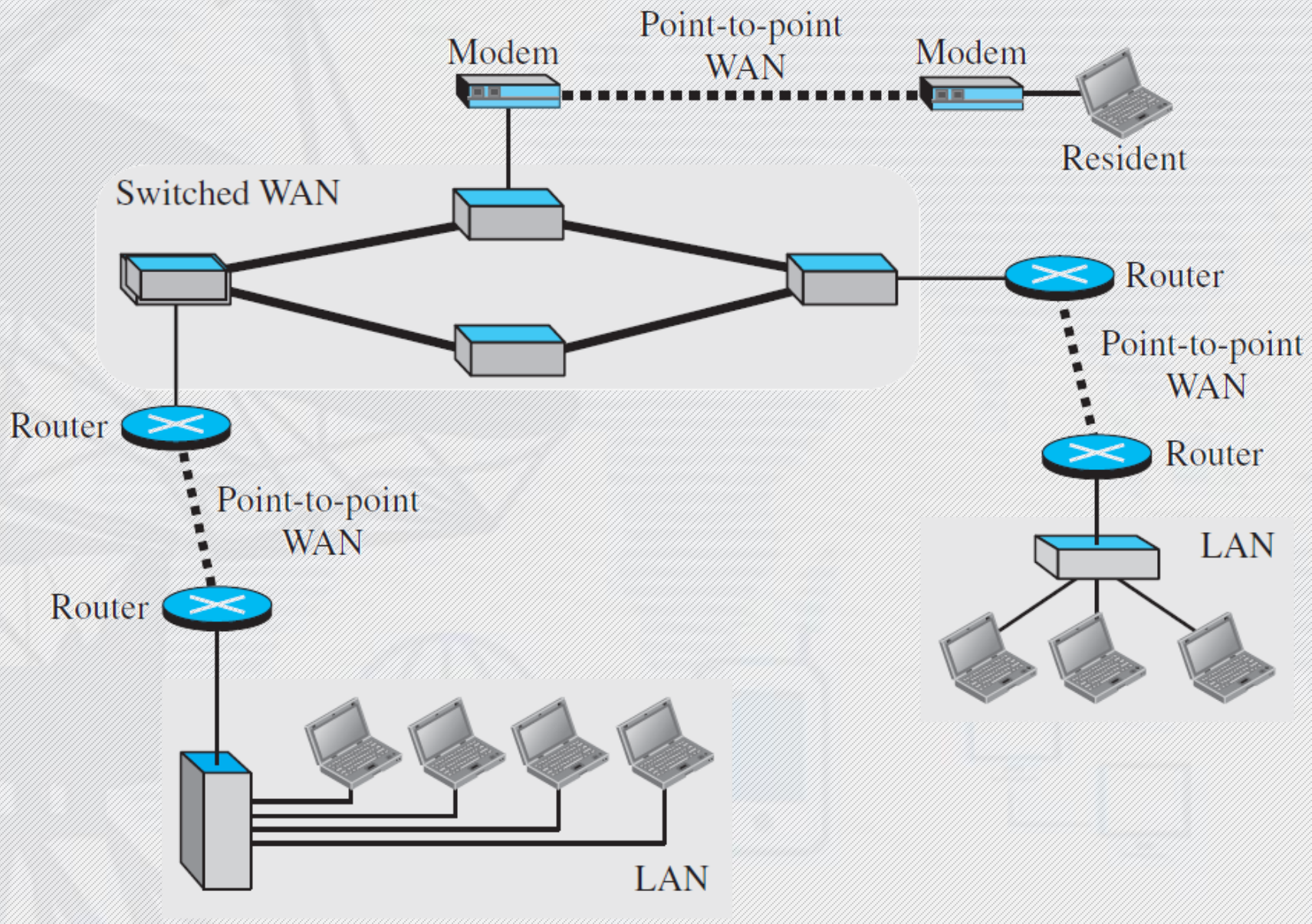



A point-to-point WAN



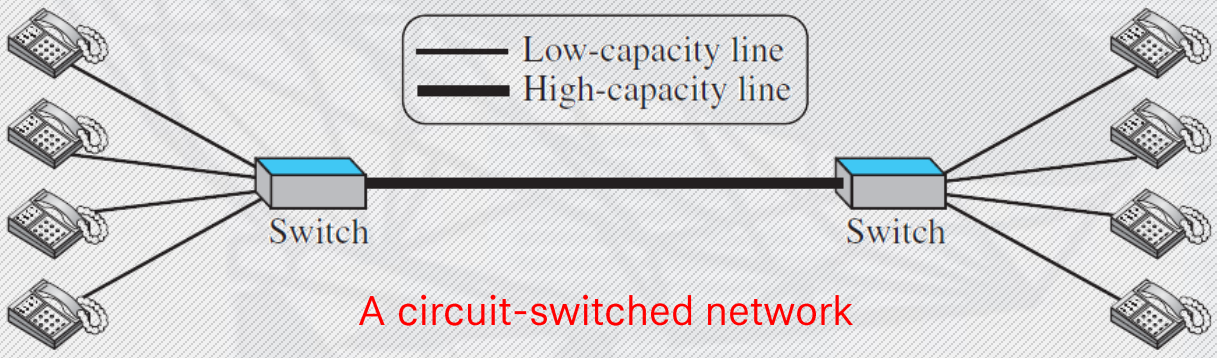
An internetwork

# 2. NETWORK TYPES AND MODELS

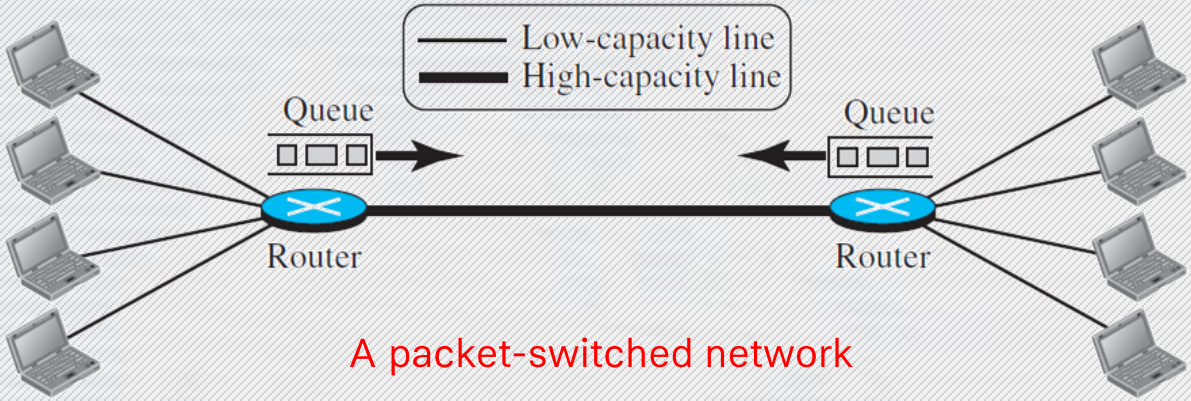


## Switching

- An internet is a switched network in which a switch connects at least two links together; where a switch needs to forward data from a network to another network when required.




A circuit-switched network




A packet-switched network

- Always available between the two end systems; the switch can only make it active or inactive.
- Efficient only when it is working at its full capacity; most of the time, and inefficient when it is working at partial capacity.

- Make the switches function for both storing and forwarding.
- There is no waiting for twice capacity. But, when it's working at its full capacity, the packets should be stored and forwarded in order they arrived.

- A protocol defines the rules that both sender and receiver and all intermediate devices need to follow to be able to communicate effectively.

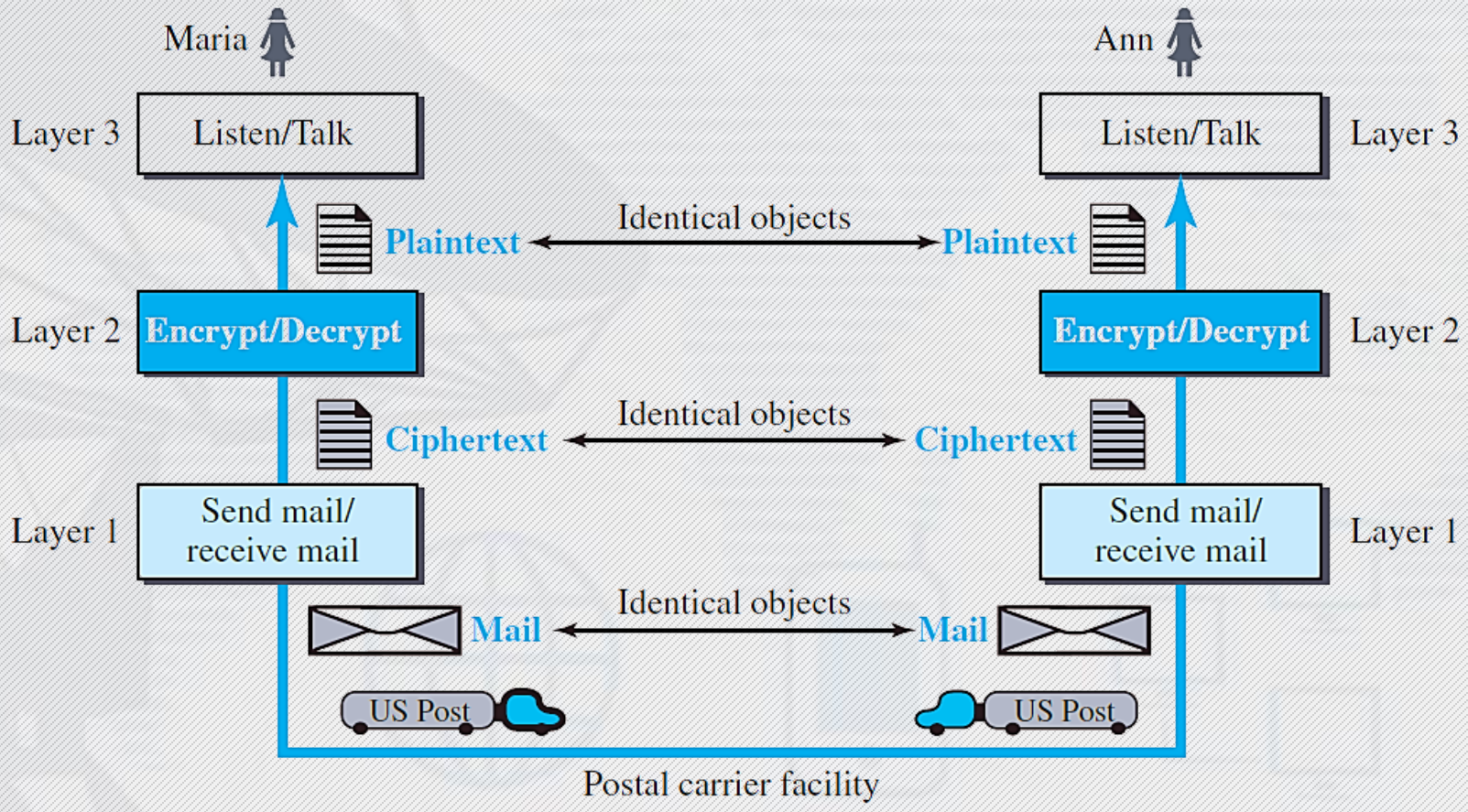
## First Scenario

- This communication scenario is so simple and occur in only one layer, or face to face communication.

A single-layer protocol

## Second Scenario

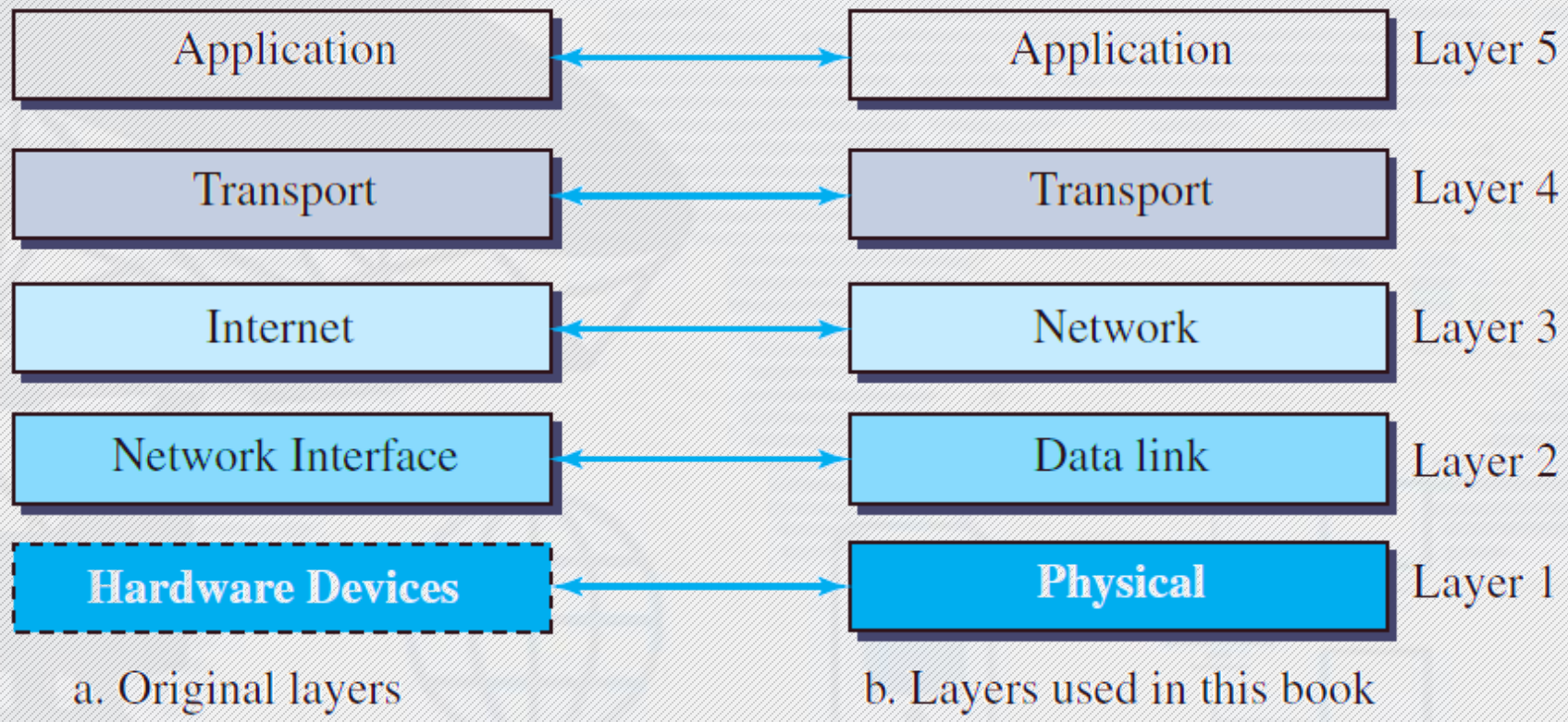
➢ This communication scenario is offered a higher-level position and occur at three layers.




A three-layer protocol

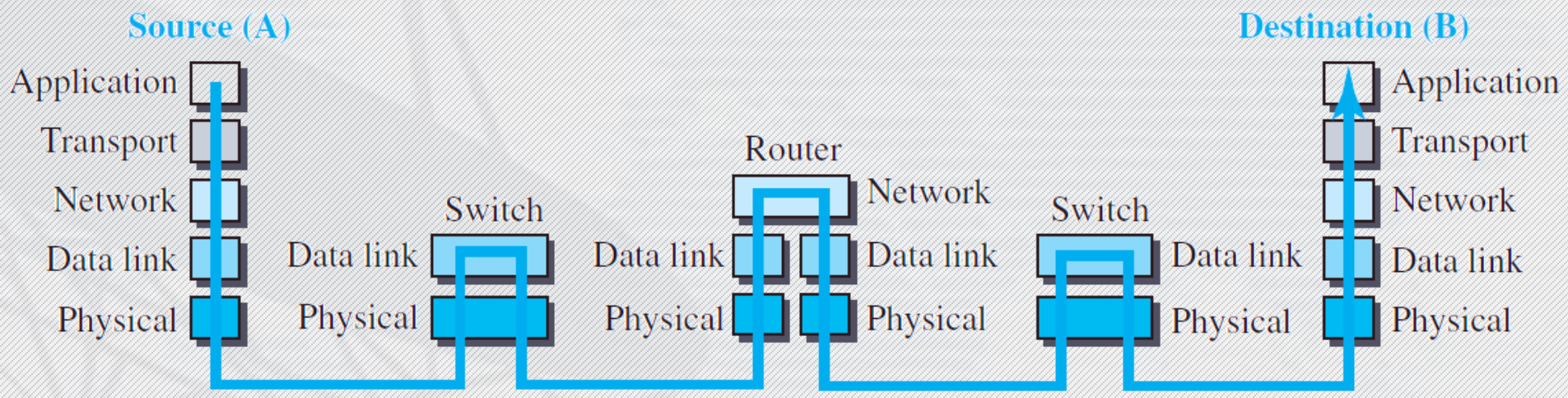
# 4. TCP/IP PROTOCOL SUITE

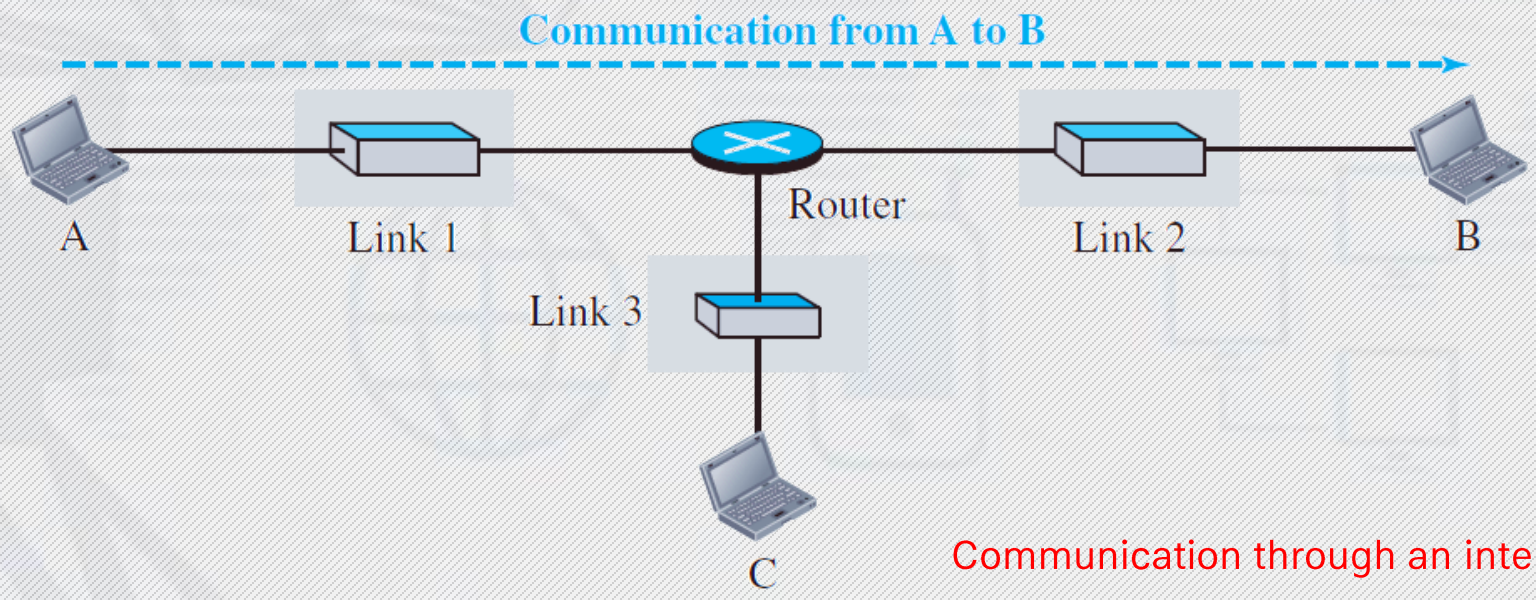
- TCP/IP is a protocol suite organized in different layers and used in the internet today; its hierarchical protocol made up of interactive modules; which provide a specific functionality.




Layer in the TCP/IP protocol suite

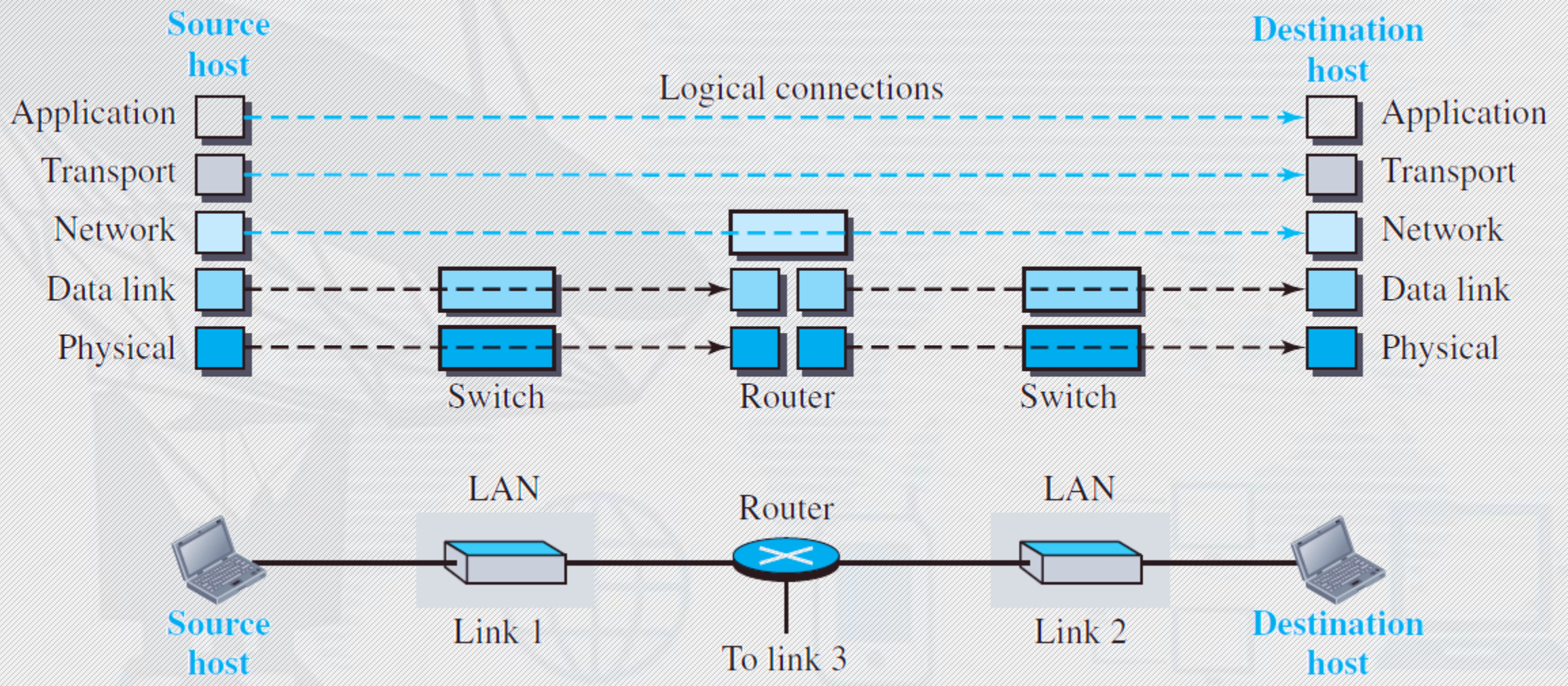
## Layered Architecture



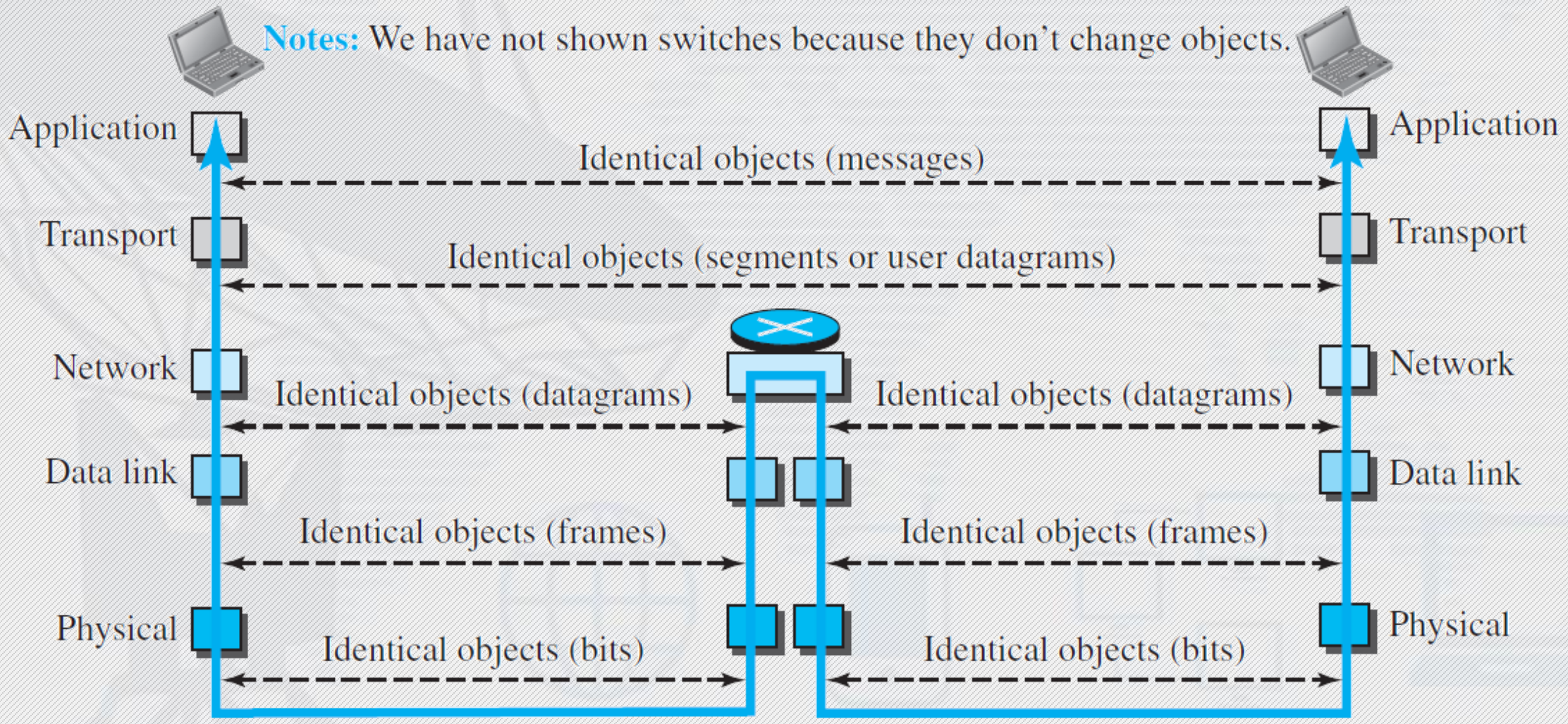

Communication through an internet

## Layers in the TCP/IP Protocol Suite




Logical connections between layers of the TCP/IP protocol suite

## Layers in the TCP/IP Protocol Suite




Identical objects in the TCP/IP protocol suite

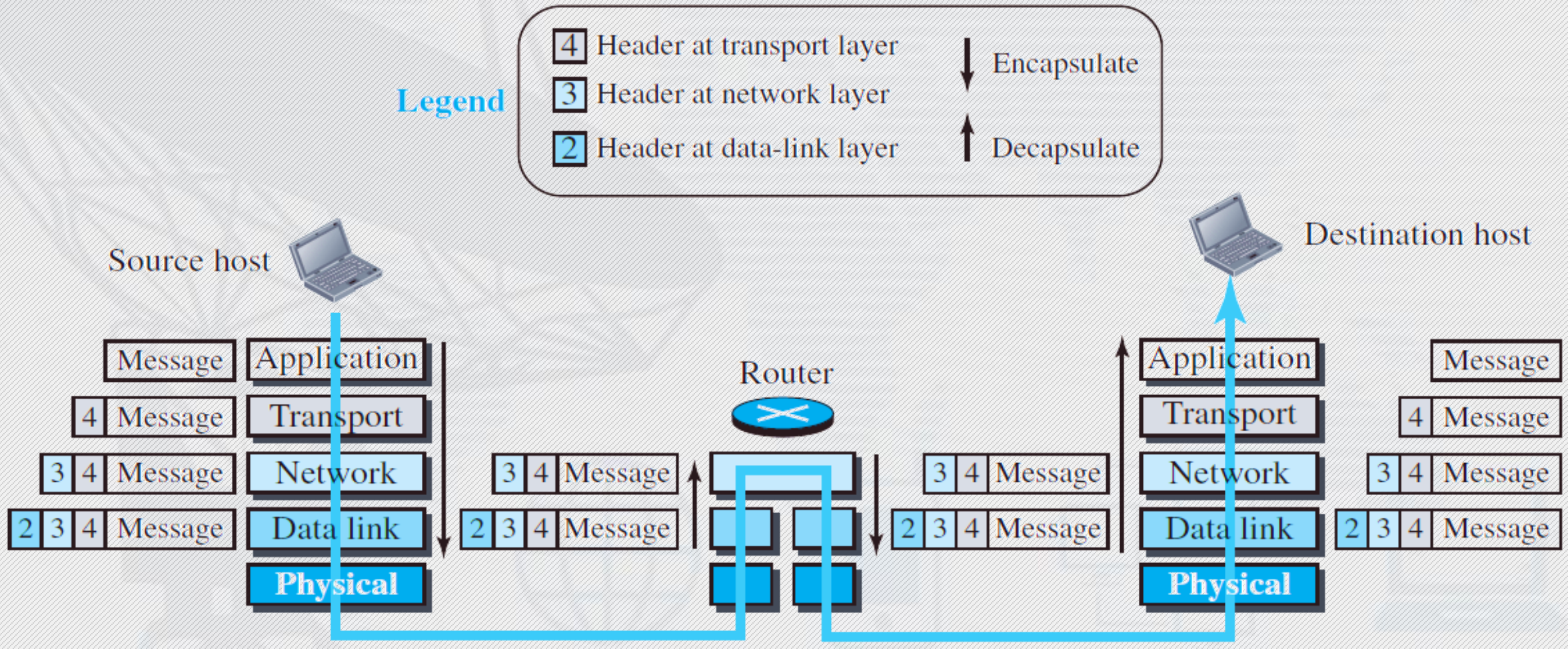
## Description of Each Layer

- **Physical Layer** is responsible for carrying individual bits in a frame across the link; there is another hidden layer and transmission media under the physical layer; where the bits received in a frame from the data-link layer are transformed and sent through the transmission media.
- **Data-Link Layer** is responsible for taking the datagram and moving it across the link; where the link can be a wired LAN, a wireless LAN, a wired WAN, or a wireless WAN. The data-link layer takes a datagram and encapsulates it in a packet called a *frame*.
- **Network Layer** is responsible for creating a connection between the source computer and the destination computer or host-to-host communication. It defines the format of the packet, called a datagram at the network layer and routing a packet from it source to its destination, which is achieved by each router forwarding the datagram to the next router in its path.

## Description of Each Layer

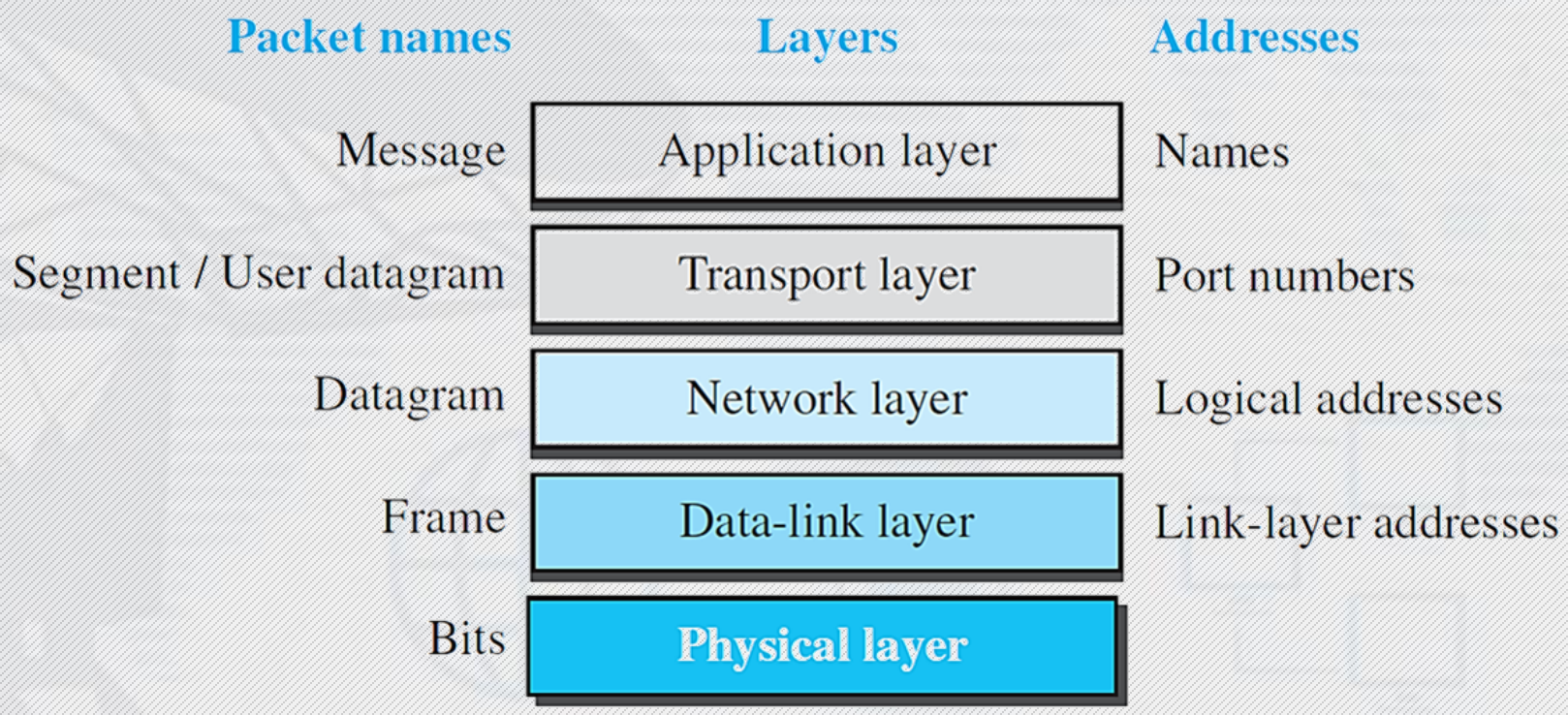
- **Transport Layer** is responsible for giving the services to the application layer; to get a message from an application program running on the source host and deliver it to the corresponding application program on the destination host. It also called an end-to-end logical connection to gets the message from the application layer, encapsulates it in a transport layer packet, called a *segment* or *user datagram*.
- **Application Layer** is responsible for exchange message of the logical connection between two application layers through a bridge. Communication at the application layer is between two processes; where a process sends a request to the other process and receives a response, also called process-to-process communication.

## Encapsulation and Decapsulation



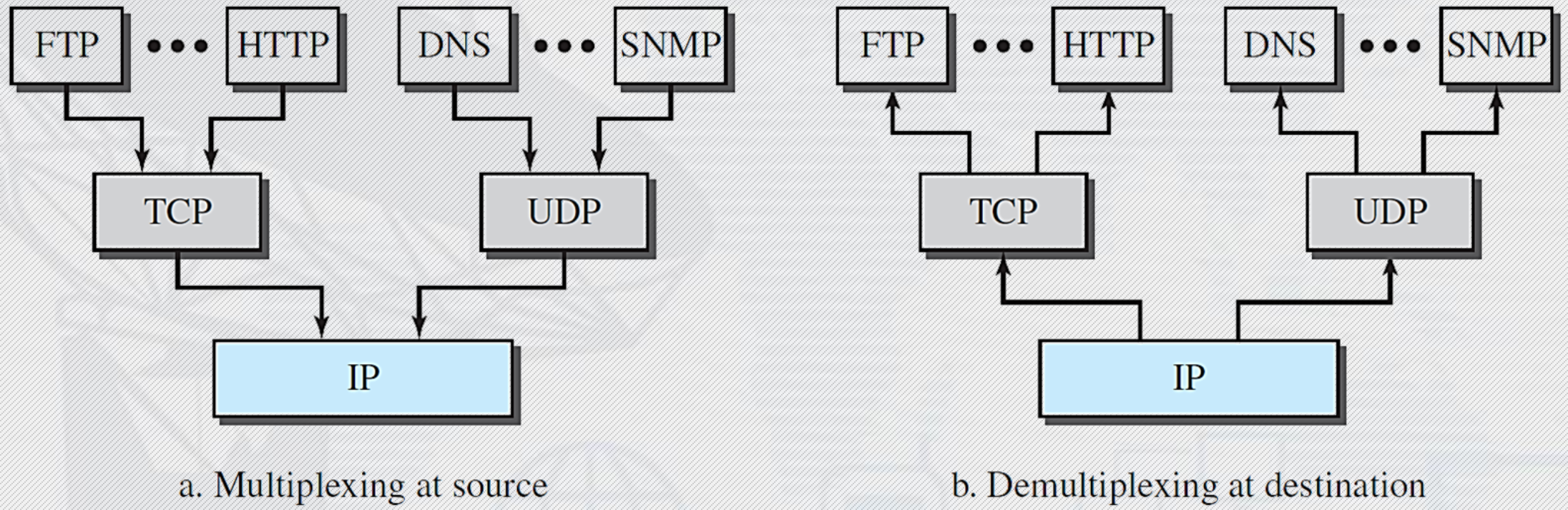
## Addressing

- Any communication that involves two parties needs two addresses: source address and destination address. Except the physical layer doesn't need the addresses; the unit of data exchange is a bit which definitely cannot have an address.




Addressing in the TCP/IP protocol suite

## Multiplexing and Demultiplexing




a. Multiplexing at source

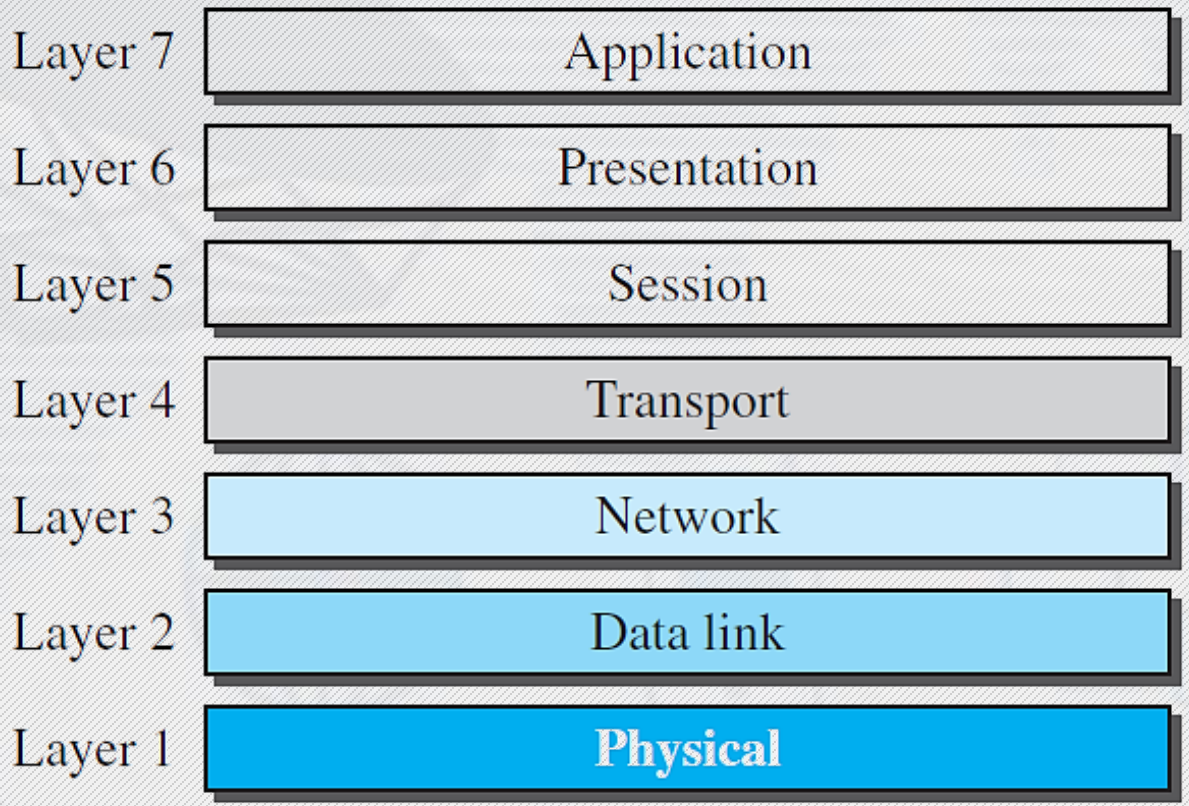
b. Demultiplexing at destination

Multiplexing and demultiplexing

# 5. THE OSI MODEL

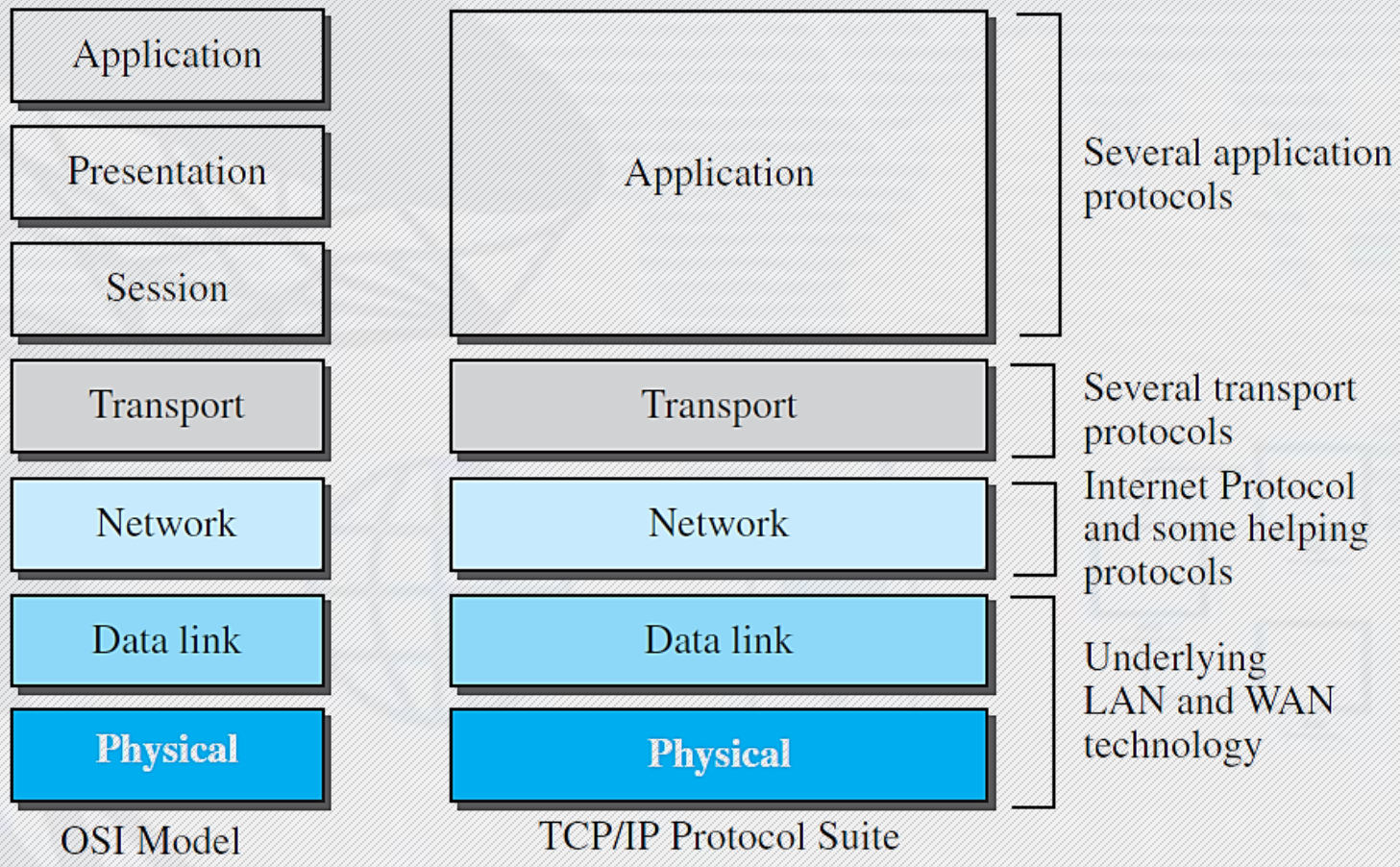


- The purpose of OSI model is to show how to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software.
- It is a model for understanding and designing a network architecture that is flexible, robust, and interoperable.



## OSI vs TCP/IP

- There are two layers, session and presentation, are missing from the TCP/IP protocol suite and the application layer in the suite is considered to be combination of the three layers in the OSI model.



## Lack of the OSI Model's Success

- Most experts were at first excited and thought that the TCP/IP protocol would be fully replaced by the OSI model and it did not happen for several reason:
  - OSI was completed when TCP/IP was fully in place and a lot of time and money had been spent on the suite.
  - Some layers in the OSI model were never fully define. Actually, the presentation and session layers were not fully define, nor were they fully describe, and the corresponding software was not fully developed.
  - When OSI was implemented by an organization in a different application, it did not show a high enough level of performance to entice the Internet authority to switch from the TCP/IP protocol suite to the OSI model.

## Data Communications

- Data communications are the transfer of data from one device to another via some form of transmission medium; and must transmit data to the correct destination in an accurate and timely manner.
- The five components that make up a data communication system are message, sender, receiver, medium, and protocol. Data flow between two devices can occur in one of three ways: simplex, half-duplex, or full-duplex.

## Network Models

- TCP/IP is a hierarchical protocol suite made of five layers: **physical layer**, **data-link layer**, **network layer**, **transport layer**, and **application layer**.
- Four levels of addresses are used in an internet following the TCP/IP protocols: physical (link) addresses, logical (IP) addresses, port addresses, and specific addresses.

# 7. HOMEWORK



1. What are three criteria necessary for an effective and efficient network?
2. What are the difference between half-duplex and full-duplex transmission modes?
3. Why are protocols needed?
4. What are some of the factors that determine whether a communication system is a LAN or WAN?
5. Assume six devices are arranged in a mesh topology. How many cables are needed? How many ports are needed for each device?
6. A host communicates with another host using the TCP/IP protocol suite. What is the unit of data sent or received at each of the following layer?

   a. Application Layer b. Network Layer c. Data-Link Layer

7. Match the following to one or more layers of the TCP/IP protocol suite:

   a. Creating user datagram

   b. Responsibility for handling frames between adjacent nodes

   c. Transforming bits to electromagnetic signals

# Thank you!

# Any Question?